TM 5-286

WAR DEPARTMENT TECHNICAL MANUAL

SEMIPERMANENT HIGHWAY AND RAILWAY TRESTLE BRIDGES

WAR DEPARTMENT *APRIL 1945*

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PART ONE

GENERAL

CHAPTER 1

SCOPE OF MANUAL

1. PURPOSE. a. This manual gives technical information on semipermanent highway and railway trestle bridges. It covers their construction from advance planning to actual fabrication and erection. It is designed as a source of detailed instructions and drawings for particular structures in the field as well as a reference handbook and text for training.

b. The standard designs in this manual are intended to replace nonstandard designs and reduce design work in the field to a minimum. Therefore, the manual does not discuss design *methods*. Where field-designed bridges are to be constructed, reference should be made to FM 5–10, for appropriate design methods.

2. ORGANIZATION OF MANUAL. a. Text. The text covers procedure for selecting location, type and length of spans, and type and height of supports. It explains methods of fabricating steel, of framing timber, and of erecting steel and timber bridges. It describes special tools and construction equipment used, and gives instructions for maintenance and repair of bridges.

b. Drawings. General drawings show assembly of parts in standard units of construction. Detail drawings cover fabrication of steel parts and cutting and framing of timber parts from stock materials. General and detail drawings are given for special equipment that can be made in the field for erecting high towers and long spans.

c. Tables. Tables on drawings list specific materials used in each unit of construction. Tables in text list materials, quantities, tool and equipment requirements, and give time and labor estimates for different units of construction and for different combinations of construction units used in completed bridges.

d. Appendix. The appendix includes guides to design of plate girders, information on truck- and crawler-mounted cranes, and construction equipment, cofferdam details for foundation repairs in water not over 10 feet deep, and useful tabular data.

3. USE OF MANUAL. a. General Background. General information on the bridges is given in Part One. This includes general description of the bridges, advance planning data for staff use, design specifications and limitations, and information on capacities and traffic control.

b. Planning. Three phases of planning are discussed in different parts of the manual:

(1) Advance staff planning to determine theater stockage or task force requirements is treated in chapter 3.

(2) Site selection, bridge lay-out, and detailed construction plans for the benefit of the engineer section and commanders responsible for construction are discussed in chapters 6 to 9.

(3) Erection schemes that may be used by construction officers are dealt with in chapter 14.

TABLE I. *Range of bridge spans, supports, and foundations for semipermanent trestle bridges*[1]

Construction	Highway bridges		Railway bridges	
	Timber Stringers	Steel Stringers	Timber Stringers	Steel Stringers
Spans: Material		15', 20', 30', 40', 50'	12', 14', 16'	15', 20', 25', 30', 35'
Designs for span length	11', 13', 15'	60', 70', 80', 90'		40', 45', 50'
Intermediate pile bents and piers:				
Timber pile bents	30'	No design[3]	30'	No design
Timber pile piers[5]	Not shown[2]	30'	Not shown	15'
Steel pile bents[5]	Not shown	30'	Not shown	23'
Steel pile piers	Not shown	35'	Not shown	23'
Timber towers:	80'	80'	80'	80'
On spread footings	Concrete pedestals; Timber grillage			
On timber piling	Timber sills; Concrete pedestals, not shown			
On steel piling	Timber sills, no design; concrete pedestals, not shown			
Steel towers: On spread footings	No design	80'; Concrete pedestals; Steel grillage	No design	80'; Concrete pedestals; Steel grillage
On timber piling		Concrete pedestals		Concrete pedestals
On steel piling		Concrete pedestals; Steel framed caps		Concrete pedestals; Steel framed caps
Abutments with end dam:	6'[4] Not shown	6' Concrete	6' Not shown	6' Concrete
On spread footing	Timber grillage and end dam			15' span: Timber grillage and end dam; Over 15' span: No design
On timber piles	Pile bent and timber end dam			Up to 25' span: Pile bent and timber end dam; Over 25' span: Pile pier
On steel piles	Not shown	Steel pile bent and timber end dam	Not shown	Steel pile bent and timber end dam

[1] Maximum height from ground to grade is shown for the different types of support.
[2] "Not shown" indicates that this type of support is not normally used for these spans, although designs are prepared which could be applied.
[3] "No design" indicates that this type of support as designed cannot be used for these spans.
[4] Maximum height of retained fill.
[5] See table XVII for height limitations on pile bents and piers.

c. Construction. Preliminary work, details of fabrication and assembly, methods of erection, and erection equipment are discussed in chapters 10 to 16. Design drawings in Part Six include necessary working drawings for fabrication and assembly. Tables accompanying the text give material and man-hour requirements.

d. Maintenance and repair. Maintenance and repair are covered in Part Three.

4. RELATED PUBLICATIONS. a. General.

Engineer Troops .... FM 5–5
Operations of Engineer Units .... FM 5–6
Construction and Routes of Communication .... FM 5–10
Explosives and Demolitions .... FM 5–25
Reference Data .... FM 5–35
Rigging and Engineer Hand Tools .... TM 5–225
Carpentry .... TM 5–226
Topographic Drafting .... TM 5–230
Surveying .... TM 5–235
Interpretation of Aerial Photographs .... TM 5–246
Construction in the Theater of Operations .... TM 5–280
Standard Plans—Roadway, Track, and Structures .... TM 55–276

b. Fixed bridge equipment.

Portable Steel Highway Bridges, H–10 and H–20 .... TM 5–274
Fixed Steel Panel Bridge, Bailey type .... TM 5–277

Semipermanent Highway Steel Fixed Bridges, 30-, 60-, and 90-foot Spans .... TM 5–285
I-Beam Railway Bridge .... TM 5–371

c. Erection equipment. See FM 21–6 for list of latest War Department publications covering operation, repair, and lubrication of engineer mechanical equipment and special tools.

CHAPTER 2

GENERAL DESCRIPTION OF BRIDGES

5. PURPOSE OF BRIDGES. a. The semipermanent highway and railway trestle bridges described in this manual are intended primarily for use in:

(1) Replacing existing temporary or inadequate bridges.
(2) Crossing gaps on new lines of communication.

b. These bridges usually replace:

(1) Temporary earth-filled bypasses.
(2) Temporary bridges with structural limitations.
(3) Demolished bridges temporarily repaired.
(4) Portable tactical bridges needed for operations farther forward.

6. LOAD CLASSIFICATION AND WIDTH OF BRIDGES. a. Highway bridge designs in this manual are for semipermanent bridges of the following U. S. load classes and widths:

Class 50, single-lane, 12½-foot roadway .... (sheets 1–43)
Class 50, double-lane, 22-foot roadway .... (sheets 44–90)
(Also used as class 80 single-lane bridge)
Class 25, double-lane, 22-foot roadway .... (sheets 91–127)

b. Railway bridge designs are for only one class of semipermanent bridge: E–45, single-track, 4-foot 8½-inch and narrower gauges (sheets 156–225)

c. The class 50 double-lane bridge is adequate for single-lane class 80 traffic. Traffic control conditions under which other bridges can carry loads beyond their rated weight-class are given in chapter 5.

d. Twenty-percent reduction in capacity is required if machine bolts are substituted for rivets or structural ribbed bolts in certain steel construction units. (See par. 224.)

7. TRESTLE BRIDGE NOMENCLATURE. This paragraph gives nomenclature of the principal parts of a trestle bridge as used in this manual. For other terms see index.

Braced bents. Pile bents connected by longitudinal bracing. (See fig. 16.)

Framed bent. A single transverse row of timber columns connected by transverse bracing and a cap and sill. Two or more framed bents connected by longitudinal bracing form a framed tower. (See fig. 10).

Grade. Elevation of top of tread on highway bridges, or top of cross tie on railway bridges.

Pile bent. A support consisting of a single transverse row of piles connected by transverse bracing and a cap. (See fig. 1.)

Pile pier. A support consisting of pile bents connected by longitudinal bracing and corbels or diaphragms. (See fig. 5.)

Table II. *Illustrations of combinations of units for trestle bridges.*

Combination	Single-lane highway class 50	Double-lane highway class 50	Double-lane highway class 25	Railway E–45
PILE FOOTINGS				
Timber-stringer spans, timber pile bents.	Fig. 1	Fig. 2		Fig. 15
Steel-stringer spans steel pile bents.	Fig. 3	Fig. 4	Fig. 4	Fig. 16
Steel-stringer spans, timber pile piers.		Fig. 5		Fig. 17
Steel-stringer spans, steel pile piers.	Fig. 6	Fig. 7	Fig. 7	Fig. 18
Steel-stringer spans, framed timber towers, timber sill, timber piles.		Fig. 8(1), Fig. 8(2)		Fig. 19(1)
Steel-stringer spans, framed steel towers, concrete pedestal, timber piles.		Fig. 9(1)	Fig. 9(1)	Fig. 20(2)
Steel-stringer spans, framed steel tower, concrete pedestal, steel piles.		Fig. 9(2)	Fig. 9(2)	Fig. 20(3)
Steel-stringer spans, framed steel tower, steel frame, steel piles.				Fig. 20(1)
Timber-stringer spans, framed timber towers, timber sill, timber piles.	Fig. 10(2)	Fig. 11(1)		Fig. 21(1)
SPREAD FOOTINGS				
Timber-stringer spans, framed timber towers, concrete pedestals.	Fig. 10(3)			Fig. 21(2)
Steel-stringer spans, framed timber towers, concrete pedestals.	Fig. 12		Fig. 13	Fig. 19(2)
Steel-stringer spans, framed steel tower, concrete pedestals.		Fig. 9(3)	Fig. 9(3)	Fig. 20(4)
Timber-stringer spans, framed timber tower, timber grillage.	Fig. 10(1)	Fig. 11(2)		Fig. 21(3)
Steel-stringer spans, framed timber tower, timber grillage.		Fig. 8(3)		Fig. 19(3)
Steel-stringer spans, framed steel tower, steel grillage.	Fig. 14			Fig. 20(5)

Span. The distance between two supports holding up a structure. Also used to mean *superstructure.*

Substructure. The parts of a structure which provide support for the superstructure.

Superstructure. The part of a structure above and between supports. Also called *span.*

Tower. Two or more framed timber or steel bents tied together by bracing to form a supporting unit for spans. Towers are supported on timber, concrete, or steel foundation units.

Trestle bridge. A structure consisting of a series of supports and decked stringer spans.

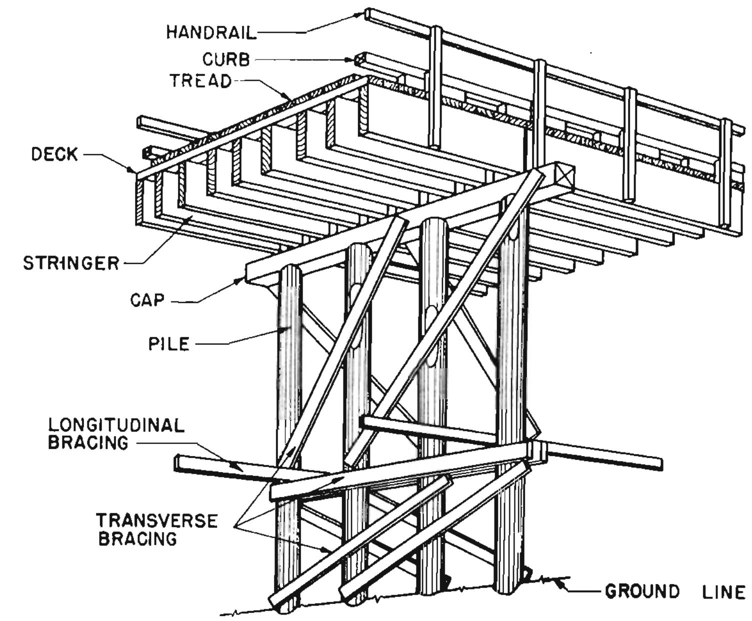


Figure 1. Highway bridge, class 50, single-lane, timber stringers on timber pile bent.

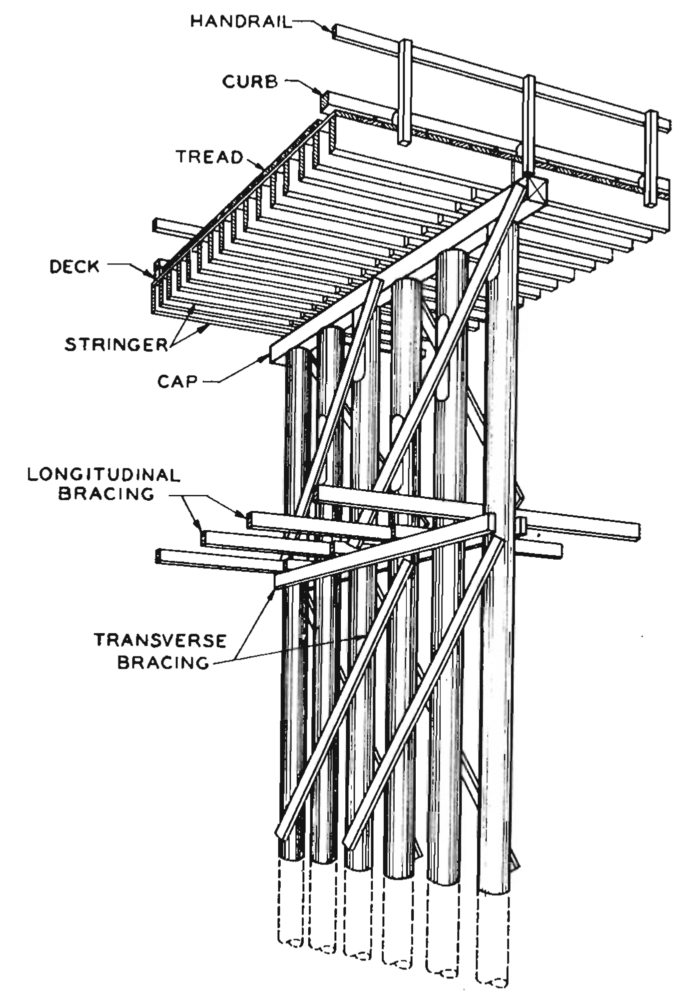


Figure 2. Highway bridge, class 50, double-lane, timber stringers on timber pile bent.

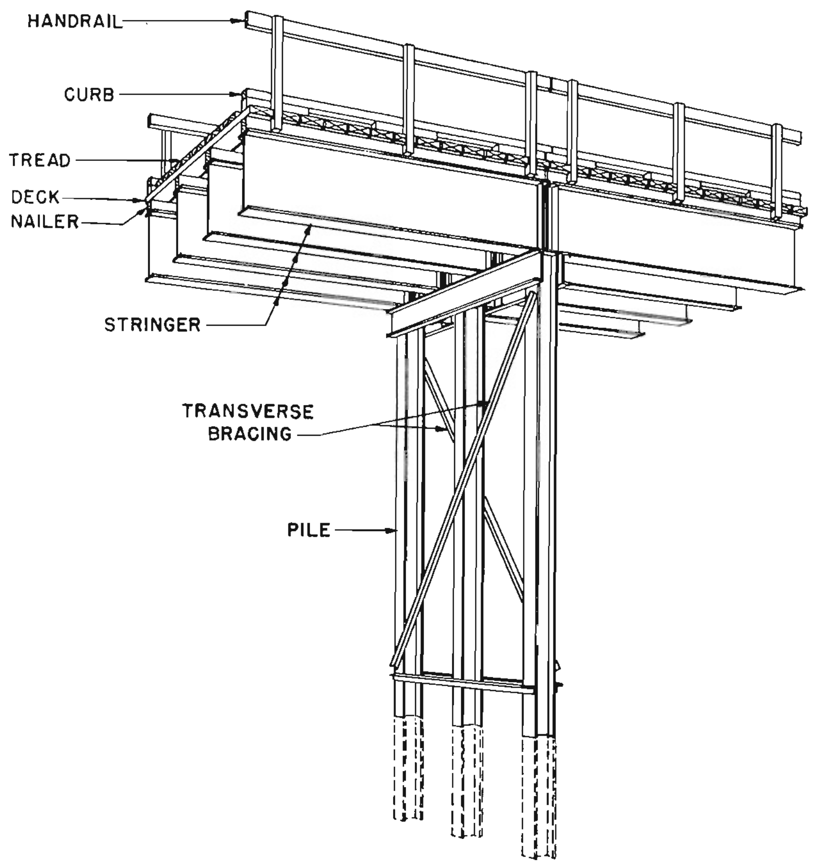


Figure 3. Highway bridge, class 50, single-lane, steel stringers on steel pile bent.

Unit of construction. A structural assembly consisting of a span, a support, or a foundation. Units of construction are combined to make a bridge. Interchangeable designs for each of the three classes of construction unit are given in this manual. The proper selection and combination of construction units are discussed in chapters 3 and 7.

8. TYPES OF CONSTRUCTION. a. General. (1) All bridges in this manual are trestle type bridges. Complete drawings of units of construction (par. 7) are furnished for various spans, supports, and foundations. Types of units of construction covered in this manual are listed below. Principles governing selection of different types of construction units are given in paragraph 17.

(2) Construction units are combined as specified in table I to provide bridges of standard load class and width. (See par. 6.) These bridge types are shown in figures 1 to 21. (See table II.)

(3) For a particular bridge site, suitable foundations, supports, and spans are combined into a single- or multiple-span trestle bridge. Typical highway and railway bridge lay-outs for typical gaps are described in chapter 9.

b. Spans. Units of construction for spans are of two types:

Type	*Maximum span (ft.)* *Highway*	*Railway*
(1) Timber stringer	15	16
(2) Steel stringer	90	50

Standard span lengths of each type are given in table I.

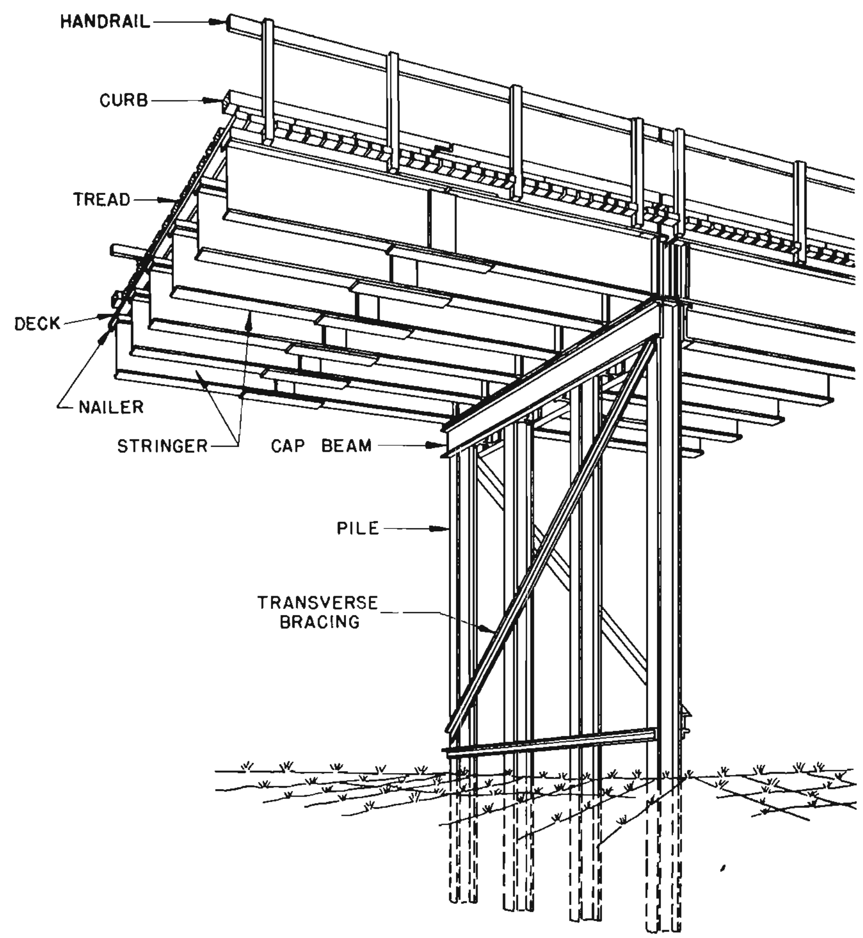


Figure 4. Highway bridge, class 50, double-lane, steel stringers on steel pile bent; class 25 similar except 3 piles in bent.

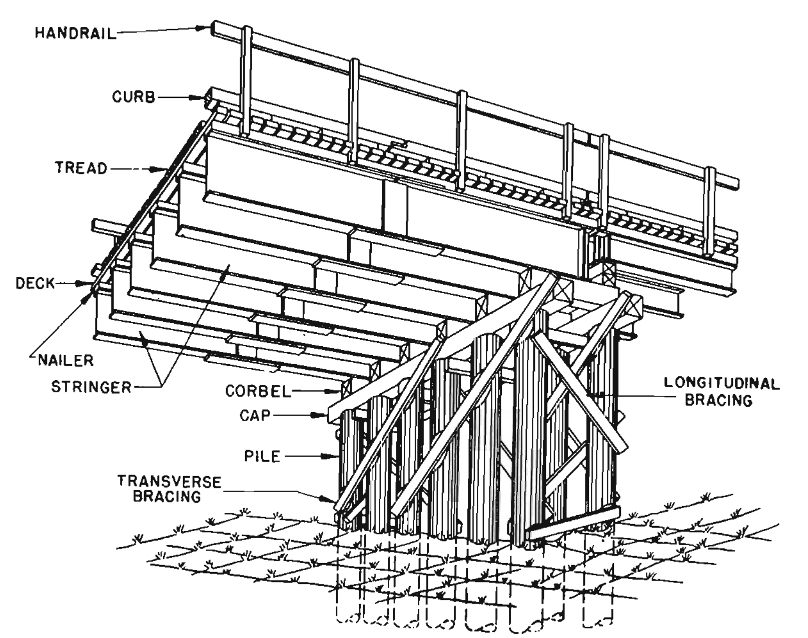


Figure 5. Highway bridge, class 50, double-lane, steel stringers on timber pile pier.

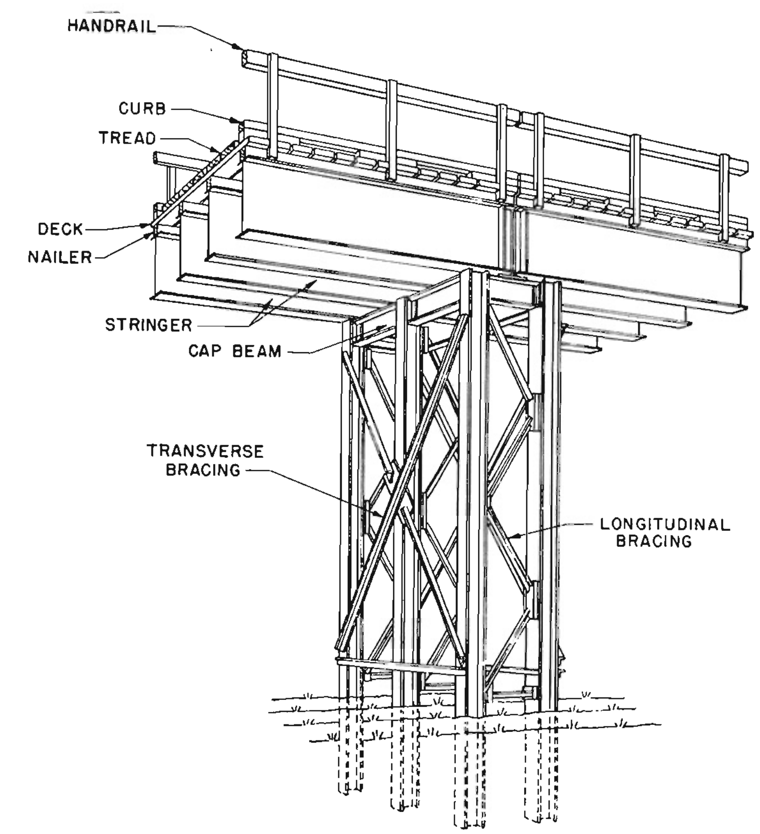


Figure 6. Highway bridge, class 50, single-lane, steel stringers on steel pile pier.

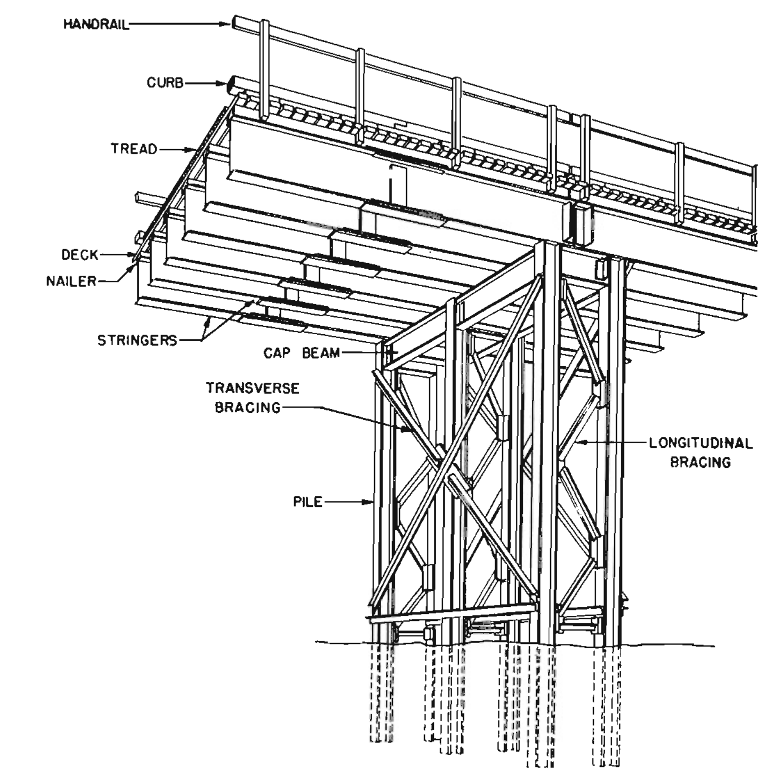


Figure 7. Highway bridge, class 25 or class 50, double-lane, steel stringers on steel pile pier.

c. Supports. Units of construction for supports are of the following types:

	Type	Maximum safe height from grade to ground (ft.)		Maximum height detailed on drawings, ground to bottom of stringers (ft.)	
		Highway	Railway	Highway	Railway
(1)	Timber pile bents	30	30	28	28
(2)	Timber pile piers	30	15	14	11½
(3)	Steel pile bents	30	23	20	20
(4)	Steel pile piers	35	23	20	20
(5)	Framed timber towers	80	80	76	76
(6)	Steel towers	80	80	77	77
(7)	Timber grillage abutment	6[1]	6[1]	4	4
(8)	Timber pile abutment	6[1]	6[1]	4	4
(9)	Steel pile and timber abutment	6[1]	6[1]	4	3½
(10)	Concrete abutment	6[1]	6[1]	4½	4½

[1] Height of fill retained behind abutment.

The types of spans and range of span lengths with type and limiting height of supports are given in table I. For limitation of span length bv high supports, see paragraph 223*e*.

d. Foundations. Units of construction for foundations under both highway and railway towers are of the following types:

Type

(1) Timber grillage.
(2) Steel grillage.
(3) Concrete pedestals on ground.
(4) Timber piles and timber sills.
(5) Timber piles capped with concrete pedestals.
(6) Steel piles capped with concrete pedestals.
(7) Steel piles capped with steel frames.

The types and ranges of spans and supports for each type of foundation are given in table I.

9. FEATURES OF DESIGN. a. Standardization. Use of the standard designs in this manual for construction of the four standard bridge classes in paragraph 6 is intended to:

(1) Eliminate structural design work and capacity estimation in the field.
(2) Provide balanced designs which save materials and construction time.
(3) Utilize available stock-pile materials.
(4) Reduce to a minimum the variety of sizes, shapes, and types of material required.
(5) Simplify planning, stock piling, erection, and maintenance.
(6) Indicate the necessary scope of training for construction of semipermanent trestle bridges.

b. Flexibility. Designs are provided for widely different conditions. Units of construction can be combined to satisfy different requirements at different points on the same bridge. Selection of the type of construction best-suited to conditions in the theater is simplified by tables V to VIII. Wide deviations of final construction from original advance staff approximations or from bridge lay-out to meet unforeseeable or difficult conditions are possible because of

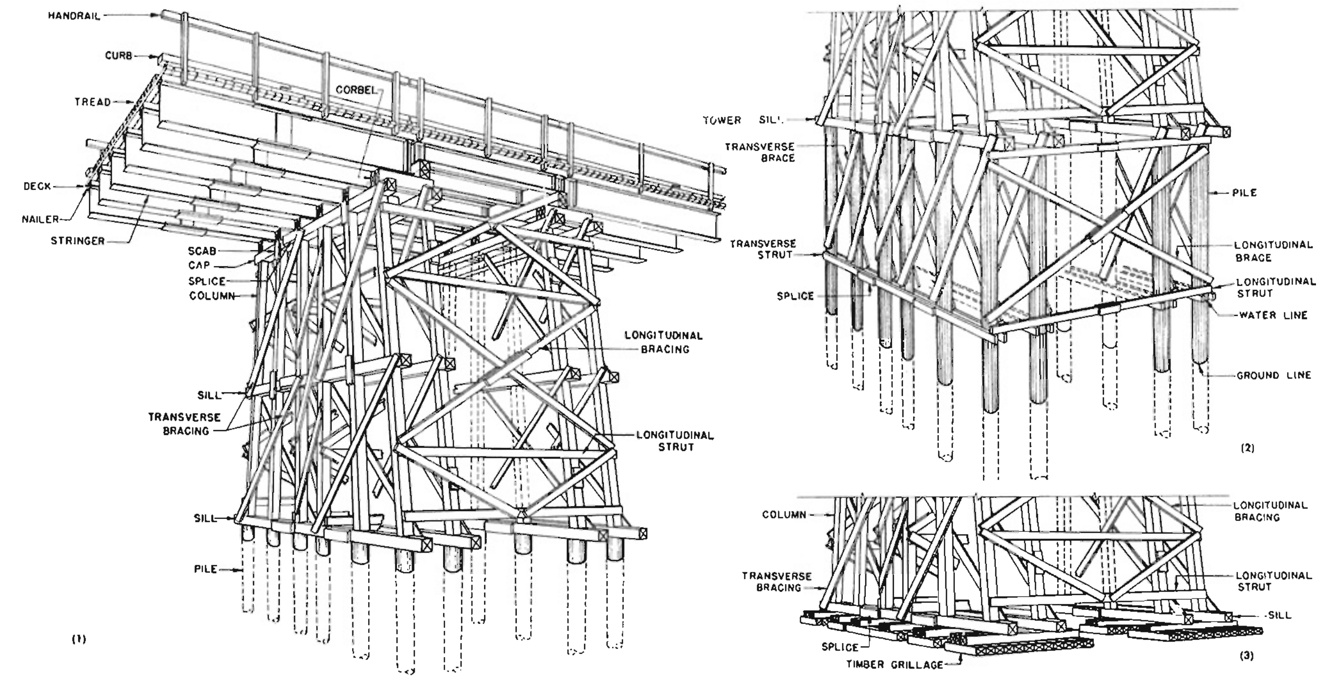


Figure 8. Highway bridge, class 50, double-lane, steel stringer spans, framed timber tower:

(1) On timber piles constructed on ground or in shallow water.
(2) On braced timber piles constructed in deep water.
(3) On timber grillages.

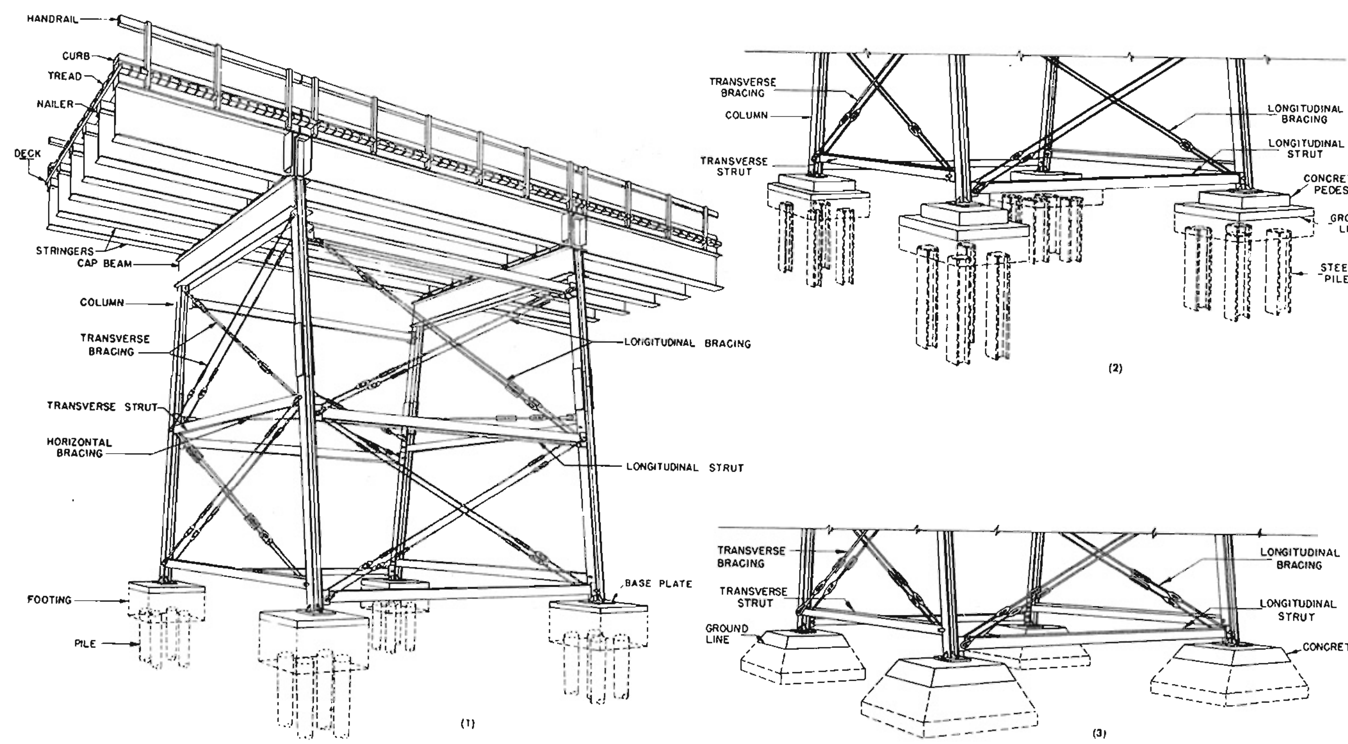


Figure 9. Highway bridge, class 25 or class 50, double-lane, steel stringer spans, steel tower:

(1) On concrete pedestals, timber piles.
(2) On concrete pedestals, steel piles.
(3) On concrete pedestals.

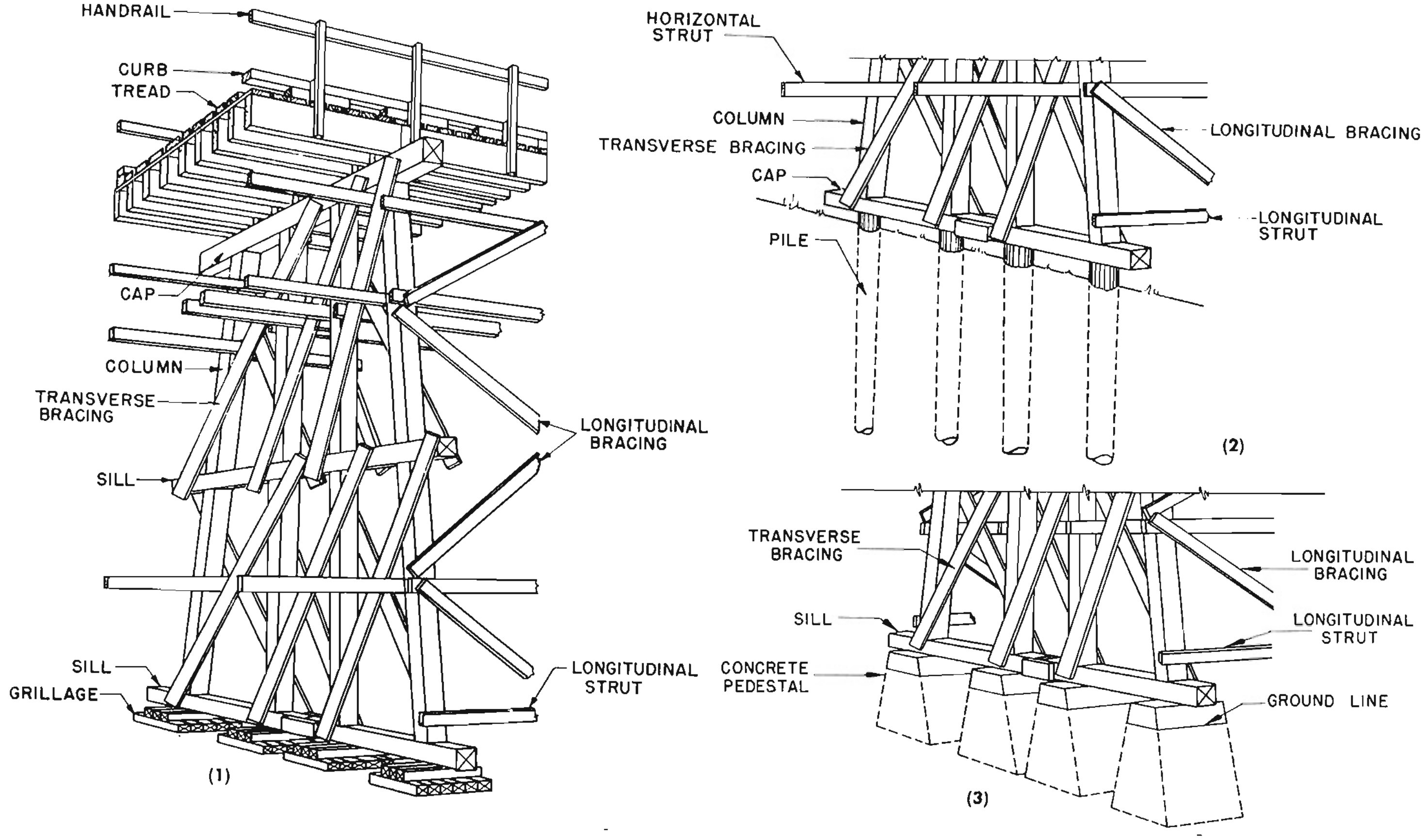


Figure 10. Highway bridge, class 50, single-lane, timber stringer spans, framed timber tower:

(1) On timber grillages.
(2) On timber sills, timber piles.
(3) On concrete pedestals.

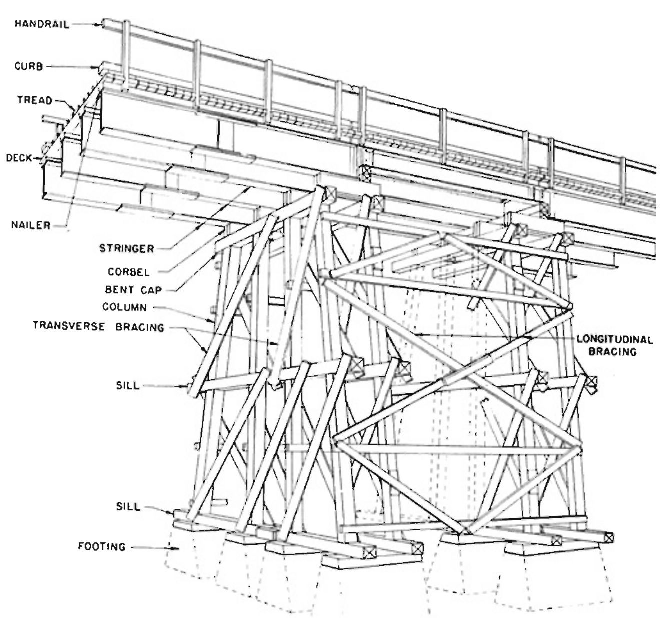


Figure 12. Highway bridge, class 50, single-lane, steel stringer spans, framed timber tower on concrete pedestals.

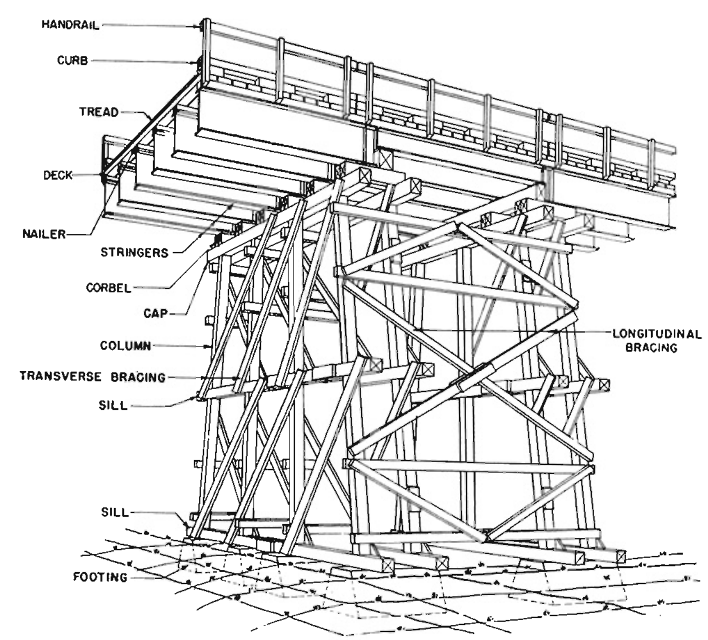


Figure 13. Highway bridge, class 25, double-lane, steel stringer spans, framed timber tower on concrete pedestals.

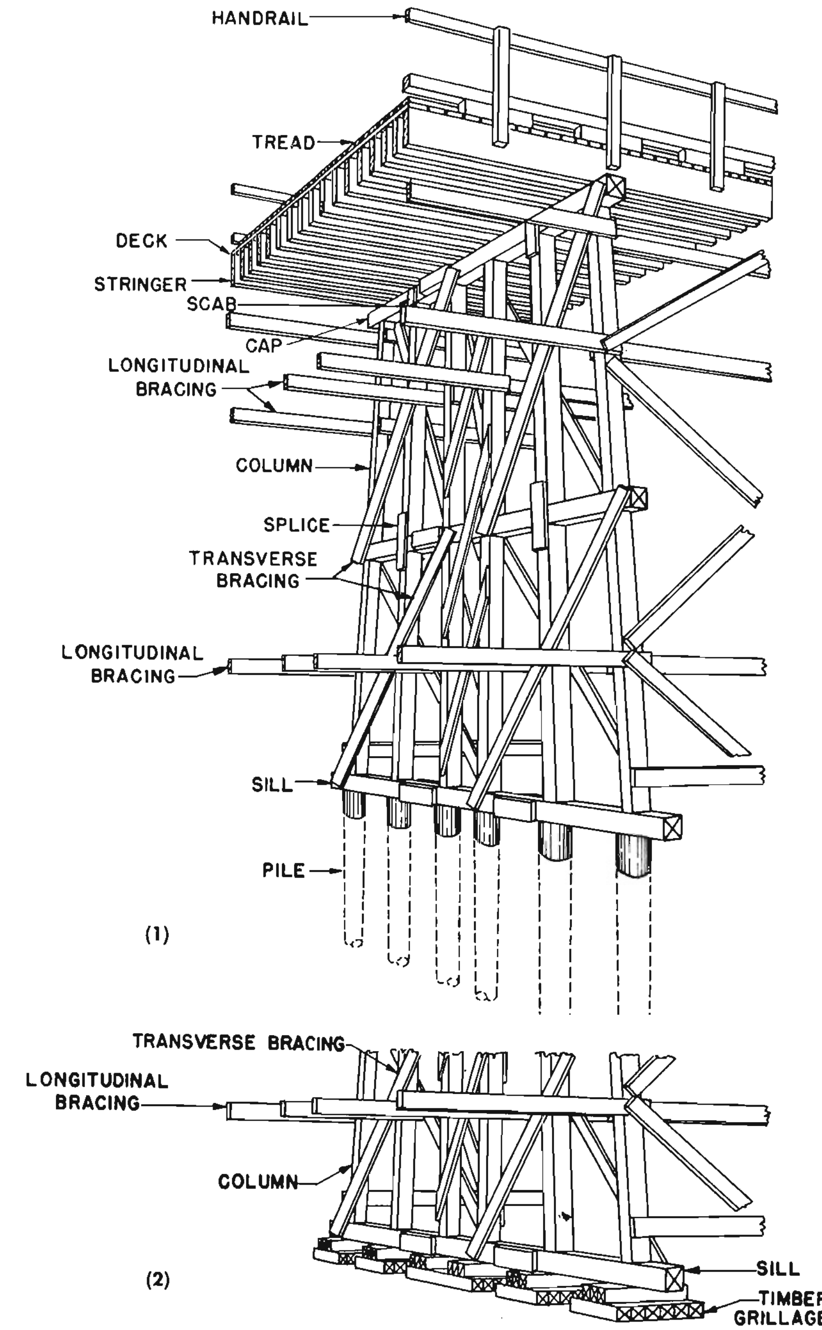


Figure 11. Highway bridge, class 50, double-lane, timber stringer spans, framed timber tower:

(1) On timber sills, timber piles.
(2) On timber grillages.

flexibility of designs, use of identical sections in different units of construction, and provision of alternative designs.

c. Economy of materials. Economy of materials results from balanced design of units of construction, use of materials commonly available locally, and flexibility of designs.

10. DESIGN LIMITATIONS. a. Semipermanent bridges. (1) Bridges in this manual are classed as *semipermanent* bridges which differ in design from *civilian* bridges and *tactical* bridges.

(2) The following design restrictions distinguish semipermanent bridges from civilian structures:

(*a*) Designs are for specific military load limits and for controlled traffic. (See ch. 5.)

(*b*) Allowable stresses are greater than normally used in civilian practice. (See ch. 4.)

(3) The following characteristics distinguish semipermanent bridges from most tactical bridges:

(*a*) Designs are for standard load classes and roadway widths (par. 6) which usually exceed the frequently critical clearance and load capacity of tactical bridges.

(*b*) Bridges are not temporary structures. They are not intended to be dismantled for use farther forward in the combat zone as front lines advance.

(*c*) Erection time generally is greater than for tactical bridges.

(*d*) Transportation requirements generally exceed those for tactical bridges because larger and heavier units are used.

(*e*) More deliberate erection methods and special erection equipment and tools not organic in engineer troops units are required.

(4) The semipermanent trestle bridges in this manual are also distinguished from *prefabricated* semipermanent bridges such as the H20 box-girder steel fixed bridge or the semipermanent highway bridge, 30-, 60-, and 90-foot spans. The bridges in this manual are not issued prefabricated, but are fabricated in the field from class IV materials (par. 12) so span length and height of supports can be varied in small increments and various types of construction can be used to suit the site. However, the supports described in this manual can be adapted for use with *prefabricated* semipermanent spans. (See par. 11.)

b. Stream characteristics. The bridges in this manual are suitable for crossing shallow tidal waters, shallow streams, deep streams not over 80 feet wide, and deep valleys or ravines. They are not intended for use where foundations must be constructed in deep water, where drift or ice is heavy, scour is excessive, or where large flood flows are frequent.

c. Unbraced lengths of pile foundations. Bridges with pile foundations can be built in water where the unbraced length of piles from *firm* stream-bed material to the lowest point of bracing, *with allowance for probable scour* (par. 75), does not exceed the following:

Distance grade to ground (ft.)	*Maximum unbraced length of pile (ft.)*
Less than 30	20
30 to 50	15
50 to 80	10

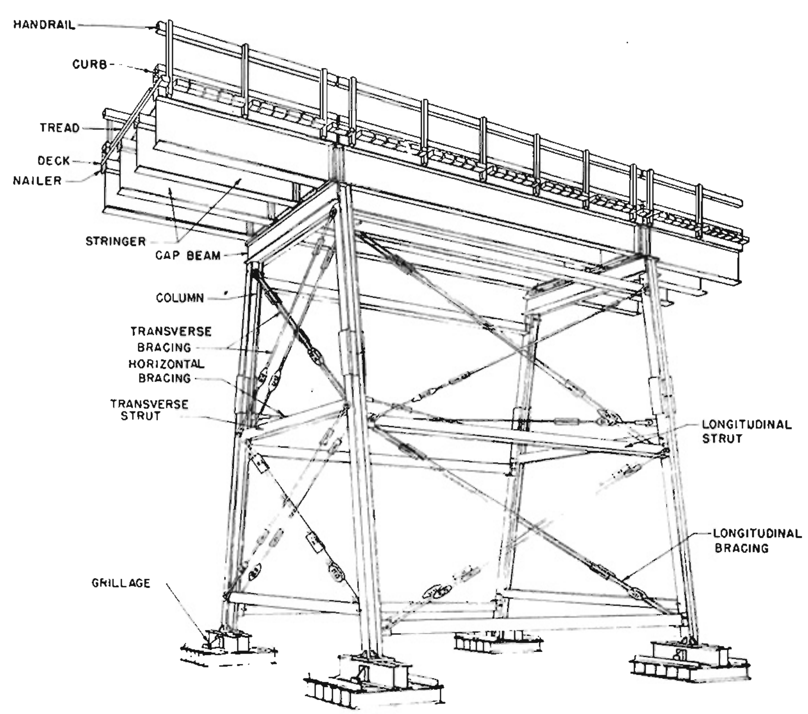


Figure 14. Highway bridge, class 50, single-lane, steel stringer spans, steel tower on steel grillages.

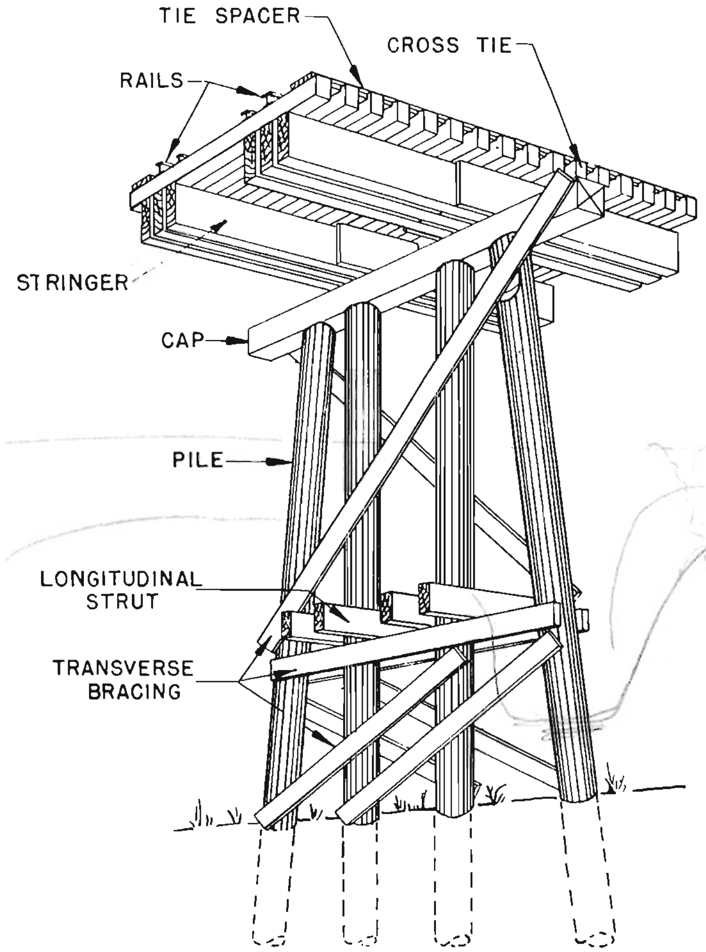


Figure 15. Railway bridge, timber stringers on timber pile bents.

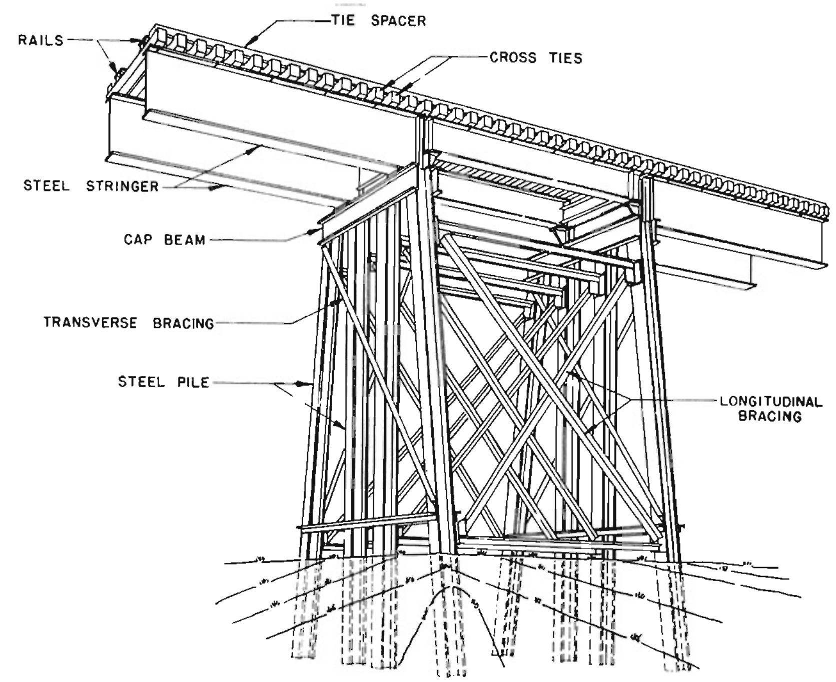


Figure 16. Railway bridge, steel stringers on braced steel pile bents.

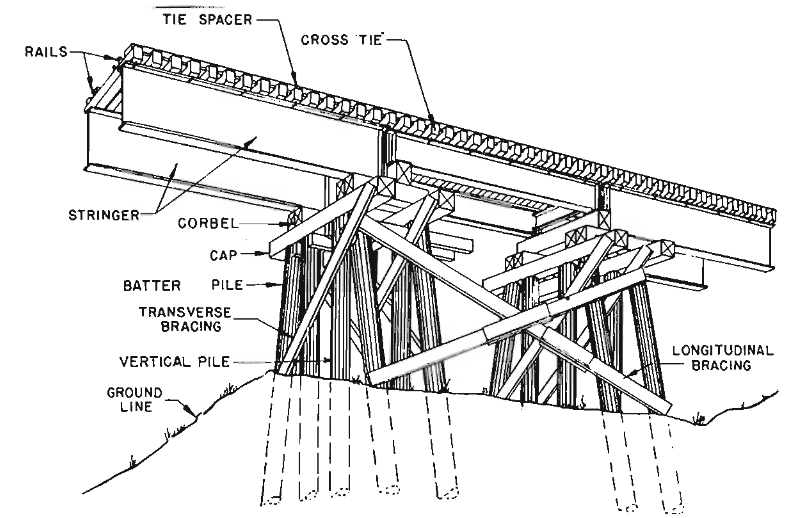


Figure 17. Railway bridge, steel stringers on braced timber pile piers.

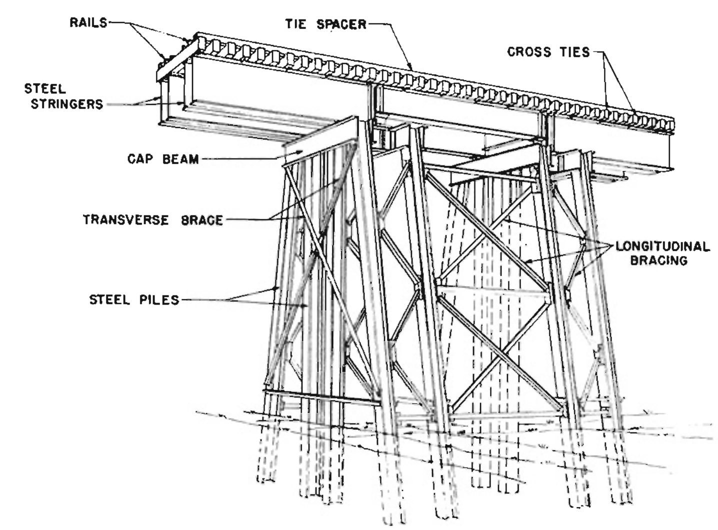


Figure 18. Railway bridge, steel stringers on braced steel pile piers.

11. DESIGN ALTERNATIVES, MODIFICATIONS, AND ADAPTATIONS.

a. General. This manual does not include design methods. Changes in designs should not be made except by qualified engineer officers trained in bridge design. Design methods are specified in FM 5–10.

b. Alternatives. Data on alternative nonstandard connections, decking, and stringer sections are given in chapter 18.

c. Modifications. The standard designs show level grades, straight alignment, and symmetrical towers. Chapter 18 gives methods of modifying designs for grades, curved alignment, and sloping banks. Grades on structures are limited to normal operating grades.

d. Adaptations. (1) Details are given (sheets 235 to 245) for adapting substructure units to the following standard prefabricated highway superstructures:

(*a*) Semipermanent highways, steel fixed bridges, 30-, 60-, and 90-foot spans (TM 5–285).

(*b*) Panel steel fixed bridge, Bailey-type (TM 5–277).

(*c*) Box-girder steel fixed bridges, H10 and H20 (TM 5–274).

(2) By modifying the end bearings of the I-beam railway bridges (TM 5–371), they can be used with any of the standard railway supports in this manual, except timber pile bents. The unit construction railway bridge (spans 50 to 85 feet) (TM 5–372) and through truss railway bridge (spans 90 to 150 feet) (TM 5–373) cannot be used on any of the railway supports in this manual. They must be supported respectively on light standard (L-type) and standard (T-type) unit steel trestles (TM 5–374) or on specially designed piers.

12. MATERIALS AND EQUIPMENT. a. Class IV supplies. Bridges in this manual can be fabricated in the field from class IV material and with organic equipment normally issued to engineer troops or class IV tools and equipment available in communications zone depots.

b. Timber. Designs use timber in:

(1) All bridge flooring, curbs, and handrails.
(2) Stringers up to 16-foot spans.
(3) Framed bents and towers under all spans.
(4) Pile bents, piers, and foundation piles.
(5) Abutments under all spans.
(6) Grillages under timber towers.

c. Structural steel. Designs are prepared for steel furnished in 40-foot lengths. Designs use steel in:

(1) Stringers in spans.
(2) Framed steel towers.
(3) Pile bents and pile piers.
(4) Abutments.
(5) Grillages under towers.
(6) Steel frame on steel piles.

d. Concrete. Reinforced concrete is not used in these bridge designs. Designs use unreinforced concrete in:

(1) Abutments.
(2) Foundation pedestals on ground under:
(*a*) Framed timber towers.
(*b*) Framed steel towers.
(3) Grout under steel grillages.
(4) Pedestals supported on timber or steel foundation piles.

e. Hardware. Black, unpainted hardware is used throughout.

f. Paint. Semipermanent bridges are painted only when necessary for

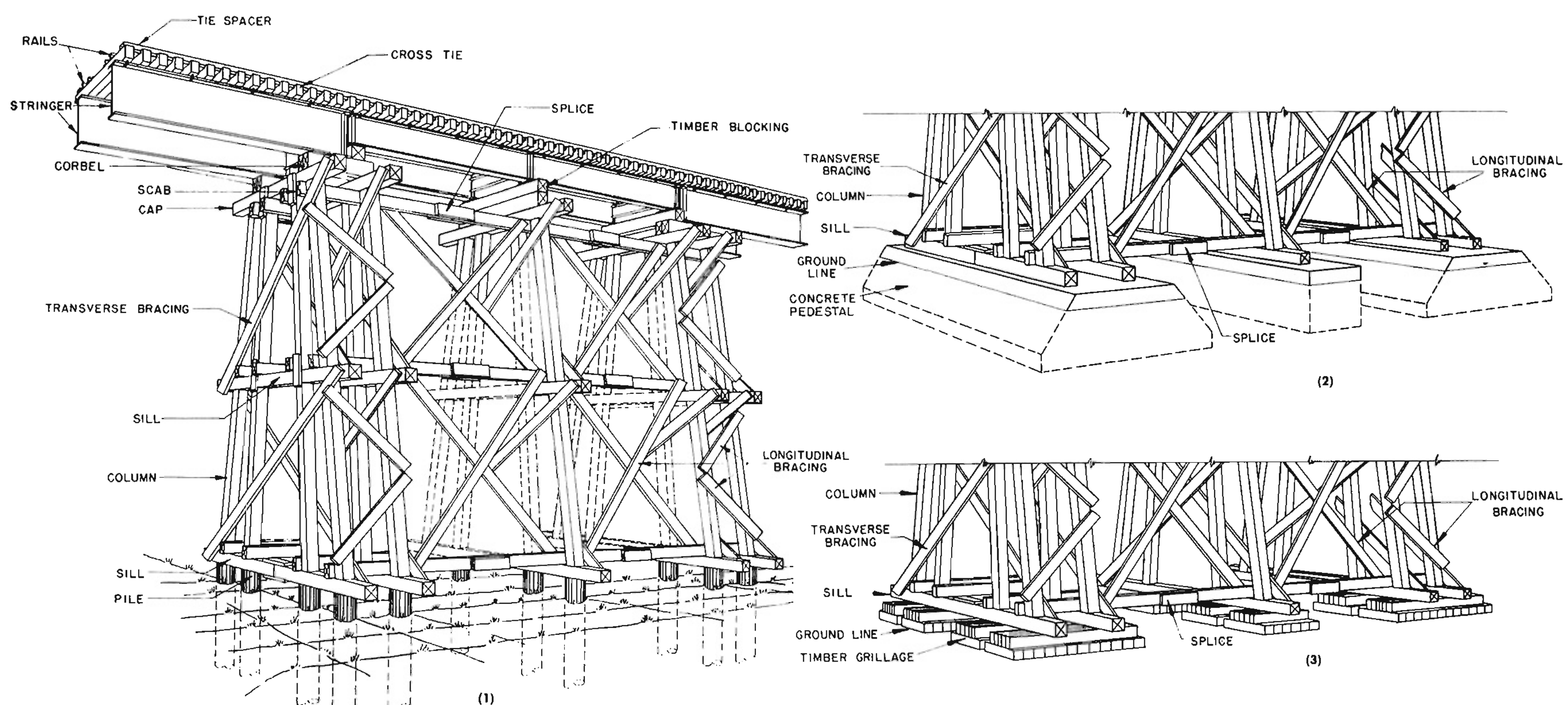


Figure 19. Railway bridge, steel stringer spans, framed timber tower.

(1) On timber sills, timber piles.
(2) On concrete pedestals.
(3) On timber grillages.

TABLE III. *Sizes, lengths, and principal uses of timber in semipermanent bridges.*

Size (inches)	Length (feet)	Use
12 x 12	10, 12, 14, 16, 18 or random	Pile bent and pier cap
10 x 12	12, 20, or random	Class 25 tower cap. Blocking under stringers
10 x 10	12, 14, 16, 18, 20, 22, or random	Tower caps and sills. Columns. Abutment cap
8 x 12	16, 20, or random	Corbels on piers and double bents
8 x 10	Random	Blocking under stringers
8 x 8	8, 12, 14	Abutment bulkhead posts
6 x 18	16	Railway stringer, 14- and 16-foot span
6 x 16	16	Highway stringer
6 x 12	10, 12, 16, or random	Blocking under stringers
6 x 10	12, 14, 16, 18, 20	Railway tower struts
6 x 8	12, 16, 20, or random	Abutment footing and bulkhead posts. Timber grillage
6 x 6	10, 12, 14, 16, or random	Curb. Nailer
4 x 12	14, 16, 18, 20, 22, 24, or random	Deck on steel stringers. Bulkhead
4 x 10	16, 18, 20, 22, 24, or random	Railway tower longitudinal bracing. Scabs
4 x 8	14, 16, 18, 20, 22, 24, 26, or random	Bent, pier, and tower bracing. Railway walkway
4 x 4	Random	Handrail posts. Walkway
3 x 14	12	Spacers between stringers.
3 x 12	12, 14, 16, 20, 24, or random	Tread plank. Deck plank on timber stringers
3 x 10	8, 12, 14, 16, or random	Scabs for columns. Railway pier and tower bracing. Tie spacers.
3 x 8	8, 10, 12, 14, or random	Spacers and scabs for timber stringers
3 x 4	Random	Handrail post fill.
2 x 12	12, 14, 16, 20, or random	Tread plank on laminated deck. Scabs for railway stringers
2 x 10	14, 16, or random	Railway walkway, scabs on bracing
2 x 8	Random	Scabs for highway bracing
2 x 6	10, 12, 14, 16, or random	Handrail. Walkway. Railway tie spacers
2 x 4	14	Laminated deck on steel stringers
2 x 4	24	Laminated deck on timber stringers

long-time protection of steel. Painting may be justified in localities with high precipitation and salt-water spray. (See par. 197.)

13. CONNECTIONS. a. Timber. Nailed, drifted, and bolted connections are used exclusively. Special timber connectors are not required for these designs.

b. Steel. Details are provided for three methods of making splices and connections.

(1) *Bolting* (*a*) *Structural ribbed bolts* (table LXXVII), $\frac{7}{8}$-inch diameter can be used for all splices, stiffeners, and diaphragms.

(*b*) *Standard machine bolts* (table LXXV), can be used for temporary connections. If standard machine bolts are used in stringer or column splices, bridge ratings must be reduced. (See par. 224.)

(2) *Riveting.* All permanent connections, except pinned and welded connections, are designed for $\frac{7}{8}$-inch structural rivets. Structural ribbed bolts and rivets can be used interchangeably. Rivets are listed in bills of materials. Structural ribbed bolts of appropriate length may be substituted. (See table XLIV.)

(3) *Welding.* (*a*) Structural welding is used for:

1. Clips welded to tops of beams for attachments or nailers.
2. Shims to support nonuniform stringers.
3. Base plates welded to tower columns.
4. Attachment of tower bracing connections.
5. Splicing of tower bracing rods.

(*b*) Welded designs are also prepared as alternative to bolted or riveted construction for all fabrication of structural steel.

14. PERSONNEL TRAINING AND QUALIFICATIONS. a. Simple bridges with only abutments, bents, and short spans can be built by troops trained in the use of common tools and supervised by officers and noncommissioned officers experienced in building minor structures.

b. Bridges with high towers and long spans require troops trained in steel fabrication, timber framing, and erection, and officers and noncommissioned officers experienced in supervision of heavy timber and structural steel work. The experience and necessary qualifications of troops and supervisors employed on big bridges must not be minimized.

c. The labor estimates in chapters 3 and 8 assume troops are adequately trained in steel-bridge construction. Although these man-hour tables do not include operators who accompany equipment, such operators must be fully trained in use of the special organic or class IV equipment.

CHAPTER 3

ADVANCE PLANNING

15. PURPOSE. The information given in this chapter will aid in advance staff planning of trestle-crossing requirements and in developing stock-pile needs.

16. BRIDGE REQUIREMENTS. General requirements for trestle crossings in theaters of operations are determined from the basic information supplied by intelligence sources, reconnaissance maps, aerial surveys, and hydrological reports. From these data, estimates are made of:

a. Number and character of trestle crossings required in the theater.

b. Probable length and average height of bridges required at these crossings.

c. Crossings that can be made with the designs given in this manual. The kinds of crossings for which these designs can be used are described in chapter 2.

d. Type of construction suited to each crossing.

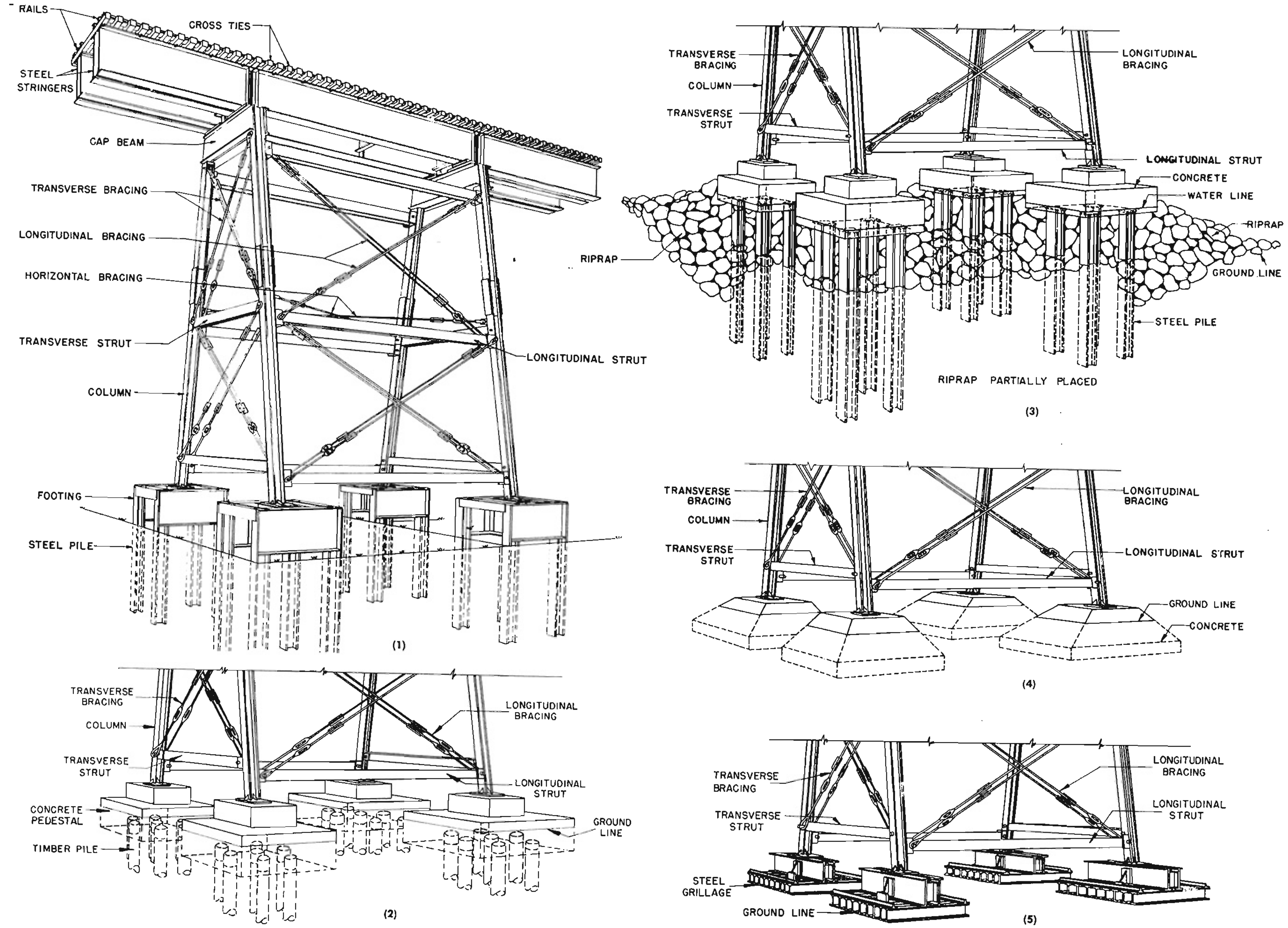


Figure 20. Railway bridge, steel stringer spans, steel tower:

(1) On steel frames, steel piles.
(2) On concrete pedestals, timber piles.
(3) On concrete pedestals, steel piles.
(4) On concrete pedestals.
(5) On steel grillages.

17. SELECTION OF TYPE. a. Conditions for which the different types of construction are best suited are:

(1) *Spans on pile bents.* Best where short spans can be used, as in shallow streams, swamps, tidal waters, and floodways in wide valleys. (See table XVII.) They are usually not economical if piles must be over 60 feet long.

(2) *Spans on pile piers.* Best for bridges of intermediate height and longer span (table XVII) across narrow streams and floodways.

TABLE IV. *Sizes and principal uses of steel in semipermanent bridges.*

Abbreviations: 50S, class 50, single-lane. 50D, class 50, double-lane. 25D, class 25, double-lane. RR, railway.

Size, inches	Use
(Pounds)	*Wide-flange structural steel beams:*
36 I 230	Stringer 50D 90-, RR 45-foot span.
36 I 182	Stringer 50S 90-, 50D 80-, RR 40-foot span.
36 I 150	Stringer 50S 80-, 50D 70-, RR 50-, 35-foot span.
33 I 132	Stringer 50S 70-, 50D 60-, 25D 90-, RR 30-foot span.
33 I 125	Stringer 50S 60-, 50D 50-, 25D 80-foot span.
30 I 108	Stringer 50S 50-, 25D 70-, RR 25-foot span. 50D tower cap.
27 I 91	Stringer 50D 40-, 25D 60-, RR 20-foot span.
24 I 87	Stringer 50S 40-, 25D 50-foot span.
24 I 74	Stringer 50S 30-, 50D 30-foot span. 50D tower cap. RR bracing connection.
21 I 63	Stringer 25D 40-, RR 15-, and double 15-foot span.
21 I 59	Stringer 50D 20-, 25D 30-foot span. RR tower cap.
18 I 77	RR pile-pier corbel.
18 I 47	Stringer 50S 20-, 500 15-foot span. 50S tower cap.
16 I 58	H pile pier cap. Pile bracing connections.
16 I 36	Stringer 50S 15-, 25D 20-foot span.
14 I 30	Stringer 25D 15-foot span.
12 I 65	RR tower columns and connections.
12 I 53	Piles. Grillage H tower columns and connections. Abutment pile cap.
10 I 42	Tower struts.
8 I 24	RR pile-pier bracing.
	Structural steel channels:
18 [42.7	Pile bent caps. RR span diaphragms.
15 [33.9	Pile bent caps. Abutment pile connections.
12 [20.7	RR span lateral bracing. H span diaphragms.
10 [15.3	RR span lateral bracing.
	Structural steel angles:
6 x 4 x ⅜	Riveted span stiffeners, connections.
4 x 3 x 5/16	Pile bent bracing, connections.

Size, inches	Use
(Thickness)	*Structural steel plate:*
1	Column base plate. Flange splice.
⅞	Bearing plate. Flange splice.
¾	Bearing plate. Flange splice.
⅝	Flange splice. Welded stiffeners, connections.
½	Flange splice. Column splice. Welded stiffeners, connections.
⅜	Web splice. Column base stiffeners. Welded stiffeners, connections.
¼	Nailer attachment. Walkway attachment.
	Adjustable rod cross bracing for steel towers pin connected to columns:
¾ round ¾ square loop rods 1⅛ turnbuckle	Vertical bracing except railway longitudinal bracing.
1½ round pin ¼ x 2¼ cotter pins Washers 2 pipe sleeve	Pin connections for ¾ round vertical tower bracing.
1¼ round 1¼ square loop rods 1⅝ turnbuckle	Railway longitudinal bracing.
2 round pin ⅜ x 3 cotter pins Washers 4 pipe sleeve	Railway longitudinal bracing connections.
¾ round ¾ square upset rods 1⅛ turnbuckle No. 3 clevice with 1 3/16 headed pin ¼ x 2½ cotter pin	Horizontal bracing all towers.

Size, inches	Use
	Machine bolts with nuts and washers:
½	RR cross ties. Nailer connection. Walkways.
⅝	RR cross-tie spacer.
¾	Steel-span anchor bolts. Bridge deck. Pile bracing.
⅞	Steel-span anchor bolts. Structural steel fitting up.
1	Timber pile bracing. Timber tower bracing with washers.
	Driftbolts:
½	Timber grillage.
¾	Timber tower column. Stringer. Curb.
	Hook bolt with nut and washer:
¾	Railway cross ties on steel stringer.
(Length)	*Buttonhead ⅞-inch rivets:*
2	Pile bents and piers.
2¼	Bents. Stringers.
2½	Bents. Piers. Towers. Stringers.
2¾	Bents. Piers. Towers. Stringers.
3	Bents. Piers. Towers. Stringers.
3¼	Towers. Stringers.
3¾	Stringers.
4	Stringers.
4¼	Stringers.
4¾	Stringers.
5	Stringers.
	Wire nails and wire spikes:
20 d	Handrail. Walkway. Tie spacers.
30 d	Nailer clips. Laminated deck.
50 d	Tread plank.
60 d	Toenailing only.
5/16 x 7	Deck plank. Bulkhead.
⅜ x 10	Abutment grillage.

(3) *Spans on framed towers.* Used for high bridges. (See table XVII) across deep valleys and ravines.

(*a*) On pile footings in soft, marshy, or loose sandy soil.

(*b*) On spread footings in firm soil, compacted sand, gravel, boulders, and rock.

(4) *Timber spans.* Designs limited to 15-foot-long highway spans and 16-foot-long railway spans.

(5) *Steel spans.* Use required for all spans exceeding length limit for timber spans.

b. Except where span length is the controlling factor, choice between timber and steel is based on economy in construction, materials and equipment available, transportation and skill of construction forces.

18. CLASS IV MATERIALS USED IN BRIDGES. a. Timber. Sizes, lengths, and principal uses of timbers required in all construction units (par. 8) provided by the manual are listed in table III.

b. Steel. Rolled steel shapes required in all units of construction and their principal uses are tabulated in table IV.

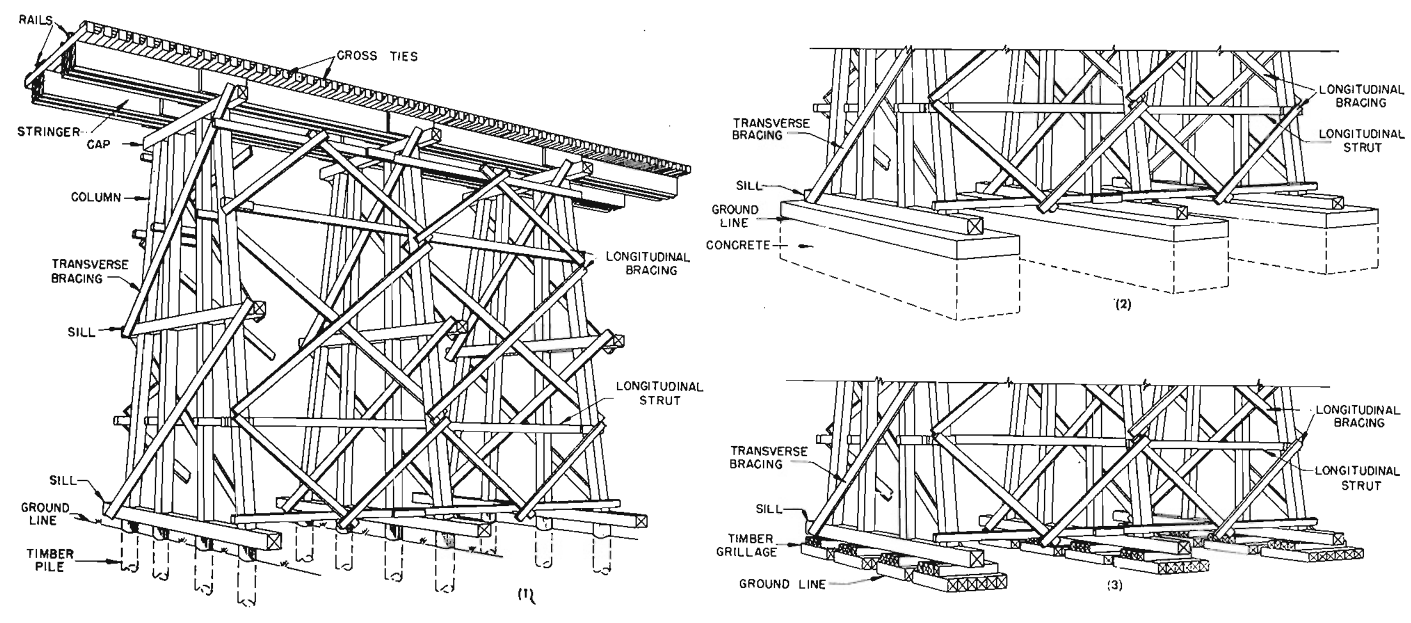


Figure 21. Railway bridge, timber stringer spans, framed timber tower:

(1) On timber sills, timber piles. (2) On concrete pedestals. (3) On timber grillages.

19. EQUIPMENT USED IN CONSTRUCTION. Tools and equipment normally needed to construct semipermanent highway and railway bridges of stock-pile materials are listed in table XXXIA.

20. COMPARATIVE ECONOMY OF BRIDGE TYPES. Tables V to VIII inclusive give material quantities and man-hours of labor required per foot of bridge to build each type and height of structure for which designs are provided. These tables permit quick comparison of the economy with which different types of bridges of the same height can be built, and aid in selecting the bridge type best suited to material, transportation, and personnel available in the theater.

21. ESTIMATES. Quantities of principal materials and man-hours of labor needed to build a bridge of any type covered in the manual are estimated in the following manner:

a. Length and average height are approximated and type is selected. (See par. 16.)

b. Unit quantities for the type and average height of the bridge are taken from tables V to VIII inclusive, and are multiplied by the bridge length. The quantity allowances for end spans and abutments given in the tables are added or subtracted as shown.

22. ANTICIPATING STOCK-PILE NEEDS. a. Estimates of materials of each kind needed for the bridges in the theater are obtained by approximating the number of each unit of construction required; that is, the number of each type of foundation unit, the number and average height of each type of tower unit, and the number and length of each type of span required. From the bills of materials given on the detail drawings for each unit, quantities of all materials needed to build that unit are taken. These quantities are multiplied by the number of units to be built in the theater. Quantities are combined into lists of stock-pile requirements.

Caution: In preparing lists of stock-pile requirements, allowance must be made for loss and damage in transit.

b. Because the designs are flexible, alternatives are provided, and identical sections can be used in different units, final construction can deviate widely from original estimates without wasting stocked materials.

CHAPTER 4

DESIGN SPECIFICATIONS

Section I. GENERAL CONDITIONS

23. LOADS AND FORCES. The bridges in this manual are designed to withstand various combinations of the following loads and forces:

a. Dead load. The weight of the bridge itself.

b. Live load. The weight of traffic on the bridge, including troops, vehicles, or trains.

c. Impact. The dynamic effect of moving live load expressed as a percentage of the live load.

d. Longitudinal forces. Horizontal longitudinal forces representing the effects of wind and of the motion, stopping, or starting of vehicles or trains on the bridge.

e. Lateral forces. Horizontal lateral forces representing the nosing effect of the locomotive and the effect of wind on the structure and on live load for railway bridges and the effect of wind on the structure only for highway bridges.

24. DEAD-LOAD WEIGHTS. Weights used in computing dead loads are:

Steel—490 pounds per cubic foot.
Timber—50 pounds per cubic foot.
Concrete—150 pounds per cubic foot.
Rails and fastenings—200 pounds per linear foot of railway bridge.

25. WIND FORCES ON BRIDGES. The bridges are designed for a lateral wind load of 30 pounds per square foot on 1½ times the area of the bridge as seen in elevation. This represents the effect of an 85-mph wind. They are also designed for a longitudinal wind load of 15 pounds per square foot on ¾ times the area of spans as seen in elevation and on 1½ times the area of towers and bents as seen in cross section. See paragraph 38 for wind forces on live load.

26. EXPANSION AND CONTRACTION. No provision is made for expansion and contraction of timber spans. Steel stringers are fixed at one end with slotted holes at the other end to allow for changes in length resulting from temperature variations between 120° F and —30° F. Stresses due to expansion and contraction are disregarded.

27. FOOTWALKS. Walks are not part of the basic designs for highway and railway bridges. Footwalks, which may be added to all bridges, and refuge bays for railway bridges are designed for pedestrian loads of 85 pounds per square foot. Increased stresses in stringers and supports to which footwalks are attached are disregarded.

Section II. HIGHWAY CLEARANCES AND LOADS

28. BRIDGE CLASSES. a. Highway bridge designs in this manual include the following classes:

(1) Class 50, single-lane bridge.
(2) Class 50, double-lane bridge, usable also as class 80 single-lane bridge.
(3) Class 25, double-lane bridge.

b. The hypothetical vehicles used for designing these bridges are shown in figures 22 and 23. All weights and loads are in short (US) tons of 2,000 pounds. Assumed spacing of vehicles is 90 feet center-to-center. The hypothetical class 80 vehicle is a tracked vehicle 14 feet 8 inches wide with 14 feet 0 inches ground contact and 36-inch tracks.

29. CLEARANCES. a. The width between curbs is:

Double-lane bridges	22′–0″
Class 50, single-lane bridge	12′–6″
Class 25, single-lane bridge	10′–8″ (No designs included)

b. The height of curb is 10 inches for all bridges.

c. Abutments are designed for the following widths between edges of approach-road shoulders:

Double-lane bridges	26′–0″
Class 50, single-lane bridge	16′–6″

d. Handrails are 3 feet high. The width between handrails is:

Double-lane bridges, timber stringers	23′–8″
Double-lane bridges, steel stringers	22′–8″
Class 50, single-lane bridge, timber stringers	13′–8″
Class 50, single-lane bridge, steel stringers	13′–2″

30. LIVE LOAD. a. Highway bridge floors are designed for the tracked-vehicle and wheel loads given in table IX for class 25 and 50 loadings.

b. Stringers and supports are designed for the loadings shown in figure 22 for class 25 and in figure 23 for class 50.

(1) The axle and track loads of critical vehicles shown in the figures determine maximum shears and reactions.

(2) The diagrams show concentrated load equivalents used in computing bending moments. Concentrated load equivalent (CLE) is the single-axle load which at midspan causes the same maximum moment as the actual vehicle. (See par. 211, FM 5-10.)

c. Lateral distribution of track or wheel loads on stringers is assumed to be the following:

(1) For interior stringers, fraction of track or wheel load carried by each stringer is:

	3″ tread 3″ deck	*3″ tread 4″ deck*
(*a*) For single-lane bridges	$\frac{S}{4.5}$	$\frac{S}{5.0}$
(*b*) For double-lane bridges	$\frac{S}{4.0}$	$\frac{S}{4.25}$

Where, S=average spacing of stringers in feet.

(2) For an outside stringer, load equals reaction of the track or wheel load, assuming the deck to act as a simple beam between stringers.

31. IMPACT. Impact loads are assumed to be 15 percent of live load. Impact loads are applied in designing all steel members except steel piles; they are disregarded for all timber members, piles, and foundations.

32. TRACTION AND BRAKING FORCES. In addition to longitudinal wind forces given in paragraph 25, highway bridges are designed for a horizontal longitudinal braking force equal to 5 percent of the live load acting at the surface of the bridge floor. This force represents the effect of moving, starting, and stopping vehicles on the bridge.

Section III. RAILWAY TRACK AND LOADS

33. GAUGE AND CLEARANCE. a. Railway bridges are designed for standard 4-foot 8½-inch gauge track. The same designs are used for narrower track. Placing of rails for 1-meter (3-foot 3⅜-inch) gauge track is shown on the drawings.

b. The structure gauge or clearance of bridge parts for standard track is shown on figure 24. Only handrails and braces for footwalks and refuge

TABLE V. *Class 50, single-lane highway bridges. Approximate quantities per linear foot of bridge.*[1]

Combination	1			2			3				4			5			
Distance grade to ground (feet)	Timber stringers, timber pile bents			Steel stringers, steel pile bents			Steel stringers, timber pile piers				Steel stringers, steel pile piers			Steel stringers, framed timber towers, timber sill, timber piles			
	Timber piling[2] (1 in. ft.)	Timber (mbm)	Man-hours	Metal[2] (lb.)	Timber (mbm)	Man-hours	Metal (lb.)	Timber (mbm)	Timber piling[2] (1 in. ft.)	Man-hours	Metal[2] (lb.)	Timber (mbm)	Man-hours	Metal (lb.)	Timber (mbm)	Timber piling[2] (1 in. ft.)	Man-hours
10	7.2	.18	8.7	573	.16	13.2	315	.19	6.7	12.4	813	.15	22.1	....	....	....	....
20	10.7	.22	9.5	583	.15	11.2	372[3]	.18[3]	8.0[3]	10.2[3]	830	.15	23.0	270	.30	7.1	19.1
30	12.5	.22	9.5	....	....	....	....	....	....	....	....	....	....	320	.34	5.8	23.0
40	....	....	....	....	....	....	....	....	....	....	....	....	....	415	.37	4.9	25.7
50	....	....	....	....	....	....	....	....	....	....	....	....	....	472	.39	4.3	26.6
60	....	....	....	....	....	....	....	....	....	....	....	....	....	508	.40	3.8	28.7
70	....	....	....	....	....	....	....	....	....	....	....	....	....	584	.42	3.4	31.5
80	....	....	....	....	....	....	....	....	....	....	....	....	....	738	.44	3.0	33.2
Add per bridge	+140	+0.7	+40	+10,000	+1.6	+130	....	+0.7	−20	....	+300	+1.6	−100	....	−5.0	+90	−300

Combination	6					7				8			9			10		
Distance grade to ground (feet)	Steel stringers, framed steel towers, concrete pedestals, timber piles					Steel stringers, framed steel towers, concrete pedestals, steel piles				Steel stringers, framed steel towers, steel frames, steel piles			Timber stringers, framed timber towers, timber sills, timber piles			Timber stringers, framed timber towers, concrete pedestals		
	Metal (lb.)	Timber (mbm)	Timber piling[2] (1 in. ft.)	Concrete (cu. yd.)	Man-hours	Metal[2] (lb.)	Timber (mbm)	Concrete (cu. yd.)	Man-hours	Metal[2] (lb.)	Timber (mbm)	Man-hours	Timber (mbm)	Timber piling[2] (1 in. ft.)	Man-hours	Timber (mbm)	Concrete (cu. yd.)	Man-hours
10	....	....	....	....	....	....	....	....	....	—	—	—	—	—		....	....	....
20	582	.15	4.6	.29	18.1	840	.15	.29	21.2	955	.15	26.3	....	—	—	.29	.67	14.9
30	620	.15	4.6	.29	18.9	868	.15	.29	22.0	970	.15	27.9	.35	5.3	16.5	.35	.67	17.8
40	766	.15	4.0	.25	23.5	945	.15	.26	26.2	1,036	.15	29.9	.42	5.3	20.0	.42	.67	20.8
50	813	.15	3.6	.22	25.2	1,001	.15	.23	27.7	1,082	.15	29.2	.49	5.3	23.5	.49	.72	23.5
60	892	.15	3.2	.20	27.6	1,080	.15	.20	29.8	1,165	.15	31.0	.56	5.3	27.3	.56	.72	27.7
70	950	.15	2.9	.18	26.9	1,200	.15	.19	29.2	1,275	.15	33.8	.64	5.3	31.0	.64	.80	33.6
80	1,134	.15	3.3	.19	32.2	1,290	.15	.17	33.4	1,458	.15	35.1	.70	5.3	34.1	.70	.80	34.4
Add per bridge	−10,000	+1.8	+140	−10.0	−200	....	+1.6	−10.0	−200	−5,000	+1.6	−300	−1.0	+220	−40	−3.0	+32.0	+200

Combination	11				12				13		14			15		
Distance grade to ground (feet)	Steel stringers, framed timber towers, concrete pedestals				Steel stringers, framed steel towers, concrete pedestals				Timber stringers, framed timber towers, timber grillages		Steel stringers, framed timber towers, timber grillages			Steel stringers, framed steel towers, steel grillages		
	Metal (lb.)	Timber (mbm)	Concrete (cu. yd.)	Man-hours	Metal (lb.)	Timber (mbm)	Concrete (cu. yd.)	Man-hours	Timber (mbm)	Man-hours	Metal (lb.)	Timber (mbm)	Man-hours	Metal (lb.)	Timber (mbm)	Man-hours
10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20	321	.27	.66	19.1	582	.15	.34	16.8	.32	11.1	270	.35	17.3	798	.15	16.8
30	415	.31	.64	24.9	620	.15	.42	18.3	.39	13.9	320	.38	18.0	838	.15	17.7
40	472	.34	.56	28.2	766	.15	.37	23.1	.46	17.0	415	.41	23.2	955	.15	22.5
50	508	.36	.48	30.3	804	.15	.41	25.6	.53	20.1	472	.42	26.2	972	.15	24.4
60	585	.38	.50	31.4	892	.15	.36	28.3	.61	23.7	508	.44	28.4	1,083	.15	27.5
70	740	.40	.46	35.5	950	.15	.33	27.5	.68	26.9	584	.45	29.0	1,123	.15	27.1
80	740	.44	.46	37.2	1,134	.15	.30	32.0	.74	29.5	738	.46	32.3	1,294	.15	31.6
Add per bridge	—	−7.0	+14.0	−200	−10,000	—	+27.0	+80	−1.0	....	....	−6.0	−300	−17,000	+4.0	−100

TABLE VI. *Class 50, double-lane highway bridges. Approximate quantities per linear foot of bridge.*[1]

10	12.0	.31	10.4	860	.23	19.6	528	.29	12.0	17.0	1,190	.21	29.3	....	....	....	....
20	16.0	.36	12.2	915	.22	17.2	612[3]	.26[3]	12.0[3]	15.7[3]	1,325	.21	34.2	478	.44	10.7	26.3
30	20.0	.38	13.4	....	....	....	....	....	....	....	....	....	....	547	.47	8.7	27.2
40	....	....	....	....	....	....	....	....	....	....	....	....	....	740	.51	7.4	33.0
50	....	....	....	....	....	....	....	....	....	....	....	....	....	810	.54	6.4	38.6
60	....	....	....	....	....	....	....	....	....	....	....	....	....	810	.61	6.4	41.7
70	....	....	....	....	....	....	....	....	....	....	....	....	....	920	.63	5.6	45.5
80	....	....	....	....	....	....	....	....	....	....	....	....	....	920	.68	5.6	48.2
Add per bridge	+180	+1.2	+50	+10,000	+2.2	+170	....	+0.6	−60	....	+2,400	+2.2	−60	....	−8.0	+100	−500

10	....	....	....	....	....	....	....	....	....	—	—	—	—	—	—	—	—	—
20	956	.22	4.6	.29	25.6	1,200	.22	.29	27.8	1,334	.22	31.8	.45	8.0	16.8	.45	1.04	22.0
30	990	.22	4.6	.29	26.5	1,230	.22	.29	29.4	1,370	.22	33.4	.53	8.0	20.5	.53	1.04	25.8
40	1,210	.21	5.0	.29	32.6	1,425	.22	.25	34.0	1,545	.21	37.4	.62	8.0	24.3	.62	1.04	29.6
50	1,245	.22	4.5	.26	35.7	1,435	.22	.23	37.4	1,545	.22	40.5	.71	8.0	28.4	.71	1.11	34.4
60	1,360	.22	5.3	.32	39.5	1,550	.22	.23	40.0	1,658	.22	42.9	.80	8.0	32.6	.80	1.11	38.6
70	1,425	.22	4.8	.28	41.1	1,595	.22	.20	41.9	1,690	.22	44.5	.90	8.0	36.9	.90	1.21	43.7
80	1,526	.22	4.8	.28	43.7	1,695	.22	.20	44.1	1,791	.22	46.8	.98	8.0	40.3	.98	1.21	47.2
Add per bridge	−15,000	+2.9	+260	−10.0	−300	−1,000	+2.2	−10.0	−200	−6,000	+2.2	−300	−1.0	+300	−100	−4.0	+49.0	+300

10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	478	.44	1.20	32.3	971	.23	.49	27.6	.51	16.0	478	.51	24.6	1,225	.23	26.8
30	547	.47	1.03	32.5	990	.22	.52	26.8	.59	19.8	547	.53	25.8	1,320	.22	27.0
40	740	.51	0.96	38.7	1,210	.21	.46	32.1	.68	23.5	740	.57	31.7	1,500	.21	32.0
50	810	.54	0.83	44.0	1,245	.22	.48	35.3	.77	27.6	810	.58	37.6	1,510	.22	35.5
60	810	.61	0.86	47.7	1,360	.22	.48	38.9	.87	32.0	810	.66	40.9	1,615	.22	38.0
70	920	.63	0.84	51.7	1,425	.22	.43	41.0	.96	36.3	920	.67	44.8	1,654	.22	40.2
80	920	.68	0.84	54.5	1,526	.22	.43	43.0	1.04	39.7	920	.73	47.5	1,755	.22	42.5
Add per bridge	—	−10.0	+27.0	−200	−15,000	—	+46.0	+100	—	....	—	−7.0	−350	−26,000	+4.9	−300

TABLE VII. *Class 25, double-lane highway bridges. Approximate quantities per linear foot of bridge.*[1]

10	8.0	.26	8.3	760	.24	20.0	431	.29	8.0	14.9	883	.21	26.7	....	....	....	....
20	10.7	.32	10.0	685	.22	14.5	608	.25[3]	6.4[3]	19.8[3]	1,040	.21	31.0	392	.38	5.8	20.2
30	13.3	.32	10.8	—	....	....	....	....	....	....	....	....	....	577	.38	4.3	28.2
40	....	....	....	....	....	....	....	....	....	....	....	....	....	577	.43	4.3	30.6
50	....	....	....	....	....	....	....	....	....	....	....	....	....	669	.45	3.8	35.1
60	....	....	....	....	....	....	....	....	....	....	....	....	....	669	.52	3.8	38.0
70	....	....	....	....	....	....	....	....	....	....	....	....	....	760	.52	3.4	34.0
80	....	....	....	....	....	....	....	....	....	....	....	....	....	830	.53	3.1	38.3
Add per bridge	+200	+1.1	+50	+12,000	+2.2	+200	....	+0.9	+40	+40	+2,400	+2.2	....	—	−6.0	+150	−400

10	—	....	....	....	....	....	....	....	....	—	—	—	—	—	—	—	—	....
20	760	.23	4.6	.29	23.1	1,002	.23	.29	26.3	1,138	.23	29.7	.38	5.3	13.8	.38	.67	17.1
30	860	.22	3.6	.22	27.9	1,040	.22	.23	31.0	1,150	.22	33.6	.45	5.3	17.0	.45	.67	20.3
40	968	.22	3.6	.22	30.6	1,150	.22	.23	33.4	1,238	.22	35.9	.52	5.3	20.3	.52	.72	24.2
50	1,031	.22	3.2	.20	33.1	1,201	.22	.20	35.8	1,296	.22	38.0	.60	5.3	23.9	.60	.72	27.7
60	1,130	.22	3.2	.20	35.6	1,300	.22	.20	38.0	1,395	.22	40.1	.68	5.3	27.5	.68	.80	32.0
70	1,195	.22	3.6	.21	31.9	1,350	.22	.19	33.5	1,435	.22	35.7	.76	5.3	31.2	.76	.80	35.8
80	1,310	.21	3.3	.19	36.9	1,445	.21	.17	38.1	1,525	.21	40.2	.83	5.3	34.1	.83	.80	38.7
Add per bridge	−13,000	+2.6	+200	−10.0	−300	+1,000	+2.2	−10.0	−100	−1,000	+2.2	−300	−1.0	+280	−100	+1.5	−10	—

10	—	....	—	....	—	—	—	....	—	....	—	—	—	....	....	—
20	392	.38	.66	23.5	758	.23	.42	22.5	.41	13.4	392	.42	19.3	975	.23	22.0
30	530	.40	.64	30.8	858	.22	.37	26.7	.49	16.6	530	.44	26.2	1,045	.22	26.2
40	575	.43	.56	34.2	976	.22	.37	29.4	.56	19.9	575	.46	30.0	1,135	.22	30.0
50	575	.49	.56	36.9	996	.22	.40	31.9	.64	23.4	575	.52	32.6	1,165	.22	30.8
60	670	.52	.57	42.3	1,105	.22	.40	34.3	.72	27.2	670	.55	37.6	1,282	.22	35.2
70	762	.52	.51	37.8	1,158	.22	.36	36.8	.80	31.0	762	.55	33.7	1,385	.22	37.0
80	830	.53	.46	42.0	1,290	.22	.33	34.2	.87	33.9	830	.55	38.0	1,500	.22	34.3
Add per bridge	—	−9.0	+38.0	−50	−13,000	—	+51.0	+200	—	—	—	−5.0	−200	−20,000	+4.9	−100

TABLE VIII. *E–45 railway bridges. Approximate quantities per linear foot of bridge.*[1]

10	7.5	.11	5.2	765	.04	27.2	236	.09	13.7	12.0	1,080	.04	29.0	....	....	....	....
20	10.0	.15	6.6	840	.04	22.4	295[4]	.10[4]	12.5[4]	12.1[4]	1,314	.04	32.3	288	.20	6.15	17.5
30	12.5	.15	7.3	....	....	....	....	....	....	....	....	....	....	326	.25	8.56	21.4
40	....	....	....	....	....	....	....	....	....	....	....	....	....	326	.32	8.57	25.2
50	....	....	....	....	....	....	....	....	....	....	....	....	....	404	.38	10.15	31.6
60	....	....	....	....	....	....	....	....	....	....	....	....	....	404	.45	10.15	35.3
70	....	....	....	....	....	....	....	....	....	....	....	....	....	512	.50	9.50	39.4
80	....	....	....	....	....	....	....	....	....	....	....	....	....	512	.57	9.50	43.2
Add per bridge	+140	+0.4	+60	+2,900	+1.2	−100	....	+.19	+167	+30	−19,000	+1.2	−500	....	−6.0	+340	−300

10	....	....	—	—	—	....	....	....	....	—	....	....	—	....	....	—	—	—
20	632	.04	7.38	.44	21.8	890	.04	.31	22.4	1,040	.04	26.7	.23	5.0	12.0	.23	.91	18.0
30	682	.04	8.60	.57	24.5	940	.04	.31	24.0	1,090	.04	28.2	.30	9.2	17.3	.30	1.00	21.7
40	875	.04	8.60	.57	28.8	1,090	.04	.31	28.3	1,235	.04	32.4	.37	9.2	20.9	.37	1.20	27.7
50	925	.04	9.14	.53	33.0	1,165	.04	.29	31.4	1,300	.04	35.3	.43	9.2	24.2	.43	1.35	31.8
60	1,068	.04	11.45	.99	39.5	1,310	.04	.29	35.7	1,445	.04	39.5	.50	9.2	27.9	.50	1.35	35.5
70	1,182	.04	11.80	.92	42.2	1,410	.04	.27	37.9	1,530	.04	40.1	.58	9.2	31.7	.58	1.47	40.5
80	1,328	.04	11.80	.92	46.4	1,550	.04	.27	42.0	1,680	.04	45.5	.64	9.2	35.0	.64	1.47	43.7
Add per bridge	−12,000	+2.1	+200	−23.0	−400	−4,000	+1.2	−12.0	−200	−10,000	+1.2	−300	−2.0	+153	−100	—	−16	−200

10	—	....	—	....	—	....	....	....	....	....	—	....	....	....	....	....
20	274	.21	1.15	25.3	620	.04	.72	22.0	.27	16.6	274	.26	17.7	1,000	.04	21.1
30	274	.28	1.28	30.3	680	.04	.80	23.5	.35	15.3	274	.34	21.4	1,140	.04	23.1
40	295	.35	1.46	35.3	825	.04	.80	27.7	.42	18.9	295	.40	24.6	1,290	.04	27.3
50	334	.40	1.52	38.5	925	.04	.86	32.1	.49	22.7	334	.48	28.6	1,350	.04	30.6
60	334	.48	1.66	44.0	1,070	.04	.86	36.3	.56	26.4	334	.55	32.8	1,500	.04	34.9
70	410	.53	1.75	50.0	1,185	.04	.80	38.5	.67	31.7	410	.60	37.8	1,590	.04	37.1
80	410	.60	1.75	53.7	1,325	.04	.80	42.5	.73	34.8	410	.67	41.5	1,730	.04	41.2
Add per bridge	—	−8.0	+2.0	−300	−10,000	....	+15.0	−200	−1.0	−100	....	−6.0	−400	−25,000	+3.1	−400

[1] Quantities shown are based on recommended span lengths shown in the selection diagrams, tables XVII to XXIV.
[2] Pile length based on 20-foot penetration.
[3] For height of 18-feet.
[4] For height of 15-feet.

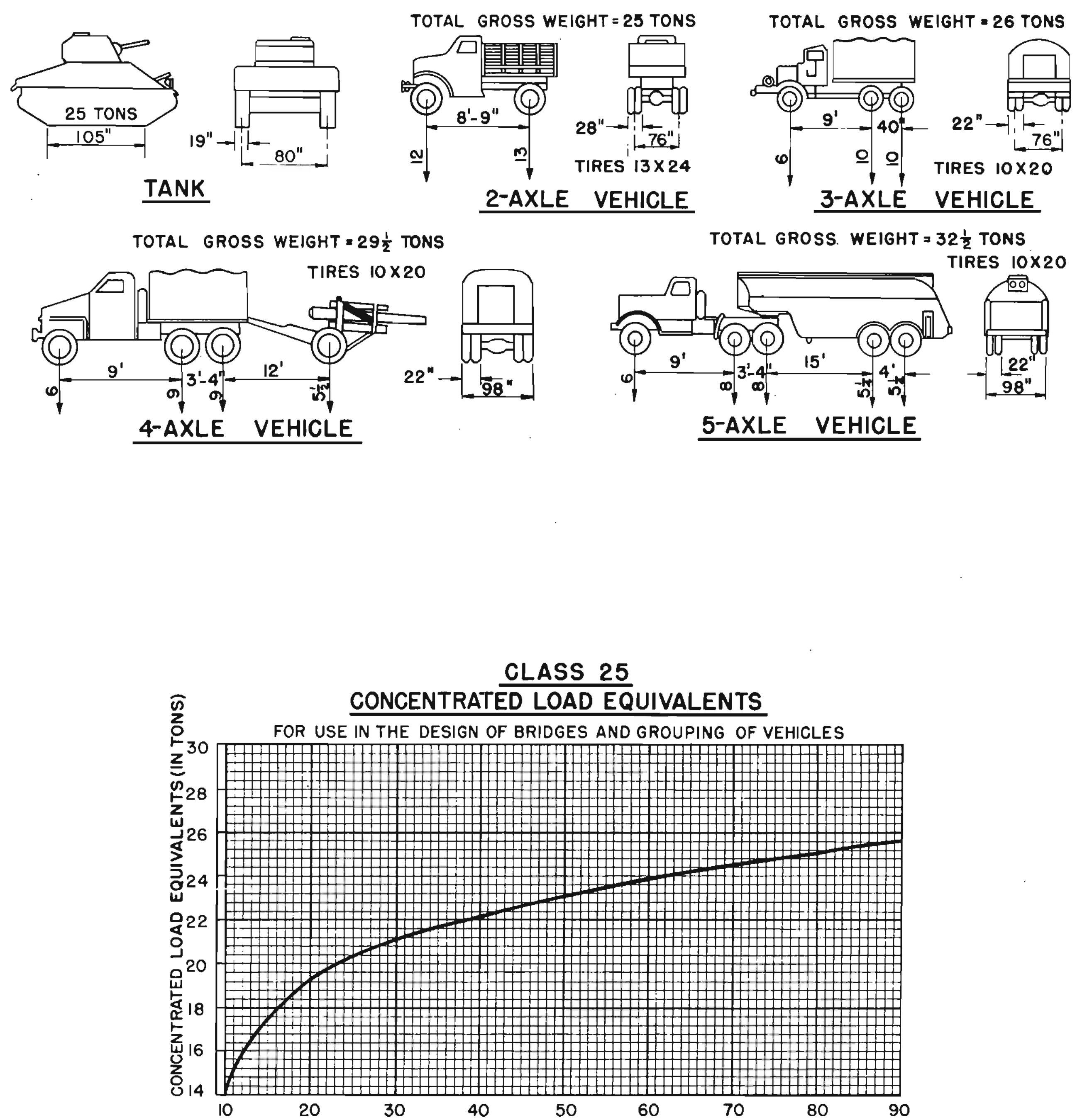


Figure 22. Class 25, track, axle, and wheel loads, and concentrated load equivalents for design of military bridges, 10- to 90-foot spans.

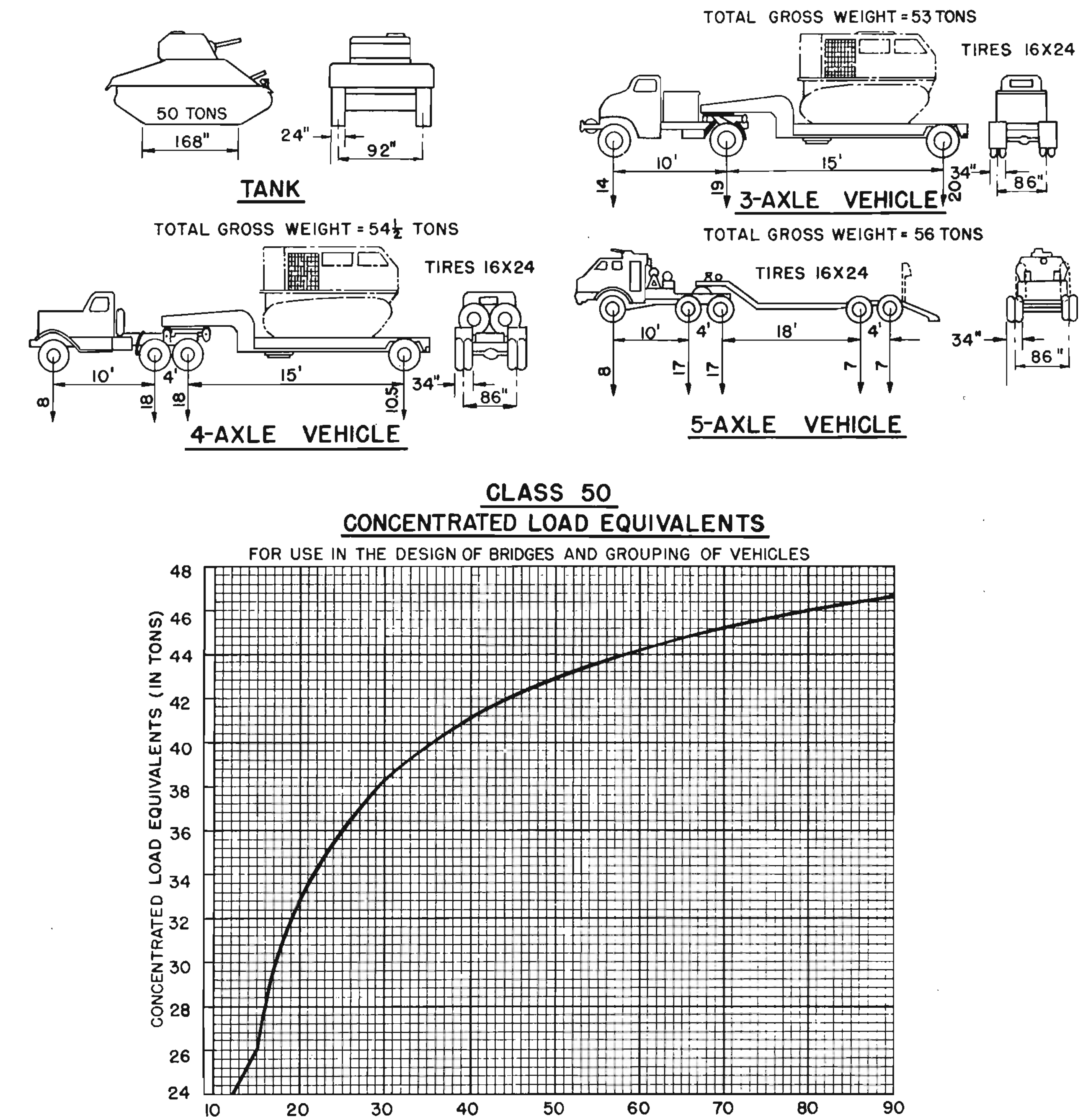


Figure 23. Class 50, track, axle, and wheel loads, and concentrated load equivalents for design of military bridges, 10- to 90-foot spans

bays extend above track. Handrail is 12 feet from bridge center line.

c. Abutments are designed for a 15-foot-wide embankment.

34. LIVE LOAD. These bridges are designed for Cooper's E–45 loading and a maximum speed of 40 mph. Figure 24 shows details of this loading and the relation between Cooper's loadings and British standard unit (BSU) loadings. Cooper's E–45 is equivalent to BSU 20. Note that British loads are given in long tons (2,240 pounds).

(1) Structure-clearance diagram for straight track.
(2) Locomotive and train, Cooper's E–45 loading.
(3) Alternative concentrated loads for short spans.
(4) Relation between Cooper's E- loading and British standard unit (BSU) loading.
(5) BSU 20 loading.

35. IMPACT. Impact loads are assumed to be a percentage of live load as expressed by the formula: $I = 100 - 0.60\ L$

Where,

I = percent addition to static live load.

L = length of span in feet.

This impact load includes the effects of uneven rail joints and unbalanced locomotive driver wheels. Impact loads are applied in designing all steel members except steel piles; they are disregarded for all timber members, piles, and foundations.

TABLE IX. *Track, axle, and wheel loadings for design of flooring of military bridges.*

Bridge classification	Class 25	Class 50
Clear roadway	128″	150″.
Track vehicle:		
Weight of critical tank	25 tons	50 tons.
Length of ground contact	105″	168″.
Width of each track	19″	24″.
Distance c to c of tracks	80″	92″.
Axle load:		
Single axle:		
Axle load	13 tons	20 tons.
Wheel:		
Width	28″	34″.
Number of tires	4 (dual)	4 (dual).
Width out-to-out of wheels	100″	124″.
Bogie axle:		
Maximum axle load when total number of axles are:		
3	10 tons	19 tons.
4	9 tons	18 tons.
5 or more	8 tons	17 tons.
Wheel:		
Width	22″	34″.
Tires (dual)	10 x 20	16 x 24.
Spacing, c to c	76″	86″.
Width out-to-out of wheels	98″	120″.
Axle spacing	40″	48″.
Wheel load:		
Single tire:		
Load	4 tons	5 tons.
Tire size	16 x 24	16 x 24.
Dual tire:		
Load	6½ tons	10 tons.
Tire size	13 x 24	16 x 24.
Wheel width	28″	34″.

Note: Loadings for class 80 bridges are described in paragraph 28.

36. NOSING OF LOCOMOTIVES. To withstand the effect of nosing of moving locomotives, bridges are designed for a concentrated moving horizontal lateral force of 20,000 pounds applied at top of rail at any point in the span. Vertical effects of this lateral force are disregarded.

37. TRACTION AND BRAKING FORCES. In addition to longitudinal wind forces (par. 25), railway bridges are designed for a horizontal longitudinal force representing the effects of train traction or braking. The design force used is the larger of the following:

a. Twenty-five percent (25%) of the weight on locomotive drivers, representing traction effect.

b. Fifteen percent (15%) of the total live load on the bridge, representing braking effect.

38. WIND ON TRAIN. In addition to the lateral wind forces (par. 25), railway bridges are designed for a lateral horizontal wind load of 300 pounds per foot of track applied 8 feet above top of rail. This force represents the effect of wind on the side of a train on the bridge.

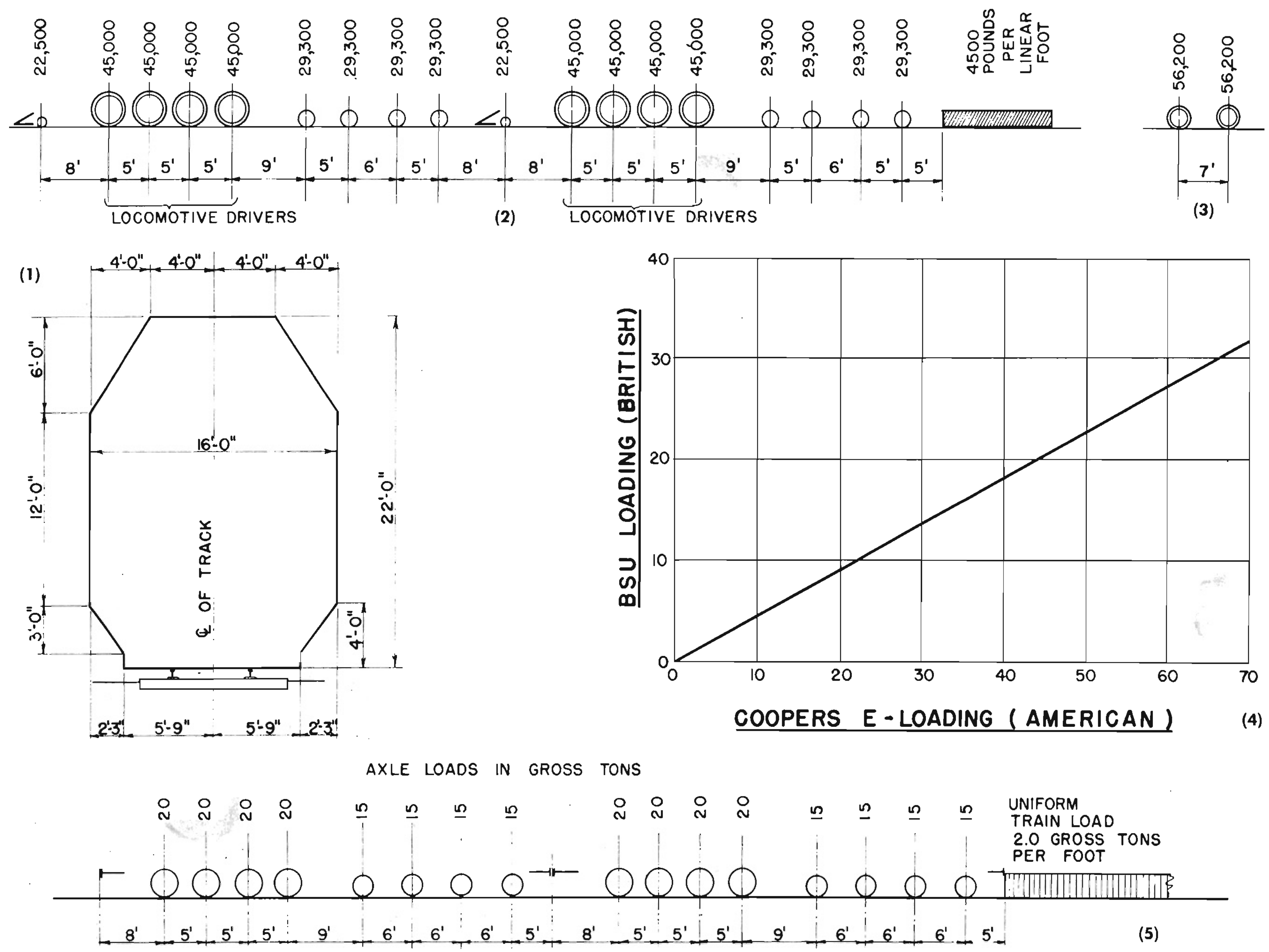


Figure 24. Live loads and structure-clearance diagram for E–45 military railway bridges.

Section IV. MATERIALS AND WORKING STRESSES

39. STEEL MATERIALS. a. Structural and rivet steel. The designs are based on steel with the following physical properties:

	Structural steel	*Rivet steel*
Tensile strength (pounds per square inch=psi)	60,000=72,000 psi	52,000=62,000 psi
Minimum yield point, one-half of tensile strength but not less than	33,000 psi	28,000 psi

These properties are characteristic of the American structural steel normally available in depots. Where steel of uncertain origin or lower strength is used, load capacities must be reduced in proportion to the lower yield point, or the size of members and connections shown on the drawings must be increased. This must be done because of the relatively high allowable working unit stresses (par. 40) used in the designs. For example, a basic tensile working stress of 27,000 psi has been adopted for semipermanent military bridges, as compared to 18,000 psi used for civilian highway and railway bridges. (See table L for moments and shears.)

b. Structural ribbed bolts. Structural ribbed bolts (table LXXVII) are made of steel having a tensile strength of 70,000 psi. They are ⅞-inch size with 15 longitudinal ribs and .95-inch outside diameter of the ribbed shank and are used in 15/16-inch holes. They have full buttonheads and are threaded with special screw threads for 7/8-inch self-locking nuts 1 1/8 inches thick.

c. Machine bolts and nuts. (table LXXV). Designs using black or unfinished machine bolts are based on common bolts with a yield point of approximately 45,000 psi.

d. Welding rods and electrodes. Welding rods for oxyacetylene welding are mild-steel rods. Electric-arc welding electrodes must be heavily coated, mild-steel, shielded-arc electrodes for all-position, general-purpose work. They are used with reverse-polarity (electrode positive) direct-current welders.

40. STEEL WORKING STRESSES. Steel bridge designs in this manual are based on the allowable working unit stresses shown below. These stresses are not exceeded by any combination of design loads and forces excluding lateral and longitudinal forces. Where lateral and longitudinal forces are considered in combination with other loads and forces, allowable working unit stresses 15 percent higher than those listed below are permitted. All stresses are in pounds per square inch unless otherwise noted.

a. Structural and rivet steel. (1) *Tension.* Axial tension on net section.

(*a*) Structural members 27,000
(*b*) Machine bolts, at root of thread 20,000
(2) *Axial compression.* On gross section
for length of member .... —L inches
and radius of gyration .... —r inches
(*a*) For values of $\frac{L}{r}$ not greater than 140.

1. Riveted or bolted ends. .... $22{,}500 - \frac{3}{8}\left(\frac{L}{r}\right)^2$

2. Pinned ends .... $22{,}500 - \frac{1}{2}\left(\frac{L}{r}\right)^2$

(*b*) For values of $\frac{L}{r}$ over 140 but not to exceed 200, bolted or pinned ends. $\dfrac{56{,}000}{1 + \dfrac{L^2}{5{,}750\, r^2}}$

(*c*) Compression, splice material 24,000
(*d*) Stiffeners of plate girders 24,000
(3) *Bending.* On extreme fiber of rolled and built-up sections.
(*a*) Compression in flanges of width b inches and length of unsupported flange between lateral connections or knee braces L inches .... $27{,}000 - 7.5\left(\frac{L}{b}\right)^2$

(Double-plank floors or laminated floors securely nailed and held to steel stringers by welded or bolted connections are assumed to furnish continuous lateral support.)

(*b*) Tension on net section 27,000
(*c*) Pins, structural-grade hot-rolled steel 33,000
(*d*) Pins, cold-rolled steel 45,000
(*e*) Bolts 27,000
(4) *Diagonal tension.* In webs of girders of rolled beams; at sections where maximum shear and moment occur simultaneously 27,000
(5) *Shear.*
(*a*) Girder webs, gross section 16,500
(*b*) Pins 17,000
(*c*) Power-driven rivets and structural ribbed bolts in tight-fitting holes 15,000
(*d*) Unfinished bolts 12,000
(6) *Bearing.*
(*a*) Pins, steel parts in contact 33,000
(*b*) Power-driven rivets and structural ribbed bolts in tight-fitting holes 30,000
(*c*) Unfinished bolts 25,000

b. Welds. (1) *Fillet welds.* On throat area, tension, compression or shear 9,600
(This is 425 pounds per linear inch of weld for each 1/16 inch of size.)
(2) *Butt welds.* On weld area.
(*a*) Shear 12,000
(*b*) Compression 16,000

41. TIMBER MATERIALS. Timber bridge designs in this manual are based on use of seasoned, dry timber of American species of 1,400-pound stress grade as shown in table LVIII. This grade includes select structural Douglas fir, merchantable structural longleaf southern pine, or dense structural shortleaf southern pine. The designs cannot be used with unseasoned or wet timber and timber of lower grades, unless sizes and connections are increased or load capacities decreased proportionately.

42. TIMBER WORKING STRESSES. The following allowable working unit stresses govern the design of wood members of bridges in this manual. These stresses are not exceeded by any combination of design loads and forces. (See par. 23.) Values are in pounds per square inch.

a. Extreme fiber stress in bending 2,100
b. Horizontal shear (parallel to grain) 150
c. Compression perpendicular to grain 500
d. Compression, parallel to grain, on cross section of members with:

length L inches
least dimension d inches

(1) For $\frac{L}{d}$ — values not greater than 11 1,750

(2) For $\frac{L}{d}$ — values over 11 but not greater than 21.5 .... $1{,}750\left[1 - \frac{1}{3}\left(\frac{L}{21.5\,d}\right)^4\right]$

(3) For $\frac{L}{d}$ — values over 21.5 but not to exceed 50. $\dfrac{535{,}000}{\left(\dfrac{L}{d}\right)^2}$

43. CONCRETE MATERIALS. Designs for concrete caps, footings, and abutments are based on unreinforced concrete having a 28-day compressive breaking strength of 2,500 psi. Concrete of this quality should have a maximum water-cement ratio of 6 1/4 gallons of water per sack of cement. (See ch. 8, FM 5–10, for detailed information on proportioning, mixing, placing, and curing concrete.)

44. CONCRETE WORKING STRESSES. The following allowable working unit stresses govern the design of concrete parts of bridges in this manual. Values are in pounds per square inch.

a. Compression in pedestals, height to thickness ratios not to exceed 3 to 1 750
b. Bending stress in extreme fiber.
(1) Compression 1,250
(2) Tension 90
c. Shear 75
d. Punching shear 200
e. Bond to timber or steel piles 15

45. SOIL PRESSURES. Designs for spread footings and abutments are based on soils capable of developing a safe allowable bearing pressure of 3,000 pounds per square foot. (See par. 70.) This value is used in proportioning footings for combinations of dead and live loads. However, for combinations of lateral and longitudinal forces with dead and live loads, a maximum bearing pressure of 4,000 pounds per square foot is allowed on these soils.

46. BEARING-PILE LOADS. a. Designs for pile bents and piers, foundation piles, and pile abutments are based on piles driven to the bearing values shown on the drawings. Pile bearing values are determined in accordance with section III, chapter 12. The maximum pile loads in these designs are:

(1) Timber piles, 18 tons.
(2) Steel piles, 50 tons.

b. These pile capacities are used for combinations of dead and live loads. However, for combinations of lateral and longitudinal forces with dead and live loads, permitted loads on piles are:

(1) Timber piles, 25 tons.
(2) Steel piles, 60 tons.

47. FIELD DESIGN. Field designs are necessary for scaffolding, concrete forms, ramps, and other temporary construction: See TM 5–225 for detailed information on rigging and TM 5–226 for information on carpentry.

CHAPTER 5

CAPACITIES AND TRAFFIC CONTROL

48. NORMAL LOADS FOR CONTROLLED TRAFFIC. a. The normal movement of all vehicles across bridges is governed by military traffic regulations. The designs in this manual are based on controlled traffic having the following normal restrictions:

(1) Weight-class of vehicles does not exceed posted capacity of bridges. For definition of weight class and equivalent weight class, see FM 5–10, paragraphs 239 and 245.

(2) Vehicle spacing 30 yards, the closest military-vehicle spacing normally permitted.

(3) Maximum speed 25 mph, normally not exceeded by heavy military vehicles. The vehicles may veer from side to side, and move in both lanes of double-lane bridges.

(4) Only these normal restrictions are necessary when class 50 double-lane bridges are used for single-lane traffic by class 80 vehicles. (See par. 28.)

b. The normal traffic regulations given in *a* cannot be violated without risk of overstressing these bridges.

49. POSTING BRIDGES. a. Bridges are marked with their capacity under controlled traffic as defined above. (See tables X, XI, and XII.) This is referred to as posted capacity, US class 50, or US class 25. Class 50 double-line bridges *may* also be posted as US class 80 *for single-lane traffic only.* (See par. 239 FM 5–10.)

b. The hypothetical vehicles used as design loads for class 50 and class 25 bridges are shown in figures 22 and 23. The hypothetical class 80 vehicle is described in paragraph 28.

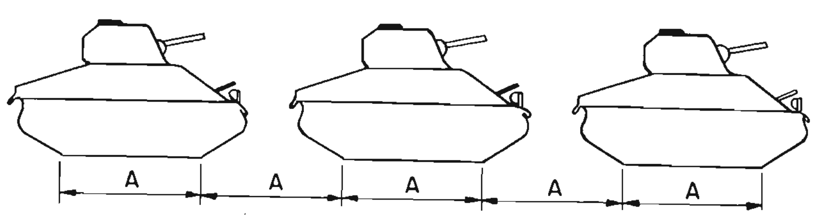
50. OVERLOADS. a. Excessive stresses may be caused by:

(1) Loads of weight-class exceeding posted capacity of the bridge if crossed without special traffic restrictions.

(2) Loads less than or equal to posted capacity of the bridge crossed at excessive speeds or decreased spacing of vehicles.

b. Loads of weight-class exceeding posted capacity are permitted provided additional traffic restrictions are enforced. For such overloads there are two types of crossing, each with special traffic restrictions:

(1) *Caution* crossing. (See par. 51.)



SPACING OF TRACKED VEHICLES FOR UNRESTRICTED CROSSING

CLASS	WEIGHT (TONS)	A (INCHES)
4	4 TONS	80"
9	9 TONS	80"
12	12 TONS	80"
16	16 TONS	105"
20	20 TONS	105"
25	25 TONS	105"
35	35 TONS	132"
50	50 TONS	168"
65	65 TONS	216"
80	80 TONS	264"

Figure 25. Tank loads used in rating bridges for unrestricted traffic.

(2) *Risk* crossing. (See par. 52.)

c. If normal traffic restrictions as to speed and spacing are violated, the bridge must be restricted to vehicles of weight-class less than normal posted capacity. Crossings of such decreased loads are known as *unrestricted* crossings.

d. Design loads of the following weight-classes have been considered in rating the bridges for caution, risk, or unrestricted crossings: 80, 65, 35, 20, 16, 12, 9, and 4.

51. CAUTION CROSSING. a. Overloads cross with *caution* if the following traffic restrictions are enforced:

(1) Speed not over 5 mph, to reduce effect of impact.

(2) Distance between vehicles at least 50 yards, to reduce load on spans.

(3) Vehicle centered on bridge, to avoid overstress in outside stringers.

(4) Single-lane traffic on two-lane bridges, to reduce loads concentrated near center line of roadway. (Note that this is the only restriction necessary to permit class 80 traffic (par. 28) on class 50 double-lane bridges. This is not a caution crossing.)

(5) No braking or gear shifting on bridge, to reduce longitudinal forces on bridge.

b. Maximum weight-classes of vehicles that can cross with *caution* are listed in separate columns in tables X, XI, and XII. If these vehicles comply with the restrictions in *a* above, allowable stresses given in chapter 4, section IV will not be exceeded.

52. RISK CROSSING. a. Overloads cross with *risk* if the following traffic restrictions are enforced:

(1) Speed not over 3 mph.

(2) Only one vehicle allowed on bridge at a time.

(3) Vehicle centered on bridge deck.

(4) No braking or gear shifting on bridge.

(5) Vehicle guided across bridge by man on foot to insure observance of restrictions (1), (3), and (4).

b. Maximum weight-classes of vehicles that can cross with *risk* are listed in separated columns in tables X, XI, and XII. If these vehicles cross the bridge, the allowable stresses in section IV, chapter 4, are *exceeded,* even if all restrictions in *a* are observed. Such loads involve a *definite risk of bridge failure,* since the values of maximum permissible weight-class for crossing with *risk* have been computed using stresses at or near the *yield point* of the materials. Risk crossings should be permitted only on well-maintained bridges when specifically authorized by the responsible headquarters.

53. UNRESTRICTED CROSSING, DECREASED LOADS. a. Normally, *unrestricted traffic* is not permitted on military bridges. If the situation requires or justifies relaxing normal restrictions, the maximum weight-class of vehicles must be reduced on long bridge spans. (See par. 53c.)

b. The permissible weight-class of vehicles for unrestricted traffic was computed for columns of tanks of the weights, ground-contact lengths, and spacings shown in figure 25. The capacities for unrestricted traffic of single spans are listed in tables X, XI, and XII. The capacities for unrestricted traffic bridges of two or more spans are limited by the substructure capacities and are shown in tables XIII and XIV for combined lengths up to 180 feet of two spans on a common support.

c. Capacity is not reduced for unrestricted crossings on:

(1) Single-span, single-lane, class 50 bridges, up to 40 feet long.
Single-span, double-lane, class 50 bridges, up to 50 feet long.
Single-span, double-lane, class 25 bridges, up to 30 feet long.

(2) Multiple-span, class 50 bridges, with combined length of two spans on a common support 53 feet or less.

Multiple-span, class 25 bridges, with combined length of two spans on a common support 35 feet or less.

54. CAPACITY TABLES. a. Superstructure. Capacities of spans, with timber stringers and steel stringers, are given in tables X, XI, and XII.

TABLE X. *Single-lane, class 50 bridges, capacities of superstructures.*

Span length (feet)	Stringer	Traffic condition			
		Controlled	With caution	With risk	Unrestricted
		Posted capacity[2]	Maximum class of loading[2]	Maximum class of loading[2]	Maximum class of loading
11	Timber	50	80		50
13	Timber	50	80		50
15	Timber	50	80		50
15	Steel	50	80		50
20	Steel	50	80		50
30	Steel	50	80		50
40	Steel	50	80		50
50	Steel	50	80		35
60	Steel	50	80		35
70	Steel	50	80		25
80	Steel	50	80		20
90	Steel	50	80		20

[1] To determine over-all capacity of bridge for unrestricted crossings, see table XIII for capacity of substructure.
[2] Capacity of substructure same as capacity of superstructure.

TABLE XI. *Double-lane, class 50 bridges, capacities of superstructures.*

Span length (feet)	Stringer	Traffic condition			
		Controlled (posted capacity)[2]		Caution or risk one lane	Unrestricted[1] two lanes
		Two lanes	One lane	Maximum class of loading[2]	Maximum class of loading
11	Timber	50	80		50
13	Timber	50	80		50
15	Timber	50	80		50
15	Steel	50	80		50
20	Steel	50	80		50
30	Steel	50	80		50
40	Steel	50	80		50
50	Steel	50	80		50
60	Steel	50	80		35
70	Steel	50	80		20
80	Steel	50	80		20
90	Steel	50	80		20

[1] To determine over-all capacity of bridge for "unrestricted" crossings, see table XIII for capacity of substructure.
[2] Capacity of substructure same as capacity of superstructure.

TABLE XII. *Double-lane, class 25 bridges, capacities of superstructures.*

Span length (feet)	Stringer	Traffic condition			
		Controlled two lanes	With caution one lane	With risk one lane	Unrestricted[1] two lanes
		Posted capacity[2]	Maximum class of loading[2]	Maximum class of loading[2]	Maximum class of loading
11	Timber	25	35	50	25
13	Timber	25	35	50	25
15	Timber	25	35	50	25
15	Steel	25	50	65	25
20	Steel	25	50	65	25
30	Steel	25	50	65	25
40	Steel	25	35	50	16
50	Steel	25	35	50	16
60	Steel	25	35	50	12
70	Steel	25	35	50	9
80	Steel	25	35	50	9
90	Steel	25	35	50	4

[1] To determine over-all capacity of bridge for unrestricted crossings, see table XIV for capacity of substructure.
[2] Capacity of substructure same as capacity of superstructure.

b. Substructure. (1) For "controlled," "with caution," and "with risk" crossings, the superstructure governs bridge capacity.

(2) For "unrestricted" crossings, the substructure generally governs capacity. These capacities are given in tables XIII and XIV.

TABLE XIII. *Class 50 bridges, capacities of substructures for unrestricted crossings.*

Combined length of two spans on common support (feet)	Maximum class of loading	Combined length of two spans on common support (feet)	Maximum class of loading
53	50	105	16
58	35	120	12
68	25	160	9
84	20	over 180	4

TABLE XIV. *Double-lane, class 25 bridges, capacities of substructures for unrestricted crossings, two lanes.*

Combined length of two spans on common support (feet)	Maximum class of loading	Combined length of two spans on common support (feet)	Maximum class of loading
35	25	59	12
46	20	82	9
56	16	180	4

c. Loads and stresses. Stresses caused by loads under "controlled," "with caution," and "unrestricted," are within the allowable limits stipulated in this chapter.

55. APPLICATION OF CAPACITY TABLES. a. The capacity of a bridge depends on:

(1) Longest span in bridge, for "controlled," "with caution," and "with risk" crossings.

(2) Longest span in bridge or the longest combined length of two spans on a common support for "unrestricted" crossings.

b. To illustrate the use of capacity tables for determining over-all bridge capacity, reference is made to figure 35, chapter 9, showing a class 50 single-lane bridge.

Longest span	= 50′ (span 8)	
Longest combined length of two spans on a common support	= 65′ (span 7 + span 8 on pier 7.)	
Posted capacity	US Class 50	(See table X, column 3.)
Crossing With caution	US Class 80	(See table X, column 4.)

Since vehicles of the heaviest load classification can cross "with caution," no "with risk" classification is required. For "unrestricted" crossings, bridge capacity is:

Superstructure	Class 35	(See table X, column 6, for 50-foot span.)
Substructure	Class 25	(See table XIII for loaded length not exceeding 65 feet.)

The capacity of the bridge under various classes of traffic control is then:

Traffic control	*Class of loading*
"Controlled" (posted capacity)	50
"With caution"	80
"Unrestricted"	25

PART TWO

CONSTRUCTION OPERATIONS

CHAPTER 6

SITE SELECTION, RECONNAISSANCE, AND SURVEYS

Section I. SITE SELECTION

56. GENERAL. a. Semipermanent bridges are usually built to:

(1) Replace demolished bridges, bridges of limited capacity, or standard stream-crossing equipment.

(2) Provide crossings at new sites for new routes or for relocated existing routes.

b. If the bridge replaces a demolished structure, the original site is usually chosen so approaches and undamaged parts of the replaced bridge can be used. However, a bypass bridge may be more practicable where debris is difficult to move and damaged parts require extensive repair. (See fig. 26(2).)

(1) Reconstruction by replacing demolished spans with timber trestle construction.

(2) A new bridge with new approaches built alongside a partly demolished structure. Use of standing parts of the demolished bridge was not practicable because of its height and the large amount of debris to be moved.

c. If a new location is chosen, alternate sites are considered and the advantages or disadvantages of each compared. The site should provide a suitable crossing at the least cost in time, labor, and material. Tables V to

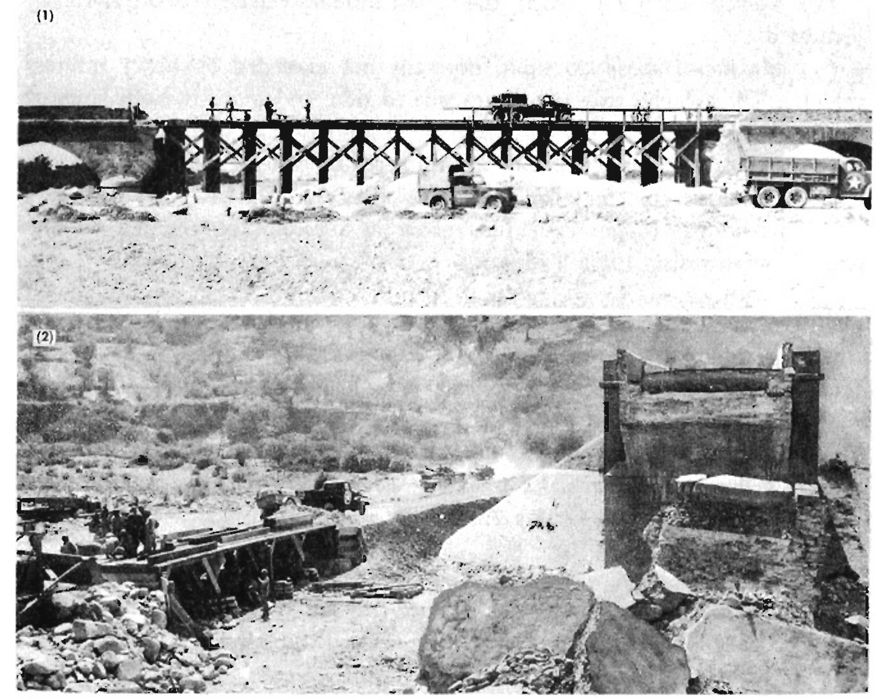


Figure 26. Replacing demolished bridges.

VIII give approximate quantities of labor and materials to help make comparisons. Important factors in site selection are discussed below.

57. APPROACH ROADS. In comparing sites, the amount of construction involved in building access roads and approaches must be considered. Unless the crossing presents particularly difficult construction problems or requires a large structure, its location is usually less important than that of approach and access roads. Factors to be considered in location of roads are discussed in FM 5–10.

58. ALIGNMENT. a. Bridge and stream. A site at which a stream can be crossed at right angles is best. Other crossings require longer structures with construction skewed or towers and bents set at an angle to the stream flow. Such crossings are to be avoided because skewed construction is more difficult, and towers and bents at an angle to the current obstruct the flow and tend to catch more debris than if parallel to the stream.

b. Bridge and approaches. Alignment of a bridge and its approaches should be as straight as possible. (1) Curves on or close to railway bridges are avoided if at all possible, and in no event should curvature on a bridge exceed 6° 30.′ With that curvature, train speeds must be limited to 20 mph.

(2) Sharp curves in approaches to highway bridges must end at least 60 feet from the bridge, if it is to be crossed by long trailer units. Preferably, approaches are straight for 150 feet.

59. STREAM CHANNEL. a. A site on a narrow, straight, and uniform reach of a stream is preferred because:

(1) A narrow channel requires a shorter bridge.

(2) Banks of straight and uniform channels are less apt to erode and cave in. Erosion is particularly severe below sharp bends in a channel.

(3) Islands or other obstructions interrupt smooth flow and tend to cause

destructive cross currents during floods.

b. Uniform depth of water is desirable because scour is less apt to occur during floods.

c. Deep water requires special construction methods which are avoided wherever possible. The limiting conditions for construction outlined in this manual are given in paragraph 10.

60. FOUNDATION CONDITIONS. a. Foundation conditions are an important factor in site selection. This manual provides foundation types for all conditions ordinarily encountered; their adaptation is discussed in chapter 7. Material, labor, and equipment requirements for foundations vary widely; requirements are given in chapter 8.

b. Firm, gently sloping banks are preferred as they permit more efficient use of truck- and crawler-mounted erection equipment. Soft, muddy, or steep banks limit the efficiency of both men and equipment.

c. Sliding or heaving banks should be avoided. Even the most substantial construction cannot successfully resist displacement by large masses of moving earth.

(1) Slides are most often caused by the saturation and softening of heavily loaded layers of clay or mud. Evidences of their occurrence are easily recognized.

(2) Heaving is usually caused by embankments overloading soft clay or mud. Except in the softest soils, it can be avoided by placing abutments well back of the bank line and by limiting the height of embankments.

61. CONSTRUCTION FACILITIES. The site should include a firm, level area suitable as a material and fabrication and framing yard. It should also have a nearby bivouac area for construction forces, and an access road over which materials, equipment, and supplies can be brought to the work.

Section II. RECONNAISSANCE

62. PURPOSE. The purpose of a reconnaissance is to get the information necessary for selecting a site and for determining the type and principal features of the construction. If a demolished structure is to be replaced, the condition and extent of any standing parts that might be used in reconstruction should also be determined.

63. PERSONNEL. Reconnaissance for sites of semipermanent bridges should be assigned to an officer experienced in bridge reconnaissance. He must know what information is necessary and be able to recognize the relative importance of the various factors so he can compare sites. This requires that he be able to visualize at each prospective site the completed bridge and all principal steps in its construction. He must, furthermore, be thoroughly familiar with the communication requirements of the installation, and with the adaptability, limitations, and labor, material, and equipment requirements of various type bridges.

64. RECONNAISSANCE INSTRUCTIONS. For general information on reconnaissance instructions, see FM 5–6. Reconnaissance instructions for these bridges should specifically cover the points listed below; if they do not, the information should be requested before going into the field:

a. Vehicle weight-class requirements.

b. Number of lanes required.

c. Minimum clearance requirements over canals, streams, roads, or railroads.

d. Existing limitations on availability of construction materials and equipment.

e. Availability and experience of construction troops.

f. Time for construction.

65. PRELIMINARY STUDY. a. Review the requirements listed in the statement of theater construction policy. Gather all available information on the stream including maps and stream-flow data. Request stream data, particularly information on floods, from intelligence section. If a choice of sites is permitted, make an initial map study to determine which sites best fit the communication network. Ordinarily this study discloses factors which limit the choice of locations and suggests other factors requiring special investigation on the ground.

b. Investigate the source and availability of materials and construction equipment; also the means of bringing these to the various sites. Determine limitations on construction imposed by lack of certain equipment or material.

c. Preparations for reconnaissance include assembly of necessary surveying instruments, tools and transportation, including some means of crossing the stream if necessary. Picks, shovels, bars, mauls, rope, and an earth auger should be included for prospecting and sounding foundations. Photographic equipment is desirable to take pictures of the sites.

66. RECONNAISSANCE METHODS. a. Reconnaissance should be as deliberate and complete as time permits. Through reconnaissance reduces the likelihood of picking a poor location or of having to abandon work because of unfavorable conditions not disclosed until construction is underway.

b. Topographic features need not be obtained in great detail or with extreme exactness. They may be determined by stadia or with tape, compass, and hand level by survey methods described in FM 5–10 and TM 5–235.

c. Stream characteristics are determined by observing velocity and evidences of flood heights on banks and buildings and of drift lodged in trees and brush. Where possible, these observations are supplemented by inquiry and checked against available stream-flow records.

d. Foundation conditions are estimated by visual examination of exposed banks and by soundings in the stream bed.

e. Location and alignment of approaches are determined by rough ground survey, by aerial survey, or by paper location on contour maps of the area.

67. RECONNAISSANCE REPORTS. A reconnaissance report in brief written form conforming to the general requirements given in FM 5–6 is submitted for each site. A form like that shown in table XV serves as a guide to prevent omitting important items from the investigations or from the report. To provide complete site information, maps, sketches, photographs, and brief descriptions should supplement the data on the form.

Section III. SITE SURVEY

68. PURPOSE. A detailed survey is made *after* the site has been selected from the information furnished by reconnaissance. Its purpose is to furnish exact information from which the bridge lay-out can be determined, materials requisitioned, and construction procedure outlined. It is submitted as drawings of the site in plan and profile, with graphical presentation of subsurface conditions. (See fig. 27.)

69. TOPOGRAPHY. a. The center line of the bridge is established on the ground and reference points are established on it to which all topographic features are tied by survey. The survey should fix the location of all topographic features which may have bearing on lay-out or construction.

b. The survey drawings should include the following:

(1) Location map showing relation of the site to:

(*a*) Communication routes.

(*b*) Bivouac areas for construction troops.

(*c*) Nearest water supplies.

(*d*) Local sources of sand, gravel, timber, and other construction materials.

(2) Detailed plan of the site to a scale of not less than 1 inch to 40 feet showing:

(*a*) Alignment of the proposed structure and tentative position of towers, bents, and abutments.

(*b*) Position of piers and abutments of any existing structure. If these are to be used in the new construction, enlarged details are attached giving complete measurements and notes on condition and repair needed.

(*c*) Course of the stream with bank lines and direction and distribution of flow.

(*d*) Natural features of the site such as caving banks, exposed rock ledges, dirt piles, drainage courses, and trees and wooded areas.

(*e*) Works of man such as dikes, walls, fences, power and utility lines, sewers, drainage structures, buildings, and roads and streets.

(*f*) Elevation contours extending at least 100 feet each side of the bridge center line and 200 feet beyond each abutment.

(*g*) Location of all bench marks and their elevations; all reference points; and all borings and soil tests.

(3) Profile to equal horizontal and vertical scales of not less than 1 inch to 40 feet, showing:

(*a*) Ground surface on center line of the proposed bridge, extending not less than 200 feet back of each abutment.

(*b*) Elevation of high and low water.

(c) Foundation materials as disclosed by test pits and borings.

70. FOUNDATION INVESTIGATION. a. Rod soundings. Foundation conditions can be explored to depths of 12 to 15 feet with a pointed steel sounding rod. In soft ground, much greater depths can be reached.

(1) Round rods ¾ or 1-inch in diameter are used in lengths of 5, 10, and 15 feet. They are preferably driven with a sleeve driver, such as can be made by capping and weighting a short length of pipe. An 8-pound hammer can also be used. As the limit of each rod is reached, the rod is withdrawn and the next longer rod driven into the hole. Rods are pulled with a lever fastened to the rod with a chain. (See fig. 28.) They can be pulled more easily if first turned with a pipe wrench. Where soundings deeper than 15 feet are made, threaded rod sections are joined and driven with the aid of a clamped cross arm.

(2) Differences in type, consolidation, and moisture content of soils penetrated by the rod are judged by the sound and speed of driving.

(3) In making soundings to bed rock through soils containing boulders

TABLE XV. *Outline of site reconnaissance for semipermanent bridge construction.*

Reference.............. Reconnaissance Instruction No..

(See table 11, FM 5–6)

Purpose of reconnaissance:...

Facility required. ....

(Single- or double-track railway and gauge; single- or double-lane highway, load capacity, and width between curbs; sidewalks and widths)

Date and time of reconnaissance: ....

Date and time of report: ....

1. Stream crossed: ....
2. Designation of crossing: ....
3. Highway or railroad: ....
4. Near: ....
   a. Distance: ....
   b. Direction: ....
5. Bridge replaced:
   a. Kind: ....
   (Single- or double-track railway and gauge; single- or double-lane highway and width between curbs; sidewalks and widths)
   b. Type: ....
   (ponton, beam, girder, truss, arch, suspension)
   c. Load capacity: ....
   d. Construction: ....
   (steel, timber, concrete, masonry)
   (1) Substructure: ....
   (2) Superstructure: ....
   e. Span lengths: ....
   f. Over-all length: ....
   g. Maximum height above stream bed: ....
   h. Height at abutments: ....
   i. Alignment: ....
   j. Grade: ....
   k. Condition: ....
   (1) Substructure: ....
   (2) Superstructure: ....
   l. Parts usable in new construction:
   (1) Substructure: ....
   (2) Superstructure: ....
   m. Approaches:
   (1) Alignment: ....
   (2) Grade: ....
   (3) Width: ....
   (4) Character of surface: ....
   (5) Condition: ....
6. Stream characteristics:
   a. Depth:
   (1) Observed: ....
   (2) Low water: ....
   (3) High water: ....
   b. Width:
   (1) Observed: ....
   (2) Low water: ....
   (3) High water: ....
   c. Velocity:
   (1) Observed: ....
   (2) Low water: ....
   (3) High water: ....
   d. Flood periods and duration: ....
   e. Amount and character of debris carried during flood:
   ....
   f. Character of bed and banks: ....
   g. Height of banks: ....
7. Foundation conditions:
   a. Stream bed: ....
   b. Right bank: ....
   c. Left bank: ....
8. Topographic and man-made features:
   a. Buildings: ....
   b. Walls and fences: ....
   c. Utility lines: ....
   d. Wooded areas: ....
   e. Other features: ....
9. Approaches to be constructed:
   a. Length: ....
   b. Character of ground traversed: ....
   ....
   c. Grades: ....
   d. Alignment: ....
10. Construction features:
   a. Communication routes:
   (1) Designation or description: ....
   (2) Classification: ....
   (3) Width: ....
   (4) Character of surface: ....
   (5) Condition: ....
   (6) Alignment and grade: ....
   b. Fabrication and storage areas:
   (1) Location: ....
   (2) Size: ....
   (3) Character: ....
   c. Bivouac areas:
   (1) Location: ....
   (2) Size: ....
   (3) Character: ....
   d. Areas for parking vehicles:
   (1) Location: ....
   (2) Size: ....
   (3) Character: ....
   e. Water supply:
   (1) Location: ....
   (2) Quality: ....
   (3) Quantity: ....
   f. Construction materials available locally:
   (1) Kind: ....
   (timber, stone, gravel, sand)
   (2) Location: ....
   (3) Quality: ....
   (4) Quantity: ....
11. General remarks:
   ....
   ....
   ....
   ....
12. Recommendation:
   ....
   ....
   ....
   ....
   ....
   (name, grade, organization)

Reconnaissance party: ....

Maps used: ....

Annexes:

1. Maps and photographs
2. Sketches and drawings
3. Lay-outs
4. Estimates

or logs, at least three soundings spaced about 3 feet apart are made at each test to insure that soundings are not being stopped by an obstruction before reaching bed rock.

(4) A party of 3 men can make 15 to 20 soundings a day through 15 feet of usual alluvial soil.

b. Borings. For pile- supported construction, foundation materials must be investigated to depths of 20 to 40 feet to get the information necessary for requisitioning piles. This investigation is made by either auger or water-jet borings.

(1) *Auger borings.* Auger borings are most effective for shallow exploration of soils free from coarse gravel or loose rock.

(*a*) The motorized gasoline-engine-driven earth auger can be used for boring to depths of 15 feet in soils free of boulders over 3 inches in diameter. Unless immediately available, however, its use is usually not justified.

(*b*) The handled post-hole augers shown in figure 29 can be used for boring to depths of 20 to 25 feet by lengthening the stem with ¾-inch-diameter pipe extensions. Extension sections should be threaded and should be in 3- or 4-foot lengths; they should be added as the depth of the hole increases.

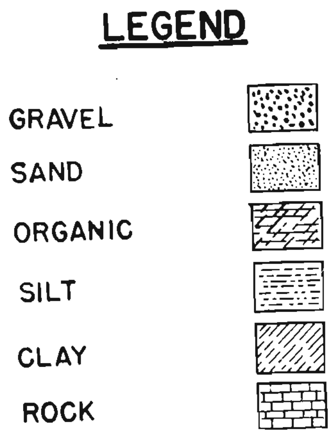


Figure 27. Symbols used in representing soil classifications.

In ordinary material, a party of three men can bore two holes a day to depths of 20 feet or more.

(2) *Wash borings.* Wash borings can be made to considerable depths through any fine-grained soil; gravel or gravelly soils are penetrated with difficulty. The boring is made by driving a casing pipe a few feet at a time and then washing the material from inside the pipe to the surface by churning a smaller water jet up and down inside the casing. The overflow of wash water is caught in a bucket as it leaves the casing pipe and the suspended material is allowed to settle for analysis.

(*a*) The sand content of the sample is always higher than that of the soil in its natural state, since the fine silt and clay particles are carried away in the wash water. The experienced driller judges the material penetrated not by the samples alone, but also by the color of the wash water, the speed of drilling, and the resistance of the casing to driving. Accurate determination of materials penetrated requires that the casing be driven ahead of the jet so material brought to the surface is only that forced into the casing by driving.

(*b*) The usual party for making wash borings is four men. In ordinary material, they can make two borings a day to depths of 30 to 40 feet.

(*c*) Equipment for making wash borings is shown in figure 30. It consists essentially of 2-inch-diameter black pipe for casing, a ¾-inch-diameter black pipe for the jet, a hammer and drive head for driving the casing, a tripod from which a block is suspended for handling the hammer and jet pipe, a pump to supply water to the jet, and clamps, tackle, and jacks for pulling the casing after the hole is completed. Casing and jet pipe should be in about 5-foot lengths for easy handling. The tip of the jet should be flattened to a chisel point for boring through clay, but need not be flattened when working in sandy soil.

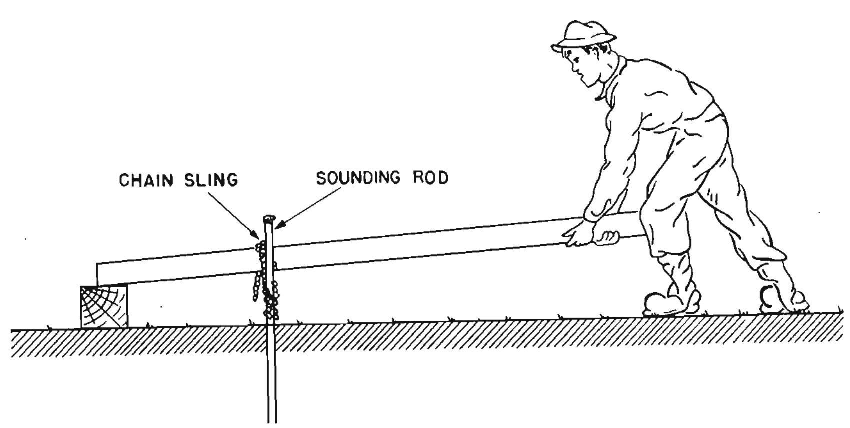


Figure 28. Method of pulling sounding rods.

(3) *Core borings.* In soft soils and clays containing boulders, core drilling may be necessary to find the true foundation conditions. Similarly it may be necessary to bore into subsurface rock to learn whether it is a thin ledge or bed rock and to judge the quality of the rock. The gasoline-engine-driven lightweight rotary well-drilling machine model 43–5 (fig. 31) can be used to advantage for such foundation explorations. In soils it will auger holes up to 10 inches in diameter; in rock it will drill 3-inch holes producing 2-inch cores. Depending on the nature of the rock, cores can be drilled at rates of ½ to 1 foot per minute in holes up to 40 feet deep. The drill is capable of drilling holes over 100 feet deep. The equipment weighs about 3,000 pounds complete without mud pump. For complete details, see the Technical Manual on this equipment.

c. Test pits. Test pits are dug to explore foundation materials for spread footings and sills. Pits are made only large enough for one man to work in. They should be extended beyond the expected bottom of the footing to make sure that the foundation strata is thick enough to carry the intended loads and is not immediately underlain by softer material. They should be shored and braced. (See par. 160.)

d. Load tests. Before spread footings and sills are built on soils whose adequacy is in doubt, load tests (fig. 32) are necessary to determine the bearing capacity of the foundation material. These are made by test-loading a small area at the elevation of the proposed footings.

(1) A square bearing plate is set and leveled in a shallow depression just large enough to receive the plate. A post supporting the loading platform is centered on the plate and braced against tipping. The platform is loaded with sandbags of measured weight until the foundation material is subjected to the unit load at which it is to be tested.

(2) The size of the bearing plate differs with the type of soil being tested.

(*a*) On cohesionless soils, gravel, confined sand or sandy soil, a plate 8½-inches square, having an area of ½-square foot can be used.

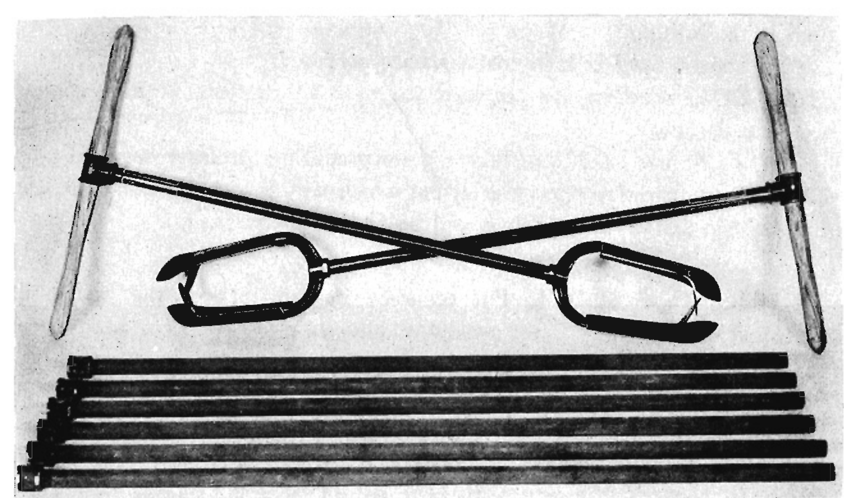


Figure 29. Post-hole auger with handle and extensions for 6-inch diameter holes.

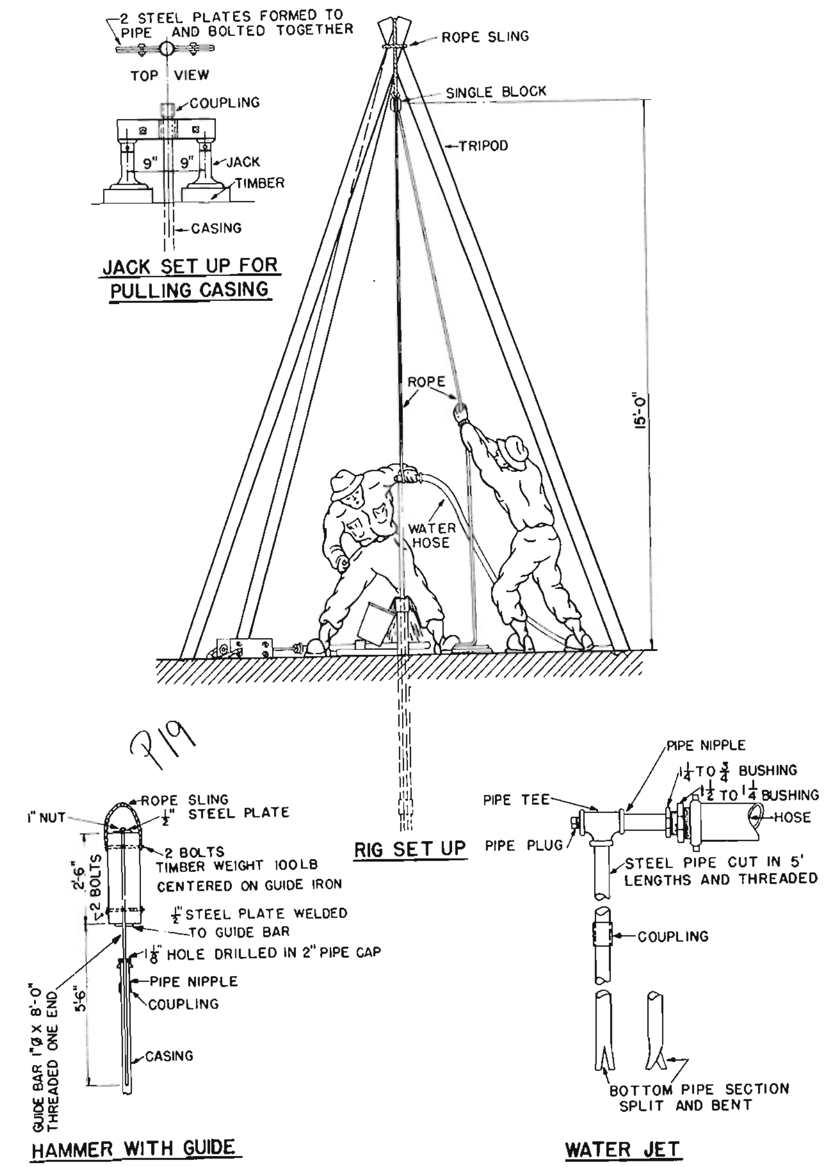


Figure 30. Use of wash-boring equipment for subsurface exploration. Inset views show equipment made up in the field of class IV materials.

(*b*) On firm cohesive soils, clays, and silts, the test area should be increased to at least 1 square foot.

(*c*) On plastic soils, soft clay, or mud, the test area should be at least 2 square feet.

(3) If cohesive and plastic soils are tested during dry periods, they should be wetted to the maximum moisture expected during the wet season.

(4) The initial settlement under load is determined by observations before and immediately after loading, and the test is allowed to stand for 12 hours while additional observations are made. If at the end of the test period, no appreciable settlement is observed in addition to that at the initial loading, the loading is increased and the test repeated. The critical capacity of the soil is exceeded when settlement continues at a constant rate after the addition of load. Foundation loads exceeding 75 percent of the critical capacity of the soil should not be used.

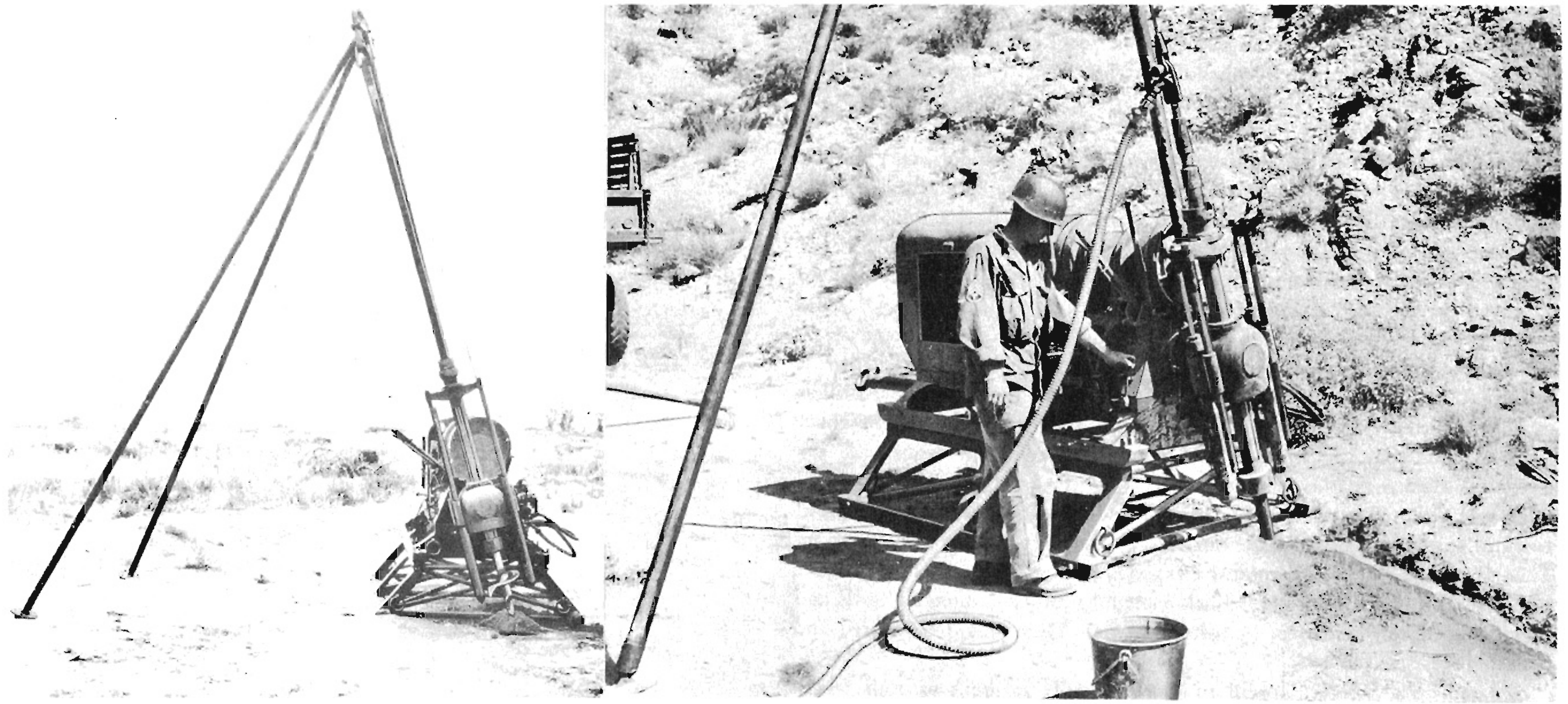


Figure 31. Lightweight rotary well-drilling machine. Used as earth auger and core drill.

CHAPTER 7

BRIDGE LAY-OUT

Section I. GENERAL CONSIDERATIONS

71. LAY-OUT DEFINED. **a.** Bridge lay-out is the process of determining all principal features of the construction including:

(1) Height of bridge.

(2) Location of abutments and foundations.

(3) Lengths and positions of spans.

(4) Type and units of construction.

b. Lay-out requires preparing sketches of the bridge in plan and elevation, and assembling complete plans of all units of construction.

c. The lay-out also provides all information needed for planning construction operations and for requisitioning materials and equipment.

72. INFORMATION REQUIRED. To make the bridge lay-out as defined above, it is necessary to have complete data on the bridge site including the approved reconnaissance report (par. 67) and site survey. (See pars. 68 to 70.)

73. MECHANICS OF LAY-OUT. **a.** A bridge lay-out is worked out in the following sequence:

(1) Grade line of top of bridge deck is drawn on the ground profile as determined by approach grades, flood levels, or clearances under the bridge.

(2) Position of each abutment is determined and shown on the profile.

(3) Position and lengths of principal openings are indicated as required by flood water or traffic under the bridge.

(4) Type and units of construction and span lengths are chosen. Units are sketched in on the profile.

(5) Outlines of foundations and approach roads are drawn on the contour map.

(6) Principal dimensions and notes concerning construction are added.

(7) Listing is made of working drawings for each unit of construction used in the bridge.

(8) Consolidated bills of materials are prepared.

(9) Detail sketches are prepared to cover adjustments in dimensions of standard designs.

b. Difficult site conditions may require preparing alternate bridge lay-outs. These are compared to select the lay-out which will carry traffic most efficiently, cost least in materials and labor, and be fastest to construct.

74. HEIGHT OF BRIDGE. For economy in construction, the bridge floor elevation (grade line) is set as low as clearance requirements and approach grades allow.

a. Clearance. (1) The bottom of stringers must be above the level of the highest probable flood expected during the required life of the bridge. In addition, a suitable allowance should be made for drift carried at that flood stage. In view of the semipermanent nature of the bridges, they are not built to withstand the highest floods of extremely infrequent occurrence.

(2) If the stream is open to navigation, stringers must be high enough to allow boats to pass under the bridge at normal high water. Where this is not practicable, a removable floating section is used or a draw span is improvised.

(3) Over roadways or railway tracks, usual vertical clearance requirements are:

(*a*) Highways:

Military vehicles .... 12 feet

Civilian unrestricted traffic .... 14 feet

(*b*) Railway:

22 feet above top of rail. See figure 24 (1) for clearance diagram.

b. Approach grades. (1) Preferred maximum approach grades are:

	Percent
(*a*) Highways	10
(*b*) Railways	1

(2) Maximum approach grades, used for short straight stretches only and not to be exceeded in any case, are:

	Percent
(*a*) Highways	12
(*b*) Railways	2

(3) Transition curves should be provided to avoid sudden changes of grades at the ends of the bridge. Grades should not be so great that washing of the road surface occurs during rains.

75. LENGTH OF BRIDGE. **a. Low bridges.** (1) Generally, low trestle bridges should be only long enough to reach from one overflow bank to the other. The approach roads are placed on fill or are permitted to flood during high water.

(2) In shallow or slow-moving streams, the channel between banks can be restricted by approach embankments only if enough waterway is left to pass flood flows at velocities that will not cause scour. Water velocities at which scour occurs are given in table XVI.

b. High bridges. (1) Length of high trestle bridges is fixed by economic height of approach embankments. If adequate earth-moving equipment is available, embankments up to 15 feet high can usually be made quicker than trestles of equal height can be built.

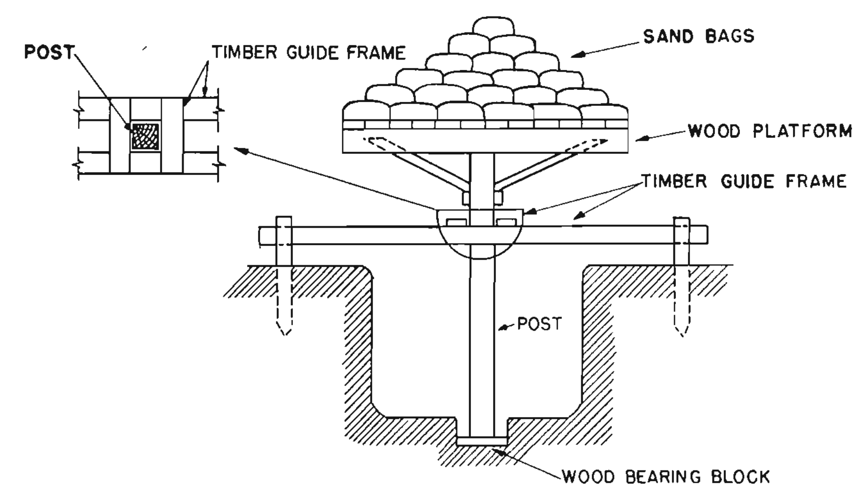


Figure 32. Load test to determine bearing capacity of soil.

TABLE XVI. *Scouring velocities of water.*

Material	Current (fps)	Material	Current (fps)
Fine sand or silty sand....	0.50	Small boulders	8.00 – 10.00
Coarse sand	1.50 – 2.00	Soft rock	6.00 – 10.00
Silt	2.50 – 4.00	Hard rock	10.00 – 15.00
Stiff clay	4.00 – 6.00	Concrete	15.00 – 20.00
Gravel	2.00 – 8.00		

(2) Maximum height of retained fill behind abutments is 6 feet. Where the bridge deck is more than 6 feet above ground, abutments are set on fill. Fill must be well compacted. Where compaction is difficult, pile abutments (sheet 21) are preferred. Piles should penetrate the ground beneath the fill far enough to develop required capacity. (See ch. 12.) Where scour may occur, fills and abutments are protected with riprap.

76. LOCATION AND LENGTHS OF PRINCIPAL OPENINGS. a. Traffic requirements. (1) *Navigation.* Openings required over navigable waterways vary with the water traffic and with stream conditions. Conditions of the site must be examined and openings located to satisfy the particular navigational requirements.

(2) *Highways and railways.* (*a*) Usual horizontal clearance required for highways and railways are as follows:

1. Single-lane highway—12 feet 6 inches.
2. Double-lane highway—22 feet.
3. Single-track railway—16 feet (fig. 24 (1)).
4. Multiple-track railway—16 feet plus distance center-to-center of outside tracks.

(*b*) If roadways or tracks are curved or pass under the bridge at an angle, openings must be increased to maintain the required clearance. Width must also be increased if space for walkways or road-side drainage is required.

b. Foundations. (1) Openings are located so obstructions and unfavorable foundation conditions are avoided. Unfavorable foundation locations may be caused by steep banks, shelving ledges, debris, or underground utilities.

(2) The foundation designs in this manual are not intended for use in deep water (par. 10) or in locations subject to unusual scour.

(3) Supports are located to avoid strong currents and maximum drift during high water.

Section II. SELECTING TYPE AND UNITS OF CONSTRUCTION

77. GENERAL. Principal factors to be considered in selecting types and units of construction are:

a. Material limitations.
b. Equipment limitations.
c. Labor limitations.
d. Flood problems.
e. Foundation problems.
f. Economy in construction.

78. SELECTION DIAGRAMS. a. Diagrams to aid in selecting type of construction are given in tables XVII to XXIV. Two diagrams are given for each bridge class, one showing combinations of units with spread footings and one showing combinations of units with pile foundations. Sets of drawings covering each type of construction are also listed.

b. Diagrams may be entered from the left with height of structure, or from the right with span length. Preferred combinations of units are indicated by heavy lines. Order of preference in each bracket is given by order of listing from top of diagrams.

79. MATERIALS LIMITATIONS. a. General. Principal materials used in semipermanent trestle bridges are timber and steel. Concrete is used only in foundation units; designs in timber or steel are also provided. Timber is usually easiest to obtain and when not available at engineer depots can often be obtained locally.

b. Span lengths. Material for stringers determines the maximum span that can be used. The lengths of timber and steel spans for which designs are provided are listed in table I. Maximum span lengths are given also in the selection diagrams, tables XVII to XXIV.

c. Tower heights. Towers up to 80 feet high can be built of either timber or steel if necessary sections are available.

d. Pile foundations. If piles for bents and piers do not extend far enough above ground after securing necessary penetration, they must be spliced. Designs are provided for pile bents and piers up to the limiting heights from ground or water surface to top of cap listed in chapter 2 and in the selection diagrams.

e. Grillages. Sections required for steel grillages are the same as those used in steel towers. For timber grillages 6- by 8-inch timber only is used.

f. Concrete foundations. Concrete for foundations requires cement from engineer depots, and aggregates and mixing water from sources close to the site.

80. EQUIPMENT LIMITATIONS. a. Framing and fabrication. Timber bridges can be framed with organic equipment of construction troops. Fabrication of steel requires special equipment for cutting, drilling, and riveting or welding, much of which must be secured from depots. Tools and equipment required for fabrication of steel are described in chapter 11.

b. Erection. Timber bridges can be erected with organic equipment and, if necessary, without powered equipment. Steel members are heavier and generally longer; their handling and erection requires heavy equipment. Difficult erection problems require special equipment. Erection equipment is described in chapter 14.

c. Pile driving. Pile construction requires standard pile-driving equipment. Safe construction of the designs given cannot be obtained with light, expedient pile drivers.

81. LABOR LIMITATIONS. a. Engineer troops are familiar with the use of carpentry tools in framing timber. Timber framing does not require the specialized skills needed for fabricating steel. Template making, lay-out of steel, cutting, drilling, riveting, and welding, all require special training.

b. Erection of long spans on high towers is hazardous. It should be undertaken only by well-trained and properly equipped erection crews.

82. FLOOD PROBLEMS. Choice of construction type is influenced by characteristics of the stream at flood stage. The flood channel should be obstructed as little as possible. Units requiring longitudinal bracing should not be used where they will be subjected to strong currents, drift, or ice.

a. Span lengths over floodways should be made as long as practicable to reduce stream obstructions.

b. Pile bents and pile piers offer least obstruction and greatest strength against transverse loads imposed by current, drift, and ice.

c. Steel towers present less obstruction to stream flow than wood towers and are more stable than timber towers during floods. Steel frame pedestals on steel piles provide very secure anchorage; their construction is justified if frequent, extreme flash floods are expected.

d. Because of their buoyancy, timber towers should not be used where they will be fully submerged at flood stage, unless weighted down to prevent flotation.

e. If the stream bed is subject to scour, pile foundations are preferred. Spread footings, if used, are protected with riprap.

83. FOUNDATION PROBLEMS. a. Spread footings. Spread footings require stable foundation material able to support a unit load of not less than 3,000 pounds per square foot. Bearing capacity of soil should be determined by the load tests described in chapter 6. If test data are not available, approximate bearing capacities of soils given in table XXV can be used.

TABLE XXV. *Bearing capacity of soils.*

General description	Condition	Safe allowable pressure (psf)
Fine-grained soils: Clays, silts, very fine sands, or mixtures of these containing few coarse particles of sand or gravel. Classification: MH, CH, OH, ML, CL, OL.	Soft, unconsolidated, having high moisture content (mud)	1,000
	Stiff, partly consolidated, medium moisture content	4,000
	Hard, well-consolidated, low moisture content (slightly damp to dry).	8,000
Sands and well-graded sandy soils containing some silt and clay. Classification: SW, SC, SP, SF.	Loose, not confined	3,000
	Loose, confined	5,000
	Compact	10,000
Gravel and well-graded gravelly soils containing some sand, silt, and clay. Classification: GW, GC, GP.	Loose, not confined	4,000
	Loose, confined	6,000
	Compact	12,000
	Cemented sand and gravel	16,000
Rock	Poor quality rock, soft and fractured; also hardpan	10,000
	Good quality; hard and solid	20,000

b. Pile foundations. Pile foundations are used if the soil will not safely support spread footings, if deep excavation is required to reach a satisfactory bearing for spread footings if scour may occur, or if currents or floods make lateral support necessary. Pile foundations may also be used where depth of water makes construction of spread footings difficult. Usual depths to which piles must be driven to develop satisfactory bearing capacity are obtained from table XXVI.

84. ECONOMY IN CONSTRUCTION. a. Proportions. Span lengths should be balanced against height of supports to secure the most economic proportions. Recommended span lengths for each type of supporting structure based on least expenditure in materials and labor are shown on the selection diagrams. Where a range of values is shown, shorter spans in lower structures and longer spans in higher structures give maximum economy.

TABLE XVII. *Selection diagram, class 50, single-lane highway bridges with pile foundations.*

HEIGHT OF BRIDGE[3]	TYPE OF FOUNDATION	TYPE OF SUPPORT	TYPE OF SPAN	RECOMMENDED SPAN LENGTH (feet)	MAXIMUM SPAN LENGTH (feet)
Abutments up to 6 ft[4]		Timber pile abutment 50 s-6 50 s-7	Timber stringers 50 s-1	15	15
			Steel stringers 50 s-2	15 to 90	90
		Steel pile abutment 50 s-7	Steel stringers 50 s-2	15 to 90	90
Intermediate Supports up to 18 ft[2]	Pile bents or pile piers	Timber pile bent 50 s-8	Timber stringers 50 s-1	15	15
		Timber pile pier 50 s-9[7]	Steel stringers 50 s-2	30, 40	90, 50[7]
		Steel pile bent 50 s-10	Steel stringers 50 s-2	30, 40	[5]
		Steel pile pier 50 s-10	Steel stringers 50 s-2	60, 70	90
Intermediate Supports 18 to 30 ft	Pile bents or pile piers	Timber pile bent 50 s-8	Timber stringers 50 s-1	15	15
		Steel pile bent 50 s-10[8]	Steel stringers 50 s-2	30, 40	50, 35[8]
		Steel pile pier 50 s-10 Maximum height of bridge 35 ft[8]	Steel stringers 50 s-2	60, 70	90
	Pile footings — Timber piles — Timber sill 50 s-11[6]	Framed timber tower 50 s-4	Steel stringers 50 s-2	30, 40, 50, 60	90
	Pile footings — Timber piles — Concrete pedestal 50 s-13	Framed steel tower 50 s-5	Steel stringers 50 s-2	40, 50, 60	90
	Pile footings — Steel piles — Concrete pedestal 50 s-13	Framed steel tower 50 s-5	Steel stringers 50 s-2	40, 50, 60	90
	Pile footings — Steel piles — Steel frame 50 s-14	Framed steel tower 50 s-5	Steel stringers 50 s-2	40, 50, 60	90
Intermediate Supports 30 to 80 ft	Pile footings — Timber piles — Concrete pedestal 50 s-13	Framed steel tower 50 s-5	Steel stringers 50 s-2	60, 70, 80, 90	90
	Pile footings — Timber piles — Timber sill 50 s-11[6]	Framed timber tower 50 s-4 50 s-3	Steel stringers 50 s-2	60, 70, 80, 90	90
			Timber stringers 50 s-1	15	15
	Pile footings — Steel piles — Concrete pedestal 50 s-13	Framed steel tower 50 s-5	Steel stringers 50 s-2	60, 70, 80, 90	90
	Pile footings — Steel piles — Steel frame 50 s-14	Framed steel tower 50 s-5	Steel stringers 50 s-2	60, 70, 80, 90	90

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 1 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

[5] Average length of two spans on bent.

[6] Where built over water, use braced piles as shown on sheet 36.

[7] Timber pile piers can be built to 30 feet maximum height from grade to ground. When height exceeds 18 ft the average length of two spans on pier is not to exceed 5C feet, and additional bracing similar to that detailed for lower piers is to be provided.

[8] Steel pile bents can be built to 30 feet maximum height from grade to ground. For heights up to 23 feet the average length or two spans on bent is not to exceed 35 feet.

TABLE XVIII. *Selection diagram, class 50, single-lane highway bridges with spread footings.*

HEIGHT OF BRIDGE[3]	TYPE OF SUPPORT	TYPE OF SPAN	RECOMMENDED SPAN LENGTH (feet)	MAXIMUM SPAN LENGTH (feet)
Abutments Up to 6 ft[4]	Timber Grillage abutment 50 s-6 50 s-7	Timber stringers 50 s-1	15	15
		Steel stringers 50 s-2	15 to 90	90
	Concrete abutment 50 s-7	Steel stringers	15 to 90	90
Intermediate Supports Up to 30 ft	Concrete pedestal 50 s-12 50 s-13 — Framed timber tower 50 s-3 50 s-4	Timber stringers 50 s-1	15	15
		Steel stringers 50 s-2	30, 40, 50	90
	Concrete pedestal 50 s-12 50 s-13 — Framed steel tower 50 s-5	Steel stringers 50 s-2	40, 50, 60	90
	Timber grillage 50 s-16 — Framed timber tower 50 s-3 50 s-4	Timber stringers 50 s-1	15	15
		Steel stringers 50 s-2	30, 40, 50	90
	Steel grillage 50 s-16 — Framed steel tower 50 s-2	Steel stringers 50 s-2	40, 50, 60	90
Intermediate Supports 30 to 80 ft	Concrete pedestal 50 s-13 — Framed steel tower 50 s-5	Steel stringers 50 s-2	50, 60, 70, 80, 90	90
	Steel grillage 50 s-15 — Framed steel tower	Steel stringers 50 s-2	50, 60, 70, 80, 90	90
	Concrete pedestal 50 s-12 — Framed timber tower 50 s-4 50 s-3	Steel stringers 50 s-2	50, 60, 70, 80, 90	90
		Timber stringers 50 s-1	15	15
	Timber grillage 50 s-16 — Framed timber tower 50 s-4 50 s-3	Steel stringers 50 s-2	50, 60, 70, 80, 90	90
		Timber stringers 50 s-1	15	15

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 1 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

TABLE XIX. *Selection diagram, class 50, double-lane highway bridges with pile foundations.*

HEIGHT OF BRIDGE [3]	TYPE OF FOUNDATION			TYPE OF SUPPORT	TYPE OF SPAN	RECOMMENDED SPAN LENGTH (Feet)	MAXIMUM SPAN LENGTH (Feet)
Abutments up to 6 ft [4]				Timber pile abutment 50 D-6 50 D-6	Timber stringers 50 D-1	15	15
					Steel stringers 50 D-2	15 to 90	90
				Steel pile abutment 50 D-7	Steel stringers 50 D-2	15 to 90	90
Intermediate supports up to 18 ft [3]	Pile bents or pile piers			Timber pile bent 50 D-8	Timber stringers 50 D-1	15	15
				Timber pile pier [7] 50 D-9	Steel stringers 50 D-2	30, 40	90, 50 [7]
				Steel pile bent 50 D-10	Steel stringers 50 D-2	30, 40	50 [5]
				Steel pile pier 50 D-10	Steel stringers 50 D-2	60, 70	90
Intermediate supports 18 to 30 ft	Pile bents or pile piers			Timber pile bent 50 D-8	Timber stringers 50 D-1	15	15
				Steel pile bent 50 D-10 [8]	Steel stringers 50 D-2	30, 40	50, 35 [5]
				Steel pile pier 50 D-10 Maximum height of bridge 35 ft [3]	Steel stringers 50 D-2	60, 70	90
	Pile footings	Timber piles	Timber sills 50 D-11 [6]	Framed timber tower 50 D-4	Steel stringers 50 D-2	30, 40 50	90
			Concrete pedestal 50 D-13	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60	90
		Steel piles	Concrete pedestal 50 D-13	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60	90
			Steel frame 50 D-14	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60	90
Intermediate supports 30 to 80 ft	Pile footings	Timber piles	Concrete pedestal 50 D-13	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60, 70	90
			Timber sills 50 D-11 [6]	Framed timber tower 50 D-4 50 D-3	Steel stringers 50 D-2	40, 50, 60, 70	90
					Timber stringers 50 D-1	15	15
		Steel piles	Concrete pedestal 50 D-13	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60, 70	90
			Steel frame 50 D-14	Framed steel tower 50 D-5	Steel stringers 50 D-2	40, 50, 60, 70	90

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 44 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

[5] Average length of two spans on bent.

[6] Where built over water, use braced piles as shown on sheet 81.

[7] Timber pile piers can be built to 30 feet maximum height from grade to ground. When height exceeds 18 ft the average length of two spans on pier is not to exceed 50 feet, and additional bracing similar to that detailed for lower piers is to be provided.

[8] Steel pile bents can be built to 30 feet maximum height from grade to ground. For heights up to 23 feet the average length of two spans on the bent is not to exceed 50 feet. When height exceeds 23 feet the average length of two spans on bent is not to exceed 35 feet.

TABLE XX. *Selection diagram, class 50, double-lane highway bridges with spread footings.*

HEIGHT OF BRIDGE [3]	FOOTING	TYPE OF SUPPORT	TYPE OF SPAN	RECOMMENDED SPAN LENGTH (Feet)	MAXIMUM SPAN LENGTH (Feet)
Abutments up to 6 ft		Timber grillage abutment 50 D-6 50 D-7	Timber stringers 50 D-1	15	15
			Steel stringers 50 D-2	15 to 90	90
		Concrete abutment 50 D-7	Steel stringers 50 D-2	15 to 90	90
Intermediate supports up to 30 ft	Concrete pedestal 50 D-12 50 D-13	Framed timber tower 50 D-3 50 D-4	Timber stringers 50 D-1	15	15
			Steel stringers 50 D-2	20, 30, 40	90
		Framed steel tower 50 D-2	Steel stringers 50 D-2	40, 50	90
	Timber grillage 50 D-16	Framed timber tower 50 D-3 50 D-4	Timber stringers 50 D-1	15	15
			Steel stringers 50 D-2	30, 40	90
	Steel grillage 50 D-15	Framed steel tower 50 D-5	Steel stringers 50 D-2	30, 40, 50	90
Intermediate supports 30 to 80 ft		Framed steel tower 50 D-5	Steel stringers 50 D-2	50, 60, 70	90
	Steel grillage 50 D-15	Framed steel tower 50 D-5	Steel stringers 50 D-2	50, 60, 70	90
		Framed timber tower 50 D-4 50 D-3	Steel stringers 50 D-2	40, 50, 60, 70	90
			Timber stringers 50 D-1	15	15
	Timber grillage 50 D-16	Framed timber tower 50 D-4 50 D-3	Steel stringers 50 D-2	40, 50, 60, 70	90
			Timber stringers 50 D-1	15	15

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 44 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

Table XXI. *Selection diagram, class 25, double-lane highway bridges with pile foundations.*

Height of bridge [3]	Type of foundation	Type of support	Type of span	Recommended span length (feet)	Maximum span length (feet)
Abutments up to 6 ft [4]		Timber pile abutment 25 D-6, 25 D-7	Timber stringers 25 D-1	15	15
			Steel stringers 25 D-2	15 to 90	90
		Steel pile abutment 25 D-7	Steel stringers 25 D-2	15 to 90	90
Intermediate supports up to 18 ft [7]	Pile bents or pile piers	Timber pile bent 25 D-8	Timber stringers 25 D-1	15	15
		Timber pile pier 25 D-9 [7]	Steel stringers 25 D-2	20, 30, 40, 50	90, 60 [7]
		Steel pile bent 25 D-10	Steel stringers 25 D-2	20, 30, 40	50
		Steel pile pier 25 D-10	Steel stringers 25 D-2	60, 70	90
Intermediate supports 18 to 30 ft	Pile bents or pile piers	Timber pile bent 25 D-8	Timber stringers 25 D-1	15	15
		Steel pile bent 25 D-10 [8]	Steel stringers 25 D-2	20, 30, 40	50, 35 [8]
		Steel pile pier 25 D-10	Steel stringers 25 D-2	60, 70	90
		Maximum height of bridge 35 ft [7]			
	Pile footings; Timber piles; Timber sill 25 D-11 [6]	Framed timber tower 25 D-4	Steel stringers 25 D-2	30, 40, 50, 60	90
	Pile footings; Timber piles; Concrete pedestal 25 D-13	Framed steel tower 25 D-5	Steel stringers 25 D-2	40, 50, 60	90
	Pile footings; Steel piles; Concrete pedestal 25 D-13	Framed steel tower 25 D-5	Steel stringers 25 D-2	40, 50, 60	90
	Pile footings; Steel piles; Steel frame 25 D-14	Framed steel tower 25 D-5	Steel stringers 25 D-2	40, 50, 60	90
Intermediate supports 30 to 80 ft	Pile footings; Timber piles; Concrete pedestal 25 D-13	Framed steel tower 25 D-5	Steel stringers 25 D-2	60, 70, 80, 90	90
	Pile footings; Timber piles; Timber sill 25 D-11 [6]	Framed timber tower 25 D-4, 25 D-3	Steel stringers 25 D-2	60, 70, 80, 90	90
			Timber stringers 25 D-1	15	15
	Pile footings; Steel piles; Concrete pedestal 25 D-13	Framed steel tower 25 D-5	Steel stringers 25 D-2	60, 70, 80, 90	90
	Pile footings; Steel piles; Steel frame 25 D-14	Framed steel tower 25 D-5	Steel stringers 25 D-2	60, 70, 80, 90	90

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 91 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

[5] Average length of two spans on bent.

[6] Where built over water use braced piles as shown on sheet 121.

[7] Timber pile piers can be built to 30 feet maximum height from grade to ground. When height exceeds 18 feet the average length of two spans on pier is not to exceed 60 feet and the additional bracing similar to that detailed for low piers is to be provided.

[8] Steel pile bents can be built to 30 feet maximum height from grade to ground. For heights up to 23 feet the average length of two spans on bent is not to exceed 50 feet. When height exceeds 23 feet the average length of two spans on bent is not to exceed 35 feet.

Table XXII. *Selection diagram, class 25, double-lane highway bridges with spread footings.*

Height of bridge [3]	Footing	Type of support	Type of span	Recommended span length (feet)	Maximum span length (feet)
Abutments up to 6 ft [4]		Timber grillage abutment 25 D-6, 25 D-7	Timber stringers 25 D-1	15	15
			Steel stringers 25 D-2	15 to 90	90
		Concrete abutment 25 D-7	Steel stringers 25 D-2	15 to 90	90
Intermediate supports up to 30 ft	Concrete pedestal 25 D-12, 25 D-13	Framed timber tower 25 D-3, 25 D-4	Timber stringers 25 D-1	15	15
			Steel stringers 25 D-2	30, 40, 50	90
		Framed steel tower 25 D-5	Steel stringers 25 D-2	40, 50, 60	90
	Timber grillage 25 D-16	Framed timber tower 25 D-3, 25 D-4	Timber stringers 25 D-1	15	15
			Steel stringers 25 D-2	30, 40, 50,	90
	Steel grillage 25 D-15	Framed steel tower 25 D-2	Steel stringers 25 D-2	40, 50, 60	90
Intermediate supports 30 to 80 ft	Concrete pedestal 25 D-13	Framed steel tower 25 D-5	Steel stringers 25 D-2	50, 60, 70, 80	90
	Steel grillage 25 D-15	Framed steel tower 25 D-5	Steel stringers 25 D-2	50, 60, 70, 80	90
	Concrete pedestal 25 D-12	Framed timber tower 25 D-3, 25 D-4	Steel stringers 25 D-2	50, 60, 70, 80, 90	90
			Timber stringers 25 D-1	15	15
	Timber grillage 25 D-16	Framed timber tower 25 D-3, 25 D-4	Steel stringers 25 D-2	50, 60, 70, 80, 90	90
			Timber stringers 25 D-1	15	15

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 91 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

Table XXIII. *Selection diagram, E–45 railway bridges with pile foundations.*

HEIGHT OF BRIDGE [3]	TYPE OF FOUNDATION	TYPE OF SUPPORT	TYPE OF SPAN	RECOMMENDED SPAN LENGTH (feet)	MAXIMUM SPAN LENGTH (feet)
Abutments up to 6 ft		Timber pile abutment RR–6 RR–7	Timber stringers RR–1	16	16
Abutments up to 6 ft		Timber pile abutment RR–6 RR–7	Steel stringers RR–2	15 to 50	50
Abutments up to 6 ft		Steel pile abutment RR–7	Steel stringers RR–2	15 to 50	50[4]
Intermediate supports up to 15 ft	Pile bents or pile piers	Timber pile bent RR–8	Timber stringers RR–1	16	16
Intermediate supports up to 15 ft	Pile bents or pile piers	Timber pile pier RR–9	Steel stringers RR–2	20, 25, 30	50
Intermediate supports up to 15 ft	Pile bents or pile piers	Steel pile bent RR–10	Steel stringers RR–2	20, 25, 30	30
Intermediate supports up to 15 ft	Pile bents or pile piers	Steel pile pier RR–10	Steel stringers RR–2	35, 40, 45	50
Intermediate supports 15 to 30 ft	Pile bents or pile piers	Timber pile bent RR–8 Maximum height of bridge 30 ft [3]	Timber stringers RR–1	16	16
Intermediate supports 15 to 30 ft	Pile bents or pile piers	Steel pile bent RR–10 Maximum height of bridge 23 ft [3]	Steel stringers RR–2	20, 25, 30	30
Intermediate supports 15 to 30 ft	Pile bents or pile piers	Steel pile pier RR–10 Maximum height of bridge 23 ft [3]	Steel stringers RR–2	35, 40, 45	50
Intermediate supports 15 to 30 ft	Pile footings — Timber piles — Timber sill RR-11 [5]	Framed timber tower RR–4	Steel stringers RR–2	35, 40, 45, 50	50
Intermediate supports 15 to 30 ft	Pile footings — Timber piles — Concrete pedestal RR–13	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 15 to 30 ft	Pile footings — Steel piles — Concrete pedestal RR–13	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 15 to 30 ft	Pile footings — Steel piles — Steel frame RR–14	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Pile footings — Timber piles — Concrete pedestal RR–13	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Pile footings — Timber piles — Timber sill RR-11 [5]	Framed timber tower RR–4 RR–3	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Pile footings — Timber piles — Timber sill RR-11 [5]	Framed timber tower RR–4 RR–3	Timber stringers RR–1	16	16
Intermediate supports 30 to 80 ft	Pile footings — Steel piles — Concrete pedestal RR–13	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Pile footings — Steel piles — Steel frame RR–14	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50

(Diagram rendered as table; in the original, heavy lines indicate preferred combinations: Timber pile abutment with steel stringers; Timber pile pier with steel stringers; Steel pile bent with steel stringers (15 to 30 ft); Timber sill/Framed timber tower with timber piles (30 to 80 ft).)

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 156 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

[5] Where built over water, use braced piles as shown on sheet 212 and 213.

Table XXIV. *Selection diagram, E–45 railway bridges with spread footings.*

HEIGHT OF BRIDGE [3]	FOOTING	TYPE OF SPAN		RECOMMENDED SPAN LENGTH (feet)	MAXIMUM SPAN LENGTH (feet)
Abutments up to 6 ft		Timber grillage abutment RR–6 RR–7	Timber stringers RR–1	16	16
Abutments up to 6 ft		Timber grillage abutment RR–6 RR–7	Steel stringers RR–2	15	15
Abutments up to 6 ft		Concrete abutment RR–7	Steel stringers RR–2	15 to 50	50
Intermediate supports up to 30 ft	Concrete pedestal RR–12 RR–13	Framed timber tower RR–3	Timber stringers RR–1	16	16
Intermediate supports up to 30 ft	Concrete pedestal RR–12 RR–13	Framed timber tower RR–3	Steel stringers RR–2	30	50
Intermediate supports up to 30 ft	Concrete pedestal RR–12 RR–13	Framed steel tower RR–5	Steel stringers RR–2	35, 40, 45, 50	50
Intermediate supports up to 30 ft	Timber grillage RR–16	Framed timber tower RR–3	Timber stringers RR–1	16	16
Intermediate supports up to 30 ft	Timber grillage RR–16	Framed timber tower RR–3	Steel stringers RR–2	30	50
Intermediate supports up to 30 ft	Steel grillage RR–15	Framed steel tower RR–5	Steel stringers RR–2	35, 40, 45, 50	50
Intermediate supports 30 to 80 ft	Concrete pedestal RR–13	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Steel grillage RR–15	Framed steel tower RR–5	Steel stringers RR–2	40, 45, 50	50
Intermediate supports 30 to 80 ft	Concrete pedestal RR–12	Framed timber tower RR–3 RR–4	Steel stringers RR–2	30 35, 40, 45	50
Intermediate supports 30 to 80 ft	Concrete pedestal RR–12	Framed timber tower RR–3 RR–4	Timber stringers RR–1	16	16
Intermediate supports 30 to 80 ft	Timber grillage RR–16	Framed timber tower RR–4 RR–3	Steel stringers RR–2	30 35, 40, 45	50
Intermediate supports 30 to 80 ft	Timber grillage RR–16	Framed timber tower RR–4 RR–3	Timber stringers RR–1	16	16

(Diagram rendered as table; in the original, heavy lines indicate preferred combinations: Timber grillage abutment with timber stringers; Concrete pedestal with framed timber tower and steel stringers (up to 30 ft); Concrete pedestal/Framed steel tower with steel stringers (30 to 80 ft).)

[1] Heavy lines indicate preferred combination of units. Other combinations shown in vertical position in brackets by order of preference.

[2] Drawing-set number listed on sheet 156 is noted under each construction unit in table.

[3] Height of structure from grade to ground.

[4] Height of retained fill.

TABLE XXVI. *Approximate load capacities per foot of penetration for piles deriving their support principally from friction. Use for preliminary estimates of required length and number of piles when actual test data are not available.*

Soil type	Range of safe load, per foot of penetration for pile of mean diameter: 9"	12"	15"
	Ton	*Ton*	*Ton*
Fine grained soils: Clays, silts, very fine sands or mixtures containing few coarse sand and gravel particles. Classification: MH, CH, OH, ML, CL, OL.			
Condition 1: Soft, unconsolidated, high moisture content (mud).	0.1 to 0.15	0.13 to 0.2	0.16 to 0.25
Condition 2: Stiff, partly consolidated, medium moisture content.	.15 to .4	.2 to .6	.25 to .8
Condition 3: Hard, well-consolidated, low moisture content (slightly damp or dry).	.4 to .9	.6 to 1.2	.8 to 1.5
Sands and well-graded sandy soils containing some silt and clay. Classification: SW, SC, SP, SF.	.6 to 1.2	.8 to 1.6	1.0 to 2.0
Gravel, well-graded sandy soils containing some sand, silt, and clay. Classification: GW, GC, GP, GF.	.7 to 2.0	1.0 to 2.5	1.2 to 3.0

(1) Soils classification as shown in FM 5-10, 1944 edition, table I.
(2) For other pile diameters, safe load varies in proportion to diameter.
(3) Piles must be driven at least 8 feet in hard ground and 15 to 20 feet in soft ground.
(4) Piles resting on a hard stratum act as columns and this table does not apply.
(5) The above values of pile bearing capacity are used in estimates of piling, lacking more accurate information. The required pile penetration should always be based on actual driving described in paragraph 155.

b. Duplication. Uniformity in type and units of construction is preferred. Repetition makes for faster and better work and limits the variety of equipment required.

c. Transportation. Materials close at hand or readily available are preferred. Construction requiring lighter and fewer pieces of equipment is preferred for the same reason.

d. Time. Ordinarily, timber construction requires less time than longer-span steel construction.

85. COMPARATIVE ESTIMATES. After alternative lay-outs have been made, estimates of materials and labor as well as principal equipment requirements are compared. Material requirements for all units of construction are given in tables XXVII to XXX. Man-hour requirements for all units are given in tables XXXIII to XXXVII. Equipment requirements are given in table XXXI.

CHAPTER 8

CONSTRUCTION PLANNING

86. GENERAL. a. Careful planning of work eliminates unnecessary delay and rehandling of materials and parts. It insures completing parts in orderly sequence and completing the bridge within the time allotted.

TABLE XXVII. *Summary of materials—highway bridges, class 50, single-lane.*

(1) Summary of materials for bents, piers, and abutments.

Type	Abutments: Timber pile		Steel pile	Timber grillage						Concrete		Bents: Timber pile bent	Steel pile bent	Piers: Timber pile pier	Steel pile pier
Height of retained fill	6 feet		6 ft.	3 feet			6 feet			3 ft.	6 ft.				
Maximum span—feet	15	90	90	15	40	90	15	40	90	90	90	15	[4]50	90	90
Piles—each	[1]6	[1]6	[1]5	....	....	....	....	....	....	....	....	4	3	8	6
Timber—mbm	0.72	0.88	0.81	0.69	0.92	1.41	1.39	1.59	1.99	....	....	[3]0.19 / 0.78 / 0.77	....	[6]1.08 / 1.10	....
Steel—tons	....	....	1.32	....	....	....	....	....	....	....	....	....	[5]0.94 / 0.99	....	[5]2.05 / 2.49
Concrete—cu. yd.	....	....	....	....	....	....	....	....	....	[2]11.7 / 14.0	[2]18.0 / 20.8	....	....	....	....

[1] Includes 2 wing piles.
[2] For 36- and 16-inch steel stringers.
[3] For heights of 10, 20 and 30 feet. Includes longitudinal bracing.
[4] Average length of two spans on bent. See table LI.
[5] For heights of 10 and 23 feet.
[6] For heights of 10 and 18 feet.

(2) Summary of materials for footings.

Timber grillages: Unit	Timber (mbm)	Steel grillages (Bolted): Unit	Steel (tons)	Concrete pedestals: Unit	Concrete (cu. yd.)	Unit	Concrete (cu. yd.)	Concrete pedestals, timber piles: Unit	Piles (number)	Concrete (cu. yd.)	Concrete pedestals, steel piles: Piles (number)	Concrete (cu. yd.)	Timber sills, timber piles: Piles (number)	Steel frame, steel piles: Piles (number)	Steel (tons)
G113	0.32	S101	1.89	F104	11.4	F112	5.6	F134	4	5.0	4	5.1	12	4	1.19
G114	0.16	S102	2.86	F105	6.0	F113	3.0	F135	5	5.8	....	....	24	....	....
G115	0.64	....	....	F106	10.2	F114	2.7	F136	6	7.1	....	....	....	....	....
G116	0.32	....	....	F107	5.2	F115	2.5	F137	7	9.3	....	....	....	....	....
G117	0.29	....	....	F108	9.1	F121	7.4	....	....	....	....	....	....	....	....
G118	0.15	....	....	F109	4.5	F122	9.1	....	....	....	....	....	....	....	....
G119	0.58	....	....	F110	6.1	F123	10.8	....	....	....	....	....	....	....	....
G120	0.29	....	....	F111	5.9	F124	12.9	....	....	....	....	....	....	....	....

(3) Summary of materials for towers and spans.

Framed timber towers[1]: Timber spans: Height (ft.-in.)	mbm	Steel spans: Height (ft.-in.)	mbm	Framed steel towers[1]: Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Timber spans[2]: Length (feet)	Timber (mbm)	Steel spans: Length (feet)	Steel (tons)	Timber (mbm)
13–4	2.60	13–4	5.03	77	26.11	59	20.14	41	14.51	23	8.99	11	1.90	15	1.37	2.40
25–10	5.01	25–10	9.45	75	25.79	57	19.84	39	14.13	21	8.74	13	2.21	20	2.18	3.15
38–4	7.55	38–4	14.18	73	25.65	55	19.54	37	13.85	19	8.43	15	2.55	30	4.72	4.66
50–10	10.18	50–10	19.08	71	25.19	53	19.25	35	13.59	17	8.22	....	....	40	7.44	6.17
63–4	12.92	63–4	24.20	69	24.89	51	18.98	33	13.32	15	7.98	....	....	50	12.13	7.69
75–10	15.75	75–10	29.58	67	21.27	49	15.50	31	10.04	....	....	....	....	60	16.34	9.18
....	....	....	....	65	21.00	47	15.23	29	9.78	....	....	....	....	70	20.20	10.73
....	....	....	....	63	20.71	45	14.97	27	9.52	....	....	....	....	80	26.37	12.21
....	....	....	....	61	20.43	43	14.68	25	9.25	....	....	....	....	90	37.39	13.76

[1] Material in tower spans not included.
[2] Includes timber in deck.

TABLE XXVIII. *Summary of materials—highway bridges, class 50, double-lane.*

(1) Summary of materials for bents, piers, and abutments.

Type	Abutments												Bents		Piers	
	Timber pile			Steel pile	Timber grillage						Concrete		Timber pile bent	Steel pile bent	Timber pile pier	Steel pile pier
Height of retained fill	6 feet			6 feet	3 feet			6 feet			3 feet	6 feet				
Maximum span—feet	15	50	90	90	15	40	90	15	40	90	90	90	15	[4]50	90	90
Piles—each	[1]8	[1]8	[1]10	[1]6	....	....	....	....	....	....	....	....	6	4	12	6
Timber—mbm	1.16	1.45	1.50	1.09	1.17	1.39	2.11	2.22	2.43	3.38	....	....	[3].34 1.15 1.39	....	[6]1.70 1.75	....
Steel—tons	....	....	....	1.65	....	....	....	....	....	....	....	....	....	[5]1.78 1.81	....	[5]3.26 3.70
Concrete—cu. yd	....	....	....	....	....	....	....	....	....	....	[2]18.2 21.4	[2]28.1 32.1	....	....	....	....

[1] Includes 2 wing piles.
[2] For 36- and 18-inch steel stringers.
[3] For heights of 10, 20, and 30 feet from grade to ground. Includes longitudinal bracing.
[4] Average length of two spans on bent. See table LI.
[5] For heights of 10 and 23 feet from grade to ground.
[6] For heights of 10 and 18 feet from grade to ground.

(2) Summary of materials for footings.

Timber grillages		Steel grillages		Concrete pedestals		Concrete pedestals, timber piles			Concrete pedestals, steel piles		Timber sills, timber piles	Steel frame, steel piles	
Unit	Timber (mbm)	Unit	Steel (tons)	Unit	Concrete (cu. yd.)	Unit	Piles (number)	Concrete (cu. yd.)	Piles (number)	Concrete (cu. yd.)	Piles (number)	Piles (number)	Steel (tons)
G113	0.32	S-101	1.89	F105	6.0	F134	4	5.0	4	5.1	8	4	1.14
G114	0.16	S-102	2.39	F107	5.2	F135	5	5.8	....	....	16	....	....
G117	0.29	....	....	F109	4.5	....	....	....	....	....	....	....	....
G118	0.14	....	....	F113	3.0	....	....	....	....	....	....	....	....
....	....	....	....	F114	2.7	....	....	....	....	....	....	....	....
....	....	....	....	F115	2.5	....	....	....	....	....	....	....	....
....	....	....	....	F120	6.0	....	....	....	....	....	....	....	....
....	....	....	....	F121	7.4	....	....	....	....	....	....	....	....
....	....	....	....	F122	9.1	....	....	....	....	....	....	....	....

(3) Summary of materials for towers and spans.

Framed timber towers[1]				Framed steel towers[2]													
Timber spans		Steel spans										Length (feet)	Timber (mbm)				
												Standard					
Height (ft.-in.)	mbm	Height (ft.-in.)	mbm	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons			Length (feet)	Steel (tons)	Timber (mbm)
13–4	3.61	13–4	7.10	77	32.11	59	25.99	41	19 89	23	14.03	11	3.20	15	2.85	3.90
25–10	6.78	25–10	13.03	75	31.82	57	25.73	39	19.59	21	13.79	13	3.74	20	4.33	4.80
38–4	10.01	38–4	19.24	73	31.54	55	25.44	37	19.34	19	13.53	15	4.31	30	7.92	6.87
50–10	13.38	50–10	25.52	71	31.26	53	25.19	35	19.07	17	13.29	....	....	40	12.26	8.79
63–4	17.00	63–4	32.40	69	30.99	51	24.93	33	18.83	15	13.06	....	....	50	21.17	10.86
75–10	20.71	75–10	39.46	67	27.06	49	20.88	31	15.03	....	....	....	....	60	27.50	12.64
....	....	....	....	65	26.88	47	20.63	29	14.66	....	....	....	....	70	36.26	14.71
....	....	....	....	63	26.55	45	20.37	27	14.53	....	....	....	....	80	50.28	16.44
....	....	....	....	61	2..29	45	20.10	25	14.27	....	....	....	....	90	72.35	18.27

[1] Material in tower spans not included.
[2] Includes timber in deck.

b. Construction planning requires:

(1) A careful estimate of the material, equipment, and personnel required to do the job.

(2) A time schedule of construction operations covering all work to be done, equipment to be used, materials required, and labor to be employed.

(3) A progress schedule and a simple system of periodic reports and records of progress so work done can be readily compared with the scheduled progress. This promotes effective supervision and job control.

c. Exact material requirements for the bridge itself are established as soon as the final layout is made. (See par. 71.) Equipment and personnel requirements and materials required for temporary construction depend on the construction procedure and the schedule adopted.

87. MATERIAL REQUIREMENTS. a. Bridge material. The drawings list all materials required for each unit of construction. A bill of materials showing each item used for each unit is prepared from these lists. Requisitions of materials for the bridge are prepared by combining similar items from all bills of materials into listings of total quantities of each item. Bills of materials contain exact count of all pieces. In requisitioning hardware such as bolts, nuts, rivets and nails, 15 percent should be added for waste, loss, and rejections.

b. Erection material. Materials needed for temporary use, such as concrete forms, falsework, cofferdams, and construction shelters are determined after the erection method has been chosen. When requisitioning these materials, unforeseen requirements and local sources of materials are taken into account. Wherever possible, construction is planned so material to be used in the final structure can also be used for temporary purposes. The manual does not give quantities of material which may be required in temporary construction. Material estimates for concrete forms, falsework, and scaffolding should be prepared from field construction sketches following instructions of TM 5–226.

88. EQUIPMENT REQUIREMENTS. a. Erection equipment requirements differ with site conditions and erection methods. Table XXXI gives tool and equipment items needed to construct each unit under usual site conditions and for the following construction procedures.

(1) Bridges less than 35 feet high from ground to grade, erected with a crawler-mounted crane operating from ground level. (See par. 210.)

(2) Bridges over 35 feet high from ground to grade.

(*a*) Towers erected with special equipment described in paragraphs 211 and 213.

(*b*) Spans not more than 50 feet long, erected with truck-mounted crane operating from deck level. (See par. 208.)

(*c*) Spans over 50 feet long, erected with the special equipment described in paragraphs 212 and 214.

(3) If other procedures are followed, equipment requirements must be modified accordingly.

b. The number of pieces of each equipment item needed is determined after the construction schedule is prepared and the time allocated to each operation is fixed. Table XXXIA gives the number necessary to outfit a single crew or detail in each operation. Operations such as framing, drilling, riveting, welding, and the like may require several crews, all using identical items of equipment.

TABLE XXIX. *Summary of materials—highway bridges, class 25, double-lane.*

(1) Summary of materials for bents, piers, and abutments.

Type	Abutments										Bents		Piers	
	Timber pile		Steel pile	Timber grillage				Concrete			Timber pile bent	Steel pile bent	Timber pile pier	Steel pile pier
Height of retained fill	6 feet		6 ft.	3 feet		6 feet		3 ft.	6 ft.					
Maximum span, feet	15	90	90	15	90	15	90	90	90		15	[4]50	90	90
Piles, each	[1]7	[1]7	[1]6	....	....	....	....	....	....		4	3	8	6
Timber, mbm	1.11	1.32	1.09	1.17	1.54	2.22	2.44	....	....		[3].34 1.16 1.21	....	[6]1.71 1.75	....
Steel, tons	....	....	1.62	....	....	....	....	....	....		....	[5]1.77 1.80	....	[5]3.18 3.62
Concrete, cu. yd	....	....	....	....	....	....	....	[2]18.7 22.1	[2]28.8 33.0		....	....	....	....

[1] Includes 2 wing piles.
[2] For 36- and 14-inch steel stringers.
[3] For heights of 10, 20, and 30 feet from grade to ground. Includes longitudinal bracing.
[4] Average length of two spans on bent. See table LI.
[5] For heights of 10 and 23 feet from grade to ground.
[6] For heights of 10 and 18 feet from grade to ground.

(2) Summary of materials for footings.

Timber grillages		Steel grillages		Concrete pedestals		Concrete pedestals, timber piles			Concrete pedestals, steel piles		Timber sills, timber piles	Steel frame, steel piles	
Unit	Timber (mbm)	Unit	Steel (tons)	Unit	Concrete (cu. yd.)	Unit	Piles (number)	Concrete (cu. yd.)	Piles (number)	Concrete (cu. yd.)	Piles (number)	Piles (number)	Steel (tons)
G113	0.32	S101	1.89	F105	6.0	F134	4	5.0	4	5.1	8	4	1.19
G114	0.16	S102	2.86	F107	5.2	F135	5	5.8	....	....	16	....	....
G117	0.29	....	....	F109	4.5	....	....	....	....	....	....	....	....
G118	0.15	....	....	F113	3.0	....	....	....	....	....	....	....	....
....	....	....	....	F114	2.7	....	....	....	....	....	....	....	....
....	....	....	....	F115	2.5	....	....	....	....	....	....	....	....
....	....	....	....	F120	6.0	....	....	....	....	....	....	....	....
....	....	....	....	F121	7.4	....	....	....	....	....	....	....	....
....	....	....	....	F122	9.1	....	....	....	....	....	....	....	....
....	....	....	....	F123	10.8	....	....	....	....	....	....	....	....

(3) Summary of materials for towers and spans.

Framed timber towers[1]				Framed steel towers[1]								Timber spans[2]		Steel spans		
Timber spans		Steel spans														
Height (ft.-in.)	mbm	Height (ft.-in.)	mbm	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Length (feet)	Timber (mbm)	Length (feet)	Steel (tons)	Timber (mbm)
13–4	3.19	13–4	6.44	77	30.18	59	23.95	41	17.97	23	12.11	11	2.65	15	2.03	3.91
25–10	5.82	25–10	11.28	75	29.89	57	23.68	39	17.66	21	11.87	13	3.09	20	2.89	4.90
38–4	8.56	38–4	16.41	73	29.60	55	23.39	37	17.41	19	11.62	15	3.56	30	6.47	7.09
50–10	11.49	50–10	21.71	71	29.33	53	23.15	35	17.14	17	11.38	....	....	40	8.75	8.88
63–4	14.53	63–4	27.38	69	29.05	51	22.88	33	16.90	15	11.13	....	....	50	15.20	10.62
75–10	17.66	75–10	33.28	67	25.01	49	18.96	31	13.11	....	....	....	....	60	19.60	12.55
....	....	....	....	65	24.78	47	18.71	29	12.75	....	....	....	....	70	26.37	14.62
....	....	....	....	63	24.51	45	18.44	27	12.61	....	....	....	....	80	34.17	16.67
....	....	....	....	61	24.29	43	18.18	25	12.36	....	....	....	....	90	41.62	18.50

[1] Material in tower spans not included
[2] Includes timber in deck.

TABLE XXX. *Summary of materials—E-45 railway bridges.*

(1) Summary of materials for bents, piers, and abutments.

Type	Abutments											Bents		Piers	
	Timber pile				Steel pile	Timber grillage				Concrete		Timber pile bent	Steel pile bent[4]	Timber pile pier[6]	Steel pile pier[6]
Height of retained fill	6 feet				6 ft.	3 feet		6 feet		3 ft.	6 ft.				
Maximum span feet	16	25	45	50	50	16	15	16	15	50	50	16	15 & 50	15 & 50	15 & 50
Piles—each	[1]6	[1]6	[1]10	[1]10	[1]6	....	....	....	....	....	....	4	8	16	16
Timber—mbm	.62	.72	1.03	1.12	.58	.82	.98	1.57	1.65	....	....	[3].17 .80 .80	....	[2]1.61 2.81	....
Steel—tons	....	....	....	....	.69	....	....	....	....	....	....	....	[5]2.93 3.32	....	6.31 8.71
Concrete—cu. yd	....	....	....	....	....	....	....	....	....	[2]13.1 14.4	[2]18.9 20.4	....	....	....	....

[1] Includes 2 wing piles.
[2] For 36- and 21-inch steel stringers.
[3] For heights of 10, 20, and 30 feet from grade to ground. Includes longitudinal bracing.
[4] Quantities are per tower—2 pile bents braced longitudinally.
[5] For heights of 10 and 23 feet from grade to ground.
[6] Quantities are per tower—2 pile piers braced longitudinally.
[7] For heights of 10 and 15 feet from grade to ground.

(2) Summary of materials for footings.

Timber grillages				Steel grillages		Concrete pedestals				Concrete pedestals, timber piles			Concrete pedestals, steel piles		Timber sills, timber piles	Steel frame, steel piles	
Unit	Timber (mbm)	Unit	Timber (mbm)	Unit	Steel (tons)	Unit	Concrete (cu. yd.)	Unit	Concrete (cu. yd.)	Unit	Piles (number)	Concrete (cu. yd.)	Piles (number)	Concrete (cu. yd.)	Piles (number)	Piles (number)	Steel (tons)
G93	.29	G107	.35	S101	1.89	F81	52	F94	24	F135	5	5.8	4	5.1	12	4	1.18
94	.32	108	.18	102	2.85	82	46	95	22	136	6	7.1	....	....	22	....	....
95	.35	109	.32	103	3.75	83	42	96	19	137	7	9.3	....	....	20	....	....
96	.58	110	.16	....	....	84	38	97	17	138	8	9.3	....	....	30	....	....
97	.64	111	.29	....	....	85	33	98	16	139	10	17.3	....	....	38	....	....
98	.70	112	.14	....	....	86	29	99	15	140	11	17.3	....	....	....	....	....
99	.20	....	....	....	....	87	40	101	5.9	....	....	....	....	....	....	....	....
101	.35	....	....	....	....	88	36	102	5.4	....	....	....	....	....	....	....	....
102	.24	....	....	....	....	89	32	103	4.8	....	....	....	....	....	....	....	....
103	.51	....	....	....	....	90	29	123	10.8	....	....	....	....	....	....	....	....
104	.26	....	....	....	....	91	26	124	12.9	....	....	....	....	....	....	....	....
105	.38	....	....	....	....	92	22	125	15.1	....	....	....	....	....	....	....	....
106	.19	....	....	....	....	93	27	....	....	....	....	....	....	....	....	....	....

(3) Summary of materials for towers and spans.

Framed timber towers[1]				Framed steel towers[1]								Timber spans		Steel spans		
Timber spans		Steel spans														
Height (ft.-in.)	mbm	Height (ft.-in.)	mbm	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Height (ft.)	Tons	Length (ft.)	Timber[2] (mbm)	Length (ft.)	Steel (tons)	Timber (mbm)
13–4	4.72	13–4	8.22	77	28.4	61	22.1	45	16.0	29	10.2	12	1.11	15	1.57	.61
25–10	8.37	25–10	13.99	75	28.0	59	21.7	43	15.7	27	9.9	14	1.32	20	2.56	.81
38–4	12.57	38–4	20.49	73	27.7	57	21.4	41	15.4	25	9.6	16	1.56	25	3.70	1.02
50–10	16.90	50–10	27.27	71	27.3	55	21.0	39	15.0	23	9.3	....	....	30	5.05	1.22
63–4	21.42	63–4	34.26	69	26.9	53	20.7	37	14.7	21	9.0	....	....	30 Spec.	2.93	1.22
75–10	26.12	75–10	42.00	67	23.1	51	20.3	35	14.4	19	8.6	....	....	35	6.42	1.42
....	....	....	....	65	22.8	49	16.7	33	14.0	17	8.3	....	....	40	8.52	1.63
....	....	....	....	63	22.5	47	16.4	31	10.6	15	8.0	....	....	45	12.18	1.83
....	....	....	....	....	....	....	....	....	....	....	....	....	....	50	17.54	2.03

[1] Material in tower span not included.
[2] Includes timber in deck.

Stock Number	Item	Size	Number for one crew	Abutments				Bents				Piers				Footings							Towers				Spans				Source
				Highway and railway				Highway		Railway		Highway		Railway		Highway and Railway							Highway and Railway				Highway and Railway				
																Steel pile		Timber pile		Spread footings			Steel		Timber		Steel			Timber	
				Concrete	Steel pile	Timber pile	Timber grillage	Steel pile	Timber pile	Steel pile	Timber pile	Steel pile	Timber pile	Steel pile	Timber pile	Concrete pedestals	Steel frame	Concrete pedestals	Timber sills	Concrete pedestals	Steel grillage	Timber grillage	Spans 15′ to 35′	Spans 35′ to 77′	Spans 12.5′ to 35′	Spans 35′ to 75′	15′ to 50′	60′ to 90′ Less than 35′ high	60′ to 90′ More than 35′ high	11′ to 16′	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
78–2965.04	Crane, truck mounted, gasoline-engine driven	3/8 cu. yd.	1	....	....	....	X	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	X	X	X	X	X	X	T/E or class IV.
78–2965.07	Crane, truck mounted, gasoline-engine driven	3/4 cu. yd.	1	....	....	....	....	....	....	X	X	....	....	X	X	....	....	....	....	....	....	....	....	....	....	....	X	X	....	....	T/E or class IV.
78–7585.07	Crane, crawler mounted, gasoline-engine driven, with crane boom.	3/4 cu. yd.	1	....	X	X	....	X	X	....	....	X	X	....	....	....	....	X	X	....	....	....	....	....	....	....	....	....	....	....	T/E or class IV.
78–5785.14	Mixer, concrete, gasoline-engine driven, trailer mounted	14 cu. ft.	1	X	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	X	....	....	....	....	....	....	....	....	....	....	Class IV.
69–9280.5–3	Wheelbarrow, general utility, steel tray, steel handles	3 cu. ft.	12	X	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	X	....	....	....	....	....	....	....	....	....	....	Class IV.
66–5335.5–18	Hammer, drop, pile-driver	1800 pound	1	....	X	X	....	X	X	....	....	X	X	....	....	X	X	X	X	....	....	....	....	....	....	....	....	....	....	....	Class IV.
66–3250.5	Compressor, air, trailer mounted diesel-engine driven[1]	500 cfm	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Class IV.
66–5340.7	Hammer, pneumatic or steam, pile-driver	5000 pound	1	....	....	....	....	....	....	X	X	....	....	X	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Class IV.
11–2650.4	Jetting set, portable, complete with gasoline-engine driven centrifugal pump and accessories, 4″.	200 gpm	1	....	X	X	....	X	X	X	X	X	X	X	X	X	X	X	X	....	....	....	....	....	....	....	....	....	....	....	Class IV.
11–4619.24	Pump, centrifugal, gasoline-engine driven, base mounted, 2-inch discharge.	55 gpm	1	X	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	X	....	....	....	....	....	....	....	....	....	....	Class IV.
66–3270.105	Compressor, air, truck or trailer mounted, gasoline-engine driven, and accessories.	105 cfm	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	T/E or class IV.
40–4003.3	Drill, pneumatic, portable, woodboring	#3 Morse Taper	1	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	Class IV.
40–8062.24	Saw, Chain, portable, pneumatic	24 in.	1	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	Class IV.
40–8128.12	Saw, circular, portable, pneumatic	12 in.	1	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	Class IV.
66–2435.7	Breaker, paving, pneumatic	70 lb.	1	X	X	X	X	....	....	....	....	....	....	....	....	X	....	X	....	X	X	X	....	....	....	....	....	....	....	....	Class IV.
66–4575.55	Drill, pneumatic, portable, rock	55 lb.	1	X	....	....	X	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	....	....	....	....	....	....	....	....	Class IV.
66–8065.3–5	Spade, pneumatic, digger	3/4″ x 2 3/4″ shank 5 1/2″ blade size	2	X	X	X	X	....	....	....	....	....	....	....	....	X	....	X	....	X	X	X	....	....	....	....	....	....	....	....	T/E or class IV.
66–6845.5	Nail driver, pneumatic with nail sets and rivet-buster	6 CND	1	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	T/E or class IV.
40–1932.5–08	Rivet set, pneumatic, buttonhead for naildriver, 6 CND	7/8-inch	2	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	Class IV.
40–3871.3	Drill, pneumatic, portable non-reversible, for steel	#3 Morse Taper	1	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	T/E or class IV.
40–5257.5	Grinder, pneumatic, rotary type	5 and 8 inch	1	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	T/E or class IV.
11–7468.5	Pump, sump, pneumatic, 2 1/2-inch discharge	150 gpm	1	X	X	X	X	....	....	....	....	....	....	....	....	X	....	X	....	X	X	X	....	....	....	....	....	....	....	....	T/E or class IV.
66–8425.5	Tamper, backfill, pneumatic	....	1	X	X	X	X	....	....	....	....	....	....	....	....	X	....	X	....	X	X	X	....	....	....	....	....	....	....	....	T/E or class IV.
66–6070.3	Lead, pile-driving, steel, hanging	20-, 15-, 10-foot sections	1	....	X	X	....	X	X	X	X	X	X	X	X	X	X	X	X	....	....	....	....	....	....	....	....	....	....	....	Class IV.
40–4498.3–6	Drill, twist, high-speed-steel, taper shank, Morse Taper No. 3.	15/16 inch	12	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	Class IV.
40–5455.3	Hammer, pneumatic, chipping, heavy duty	3 inch stroke	1	....	....	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	Class IV.
40–9823.5	Wrench, pneumatic, reversible, impact type	3/4 to 1 1/4 inch	1	....	X	X	X	X	X	X	X	X	X	X	X	....	X	....	X	....	X	X	X	X	X	X	X	X	X	X	Class IV.
41–2009.7–5	Carrier, timber, handled	4 ft.	4	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	Class IV.
41–4725.5–5	Hook, cant	4 ft.	4	X	X	X	X	....	X	....	X	....	X	....	X	X	....	X	X	X	....	X	....	....	X	X	X	X	X	X	Class IV.
79–3015.7–10	Clamp, guardrail, 10-ton ponton	....	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Class IV.
79–3015.7–25	Clamp, guardrail, 25-ton ponton	....	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Class IV.
41–4692.2–5	Hoist, chain, differential	5 ton	1	....	X	....	....	X	X	X	X	X	X	X	X	....	X	....	X	....	....	....	X	X	X	X	X	X	X	X	Class IV.
41–4878.5–12	Jack, hydraulic	12 ton	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Set 640–01 or class IV.
41–4944.3–15	Jack, ratchet-lever, double socket, with foot lift	15 ton	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Set 210.50.
41–4955.5–12	Jack, screw, with lever	12 ton	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Set 640–01 or class IV.
43–2219.08–04	Bolt, machine, steel, square head, with hexagon nut	4 inch	—[2]	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	Class IV.
43–9215.5–08	Washer, iron or steel, round, standard 2 1/4-inch diameter, 5/32-inch thick.	7/8-inch	—[2]	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	Class IV.
Set 970–01	Welding equipment, electric-arc	Set No. 1, 300 amp.	1	....	....	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	T/E or class IV.
Set 970–02	Welding and cutting equipment, oxyacetylene	Set No. 2	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	T/E.
	Special tools for structural work (not in class IV at time	of publication)																													
41–2312.300–065	Clamp, C-, heavy service	6 1/2-inch capacity	6	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	
41–5812.3	Pin, drift, 5 1/2-inch length, taper ends	15/16-inch	—[2]	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	
....	Riveting-equipment, structural, set	7/8-inch rivets	[3]	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	
....	Erection equipment, steel and timber structural, set	7/8-inch and 1-inch bolts	[2]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
....	Reamer, high-speed-steel, bridge, taper, Morse taper No. 3.	1 5/16-inch	6	....	X	....	....	X	....	X	....	X	....	X	....	....	X	....	....	....	X	....	X	X	....	....	X	X	X	....	
....	Hole cutter, adjustable highspeed steel, Morse taper No. 3, Clark, No. 4 or equal, with 3 sets blades, pilot and 3/8-inch drill.	1 1/2- to 3-inch	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	....	....	....	....	X	....	
41–49385–10	Jack, pushing and pulling, ratchet type	10-ton	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

[1] May be used instead of multiple 105 cfm units.
[2] See table XXXIC.
[3] See table XXXIB.

TABLE XXXIB. *Tool set for riveting with 7/8-inch steel rivets.*

Stock No.	Description	Quantity in set
40–5488.180–610	Hammer, pneumatic, riveting, 18-pound.	1
40–5950.06–2	Holder-on, pneumatic, 8-inch closed length with set.	1
40–7732.5–08	Rivet set, pneumatic, buttonhead, 7/8-inch, retainer type.	3
41–3604.11–18	Forge, coal-burning, rivet-heating, 18-inch.	1
41–6508.3–5	Rake, fire, portable forge.	1
41–7457.5–5	Shovel, blacksmith, portable forge.	1
	Tongs, rivet-heating and pitching.	1
	Tongs, rivet-sticking.	1
	Can, rivet-catching, handled.	1
	Bar, dolly, riveting 7/8-inch offset.	2
	Bar, dolly, riveting 7/8-inch heel.	2
	Chisel, rivet-buster, 1¼-inch edge.	1
	Rivet-buster, handled, 1½-inch edge.	1
	Punch, backing-out, bar.	1
	Punch, backing-out, handled.	1
	Hammer, striking, handled, 8-pound.	1
	Wrench, structural offset, 1 5/16-inch opening, 15-inch.	2

TABLE XXXIC. *Erection equipment, steel and timber, set.*

Stock No.	Description	Quantity in set
	Wrench, structural offset, 1 5/16-inch opening, 18-inch.	2
	Wrench, structural offset, 1½-inch opening, 18-inch.	2
	Wrench, ratchet, reversible, 16-inch handle with:	
	Loose open socket, 6-point, 1 5/16-inch for 7/8-inch bolts.	2
	Loose open socket, 4-point, 1½-inch for 1-inch bolts.	2
41–1277.3–26	Bar, pinch, offset, 26-inch.	2
41–9537.5–5	Wrench, adjustable, crescent, 1 11/16-inch opening, 15-inch.	1
41–4347.5–08	Hammer, striking, handled, 8-pound.	1
37–2456.7–5	Belt, lineman's safety, leather.	2
21–7555.3–05	Rope, manila, 3-strand, ½-inch.	50 ft.

Note: Quantity of fitting-up bolts 25 percent of quantity of rivets. Two washers per bolt. Quantity of driftpins 30 percent of quantity of rivets.

TABLE XXXII. *Required compressor capacity for portable pneumatic construction tools.*

Compressor capacity required in percent of the total maximum possible air consumption of all tools connected.

Altitude	Number of tools						
	1	2	5	8	12	20	30
	Percent of total connected tool consumption						
At set level	100	90	80	75	70	60	55
3,000 feet	110	100	90	83	75	65	60
6,000 feet	120	110	100	90	80	70	65
10,000 feet	130	120	110	100	90	78	70

c. Equipment can often be used to construct more than one unit or class of units. Cranes, special tools having only occasional use, and auxiliary equipment such as sharpening and repair tools serve several crews or details.

d. Organic equipment should be fully utilized and class IV items drawn from depot only when necessary to supplement regularly issued equipment. Common hand tools included in engineer squad and engineer platoon sets for carpentry, pioneer, and demolition work have not been listed. They are presumed to be available on all jobs and must be increased in number if required.

e. Table XXXIA does not include special supplies and equipment such as cordage, wire rope, rafting equipment and powerboats, diving sets, large air compressors, pipe and fittings, large pumps, hose for water and air, electric light plants, maintenance tools, goggles for welders, chippers, and grinders, safety belts for men working aloft, or other personal protective equipment. Those must be requisitioned in accordance with the job requirements.

f. The special tool sets listed below for manufacture and maintenance of small tools, jigs and fixtures should be available for all bridge construction. Trained specialists to operate this equipment must also be provided.

Blacksmith equipment, set No. 1.
Pipefitting equipment, set No. 1.
Rigging equipment, set No. 1.
Sign painting equipment, set No. 1.
Surveying equipment, set No. 6 (general-purpose).

g. Large-capacity compressors operating several air tools can be used instead of the 105cfm truck-counted compressors of organic equipment. However, a single unit should not be depended on where a breakdown of that unit would stop the entire operation.

(1) Volumes of air required to operate different pneumatic tools at sea level are given in table LXXXI.

(2) All tools drawing air from a single compressor are rarely in operation at one time. Capacity requirements at different altitudes for compressors driving several air tools are given in table XXXII. Compressors driving riveting equipment must be large enough to operate all hammers at full capacity.

89. LABOR REQUIREMENTS. a. Tables of labor requirements. Normal man-hour requirements for typical construction operations are given in table XXXIII. Man-hours of labor required to construct each unit are shown in tables XXXIV to XXXVII, inclusive. These tables also list the size crew normally required for efficient work in each operation.

(1) Tables are based on civil construction practice under average working conditions using power tools whenever possible. In military construction, allowance must be made for:

(*a*) Skill of workers, training of troops.
(*b*) Working conditions, extreme heat or cold.
(*c*) Adequacy of equipment.

(2) The tables give man-hours of direct labor only. They do not make allowance for lost time, time required to deliver materials and equipment to the site, maintenance of equipment, administration, supervision, and other overhead items. Tables include foremen but do not include machine operators who accompany equipment.

b. Use of tables. After the lay-out is determined and the units of construction chosen, man-hours of labor for each principal operation are tabulated for all units of the bridge.

TABLE XXXIII. *Man-hours of labor required for principal construction operations in terms of units of quantity.*

Operation	Unit	Man-hours per unit	No. of men in crew
Steel			
Bolting	Bolt	.060	2
Chipping	Lin. ft.	.083	1
Cutting (oxyacetylene)	Lin. ft.	.067	2
Drilling	Lin. ft.	3.200	2
Driving steel piles	Lin. ft.	.133	8
Handling (arrival through fabrication)	Ton	7.000	7
Span erection	Ton	2.500	9
Tower erection	Ton	3.500	9
Laying out	Hole	.040	2
Pattern making			2
Reaming (10% all holes)	Hole	.067	2
Riveting			
Erection	Rivet	.150	4
Fabrication	Rivet	.100	4
Welding	Lb.	.700	2
Timber			
Bolting	Bolt	.133	2
Boring	Lin. ft.	.100	2
Driving driftbolts	Bolt	.017	1
Driving nails	Nail	.003	1
Driving spikes	Spike	.008	1
Driving piles	Lin. ft.	.200	8
Handling (arrival through fabrication)	Fbm.	.010	7
Handling			
Span erection	Fbm.	.004	9
Tower erection	Fbm.	.006	9
Laying out	Fbm.	.004	2
Sawing	Sq. ft.	.033	2
Sawing piles	Pile	.167	2
Excavation, hand	Cu. yd.	1.000	7
Handling cement	Bbl.	.133	9
Handling piles	Pile	1.000	7
Handling sand and gravel	Cu. yd.	.500	5
Mixing and placing concrete	Cu. yd.	2.000	24
Placing and removing scaffolds			4

(1) Tables listing man-hours to construct abutments, bents, piers, and spans give directly the man-hours required for each unit.

(2) Tables listing man-hours to construct footings and towers give man-hours required for each unit of quantity of principal material in that unit. This means that the quantities of principal materials must be taken from the material summaries shown in tables XXVII to XXX before labor requirements can be determined.

(3) Man-hours and crew-hours of labor for all units are totaled to obtain the over-all requirements for each operation.

(4) Man-hours are shown for riveted construction. Man-hours for welded construction approximate 70 and bolted construction approximate 95 percent of those required for riveted construction.

c. Crews. The number of crews assigned to each operation must be sufficient to keep the work on schedule.

90. CONSTRUCTION SCHEDULE. a. Purpose. A construction schedule is a detailed time plan showing all operations in their proper sequence. Making a schedule is an aid to planning because it requires advance consideration of every operation and the equipment, labor, and materials associated with it.

TABLE XXXIV. *Man-hours of labor to build units of class 50, single-lane, highway bridges.*

(1) Labor to build abutments, bents, and piers[1]

Operation	Number of men in crew	Abutments							Bents				Piers						
		Timber pile		Steel pile	Timber grillage		Concrete		Timber pile			Steel pile	Timber pile		Steel pile				
		Steel spans	Timber spans		3 ft.[2]	6 ft.[2]	3 ft.[2]	6 ft.[2]	Under 9 ft.[3]	9 to 17 ft.[3]	17 to 28 ft.[3]		Under 8 ft.[3]	8 to 12 ft.[3]	Under 6 ft.[3]	8 to 10 ft.[3]	12 to 14 ft.[3]	16 to 18 ft.[3]	20 ft.[3]
Sheet number	......	23	21	25	22	22	27	27	28	28	28	32	30	30	32	32	32	32	32
Excavation	7	......	......	......	14	29	53	74	......	......	......	......	......	......	......	......	......	......	......
Pile driving	8	45	45	81	......	......	......	......	33	33	33	54	64	64	98	115	115	116	116
Form building	9	......	......	......	......	......	59	73	......	......	......	......	......	......	......	......	......	......	......
Concrete mixing and placing	24	......	......	......	......	......	43	59	......	......	......	......	......	......	......	......	......	......	......
Steel fabrication	......	......	......	30	......	......	......	......	......	......	......	55	......	......	90	132	146	157	166
Handling	7	......	......	6	......	......	......	......	......	......	......	14	......	......	12	18	22	26	28
Drilling	2	......	......	17	......	......	......	......	......	......	......	25	......	......	45	71	79	84	90
Miscellaneous	......	......	......	7	......	......	......	......	......	......	......	16	......	......	33	43	45	47	48
Steel erection	......	......	......	8	......	......	......	......	......	......	......	44	......	......	58	81	86	92	98
Rigging and handling	9	......	......	3	......	......	......	......	......	......	......	26	......	......	30	35	37	39	41
Fitting up	2	......	......	1	......	......	......	......	......	......	......	4	......	......	7	11	12	12	13
Riveting	4	......	......	4	......	......	......	......	......	......	......	14	......	......	21	35	37	41	44
Timber framing	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Handling	7	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Boring and sawing	2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Timber erection	......	18	13	21	44	55	......	......	8	34	46	......	47	63	......	......	......	......	......
Rigging and handling	9	9	8	9	30	37	......	......	5	22	23	......	24	29	......	......	......	......	......
Boring and sawing	2	3	1	3	4	3	......	......	1	5	9	......	13	20	......	......	......	......	......
Miscellaneous	......	6	4	9	10	15	......	......	2	7	14	......	10	14	......	......	......	......	......
Total man-hours	......	63	58	140	58	84	155	206	41	67	79	153	111	127	246	328	347	365	380

[1] Man-hours of labor are total for one unit. [2] Height from ground to grade. [3] Height from ground to top of cap.

TABLE XXXIV. Continued

(2) Labor to build footings and towers[1]

Operation	Number of men in crew	Spread footings			Pile footings				Towers	
		Timber grillage	Steel grillage	Concrete pedestal	Concrete pedestal, timber piles	Concrete pedestal, steel piles	Timber sills, timber piles	Steel frame, steel piles	Framed steel tower	Framed timber tower
Sheet number	....	43	41	37	39	39	36	40	12	7–10
Unit of quantity	....	*Mbm.*	*Ton.*	*Cu. yd.*	*Pile*	*Pile*	*Pile*	*Pile*	*Ton.*	*Mbm.*
Excavation	7	6	3	3	4	5	....	....	....	....
Pile driving	8	....	....	....	7	17	8	9	....	....
Form building	9	....	....	2	3	4	....	....	....	....
Concrete mixing and placing	24	....	....	4	5	6	....	....	....	....
Steel fabrication	....	....	20	....	....	....	....	28	29	....
Handling	7	....	6	....	....	....	....	5	8	....
Drilling	2	....	11	....	....	....	....	13	13	....
Miscellaneous	....	....	3	....	....	....	....	10	8	....
Steel erection	....	....	6	....	....	....	....	11	20	....
Rigging and handling	9	....	4	....	....	....	....	5	17	....
Fitting up	2	....	2	....	....	....	....	1	1	....
Riveting	4	....	0	....	....	....	....	5	2	....
Timber framing	....	23	....	....	....	....	....	....	....	17
Handling	7	8	....	....	....	....	....	....	....	6
Boring and sawing	2	11	....	....	....	....	....	....	....	7
Miscellaneous	....	4	....	....	....	....	....	....	....	4
Timber erection	....	22	....	....	....	....	1	....	....	27
Rigging and handling	9	10	....	....	....	....	1	....	....	26
Boring and sawing	2	12	....	....	....	....	....	....	....	0
Miscellaneous	....	0	....	....	....	....	....	....	....	1
Total man-hours	....	51	29	9	19	32	10	48	49	44

[1] Man-hours of labor are for one unit of quantity.

Because of this, no essential part of scheduled work is likely to be overlooked.

b. Preparation. (1) The schedule is prepared from the tabulation of man-hours of labor required in each principal operation. It must take into account the following factors:

(*a*) Time allowed for completion.

(*b*) Equipment and troops available.

(*c*) Delivery of construction materials.

(*d*) Logical sequence of operations.

(*e*) Necessary delays between operations.

(*f*) Weather.

(2) The construction schedule is a bar diagram with a separate bar for each principal operation. The time required to complete each operation is represented by the length of the bar for that operation. The schedule with bar diagram for a typical bridge is shown in table XL. It is prepared in the following order:

(*a*) The number of crews for each operation is tentatively established. By dividing crew-days or crew-hours (taken from the tabulation of labor requirements in table XXXIX) by the number of crews used, the time in days or hours to complete the operation is found.

(*b*) Starting and completion time for each operation is plotted on the date and hour chart, with attention to each of the factors listed in paragraph 90b. Schedules must be set up so preceding steps will be complete before subsequent work is to start.

(*c*) After the tentative schedule is drawn up, the number of men and the essential pieces of equipment in each operation are noted. These are totaled for all operations to determine the number of men occupied each day or hour and the number of pieces of each principal equipment item required at one time.

(*d*) Time allotted to the several operations is adjusted so the number of men required during the construction period is as uniform as possible, and each piece of equipment is used most efficiently.

c. Use. (1) The first use of the schedule is to determine:

(*a*) Number of men and amount of equipment required on whole job.

(*b*) Distribution of men and equipment.

(*c*) Number of men and amount of equipment required during any interval of construction period.

(*d*) Time at which construction materials must be delivered to site.

(2) During the construction period, the schedule guides the officer in charge in assigning men and materials to specific operations.

d. Shifts. In these schedules, an 8-hour work period is referred to as a day. When two or three shifts are planned, the schedule must be prepared for shifts rather than for days. In planning such operations, full consideration must be given to the effect on efficiency of length of daylight, problems of night lighting, weather and other local conditions, and tactical problems.

91. REPORTS AND PROGRESS RECORDS. A simple and effective system of daily reports of work accomplished is necessary for proper job control. From these a progress report is compiled daily for submission to higher authority giving direct comparison between scheduled and actual construction progress. Figure 37(1) gives one form of construction progress chart which shows progress for the entire job as a curve in which percentage of completion is plotted against time. This graph can be used alone or together with the more detailed chart shown in figure 37(2). In the detailed chart, percentages of completion of the entire job and of each principal operation are represented by bar diagrams.

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92. ORGANIZATION CHART. It is advisable to prepare and post an organization chart showing specific responsibilities, channels of supervision, and coordination. Ordinarily, this is covered generally by the standing operating procedure (SOP) of the construction unit. However, each bridge project usually has some special features which necessitate modifying and elaborating specific duties to insure complete understanding by all personnel. A typical organization chart is shown in figure 33.

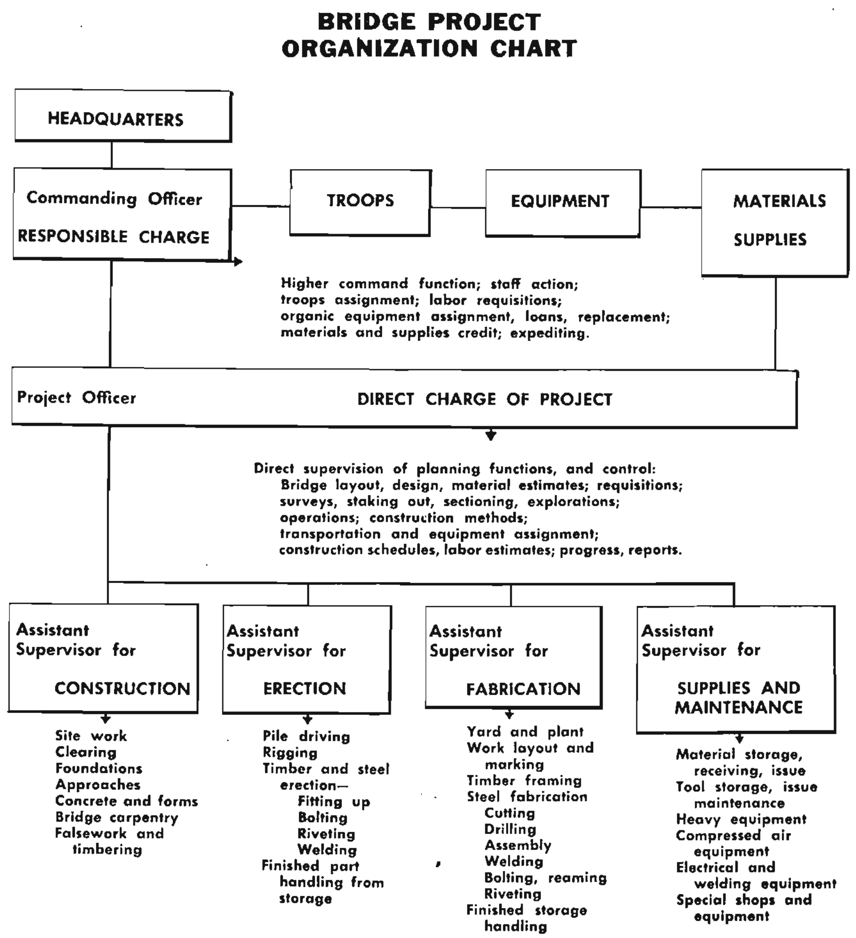


Figure. 33. Sample organization chart for bridge project. If more than one platoon is used, officer assistants supervise their work.

CHAPTER 9

PLANNING TYPICAL CROSSINGS

Section I. BRIDGE LAY-OUT

93. SCOPE. a. This chapter illustrates how to solve typical bridge problems. Determination of bridge lay-out is described for two typical crossings, one a high railway trestle bridge, the other a highway bridge. Construction planning is discussed only for the railway bridge; planning for the highway bridge or any other bridge would be similar.

TABLE XXXIV. Continued

(3) *Labor to build spans.*[1 2]

Operation	Size of crew	Timber spans	Steel spans 15 ft.	20 ft.	30 ft.	40 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.
Sheet number	....	2	4	4	4	4	4	4	4	4	4
Steel fabrication	....	....	61	65	115	138	446	587	783	901	1352
Handling	7	....	8	12	28	42	67	118	116	150	256
Drilling	2	....	28	28	49	56	243	294	429	506	752
Miscellaneous	....	....	25	25	38	40	136	175	238	245	344
Steel erection	....	....	41	43	56	62	76	272	277	301	326
Rigging and handling	9	....	29	31	38	44	55	242	252	267	291
Fitting up	2	....	3	3	4	4	7	8	10	11	12
Riveting	4	....	9	9	14	14	14	22	15	23	23
Timber framing	....	40	29	35	51	67	85	105	118	128	154
Handling	7	20	15	19	29	36	45	67	63	69	100
Boring and sawing	2	9	6	6	8	13	17	11	23	25	14
Miscellaneous	....	11	8	10	14	18	23	27	32	34	40
Timber erection	....	24	12	16	22	28	35	45	49	53	58
Rigging and handling	9	14	7	9	14	18	23	27	32	34	40
Boring and sawing	2	3	2	4	3	3	3	5	6	6	7
Miscellaneous	....	7	3	3	5	7	9	13	11	13	11
Total man-hours	....	64	143	159	244	295	642	1009	1227	1383	1890

[1] Man-hours of labor are total for one unit. [2] For walkways add 45.0 man-hours per mbm.

TABLE XXXV. *Man-hours of labor to build units of class 50, double-lane, highway bridges.*

(1) *Labor to build abutments, bents, and piers.*[1]

Operation	Number of men in crew	Abutments: Timber pile, Steel spans	Abutments: Timber pile, Timber spans	Abutments: Steel pile	Abutments: Timber grillage, 3 ft.[2]	Abutments: Timber grillage, 6 ft.[2]	Abutments: Concrete, 3 ft.[2]	Abutments: Concrete, 6 ft.[2]	Bents: Timber pile, Under 9 ft.[3]	Bents: Timber pile, 9 to 17 ft.[3]	Bents: Timber pile, 17 to 28 ft.[3]	Bents: Steel pile	Bents: Timber pile, Under 8 ft.[3]	Bents: Timber pile, 8 to 12 ft.[3]	Piers: Steel pile, Under 6 ft.[3]	Piers: Steel pile, 8 to 10 ft.[3]	Piers: Steel pile, 12 to 14 ft.[3]	Piers: Steel pile, 16 to 18 ft.[3]	Piers: Steel pile, 20 ft.[3]
Sheet number	......	66	64	69	65	65	71	71	72	72	72	76	74	74	76	76	76	76	76
Excavation	7	......	......	......	18	30	62	94	......	......	......	......	......	......	......	......	......	......	......
Pile driving	8	70	57	95	......	......	......	......	45	45	45	66	89	89	98	116	117	118	119
Form building	9	......	......	......	......	......	82	115	......	......	......	......	......	......	......	......	......	......	......
Concrete mixing and placing	24	......	......	......	......	......	61	83	......	......	......	......	......	......	......	......	......	......	......
Steel fabrication	......	......	......	51	......	......	......	......	......	......	......	90	......	......	140	162	176	198	212
Handling	7	......	......	8	......	......	......	......	......	......	......	22	......	......	19	23	28	35	38
Drilling	2	......	......	30	......	......	......	......	......	......	......	45	......	......	75	86	93	105	113
Miscellaneous	......	......	......	13	......	......	......	......	......	......	......	23	......	......	46	53	55	58	61
Steel erection	......	......	......	14	......	......	......	......	......	......	......	70	......	......	82	90	100	111	119
Rigging and handling	9	......	......	4	......	......	......	......	......	......	......	36	......	......	36	38	41	45	47
Fitting up	2	......	......	2	......	......	......	......	......	......	......	6	......	......	12	13	14	16	17
Riveting	4	......	......	8	......	......	......	......	......	......	......	28	......	......	34	39	45	50	55
Timber framing	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Handling	7	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Boring and sawing	2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Timber erection	......	26	18	34	60	74	......	......	12	39	57	......	58	76	......	......	......	......	......
Rigging and handling	9	11	11	13	41	51	......	......	9	25	32	......	28	33	......	......	......	......	......
Boring and sawing	2	5	2	9	5	4	......	......	1	6	10	......	17	23	......	......	......	......	......
Miscellaneous	......	10	5	12	14	19	......	......	2	8	15	......	13	20	......	......	......	......	......
Total man-hours	......	96	75	194	78	104	205	292	57	84	102	226	147	165	320	368	393	427	450

[1] Man-hours of labor are total for one unit. [2] Height from ground to grade. [3] Height from ground to top of cap.

TABLE XXXV. Continued

(2) *Labor to build footings and towers.*[1]

Operation	Number of men in crew	Spread footings: Timber grillage	Spread footings: Steel grillage	Spread footings: Concrete pedestal	Spread footings: Concrete pedestal, timber piles	Pile footings: Concrete pedestal, steel piles	Pile footings: Timber sills, timber piles	Pile footings: Steel frame, steel piles	Towers: Framed steel tower	Towers: Framed timber tower
Sheet number	...	89	87	83	84	85	81	86	55	50–53
Unit of quantity	...	*Mbm.*	*Ton.*	*Cu. yd.*	*Pile*	*Pile*	*Pile*	*Pile*	*Ton.*	*Mbm.*
Excavation	7	6	3	3	4	5	...	...	...	...
Pile driving	8	...	...	...	7	17	8	9	...	...
Form building	9	...	...	2	3	4	...	...	...	...
Concrete mixing and placing	24	...	...	4	5	6	...	...	...	...
Steel fabrication	...	...	20	...	...	...	...	28	34	...
Handling	7	...	6	...	...	...	...	5	4	...
Drilling	2	...	11	...	...	...	...	13	15	...
Miscellaneous	...	...	3	...	...	...	...	10	15	...
Steel erection	...	...	6	...	...	...	...	11	16	...
Rigging and handling	9	...	4	...	...	...	...	5	12	...
Fitting up	2	...	2	...	...	...	...	1	1	...
Riveting	4	...	0	...	...	...	...	5	3	...
Timber framing	...	23	...	...	...	...	...	...	...	18
Handling	7	8	...	...	...	...	...	...	...	6
Boring and sawing	2	11	...	...	...	...	...	...	...	8
Miscellaneous	...	4	...	...	...	...	...	...	...	4
Timber erection	...	22	...	...	...	...	1	...	...	25
Rigging and handling	9	10	...	...	...	...	1	...	...	16
Boring and sawing	2	12	...	...	...	...	...	...	...	0
Miscellaneous	...	0	...	...	...	...	...	...	...	9
Total man-hours	...	51	29	9	19	32	10	48	50	43

[1] Man-hours of labor are for one unit of quantity.

TABLE XXXV. Continued

(3) *Labor to build spans.*[1,2]

Operation	Size of crew	Timber spans	Steel spans: 15 ft.	20 ft.	30 ft.	40 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.
Sheet number	...	45	47	47	47	47	47	47	47	47	47
Steel fabrication	...	...	93	112	177	231	607	909	1346	1874	2897
Handling	7	...	19	29	43	67	116	150	195	277	395
Drilling	2	...	35	41	78	97	298	502	785	1148	1857
Miscellaneous	...	...	39	42	56	67	193	257	366	449	645
Steel erection	...	...	48	54	72	84	109	310	334	382	435
Rigging and handling	9	...	32	35	44	55	76	267	286	324	377
Fitting up	2	...	4	4	5	6	10	13	18	20	20
Riveting	4	...	12	15	23	23	23	30	30	38	38
Timber framing	...	66	45	55	83	108	135	161	193	212	239
Handling	7	35	30	39	45	58	74	88	108	117	131
Boring and sawing	2	14	3	1	16	21	25	29	34	37	42
Miscellaneous	...	17	12	15	22	29	36	44	51	58	66
Timber erection	...	33	15	22	30	40	48	58	69	80	90
Rigging and handling	9	21	11	15	22	29	36	44	52	59	66
Boring and sawing	2	4	1	1	2	3	3	4	5	7	8
Miscellaneous	...	8	3	6	6	8	9	10	12	14	16
Total man-hours	...	99	201	243	362	463	899	1438	1942	2548	3661

[1] Man-hours of labor are total for one unit. [2] For walkways add 45 man-hours for mbm.

b. It is assumed in this illustration that reconnaissance has been made, the site chosen, and surveys completed in accordance with instruction given in chapter 6.

94. SITE DESCRIPTION. The following assumptions are made:

a. Characteristics of site. Data obtained by site survey shown in figure 34 include:

(1) Topographic plan of site.
(2) Location and alignment of bridge.
(3) Ground profile on bridge center line.
(4) Logs of borings.
(5) Normal water level and high-water level.
(6) Stream has fairly uniform flow.
(7) Stream banks show evidence of scour and shifting of stream bed.

b. Material. Steel, timber, cement, and aggregates are available. Adequate timber for piling cannot be found locally.

c. Equipment. All pieces of construction equipment needed to supplement organic equipment can be drawn from depot, including crawler-mounted and truck-mounted cranes up to ¾-cubic-yard capacity.

d. Construction period. The construction period falls between annual floods; river stage during construction will be approximately normal (elevation 131).

e. Access to bridge site. Both banks at the bridge site are directly accessible by highway. Construction can proceed from both ends of the structure if desired.

95. LAY-OUT OF RAILWAY CROSSING. a. Height of bridge. The elevation of base of rail (elevation 180.0) across the bridge is determined by the grade of the approaches; in this case, the bridge will be about 40 feet high at the stream banks.

b. Length of bridge. To avoid high approach fills, abutments are tentatively located at the rim of the stream valley. This fixes the length of the bridge at about 400 feet.

c. Principal openings. A 50-foot center span is selected so as not to obstruct the channel and to permit foundations to be built on dry ground. This span length requires steel stringers. (See par. 8.)

d. Foundation types. (1) *Pile footings.* (*a*) The boring logs indicate that the westerly three-fourths of the bridge will be on soft alluvial soil, either silty or sandy clay. These materials cannot safely support the load of 3,000 pounds per square foot necessary for spread footings. (See table XXV.) Pile footings must be used for this portion of the structure.

(*b*) Timber friction piles are selected since bed rock is too far below the surface to justify using either timber or steel point bearing piles. (See par. 145.) Although subject to alternate wetting and drying, untreated piles would be satisfactory for semipermanent construction. However, since piling is not available locally and only creosoted piles are stocked in depot, these are requisitioned.

(*c*) Penetration of about 25 feet is required to develop the needed bearing capacity of 18 tons per pile. (See table XXVI.) To allow for contingencies and cut-off, 30-foot timber piles are requisitioned.

(*d*) The selection diagram (table XXIII) shows that for bridges over 30 feet high supported on timber piles, concrete pedestals are preferred.

(2) *Spread footings.* The easterly one-fourth of the bridge will be on rock

TABLE XXXVI. *Man-hours of labor to build units of class 25, double-lane, highway bridges.*

(1) *Labor to build abutments, bents, and piers.*[1]

Operation	Number of men in crew	Abutments: Timber pile: Steel spans	Abutments: Timber pile: Timber spans	Abutments: Steel pile	Abutments: Timber grillage: 3 ft.[2]	Abutments: Timber grillage: 6 ft.[2]	Abutments: Concrete: 3 ft.[2]	Abutments: Concrete: 6 ft.[2]	Bents: Timber pile: Under 9 ft.[3]	Bents: Timber pile: 9 to 17 ft.[3]	Bents: Timber pile: 17 to 28 ft.[3]	Bents: Steel pile	Piers: Timber pile: Under 8 ft.[3]	Piers: Timber pile: 8 to 12 ft.[3]	Piers: Steel pile: Under 6 ft.[3]	Piers: Steel pile: 8 to 10 ft.[3]	Piers: Steel pile: 12 to 14 ft.[3]	Piers: Steel pile: 16 to 18 ft.[3]	Piers: Steel pile: 20 ft.[3]
Sheet number	......	106	104	109	105	105	111	111	112	112	112	116	114	114	116	116	116	116	116
Excavation	7	......	......	......	18	30	62	94	......	......	......	......	......	......	......	......	......	......	......
Pile driving	8	51	45	95	......	......	......	......	33	33	33	54	64	64	98	115	118	118	118
Form building	9	......	......	......	......	......	82	115	......	......	......	......	......	......	......	......	......	......	......
Concrete mixing and placing	24	......	......	......	......	......	61	83	......	......	......	......	......	......	......	......	......	......	......
Steel fabrication	......	......	......	51	......	......	......	......	......	......	......	68	......	......	110	154	169	181	197
Handling	7	......	......	8	......	......	......	......	......	......	......	18	......	......	13	21	25	27	33
Drilling	2	......	......	30	......	......	......	......	......	......	......	33	......	......	57	82	91	99	107
Miscellaneous	......	......	......	13	......	......	......	......	......	......	......	17	......	......	40	51	53	55	57
Steel erection	......	......	......	14	......	......	......	......	......	......	......	52	......	......	66	86	93	105	112
Rigging and handling	9	......	......	4	......	......	......	......	......	......	......	28	......	......	32	36	38	41	45
Fitting up	2	......	......	2	......	......	......	......	......	......	......	5	......	......	9	12	13	18	18
Riveting	4	......	......	8	......	......	......	......	......	......	......	19	......	......	25	38	42	46	49
Timber framing	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Handling	7	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Boring and sawing	2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Timber erection	......	22	19	34	60	74	......	......	8	34	46	......	47	63	......	......	......	......	......
Rigging and handling	9	10	12	13	41	51	......	......	5	22	23	......	24	29	......	......	......	......	......
Boring and sawing	2	3	1	9	5	4	......	......	1	5	9	......	13	20	......	......	......	......	......
Miscellaneous	......	9	6	12	14	19	......	......	2	7	14	......	10	14	......	......	......	......	......
Total man-hours	......	73	64	194	78	104	205	292	41	67	79	174	111	127	274	355	377	404	427

[1] Man-hours of labor are total for one unit. [2] Height from ground to grade. [3] Height from ground to top of cap.

TABLE XXXVI. Continued

(2) *Labor to build footings and towers.*[1]

Operation	Number of men in crew	Spread footings: Timber grillage	Spread footings: Steel grillage	Spread footings: Concrete pedestal	Pile footings: Concrete pedestal, timber piles	Pile footings: Concrete pedestal, steel piles	Pile footings: Timber sills, timber piles	Pile footings: Steel frame, steel piles	Towers: Framed steel tower	Towers: Framed timber tower
Sheet number	....	127	125	122	123	123	121	124	102	97–100
Unit of quantity	....	*Mbm.*	*Ton.*	*Cu. yd.*	*Pile*	*Pile*	*Pile*	*Pile*	*Ton.*	*Mbm.*
Excavation	7	6	3	3	4	5	....	....	....	....
Pile driving	8	....	....	....	7	17	8	9	....	....
Form building	9	....	....	2	3	4	....	....	....	....
Concrete mixing and placing	24	....	....	4	5	6	....	....	....	....
Steel fabrication	....	....	20	....	....	....	....	28	34	....
Handling	7	....	6	....	....	....	....	5	4	....
Drilling	2	....	11	....	....	....	....	13	15	....
Miscellaneous	....	....	3	....	....	....	....	10	15	....
Steel erection	....	....	6	....	....	....	....	11	16	....
Rigging and handling	9	....	4	....	....	....	....	5	12	....
Fitting up	2	....	2	....	....	....	....	1	1	....
Riveting	4	....	0	....	....	....	....	5	3	....
Timber framing	....	23	....	....	....	....	....	....	....	17
Handling	7	8	....	....	....	....	....	....	....	6
Boring and sawing	2	11	....	....	....	....	....	....	....	7
Miscellaneous	....	4	....	....	....	....	....	....	....	4
Timber erection	....	22	....	....	....	....	1	....	....	27
Rigging and handling	9	10	....	....	....	....	1	....	....	26
Boring and sawing	2	12	....	....	....	....	....	....	....	0
Miscellaneous	....	0	....	....	....	....	....	....	....	1
Total man-hours	....	51	29	9	19	32	10	40	50	44

[1] Man-hours of labor are for one unit of quantity.

or sandy clay. Spread footings are satisfactory for this portion of the structure. Table XXIV shows that concrete pedestals are the preferred spread footings for bridges over 30 feet high.

e. Superstructure. (1) The selection diagram (table XXIII) for bridges with pile foundations shows that framed steel towers are the preferred support for steel-stringer spans. The central part of the structure then will be a 50-foot steel-stringer span on framed steel towers with concrete pedestal foundations on timber piles. Tower spans will be 25 feet long. (See sheet 184.)

(2) Two 50-foot spans and one 25-foot tower span will be needed to reach the east abutment. Similar construction is used on the west to permit duplication in fabrication. (See par. 84.) These spans are within the recommended lengths for spans on steel towers.

(3) Tower 1 exceeds the recommended height for timber pile piers (table I) and a framed tower must be used. A steel tower conforming with the rest of the structure is chosen rather than a timber tower which also could be used.

(4) Span 1 is made 25 feet long since this length gives a satisfactory location for the west abutment and duplicates the spans used on the towers. An 8-foot fill is used west of the abutment, since it is more economical than trestle construction and ample waterway opening has been provided. (See par. 75*a*.) The fill retained by the abutment is about 6 feet high.

(5) At all tower bents, one span will have a fixed bearing and the other an expansion bearing.

f. Selection of construction units. (1) *Deck.* Standard open timber deck without walkways will be used. This is shown on sheets 158 and 159. One refuge bay (sheet 174) will be provided near the center of the bridge.

(2) *Spans and towers.* Lay-out of spans and towers fixes the construction unit drawing sets to be used. (See sheet 156.) These units are the following:

(*a*) *Towers 1, 2, 3, 4, and 5,* framed steel towers, drawing set RR–5, sheet 184.

(*b*) Tower spans, 25-foot steel-stringer spans, drawing set RR–2, sheet 158.

(*c*) *Span 1;* 25-foot steel-stringer span, drawing set RR–2, sheet 158.

(*d*) *Spans 2, 3, 4, 5, and 6,* 50-foot steel-stringer spans, drawing set RR–2, sheet 159.

(3) *Foundations.* Concrete pedestal units are determined by tower height and span length. Drawings showing these pedestals are given in set RR–13.

(*a*) *Pile footings.* Type F138 footings are required for towers except the west bent of tower 1 where type F135 can be used. (See sheet 215.)

(*b*) *Spread footings.* Type F124 spread footings are required to support columns of tower 5. (See sheet 216.)

(4) *West abutment.* A timber pile abutment (drawing set RR–7) is chosen for the west abutment where the soil is not capable of supporting a spread footing. A six-pile abutment (four bearing piles and two wing piles) is required for a 25-foot span. (See sheet 195.)

(5) *East abutment.* A concrete abutment (drawing set RR–7) is chosen for the east abutment, since the soil there has adequate bearing capacity. The large abutment (sheet 199) is required since height of retained fill is over 3 feet. A timber grillage abutment cannot be used at this location since the span supported by the abutment is over 15 feet. (See table XXIV.)

g. Construction drawings. The general plan and elevation drawing (fig. 34) is completed by adding dimensions, elevations, and other data, including stationing of center line of substructure units, elevations of pedestals, mark number of footings, and heights of towers. Location of fixed and expansion bearings is also indicated.

96. LAY-OUT OF HIGHWAY CROSSING. Figure 35 illustrates a lay-out for a single-lane highway crossing at the location described in paragraph 94.

a. Top of bridge deck is set to give clearance above high water. (See par. 74*a*.) Grades of approaches are not steeper than 10 percent.

b. Tests have shown that the soil will not support spread footings, so pile supports must be used. Table XVII shows that timber stringers on timber pile bents are preferred for bridges less than 30 feet high. Timber pile piers will be used at each end of the central span.

c. A 50-foot steel span is necessary across the stream, so the two piers will be above the steep banks. Stream width is then free from obstructions to drift or ice and foundations are not subject to scouring.

d. The third span from the pile pier on the west side is over 17 feet high and the sixth span is less than 17 feet high. (See sheet 29.) Longitudinal bracing is required only under the third span.

e. The east abutment is founded on rock. Since concrete is not needed for other units, a timber grillage abutment is used.

Section II. CONSTRUCTION PLANNING FOR A RAILWAY BRIDGE

97. DRAWINGS. Drawing sets for each construction unit are shown by the selection diagrams in tables XXIII and XXIV. Sheet numbers included in these sets are shown on sheet 156. The drawing sets required for the railway bridge described in section I are as follows:

a. Abutments .... Set RR–7
b. Pile footings .... Set RR–13
c. Spread footings .... Set RR–13
d. Framed steel towers .... Set RR–5
e. Steel stringers .... Set RR–2

98. MATERIAL LISTS. a. Bridge materials. The drawings included in sets listed in paragraph 97 give complete bills of materials for each unit. Material quantities are shown in summary form in table XXX. The forms of typical bills of materials and of material requisitions are shown in table XXXVIII and figure 36 respectively.

b. Erection materials. Quantities of materials needed for temporary construction, concrete forms, construction shelters, platforms, and scaffolding are estimated after the construction scheme has been outlined.

99. MAN-HOUR REQUIREMENTS. a. Man-hour and personnel requirements are obtained from table XXXVII and are shown in table XXXIX. This data is used in making up the construction schedule shown in table XL.

b. Table XXXIX is prepared as follows:

(1) Entries in columns 1, 2, 5, 8, 11, 14, and 15 are taken directly from table XXXVII.

(2) Entries in columns 3, 6, and 9 are obtained by multiplying values from table XXXVII by the number of piles in the footings for each tower.

(3) The entry in column 12 is obtained by multiplying values from table XXXVII by 51, the cubic yards of concrete in the footings of tower 5.

(4) Entries in columns 4, 7, 10, and 13 are obtained by multiplying values from table XXXVII by the tons of steel in each tower.

(5) The entry in column 16 is obtained by multiplying values from table XXXVII by 5, since there are five 50-foot spans in the bridge.

(6) The entries in column 17 are estimated.

(7) The entry in column 18 is the sum of columns 1 to 17 inclusive.

TABLE XXXVI. Continued

(3) *Labor to build spans.*[1] [2]

Operation	Size of crew	Timber spans	Steel spans: 15 ft.	20 ft.	30 ft.	40 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.
Sheet numbers	....	92	94	94	94	94	94	94	94	94	94
Steel fabrication	....	....	83	91	147	175	589	733	1170	960	1522
Handling	7	....	10	15	35	48	83	106	148	187	227
Drilling	2	....	42	44	70	82	299	389	655	505	873
Miscellaneous	....	....	31	32	42	45	207	238	367	268	422
Steel erection	....	....	53	55	76	81	97	294	312	341	360
Rigging and handling	9	....	30	32	41	46	62	248	266	283	302
Fitting up	2	....	8	8	12	12	12	16	16	20	20
Riveting	4	....	15	15	23	23	23	30	30	38	38
Timber framing	....	55	42	54	80	107	139	159	185	209	235
Handling	7	29	24	30	45	59	77	88	103	117	131
Boring and sawing	2	12	6	9	13	18	24	27	31	33	38
Miscellaneous	....	14	12	15	22	30	38	44	51	59	66
Timber erection	....	28	19	24	32	42	52	60	71	83	94
Rigging and handling	9	18	12	16	22	30	38	44	51	58	66
Boring and sawing	2	3	3	4	4	4	5	6	8	11	12
Miscellaneous	....	7	4	4	6	8	9	10	12	14	16
Total man-hours	....	83	197	224	335	405	877	1246	1738	1593	2211

[1] Man-hours of labor are total for one unit. [2] For walkways add 45 man-hours per mbm.

TABLE XXXVII. *Man-hours of labor to build units of E–45 railway bridges.*

(1) *Labor to build abutments, bents, and piers*[1]

Operation	Number of men in crew	Abutments: Timber pile, Steel spans 15-25′ long	Timber pile, Steel spans 25-50′ long	Timber pile, Timber spans	Steel pile	Timber grillage 3 ft.[2]	Timber grillage 6 ft.[2]	Concrete 3 ft.[2]	Concrete 6 ft.[2]	Bents: Timber pile Under 9 ft.[3]	Timber pile 9 to 17 ft.[3]	Timber pile 17 to 28 ft.[3]	Steel pile[4]	Piers: Timber pile[6] Under 8 ft.[3]	Timber pile[6] 8 to 12 ft.[3]	Steel pile[5] Under 6 ft.[3]	Steel pile[5] 8 to 10 ft.[3]	Steel pile[5] 12 to 14 ft.[3]	Steel pile[5] 16 to 18 ft.[3]	Steel pile[5] 20 ft.[3]
Sheet number	......	195	195	193	197	194	194	199	199	200	200	200	204	202	202	205	205	205	205	205
Excavation	7	......	......	......	......	......	......	91	90	......	......	......	......	......	......	......	......	......	......	......
Pile driving	8	45	70	45	92	......	......	......	......	33	33	33	59	107	107	210	210	210	210	210
Form building	9	......	......	......	......	......	......	48	67	......	......	......	......	......	......	......	......	......	......	......
Concrete mixing and placing	24	......	......	......	......	......	......	47	56	......	......	......	......	......	......	......	......	......	......	......
Steel fabrication	......	......	......	......	39	......	......	......	......	......	......	......	504	......	......	548	611	650	727	733
Handling	7	......	......	......	6	......	......	......	......	......	......	......	82	......	......	45	58	80	88	94
Drilling	2	......	......	......	22	......	......	......	......	......	......	......	337	......	......	362	372	381	434	434
Miscellaneous	......	......	......	......	11	......	......	......	......	......	......	......	85	......	......	141	181	189	205	205
Steel erection	......	......	......	......	16	......	......	......	......	......	......	......	132	......	......	180	272	307	360	363
Rigging and handling	9	......	......	......	4	......	......	......	......	......	......	......	68	......	......	83	115	124	131	134
Fitting up	2	......	......	......	4	......	......	......	......	......	......	......	48	......	......	29	41	45	51	51
Riveting	4	......	......	......	8	......	......	......	......	......	......	......	16	......	......	68	116	138	178	178
Timber framing	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Handling	7	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Boring and sawing	2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Timber erection	......	15	22	13	32	31	45	......	......	8	30	41	......	56	124	......	......	......	......	......
Rigging and handling	9	6	10	6	8	20	26	......	......	6	20	25	......	34	53	......	......	......	......	......
Boring and sawing	2	4	5	1	8	2	4	......	......	1	4	7	......	11	32	......	......	......	......	......
Miscellaneous	......	5	7	6	16	9	15	......	......	1	6	9	......	11	39	......	......	......	......	......
Total man-hours	......	60	92	58	179	31	45	186	213	41	63	74	695	163	231	938	1093	1167	1297	1306

[1] Man-hours of labor are total for one unit. [2] Height from ground to grade. [3] Height from ground to top of cap.
[4] Unit is two bents with longitudinal bracing. [5] Unit is two piers with longitudinal bracing.

TABLE XXXVII. Continued.

(2) *Labor to build footings and towers.*[1]

Operation	Number of men in crew	Spread footings: Timber grillage	Spread footings: Steel grillage	Spread footings: Concrete pedestal	Pile footings: Concrete pedestal, timber piles	Pile footings: Concrete pedestal, steel piles	Pile footings: Timber sills, timber piles	Pile footings: Steel frame, steel piles	Towers: Framed steel tower	Towers: Framed timber tower
Sheet number	......	223	218	214	215	216	212	217	184	175–179
Unit of quantity	......	*Mbm.*	*Ton*	*Cu. yd.*	*Pile*	*Pile*	*Pile*	*Pile*	*Ton*	*Mbm.*
Excavation	7	6	3	3	4	6	......	......	......	......
Pile driving	8	......	......	......	7	15	8	9	......	......
Form building	9	......	......	2	3	4	......	......	......	......
Concrete mixing and placing	24	......	......	4	5	6	......	......	......	......
Steel fabrication	......	......	20	......	......	......	......	28	37	......
Handling	7	......	6	......	......	......	......	5	4	......
Drilling	2	......	11	......	......	......	......	13	25	......
Miscellaneous	......	......	3	......	......	......	......	10	8	......
Steel erection	......	......	6	......	......	......	......	11	23	......
Rigging and handling	9	......	4	......	......	......	......	5	16	......
Fitting up	2	......	2	......	......	......	......	1	2	......
Riveting	4	......	0	......	......	......	......	5	5	......
Timber framing	......	23	......	......	......	......	......	......	......	18
Handling	7	8	......	......	......	......	......	......	......	6
Boring and sawing	2	11	......	......	......	......	......	......	......	8
Miscellaneous	......	4	......	......	......	......	......	......	......	4
Timber erection	......	22	......	......	......	......	1	......	......	33
Rigging and handling	9	10	......	......	......	......	1	......	......	31
Boring and sawing	2	12	......	......	......	......	......	......	......	0
Miscellaneous	......	0	......	......	......	......	......	......	......	2
Total man-hours	......	51	29	9	19	31	10	48	60	51

[1] Man-hours of labor are for one unit of quantity.

TABLE XXXVII. Continued.

(3) *Labor to build spans*[1,2]

Operation	Size of crew	Timber spans	Steel Spans: 15 ft.	20 ft.	25 ft.	30 ft.	Special 30 ft.	35 ft.	40 ft.	45 ft.	50 ft.
Sheet number	......	157	158	158	158	158	158	158	158	158	159
Steel fabrication	......	......	65	76	112	112	103	139	166	383	579
Handling	7	......	9	14	26	24	20	43	60	67	123
Drilling	2	......	30	36	53	53	60	60	68	211	292
Miscellaneous	......	......	26	26	33	35	23	36	38	105	164
Steel erection	......	......	38	41	58	54	57	63	62	85	130
Rigging and handling	9	......	29	30	35	38	40	40	41	55	69
Fitting up	2	......	2	3	4	4	4	4	4	8	12
Riveting	4	......	7	8	19	12	13	19	17	22	49
Timber framing	......	27	9	14	21	19	19	23	28	29	33
Handling	7	13	5	7	11	10	12	14	15	15	21
Boring and sawing	2	8	2	3	3	4	2	4	4	6	3
Miscellaneous	......	6	2	4	7	5	5	5	9	8	9
Timber erection	......	15	6	8	6	11	9	12	11	17	18
Rigging and handling	9	9	3	4	4	5	5	6	7	8	9
Boring and sawing	2	2	1	1	1	1	1	1	1	3	3
Miscellaneous	......	4	2	3	1	5	3	5	3	6	6
Total man-hours	......	42	118	139	197	196	188	237	267	514	748

[1] Man-hours of labor are total for one unit. [2] For walkways and refuge bays add 45 man-hours for mbm.

TABLE XXXVIII. *Bills of materials for a typical railway bridge.*

(1) *Bill of materials—structural steel.*

Description	Piece: Mark	Piece: Size (in.) (lb.)	Piece: Length (ft.–in.)	Piece: Unit Weight (lb.)	Quantity for one construction unit	Total required: Quantity	Total required: Weight (lb.)
Six 25-foot spans:							
Stringers	404	30 I 108	24–10½	2,686	1	6	16,116
Stringers	405	30 I 108	24–10½	2,686	1	6	16,116
(Other items entered from bill of materials, sheet 160.)							
Five 50-foot spans:							
Stringers	414–417	36 I 150	40–0	6,000	4	20	120,000
Stringers	424–427	36 I 150	9–10½	1,487	4	20	29,740
(Other items entered from bill of materials, sheet 160.)							
Five towers, 1 to 5—Materials common to all towers:							
Cap beam	651	21 I 59	10–3	605	4	20	12,100
(Other items entered from bill of materials, table B, sheet 186.)							
Tower 1, One-story, 15-foot, Pieces which vary for different tower heights:							
Tower columns	1727R L	12 I 65	15–2¼	985	4	4	3,940
(Other items entered from bill of materials sheet 192 and table A, sheet 187 for 15-foot tower height.)							
(Towers 2 to 5. Pieces which vary for different tower heights listed from same sheets.)							
West abutment:							
Bearing plates	P1	12x1	1–8	68	2	2	136
(Other items entered from bill of materials, sheet 178.)							
East abutment:							
Bearing plates	P1	12x1	1–4	54	4	4	216
(Other items entered from bill of materials, sheet 178.)							

TABLE XXXVIII. *Bills of materials for a typical railway bridge.*

(2) *Bill of materials—timber and piling.*

Description	Mark	Piece: Size (in.)	Piece: Length (ft.–in.)	fbm. each	Quantity for one construction unit	Total required: Quantity	Total required: mbm
Timber:							
Six 25-foot spans:							
Ties	372	6x8	8–6	34	25	150	2.700
(Other items entered from bill of materials, sheet 161.)							
Five 50-foot spans:							
Ties	372	6x8	8–6	34	50	250	4.500
(Other items entered from bill of materials, sheet 161.)							
West abutment:							
Bulkhead plank	178	4x12	20–0	80	6	6	.480
(Other items entered from bill of materials, sheet 196.)							
Piling (Creosoted timber):							
West abutment:							
Bearing piles			30–0		4	4	
Wing piles	300		15–0		2	2	
Towers No. 1			30–0		26	26	
Towers No. 2 to No. 4			30–0		32	96	

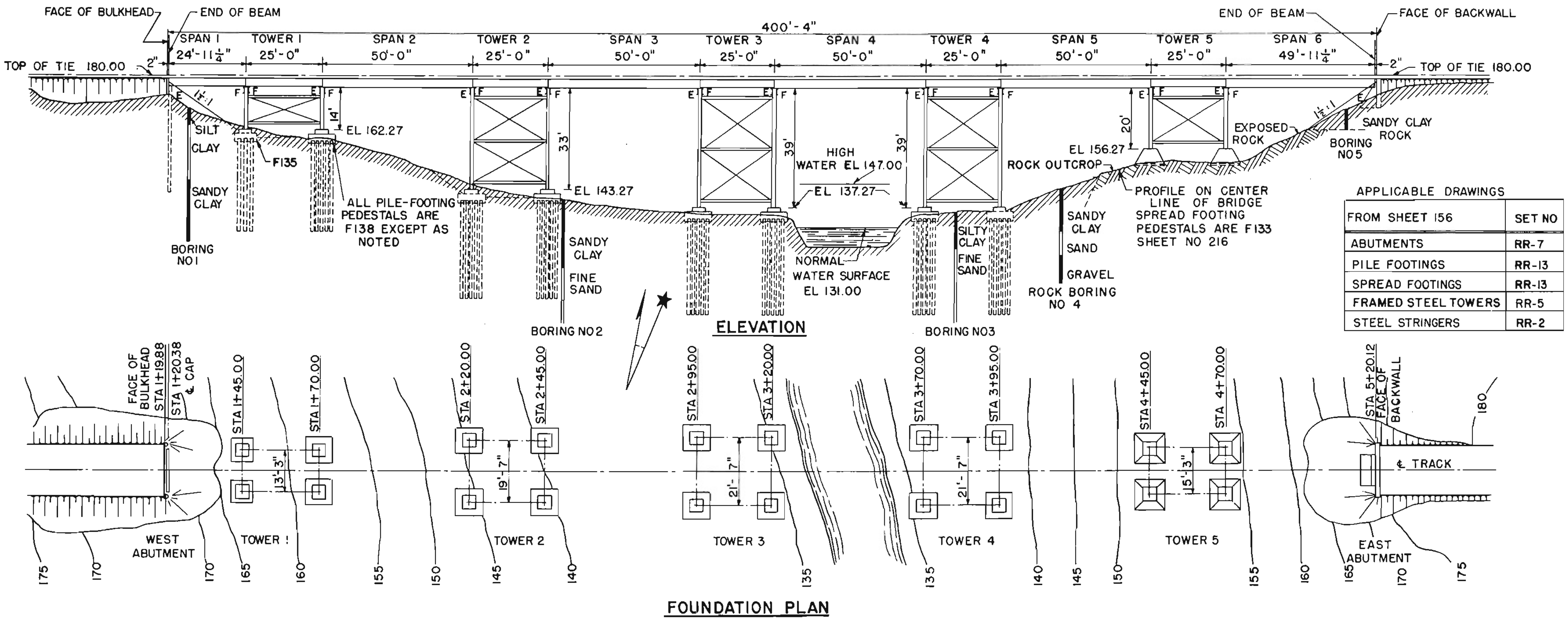


Figure 34. Lay-out of a typical railway bridge.

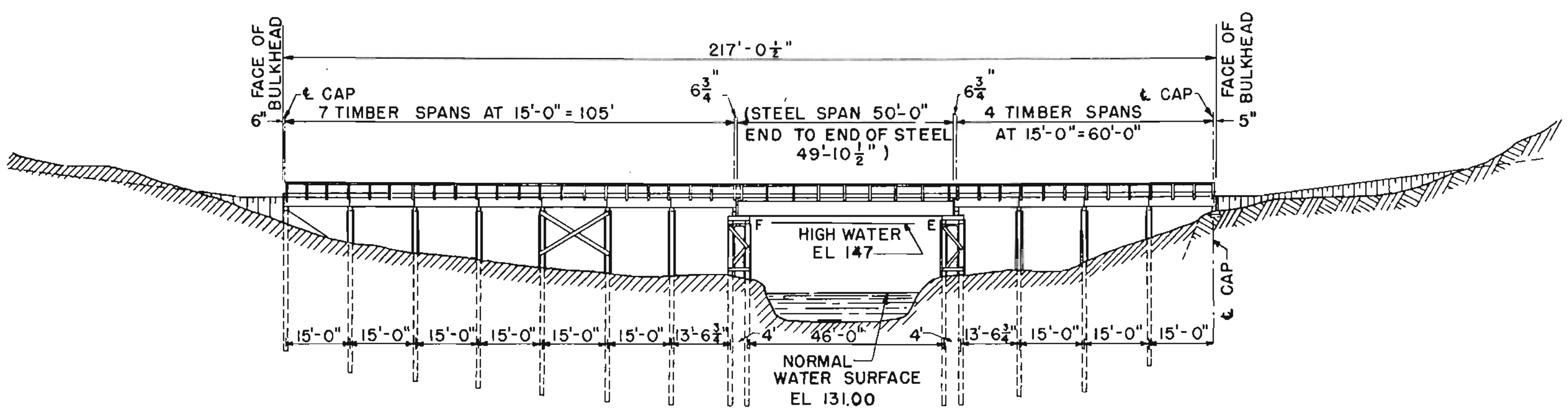


Figure 35. Lay-out of a typical highway bridge.

TABLE XXXVIII. *Bills of materials for a typical railway bridge. Continued.*

(3) *Bill of materials—hardware*

Description	Piece: Mark	Piece: Size	Piece: Length (in.)	Piece: Unit Weight (lb.)	Quantity for one construction unit	Total required: Quantity	Total required: Weight (lb.)
Six 25-foot spans:							
Hook bolt with washer and nut	H13	¾"	13	2.1	16	96	202
(Other items entered from bill of materials, sheet 161.)							
Five 50-foot spans:							
(Other items entered from bill of materials, sheet 161.)							
West abutment:							
Bolt with nut and two washers	B22	¾"	22	2.95	16	16	47
(Other items entered from bill of materials, sheet 196.)							
East abutment:							
Anchor bolt with nut and two washers	B24	¾"	24	3.5	12	12	42
Tower pedestals:							
Anchor bolt with nut and two washers	E24	1"	24	6.5	16	80	520

(4) *Bill of materials—concrete*[1]

	Cement sacks	Fine aggregate (cu. yd.)[2]	Coarse aggregate (cu. yd.)[2]
Per cubic yard	6.03	0.51	0.72
For 212.3 cu. yds.	1,280	108	153
Waste 5 percent	63	5	8
Total required	1,344	113	161

[1] Quality of concrete: maximum size of aggregate, 2½-inch, water cement ratio 6 gal. per sack, slump 3 to 4 inches. See table XL, FM 5–10.
[2] Damp-loose condition.

100. CONSTRUCTION SCHEDULE. Preparation of the construction schedule from the tabulation of man-hour requirements is discussed in chapter 8. The schedule of the typical railway bridge is shown by table XL.

a. The entries in column 1 are taken directly from column 18 of table XXXIX. The values entered in columns 2 to 7 are computed in accordance with instructions given in chapter 8.

b. The days (par. 90*d*) required to complete each operation (col. 6, table XL) are plotted graphically on the schedule. In plotting these values, the necessary continuity of operations is kept in mind. The number of men employed each day should be as nearly constant as possible.

c. The planned sequence of operations is as follows:

(1) Clearing and earthwork are started immediately.

(2) Fabrication, drilling particularly, requires more time than other operations and is started as early as possible.

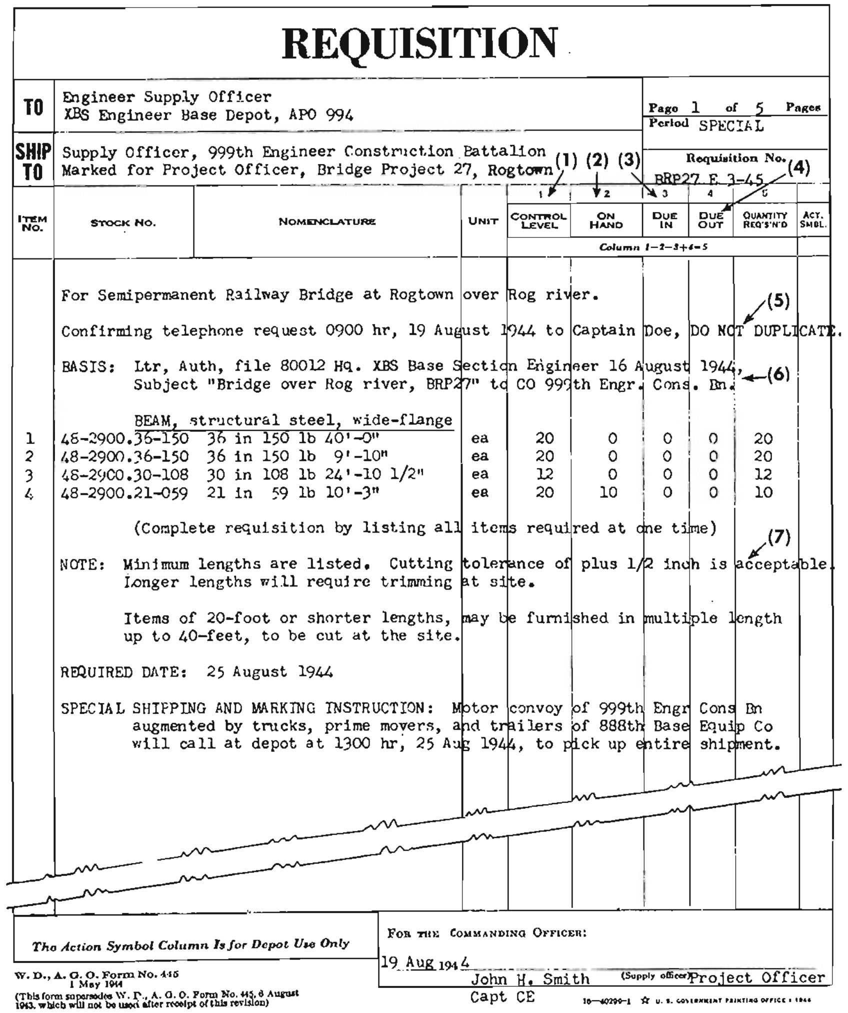
(3) Pile driving starts as soon as the first of the footings are excavated (normally the second day).

(4) Form building and concreting start on the third and fifth days respectively. Concreting is staggered with form building and excavation to balance personnel requirements.

(5) Steel erection is started on the ninth day, as soon as the first concrete is 3 days old.

(6) Dismantling equipment and clean-up work is done during the last few days as other operations are concluded and men become available.

d. At the bottom of the bar graph, the total labor requirements for each day are shown. These totals do not include supervisory personnel, nor allowances for surveying, equipment maintenance, and delivery of materials to the site.



REQUISITION

TO: Engineer Supply Officer
XBS Engineer Base Depot, APO 994

Page 1 of 5 Pages
Period SPECIAL

SHIP TO: Supply Officer, 999th Engineer Construction Battalion
Marked for Project Officer, Bridge Project 27, Rogtown

Requisition No. BRP27 E 3-45

Item No.	Stock No.	Nomenclature	Unit	1 Control Level	2 On Hand	3 Due In	4 Due Out	5 Quantity Req's'n'd	Act. Smbl.
				Column 1−2−3+4=5					

For Semipermanent Railway Bridge at Rogtown over Rog river.

Confirming telephone request 0900 hr, 19 August 1944 to Captain Doe, DO NOT DUPLICATE. (5)

BASIS: Ltr, Auth, file 80012 Hq. XBS Base Section Engineer 16 August 1944, Subject "Bridge over Rog river, BRP27" to CO 999th Engr. Cons. Bn. (6)

BEAM, structural steel, wide-flange

Item No.	Stock No.	Nomenclature	Unit	Control Level	On Hand	Due In	Due Out	Quantity Req's'n'd
1	48-2900.36-150	36 in 150 lb 40'-0"	ea	20	0	0	0	20
2	48-2900.36-150	36 in 150 lb 9'-10"	ea	20	0	0	0	20
3	48-2900.30-108	30 in 108 lb 24'-10 1/2"	ea	12	0	0	0	12
4	48-2900.21-059	21 in 59 lb 10'-3"	ea	20	10	0	0	10

(Complete requisition by listing all items required at one time)

NOTE: Minimum lengths are listed. Cutting tolerance of plus 1/2 inch is acceptable. (7) Longer lengths will require trimming at site.

Items of 20-foot or shorter lengths, may be furnished in multiple length up to 40-feet, to be cut at the site.

REQUIRED DATE: 25 August 1944

SPECIAL SHIPPING AND MARKING INSTRUCTION: Motor convoy of 999th Engr Cons Bn augmented by trucks, prime movers, and trailers of 888th Base Equip Co will call at depot at 1300 hr, 25 Aug 1944, to pick up entire shipment.

The Action Symbol Column Is for Depot Use Only

FOR THE COMMANDING OFFICER:
19 Aug 1944
John H. Smith (Supply officer) Project Officer
Capt CE

W. D., A. G. O. Form No. 446
1 May 1944
(This form supersedes W. D., A. G. O. Form No. 445, 6 August 1943, which will not be used after receipt of this revision)
16—40290-1 ☆ U. S. GOVERNMENT PRINTING OFFICE : 1944

1. Column 1 shows total requirement for project.
2. Column 2 shows quantity available locally, including substitute, reclaimed, locally procured or produced materials.
3. Column 3 shows quantity previously requisitioned but not yet received.
4. Column 4 shows quantity due in or on hand which is committed to some other project or to be returned to depot as unserviceable or salvage.
5. Requisition confirming telephone or telegraph request is identified and marked DO NOT DUPLICATE.
6. Authority for issue is stated above the items on the requisition by citing the project order or showing a complete reference.
7. Special instructions such as grade of material, permissible substitutions, multiple or random lengths, packing, marking, and unit load limitations are given for appropriate item numbers when necessary.

Property issue slip, AGO form 446, is preferred in some theaters, because it serves also as tally-out and shipping document.

Figure 36. Standard requisition form, showing required information, typical items, and guide for preparing material requisition.

101. EQUIPMENT REQUIREMENTS. Tools and equipment needed in addition to organic items are shown in table XXXI A. The number of each equipment item needed is determined by the construction schedule, table XL. The special tool and equipment items for construction of the typical railway bridge are shown in table XLI. The following equipment use is planned.

a. Cranes. One crane will be used in the fabrication yard and two at the site to drive piles and erect steel. Data on crawler-mounted and truck-mounted cranes are given in tables LXXXIII and LXXXII.

(1) A ⅜-cubic-yard truck-mounted crane will be used in the fabrication yard to handle materials and finished parts.

(2) A ¾ cubic-yard crawler-mounted crane with 35-foot boom is needed to drive 30-foot piles. (See table LXXXIII.) This machine also will erect all parts of the structure from the ground except spans 3 and 4 and the upper story of towers 3 and 4.

(3) Spans 3 and 4 will be erected from the deck with a ¾-cubic-yard truck-mounted crane. The maximum load to be handled is one 50-foot stringer weighing 4 tons. It must be handled at 25-foot reach.

b. Gin poles. Towers 3 and 4 are too high to be erected by a crane with standard 35-foot boom. Gin poles like these described in paragraph 211 will be used to erect the top stories of these towers. After erection of towers 2, 3, and 4, these poles will be cut to length and used as struts for towers 1 and 5. Towers 1 and 5 can be erected by cranes.

c. Compressors. The number of pneumatic tools needed is obtained from the construction schedule, table XL. In the fabrication yard, most of the air required will be for drilling steel. Eight drills will be used and each drill requires 93 cfm of compressed air. (See table LXXXI.) Two 315-cmf trailer-mounted compressors will be needed. Additional capacity for peak requirements can be furnished by the 105-cfm truck-mounted compressors. The 105-cmf compressors will also furnish air for riveting crews. One compressor is needed for erection riveting.

102. PROGRESS REPORTS. Progress reports for the typical railway bridge are shown by figures 37(1) and 37(2). These are prepared from the percentage break-down of man-hour requirements. (See table XLII.)

a. Table XLII is prepared by reducing the man-hours of labor required for each operation from table XXXIX to a percentage of the labor required to complete the entire bridge. These percentages are tabulated in columns 1 to 21 inclusive of table XLII. The work in each principal operation scheduled for completion at the end of successive periods is obtained by proportion from the construction schedule. (See table XL.) These proportions are applied to the percentages that the operations are of the entire work (col. 21) to obtain the entries in columns 22 to 27 inclusive.

b. Total percentages from columns 22 to 27 inclusive are plotted as the schedule curve of figure 37(1) and from this curve, the graph of scheduled progress for the entire job is plotted (figure 37(2)). Scheduled progress in each operation is also plotted in figure 37(2), the length of the bar representing the duration of the operation being obtained from the construction schedule, table XL. At the end of each day percentage of work actually completed is estimated by referring to table XLII and plotted on the charts for comparison with scheduled progress.

Table XXXIX. *Man-hour requirements for constructing a typical railway bridge.*[1]

Operation	Abutments		Towers												Spans			Total man-hours
			No. 1			No. 2			No. 3 and 4			No. 5			Span 1	Spans 2 to 6	General	
	West	East	Foundation	Tower	Span	Foundation	Tower	Span	Foundation	Tower	Span	Foundation	Tower	Span				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Clearing[2]	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	240	240
Excavation	......	90	112	......	......	138	......	......	276	......	......	129	......	......	......	......	......	745
Pile driving	45	......	190	......	......	234	......	......	468	......	......	......	......	......	......	......	......	937
Form building	......	67	78	......	......	96	......	......	192	......	......	124	......	......	......	......	......	557
Concrete mixing and placing	......	56	133	......	......	163	......	......	326	......	......	196	......	......	......	......	......	874
Steel fabrication	......	......	......	296	112	......	518	112	......	1,110	224	......	318	112	112	2,895	......	5,809
Handling	......	......	......	32	26	......	56	26	......	120	52	......	34	26	26	615	......	1,013
Drilling	......	......	......	200	53	......	350	53	......	750	106	......	215	53	53	1,460	......	3,293
Miscellaneous	......	......	......	64	33	......	112	33	......	240	66	......	69	33	33	820	......	1,503
Steel erection	......	......	......	184	58	......	322	58	......	690	116	......	198	58	58	650	......	2,392
Rigging and handling	......	......	......	128	35	......	224	35	......	480	70	......	138	35	35	345	......	1,525
Fitting up	......	......	......	16	4	......	28	4	......	60	8	......	17	4	6	60	......	205
Riveting	......	......	......	40	19	......	70	19	......	150	38	......	43	19	19	245	......	662
Timber framing	......	......	......	......	21	......	......	21	......	......	42	......	......	21	21	165	......	291
Handling	......	......	......	......	11	......	......	11	......	......	22	......	......	11	11	105	......	171
Boring and sawing	......	......	......	......	3	......	......	3	......	......	6	......	......	3	3	15	......	33
Miscellaneous	......	......	......	......	7	......	......	7	......	......	14	......	......	7	7	45	......	87
Timber erection	15	......	......	......	6	......	......	6	......	......	12	......	......	6	6	90	......	141
Rigging and handling	6	......	......	......	4	......	......	4	......	......	8	......	......	4	4	45	......	75
Boring and sawing	4	......	......	......	1	......	......	1	......	......	2	......	......	1	1	15	......	25
Miscellaneous	5	......	......	......	1	......	......	1	......	......	2	......	......	1	1	30	......	41
Cleanup, etc.[2]	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	400	400
Total man-hours	60	213	513	480	197	631	840	197	1,262	1,800	394	449	516	197	197	3,800	640	12,386

[1] Man-hours required for supervision, surveying, equipment maintenance, etc. not included.

[2] Estimated roughly.

Table XLI. *Special equipment list for constructing a typical railway bridge.*

Stock number	Description	Number required
78–7585.07	Crane, crawler-mounted, gasoline-engine driven, 35-foot boom, ¾ cu. yd.	1
78–2965.07	Crane, truck-mounted, gasoline-engine driven, ¾ cu. yd.	1
78–2965.04	Crane, truck-mounted, gasoline-engine driven, ⅜ cu. yd.	1
66–6070.3	Lead, pile driving, steel hanging	1
66–5340.7	Hammer	1
11–2650.4	Jetting set, portable, complete with gasoline-engine driven 200 gpm centrifugal pump and accessories	1
66–3250.315	Compressor, air, trailer-mounted, 315 cfm	2
78–5785.14	Mixer, concrete, gasoline-engine driven, trailer-mounted, 14 cu. ft.	1
69–9280.5–3	Wheel barrow, steel tray and handles, 3 cu. ft.	12
11–4619.24	Pump, 55 gpm centrifugal, gasoline-engine driven, base-mounted, 2-inch discharge	1
40–3871.3	Drill, penumatic, portable, nonreversible, for steel	8
	Erection equipment, steel and timber, structural, set	1
	Riveting equipment, structural, set	1
	Rigging equipment, set No. 1	1
	Blacksmith equipment, set No. 1	1
	Pipefitting equipment, set No. 1	1
	Rigging equipment, set No. 1	1
	Sign painting equipment, set No. 1	1
	Surveying equipment, set No. 6	1

Table XL. Construction schedule for a typical railway bridge

Operation	Total man-hours	Man-days	Size of detail	Detail-days	Number of details	Days required	Men required	Construction period—days																														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Clearing	240	30	10	3	1	3	10	X	X	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Excavation	745	93	7	13	2	7	14	X	....	....	X	....	X	X	....	X	....	X	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pile driving	937	117	8	15	1	15	8	....	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Form building	557	70	9	8	1	8	9	....	....	X	X	....	X	X	....	X	....	X	....	....	X	....	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Concrete mixing and placing	874	109	24	5	1	6[1]	24	....	....	....	....	X	....	....	X	....	X	....	....	X	....	X	....	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Steel fabrication	5,809	726	....	....	....	25	29	....	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	....	....	....	....	....
Handling	1,013	127	7	18	1	18	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Drilling	3,293	411	2	205	8	25	16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Miscellaneous	1,503	188	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Steel erection	2,392	299	....	....	....	21	15	....	....	....	....	....	....	....	....	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rigging and handling	1,525	191	9	21	1	21	9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Fitting up	205	26	2	13	1	13	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Riveting	662	82	4	20	1	20	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Timber framing	291	36	....	....	....	3	11	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	X	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Handling	171	21	7	3	1	3	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Boring and sawing	33	4	2	2	1	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Miscellaneous	87	11	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Timber erection	141	18	....	....	....	2	11													Work done by steel erection detail																		
Rigging and handling	75	10	9	1	1	1	9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Boring and sawing	25	3	2	2	1	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Miscellaneous	41	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Clean-up, etc.	400	50	10	5	1	5	10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	X
Total[2]	12,386	1,548	Men employed[2]					24	47	56	60	61	60	60	61	75	76	75	77	76	72	76	72	68	44	44	44	44	44	44	44	44	44	25	25	25	25	25

[1] One day required for each tower and the east abutment.

[2] Supervision, equipment maintenance, surveying, etc., not included.

c. The progress charts (fig. 37) assume the following status of work at the end of the tenth day of construction.

Clearing	complete.
West abutment	complete.
Span 1	complete.
Tower 1	complete.
Span 2	steel fabricated and timber framed.
Tower 2	foundations complete, steel fabricated, and timber framed.
Tower 3	foundations excavated, piles driven, forms built, and steel fabricated.
Tower 4	foundations excavated.

d. To prepare progress charts (fig. 37), the status of each operation as given above must be converted to percentage of completion. The calculations are shown below. (The percentages of total work represented by each operation on each unit of construction are from table XLII.)

Clearing .... 1.9% ÷ 1.9% = 100%

Excavation .... 0.9 + 1.1 + 1.1 + 1.1 = 4.2% ÷ 6.0% = 70%

Pile driving .... 0.4 + 1.5 + 1.9 + 1.9 = 5.7% ÷ 7.6% = 75%

Form building .... 0.6 + 0.8 + 0.8 = 2.2% ÷ 4.6% = 48%

Concrete mixing and placing .... 1.1 + 1.3 = 2.4% ÷ 7.0% = 34%

Steel fabrication:

0.9 + 2.4 + 0.9 + 4.7 + 4.2 + 0.9 + 4.5 + 0.9 = 19.4% ÷ 46.9% = 41%

Steel and timber erection:

0.1 + 0.1 + 0.5 + 0.1 + 0.5 + 1.3 = 2.6% ÷ 20.5% = 13%

Timber framing .... 0.2 + 0.1 + 0.3 + 0.2 = 0.8% ÷ 2.3% = 35%

Clean up .... 0% ÷ 3.2% = 0%

Total work .... 39.2% ÷ 100% = 39.2%

CHAPTER 10

PRELIMINARY WORK AND CONSTRUCTION SURVEYS

103. PRELIMINARY. a. Pioneer work. The construction troops move up with pioneer tools and dozers, establish security, build pioneer access roads, prepare the site, and provide drainage.

b. Access roads. Existing roads may have to be improved or new roads constructed to reach the site. High priority must be given to this work to permit early delivery of equipment and supplies.

c. Preparation of site. The work area should be prepared in accordance with the approved construction plan. Preparation of site includes:

(1) Clearing work areas of underbrush, trees, drift, and debris.

(2) Clearing, leveling, and draining work areas for storage of materials, fabrication and framing operations, assembly of parts, turn-arounds, and tools and equipment.

(3) Providing shelter for tools and supplies.

(4) Providing dunnage for storage of materials.

104. ASSEMBLY OF EQUIPMENT. a. General. Tools and equipment should be assembled and prepared for use before they are needed. Priority should be given to tools and equipment used in early stages of construction.

b. Storage. Provision should be made for sheltering tools stored at the site. Vigilant supervision is necessary to make sure that tools and equipment are returned to their storage place when not in use. Principal minimum space requirements for storage and maintenance of tools and equipment are:

(1) Hand-tool and hardware storage .... ½ square yard per worker, one-half of it under cover.

(2) Pneumatic-tool storage and maintenance shop .... ¼ square yard per worker.

(3) Machine, blacksmith, and pipe-fitting shops, including tool sharpening .... 30 square yards or more.

(4) Riggers' shop .... 20 square yards or more.

(5) Heavy-equipment storage and maintenance .... 50 to 200 square yards.

c. Maintenance. Daily inspection, cleaning, lubrication, and repair are essential if tools and equipment are to be in good working order at all times. It is particularly important that ropes, slings, blocks, winches, brakes, and other equipment carrying heavy loads be checked for defects. Defective load handling equipment should be repaired or removed from service. This prevents serious accidents and delays.

105. ASSEMBLY OF MATERIALS. a. General. All material required for constructing the bridge is assembled at the site without delay. Priority is given to securing material needed in the early stages, particularly to assembly of steel which must be fabricated before erection. Assembly of material is coordinated with the construction schedule. (See par. 90.)

b. Care in shipment. Care must be taken to avoid damage in assembling and transporting material. Light and heavy steel sections should not be loaded together. Small parts such as nails, bolts, rivets, and the like, should be packed in kegs or boxes. Adequate timber bracing and blocking should be provided to prevent material shifting during shipment.

c. Storage. Materials delivered to the site should be immediately sorted and stored as described in chapter 11. Small parts like nails, bolts, nuts and washers, and rivets should be kept under cover. Cement must be off the ground

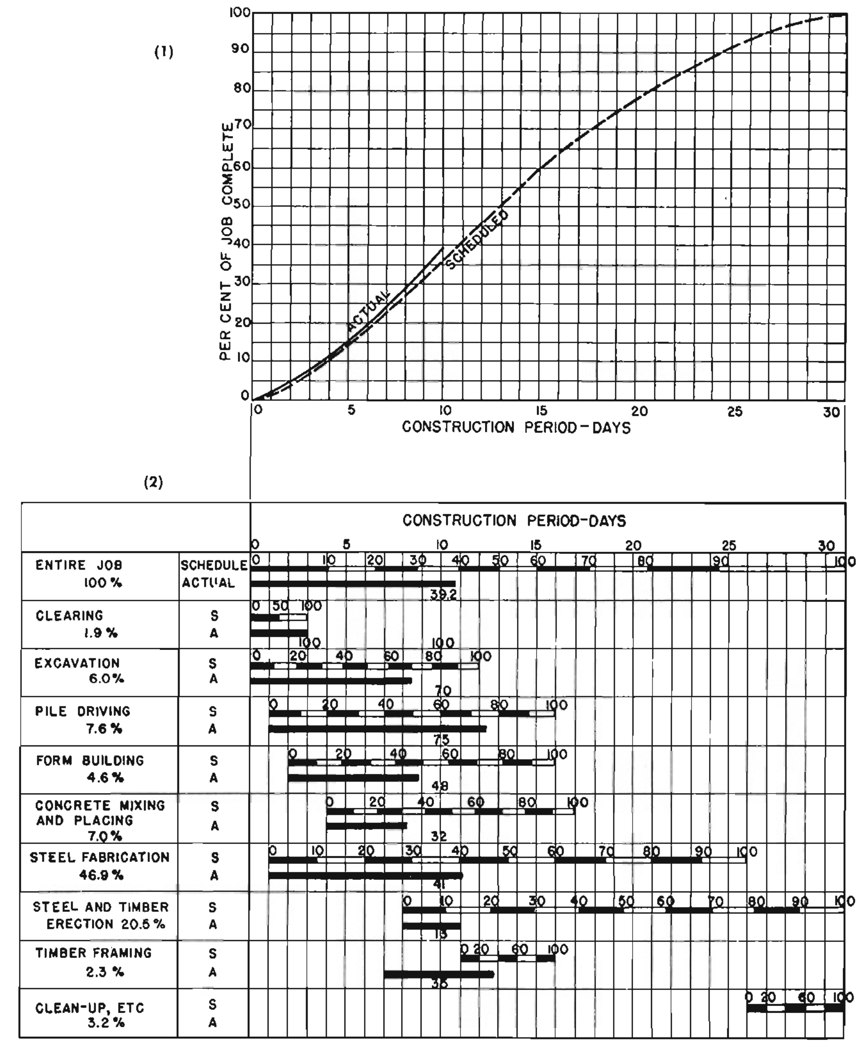


Figure 37. Construction progress charts for a typical railway bridge.

(1) Progress graph.

(2) Progress bar diagram.

TABLE XLII. *Percentage break-down of man-hour requirements for a typical railway bridge.*

Operation	Abutments		Towers															Spans		General	Percent of job	Percent of job complete					
	West	East	No. 1			No. 2			No. 3			No. 4			No. 5			Span 1	Spans 2 to 6			1st day	5th day	12th day	16th day	26th day	31st day
			Foundation	Tower	Span	Foundation	Tower	Span	Foundation	Tower	Span	Foundation	Tower	Span	Foundation	Tower	Span										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
Clearing	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1.9	1.9	0.7	1.9	1.9	1.9	1.9	1.9
Excavation	....	0.7	0.9	....	....	1.1	....	....	1.1	....	....	1.1	....	....	1.1	....	....	....	....	....	6.0	0.9	1.7	6.0	6.0	6.0	6.0
Pile driving	0.4	....	1.5	....	....	1.9	....	....	1.9	....	....	1.9	....	....	....	....	....	....	....	....	7.6	....	2.0	5.6	7.6	7.6	7.6
Form building	....	0.5	0.6	....	....	0.8	....	....	0.8	....	....	0.8	....	....	1.1	....	....	....	....	....	4.6	....	1.2	3.5	4.6	4.6	4.6
Concrete mixing and placing	....	0.4	1.1	....	....	1.3	....	....	1.3	....	....	1.3	....	....	1.6	....	....	....	....	....	7.0	....	1.1	3.5	5.9	7.0	7.0
Steel fabrication	....	....	....	2.4	0.9	....	4.2	0.9	....	4.5	0.9	....	4.5	0.9	....	2.5	0.9	0.9	23.4	....	46.9	....	7.5	20.6	28.1	45.9	46.9
Steel erection	....	....	....	1.5	0.5	....	2.6	0.5	....	2.7	0.5	....	2.8	0.5	....	1.6	0.5	0.5	5.2	....	20.5	....	....	3.9	7.8	17.6	20.5
Timber framing	....	....	....	....	0.1	....	....	0.2	....	....	0.1	....	....	0.2	....	....	0.2	0.2	1.3	....	2.3	....	....	0.7	2.3	2.3	2.3
Timber erection	0.1	....	....	....	0.1	....	....	0.1	....	....	0.1	....	....	0.1	....	....	0.1	0.1	0.4	....	....	Work	done	by ste	el ere	ction	detail
Clean-up, etc	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3.2	3.2	....	....	....	....	....	3.2
Total	0.5	1.6	4.1	3.9	1.6	5.1	6.8	1.7	5.1	7.2	1.6	5.1	7.3	1.7	3.8	4.1	1.7	1.7	30.3	5.1	100.0	1.6	15.4	45.7	64.2	93.9	100.0

in a watertight shack or on a timber platform, where it should be covered with tarpaulins. Principal space requirements for storage are:

(1) Stock-length storage adequate to handle 40-foot steel pieces and of sufficient size for tonnage in storage at one time, estimated at 1 square yard of net area per ton. Storage-pile width should not exceed 15 feet.

(2) Timber storage estimated at 2 square yards of net area per thousand board feet (mbm).

(3) Adequate space for storage of finished parts and fabricated or framed assemblies.

d. Access to work and storage areas. All work and storage areas should be easily accessible to cranes with driveways 16 feet wide. No point in the storage, fabrication, or framing areas should be more than 10 feet from a driveway.

106. TRANSPORTATION. a. Truck-trailer. (1) Except for piles, the maximum length of stock-pile sections used in semipermanent bridges is about 40 feet. These sections can be transported by 8-ton or 16-ton full flat-bed trailers. (See fig. 38.)

(2) Piles may be up to 90 feet long. Transportation of long piles requires two-wheel utility pole type trailers. Piles are carried by the trailer and in a pivoted cradle on the truck.

b. Rail loading. (1) Units constructing these bridges ordinarily are not concerned with loading and rail transportation. However, they unload material at rail sidings or from cars at the sites of railway bridges.

(2) All class IV materials except long piles can be carried in standard-length commercial railway cars, but some sections are too long for standard military railway cars. Where the length of pieces exceeds the length of cars, pieces are placed so their weight rests on one car, called the load car, and the overhang extends over an adjacent car, called the idler car. Extremely long piles may have to be carried in cradles on two load cars.

c. Unloading. Trailers and cars are usually unloaded with a truck- or crawler-mounted crane. (See fig. 39.) However, light pieces can be unloaded by hand. Steel pieces should not be thrown from the trailer or car, but should be slid to the ground on skids. (See fig. 40.)

107. CONSTRUCTION SURVEYS. a. General. (1) Construction surveys with transit, level, and tape are made to stake out the work on the ground. Surveys are required to fix the elevation of sills and bearing plates and to

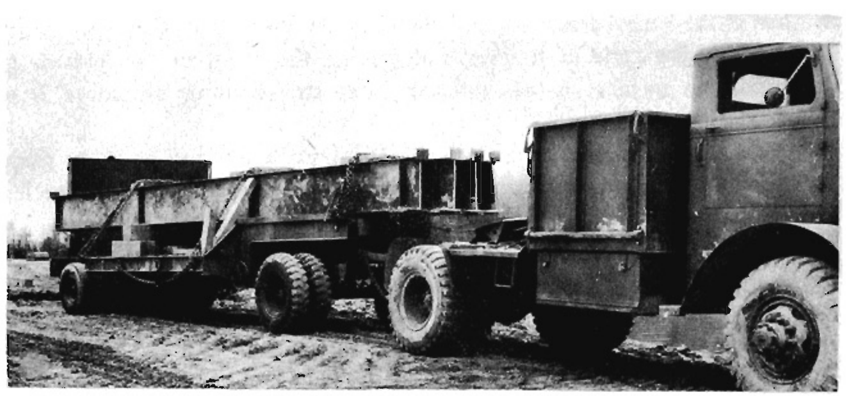


Figure 38. Steel-stringer sections loaded on a trailer. Timbers level the beams and chains and shoring secure the load. Stringers shown are for a 30-foot-span semipermanent highway steel bridge.

locate the position of anchor bolts and the center lines of bridge, foundations, and bearings.

(2) The vertical distance from top of deck to top of cap or to bottom of bearing is shown on the assembly drawings for all units. Position of anchor bolts with respect to the bridge centerline and the centerline of the foundation is also shown for all units.

(3) Bridge surveys are discussed in FM 5–10. Instructions on the use of instruments and the procedure followed in construction surveys are given in TM 5–235.

b. Location of center lines of bridge and foundations. The position of the bridge centerline is established by the construction plan. It usually coincides with the centerline used in the site survey. The final centerline is located on the ground and marked by stakes set at each end of the line. From a starting

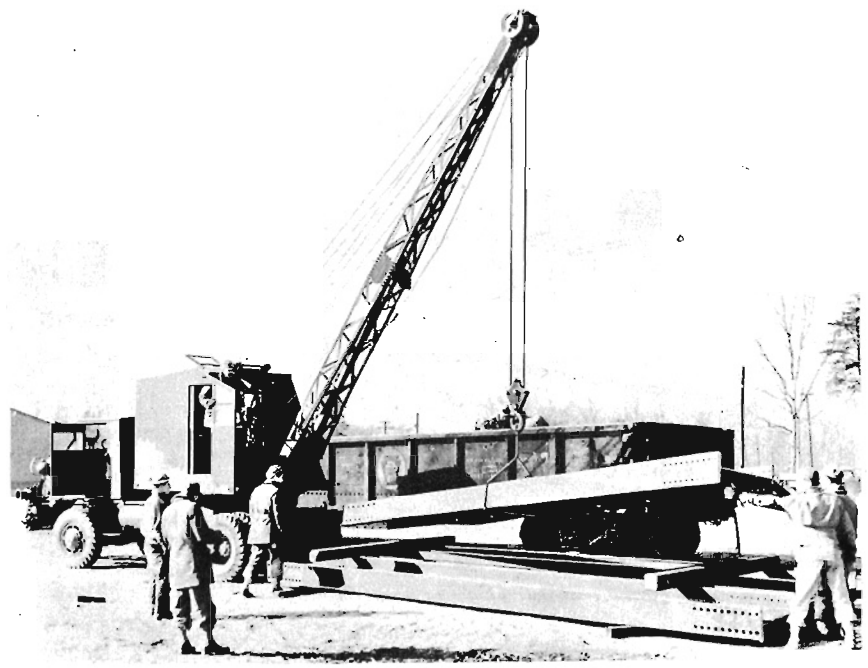


Figure 39. Unloading stringer sections from a gondola car with a 3/8-cubic-yard truck-crane. The timber dunnage keeps the steel off the ground and facilitates placing wire-rope slings. Sections shown are for a 60-foot-span semipermanent highway steel bridge.

point at one abutment, also fixed in position by the construction plan, the locations of the other abutment and of each foundation unit are established.

(1) *Direct measurement.* (*a*) Wherever conditions permit, centers of all units are established by direct lining with transit and measuring with tape. Distances between foundation units are measured and centers marked by stakes. The centerline of each bent is established by turning a 90° angle from the bridge centerline. The center of each footing or of each pile of pile bents is located by measurement from the bridge centerline and is marked. Reference stakes from which centers can be reestablished are preferably set outside the construction area where they will not be disturbed. Where this is not possible, their presence is made evident by guard stakes and flags.

(*b*) Where wide streams or swampy areas are crossed and direct measurement on the ground is impossible, centerlines may be located by triangulation, or platforms from which measurements can be made, may be built on posts at the centers of each bent.

(2) *Triangulation.* (*a*) A base line running at approximately 90° to the

Figure 40. Unloading light steel sections from a trailer by hand. Skids are used to slide beams to the ground.

bridge centerline is laid out on firm level ground on one bank as close to the stream as practicable. The base line should be at least half the greatest distance to be measured; longer base line is preferable. One end of the base line is on the bridge centerline.

(*b*) A point on the bridge centerline is established at random on the opposite bank. From each end of the base line, angles to the point on the far bank are carefully measured with a transit. From the measured angles and the known length of base line, the distance to the point on the far bank is computed.

(*c*) Intermediate inaccessible points on the bridge centerline are established by turning computed angles from the base line to lines intersecting the bridge centerline at those points.

(*d*) Extreme care must be used to avoid inaccuracies in triangulation. The base line and angles must be accurately measured and carefully checked.

(*e*) For long triangulations, two base lines are preferred, one on each bank. Locations are made from one base line and checked from the other.

c. Elevations of foundations and bearings. Before elevations are run to foundation units, bench marks should be established near both ends of the bridge and at other convenient locations near the construction areas. The reference elevation (datum) should be the one used in the site survey. Elevations of bearing on foundation units are given on the construction plan or may be obtained by subtracting the depth of the intervening superstructure and supports from the elevation of the bridge grade line. These elevations are marked by grade stakes set close to the construction areas. Grade stakes should be protected by guard stakes or framework.

d. Anchor bolts and bearings. (1) Particular care must be used in setting anchor bolts. The position of anchor bolts in concrete foundations should be checked after forms are completed and immediately before concrete is placed.

(2) After foundation units are completed, centers of bearings should be reestablished accurately on the finished foundation.

e. Accuracy. Accurate measurements are extremely important in bridge construction and particularly for steel bridges. Steel tapes must be used for all measurements. These should be checked with the tapes used in fabrication and framing of parts. All measurements should be carefully checked to eliminate errors. Steel tacks marking the exact point of reference should be used in all survey stakes.

CHAPTER 11

FABRICATION AND FRAMING

Section I. STEEL FABRICATION

108. GENERAL. **a.** Fabrication of steel for towers and superstructures consists of cutting, drilling, and assembling the shapes, plates, and bars received from engineer depots in stock sizes and lengths.

b. Fabrication methods depend on the size of the structure, the tools available, and the skill of the personnel.

c. Strength of the finished structure depends on careful fabrication and fitting, and the bolting, riveting, or welding by which parts are joined.

d. Ease of making connections during erection is largely determined by the accuracy of fabrication.

109. TOOLS AND EQUIPMENT. **a.** Tools and equipment needed for fabricating semipermanent bridges are listed in table XXXI. This list does not include hand tools regularly issued to squads or platoons, or personal protective equipment such as goggles and safety belts.

b. A crane, preferably the ⅜-cubic-yard truck-mounted crane, should be available in the fabrication yard at all times for unloading steel and for moving and turning the heavier pieces during fabrication and assembly.

110. FABRICATION YARD. **a.** The fabrication yard is laid out to suit the fabrication procedure and the size of the bridge. It must be on firm, level ground, providing ample working space, and preferably should adjoin the bridge site.

b. The yard is divided into the following areas:

(1) Area for storage of stock-length steel.

(2) Area for lay-out, cutting and drilling of individual parts.

(3) Area for drilling and reaming assembled parts and for bolting, riveting, and welding.

(4) Area for storage of fabricated subassemblies.

111. WORK SCHEDULE. **a.** Fabrication of steel should be started well ahead of erection so parts will be ready when needed.

b. The work is divided so all available men and equipment can be employed. Maximum efficiency is obtained when work is organized on an assembly-line basis with each crew assigned the fabrication of one group or class of members.

112. MATERIAL RECEIVING AND STORAGE. **a. Receiving.** As material arrives at the site, each piece is checked to insure that its size and length are correct and that it is in good condition. Wrong-size pieces and pieces severely damaged in transit are returned for exchange.

b. Record. A record is kept of each piece of material in the storage yard and its intended use.

(1) Cutting lists are prepared and each piece is given the mark number or numbers in the bills of materials.

(2) All material taken from the yard is checked out by the stockkeeper.

c. Storage. Time and labor are saved by storing materials carefully.

(1) Pieces of one size and length are stored together on timber blocking. Pieces are separated so slings can be easily attached. If stacked in more than one layer, layers are separated with timber dunnage.

(2) Pieces are stored so those needed first can be most easily reached.

(3) All pieces are placed within easy reach of the yard crane. Stacks are not over 15 feet wide and are at least 16 feet apart.

113. STRAIGHTENING BENT MATERIAL. **a.** Bent or twisted pieces must be straightened before being used in fabrication.

(1) If the damage is so severe that the strength of the piece is in doubt, it should be used only as miscellaneous stock to be cut up for secondary use.

(2) No attempt should be made to reclaim pieces that have short kinks or buckles or that show surface cracks at the point of injury.

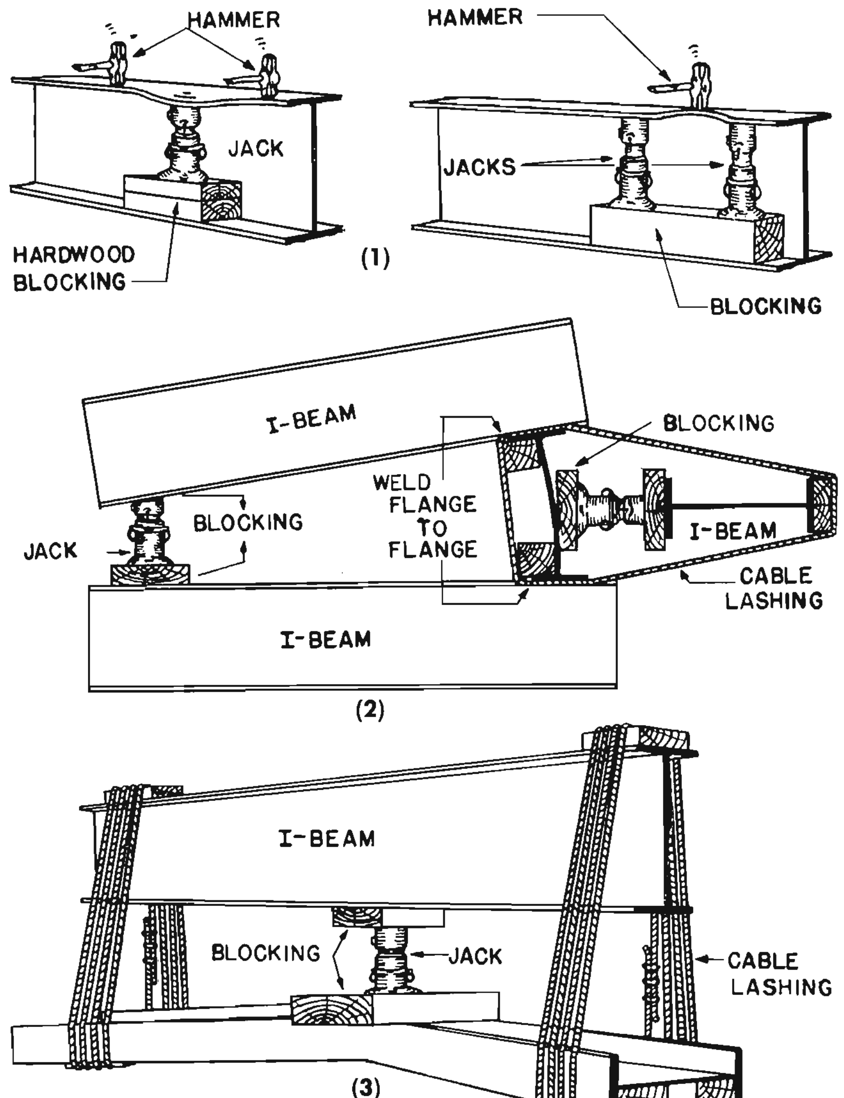


Figure 41. Methods of straightening bent beams with jacks and tackle.

(1) Localized flange bends.
(2) I-beam web bent longitudinally.
(3) I-beam bent transversely.

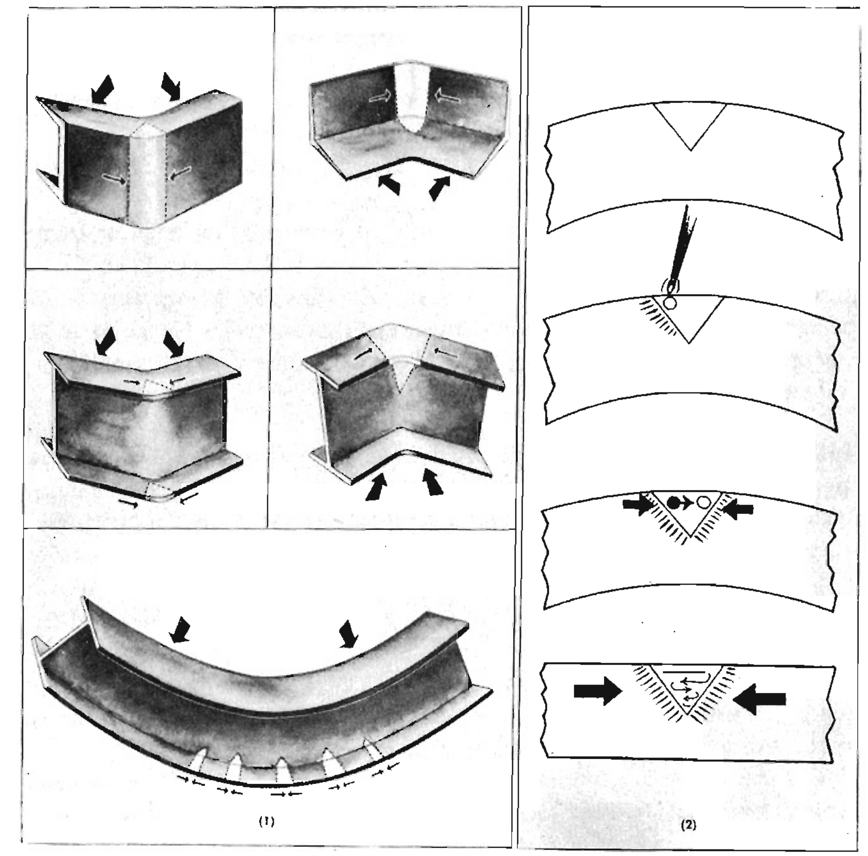


Figure 42. Heat-straightening of beams.

(1) Areas to which heat should be applied to heat-straighten typical beams.
(2) Sequence of operations in heat-straightening bent members.

b. Examples of common damage to rolled beams and of methods of straightening them with jacks and tackle are shown in figure 41. Straightening is assisted by heating the metal with a blow torch or an oxyacetylene torch adjusted to a neutral flame.

c. Members can also be heat-straightened as illustrated in figure 42. The outside of the bend is heated while the inside of the bend is kept cool. The heated metal tries to expand but is restrained by the cooler metal surrounding it. Then as the heated area cools and contracts, the member tends to straighten. By repeating the cycle of heating and cooling the metal on the outside of the bend, the member is straightened. Heat straightening procedure is as follows:

(1) Mark with chalk the area to be heated. Usually this will be in the shape of a triangle because more heat is needed at the outside of the bend and less toward the center.

(2) An oxyacetylene torch with a large welding tip is used. Hold the flame steady at a point near the apex of the triangle (toward the center) or at the outer edge as shown in figure 42(2) until the metal reaches a light cherry-red color.

(3) When the area immediately under the tip has reached the proper temperature, slowly move the tip to one side so the heated area moves with it. Watch the work closely to keep the hot spot moving properly, otherwise there will be no upsetting and the metal may be burned. Under no circumstances

should the metal be heated to the melting point. Cool the metal on the inside of the bend with water, ice, or wet rags.

(4) Continue this procedure until the small circle of hot metal has covered all of the area within the triangle; then allow the member to cool. If the member is still not straight repeat the operation at the same or an adjacent point. A little heat applied several times is better than too much heat all at once. Long bends are straightened best by heating several times at intervals along the bend.

Caution: Operators should practice heat-straightening on scrap metal before attempting to straighten a structural member.

d. If the strength of a piece is in doubt after straightening, it should be reinforced by welding on plates which extend far enough beyond the zone of apparent damage to develop their full strength.

114. LAY-OUT. a. General. (1) Lay-out is the process of marking material for cutting and drilling or welding. It must be done accurately for it determines the exactness of subsequent operations.

(2) Only steel squares, steel rulers, and steel tapes are used. Woven metallic tapes must not be used for lay-out work. All tapes should be checked against each other to insure they are all exactly alike.

b. Procedures. The two principal lay-out procedures are as follows:

(1) *Scratching.* For members having little duplication, all cuts and holes are marked directly on the metal in the exact positions shown on the detail drawings. No guide or pattern is used, cuts and holes being located by direct measurement. (See fig. 43.) Cuts are marked with metal workers' soapstone crayon and all holes are center-punched. All measurements should be carefully checked.

(2) *Templates.* Lay-out templates (fig. 44) are full-scale patterns of wood or stencil paper made to the exact size and shape of the piece for which they are used and containing all holes to be made in the finished piece. Holes are located exactly but are drilled only large enough to guide the center punching of holes in the steel with straight shank center punches. Templates are clamped to the material in exact position; all holes are center-punched and all cuts marked.

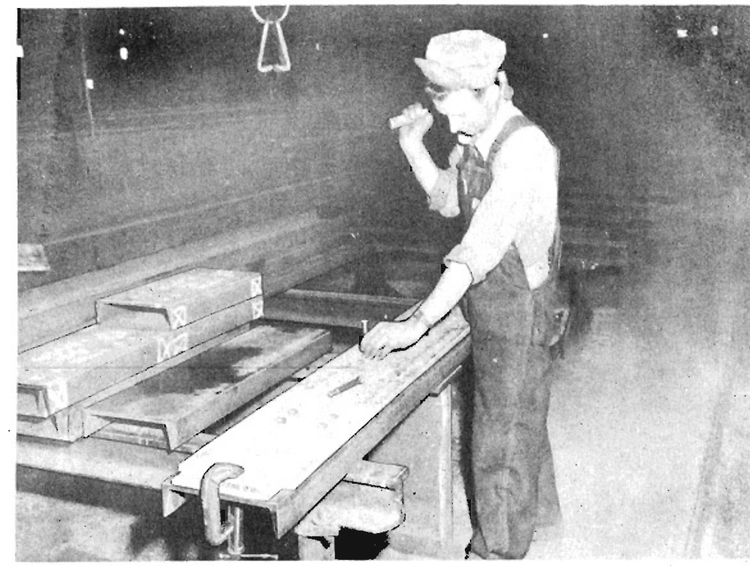


Figure 44. Wood template used to guide center-punching for holes in a short steel channel.

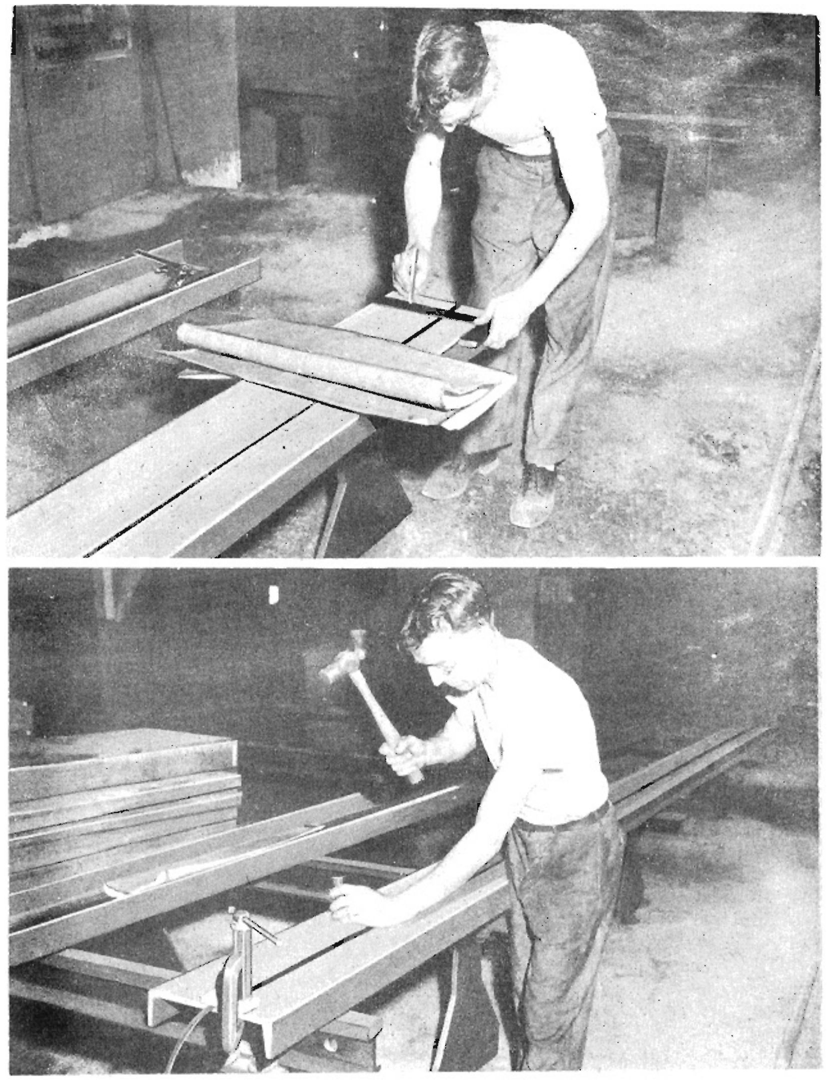
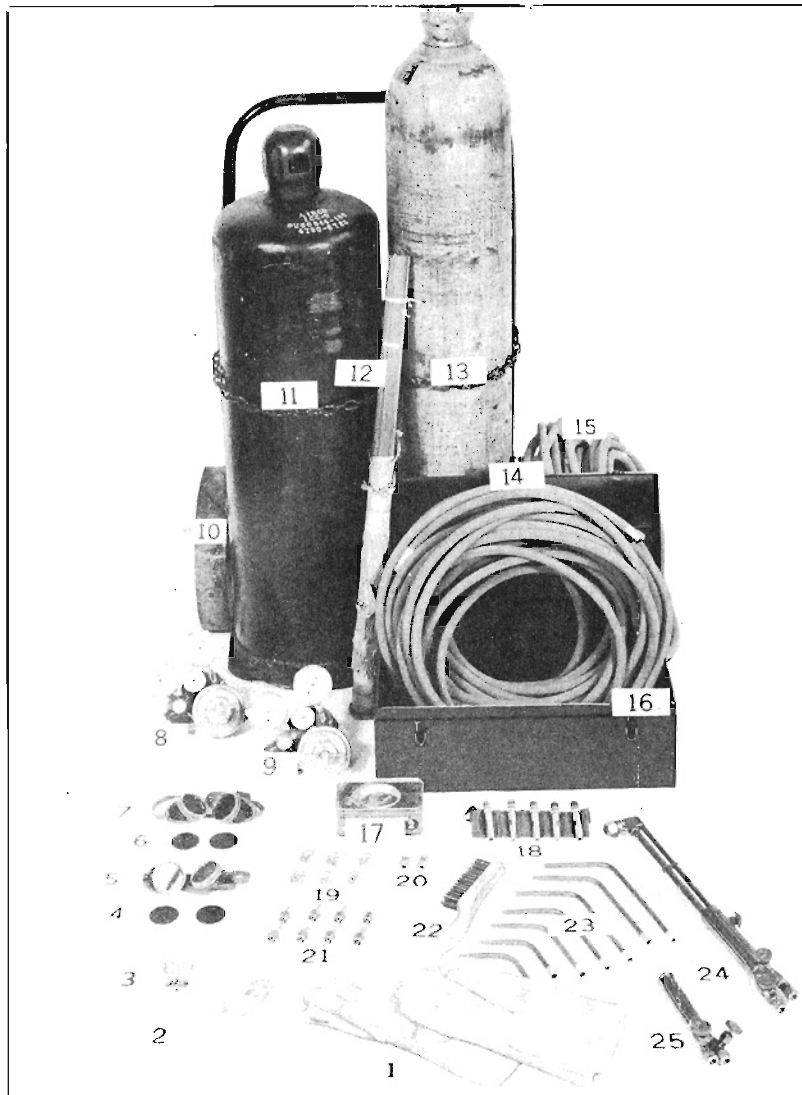


Figure 43. Lay-out procedure when little duplication is required. Steel tape clamped to the work for measurements from one end.



WELDING EQUIPMENT — SET NO. 2
Oxyacetylene

1.	Gloves, welder's leather.
2.	Ignitor, oxyacetylene.
3.	Flints, ignitor, oxyacetylene.
4, 6.	Lens, goggle, welder's, shades Nos. 5, and 6.
5, 7.	Goggles, welder's type II.
8.	Regulator, 2-stage, acetylene.
9.	Regulator, 2-stage, oxygen.
10.	Truck, hand, gas cylinder, oxyacetylene.
11.	Gas, acetylene, 225-cubic-foot cylinder.
12.	Rods, welding, oxyacetylene, manganese bronze 3/16-inch, steel mild ⅛-inch, steel mild ¼-inch.
13.	Gas, oxygen 220- to 240-cubic-foot cylinder.
14.	Hose, gas, acetylene, red with couplings, 5/16-inch, 50-foot.
15.	Hose, gas, oxygen, green, with couplings, 5/16-inch, 50-foot.
16.	Box, welding and cutting equipment, steel.
17.	Flux, welding, 1-lb. can.
18, 24.	Torch, oxyacetylene, cutting, with 5 tips, Smith Nos. 2-4, 3-6, 4-6, 6-6, and 6SC; of Airco, Nos. 2, 4, 6, 8, and 11.
19.	Clamp, hose, oxyacetylene, 5/16-inch.
20, 21.	Coupling, hose, oxyacetylene, 5/16 thread; oxygen, right-hand 9/16-inch 18-thread; with nut and ¼-inch to 5/16-inch gland.
22.	Brush, wire, scratch, with wood handle, 4 x 17 rows, 10-inch.
23, 25.	Torch, oxyacetylene, welding with tips, Smith Nos. 50, 51, 52, 53, 54, 56, 57, B68, B69, B612; or Airco Nos. 1, 3, 5, 7, 8, 9, 10.

Not Shown: Adaptor, acetylene regulator.
Cleaners, welding and cutting equipment, cutting tip.
Wrenches, regulator; torch, cutting; torch, welding.

Figure 45. Oxyacetylene cutting and welding equipment, set No. 2.

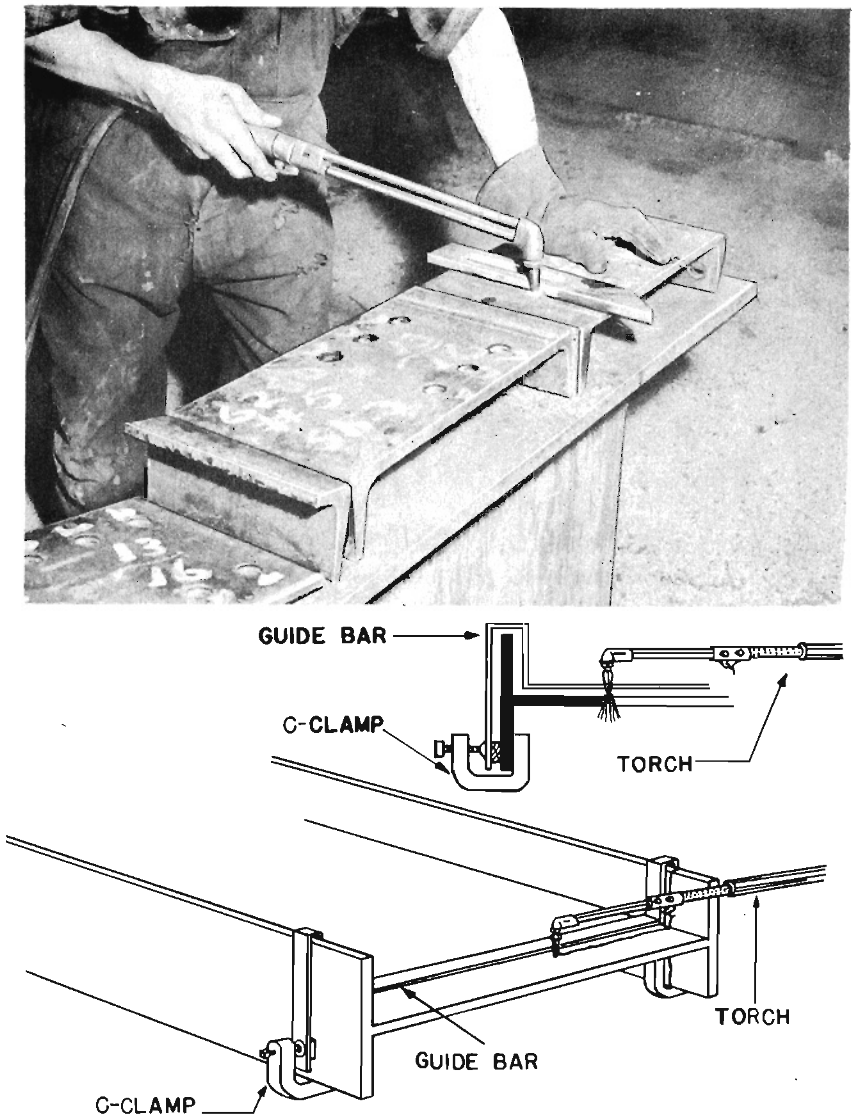


Figure 46. Guiding the oxyacetylene cutting torch.

(1) Bar clamped to beam to guide torch.
(2) Cutting steel channels with a torch guided by a flat bar laid on the line of the cut.

(*a*) Templates for short members and plates are made in one piece of the same size as the piece to be fabricated.

(*b*) For long members such as beams and columns, templates cover only the connections. Templates may be joined by a board to insure accurate spacing or may be handled separately, the template for each connection being clamped to the member after spacing and lining by measurement.

115. MARKING. Each part and each member of assembled parts is marked to correspond with markings on the detail drawings. The identifying number gives the principal member by mark number and the pieces attached to it in fabrication by letter and number. These marks are painted on each piece on completion of its lay-out, so pieces can be identified during fabrication, assembly, and erection.

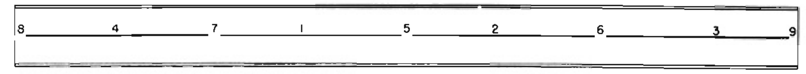


Figure 47. Order of making cuts in splitting rolled beams.

116. CUTTING. a. General. The principal cutting tool in the field is the oxyacetylene torch. In the hands of a skilled operator, it is a fast and versatile tool. It is used in making all cuts in steel, to bevel edges for welding, and to cut rough holes for bolting and riveting, slots for anchor bolts on stringers, and anchor-bolt holes in steel-column base plates.

b. Oxyacetylene cutting torch. The oxyacetylene cutting torch is fitted with a tip containing a central jet which discharges pure oxygen surrounded by other jets which discharge mixed oxygen and acetylene. Tips are selected to suit the thickness of metal to be cut. Recommended tip sizes are given in table XLIII.

TABLE XLIII. *Oxyacetylene cutting data.*

Thickness of steel—inches......	¼	⅜	½	¾	1
Diam. of cutting orifice—inches	.03	.03	.04	.06	.06
Cutting speed—					
lineal inches per minute........	17–25	16–24	15–23	13–21	12–18
Oxygen consumption—					
cubic feet per hour................	29–34	37–46	68–77	127–151	144–160
Acetylene consumption—					
cu. ft. per hour	7–8	7–8	12–14	14–20	14–20

c. Procedure. (1) To preheat the steel to its kindling temperature in oxygen (1,400 F to 1,600 F), the torch flame is adjusted to neutral by gradually opening the oxygen valve and shortening the acetylene flame until a clearly defined inner luminous cone is visible at the end of the tip.

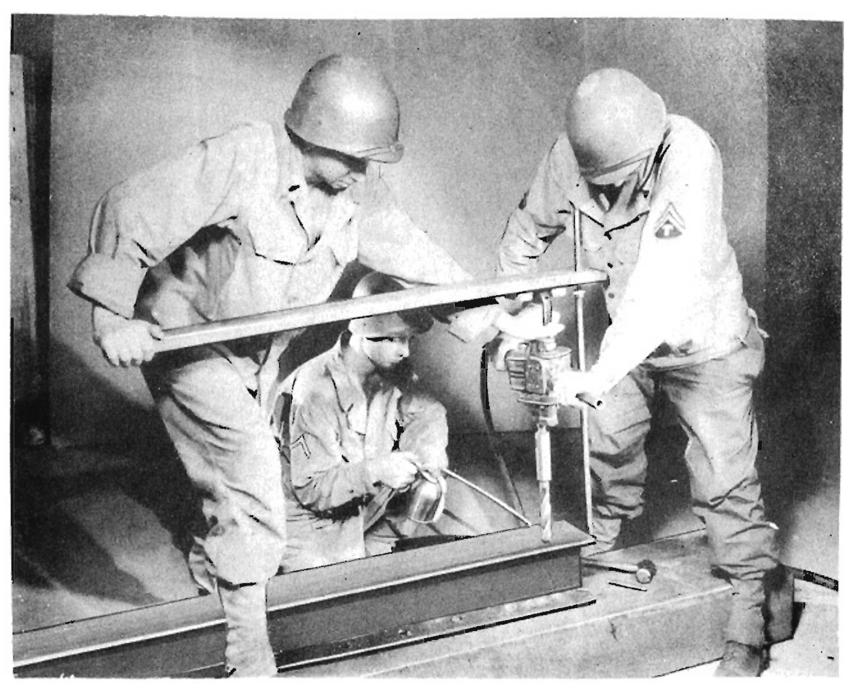
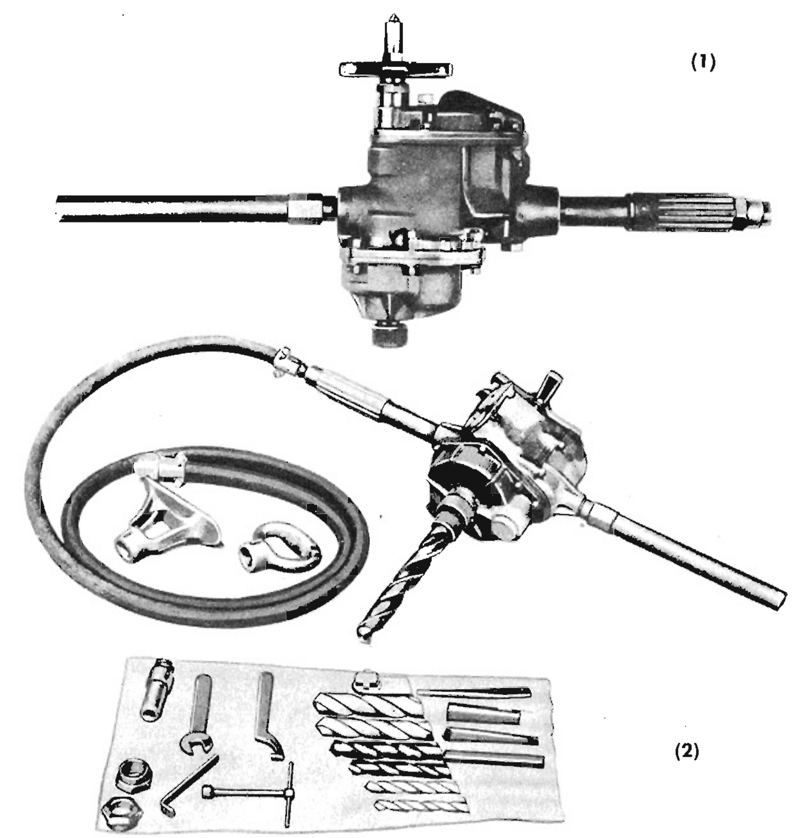


Figure 48. Drilling 15/16-inch holes in steel with the pneumatic wood borer.

(2) To start the cut, the torch is held perpendicular to the work at the end of the cut; the inner core of the preheating flame should be about 1/16 of an inch from the metal.

(3) The torch is held stationary until the metal under the tip is raised to a bright red heat; then the valve of the oxygen jet is slowly opened. As the cut starts, a shower of sparks falls from the opposite side of the work.



DRILL, PNEUMATIC, PORTABLE, NONREVERSIBLE,
NO. 3 MORSE TAPER SOCKET, FOR STEEL, WITH ACCESSORIES

Drill, twist, high-speed steel, No 2 Morse taper, ½-, ⅝-, and ¾-inch, each	2
Drill, twist, high-speed steel, No 3 Morse taper, ⅞-, 1-, 1⅛-, and 1¼-inch, each	2
Canvas container, for twist drills	1
Sleeve, Morse taper No 2 to No 3	1
Countersink, high-speed steel, No 3 Morse taper, ¾-inch	2
Breast plate, with stud and nuts	1
Feed screw, 3¾-inch travel	1
Grip handle, with stud and nuts	1
Leader hose, ½-inch, 20 feet long, with couplings	1
Chuck, reamer	2
Nipple, hose, ¾- to ½-inch	1
Pin, ejecting	2
Wrench, socket, 7/16- and ½-inch, and spanner	6
Gun, grease	1
Tool box, wood or steel	1

(3)

Figure 49. Portable pneumatic drill for up to 1¼-inch holes in steel.

(1) Piston type, 41-pound drill with accessories.
(2) Vane type, 35-pound drill.
(3) Accessories for complete drill when issued with 105-cfm motorized compressor.

(4) The flame is drawn slowly along the line of the cut. The movement should be just fast enough for the cut to continue to penetrate and cut completely. If the cutting is done properly, a clean narrow cut results.

d. Guides. Where exactness in the finished cut is necessary, as at the ends of columns or beams, or for accurate splitting of beams, a torch guide is used. The guide can be a bar shaped to fit the beam and clamped to it (fig. 46(1)), or a straight-edged bar heavy enough to hold its position without slipping (fig. 46(2)).

e. Splitting rolled shapes. T-shaped pieces are obtained by splitting I-beams lengthwise through the web. Release of internal stresses locked in beams during rolling causes parts to bend or warp when the beams are split unless the splitting process is carefully controlled. The proper procedure is to:

(1) Cut beams to length before splitting.

(2) Make splitting cuts about 2 feet long, leaving 2 inches of undisturbed metal at the ends of the beam and between all cuts. (See fig. 47.) As the cut is made, cool the steel immediately back of the torch by laying wet burlap over the cut.

(3) After splitting cuts have been made and the beam cooled, burn through the metal between cuts, starting at the center of the beam and working toward the ends.

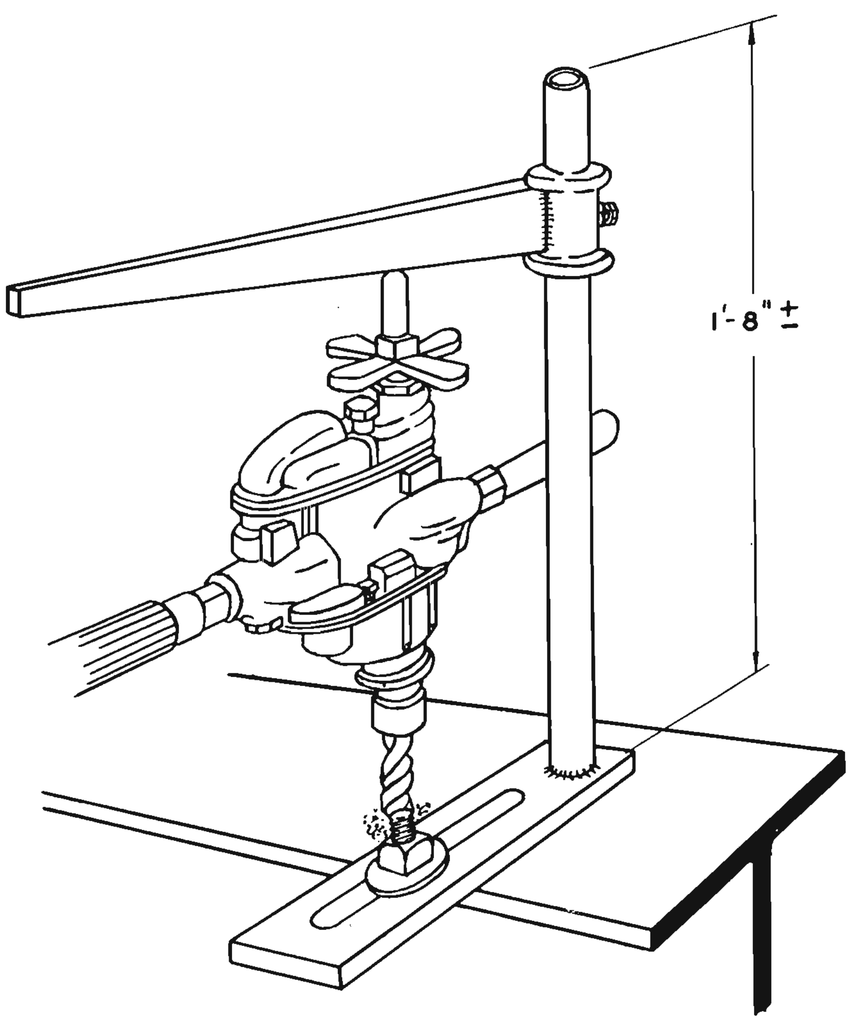


Figure 50. Adjustable clamp or "old man" used when drilling steel with pneumatic drill. A drill bar may be used instead.

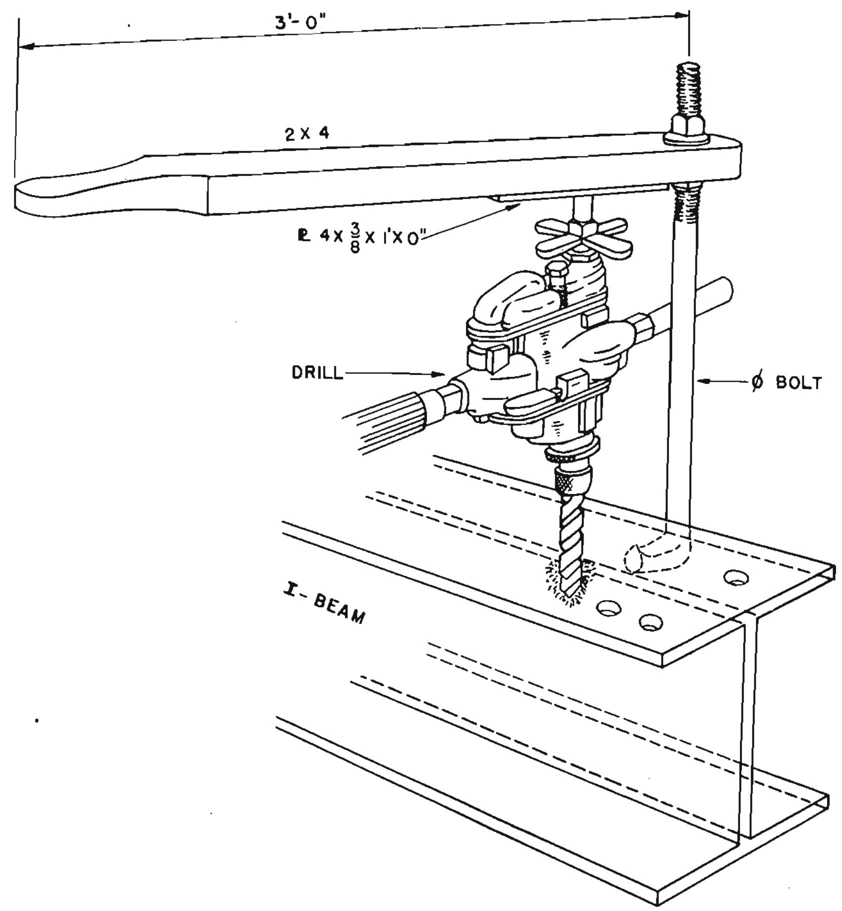


Figure 51. Drill bar used with pneumatic drill. The drill bar is less stable than the "old man" shown in figure 50.

117. TRIMMING. a. Cuts made with an oxyacetylene torch are rough, because melted and oxidized metal adheres to the cut edges. The oxidized metal can be removed with a chisel. Edges of the cut can be roughly smoothed by hammering; this gives edge satisfactory for most purposes.

b. Where close-fitting joints are required, edges must be smoothed by chipping. Chipping is done with the pneumatic chipping hammer (stock number 40–5455) or with a cold chisel.

c. Tolerances to which stringer sections must be cut are given in paragraph 223*a* (6) (*b*), 5 and 6.

118. GRINDING. It is seldom necessary to grind cut edges. However, end stiffener angles of girders and beams must fit closely against the bottom flange or be welded. The inside leg of the stiffener is shortened to clear the beam fillets and the outstanding leg is ground to an even bearing. Either portable or bench-mounted pneumatic grinders can be used. The use of power grinding tools is described in TM 5–225.

119. DRILLING AND CUTTING HOLES. a. Sizes of holes. (1) The following holes in steel are required for semipermanent bridges.

(*a*) $\frac{1}{4}$-inch-diameter holes in clips for attaching nailing strips to highway stringers.

(*b*) $\frac{3}{8}$-inch-diameter pilot holes used in cutting 1-9/16-inch-diameter and 2-1/16-inch-diameter holes.

(*c*) 9/16-inch-diameter holes for $\frac{1}{2}$-inch bolts, if nailing strips of highway stringers are attached by bolting.

(*d*) 15/16-inch-diameter holes for $\frac{7}{8}$-inch bolts and rivets.

(*e*) 15/16- by $2\frac{1}{2}$-inch slotted holes for $\frac{7}{8}$-inch anchor bolts at expansion bearings of stringers.

(*f*) $1\frac{1}{4}$-inch-diameter holes for 1-3/16-inch pins of horizontal tower bracing connections made with clevices.

(*g*) 1-9/16-inch-diameter holes for $1\frac{1}{2}$-inch pins of transverse vertical bracing of railway bridge towers and longitudinal and transverse vertical bracing of highway bridge towers. The drawings show 1-9/16-inch-diameter holes for anchor bolts in tower column bearing plates; these holes can be made $1\frac{1}{4}$-inch-diameter if special care is used to set anchor bolts accurately.

(*h*) 2-1/16-inch-diameter holes for 2-inch pins connecting longitudinal bracing of railway bridge towers.

b. Pneumatic drills. (1) The pneumatic reversible wood borer furnished engineer troops with the 105-cfm compressor can be used to drill holes in steel (fig. 48), but its use is not recommended if much drilling is required. The portable nonreversible pneumatic drill (stock number 40–3871.3) is preferred. (See fig. 49.) This drill is fitted with a screw-feed spindle for operation in an adjustable support (fig. 50) or is used with a drill bar. (See fig. 51.) Figure 52 shows a column press and carriage that can be made in the field to expedite drilling if much drilling is to be done.

c. Drilling. Holes $1\frac{1}{4}$ inches in diameter and smaller are drilled with high-speed steel twist drills.

(1) Enough pressure should be applied to the drill to make it cut a clean full chip. Slow feeding hardens the steel being drilled and spoils the drill.

(2) Drills are cooled with mineral lard oil or a soluble oil emulsion. A good drilling compound is made by mixing 1 part by weight of soda ash dissolved in water with 4 parts lubricating oil, and adding to 50 parts of water. Free use of oil or drilling compound is necessary to prevent spoiling drills.

(3) For efficient drilling, drills should be resharpened after every 100 holes

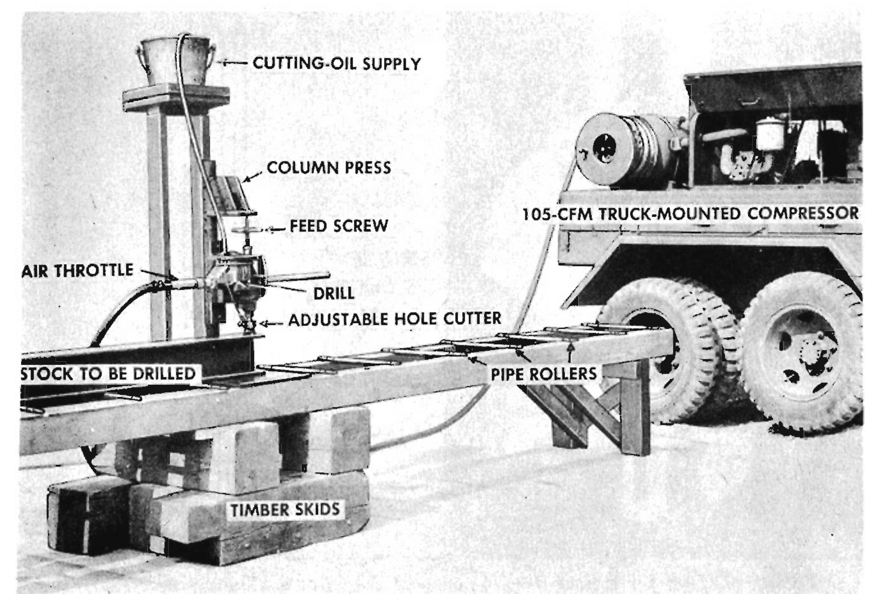


Figure 52. Production drilling. General view of production drilling lay-out.

An ample supply of twist drills and one or more drill grinders are needed on the usual job.

(4) A crew of three men using a pneumatic drill and drill bar should drill:
30 holes per hour in $\frac{1}{2}$-inch steel.
20 holes per hour in 1-inch steel.

d. Cutting holes. Holes 1-9/16 and 2-1/16 inches in diameter are cut with an adjustable hole cutter. (See fig. 53.)

(1) The drill must be held firmly in its support. (See fig. 52.)

(2) A $\frac{3}{8}$-inch-diameter pilot hole is drilled at the exact center of the hole to be cut. The pilot hole must not be oversize.

(3) The cutter should be fed into the metal slowly to avoid excessive tooth breakage. The tool should be flooded with oil as in drilling. Five to 10 minutes, including time for setting up drill and cutter, are required for cutting a 2-1/16-inch hole in $\frac{1}{2}$-inch steel.

(4) The hole cutter cannot be used in metal over 5/8-inch thick. Holes in tower column bearing plates for anchor bolts must be burned or may be drilled $1\frac{1}{4}$-inch diameter. (See par. 119.)

e. Holes for rivets and bolts. (1) *Subdrilling.* Holes 13/16-inch in diameter may be subdrilled separately in all connecting parts and reamed to full size after assembly. Subdrilling is not recommended if parts can be assembled and drilled full size.

(2) *Drilling full size.* Holes may be drilled full size by either of two methods.

(*a*) Clamp a number of similar splice plates together and drill them all at one time. Then clamp these drilled plates to the members to which they connect to guide the drilling of full-size holes in those members. After the first holes are drilled, replace clamps with bolts to hold the parts more securely.

(*b*) Clamp the undrilled splice plates to the beams and columns and drill holes through all parts in one operation. Such pieces must be match-marked for reassembly in the same positions. With this drilling method, hole centers need not be located with great accuracy but drills must be well plumbed.

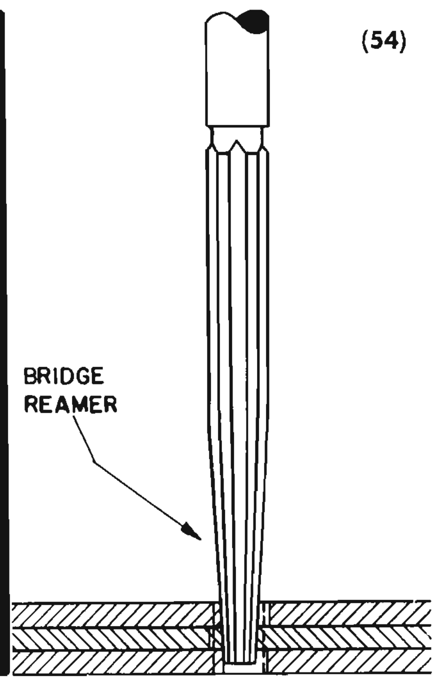


Figure 53. Tool for cutting 1-9/16-inch and 2-1/16-inch-diameter holes in steel.

Figure 54. Reaming with a taper bridge reamer.

f. Holes for pins. Holes for pins connecting tower bracing must be located by exact measurement; each hole must be cut separately. Special care must be taken to insure that holes in opposite sides of members are in exact alignment.

g. Slotted holes. Slotted holes, 15/16 by $2\frac{1}{2}$ inches, for anchor bolts at expansion bearings of steel beams are made by drilling two 15/16-inch-diameter holes centered 1-9/16 inches apart and then cutting out the metal between with an oxyacetylene torch. Rough edges made in burning are smoothed with a file.

120. ASSEMBLING. After all members have been cut and holes drilled or burned, they are assembled on blocking for fitting (and when necessary, reaming) and for riveting, bolting, or welding into subassemblies. Permanent connections ordinarily made in fabrication are shown on the detail drawings.

a. Blocking should be waist high to permit reaming, riveting, or bolting on the underside of the assembly.

b. Members connecting in one plane are assembled and carefully aligned to correct angle and dimension.

c. Connections are pinned with driftpins and bolted with fitting-up bolts to hold them securely.

(1) For 15/16-inch-diameter drilled holes, driftpins are 15/16 inch in diameter, fitting-up bolts $\frac{7}{8}$ inch in diameter.

(2) For 13/16-inch-diameter subdrilled holes, driftpins are 13/16 inch in diameter, fitting-up bolts $\frac{3}{4}$ inch in diameter.

d. Tower columns having connections in two planes are assembled and fitted separately with connecting members in each plane.

121. REAMING. Subdrilled, mismatching, and burned holes are reamed to clean, full-size holes while parts are assembled on the blocking.

a. The portable, nonreversible pneumatic drill is used in reaming.

b. Taper bridge reamers (fig. 54) are used for aligning full size but mismatching and burned holes. The bridge reamer is tapered for about half its length and its cutting edges are on the sides of the tool, permitting it to enter small or poorly matching holes and to remove the necessary metal with the least slotting of the hole.

122. BOLTING. Standard machine bolts and structural ribbed bolts, also referred to as rivet bolts, are used in semipermanent bridge construction.

a. Machine bolts. (1) Standard machine bolts are used for temporary connections in fitting up and in erection. They should not be used for permanent connections except as shown in paragraph 224.

(2) Seven-eighth-inch bolts are used for full-size holes. The bolts have U. S. Standard square heads and hexagon nuts. Washers are used under the nut. These are not supplied with the bolt but must be requisitioned separately. Principal dimensions and weights of standard machine bolts are given in tables LXXV and LXXVI.

(3) Length of bolts should be such that with the nut drawn tight at least $\frac{1}{4}$ inch of thread protrudes beyond the nut. In fitting up, any excess length of bolt shank is taken up with extra washers to save time in turning down nuts.

(4) When used in permanent connections, nuts should be drawn as tight as possible and threads beyond the nut peened to keep the nuts tight. The thread should be outside the parts being joined and washers should be used under nuts. Bolts should alternate in direction through the work.

(5) A crew of 2 men working with hand wrenches can place and tighten 25 to 30 bolts per hour.

b. Structural ribbed bolts. (1) *Bolts.* Structural ribbed bolts (par. 39*b*) can be used instead of rivets in all permanent connections.

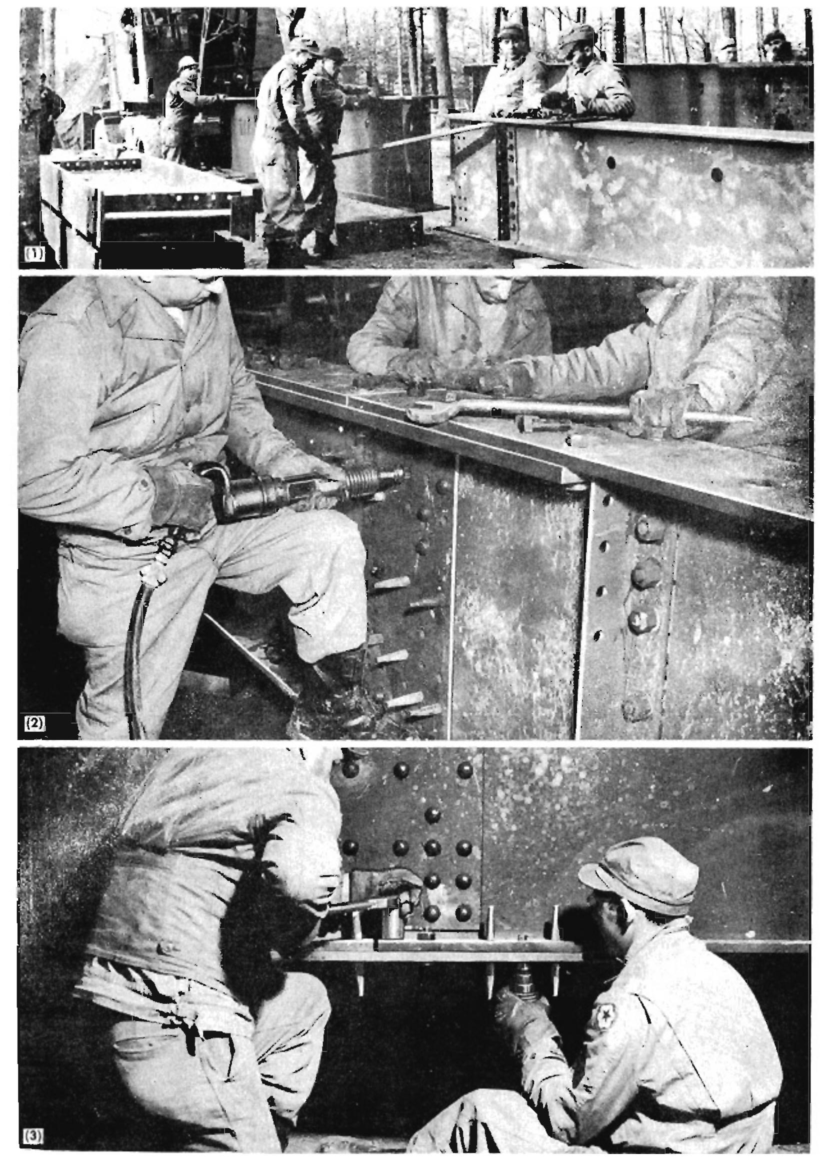


Figure 55. Splicing beam sections preparatory to erection.

(1) Assembling beam sections preparatory to splicing. One section being moved with crane. Timber blocks and wedges adjust sections to correct fit. (2) Align bolt holes with driftpins before bolting. Machine bolts are used to hold the members tightly together until structural ribbed bolts are placed. Note the use of the pneumatic hammer for driving structural ribbed bolts. (3) Driving structural ribbed bolts in lower flange splice. Note the clearance required under the beam for the pneumatic hammer. If sledges are used for driving bolts, the beam is laid on its side.

(*a*) The shanks of structural ribbed bolts are formed with ribs having an outside diameter slightly greater than that of the 15/16-inch holes into which they are driven. The ribs flatten and fill the hole, giving a tight fit.

(*b*) The length of the ribbed shank should equal the thickness of the metal connected or be not over ⅛ inch longer. Excess length of shank can be taken up by using a washer under the nut.

(*c*) Table LXXVII gives principal dimensions and weights of structural ribbed bolts for lengths of grip used.

(*d*) Lengths of rivets are given in bills of materials. Table XLIV gives equivalent lengths of structural ribbed bolts.

TABLE XLIV. *Conversion of rivet lengths to lengths of structural ribbed bolts.*[1]

Length of undriven rivet (inches)	Length of ribbed bolt (inches)	Length of undriven rivet (inches)	Length of ribbed bolt (inches)
2	1 11/16	3¾	3 3/16
2¼	2 1/16	4	3 9/16
2½	2¼	4¼	3¾
2¾	2 7/16	4½	3 15/16
3	2 ⅝	4¾	4⅛
3¼	2 13/16	5	4 5/16
3½	3		

[1] Lengths of rivets and ribbed bolts are total lengths of shanks under heads.

(2) *Fitting up.* Parts being connected are aligned with drift pins and then securely bolted with machine bolts. A bolt or a pin should be used in every second hole. The number of bolts and pins used should be about equal.

(3) *Driving.* (*a*) Before driving any structural ribbed bolts in a joint, tighten all fitting-up bolts so all parts are drawn firmly together. Ribbed bolts must not be used to do this because the special lock threads will strip. Holes for ribbed bolts must be perpendicular to the faces of the metal connected. (See fig. 55.)

(*b*) Structural ribbed bolts are driven into all open holes in a joint before removing any driftpins or fitting-up bolts. Drive a driftpin through each hole to clear and smooth it and to line up the parts before driving the ribbed bolt. Drive each ribbed bolt with a pneumatic nail driver (fig. 58) or a maul to a solid bearing on the head. Then run on the nut and tighten it to a snug fit with the impact wrench (fig. 56) (stock number 40–9823.5) or with a

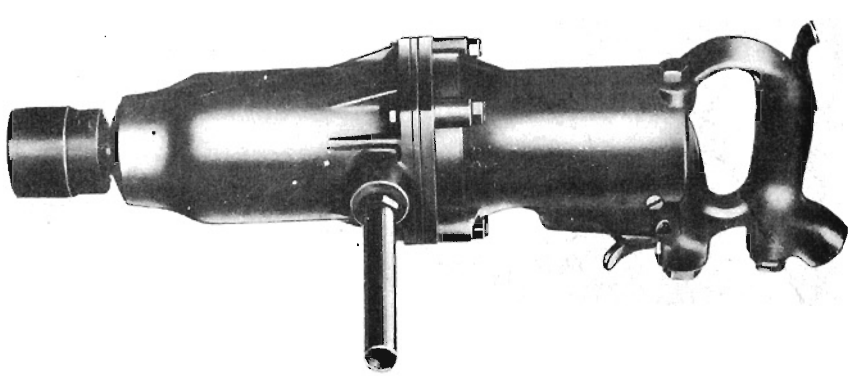


Figure 56. Pneumatic impact wrench.

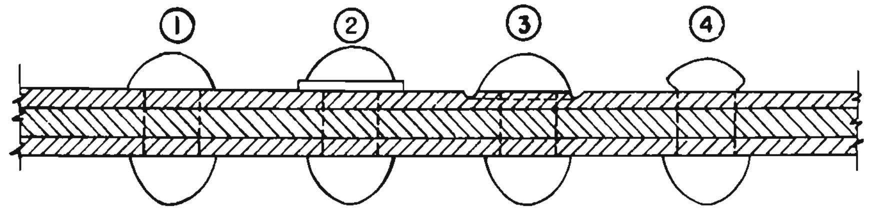


Figure 57. Rivet heads formed with correct and incorrect lengths of stock.

hand wrench. Tap the head of the bolt with a hammer as the nut is turned to assist in getting a tight fit. Do not force the nut too much as there is danger of stripping the threads.

(*c*) After all open holes in each joint are filled with ribbed bolts, driftpins and fitting-up bolts are successively removed and replaced with ribbed bolts. Each hole is cleared with a driftpin before driving the ribbed bolt.

(*d*) Discard all ribbed bolts that have been driven and removed. Do not reuse them.

(4) *Performance.* A bolting crew of 3 men equipped with pneumatic tools can drive and tighten 25 to 40 bolts per hour. A crew of 2 men equipped with hand tools can drive and tighten 20 to 30 bolts per hour.

123. RIVETING. a. Rivets. Rivets used in semipermanent bridge construction are ⅞-inch buttonhead rivets driven while hot in 15/16-inch holes.

b. Length of rivets. (1) The length of the rivet is the thickness of the part being connected (the grip) plus the length needed to form a head and fill out the rivet hole. Length of stock needed to fill out the hole and to form the buttonhead is given in table XLV. Grips are measured to the nearest ⅛ inch, and the stock needed for head and rivet swell is added to determine the length rivet needed. Lengths of all rivets are shown on the detail drawings.

(2) Excessive rivet stock produces capped heads. Inadequate stock does not permit the forming of full heads. Examples of rivet heads formed by using correct and incorrect lengths of rivet stock are shown in figure 57.

TABLE XLV. *Length of ⅞-inch rivet stock required to fill 15/16-inch hole and form full buttonhead.*

Grip (inches)	*Added stock (inches)*	*Grip (inches)*	*Added stock (inches)*
½ to 1¼	1½	1¾ to 3	1¾
1⅜ to 1⅝	1⅝	3⅛ to 3⅞	1⅞

(1) Correctly formed head.
(2) Excess stock used.
(3) Inadequate stock used.
(4) Inadequate stock used.

c. Fitting up. (1) Tight rivets depend largely on adequate bolting and pinning. Unless bolts are drawn tight before riveting, some rivets will be loose in their holes after they cool.

(2) Before riveting, parts being connected are securely bolted and pinned together with either a bolt or a driftpin in every second hole. The number of bolts used should be about twice the number of pins.

d. Equipment and tools. (1) *Hammer.* The pneumatic nail driver (fig. 58) furnished engineer troops with the 105-cfm compressor or the pneumatic riveting hammer available in class IV supplies is used for driving rivets. Rivet sets for ⅞-inch buttonhead rivets are not a standard accessory for this hammer and must be requisitioned separately.

(2) *Holder-on.* The pneumatic holder-on (stock number 40–5950.06) with set for ⅞-inch buttonhead rivets is desirable if many rivets are to be driven. The tool is used for bucking up rivets in positions where the holder-on can be backed by adequate support.

(3) *Hand tools.* Hand tools used in riveting are shown and listed in figure 59.

e. Order of driving. Rivets are driven first in holes not filled with bolts or driftpins. Riveting should start at the center of the connection and proceed outward. After open holes have been filled, bolts and driftpins are removed two or three at a time and replaced with rivets.

f. Riveting crew. (1) The riveting crew consists of four men as follows:

(*a*) The *heater,* who heats the rivets and passes them to the sticker.

(*b*) The *sticker,* who receives the rivets from the heater and puts them in the hole.

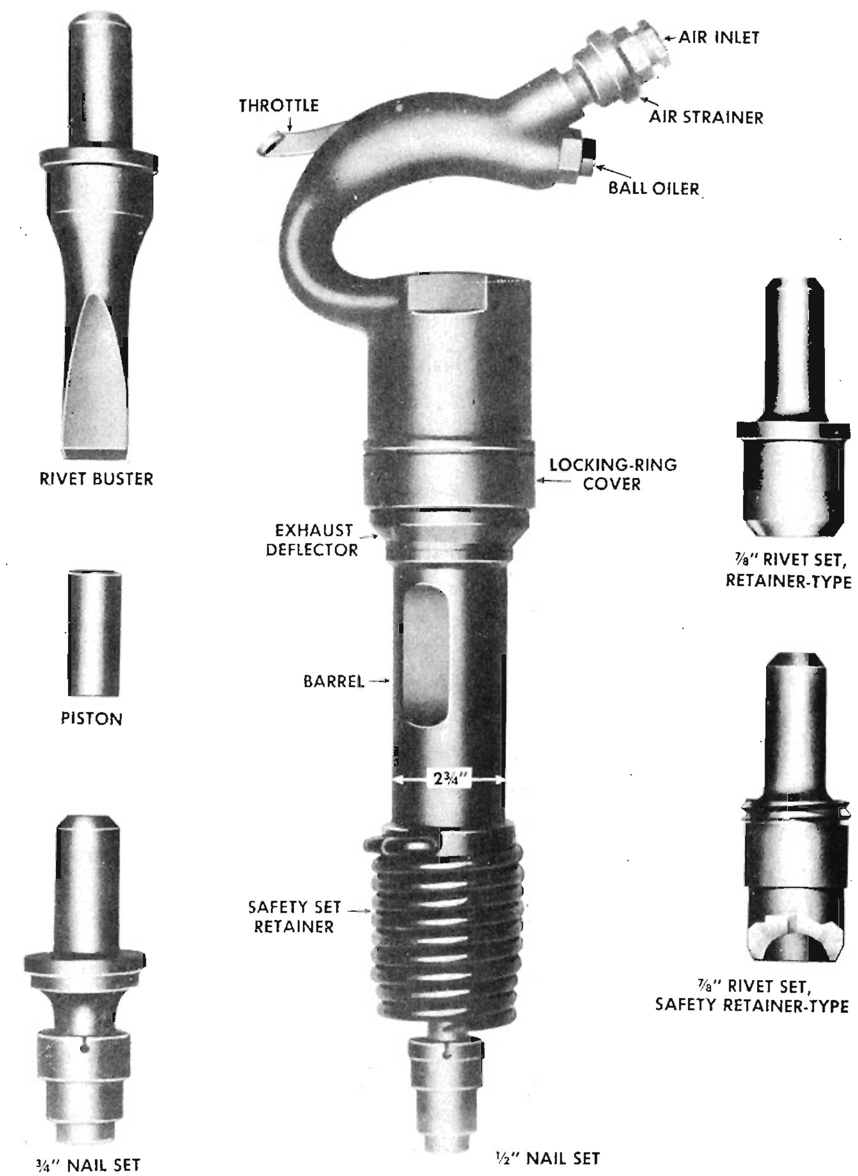
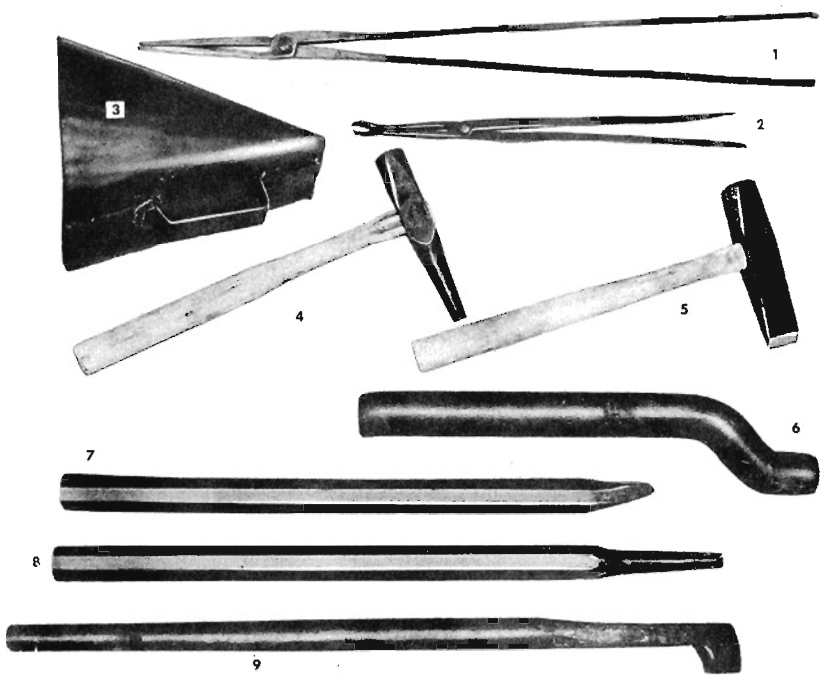


Figure 58. Pneumatic nail driver with accessories. Rivet set for ⅞-inch buttonhead rivets is not a standard accessory.



1. Tongs, rivet-heating and pitching.
2. Tongs, rivet-sticking.
3. Can, rivet-catching.
4. Punch, backing-out, handled, $\frac{3}{4}$-inch.
5. Rivet buster, handled, $1\frac{1}{2}$-inch cutting edge.
6. Bar, dolly, riveting, off set, $\frac{7}{8}$-inch.
7. Chisel, rivet-buster, $1\frac{1}{4}$-inch.
8. Punch, backing-out, bar, $\frac{3}{4}$-inch.
9. Bar, dolly, riveting, heel, $\frac{7}{8}$-inch.

Figure 59. Hand tools used in riveting.

(*c*) The *bucker,* who holds the rivets firmly in the hole against the force of the hammer blows.

(*d*) The *riveter,* who forms the rivet head with the pneumatic hammer, causing the rivet to fill its hole.

(2) The riveter heads the crew. Good riveting depends on fast and efficient work by all members. Ample time for training riveting crews is essential.

(3) In assembling parts in fabrication, a well-trained riveting crew can drive 30 to 40 rivets per hour.

g. Heating. Rivets are heated for driving in a coal-burning forge with hand bellows (stock number 41–3604.11–18).

(1) The needs of the work are anticipated by placing several rivets of the length required for the connection in the fire at a time. These are heated before being withdrawn singly, as required for driving.

(2) The shank of a properly heated rivet is a uniformed light cherry red; the head remains a dull red.

(3) Rivets should not be heated beyond a light cherry red nor left in the fire for long periods, since they may become burned and pitted through excessive heat and are then unfit for use.

h. Sticking. (1) As the rivets are needed, they are taken from the forge and passed to the sticker. If the forge is some distance from the work, rivets are tossed to the sticker, who catches them in a catching can.

(2) After catching a rivet, the sticker takes it in his tongs, strikes the head sharply against the metal to remove all cinders and scale, and enters it in the hole.

Caution: A 15/16-inch driftpin should be driven through each hole before the rivet is entered to insure a clean well-aligned hole.

i. Bucking. For most riveting, the pneumatic holder-on is best for bucking rivets. In positions where the holder-on cannot be used, bucking is done with hand tools called dolly bars. (See figs. 59 and 60.)

(1) *Holder-on.* The pneumatic holder-on is best suited to bucking rivets in flanges of beams. Blocking is used under the holder-on to raise it high enough.

(2) *Hand dollies.* Hand dollies are of two types.

(*a*) *Dolly bar.* The dolly bar (fig. 59) is a heavy steel bar with ends cupped to fit the buttonheads of $\frac{7}{8}$-inch rivets. One end is offset to permit bucking rivets in beam flanges close to the web of the beam.

(*b*) *Heel dollies.* The heel dolly is adapted to bucking in close clearances. It is used like a lever with blocking providing the fulcrum.

j. Driving. In driving rivets, the hammer must be held against the rivet with considerable pressure and should be rotated or rolled slightly (fig. 61) to aid in forming the head. Clearances required for driving are shown in figure 62.

(1) Care is used not to ring the metal being riveted by rolling the hammer too much.

(2) The hammer must line up closely with the rivet or the head will not be concentric with the rivet.

(3) No attempt should be made to drive a rivet that has cooled below a dull red heat.

(4) Full air pressure must be maintained on the hammer or the force of its blow is reduced and rivets will be poorly driven.

k. Testing. An inspector tests rivets for soundness after they have cooled. The officer in charge is responsible for the quality of work and should assure himself that all rivets are tested and are satisfactory.

(1) Testing is done by holding the finger or a small piece of metal against one side of the preformed head and striking the opposite side of the same head with a light hammer. If the rivet is loose, the jar of the hammer blow is transmitted to the opposite side. If the rivet is tight, no jar or vibration is noticeable.

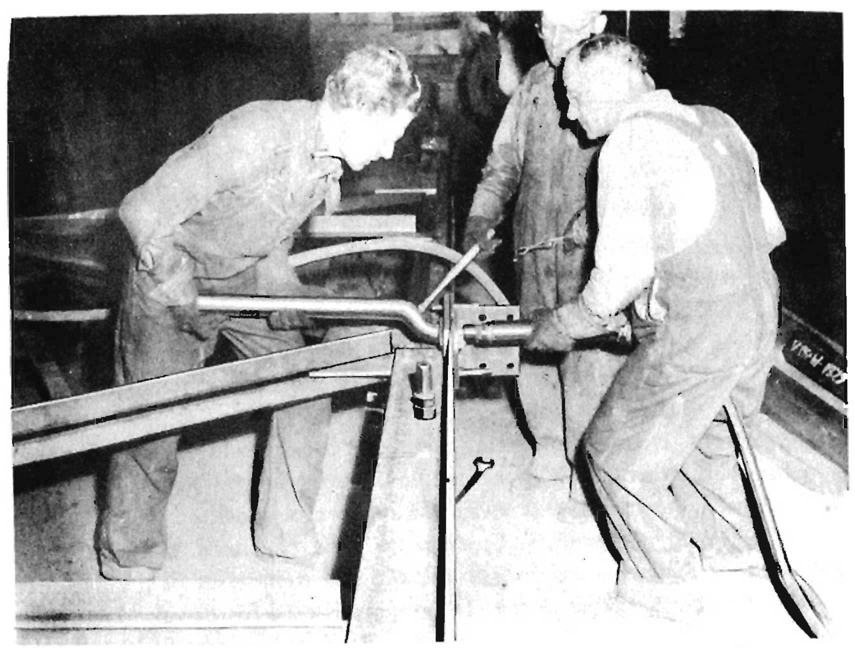
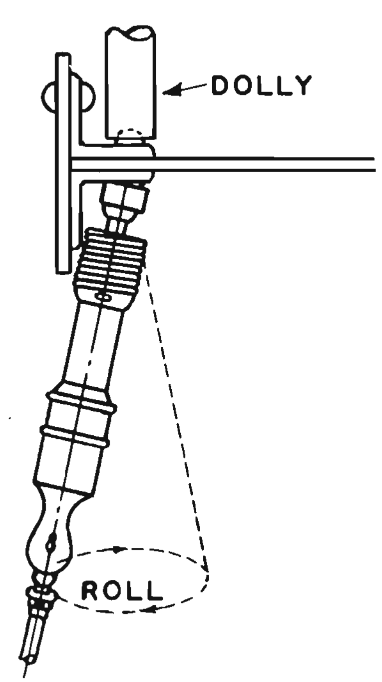


Figure 60. Bucking $\frac{7}{8}$-inch rivet with a dolly bar.

(61)



(62)

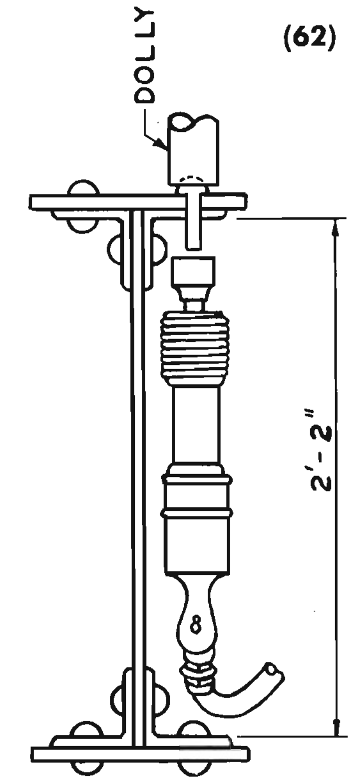


Figure 61. Positions of pneumatic hammer and dolly in driving rivets.

Figure 62. Clearance required for riveting.

(2) If only a slight jar is felt, the rivet should be left in place if one of a group of several rivets, since in removing it other rivets in the group may be loosened and the rivet hole enlarged. Loose rivets and rivets with inadequate or burnt heads should be removed and replaced. (See fig. 63.)

l. Removal of rivets. (1) An unsatisfactory rivet is driven out of its hole with a backing-out punch after the head has been removed.

(2) The head is broken off with a rivet buster set in the pneumatic driving hammer or with hand tools, a maul and a handled rivet buster or a bar buster. The rivet buster is a standard accessory with the pneumatic nail driver.

(3) If rivets are in thin metal or cannot be reached with a rivet buster, heads are burned off with an oxyacetylene torch. While burning heads off, care must be taken not to burn the metal around the rivet.

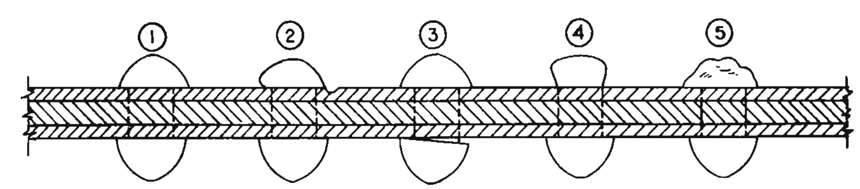
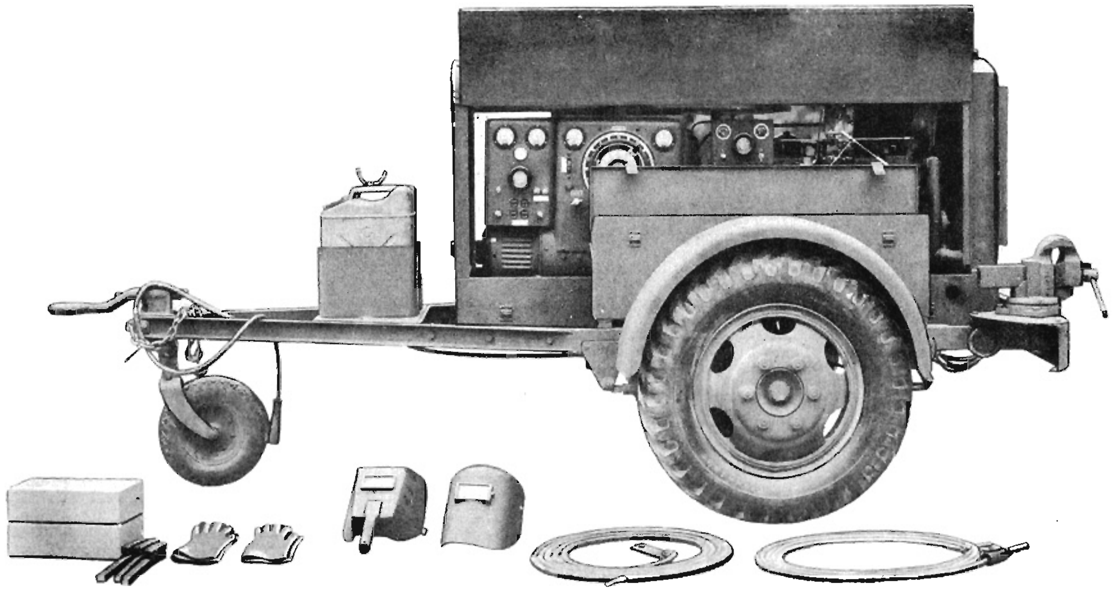


Figure 63. Examples of poorly formed rivet heads.

(1) Head not concentric with rivet.
(2) Riveting hammer not held in line with rivet.
(3) Dolly bar not held in line with rivet.
(4) Rivet allowed to cool before driving.
(5) Rivet too hot when driven.



WELDING EQUIPMENT — Set No. 1 Electric arc, 300-amp.	
Apron, welder's, leather.	2
Brush, wire, scratch, with wood handle, 3 x 17 rows, 14-inch.	4
Cable, electrode, arc welding, 2-0, with lugs, 50 feet long.	1
Cable, ground, arc welding, 2-0, with lugs, 50 feet long.	1
Gloves, welder's, leather.	2
Helmet, welder's.	1
Holder, electrode, 300-amp. capacity.	2
Lens, helmet or hand shield, welder's cover.	12
Lens, helmet or hand shield, welder's, filter shade No. 12.	12
Mittens, asbestos.	2
Shield, welder's, hand held.	1
Sleeve, arc welder's leather.	1
Welder, electric arc, gasoline-engine-driven, 300-amp., skid mounted.	1

Figure 64. Electric arc-welding equipment. set No. 1, 300-ampere, trailer-mounted.

124. WELDING. a. Processes. The two principal welding processes used in structural work are:

(1) *The oxyacetylene process* in which welding heat is obtained by burning acetylene gases as they mix with oxygen discharged under pressure from a torch designed for the purpose. This process is preferred for butt welds of heavy metal. Oxyacetylene welding and cutting equipment (fig. 45) is described in TM 5–4100.

(2) *The electric-arc process,* in which the welding heat is developed in the electric arc formed between a suitable electrode and the base metal. This process is generally preferred for structural welding. The 300-ampere gasoline-engine-driven electric-arc welder (fig. 64) is suitable for structural welding. It is available as class IV equipment.

b. Types of welds. The principal types and positions of welds used in structural work are illustrated in figure 65. Nomenclature of welds is shown in figure 66. Ease of welding is determined largely by position, in the following order.

(1) Flat.
(2) Vertical.
(3) Horizontal.
(4) Overhead.

Whenever possible, work should be turned so welding can be done flat.

c. Welders. (1) *General.* Welding of steel for semipermanent bridges requires experienced structural welders. The quality and strength of the weld depends more on the skill of the welder than on any other single factor. The skill of a welder can be determined only by knowledge of his past performance or by testing sample welds made on the job.

(2) *Qualification tests.* The two tests described below qualify structural welders. They can be performed in the field without elaborate equipment. If after testing one or more sample welds by each method, the officer in charge is not satisfied with the skill of a candidate, additional training should be given before the tests are repeated.

(*a*) *Guided-bend test.* The guided-bend test is used to determine the quality of the weld metal at the face and root of the welded joint, the degree of penetration, and the fusion to the base metal. Tests are made both with the face and root of the weld in tension. (See fig. 68.)

1. The test is made in a die and plunger which can be made in the field as illustrated in figure 67.
2. Test specimens are flame-cut from sample butt weld of plates 3/8 of an inch thick.
3. The test specimen is placed across the die and forced into it by the plunger. Force is applied to the plunger with a hydraulic press such as the 10-ton press furnished with the motorized general-purpose shop.
4. To fulfill the requirements of the test, the specimen must bend through 180° without developing cracks greater than 1/8 inch in any dimension. Satisfactory guided-bend test samples are illustrated in figure 68.

(*b*) *Nick-break test.* The nick-break test determines the internal quality of the weld metal and reveals any internal defects, such as slag inclusion, gas

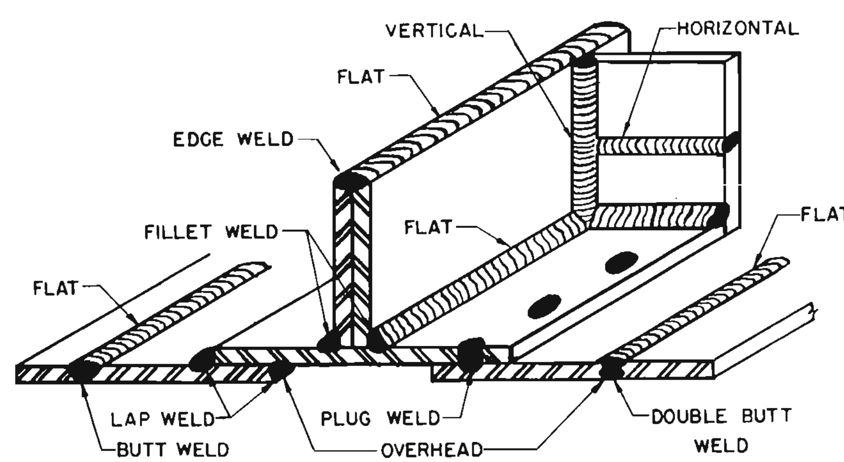


Figure 65. Types and positions of welds. Positions of welds are flat, horizontal, vertical, and overhead.

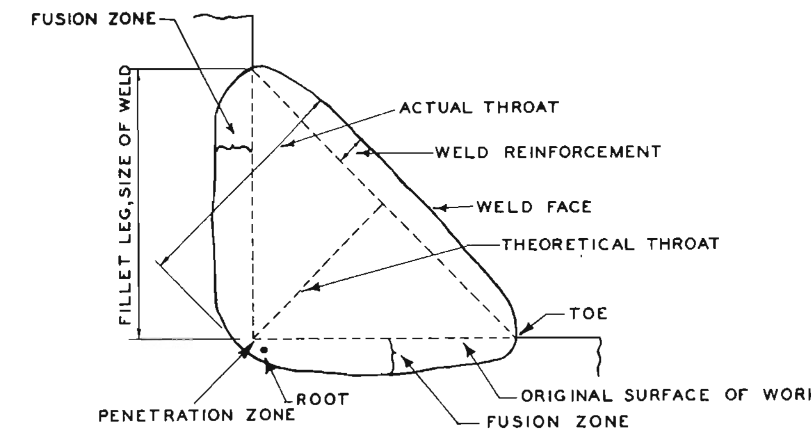


Figure 66. Nomenclature of fillet welds.

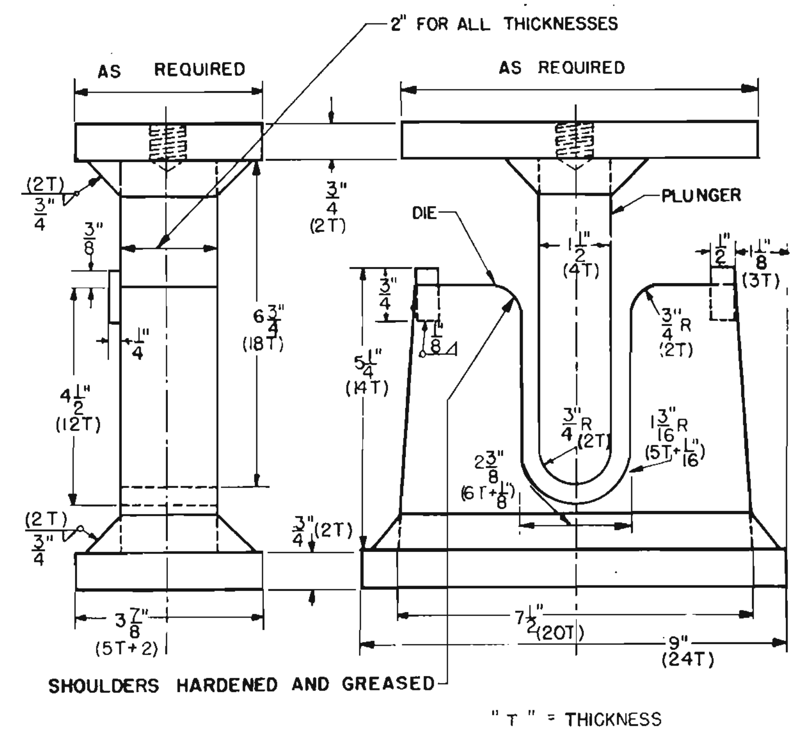


Figure 67. Die and plunger for guided-bend test of butt welds.

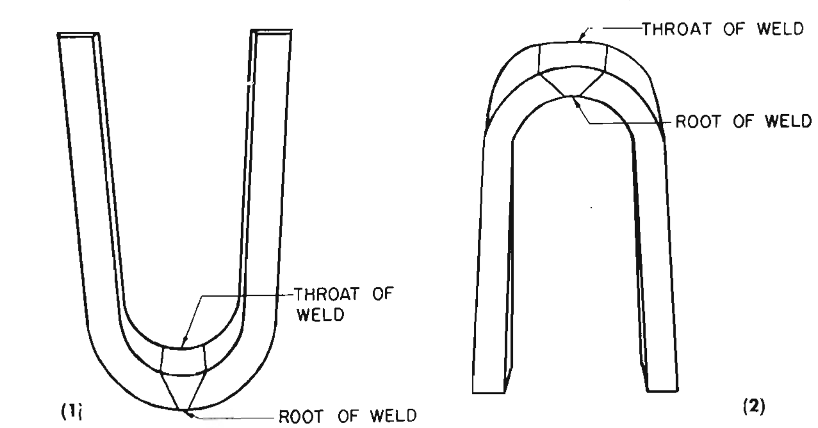


Figure 68. Examples of satisfactory guided-bend tests of butt welds.

pockets, lack of fusion, and oxidized or burned metal.

1. Test specimens are flame-cut from a sample weld as for the guided-bend test.
2. A saw cut is made at each edge through the center of the weld. Depth of cut is one-eighth the width of the test specimen.
3. The saw-nicked specimen is placed on two steel blocks as shown in figure 69 and broken by repeated blows with a heavy hammer.
4. Weld metal exposed in the break should be completely fused, free from slag inclusions, and contain no gas pockets greater than 1/16 of an inch across their greatest dimension. There should not be over six pores or gas pockets per square inch of exposed weld.

d. Preparation of metal for welding. Strength of a welded joint depends largely on correct preparation of the metal edges being welded.

(1) Edges should be dry and if welded in temperatures below 32° F should be heated until warm to the hand.

(2) All mill scale, rust, oxide, paint, and other impurities, such as slag particles adhering to flame-cut edges, must be removed.

(3) Edges must be regular in contour and without nicks or notches.

(4) Before butt-welding, edges to be joined are separated 1/16 to ⅛ inch, depending on the type weld and the thickness of parts being joined.

(5) Plates are beveled 30° on one side for butt welds of plates up to ½-inch thick and on both sides for heavier plates.

e. Oxyacetylene welding. Good welds require the proper tip and welding rod, correct flame adjustment, and manipulation of torch and welding rod. Satisfactory welds are produced by manipulating the torch and welding rod either forehand or backhand. Backhand welding is preferred on structural work since it uses less metal, requires less puddling of the molten metal, and uses less welding rod than other methods. Backhand welding is illustrated in figure 70.

(1) *Procedure.* (*a*) The welding tip precedes the rod in the direction of the weld with the flame pointed back to the molten puddle. The rod is held between the welding tip and the molten puddle.

(*b*) With the heat carefully balanced to melt the end of the rod and the

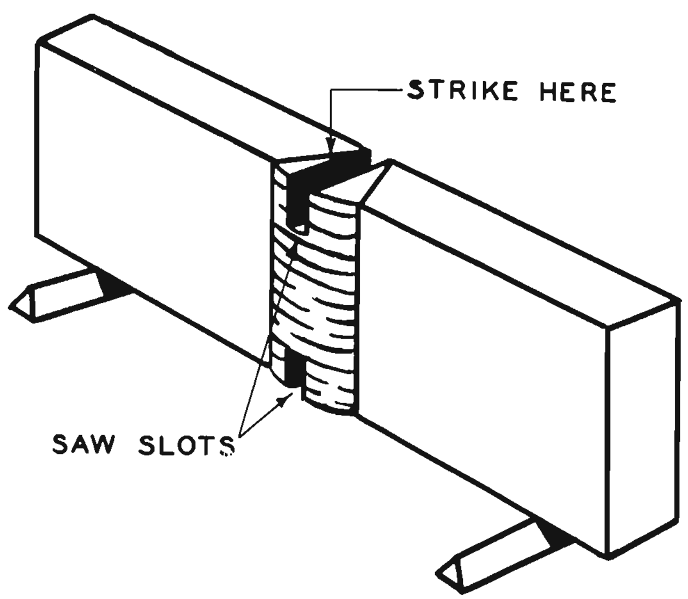


Figure 69. Nick-break testing of sample butt welds.

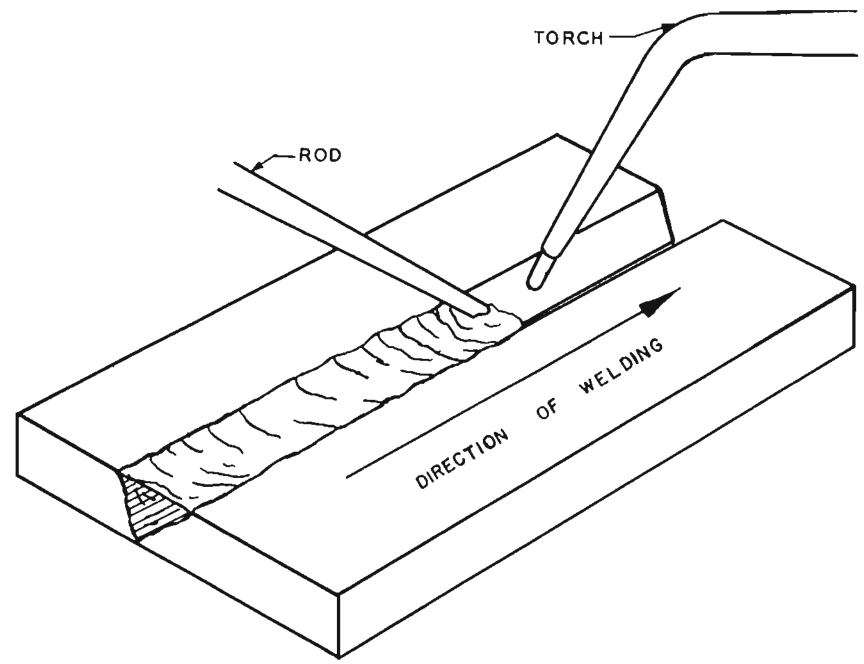


Figure 70. Position of rod and tip in backhand welding.

side walls of the plate being welded, the rod and the tip are moved in opposite semicircular paths across the line of the weld while being advanced slowly and uniformly in the direction of the weld.

(*c*) As the flame passes the end of the rod in each motion, a short length of rod is melted and deposited in the weld. The rod is rolled or rotated so it melts off evenly.

(2) *Performance data.* Oxyacetylene welding performance data for butt welds is given in table XLVI.

TABLE XLVI. *Oxyacetylene welding performance data for butt welds.*

Thickness of steel—inches	⅛	½	¾
Joint preparation	90°V	60°V	60°V
Diameter of rod—inches	3/16	3/16	3/16
Speeds—feet per hour	4–5	5–6	2.5–3.5
Oxygen consumption cu. ft. per hour	46	58	92
cu. ft. per ft. of weld	11–9	12–10	37–26
Acetylene consumption cu. ft. per hour	44	56	88
cu. ft. per ft. of weld	11–9	11–9	35–25
Rod consumption—lb. per hour	2.4–3.0	2.9–3.5	3.3–4.6
lb. per ft. of weld	.60	.64	1.31

f. Electric-arc welding. Several operating variables, such as current, voltage, polarity, arc length, position of electrode, weaving motion, and speed of weld, control the quality of arc welds. Good welds cannot be produced unless all of these conditions are carefully controlled. Weld metal must be deposited uniformly and good penetration of the weld into the base metal must be secured.

(1) *Procedure.* (*a*) The welding arc is started by striking or brushing the electrode against the plates being welded and short-circuiting the welding current. The resulting surge of high current causes both the end of the electrode and a small spot on the plate beneath to melt instantly.

(*b*) As contact is made, the electrode is raised to establish an arc. After the arc is established, particles of metal melt off the end of the electrode and are deposited in the molten crater on the plate surface.

(*c*) As the electrode melts, it is fed down to the plate to maintain a uniform arc and is moved in a weaving motion along the weld, depositing the weld bead and fusing the side walls of the weld.

(2) *Performance data.* Arc-welding performance data for fillet welds is given in table XLVII.

TABLE XLVII. *Arc-welding performance data for fillet welds.*

Size of fillet—inches	1/4	5/16	3/8	1/2
Size of electrode—inches	3/16	3/16	7/32	7/32
Electrode consumption including waste-lb. per foot of weld	0.20	0.30	0.45	0.80
Speed—foot per hour	8	6	4.5	2.5

g. Multiple-layer welding. In making welds larger than 5/16 inch, the weld metal is deposited in two or more passes. This avoids using a large rod or electrode, and carrying a large puddle of molten metal in the weld. It also secures good fusion with the side walls. By depositing the weld in multiple layers, the welder can concentrate on good penetration at the root of the weld on the first pass and on good fusion with the side walls of the weld on succeeding passes.

Caution: Before the following weld metal is deposited, initial layers must be cleaned of all scale, oxide, and slag by scraping or brushing with a wire brush.

h. Distortion. (1) Metal added in welding is essentially cast metal. As this metal cools, it shrinks and produces stresses in and near the weld which may cause warping or buckling. If the welded parts are restrained, these stresses may break the weld.

(2) Welding stresses can be reduced by proper spacing of parts being

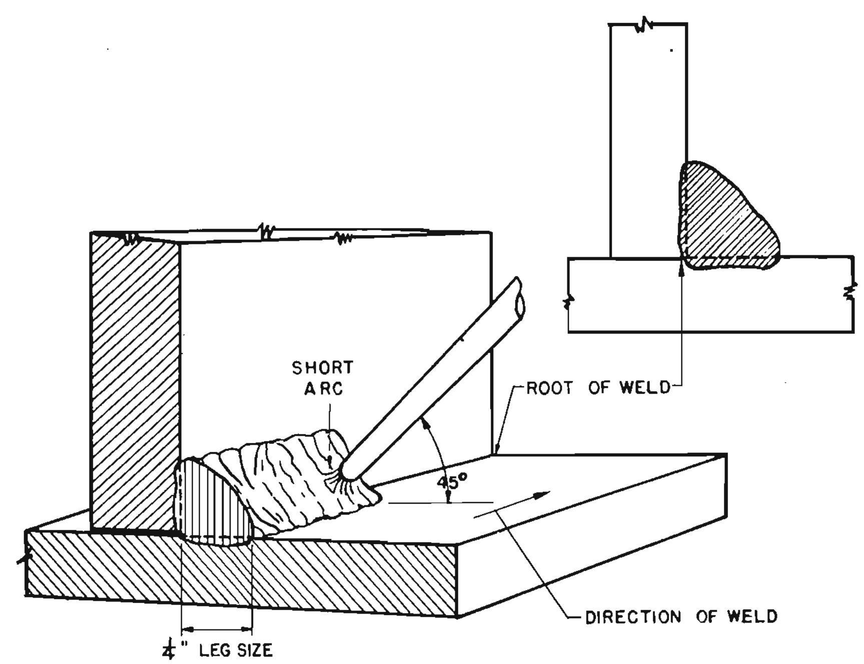


Figure 71. Position of electrode in making a fillet weld.

welded, correct welding sequence, and control of the welding heat.

(*a*) Clamps, jigs, or fixtures employed to hold the parts in place during welding permit enough movement to allow for weld shrinkage.

(*b*) Tack welds used to hold parts during welding should be spaced to permit welded parts to contract and be located where they will become part of the completed weld. They should be less than 1 inch long and at least 12 inches apart in long seams. Broken tack welds must be removed before final welding.

(*c*) The back-step method of welding illustrated in figure 72 is often used to counteract contraction in long welds.

(*d*) Where multiple-layer welds are made from both sides of a plate, layers are alternated, the initial pass being made on one side of the joint followed by a pass from the other side.

(*e*) Intermittent welds of fillet-welded T-joints are staggered to reduce warp and distortion, a short weld being made on one side of the joint followed by a weld on the other side. (See fig. 73.)

(3) Welding stresses can be relieved somewhat by lightly peening the finished weld. Excessive or severe peening, however, may cause brittleness or hardening of the finished weld and contribute to its failure.

i. Inspection. Finished welds should be inspected visually for undercut, overlap, surface checks, cracks, and other defects. Properly welded joints should be uniform in appearance with evenly deposited weld metal. Fusion of the side walls is most important and should be complete in a good joint. Desirable and defective weld profiles are shown in figure 74.

125. BLACKSMITHING. a. Work done in the blacksmith shop is of two principal types. (1) Making of small parts requiring bending, forging, welding, or grinding. These parts are:

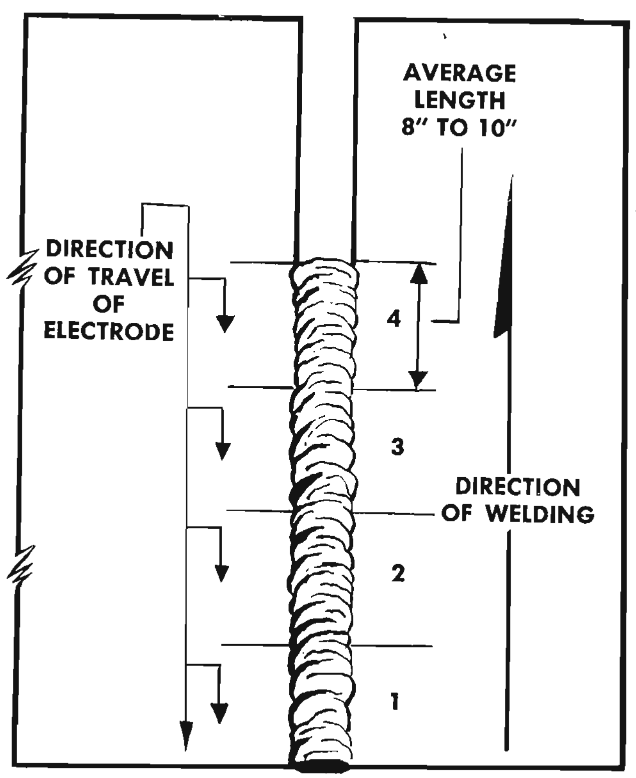


Figure 72. Back-step welding to counteract contraction.

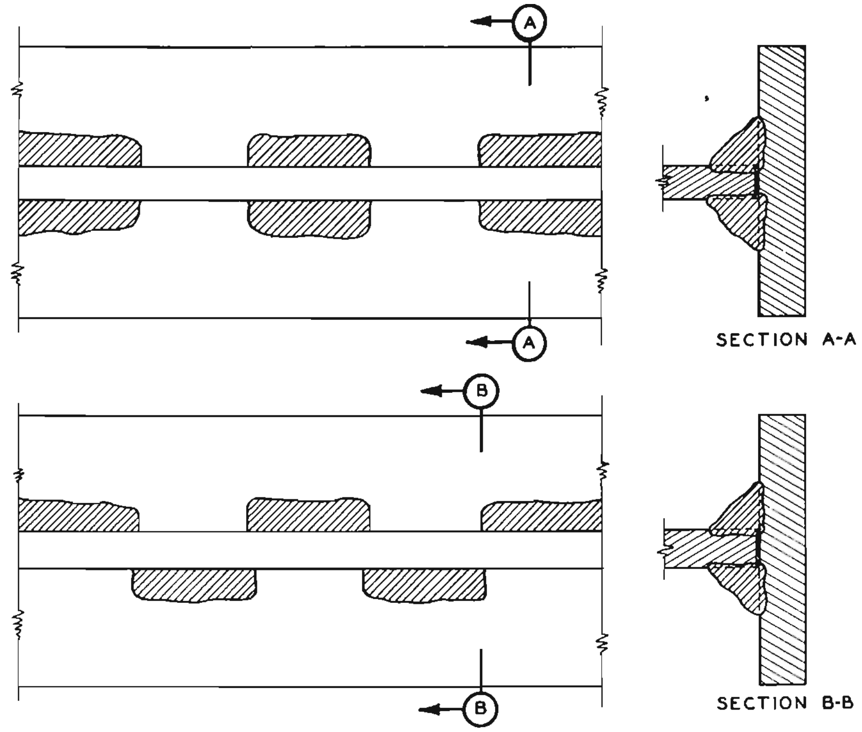


Figure 73. Fillet welds spaced intermittently to counteract distortion.

(*a*) Plates connecting horizontal tower bracing to tower columns. These are bent and drilled as shown on the drawings.

(*b*) Diagonal bracing rods which are cut to length and welded to threaded stub ends and loop rods.

(*c*) End stiffener angles of beams when grinding to exact fit is required.

(*d*) Hook bolts and driftbolts when not supplied from depot.

(2) Making of small fabrication and erection tools, straight shank center punches, parts for erection equipment such as that described in chapter 16, and sharpening cutting tools.

b. Tools and equipment in the blacksmith sets furnished engineer troops and their care and use are described in TM 5–225.

126. MATCH MARKING. Before separating parts assembled in the fabrication yard, they are all match-marked so they can be erected in the same relative positions. Each joint of two or more members is given a distinguishing number which is painted at the end of each member entering the joint.

127. STORING COMPLETED MEMBERS. After match marking, the assembled parts of the structure are separated into individual members or subassemblies. These are placed in the storage yard to await erection. Parts are stored so they can be reached as they are needed, without moving other members. Timber dunnage is used to keep steel parts off the ground.

128. INSPECTION OF COMPLETED PARTS. Parts should be followed through fabrication by an inspector trained in all requirements of the work. Principal dimensions and connections of all completed members should be checked against the detail drawings. Bolted connections should be checked for tightness. Rivets should be tested as described in paragraph 123. Welds should be inspected as described in paragraph 124.

Section II. TIMBER FRAMING

129. SCOPE. a. This manual assumes that the construction forces are experienced with woodworking tools and with the methods of working with timber described in FM 5–10 and TM 5–226. It covers only special framing requirements and operations applying to construction of semipermanent bridges.

b. The term "framing" as used here applies to the cutting, shaping, and boring of timbers for their use in structures, and to related operations performed in the framing yard.

130. WORKMANSHIP. Structures required to carry heavy moving loads must be accurately framed. No blocking or shimming of improperly fitting parts can be permitted.

a. Columns must be cut to exact length and bevel.

b. Ties must be dapped and stringers sized to correct depth so that all loads will be properly distributed.

c. Cuts must be straight and even to secure full bearing.

131. PROPERTIES OF WOOD. a. Unlike other structural materials, wood does not have the same physical properties in all directions. In compression, tension, and bending, it is stronger in the direction of the grain. In shear, it

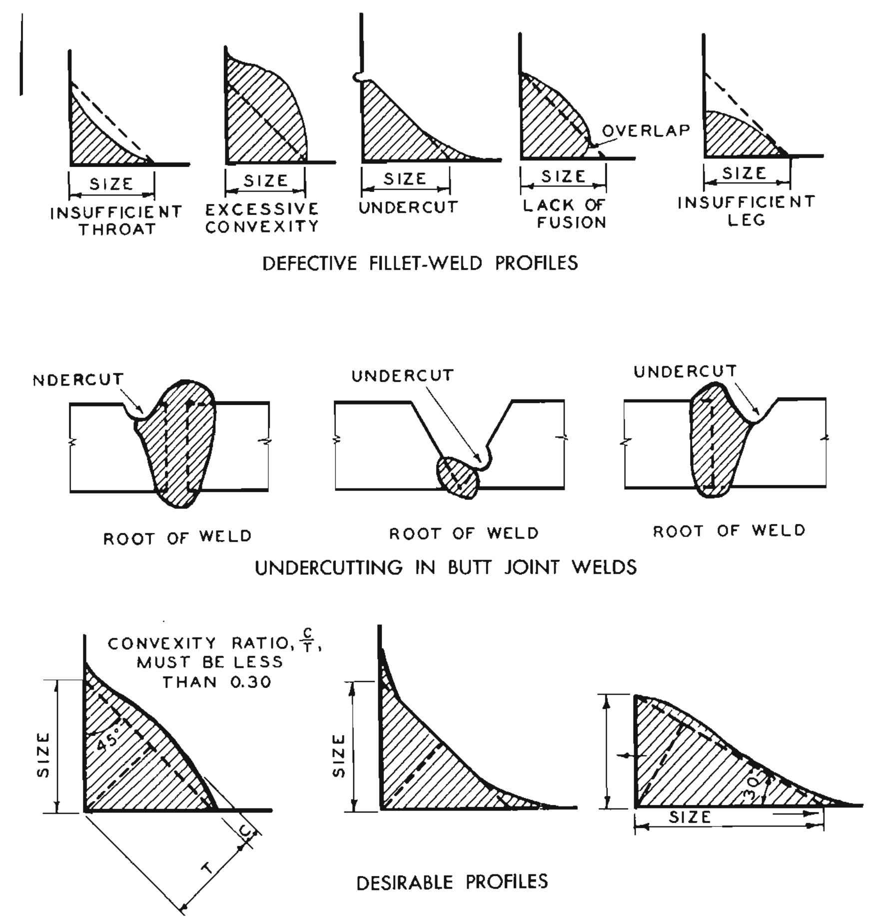


Figure 74. Desirable and defective weld profiles.

is stronger across the grain. Wood splits easily along the grain but not across it. In drying, wood shrinks more across the grain than along the grain. These characteristics must always be kept in mind.

b. Strength of wood depends on its species and speed of growth, position in the log from which it was cut, and the manner and amount of its curing. Green or poorly seasoned wood is not as strong as well-seasoned timber and shrinks more in aging. Timbers which are used together should be of the same kind and should be equally seasoned. Green timber should not be mixed indiscriminately with well-seasoned wood.

132. FRAMING YARD. a. Timber is ordinarily framed on firm, level ground close to the bridge site and immediately adjacent to the timber storage.

b. If the size of the work justifies, one or more framing platforms are built. Platforms are made of planking later to be used in some other part of the work. They are loosely nailed to joists laid on the ground and are carefully leveled. Platforms must be large enough to permit assembling a complete bent or a story of a bent.

133. TOOLS AND EQUIPMENT. a. Tools and equipment needed for framing semipermanent bridges are listed in table XXXIA. The listing does not include hand tools regularly issued to all squad units.

b. Principal power tools used in the framing yard are:

(1) The portable pneumatic tool accessories with the 105-cfm truck-mounted compressor including the following:

(*a*) Chain saw with 24-inch blade.

(*b*) Circular saw with 12-inch blade.

(*c*) Wood-boring reversible drill with 7/16-, ¾-, and 1-inch wood augers, 12, 18 and 36 inches long.

(*d*) Nail driver for driving large nails and spikes.

(2) Gasoline-engine-driven chain saw (stock number 40–8029.36) with 36-inch blade.

c. Timber can be manhandled but it is better to have a small truck-mounted crane available for moving heavier pieces.

134. RECEIVING AND STORAGE. As timber is received on the job, it is checked against the requisition and inspected for damage or natural defects.

a. Pieces of timber of the same species and grade differ widely in quality. Clear, straight-grained pieces free from large knots or other defects are chosen for members such as stringers, columns, caps, and flooring. Less perfect pieces are set aside to be used for blocking, bracing, curb, and handrails, and are stacked separately.

b. Timbers are stacked close to the framing yard, those of the same kind, length, and use being stacked together. Timbers are blocked up off the ground and layers are separated with plank stripping.

135. LAY-OUT. a. Posts of bents and towers. Posts of bents and towers must be cut to exact length and bevel. Careful workmanship is necessary in their framing. Lengths of pieces and bevels of end cuts are given on the detail drawings.

(1) When framing on a platform, the outline of each bent is drawn on the platform. Timbers are laid down and marked for cutting from the outline of the bent for which they are intended.

(2) When no platform is used, each post is marked for cutting by careful measurement. To eliminate variations between measurements, a 2- by 1-inch measuring stick the length of the longest post is marked with the controlling dimensions. This stick is used in all measurements instead of a tape or rule.

b. Caps, sills, and bracing. Caps, sills, and bracing need not be cut exact length. They are marked for cutting by direct measurement with tape or rule. Length of all pieces is shown on the detail drawings.

c. Stringers, flooring, and railing. Stringers, floor plank, and railing are not ordinarily framed on the ground, but are squared and cut to length during erection as described in chapter 15.

d. Scabs, blocking, and handrail posts. Miscellaneous small parts such as scabs, blocking, and handrail posts are usually cut to length by marking from a pattern. One such piece is made to the dimensions shown on the detail drawings and is used for marking all other pieces.

136. SAWING. a. Portable, power-driven saws are ordinarily used for rough cuts of all heavy timbers. Circular saws can be used for cutting timbers up to 4 inches thick.

b. Two-man crosscut saws are preferred for making accurate finish cuts and for small framing jobs. Unless a power saw is rigged and immediately available, occasional cuts can be made more efficiently by hand.

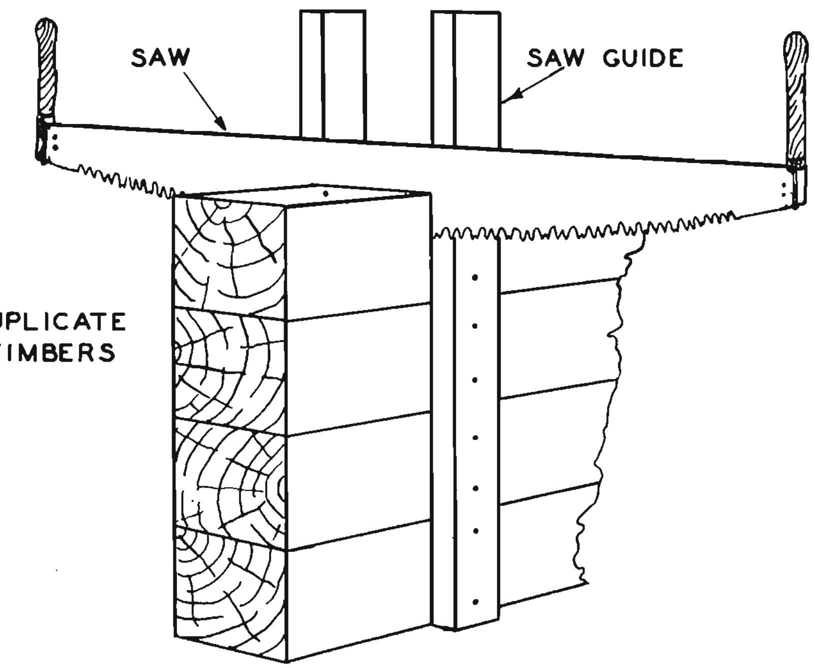


Figure 75. Saw guide used in sawing duplicate timbers.

c. If the amount of duplication justifies, timbers to be cut to the same dimension may be stacked as shown in figure 75 and all accurately cut in one operation. Strips are lightly nailed on each side at the cut to hold the timbers in place and to guide the saw.

137. SIZING AND DAPPING. a. Sizing. Caps, sills, and stringers of rough sawn lumber must be sized to exact depth at all points of bearing. Surfaced timbers do not ordinarily require sizing. Sizing is done with an adz. Even cuts to connect depth are made to provide full bearing.

b. Dapping. Ties are dapped (notched) over splices in beam flanges to the thickness of the splice plate.

(1) A saw cut is made each side of the dap and the wood between cuts removed with an adz.

(2) No allowance is made for projecting heads of rivets nor are ties countersunk for rivet heads. The first few trains over the bridge will force ties down to a full bearing on the girders.

138. BORING. a. Timber bents. Bents are assembled for boring on a framing platform or on carefully leveled blocking.

(1) Diagonal bracing of one face is laid down first, followed by the caps, sills, and posts, and the diagonal bracing of the opposite face.

(2) Bracing is lightly nailed to hold all pieces in position and holes are bored.

(3) If the bent is not to be erected as a unit, all parts are match-marked before the bent is taken apart. Each connection is designated by a numeral painted at the end of each member making up the joint.

(4) If it is planned to erect the bents assembled, bolts are driven and the bents stacked in orderly fashion to await erection.

b. Nailer strips. When bolted to steel stringers, nailer strips are cut, bored, and bolted before erection. Each nailer strip is marked for boring from the holes previously drilled in the flanges of the beam to which it is attached.

c. Other parts. To permit adjusting differences in makeup, other parts such as longitudinal bracing of towers and bents, stringers, caps, deck timbers, and railing posts ordinarily are not bored until in place.

139. MACHINE BOLTS. a. Bolts used in semipermanent bridges for bolting timber parts are ½-, ¾- and 1-inch machine bolts having square unfinished heads and nuts. Bolts must be fitted with round steel washers under head and nut. Washers are not supplied with bolts and must be requisitioned separately.

b. Holes for bolts are bored the same diameter as the bolt. When bolts are in place, nuts should be tightened until the washers bite into the wood. This compensates for shrinkage as the wood ages and dries.

c. When a bolt is not driven at right angles to the face of a timber, the timber must be beveled under the washer to provide full, even bearing. Curved faces are flattened for the washer by a shallow adz cut.

d. Bolts should not be closer to the edge of a timber than one and one-half times the diameter of the bolt. Bolts should not be closer together than two and one-half times the bolt diameter nor closer to the end of a timber than seven times the bolt diameter.

140. DRIFTBOLTS. a. Driftbolts used in semipermanent bridges are ½- and ¾-inch diameter. They are available in class IV supplies with square heads and cone points, or they can be cut from round rods and driven without head or point. Where drawings show flush driftbolts either of the following may be used: (1) a standard driftbolt with head sheared off, (2) a plain driftbolt cut from round bar stock. Driftbolts are driven in prebored holes and are used only for shear connections. They are never used to resist tension.

b. Holes for driftbolts are drilled the same size as the bolts. For bolts parallel with the grain of the wood, the holes are 3 inches shallower than the length of the bolt.

141. NAILS AND SPIKES. Nails and spikes are used in the framing yard to make temporary connections during marking, sawing, and bolting.

a. Types of nails and spikes used in the structures are listed in table III.

b. When one piece of timber is spiked to another, the nail or spike should penetrate the second timber at least one-half of the length of the nail or spike. Use of nails to resist direct pull is to be avoided; where so used, nails should be driven through and clinched.

CHAPTER 12

PILES AND PILE DRIVING

Section I. PILES

142. SCOPE. Pile and pile-driving information in this chapter deals with the detailed work processes. Construction of pile foundations and abutments of semipermanent bridges is described in chapter 13.

143. USE. **a.** Where the ground near the surface cannot support bridge loads on spread footings, *bearing piles* carry loads in the following ways:

(1) As a *point-bearing pile* by point resistance on a hard underlying layer of compacted sand, gravel, or rock.

(2) As a *friction pile* by frictional resistance of penetrated soil.

b. Bearing piles are also used on solid ground in the following cases:

(1) Where spread footings may be undercut by stream scour.

(2) Where water is too deep or stream current too fast to permit constructing spread footings.

c. The uses of *sheet piling* are discussed in paragraph 146.

144. TIMBER BEARING PILES. **a. General.** Straight tree trunks cut above ground swell with branches closely trimmed and bark removed are used as timber bearing piles. A good pile has the following characteristics:

(1) Free of sharp bends, large or loose knots, shakes, splits, and decay.

(2) A straight line between centers of butt and tip lies within body of pile.

(3) A uniform taper from butt to tip.

b. Size. Limiting cross section dimensions of piles are:

(1) Piles shorter than 40 feet, 8- to 11-inch tip (small end) diameters and 12- to 18-inch butt (large end) diameters.

(2) Piles longer than 40 feet, 6- to 8-inch tip diameter and 13- to 20-inch butt diameter. The butt diameter must not exceed the clearance between pile driver leads.

c. Source of piles. (1) Piles are usually obtained locally from stock or standing timber and are untreated.

(2) Creosoted piles 16, 30, 40, 50, 60, 70, 80, and 90 feet long are available as class IV supplies.

d. American timber. Piles can be made of any sound wood that will stand driving. Recommended American timber that will stand driving and has high durability is listed below:

(1) Red or white oak.
(2) Pine.
(3) Douglas fir.
(4) Larch.
(5) Cypress.
(6) Cedar.
(7) Spruce.

e. Foreign timber. The following foreign timber may be used for piling as indicated:

(1) Teak—Southeast Asia, high strength, high durability.
(2) Sal—India, high strength.
(3) Jarul—India.
(4) White siris—India.
(5) Doedar—India, medium strength.
(6) Chir—India, medium strength.
(7) Poon—India, medium strength.
(8) Eucalyptus:
Iron bark or Jarrah—Australia, medium strength, high durability.
White or red gum—Australia, medium strength, high durability.
(9) Mahogany—Central America, high strength, high durability.
(10) Palmetto—Tropics, low strength, borer resistant.
(11) Norway pine—Europe, medium strength.
(12) White deal—Europe, low strength.
(13) Kail—Europe, low strength.

f. Pile life. Life of a pile depends on the specie and condition of the wood, pretreatment, its position with respect to water, and its exposure to borers and rotting. In general, the life of creosoted and untreated piles is as follows:

(1) *Creosoted piles.* Creosoted piles last from 5 to 10 years in water infested by marine borers; 10 to 20 years when alternately wet and dry; and indefinitely when continually submerged in water.

(2) *Untreated piles.* Untreated piles usually last 3 to 6 *months* in water infested by marine borers; 5 to 10 years when alternately wet and dry; and indefinitely when continually submerged in water.

Note: Some tropical hardwoods such as cypress, teak, and mahogany last 3 to 4 years in water infested by marine borers. Palmetto is also borer-resistant but will not stand hard driving.

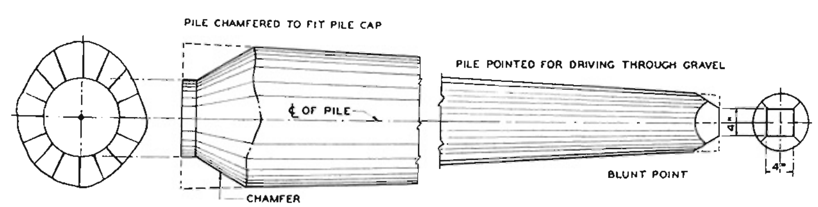


Figure 76. Preparation of timber pile. The butt end is chamfered and the tip is pointed for hard driving.

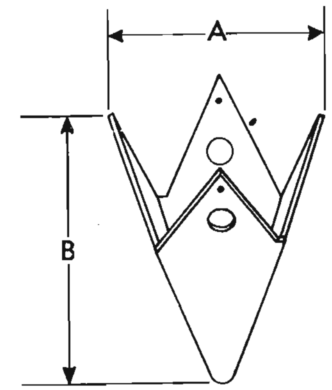
g. Preparation for driving. Before piles are driven, they are trimmed, the butt shaped to fit the pile cap, and the tip pointed or squared off. If pile caps are not used or if crushing and splitting occur, the top end of the pile is wrapped with steel wire or banded. Steel shoes are sometimes used to protect the pile tip when driving through gravel or soil containing boulders.

(1) *Butt preparation.* The butt is cut square and chamfered (fig. 76) to fit into the recessed pile cap. When driving with a steam hammer, which does not use a recessed cap, the chamfering concentrates the hammer blow on the central area of the butt and helps prevent splitting.

(2) *Pointing.* When driving through hard clay and coarse gravel, the tip is trimmed as shown in figure 76. In silts, and soft clays, the tip may be cut square and left unpointed.

(3) *Pile shoes.* Steel pile shoes (fig. 77) in two sizes are normally available in depots. The dimensions of these shoes are given in table XLVIII.

TABLE XLVIII. *Steel pile-shoe dimensions.*



Shoe	For piles	A (inches)	B (inches)
No. 1—	6-in. to 9-in. dia.	7⅝	9¾
No. 2—	8-in. to 11-in. dia.	9	11½

h. Splicing. Piles can be spliced if single piles of required length are not available or if long piles cannot be handled in the driver. Splices are also used to restore upper sections of burned or damaged trestle piles. Splices are of two types:

(1) Sleeve joints (fig. 78) made of 8- or 10-inch steel line pipe cut in 3-foot lengths. Contact ends must be carefully cut to give full contact. Pile ends are trimmed to fit snugly in the pipe. A flat transverse bar through the sleeve between the abutting pile ends keeps the sleeve in place during driving.

(2) Bolted timber or steel splice pieces as shown in figure 79.

145. STEEL BEARING PILES. **a. General.** Steel piles are best suited for:

(1) Driving to rock or other hard bearing surface below the reach of timber piles.

(2) Penetrating layers of gravel through which timber piles cannot be driven.

(3) Driving in rock-bedded and swiftly flowing streams where timber piles cannot be driven deep enough for stability.

b. Form and size. The preferred steel-pile section is the 12- by 12-inch, 53-pound, H-section. The sections used must:

(1) Be heavy enough to withstand hard driving.

(2) Be rigid enough to be handled and serve as a column.

(3) Provide suitable surface to attach pile-bent bracing. However, steel piles

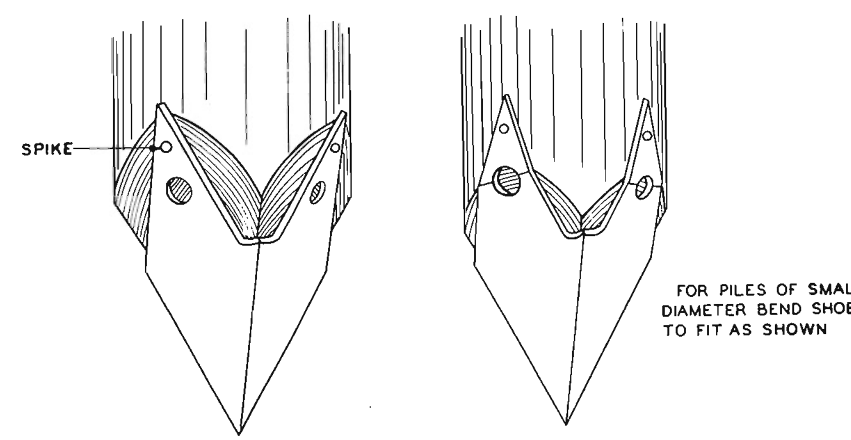


Figure 77. Steel pile shoe used to protect tips of timber piles in hard driving.

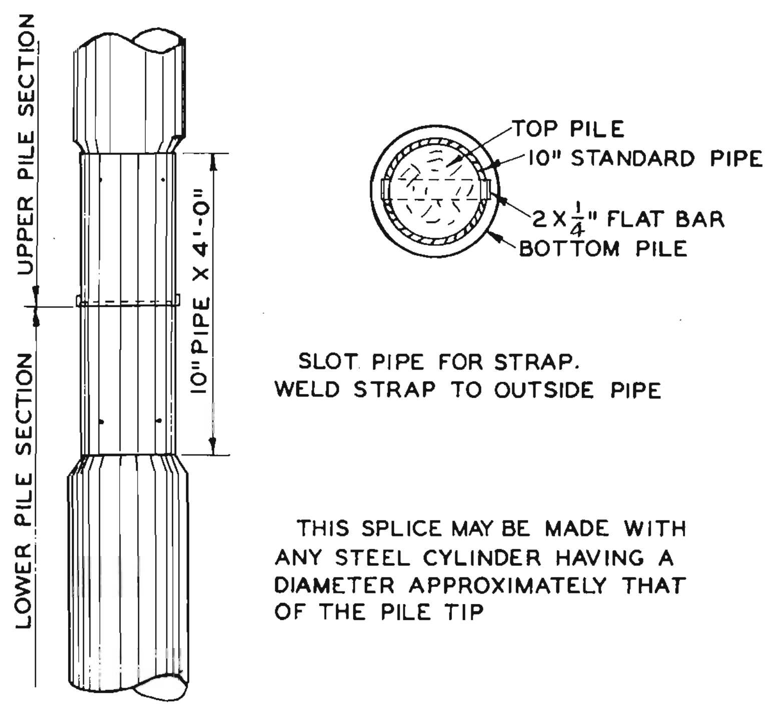


Figure 78. Timber-pile splice using steel line-pipe for a sleeve joint.

under concrete pedestals may be of any shape since bracing is not used.

c. Splicing. Steel piles can be spliced using welded, bolted, or riveted splice plates. (See fig. 80.) Unless butt-welded, ends of spliced sections must be in contact over their full area.

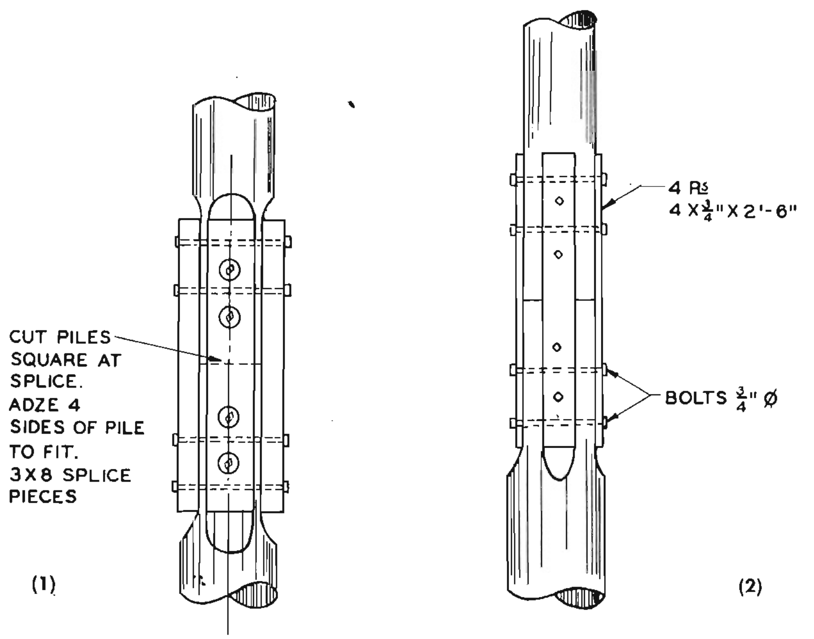


Figure 79. Timber-pile splice using timber or steel splice pieces:

(1) Timber splice pieces.
(2) Steel splice pieces.

146. SHEET PILING. a. General. Sheet piling is used to resist horizontal pressure of water or soil in the following operations:

(1) Excavating for abutments and foundations in soft soils. It is used to keep banks and trenches from caving in and must be securely braced with struts and rangers or wales.

(2) Foundation construction and repair in water. The sheet piling is driven into the stream bottom around the working area so it can be pumped dry.

b. Timber sheet piling. (1) *Types.* (*a*) Single-row sheet piling is normally used in dry earth. (See fig. 81 (1).)

(*b*) Double-row overlapping plank is normally used in saturated earth. (See fig. 81 (2).) The two planks are usually bolted together in shiplap form before driving.

(*c*) Wakefield sheet piling is used in water or under hard driving conditions. (See fig. 81 (3).) It is made of three thicknesses of equal-width plank nailed

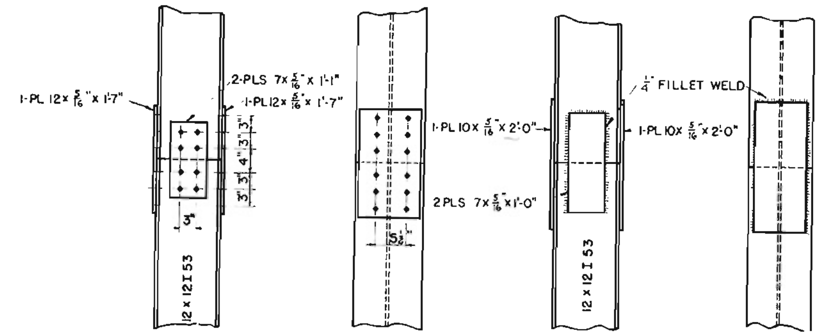


Figure 80. Steel-pile splices using bolted or welded splice plates.

and bolted together. Three 2- or 3- by 12-inch planks are used. All planks should be finished lumber.

1. Two-inch planks are bolted together with two ½-inch bolts at 6-foot centers. Three-inch planks are bolted with two ⅝-inch bolts at 6-foot centers. Spikes are driven at about 18-inch centers in two rows between bolts.
2. If bolts are not used, spacing of spikes is reduced to 12 inches and the rows are offset.

(2) *Preparation for driving.* The head of the sheet pile is chamfered to concentrate hammer blows on the center of the pile. The foot of the pile is cut at a 6 to 12 slope (fig. 81) to force piles together during driving.

c. Steel sheet piling. (1) Interlocking steel sheet-piling sections have the following advantages:

(*a*) Lug-and-groove interlock on each edge guides the pile during driving and can transfer tension from pile to pile.

(*b*) Strong and easy to drive and align in hard driving.

(*c*) Interlocking lug-and-groove shape reduces leakage in cofferdams.

(*d*) Can be pulled easily and used repeatedly.

(2) The following steel sheet piles are available in class IV supplies:

(*a*) A 5-inch 36- pound deep-arch wall section with an effective width of 16 inches. (See fig. 82 (1).)

(*b*) A 30.7-pound curved corner section (fig. 82 (2)).

147. CONCRETE PILES. Concrete piles are not ordinarily used in military bridges. However, there are two general types:

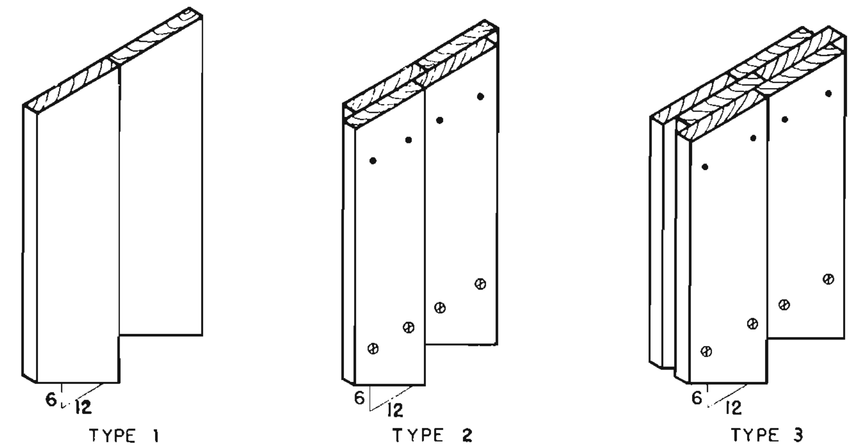


Figure 81. Timber sheet-pile types showing head and point details.

(1) Single-row plank piling.
(2) Double-row plank or shiplap piling.
(3) Wakefield piling.

a. Precast piles are steel-reinforced members that are cast and thoroughly cured before driving.

b. Cast-in-place piles are columns of unreinforced concrete made by pouring concrete into a hole made with a shell, mandrel, or earth auger. They can be used instead of wood or steel piles to carry foundation loads through firm soil to a subsurface layer of rock. Cast-in-place piles should not be less than 15 inches in diameter.

(1) Both truck-mounted and skid-mounted engine-driven earth augers are class IV equipment. They will drill up to 22-inch holes, 15 feet deep, in soils not containing boulders over 3 inches in diameter.

(2) Mandrels can be made of wood, or of steel pipe, if available. Mandrels must not be withdrawn until all holes for the pile group have been driven, or the open holes will be caved by the compression caused in driving mandrels for succeeding holes.

(3) Piles can be cast in place only in soil that will stand without caving. Holes should be filled with concrete immediately after being made. The soil around the piles must not be disturbed for at least 12 hours after the concrete is poured.

(4) Commercial cast-in-place piles having a predriven steel shell may be used if available.

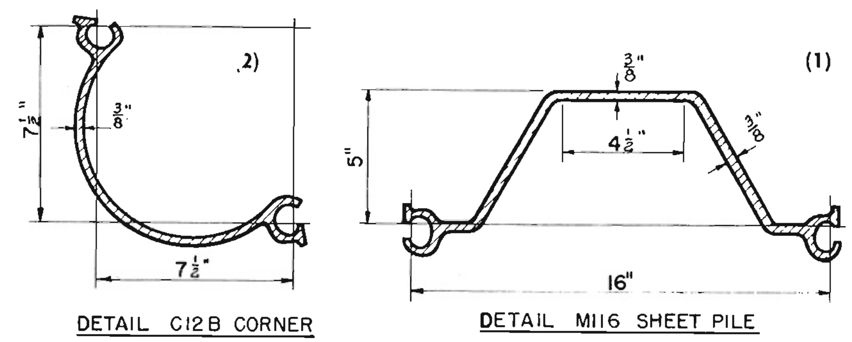
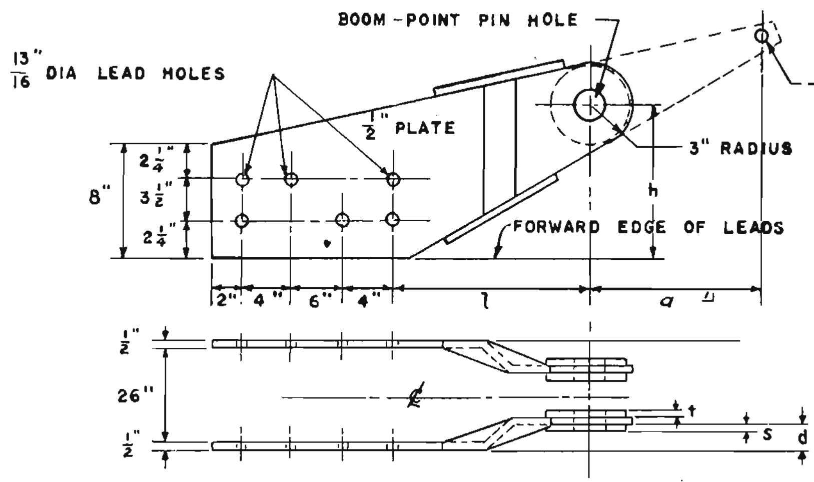


Figure 82. Cross section of standard steel sheet piling.

(1) 16-inch, 36-pound, 5-inch deep-arch section.
(2) 30.7-pound corner section.



CRANE MAKE	BOOM-POINT PIN HOLE DIAMETER (INCHES)	l	h	d	s	t
		INCHES				
QUICKWAY 3/8 CU.-Y.D. TRUCK-MOUNTED CRANE	2	12	9 1/4	4 1/4	1/4	0
BUCYRUS-ERIE MODEL-15B 1/2-CU.-YD. SHOVEL	2 1/2	15	11 3/16	1 3/4	1/2	0
OSGOOD MODEL 200 2/ 1/2-CU.-YD. SHOVEL	1 9/16 2/	16	1/2	3 1/8	1/2	0
BUCKEYE MODEL 70 1/	3	12 3/4	8 11/16	5 1/4	1/2	0
LORAIN MODEL 82 3/	2 9/16	19 3/4	12	6 1/4	1/2	0
NORTHWEST MODEL 78 D	3 1/16	15	12 1/2	0	1/2	0
25-TON STIFF-LEG DERRICK 3/	2	18	15	6 1/4	0	1
30-TON STIFF-LEG DERRICK 3/	2	42	12 3/4	4 5/8	0	1

1/ BUCKEY ADAPTORS HELD WITH 1/2 X 25 1/2" BOLT ABOVE BOOM-POINT SHEAVE, *a* = 12 INCHES

2/ OSGOOD ADAPTORS ATTACHED ABOVE BOOM-POINT SHEAVE, FURNISHED WITH 1 1/2 X 26-INCH THREADED ROD

3/ ADAPTORS SUPPLIED WITH SPECIAL BOOM-POINT SHEAVE PIN

Figure 83. Boom-point adapters for standard pile-driving equipment.

Section II. PILE DRIVING

148. DEFINITION. Pile driving consists of the following operations:

a. Hoisting and placing the pile in position for driving.

b. Driving the pile to desired penetration.

149. PILE-DRIVING EQUIPMENT. a. General. (1) Pile-driving equipment consists of:

(*a*) *Pile hammer* (steam-pneumatic or drop hammer) to deliver driving blow.

(*b*) *Pile cap* to cushion hammer blow and guide pile butt during driving.

(*c*) *Leads* to guide cap and hammer.

(*d*) *Hammer line* and *pile-handling line* to raise and lower hammer and to position pile.

(*e*) *Jets* may be used to facilitate driving.

(2) Newly standardized pile-driving leads and standard 1,200-, 1,800-, and 3,000-pound drop hammers with pile caps, as well as 5,000-, and 7,000-pound pneumatic or steam hammers, are available in class IV supplies. Adapters for standard loads are furnished with the crane booms of recently purchased standard cranes, shovels, and derricks. (See fig. 83.) If necessary, adapters can be made in the field to fit crane-boom pins of available cranes.

(3) Nonstandard pile-driving equipment with leads, hammers, and pile caps of manufacturer's own design are available as attachments for some truck-mounted and crawler-mounted cranes and shovels purchased before standardization.

b. Pile-driving hammers. (1) Light sheet piling can be driven into soft ground with a heavy hardwood hand maul or with a pneumatic paving breaker. (See fig. 84.)

(2) Bearing piles and heavy sheet piling must be driven with the heavier hammers listed below. Hammers must be heavy enough to secure the required friction-pile capacity (par. 155) at penetrations of not less than 1/8-inch per blow.

(*a*) *Drop hammers. 1.* Drop hammers (fig. 85) weighing 1,200-, 1,800-, 2,500-, and 3,000-pounds are issued with some standard shovels or can be obtained from depots.

2. Accessory to the hammer is a cast-steel pile cap or follow block which is recessed to fit over the head of the pile. It also has jaws by which it is guided in the leads. The pile cap transmits the hammer blows to the pile and holds it in position between the leads during driving. The standard pile cap shown in figure 85 is for wood piles; steel bearing piles and steel sheet piles require special pile caps or adapters

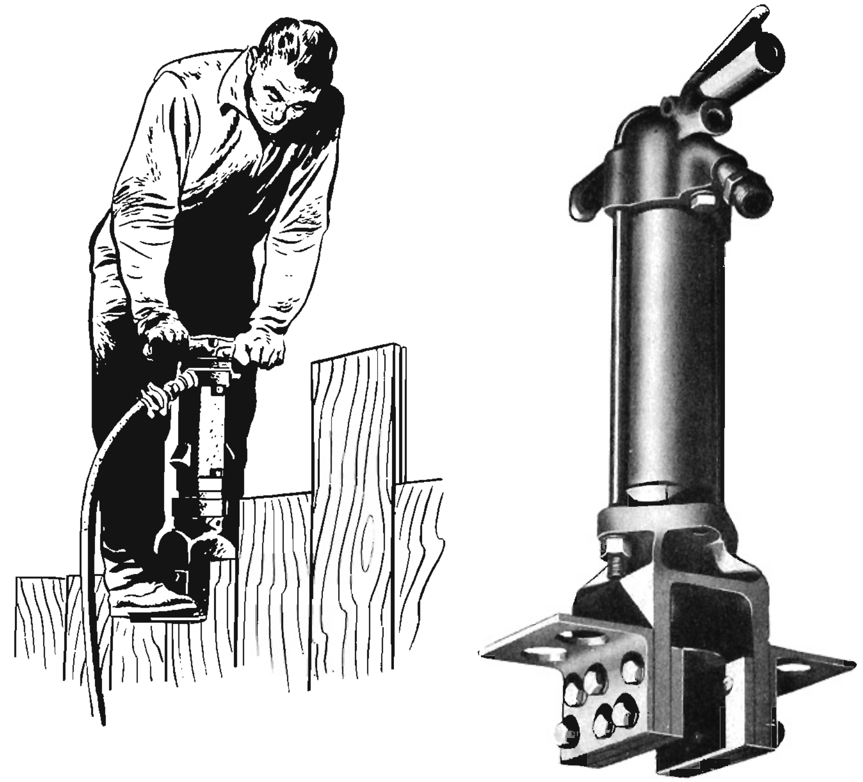


Figure 84. Pneumatic paving breaker with sheet-piling driver head.

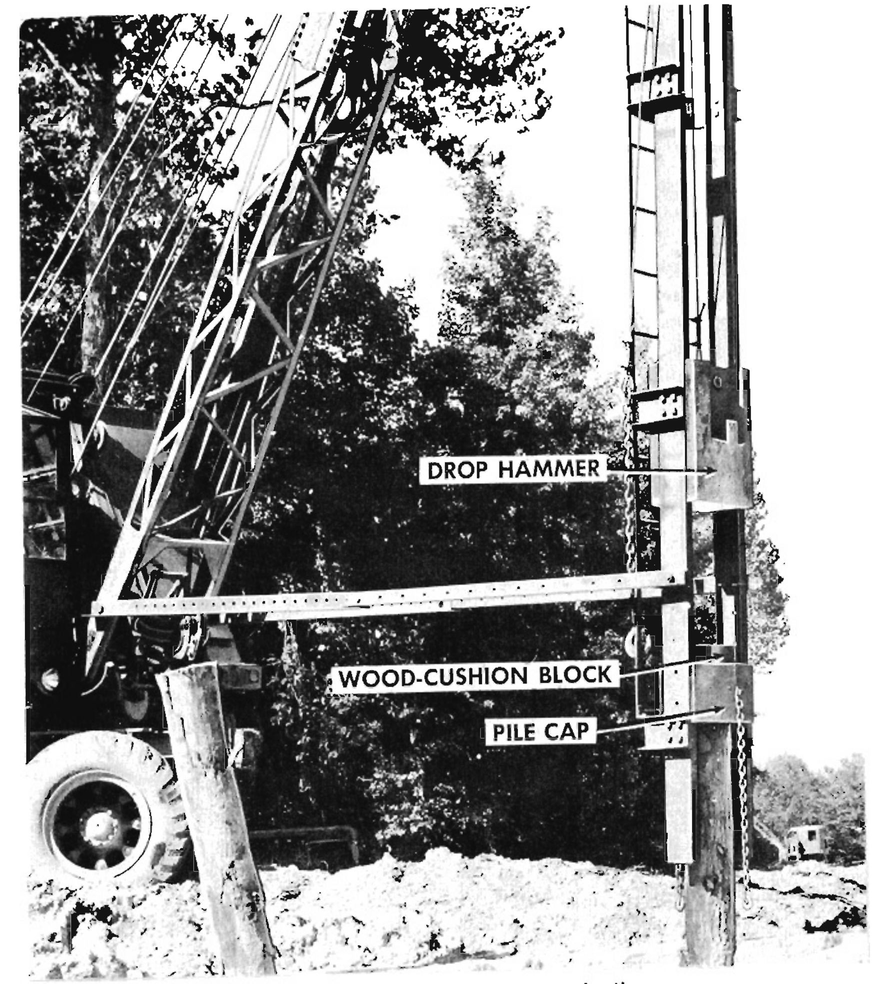


Figure 85. Standard drop hammer and pile cap.

3. For efficient work, drop hammers should weigh as much as the pile being driven; preferably, they should weigh twice as much.

(*b*) *Steam hammers. 1.* 5,000- and 7,000-pound double-acting steam-pneumatic hammers are available as class IV equipment. The piston in double-acting hammers is lifted up and driven down against the pile cap. In single-acting hammers, no pressure is exerted on the piston during its downward movement. A 10,200-pound single-acting hammer is available with some engineer units. (See fig. 86.)

2. Steam-pneumatic hammers can be run on steam or compressed air. Steam and air requirements as well as dimensions, weights, and performance data are given in table XLIX.

3. The cap of a standard steam-pneumatic hammer is an integral part of the hammer. Cap fittings to position steel sheet and bearing piles are shown in figure 87.

c. Leads. (1) Pile-driving leads are constructed of wood or steel. Wood leads should be lined with steel to reduce wear and friction.

(2) Leads are classified according to the method of attachment listed below:

(*a*) *Fixed leads* are rigidly attached to the pile driver; they are used to drive vertical piles only.

(*b*) *Swinging leads* are pivoted and braced at an angle to drive *batter piles*—piles driven at an angle. (See fig. 15.)

TABLE XLIX. *Characteristics of stem-pneumatic hammers.*

	Double-acting		Single-acting
Weight of hammer, lb.	5,000	7,000	10,200
Weight of striking part, lb.	800	1,600	5,000
Over-all height, in.	73	98	159
Width between leads, in.	22	21	20
Stroke of piston, in.	9.5	17	36
Steam operation:			
Boiler pressure, psi	100	100	80
Boiler required, hp	35	45	40
Pneumatic operation:			
Air pressure, psi	100	100	80
Volume, cfm	450	600	565

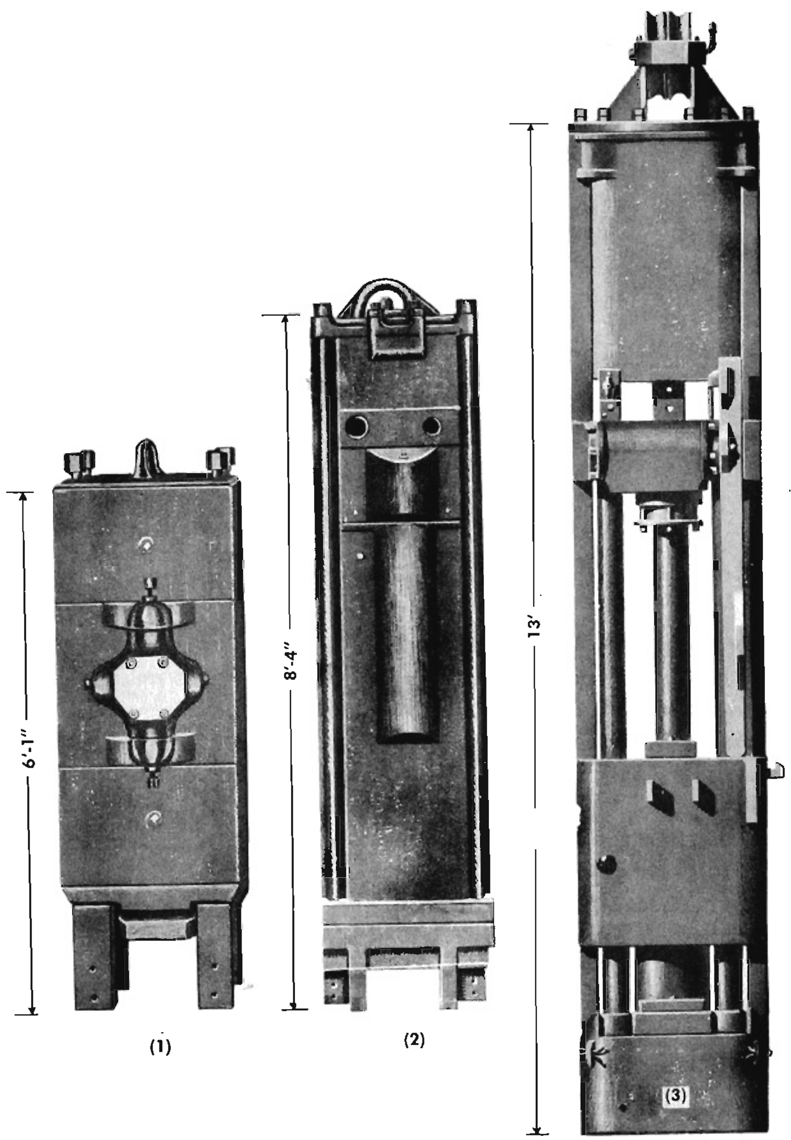


Figure 86. Steam-pneumatic pile hammers:

(1) 5,000-pound double-acting hammer.
(2) 7,000-pound double-acting hammer.
(3) 10,000-pound single-acting hammer.

(*c*) *Hanging leads* are hung from the boompoint with wire rope tackle. They can be used to drive vertical or batter piles, but their use should be avoided since control of their alignment is difficult.

(3) Leads are normally attached to a crane boom with adapters or brackets on the boom-point pin or shaft. This limits batter to one direction.

(4) Standard leads of steel are issued in 10-, 15-, and 20- foot sections. The 20-foot section is used as the top section and 10- and 15-foot sections can be added underneath it.

(5) When leads are used with the standard cranes and shovels, the lead foot is braced with a telescoping catwalk connected to the base of the boom.

d. Truck-, crawler-, and skid-mounted equipment. (1) Three-eighth- and ¾-cubic-yard truck-mounted cranes with standard pile-driving attachments are available as class IV equipment. (See fig. 88.)

(2) Crawler-mounted shovels in all sizes available to troops are issued with crane booms and most of them can be fitted with the standard pile-driving attachment. (See fig. 89.)

(3) The standard skid-mounted pile drivers are of wood or steel construction.

(*a*) The steel-frame skid-mounted pile driver is equipped with a 5,000-pound double-acting steam-pneumatic hammer and 55- or 65-foot standard leads. (See fig. 90.) The leads can be inclined in two directions: in line with the skid frame using the forebatter guide; and perpendicular to it, using the moonbeam.

(*b*) The wood-frame skid-mounted pile driver is usually equipped with the 5,000-pound hammer and has 66-foot wood leads. These leads are for vertical piles.

(4) Derricks can be equipped with adapters to handle the standard pile-driving attachments.

e. Jetting equipment. (1) Jetting consists of forcing air, water, or both, around and under a pile to displace, loosen, and lubricate the surrounding soil.

(2) Air and water jets are used in silt, sand, or gravelly soils to assist pile driving. In sand where jets are most effective, piles can be sunk to within a few feet of full penetration with water-air jets alone; the hammer must rest on the pile to give it sufficient weight to overcome buoyancy.

(3) One hundred to 250 gpm of water are usually required for effective driving depending on soil and penetration.

(4) Jetting equipment shown in figure 91 can be requisitioned by parts from class IV equipment and supplies. Jetting pumps may also be furnished with jetting pipe assemblies of slightly different dimensions.

(1) Pump.
(2) Suction hose.
(3) Jetting-pipe assembly of class IV material.

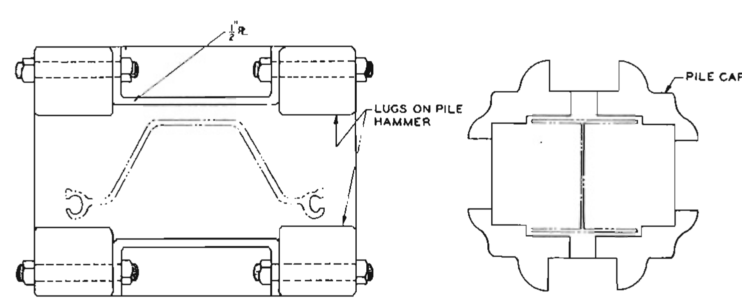


Figure 87. Steam-pneumatic pile-hammer cap fittings:

(1) Steel-sheet-pile cap fitting.
(2) Steel-bearing-pile cap fitting.

150. USE OF EQUIPMENT IN BRIDGE-FOUNDATION CONSTRUCTION. Bridge-foundation piles can be driven with the pile-driving rig on the bridge deck, on the ground, or on floating rafts or barges. Use of standard equipment to drive piles in bents, footing piles, and sheet piling is discussed and illustrated below.

a. Piles in bents. (1) *Driving from bridge deck.* Any pile-driving rig can be used from the deck of a bridge if leads can reach the next bent (fig. 92). The limiting reach of truck- and crawler-mounted equipment is given in tables LXXXII and LXXXIII.

(*a*) *Piles.* Timber piles are driven in the normal manner. Steel piles must be driven with their webs parallel to bridge center line. This requires that the leads be rigged as hanging leads and guyed in position, or chamfering of the pile flanges to fit in the cap and a frame at the foot of the leads to guide the pile.

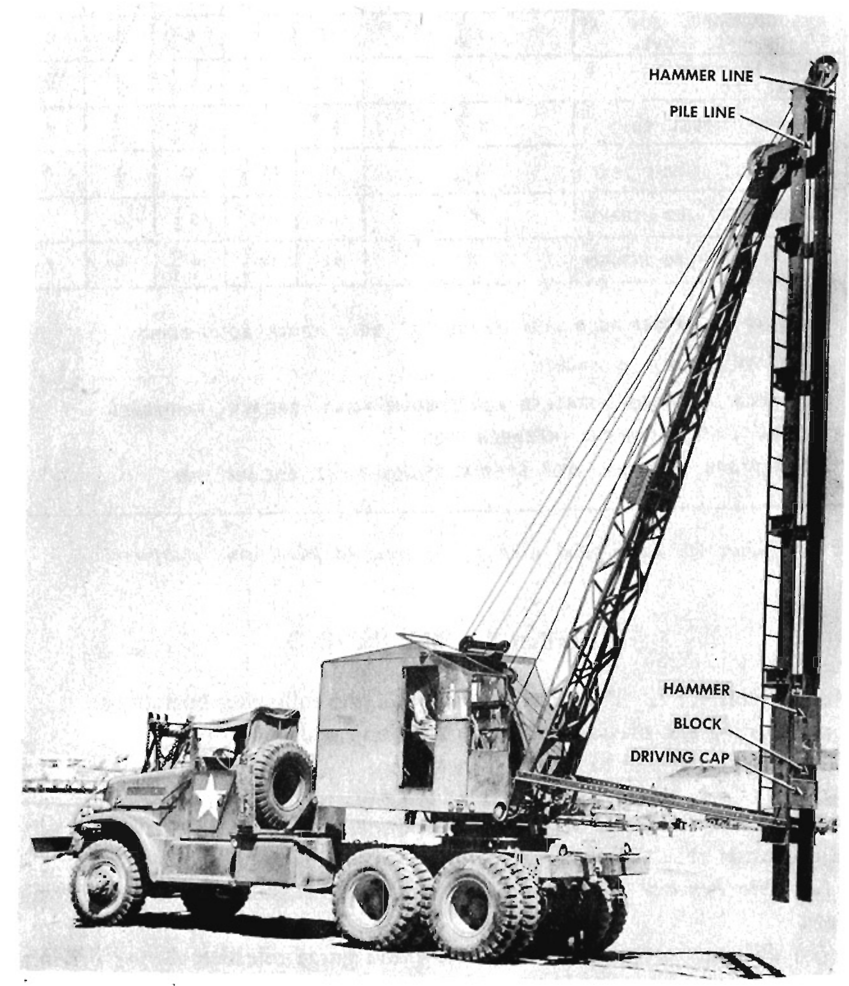


Figure 88. Truck-mounted crane with pile-driving attachment of manufacturer's design.

(*b*) *Batter piles. 1.* The outside piles of railway-bridge bents are battered. The inside vertical piles should be driven first to carry a horizontal frame upon which the lower end of the leads can be supported for driving the outside battered piles. Leads may be either of hanging or swinging type. Figure 93 shows arrangement of hanging leads resting on frame in position to drive a batter pile.

2. A steam-pneumatic hammer is required when driving batter piles with *hanging* leads. With *swinging* leads a drop hammer can be used to drive batter piles provided leads are well-greased.

3. An expedient adapter can be used to swing leads laterally. (See fig. 94.) The foot of the leads must be securely guyed and supported.

(1) Boom-point wire-rope lead suspension.

(2) Frame fastened to vertical piles to guide foot of leads in driving batter piles.

(2) *Driving from ground and rafts.* (*a*) If site conditions permit, piles should be driven from the ground. When bents with batter piles are constructed, the pile driver should be placed in line with the bent to utilize the batter adjustment of standard leads.

(*b*) When piles are driven in water, pile drivers can be mounted on rafts or barges. (See figs. 95 and 96.)

(1) ⅜-cubic-yard crane mounted on a pneumatic M3 raft.

(2) ½-cubic-yard shovel equipped with crane-boom and pile-driving attachment mounted on a five-ponton 25-ton ponton raft..

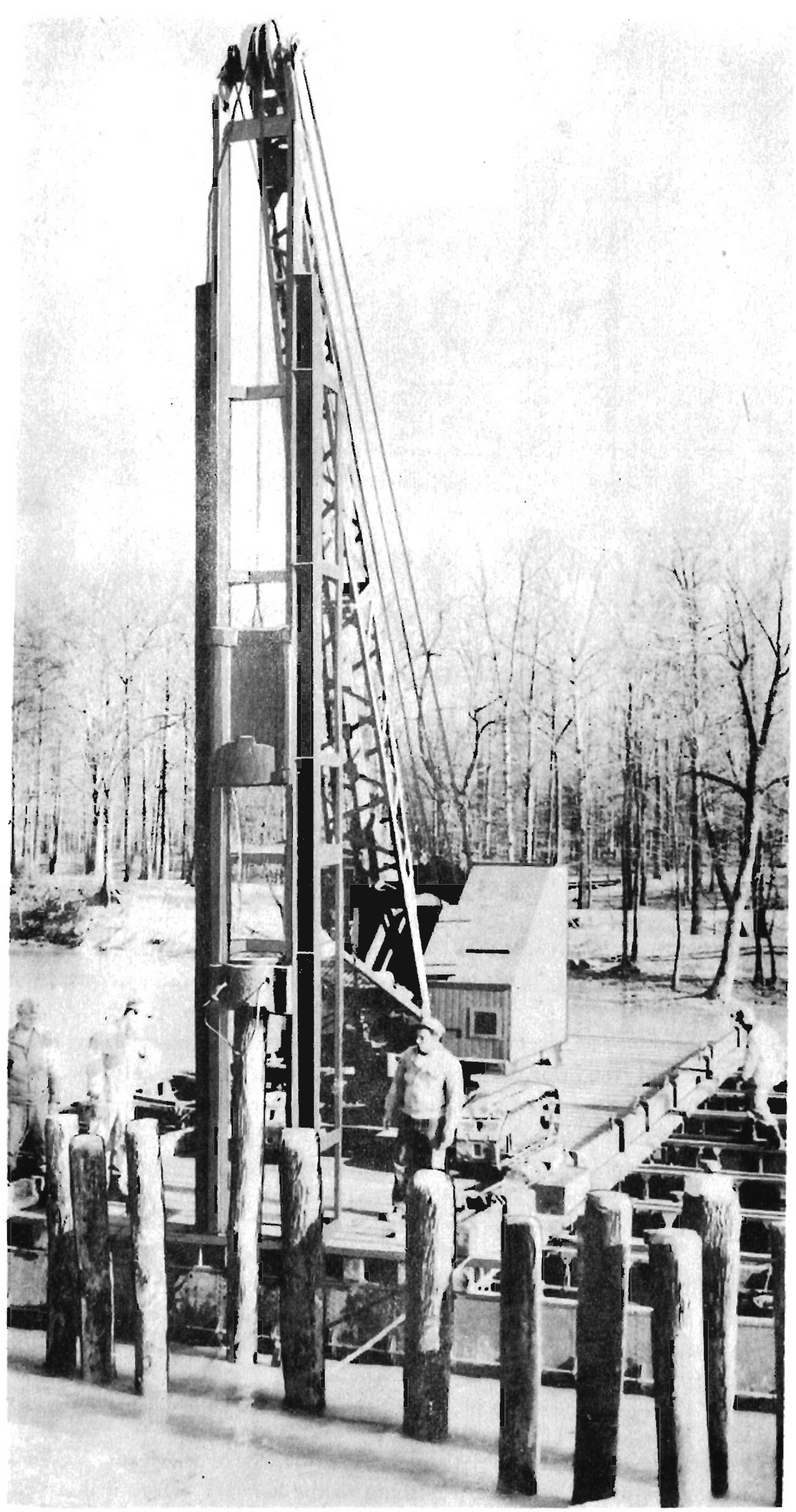


Figure 89. Shovel with crane boom and standard pile-driving attachment driving timber piles.

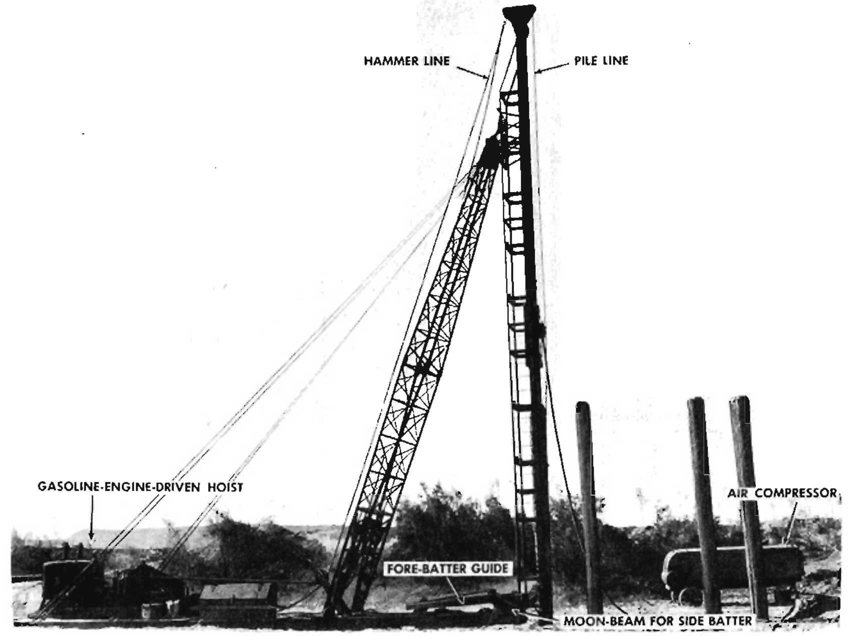


Figure 90. Steel-frame skid-mounted pile driver with swinging leads.

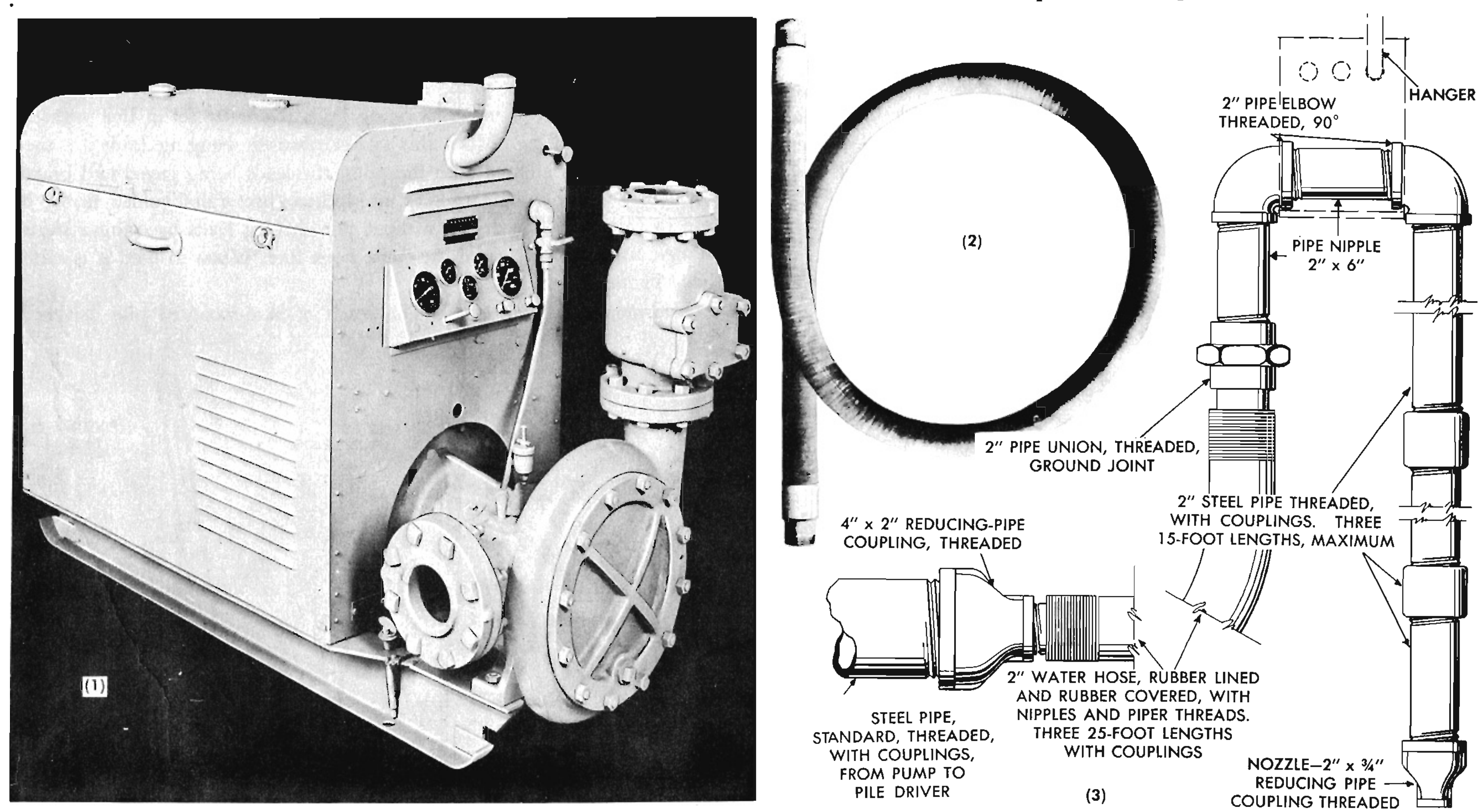


Figure 91. Jetting equipment with 200-gpm, 350-foot head, 150-psi, centrifugal pump.

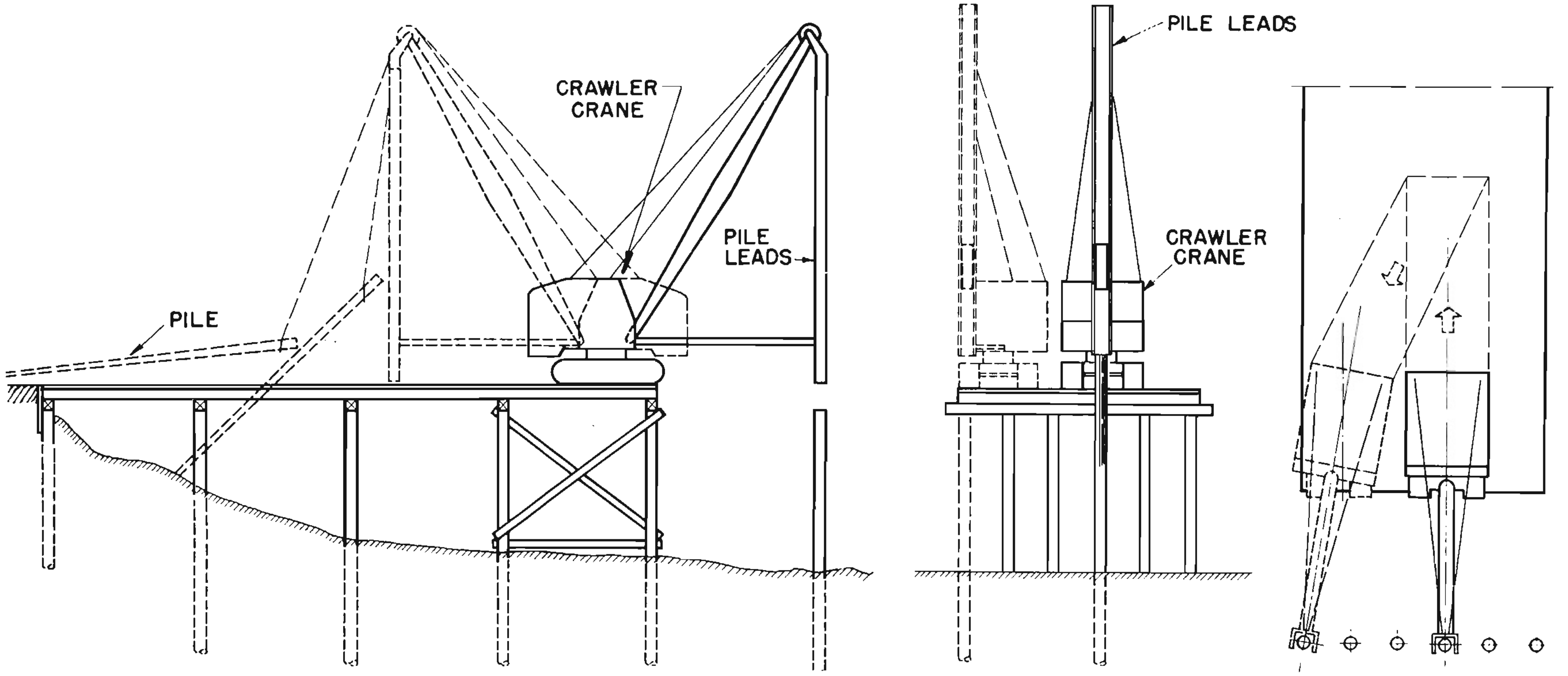


Figure 92. Driving piles from bridge deck. Note equipment reach.

b. Piles in footings. Piles for footings are usually driven from the ground or from rafts or barges. However, if piles are driven from deck level, leads must be lowered to guide pile and hammer. Driving footing piles follows generally the procedure used in driving pile bents; no batter piles are used.

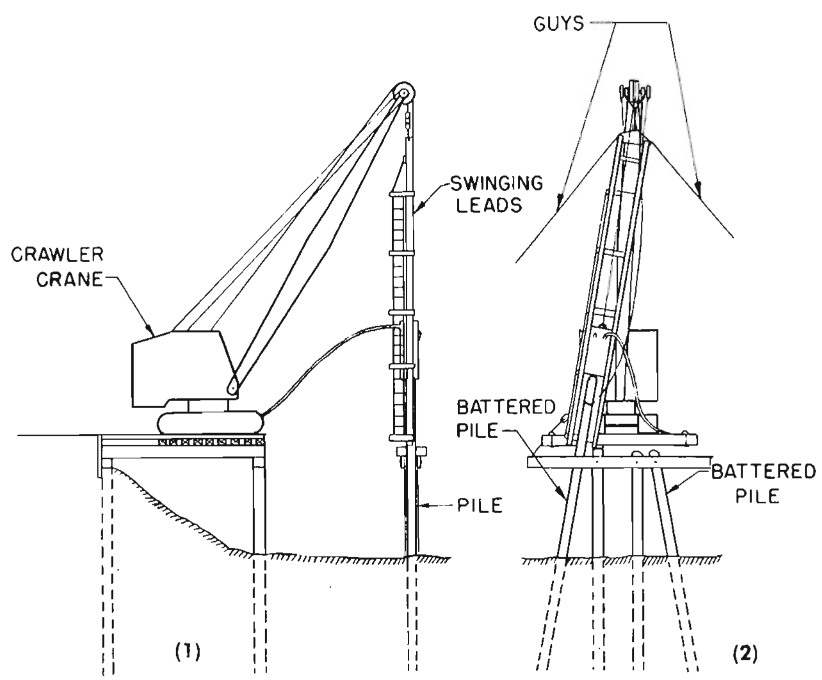


Figure 93. Driving batter piles from bridge deck.

c. Sheet piling. Sheet piling is normally driven from the ground or from barges or rafts. A driver using swinging leads is usually set in line with the face of the sheet piling. When this is not possible, hanging leads are used because they can be aligned with the piles, the leads being guyed and braced to previously driven piles. Securely interlocked sheet piles guided firmly by cofferdam frames can be driven without pile driving leads by using a steam-pneumatic hammer hung from the crane hoist line. When so used it is called a *flying* hammer.

d. Skid-mounted pile drivers. The reach of skid-mounted pile drivers is limited to about 20 feet, depending on weight of pile and hammer on the overhanging end and weight of hoist at the back end. The distance between bents cannot normally exceed 20 feet when the pile driver is used on the bridge deck. To extend tne reach, the back end can be loaded with ballast or lashed down to a pile bent. On single-lane and railway bridges, it may be necessary to use outriggers on the pile bents. They should be used on the deck only when other types of drivers are not available.

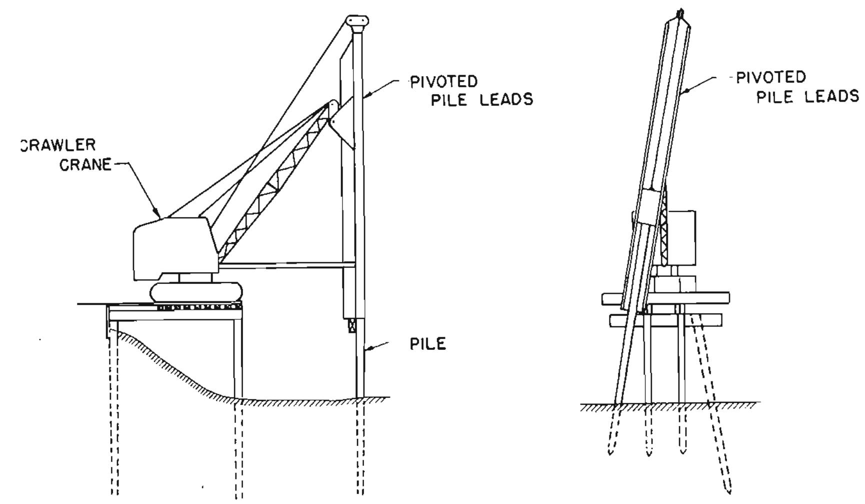


Figure 94. Expedient adapter used to swing leads laterally. The foot of the leads must be securely guyed and supported.

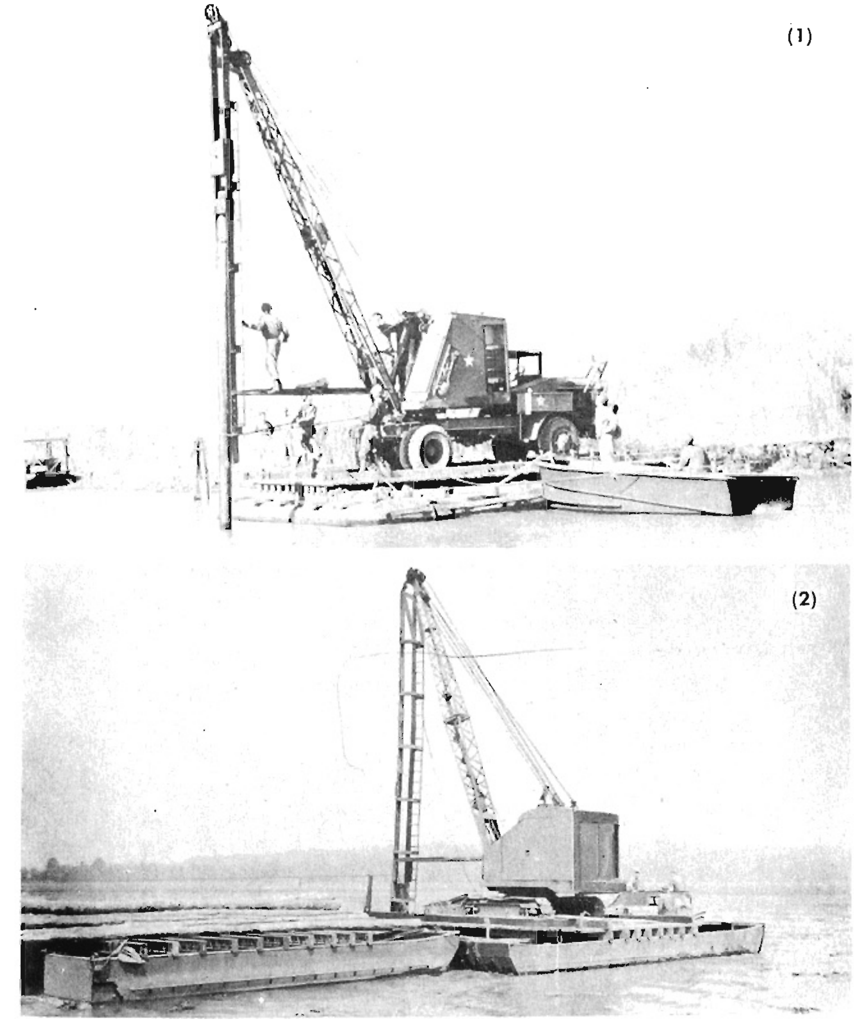


Figure 95. Raft-mounted pile drivers.

151. DRIVING PROCEDURE. a. Bearing piles. (1) Piles are delivered within reach of the handling line. In handling, the pile line is attached near the pile butt, the pile is dragged or floated to the foot of the leads, and the pile is hoisted free of the ground.

Note. In attaching pile line with hook, the open part of the hook should face toward the pile tip. (See fig. 97 (1).)

(2) The pile hammer is raised and held at the top of the leads. When a drop hammer is used, the pile cap is slung to the hammer before it is raised.

(3) The pile is pulled up into the leads and the foot of the pile is placed in position. If the pile is driven through water a timber frame may be placed at the foot of the leads to position the lower end of the pile.

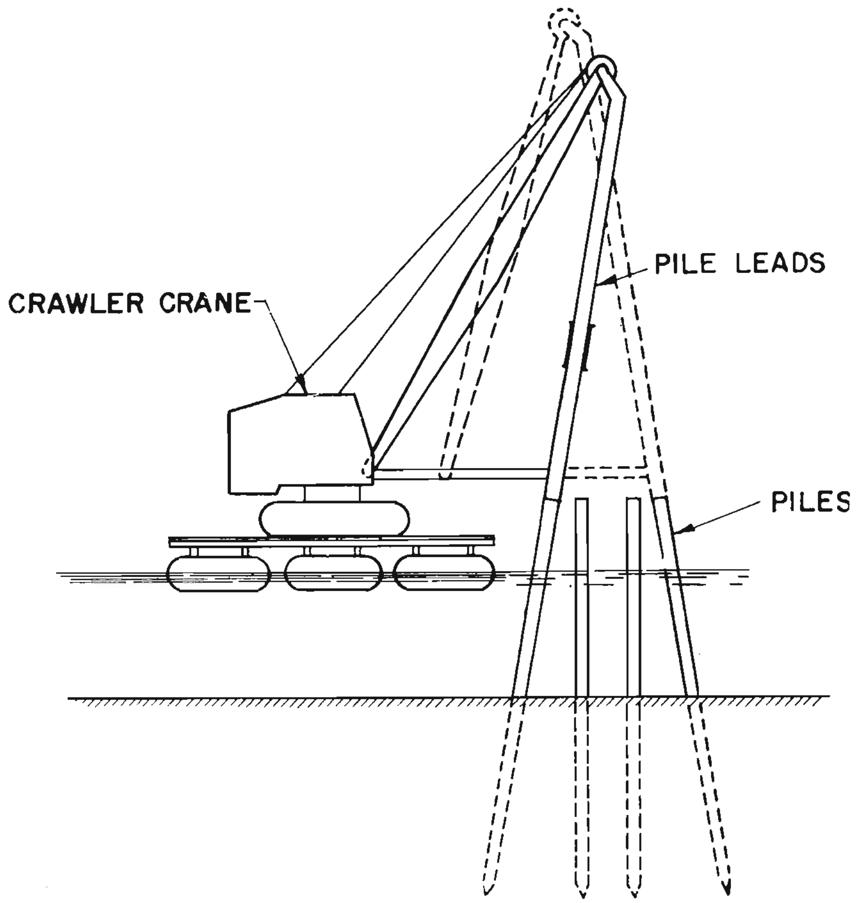


Figure 96. Raft-mounted pile driver with pile driver in line with pile bent. This allows use of swinging leads to obtain pile batter.

(4) The pile is centered under the pile cap and the pile cap and hammer are lowered to the pile. A method of doing this is shown in figure 97 (1), (2), and (3).

(5) (*a*) *Drop hammers.* With drop hammers, driving is started slowly, the hammer being raised only a few inches until the tip of the pile is firmly set. The height of fall is then increased gradually to a maximum of 10 to 15 feet. Driving blows should be as rapid as possible to keep the pile moving. If an obstruction such as a boulder or sunken log is reached, a few fast heavy blows can be used to displace or break the obstruction. Repeated long drops should be avoided, since they tend to crush and split the pile butt.

(*b*) *Steam hammers.* Pressure on the first few blows of steam hammers is restricted until the pile tip is firmly set; it is then increased to full pressure as indicated in table XLIX.

(6) (*a*) During driving the pile is watched for indications of splitting or breaking below ground. If driving is hard and suddenly becomes easier or if the direction of the pile suddenly changes, it is probably broken or split. Broken or split piles must be replaced. This can be done by driving a new pile nearby (offsetting) or pulling the broken pile and driving another pile in its place.

(*b*) Springing causes loss of hammer efficiency and pronounced bouncing of the hammer. Springing and bouncing will occur under the following conditions:

1. Using crooked piles.

2. When pile butt is not square.

3. When pile and leads are out of line.

4. When too light a hammer is used.

5. When penetration ceases because of obstruction or refusal.

(7) If the fibers at the head of a pile become crushed or broomed, much of the hammer's energy is lost. A broomed pile should be cut back to sound wood and reshaped.

(8) Piles driven to rock or other hard strata are often damaged by overdriving with consequent loss of capacity. The effect of overdriving is illustrated in figure 98.

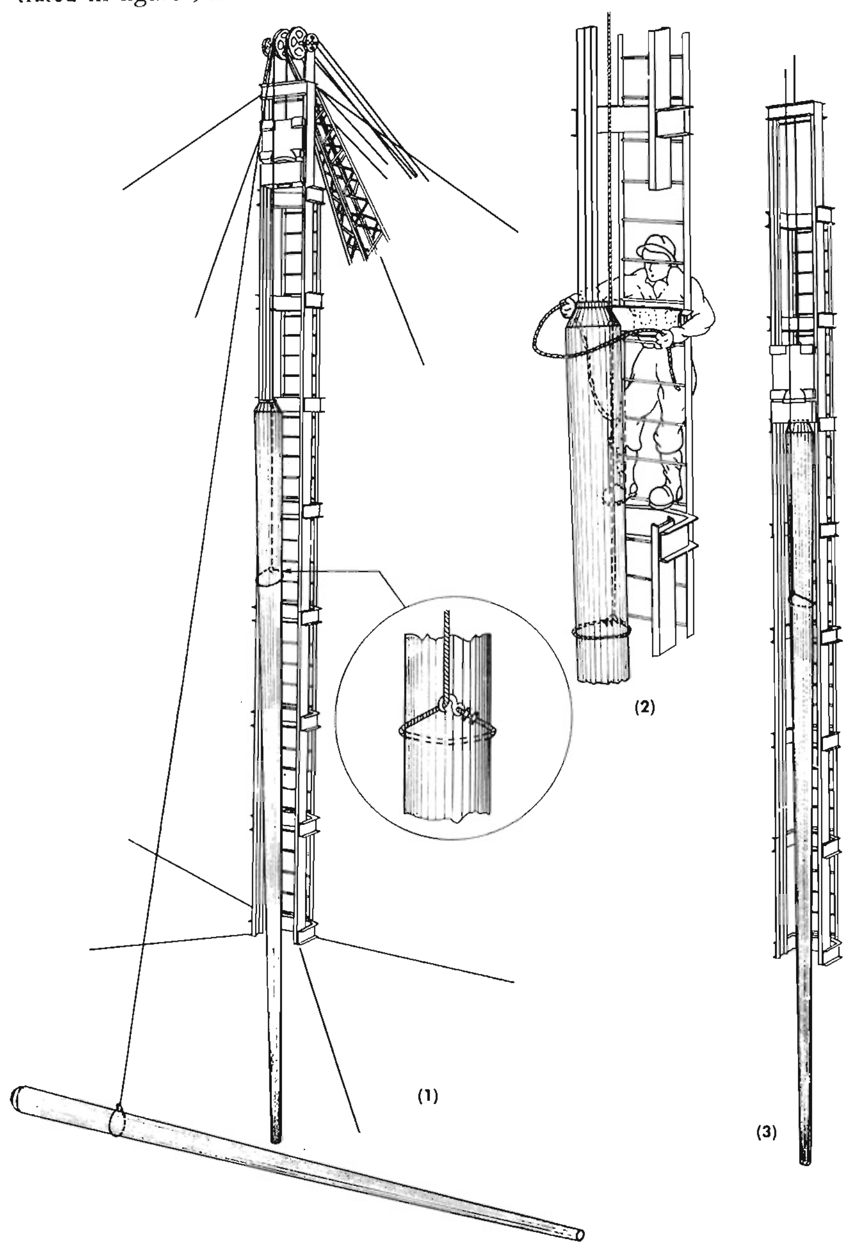


Figure 97. Placing pile in leads.

(1) Pile hoisted in front of leads. Note pile-line attachment detail.
(2) Line thrown around pile butt.
(3) Hammer and cap lowered on pile ready to start driving.

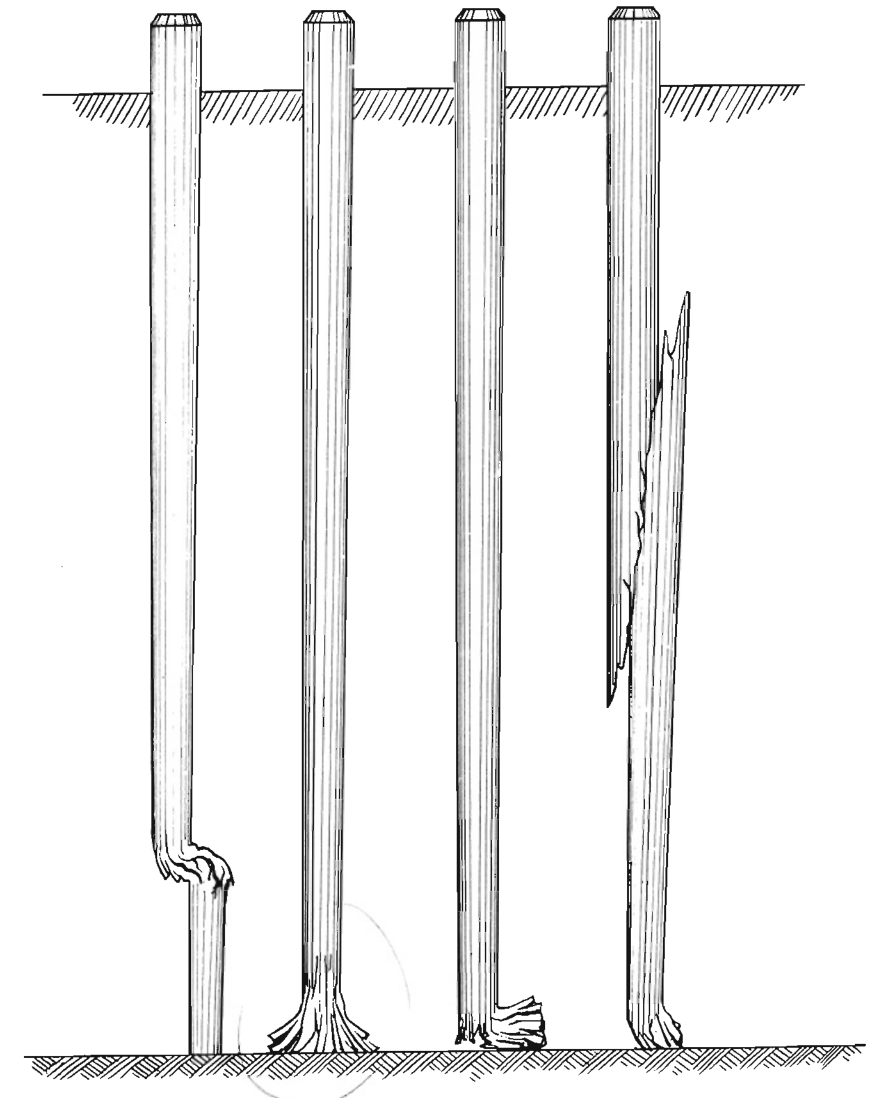


Figure 98. Effect of overdriving on wood piles.

b. Sheet piling. General procedure in driving sheet piling varies from bearing-pile driving in the following ways:

(1) The sheet pile heads are bored for handling-line shackles.

(2) The lower end of the steel-sheet-pile slot should be plugged to keep out dirt and to allow easy driving of succeeding piles.

(3) The first sheet pile is driven only until the point is firmly set; succeeding sheet piles are driven to the same point; each pile is then driven a few feet at a time to the required penetration.

(4) The pile tongue should be kept at the free edge so stones will not become wedged in the groove and make it difficult to drive the succeeding pile.

(5) Timber sheet piles can be held close together by snubbing a line tightly around the group.

c. Jetting. (1) Jetting aids pile driving.

(2) Jets are usually not fastened to the pile but are handled separately by a line attached to the top of the jet and carried over a pulley at the top of the leads. They are lowered into the ground by their own weight as the water removes the soil at their points.

(3) The jets are manhandled and are kept in motion to prevent coarse

material packing around the pipe and causing it to stick.

(4) Jets may be used singly or in pairs. If two jets are used, one jet is kept moving slightly ahead of the pile while the other is slowly raised and lowered between the foot of the pile and the ground surface to maintain a flow of water along the pile.

(5) While being driven a pile will tend to move toward a single jet. This tendency is used to straighten piles. (See fig 101.)

(6) Jets should be taken up before the pile reaches final penetration and the pile sunk the last few feet with the hammer alone.

d. Realigning piles. When piles are not driven straight, they can be realigned by using one of the following methods:

(1) Inclined strut. (See fig. 99.)

(2) Block and tackle. (See fig. 100.)

(3) Single water jets. (See fig. 101.)

Note. The greater the penetration the harder realignment becomes. Alignment should be checked during driving and piles should be realigned as soon as misalignment is noticed.

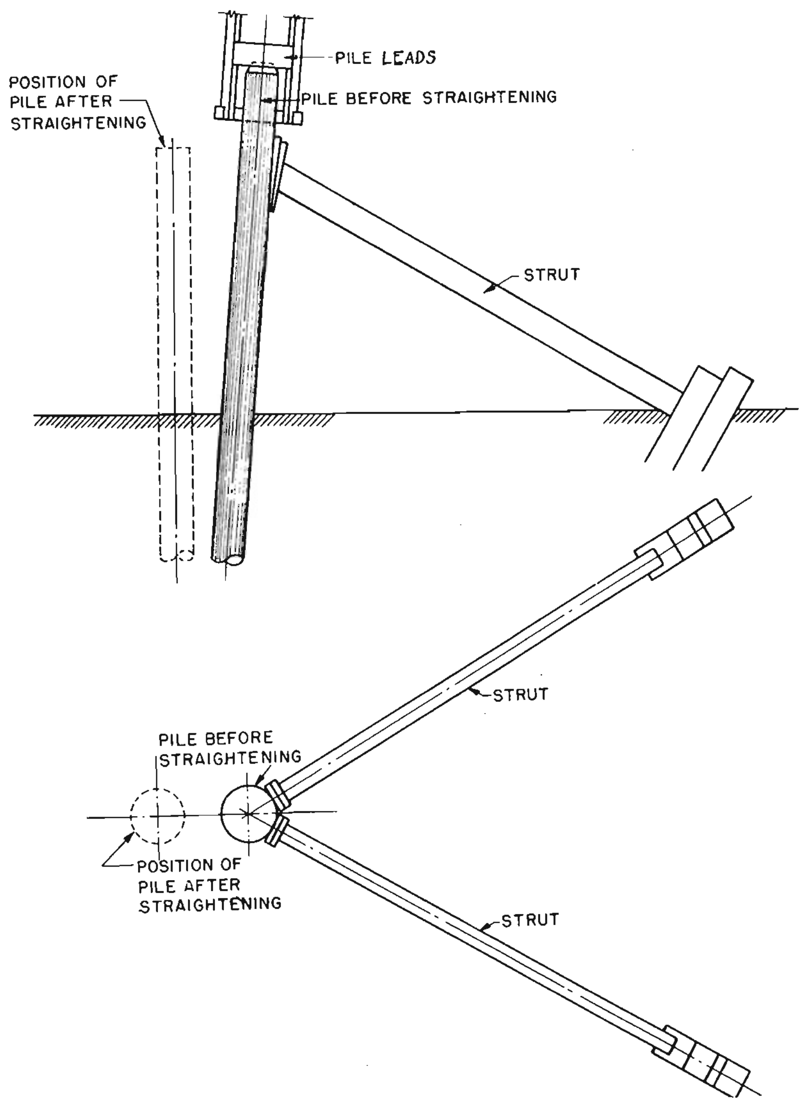


Figure 99. Straightening pile with inclined struts.

e. Driving sequence. (1) Driving should progress from an area of high resistance to low resistance, toward a stream, or down slopes. This minimizes shoving previously driven piles out of place, when driving succeeding piles.

(2) When piles are driven in a group:

(*a*) Outer rows are driven first if they derive their principal support by friction. (See par. 154.)

(*b*) Inner rows are driven first if the piles derive their support by point bearing.

152. PULLING PILES.

a. If piles must be removed, they can be pulled with the pile line or by the inverted hammer arrangement shown in figure 102. Pulling damaged piles should begin immediately after the pile has been broken, so the ground around the pile does not consolidate to make pulling more difficult. Jetting can be used to help loosen a pile. A few blows with a hammer may help loosen a pile.

b. Piles can be pulled with tackle suspended from an A-frame or gin pole. A pull of 25 to 75 tons may be required. If a crane is used, the boom must be snubbed to the ground to prevent the crane's upsetting if piles suddenly come loose or the tackle breaks.

c. The light steam hammer can be inverted and used in pulling piles. A cable sling is passed over the hammer and attached to the pile as shown in figure 102. A steady pull is put on the pile to keep it in motion as it is lifted by the upward blow of the inverted hammer.

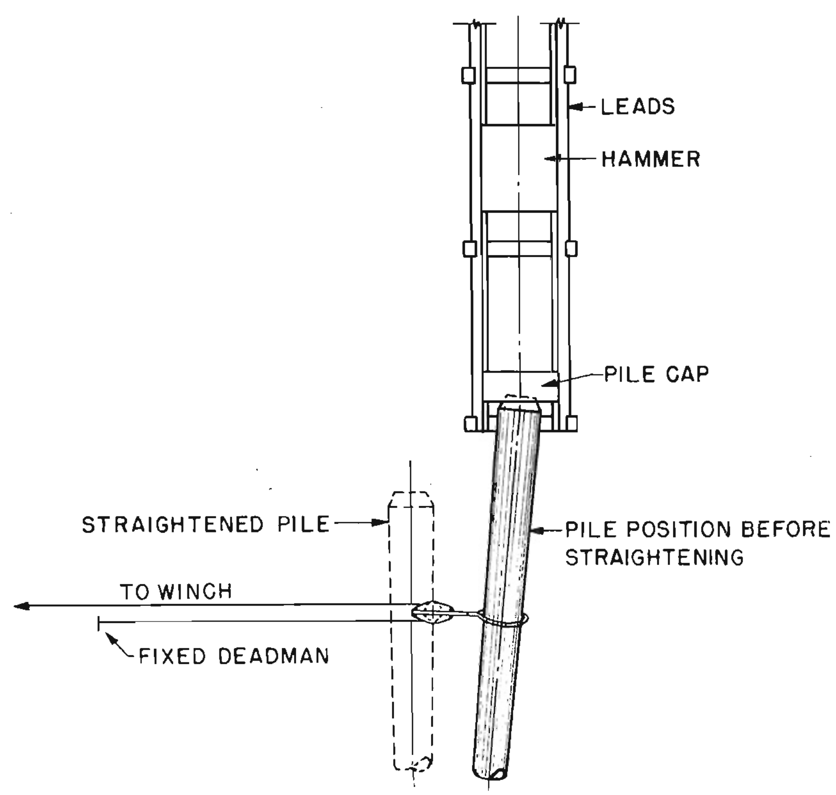


Figure 100. Straightening pile with block and tackle.

(1) Correcting pile-tip position.

(2) Correcting pile-butt position.

153. LOADS ON BEARING PILES.

a. Bearing piles in bridge foundations carry vertical loads (the weight of the bridge and vehicles) and horizontal loads from wind, current, and movement of vehicles on the bridge.

b. The vertical loads determine the required pile resistance; the horizontal loads limit the bent and tower heights in deep swift water. (See par. 10.) Pile sizes should not be smaller than given in paragraph 144.

c. Pile design loads are shown on the assembly drawings for the different pile foundation designs. The loads given are dead and live loads, or 80 percent of dead and live load in combination with loads from lateral and longitudinal forces whichever is greater. The range of loads is:

(1) Timber piles—8 to 18 tons.

(2) Steel piles—10 to 50 tons.

154. FACTORS GOVERNING PILE CAPACITY.

a. Pile Stress. The portions of piles above the ground (between braces) act as columns. The loads on

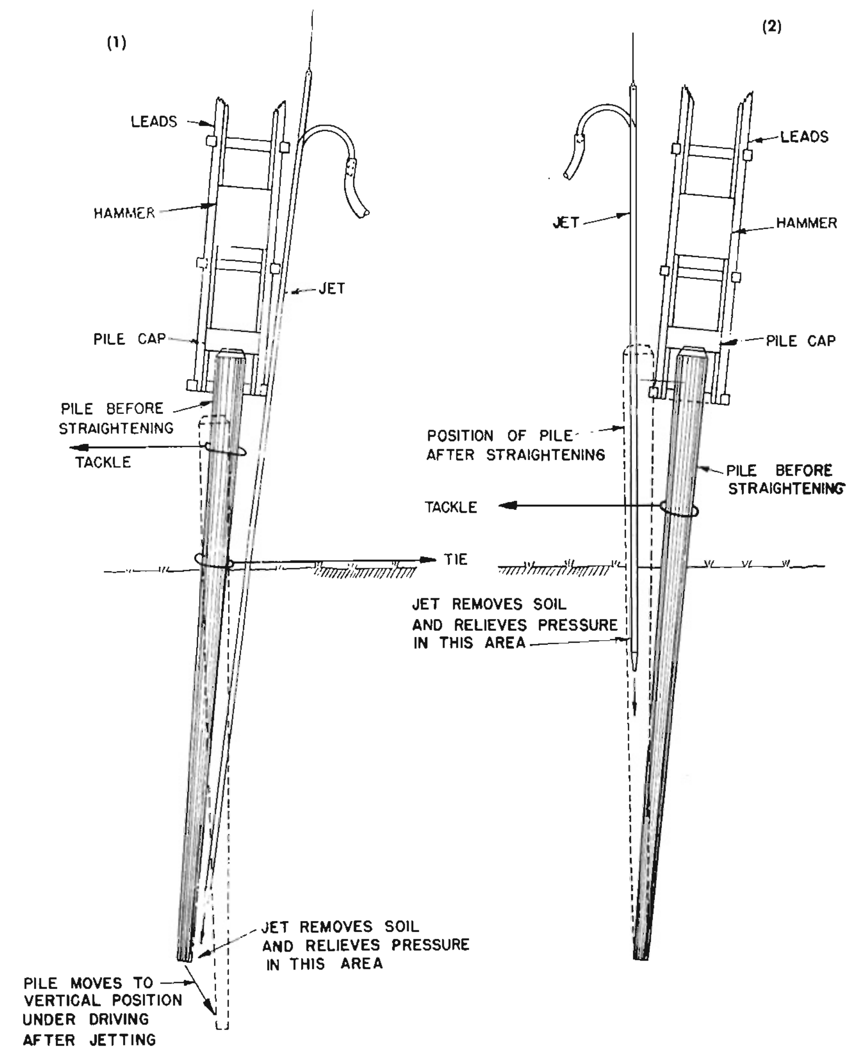


Figure 101. Straightening pile with water jet.

pile bents and on individual piles under towers therefore must not exceed their unbraced column strength. Also the permissible timber stress for compression perpendicular to the grain must not be exceeded for pile-cap bearing on the pile. The timber working stress must not be exceeded by combined compression and bending at a point below ground where the soil is firm enough to give the pile side support. (See par. 156.)

b. Point bearing resistance. The strength of timber piles resting solidly on rock or other hard bearing surface is governed by the timber stresses. In all but the softest soils, point bearing on the soil under the pile provides some of the load resistance. In firm sand and gravel, the point resistance may exceed one-third of the total load resistance of timber piles. The remainder of the penetration load resistance is frictional force on the pile surface.

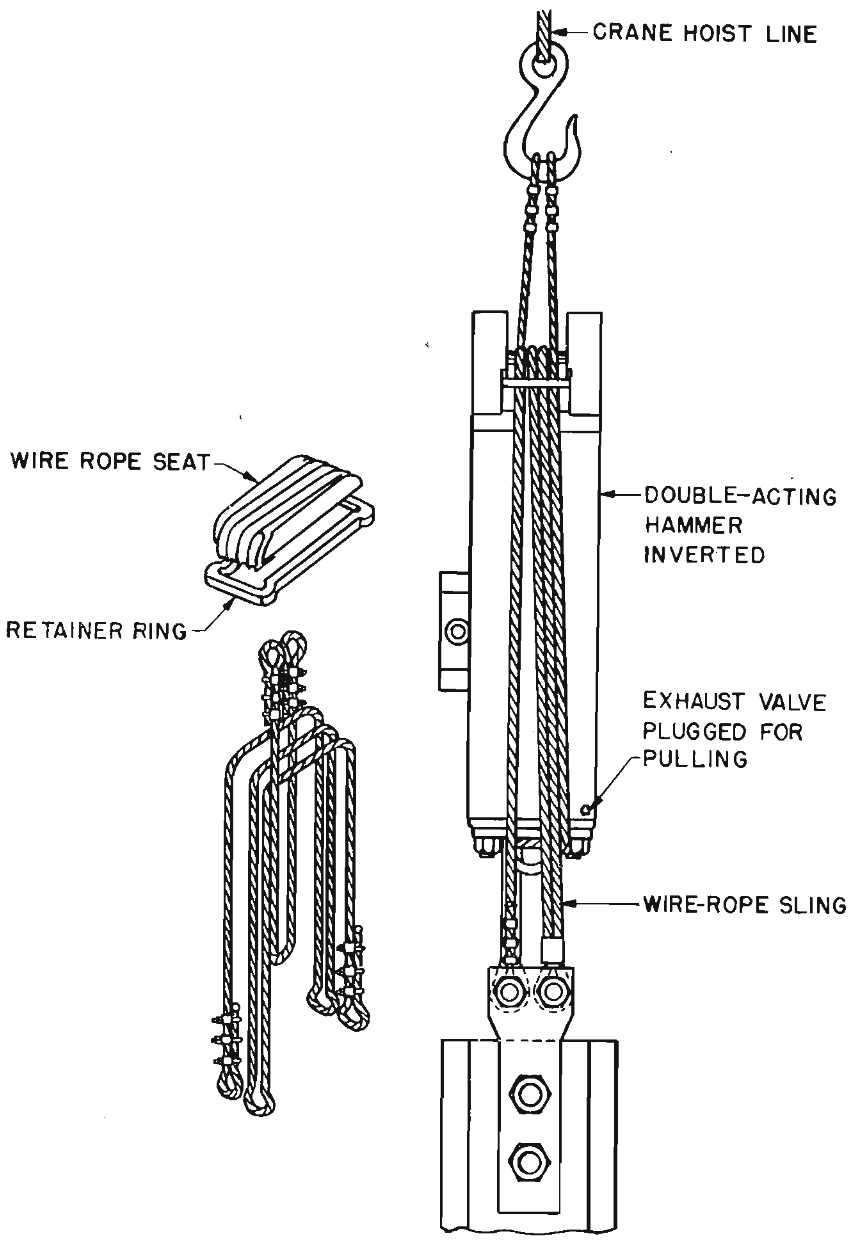


Figure 102. Wire-rope sling stream-pneumatic-hammer assembly used to pull piles. Exhaust valve must be plugged for pulling.

c. Frictional resistance. The load capacity determined by friction between the soil and the pile surface is proportionate to the circumference of the pile and to its penetration of the ground. The friction increases with increased grain size, good grading, and soil compaction; in fine grained soils, it decreases with increased soil moisture. For short penetrations in fine-grained soils, timber piles have greater frictional capacity than steel piles because of their greater displacement.

155. FRICTION BEARING-PILE CAPACITY. a. General. The capacity of friction bearing piles (defined in par. 143 (2)) is estimated by:

(1) Static friction based on penetration surface area and frictional resistance in similar soils. (See table XXVI.)

(2) Dynamic resistance based on driving energy. (See par. 155 c.)

b. Preliminary estimates. Before driving begins, the size and length of friction piles required are estimated as described in paragraph 83. The length of point-bearing piles is determined by depth to rock or other firm bearing material.

c. Estimation of pile capacity using driving data. (1) The following formulas are used to estimate the safe bearing-pile capacity from data obtained during driving. In bridge construction, each pile is driven until the average penetration per blow becomes less than that developing the required bearing capacity.

(*a*) Piles driven by drop hammer.

Timber pile .... $P = \frac{2\,Wd.h}{s + 1.0}$

Steel pile .... $P = \frac{3\,Wd.h}{s + 1.0}$

(*b*) Piles driven by single-acting pneumatic or steam hammer.

Timber pile .... $P = \frac{2\,Wr\,H}{s + 1.0}$

Steel pile .... $P = \frac{3\,Wr\,H}{s + 0.1}$

(*c*) Pile driven by double-acting pneumatic or steam hammer.

Timber pile .... $P = \frac{2\,E}{s + 0.1}$

Steel pile .... $P = \frac{3\,E}{s + 0.1}$

Symbols:

h = average height in feet of fall of drop hammer for last six blows.

H = stroke of ram in inches.

P = estimated safe load capacity in pounds per pile.

s = average pile penetration in inches per blow for the last 6 blows of drop hammer or last 20 blows of pneumatic or steam hammer. For small values of s the formula does not give consistent results. In that case, an average may be taken for several adjacent piles driven to approximately the same penetration. See subparagraph 149*b*(2).

Wd = weight of drop hammer in pounds.

Wr = weight of ram of steam or pneumatic hammer in pounds. (See Table XLIX).

E = driving energy in foot-pounds per blow of double-acting steam or pneumatic hammer, which may be estimated as follows:

	Strokes per minute	*Energy foot-pounds per blow*
5,000-lb. hammer	225	4,150
	195	3,720
	170	3,280
7,000-lb. hammer	140	8,200
	130	7,000
	120	5,940

(2) The formulas are subject to certain limitations and modifications.

(*a*) The capacity formulas are reliable for bearing piles which derive their support principally from skin friction in granular non-plastic soils, such as gravel, coarse-grained sand, and dry fine-grained sand. For piles driven into fine-grained silts, clays, and saturated fine sands, the formulas give values which are too conservative.

(*b*) Except in rare instances, bearing capacities of friction piles increase after driving. To determine whether or not soil conditions are such that the formulas apply, compare the average penetration per blow during the last six blows with the average penetration per blow after a 24-hour rest. If the penetration per blow after 24 hours is less than two-thirds the penetration when first driven, a soil condition is indicated for which the formulas give unnecessarily conservative values. The increase in bearing capacity after driving may make it possible to avoid splicing piles. If the required bearing capacity does not develop, drive a friction pile to nearly its full depth, allow it to stand 24 hours, and then check its capacity with at least 10 blows with a drop hammer or 30 blows with a steam-pneumatic hammer. Piles need not be spliced and driven deeper if the average penetration per blow on redriving is less than that required by the formula to give the needed bearing capacity.

(*c*) When jetting is used to aid driving, the formulas apply only if the pile is rested after jetting and then driven to final position without jetting. Data from the final driving is used in the formulas.

d. Static-load test. (1) *General.* Static-load tests can be used to estimate the capacity of piles driven in *any type soil* by *any driving method.* This is a reliable method but is slow and cumbersome.

(2) *Soil type limitations.* (*a*) Load testing of piles driven in granular non-plastic soils can begin immediately after driving.

(*b*) Piles driven in fine-grained silts, clays, and saturated fine sands must be allowed to *rest* at least 24 hours after driving before static-load testing is started. When piles are driven in these soils, the skin-friction resistance during driving is much less than the skin-friction resistance after a 24-hour *rest,* while the point-resistance is greater during driving than after a rest. This is because the compression of the material under the pile point during driving compacts the soil and squeezes water out of it. The water escaping upward along the sides of the pile lubricates it and reduces skin friction. During the *rest* the water seeps away from the pile into the adjacent soil and the earth settles against the pile, grips it, and develops skin friction.

(3) *Jetted piles.* Piles placed by jetting, or by both driving and jetting, are surrounded by a lubricating film of air and water. A 24-hour rest is required to allow the water to seep away from the pile and the earth to settle against it.

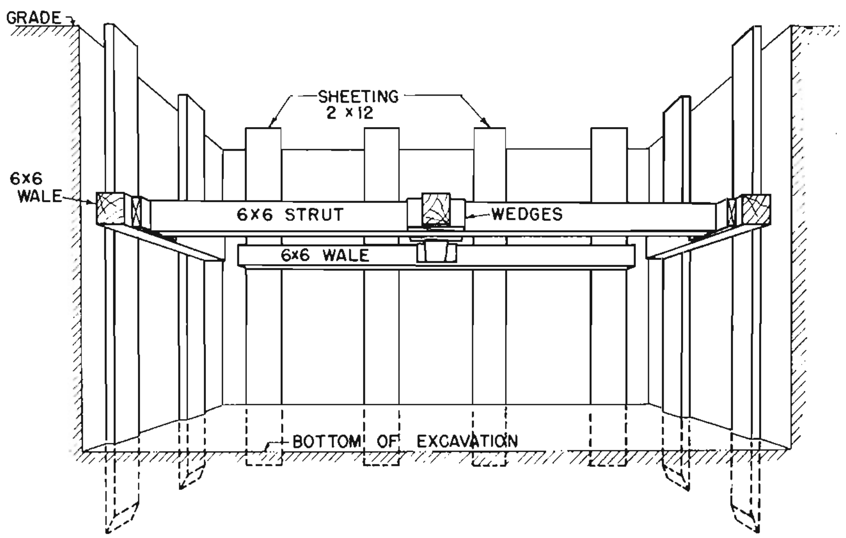
(4) *Testing methods.* A simple testing method is to build a platform on top of a pile and load it. Beginning with a load somewhat below the predicted safe load, weight is added and left for 48 hours. Meanwhile, careful

measurements of settlement and time are recorded. The maximum safe load per pile is one-half the total applied load which in 48 hours produces settlement of one-half inch, not including the initial settlement during and immediately after applying the load increment.

156. CAPACITY OF PILES ACTING AS COLUMNS. a. Capacity Formula. The capacity of timber piles acting as columns is determined by the column-stress formula for piles: $1000\left(1-\frac{L}{60d}\right)$ in which $\frac{L}{d}$ is the length to diameter ratio for the unbraced length of pile, and 1,000 psi the allowable working stress for continuously wet wood of the grade carried in depot stocks. This stress also governs for combined bending and compression.

b. Unbraced length. (1) The unbraced length of pile is taken as the longest distance between transverse or longitudinal braces, or from the lowest brace connection to a point slightly below ground where the soil is firm enough to give the pile side support (for well-consolidated soils, up to one-eighth the penetration).

(2) The maximum column loads for piles of 10-, 13-, and 16-inch diameter acting as columns are:



Excavation		Sheeting	Wales	Cross braces or struts			
Depth in feet	Kind of soil	(2- by 4-inch lumber) Type of construction	(4-foot spacing) Size in inches	Lumber size in inches — For trench width or unbraced length of 3 feet	6 feet	9 feet	Maximum longitudinal spacing in feet
5 to 10	Hard, compact	Open; spaced not over 8 feet	2 x 10	4 x 4	4 x 6	6 x 6	8
4 to 10	Soft, sandy	Close sheeting	4 x 6[1]	4 x 4	4 x 4	6 x 6	6
4 to 10	Hydrostatic pressure	Tongue-and-groove sheeting	6 x 8[1]	4 x 6	6 x 6	6 x 6	6

[1]Wales placed with larger dimension horizontal.

Figure 103. Bracing and sheeting excavations.

(1) Typical excavation in firm earth.
(2) Minimum sizes of timber.

Unbraced length (feet)	*Average diameter unbraced length of pile* 10 in. (tons)	13 in. (tons)	16 in. (tons)
10	(32)	....	....
20	(24)	....	....
30	16	(35)	....
40	8	(25)	(50)
50	....	15	(37)

Values with parenthesis are higher than used in these designs (par. 46).

157. PILE PENETRATION. Bearing piles must be driven at least 8 feet into firm ground and 15 to 20 feet into soft ground. Piles must be driven deeper if scour is probable.

158. SHEET PILING. a. Sheet piles are used to resist horizontal forces. Maximum depths are governed by the following: (1) Strength of sheet piles in bending and strength of interlock in cellular construction.

(2) Strength and spacing of wales in braced trenches and tied or braced cofferdams.

(3) Strength of struts between wales of inside-braced cofferdams.

(4) Strength of tie rods between outside wales in filled cofferdams.

b. The use of timber and steel sheet piles in typical cofferdam construction with safe spacing of supporting wales is shown in appendix II.

CHAPTER 13

FOUNDATIONS AND ABUTMENTS

Section I. GENERAL

159. SCOPE. a. This chapter describes methods of constructing the different types of foundations included in this manual. Two general types of foundations are considered:

(1) Pile foundations: bents, piers, footings, and abutments.

(2) Spread foundations: grillages, concrete pedestals, and abutments. Timber cribs and concrete or masonry piers are not included.

b. Driving bearing piles for foundations and abutments and sheet piles to protect foundation excavations is discussed in detail in chapter 12. However, bracing and capping of pile bents and piers is discussed in this chapter. General information on construction of foundations is given in FM 5–10.

c. Designs and construction procedures for foundations described in this manual should not be used in regions where permanently frozen ground (permafrost) exists. In permafrost, it is usually necessary to modify designs and construction normally used under other climatic conditions. (See TB 5–255–3.)

160. EXCAVATING. Excavations for footings and abutments of semi-permanent bridges are usually shallow. Excavating machines, power shovels, or draglines, can be used to advantage for preliminary grading. Finished excavations are usually made with hand tools.

a. Dry excavation. (1) In dry or moist soil, excavations to depths of 4 to 5 feet can usually be made without shoring or sheeting. Sides of the excavation are vertical if the ground is firm and has no tendency to cave or slide. In loose earth, sides of the excavation must be sloped.

(2) Deeper excavations, excavations at the foot of steep slopes, and excavations close to railway tracks or to areas heavily loaded by other foundations, must be shored or sheeted to prevent caving.

(*a*) Continuous sheeting need not be used in firm, stable, earth. Plank are set vertically at intervals not greater than 5 feet and are held by horizontal wales and struts. (See fig. 103.)

(*b*) In unstable or sandy soils, sheeting must be continuous. It is held by horizontal sets consisting of wales and struts framed to the size of the excavation. Vertical sheeting is driven around the outside of the sets as the excavation is deepened.

b. Cofferdam excavation. (1) *Cofferdams.* (*a*) Excavations through water or in saturated soil are made inside watertight cofferdams. Cofferdams are built by driving closely fitting or interlocking sheet piling or sheeting around timber wales framed to the dimensions of the excavation. Typical cofferdams and data for their design are given in appendix II.

(*b*) For cofferdams started on the ground, a shallow hole is dug. The wale frame is set in the excavated area and serves as a guide for driving the sheeting. For cofferdams started in the water, the wale frame is floated in place and guide piles or posts are driven to anchor the frame in position. The frame then serves as a guide for driving the sheeting.

(*c*) In shallow excavations, the sheeting may be driven to the full required depth before excavation is started. In deeper excavations, sheeting is driven until driving becomes difficult; the hole is then partially excavated, an additional set is placed if needed, and driving is resumed. The two operations are used alternately until the required depth of excavation is reached.

(*d*) Excavation in small cofferdams is usually done with hand tools, and the cofferdam must be unwatered while excavation proceeds. In sand, gravel, or other porous soil, the sheeting must be driven far enough ahead of the excavation to prevent large amounts of water flowing up through the bottom of the excavation. In tight silty soils or clay, the sheeting need be driven only enough to embed it firmly below bottom of excavation.

(2) *Unwatering cofferdams.* Cofferdams usually leak appreciably and pumping is necessary to remove the water. Portable low-head centrifugal pumps should be used. A strainer must always be used on the suction end to keep out trash and stones.

(*a*) The pneumatic sump pump (stock number 11–7468.5) having a capacity of 175 gpm at 25-foot head is best. Its operation requires 80 cubic feet of air per minute at 80 pounds pressure. This pump is suspended in a sump inside the cofferdam. It will continue to operate even when submerged.

(*b*) Gasoline-engine-driven pumps available in class IV supplies include a base-mounted centrifugal pump (stock number 11–4619.28) having a capacity of 166 gpm at 25-foot head, and a portable centrifugal pump (stock number 11–4619.24) having a capacity of 55 gpm at 50-foot head. The larger pump is usually needed, but the small pump will unwater small cofferdams in tight soils.

(*c*) Gasoline-engine-driven centrifugal pumps must be set outside the cofferdam to avoid danger from exhaust fumes. To reduce suction lift they should be set as low as possible. The suction hose should be set in a sump and be kept completely submerged to prevent the pump sucking air and losing its prime.

(3) *Control of leakage.* Leaks in walls of cofferdams are caused by poorly fitting, defective, and broken or split sheeting. Large leaks can be stopped by driving additional sheet piles behind the sheeting and by calking openings from inside the cofferdam. Small openings above the bottom can be stopped by sifting sand, cinders, or grain into the water close to the leak where it will be carried into the opening by the flow of water. Rapid unwatering of a cofferdam compacts the surrounding soil, reduces the flow of water through it, and causes small crevices to be filled with silt and sand.

c. Size of excavation. (1) Excavations in firm soil for concrete foundations having vertical sides can be made the size of the foundation. Sides are cut to line and squared, and the concrete is placed without forms.

(2) Cofferdams for wet excavations are made with 1-foot or more clearance between concrete forms and sheeting on all sides. Water leaking into the cofferdam can be pumped out of this space before it damages fresh concrete.

161. CONCRETE. a. Use. Concrete is used without reinforcing in pedestals and abutments of semipermanent bridges. It is preferably used only where water can be excluded from the forms. Placing of concrete under water should be done only when experienced personnel are available.

b. References. See paragraph 43 for quality of concrete required. See chapter 9, TM 5–226, for detailed information on concrete form construction.

c. Equipment. (1) The 14-cubic-foot trailer-mounted concrete mixer furnished to construction units mixes from 12 to 15 cubic yards of concrete per hour. This capacity is ample for pouring foundations of semipermanent bridges, the largest of which contains approximately 35 cubic yards of concrete.

(2) Materials are stock-piled close to the mixer and are delivered to it in wheelbarrows. Five wheelbarrows are needed to handle materials, two for fine aggregate and three for coarse aggregate. Six to eight wheelbarrows should be provided to deliver mixed concrete to the forms.

(3) Seven to eight gallons of mixing water are required per minute. It can be pumped to the mixer or can be delivered in tanks by truck.

d. Anchor bolts in concrete. Anchor bolts embedded in concrete must be accurately set with wood templates held by timber frames nailed to the forms. They should be set before concrete is placed and their position checked immediately before and after placing the concrete. Anchor bolts must not be driven into the concrete after it is placed.

e. Steel reinforcement. The concrete designs in this manual do not require reinforcing steel. However, the advantages of steel reinforcement warrant the use of available scrap material such as wire mesh, fencing, or salvaged Sommerfeld or bar-and-rod type landing mat to strengthen abutment bulkheads and concrete pedestals. In bulkheads, reinforcement should be near the rear face and extending well below the bridge seat. In concrete pedestals on piles, horizontal reinforcement should be placed both ways near the top of piles.

162. BACKFILL AND GRADING. a. Footings and grillages must be backfilled to prevent the ponding of water around the footing and consequent softening of the foundation material.

b. Backfill should be placed in uniform, horizontal layers of not more than 6 to 12 inches, and each layer should be thoroughly compacted with hand or pneumatic tampers (stock number 66–8425.5). After backfilling, the ground surface should be graded so surface water will be carried away from the footing.

Section II. FOUNDATIONS

163. PILE BENTS. Pile bents are not usually braced and capped by the pile-driver crew. When the pile-driver rig is advanced over the structure, a crew lays stringers and sufficient flooring for pile-driving equipment.

a. Timber pile bents (fig. 1). Where piles are not driven to exact position, they must be pulled into place and aligned with tackle and aligning frame (fig. 105) before the bent can be braced and capped.

(1) After the piles are drawn into position, planks are spiked at the correct elevation to guide the saw in cutting off the piles (fig. 104); the piles are cut off either with a two-man crosscut saw or with a power chain saw; the cap timber is put in place; holes for driftbolts are bored through the cap and into the head of the pile; and the driftbolts are driven.

(2) After the bent is capped, guides and aligning frame are removed, bracing is nailed into place, holes are bored through bracing and piles, and bolts are inserted to complete the bent. Preboring of piles, cap, and bracing

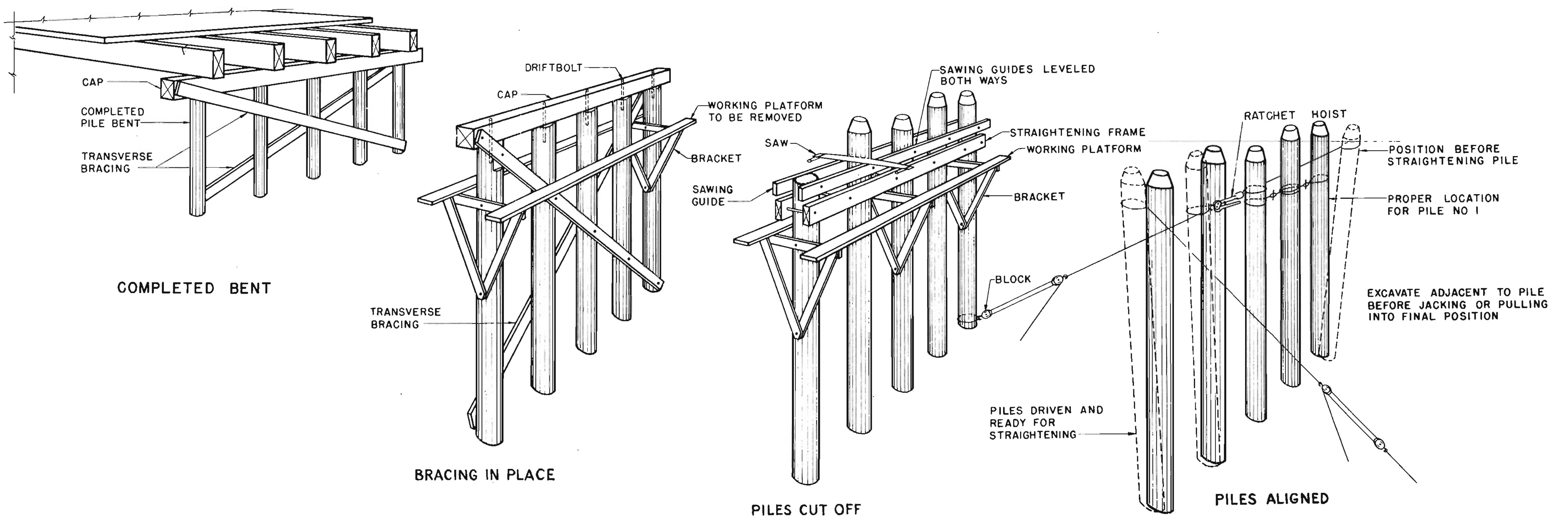


Figure 104. Aligning timber piles and successive steps in completing pile bents.

is not practical because of variations in shape, size, and spacing of piles. Methods of dapping and blocking to compensate for differences in size of piles are shown in figure 106.

(1) Bracing on face of larger piles, filler blocks used on smaller piles.

(2) Bracing face of smaller piles, larger piles dapped.

(3) Bracing pulled against all piles, no blocking or dapping.

b. Steel pile bents (fig. 3). Steel piles in bents must be driven so their webs are parallel with bridge center line. If not, piles must be rotated as well as aligned before they can be capped and braced. To draw piles into position, tackle, jacks, and timber frames are used as shown in figure 107.

(1) *Capping.* Caps are bolted, riveted, or welded to piles. Bolting with standard machine bolts is preferred, since inaccuracies in connections can be best compensated by this method.

(*a*) *Bolted connections.* After caps have been assembled with their diaphragms and drilled for connections, they should be set in place on the piles and held by clamps or on blocking from the straightening frame. Holes are then drilled or burned and reamed. Piles are marked and are cut off with an oxyacetylene torch. Bolts are inserted and tightened.

(*b*) *Welded connections.* These are made with the cap bolted or clamped in place and supported from the straightening frame.

(2) *Bracing.* (*a*) Irregularities in the positioning of piles makes it impractical to prebore holes, either in bracing or in piles. Welded bracing connections are preferred to bolted or riveted connections.

(*b*) After caps have been connected, bracing is raised to position and held with clamps. Holes for bolts or rivets are drilled or the connections are welded.

164. PILE PIERS (fig. 5). After individual bents are completed, jacks or tackle are used to draw them to correct spacing and to parallel alignment. Longitudinal corbels and bracing are installed to complete the pier.

165. SILLS ON TIMBER PILES (fig. 8 (1)). In driving piles to carry sills, particular care must be used to drive piles in correct alignment. They usually do not project enough above ground line to permit them to be aligned after driving.

166. STEEL FRAMES ON STEEL PILES (fig. 20 (1)). **a.** Piles to be capped with steel frames must be accurately driven. For this reason timber guide frames are used. Steel frames are prefabricated but are not assembled for erection.

b. Piles are prepared for frames and frames are set in the following sequence:

(1) Piles are cut off at correct elevation and flanges are cut (coped) as required for attachment of steel frame.

(2) Cross beams are set and held in place with clamps while holes for their connection are drilled in piles.

(3) Fitting-up bolts are inserted and drawn tight.

(4) Cross diaphragms between beams are set and are bolted with fitting-up bolts.

(5) End angles between piles are set and held in place with clamps while holes for their connection are drilled.

(6) Final connection of all parts is made with machine bolts, rivets, or structural ribbed bolts.

c. After all parts of the four tower foundation frames are completed, the center of each tower column is carefully determined. From these centers, holes for anchor bolts are marked and drilled or burned.

167. CONCRETE PEDESTALS ON PILES (fig. 9 (1)). The pedestals of pile-supported concrete pedestal footings are normally at ground level. However, when piles are in water the concrete pedestals are built above water. Butts of piles should be either thoroughly saturated before concrete is placed or should be sealed against water.

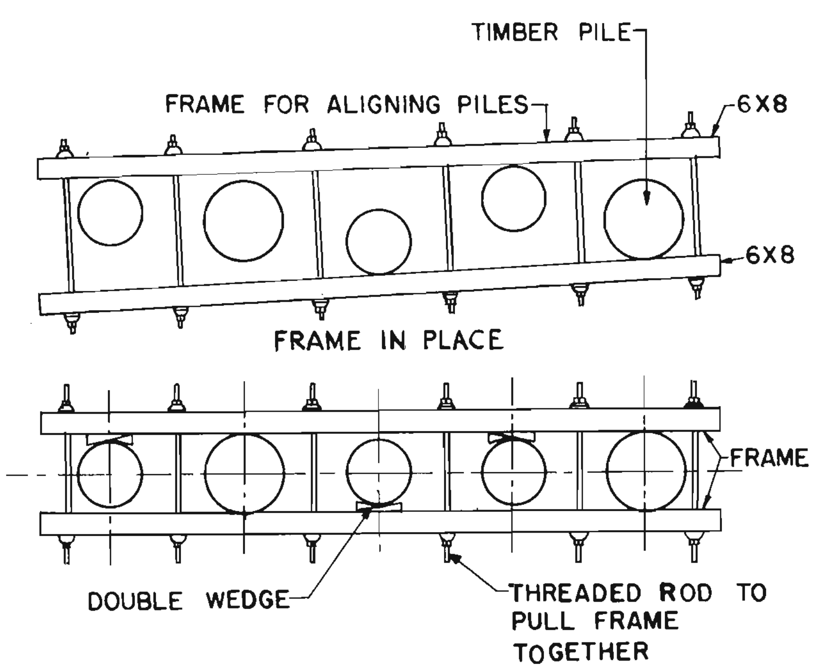
a. Pedestals in soil (fig. 20 (2)). The bottoms of concrete pedestals must be set below the frost line usually from 3 to 5 feet deep, depending on climatic conditions. After piles are driven, the bottom of the pedestal excavation is leveled, piles are cut off at the correct elevation, forms are built, and concrete is poured. If the bottom of the excavation is soft, a bed of sand or gravel is laid before the concrete is placed.

b. Pedestals over water (fig. 20 (3)). When placing concrete pedestals over water, timber sills are bolted to the piles and a platform somewhat larger than the pedestal is built on them at the level of bottom of pedestal. Piles are then cut off at correct elevation, forms are constructed on the platforms, and concrete is placed.

168. BRACING PILES BELOW WATER. Foundation piling should not have unbraced lengths from firm ground up to bottom of sills, pedestals, or transverse bracing greater than given in paragraph 10. Underwater lateral support can be provided by wire-rope bracing or riprap.

a. Wire-rope bracing. Piles of bents and piers are braced below water with wire-rope guys connected as shown in figures 108 and 109. Guys must be tight to be effective. The section braced with wire rope should not be more than 12 to 15 feet high.

(1) *Guys on wood piles.* To install guys on wood piles, two turns in the middle of the guy rope are taken around the outside pile of the bent and are pushed down to the bottom with a pole. One end of the line is looped twice around the pile at the other end of the bent above waterline. A pull-jack or turnbuckle is used to draw the line tight and the two ends of the guy rope



FRAME TIGHTENED, PILES IN POSITION

Figure 105. Aligning frame to draw timber piles into position for capping.

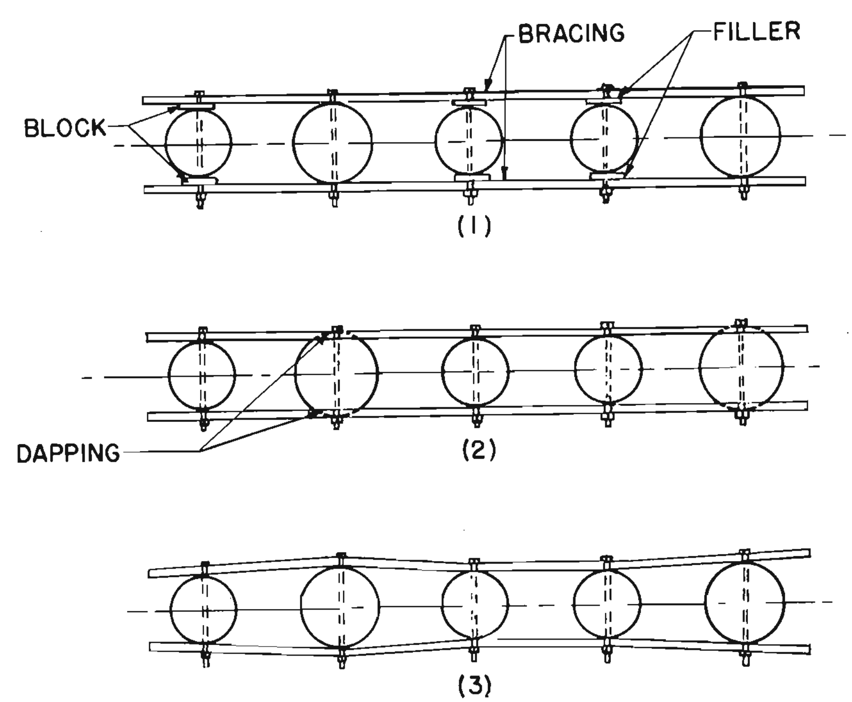


Figure 106. Methods of blocking and dapping piles for bracing to compensate for different size piles.

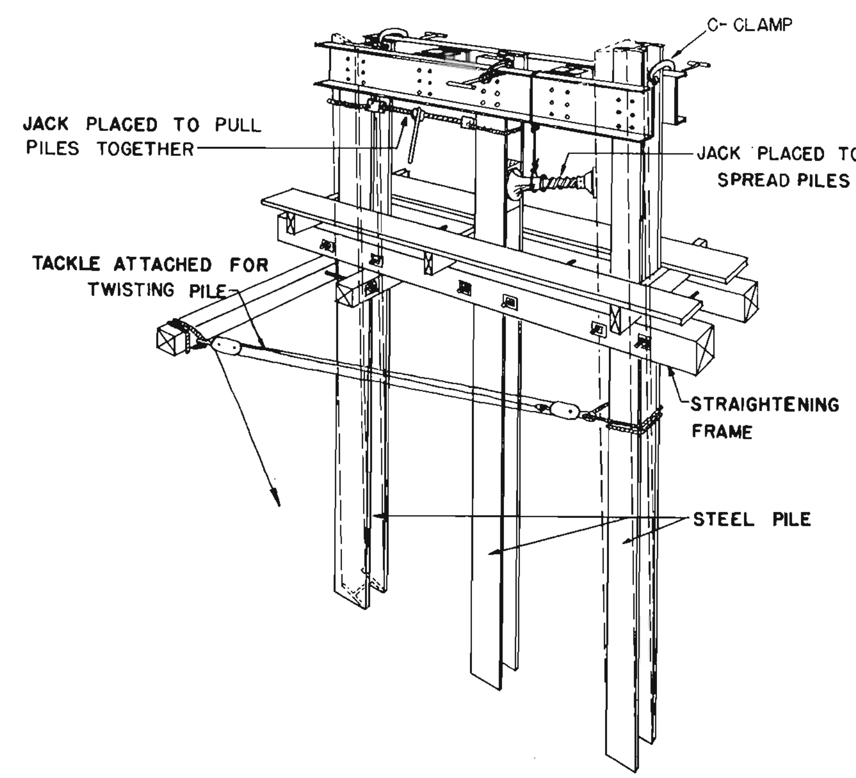


Figure 107. Pulling steel piles into position before drilling to connect cap and bracing.

are connected. Guy ropes are ½-inch galvanized wire rope and are connected with galvanized wire-rope clips.

(2) *Guys on steel piles.* Before the pile is completely driven, two wire ropes are connected to the pile through holes drilled or burned in each flange. The wire ropes are lashed to the pile, and the pile is driven to final position, the lower ends of the wire ropes being near stream-bed level. Lashing is removed, and the free end of each guy is threaded through a hole burned or drilled in upper end of the pile at the opposite end of the bent. The guy rope is then drawn tight and wire-rope clips installed. Guys on steel piles are placed in paris connecting into each flange of the pile. Guy ropes are ½-inch galvanized wire rope connected at each end with three ½-inch galvanized wire-rope clips.

b. Riprap. Riprap placed around foundation piles protects against scour and gives lateral support to the piles. (See fig. 20 (3).) Riprap must be deposited in uniform horizontal layers so piles will not be forced out of position. Side slopes of riprap should not be steeper than 1½ to 1.

(1) *Stone riprap.* Stones, concrete, or masonry in pieces weighing 50 to 100 pounds are used if available. Irregular pieces stay in place better than rounded stones. Stones weighing less than 50 pounds should not be used for riprap.

(2) *Sacked concrete riprap.* Sacked concrete can also be used as riprap. Cloth cement sacks or burlap bags of 1- to 2-cubic foot capacity are filled about two-thirds full, securely tied, and placed before the concrete sets. A 1-to-6 mix concrete using local sand or sandy soil for aggregate is satisfactory.

169. CONCRETE PEDESTALS ON GROUND. **a.** Concrete pedestals are set at least 3 feet below ground surface. They are set lower if necessary to:

(1) Reach firm soil having adequate bearing capacity.

(2) Protect from frost action in cold climates.

b. If excavation is carried deeper than intended, it must not be filled in with earth. Backfill is made with well tamped, selected, well graded sand and gravel, or concrete is used and the thickness of the pedestal is increased accordingly.

170. GRILLAGES. **a. Bedding.** To avoid uneven settlement, grillages must be carefully bedded and set. They must not be placed on loose, plastic, or nonuniform soil, nor on frost-bearing ground.

(1) To secure even bedding, grade stakes are set at each corner of the grillage excavation. From these the ground is carefully leveled, using a straightedge and carpenter's level. High points over the area are removed with shallow cuts. Low areas are filled and the soil firmly tamped.

(2) Tamping is done with a hand tamper; pneumatic tampers should not be used. Water can be used sparingly to aid in compacting loose, dry soil but the bed must not be muddy. Sand or fine gravel can be used to fill low spots in the surface.

(3) Where soil conditions are unsatisfactory, the ground below the grillage is excavated to uniform, firm soil below frost line, drainage outlets are installed, and excavation is backfilled with select material well-compacted.

b. Timber grillages. (fig. 10 (1)). Grillage timbers are placed one by one on the prepared bed. Each timber should be firmly bedded and the top surface of the first course leveled before placing the second course. Holes for driftbolts are then drilled and driftbolts driven to hold the two courses together.

c. Steel grillages (fig. 14). Steel grillages are usually assembled in the

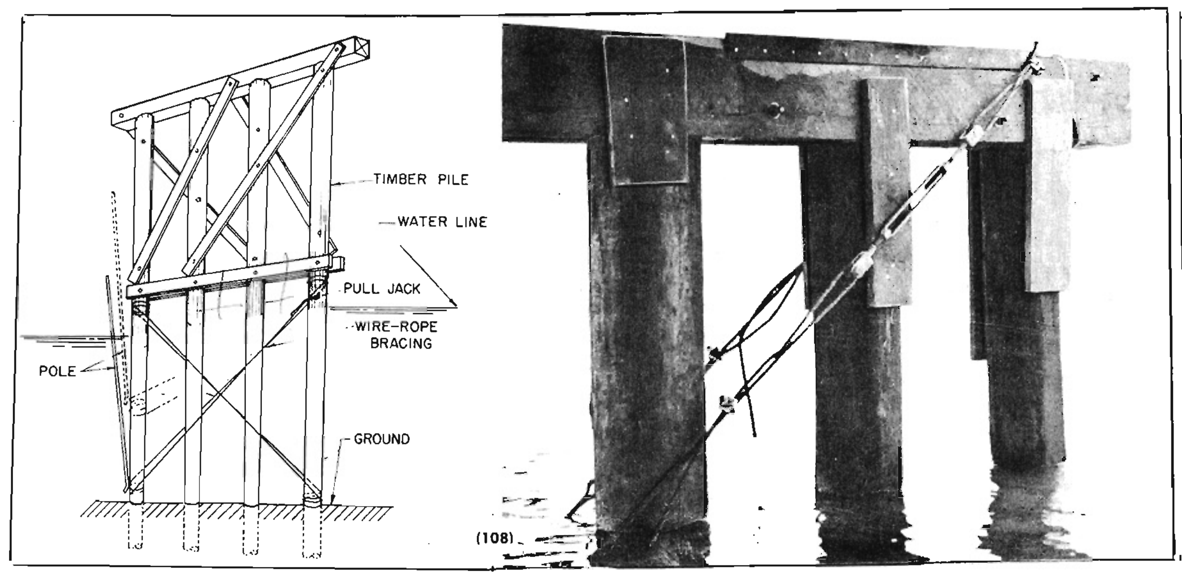


Figure 108. Method of attaching wire-rope guys to brace timber piles below water.

(1) Arrangement of guys on bent.

(2) Guys in place, tightened with turnbuckle.

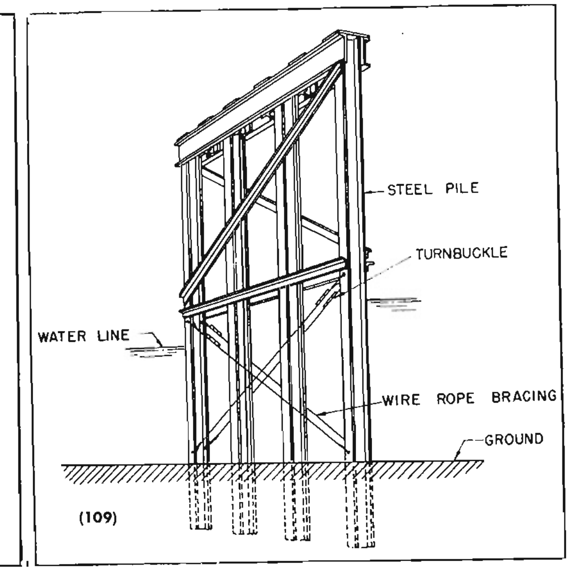


Figure 109. Method of attaching wire-rope guys to brace steel piles below water.

fabrication yard and set as a unit. Because of their weight, they must be handled by a crane. They must be set exactly to permit correct placement of tower columns. Grillages may be set in a concrete bedding to obtain full uniform bearing.

171. FOUNDATIONS ON ROCK. Where foundations are on solid rock, no grillages are required. Column bearing plates are set on the rock after leveling the bearing area with grout or concrete. Anchor bolts are set in drilled holes and are cemented in place with grout.

Section III. ABUTMENTS

172. PILE ABUTMENTS. **a.** Pile abutments consist of one or two rows of timber or steel piles capped to form a seat for stringers of the end span, and a timber and pile bulkhead (end dam) to retain the approach embankment. See sheet 21 for details of a typical pile abutment.

b. Procedure for construction of pile abutments is as follows:

(1) Piles are driven and are cut off at correct elevations.

(2) Bearing piles are capped and posts to support the bulkhead are bolted to the piles.

(3) Horizontal planks of the bulkhead are nailed to the posts and ends are cut square.

c. After the bulkhead is built, the approach embankment is extended to the abutment and allowed to spill past the ends of the bulkhead. Fill against the bulkhead must be well compacted.

173. TIMBER-GRILLAGE ABUTMENTS. **a.** Timber-grillage abutments consist of vertical posts set on a timber grillage. These are capped to form a seat for the stringers of the end span. The bulkhead is supported by the posts which are anchored by guy ropes to deadmen under approach fill. For low abutments, the posts are omitted and the cap supporting the stringers rests directly on the grillage. See sheet 22 for details of a typical timber-grillage abutment.

b. Procedure for construction of a timber-grillage abutment is as follows:

(1) The grillage is assembled and set as a unit.

(2) Posts, cap, and bulkhead timbers are framed, assembled, and set on the grillage.

(3) Posts and backwall are braced away from the bridge at a slight batter, not over 1 in 12.

(4) Wire-rope guys are attached to the posts with wire-rope clips, anchored to deadmen under the approach fill, and tightened.

(5) The approach fill is placed against the backwall in well-tamped layers. When enough fill is placed to keep the backwall from overturning, the temporary bracing is removed. As additional fill is placed, posts and backwall will be forced to correct vertical position.

174. CONCRETE ABUTMENTS. **a.** Principal operations required for construction of concrete abutments are covered in section I. The rules in paragraph 169 for concrete pedestals apply also to abutments. See sheet 27 for details of a typical concrete abutment.

b. Abutment concrete should be placed without construction joints. Under no condition should a construction joint be made at the top of the bridge seat unless steel dowels are provided to connect the backwall with the concrete below.

c. Abutments should not be backfilled until the concrete has attained ample strength. At least 5 days should be allowed when using standard Portland cement concrete and 2 days when using high early-strength concrete. The top of the backwall should be protected with timbers during construction of the entire bridge. The wheels of heavily loaded construction vehicles should not be permitted close to the backwall, except on planking heavy enough to carry their load well back on the embankment.

CHAPTER 14

ERECTION PLANNING AND EQUIPMENT

Section I. ERECTION PLANNING

175. GENERAL. Erection procedure is determined by the type and size of bridge, the site the skill and experience of personnel, and the capacity of available equipment.

176. SELECTION OF PROCEDURE. **a.** Step-by-step erection procedure must be developed. The speed of erection depends on the ingenuity of the officer in charge of construction. Larger bridges and difficult erection problems require accurate and detailed planning, including:

(1) Sketches of positions of equipment.

(2) Plotting of reach and lifting capacity of equipment in each position.

(3) Tabulation of weights of parts to be erected.

b. Sound procedure results in:

(1) Quick erection with a minimum of special equipment and labor, least chance of delay through accident or mishandling, and least risk to men and equipment.

(2) Delivery of materials or assemblies within reach of equipment.

(3) Employment of forces in separate groups not concentrated on one task or at one piece of equipment.

(4) Firm footing and ample working room for all operations.

c. Suggested methods of erecting structures of different types, heights, and span lengths under different site conditions, and detailed procedure for erecting typical units are given in chapter 16. Expedient erection of large structures may require combining two or more of the methods described, each being used to erect that part of the structure to which it is best adapted.

177. CHARACTERISTICS OF SITE. **a.** Characteristics of a bridge site are controlling factors in determining general layout, span lengths, and height of supporting towers or bents. These, in turn, are primary factors in determining erection procedure.

b. Condition of approaches and their location with respect to the existing road net determine whether erection can be carried on from one or both ends of the structure and whether materials must be delivered to one or both approaches at deck level or to the ground or water below.

c. A firm, gently sloping bank permits free use of equipment and free conduct of operations on the ground. Soft or steep banks require erection from overhead or from falsework. A wide waterway may require using floating equipment.

178. SKILL OF PERSONNEL. **a. General.** The skill and experience of available troops must be considered in developing procedure, particularly for difficult erection problems. Ability to handle equipment expertly and safely under maximum loads, knowledge of precautions necessary in handling heavy loads, and ability to anticipate contingencies are gained only through experience.

b. Crane operators. Able crane and machine operators judge the speed with which capacity loads can be raised, lowered, or swung by the feel of their equipment; this ability can be gained only through experience. If skilled operators are not available, procedure should be planned to avoid handling erection parts near the capacity or maximum reach of erection equipment.

c. Riggers. If the men are unaccustomed to working above ground, the number of connections to be made during erection should be reduced to a minimum by assembling parts on the ground and erecting them as units.

d. Welders. (1) Highly skilled welders are required for erection welding. They must have passed qualification tests for welds of horizontal and vertical position. (See par. 124 and fig. 65.)

(2) Welding main-member splices and connections during erection is not recommended. Secondary members, bracing, and fittings, which are less important to the safety of the bridge can be welded in place.

179. CAPACITY OF EQUIPMENT. Each principal member and subassembly must be examined to determine whether its erection is within the reach and safe load capacity of available equipment. If not, erection procedure must be modified or special equipment provided. Safe load capacities of standard truck-mounted and crawler-mounted cranes are given in tables LXXXII and LXXXIII. These data are used in determining construction schemes. *Before handling loads near the maximum capacities, each crane or rig should be tested at the site since counterweights and construction may vary for equipment of one model.*

Section II. EQUIPMENT

180. HAND TOOLS. Tools required to erect typical semipermanent bridge units are listed in table XXXI. This table does not include hand tools regularly issued to engineer squads and platoons. Figure 110 shows special tools required for erecting steel bridges.

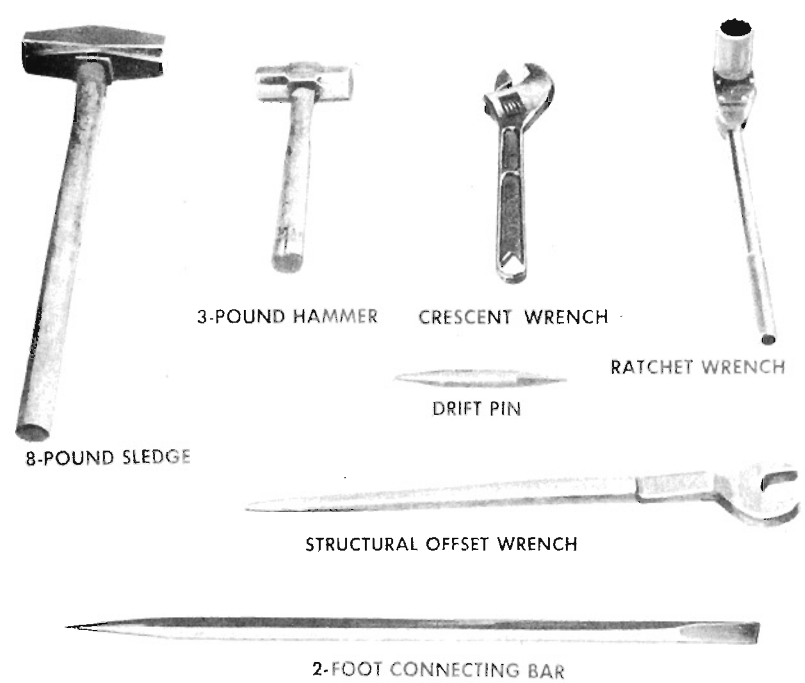


Figure 110. Hand tools used in erecting steel bridges.

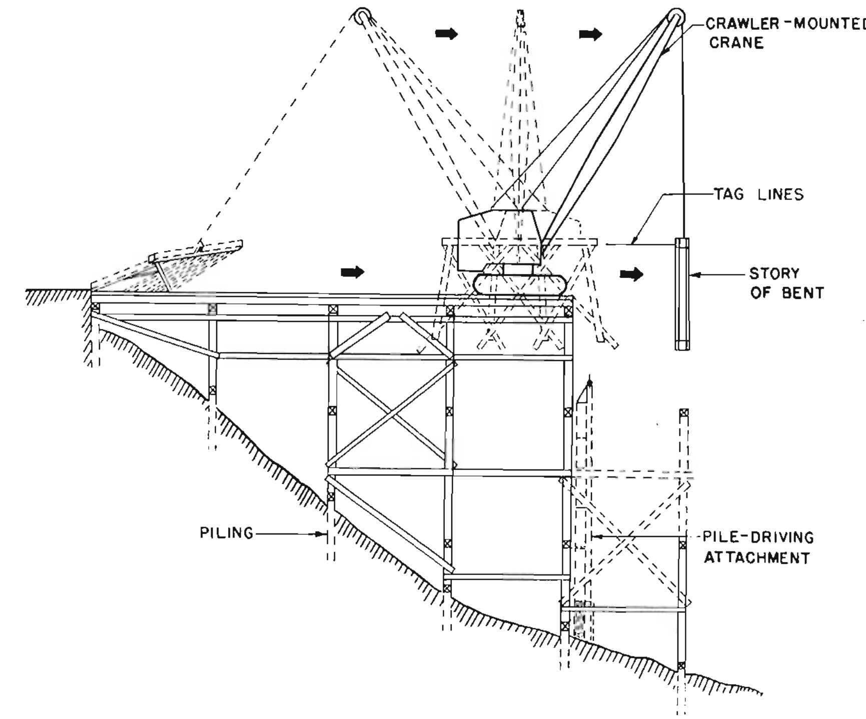


Figure 111. Crawler-mounted crane operating from deck of bridge to drive piles and erect timber towers within reach of crane.

181. RIGGING. **a.** Rigging instructions given in TM 5–225 cover use of lines and tackle and of gin poles and shears.

b. Capacity of gin poles and shears of moderate height and reach is usually determined by the strength of guys and their anchorage. For the higher lifts and greater reaches often required in bridge erection, the strength of spars becomes the controlling factor in determining capacity.

c. Stresses in guys and spars for different inclinations of each are shown in table LXXIV. Safe stresses in round and square spars of varying lengths are given in table LXXIII. Safe load capacities of wire rope and cordage are obtained from tables LXII, LXIII, and LXIV.

182. CRANES. Truck- and crawler-mounted cranes are preferred for erecting semipermanent bridges. They can be used to extend construction by moving out over the successively completed spans (fig. 111) or, if conditions permit, they can work from the ground. (See fig. 112.) Timber mats can be used to operate cranes over soft ground. For work over water they can be placed on a raft or barge. When operating from floating equipment, the raft or barge must be large enough to support the machine and its load without losing stability. Booms of the standard cranes are sectional and can be extended to raise loads to considerable heights.

a. Truck-mounted cranes. (1) Truck-mounted cranes are suitable for erecting structures of moderate span; on larger bridges they are used principally to handle parts behind the main erection units and to supplement fixed or less mobile equipment. For details see chapter 16.

(2) Truck-mounted cranes are highly mobile but require a firm level base for their operation; they should not be used on rough or soft ground.

(3) Outriggers give stability when handling heavy loads. (See fig. 113.) They may not increase the capacity of the crane to handle end loads but they

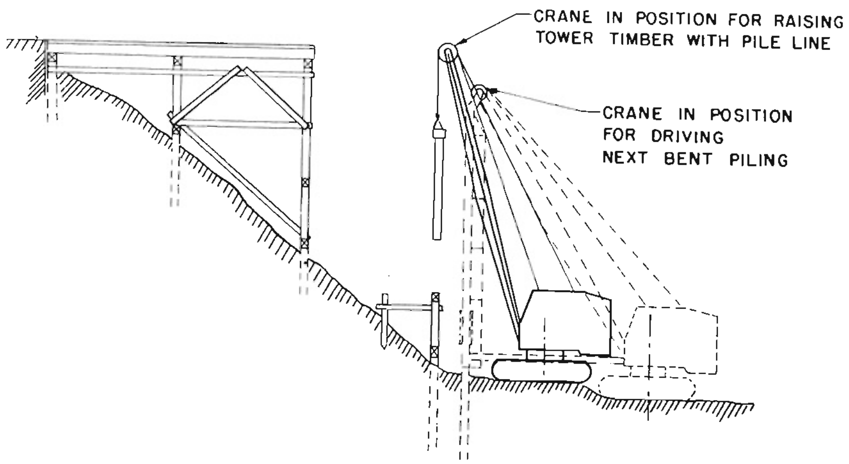


Figure 112. Crawler-mounted crane operating from ground to drive piles and erect timber towers.

always permit handling heavier side loads. Outriggers for the ⅜-cubic yard trucks are obtained from depots.

b. Crawler-mounted cranes. (1) Crawler-mounted cranes and crawler-mounted shovels with crane-boom attachments are available to engineer troops in capacities from ⅜ to 2 cubic yards. (See table LXXXIII.)

(2) They are less mobile than truck-mounted cranes but can maneuver easily and are better suited to erection use.

(3) They can be operated over rough ground, ground too soft to support truck-mounted equipment, and, if the bottom is firm, in water deep enough to cover their crawlers.

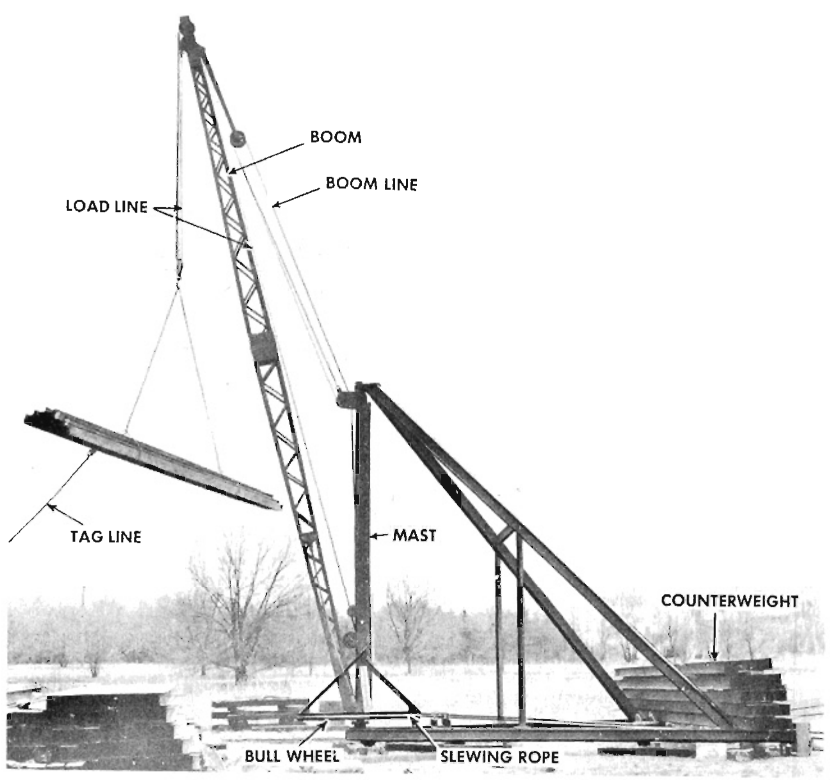


Figure 114. Four-ton stiff-leg derrick. Hoist is not in view.

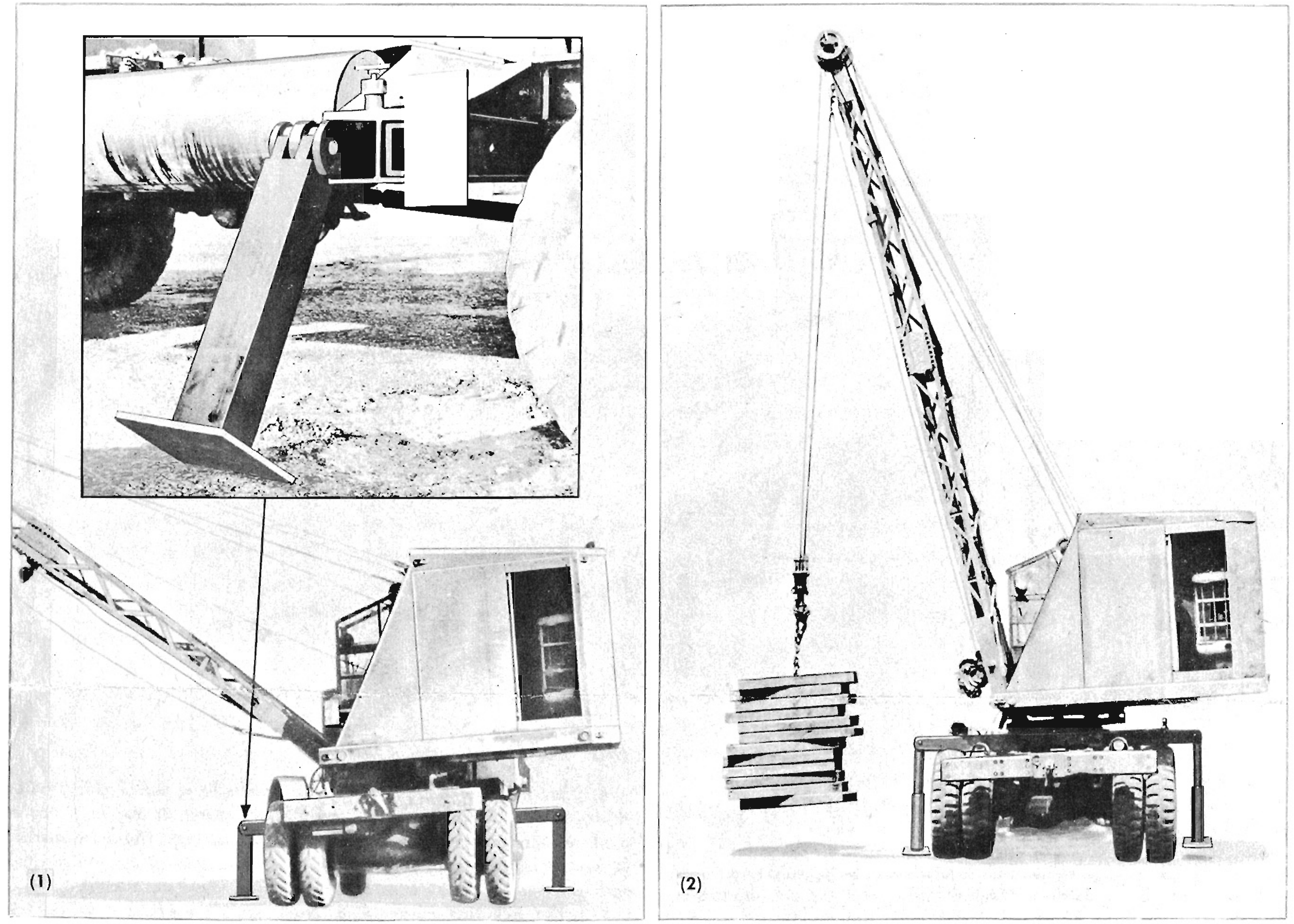


Figure 113. Truck-mounted ⅜-cubic yard crane with outriggers lifting test load over the side. Insert shows outrigger details. Outriggers are obtained from depots and installed in the field.

(1) Coleman truck-mounted crane.

(2) Brockway truck-mounted crane.

183. DERRICKS. Two types of derricks are ordinarily used in semipermanent bridge construction. Their use is not economical unless continued operations are carried on within reach of their booms.

a. Guy derrick. (1) A guy derrick consists of a mast, a boom pivoted at the foot of the mast, and guys and tackle. If the guy lines to the top of the mast clear the end of the boom, the boom can be swung through a full circle. Loads are moved by hand hoist or by engine-driven hoist.

(2) Details of a guy derrick designed for erection of high timber towers are shown on sheets 232 to 234 inclusive. Boom and mast of this derrick can be made of materials used later in the bridge. Special parts can be made in the field.

b. Stiff-leg derrick. (1) The mast of a stiff-leg derrick (fig. 114) is held in a vertical position by two inclined struts connected to the top of the mast. The struts are spread apart 60° to 90° to provide support in two directions and are attached to sills extended from the bottom of the mast. The mast and boom swing through an arc of about 270°.

(2) Steel derricks of the stiff-leg type are available to engineer troops in two sizes: 4-ton rated capacity at 28-foot radius, and 30-ton rated capacity at 38-foot radius when properly counterweighted. Both derricks are erected on fixed bases. Their adaptability to bridge construction is limited by their weight, dimensions, and immobility.

(*a*) The 4-ton derrick including a skid-mounted two-drum gasoline-engine-

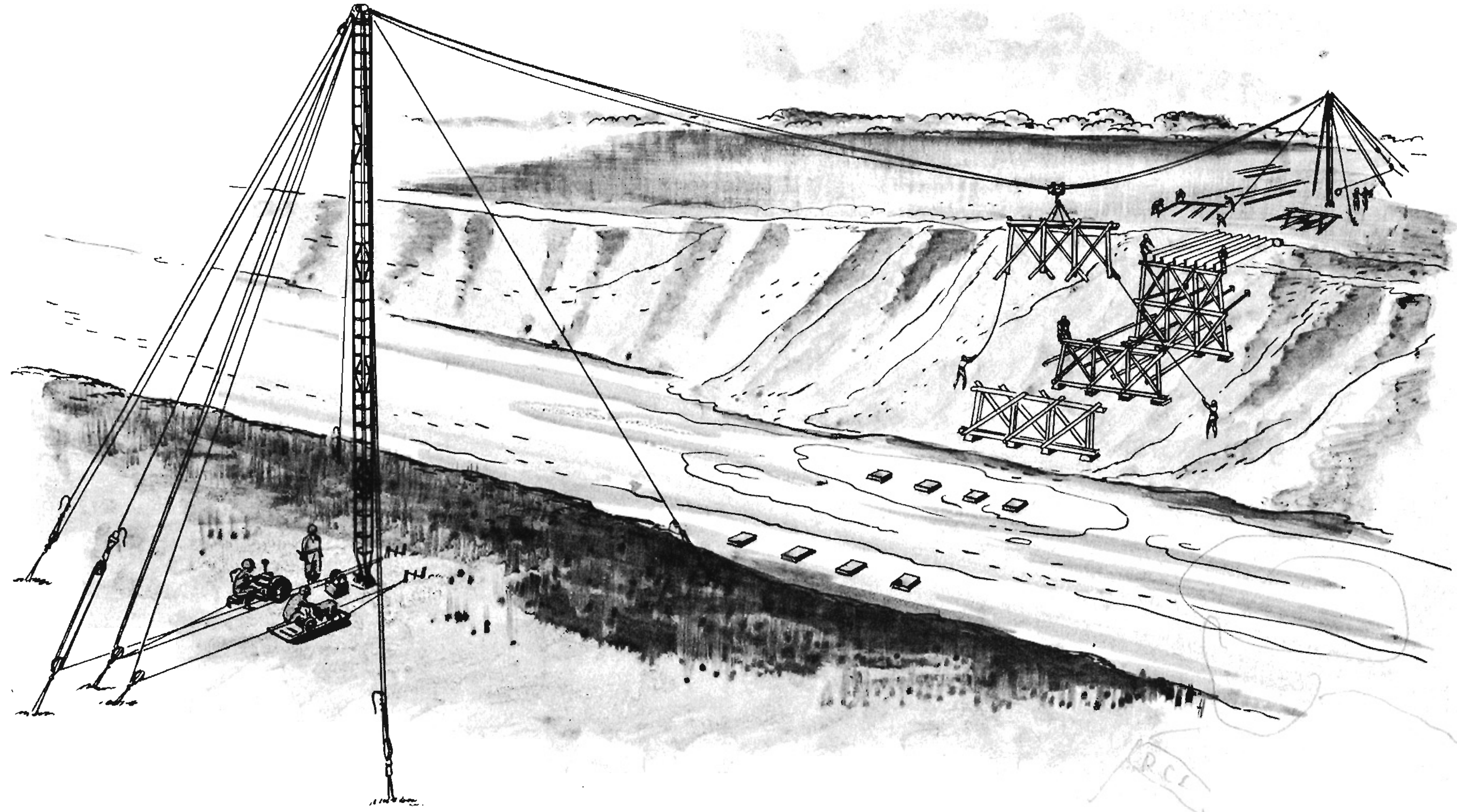


Figure 115. Medium cableway in position over bridge center line for erection of bridge.

driven hoist weighs 7 tons and occupies a space 22 feet square.

(*b*) The 30-ton derrick including a skid-mounted two-drum hoist weighs approximately 22 tons and occupies a space 29 feet square.

Note. When used on the deck of double-lane bridges, these derricks must be moved on rollers. Derricks on single lane and railway bridges must be supported by outriggers.

c. Field-constructed derricks. Lashed stiff-leg and guy-mast derricks are described in TM 5–225. These and similar derricks often serve some special use in bridge construction. However, they must be seated on a fixed base or on a skid frame.

184. CABLEWAYS. a. The medium cableway (fig. 115), developed for military operations, can be used effectively for erecting timber and steel towers and for launching light stringers. The maximum cableway span is 1,200 feet, the cableway tower height 63 feet, rated capacity 3,000 pounds, and maximum hook load with caution 4,000 pounds. It can be installed in 6 hours by trained engineer troops. It weighs 20,000 pounds and is transported on four trucks.

b. The cableway should be installed with the base of cableway towers approximately at grade and on the bridge center line. For detailed information, see Technical Manuals on this equipment.

185. HOISTS. Hoists are of two principal types, drum hoists, including winches and crab hoists, and chain hoists.

a. Drum hoists. A drum hoist consists essentially of one or more winding drums, a train of reducing gears, and a power source. It may carry one or more winch or capstan heads for handling secondary lines. Hoists are attached to construction equipment of many types either as an essential part of a machine such as a crane or derrick or as an attachment on trucks and tractors.

(1) The following power-driven drum hoists are available to engineer troops.

Power	*Number of drums*	*Capacity in tons*
Diesel	2	6
Gasoline (fig. 116)	2	4
Pneumatic (fig. 117)	1	1

(2) Single-drum hand winches of 2-, 5- and 15-ton capacities are available as class IV equipment. (See fig. 118.) A winch arranged for attachment to a boom or mast is called a crab hoist. Winches are used principally to operate gin poles, shears, and derricks.

b. Chain hoists. Chain hoists (fig. 119) are used for raising and holding loads and are particularly useful when accurate placing or adjustment of loads is required. They are of two types: differential chain hoists available in capacities of 1 to 5 tons, and ratchet chain hoists in capacities of 1½ to 4½ tons.

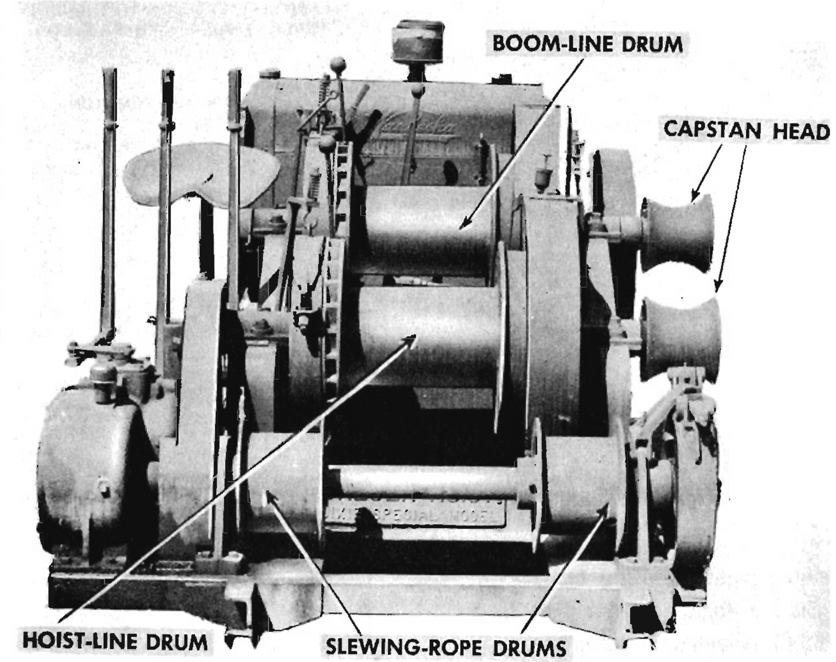


Figure 116. Gasoline-engine-driven hoist, double-drum, 4-ton capacity.

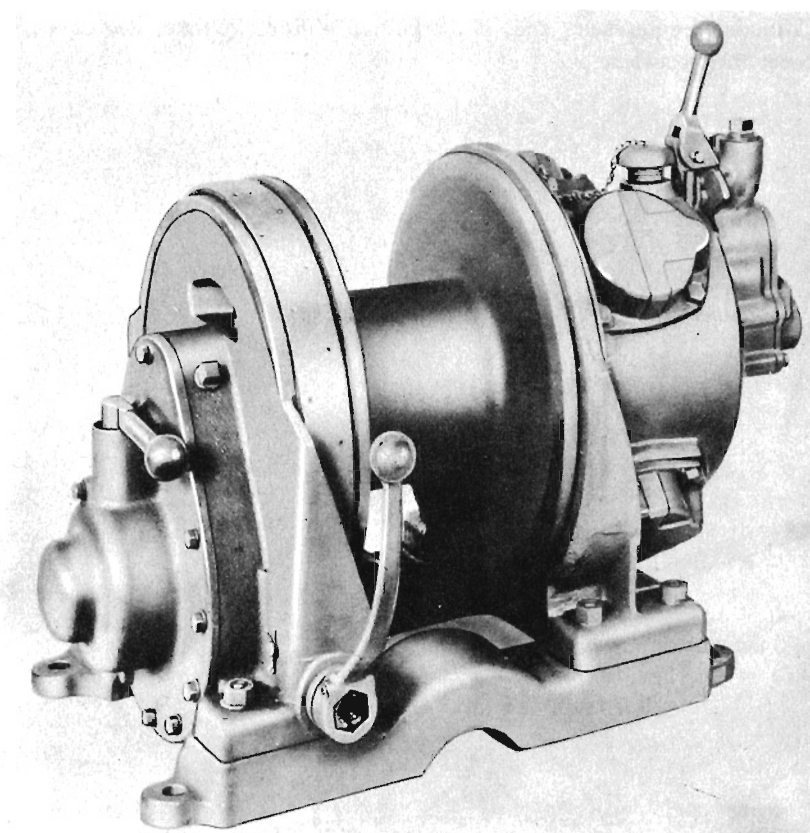


Figure 117. Pneumatic hoist, single-drum, 1-ton capacity.

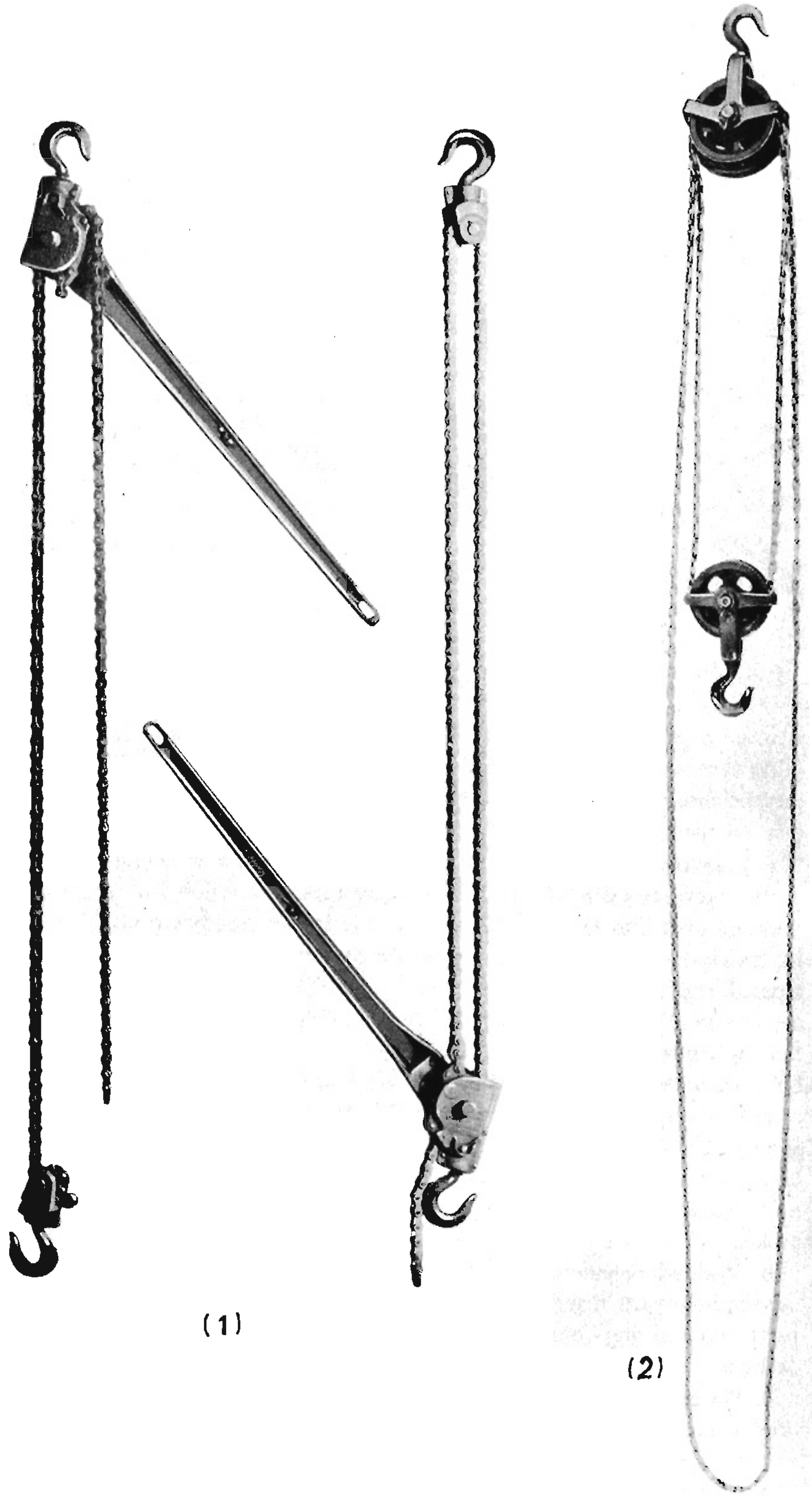


Figure 119. Chain hoists, hand-operated.

(1) Ratchet chain hoist. View shows standard bridge hoists rigged for 1½- and 3-ton loads.
(2) Differential chain hoist.

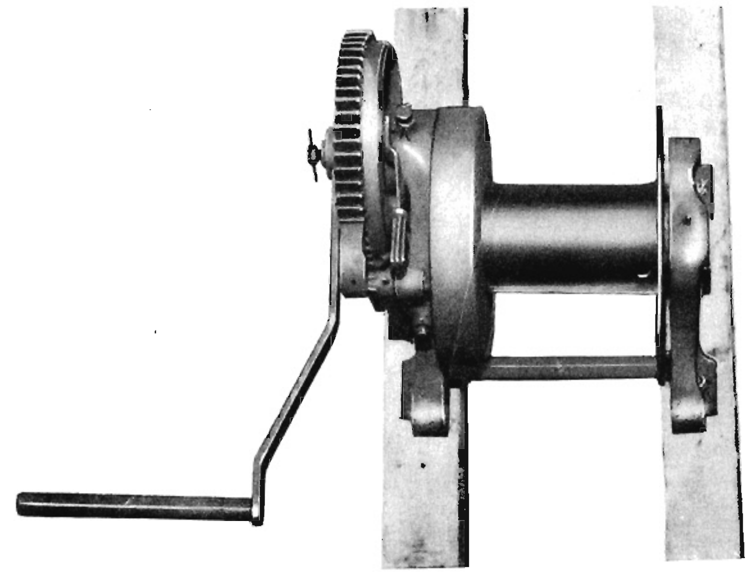


Figure 118. Hand winch, single-drum, 2-ton capacity, mounted on timber frame.

186. JACKS. Jacks are used to raise or lower heavy loads short distances. They are available in capacities from 5 to 100 tons. Small-capacity jacks are operated through a rack bar or screw while those of large capacity are usually operated hydraulically. Jacks most used in bridge construction are:

a. Pushing and pulling jacks. Pushing and pulling jacks (fig. 120(1)) are screw jacks of 10-ton rated capacity with end fittings which permit pulling parts together or pushing them apart. Their principal use in erection is to spread or brace parts and to tighten lines or lashing.

b. Ratchet lever jack. The ratchet lever jack (fig. 120(2)) available to engineer troops as part of panel bridge equipment is a rack-bar jack having a rated capacity of 15 tons and an effective movement of at least 11 inches. It has a foot lift by which loads close to its base can be engaged.

c. Screw jacks. Screw jacks (fig. 120 (3)) having a rated capacity of 12 tons are supplied with the platoon pioneer set. They are about 13 inches high when closed and have a safe rise of at least 7 inches. This jack can be used for general erection purposes.

d. Hydraulic jacks. Hydraulic jacks (fig. 120 (4)) are available in class IV supplies in capacities up to 100 tons. Loads normally encountered in semipermanent bridge construction do not require large-capacity hydraulic jacks.

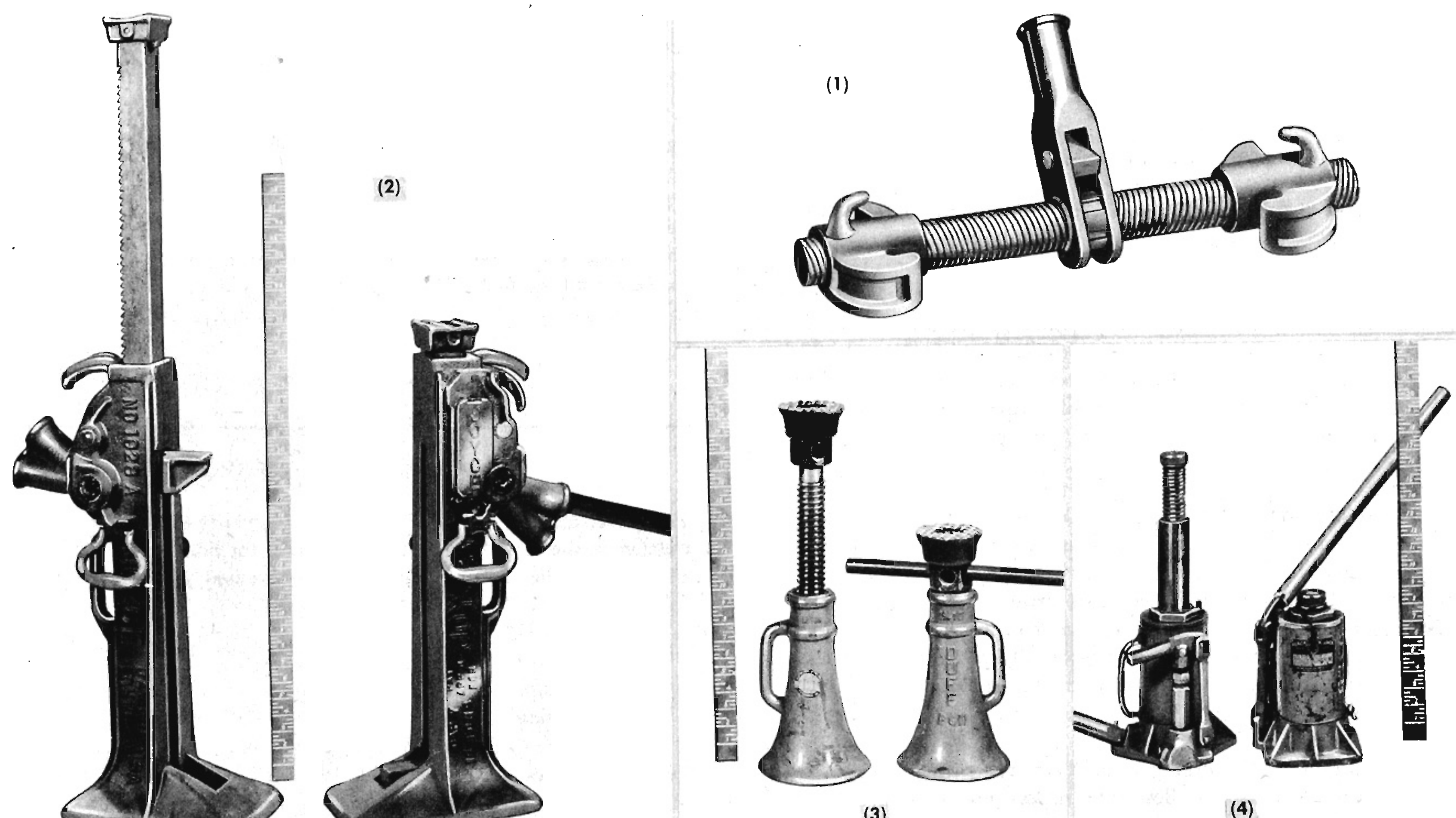


Figure 120. Mechanical jacks used in semipermanent bridge construction.

(1) Pushing and pulling jack. (2) Ratchet lever jack with foot lift. (3) Screw jack. (4) Hydraulic jack.

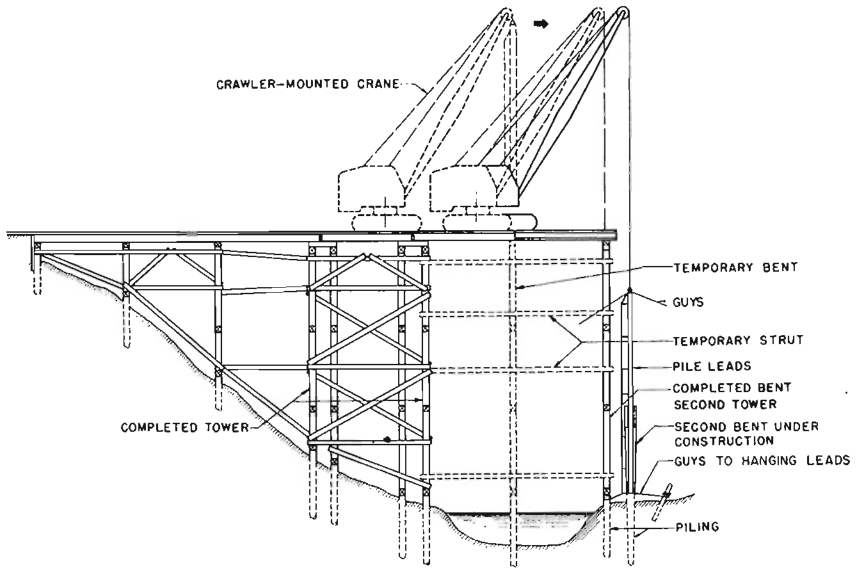


Figure 121. Crawler-mounted crane operating over falsework to drive piling and erect timber tower for long span.

Those supplied with the squad pioneer set have a rated capacity of 12 tons, a rise of at least $5\frac{1}{4}$ inches, and when closed are 11 inches high. They are large enough for usual construction needs.

Section III. FALSEWORK

187. GENERAL. Falsework is any construction intended for erection use only and then removed or abandoned. It includes temporary towers, bents, or trestles, fixed and floating platforms, staging, runways, and ladders. On major structures, temporary trestles provide quick access to points of construction. Falsework bents provide temporary supports for erection of superstructure spans. Staging is used to provide working platforms. Ladders should be provided for all towers. Safety should be given full consideration in locating and designing falsework. Whenever practicable, falsework should be built of local materials or materials that can be used in the permanent structure after they have served their temporary purpose.

188. FALSEWORK BENTS. Falsework bents can be used to support long spans when they are erected in sections before splicing, or when they are erected before the permanent tower or bent supporting their outer end has been built. Their use makes it possible to drive piling and erect superstructure with light mobile cranes. Falsework bents must be well-built, securely braced or guyed, and must be adequate to support all loads placed on them. Typical applications are shown in figures 121 and 122 and are described in detail in paragraph 209.

189. FALSEWORK TRESTLE. Foundations, towers, and bents of long-span bridges can be built over shallow water or soft ground by first constructing a low trestle to support erection equipment. The trestle is usually built alongside the line of the towers to be erected. (See fig. 122.) It is made as light as equipment and erection loads will permit and only wide enough for the equipment used.

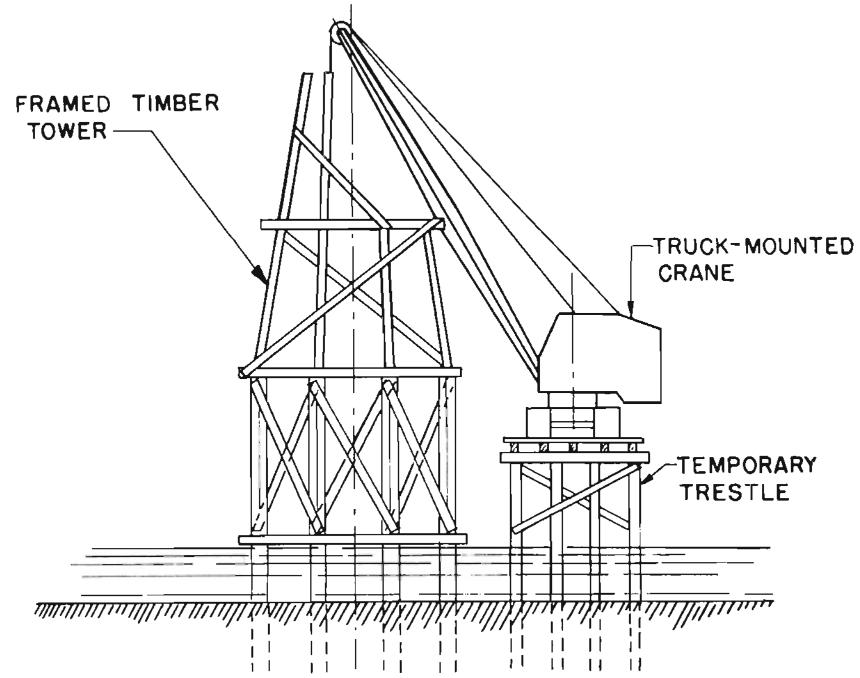


Figure 122. End view of crawler-mounted crane operating over temporary trestle built alongside bridge as a platform from which to drive piling and erect timber towers.

190. PLATFORMS AND SCAFFOLDING. a. Drilling, bolting, and nailing of timber towers is ordinarily done from scaffolds (fig. 123) carried up from story to story as erection advances.

b. Operations such as fitting up, bolting, riveting, and welding require the use of hanging scaffolds called floating platforms. These are easily moved from connection to connection by two men. Two such platforms are usually needed at each connection being made.

CHAPTER 15

STEEL AND TIMBER ERECTION

Section I. STEEL ERECTION

191. GENERAL. a. All parts and subassemblies of parts are prepared for erection in the fabrication yard, where holes for bolts and rivets are drilled and subassemblies are match-marked. Prefabricated parts are erected in the following sequence:

(1) Raising and entering.
(2) Plumbing and aligning.
(3) Fitting up.
(4) Connecting.

b. Since piles cannot be driven to exact position and alignment, parts for steel pile bents cannot be completely fabricated until in place. Special features of their erection are discussed in paragraph 163.

192. RAISING AND ENTERING. a. Riveted and bolted connections. (1) Members or subassemblies are raised into position with slings. Slings are attached to column sections near the upper end so the column will hang vertically; they are attached to horizontal members, bracing, struts, and girders so they balance. While being raised, all parts must be guided with tag lines by men on the ground.

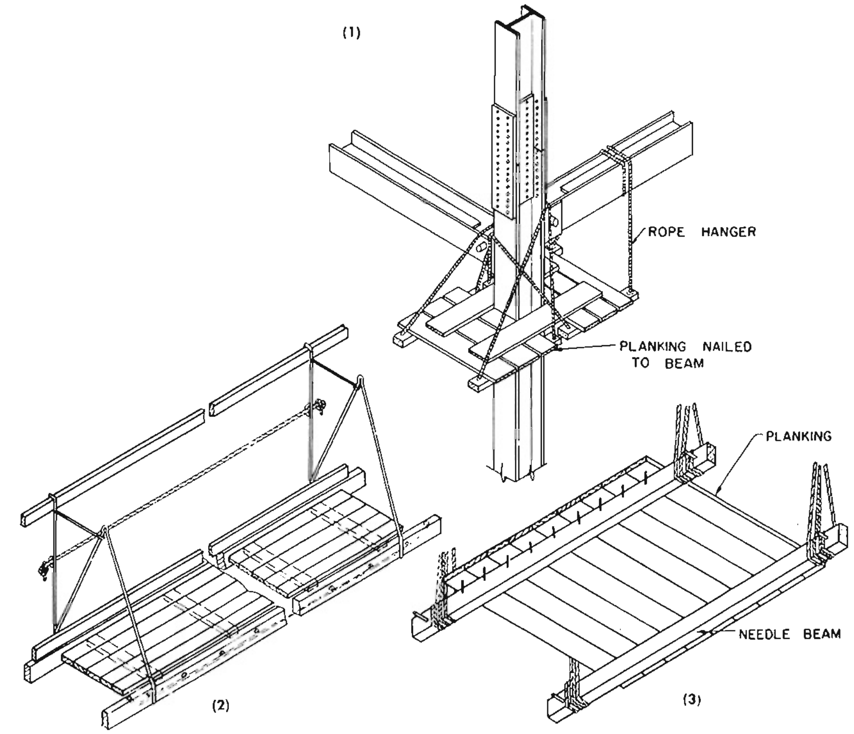


Figure 123. Examples of hanging scaffolds used in bolting and riveting steel bridges.

(2) As the part is drawn near the connecting point, it is caught by a rigger on the previously erected work. The rigger uses an erection bar as a lever to draw the part into position. When any hole in the part being raised matches its corresponding hole in the previously erected work, the rigger inserts the tapered end of a structural or spud wrench through the holes to hold the connection. The member is then shifted as necessary to bring other holes into line. When the other holes match, driftpins are inserted, erection or fitting-up bolts are added and drawn tight, and slings are released.

(3) When splices are made with tightly fitting parts, it is occasionally necessary to wedge or jack splice plates apart so the connecting part can enter between splice plates. Connections must not be forced by heavy pounding with a sledge as the metal will be injured, rivets and bolts loosened, and welds broken.

b. Welded connections. If parts are welded in place, erection bolts are used to hold parts together while they are being welded. Procedure for raising parts and entering connections is similar to that for riveted or bolted connections.

c. Pin connections. Horizontal struts and diagonal bracing rods of steel towers are connected to the tower columns with pins. (See fig. 124.)

(1) In connecting horizontal struts and diagonal bracing rods to tower columns, the strut is first lifted into position and rested on erection bolts in the tower column. The connecting pin is then driven, passing in order through: one flange of the tower column, one flange of the strut, the first eye of the bracing rod, the pipe separator, the second eye of the bracing rod, the second

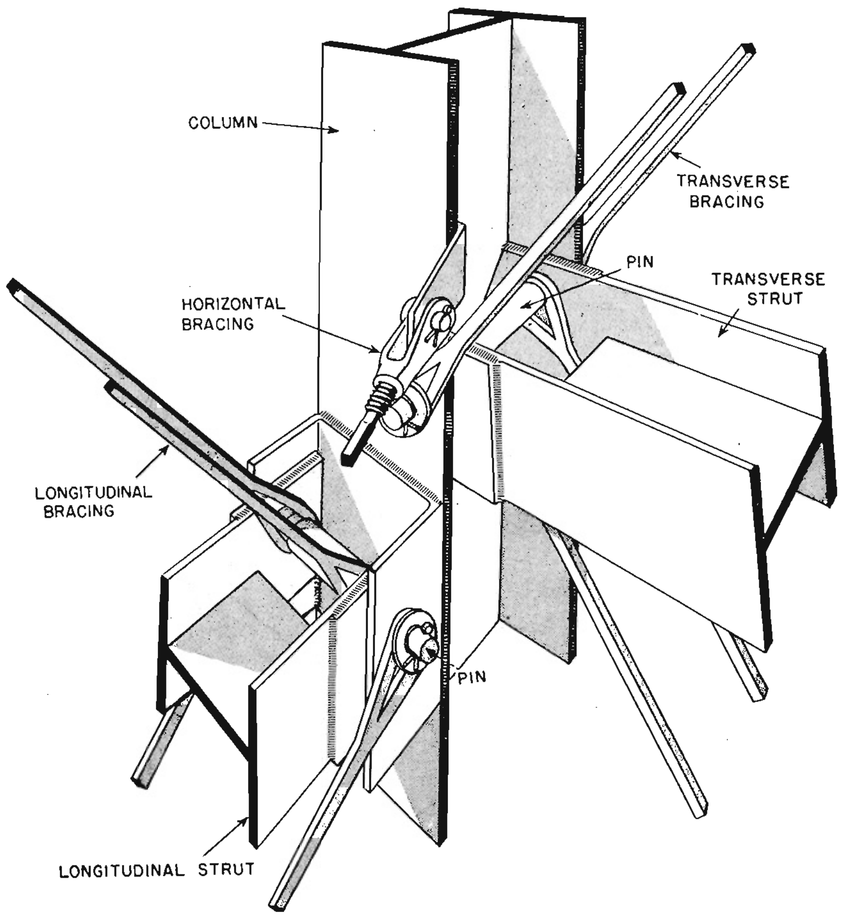


Figure 124. Pin connections of bracing to tower column.

flange of the strut, and the second flange of the column. The two outer diagonals are threaded over the pin, washers are added, and cotter pins are driven through the holes at the ends of the pin.

(*a*) If the bracing rods are from the panel below, they are already connected at their lower end to the opposite column and considerable force is required to pull them into position. This force can be supplied with tackle attached to the column and to the turnbuckle which joins the two sections of the bracing rod. The rod is lengthened with the turnbuckle so it can be pulled into position without too much effort.

(*b*) If the bracing rods are diagonals for the panel above, they are lowered into position, either singly or together, for insertion of the pin. After the pin is inserted, the free ends of the rods are lashed to the horizontal strut until they are needed to complete the connection above.

(2) The horizontal diagonal bracing rods are connected by a clevice and pin to a plate attached to the tower column. After the rods are attached, turnbuckles must be carefully tightened to take the sag out of the bracing rods and to square the tower.

193. PLUMBING AND ALIGNING. After their erection, towers and bents must be plumbed to bring all parts of the structure into correct position and alignment. If parts have been accurately fabricated, little adjustment will be required.

a. Riveted and bolted construction. Riveted or bolted towers and bents are not plumbed until all parts have been erected. Plumbing should begin with the bottom panel and progress upward.

(1) Erection bolts are first loosened in splices at which correction is required. At joints requiring major correction, it may be necessary to loosen driftpins also. Bolts and driftpins must not be removed, but only loosened enough to permit the joint to rotate.

(2) Columns are plumbed by adjusting the length of diagonal bracing rods with the turnbuckle in each rod.

(3) After correction is made, bolts are tightened and driftpins redriven to prevent the joint slipping.

b. Welded construction. In welded construction, splices in tower columns are made as each section is erected. Bracing connections are usually not welded until all parts of the tower or bent have been erected.

(1) As each column splice is made, it is carefully aligned to make sure that the column will be straight from bottom to top.

(2) If after all parts have been erected, it is found that the tower or bent is not plumb, the condition is corrected in the following manner.

(*a*) Temporary diagonals of wire rope are run from the base of one column to the top of the adjacent column. A pushing and pulling jack is linked with each of these false diagonals to adjust its length.

(*b*) Connections of the diagonal bracing are loosened.

(*c*) The position of the tower or bent is corrected by adjusting the length of the false diagonals.

(*d*) Connections for the bracing are tightened and false diagonals removed.

194. FITTING UP. a. Riveted construction. Fitting up of joints to be riveted consists of reaming all mismatched holes, adding erection bolts and driftpins, and pulling parts securely together for riveting. For details see chapter 11. Fitting up is ordinarily done by a two-man crew working on floating scaffolds.

(1) Driftpins should not be forced into holes by hard driving. Holes that do not match should be reamed.

(2) Erection bolts should draw parts firmly together. Tight erection bolts are necessary to get good connections with rivets or structural ribbed bolts.

b. Bolted construction. When connections are made with machine bolts, fitting up is not ordinarily a separate operation. The crew that fits up the joint completes the permanent connection.

c. Welded construction. No bolts other than those used in raising and entering parts are driven at joints to be welded. Secondary members may be clamped in place, if they support no load during erection and the safety of the welding crew is not jeopardized. Fitting of minor connections made after erection is complete is done by the welder and his assistant.

195. CONNECTING. Connections are made by riveting, bolting, or welding, or with pins.

a. Riveting. Riveted connections are made by a four-man crew in a manner similar to that described in paragraph 123 for riveting in fabrication.

(1) The heater's forge is set up on a solidly supported platform of 2- by 12-inch planking. It should be erected as near the work as possible and on the same level. If riveting is being done on more than one level, the heater's forge should be placed where it can serve all points most efficiently. Others of the riveting crew, the sticker, bucker, and riveter, work from floating scaffolds hung at the joint being riveted.

(2) The riveting crew first makes sure that erection bolts are tight and that open holes match and are clean. Rivets are driven first in open holes near the center of the joint. Erection bolts and driftpins are removed as riveting progresses outward.

(3) Connections cannot be riveted in place as readily as on the ground, since movements of the men are restrained by the relative insecurity of the floating scaffold and much time is lost in moving equipment from one scaffold to another. An efficient four-man crew can average about 25 rivets per hour.

b. Bolting. Connections made with machine bolts are completed by the bolting crew. Connections are bolted in the manner described in paragraph 122.

c. Welding. (1) Welding during erection is used extensively to connect bracing members, diaphragms, and fittings. Splicing main girders by welding after erection is not recommended; the welded splices shown on drawings necessitate overhead welding of important fillet welds unless the stringers can be turned during welding.

(2) Tower column splices can be welded after erection by highly skilled welders. When column splices are welded, erection proceeds slowly as erection of each main member must await completion of welds connecting previously erected members.

d. Pin connections. Pin connections are made as parts are lifted into place as described in paragraph 192.

196. ADJUSTING OF BRACING. After all parts of the structure are in place and connections made, rod bracing must be adjusted and tightened with the turnbuckles. Intersecting diagonals in any panel should be equally tight. No slack in these diagonals is permitted but they must not be drawn so tight that they are under heavy stress. After adjusting, the turnbuckles are wired or blocked so they will not loosen by vibration.

197. PAINTING. Semipermanent bridges are not ordinarily painted. However, in locations where rapid corrosion is expected, painting is advisable if the bridge is to serve more than 1 year.

a. Painting is preferably done in the yard. It may be done after all steel is erected and connections made but before timber deck is placed. Before painting, steel must be cleaned of all oil, scale, loose rust, and dirt. Standard paints should not be applied on moist surfaces or when the temperature is below 40° F. Crevices between parts should be carefully sealed with paint to exclude moisture.

b. Painting may be with brush or spray gun. Paint should be used as prepared by the manufacturer and should be thinned only if necessary for spraying. Average coverage of 1 gallon of paint on steel surfaces is:

	Square feet
Brush painting	200 to 400
Spray painting	400 to 600

Average labor for applying 1 gallon of paint on steel, not including time required to clean surfaces, is:

	Hours
Brush painting	3 to 5
Spray painting	1 to 2

Section II. TIMBER ERECTION

198. TOWERS AND FRAMED BENTS. a. Members for towers and framed bents are prepared for erection in the framing yard as described in chapter 11.

They are erected either singly or as assemblies of several members, usually a complete bent or a story of a bent as the capacity of erection equipment permits. (See figs. 115 and 125.) Match-marking of members provides for their erection in the position for which they were framed.

(1) Slings are attached to members or subassemblies of members and they are raised to position. Sling attachment points must be carefully chosen in erecting subassemblies so they will not be wracked, pulled apart, or broken when lifted.

(2) When in position, members or subassemblies are guyed or braced temporarily until permanent bracing can be erected and connections made. Columns are toenailed to sills and caps, and bracing is nailed in place. Holes for bolts are drilled, bolts are driven, and nuts tightened.

b. It is important that columns have full bearing over their entire cross section against caps and sills.

(1) Thin shims or wedges should not be used to correct errors in framing. Thin pieces of wood warp and split and soon work out of a connection. Steel plates or shims can be used but they must be single pieces wide enough to provide contact over the full face of the column.

(2) If a column is not cut square or to correct bevel, it can be recut short enough to be filled-in with a hardwood block not less than 4 inches thick. The block must be long enough to extend 1 foot beyond the column on each side and must be securely bolted to the cap.

c. Splices in bracing members, diagonals, and struts should be carefully made; they should always be bolted. Nailed splices of timbers are inadequate in semipermanent bridges.

199. STRINGERS. **a.** The short span of timber stringers either in pile trestles or in framed bent construction permits placing them by hand (fig. 126) or with a truck- or crawler-mounted crane operating from the deck of previously completed work. The centerline of the bridge is projected onto the cap of the bent as it is completed, and the position of stringers is marked on the cap by measurement from the centerline.

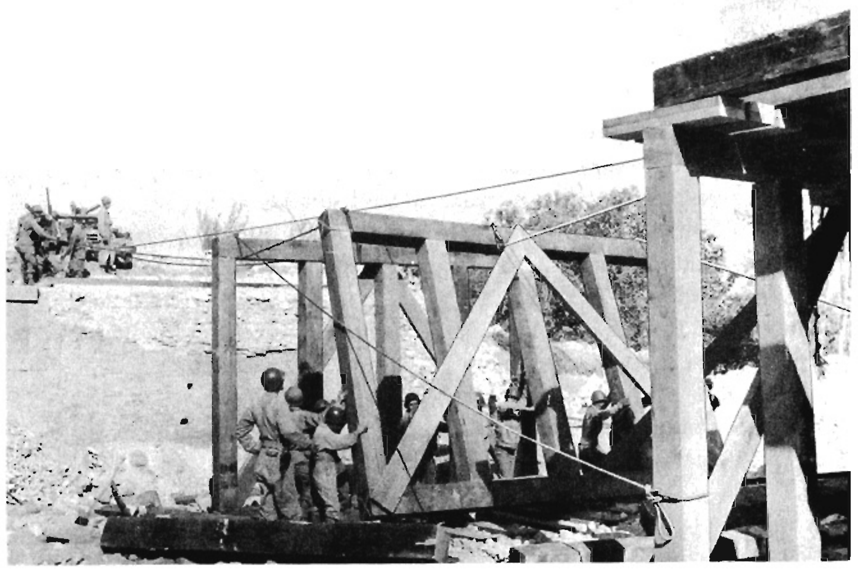


Figure 125. Raising framed bents into position with truck winch. Bridge details are not standard.

(1) Interior stringers of highway bridges overlap the cap, and it is not necessary to cut them to exact length. They must be long enough to have full bearing on the cap, however.

(2) Stringers of railway bridges and the outside stringers of highway bridges are butt-spliced over the cap. It is imperative that these stringers be cut in place to exact length. One end of the stringer is cut square and butted against the stringer of the preceding span; the cut for the opposite end is marked and squared with the stringer in position and the cut made on the line marked.

b. Stringers are toenailed to the cap, preferably with one 40d nail on each side of each end of the stringer. Holes are bored for driftbolts and bolts are driven. Scabs splicing stringers over bents are nailed in place, holes are bored and bolts are tightened.

Figure 126. Bringing up timbers to be set in place with erection equipment. Heavy timbers are being manhandled with peavies.

200. RAILWAY DECK. **a.** Ties for railway deck are landed on the stringers with the erection equipment and are manhandled into position. The preframed tie-spacing timbers insure correct spacing of ties. Ties are fastened to steel stringers with hook bolts (fig. 127) and to timber stringers with driftbolts through every third tie.

b. Laying of track is described in FM 5–10.

201. HIGHWAY DECK. It is ordinarily more efficient to manhandle deck planks than to place them with erection equipment. On steel stringers, nailers are attached to top flanges of stringers either with welded clips or bolts as shown on sheet 128. Deck planks are nailed directly to timber stringers or to the nailers on steel stringers. About 1-inch space is allowed between all planking, except laminated planking, to allow drainage and easy maintenance. Typical deck-laying procedures are illustrated in figures 128 to 130 inclusive.

202. WALKWAYS AND HANDRAILS. So far as practicable, curbs and handrails are framed before erection. Brackets for walkways are ordinarily assembled in advance.

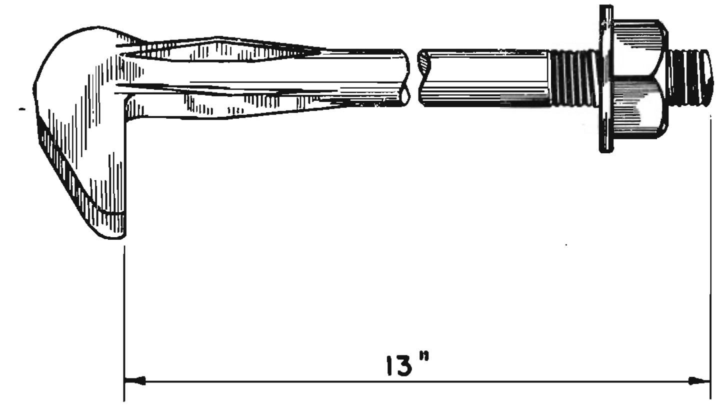


Figure 127. Hook bolt for fastening ties to steel stringers.

Section III. SAFETY RULES

203. HANDLING OF LOADS. **a.** Before swinging heavy loads, equipment and rigging are both checked under load.

b. Heavy loads are moved slowly and kept under control at all times. They are moved in only one direction at a time. The critical moment in the lowering of a heavy load is when the load is checked; at that moment the equipment must withstand the inertia of the load as well as its weight.

c. Loads are guided and prevented from swinging sidewise with tag lines tied to the load and held by one or more men on the ground.

d. Loads should not be lifted during strong or gusty winds.

e. Loads should not be swung over the heads of working men.

f. While hoisting equipment is in operation, the operator should not be permitted to perform any other work.

g. An operator should not be permitted to leave his position at the controls while a load is suspended from a crane or derrick.

h. Only one person in each crew should give signals to an equipment operator.

204. TACKLE. **a.** Slings and tackle should be inspected frequently and frayed or worn equipment replaced.

b. Wire rope should be removed from service when 4 percent of the total number of wires in the rope are found broken or when:

(1) Three broken wires are found in one strand of 6-by-7 wire rope.

(2) Six broken wires are found in one strand of 6-by-19 wire rope.

(3) Nine broken wires are found in one strand of 6-by-37 wire rope.

c. Wire ropes should not be used on sheaves or blocks having a diameter less than those specified in table LXVII.

d. Wire-rope slings are preferred to chain slings for handling loads.

e. Wood blocking should be placed under slings lifting heavy steel members to prevent slings being cut.

f. Shackles are preferred to hooks for attaching blocks. Hooks, if used, must be moused.

g. Blocking or cribbing should always be used to secure necessary height under jacks. Jacks should not be set on a post or strut where they might kick sideways under strain.

h. Loose lines should not be permitted to hang from the structure or from equipment.

Figure 128. Nailing deck plank to timber stringers. The timber stringers shown are substitute-size shallow stringers.

205. SCAFFOLDS. a. Scaffolding should be of ample strength and secure against slipping or overturning.

b. Loose boards should not be allowed to project beyond their supports.

c. Nails should not be used in tension to hold scaffolding or falsework. They should always be driven all the way in.

d. Scaffold horses should be supported evenly and should be nailed to the platform on which they are supported.

e. Ladders should be blocked at foot or tied at top to prevent slipping. Scaffolds over 6 feet high should have a guardrail on the back side.

206. INDIVIDUALS. Individuals must:

a. Stand clear of loads suspended in the air.

b. Stand away from and out of line with rope lines under heavy strain.

c. Not ride a load being lifted or lowered into place.

d. Not stand in the line of movement of a load.

e. Not stand within the angle formed by a line carried over a block.

f. Not feel for matching holes with fingers or hand.

g. Not work beneath other operations where falling tools, bolts, and erection parts are a hazard.

h. Use all prescribed personal protective equipment, such as goggles and safety belts.

CHAPTER 16

ERECTION METHODS

207. GENERAL. a. The procedures described in this chapter give methods for quick and safe erection under normal conditions of any of the structures described in the manual. Other equally satisfactory procedures can be developed. Combinations of these procedures and adaptations of other procedures may be necessary where site conditions are unusual.

b. Single-span bridges are erected by launching stringers from the shore, following methods described in TM 5–285. Where stringers can be launched from previously completed spans, similar methods are used to erect long spans of multiple-span bridges.

c. Multiple-span trestle bridges can be erected in the following ways:

(1) From deck level by advancing construction as successive spans are completed:

(*a*) Spans short enough so supports one span away can be reached with erection equipment; no falsework required.

(*b*) Spans so long that supports one span away cannot be reached; falsework required for erecting towers.

(*c*) Spans so long that equipment cannot lift one stringer at a reach of one-half span; falsework or special rig required for erection of spans.

(2) From ground level:

(*a*) Height of bridge within lifting height of equipment; no special erection equipment required.

(*b*) Height of bridge beyond lifting height of equipment.

1. Bridge carried on steel towers; gin poles required.

2. Bridge carried on timber towers; guy derrick required.

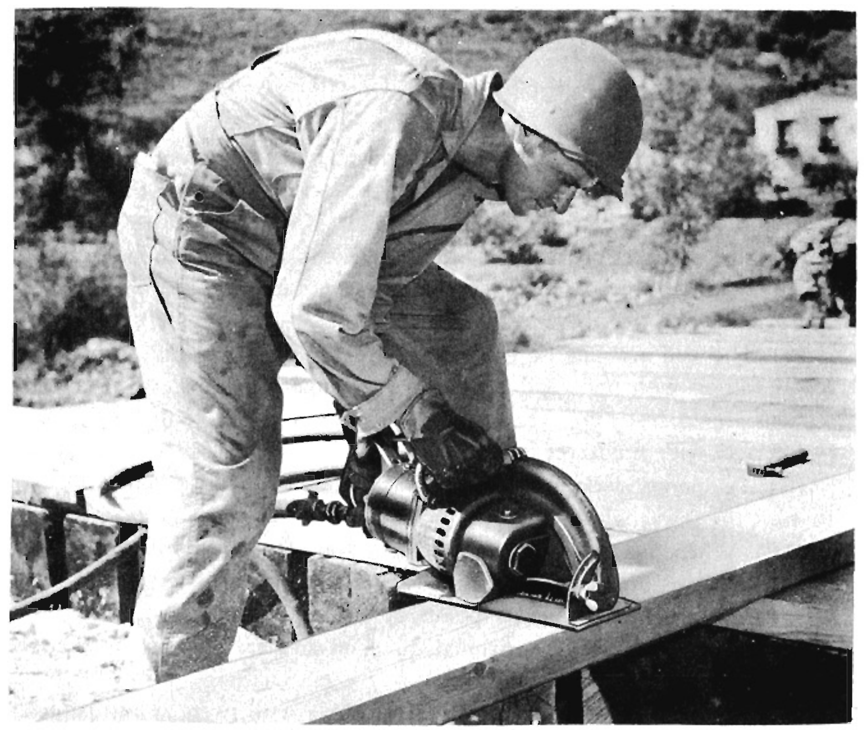


Figure 129. Cutting deck plank to length with circular portable pneumatic saw.

208. ERECTION FROM BRIDGE DECK WITHOUT FALSEWORK. Bridges built of a succession of relatively short spans can be erected from deck level without falsework. Erection equipment preferred is a ¾-cubic-yard truck-mounted crane.

a. Spans supported on pile bents (fig. 92). Erection of short spans on pile bents proceeds in the following manner.

(1) Materials and fabricated parts from the fabricating yard are delivered to the bridge within reach of handling equipment.

(2) The first pile bent is constructed with the crane on the abutment.

(3) Stringers for the first span are set in place on the abutment and the first bent.

(4) Deck planks, or ties for railway bridges, are laid. Stringers on railway spans are spread apart and cross ties staggered to obtain a temporary deck wide enough for the crane.

(5) The crane is moved out over the deck to the first bent. The second bent is driven and the second span erected. This procedure is repeated until the far abutment is reached.

(6) As the crane is moved off each span, stringers are set in final position, the deck is nailed, tread planks and curbs are placed, and walkway and handrails are constructed to complete the span.

b. Spans on pile piers. Procedure for erecting bridges with short steel-stringer spans on timber pile piers is similar to that for bridges on pile bents. It is necessary to reach and construct only the nearest bent of the forward pile pier before an intervening span can be placed temporarily and the crane moved out on the structure.

(1) The second bent of the pile pier is constructed and the pile pier completed.

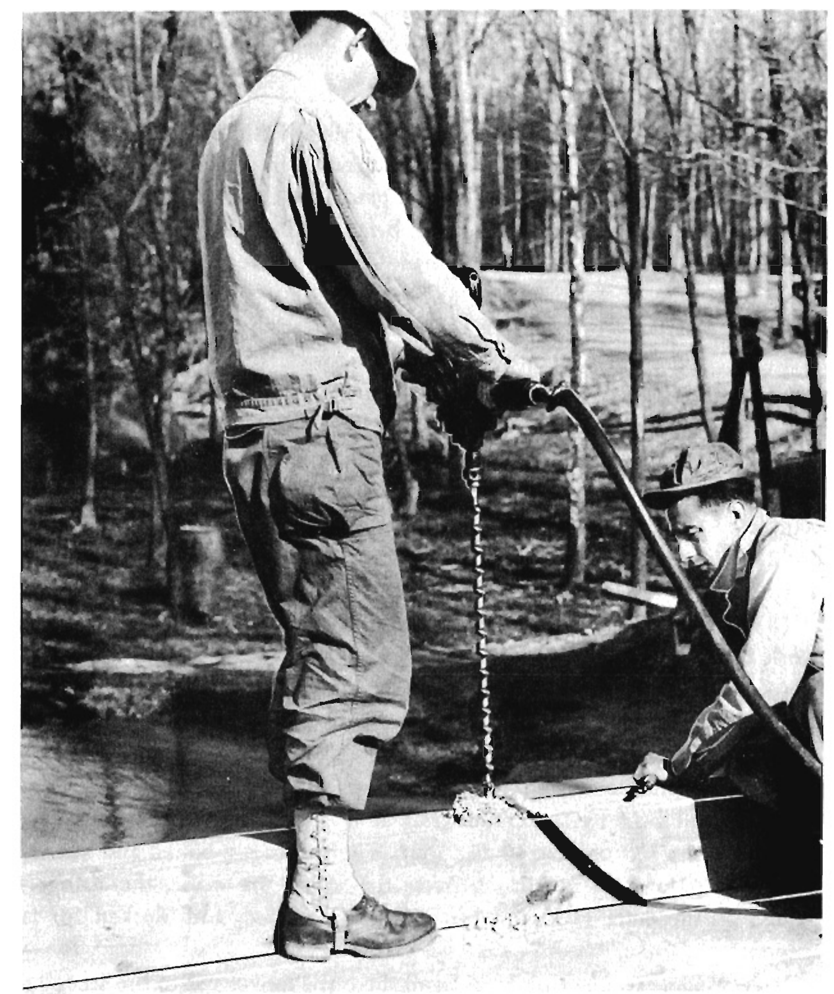


Figure 130. Drilling curb with pneumatic wood borer.

(2) The stringers can be set in final position on corbels after the crane has moved forward off the span.

c. Spans on framed timber towers. Foundations for framed towers are usually constructed in advance. Erection of timber towers proceeds as follows:

(1) Sills on foundation, although framed with the bents, are set separately and anchored to piles with scabs or driftbolts or to footings with anchor bolts.

(2) The first tower bent is delivered to the crane assembled. (It may be assembled on the ground immediately behind the crane.) The crane then places the bent over the previously placed sill. (See fig. 111.) The bent is carefully guided with tag lines. Bents more than one story high are set one story at a time.

(3) The bent is braced with final struts or temporary bracing or is guyed, and anchor bolts are tightened.

(4) Stringers are set and deck is laid.

(5) The crane is moved out on the structure. The remaining bents of the tower are erected and longitudinal tower bracing is installed.

(6) Guys and temporary bracing holding the first bents are removed.

(7) Stringers of the tower span are set in place and deck is laid. The crane is then ready to move forward.

(8) When towers are carried on timber piles, piles are usually driven while erection of superstructure proceeds. If the crane is used to drive piles and erect the bridge, pile hammer and leads are set aside so the full capacity of the crane is available for handling tower bents and stringers while piles are being cut off and capped.

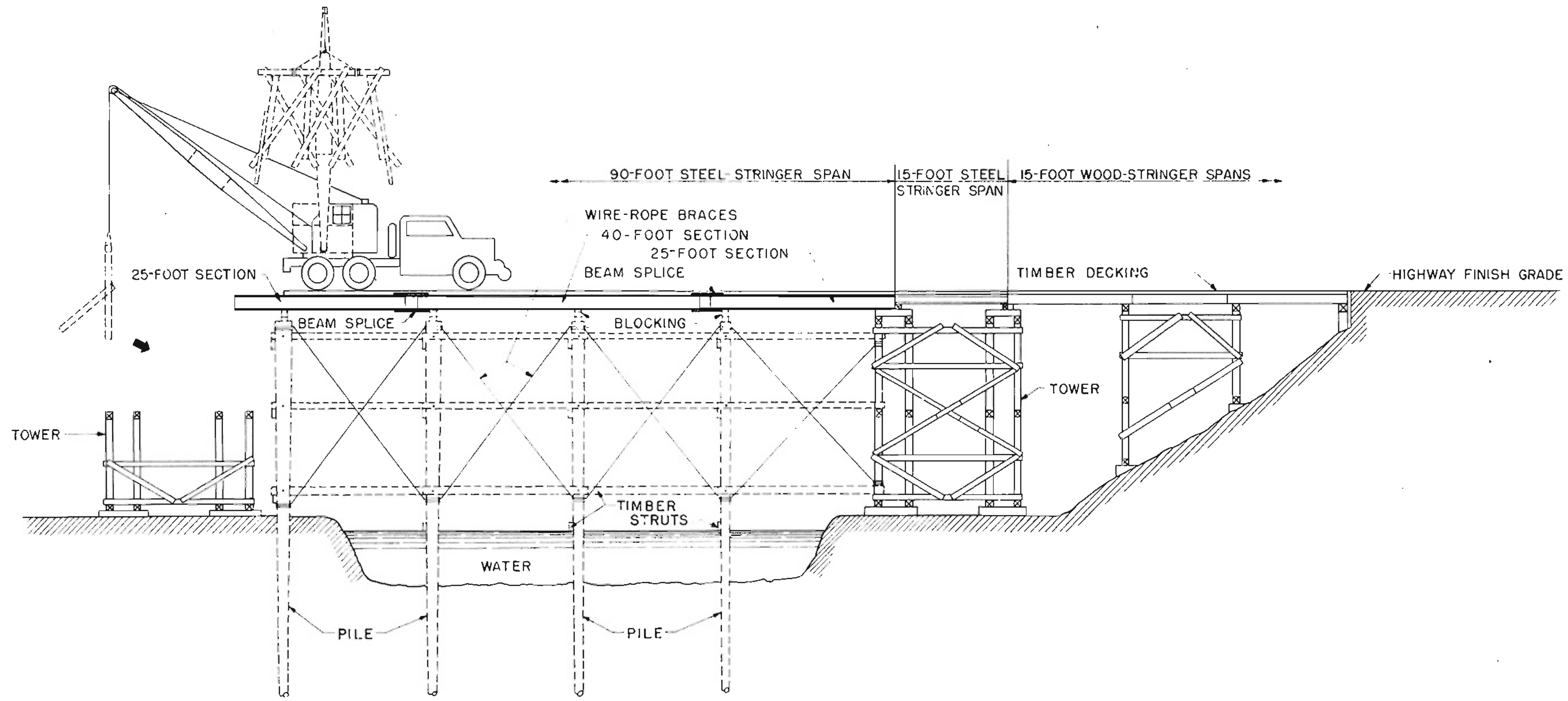


Figure 131. Ninety-foot steel-stringer span on timber towers erected on falsework. Crane is shown erecting far tower from span supported on falsework.

209. ERECTION FROM BRIDGE DECK USING FALSEWORK.

a. Falsework is used to advantage in erecting moderately high bridges over water or ground too soft to support erection equipment. It is not usually justified for structures over 40 feet high. Falsework bents can be pile bents or well-braced timber bents. Allowance should be made for 1 to 2 feet of blocking between caps and bottom of stringers *when in position.*

b. The following procedure is outlined for erecting a 90-foot highway span having its outer end supported on a timber tower. (See fig. 131.) The same procedure can be used to erect other structures. Stringers are erected in sections and are spliced in place.

(1) The crane moves into position at the end of the gap, and the first falsework bent is constructed approximately 20 feet beyond the end bent of the completed span.

(2) The first sections of all stringers are set in place with their outer ends resting on the falsework bent. These stringer sections are 25 feet long.

(3) To prevent stringers overturning they are blocked over the falsework bent.

(4) Temporary decking is laid and the crane moves out on the span to but not beyond the falsework bent. A second bent is constructed approximately 20 feet beyond the first.

(5) The middle section of each stringer except the center stringer is set in place and held by the crane while it is spliced to the previously erected section. These sections are 40 feet long. The splices are bolted and pinned but final connections are not made. After the splices are made, the stringers are seated on the outer falsework bent, carefully leveled, and blocked for lateral support.

(6) Temporary decking is laid and the crane moves out to the second falsework bent. A third bent is placed approximately 20 feet beyond the second to support the outer end of the middle stringer section. Piles for this falsework bent must be driven between the steel stringers.

(7) The stringers are wedged up for even support and temporary decking is laid out to the third bent. The crane moves out and a fourth bent is erected approximately 20 feet beyond the third.

(8) The end sections of the girders are lifted into place, spliced to the center section with bolts and pins, and are seated on the fourth bent. These sections are 25 feet long. The stringers must be wedged up slightly so as not to interfere with the tower construction.

(9) Temporary decking is laid on the end section, and the crane moves out to erect the tower which supports the ends of the stringers.

(10) When the tower is completed and stringers lowered to final position the crane moves off the span and the temporary decking is removed.

(11) Stringers are jacked at points of temporary bearing to correct alignment in both vertical and horizontal direction and are then set on their end bearing plates.

(12) Permanent girder splices are made either with rivets or with structural ribbed bolts. Bracing and diaphragms are installed.

(13) Blocking over the falsework bents is removed, leaving the stringers supported only on end bearings. Falsework bents are dismantled.

(14) Bridge floor, curb, and handrail are added to complete the span.

210. ERECTION FROM GROUND WITH CRANES.

a. Where ground and site conditions permit, long-span bridges of moderate height can be erected more easily from ground level or from rafts. A ¾-cubic-yard crawler-mounted crane is the equipment preferred. It is more maneuverable than truck-mounted cranes and can be operated over rougher and softer ground. Erection of superstructure from the ground proceeds in the following manner:

(1) The first tower is erected (fig. 132), the tower plumbed, and permanent connections are made between members. The crane also raises stringers of the tower span to place.

(2) If two cranes are not available, a gin pole is erected at the abutment in position to raise one end of one of the outside stringers. The crane is moved into position to handle the other end of the same stringer, delivered below

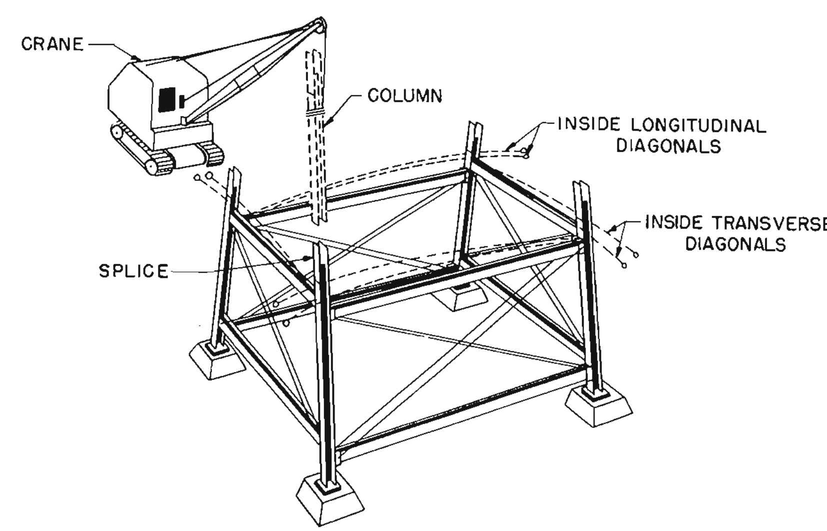


Figure 132. Crawler-mounted crane erecting steel tower from ground.

the span. Lines are attached from the gin pole and from the crane, and the stringer is raised to position.

Caution: The crane must be on firm, level footing when stringers are raised. Where necessary, the ground should be leveled and mats laid.

(3) The gin pole and crane are moved laterally and successive stringers are raised until all stringers of the span are in place.

(4) Diaphragms and bracing are erected and connections made. Deck is laid to the far end of the tower span.

(5) The gin pole is moved to the completed tower for erection of the second span, while the crane places the next tower.

211. ERECTING HIGH STEEL TOWERS WITH STEEL GIN POLES. High steel towers cannot be erected with standard truck- or crawler-mounted cranes. Special equipment must be used. Suggested procedure for erecting towers is illustrated in figure 133. Use of the same equipment parts in launching spans is shown in figures 134 and 135.

a. Equipment. The erecting equipment consists of four gin poles, one for each column of the tower.

(1) Gin poles are made of the 10-inch 42-pound beam section used for tower struts. Accessories and fittings, except tackle and hoists, can be made in the field. Details of gin poles and fittings are shown on sheets 228 and 229.

(2) Hoists for raising members are described in chapter 14. Single-drum pneumatic hoists are preferred, one for each of the four gin poles. Hand winches are used for holdback lines and can be used for hoisting lines if pneumatic hoists are not available.

(3) Holes for bolts connecting gin poles to columns are shown on column details.

b. Tower erection procedure. Construction of a two-story tower is described below. Similar procedure is followed in erecting higher towers.

(1) The gin poles are set on blocking next to the column foundations. (See fig. 133 (1).) The bottom section of each tower column is set on its foundation. Anchor-bolt nuts are run on and tightened. The anchor bolts hold the columns erect while bracing is added.

(2) Transverse tower bracing of the bottom story is erected. (See fig. 133 (2)): first the bottom strut, then the diagonal rod-bracing with loops between the flanges of struts (inside diagonals), then the top strut and inside diagonal of the second story. Bracing connections are made with pins as described in chapter 14. Struts must be raised at an angle to enter between flanges of tower columns. The high end is rested on a temporary 14-inch bolt immediately below its connection; the other end is raised and the temporary bolt under that end is inserted.

(3) Longitudinal bracing of the bottom story is erected as shown in figures 133 (3) and 133 (4): first the bottom strut, then the inside diagonal of the bottom story, then the top strut and the inside diagonals of the second story, and finally the outside diagonal rod bracing of the bottom story.

(4) Gin poles are raised with tackle to new positions for erecting the second story as shown in figure 133 (5) and sheet 228. Above ground, the gin pole is held as follows:

(*a*) Supporting brackets are pinned to the base of the gin pole and are bolted to the column at each level.

(*b*) Temporary straps are attached to each column to guide the gin poles while being raised.

(*c*) Tackle is attached to the top of the tower and to the bottom of the gin pole, and the gin pole is lifted into position.

(5) The second section of each tower column is erected and splices are bolted and pinned.

(6) Column caps are erected and are connected with bolts and driftpins. Gin poles must be leaned away from tower columns during erection of caps. (See fig. 133 (6).) Inside transverse diagonals of the second story are raised between flanges of the column sections before the column cap is connected but are not connected at the top until after the cap is connected.

(7) Longitudinal struts and bracing are erected and connected. (See fig. 133 (7).) The inside diagonals are leaned against the column below the connection; the top struts are lifted into place and they and the inside diagonals are connected; the outside diagonals are raised and connected last.

(8) Stringers of the tower span are erected as shown in figure 133 (8), using all four hoist lines on one stringer.

(9) After all stringers are in place, horizontal tower bracing is erected and the tower is squared and plumbed. Riveting of column splices or bolting with structural ribbed bolts can then proceed.

(10) Gin poles are lowered to the ground with tackle attached near the top of the tower column and to the bottom of the gin pole. (See fig. 133 (9).)

212. ERECTING LONG SPANS WITH STEEL OUTRIGGERS. Equipment for launching the stringers consists of the four gin poles used in erecting the towers and the outrigger accessories detailed on sheets 230 and 231. Assembly of the gin poles and outriggers is shown on sheet 228.

a. Outriggers are assembled on the towers at center line of bridge (see fig. 134) as follows:

(1) Outrigger accessories and supporting beams are attached to the gin poles to make the two outrigger assemblies.

(2) Rods to support outriggers are connected at their upper ends to the tower columns. Their lower ends are connected to the outrigger support beams later after the beams have been raised.

(3) Tackle is attached to the top of each tower column and to the outriggers. Assemblies are raised, supporting rods connected, and outriggers tied back to towers.

(4) Tackle is attached to outer ends of outriggers and outriggers are pivoted forward to position.

b. Stringers are delivered to the end of the completed spans and are placed on pipe rollers for launching. Beveled plates are welded to stringer bottom flanges at splices (fig. 135) so stringers will be lifted at outrigger rollers and will clear splice plates and rivet heads. Outside stringers are launched first.

Caution: Long beams have little lateral stiffness; every care must be taken to prevent their twisting or overturning.

c. Tackle is attached from the far tower to the stringer and the stringer is pulled across the gap. (See fig. 135 (2).) As the forward end of the stringer reaches each outrigger, the height of that outrigger is adjusted with tackle so it supports the end of the stringer.

d. When the stringer is centered over the span, it is lowered onto the column cap (fig. 135 (3)) by slacking both outriggers together while keeping the stringer carefully centered and securely held with tackle at each end. Stringers are seated on timber skids on top of the tower and are braced to prevent their overturning. (See fig. 136.) When a stringer is seated, outriggers are lowered far enough to clear the stringer.

Note. Bottom member of timber skid must be a continuous piece dapped over bearing plates and rivet heads.

e. The stringer is jacked laterally to position as shown in figure 136. Jacking must be carefully controlled so stringers are moved slowly without jerking. Sliding surfaces of timber skid should be smooth and well-oiled.

f. When all stringers of the span have been launched, seated on blocking, and jacked to position, outriggers are lowered and removed from the towers.

g. Diaphragms and bracing between stringers are installed, and sections of the timber skid are then sawed out to permit seating jacks on the tower cap beam under end diaphragms. (See fig. 137.) The span is raised slightly on jacks, blocking is removed, and the span seated in its final position.

213. ERECTING HIGH TIMBER TOWERS. Special equipment must be used to erect high timber towers beyond the lifting height of standard equipment. Suggested procedure for erecting these structures is shown in figures 138 and 139.

a. Equipment. The guy derrick, detailed on sheets 232 to 234 inclusive, is used. Mast, boom, and sill of the derrick are of bridge-timber sizes.

(1) All derrick parts can be made in the field; tackle and winches are class IV or organic equipment.

(2) Hand winches (stock number 66–9450.050–000) can be used for hoisting on load lines and boom lines.

(3) Swing of the boom is controlled with tackle attached to the boom and to the tower bracing or columns. The derrick rests on timbers laid longitudinally on the tower sills or caps.

b. Tower erection. Procedure for erecting a two-story tower is given below. Procedure for erecting a higher tower is similar.

(1) Sills of all bents are laid and bolted to foundations.

(2) The derrick (fig. 139 (1)) is set up. Guys to the mast are anchored to extreme corners of the tower. The derrick sill is anchored to prevent the foot of the derrick sliding.

(3) Tower bents are delivered by units close to the tower. Each unit includes posts, cap, and transverse bracing for one story. Bracing is spread away from the base of the posts slightly so it will not interfere with sills when set in place. If necessary, temporary filler blocks are put on bolts connecting bracing at top of posts.

(4) The first-story section of one end bent is lifted and set in place. (See fig. 138 (1).) Longitudinal bracing members are connected temporarily to hold the section upright.

(5) Forward guys of the derrick are moved one at a time, so they do not interfere with the inside bent to be set next.

(6) The first-story section of the next bent is lifted and set on its sill. Longitudinal bracing connecting the two bents is bolted in place. (See fig. 138 (2).)

(7) The derrick boom is swung through 180° to set the bents at the opposite end of the tower. As the boom is swung, the guy line in its path must be released, thrown over the boom, and again connected near the corner of the tower. Never release more than one guy at a time.

(8) First-story sections of the remaining two bents are erected, the end bent first then the inner bent (fig. 138 (3)) as described above.

(9) Longitudinal tower bracing of the first story is completed.

(10) The derrick is raised as described in subparagraph 213*c* onto the caps of the first story.

(11) Second-story sections of each bent are raised in the same sequence as the first story (figs. 138 (4), 138 (5), and 138 (6)).

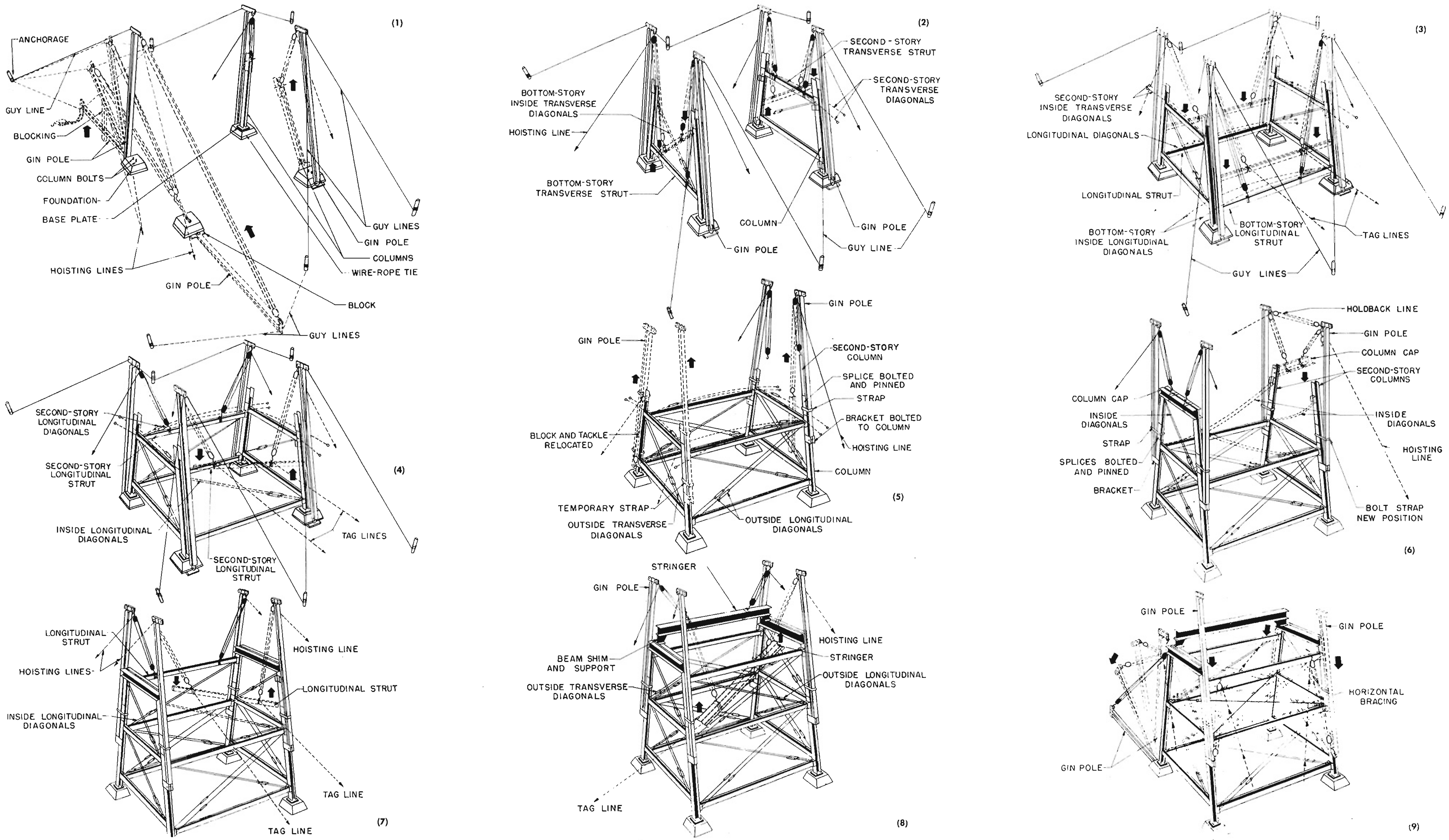


Figure 133. Sequence of erecting two-story steel tower with steel gin poles made of bridge sections.

(1) Setting gin poles on ground to erect first story; tower columns being erected.

(2) Transverse struts raised to position while diagonal bracing rods connecting between flanges (inside diagonals) are tied in position. It is difficult to enter diagonals into the corner between the column and the strut after the strut is in place.

(3) Erecting bottom longitudinal struts and inside diagonals of first story.

(4) Erecting upper longitudinal struts of first story. Inside diagonal braces of second story are connected at lower ends.

(5) First story. Gin poles being raised to position for erecting second story. View shows second-story inside bracing connected at lower ends.

(6) Second story. Lower columns in place. Column caps being erected.

(7) Erecting longitudinal strut with inside diagonal bracing tied into position at upper end. The pin is threaded through the holes in the strut and the loops of inside diagonals at one time.

(8) Tower erected. Setting tower stringer in place.

(9) Gin poles lowered to ground after erecting tower. Only one tower stringer is shown.

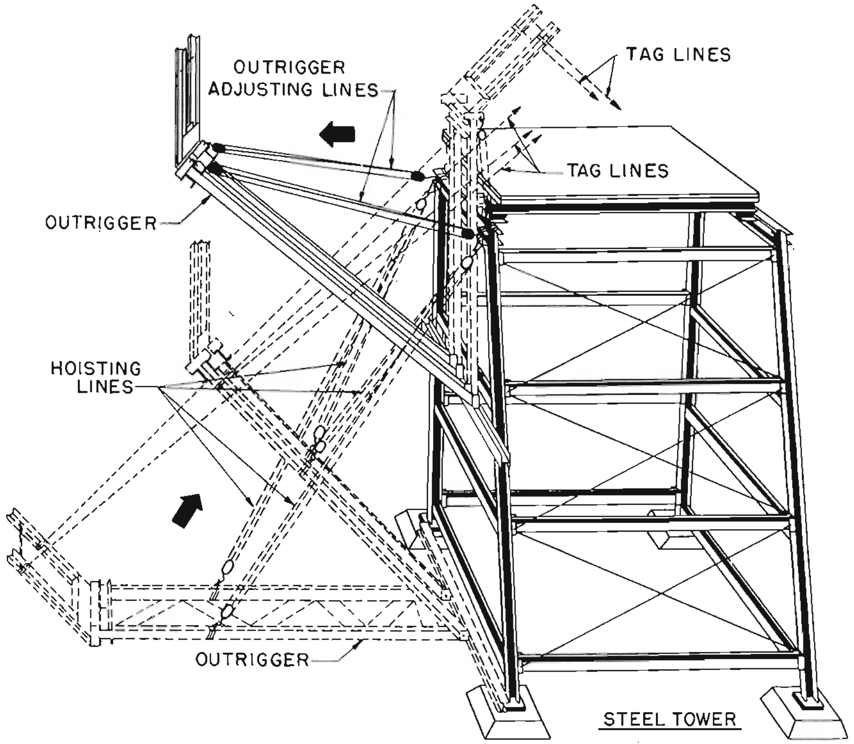


Figure 134. Two gin poles connected with bracing, rollers, and guide frame serve as outriggers used to launch long steel stringers from bridge deck. Successive steps in raising outriggers are shown.

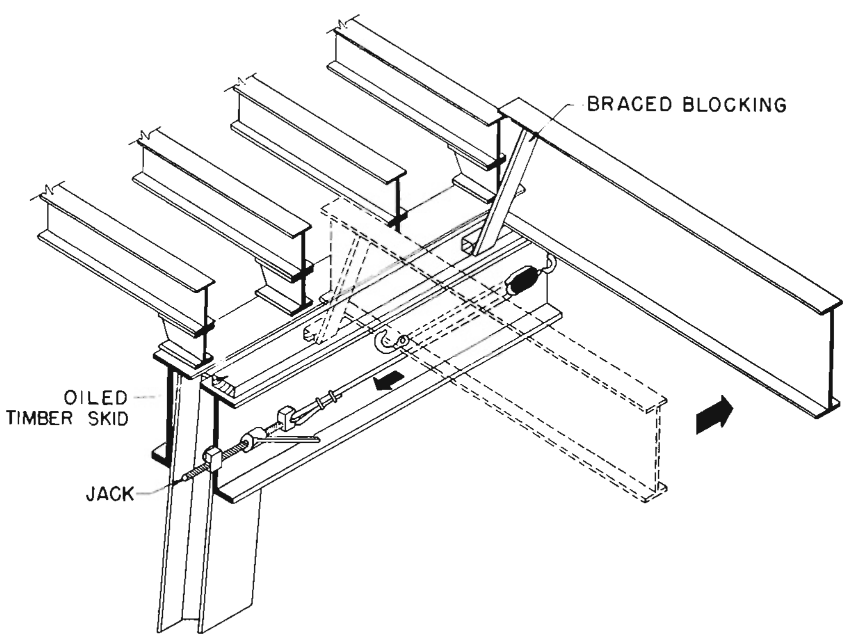


Figure 136. Jacking stringer into position using timber skid, tackle, and pushing-and-pulling jack.

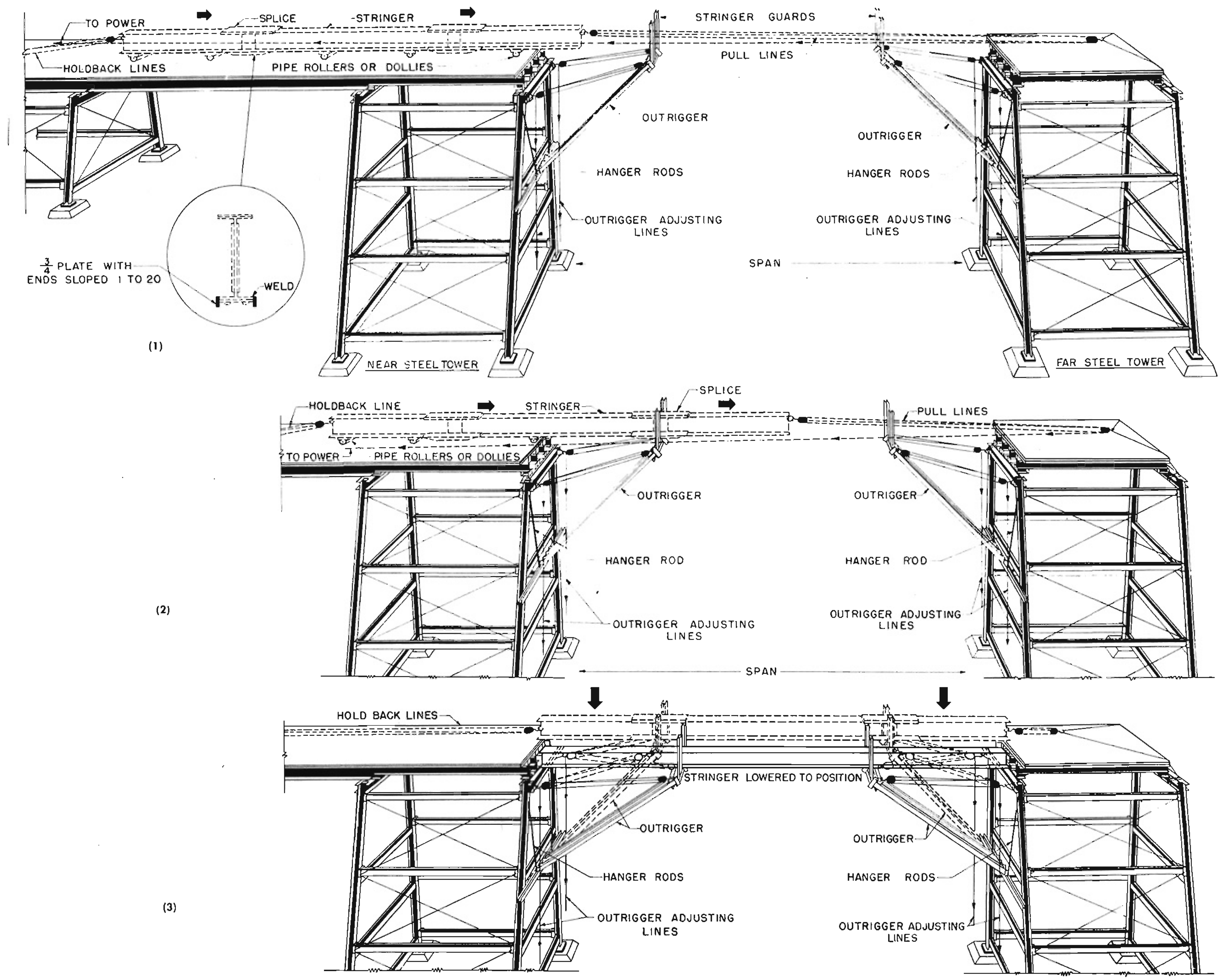


Figure 135. Launching steel stringers from bridge deck with outriggers.

(1) Outriggers and stringer in position for launching; tackle attached, stringer on pipe rollers.

(2) Stringer supported on outrigger being drawn across gap.

(3) Launching completed, stringer lowered to column cap beam by paying out outrigger adjusting lines.

(12) Longitudinal bracing is raised and connected. Corbels are set in place, drilled, and bolted.

(13) Stringers are raised from ground over the side of the tower and swung between the derrick guys into position. Stringers on one side of the derrick are raised first, the derrick boom is swung around, and then the stringers on the other side are set. (See fig. 138 (7).)

c. Elevating derrick to higher level. Assembly of the guy derrick is shown in figure 139 (1). It is raised from one level to the next in the following manner.

(1) Tackle guys are attached to the boom point. The boom is raised as close to the mast as possible, and guys to the boom point are secured.

(2) The boom tackle is released from the point of the boom and is lashed near its base. (See fig. 139 (2).)

(3) Using the mast as a gin pole, the boom is lowered and seated on timbers either on the ground or at the base of the derrick. (See fig. 139 (3).)

(4) The boom tackle is released from the boom and the hoisting tackle is connected to the mast with lashing far enough down for a 13-foot lift. (See fig. 139 (4).)

(5) Guys on the mast are slacked and with the boom as a gin pole the mast and sill are raised to the second level and seated on its timbering. (See figs. 139 (5) and 139 (6).)

(6) The hoisting tackle is released from the mast and the boom tackle is lashed to the boom near its base. (See fig. 139 (7).)

(7) The boom is raised with the mast as a gin pole and connected at the higher level. (See fig. 139 (8).) Guys guide the boom as it is raised.

(8) Tackle is again connected as shown in figure 139 (1) and guys to the boom point are released.

214. LAUNCHING LONG SPANS WITH GIN POLES.

Stringers are launched from the deck of completed spans as shown in figure 140, using gin

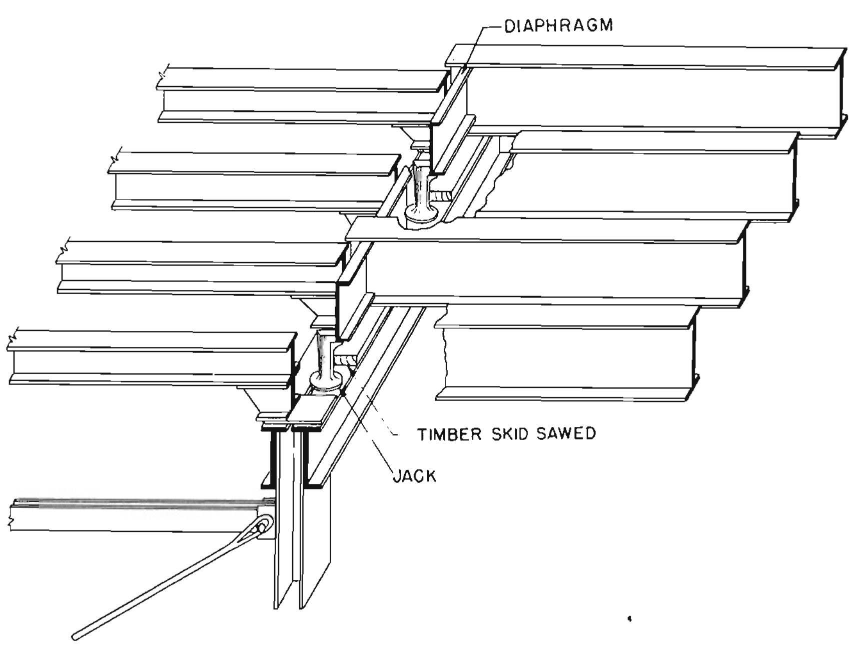


Figure 137. Lowering stringers to final position on bearings. Two or more stringers are lowered as a unit after diaphragms have been connected. Timber skids are sawed free from jacks.

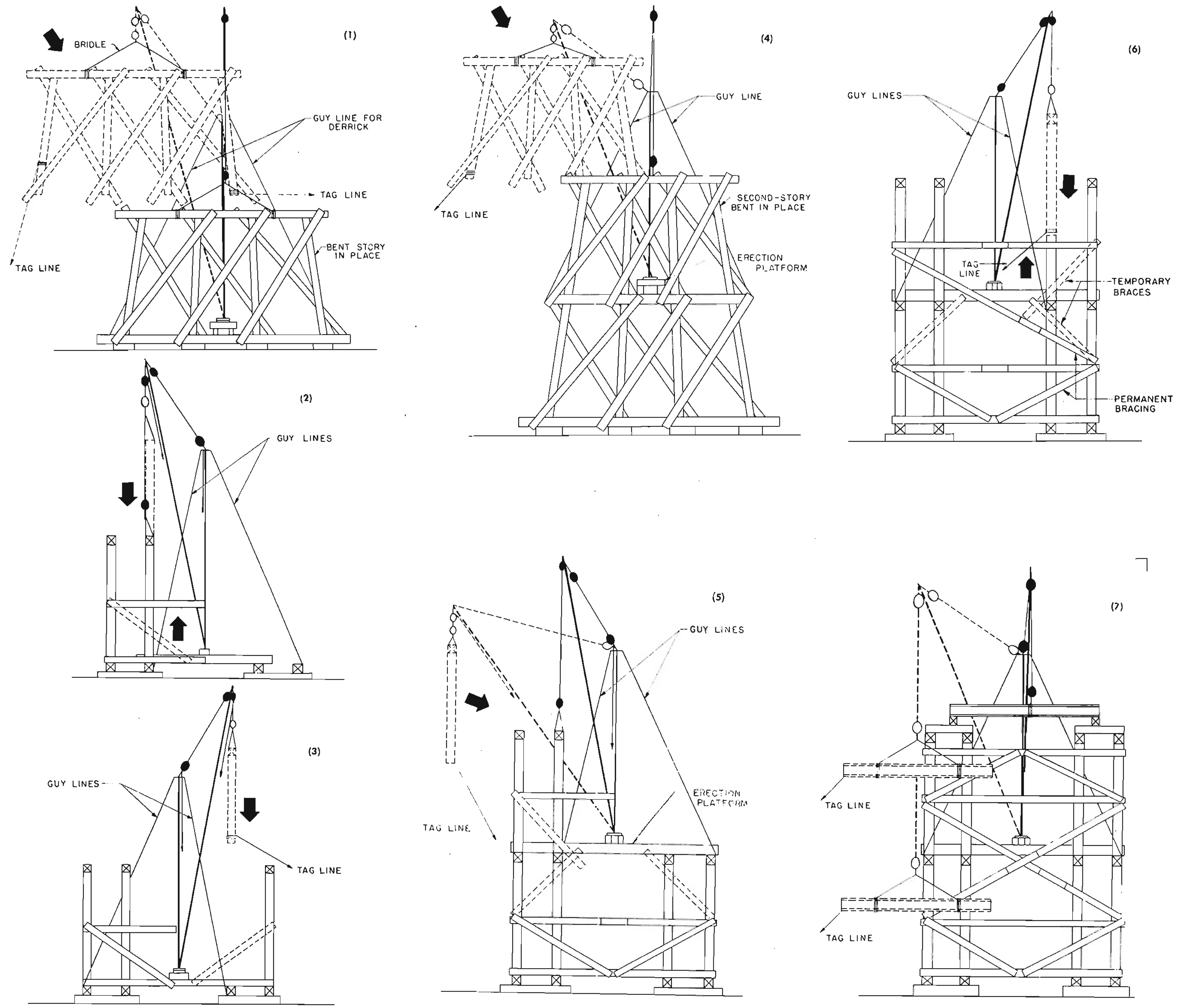


Figure 138. Sequence of erecting two-story timber tower with guy derrick made of bridge timbers

(1) Guy derrick placed on erection platform of timbers between tower bents. First-story outside bent being erected.

(2) First-story inside bent being erected. Temporary longitudinal bracing placed.

(3) Last first-story bent being lifted into place. Guy lines have been shifted to clear he bent.

(4) Derrick raised and erecting second-story end bent.

(5) Guy lines shifted for setting inside bent. Temporary bracing for second story; permanent longitudinal bracing in first story.

(6) Erection proceeds from the outside toward the center of the tower at each level.

(7) Tower erected. Derrick placing steel stringers of tower span.

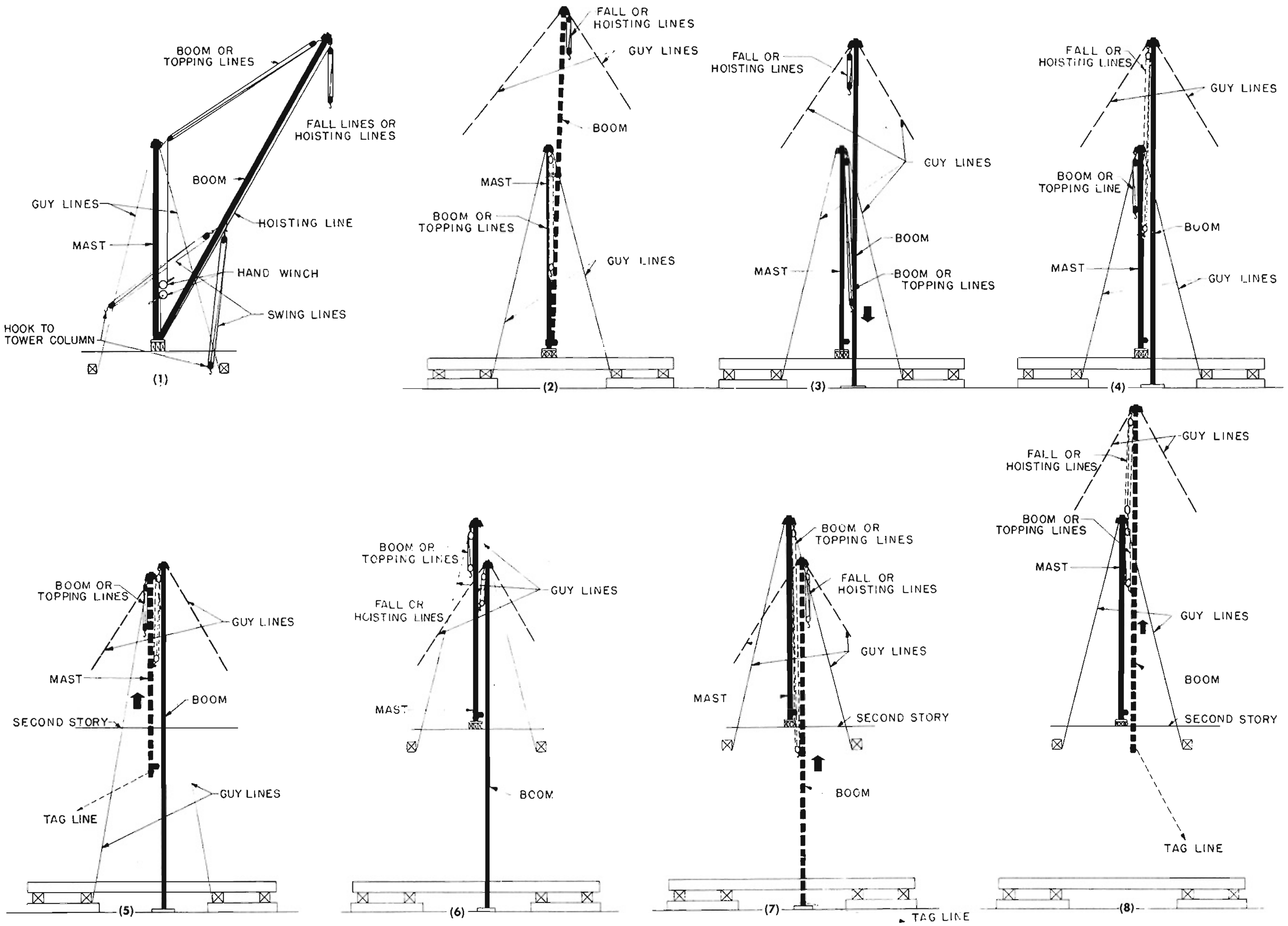


Figure 139. Steps in raising guy derrick to higher level for erection of multi-story timber towers.

(1) Guy derrick in working position.
(2) Boom raised to mast before shifting boom line. Temporary boom from mast step.
(3) Boom lowered and standing on timber platform.
(4) Boom guyed as gin pole to raise mast.
(5) Mast and sill raised by boom to higher level.
(6) Mast and sill seated and guyed at higher level. Sill must be securely anchored to prevent its sliding.
(7) Mast acting as gin pole to raise boom.
(8) Guyed mast and boom line used to raise boom to mast step.

poles. TM 5–285 contains detailed information on this launching procedure. The steel gin poles or the mast and boom used in erecting towers can be rigged as gin poles for this launching.

a. The shortest gin pole or the mast of the derrick is rigged on the far tower and the longest gin pole or boom of the derrick is set up on the near tower. Both are guyed to anchorages at ground level.

b. A fully assembled stringer is set on pipe rollers or on dollies on the bridge deck. A timber frame to guide the stringer and hold it upright during launching (fig. 141) is made and bolted at the end of the completed spans.

c. Tackle is attached from each gin pole to the forward end of the stringer with wire-rope lashing. A snubbing line is attached to the rear end of the stringer.

(1) Tackle must be attached so the beam has no tendency to twist or overturn.

(2) Each tackle must be strong enough to support the full weight of the stringer.

d. The stringer is launched across the gap by hauling in on the far tackle while paying out the near tackle. The snubbing line should be only tight enough to control the rate of movement. The tackle must be controlled during launching so the stringer bears on the forward roller at all times.

e. When the forward end of the stringer nears the far support, tackle from the gin pole on the near tower is connected with lashing to the near end of the stringer, the stringer is centered over the gap, and is lowered onto its bearings. The stringer is blocked in place.

f. Gin poles are shifted and succeeding stringers are launched in the same manner. Diaphragms are connected as soon as two stringers are seated. When all stringers of the span are in place, deck is laid to complete the span.

PART THREE

MAINTENANCE AND REPAIR

CHAPTER 17

MAINTENANCE AND REPAIR

215. GENERAL. General information on maintenance and repair of bridges is given in FM 5–10.

a. Inspection. Maintenance and repair required on these bridges are determined by periodic inspection. The frequency of inspections depends on:

(1) Importance of bridge.
(2) General condition and workmanship.
(3) Character and amount of traffic.
(4) Type of structure (timber or steel).

Ordinarily, a general monthly inspection is made by an officer experienced in bridge maintenance. Additional inspections should be made after each high water or whenever the bridge has been damaged in any way.

b. Repairs. Continual, properly directed maintenance will largely eliminate the need for extensive repairs and will keep the bridge open to traffic at all times.

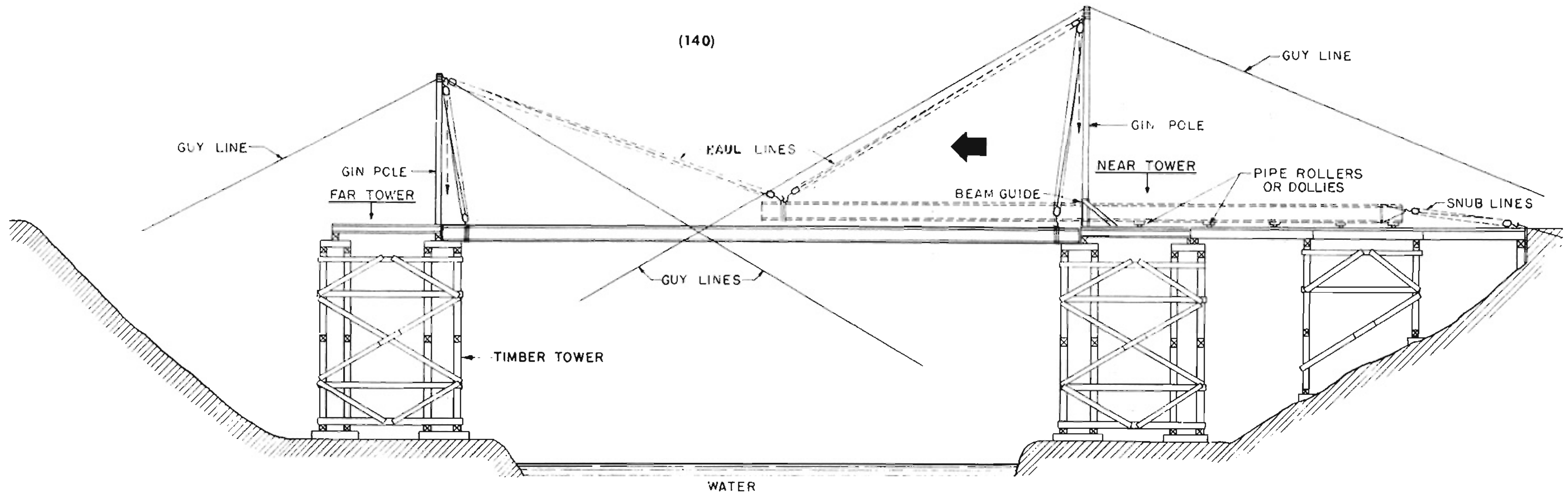


Figure 140. Launching steel stringers with gin poles. Gin poles on timber towers must be guyed to ground.

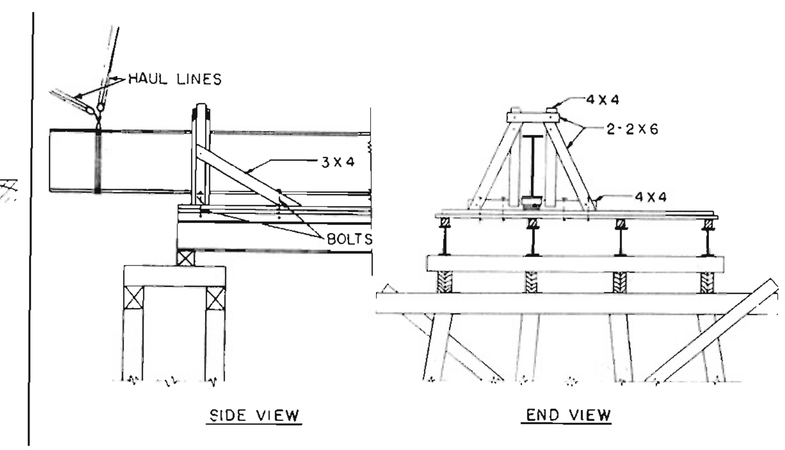


Figure 141. Timber frame used to guide stringer during launching. The beam should be launched directly over a stringer of the completed bridge.

216. BRIDGE FLOOR. a. Highway bridges. (1) Nails in floor planks should be redriven as they work loose. Damaged or worn longitudinal tread plank forming the wearing surface should be replaced when 10 to 15% of the original thickness has worn away. Splintering and rapid wear can be prevented by a tar or asphalt coating over which coarse sand or fine gravel is spread.

(2) Curbs and handrails should be checked regularly for loose connections. Replacement is usually necessary only when members have been damaged by accidents.

b. Railway bridges. Burned or damaged ties should be replaced promptly. Rail fastenings, hook bolts, and tie-spacer connections should be kept tight.

217. BEARINGS. a. Wherever steel work rests on masonry or timber supports its tendency to rust increases. As dirt and debris at these points accelerates rusting, these areas should be kept clean.

b. Expansion bearings must be clean to function properly. Slotted holes must be free of dirt and rust.

c. Any obstruction to free movement of stringers at expansion joints must be removed promptly.

218. CONNECTIONS. a. Timber. Unless thoroughly seasoned, timber shrinks during the early life of the structure. Frequent checks should be made and all bolted and nailed connections tightened when loose.

b. Steel. Properly made riveted or welded joints require no maintenance. Structural ribbed bolts have little tendency to loosen, but they should be examined and nuts drawn tight if loose. Rivets and bolts are tested for looseness by striking with a light hammer as explained in paragraph 123.

219. TIMBER MEMBERS. a. Failure of structural timbers may be caused by decay, rot, excessive load, structural defect, fire, or explosives.

b. Untreated timbers in contact with the ground often deteriorate rapidly. Timbers continuously below water do not decay but may be attacked by marine borers. In some localities, insects may cause serious damage to timber structures. Piling and timbers in footings and abutment bulkheads should be checked carefully, and damaged timbers should be replaced. Damage by insects can be arrested or retarded by painting with creosote. Piling may be repaired by splicing in new sections above the ground line. (See par. 144.)

220. STEEL MEMBERS. a. Rusting. (1) Rusting is rarely rapid enough to require special attention on semipermanent bridges. However in locations subject to salt-water spray and in moist, warm climates, serious rusting of steel parts in contact with timber members may occur. Dirt and trash should not be permitted to accumulate in pockets and crevices between members since it retains moisture and promotes rusting.

(2) Rust flakes are five to eight times as thick as the metal from which they are formed. Loose rust is not serious; only deep pitting needs to be checked. Areas subject to severe rusting should be painted or coated with tar or asphalt. For painting of steel bridges, see paragraph 197.

b. Bracing. Turnbuckles permit adjusting the rod diagonals of framed steel towers. Shake the rods to see that none are loose and that none are under undue tension. Rods should be tight but not heavily stressed. Uniform adjustment should be maintained.

c. Replacement. Replacement of steel members in semipermanent bridges is usually necessary only when they have been damaged by accident or explosives.

221. FOUNDATIONS. a. Scour. Foundations should be inspected after each high water. Soundings should be made around bridge foundations in water if there is any indication of scour.

(1) Where scour has occurred, the original contour of the stream bed should be restored by filling with stone, and the foundation should be protected with riprap.

(2) Where spread footings have been partly undermined, concrete or tightly packed stone should be used to restore the original bearing area. The surrounding area must be thoroughly protected with riprap so the new supporting material will remain in place.

(3) If repair must be made in deep water, a cofferdam of either type shown in appendix II, figures 152 or 154, can be used.

b. Settlement. Foundation settlement can be caused by overload or by softening or shrinkage of the foundation material.

(1) Minor settlement can be corrected by jacking up the supported structure and inserting shims between it and the settled foundations. Shims should be placed between stringers and pile caps of pile bents and piers, and between bearing plates and pedestals. Steel shims should be used under steel members and steel or hardwood shims under timber members.

(2) Wherever possible, conditions causing settlement should be corrected before major damage occurs and it becomes necessary to replace the foundation.

(*a*) Areas close to spread footings on earth should be graded so they drain properly.

(*b*) If foundations are threatened by scour or caving of stream banks, banks should be protected with timber and brush mats, riprap, dumped stone, or pile and timber retaining walls. (See par. 225, FM 5–10.)

c. Drift. Drift should not be allowed to collect against bridge supports. Masses of drift may destroy the bridge during flood; during low stream stages they are a fire hazard. When large amounts of drift are carried by the stream, constant attention may be required to keep it from massing against supports. Small pieces of drift can be cleared with poles and hooks; large pieces can be pulled clear by a crane working from the bank or from the bridge deck.

d. Ice. Moving sheet ice and ice jams against the bridge must be broken, by blasting when necessary. Piling may be worn and cut by thin floating ice. Where such damage becomes severe, piles can be protected with sheet metal bands.

222. APPROACHES. Approaches at abutments should be well maintained. Settlement of the approaches back of the abutments should be corrected immediately.

a. Highway bridges. Grade line of unpaved approaches of highway bridges should be about 1 inch above the grade line of the bridge. The grade line of paved approaches should be the same as that of the bridge.

b. Railway bridges. To prevent a dip in the track, ballast should be added to track back of bridge abutments as settlement occurs.

PART FOUR

DESIGNS

CHAPTER 18

DESIGNS

223. STANDARD DESIGNS. a. Arrangement of drawings.

(1) The design drawings are arranged in the following groups:

Group 1: Sheets 1–43, Highway, class 50, single-lane.

Group 2: Sheets 44–90, Highway, class 50, double-lane.

Group 3: Sheets 91–127, Highway, class 25, double-lane.

Group 4: Sheets 128–155, Drawing common to all highway bridges.

Group 5: Sheets 156–225, Railway, E–45.

Group 6: Sheets 226–227, Alternative welded details for steel towers.

Group 7: Sheets 228–234, Special erection equipment.

Group 8: Sheets 235–245, Adaptations to prefabricated standard bridges.

(2) The design drawings for each unit of construction make up a drawing set. The drawings comprising each set are listed on:

Sheet 1, Highway, class 50, single-lane.
Sheet 44, Highway, class 50, double-lane.
Sheet 91, Highway, class 25, double-lane.
Sheet 156, Railway, E–45.

For example, sheets required for a framed steel tower for a railway bridge are listed on sheet 156, set RR–5.

(3) In each set there is a basic drawing showing assembled views. Companion sheets show fabrication details, bills of materials, symbols used on drawings and general notes. The general note sheet 154 and symbol sheet 155 are included in all drawing sets.

(4) All pieces of each unit are given mark numbers. The mark number distinguishes each piece as to size, length, and fabrication details. Mark numbers carrying designation R (right) and L (left) have the same details but in reverse positions. Where pieces are marked with "X end," the piece must be set with the "X end" in position as shown on the assembly plan. Stock numbers are shown for requisitioning from supply depots. Complete stock numbers are given where full length pieces are required. For short pieces or random-length pieces the subdecimal of the stock number indicating length has been omitted.

(5) Pieces such as floor planking and handrails are specified as to length in bill of materials. Random lengths may be used as indicated on the drawings and for short pieces.

(6) Span lengths are fixed by the stringer lengths which remain the same for end, intermediate, and single spans.

(*a*) *Timber spans.* No space is left between ends of stringers on intermediate supports nor between stringers and end dam on abutments. Stringers in highway spans have lapped ends on intermediate supports; stringers on railway spans have butted ends. Timber span dimensions are measured as follows:

	At intermediate support, to:	*At abutment, to:*
Highway span, 11-, 13-, 15-foot	Center of cap	Center of cap
Railway span, 12-, 14-, 16-foot	Center of cap	Face of end dam

(*b*) *Steel spans.* Designs are prepared for:

Highway spans, 15-foot length and 20- to 90-foot length by even 10-foot intervals.

Railway spans, 15- to 50-foot length by even 5-foot intervals; also 30-foot length of two continuous 15-foot spans with center support.

The over-all length of steel stringers is $1\frac{1}{2}$ inches less than the designated span. On intermediate supports, the $1\frac{1}{2}$-inch space allows for expansion of the stringers and variation in position of the support. On abutments, 2-inch clearance is figured between ends of stringers and face of bulkhead posts, except railway pile bent abutments for 25-foot maximum span and timber grillage abutments for 15-foot span on which the stringers extend $1\frac{1}{4}$ and $2\frac{1}{4}$ inches respectively beyond the face of the bulkhead posts. Steel-span dimensions with respect to the different types of support are measured as follows:

1. *Highway spans on intermediate supports.*

Timber pile piers	To center of pier
Steel pile bents	To center of bent
Steel pile piers	To center of pier
Timber towers, span to tower	2′-5″ beyond center of end bent
15-foot tower span	1′-7″ beyond center of inside bent
Steel towers, span to tower	To center of bent
30-foot tower span	To center of bent

2. *Highway spans on abutments.*

Timber grillage, class 25, all spans	$3\frac{3}{4}$″ beyond center of cap
class 50, 15-to 40-foot span	$3\frac{3}{4}$″ beyond center of cap
class 50, 40-to 90-foot span	$4\frac{3}{4}$″ beyond center of cap
Timber pile bent, all spans	$4\frac{3}{4}$″ beyond center of cap
Steel pile bent, all spans	$4\frac{3}{4}$″ beyond center of cap
Concrete, all spans	$1\frac{1}{4}$″ from face of backwall

3. *Railway spans on intermediate support.*

Braced timber pile piers, span to pier	2′-5″ beyond center of end bent
15- foot span between piers	1′-7″ beyond center of bent
Braced steel pile bents, 15- to 30- foot spans	To center of bent
Braced steel pile piers, 35- to 50- foot span to pier, and 15-foot span between piers	To center of piers
Timber tower, span to tower	2′-2″ beyond center of end bent
Double 15-foot tower span	1′-10″ beyond center of inside bent
Steel tower, span to tower	To center of bent
25-foot tower span	To center of bent

4. *Railway spans on abutments.*

Timber grillage, 15-foot span only	8″ beyond center of cap
Timber pile bent, 15- to 25-foot span	8″ beyond center of cap
Timber pile pier, 30- to 45-foot span	$6\frac{3}{4}$″ beyond center of pier
50-foot span	$4\frac{3}{4}$″ beyond center of cap
Steel pile bent, all spans	$4\frac{3}{4}$″ beyond center of cap
Concrete, all spans	$1\frac{1}{4}$″ from face of backwall

5. *Riveted spliced stringers.* For riveted spliced stringers exceeding 40 feet in length bills of materials are shown assuming exact length for 40 foot sections. All other sections are shown in bills of materials $\frac{1}{2}$-inch less in length than dimensioned on the fabrication drawings in order to provide cutting tolerance of minus 0 to plus $\frac{1}{2}$-inch. Where 40 foot sections overrun or underrun lengths of adjacent sections must be adjusted accordingly.

6. *Welded spliced stringers.* For welded spliced stringers exceeding 40 feet in length bills of materials are shown assuming exact lengths of all pieces as dimensioned on the fabrication drawings. Spliced ends must be fitted, beveled and trimmed to exact length with allowances of 1/8-inch gap for butt welding.

7. *Bills of materials.* These are complete for all standard designs. When modifying standard designs, adjustments must be made for other material needed. The drawings show details of timber and steel stringer spans meeting on a common support, and unequal depth steel stringers meeting at a common support. The drawings from which bills of materials and details for shims, blocking, bearing plates, and anchor bolts can be obtained are shown on sheet 154. Anchor bolts for anchoring framed towers to footings are shown in bill of materials for footings.

b. Use of drawings. After the bridge lay-out has been determined and the types of units of construction selected, the complete list of drawings required for assembly of parts, bills of materials, and fabrication details can be made by combining the lists of drawings for all units used in the bridge.

c. Variation in tower heights. (1) *Framed steel towers.* Complete plans for framed steel towers varying in height from 15 to 77 feet by 2-foot increments are included in the manual. In the lay-out, footing elevations are adjusted so towers of odd height are not used.

(2) *Framed timber towers.* (*a*) Complete plans including bills of materials are given for timber towers varying in height from 13 feet 4 inches to 75 feet 10 inches. If dressed-size timber is used for caps and sills the column lengths shown on sheets 148 and 183 should be increased to compensate for the smaller size.

(*b*) Towers 13 feet 4 inches, 25 feet 10 inches, 38 feet 4 inches, 50 feet 10 inches, 63 feet 4 inches, or 75 feet 10 inches high are built of full 12-foot 6-inch stories. Towers of intermediate heights are built of one or more full 12-foot 6-inch stories and a short bottom story. In preparing bills of materials for towers containing a short bottom story, the bottom story is counted as a full story and members for it are cut in the field to fit. Footing locations are shown for heights varying by 2-foot intervals. (See sheets 37, 82, 121, and 214.)

d. Longitudinal bracing. (1) *Timber pile bents.* In trestle bridges of timber stringers on timber pile bents more than 17 feet high, longitudinal bracing is required between bents in every third span. Where longitudinal bracing is two panels high, longitudinal struts are added in unbraced spans. Bents less than 17 feet high require no longitudinal bracing.

(2) *Steel pile bents.* Steel pile bents for highway spans are not braced longitudinally. For railway bridges, longitudinal bracing is required in alternate spans.

e. Combinations of spans. Combinations of spans and supporting units, bents, piers, and towers are shown in the selection diagrams, tables XVII to XXIV inclusive. Details of junctions of steel and timber spans on a common support are shown on the drawings.

Caution: The combined length of the two spans on a common support must never exceed the lengths shown below. (Height of support is measured from grade to ground.)

Type of bridge and support	*Maximum combined length of two spans on common support Feet*
Highway, all classes, on timber pile bent up to 30 feet high	30
on timber pile pier up to 18 feet high	180
on steel pile bent up to 23 feet high	100
23 to 30 feet high	70
on steel pile pier up to 35 feet high	180
Highway, class 50 on timber pile pier 18 to 30 feet high	100
Highway, class 25 on timber pile pier 18 to 30 feet high	120
Railway, on timber pile bent up to 30 feet high	32
on timber pile pier up to 15 feet high	50+15
on steel pile bent up to 23 feet high	30+15
on steel pile pier up to 23 feet high	50+15

f. Construction in water. Limitations of construction in water are given in paragraph 10.

g. Expansion and contraction. (1) No provision is necessary in timber bridges for expansion and contraction of stringers.

(2) Bearings at one end of all steel stringers have slotted bolt holes permitting expansion and contraction of stringers with temperature changes.

(*a*) Steel stringers should be arranged at intermediate supports so there is one expansion and one fixed bearing at each support.

(*b*) Timber decks of highway structures on steel-stringer bridges must be broken over all expansion joints. Timbers must not extend across the joint but must be cut at the ends of the stringers as shown on sheet 128. Nailers should be placed on end diaphragms of steel spans for full width of roadway to provide additional support for roadway planking.

h. Riprap. Where foundations are built in water and protection must be made against scour around piles, riprap (par. 168*b*) can be placed as indicated on the drawings. Extreme amounts of riprap are shown. The amount necessary depends on stream characteristics. (See par. 221*a*.) Enough riprap should be used to:

(1) Protect the bottom effectively against scour.

(2) Keep the unbraced pile length within limits given in paragraph 10. No riprap should be used around piles if the stipulated maximum water depth (par. 10) is unlikely to be exceeded after scour. Riprap unwisely placed may restrict the flow of the stream and cause scour which otherwise would not have occurred.

i. Walkways and refuge bays. Walkways may be provided on highway bridges (sheet 130) and refuge bays or walkways may be provided on railway bridges (sheet 174) if the bridge is long and a safety zone is desired. If a sidewalk is added when the bridge is constructed, its design can be simplified by using extended deck plank as walkways, or by using extra long cross ties at intervals.

j. Tower bracing for steel towers. The standard designs for either riveted, bolted, or welded construction provide longitudinal, transverse, and horizontal bracing of round rod sections with pin and connections. Each diagonal of longitudinal or transverse bracing consists of two loop rods threaded at the straight end and a turnbuckle. Each rod of the horizontal bracing consists of two clevises, two rods threaded at both ends, and a turnbuckle requisitioned as one unit from the supply depot. After the length of the diagonal is determined one of the threaded rods or loop rods is cut in two and a length of additional rod is spliced in to give correct length. Pipe sleeves, washers, and cotter pins complete the assembly in erected position.

k. Splices. Splices shown for steel stringers are designed on the basis of actual shears and moments at the point of splice. A change in the location of a splice on the beam should be made only on the recommendation of experienced designers.

224. ALTERNATIVES. a. Connections. The manual shows details of riveted, bolted, and welded connections of steel parts. Structural ribbed bolts may be used instead of rivets; nominal size (but not length) and number of bolts is the same as for rivets.

(1) If 7/8-inch machine bolts are substituted for rivets, the bridge capacities must be adjusted as shown in the following paragraphs.

(*a*) Capacity must be reduced 20 percent for the following steel construction units using machine bolts:

Construction unit	*Machine bolts used in*
All spans over 40 feet long	Stringer splices.
Pile piers under highway spans of over 140-foot combined length	Corbels and cap beams.
Towers supporting class 50 highway	Cap beam, column splices.
Two-story, over 70-foot span.	
Three-story, over 60-foot span.	
Four-story, over 50-foot span.	
Pile bents under railway spans of 40-and 45-foot combined length	Cap beam.
Pile piers under railway spans of 50-, 55-, and 60-foot combined length	Corbel and cap beam.
Pile abutment under 50-foot railway span	Cap beam.
Towers and steel pile frames supporting railway span	Cap beam, column splices, steel-frame connections.
Three-story, for 50-foot span.	
Four-story, over 40-foot span.	

(*b*) No reduction in capacity is required for steel construction units with machine bolts in:

Stiffeners, diaphragms, bracing for spans, bents, and piers.

Highway pile bents, abutments, steel pile frames under towers.

Pile piers under highway spans up to 140-foot combined length.

Towers, class 25, any height and span.

Towers, class 50, two-story up to 70-foot span.

three-story up to 60-foot span.

four-story up to 50-foot span.

Pile bents under railway spans of 30- and 35-foot combined length.

Pile piers under 50-foot railway span (65-foot combined length).

Pile abutments under railway spans up to 45-foot length.

TABLE L. *Moments and shears for steel stringers for standard designs.*

Span (feet)	Max moment (ft. kips)	SM required (inch³)	Max shear (kips)	Web area required (sq. in.)
CLASS 50, SINGLE-LANE HIGHWAY (EACH OF 4 STRINGERS)				
15	112.6	50.1	35.0	2.12
20	174.1	78.9	40.3	2.45
30	305.6	138.3	47.5	2.88
40	446.6	202.2	51.9	3.15
50	593.8	268.8	55.5	3.37
60	763.7	345.9	59.2	3.59
70	925.8	419.3	61.9	3.75
80	1127.9	501.5	65.6	3.98
90	1340.6	596.0	68.9	4.18
CLASS 50, DOUBLE-LANE HIGHWAY (EACH OF 6 STRINGERS)				
15	138.8	61.7	35.2	2.13
20	213.2	94.8	40.6	2.46
30	374.5	166.4	47.8	2.90
40	550.9	245.0	52.8	3.20
50	735.0	326.7	56.8	3.44
60	931.8	414.2	60.2	3.65
70	1144.1	508.5	63.4	3.84
80	1383.2	615.0	67.2	4.07
90	1663.5	739.0	72.0	4.36
CLASS 25, DOUBLE-LANE HIGHWAY (EACH OF 6 STRINGERS)				
15	79.1	35.2	20.1	1.22
20	120.2	53.4	22.8	1.38
30	210.6	93.6	26.8	1.62
40	305.0	135.6	29.3	1.77
50	408.2	181.4	31.2	1.89
60	516.7	229.8	33.3	2.02
70	641.6	285.2	35.5	2.15
80	773.6	343.8	37.6	2.28
90	924.2	410.8	40.0	2.42
RAILWAY, E-45 (FOR EACH RAIL)				
15	277.4	129.5	88.1	5.34
20	452.2	210.3	108.9	6.60
25	661.2	306.0	122.4	7.42
30	883.2	404.6	134.6	8.16
35	1119.0	519.0	146.7	8.90
40	1388.5	636.0	157.7	9.56
45	1689.5	759.0	170.8	10.35
50	2002.0	907.0	180.8	10.95

1 Kip = 1,000 lb.

Towers and steel pile frames supporting railway spans.
Three-story up to 45-foot span.
Four-story up to 40-foot span.

(*c*) Machine bolts used for final connections must have shanks (unthreaded length) not shorter than the thickness of the joined steel sections. Washers are used and nuts must be tight.

b. Roadway decks. An alternative to the standard double-layer plank roadway is the laminated floor with longitudinal tread plank. The two types are shown on sheet 128. Use of laminated floor is recommended where plank for the standard floor is not available and the smaller dimension timber required for it can be obtained.

c. Stringer sections. (1) *Standard designs.* For each class of traffic and each standard span length, there is one standard stringer design. Standard sections should be used for all new structures if the required sections are available. Moments and shears are listed in table L. Where possible standard designs should also be used in reconstructing existing or damaged structures. Any deviation from standard span lengths or standard number or sections of stringers requires adjusting details and bills of materials.

(2) *Nonstandard designs.* Nonstandard spans should be used only where standard stringer sections are not available or where existing bridge supports fix span lengths for new superstructures. Design data for selecting stringer sections for spans not of standard length and stringer sections not used in the standard designs are given in figures 142 to 144 inclusive and table LI.

(3) *Use of design data.* The following examples illustrate the use of this design data.

(*a*) *Highway bridges—steel stringers.* The tables (figs. 142(2), 142(4) or 143(2)) are used when span lengths are standard but standard stringer sections are not available. The graphs (figs. 142(3), 142(5) or 143(3)) are used when span lengths are not standard.

1. *Example A:* Required: 40-foot span, class 50, single-lane highway. Condition: 24-inch 87-pound I-beam required for standard design not available. From the table (fig. 143(2)) there are two substitutes:
   5 stringers, 24-inch I 74-pound
   6 stringers, 21-inch I 63-pound
   Details such as diaphragms must be modified accordingly.
2. *Example B:* Required: 68-foot span, class 50, single-lane highway. Enter lower edge of graph (fig. 143(3)) with 68-foot span; follow vertically to intersection with curve marked "4 stringers—standard design"; read at left side of graph—"33-in. I 132-lb."; or for "5 stringer alternate No. 1," read at left side of graph "33-in. I 125-lb."; or for "6 stringer alternate No. 2", read at left side of graph "30-in. I 108-lb."

(*b*) *Highway bridges—timber stringers.* Table LI is used for standard length spans. No data are given for odd-length timber spans.

Example C: Required: 15-foot timber span, class 25, double-lane highway. Condition: Stringers deeper than 14 inches are not available. From table LI, the net width of 14-inch stringer required is 75 inches. Hence, 14-inch net-dimension stringers can be used as follows:

19 — 4 x 14 W = 19 x 4 = 76 inches
13 — 6 x 14 W = 13 x 6 = 78 inches
10 — 8 x 14 W = 10 x 8 = 80 inches

(*c*) *Railway bridges—steel stringers.* For standard span length, no alternative sections are given. For special span lengths, figure 144 is used, the procedure being as outlined in example B above.

(*d*) *Railway bridges—timber stringers.* For special span lengths, no design data are given. For standard span lengths, table LI is used, the procedure being as outlined in example C above.

(*e*) *Plate girders.* If rolled beams are not available but plates and angles can be obtained, plate girders can be fabricated in the field and used instead of rolled sections. The design of riveted and welded plate girders equivalent to standard rolled beams is given in appendix I.

TABLE LI. *Required total width of timber stringers in inches for different highway and railway spans.*

Span (feet)	Stringer depth (surfaced dimension lumber) 12-inch	14-inch	16-inch	18-inch
	HIGHWAY SPANS, CLASS 50, SINGLE-LANE			
11	62	55	49	44
13	74	56	50	45
15	88	67	52	46
	HIGHWAY SPANS, CLASS 50, DOUBLE-LANE			
11	114	100	89	79
13	138	103	91	81
15	164	124	94	84
	HIGHWAY SPANS, CLASS 25, DOUBLE-LANE			
11	71	58	52	47
13	90	66	53	48
15	108	75	62	51
	RAILWAY SPANS, E–45 LOADING, TWO RAILS			
12	44	36	32	28
14	60	44	36	32
16	76	56	42	38

225. MODIFICATIONS.

a. Towers on sloping banks. (1) Standard tower designs have the base plates of all four columns of the same elevation. Footings should be at different levels only where the bank is very steep or where the excavation necessary to place footings at a uniform level would be difficult.

(2) Where footings must be at different levels, bracing is divided into stories to fit the highest column of the tower. Material is requisitioned to construct a standard tower of height of highest column. Bracing and the short column in the bottom story are modified in the field to fit the conditions. The footing under the short column is pleaced nearer to the bridge center line so the column batter is maintained. Modification of column lengths and bracing to fit footings at different levels is shown in figure 145.

b. Curved alignment. (1) *General.* For long bridges on sharp curves, bents, piers, or towers are set on radial lines. However, bents in each individual pier or tower should be parallel to avoid special longitudinal bracing. Span lengths are measured on roadway center line. Where supports are on radial lines, the outer stringers are longer than the inner stringers. Where possible this adjustment is made in the slotted-hole locations only, the actual stringer length remaining unchanged.

(2) *Railway bridges.* (*a*) For curved track alignment on a straight bridge, the maximum length of straight bridge for any given curve is given by the formula:

$$L = \sqrt{\frac{2RM}{3}}$$

Symbols:

L = total length of straight bridge in feet.

R = radius of curve in feet $= \dfrac{5730}{\text{degree of curve}}$

M = Length in inches of middle ordinate of curve taken over total length of straight bridge.
(M must not exceed 8 inches.)

(*b*) For a given length of bridge, the sharpest curve (fig. 146) that can be used is given by the formula:

$$R = \frac{3L^2}{2M}$$

(*c*) The following speed restrictions should be enforced on railroad bridges built on a curve.

Degree of curve	*Permissible speed in m.p.h.*
0° to 1° 30′	40
1° 30′ to 2° 30′	30
2° 30′ to 6° 30′	20

With speeds restricted as shown above, no superelevation of track is necessary.

(*d*) No provision is necessary for strengthening railway bridges for centrifugal forces resulting from curved alignment.

(3) *Highway bridges.* No speed reduction or superelevation is proposed on highway bridges built on curve.

c. Grades. All designs given in the manual are for bridges with level roadway or deck. For bridges on grade, blocking or shims are used between stringers and supports. Shims must be beveled to conform with the roadway slope.

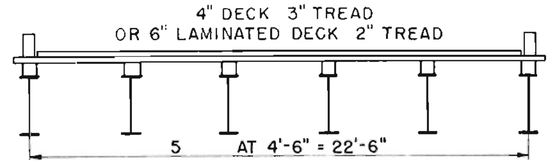
226. ADAPTATIONS.

a. Highway bridges. Bents, piers, and abutments of class 50 single-lane highway bridges can be adapted to standard steel highway spans described in other manuals.

(1) *Semipermanent highway steel bridges,* 30-, 60-, *and* 90-*foot spans.* These semipermanent prefabricated highway bridges are described in TM 5–285. They are referred to as prefabricated semipermanent highway or 1943 design bridges. Modification of standard supporting structures for use with these spans is shown on sheets 235 to 243.

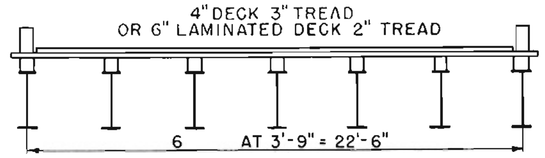
Support	Sheet number 30-*foot*	60-*foot*	90-*foot*
Framed timber tower	235	238	241
Steel pile pier	236	239	242
Timber pile pier	236	239	242
Timber grillage abutment	236	239	242
Concrete abutment	237	240	243
Steel pile abutment	237	240	243
Timber pile abutment	237	240	243

DOUBLE-LANE HIGHWAY

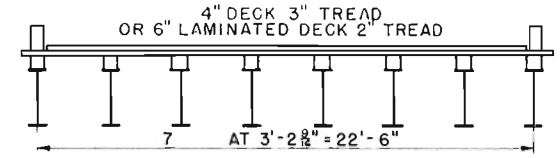


STANDARD DESIGN 6 STRINGERS

(1)



ALTERNATE NO 1, 7 STRINGERS



ALTERNATE NO 2, 8 STRINGERS

(2)

CLASS 25

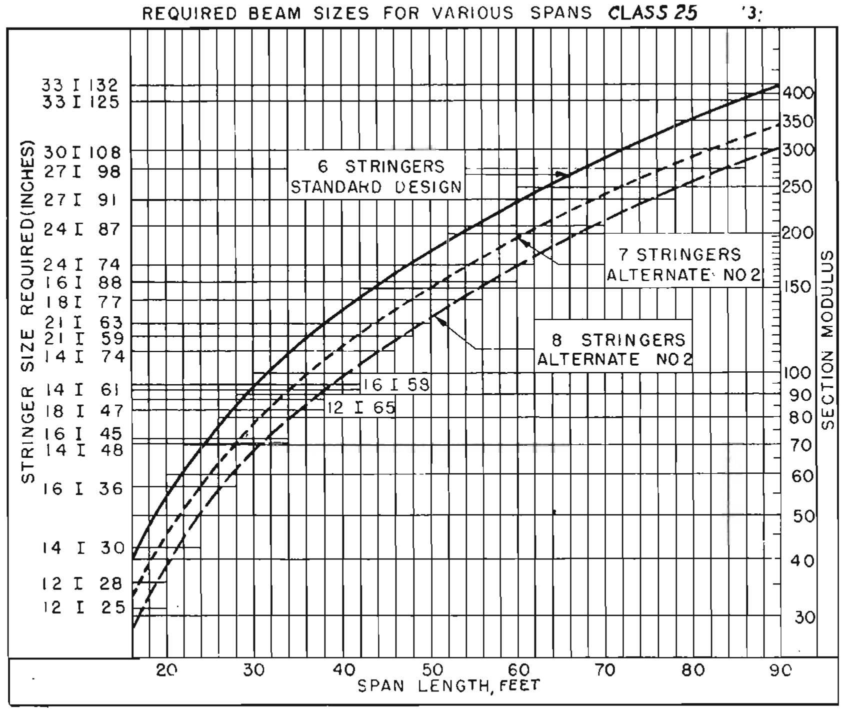
SPAN LENGTH (FEET)	STANDARD DESIGN 6 STRINGERS SIZE(INCHES)	ALTERNATE NO 1 7 STRINGERS SIZE(INCHES)	ALTERNATE NO 2 8 STRINGERS SIZE(INCHES)
15	14 I 30	12 I 25	12 I 25
20	16 I 36	16 I 36	14 I 30
30	21 I 59	18 I 47	16 I 45
40	21 I 63	21 I 59	21 I 59
50	24 I 87	24 I 74	21 I 63
60	27 I 91	24 I 87	24 I 74
70	30 I 108	27 I 98	24 I 87
80	33 I 125	30 I 108	30 I 108
90	33 I 132	30 I 108	30 I 108

(4)

CLASS 50

SPAN LENGTH (FEET)	STANDARD DESIGN 6 STRINGERS SIZE(INCHES)	ALTERNATE NO 1 7 STRINGERS SIZE(INCHES)	ALTERNATE NO 2 8 STRINGERS SIZE(INCHES)
15	18 I 47	16 I 36	14 I 30
20	21 I 59	18 I 47	16 I 45
30	24 I 74	24 I 74	21 I 59
40	27 I 91	24 I 87	24 I 74
50	33 I 125	30 I 108	27 I 91
60	33 I 132	33 I 125	30 I 108
70	36 I 150	33 I 132	33 I 125
80	36 I 182	36 I 150	36 I 150
90	36 I 230	36 I 182	36 I 182

REQUIRED BEAM SIZES FOR VARIOUS SPANS CLASS 25 (3)



(5) REQUIRED BEAM SIZES FOR VARIOUS SPANS CLASS 50

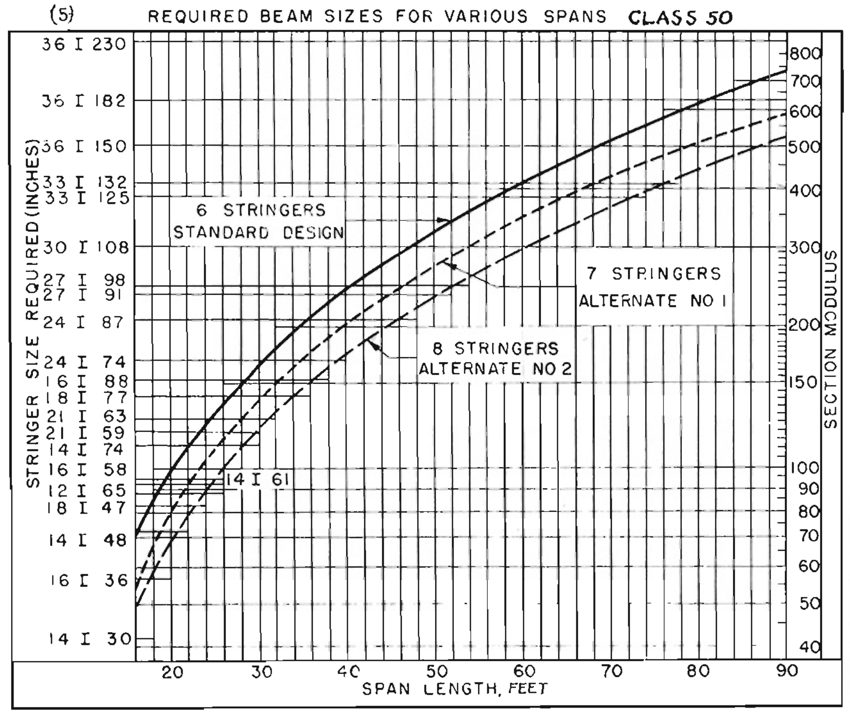
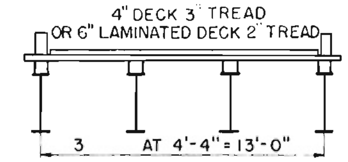


Figure 142. Alternative stringers for double-lane highway bridges.

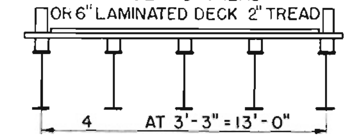
(1) Stringer spacing and arrangement.
(2) Table of standard and alternative stringer sections, class 25 highway bridges.
(3) Graph of required stringer sizes for different spans, class 25 highway bridges.
(4) Table of standard and alternative stringer sections, class 50 highway bridges.
(5) Graph of required stringer sizes for different spans, class 50 highway bridges.

SINGLE-LANE HIGHWAY

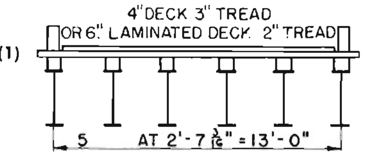


STANDARD DESIGN 4 STRINGERS

(1)



ALTERNATE NO 1, 5 STRINGERS



ALTERNATE NO 2, 6 STRINGERS

(2)

CLASS 50

SPAN LENGTH (FEET)	STANDARD DESIGN 4 STRINGERS SIZE(INCHES)	ALTERNATE NO 1 5 STRINGERS SIZE(INCHES)	ALTERNATE NO 2 6 STRINGERS SIZE(INCHES)
15	16 I 36	14 I 30	12 I 25
20	18 I 47	16 I 45	16 I 36
30	24 I 74	21 I 59	21 I 59
40	24 I 87	24 I 74	21 I 63
50	30 I 108	27 I 91	24 I 87
60	33 I 125	30 I 108	27 I 91
70	33 I 132	33 I 125	30 I 108
80	36 I 150	33 I 132	33 I 125
90	36 I 182	36 I 150	33 I 132

(3) REQUIRED BEAM SIZES FOR VARIOUS SPANS CLASS 50

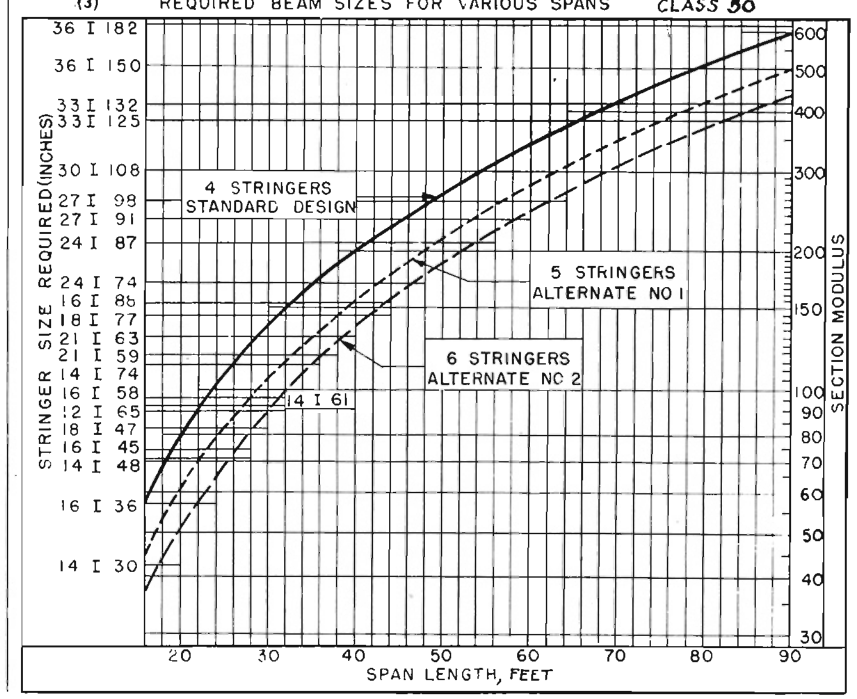


Figure 143. Alternative stringers for single-lane highway bridges.

(1) Stringer spacing and arrangement.
(2) Table of standard and alternative stringer sections.
(3) Graph of required stringer sizes for different spans.

(2) *Fixed steel panel bridge, Bailey type.* Bailey bridges are described in TM 5–277. They may be used with timber pile bents, piers, and abutments, steel pile bents and abutments, or with concrete abutments of this manual. Necessary modifications are shown on sheet 244.

(3) *Portable steel highway bridge H–10 and H–20.* These bridges are described in TM 5–274. They may be used with steel or timber pile piers or abutments or with concrete abutments of this manual. Necessary modifications are shown on sheet 245.

b. I-beam railway bridges. I-beam spans are described in TM 5–371. By modifying the end bearings, they may be used with any of the railway supports given in this manual except timber pile bents.

PART FIVE

APPENDIX I

PLATE GIRDER DESIGN

1. GENERAL. Typical details of riveted and welded plate girders are given on figures 150 and 151 respectively. These girders can be used instead of the 21- and 24-inch beams used in the standard designs. Examples of the method used in designing the 24-inch girders are given in the following paragraphs. The examples will guide trained designers in proportioning plate girders to be used instead of standard rolled beams and in checking and repairing plate girders found in the field.

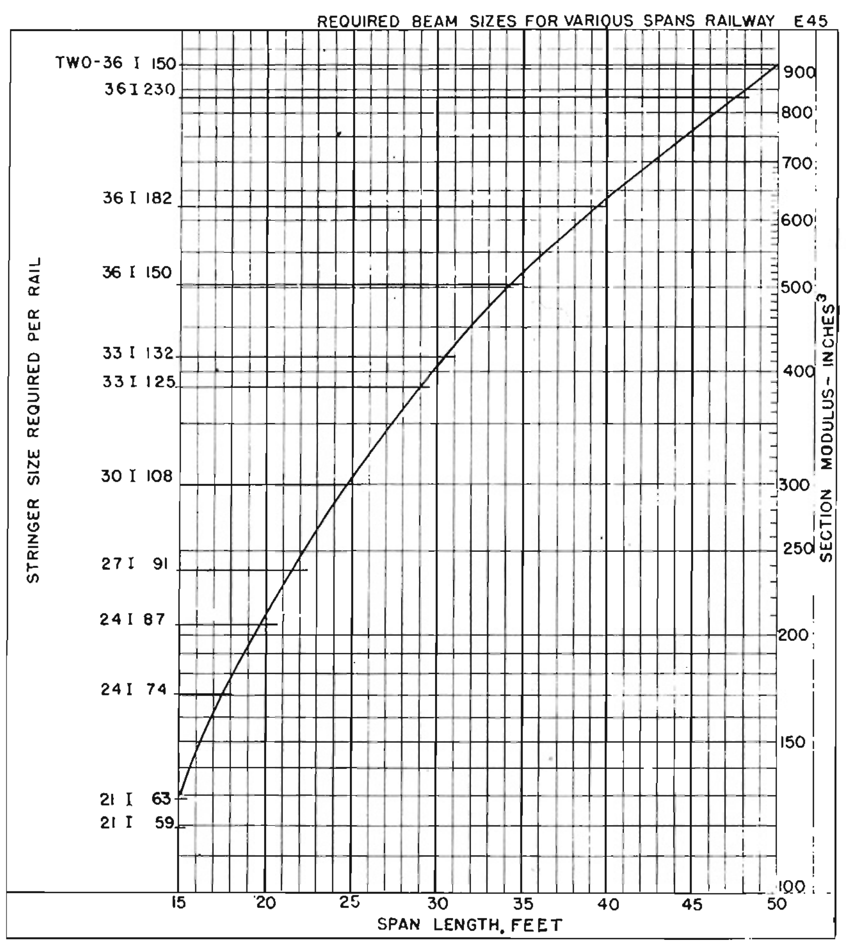


Figure 144. E–45 railway bridges. Graph of required stringer sizes to different spans.

2. PROBLEM. The problem is to design a plate girder to be used instead of the 21-inch 63-pound rolled beam used in the standard 40-foot span of the class 25, double-lane highway bridge. From table L, the moments and shears to which the girder will be subjected are:

Maximum moment (M) = 305.0 foot kips.
Maximum shear (V) = 29.3 kips.

3. RIVETED DESIGN. Use 24-inch plate girder with ⅜-inch web (class IV material) as shown in figure 147.

a. Determine flange section. Approximate distance between the centers of gravity of flanges: 24½″—2″=22½″

Allowable stress .... 27,000 psi

Net area of flange required .... $\dfrac{305.0 \times 12}{27.0 \times 22.5} = 6.02$ sq. in.

Less one-eighth of web area effective as flange .... $\frac{1}{8} \times 24 \times \frac{3}{8} = 1.12$ sq. in.

Additional net area required in flange .... = 4.90 sq. in.

Use two angles, 5- by 3½- by ⅜-inch.

Gross area .... $2 \times 3.05 = 6.10$ sq. in.

Deduct two holes for rivets .... $2 \times 15/16 \times \frac{3}{8} = .70$ sq. in.

Net area provided .... 5.40 sq. in.

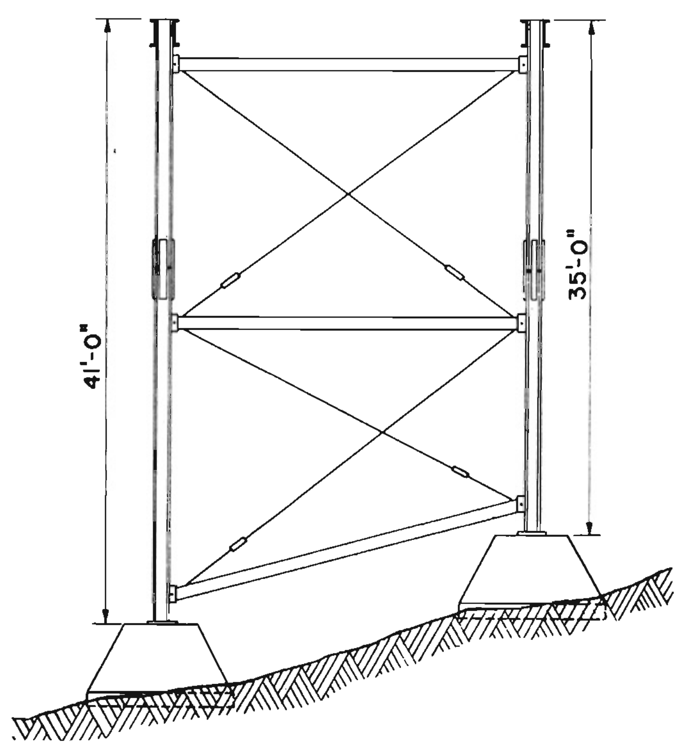


Figure 145. Bracing of framed steel tower modified to suit footings set at different levels.

b. Check flange stress for actual distance between centers of gravity of flanges.

Center-to-center flanges .... 24.5″ — (2 × .86″) = 22.78″
One-eighth area of web .... = 1.12 sq. in.
Net area, two angles .... 5 by 3½ by ⅜ = 5.40 sq. in.
Total net area .... 6.52 sq. in.

Stress in flange .... $\dfrac{305.0 \times 12}{6.52 \times 22.78} = 24.6$ K/sq. in. = 24,600 psi.

Allowable stress .... = 27,000 psi.

c. Check shear stress in web.

Maximum shear .... = 29.3 kips.
Area of web .... $24 \times \frac{3}{8}$ = 9.0 sq. in.

Shear stress in web .... $\dfrac{29.3}{9.0}$ = 3,260 psi.

Allowable stress .... = 16,500 psi.

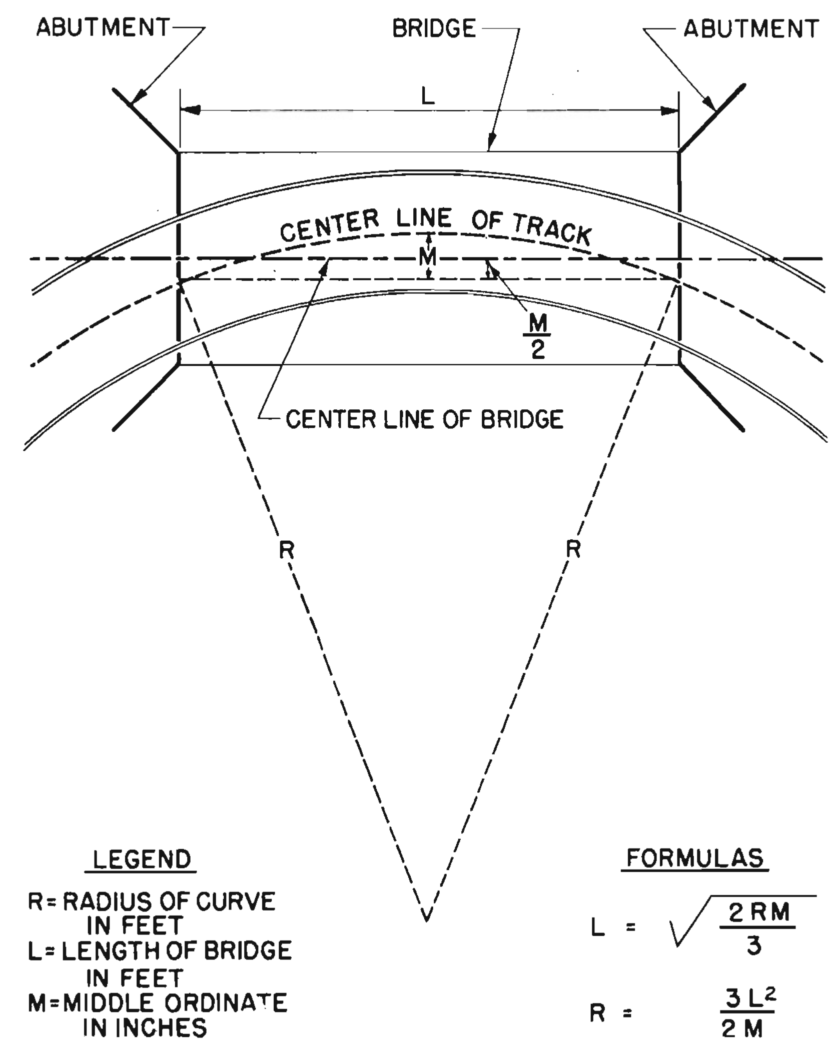


Figure 146. Factors used to determine permissible curvature of track on railway bridges.

d. Determine stiffener spacing. No intermediate web stiffeners are required because $\frac{d}{t} = \frac{17.5}{.375} = 46.7$ (fig. 147), which is less than 70. Generally, when $\frac{d}{t}$ is greater than 70, intermediate stiffeners are provided. Their spacing must not exceed 72 inches or that given by the formula:

$$d = \frac{10{,}500\, t}{\sqrt{S}}$$

Symbols:

d = clear distance between stiffeners in inches.
t = thickness of web in inches.
S = unit shearing stress (psi) of gross section of web at point considered.

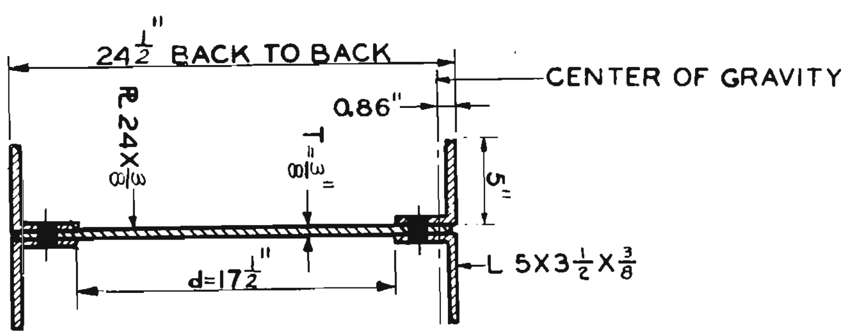


Figure 147. Cross section through riveted plate girder equivalent to 21-inch 63-pound rolled beam.

e. Determine spacing of flange rivets.
Value of ⅞-inch rivet in bearing on ⅜-inch plate:

$$30{,}000 \times .875 \times .375 = 9{,}840 \text{ lb/rivet}$$

Value of ⅞-inch rivet in double shear:

$$\frac{2 \times \pi \times .875^2 \times 15{,}000}{4} = 18{,}050 \text{ lb/rivet}$$

Bearing value governs since it is less than value in double shear.

Flange rivet stress .... $\frac{29{,}300}{22.78} = 1{,}290$ lb./in.

Wheel concentration (assumed longitudinal distribution of wheel load at gage line of rivets is 24 inches) .... $\frac{16{,}000}{24} = 665$ lb./in.

Resultant stress .... $\sqrt{1{,}290^2 + 665^2} = 1{,}450$ lb./in.

Required rivet spacing .... $\frac{9{,}840}{1{,}450} = 6.8$ in.

Maximum 5-inch spacing has been used (6-inch could have been used).

f. Select end-bearing stiffeners.

Maximum end reaction .... 29.3 kips

Area required at 30,000 psi. .... $\frac{29{,}300}{30{,}000} = .98$ sq. in.

Use two angles, 4- by 6- by ⅜-inch to fit diaphragm connection.

g. Design web splice. (See fig. 148.) The sheer used in this example is the maximum that can occur in the girder, and actually governs only for a splice near the supports.

(1) *For moment carried by web.*

Web area carrying moment ....⅛ × 24 × ⅜ = 1.12 sq. in.
Use two flat bars 2½ × ⅜ .... = 1.875 sq. in.
Net area with two rivet holes deducted .... = 1.175 sq. in.

Rivets required .... $\frac{1.12 \times 27{,}000}{9{,}840} = 3.07$ rivets

Space rivets at 3-inch centers. Rivet spacing required for normal flange stress is 6.8 inches. Therefore, number of rivets required through flange angles and 2½- by ⅜-inch bar is .... $\frac{3.07}{1 - \frac{3.0}{6.8}} = 5.5$ rivets.

Use five rivets.

(2) *For shear carried by web.* See fig. 148. Use two plates 13 inches by ⅜ inches by 1 foot 5 inches.

Maximum shear .... = 29.3 kips

Section modulus of rivets .... $\frac{4(3.5^2 + 7^2)}{7} = 35$ in.^{3}

Moment on rivet group .... = 29, 300 × 3.5 = 105,500 in./lb.

Rivet stress (resultant of shear and moment stresses)

$$\sqrt{\left(\frac{102{,}500}{35}\right)^2 + \left(\frac{29{,}300}{10}\right)^2} = 4{,}100 \text{ lb./rivet}$$

Allowable .... = 9,840 lb./rivet

The resulting stresses in the web splice rivets are well under the allowable stress. However, a minimum of two vertical rows of rivets should be provided on each side of center line of splice.

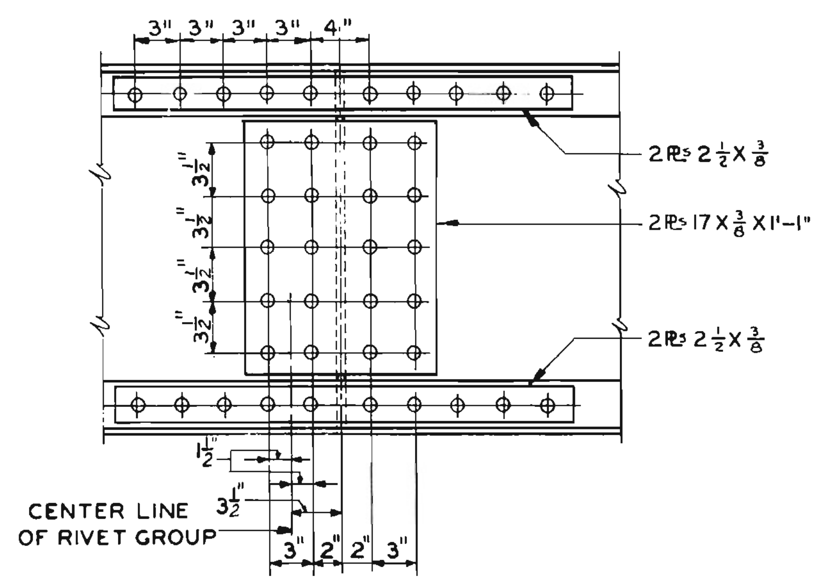


Figure 148. Riveted web splice of plate girder equivalent to 21-inch 63-pound rolled beam.

h. Design flange splice. The moment used is the maximum that can occur in the girder and actually governs only for a splice near the center of the span.

Net area of 5- by 3½- by ⅜-inch angle with two rivet holes out (one through horizontal and one through vertical leg) is

3.05- 2 × 15/16 × ⅜ = 2.35 sq. in.

Use 5- by 3½- by ⅜-inch splice angles. Rivets required in single shear at 9,025 pounds, each to develop 5- by 3½- by ⅜-inch angles, are

$$\frac{2.35 \times 27{,}000}{9{,}025} = 7.05 \text{ rivets}$$

Use four rivets in each leg of angle.

i. Detail. For complete detail of girder, see figure 150.

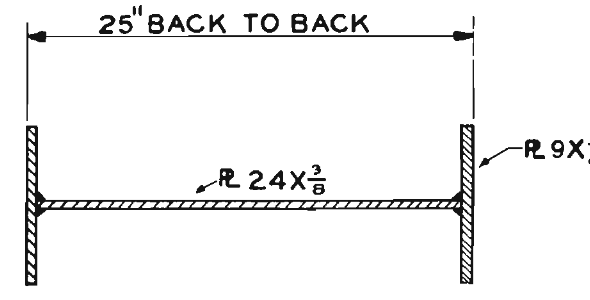


Figure 149. Cross section through welded plate girder equivalent to 21-inch 63-pound rolled beam.

4. WELDED DESIGN. See figure 149. Use 24-inch plate girder with ⅜-inch web.

a. Determine flange section.

Distance between centers of gravity of flanges .... = 24½"

Area of flange required.............................. $\frac{305.0 \times 12}{27.0 \times 24.5} = 5.54$ sq. in.

Less one-sixth of web area ....1/6 × 24 × ⅜ = 1.50 sq. in.
Additional area required .... = 4.04 sq. in.
Use 9- by ½-inch plate, area .... = 4.5 sq. in.

b. Check shear stress in web.

Maximum shear .... 29.3 kips

Unit stress in web .... $\frac{29{,}300}{24 \times ⅜} = 3{,}260$ psi.

Allowable .... 16,500 psi.

No intermediate stiffeners will be required, because $\frac{d}{t}$ of web plate $\frac{24}{.38} = 64$, under 70. For further explanation, see paragraph 3*d*.

c. Determine flange plate connection to web.

Maximum horizontal shear at connection $\frac{29{,}300}{24} = 1{,}215$ lb./in.

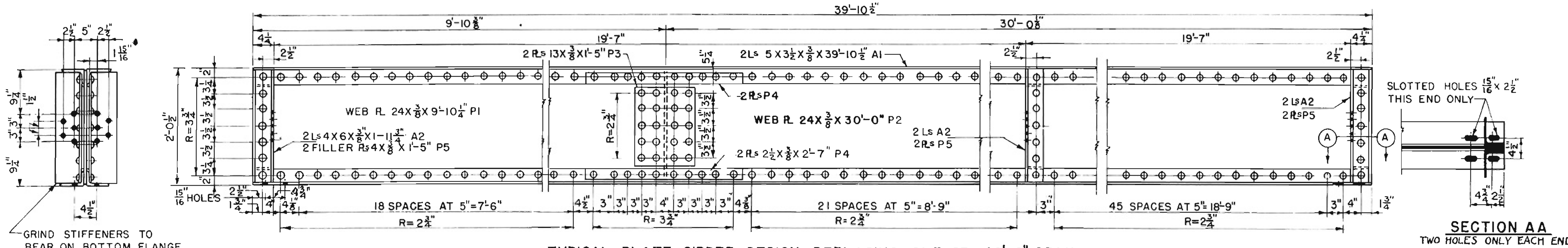
Value of 2- by 5/16-inch fillet weld, both faces of web ....2 × 2 × 5 × 425 = 8,500 lb.

Use 5/16- by 2-inch fillet weld, 5 inches center-to-center, both faces.

Stress in weld ....1,215 × 5 = 6,075 lb.

d. Select end bearing stiffeners. As stated in paragraph 3, only nominal material is required for bearing stiffeners. Use two 4- by ⅜-inch plates. Weld stiffener plates to web with continuous ¼-inch fillet weld.

e. Design of web splice. The shear used in this example is the maximum that can occur in the girder. (See par. 3g.)



TYPICAL PLATE-GIRDER DESIGN REPLACING 21 I 63 40'-0" SPAN

(FOR BILL OF MATERIALS SEE TABLE A)

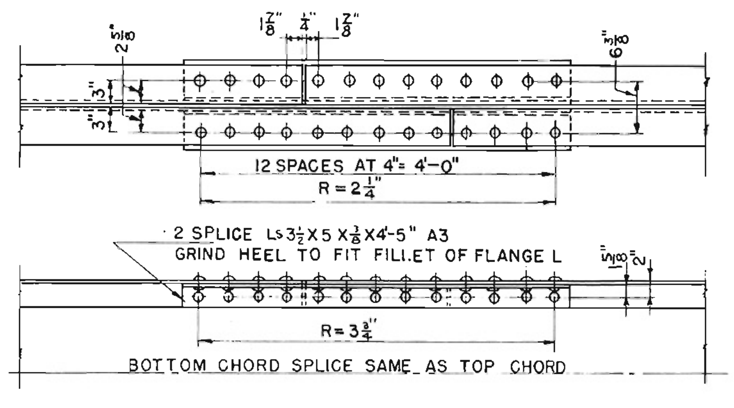
TABLE A

ITEM	STOCK NO	MARK	SHAPE	SIZE	QUANTITY	LENGTH	WT EACH
WEB		P1	PL	24X⅜	1	9'-10¼"	302
WEB		P2	PL	24X⅜	1	30'-0"	918
SPLICE		P3	PL	13X⅜	2	1'-5"	21
SPLICE		P4	PL	2½X⅜	4	2'-7"	8
FILLER		P5	PL	4X⅜	6	1'-5"	7
FLANGE	48-2240.5 -04	A1	L	5X3½X⅜	4	39'-10½"	410
STIFFENER	48-2240.64-04	A2	L	6X4X⅜	6	1'-11¾"	24
RIVET			ø	⅞	240	2¾"	
RIVET			ø	⅞	37	3¾"	

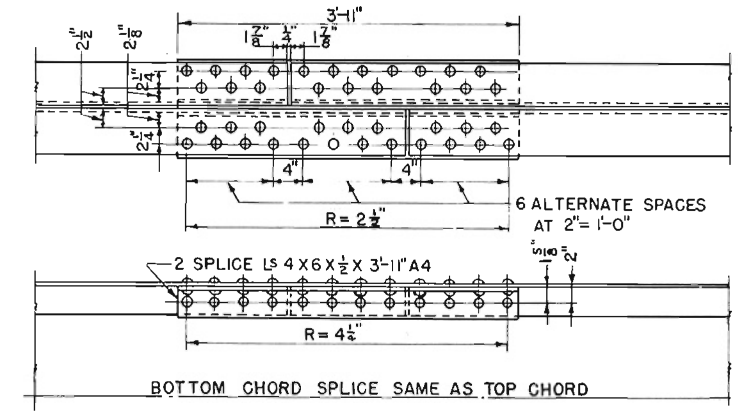
TABLES DO NOT INCLUDE MATERIAL FOR FLANGE SPLICES

TABLE B

ITEM	STOCK NO	MARK	SHAPE	SIZE	QUANTITY	LENGTH	WT EACH
WEB		P1	PL	30X⅜	1	9'-10¼"	377
WEB		P2	PL	30X⅜	1	30'-0"	1148
SPLICE		P3	PL	13X⅜	2	1'-10"	30
SPLICE		P4	PL	3X⅜	4	2'-1"	8
FILLER		P5	PL	4X⅜	6	1'-10"	9
FLANGE	48-2240.64-04	A1	L	6X4X⅜	4	39'-10½	491
STIFFENER	48-2240.64-04	A2	L	6X4X⅜	6	2'-5¾"	31
RIVET			ø	⅞	248	2¾"	
RIVET			ø	⅞	43	3¾"	

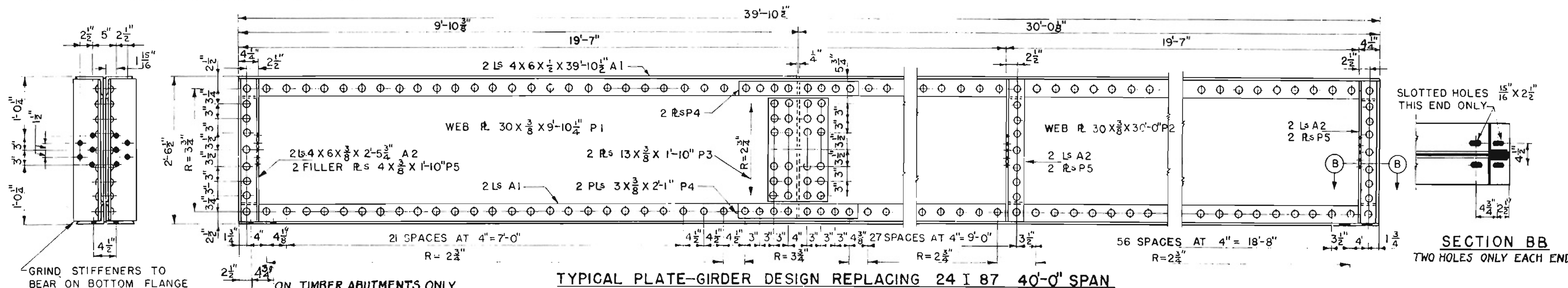


DETAIL OF FLANGE SPLICE FOR 3½X5X⅜ Ls



DETAIL OF FLANGE SPLICE FOR 4X6X½L

NOTE: CENTER OF FLANGE SPLICE MUST BE AT LEAST 8 FEET FROM CENTER OF SPAN.
FLANGE SPLICE MUST NOT BE ON SAME END OF STRINGER AS WEB SPLICE.
WEB SPLICE SHOWN IN ASSEMBLED VIEW.



TYPICAL PLATE-GIRDER DESIGN REPLACING 24 I 87 40'-0" SPAN

(FOR BILL OF MATERIALS SEE TABLE B)

Figure 150. Riveted plate girders.

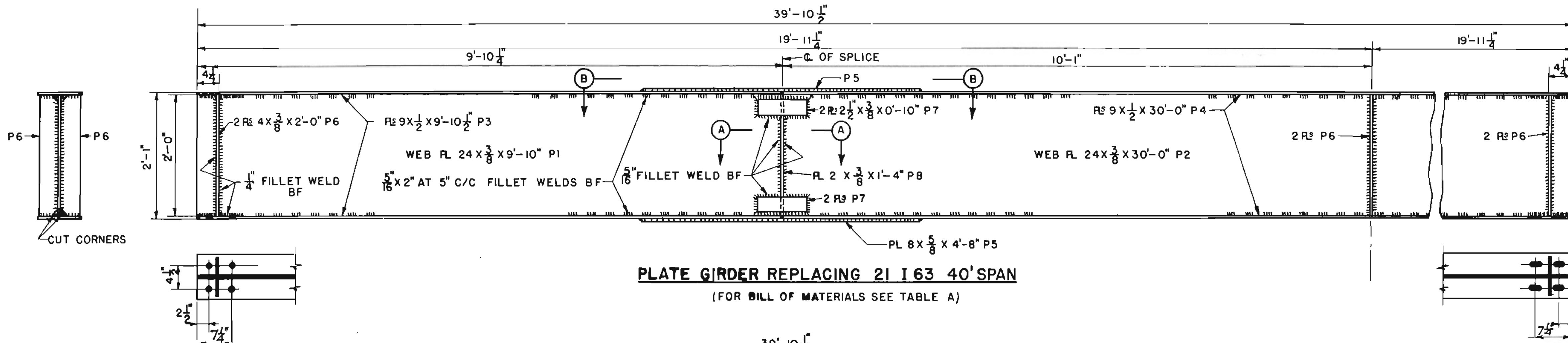


PLATE GIRDER REPLACING 21 I 63 40' SPAN

(FOR BILL OF MATERIALS SEE TABLE A)

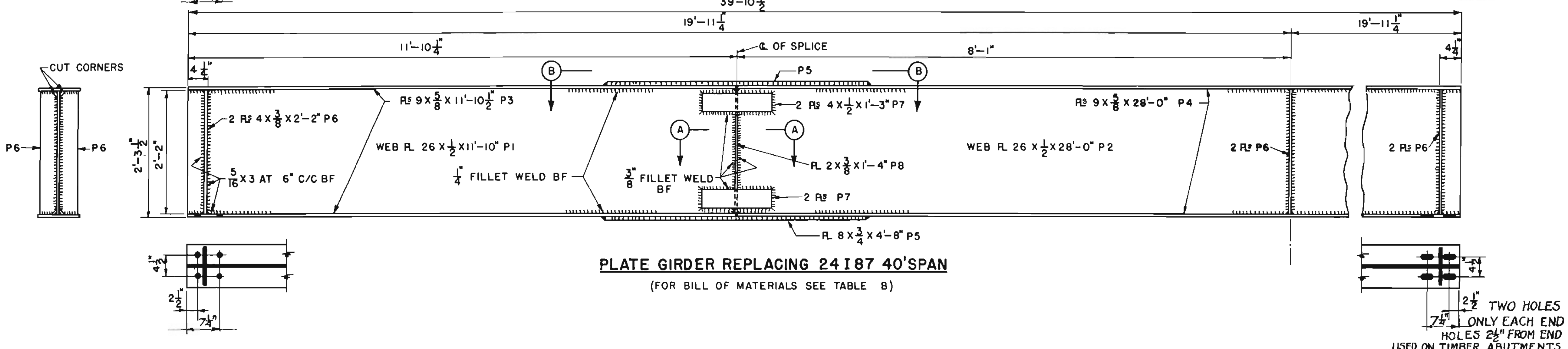


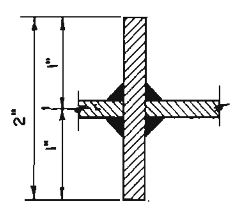
PLATE GIRDER REPLACING 24 I 87 40' SPAN

(FOR BILL OF MATERIALS SEE TABLE B)

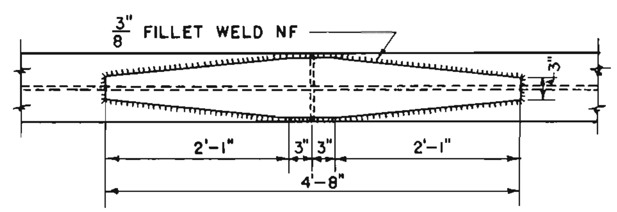
TABLE A

MATERIAL FOR ONE GIRDER 25" DEEP

ITEM	STOCK NO.	MARK	SHAPE	SIZE	QUAN.	LENGTH	WT. EACH
WEB		P 1	PL	24 X 3/8	1	9'-10"	300
WEB		P 2	PL	24 X 3/8	1	30'-10"	918
FLANGE		P 3	PL	9 X 1/2	2	9'-10 1/2"	151
FLANGE		P 4	PL	9 X 1/2	2	30'-10"	459
FLANGE SPLICE		P 5	PL	8 X 5/8	2	4'-8"	58
STIFFENER		P 6	PL	4 X 3/8	6	2'-0"	10
WEB SPLICE		P 7	PL	2 1/2 X 3/8	4	0'-10"	3
WEB SPLICE		P 8	PL	2 X 3/8	1	1' 4"	3
ELECTRODES					TOTAL WEIGHT		35



SECTION A-A



SECTION B-B

TABLE B

MATERIAL FOR ONE GIRDER 27 1/4" DEEP

ITEM	STOCK NO.	MARK	SHAPE	SIZE	QUAN.	LENGTH	WT. EACH
WEB		P 1	PL	26 X 1/2	1	11'-10"	523
WEB		P 2	PL	26 X 1/2	1	28'-10"	1238
FLANGE		P 3	PL	9 X 5/8	2	11'-10 1/2"	227
FLANGE		P 4	PL	9 X 5/8	2	28'-10"	535
FLANGE SPLICE		P 5	PL	8 X 3/4	2	4'-8"	69
STIFFENER		P 6	PL	4 X 3/8	6	2'-2"	11
WEB SPLICE		P 7	PL	4 X 1/2	4	1'-3"	9
WEB SPLICE		P 8	PL	2 X 3/8	1	1'-4"	3
ELECTRODES					TOTAL WEIGHT		54

Figure 151. Welded plate girders.

(1) Web area carrying moments..........$1/6 \times 24 \times 3/8$ = 1.50 sq.in.

Use two $2\frac{1}{2}$- by $\frac{3}{8}$- by 10-inch plates—area .... = 1.875 sq. in.

Develop each plate for $1.50 \times 27{,}000$ .... = 20,200 lb.

Capacity of 5/16-inch fillet weld 5×425 .... = 2,125 lb./in.

Length of weld required .... $\frac{20{,}200}{2{,}125}$ = 9.5 in.

Use .... 2×5 = 10 in.

(2) Develop web splice for maximum shear of 29.3 kips. In this example, a 2- by $\frac{3}{8}$-inch by 1-foot 4-inch plate inserted between ends of web plates has been used as a convenient butt-joint detail.

Length of 5/16-inch weld required .... $\frac{29{,}300}{2125}$ = 13.9 in.

Length of 5/16-inch weld provided .... = 32 in.

f. Design flange splice. The moment used in this example is the maximum that can occur in the girder (see par. 3h). (In this example with no butt joint between ends of flange plates, all flange stress is carried by splice plate.)

Area of flange plate ....$9 \times \frac{1}{2}$ = 4.5 sq.in.

Use 8-inch by 5/8-inch by 4-foot 8-inch splice plate, area .... = 5.0 sq. in.

Length of $\frac{3}{8}$-inch fillet weld required.

$$\frac{4.5 \times 27{,}000}{6 \times 425} = 48 \text{ inch}$$

Length of $\frac{3}{8}$-inch fillet weld provided = 4 ft. 8 in. = 56 in.

(In standard stringer splices, butt welds are used between the ends of the beam flanges and are effective for compressive stress transfer of 16,000 psi.)

Taper ends of flange splice plates as shown on figure 151.

g. Drawing. For complete details of welded girder, see figure 151.

APPENDIX II

COFFERDAMS

1. GENERAL. a. This appendix shows the arrangement of wales, posts, and bracing in sheet pile cofferdams (figs. 152 to 154) and gives tables (tables LII to LVI inclusive) for the selection of timber sizes and spacing of wales.

b. The cofferdams are intended for use in repairing partly demolished masonry piers for use as foundations for semipermanent trestle bridges. They should not be used in water over 10 feet deep. They can also be used in constructing concrete pedestal and grillage foundations in water. (See par. 221.)

2. EXAMPLE. The following example illustrates the use of the data in designing a cofferdam 30 feet long by 10 feet wide.

a. From table LIV, for 10-foot depth, use three-wale cofferdam with wales spaced 4 feet apart in the bottom panel and 6 feet apart in the top panel.

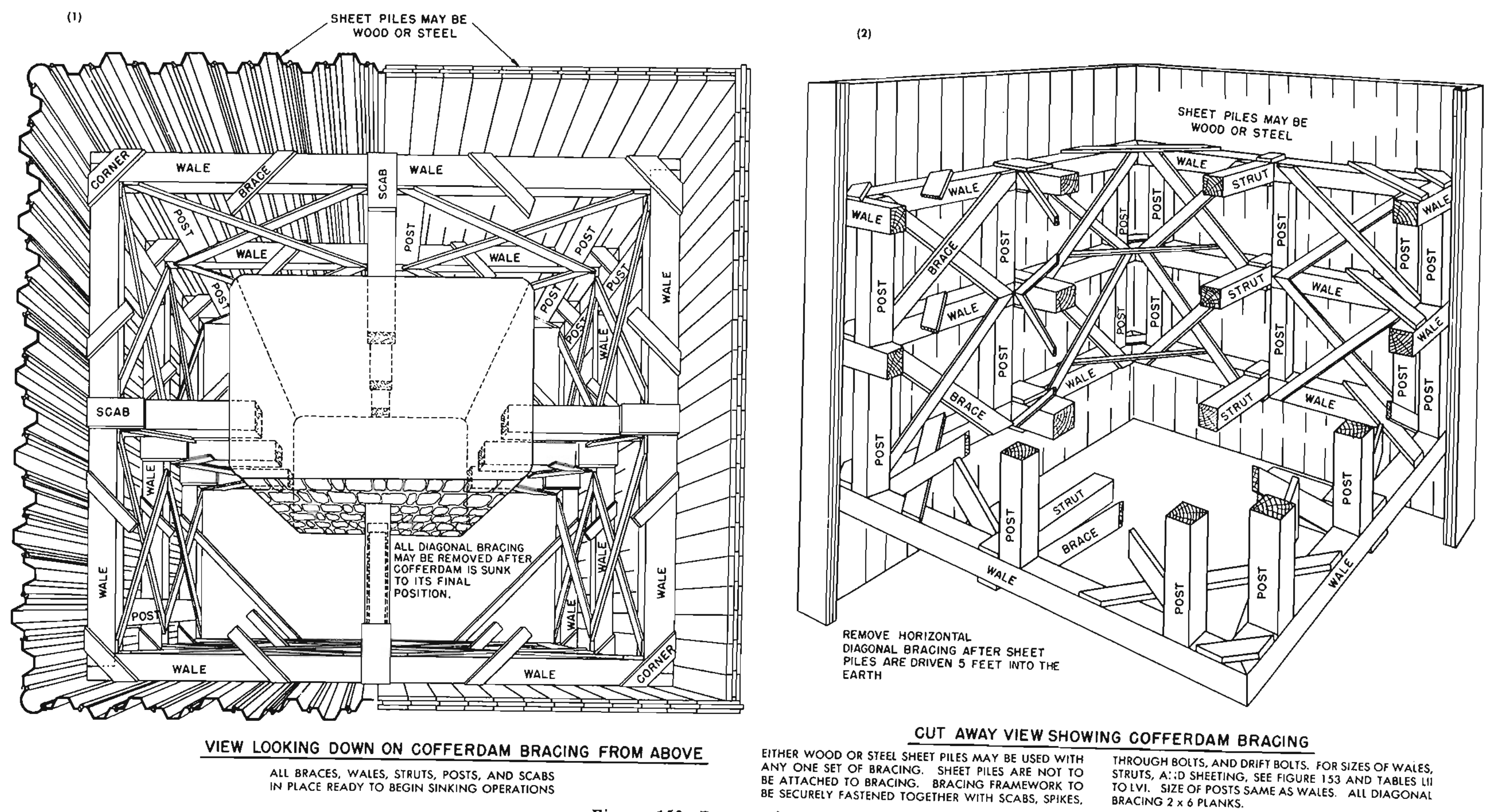


Figure 152. Rectangular cofferdams.

(1) Top view.
(2) Cut away view.

Use two transverse struts at each wale level, making the wale span 10 feet and the strut length 10 feet.

b. From table LV, for 10-foot strut spacing and h_1 of 6 feet, 10-by 10-inch wales are selected.

c. From table LVI for 10-foot strut spacing and h_1 of 6 feet, 6- by 6-inch struts are selected.

d. Posts will be the same size as the wales, 10- by 10-inch.

e. Sheet piling may be 4-inch shiplap, 6-inch Wakefield, or steel sheet piling.

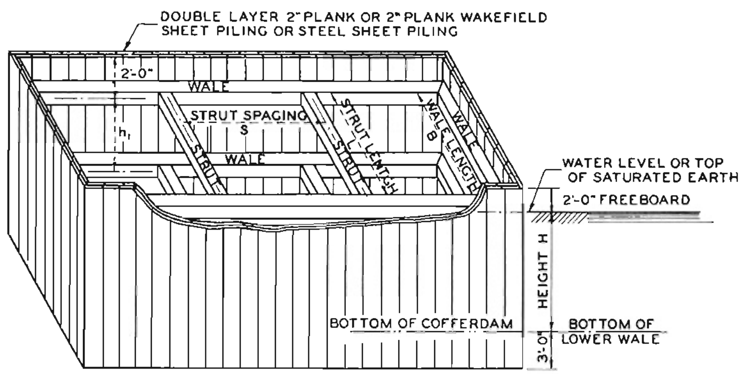


Figure 153. Cofferdam dimensions.

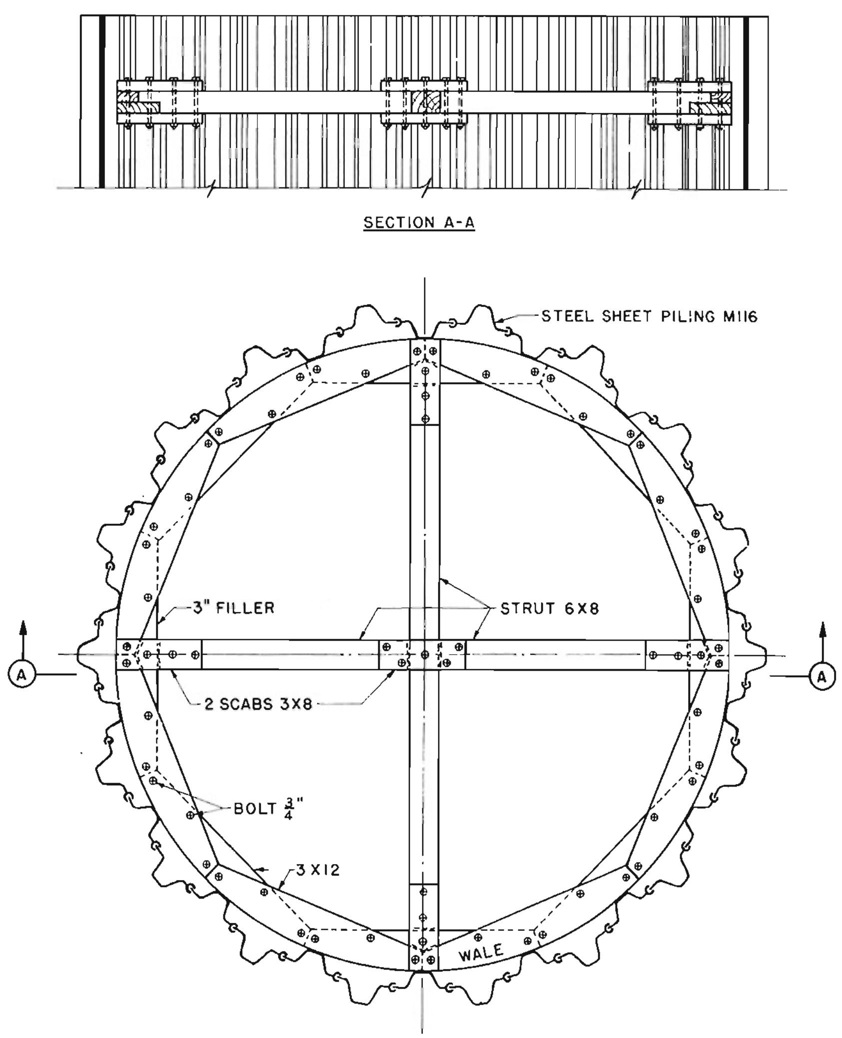


Figure 154. Circular cofferdam.

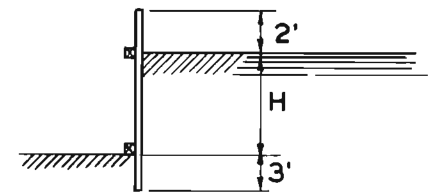


Table LII. Minimum wale size—2-wale cofferdam

H	Strut spacing S or unsupported length of wale b in feet—See fig. 153: 5	6	7	8	9	10	11	12	13	14	15	16	17
	SIZE OF WALE												
5	6 x 6	6 x 6	6 x 6	6 x 6	8 x 8	8 x 8	8 x 8	8 x 8	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10
6	6 x 6	6 x 6	8 x 8	8 x 8	8 x 8	8 x 8	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	12 x 12	12 x 12
7	6 x 6	8 x 8	8 x 8	8 x 8	8 x 8	10 x 10	10 x 10	10 x 10	10 x 10	12 x 12	12 x 12	12 x 12	12 x 12

Table LIII. Minimum size and maximum length of struts—2-wale cofferdam

H	Strut spacing S in feet: 5	6	7	8	9	10	11	12	13	14	15	16	17
	SIZE AND LENGTH OF STRUTS—SEE FIG. 153												
5	6 x 6 19'-0"	6 x 6 19'-0"	6 x 6 18'-6"	6 x 6 18'-0"	6 x 6 17'-6"	6 x 6 17'-6"	6 x 6 17'-0"	6 x 6 16'-6"	6 x 6 16'-0"	6 x 6 16'-6"	6 x 6 15'-0"	6 x 8 17'-6"	6 x 8 17'-0"
6	6 x 6 18'-6"	6 x 6 18'-0"	6 x 6 17'-6"	6 x 6 17'-0"	6 x 6 16'-6"	6 x 6 16'-0"	6 x 6 15'-6"	6 x 6 15'-0"	6 x 6 14'-6"	6 x 6 14'-0"	6 x 8 16'-0"	6 x 8 16'-0"	8 x 8 20'-0"
7	6 x 6 17'-6"	6 x 6 16'-6"	6 x 6 16'-0"	6 x 6 15'-6"	6 x 6 15'-0"	6 x 6 14'-6"	6 x 6 14'-0"	6 x 6 13'-6"	6 x 6 13'-0"	6 x 8 14'-6"	8 x 8 20'-0"	8 x 8 20'-0"	8 x 6 19'-6"

Table LIV. Wale spacing—3-wale cofferdam

H	8.5	10.0	11.5	13.5
h_1	5.0	6.0	7.0	8.0
h_2	3.5	4.0	4.5	5.5

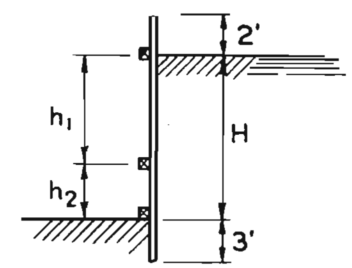


Table LV. Minimum wale size—3-wale cofferdam

h_1	Strut spacing S or unsupported length of wale B in feet—See fig. 153: 5	6	7	8	9	10	11	12	13	14	15	16	17
	SIZE OF WALE												
5	8 x 8	8 x 8	8 x 8	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	12 x 12	12 x 12	12 x 12	12 x 12	....
6	8 x 8	8 x 8	10 x 10	10 x 10	10 x 10	10 x 10	12 x 12	12 x 12	12 x 12	....	....	....	....
7	10 x 10	10 x 10	10 x 10	12 x 12	12 x 12	12 x 12	12 x 12	....	....	....	....	....	....
8	10 x 10	12 x 12	12 x 12	12 x 12	....	....	....	....	....	....	....	....	....

Table LVI. Minimum size and maximum length of struts—3-wale cofferdam

b_1	Strut spacing S in feet: 5	6	7	8	9	10	11	12	13	14	15	16	17
	SIZE AND LENGTH OF STRUTS—SEE FIG. 153												
5	6 x 6 17'-0"	6 x 6 16'-0"	6 x 6 15'-6"	6 x 6 15'-0"	6 x 6 14'-6"	6 x 6 14'-0"	6 x 6 13'-6"	6 x 6 13'-0"	6 x 8 14'-6"	6 x 8 14'-0"	8 x 8 19'-6"	8 x 8 19'-0"	...
6	6 x 6 15'-6"	6 x 6 14'-6"	6 x 6 14'-0"	6 x 6 13'-6"	6 x 6 12'-6"	6 x 6 12'-0"	6 x 6 11'-6"	6 x 8 13'-0"	8 x 8 18'-0"	...	...	...	...
7	6 x 6 14'-0"	6 x 6 13'-0"	6 x 6 12'-6"	6 x 6 12'-0"	6 x 6 11'-0"	6 x 6 10'-6"	6 x 8 12'-0"	...	...	...	...	...	...
8	6 x 6 13'-0"	6 x 6 12'-0"	6 x 6 11'-0"	6 x 6 10'-6"	...	...	...	...	...	...	...	...	...

APPENDIX III

TABLES OF USEFUL DATA

(Tables LVII through LXXXVI)

TABLE LVII. *Weights of common materials.*

Material	Wt. in lb. per cu. ft.
Aluminum:	
Cast	160
Wire	168
Asphalt	60–80
Brass	510–542
Brick	110–130
Bronze	545–555
Coal:	
Anthracite	97
Bituminous	84
Concrete:	
Reinforced	150
Plain	140–150
Copper, cast	549–558
Earth:	
Clay:	
Dry, compacted	100
Damp, plastic	110
Common:	
Dry, loose	65–88
Moist, compacted	95–135
Mud, wet:	
Fluid	104–120
Compacted	110–130
Sand:	
Dry, compacted	110
Damp, loose	94
Gravel, crushed rock:	
Damp, loose	82–125
Dry, compacted	90–145

Material	Wt. in lb. per cu. ft.
Ice	56
Iron:	
Grey cast	439–445
Wrought	487–492
Lead	710
Lime	53–75
Masonry:	
Mortar rubble	155
Dry rubble	125
Rock solid:	
Granite	125–187
Shale	162
Soapstone	162–175
Trap	187–190
Salt	129–131
Snow:	
Fresh, fallen	5–12
Wet, compact	15–20
Steel	474–494
Tar	75
Tin	455
Water:	
Fresh	62.4
Sea	64.0
Zinc	438

TABLE LVIII. *Structural timber-allowable stresses. U. S: structural timber.*

Variety and grade of wood — Species and grade description (1)	Stress grade [2] (lb.) (2)	Average unit weight [3] (lb. per cu. ft.) (3)	Allowable working stresses for military bridges [1] (psi): Extreme fiber stress in bending [4] (4)	Horizontal shear (5)	Compression perpendicular to grain (6)	Compression parallel to grain [5] (7)	Modulus of elasticity (psi) (8)
Douglas fir	...	35	...	...	...	...	1,600,000
Dense select structural	1,800	...	2,700	180	500	1,950	...
Select structural	1,600	...	2,400	180	500	1,800	...
	1,400	...	2,100	150	450	1,650	...
Yellow pine (long leaf, or dense short leaf)	...	40	...	...	...	...	1,600,000
Select structural	2,000	...	3,000	150	500	2,200	...
Prime structural	1,800	...	2,700	150	500	1,950	...
Merchantable structural; and structural square edge and sound	1,600	...	2,400	150	500	1,800	...
No. 1 structural	1,400	...	2,100	150	500	1,500	...
Larch	...	36	...	...	...	...	1,300,000
Select structural	1,800	...	2,700	200	500	1,950	...
Structural	1,600	...	2,400	150	470	1,800	...
Common structural	1,200	...	1,800	135	430	1,650	...
Redwood (structural)	...	30	...	...	...	...	1,200,000
Dense select all heart	1,400	...	2,100	135	350	1,800	...
Select all heart	1,200	...	1,800	120	350	1,650	...
Bulkhead and heart	1,100	...	1,650	120	350	1,650	...
Southern cypress	...	32	...	...	...	...	1,200,000
Select structural	1,400	...	2,100	180	400	1,800	...
Structural	1,100	...	1,650	150	400	1,500	...
Eastern hemlock	...	30	...	...	...	...	1,100,000
Select structural	1,100	...	1,650	105	400	1,050	...
FOREIGN WOODS							
Group I	...	45	...	...	...	...	1,600,000
Teak, sal, white siris, jarul, lendia, oak, ash, Philippine mahogany	...	...	1,800–2,700	200	360–500	1,680–2,000	...
Group II	...	35	...	...	...	...	1,250,000
Doodar, chir, poon, gumhar, Norway (northern) pine	...	...	1,500–2,250	150	300–450	1,340–1,800	...
Group III	...	30	...	...	...	...	1,000,000
White deal, kail	...	...	1,340–2,000	100	260–390	1,110–1,500	...

[1] Reduce all stresses to 70 percent of tabular values for greenwood and for design of parts of bridge structure continuously wet. Reduce all stress values to 75 percent of tabular values for design of structures carrying long-continued live load.

[2] Grade designations of structural timber adopted by United States lumber industry.

[3] At about 15 percent moisture content.

[4] Working stress in tension same as for bending.

[5] Working stresses for compression parallel to grain apply to posts, columns, and struts the unsupported length of which does not exceed 11 times least dimension of cross section. For working stresses for unsupported lengths from 11 to 50 times least dimension of cross section, see chapter 4.

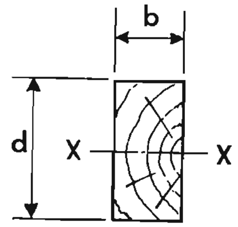


TABLE LIX. *Properties of dressed timber (S4S).*

Nominal size b (inches) d	American standard dressed size (S4S) b in inches d	Area of section A = bd (sq. in.)	Section modulus $S = \frac{bd^2}{6}$ (in.³)	Board feet per linear foot of piece	Weight in pounds per linear foot of piece when weight of wood per cubic foot equals 40 lb.	45 lb.	50 lb.
2 x 4	1⅝ x 3⅝	5.89	3.56	⅔	1.6	1.8	2.0
2 x 6	1⅝ x 5⅝	9.14	8.57	1	2.5	2.9	3.2
2 x 8	1⅝ x 7½	12.19	15.23	1⅓	3.4	3.8	4.2
2 x 10	1⅝ x 9½	15.44	24.44	1⅔	4.3	4.8	5.4
2 x 12	1⅝ x 11½	18.69	35.82	2	5.2	5.8	6.5
2 x 14	1⅝ x 13½	21.94	49.36	2⅓	6.1	6.9	7.6
3 x 6	2⅝ x 5⅝	14.77	13.84	1½	4.1	4.6	5.1
3 x 8	2⅝ x 7½	19.69	24.61	2	5.5	6.2	6.8
3 x 10	2⅝ x 9½	24.94	39.48	2½	6.9	7.8	8.7
3 x 12	2⅝ x 11½	30.19	57.86	3	8.4	9.4	10.5
3 x 14	2⅝ x 13½	35.44	79.73	3½	9.8	11.1	12.3
4 x 4	3⅝ x 3⅝	13.14	7.94	1⅓	3.7	4.1	4.6
4 x 6	3⅝ x 5⅝	20.39	19.12	2	5.7	6.4	7.1
4 x 8	3⅝ x 7½	27.19	33.98	2⅔	7.6	8.5	9.4
4 x 10	3⅝ x 9½	34.44	54.53	3⅓	9.6	10.8	12.0
4 x 12	3⅝ x 11½	41.69	79.90	4	11.6	13.0	14.5
6 x 6	5½ x 5½	30.25	27.73	3	8.4	9.5	10.5
6 x 8	5½ x 7½	41.25	51.56	4	11.5	12.9	14.3
6 x 10	5½ x 9½	52.25	82.73	5	14.5	16.3	18.1
6 x 12	5½ x 11½	63.25	121.23	6	17.6	19.8	22.0
6 x 14	5½ x 13½	74.25	167.06	7	20.6	23.2	25.8
6 x 16	5½ x 15½	85.25	220.23	8	23.7	26.6	29.6
6 x 18	5½ x 17½	96.25	280.73	9	26.7	30.1	33.4
8 x 8	7½ x 7½	56.25	70.31	5⅓	15.6	17.6	19.5
8 x 10	7½ x 9½	71.25	112.81	6⅔	19.8	22.3	24.7
8 x 12	7½ x 11½	86.25	165.31	8	24.0	27.0	29.9
8 x 14	7½ x 13½	101.25	227.81	9⅓	28.1	31.6	35.2
8 x 16	7½ x 15½	116.25	300.31	10⅔	32.3	36.3	40.4
8 x 18	7½ x 17½	131.25	382.81	12	36.5	41.0	45.6
10 x 10	9½ x 9½	90.25	142.90	8⅓	25.1	28.2	31.3
10 x 12	9½ x 11½	109.25	209.40	10	30.3	34.1	37.9
10 x 14	9½ x 13½	128.25	288.56	11⅔	35.6	40.1	44.5
10 x 16	9½ x 15½	147.25	380.40	13⅓	40.9	46.0	51.1
10 x 18	9½ x 17½	166.25	484.90	15	46.2	52.0	57.7
12 x 12	11½ x 11½	132.25	253.48	12	36.7	41.3	45.9
12 x 14	11½ x 13½	155.25	349.31	14	43.1	48.5	53.9
12 x 16	11½ x 15½	178.25	460.48	16	49.5	55.7	61.9
12 x 18	11½ x 17½	201.25	586.98	18	55.9	62.9	69.9

TABLE LX. *Properties of full-sawn timber.*

Nominal size b (inches) d	Area of section A = bd (sq. in.)	Section modulus $S = \frac{bd^2}{6}$ (in.³)	Board feet per linear foot of piece	Weight in pounds per linear foot of piece when weight of wood per cubic foot equals 40 lb.	45 lb.	50 lb.
1 x 2	2	.67	⅙	.56	.63	.70
1 x 3	3	1.50	¼	.83	.94	1.04
1 x 4	4	2.67	⅓	1.11	1.25	1.39
1 x 6	6	6.00	½	1.67	1.88	2.08
1 x 8	8	10.67	⅔	2.22	2.50	2.78
1 x 10	10	16.67	⅚	2.78	3.12	3.47
1 x 12	12	24.00	1	3.33	3.75	4.17
1 x 14	14	32.67	1⅙	3.89	4.38	4.85
1 x 16	16	42.67	1⅓	4.44	5.00	5.55
1 x 18	18	54.00	1½	5.00	5.62	6.25

All properties shown are directly proportional to width b.

To obtain properties for timbers other than 1 inch wide, multiply properties in table by actual width.

TABLE LXII. *Breaking strength of 6 x 19 wire rope.*

Size (inches)	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1½
Approximate weight per 100 feet (pounds)	10	23	40	63	90	123	160	203	250	360
GRADE	BREAKING STRENGTH (U. S. TONS)									
Iron	....	2.1	3.6	5.5	7.9	10.6	13.7	17.2	21.0	29.7
Traction steel	....	4.0	6.8	10.4	14.8	20.0	26.0	32.7	40.6	56.6
Cast steel	2.1	4.5	7.7	11.8	16.8	22.8	29.5	37.0	46.0	65.0
Mild plow steel	....	5.0	8.5	13.1	18.7	25.4	33.0	41.5	51.0	72.5
Plow steel	2.5	5.5	9.4	14.4	20.6	28.0	36.5	46.0	56.5	80.5
Improved plow steel	2.9	6.3	10.8	16.6	23.7	32.2	42.0	53.0	65.0	92.5

6 x 19 wire rope means 6 strands of 19 wires each.

The strength varies slightly with the strand construction and number of strands.

The maximum allowable working load is the breaking strength divided by the appropriate factor of safety. (See table LXIII.)

TABLE LXIII. *Wire-rope safety factors.*

Type of service	Minimum safety factor	Type of service	Minimum safety factor
Track cables	3.0	Haulage ropes	6.0
Guys	3.5	Derricks	6.0
Miscellaneous hoisting equipment	5.0	Slings	8.0

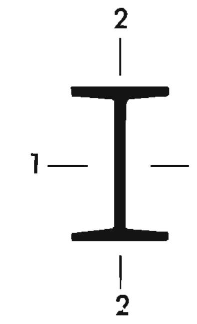


TABLE LXI. *Properties of steel beams.*

AMERICAN WIDE-FLANGE BEAMS.

Depth of section (in.)	Weight per foot (lb.)	Area of section (sq. in.)	Flange Width (in.)	Flange Thickness (in.)	Web thickness (in.)	Section modulus Axis 1–1 (in.³)	Section modulus Axis 2–2 (in.³)
36.72	300	88.17	16.655	1.680	.945	1105.1	147.1
35.88	230	67.73	16.475	1.260	.765	835.5	105.7
35.84	150	44.16	11.972	.940	.625	502.9	41.8
33.00	200	58.79	15.750	1.150	.715	669.6	87.8
33.15	132	38.84	11.510	.880	.580	413.7	36.1
33.00	125	36.78	11.500	.805	.570	385.1	32.7
29.82	108	31.77	10.484	.760	.548	299.2	25.8
27.00	98	28.82	10.000	.792	.500	255.3	24.6
26.84	91	26.77	9.983	.712	.483	233.2	21.8
24.16	87	25.58	9.025	.807	.480	204.3	20.6
23.87	74	21.77	8.975	.662	.430	170.4	16.5
21.00	63	18.52	8.25	.620	.410	128.0	13.0
20.91	59	17.36	8.230	.575	.390	119.3	12.0
18.16	77	22.63	8.787	.831	.475	141.7	20.2
17.90	47	13.81	7.492	.520	.350	82.3	9.0
16.16	88	25.87	11.502	.795	.504	151.3	32.2
15.86	58	17.04	8.464	.645	.407	94.1	14.3
16.12	45	13.24	7.039	.563	.346	72.4	8.7
15.85	36	10.59	6.992	.428	.299	56.3	6.3
14.19	74	21.76	10.072	.783	.450	112.3	26.5
13.91	61	17.94	10.000	.643	.378	92.2	21.5
13.81	48	14.11	8.031	.593	.339	70.2	12.8
13.86	30	8.81	6.733	.383	.270	41.8	5.2
12.12	65	19.11	12.000	.606	.390	88.0	29.1
12.00	28	8.23	6.500	.420	.240	35.6	5.4
11.87	25	7.39	6.500	.355	.240	30.9	4.5
11.78	53	15.59	12.046	.437	.436	67.0	21.2
10.00	49	14.40	10.000	.558	.340	54.6	18.6
10.12	45	13.24	8.022	.618	.350	49.1	13.3
9.90	21	6.19	5.750	.340	.240	21.5	3.4
7.93	24	7.06	6.500	.398	.245	20.8	5.6
6.00	15.5	4.59	6.000	.269	.240	10.0	3.06
BRITISH BEAMS (EQUIVALENT TO AMERICAN BEAMS)							
24	95	27.94	7.5	1.011	.57	211.09	16.68
18	75	22.09	7.0	.928	.55	127.91	13.30
20	65	19.12	6.5	.820	.45	122.62	10.02
18	55	16.18	6.0	.757	.42	93.53	7.88
15	42	12.36	5.0	.647	.42	57.13	4.72
12	32	9.40	5.0	.550	.35	36.84	3.88

TABLE LXIV. *Properties of commercial sisal cordage.*

Diameter (inches)	Circumference (inches)	Weight per 100 feet (pounds)	Minimum breaking strength tons	Safe load capacity tons
¼	¾	1.71	0.22	0.06
⅜	1⅛	3.45	0.51	0.13
½	1½	7.36	1.06	0.26
⅝	2	13.10	1.76	0.44
¾	2¼	16.40	2.16	0.54
⅞	2¾	22.00	3.08	0.77
1	3	26.50	3.60	0.90
1⅛	3½	35.20	4.80	1.20
1¼	3¾	40.80	5.40	1.35
1½	4½	58.80	7.40	1.85
1¾	5½	87.70	10.60	2.65
2	6	105.00	12.40	3.10
2½	7½	163.00	18.60	4.65
3	9	237.00	25.60	6.40

For quality manila, the factors for minimum breaking strength and safe load capacity may be increased 25 percent. Safe-load-capacity factors are based on a factor of safety of 4.

TABLE LXV. *Properties of chains.*

Normal size[1] (inches)	Approx. wt. per 100 feet (pounds)	Safe working load (pounds): Common iron	High grade iron	Soft steel	Special steel
⅜	160	2,700	2,980	3,300	6,400
7/16	210	3,460	3,800	4,360	8,300
½	280	4,500	4,960	5,260	10,500
⅝	430	6,940	7,620	8,460	15,200
¾	630	10,140	11,160	12,000	21,000
⅞	840	14,000	15,400	16,500	28,660
1	1,100	18,600	20,460	21,200	36,400

[1] Normal size means diameter of the bar from which the chain is formed.

TABLE LXVII. *Relation of sheaves and wire-rope diameter.*

Type of wire rope (strands by wires)	Recommended sheave and drum diameter	Minimum sheave and drum diameter
6 by 7	72 x rope diameter	42 x rope diameter.
6 by 19	45 x rope diameter	30 x rope diameter.
6 by 37	27 x rope diameter	18 x rope diameter.
8 by 19	31 x rope diameter	21 x rope diameter.

Note. These limits do not apply to blocks for wire rope tackle with loads in accordance with table LXX.

TABLE LXVIII. *Lead-line pull factors and efficiencies for hoist or fall wire rope.*

Number of parts of rope	2	3	4	5	6	7	8	9	10
Efficiency, percent	96.1	92.4	88.9	86.5	82.2	79.0	76.0	73.0	70.3
Lead-line pull factor	0.52	0.36	0.28	0.23	0.20	0.18	0.165	0.15	0.14

Note. The stress in the lead line equals the load to be lifted multiplied by the lead-line pull factor.

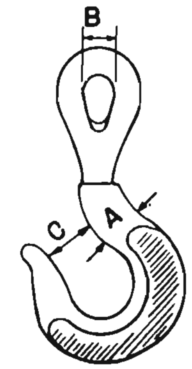


TABLE LXVI. *Safe loads on hooks.*

Diameter of metal A (inches)	Inside diameter of eye B (inches)	Width of opening C (inches)	Safe load (pounds)
⅝	¾	1	1,000
11/16	⅞	1 1/16	1,200
¾	1	1⅛	1,400
⅞	1⅛	1¼	2,400
1	1¼	1⅜	3,400
1⅛	1⅜	1½	4,200
1¼	1½	1 11/16	5,000
1⅜	1⅝	1⅞	6,000
1½	1¾	2 1/16	8,000
1⅝	2	2¼	9,400
1⅞	2⅜	2½	11,000
2¼	2¾	3	13,600
2⅝	3⅛	3⅜	17,000
3	3½	4	24,000

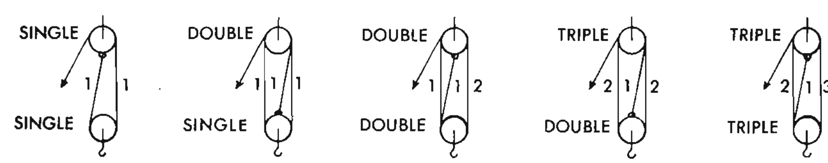


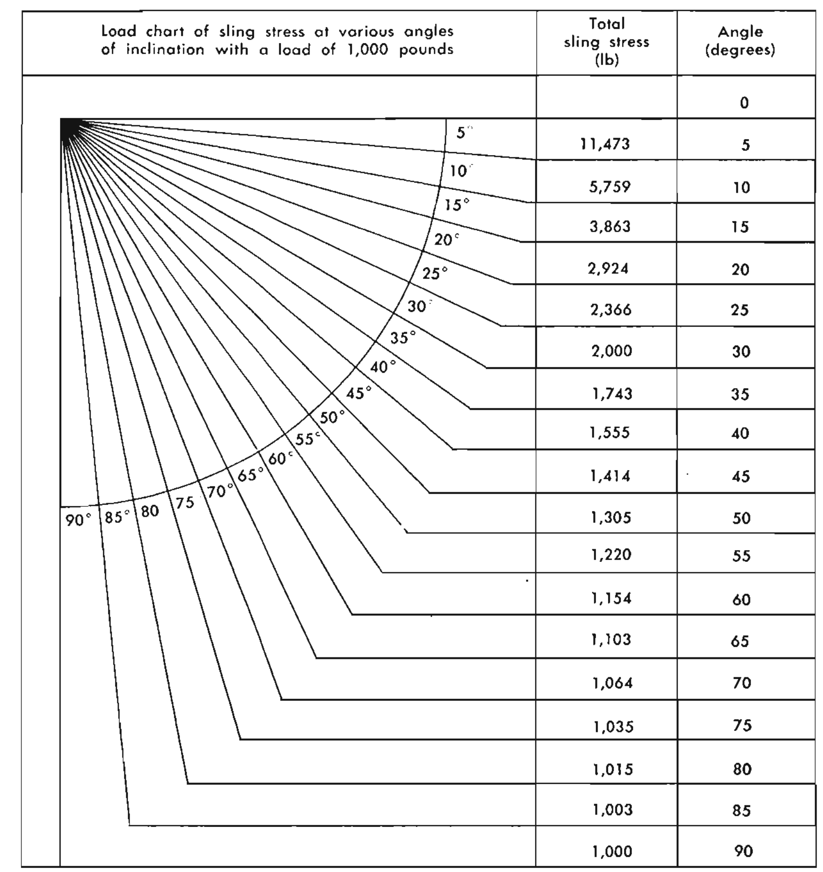
TABLE LXIX. *Simple block-and-tackle rigging for manila rope (factor of safety 3)*

Load to be lifted (tons)	Total number of sheaves in blocks	2 (2-single blocks)	3 (1-single 1-double)	4 (2-double blocks)	5 (1-double 1-triple)	6 (2-triple blocks)
½	Smallest permissible rope diameter (inch)	½	7/16	⅜	⅜	⅜
	Lead-line pull (lb.)	540	380	300	250	220
1	Rope (inch)	¾	⅝	½	½	½
	Pull	1,100	760	600	500	440
1½	Rope (inch)	⅞	¾	⅝	⅝	½
	Pull	1,600	1,100	900	750	660
2	Rope (inches)	1⅛	⅞	¾	⅝	⅝
	Pull	2,200	1,500	1,200	1,000	880
3	Rope (inches)	1 5/16	1⅛	1	⅞	¾
	Pull	3,300	2,300	1,800	1,500	1,300
4	Rope (inches)	1½	1¼	1⅛	1	1
	Pull	4,400	3,000	2,400	2,000	1,800
6	Rope (inches)	......	1½	1 5/16	1¼	1⅛
	Pull	......	4,500	3,600	3,000	2,600
8	Rope (inches)	......	....	1⅝	1½	1 5/16
	Pull	......	....	4,800	4,000	3,500

TABLE LXX. *Simple block and tackle rigging for plow-steel wire rope (factor of safety 6)*

Load to be lifted (tons)	Total number of sheaves in blocks	2 (2-single blocks)	3 (1-single 1-double)	4 (2-double blocks)	5 (1-double 1-triple)	6 (2-triple blocks)
1	Smallest permissible rope diameter (inch)	⅜	⅜	⅜	⅜	⅜
	Lead-line pull (lbs.)	1,000	720	560	460	400
2	Rope (inch)	½	⅜	⅜	⅜	⅜
	Pull	2,100	1,400	1,100	920	800
4	Rope (inch)	⅝	½	½	⅜	⅜
	Pull	4,200	2,900	2,200	1,800	1,600
6	Rope (inch)	¾	⅝	⅝	½	½
	Pull	6,200	4,300	3,400	2,800	2,400
8	Rope (inch)	⅞	¾	⅝	⅝	⅝
	Pull	8,300	5,800	4,500	3,700	3,200
10	Rope (inch)	1	⅞	¾	⅝	⅝
	Pull	10,400	7,200	5,600	4,600	4,000
15	Rope (inch)	1⅛	1	⅞	¾	¾
	Pull	15,600	10,800	8,400	6,900	6,000
20	Rope (inches)	1½	1⅛	1	⅞	⅞
	Pull	20,800	14,400	11,200	9,200	8,000

Table LXXI. Sling load chart



Stress in each leg of a sling assembly is found by dividing the total sling stress by the number of legs. If the load is over or under 1,000 pounds, divide the load by 1,000 and multiply by the total sling stress found in the table for the corresponding angle.

TABLE LXXII. *Holding power of deadmen in ordinary earth.*

Mean depth of anchorage (feet)	Inclination of pull (vertical to horizontal) and safe resistance in pounds per square foot. Vertical	1/1	1/2	1/3	1/4
3	600	950	1,300	1,450	1,500
4	1,050	1,750	2,200	2,600	2,700
5	1,700	2,800	3,600	4,000	4,100
6	2,400	3,800	5,100	5,800	6,000
7	3,200	5,100	7,000	8,000	8,400

Formula for dimensioning deadmen:

$$T = \frac{2667bh^2}{L} \text{ for a rectangular timber}$$

or

$$T = \frac{1600d^3}{L} \text{ for a round timber.........................where}$$

Symbols:

T = Maximum allowable cable pull in pounds
b = Width of the contact face of the deadman in inches
h = depth of deadman in direction of pull in inches
d = diameter of round timber in inches
L = Length of deadman in inches

TABLE LXXIII. *Safe capacity of spruce timbers as gin poles in normal operations.*

Size of timber (inches)	Safe capacity (pounds), Length in feet: 20	25	30	40	50	60
6 diameter	5,000	3,000	2,000	....	....	....
8 diameter	....	11,000	8,000	5,000	3,000	....
10 diameter	31,000	24,000	16,000	9,000	6,000	....
12 diameter	....	....	31,000	19,000	12,000	9,000
6 x 6	6,000	4,000	3,000	....	....	....
8 x 8	....	14,000	10,000	6,000	4,000	....
10 x 10........................	40,000	30,000	20,000	12,000	8,000	....
12 x 12........................	....	....	40,000	24,000	16,000	12,000

Safe capacity of each leg of shears or tripod is seven-eighths of value given.

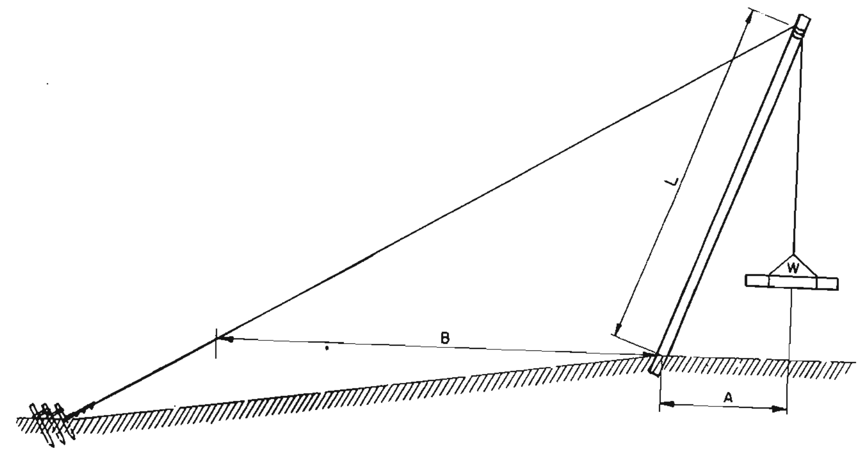


TABLE LXXIV. *Stresses in guys and spars used as gin poles.*

W = Weight to be lifted. (Include ample allowance for jars and jerks)
A = Drift
B = Horizontal distance from base of pole to guy.
L = Length of gin pole

Stress in guy for W = 1000 lb.

A \ B	$\frac{1}{2}$ L	$\frac{3}{4}$ L	L	$1\frac{1}{2}$ L	2 L
0	0	0	0	0	0
$\frac{1}{10}$ L	230	180	150	130	120
$\frac{1}{8}$ L	300	220	190	160	150
$\frac{1}{6}$ L	400	300	260	220	200
$\frac{1}{4}$ L	630	480	410	350	320
$\frac{1}{3}$ L	890	680	580	480	440

Stress in spar for W = 1000 lb.

A \ B	$\frac{1}{2}$ L	$\frac{3}{4}$ L	L	$1\frac{1}{2}$ L	2 L
0	1,000	1,000	1,000	1,000	1,000
$\frac{1}{10}$ L	1,210	1,140	1,100	1,070	1,050
$\frac{1}{8}$ L	1,260	1,180	1,140	1,090	1,070
$\frac{1}{6}$ L	1,350	1,240	1,180	1,130	1,100
$\frac{1}{4}$ L	1,550	1,380	1,290	1,210	1,160
$\frac{1}{3}$ L	1,770	1,530	1,420	1,300	1,240

Table LXXV. Standard bolt dimensions.

Diameter Total D Inches	Area: Gross Dia. D. Sq. in.	Area: Net Dia. K. Sq. In.	Number of threads per inch	Heads: Hexagon Diameter (in.) Long	Heads: Hexagon Diameter (in.) Short	Heads: Height (inches)	Heads: Square Diameter (in.) Long	Heads: Square Diameter (in.) Short	Nuts: Hexagon Diameter (in.) Long	Nuts: Hexagon Diameter (in.) Short	Nuts: Height (inches)	Nuts: Square Diameter (in.) Long	Nuts: Square Diameter (in.) Short
1/4	.049	.027	20	7/16	3/8	3/16	1/2	3/8	1/2	7/16	1/4	5/8	7/16
3/8	.110	.068	16	5/8	9/16	1/4	3/4	9/16	11/16	5/8	5/16	7/8	5/8
1/2	.196	.126	13	7/8	3/4	5/16	1	3/4	15/16	13/16	7/16	1 1/8	13/16
5/8	.307	.202	11	1 1/16	15/16	7/16	1 5/16	15/16	1 1/8	1	9/16	1 3/8	1
3/4	.442	.302	10	1 5/16	1 1/8	1/2	1 9/16	1 1/8	1 5/16	1 1/8	11/16	1 9/16	1 1/8
7/8	.601	.419	9	1 1/2	1 5/16	9/16	1 13/16	1 5/16	1 1/2	1 5/16	3/4	1 13/16	1 5/16
1	.785	.551	8	1 11/16	1 1/2	5/8	2 1/16	1 1/2	1 11/16	1 1/2	7/8	2 1/16	1 1/2
1 1/8	.994	.693	7	1 15/16	1 11/16	3/4	2 5/16	1 11/16	1 15/16	1 11/16	1	2 5/16	1 11/16
1 1/4	1.227	.890	7	2 1/8	1 7/8	13/16	2 9/16	1 7/8	2 1/8	1 7/8	1 1/8	2 9/16	1 7/8

TABLE LXXVI. *Weights of bolts with square heads and nuts—pounds per 100 bolts.*

Length of bolt under head (inches)	Diameter of bolts in inches: 1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
2	4.3	10.8	21.8	38	57	86	122	165	221
2 1/2	5.0	12.3	24.6	42	63	95	133	179	238
3	5.7	13.9	27.4	46	70	103	144	194	255
3 1/2	6.4	15.5	30.2	51	76	112	155	208	273
4	7.1	17.0	33.0	55	82	120	166	222	290
4 1/2	7.8	18.6	35.8	59	88	129	177	236	307
5	8.5	20.2	38.5	64	95	137	188	250	325
6	9.9	23.3	44.1	72	107	154	211	278	360
7	11.3	26.4	49.7	81	120	171	233	306	394
8	12.7	29.6	55.2	90	132	188	255	334	429
10	....	35.8	66.4	107	157	222	300	391	499
12	....	42.1	77.5	125	182	256	344	447	568
14	....	....	88.6	142	207	290	389	503	638
16	....	....	99.8	159	232	325	433	560	707
18	....	....	111.0	176	257	359	477	616	777
20	....	....	122.2	194	282	393	522	672	847
Per inch additional	1.4	3.1	5.6	8.7	12.5	17.0	22.3	28.2	34.8

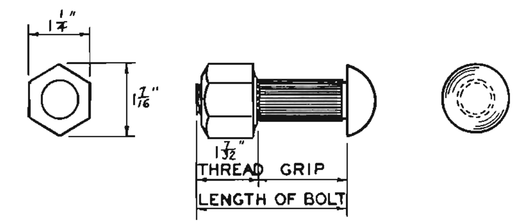
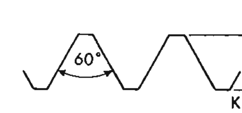
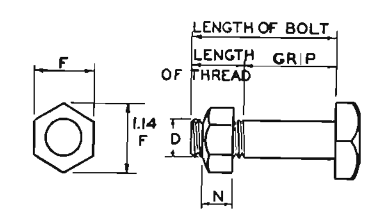


Table LXXVII. Principal dimensions and weights of 7/8-inch structural ribbed bolts

Grip: No.	Grip: G (inches)	Length of bolt L (inches)	Weight with nut (pounds)	Total thickness of work (inches)
1........................	15/32	1 11/16	0.88	3/8 to 1/2
2........................	21/32	1 7/8	.91	9/16 to 11/16
3........................	27/32	2 1/16	.94	3/4 to 7/8
4........................	1 1/32	2 1/4	.97	15/16 to 1 1/16
5........................	1 7/32	2 7/16	1.00	1 1/8 to 1 1/4
6........................	1 13/32	2 5/8	1.03	1 5/16 to 1 7/16
7........................	1 19/32	2 13/16	1.06	1 1/2 to 1 5/8
8........................	1 25/32	3	1.09	1 11/16 to 1 13/16
9........................	1 31/32	3 3/16	1.12	1 7/8 to 2
10........................	2 5/32	3 3/8	1.15	2 1/16 to 2 3/16
11........................	2 11/32	3 9/16	1.18	2 1/4 to 2 3/8
12........................	2 17/32	3 3/4	1.21	2 7/16 to 2 9/16
13........................	2 23/32	3 15/16	1.24	2 5/8 to 2 3/4
14........................	2 29/32	4 1/8	1.27	2 13/16 to 2 15/16
15........................	3 3/32	4 5/16	1.30	3 to 3 1/8





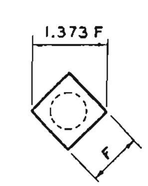


TABLE LXXVIII. *Grips, lengths, and weights of ⅞-inch rivets.*

Grip—inches	½	¾	1	1¼	1½	1⅝	1¾	2	2¼	2½	2¾	3
Undriven length—inches	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	5
Weight per 100 pounds	58	62	67	71	75	79	84	88	92	96	101	109

TABLE LXXIX. *Sizes of wire nails and spikes.*

Size	Length (inches)	Number per pound	Size	Length (inches)	Number per pound
2–d	1	900	12–d	3¼	57
3–d	1¼	615	16–d	3½	46
4–d	1½	322	20–d	4	29
5–d	1¾	250	30–d	4½	23
6–d	2	200	40–d	5	17
7–d	2¼	154	50–d	5½	13½
8–d	2½	106	60–d	6	10½
9–d	2¾	85	5/16"	7	7
10–d	3	74	⅜"	10	3

TABLE LXXX. *Allowable compressive stresses for masonry.*

Material	Allowable compressive stress (psi)
Coursed rubble—Portland-cement mortar	250
Ordinary rubble—Portland-cement mortar	200
Coursed rubble—Lime mortar	150
Ordinary rubble—Lime mortar	60
First-class granite masonry—Portland-cement mortar	800
First-class Limestone masonry—Portland-cement mortar	500
First-class sandstone masonry—Portland-cement mortar	400
Selected, hard, common brick masonry—Portland-cement mortar	200
Common brick masonry—Lime mortar	100
Common brick masonry—Portland-cement mortar	175
Paving brick masonry—Portland-cement mortar	350

TABLE LXXXI. *Properties of pneumatic tools.*

Tool	Weight (lb.)	Air consumption (cfm)	Remarks
Backfill tamper	32	30	
Clay digger	19	35	
Chipping hammer	15	29	3-inch stroke, heavy duty.
Concrete vibrator	24	28	
Drill, steel	35	93	
Drill, rock	56	86	55-pound class.
Grinder	17	58	Rotary portable.
Hammer, pneumatic or steam, pile-driver	5,000	450	
Hammer, pneumatic or steam, pile-driver	7,000	600	
Hoist	310	160	1-ton single-drum, at 80 feet per minute lift (should be run at lower speed).
Holder-on	14	Nil	Rivet set.
Nail driver	23	30	
Paving breaker	80	60	Provided with sheet-pile driving cap.
Pump, sump	29	80	2½-inch discharge, 175 gpm at 25-foot head.
Pump, sump	51	140	2½-inch discharge, 150 gpm at 100-foot head.
Riveting hammer	18	30	18-pound class.
Saw, chain	48	90	24-inch capacity.
Saw, circular	30	36	12-inch portable, 4-inch capacity.
Wood borer	31	63	2-inch capacity.
Wrench, impact	27	38	¾-inch to 1¼-inch capacity reversible.

Weight of tool and air consumption are approximate and will vary with make and model of tool. All tools operate at 80 to 90 psi.

TABLE LXXXIV. *Metric conversion tables.*

METERS TO FEET

Meters	0	1	2	3	4	5	6	7	8	9
..	...	3.28	6.56	9.84	13.12	16.40	19.68	22.97	26.25	29.53
10	32.81	36.09	39.37	42.65	45.93	49.21	52.49	55.77	59.06	62.34
20	65.62	68.90	72.18	75.46	78.74	82.02	85.30	88.58	91.86	95.14
30	98.42	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.88	177.16	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.41	206.69	209.97	213.25	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.06	249.34	252.62	255.90	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.99
90	295.28	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80

FEET TO METERS

Feet	0	1	2	3	4	5	6	7	8	9
..	..	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175

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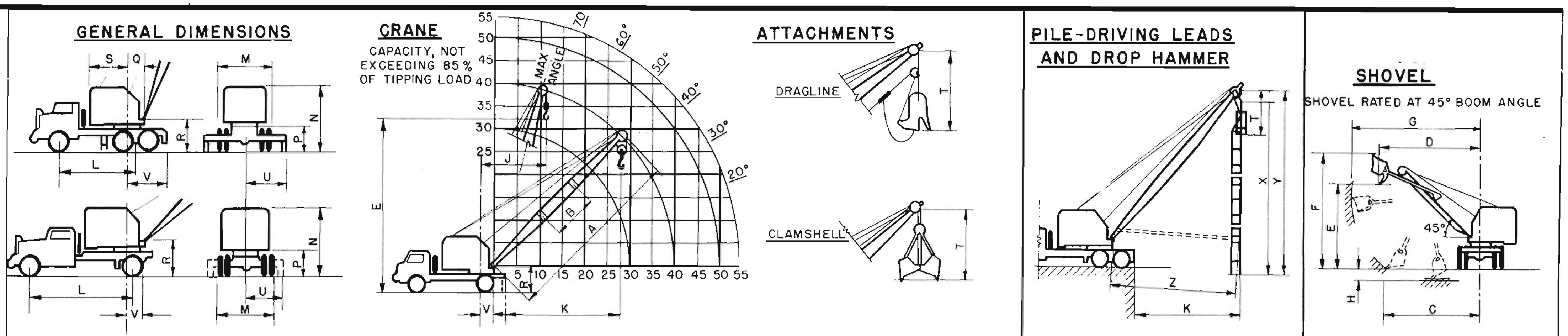
TABLE LXXXII. *Characteristics of truck-mounted cranes.*

IDENTIFICATION

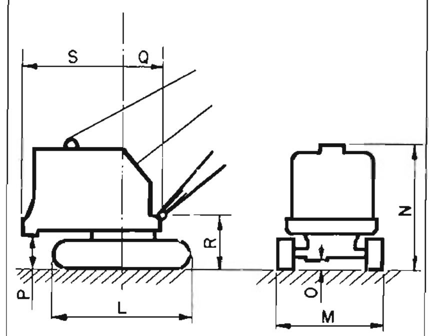
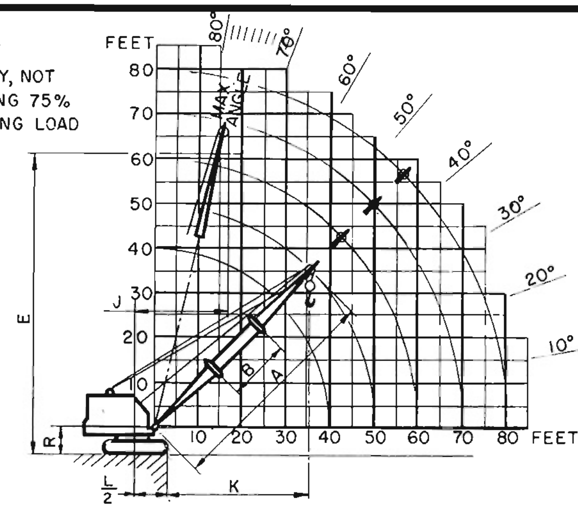
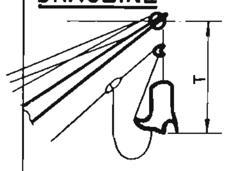
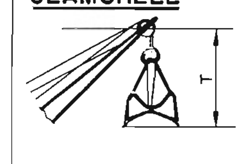
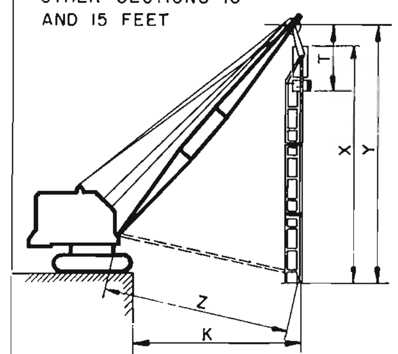
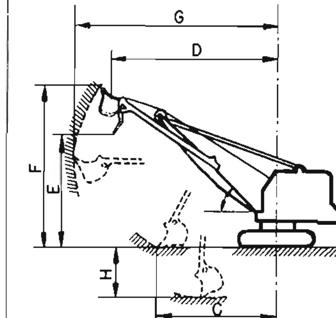
TRUCK-MOUNTED CRANES WITH ATTACHMENTS



Name of equipment number of specification	Model and type	Rating: Size	Rating: Load	Wheel base: Length L	Wheel base: Width M	Boom foot pin: Radius Q	Boom foot pin: Height R	Clearance: Tail-swing S	Clearance: Height N	Overturning distance: Rear wheel V	Overturning distance: Outrigger ⑤ Rear V	Overturning distance: Outrigger ⑤ Side U	Working weight	Boom length: Standard max A	Boom length: Center sections B	Lifting height: Hook max E	Lifting height: Boom angle MAX	Hoist rope: Wire rope DIA	Hoist rope: Single pull MAX	Crane rating and lifting capacity ①: Use of outriggers	Direction of boom	Lifting LOAD	Radius J	At clear distance K from end or side support: K	LOAD	K	LOAD	K	LOAD	Dragline ②: Weight empty	Dragline ②: Dump clear T	Clam-shell ②: Weight empty	Clam-shell ②: Dump clear T	Main dimensions ③: Pile leads X	Main dimensions ③: Drop hammer SIZE	Weight of leads hammer and cap ②	Maximum reach with 2000 lb pile K	Rig dimensions: Length max Y	Rig dimensions: Hammer clear T	Rig dimensions: Cat walk max Z	Dipper SIZE	Radius: Cutting Maximum G	Radius: Cutting At floor C	Radius: Dumping D	Height: Cutting Bank F	Height: Cutting Ditch H	Height: Dumping E	Working weight
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
		YD	TON	IN	FT	FT	FT	FT	FT				TON	FT	FT	FT	0°	IN	TON			TON		FT	TON	FT	TON	FT	TON	TON	FT	TON	FT	FT	LB	TON	FT	FT	FT	FT	YD	FT	FT	FT	FT	FT	FT	TON
SPECIFICATION	T-1137A	$\frac{3}{8}$		196	8.5			8.0	11.5	(3)			16.8	35	2AT5			$\frac{1}{2}$	3.0		END	5.5	10	12	3.25	17	2.35	22	1.7	0.4				20+10	1200	1.8	15	31	6	23	$\frac{3}{8}$		13.0	16.5		3.5	10.5	
										(4)											SIDE	3.35	10	11	2.35	16	1.6	21	1.15	0.4																		
QUICKWAY	E	$\frac{3}{8}$	$5\frac{1}{2}$	147	8.0	1.8	4.7	8.2	11.2	2.3			13	35	2AT5	36	77	$\frac{1}{2}$	3.0	NO OUTRIGGER	END	6.0	10	13	4.4	23	2.6	33	1.4	0.5	8.3	.8	6.8	26④	1200	1.4	20	29	6.5	13	$\frac{3}{8}$	20.0	13.0	16.8	16.5	3.5	10.9	13.5
TRUCK SHOVEL										4.0										DO	SIDE	2.5	10	11	2.5	21	1.0										7				$\frac{3}{8}$							
ON COLEMAN TRUCK											2.2									OUTRIGGER	END	6.0	10	13	4.4	23	2.6	33	1.4								20											
												5.0								DO	SIDE	6.0	10	9	4.5	19	2.0										16											
QUICKWAY	E	$\frac{3}{8}$	$6\frac{1}{2}$	198	8.4	1.8	5.2	8.2	11.5	3.4			17	35	2AT5	36.5	77	$\frac{1}{2}$	3.0	NO OUTRIGGER	END	6.5	10	11	4.7	21	3.6	31	1.5	0.5	8.3	.8	6.8	26④	1200	1.4	24	29	6.8	13	$\frac{3}{8}$	20.0	13.0	16.8	17	2.9	11.5	17.5
TRUCK SHOVEL										4.0										DO	SIDE	4.2	10	11	3.0	21	1.5										12											
ON BROCKWAY TRUCK											4.5									OUTRIGGER	END	6.5	10	11	4.1	21	3.5	31	1.5								24											
												6.0									SIDE	6.0	10	9	4.0	19	2.4										19											
MICHIGAN	T-6-K	$\frac{3}{8}$	$4\frac{1}{2}$	130	8.0	2.3	5.0	5.8	9.5	4.0			11	30	5	32	75	$\frac{1}{2}$	3.7	NO OUTRIGGER	END	4.5	10	10	3.1	16	2.0	26	1.2	0.5	8.0	.8	6.8	20+10	1200	1.8	11				$\frac{3}{8}$	20.4	16.0	17.2	18.4	2.2	13.1	11.0
POWER SHOVEL										4.0										DO	SIDE	3.8	10	10	2.4	16	1.5	21	1.2								9											
											5.0									OUTRIGGER	END	8.8	10	9	5.0	15	3.0	25	1.8								16											
												(6.0)								DO	SIDE	7.3	10	8	4.2	14	2.5	19	1.8								12											
THEW SHOVEL	MC3	$\frac{3}{4}$	10	175	8.0	2.3	5.5	8.8	10.9	5.0			21	40	10	42	83	$\frac{5}{8}$		NO OUTRIGGER	END	10.3	10	10	5.8	20	3.0	35	1.5	0.9	10.0			37	2000	2.5	17				$\frac{3}{4}$	24.2	15.4	20.8	21.2	5.2	15.5	22.0
LORAIN										4.0										DO	SIDE	9.3	10	11	5.3	21	2.6	36	1.4								16											
											7.0	(7.0)								OUTRIGGER	END SIDE	11.0	10	8	7.0	18	3.9	33	2.2								20											
THEW SHOVEL	MC4	$\frac{3}{4}$	12	175	8.0	2.3	5.5	8.8	10.9	5.0				40	10	41	83	$\frac{5}{8}$		NO OUTRIGGER	END	12.2	10	10	8.0	20	4.2	35	2.3					20+15	1800	2.4	24				$\frac{3}{4}$	242	15.4	20.8	21.2	5.2	15.5	22.0
LORAIN										4.0										DO	SIDE	11.0	10	11	6.5	21	3.4	36	1.8								19											
											7.0	(7.0)								OUTRIGGER	END SIDE	15.5	10	8	10.1	18	5.9	33	3.4								33											
HARNISCHFEGER	255A	$\frac{3}{4}$	12	184	8.0	2.5	6.0	8.9	11.9	5.0			14	40	10	40	81	$\frac{5}{8}$	4.5	NO OUTRIGGER	END									0.9	10.8	1.5	9.8	20+15	1800	2.4	14	36.6	7.7	14	$\frac{3}{4}$	262	15.5	21.7	21.5	6.0	14.7	26.0
										4.0										DO	SIDE	10.0	10	11	7.2	21	3.6	36	2.0								22											
											7.0	7.0								OUTRIGGER	END SIDE	18.0	10	8	12.2	18	5.8	33	3.2								31											
BAY CITY SHOVEL	18	$\frac{3}{4}$	$13\frac{1}{2}$	194	8.0	2.5	5.8	9.3	12.3	7.0			24	40	10	40	82	$\frac{5}{8}$	5.0	NO OUTRIGGER	END	13.8	10	8	8.2	18	4.3	33	2.3	1.1	10.0	1.5	9.0	20+15	1800	2.4	23				$\frac{3}{4}$	24.4	17.3	21.3	21.3	5.0	14.4	23.1
										4.0										DO	SIDE	10.0	10	11	5.2	21	2.5	36	1.4								16											
											8.0	(7.0)								OUTRIGGER	END SIDE	16.5	10	7	13.0	17	5.9	32	3.4								32											

NOTES

① LIFTING CAPACITIES INCLUDE WEIGHT OF HOOKS, BLOCKS, SLINGS, AND CHAINS; THEIR WEIGHT MUST BE ADDED TO LOAD HANDLED.
② WEIGHT OF DRAGLINE AND CLAMSHELL BUCKETS AND PILEDRIVING RIGS MUST BE CHECKED IN OPERATION.
③ PILEDRIVING 10-AND 15-FOOT LEAD SECTIONS ARE USED INTERCHANGEABLY. SINGLE-LENGTH LEADS ARE NONSTANDARD, OF MANUFACTURERS' OWN DESIGN.
④ ADAPTERS TO STANDARD PILEDRIVING LEADS ARE FURNISHED FOR QUICKWAY CRANES.
⑤ OUTRIGGER DIMENSIONS MUST BE CHECKED IN THE FIELD.

IDENTIFICATION	GENERAL INFORMATION	CRANE	DRAGLINE / CLAMSHELL	PILE DRIVER	SHOVEL
		CAPACITY, NOT EXCEEDING 75% OF TIPPING LOAD 	 	STANDARD LEADS TOP SECTION 20 FEET OTHER SECTIONS 10 AND 15 FEET 	SHOVEL RATED AT 45° BOOM ANGLE 

NAME OF EQUIPMENT NUMBER OF SPECIFICATION	MODEL AND TYPE	RATING SIZE	RATING LOAD	CRAWLER LENGTH L	CRAWLER WIDTH M	BOOM FOOT PIN RADIUS Q	BOOM FOOT PIN HEIGHT R	CLEARANCE TAIL SWING S	CLEARANCE HEIGHT N	CLEARANCE UNDER FRAME O	CLEARANCE UNDER CAB P	AUXILIARY ELECTRIC LIGHT PLANT SIZE	WORKING WT	BOOM LENGTHS LENGTH STD MAX A	BOOM LENGTHS CENTER SECTION B	LIFTING HEIGHT HOOK MAX E	LIFTING HEIGHT BOOM ANGLE MAX	HOIST ROPE WIRE ROPE DIAM	HOIST ROPE SINGLE PULL MAX	CRANE RATING LIFTING LOAD	CRANE RATING RADIUS J	LIFTING CAPACITY FOR CLEAR DISTANCE K FROM END OR SIDE OF CRAWLERS (1) K	LOAD	K	LOAD	K	LOAD	K	LOAD
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		YD	TON	FT	FT	FT	FT	FT	FT	IN	FT	WATT	TON	FT	FT	FT	0°	IN	TON	TON	FT	FT	TON	FT	TON	FT	TON	FT	TON
$\frac{3}{8}$ YD SHOVELS																													
SPEC T-1443	I	$\frac{3}{8}$	$2\frac{1}{2}$		8.0				10.5	12		750		30	5					2.5	12.0								
AUSTIN-WESTERN	BADGER	$\frac{3}{8}$	3	11.0	8.0	1.0	3.7	FIXED	9.4	12	—	1500	11	35	5	34.0	72°	$\frac{1}{2}$	5.0	3.4	10.0	11	2.3	16	1.7	21	1.3	26	1.1
BAY CITY	20	$\frac{3}{8}$	$4\frac{1}{2}$	9.8	7.7	2.0	3.8	7.0	9.8	13	2.3	750	10	30	5	31.0	75°	$\frac{1}{2}$	6.6	4.5	10.0	10	2.5	15	1.6	20	1.2	25	.9
LINK-BELT SPEEDER	LS-40	$\frac{3}{8}$	$4\frac{1}{2}$	9.7	7.9	1.8	4.2	7.5	9.8	9	3.0	750	10	30	5	28.0	73°	$\frac{1}{2}$	4.2	4.5	10.0	7	3.4	10	2.5	15	1.8	21	1.1
$\frac{1}{2}$ YD SHOVELS																													
SPEC T-1443	II	$\frac{1}{2}$	5		7.5-8				10.5	12		750		35	10					5.0	12.0								
BUCYRUS-ERIE (4)	15 B	$\frac{1}{2}$	$6\frac{1}{2}$	9.5	8.0	3.1	4.3	7.5	10.0	11	2.5	800	13	35	5	34.0	77°	$\frac{9}{16}$	4.0	6.8	10.0	10	3.7	15	2.5	20	1.9	30	1.2
LINK-BELT SPEEDER	LS-50	$\frac{1}{2}$	$5\frac{1}{2}$ (5)	9.8	8.2	1.8	4.2	7.7	9.9	12	3.0	800	12	35	5	35.0	75°	$\frac{1}{2}$	3.2	5.5	10.0	7	4.1	10	3.0	20	1.5	30	1.0
OSGOOD (4)	200	$\frac{1}{2}$	7 (5)	9.3	8.7	2.2	4.2	7.8	10.5	11	3.3	750	15	35	10	36.0	76°	$\frac{1}{2}$	4.2	6.9	10.0	10	3.4	15	2.3	20	1.7	30	1.2
$\frac{3}{4}$ YD SHOVELS																													
SPEC T-1061		$\frac{3}{4}$	7		8.0				11.0	12		1000		35	10				6.0	7.0	12.0								
BUCKEYE (4)	CLIPPER 70	$\frac{3}{4}$	7	11.7	8.7	2.3	4.7	8.5	10.6	12	2.8	1500	16	35	5	342	77°	$\frac{5}{8}$	5.6	7.3	10.0	6	7.0	9	5.0	19	2.5	29	1.8
KOEHRING	304-A	$\frac{3}{4}$	9	11.7	9.6	2.7	5.3	9.0	10.9	13	3.6	1000	19	35	5-10	350	80°	$\frac{5}{8}$	5.8	9.0	12.0	9	6.6	14	4.5	19	3.3	29	2.2
HARNISCHFEGER P&H	255-A	$\frac{3}{4}$	$8\frac{1}{2}$	11.1	9.8	2.5	4.4	8.9	10.3	10	3.0	——	17	40	10	400	74°	$\frac{5}{8}$	4.5	8.5	12.0	19	5.8	14	4.3	24	2.7	34	1.8
LIMA LOCOMOTIVE	PAYMASTER 34	$\frac{3}{4}$	10 (5)	11.0	8.6	2.9	4.6	9.2	10.4	13	3.0	1500	19	35	5	39.5	80°	$\frac{5}{8}$	5.9	12.6	10.0	6	10.0	14	4.6	19	3.4	29	2.1
SHOVELS 1 YD AND LARGER																													
MARION	342	1	14	12.1	9.7	3.3	5.0	9.0	12.1	14	3.3	800	24	40	5-10	38.3	75°	$\frac{5}{8}$	10.2	13.5	12.0	14	6.4	19	4.8	24	3.8	34	2.6
HARNISCHFEGER	655-A	$1\frac{1}{2}$	30	13.8	11.0	3.8	6.0	10.6	13.4	11	3.5	1500	42	65	5-10	60.0	78°	$\frac{3}{4}$	10.0	30.0	12.0	8	21.8	18	11.2	38	5.0	58	3.0
KOEHRING	604-B	$1\frac{1}{2}$	30	13.8	10.7	4.0	6.5	12.1	12.8	16	3.8	1500	42	65	5-10	65.0	81°	$\frac{3}{4}$-$\frac{7}{8}$	8.0	39.4	12.0	8	22.2	18	10.4	38	4.7	53	2.9
THEW SHOVEL (4)	LORAIN 82	2	30	14.1	11.4	3.1	5.5	12.0	12.1	10	2.9	1500	45	70	20	65.0	78°	$\frac{3}{4}$	12.0	21.0	15.0	13	14.0	23	8.0	43	4.0	63	2.4
LIMA LOCOMOTIVE	802	2	40	14.4	11.4	3.6	5.5	13.8	12.3	9	3.5	1500	75	60	10	58	82	$\frac{3}{4}$	12.0	40.9	12.0	13	19.3	23	10.7	38	5.8	53	3.5
NORTHWEST (4)	78 D	2	21	14.8	10.7			11.6	12.0			1500	49	70	10-20	70.0	79°	$\frac{3}{4}$	12.0	21.1	15.0	13	14.5	23	8.5	43	4.4	63	2.8
BUCYRUS-ERIE	54 B	$2\frac{1}{2}$	25	15.1	11.8	5.2	6.3	12.8	12.3		3.7	1500	63	80	20	80.0	78°	1	13.5	44.5	12.0	13	20.8	33	8.4	53	4.8	68	3.5
SPEC A S 1629		2	21									1500		80	20-30					21.0	15.0								

NAME OF EQUIPMENT NUMBER OF SPECIFICATION	DRAGLINE BUCKET CAPACITY SIZE	DRAGLINE BUCKET WT EMPTY (2)	DRAGLINE BUCKET DUMP CLEAR T	CLAMSHELL BUCKET CAPACITY SIZE	CLAMSHELL BUCKET WT EMPTY (2)	CLAMSHELL BUCKET DUMP CLEAR T	MAIN DIMENSIONS (3) PILE LEADS X	MAIN DIMENSIONS (3) DROP HAMMER SIZE	WT OF LEADS HAMMER AND CAP (2)	MAX REACH WITH 2000 LB PILE K	RIG DIMENSIONS LENGTH MAX Y	RIG DIMENSIONS HAMMER CLEAR T	RIG DIMENSIONS CATWALK MAX Z	DIPPER SIZE	RADIUS CUTTING MAX G	RADIUS CUTTING AT FLOOR C	RADIUS DUMPING D	HEIGHT CUTTING BANK F	HEIGHT CUTTING DITCH H	HEIGHT DUMPING E	WORKING WT
1	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
	YD	TON	FT	YD	TON	FT	FT	LB	TON	FT	FT	FT	FT	YD	FT	FT	FT	FT	FT	FT	TON
$\frac{3}{8}$ YD SHOVELS																					
SPEC T-1443	$\frac{3}{8}$			$\frac{3}{8}$			25 TO 35	1000						$\frac{3}{8}$	20.0		16.0			11.5	10
AUSTIN-WESTERN	$\frac{3}{8}$	.4	8.0	$\frac{3}{8}$	.8	7.0	20+10	1200	1.8	9				$\frac{3}{8}$	21.0	14.4	16.4	20.4	4.2	15.3	12
BAY CITY	$\frac{3}{8}$	.5	8.2	$\frac{3}{8}$	.8	8.0	25	1000			26.0	5.0		$\frac{3}{8}$	20.5	14.5	17.3	18.8	4.0	13.3	11
LINK-BELT SPEEDER	$\frac{3}{8}$	.5	9.5	$\frac{3}{8}$	.8	8.5	25	1125	1.2	12				$\frac{3}{8}$	20.5	14.6	17.3	18.8	4.0	13.3	10.5
$\frac{1}{2}$ YD SHOVELS																					
SPEC T-1443	$\frac{1}{2}$	.9		$\frac{1}{2}$	1.2		25 TO 30	1800						$\frac{1}{2}$	21.5		18.5			12.5	12.5-16
BUCYRUS-ERIE (4)	$\frac{1}{2}$	.7	10.0	$\frac{1}{2}$	1.2	8.5	28.5	1800	2.5	12	31.0	8.0		$\frac{1}{2}$	23.8	16.0	19.0	20.0	5.7	13.8	14
LINK-BELT SPEEDER	$\frac{1}{2}$	.7	8.7	[illegible]	1.2	7.5	30	1800	1.7	12				$\frac{1}{2}$	22.0	14.0	17.8	19.2	4.0	14.0	13
OSGOOD (4)	$\frac{1}{2}$	1.1	9.0	$\frac{1}{2}$	1.4	8.3	25	1800	2.2	11	22.5	4.0	18	$\frac{1}{2}$	23.5	17.5	20.0	19.5	4.0	14.0	15
$\frac{3}{4}$ YD SHOVELS																					
SPEC T-1061	$\frac{3}{4}$	1.2		$\frac{3}{4}$	1.5		25 TO 35	2500						$\frac{3}{4}$	24.0					14.0	18-20
BUCKEYE (4)	$\frac{3}{4}$	.9	9.5	$\frac{3}{4}$	1.5	8.5	32	2000			33.5	7.0	18	$\frac{3}{4}$	24.8	15.1	20.3	21.1	5.9	15.3	17
KOEHRING	$\frac{3}{4}$	1.0	10.0	1	1.4	10.5	30	2200	3.3	15				$\frac{3}{4}$	27.3	17.8	23.1	22.9	6.9	16.6	21
HARNISCHFEGER P&H	$\frac{3}{4}$	.9	10.0	$\frac{3}{4}$	1.5	9.0	35	2300	2.5	14	36.5	6.8	14	$\frac{3}{4}$	26.2	15.5	23.2	21.5	6.0	14.8	19
LIMA LOCOMOTIVE	$\frac{3}{4}$	1.1	10.5	$\frac{5}{8}$	1.5	9.5	20+10	2500	2.5	18				$\frac{3}{4}$	27.3	16.4	24.4	21.6	7.1	15.0	21
SHOVELS 1 YD AND LARGER																					
MARION	1	1.4	11.6	1	1.8	11.7	20+10	2500	2.5	27				1	28.5	17.3	23.0	24.0	7.7	16.7	28
HARNISCHFEGER	$1\frac{1}{2}$	1.6	12.9	$1\frac{1}{2}$	2.5	12.0	42	2300	3.3	21.3	43.2	8.0	21	$1\frac{1}{2}$	32.0	20.5	27.5	27.3	7.0	18.5	45
KOEHRING	$1\frac{1}{2}$	1.7	11.5	$1\frac{1}{2}$	2.2	12.0	20+15 +10	2500	3.4	33				$1\frac{1}{2}$	33.0	23.3	27.4	28.5	7.1	19.9	47
THEW SHOVEL (4)	2	2.2	13.6	2	3.2	12.7.	20+15 +10+10	3000	4.1	35	56.5	8.7	23.0	2	33.1	22.8	28.0	27.1	8.3	17.5	
LIMA LOCOMOTIVE	2	2.4	13.6	2	3.4	12.7		3000	4.1	41				2	35.2	21.3	30.5	27.8	9.5	18.2	73
NORTHWEST (4)	2	2.2	13.6	2	3.2			3000	4.1	38	56.0	8.3	23.0	2	33.0	21.8	28.9	25.5	7.4	16.5	57
BUCYRUS-ERIE	$2\frac{1}{2}$	2.8		$2\frac{1}{2}$	3.5			3000	4.1	50				$2\frac{1}{2}$	37.5	23.3	31.0	28.8	9.0	19.3	76
SPEC A S 1629	2			2										2	32.0		28.0			16.0	56

1. LIFTING CAPACITIES INCLUDE WEIGHT OF HOOKS, BLOCKS, SLINGS AND CHAINS; THEIR WEIGHT MUST BE ADDED TO LOAD HANDLED.
2. WEIGHT OF DRAGLINE-AND CLAMSHELL BUCKETS AND PILE-DRIVING RIGS MUST BE CHECKED IN OPERATION.
3. PILE-DRIVING 10-AND 15-FOOT LEAD SECTIONS ARE USED INTERCHANGEABLY. SHORTER LEADS AND LIGHTER DROPHAMMERS MAY BE USED TO EXTEND REACH. SINGLE-LENGTH LEADS ARE NON-STANDARD, OF MANUFACTURERS OWN DESIGN.
4. ADAPTORS TO STANDARD PILE-DRIVING LEADS ARE FURNISHED FOR THIS SHOVEL.
5. CAPACITIES FOR CRANE FURNISHED WITH EXTRA COUNTERWEIGHT; 1500 LB LS-50; 1100 LB OSGOOD; 4000 LB PAYMASTER 34.

Table LXXXV. *Metric conversion tables.*

KILOGRAMS TO POUNDS AVOIRDUPOIS

Kg.	0	1	2	3	4	5	6	7	8	9
..	...	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	52.91	55.12	57.32	59.52	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.84	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.35	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.23	209.44	211.64	213.85	216.05	218.26

POUNDS AVOIRDUPOIS TO KILOGRAMS

Lbs.	0	1	2	3	4	5	6	7	8	9
..	...	0.4536	0.9072	1.361	1.814	2.268	2.722	3.175	3.629	4.082
10	4.536	4.990	5.443	5.897	6.350	6.804	7.257	7.711	8.165	8.618
20	9.072	9.525	9.979	10.433	10.886	11.340	11.793	12.247	12.701	13.154
30	13.608	14.061	14.515	14.969	15.422	15.876	16.329	16.783	17.237	17.690
40	18.144	18.597	19.051	19.504	19.958	20.412	20.865	21.319	21.772	22.226
50	22.680	23.133	23.587	24.040	24.494	24.948	25.401	25.855	26.308	26.762
60	27.216	27.669	28.123	28.576	29.030	29.484	29.937	30.391	30.844	31.298
70	31.751	32.205	32.659	33.112	33.566	34.019	34.473	34.927	35.380	35.834
80	36.287	36.741	37.195	37.648	38.102	38.555	39.009	39.463	39.916	40.370
90	40.823	41.277	41.731	42.184	42.638	43.091	43.545	43.998	44.452	44.906

Table LXXXVI. *Factors for conversion of units.*

Unit A Measure	To convert to unit B multiply by:	To convert to unit A multiply by:	Unit B Measure
Length:			
Miles	5280	.0001894	Feet.
Feet	.167	6	Fathoms.
Feet	.0606	16.5	Rods.
Feet	.0151	66	Chain.
Feet	.0015	660	Furlongs.
Fathoms	.0083	120	Cable lengths.
Miles	1.609	.6214	Kilometers.
Yards	.9144	1.0936	Meters.
Feet	.3048	3281	Meters.
Feet	.0003048	3281.0	Kilometers.
Inches	2.54	.3937	Centimeters.
Miles	.868	1.1515	Nautical miles.
Surface:			
Square miles	640	.001563	Acres.
Acres	4840	.000207	Square yards.
Acres	43560	.00002296	Square feet.
Square mile	2.59	.3861	Square kilometers.
Acres	.4047	2471	Hectares.
Acres	4046.9	.0002471	Square meter.
Square yard	.8361	1.1960	Square meter.
Square yard	.008361	1196	Acres.
Square feet	.0929	10.764	Square meter.
Square inch	6.452	.155	Square centimeter.
Volume:			
Cubic feet	1728	.000579	Cubic inches.
Cubic feet	7.481	.1337	U. S. gallons.
Cubic feet	6.229	.1605	Imperial gallons.
Cubic feet	.8036	1.2445	U. S. bushels.
Cubic feet	12.	.0833	Board feet.
Cubic feet	.007813	128	Cords of wood.
Cubic inches	.5541	1.805	Fluid ounces (U. S.)
U. S. gallons	.83251	1.2009	Imperial gallons.
U. S. gallons	.03175	31.5	Barrels.
Cubic yard	.7645	1.308	Cubic meters.
Cubic feet	.02832	35.314	Cubic meters.
Cubic feet	28.317	.03531	Liters.
U. S. gallons	3.785	.2642	Liters.
U. S. quart	.946	1.0567	Liters.
Cubic inch	16.38716	.061	Cubic centimeters.
Pounds per cubic yard	.0593	16.856	Kilograms per hectoliter.
Velocities:			
Miles per hour	1.467	.6818	Feet per second.
Feet per second	.3048	3.281	Meters per second.
Miles per hour	.4470	2.237	Meters per second.
Miles per hour	1.609	.6214	Kilometers per hour.
Miles per hour	.8684	1.1516	Knots.
Flowing water:			
Cubic feet per second (second feet)	60.0	.01667	Cubic feet per minute.
Cubic feet per second (second feet)	448.8	.002228	U. S. gallons per minute.
Cubic feet per minute	7.481	.1337	U. S. gallons per minute.
Energy:			
Foot-pound	.001285	778.1	British Thermal Unit.
Foot-pound	.0003239	3087.77	Kilogram calories.
Foot-pound	.0000003766	2655403	Kilowatt hours.
Foot-pound	.13826	7.23300	Kilogram meters.
Power:			
Horsepower	550	.001818	Foot-pounds per second.
Horsepower	.746	1.341	Kilowatts.
Horsepower U. S.	1.0139	.98632	Horsepower, metric.
Horsepower metric	75	.01333	Kilogram meters per second.
Angles:			
Degrees, angle	.01745	57.29578	Radians.
Mils (circular)	.0562	17.78	Degrees, angular.
Mils (circular)	.008982	1.019	Radians.
Shipping:			
Cubic feet	.010	100.0	Register tons.
Cubic feet	.0250	40.0	U. S. shipping tons.
Cubic feet	.0238	42.0	British shipping tons.
Weights—Avoirdupois or commercial weight unless otherwise shown .			
Pounds	7000	.0001429	Grains.
Ounce	437.5	.002286	Grains.
Ounce (Troy or apothecaries' weight)	480	.002083	Grains.
Pounds	.0004464	2240	Long tons or gross tons.
Net tons or short tons ton (U. S.)	.89286	1.12	Long tons or gross tons. (Br)
Pounds	.4536	2.205	Kilograms.
Ounce	28.35	.03527	Grams.
Ounce (Troy or apothecaries' weight)	31.103	.03215	Grams.
Grain	.0648	15.432	Grams.
Tons, short	.907	1.1023	Tons, metric.
Tons, short	907.185	.0011023	Kilograms.
Tons, long	1.016	.9842	Tons, metric.
Pennyweight (Troy)	24		Grains.
Hundredweight (long)	112		Pounds.
Stone	14		Pounds.
Carat for diamonds	3.086	.3240	Grains (Troy).
Linear Weights:			
Pounds per foot	1.488	.672	Kilograms per meter.
Pounds per yard	.496	2.016	Kilograms per meter.
Pressure:			
Atmospheres (mean)	33.90	.02950	Feet of water.
Atmospheres (mean)	14.70	.0680	Pounds per square inch.
Atmospheres (mean)	29.92	.03342	Inches of mercury.
Pounds per square inch	2.036	.4912	Inches of mercury.
Feet of water	62.42	.01602	Pounds per square foot.
Kilograms per square centimeter	14.22	.0703	Pounds per square inch.
Kilograms per square meter	.2048	4.8824	Pounds per square foot.
Density			
Pounds per cubic foot	.0160	62.428	Grams per cubic centimeter (specific gravity for solids).
Pounds per cubic foot	16.0184	.0624	Kilograms per cubic meter.

TECHNICAL MANUAL 5-286
SEMIPERMANENT HIGHWAY AND RAILWAY TRESTLE BRIDGES

PART SIX — DRAWINGS

LIST OF DRAWINGS

Group 1. LIST OF DRAWINGS FOR SINGLE-LANE CLASS 50 HIGHWAY BRIDGES

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
1	All units	Index: Sets of drawings for units of construction
2	Timber spans (11 to 15 feet long)	General views
3	do	Bill of materials
4	Steel spans (15 to 90 feet long)	General views
5	do	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
6	do	Bill of material: steel for welded construction; lumber and hardware for alternate laminated floor
7	Timber towers for timber spans (15 to 76 feet high)	General views
8	do	Bill of materials
9	Timber towers for steel spans (15 to 76 feet high)	Details and bill of materials for connection of spans to towers
10	do	General views
11	do	Bill of materials
12	Steel towers for steel spans (15 to 77 feet high)	General views of 69- to 77-foot towers
13	do	General views of 15- to 67-foot towers
14	do	Bill of materials common to all towers
15	do	Bill of materials which vary with tower height
16	do	Riveted construction: fabrication of cap beam, strut, and pin
17	do	Riveted construction: fabrication of columns and struts
18	do	Riveted construction: fabrication of columns
19	do	Fabrication of rod bracing
20	Steel towers, bents and piers for steel spans	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
21	Timber abutments for timber spans	General views of pile abutments; bill of materials for pile and grillage abutments
22	do	General views of grillage abutments
23	Abutments for steel spans	General views of timber pile abutments; bill of materials for timber pile and timber grillage abutments
24	do	General views of timber grillage abutments
25	do	General views of steel pile abutments
26	Abutments for steel spans	Fabrication details and bill of materials for steel pile abutments
27	do	General views and bill of materials for concrete abutments
28	Timber pile bents for timber spans. (1 to 28 feet high)	Bill of materials; general views of 1- to 16-foot bents
29	do	General views of 17- to 28-foot bents
30	Timber pile piers for steel spans (1 to 13 feet high)	General views
31	do	Bill of materials; details of piers supporting one steel and one timber span
32	Steel pile bents and piers for steel spans (1 to 20 feet high)	Riveted construction: general views
33	do	Riveted construction: bill of materials
34	do	Welded construction: general views
35	do	Welded construction: bill of materials
36	Timber sill and pile foundations for timber towers	General views
37	Concrete pedestals for timber towers	General views and bill of materials
38	Concrete pedestals for steel towers	General views and bill of materials for pedestals on ground
39	do	General views and bill of materials for pedestals on piles
40	Steel frame on steel pile foundations for steel towers	General views and bill of materials
41	Steel grillage foundations for steel towers	Bolted construction: general views and bill of materials
42	do	Welded construction: general views and bill of materials
43	Timber grillage foundations for timber towers	General views and bill of materials

Group 2. DOUBLE-LANE CLASS 50 HIGHWAY BRIDGES
(Used also for class 80 single-lane traffic)

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
44	All units	Index: sets of drawings for units of construction
45	Timber spans (11 to 15 feet long)	General views
46	do	Bill of materials
47	Steel spans (15 to 90 feet long)	General views
48	do	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
49	do	Bill of materials: steel for welded construction; lumber and hardware for alternate laminated floor
50	Timber towers for timber spans (15 to 76 feet high)	General views
51	do	Bill of materials
52	timber towers for steel spans (15 to 76 feet high)	Details and bill of materials for connection of spans to towers
53	do	General views
54	do	Bill of materials
55	Steel towers for steel spans For double-lane class 50 and class 25 (15 to 76 feet high)	General views of 69- to 77-foot towers
56	do	General views of 15- to 67-foot towers
57	do	Bill of materials common to all towers
58	do	Bill of materials which vary with tower height
59	do	Riveted construction: fabrication of cap beam, strut, and pin
60	do	Riveted construction: fabrication of columns
61	do	Riveted construction: fabrication of columns and struts
62	do	Fabrication of rod bracing
63	Steel towers, bents, and piers for steel spans	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
64	Timber abutments for timber spans	General views of pile abutments; bill of materials for pile and grillage abutments
65	do	General views of grillage abutments
66	Abutments for steel spans	General views of timber pile abutments
67	do	General views of timber grillage abutments
68	do	Bill of materials for timber pile and grillage abutments
69	do	General views of steel pile abutments
70	do	Fabrication details and bill of materials for steel pile abutments
71	do	General views and bill of materials for concrete abutments
72	Timber pile bents for timber spans (1 to 28 feet high)	Bill of materials; general views of 1- to 16-foot bents
73	do	General views of 17- to 28-foot bents
74	Timber pile piers for steel spans (1 to 13 feet high)	General views
75	do	Bill of materials; details of piers supporting one steel and one timber span
76	Steel pile bents and piers for steel spans (1 to 20 feet high)	Riveted construction: general views of bents
77	do	Riveted construction: general views of piers
78	do	Riveted and welded construction: bill of materials
79	do	Welded construction: general views of bents
80	do	Welded construction: general views of piers
81	Timber sill and pile foundations for timber towers	General views
82	do	Additional views and bill of materials
83	Concrete pedestals for timber towers	General views and bill of materials

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
84	Concrete pedestals for steel towers	General views and bill of materials for pedestals on timber piles
85	do	General views and bill of materials for pedestals on ground and on steel piles
86	Steel frame on steel pile foundations for steel towers	General views and bill of materials
87	Steel grillage foundations for steel towers	Bolted construction: general views and bill of materials
88	do	Welded construction: general views and bill of materials
89	Timber grillage foundations for timber towers	General views
90	do	Additional views and bill of materials

Group 3. DOUBLE LANE CLASS 25 HIGHWAY BRIDGES
(See also sheets 55 through 62)

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
91	All units	Index; sets of drawings for units of construction
92	Timber spans (11 to 15 feet long)	General views
93	do	Bill of materials
94	Steel spans (15 to 90 feet long)	General views
95	do	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
96	do	Bill of materials: steel for welded construction; lumber and hardware for alternate laminated floor
97	Timber towers for timber spans (15 to 76 feet high)	General views
98	do	Bill of materials
99	Timber towers for steel spans (15 to 76 feet high)	Details and bill of materials for connection of spans to towers
100	do	General views
101	do	Bill of materials
102	Steel towers for steel spans (15 to 77 feet high)	Riveted construction: fabrication of cap beam
	(Note: Sheets 55 through 62 apply to steel towers for double-lane class 25 and class 50 steel spans.)	
103	Steel towers, bents, and piers for steel spans	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
104	Timber abutments for timber spans	General views of pile abutments; bill of materials for pile and grillage abutments
105	do	General views of grillage abutments
106	Abutments for steel spans	General views of timber pile abutments; bill of materials for timber pile and timber grillage abutments
107	do	General views of timber grillage abutments for 3-foot maximum fill
108	Abutments for steel spans	General views of timber grillage abutments for 6-foot maximum fill
109	do	General views of steel pile abutments
110	do	Fabrication details and bill of materials for steel pile abutments
111	do	General views and bill of materials for concrete abutments
112	Timber pile bents for timber spans (1 to 28 feet high)	Bill of materials; general views of 1- to 16-foot bents
113	do	General views of 17- to 28-foot bents
114	Timber pile piers for steel spans (1 to 13 feet high)	General views
115	do	Bill of materials; details of piers supporting one steel and one timber span
116	Steel pile bents and piers for steel spans (1 to 20 feet high)	Riveted construction: general views of bents
117	do	Riveted construction: general views of piers
118	do	Riveted and welded construction: bill of materials
119	do	Welded construction: general views of bents
120	do	Welded construction: general views of piers
121	Timber sill and pile foundations for timber towers	General views
122	Concrete pedestals for timber towers	General views and bill of materials
123	Concrete pedestals for steel towers	General views and bill of materials
124	Steel frame on steel pile foundations for steel towers	General views and bill of materials
125	Steel grillage foundations for steel towers	Bolted construction: general views and bill of materials
126	do	Welded construction: general views and bill of materials
127	Timber grillage foundations for timber towers	General views and bill of materials

Group 4. DRAWINGS COMMON TO ALL CLASSES OF HIGHWAY BRIDGES
(Sheets 154 and 155 also apply to railway bridges)

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
128	All spans	Details of floor construction and attachment of nailers to steel stringers
129	do	Details of handrail and curb
130	do	General views and bill of materials for walkway
131	Steel spans	Riveted construction: fabrication of stringers 501 to 511 and of diaphragms 527 and 528
132	do	Riveted construction: fabrication of stringers 516 and 521 and of bearing plates 3500 and 3501
133	do	Riveted construction: fabrication of stringers 513 and 523
134	Steel spans	Riveted construction: fabrication of stringers 519 and 526
135	do	Riveted construction: fabrication of stringers 515 and 522
136	do	Riveted construction: fabrication of stringers 512 and 525
137	do	Riveted construction: fabrication of stringers 514, 517, and 518
138	do	Riveted construction: fabrication of stringers 520 and 524
139	do	Welded construction: fabrication of stringers 501W to 511W and of diaphragms C3 and C4
140	do	Welded construction: fabrication of stringers 512W and 525W
141	do	Welded construction: fabrication of stringers 513W, 522W, and 523W
142	do	Welded construction: fabrication of stringers 514W, 515W, and 516W
143	do	Welded construction: fabrication of stringers 520W and 521W
144	do	Welded construction: fabrication of stringers 517W and 526W
145	do	Welded construction: fabrication of stringers 518W, 519W, and 524W
146	All timber towers	Details of bracing connections
147	do	Details of bracing connections
148	do	Details of bracing connections and of columns; column dimensions
149	Timber towers for steel spans	Details of towers supporting both timber and steel spans
150	Steel pile bents and piers for steel spans	Riveted construction: fabrication of cap beams, corbels, bracing, and connections
151	do	Welded construction: fabrication of cap beams, corbels, and bearing plates
152	Steel grillage foundations for steel towers	Bolted construction: fabrication of grillage beams
153	do	Welded construction: fabrication of grillage beams
154	All units	General notes
155	All units	Structural symbols

Group 5. E-45 RAILWAY BRIDGES

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
156	All units	Index: sets of drawings for units of construction
157	Timber spans (12 to 16 feet long)	General views and bill of materials
158	Steel spans (15 to 50 feet long)	General views of 15- to 45-foot spans; assembly diagrams for riveted construction
159	do	General views of 50-foot span
160	do	Bill of materials: structural steel for riveted construction

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
161	Steel spans (15 to 50 feet long)	Bill of materials: structural steel for welded construction, lumber, and deck hardware
162	do	Riveted construction: fabrication of lateral braces
163	do	Riveted construction: fabrication of stringers 401, 402, 403, and 420, and of diaphragms
164	do	Riveted construction: fabrication of stringers 404, 405, 406, and 407
165	do	Riveted construction: fabrication of stringers 408, 409, 410, and 411
166	do	Riveted construction: fabrication of stringers 412, 413, 418, and 419
167	do	Riveted construction: fabrication of stringers 414, 415, 416, and 417
168	do	Welded construction: assembly diagrams and fabrication of lateral braces
169	do	Welded construction: fabrication of stringers 401W, 402W, 403W, and 420W, and of diaphragms
170	do	Welded construction: fabrication of stringers 404W, 405W, 406W, and 407W
171	do	Welded construction: fabrication of stringers 408W, 409W, 410W, and 411W
172	do	Welded construction: fabrication of stringers 412W, 413W, 414W, and 415W
173	do	Welded construction: fabrication of stringers 416W, 417W, 418W, and 419W
174	Timber and steel spans	General views and bill of materials for refuge bay and walkway
175	Timber towers for timber spans (15 to 76 feet high)	General views
176	do	Bill of materials
177	Timber towers for steel spans (15 to 76 feet high)	Details for connection of spans to towers
178	do	Details and bill of materials for connection of spans to towers
179	do	General views
180	do	Bill of materials
181	All timber towers	Details of bracing connections
182	do	Details of bracing connections
183	do	Details of bracing connections and of columns; column dimensions
184	Steel towers for steel spans (15 to 77 feet high)	General views of 69- to 77-foot towers
185	do	General views of 15- to 67-foot towers
186	do	Bill of materials common to all towers
187	do	Bill of materials which vary with tower height
188	do	Riveted construction: fabrication of cap beam, strut, and pin
189	do	Riveted construction: fabrication of columns
190	do	Riveted construction: fabrication of columns and struts
191	do	Fabrication of rod bracing

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
192	Steel towers for steel spans (15 to 77 feet high)	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
193	Timber abutments for timber spans	General views of pile abutments; bill of materials for pile and grillage abutments
194	do	General views of grillage abutments
195	Abutments for steel spans	General views of timber pile abutments
196	do	Bill of materials for timber abutments; general views of timber grillage abutments
197	do	General views of steel pile abutments
198	do	Fabrication details and bill of materials for steel pile abutments
199	do	General views and bill of materials for concrete abutments
200	Timber pile bents for timber spans (1 to 28 feet high)	General views
201	do	Additional views and bill of materials
202	Timber pile piers for steel spans (1 to 11 feet high)	General views
203	do	Bill of materials
204	Steel pile bents and piers for steel spans (1 to 20 feet high)	Riveted construction: general views of bents
205	do	Riveted construction: general views of piers
206	do	Riveted construction: fabrication of cap beams, corbels, and bracing connections
207	do	Riveted construction: bill of materials
208	do	Welded construction: bill of materials
209	do	Welded construction: general views of bents
210	do	Welded construction: general views of piers
211	do	Welded construction: fabrication of cap beams, corbels, and bracing connections
212	Timber sill and pile foundations for timber towers	General views and bill of materials
213	do	General views
214	Concrete pedestals for timber towers	General views and bill of materials
215	Concrete pedestals for steel towers	General views and bill of materials for pedestals on timber piles
216	do	General views and bill of materials for pedestals on ground and on steel piles
217	Steel frame on steel pile foundations for steel towers	General views and bill of materials
218	Steel grillage foundations for steel towers	Bolted construction: general views and bill of materials for grillages S101 and S102
219	do	Bolted construction: general views and bill of materials for grillage S103
220	do	Welded construction: general views and bill of materials for grillage S103 (S101 and S102 are similar)
221	do	Bolted construction: fabrication
222	do	Welded construction: fabrication

SHEET	UNIT OF CONSTRUCTION	INFORMATION GIVEN
223	Timber grillage foundations for timber towers	General views
224	do	Additional views and bill of materials
225	Timber grillage foundations for timber towers	Additional views
Group 6. ALTERNATIVE WELDED DETAILS FOR ALL STEEL TOWERS		
226	Steel towers for steel spans	Welded construction with rod bracing: cap beams and column splices welded in fabrication and erection
227	do	Welded construction with welded angle bracing: cap beams and column splices welded in fabrication and erection
Group 7. SPECIAL ERECTION EQUIPMENT		
228	Steel gin pole and outrigger for erecting steel towers and stringers	General views
229	do	Fabrication of gin pole
230	do	Fabrication of outrigger
231	do	Bill of materials; fabrication of outrigger
232	Timber derrick for erecting timber towers and steel stringers	General views
233	do	Bill of materials; stresses when mast and boom are used as gin poles for placing stringers
234	do	Fabrication of steel parts
Group 8. ADAPTATION OF SUPPORTS TO STANDARD PREFABRICATED BRIDGES		
235	Supports for class 50 single-lane semipermanent highway bridges (TM 5-285)	Adaptation of timber towers to 30-foot I-beam spans
236	do	Adaptation of pile piers and timber grillage abutments to 30-foot I-beam span
237	do	Adaptation of pile and concrete abutments to 30-foot I-beam span
238	do	Adaptation of timber towers to 60-foot I-beam spans
239	do	Adaptation of pile piers and timber grillage abutments to 60-foot I-beam span
240	do	Adaptation of pile and concrete abutments to 60-foot I-beam span
241	do	Adaptation of timber towers to 90-foot truss span
242	do	Adaptation of pile and concrete abutments to 90-foot truss span
243	do	Adaptation of pile piers and timber grillage abutments to 90-foot truss span
244	Supports for Bailey-bridge spans up to 90 feet long (TM 5-277)	Adaptation of pile and concrete abutments, pile bents, and pile piers
245	Supports for H-10 and H-20 spans up to 99 feet long	Adaptation of pile and concrete abutments, pile bents, and pile piers

SET NUMBER 50S-1

TIMBER SPANS
(11 to 15 feet long)

SHEET	
2	General views
3	Bill of materials
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
154	General notes
155	Structural symbols

SET NUMBER 50S-2

STEEL SPANS
(15 to 90 feet long)

SHEET	
4	General views
5	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
6	Bill of materials: steel for welded construction; lumber and hardware for alternate laminated floor
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
131	Riveted construction: fabrication of stringers 501 to 511 and of diaphragms 527 and 528
132	Riveted construction: fabrication of stringers 516 and 521 and of bearing plates 3500 and 3501
133	Riveted construction: fabrication of stringers 513 and 523
134	Riveted construction: fabrication of stringers 519 and 526
135	Riveted construction: fabrication of stringers 515 and 522
136	Riveted construction: fabrication of stringers 512 and 525
137	Riveted construction: fabrication of stringers 514, 517, and 518
139	Welded construction: fabrication of stringers 501W to 511W, and of diaphragms C3 and C4
140	Welded construction: fabrication of stringers 512W and 525W
141	Welded construction: fabrication of stringers 513W, 522W, and 523W
142	Welded construction: fabrication of stringers 514W, 515W, and 516W
143	Welded construction: fabrication of stringers 520W and 521W
145	Welded construction: fabrication of stringers 518W, 519W, and 524W
154	General notes
155	Structural symbols

SET NUMBER 50S-3

TIMBER TOWERS FOR TIMBER SPANS
(15 to 76 feet high)

SHEET	
7	General views
8	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connections and of columns; column dimensions
154	General notes
155	Structural symbols

SET NUMBER 50S-4

TIMBER TOWERS FOR STEEL SPANS
(15 to 76 feet high)

SHEET	
9	Details and bill of materials for connection of spans to towers
10	General views
11	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connections and of columns; column dimensions
149	Details of towers supporting both timber and steel spans
154	General notes
155	Structural symbols

SET NUMBER 50S-5

STEEL TOWERS FOR STEEL SPANS
(15 to 77 feet high)

SHEET	
12	General views of 69- to 77-foot towers
13	General views of 15- to 67-foot towers
14	Bill of materials common to all towers
15	Bill of materials which vary with tower height
16	Riveted construction: fabrication of cap beam, strut, and pin
17	Riveted construction: fabrication of columns and struts
18	Riveted construction: fabrication of columns
19	Fabrication of rod bracing
20	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
226	Welded construction with rod bracing: cap beams and column splices welded in fabrication and erection
227	Welded construction with welded angle bracing: cap beams and column splices welded in fabrication and erection
154	General notes
155	Structural symbols

NOTE: When welded construction is used in accordance with sheets 226 or 227, bills of materials on sheets 14 and 15 and fabrication details on sheets 16, 17, and 18 must be adjusted in the field. When sheet 227 is used, sheet 19 does not apply.

SET NUMBER 50S-6

TIMBER ABUTMENTS FOR TIMBER SPANS

SHEET	
21	General views of pile abutments; bill of materials for pile and grillage abutments
22	General views of grillage abutments
154	General notes
155	Structural symbols

SET NUMBER 50S-7

ABUTMENTS FOR STEEL SPANS

SHEET	
23	General views of timber pile abutments; bill of materials for timber pile and timber grillage abutments
24	General views of timber grillage abutments
25	General views of steel pile abutments
26	Fabrication details and bill of materials for steel pile abutments
27	General views and bill of materials for concrete abutments
154	General notes
155	Structural symbols

SET NUMBER 50S-8

TIMBER PILE BENTS FOR TIMBER SPANS
(1 to 28 feet high)

SHEET	
28	Bill of materials; general views of 1- to 16-foot bents
29	General views of 17- to 28-foot bents
154	General notes
155	Structural symbols

SET NUMBER 50S-9

TIMBER PILE PIERS FOR STEEL SPANS
(1 to 13 feet high)

SHEET	
30	General views
31	Bill of materials; details of piers supporting one steel and one timber span
154	General notes
155	Structural symbols

SET NUMBER 50S-10

STEEL PILE BENTS AND PIERS FOR STEEL SPANS
(1 to 20 feet high)

SHEET	
32	Riveted construction: general views
33	Riveted construction: bill of materials
34	Welded construction: general views
35	Welded construction: bill of materials
150	Riveted construction: fabrication of cap beams, corbels, bracing, and connections
151	Welded construction: fabrication of cap beams, corbels, and bearing plates
154	General notes
155	Structural symbols

SET NUMBER 50S-11

TIMBER SILL AND PILE FOUNDATIONS FOR TIMBER TOWERS

SHEET	
36	General views
154	General notes
155	Structural symbols

SET NUMBER 50S-12

CONCRETE PEDESTALS FOR TIMBER TOWERS

SHEET	
37	General views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER 50S-13

CONCRETE PEDESTALS FOR STEEL TOWERS

SHEET	
38	General views and bill of materials for pedestals on ground
39	General views and bill of materials for pedestals on piles
12	General views of 69- to 77-foot towers
13	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 50S-14

STEEL FRAME ON STEEL PILE FOUNDATIONS FOR STEEL TOWERS

SHEET	
40	General views and bill of materials
12	General views of 69- to 77-foot towers
13	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 50S-15

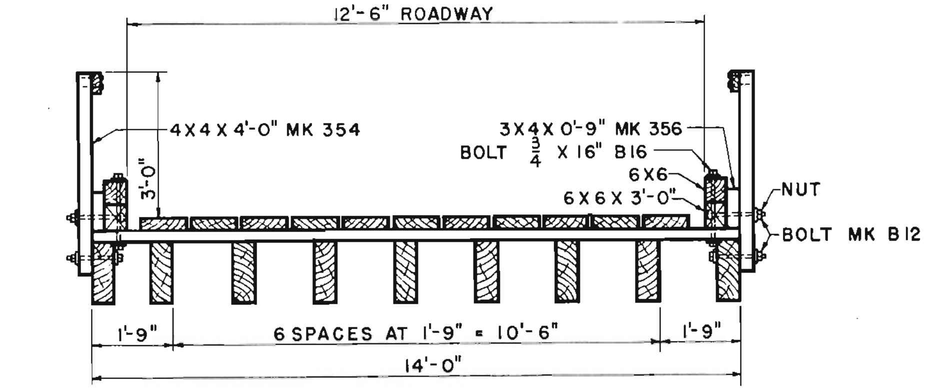
STEEL GRILLAGE FOUNDATIONS FOR STEEL TOWERS

SHEET	
41	Bolted construction: general views and bill of materials
42	Welded construction: general views and bill of materials
152	Bolted construction: fabrication of grillage beams
153	Welded construction: fabrication of grillage beams
12	General views of 69- to 77-foot towers
13	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

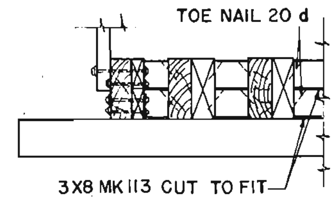
SET NUMBER 50S-16

TIMBER GRILLAGE FOUNDATIONS FOR TIMBER TOWERS

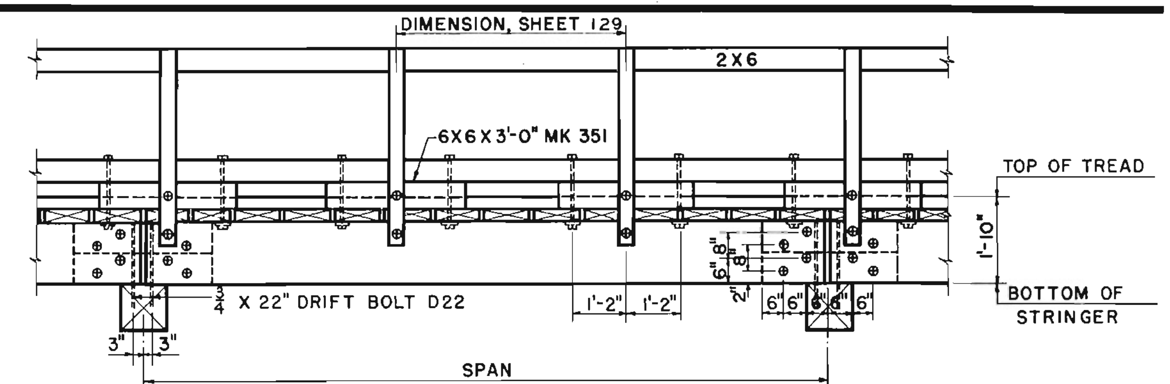
SHEET	
43	General views and bill of materials
154	General notes
155	Structural symbols



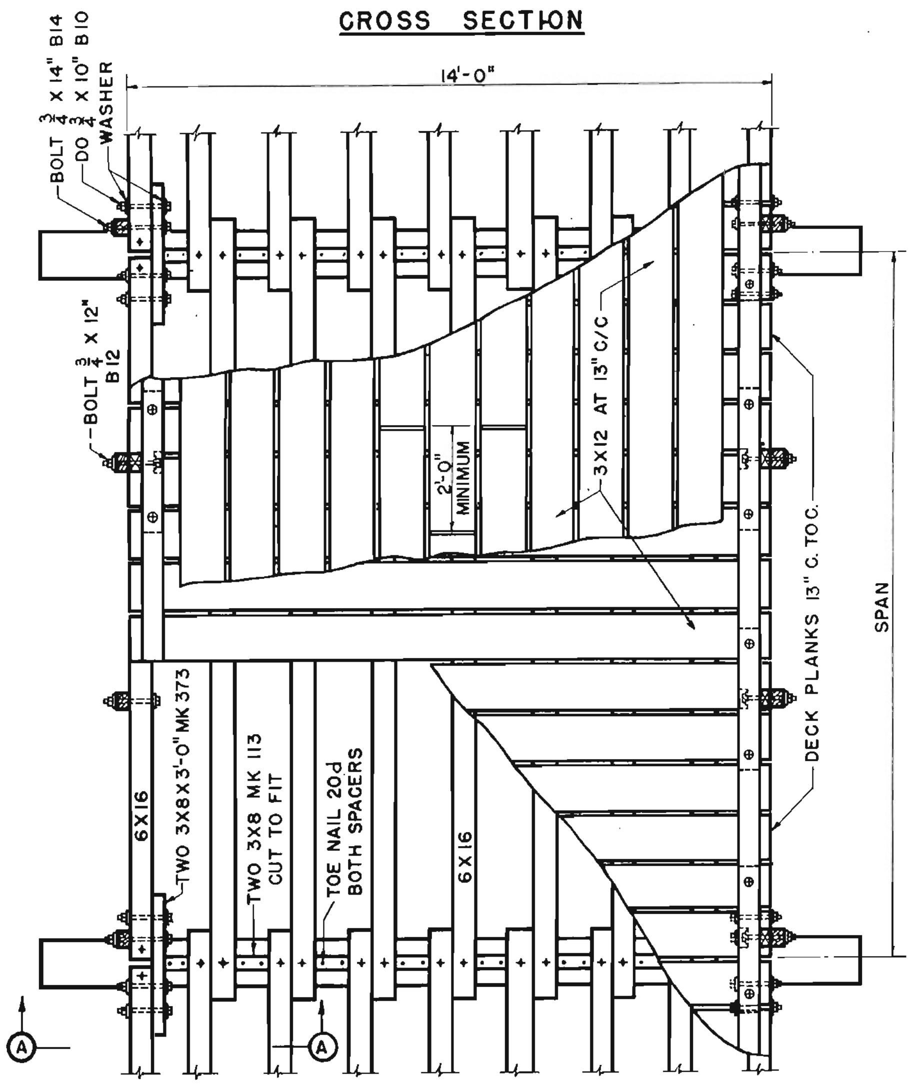
CROSS SECTION



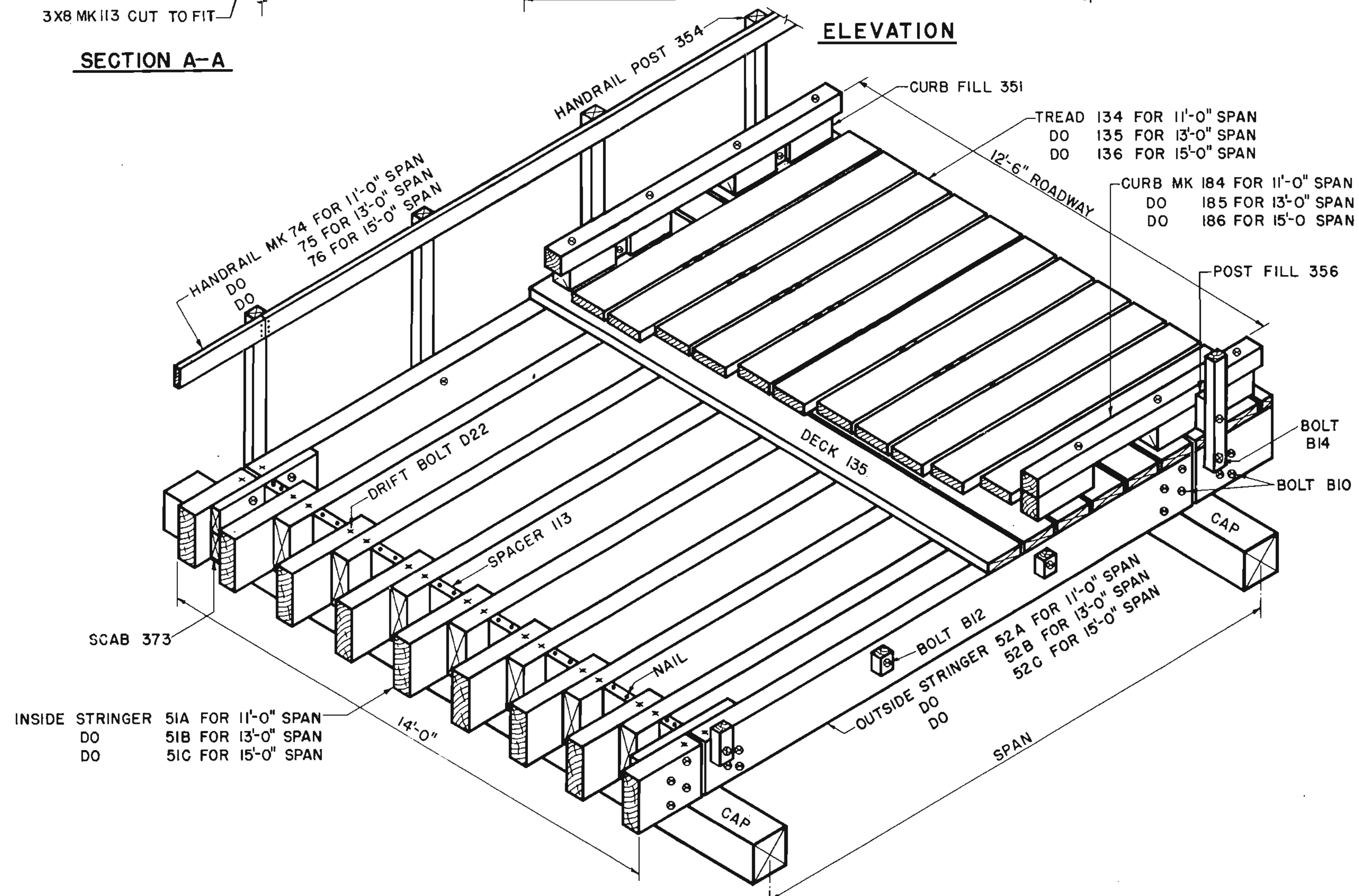
SECTION A–A



ELEVATION



PLAN



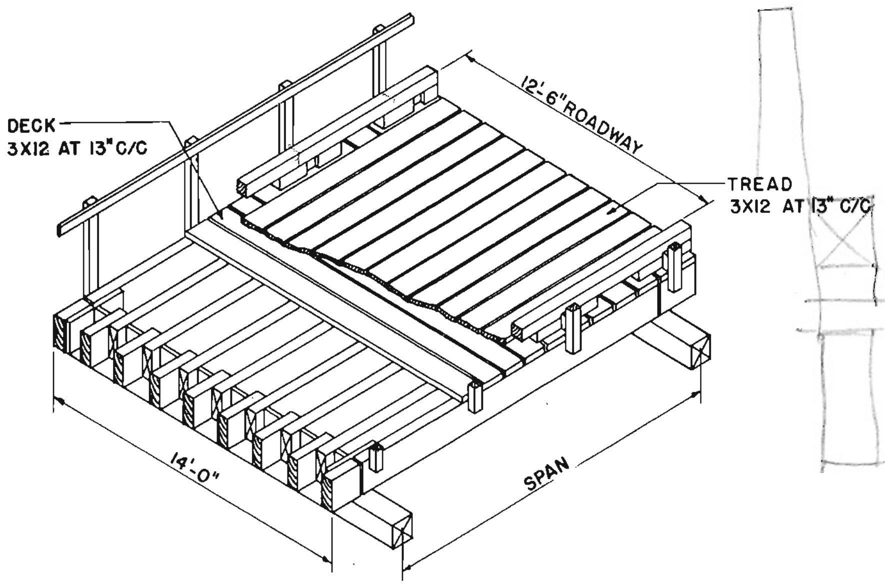
ASSEMBLED VIEW

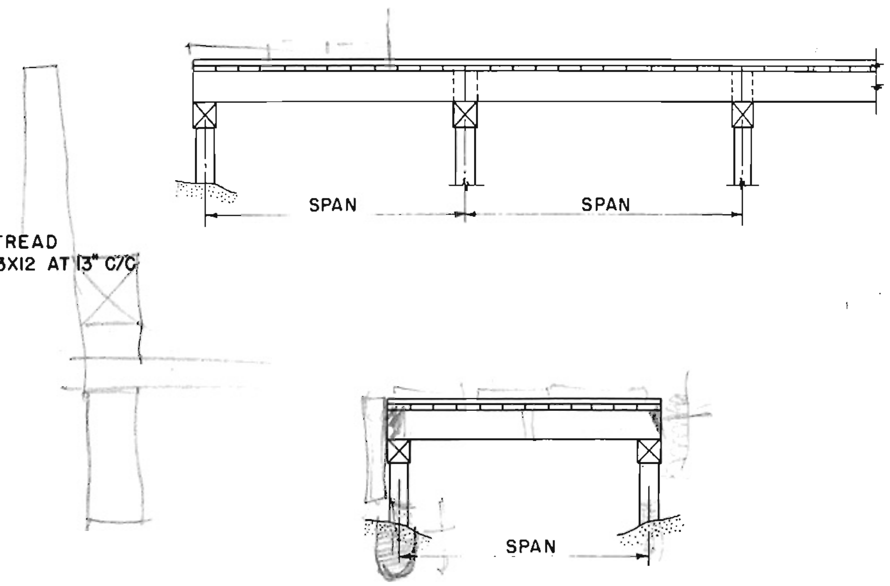
COMPANION SHEETS

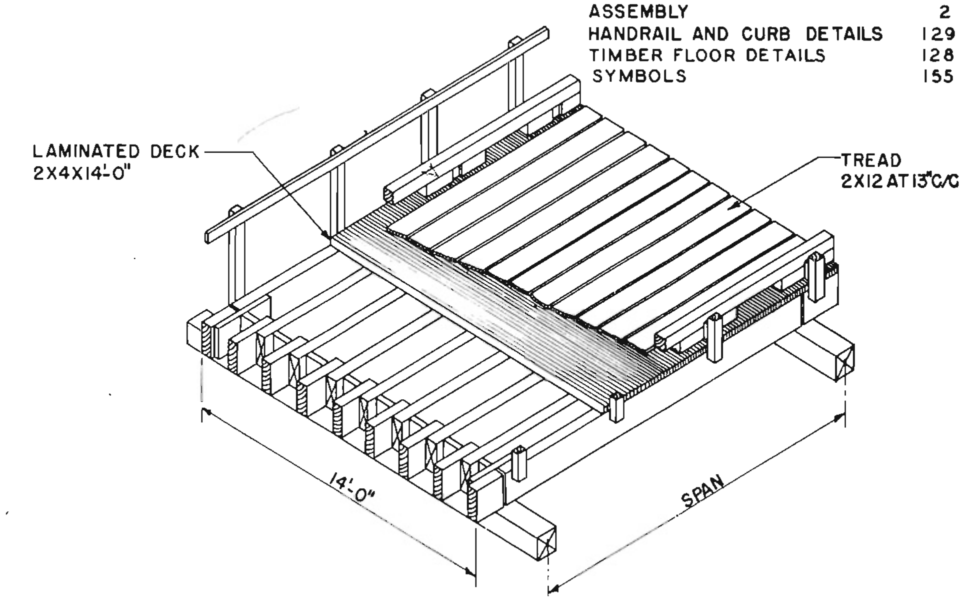
	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	3
CURB AND HANDRAIL DETAILS	129
TIMBER AND NAILING DETAILS	128
WALKWAYS	130
SYMBOLS	155

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
ASSEMBLY	2
HANDRAIL AND CURB DETAILS	129
TIMBER FLOOR DETAILS	128
SYMBOLS	155







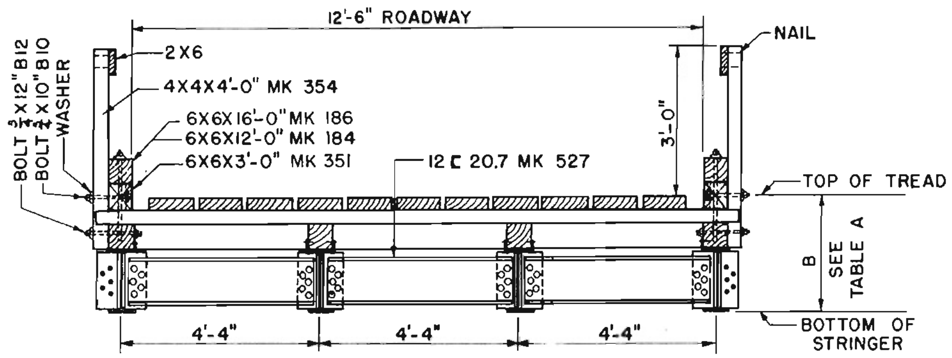
STANDARD PLANK FLOOR- BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	MARK	WEIGHT (POUNDS)	11'-0" SPAN QUANTITY	11'-0" SPAN F.B.M.	13'-0" SPAN QUANTITY	13'-0" SPAN F.B.M.	15'-0" SPAN QUANTITY	15'-0" SPAN F.B.M.
	LUMBER SOFTWOOD											
1	STRINGER		6X16	16'0"	51C	480					7	696
2	DO		6X16	16'0"	52C	480					2	256
3	DO		6X16	14'0"	51B	420			7	784		
4	DO		6X16	14'0"	52B	420			2	224		
5	DO		6X16	12'0"	51A	360	7	672				
6	DO		6X16	12'0"	52A	360	2	192				
7	SPACER	39-3330.08-1	3X8	10'0"	113	75	2	40	2	40	2	40
8	SCAB	39-3330.08	3X8	3'0"	373	23	4	24	4	24	4	24
9	TREAD AND DECK	39-3330.12	3X12	14'0"	135	158	⊔ 10	420	⊔ 23	966	⊔ 14	588
10	TREAD	39-3330.12-16	3X12	16'0"	136	180					11	528
11	DO	39-3952.12-12	3X12	12'0"	134	135	11	396				
12	CURB	39-3360.06-16	6X6	16'0"	186	180					2	96
13	DO	39-3360.06-14	6X6	14'0"	185	158			2	84		
14	DO	39-3360.06-12	6X6	12'0"	184	135	2	72				
15	CURB FILL	39-3360.06	6X6	3'0"	351	34	4	36	4	36	6	54
16	HANDRAIL POST	39-3340.04	4X4	4'0"	354	20	4	22	4	22	6	32
17	POST FILL	39-3330.08	3X4	0'9"	356	3	4	3	4	3	6	5
18	HANDRAIL	39-3880.06-16	2X6	16'0"	76	60					2	32
19	DO	39-3880.06-14	2X6	14'0"	75	52			2	28		
20	DO	39-3880.06-12	2X6	12'0"	74	45	2	24				
	STEEL HARDWARE, BLACK							POUNDS		POUNDS		POUNDS
21	MACHINE BOLT WITH SQUARE NUT AND 2 WASHERS	43-2325.07-16	3/4	16"	B16	2.52	8	20	8	20	12	30
22	DO	43-2325.07-144	3/4	14"	B14	2.27	2	5	2	5	2	5
23	DO	43-2325.07-124	3/4	12"	B12	2.02	6	12	6	12	10	20
24	DO	43-2325.07-1	3/4	10"	B10	1.77	14	25	14	25	14	25
25	DRIFT BOLT	43-1636.07-22	3/4	22"	D22	3.00	18	54	18	54	18	54
26	WIRE SPIKE	42-8488.035-07	5/16	7"		.15	90	23	108	27	126	32
27	WIRE NAIL	42-6028.3-5	50d			.10	150	19	180	23	215	27
28	WIRE NAIL	42-6028.3-2	20d			.05	24	1	24	1	32	1

⊔ -FOR SINGLE SPAN ADD ONE PLANK.

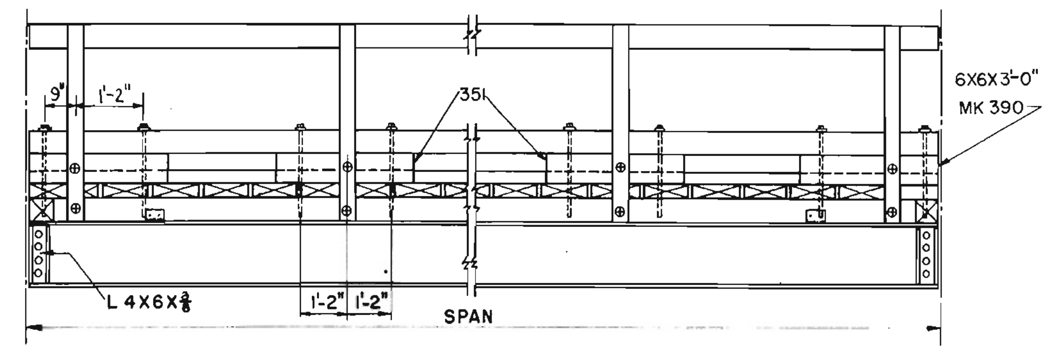
ALTERNATE LAMINATED FLOOR-BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	MARK	WEIGHT (POUNDS)	11'0" SPAN QUANTITY	11'0" SPAN F.B.M.	13'0" SPAN QUANTITY	13'0" SPAN F.B.M.	15'0" SPAN QUANTITY	15'0" SPAN F.B.M.
	LUMBER, SOFTWOOD											
1	STRINGER		6X16	16'0"	51C	480					7	895
2	DO		6X16	16'0"	52C	480					2	256
3	DO		6X16	14'0"	51B	420			7	784		
4	DO		6X16	14'0"	52B	420			2	224		
5	DO		6X16	12'0"	51A	360	7	672				
6	DO		6X16	12'0"	52A	360	2	192				
7	SPACER (STRINGER)	39-3330.08-1	3X8	10'0"	113	75	2	40	2	40	2	40
8	SCAB	39-3330.08	3X8	3'0"	373	23	4	24	4	24	4	24
9	DECK	39-3880.04-14	2X4	14'0"		35	82	765	96	895	1111	1037
10	TREAD	39-3228.12-12	2X12	12'0"		90	11	396				
11	DO	39-3228.12-14	2X12	14'0"		105			11	462		
12	DO	39-3228.12-16	2X12	16'0"		120						
13	CURB	39-3360.06-12	6X6	12'0"	184	135	2	72			11	528
14	DO	39-3360.06-14	6X6	14'0"	185	158			2	84		
15	DO	39-3360.06-16	6X6	16'0"	186	180					2	96
16	CURB FILL	39-3360.06	6X6	3'0"	351		4	36	4	36	6	54
17	HANDRAIL POST	39-3340.04-08	4X4	4'0"	354	20	4	22	4	22	6	32
18	POST FILL	39-3330.08	3X4	0'0"	356	3	4	3	4	3	6	5
19	HANDRAIL	39-3880.06-12	2X6	12'0"	74	45	2	24				
20	DO	39-3880.06-14	2X6	14'0"	75	52			2	28		
21	DO	39-3880.06-16	2X6	16'0"	76	60					2	32
	STEEL HARDWARE, BLACK							POUNDS		POUNDS		POUNDS
22	MACHINE BOLT WITH SQUARE NUT AND 2 WASHERS	43-2325.07-16	3/4	16"	B16	2.52	8	20	8	20	12	30
23	DO	43-2325.07-144	3/4	14"	B14	2.27	2	5	2	5	2	5
24	DO	43-2325.07-124	3/4	12"	B12	2.02	6	12	6	12	10	20
25	DO	43-2325.07-1	3/4	10"	B10	1.77	14	25	14	25	14	25
26	DRIFT BOLT	43-1636.07-22	3/4	22"	D22	3.00	18	54	18	54	18	54
27	WIRE NAIL	42-6028.3-2	20d			.05	24		24		32	
28	WIRE NAIL	42-6028.3-5	50d			.10	143		165		187	

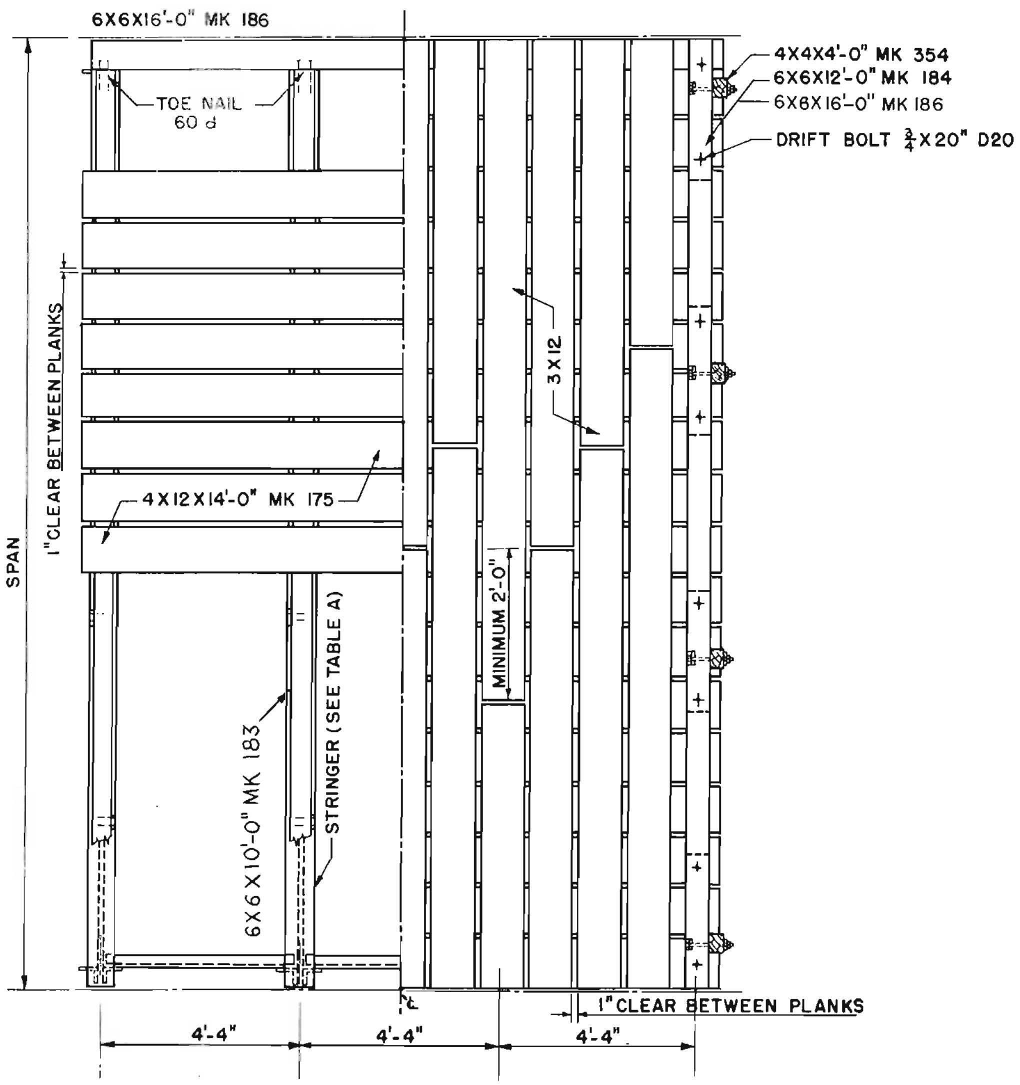


CROSS SECTION

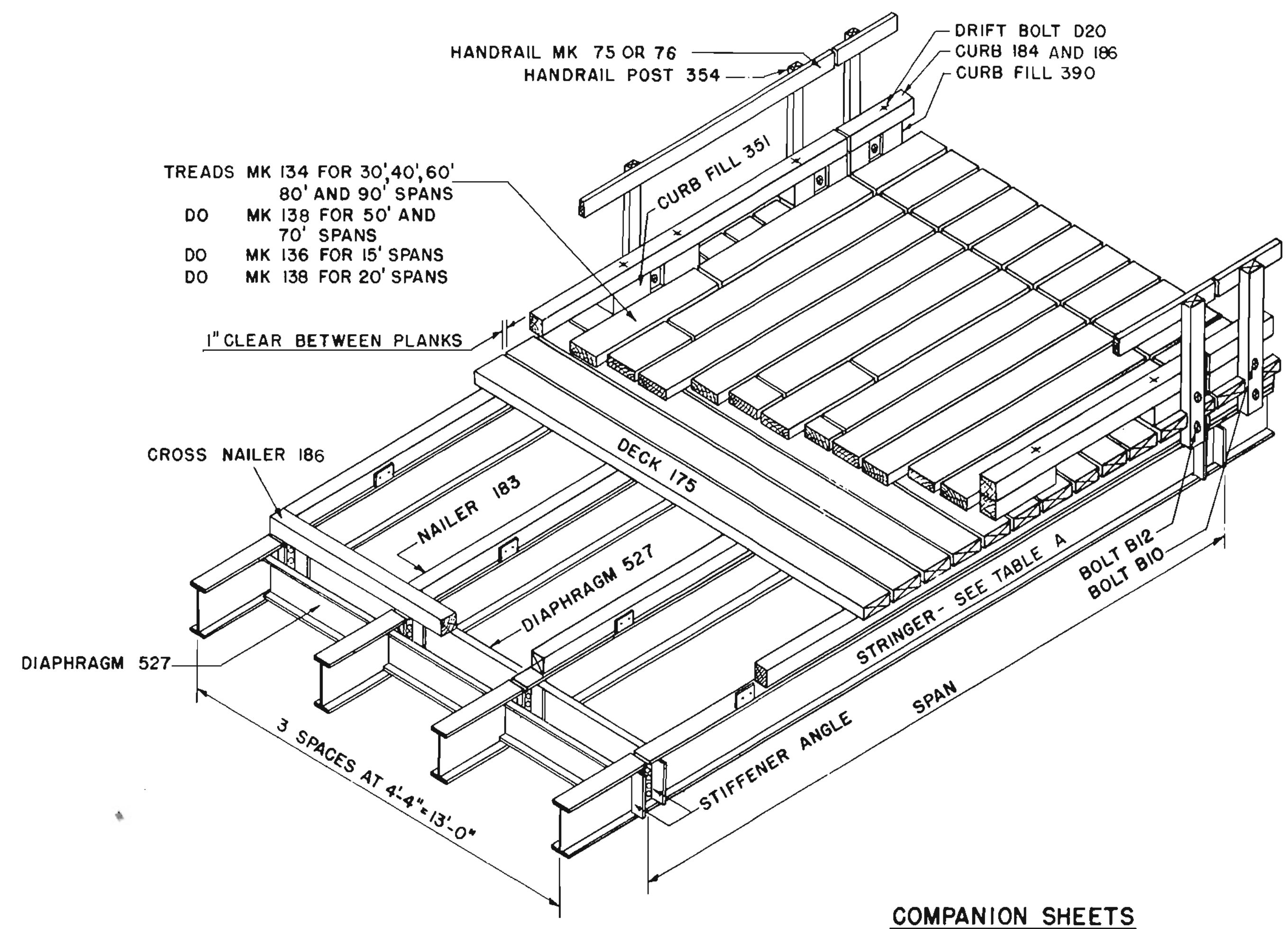
TABLE A			
SPAN	STRINGER SIZE	MK	B
15'-0"	16 I 36	502	2'-4 7/8"
20'-0"	18 I 47	505	2'-6 7/8"
30'-0"	24 I 74	510	3'-0 7/8"
40'-0"	24 I 87	511	3'-1"
50'-0"	30 I 108	514	3'-6 7/8"
60'-0"	33 I 125	517	3'-10"
70'-0"	33 I 132	519	3'-10 1/8"
80'-0"	36 I 150	523	4'-0 7/8"
90'-0"	36 I 182	525	4'-1 3/8"



ELEVATION



PLAN



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BILL OF MATERIALS FOR STANDARD PLANK FLOOR AND RIVETED STEEL DETAILS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' 16 I 36 QUANTITY	FBM	20' 18 I 47 QUANTITY	FBM	30' 24 I 74 QUANTITY	FBM	40' 24 I 87 QUANTITY	FBM	50' 30 I 108 QUANTITY	FBM	60' 33 I 125 QUANTITY	FBM	70' 33 I 132 QUANTITY	FBM	80' 36 I 150 QUANTITY	FBM	90' 36 I 182 QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																								
1	FLOOR, TREAD	39-3330.12-2	138	3 X 12	20'-0"	225			11	660					28	1680			39	2340					1
2	DO	39-3330.12-16	136	3 X 12	16'-0"	180	11	528																	2
3	DO	39-3952.12-12	134	3 X 12	12'-0"	135					28	1008	37	1332			55	1980			74	2664	83	2988	3
4	FLOOR, DECK	39-3340.12-14	175	4 X 12	14'-0"	210	14	784	19	1064	28	1568	37	2072	46	2576	55	3080	65	3640	74	4144	83	4648	4
5	NAILER	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	5
6	DO	39-3360.06-1	183	6 X 6	10'-0"	112	6	180	8	240	12	360	16	480	20	600	24	720	28	840	32	960	36	1080	6
7	CURB	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	528	12	576	14	672	7
8	DO	39-3360.06-12	184	6 X 6	12'-0"	135					4	144			4	144									8
9	CURB FILL	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	9
10	DO	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	36	8	72	10	90	14	126	16	144	20	180	22	198	26	234	10
11	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	11
12	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	12
13	DC	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	112	9	126	11	154	12	168	14	196	13
	STEEL STRUCTURAL																								
14	STRINGER		525	36 I 182	40'-0"	7280																	4		14
15	DO		525	36 I 182	24'-10 3/4"	4530																	8		15
16	DO	48-2900.36-15	523	36 I 150	40'-0"	6000															4				16
17	DO	48-2900.36-15	523	36 I 150	19'-10 3/4"	2985															8				17
18	DO	48-2900.33-132	519	33 I 132	40'-0"	5280													4						18
19	DO	48-2900.33-132	519	33 I 132	14'-10 3/4"	1970													8						19
20	DO	48-2900.33-125	517	33 I 125	40'-0"	5000											4								20
21	DO	48-2900.33-125	517	33 I 125	19'-10"	2480											4								21
22	DO	48-2900.3-108	514	30 I 108	40'-0"	4320									4										22
23	DO	48-2900.3-108	514	30 I 108	9'-10"	1060									4										23
24	DO	48-2900.24-087	511	24 I 87	39'-10½"	3470							4												24
25	DO	48-2900.24-074	510	24 I 74	29'-10½"	2110					4														25
26	DO	48-2900.18-047	505	18 I 47	19'-10½"	935			4																26
27	DO	48-2900.16-036	502	16 I 36	14'-10½"	535	4																		27
28	DIAPHRAGM	48-3790.12-21	527	12 [20.7	4'-2"	87	6		6		9		9		9		12		12		15		15		28
29	ANGLE	48-2240.64-04		L6X4X3/8	2'-3"	28											32		32		40		40		29
30	DO	48-2240.64-04		L6X4X3/8	1'-9"	22					24		24		24										30
31	DO	48-2240.64-04		L6X4X3/8	1'-3"	15			16																31
32	DO	48-2240.64-04		L6X4X3/8	1'-2"	14	16																		32
33	WEB SPLICE PLATE	47-7844.04		PL 14X3/8	2'-3"	42											8		16		16		16		33
34	DO	47-7844.04		PL 14X3/8	1'-9"	33									8										34
35	FLANGE SPLICE PLATE	47-7844.08		PL12½X7/8	4'-3"	158																	16		35
36	DO	47-7844.06		PL 12X5/8	2'-11"	74															16				36
37	DO	47-7844.05		PL 12X1/2	3'-1"	63													16						37
38	DO	47-7844.06		PL 12X5/8	4'-6"	115											8								38
39	DO	47-7844.06		PL 11X5/8	3'-1"	72									8										39
40	DO	47-7844.08		PL5 1/2X7/8	4'-3"	72																	32		40
41	DO	47-7844.08		PL 5X7/8	2'-11"	44															32				41
42	DO	47-7844.06		PL 8 3/4X5/8	3'-1"	31													32						42
43	DO	47-7844.07		PL 8 3/4X3/4	4'-6"	55											16								43
44	RIVET	43-6353.08		7/8	5"	1.04																	768		44
45	DO	43-6353.08		7/8	4 1/4"	.91															512				45
46	DO	43-6353.08		7/8	4"	.87											320				56				46
47	DO	43-6353.08		7/8	3 3/4"	.83													448						47
48	DO	43-6353.08		7/8	3 1/4"	.74																	364		48
49	DO	43-6353.08-3		7/8	3"	.70									456		224				252				49
50	DO	43-6353.08		7/8	2 3/4"	.66	32		32		72		72						336						50
51	DO	43-6353.08-23		7/8	2 1/4"	.57	60		60		90		90		90		120		120		150		150		51
52	NAILER ATTACHMENT PLATE	47-7844.03		2 X 1/4	0'-4"	.6	16		20		28		36		44		52		60		68		76		52
53	WELDING ROD	46-3772.2-7		3/16"			1.2 LB		1.5 LB		2.0 LB		2.6 LB		3.2 LB		3.8 LB		4.4 LB		5.0 LB		5.6 LB		53
	STEEL HARDWARE, BLACK																								
54	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.1	6		8		12		14		18		20		24		26		30		54
55	DO	43-2325.07-1	B10	3/4	10"	1.86	6		8		12		14		18		20		24		26		30		55
56	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		56
57	STEEL WIRE SPIKE	42-8488.035-7		5/16 X7		.15	112		152		224		296		368		448		520		592		664		57
58	STEEL WIRE NAIL	42-6028.3-6		60d		.10	16		16		16		16		16		16		16		16		16		58
59	DC	42-6028.3-5		50d		.08	187		242		392		518		590		770		832		1036		1162		59
60	DC	42-6028.3-3		30d		.05	32		40		56		72		88		104		120		136		152		60
61	DO	42-6028.3-2		20d		.04	28		38		58		68		[illegible]		98		118		128		148		61

COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 90-FOOT	4
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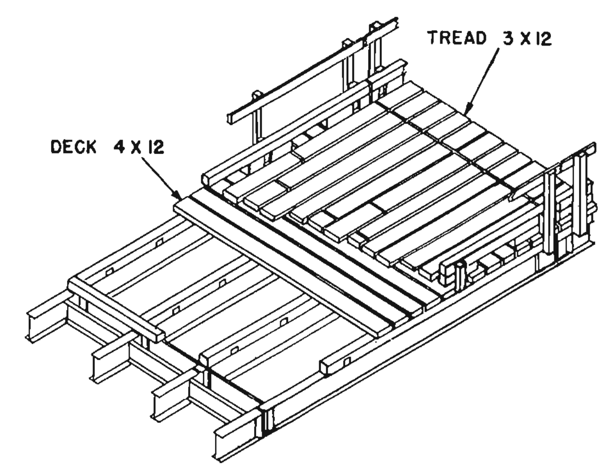

BILL OF MATERIALS FOR FLOOR AND STRINGER COMBINATIONS

	SHEET
1. STANDARD PLANK FLOOR	5
RIVETED STEEL DETAILS	5
HARDWARE	5
2. STANDARD PLANK FLOOR	5
WELDED STEEL DETAILS	6
HARDWARE	5
3. ALTERNATE LAMINATED FLOOR	6
RIVETED STEEL DETAILS	5
HARDWARE	6
4. ALTERNATE LAMINATED FLOOR	6
WELDED STEEL DETAILS	6
HARDWARE	6

BILL OF MATERIALS FOR ALTERNATE LAMINATED FLOOR AND WELDED STEEL DETAILS

					SPAN LENGTH		15'		20'		30'		40'		50'		60'		70'		80'		90'		
					STRINGER SIZE		16 I 36		18 I 47		24 I 74		24 I 87		30 I 108		33 I 125		33 I 132		36 I 150		36 I 182		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																								
1	FLOOR, DECK	39-3880.06-14	75	2 X 6	14'-0"	35	111	1554	148	2072	221	3094	295	4130	369	5166	443	6202	516	7224	590	8260	664	9296	1
2	FLOOR, TREAD	39-3880.12-2	108	2 X 12	20'-0"	150			11	440															2
3	DO	39-3880.12-16	106	2 X 12	16'-0"	120	11	352																	3
4	DO	39-3880.12-14	105	2 X 12	14'-0"	105									40	1120			55	1540					4
5	DO	39-3228.12-12	104	2 X 12	12'-0"	90					28	672	37	888			55	1320			74	1776	83	1992	5
6	NAILER	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	2	96	2	96	2	95	2	96	2	96	2	96	2	96	2	96	6
7	DO	39-3360.06-1	183	6 X 6	10'-0"	113	6	180	8	240	12	360	16	480	20	600	24	720	28	840	32	960	36	1080	7
8	CURB	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	528	12	576	14	672	8
9	DO	39-3360.06-12	184	6 X 6	12'-0"	135					4	144			4	144									9
10	CURB FILL	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	10
11	DO	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	35	8	72	10	90	14	126	16	144	20	180	22	198	26	234	11
12	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	12
13	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	13
14	DO	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	112	9	126	11	154	12	168	14	196	14
	STEEL, STRUCTURAL																								
15	STRINGER		525W	36 I 182	40'-0"	7280																	8		15
16	DO		525W	36 I 182	9'-10 1/2"	1797																	4		16
17	DO	48-2900.36-15	523W	36 I 150	40'-0"	6000															4				17
18	DO	48-2900.36-15	523W	36 I 150	39'-10 1/2"	5981															4				18
19	DO	48-2900.33-132	519W	33 I 132	40'-0"	5280													4						19
20	DO	48-2900.33-132	519W	33 I 132	29'-10 1/2"	3944													4						20
21	DO	48-2900.33-125	517W	33 I 125	40'-0"	5000											4								21
22	DO	48-2900.33-125	517W	33 I 125	19'-10 1/2"	2484											4								22
23	DO	48-2900.3-108	514W	30 I 108	9'-10 1/2"	4320									4										23
24	DO	48-2900.3-108	514W	30 I 108		1067									4										24
25	DO	48-2900.24-087	511W	24 I 87	39'-10 1/2"	3470							4												25
26	DO	48-2900.24-074	510W	24 I 74	29'-10 1/2"	2110					4														26
27	DO	48-2900.18-047	505W	18 I 47	19'-10 1/2"	935			4																27
28	DO	48-2900.16-036	502W	16 I 36	14'-10 1/2"	535	4																		28
29	DIAPHRAGM	48-3790.12-21	C3	12 [20.7	3'-11"	81	6		6		9		9		9		12		12		15		15		29
30	STIFFENER PLATE	47-7844.04	P15	4 X 3/8	2'-6"	13															40		40		30
31	DO	47-7844.04	P10	4 X 3/8	2'-0"	10									24		32		32						31
32	DO	47-7844.04	P4	4 X 3/8	1'-9"	9					24		24												32
33	DO	47-7844.04	P3	4 X 3/8	1'-4"	7			16																33
34	DO	47-7844.04	P2	4 X 3/8	1'-2"	6	16																		34
35	WEB SPLICE PLATE	47-7844.04	P14	12 X 3/8	1'-9"	27															8		16		35
36	DO	47-7844.04	P9	12 X 3/8	1'-6"	23									8		8		8						36
37	FLANGE SPLICE PLATE	47-7844.1	P7	9 X 1	4'-0"	122											4		4						37
38	DO	47-7844.05	P8	7 X 1/2	1'-10"	22													4						38
39	DO	47-7844.08	P16	9 X 7/8	3'-7"	96																	8		39
40	DO	47-7844.06	P24	10 X 5/8	5'-4"	113															4				40
41	DO	47-7844.1	P25	10 X 1	3'-8"	125															4				41
42	DO	47-7844.04	P28	9 X 3/8	1'-8"	19									4										42
43	DO	47-7844.05	P31	8 X 1/2	2'-4"	32															4				43
44	DO	47-7844.05	P33	9 X 1/2	4'-0"	61									4										44
45	DO	47-7844.08	P35	10 1/2 X 7/8	7'-6"	234																	8		45
46	DO	47-7844.06	P36	10 X 5/8	5'-0"	106																	8		46
47	DO	47-7844.1	P43	9 X 1	4'-0"	122											4		4						47
48	DO	47-7844.05	P38	9 X 1/2	4'-4"	66													4						48
49	DO	47-7844.04	P39	9 X 3/8	2'-6"	29											4								49
50	NAILER ATTACHMENT PLATE	47-7844.03		2 X 1/4	0'-4"	0.6	16		20		28		36		44		52		60		68		76		50
51	WELDING ELECTRODE	46-3772.25-5		7/32											36 LB		64 LB		80 LB		87 LB		884 LB		51
52	DO	46-3772.2-7		3/16			15 LB		17 LB		29 LB		30 LB		35 LB		45 LB		60 LB		74 LB		91 LB		52
	STEEL HARDWARE, BLACK																								
53	MACHINE BOLT, SQUARE HEAD AND TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.52	6		8		12		14		18		20		24		26		30		53
54	DO	43-2325.07-1	B10	3/4	10"	1.77	6		8		12		14		18		20		24		26		30		54
55	DRIFT BOLT, SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		55
56	STEEL WIRE NAIL	42-6028.3-6		60d		.10	8		8		8		8		8		8		8		8		8		56
57	DO	42-6028.3-5		50d		.08	187		242		392		518		590		770		832		1036		1152		57
58	DO	42-6028.3-3		30d		.05	1253		1668		2498		3328		4158		4988		5818		6638		7478		58
59	DO	42-6028.3-2		20d		.04	24		36		56		64		84		96		116		124		144		59

COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 90-FOOT	4
BILL OF MATERIALS	5
TIMBER FLOOR DETAILS	128
HANDRAIL AND CURB DETAILS	129
WALKWAYS FOR HIGHWAY BRIDGES	130
FABRICATION DRAWINGS	131 TO 145
JUNCTION TIMBER AND STEEL-STRINGER SPANS	149
GENERAL NOTES	154
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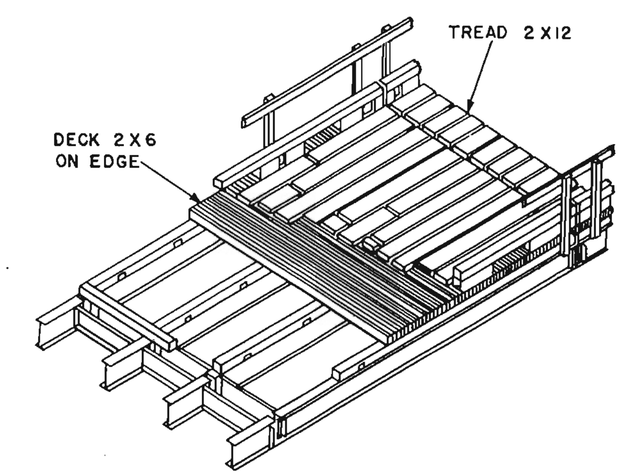
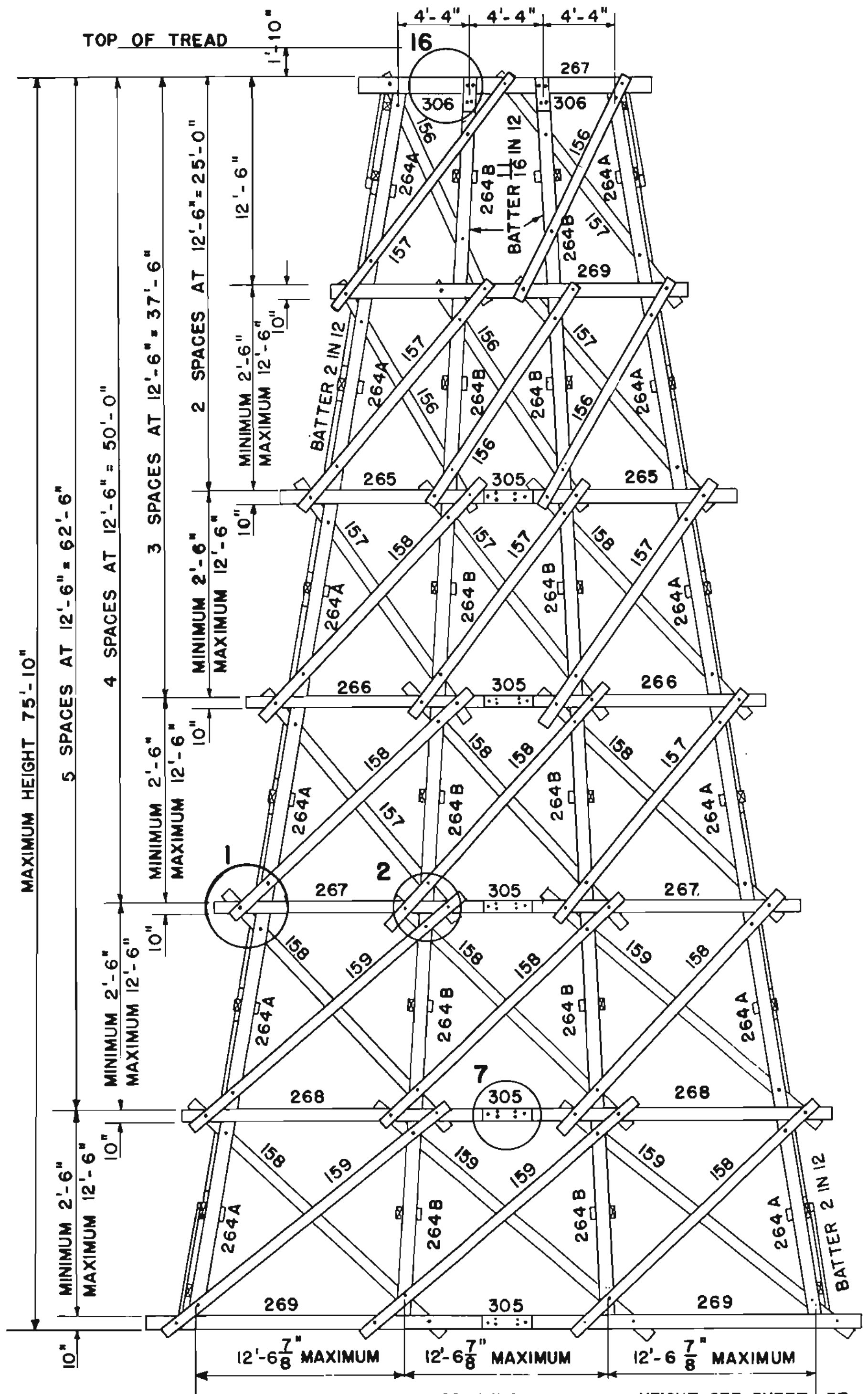
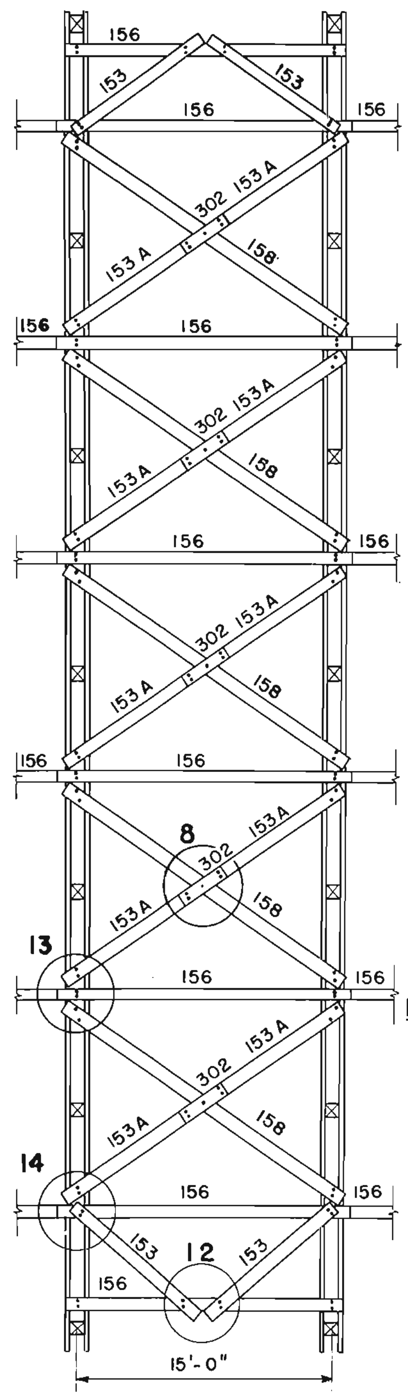


BILL OF MATERIALS FOR FLOOR AND STRINGER COMBINATIONS

	SHEET
1. STANDARD PLANK FLOOR	5
RIVETED STEEL DETAILS	5
HARDWARE	5
2. STANDARD PLANK FLOOR	5
WELDED STEEL DETAILS	6
HARDWARE	5
3. ALTERNATE LAMINATED FLOOR	6
RIVETED STEEL DETAILS	5
HARDWARE	6
4. ALTERNATE LAMINATED FLOOR	6
WELDED STEEL DETAILS	6
HARDWARE	6



TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH

COMPANION SHEETS

COMPANION SHEETS	SHEET
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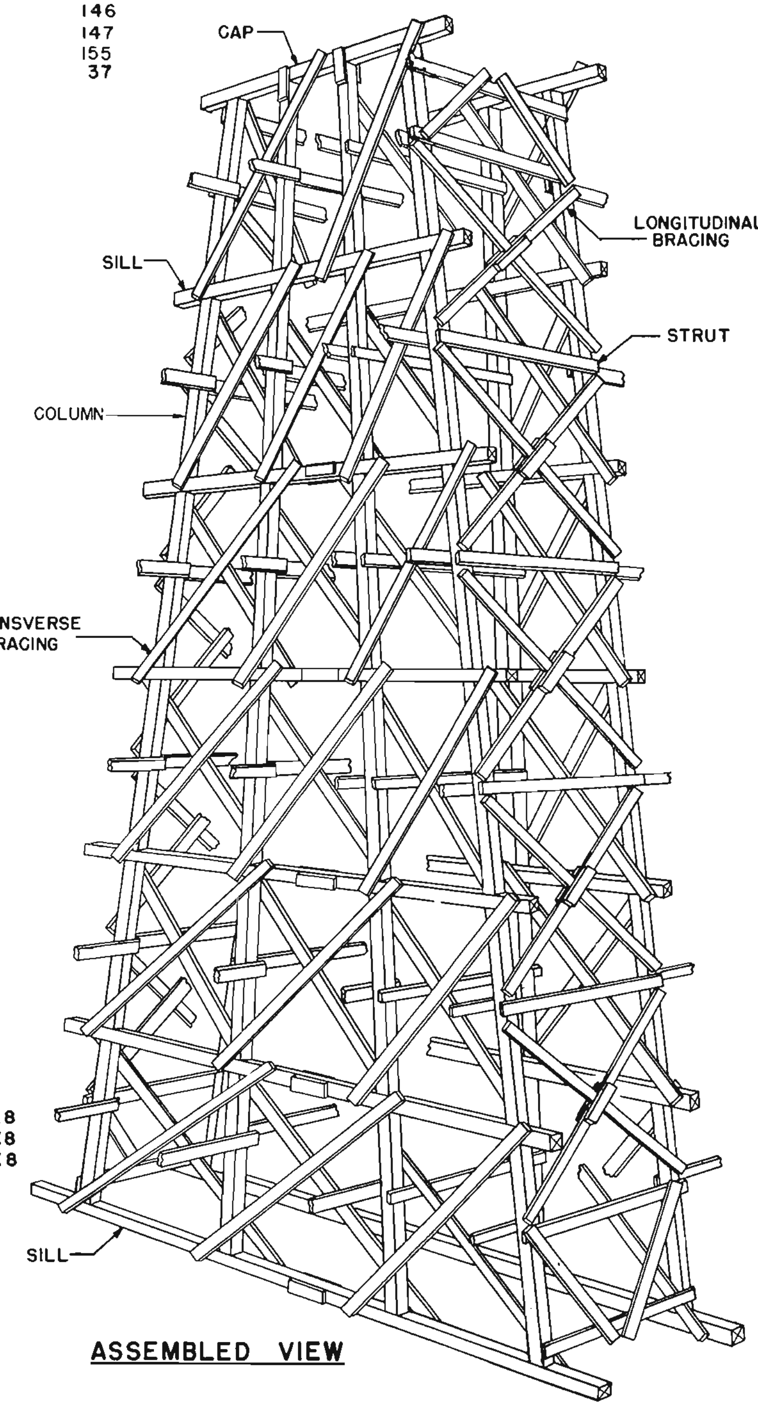
NOTES

- ALL CAPS 10 X 10
- ALL SILLS 10 X 10
- ALL COLUMNS 10 X 10
- ALL LONGITUDINAL STRUTS 4 X 8
- ALL LONGITUDINAL BRACING 4 X 8
- ALL TRANSVERSE BRACING 4 X 8



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
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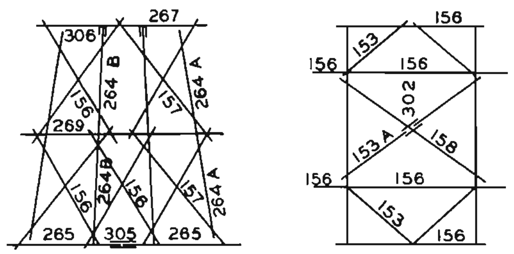
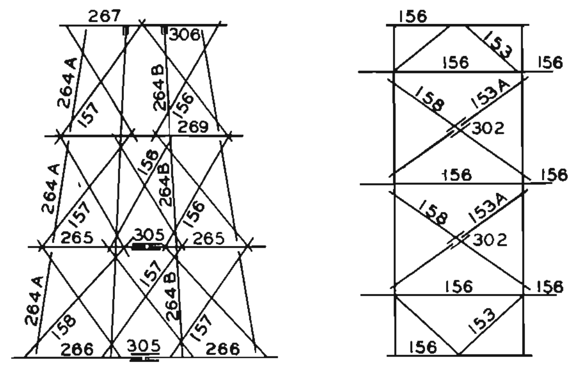
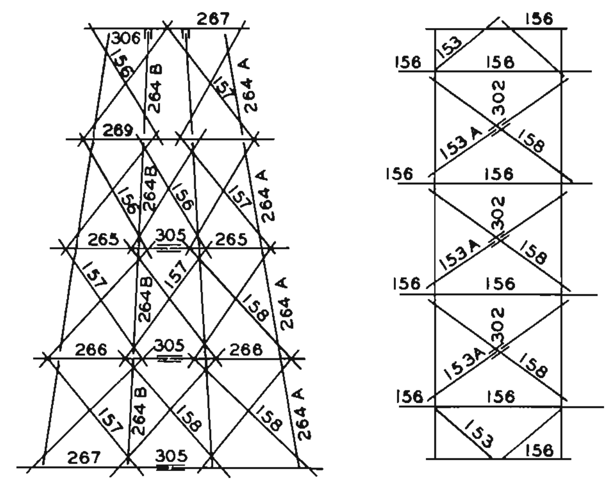
1-STORY TOWER



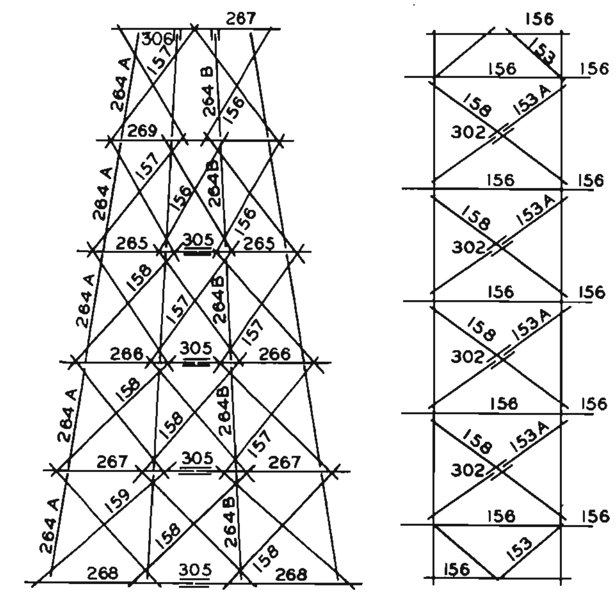
2-STORY TOWER



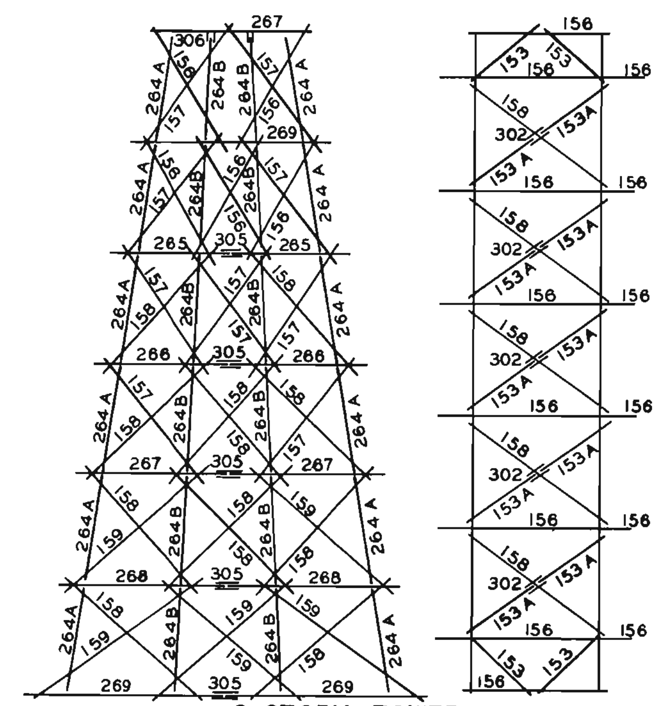
3-STORY TOWER



4-STORY TOWER



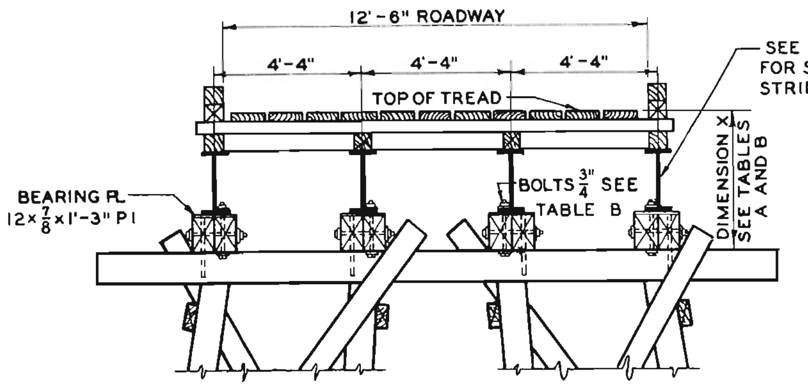
5-STORY TOWER



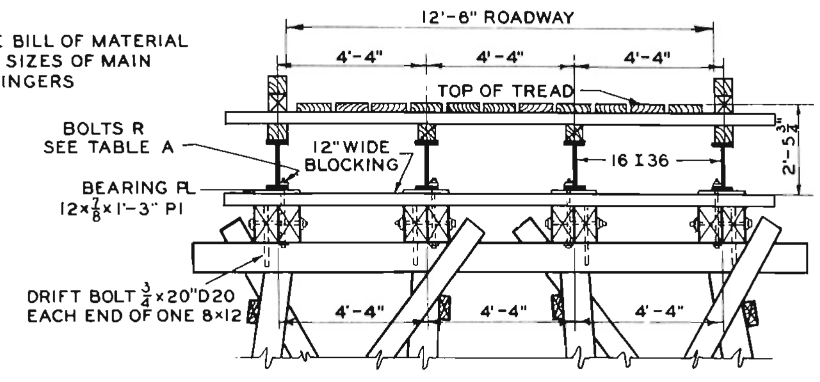
6-STORY TOWER

BILL OF MATERIAL FOR ONE TOWER OF THE NUMBER OF STORIES INDICATED

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY FBM	5 STORY 63'-4" QUANTITY	5 STORY FBM	4-STORY 50'-10" QUANTITY	4-STORY FBM	3-STORY 38'-4" QUANTITY	3-STORY FBM	2-STORY 25'-10" QUANTITY	2-STORY FBM	1-STORY 13'-4" QUANTITY	1-STORY FBM
	LUMBER, SOFT WOOD																	
1	CAP	39-6620.1-18	267	10 X 10	18'-0"	563	2	300	2	300	2	300	2	300	2	300	2	300
2	SILL	39-6620.1-22	269	10 X 10	22'-0"	688	6	1100	2	367	2	367	2	367	2	367	2	367
3	DO	39-6620.1-2	268	10 X 10	20'-0"	625	4	667	4	667								
4	DO	39-6620.1-18	267	10 X 10	18'-0"	563	4	600	4	600	4	600						
5	DO	39.6620.1-16	266	10 X 10	16'-0"	500	4	533	4	533	4	533	4	533				
6	DO	39-6620.1-14	265	10 X 10	14'-0"	438	4	467	4	467	4	467	4	467	4	467		
7	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	24	2400	20	2000	16	1600	12	1200	8	800	4	400
8	DO	39-6620.1-12	264B	10 X 10	12'-0"	375	24	2400	20	2000	16	1600	12	1200	8	800	4	400
9	STRUT	39-3340.08-16	156	4 X 8	16'-0"	160	52	2219	44	1877	36	1536	28	1195	20	853	12	512
10	BRACING	39-3340.08-22	159	4 X 8	22'-0"	220	12	704	4	235								
11	DO	39-3340.08-2	158	4 X 8	20'-0"	200	34	1813	28	1493	18	960	8	427	2	107		
12	DO	39-3340.08-18	157	4 X 8	18'-0"	180	20	960	20	960	20	960	16	768	8	384	4	192
13	DO	39-3340.08-16	156	4 X 8	16'-0"	160	12	512	12	512	12	512	12	512	12	512	4	171
14	DO	39-3340.08-1	153	4 X 8	10'-0"	100	8	213	8	213	8	213	8	213	8	213	8	213
15	DO	39-3340.08-1	153A	4 X 8	10'-0"	100	20	533	16	427	12	320	8	213	4	107		
16	SCAB	39-3340.1	305	4 X 10	3'-0"	38	20	200	16	160	12	120	8	80	4	40		
17	DO	39-3330.1	306	3 X 10	2'-0"	19	8	40	8	40	8	40	8	40	8	40	8	40
18	DO	39-3228.08	302	2 X 8	3'-4"	17	20	89	16	71	12	53	8	36	4	18		
	STEEL HARDWARE, BLACK																	
19	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-24	E24	1	24"	6.5	16		16		16		16		16		8	
20	DO	43-2325.1-2	E20	1	20"	5.6	238		190		142		94		46		10	
21	DO	43-2325.1-18	E18	1	18"	5.1	16		16		16		16		16		16	
22	DO	43-2325.1-164	E16	1	16"	4.7	172		148		124		100		76		52	
23	DO	43-2325.1-104	E10	1	10"	3.4	66		56		46		36		26		16	
24	DRIFT BOLT, PLAIN	43-1636.07-2	D20	3/4	20"	2.5	144		120		96		72		48		24	



SECTION A-A



SECTION B-B

TABLE A

SPAN	DIMENSIONS FOR EQUAL MAIN SPANS X	DIMENSIONS FOR EQUAL MAIN SPANS Y	LENGTH OF BOLT R
15'	3'-5 3/4"	0'-0"	16"
20'	3'-7 3/4"	0'-2"	18"
30'	4'-1 3/4"	0'-8"	24"
40'	4'-2"	0'-8 1/4"	24"
50'	4'-7 3/4"	1'-2"	30"
60'	4'-10 7/8"	1'-5 1/8"	32"
70'	4'-11"	1'-5 1/4"	32"
80'	5'-1 3/4"	1'-8"	36"
90'	5'-2 1/4"	1'-8 1/2"	36"

WHEN ADJACENT SPANS ARE UNEQUAL, BOLTS R MUST BE CHOSEN FOR THE LONGER SPAN

COMPANION SHEETS

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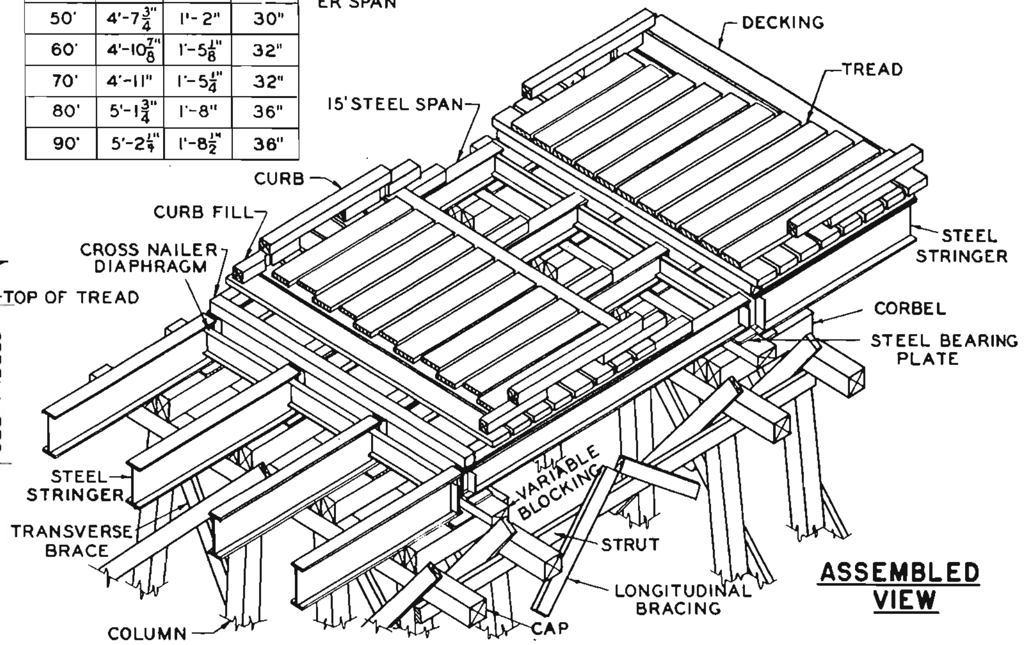
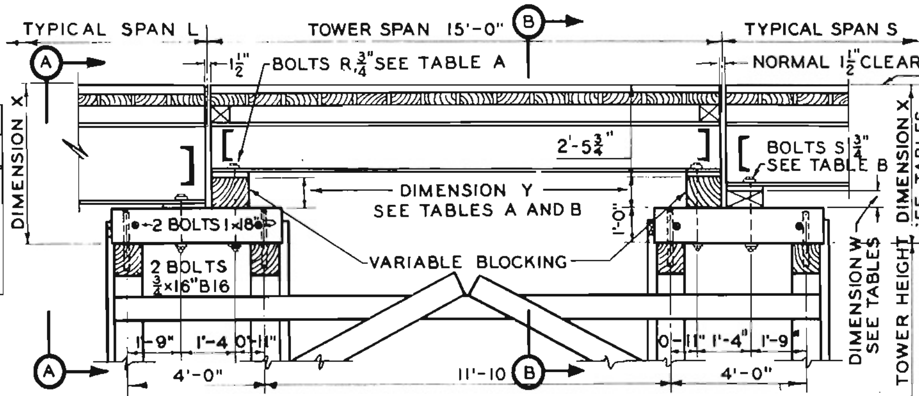


ASSEMBLED VIEW



LONGITUDINAL SECTION

TABLE B

TYPICAL SPANS		90'	80'	70'	60'	50'	40'	30'	20'
15'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"	4'-1 3/4"	3'-7 3/4"
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-8 1/4"	0'-8"	0'-2"
	W	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-8 1/4"	0'-8"	0'-2"
	BOLT S	36"	36"	32"	32"	30"	24"	24"	18"
20'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"	4'-1 3/4"	
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-8 1/4"	0'-8"	
	W	1'-6 1/2"	1'-6"	1'-3 1/4"	1'-3 1/8"	1'-0"	0'-6 1/4"	0'-6"	
	BOLT S	34"	34"	30"	30"	28"	22"	22"	
30'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"		
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-8 1/4"		
	W	1'-0 1/2"	1'-0"	0'-9 1/4"	0'-9 1/8"	0'-6"	0'-0 1/4"		
	BOLT S	28"	28"	24"	24"	22"	16"		
40'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"			
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"			
	W	1'-0 1/4"	0'-11 3/4	0'-9"	0'-8 7/8"	0'-5 3/4"			
	BOLT S	28"	28"	24"	24"	22"			
50'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"				
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"				
	W	0'-6 1/2"	0'-6"	0'-3 1/4"	0'-3 1/8"				
	BOLT S	22"	22"	18"	18"				
60'	X	5'-2 1/4"	5'-1 3/4"	4'-11"					
	Y	1'-8 1/2"	1'-8"	1'-5 1/4"					
	W	0'-3 3/8"	0'-2 7/8"	0'-0 1/8"					
	BOLT S	20"	18"	16"					
70'	X	5'-2 1/4"	5'-1 3/4"						
	Y	1'-8 1/2"	1'-8"						
	W	0'-3 1/4"	0'-2 3/4"						
	BOLT S	20"	18"						
80'	X	5'-2 1/4"							
	Y	1'-8 1/2"							
	W	0'-0 1/2"							
	BOLT S	16"							

BILL OF SUPPLEMENTAL MATERIALS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT (WEIGHT)	15' QUANTITY	15' F.B.M.	20' QUANTITY	20' F.B.M.	30' QUANTITY	30' F.B.M.	40' QUANTITY	40' F.B.M.	50' QUANTITY	50' F.B.M.	60' QUANTITY	60' F.B.M.	70' QUANTITY	70' F.B.M.	80' QUANTITY	80' F.B.M.	90' QUANTITY	90' F.B.M.	LINE
						MAIN SPAN	15'		20'		30'		40'		50'		60'		70'		80'		90'		
						STRINGER SIZE	16 I 36		18 I 47		24 I 74		24 I 87		30 I 108		33 I 125		33 I 132		36 I 150		36 I 182		
						DIMENSION X	3'-5 3/4"		3'-7 3/4"		4'-1 3/4"		4'-2"		4'-7 3/4"		4'-10 7/8"		4'-11"		5'-1 3/4"		5'-2¼"		
						DIMENSION Y	0		2"		8"		8¼"		1'-2"		1'-5 1/8"		1'-5¼"		1'-8"		1'-8½"		
	STEEL STRUCTURAL																								
1	BEARING PLATE	47-7844.08	P1	12 X 7/8	1'-3"	15	16		16		16		16		16		16		16		16		15		1
	LUMBER, SOFTWOOD																								
2	CORBEL	39-6616.12	452	8 X 12	5'-0"	150	16	640	16	540	16	640	16	640	16	640	15	640	16	640	16	640	16	640	2
3	VARIABLE BLOCKING	39-3229.12	106	2 X 12	16'-0"	120			2	64															3
4	DO	39-3360.12-16	216	6 X 12	16'-0"	360									2	192									4
5	DO	39-6615.12-16	246	8 X 12	16'-0"	480					2	256			2	256	2	256	2	255	2	256			5
6	DO	39-6620.12	286A	8¼ X 12	16'-0"	500							2	384											6
7	DO	39-6620.12	286B	8½ X 12	16'-0"	510																	2	384	7
8	DO	39-6620.12	286C	9 1/8 X 12	16'-0"	550											2	384							8
9	DO	39-6620.12	286D	9¼ X 12	16'-0"	560													2	384					9
10	DO	39-5630.12-16	285	12 X 12	16'-0"	720															2	384	2	384	10
	STEEL HARDWARE, BLACK																								
11	MACHINE BOLT, SQUARE NUT AND TWO WASHERS	43-2325.07-16	B16	3/4	16"	2.50	16		8		8		8		8		8		8		8		8		11
12	DO	43-2325.07-183	B18	3/4	18"	2.50			8																12
13	DO	43-2325.07-24	B24	3/4	24"	3.75					8		8												13
14	DO	43-2325.07-306	B30	3/4	30"	4.4									8										14
15	DO	43-2325.07-32	B32	3/4	32"	4.5											8		8						15
16	DO	43-2325.07-366	B36	3/4	36"	5.0															8		8		16
17	DO	43-2325.1-18	E18	1	18"	5.0	16		16		16		16		16		16		16		16		16		17
18	DRIFT BOLT	43-1636.07-2	D20	3/4	20"	2.5	16		16		16		16		16		15		15		16		16		18

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
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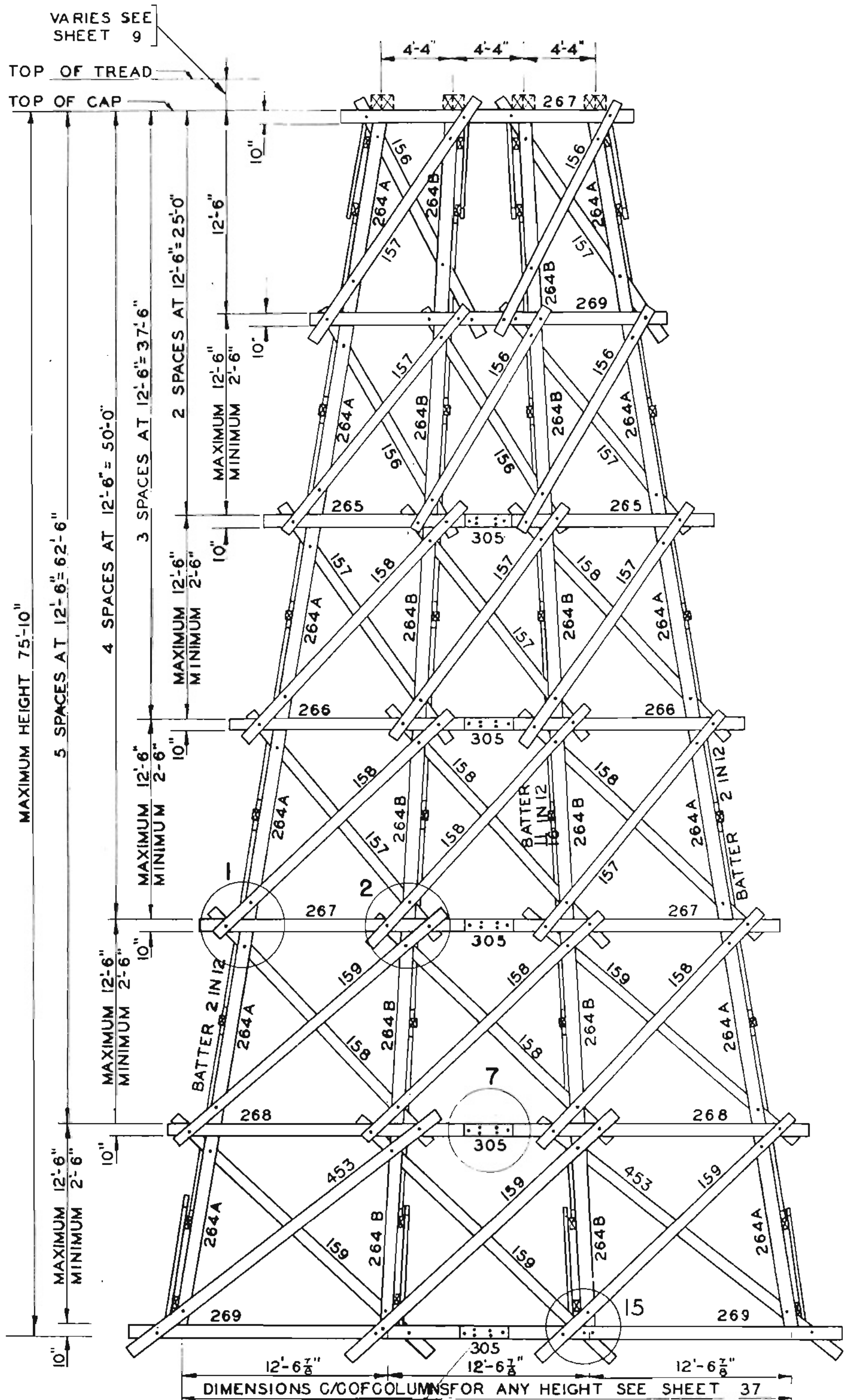
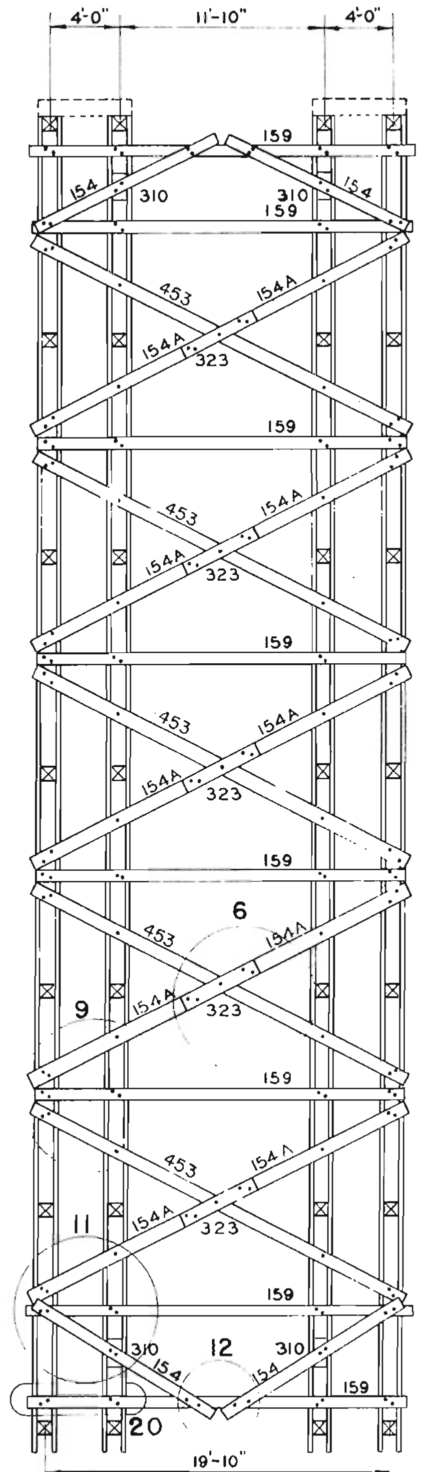
CONNECTIONS	147
CONCRETE PEDESTALS	37



TRANSVERSE ELEVATION



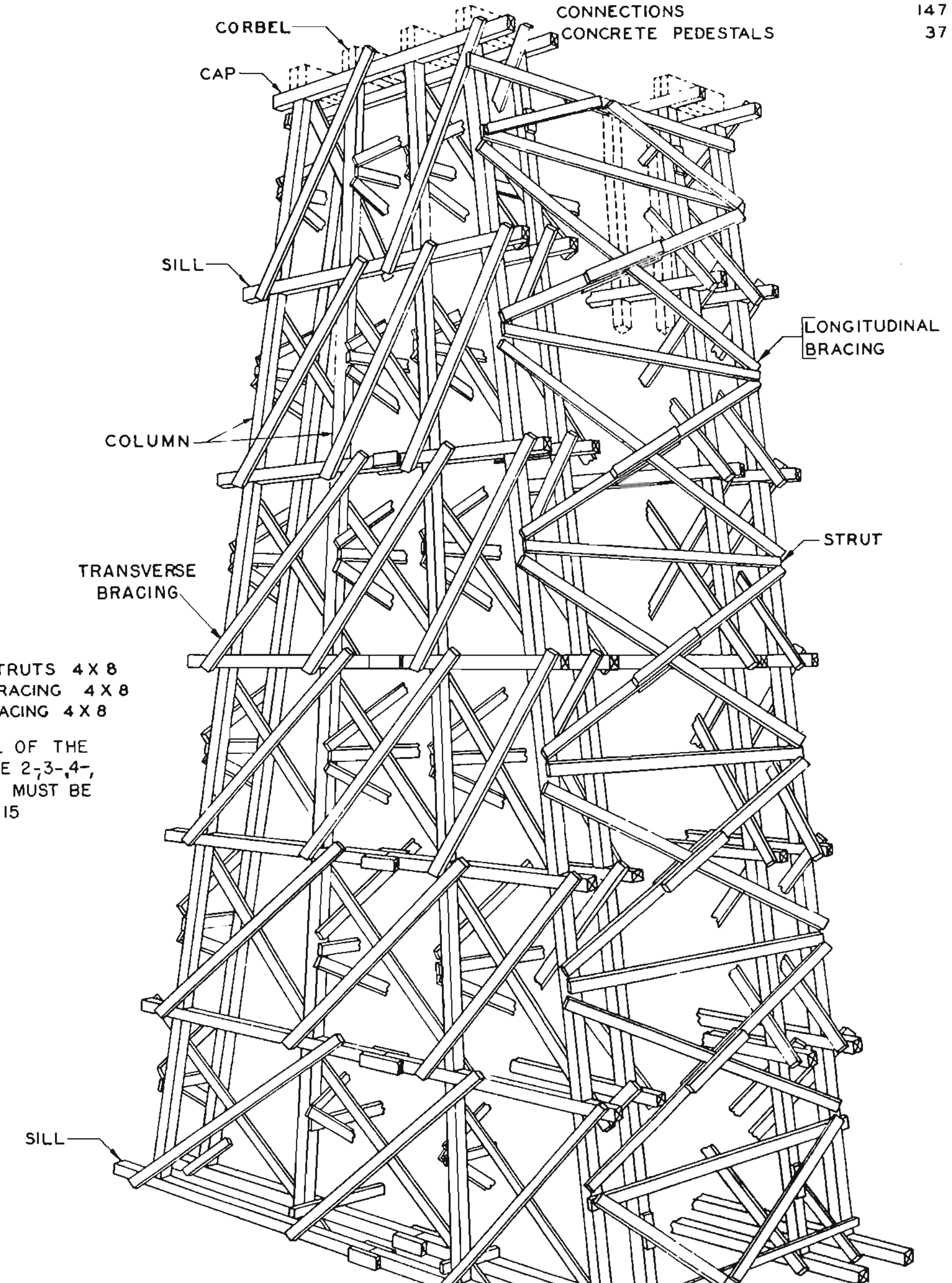
LONGITUDINAL ELEVATION

TIMBER TOWER BENT 13'-4" TO 75'-0" HIGH

NOTES

ALL CAPS 10X10
ALL SILLS 10X10
ALL LONGITUDINAL STRUTS 4X8
ALL LONGITUDINAL BRACING 4X8
ALL TRANSVERSE BRACING 4X8

THE BRACING AND SILL OF THE BOTTOM STORY OF THE 2-, 3-, 4-, AND 5-STORY BENTS MUST BE FRAMED PER DETAIL 15

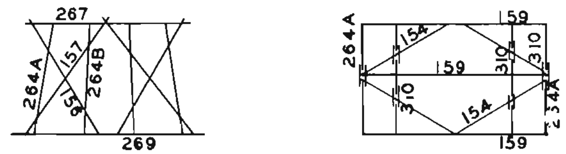


ASSEMBLED VIEW

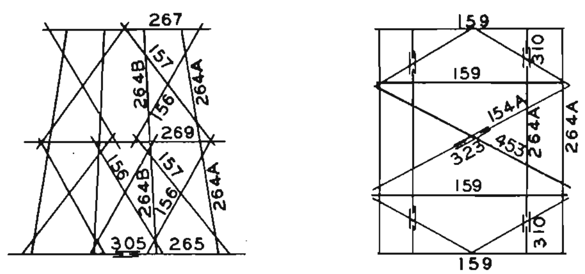
920303 O - 50 - 15

COMPANION SHEETS

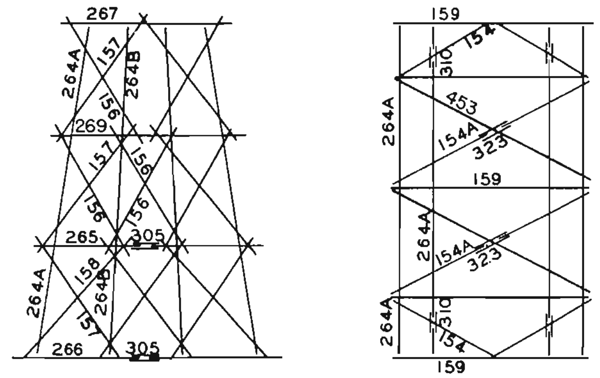
	SHEET
GENERAL NOTES	154
SUPPLEMENTAL MATERIALS	9
ASSEMBLY AND PIECE MARKS	10
CONNECTIONS AND CUTTING DIAGRAMS	148
CONNECTIONS	146
CONNECTIONS	147
SYMBOLS	155



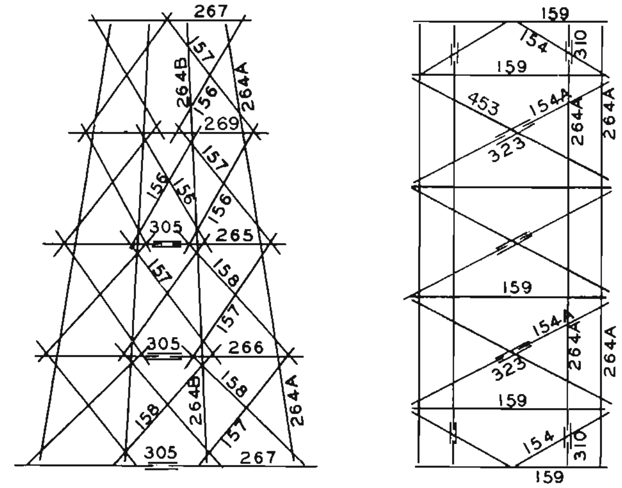
1-STORY TOWER



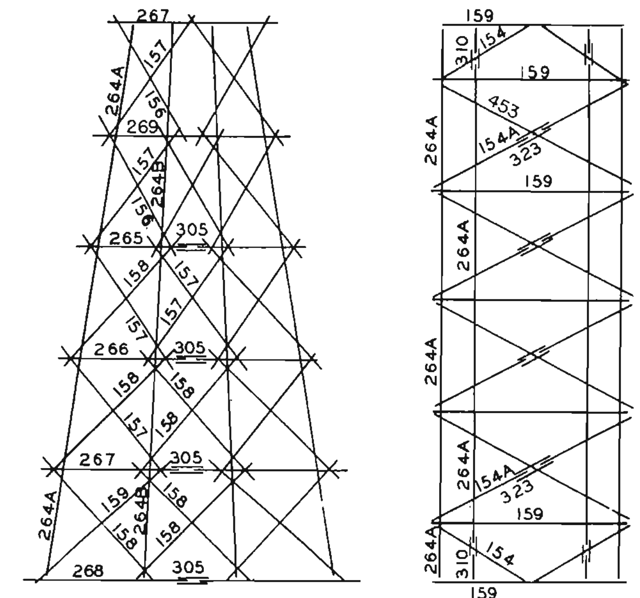
2-STORY TOWER



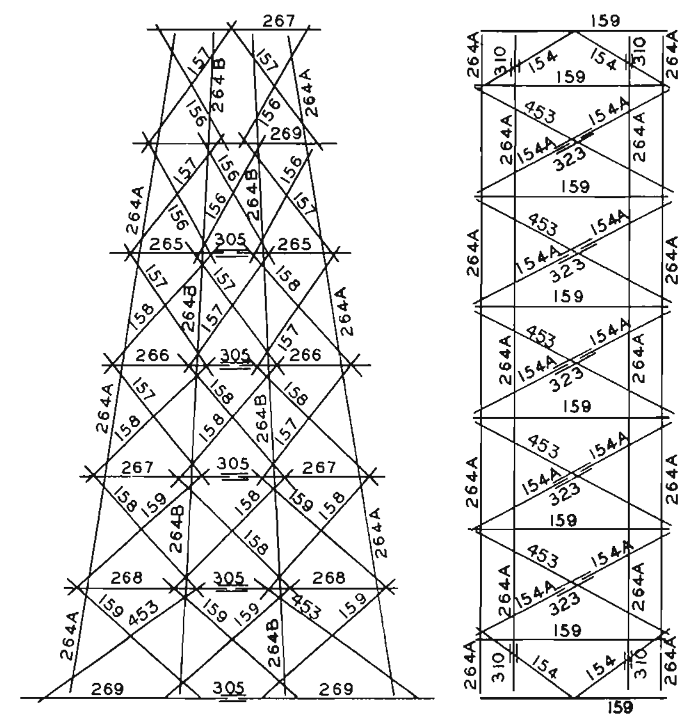
3-STORY TOWER



4-STORY TOWER



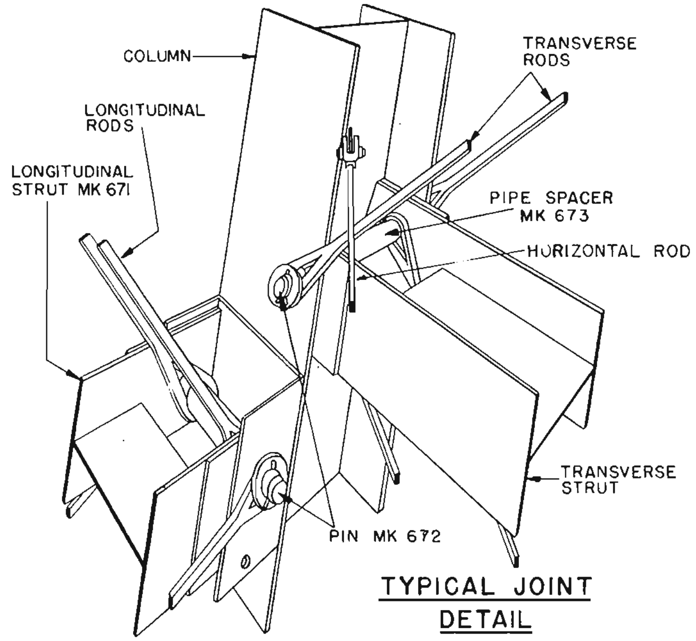
5-STORY TOWER



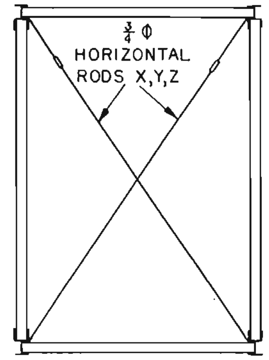
6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY FBM	5-STORY 63'-4" QUANTITY	5-STORY FBM	4-STORY 50'-10" QUANTITY	4-STORY FBM	3-STORY 38'-4" QUANTITY	3-STORY FBM	2-STORY 25'-10" QUANTITY	2-STORY FBM	1-STORY 13'-4" QUANTITY	1-STORY FBM
	LUMBER SOFT-WOOD																	
1	CAP	39-6620.1-18	267	10 X 10	18'-0"	560	4	600	4	600	4	600	4	600	4	600	4	600
2	SILL	39-6620.1-18	267	10 X 10	18'-0"	560	8	1200	8	1200	8	1200						
3	DO	39-6620.1-16	266	10 X 10	16'-0"	500	8	1067	8	1067	8	1067	8	1067				
4	DO	39-6620.1-14	265	10 X 10	14'-0"	440	8	933	8	933	8	933	8	933	8	933		
5	DO	39-6620.1-22	269	10 X 10	22'-0"	690	12	2200	4	733	4	733	4	733	4	733	4	733
6	DO	39-6620.1-2	268	10 X 10	20'-0"	630	8	1333	8	1333								
7	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	370	48	4800	40	4000	32	3200	24	2400	16	1600	8	800
8	DO	39-6620.1-12	264B	10 X 10	12'-0"	370	48	4800	40	4000	32	3200	24	2400	16	1600	8	800
9	STRUT	39-3340.08-22	159	4 X 8	22'-0"	220	32	1877	28	1643	24	1408	20	1173	16	939	12	704
10	BRACING	39-3340.08-24	453	4 X 8	24'-0"	240	28	1792	16	1024	12	768	8	512	4	256		
11	DO	39-3340.08-2	158	4 X 8	20'-0"	200	40	2133	40	2133	24	1280	8	427				
12	DO	39-3340.08-18	157	4 X 8	18'-0"	180	40	1920	40	1920	40	1920	32	1540	16	770	8	384
13	DO	39-3340.08-16	156	4 X 8	16'-0"	160	24	1024	24	1024	24	1024	24	1024	24	1024	8	341
14	DO	39-3340.08-12	154	4 X 8	12'-0"	120	16	512	16	512	16	512	16	512	16	512	16	512
15	DO	39-3340.08-12	154A	4 X 8	12'-0"	120	40	1230	32	1024	24	768	16	512	8	256		
16	DO	39-3340.08-22	159	4 X 8	22'-0"	220	24	1408	8	469								
17	SCAB	39-3340.1	305	4 X 10	3'-0"	40	40	400	32	320	24	240	16	160	8	80		
18	DO	39-2228.03	323	2 X 8	3'-8"	20	40	195	32	157	24	118	16	78	8	39		
19	DO	39-3340.1	310	4 X 10	2'-0"	30	16	107	16	107	16	107	16	107	16	107	24	160
	STEEL HARDWARE, BLACK																	
20	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-104	E10	1	10"	3.45	132		112		92		72		52		32	
21	DO	43-2325.1-164	E16	1	16"	4.75	656		560		464		368		272		144	
22	DO	43-2325.1-2	E20	1	20"	5.61	360		296		232		168		104		64	
23	DRIFT BOLT PLAIN	43-1636.07-2	D20	3/4	20"	2.50	288		240		192		144		96		48	



TYPICAL JOINT DETAIL



SECTION A-A

DIMENSION T	
SPAN LENGTH	TOP OF TREAD TO TOP OF BEARING ℄
15'-0"	2'-4$\frac{7}{8}$"
20'-0"	2'-6$\frac{7}{8}$"
30'-0"	3'-0$\frac{7}{8}$"
40'-0"	3'-1"
50'-0"	3'-6$\frac{7}{8}$"
60'-0"	3'-10"
70'-0"	3'-10$\frac{1}{8}$"
80'-0"	4'-0$\frac{7}{8}$"
90'-0"	4'-1$\frac{3}{8}$"

COMPANION SHEETS

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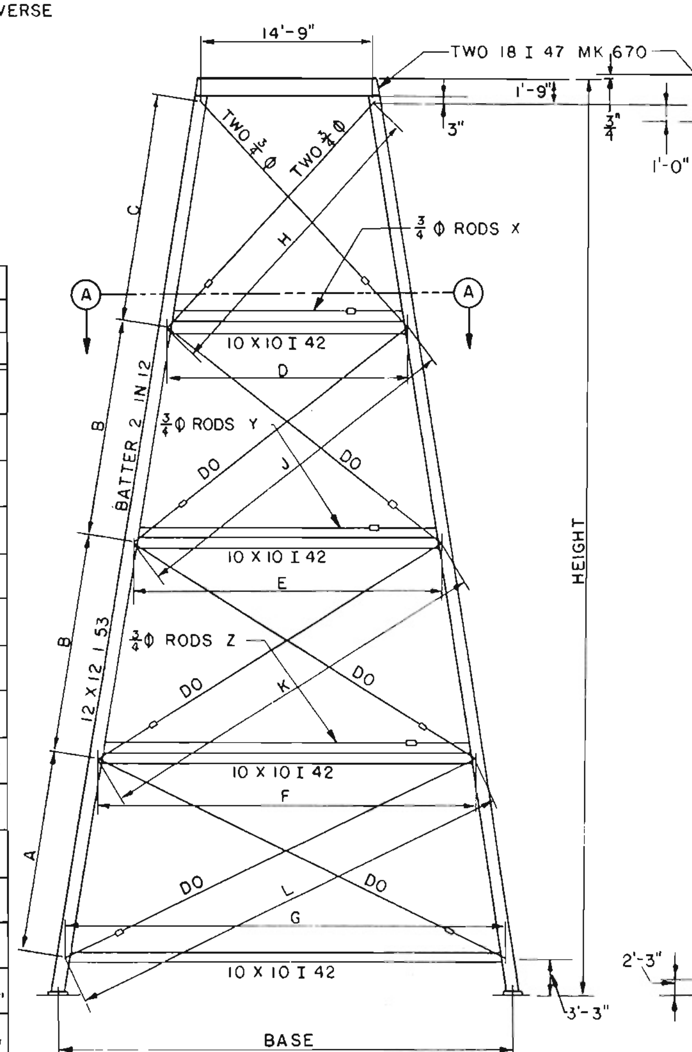
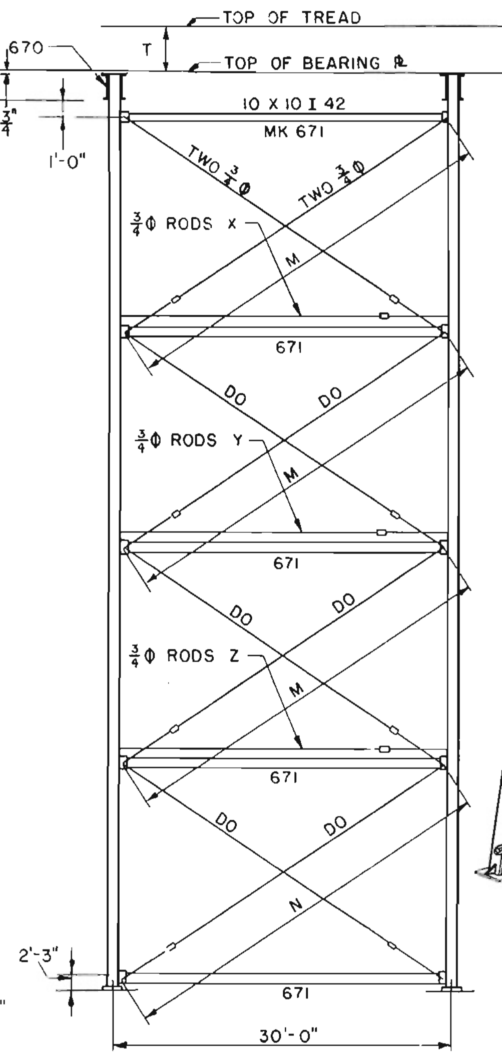
TABULATION OF TOWER DIMENSIONS AND ERECTION MARKS

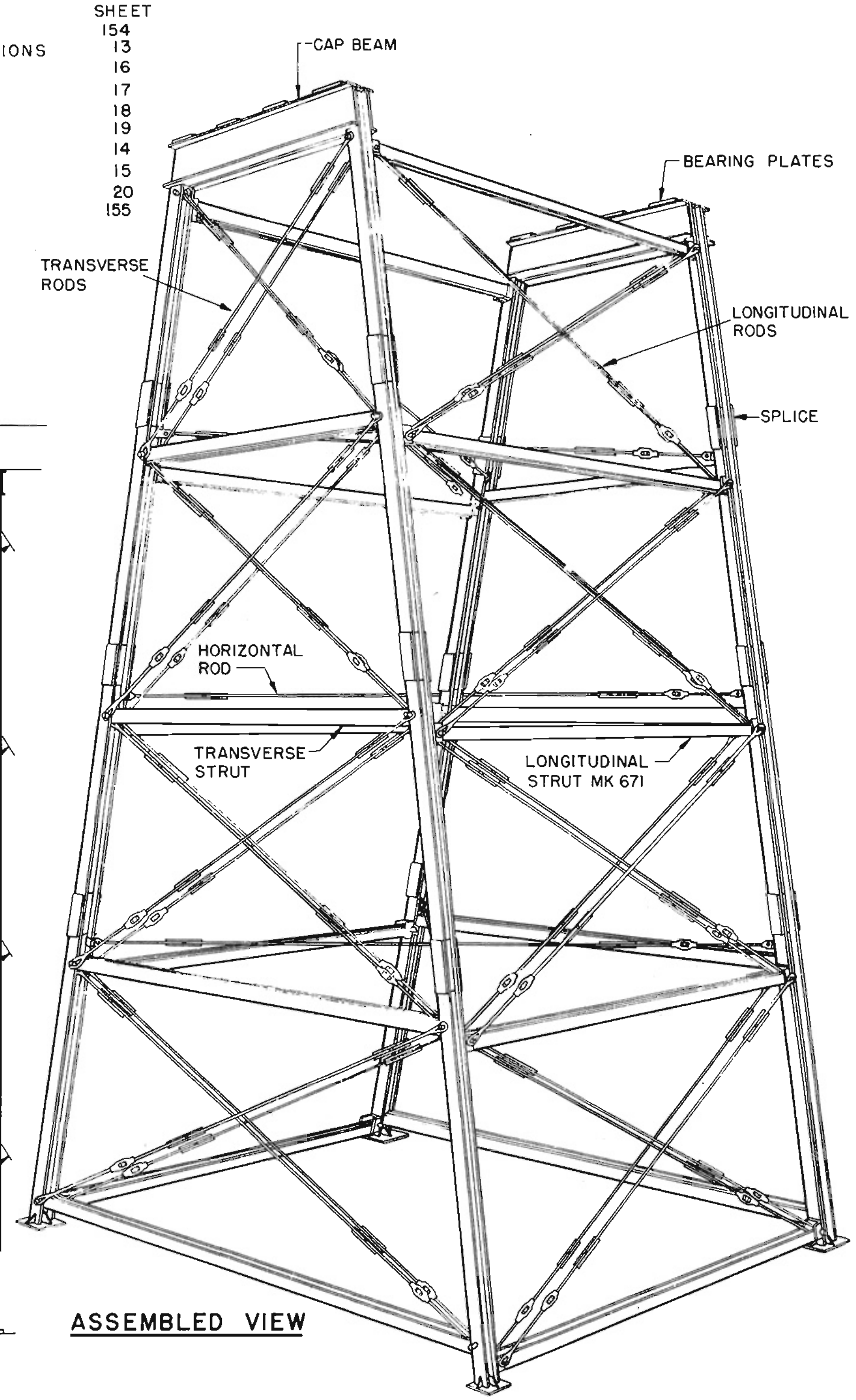
		FOUR-STORY TOWER				
HEIGHT		77'	75'	73'	71'	69'
BASE		40'-5"	39'-9"	39'-1"	38'-5"	37'-9"
A	MARK	1504	1505	1506	1507	1508
	DIMENSION	18'-3"	17'-8$\frac{7}{8}$"	17'-2$\frac{3}{4}$"	16'-8$\frac{3}{4}$"	16'-2$\frac{5}{8}$"
B	MARK	1514	1515	1516	1517	1518
	DIMENSION	18'-3"	17'-8$\frac{7}{8}$"	17'-2$\frac{7}{8}$"	16'-8$\frac{3}{4}$"	16'-2$\frac{5}{8}$"
C	MARK	1524	1525	1526	1527	1774
	DIMENSION	18'-3"	17'-8$\frac{7}{8}$"	17'-2$\frac{7}{8}$"	16"-8$\frac{3}{4}$"	16'-2$\frac{5}{8}$"
D	MARK	1578	1579	1580	1581	1582
	DIMENSION	20'-10"	20'-8"	20'-6"	20'-4"	20'-2"
E	MARK	1562	1563	1564	1565	1566
	DIMENSION	26'-10"	26'-6"	26'-2"	25'-10"	25'-6"
F	MARK	1550	1551	1552	1553	1555
	DIMENSION	32'-10"	32'-4"	31'-10"	31'-4"	30'-10"
G	MARK	1540	1541	1542	1543	1544
	DIMENSION	38'-10"	38'-2"	37'-6"	36'-10"	36'-2"
H	MARK	830	832	834	837	838
	DIMENSION	25'-4"	24'-11$\frac{1}{8}$"	24'-6$\frac{1}{4}$"	24'-1$\frac{3}{8}$"	23'-8$\frac{1}{2}$"
J	MARK	800	803	809	814	816
	DIMENSION	29'-10$\frac{3}{8}$"	29'-4$\frac{3}{8}$"	28'-10$\frac{3}{8}$"	28'-4$\frac{1}{2}$"	27'-10$\frac{5}{8}$"
K	MARK	743	750	760	767	777
	DIMENSION	34'-10$\frac{1}{8}$"	34'-2$\frac{3}{4}$"	33'-7$\frac{3}{8}$"	33'-0"	32'-4$\frac{3}{4}$"
L	MARK	709	711	718	723	729
	DIMENSION	40'-1$\frac{1}{4}$"	39'-4$\frac{1}{4}$"	38'-7$\frac{3}{8}$"	37'-10$\frac{3}{8}$"	37'-1$\frac{1}{2}$"
M	MARK	757	761	765	768	772
	DIMENSION	33'-8$\frac{3}{4}$"	33'-5$\frac{1}{2}$"	33'-2$\frac{1}{4}$"	32'-11$\frac{1}{8}$"	32'-8$\frac{1}{8}$"
N	MARK	757	761	765	768	772
	DIMENSION	33'-8$\frac{3}{4}$"	33'-5$\frac{1}{2}$"	33'-2$\frac{1}{4}$"	32'-11$\frac{1}{8}$"	32'-8$\frac{1}{8}$"
X	MARK	956	957	958	959	960
	DIMENSION	34'-6$\frac{5}{8}$"	34'-5$\frac{1}{2}$"	34'-4$\frac{3}{8}$"	34'-3$\frac{1}{4}$"	34'-2$\frac{1}{4}$"
Y	MARK	944	945	946	947	948
	DIMENSION	38'-3$\frac{1}{4}$"	38'-0$\frac{5}{8}$"	37'-10"	37'-7$\frac{3}{8}$"	37'-4$\frac{3}{4}$"
Z	MARK	920	923	926	927	928
	DIMENSION	42'-6"	42'-1$\frac{5}{8}$"	41'-9$\frac{1}{4}$"	41'-4$\frac{7}{8}$"	41'-0$\frac{3}{8}$"



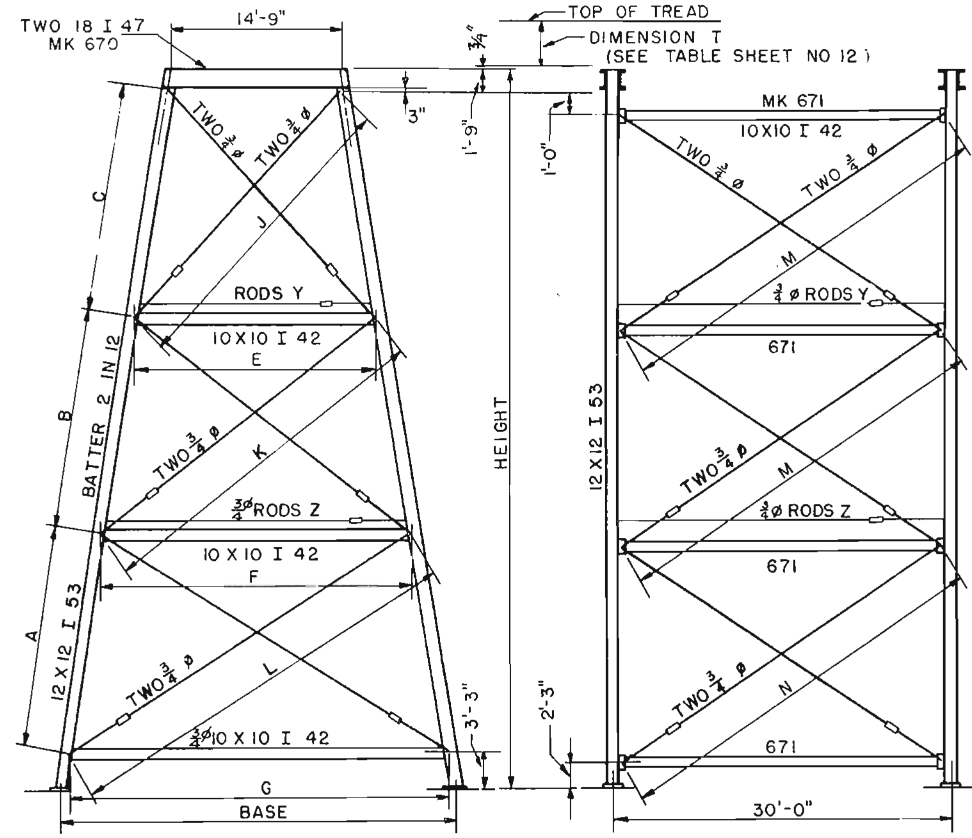
TRANSVERSE ELEVATION



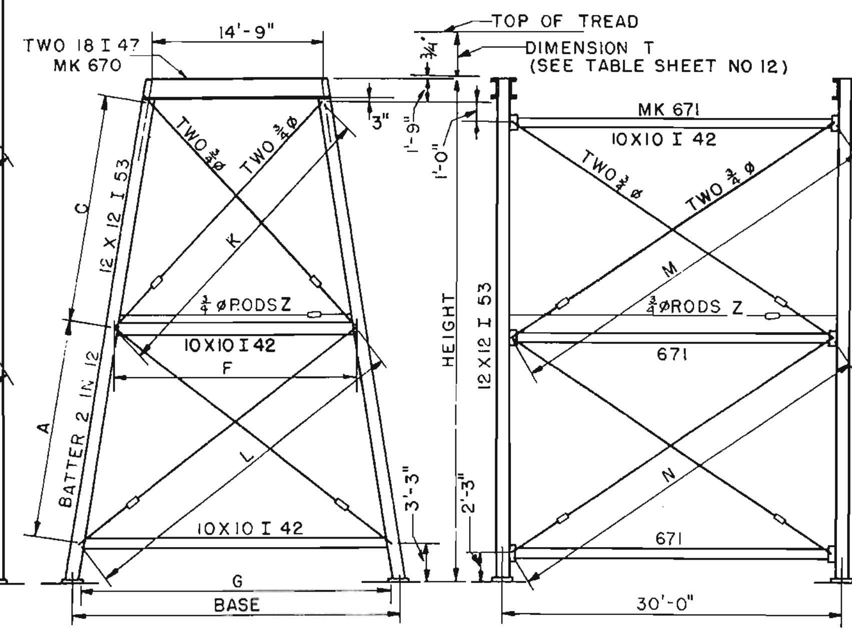
LONGITUDINAL ELEVATION



ASSEMBLED VIEW



PIN AND PIPE SPACER MK 672 AND 673 AT TRANSVERSE AND LONGITUDINAL STRUT CONNECTIONS SEE TYPICAL JOINT DETAIL SHEET 12



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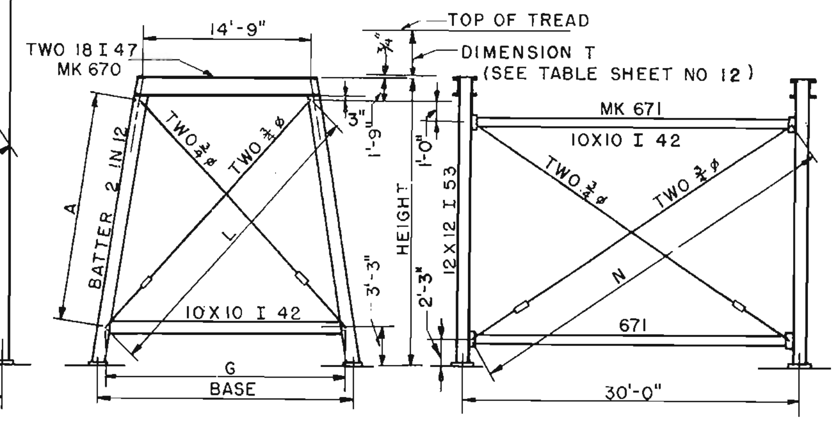

TABULATION OF TOWER DIMENSION AND ERECTION MARKS

THREE-STORY TOWER

HEIGHT		67'	65'	63'	61'	59'	57'	55'	53'	51'
BASE		37'-1"	36'-5"	35'-9"	35'-1"	34'-5"	33'-9"	33'-1"	32'-5"	31'-9"
A	MARK	1500	1502	1503	1504	1504	1506	1506	1508	1509
	DIMENSION	22'-3 5/8"	20'-3¼"	19'-3 1/8"	18'-3"	18'-3"	17'-2 3/4"	17'-2 1/8"	16'-2 5/8"	15'-2½"
B	MARK	1511	1511	1512	1513	1514	1515	1517	1518	1519
	DIMENSION	20'-3¼"	20'-3¼"	19'-9¼"	19'-3 1/8"	18'-3"	17'-8 7/8"	16'-8 3/4"	16'-2 5/8"	15'-8 5/8"
C	MARK	1521	1521	1522	1523	1524	1525	1527	1774	1528
	DIMENSION	20'-3¼"	20'-3¼"	19'-9¼"	19'-3 1/8"	18'-3"	17'-8 7/8"	16'-8 3/4"	16'-2 5/8"	15'-8 5/8"
E	MARK	1573	1573	1575	1576	1578	1579	1581	1582	1577
	DIMENSION	21'-6"	21'-6"	21'-4"	21'-2"	20'-10"	20'-8"	20'-4"	20'-2"	20'-0"
F	MARK	1558	1558	1560	1561	1562	1563	1565	1566	1567
	DIMENSION	28'-2"	28'-2"	27'-10"	27'-6"	26'-10"	26'-6"	25'-10"	25'-6"	25'-2"
G	MARK	1545	1546	1547	1548	1550	1549	1554	1555	1556
	DIMENSION	35'-6"	34'-10"	34'-2"	33'-6"	32'-10"	32'-2"	31'-6"	30'-10"	30'-2"
J	MARK	823	823	825	828	830	832	837	838	841
	DIMENSION	27'-0¼"	27'-0¼"	26'-7 1/8"	26'-2 1/8"	25'-4"	24'-11 1/8"	24'-1 3/8"	23'-8½"	23'-3 3/4"
K	MARK	784	784	787	793	800	803	814	816	819
	DIMENSION	31'-10 5/8"	31'-10 5/8"	31'-4½"	30'-10½"	29'-10 3/8"	29'-4 3/8"	28'-4½"	27'-10 5/8"	27'-4 3/4"
L	MARK	716	728	733	740	743	755	763	777	788
	DIMENSION	38'-8 3/8"	37'-3 3/4"	36'-4¼"	35'-5"	34'-10 1/8"	33'-10 7/8"	33'-4"	32'-4 3/4"	31'-5 5/8"
M	MARK	742	742	745	749	757	761	768	772	774
	DIMENSION	34'-10 3/8"	34'-10 3/8"	34'-6 7/8"	34'-3 3/8"	33'-8 3/4"	33'-5½"	32'-11 1/8"	32'-8 1/8"	32'-5 1/8"
N	MARK	735	742	749	757	757	765	765	772	780
	DIMENSION	36'-1"	34'-10 3/8"	34'-3 3/8"	33'-8 3/4"	33'-8 3/4"	33'-2¼"	33'-2¼"	32'-8 1/8"	32'-2¼"
CLEVIS ROD Y	MARK	953	953	954	955	956	957	959	989	961
	DIMENSION	34'-11¼"	34'-11¼"	34'-10 1/8"	34'-9"	34'-6 5/8"	34'-5½"	34'-3¼"	34'-2¼"	34'-1 1/8"
CLEVIS ROD Z	MARK	972	972	941	943	944	945	947	948	949
	DIMENSION	39'-2 1/8"	39'-2 1/8"	38'-11 3/8"	38'-8 5/8"	38'-3¼"	38'-0 5/8"	37'-7 3/8"	37'-4 3/4"	37'-2 1/8"

TWO-STORY TOWER

HEIGHT		49'	47'	45'	43'	41'	39'	37'	35'	33'
BASE		31'-1"	30'-5"	29'-9"	29'-1"	28'-5"	27'-9"	27'-1"	26'-5"	25'-9"
A	MARK	1500	1501	1502	1503	1504	1506	1508	1509	1510
	DIMENSION	22'-3 5/8"	21'-3½"	20'-3¼"	19'-3 1/8"	18'-3"	17'-2 3/4"	16'-2 5/8"	15'-2½"	14'-2 3/8"
B	MARK									
	DIMENSION									
C	MARK	1520	1773	1521	1523	1524	1525	1774	1529	1530
	DIMENSION	22'-3 5/8"	21'-3½"	20'-3¼"	19'-3 1/8"	18'-3"	17'-2 3/4"	16'-2 5/8"	15'-2½"	14'-2 3/8"
E	MARK									
	DIMENSION									
F	MARK	1572	1574	1573	1576	1578	1580	1582	1583	1584
	DIMENSION	22'-2"	21'-10"	21'-6"	21'-2"	20'-10"	20'-6"	20'-2"	19'-10"	19'-6"
G	MARK	1557	1559	1558	1561	1562	1564	1566	1568	1569
	DIMENSION	29'-6"	28'-10"	28'-2"	27'-6"	26'-10"	26'-2"	25'-6"	24'-10"	24'-2"
J	MARK									
	DIMENSION									
K	MARK	811	816	823	828	830	834	838	843	847
	DIMENSION	28'-8 7/8"	27'-10½"	27'-0¼"	26'-2 1/8"	25'-4"	24'-6¼"	23'-8½"	22'-11 1/8"	22'-1 7/8"
L	MARK	754	770	784	793	1054	809	816	823	829
	DIMENSION	33'-11 1/8"	32'-10 7/8"	31'-10 5/8"	30'-10½"	29'-10 3/8"	28'-10 3/8"	27'-10 5/8"	27'-0¼"	25'-11¼"
M	MARK	735	738	742	749	757	765	771	780	785
	DIMENSION	36'-1"	35'-5 5/8"	34'-10 3/8"	34'-3 3/8"	33'-8 3/4"	33'-2¼"	32'-6¼"	32'-2¼"	31'-8 5/8"
N	MARK	735	738	742	749	757	765	771	780	785
	DIMENSION	36'-1"	35'-5 5/8"	34'-10 3/8"	34'-3 3/8"	33'-8 3/4"	33'-2¼"	32'-6¼"	32'-2¼"	31'-8 5/8"
CLEVIS ROD Y	MARK									
	DIMENSION									
CLEVIS ROD Z	MARK	951	952	953	974	956	958	989	962	990
	DIMENSION	35'-4"	35'-1 5/8"	34'-11¼"	34'-9"	34'-6 5/8"	34'-4 3/8"	34'-2¼"	34'-0"	33'-9 7/8"

ONE-STORY TOWER

HEIGHT		31'	29'	27'	25'	23'	21'	19'	17'	15'
BASE		25'-1"	24'-5"	23'-9"	23'-1"	22'-5"	21'-9"	21'-1"	20'-5"	19'-9"
A	MARK	1531	1532	1533	1534	1535	1536	1537	1538	1539
	DIMENSION	26'-4¼"	24'-4"	22'-3 5/8"	20'-3¼"	18'-3"	16'-2 5/8"	14'-2 3/8"	12'-2"	10'-1 5/8"
B	MARK									
	DIMENSION									
C	MARK									
	DIMENSION									
E	MARK									
	DIMENSION									
F	MARK									
	DIMENSION									
G	MARK	1570	1571	1572	1573	1578	1582	1584	1585	1586
	DIMENSION	23'-6"	22'-10"	22'-2"	21'-6"	20'-10"	20'-2"	19'-6"	18'-10"	18'-2"
J	MARK									
	DIMENSION									
K	MARK									
	DIMENSION									
L	MARK	779	795	811	823	830	838	847	851	857
	DIMENSION	32'-3 5/8"	30'-6 1/3"	28'-8 7/8"	27'-0¼"	25'-4"	23'-8½"	22'-1 7/8"	20'-8 1/8"	19'-4 3/8"
M	MARK									
	DIMENSION									
N	MARK	715	726	735	742	757	824	785	792	799
	DIMENSION	38'-8 5/8"	37'-4½"	36'-1"	34'-10 3/8"	33'-8 3/4"	32'-8 1/8"	31'-8 5/8"	30'-10 3/8"	30'-1½"
CLEVIS ROD Y	MARK									
	DIMENSION									
CLEVIS ROD Z	MARK									
	DIMENSION									

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TABLE 8 – BILL OF MATERIALS COMMON TO ALL TOWERS

LINE	DESCRIPTION	STOCK NUMBER	MARK	DETAILED ON SHEET	SIZE (INCHES)	LENGTH	TOWER HEIGHT GROUP CLASSIFICATION: 4-STORY 69' TO 79' NUMBER	4-STORY UNIT WEIGHT (POUNDS)	3-STORY 51' TO 67' NUMBER	3-STORY UNIT WEIGHT (POUNDS)	2-STORY 33' TO 49' NUMBER	2-STORY UNIT WEIGHT (POUNDS)	1-STORY 15' TO 31' NUMBER	1-STORY UNIT WEIGHT (POUNDS)
1	CAP BEAM	48-2900.18-047	670	16	18 I 47	16'-2"	4	760	4	760	4	760	4	760
2	BEARING PLATE	47-7844.07-7	P6	16	20 X 3/4	1'-10"	8	93	8	93	8	93	8	93
3	DIAPHRAGM		D1	16	12 X 12 I 53	1'-4"	4	71	4	71	4	71	4	71
4	RIVETS IN BEARING PLATES	43-6353.08		16	7/8	2 3/4"	64	.66	64	.66	64	.66	64	.66
5	RIVETS IN WEB OF CAP	43-6353.08		16	7/8	2 1/2"	128	.62	128	.62	128	.62	128	.62
6	LONGITUDINAL STRUT		671	16	10 I 42	28'-10 3/4"	10	1215	8	1215	6	1215	4	1215
7	PIN PLATE	47-7844.04-1	P8	16	9 X 3/8	0'-10"	40	10	32	10	24	10	16	10
8	DO	47-7844.04-1	P5	17	9 X 3/8	0'-10"	32	10	24	10	16	10	8	10
9	COLUMN BASE PLATE	47-7844.1-5	P4	17	18 X 1	1'-6"	4	92	4	92	4	92	4	92
10	STIFFENERS	47-7844.04-08	P9.10.11	17	5 X 3/8	1'-5 1/2"	4	11	4	11	4	11	4	11
11	BRACING CONNECTOR		C1	17.18	12 X 12 I 53	1'-1 1/4"	20	40	16	40	12	40	8	40
12	DO	47-7844.05-22	P3	18	4 X 1/2	1'-0"	12	7	8	7	4	7		
13	WEB SPLICE	47-7844.05-22	P1	18	10 X 1/2	1'-10 1/4"	24	31	16	31	8	31		
14	FLANGE SPLICE	47-7844.05-22	P2	18	12 X 1/2	1'-10 1/4"	24	38	16	38	8	38		
15	RIVETS, WEB SPLICE	43-6353.08		18	7/8	3 1/4"	144	.74	96	.74	48	.74		
16	RIVETS, FLANGE SPLICE	43-6353.08-25		18	7/8	2 1/2"	288	.62	192	.62	96	.62		
17	[1]PIN		672	16	1 1/2 ø	1'-4 1/2"	40	8	32	8	24	8	16	8
18	[1]COTTER PIN			16	1/4 X 2 1/2		80	.1	64	.1	48	.1	32	.1
19	[1]PIPE SPACER	44-6246.7-02	673	16	2	0'-7"	40	2	32	2	24	2	16	2
20	[1]WASHER		658	16	3 3/4 X 1 9/16" HOLE	3¾	144	1.24	128	1.24	112	1.24	96	1.24
21	[2]LOOP ROD, UPSET		677	19	3/4 □	4'-7"	128	11	96	11	64	11	32	11
22	SPLICE ROD	46-6375.5-07	678	19	3/4 ø	1'-1"	256	1.6	192	1.6	128	1.6	64	1.6
23	[2]TURNBUCKLE			19	1 1/8	6"	64	2.7	48	2.7	32	2.7	16	2.7
24	[3]CLEVIS ROD, HORIZONTAL, UPSET		680	19	3/4 □	1'-7"	6	4.3	4	4.3	2	4.3		
25	[3] DO		680	19	3/4 □	1'-3"	6	3.7	4	3.7	2	3.7		
26	SPLICE ROD	46-6375.5-07	678	19	3/4 ø	1'-1"	24	1.6	16	1.6	8	1.6		
27	[3]TURNBUCKLE			19	1 1/8	6"	6	2.7	4	2.7	2	2.7		
28	[3]CLEVIS			19	NO 3 FOR 1 1/8" THREAD	5"	12	4.0	8	4.0	4	4.0		
29	[3]PIN, HEADED, CLEVIS			19	1 3/16 ø	3 1/4"	12	1.5	8	1.5	4	1.5		
30	[3]COTTER PIN			19	1/4 ø X 2 1/2		12	.1	8	.1	4	.1		
31	WELDING ELECTRODE	46-3772.2-7 46-3772.25-5			3/16 AND 7/32			330 LB		260 LB		180 LB		100 LB

[1] CONNECTOR PIN ASSEMBLY, 1½"
[2] LOOP ROD ASSEMBLY, ¾"
[3] CLEVIS ROD ASSEMBLY, ¾"

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TABLE 4 - BILL OF MATERIALS FOR PIECES WHICH VARY FOR DIFFERENT TOWER HEIGHTS

DESCRIPTION	LINE	DETAILED ON SHEET	NUMBER	77' MARK	77' REQUISITIONED LENGTH	77' UNIT WEIGHT (POUNDS)	75' MARK	75' REQUISITIONED LENGTH	75' UNIT WEIGHT (POUNDS)	73' MARK	73' REQUISITIONED LENGTH	73' UNIT WEIGHT (POUNDS)	71' MARK	71' REQUISITIONED LENGTH	71' UNIT WEIGHT (POUNDS)	69' MARK	69' REQUISITIONED LENGTH	69' UNIT WEIGHT (POUNDS)
TOWER COLUMNS 12 X 12 I 53 STOCK NO	1		2	1504R	25'-1"	1330	1505R	24'-6 7/8"	1300	1506R	24'-0 3/4"	1275	1507R	23'-6 3/4"	1250	1508R	23'-0 5/8"	1220
	2		2	1504L	25'-1"	1330	1505L	24'-6 7/8"	1300	1506L	24'-0 3/4"	127	1507L	23'-6 3/4"	1250	1508L	23'-0 5/8"	1220
	3	18	4	1514R	18'-2 3/4"	965	1515R	17'-8 5/8"	940	1516R	17'-2 5/8"	915	1517R	16'-8 1/2"	885	1518R	16'-2 3/8"	860
	4		4	1514L	18'-2 3/4"	965	1515L	17'-8 5/8"	940	1516L	17'-2 5/8"	915	1517L	16'-8 1/2"	885	1518L	16'-2 3/8"	860
	5		2	1524R	16'-5 1/2"	870	1525R	15'-11 3/8"	845	1526R	15'-5 1/4"	820	1527R	14'-11 1/4"	790	1774R	14'-5 1/8	765
	6		2	1524L	16'-5 1/2"	870	1525L	15'-11 3/8"	845	1526L	15'-5 1/4"	820	1527L	14'-11 1/4"	790	1774L	14'-5 1/8"	765
TRANSVERSE STRUTS 10 I 42 STOCK NO	7		2	1578	21'-3"	895	1579	21'-1"	885	1580	20'-11"	880	1581	20'-9"	870	1582	20'-7"	865
	8	17	2	1562	27'-3"	1145	1563	26'-11"	1130	1564	26'-7"	1120	1565	26'-3"	1100	1566	25'-11"	1090
	9		2	1550	33'-3"	1400	1551	32'-9"	1375	1552	32'-3"	1365	1553	31'-9"	1335	1555	31'-3"	1315
	10		2	1540	39'-3"	1650	1541	38'-7"	1620	1542	37'-11"	1595	1543	37'-3"	1565	1544	36'-7"	1540
TRANSVERSE RODS 3/4 Ø RODS STOCK NO 46-6375.5-07	11		8	899	15'-6"	23	900	15'-0"	23	901	14'-6"	22	901	14'-6"	22	902	14'-0"	21
	12	19	8	890	20'-0"	30	891	19'-6"	29	892	19'-0"	29	893	18'-6"	28	894	18'-0"	27
	13		8	880	25'-0"	38	881	24'-6"	37	882	24'-0"	36	884	23'-0"	35	885	22'-6"	34
	14		8	870	30'-6"	46	871	29'-6"	44	872	29'-0"	44	874	28'-0"	42	875	27'-6"	41
LONGITUDINAL RODS 3/4 Ø RODS STOCK NO 46-6375.5-07	15		24	882	24'-0"	36	883	23'-6"	35	883	23'-6"	43	884	23'-0"	35	885	22'-6"	34
	16	19	8	882	24'-0"	36	883	23'-6"	35	883	23'-6"	43	884	23'-0"	35	885	22'-6"	34
HORIZONTAL RODS 3/4 Ø RODS STOCK NO. 46-6375.5-07	17		2	1008	30'-6"	46	1008	30'-5"	46	1009	30'-0"	45	1009	30'-0"	45	1009	30'-0"	45
	18	19	2	1003	34'-0"	51	1003	34'-0"	51	1003	34'-0"	51	1004	33'-6"	50	1004	33'-6"	50
	19		2	995	38'-6"	58	996	38'-0"	57	997	37'-6"	56	997	37'-5"	56	998	37'-0"	56

DESCRIPTION	LINE	TOWER HEIGHT		67' MARK	67' REQ. LENGTH	67' UNIT WT.	65' MARK	65' REQ. LENGTH	65' UNIT WT.	63' MARK	63' REQ. LENGTH	63' UNIT WT.	61' MARK	61' REQ. LENGTH	61' UNIT WT.	59' MARK	59' REQ. LENGTH	59' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	20	18	2	1500R	29'-1 5/8"	1545	1502R	27'-1 1/4"	1435	1503R	26'-1 1/8"	1380	1504R	25'-1"	1330	1504R	25'-1"	1330
	21		2	1500L	29'-1 5/8"	1545	1502L	27'-1 1/4"	1435	1503L	26'-1 1/8"	1380	1504L	25'-1"	1330	1504L	25'-1"	1330
	22		2	1511R	20'-3"	1075	1511R	20'-3"	1075	1512R	19'-9"	1045	1513R	19'-2 7/8"	1020	1514R	18'-2 3/4"	970
	23	18	2	1511L	20'-3"	1075	1511L	20'-3"	1075	1512L	19'-9"	1045	1513L	19'-2 7/8"	1020	1514L	18'-2 3/4	970
	24		2	1521R	18'-5 3/4"	980	1521R	18'-5 3/4"	980	1522R	17'-11 3/4"	955	1523R	17'-5 5/8"	925	1524R	16'-5 1/2"	875
	25		2	1521L	18'-5 3/4"	980	1521L	18'-5 3/4"	980	1522L	17'-11 3/4"	955	1523L	17'-5 5/8"	925	1524L	16'-5 1/2"	875
TRANSVERSE STRUTS 10 I 42 STOCK NO	26		2	1573	21'-11"	920	1573	21'-11"	920	1575	21'-9"	915	1576	21'-7"	905	1578	21'-3"	895
	27	17	2	1558	28'-7"	1200	1558	28'-7"	1200	1560	28'-3"	1190	1561	27'-11"	1170	1562	27'-3"	1145
	28		2	1545	35'-11"	1510	1546	35'-3"	1480	1547	34'-7"	1450	1548	33'-11"	1425	1550	33'-3"	1395
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	29		8	896	17'-0"	26	896	17'-0"	26	897	16'-6"	25	897	16'-6"	25	899	15'-6"	23
	30	19	8	886	22'-0"	33	886	22'-0"	33	887	21'-6"	32	888	21'-0"	32	890	20'-0"	30
	31		8	872	29'-0"	44	875	27'-6"	41	877	26'-6"	40	879	25'-6"	38	880	25'-0"	38
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	32	19	16	880	25'-0"	38	880	25'-0"	38	880	25'-0"	38	881	24'-6"	37	882	24'-0"	35
	33		8	877	25'-6"	40	880	25'-0"	38	881	24'-6"	37	882	24'-0"	36	882	24'-0"	36
HORIZONTAL RODS 3/4 Ø STOCK NO 46-6375.5-07	34	19	2	1007	31'-0"	47	1007	31'-0"	47	1008	30'-6"	46	1008	30'-6"	46	1008	30'-5"	46
	35		2	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53	1002	34'-6"	52	1003	34'-0"	51

DESCRIPTION	LINE	57' MARK	57' REQ. LENGTH	57' UNIT WT.	55' MARK	55' REQ. LENGTH	55' UNIT WT.	53' MARK	53' REQ. LENGTH	53' UNIT WT.	51' MARK	51' REQ. LENGTH	51' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	20	1506R	24'-0 3/4"	1280	1506R	24'-0 3/4"	1280	1508R	23'-0 5/8"	1220	1509R	22'-0 1/2"	1170
	21	1506L	24'-0 3/4"	1280	1506L	24'-0 3/4"	1280	1508L	23'-0 5/8"	1220	1509L	22'-0 1/2"	1170
	22	1515R	17'-3 5/8"	940	1517R	16'-8 1/2"	885	1518R	16'-2 3/8"	860	1519R	15'-8 3/8"	830
	23	1515L	17'-3 5/8"	940	1517L	16'-8 1/2"	885	1518L	16'-2 3/8"	860	1519L	15'-8 3/8"	830
	24	1525R	15'-11 3/8"	845	1527R	14'-11 1/4"	790	1774R	14'-5 1/8"	765	1528R	13'-11 1/8"	740
	25	1525L	15'-11 3/3"	845	1527L	14'-11 1/4"	790	1774L	14'-5 1/8"	765	1528L	13'-11 1/8"	740
TRANSVERSE STRUTS 10 I 42 STOCK NO	26	1579	21'-1"	885	1581	20'-9"	870	1582	20'-7"	865	1577	20'-5"	860
	27	1563	26'-11"	1130	1565	26'-3"	1105	1566	25'-11"	1090	1567	25'-7"	1075
	28	1549	32'-7"	1370	1554	31'-11"	1340	1555	31'-3"	1310	1556	30'-7"	1285
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	29	900	15'-0"	23	901	14'-6"	22	902	14'-0"	21	903	13'-6"	20
	30	891	19'-6"	29	893	18'-6"	28	894	18'-0"	27	895	17'-6"	26
	31	882	24'-0"	36	883	23'-6"	35	885	22'-6"	34	887	21'-6"	32
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	32	883	23'-6"	35	884	23'-0"	35	885	22'-6"	34	885	22'-6"	34
	33	883	23'-6"	35	883	23'-6"	35	885	22'-6"	34	885	22'-6"	34
HORIZONTAL RODS 3/4 Ø STOCK NO 46-6375.5-07	34	1008	30'-6"	46	1009	30'-0"	45	1009	30'-0"	45	1009	30'-0"	45
	35	1003	34'-0"	51	1004	33'-6"	50	1004	33'-6"	50	1005	33'-0"	50

DESCRIPTION	LINE	TOWER HEIGHT		49' MARK	49' REQ. LENGTH	49' UNIT WT.	47' MARK	47' REQ. LENGTH	47' UNIT WT.	45' MARK	45' REQ. LENGTH	45' UNIT WT.	43' MARK	43' REQ. LENGTH	43' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	36	18	2	1500R	29'-1 5/8"	1540	1501R	28'-1 1/2"	1490	1502R	27'-1 1/4"	1440	1503R	26'-1 1/8"	1380
	37		2	1500L	29'-1 5/8"	1540	1501L	28'-1 1/2"	1490	1502L	27'-1 1/4"	1440	1503L	26'-1 1/8"	1380
	38	18	2	1520R	20'-6 1/8"	1080	1773R	19'-6"	1035	1521R	18'-5 3/4"	930	1523R	17'-5 5/8"	925
	39		2	1520L	20'-6 1/8"	1080	1773L	19'-6"	1035	1521L	18'-5 3/4"	980	1523L	17'-5 5/8"	925
TRANSVERSE STRUTS 10 I 42 STOCK NO	40	17	2	1572	22'-7"	950	1574	22'-3"	935	1573	21'-11"	920	1576	21 -7"	905
	41		2	1557	29'-11"	1260	1559	29'-3"	1230	1558	28'-7"	1200	1561	27'-11"	1170
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	42	19	8	892	19'-0"	29	894	18'-0"	27	896	17'-0"	26	897	16 -5"	25
	43		8	882	24'-0"	36	884	23'-0"	35	886	22'-0"	33	888	21'-0"	32
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	44	19	8	877	26'-6"	40	879	25'-6"	38	880	25'-0"	38	881	24'-6"	37
	45		8	877	26'-6"	40	879	25'-6"	38	880	25'-0"	38	881	24'-6"	37
HORIZONTAL RODS 3/4 Ø STOCK NO 46-6375.5-07	46	19	2	1007	31'-0"	47	1007	31'-0"	47	1007	31'-0"	47	1008	30'-6"	46

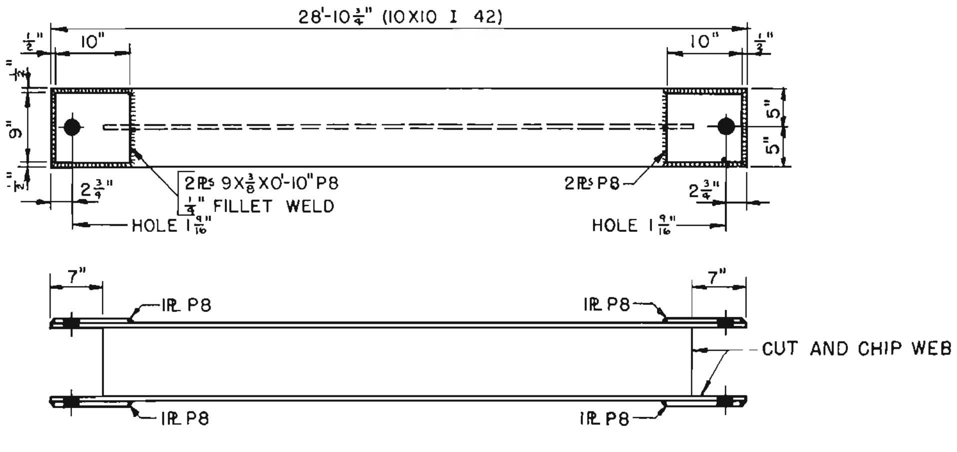
DESCRIPTION	LINE	41' MARK	41' REQ. LENGTH	41' UNIT WT.	39 MARK	39 REQ. LENGTH	39 UNIT WT.	37' MARK	37' REQ. LENGTH	37' UNIT WT.	35' MARK	35' REQ. LENGTH	35' UNIT WT.	33' MARK	33' REQ. LENGTH	33' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	36	1504R	25'-1"	1330	1506R	24'-0 3/4"	1275	1508R	23'-0 5/8"	1220	1509R	22'-0 1/2"	1170	1510R	21'-0 3/8"	1115
	37	1504L	25'-1"	1330	1506L	24'-0 3/4"	1275	1508L	23'-0 5/8"	1220	1509L	22'-0 1/2"	1170	1510L	21'-0 3/8"	1115
	38	1524R	16'-5 1/2"	870	1526R	15'-5 1/4"	820	1774R	14'-5 1/8"	765	1529R	13'-5"	710	1530R	12'-4 7/8"	660
	39	1524L	16'-5 1/2"	870	1525L	15'-5 1/4"	820	1774L	14'-5 1/8"	765	1529L	13'-5"	710	1530L	12'-4 7/8"	660
TRANSVERSE STRUTS 10 I 42 STOCK NO	40	1578	21'-3"	995	1580	20'-11"	880	1582	20'-7"	865	1583	20'-3"	850	1584	19'-11"	835
	41	1562	27'-3"	1150	1564	26'-7"	1115	1566	25'-11"	1090	1568	25'-3"	1060	1569	24'-7"	1030
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	42	899	15'-6"	23	901	14'-6"	22	902	14'-0"	21	904	13'-0"	20	905	12'-6"	19
	43	890	20'-0"	30	892	19'-0"	29	894	18'-0"	27	896	17'-0"	26	898	16'-0"	24
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	44	882	24'-0"	36	883	23'-6"	35	885	22'-6"	34	885	22'-6"	34	886	22'-0"	33
	45	882	24'-0"	36	883	23'-6"	35	885	22'-6"	34	885	22'-6"	34	886	22'-0"	33
HORIZONTAL RODS 3/4 Ø STOCK NO 46-6375.5-07	46	1008	30'-6"	46	1009	30'-0"	45	1009	30'-0"	45	1009	30'-0"	45	1010	29'-6"	44

DESCRIPTION	LINE	TOWER HEIGHT		31' MARK	31' REQ. LENGTH	31' UNIT WT.	29' MARK	29' REQ. LENGTH	29' UNIT WT.	27' MARK	27' REQ. LENGTH	27' UNIT WT.	25' MARK	25' REQ. LENGTH	25' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	47	19	2	1531R	31'-5"	1665	1532R	29'-4 3/4"	1560	1533R	27'-4 3/8"	1450	1534R	25'-4"	1340
	48		2	1531L	31'-5"	1665	1532L	29'-4 3/4"	1560	1533L	27'-4 3/8"	1450	1534L	25'-4"	1340
TRANSVERSE STRUTS 10 I 42 STOCK NO	49	17	2	1570	23'-11"	1005	1571	23'-3"	980	1572	22'-7"	950	1573	21'-11"	920
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	50	19	8	885	22'-6"	34	889	20'-6"	31	892	19'-0"	29	896	17'-0"	26
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	51	19	8	872	29'-0"	44	875	27'-6"	41	877	26'-6"	40	880	25'-0"	38

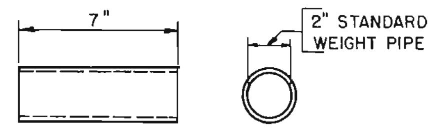
DESCRIPTION	LINE	23' MARK	23' REQ. LENGTH	23' UNIT WT.	21' MARK	21' REQ. LENGTH	21' UNIT WT.	19' MARK	19' REQ. LENGTH	19' UNIT WT.	17' MARK	17' REQ. LENGTH	17' UNIT WT.	15' MARK	15' REQ. LENGTH	15' UNIT WT.
TOWER COLUMNS 12 X 12 I 53 STOCK NO	47	1535R	23'-3 3/4"	1235	1535R	21'-3 3/8"	1130	1537R	19'-3 1/8"	1020	1538R	17'-2 3/4"	910	1539R	15'-2 3/8"	815
	48	1535L	23'-3 3/4"	1235	1536L	21'-3 3/8"	1130	1537L	19'-3 1/8"	1020	1538L	17'-2 3/4"	910	1539L	15'-2 3/8"	815
TRANSVERSE STRUTS 10 I 42 STOCK NO	49	1578	21'-3"	895	1582	20'-7"	865	1584	19'-11"	840	1585	19'-3"	810	1586	18 -7"	780
TRANSVERSE RODS 3/4 Ø STOCK NO 46-6375.5-07	50	899	15 -6"	23	902	14'-0"	21	905	12'-6"	19	907	11'-0"	17	910	9'-6"	14
LONGITUDINAL RODS 3/4 Ø STOCK NO 46-6375.5-07	51	882	24'-0"	36	885	22'-6"	34	886	22'-0"	33	888	21'-0"	32	889	20'-6"	31

COMPANION SHEETS

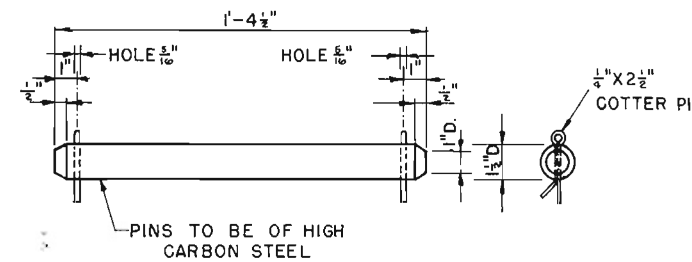
	SHEET
FRAMED STEEL TOWERS	12, 13
BILL OF MATERIALS	14, 15
STRUTS AND COLUMNS	17, 18
ROD BRACING	19
SHIMS	20
GENERAL NOTES	154
SYMBOLS	155



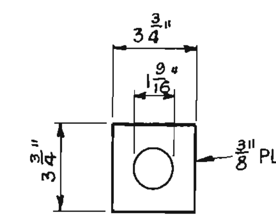
STRUT MK 671



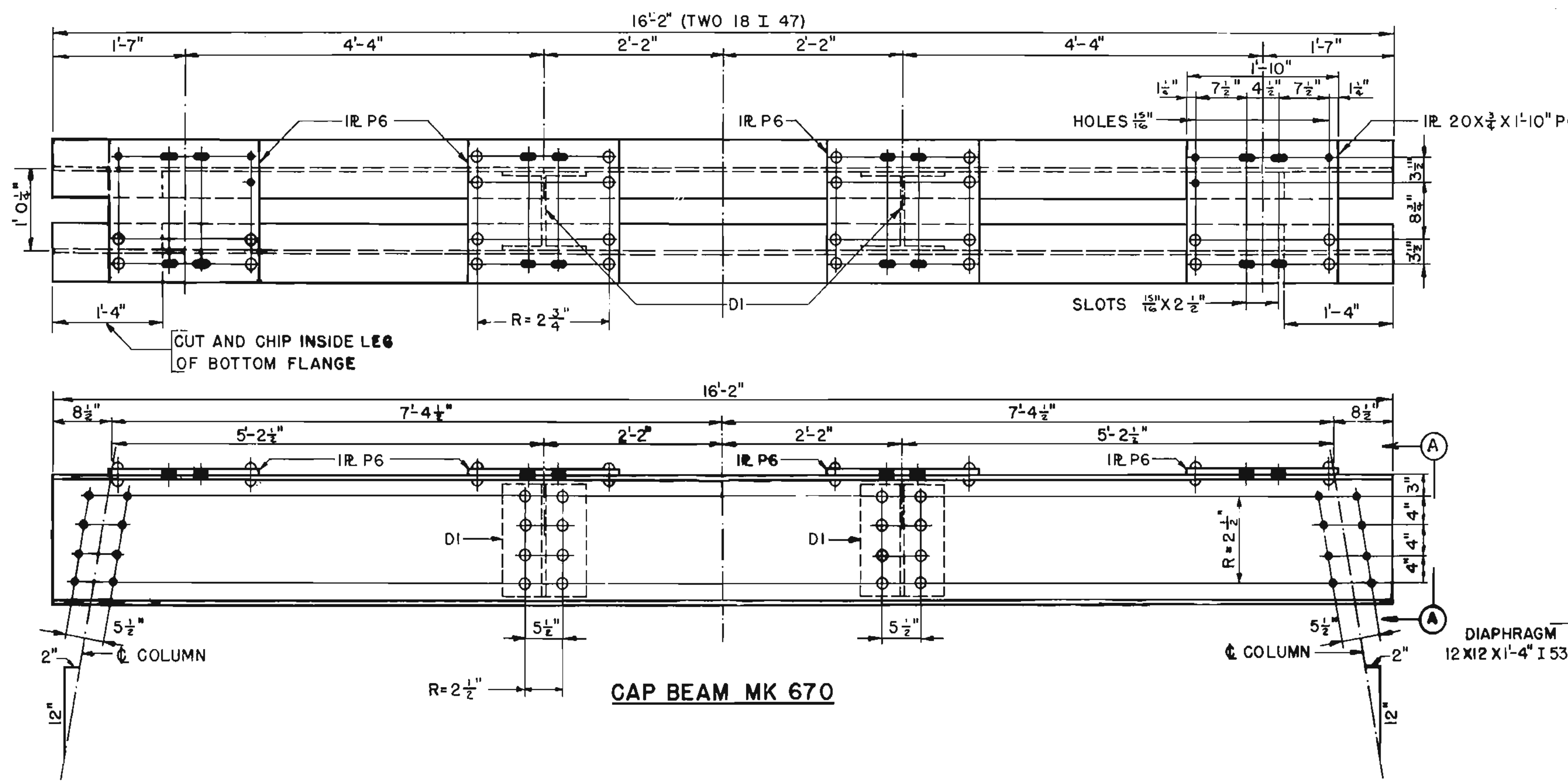
PIPE SPACER MK 673



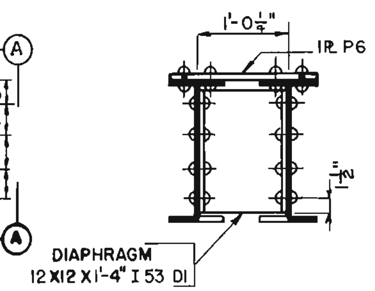
PIN AND COTTER PIN MK672



WASHER MK 658



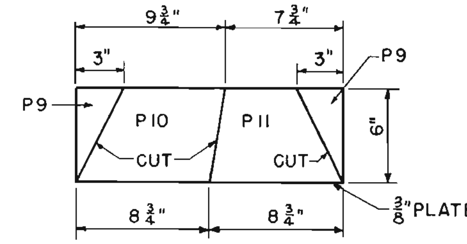
CAP BEAM MK 670



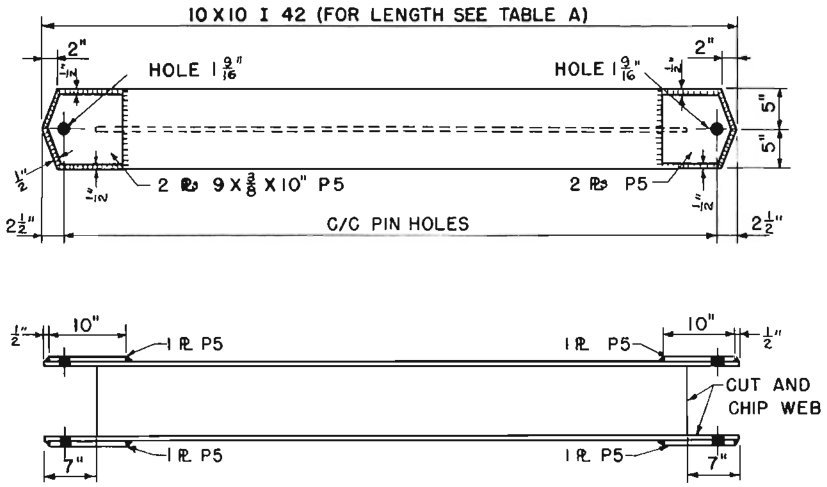
SECTION A-A

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
FRAMED STEEL TOWERS	12,13
BILL OF MATERIALS	14
BILL OF MATERIALS	15
SYMBOLS	155



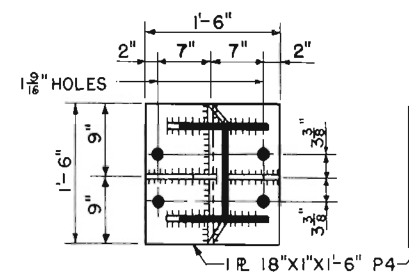
BEARING PLATE STIFFENERS P9, P10, P11



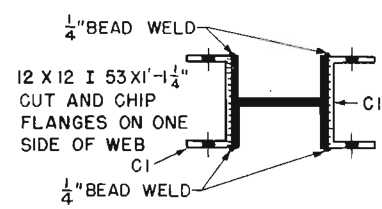
STRUT MK 1540 TO MK 1586

ALL WELDS SHOWN TO BE $\frac{1}{4}$" FILLET WELDS UNLESS OTHERWISE INDICATED

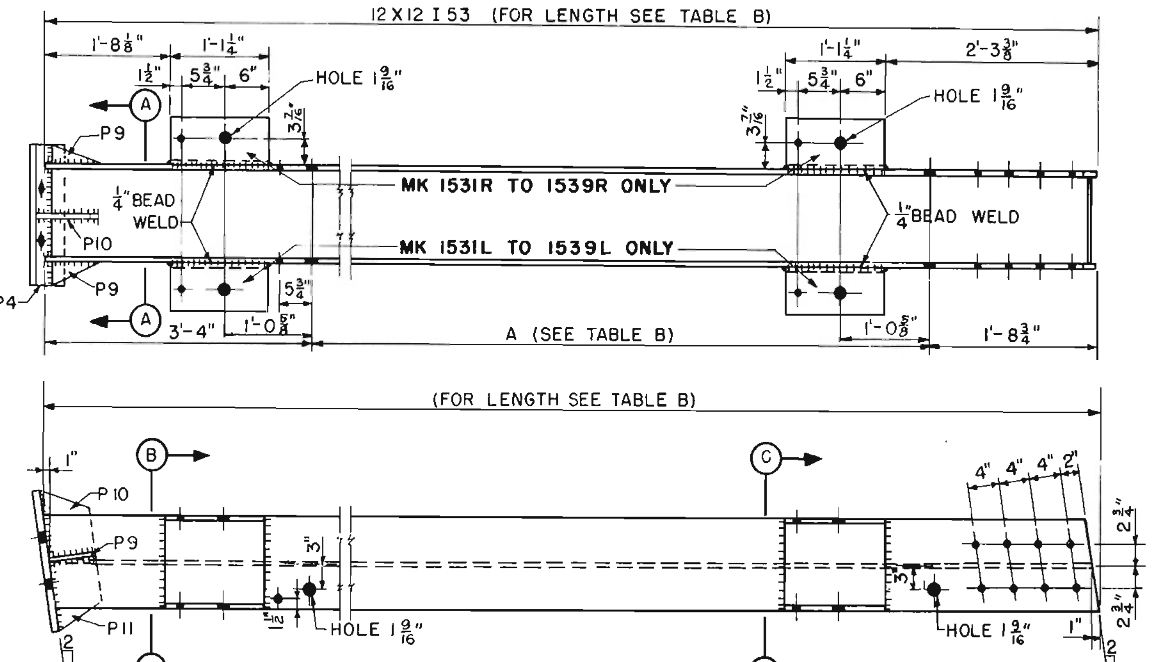
ALL RIVETS $\frac{7}{8}$" ϕ
ALL HOLES $\frac{15}{16}$"ϕ UNLESS NOTED



SECTION A-A



SECTION B-B AND C-C



COLUMN MK 1531R TO MK 1539R
COLUMN MK 1531L TO MK 1539L

TABLE A

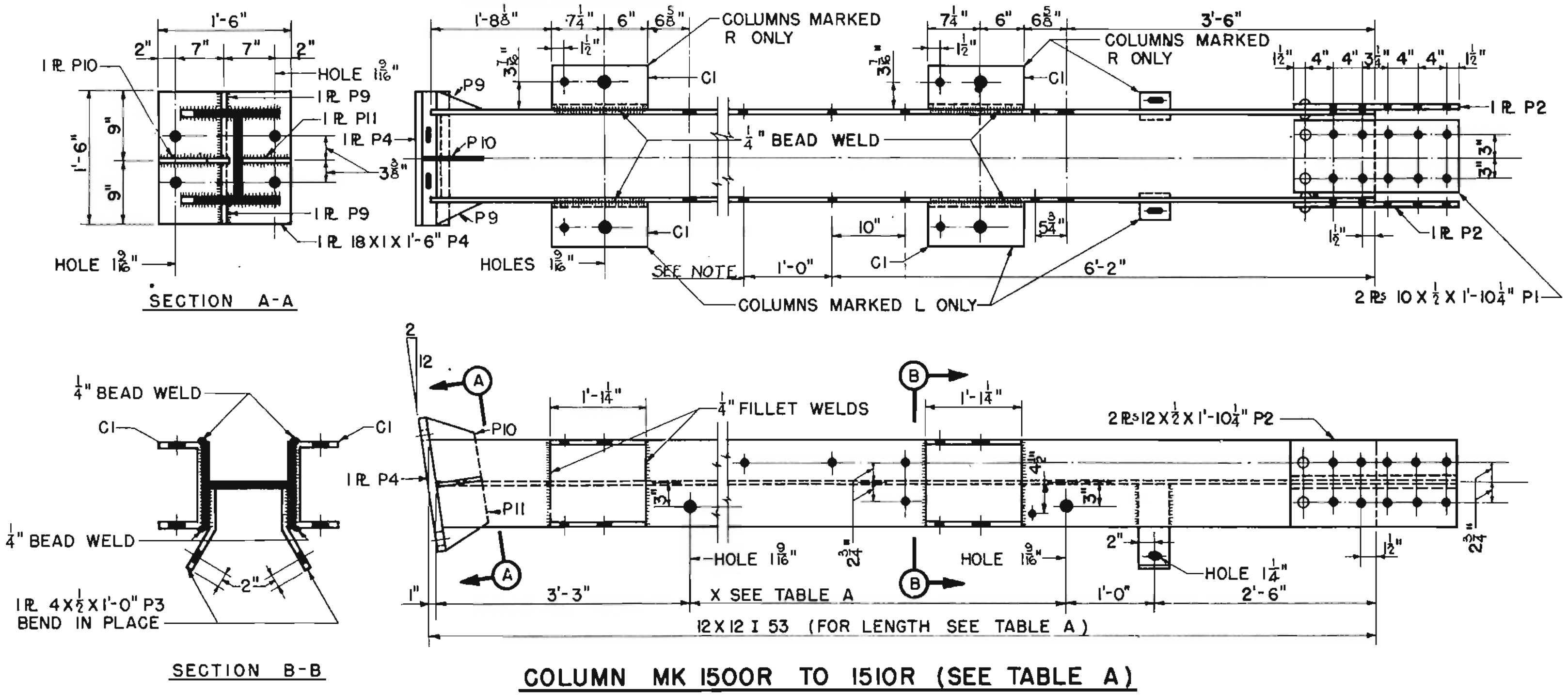
MARK	C/C PIN HOLES	LENGTH	WEIGHT
1540	38'-10"	39'-3"	1687
1541	38'-2"	38'-7"	1659
1542	37'-6"	37'-11"	1631
1543	36'-10"	37'-3"	1603
1544	36'-2"	36'-7"	1575
1545	35'-6"	35'-11"	1547
1546	34'-10"	35'-3"	1519
1547	34'-2"	34'-7"	1491
1548	33'-6"	33'-11"	1463
1549	32'-2"	32'-7"	1407
1550	32'-10"	33'-3"	1435
1551	32'-4"	32'-9"	1414
1552	31'-10"	32'-3"	1393
1553	31'-4"	31'-9"	1372
1554	31'-6"	31'-11"	1379
1555	30'-10"	31'-3"	1351
1556	30'-2"	30'-7"	1323
1557	29'-6"	29'-11"	1295
1558	28'-2"	28'-7"	1239
1559	28'-10"	29'-3"	1267
1560	27'-10"	28'-3"	1225
1561	27'-6"	27'-11"	1211
1562	26'-10"	27'-3"	1183
1563	26'-6"	26'-11"	1169

TABLE A

MARK	C/C PIN HOLES	LENGTH	WEIGHT
1564	26'-2"	26'-7"	1155
1565	25'-10"	26'-3"	1141
1566	25'-6"	25'-11"	1127
1567	25'-2"	25'-7"	1113
1568	24'-10"	25'-3"	1099
1569	24'-2"	24'-7"	1071
1570	23'-6"	23'-11"	1043
1571	22'-10"	23'-3"	1015
1572	22'-2"	22'-7"	987
1573	21'-6"	21'-11"	959
1574	21'-10"	22'-3"	973
1575	21'-4"	21'-9"	952
1576	21'-2"	21'-7"	945
1577	20'-0"	20'-5"	896
1578	20'-10"	21'-3"	931
1579	20'-8"	21'-1"	924
1580	20'-6"	20'-11"	917
1581	20'-4"	20'-9"	910
1582	20'-2"	20'-7"	903
1583	19'-10"	20'-3"	889
1584	19'-6"	19'-11"	975
1585	18'-10"	19'-3"	847
1586	18'-2"	18'-7"	819

TABLE B

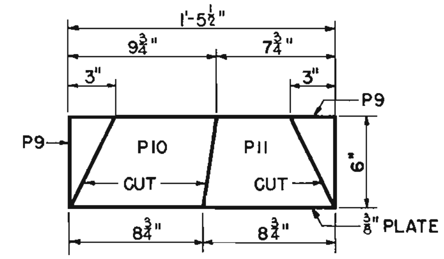
MARK	A	LENGTH	WEIGHT
1531	26'-$4\frac{1}{4}$"	31'-5"	1935
1532	24'-4"	29'-$4\frac{3}{4}$"	1830
1533	22'-$3\frac{5}{8}$"	27'-$4\frac{3}{8}$"	1715
1534	20'-$3\frac{1}{4}$"	25'-4"	1610
1535	18'-3"	23'-$3\frac{3}{4}$"	1500
1536	16'-$2\frac{5}{8}$"	21'-$3\frac{3}{8}$"	1395
1537	14'-$2\frac{3}{8}$"	19'-$3\frac{1}{8}$"	1290
1538	12'-2"	17'-$2\frac{3}{4}$"	1185
1539	10'-$1\frac{5}{8}$"	15'-$2\frac{3}{8}$"	1075



COLUMN MK 1500R TO 1510R (SEE TABLE A)
COLUMN MK 1500L TO 1510L (SEE TABLE A)

TABLE A

MARK	X	LENGTH	WEIGHT
1500	22'-3 5/8"	29'-1 5/8"	2035
1501	21'-3 1/2"	28'-1 1/2"	1980
1502	20'-3 1/4"	27'-1 1/4"	1925
1503	19'-3 1/8"	26'-1 1/8"	1875
1504	18'-3"	25'-1"	1820
1505	17'-8 7/8"	24'-6 7/8"	1795
1506	17'-2 3/4"	24'-0 3/4"	1765
1507	16'-8 3/4"	23'-6 3/4"	1740
1508	16'-2 5/8"	23'-0 5/8"	1715
1509	15'-2 1/2"	22'-0 1/2"	1660
1510	14'-2 3/8"	21'-0 3/8"	1605

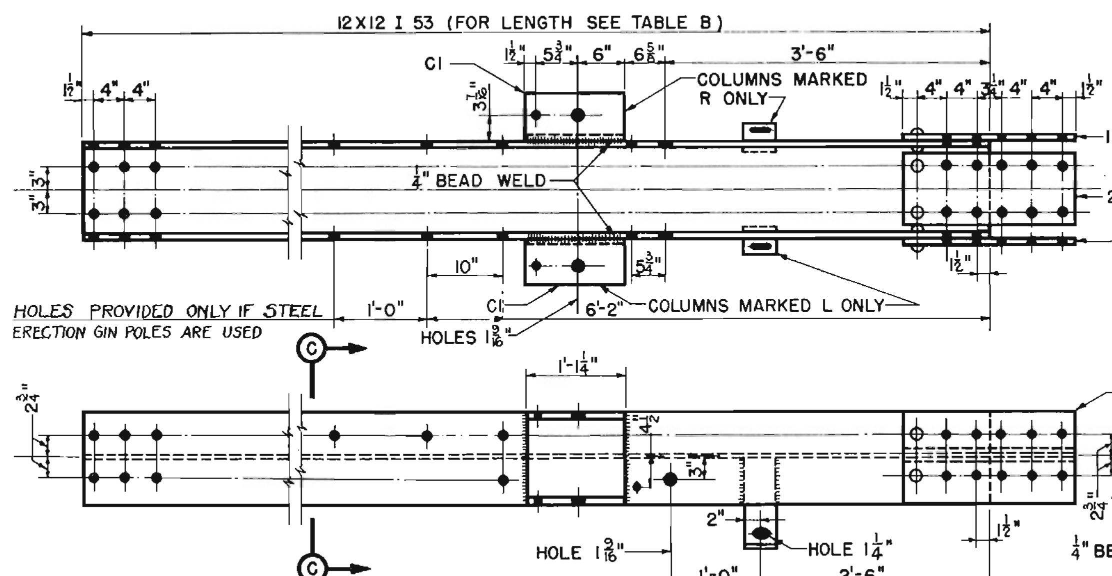


STIFFENER PLATES
COLUMN BASE

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
FRAMED STEEL TOWERS	12, 13
BILL OF MATERIALS	14
BILL OF MATERIALS	15
SYMBOLS	155

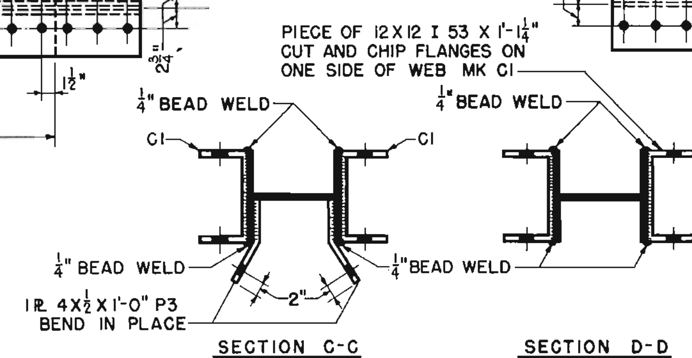
ALL WELDS 1/4" FILLET WELDS UNLESS OTHERWISE NOTED

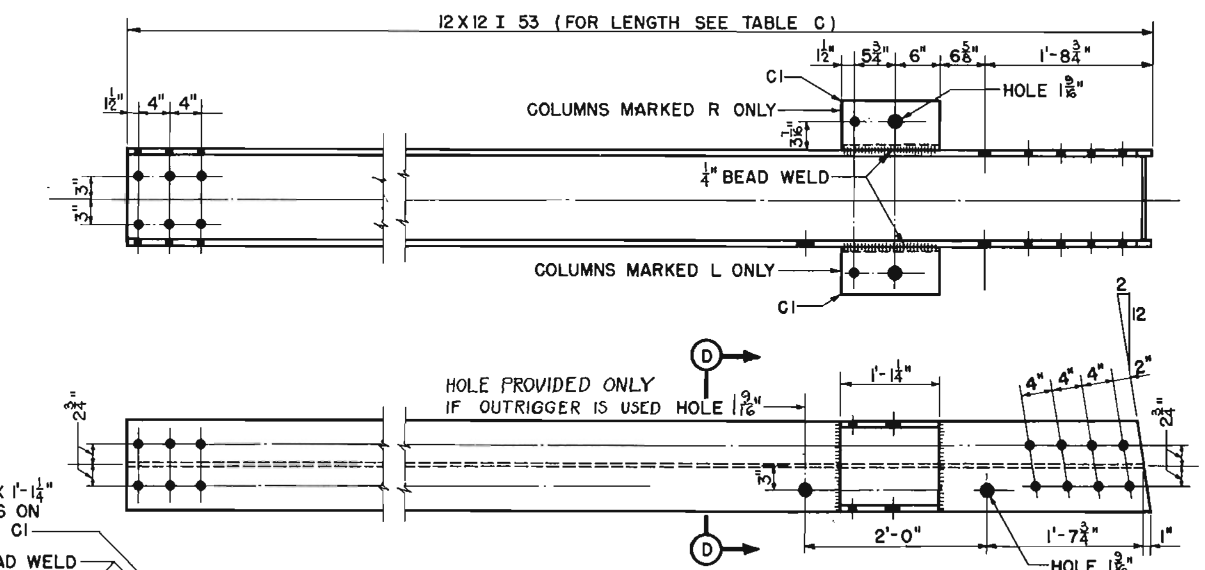


COLUMN MK 1511R TO 1519R (SEE TABLE B)
COLUMN MK 1511L TO 1519L (SEE TABLE B)

TABLE B

MARK	LENGTH	WEIGHT	MARK	LENGTH	WEIGHT	MARK	LENGTH	WEIGHT
1511	20'-3"	1329	1514	18'-2 3/4"	1221	1517	16'-8 1/2"	1141
1512	19'-9"	1302	1515	17'-8 5/8"	1194	1518	16'-2 3/8"	1114
1513	19'-2 7/8"	1276	1516	17'-2 5/8"	1167	1519	15'-8 3/8"	1087





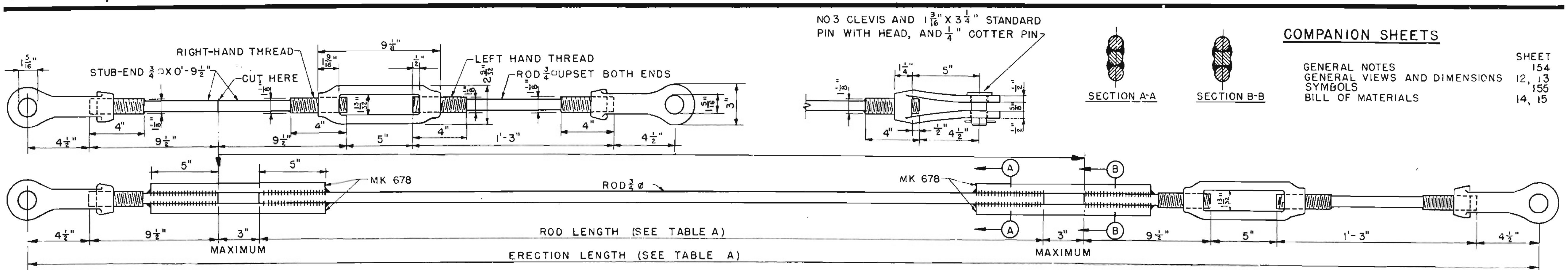
COLUMN MK 1520R TO 1530R (SEE TABLE C)
COLUMN MK 1520L TO 1530L (SEE TABLE C)

TABLE C

MARK	LENGTH	WEIGHT	MARK	LENGTH	WEIGHT	MARK	LENGTH	WEIGHT
1520	20'-6 1/8"	1125	1524	16'-5 1/2"	915	1528	13'-11 1/8"	775
1773	19'-6"	1075	1525	15'-11 3/8"	890	1529	13'-5"	750
1521	18'-5 3/4"	1020	1526	15'-5 1/4"	860	1530	12'-4 7/8"	695
1522	17'-11 3/4"	995	1527	14'-11 1/4"	830			
1523	17'-5 5/8"	970	1774	14'-5 1/8"	805			

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	12, 13
SYMBOLS	155
BILL OF MATERIALS	14, 15



CLEVIS, TURNBUCKLE, AND STUB-END ROD MK 680

TABLE A

ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
920	42'-6"	995	38'-6"	937	39'- 2 1/8"	1001	35'-0"	946	37'-10"	1003	34'-0'	952	35'-1 5/8"	1007	31'-0"	957	34'-5 1/2"	1008	30'-6"	962	34'-0"	1009	30'-0"
923	42'-1 5/8"	996	38'-0"	941	38'-11 3/8"	1001	35'-0"	947	37'- 7 3/8"	1004	33'-6"	953	34'-11 1/4"	1007	31'-0"	958	34'-4 3/8"	1009	30'-0"	963	33'-9 7/8"	1010	29'-6
926	41'-9 1/4"	997	37'-6"	943	38'- 8 5/8"	1002	34'-6"	948	37'- 4 3/4"	1004	33'-6"	954	34'-10 1/8"	1008	30'-6"	959	34'-3 1/4"	1009	30'-0"				
927	41'-4 7/8"	997	37'-6"	944	38'- 3 1/4"	1003	34'-0"	949	37'- 2 1/8"	1005	33'-0"	955	34'- 9"	1008	30'-6"	960	34'-2 1/4"	1009	30'-0"				
928	41'-0 3/8"	998	37'-0"	945	38'- 0 5/8"	1003	34'-0"	951	35'- 4"	1007	31'-0"	956	34'- 6 5/8"	1008	30'-6"	961	34'- 1 1/8"	1009	30'-0"				

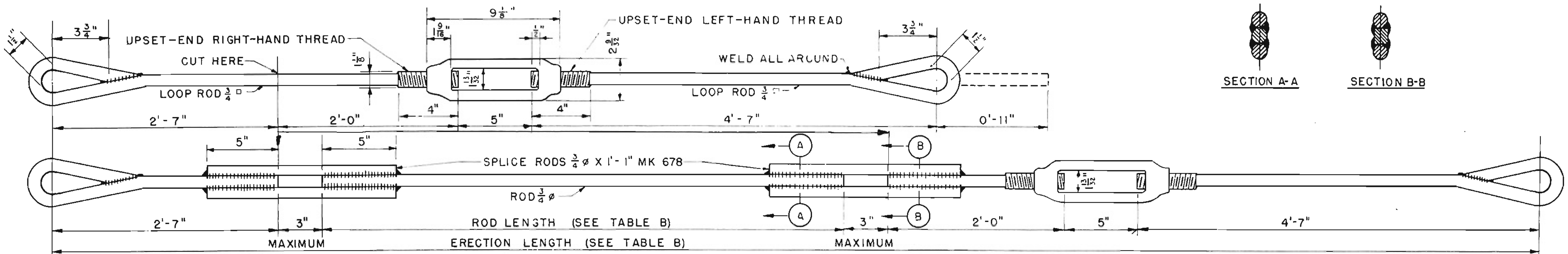
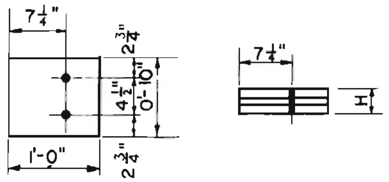


TABLE B

LOOP ROD WITH TURNBUCKLE MK 677

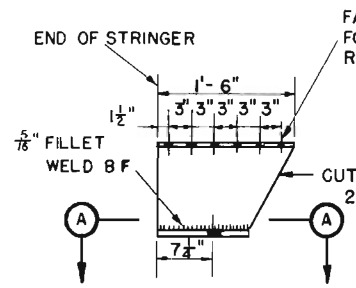
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
709	40'-1 1/4"	870	30'-6"	738	35'- 5 5/8"	879	25'-6"	761	33'- 5 1/2"	883	23'-6"	780	32'- 2 1/4"	885	22'-6"	809	28'-10 3/8"	892	19'-0"	834	24'-6 1/4"	901	14'-6"
711	39'-4 1/4"	871	29'-6"	740	35'- 5"	879	25'-6"	763	33'- 4"	883	23'-6"	784	31'-10 5/8"	886	22'-0"	811	28'- 8 7/8"	892	19'-0"	837	24'-1 3/8"	901	14'-6"
715	38'-8 5/8"	872	29'-0"	742	34'-10 3/8"	880	25'-0"	765	33'- 2 1/4"	883	23'-6"	785	31'- 8 5/8"	886	22'-0"	814	28'- 4 1/2"	893	18'-6"	838	23'-8 1/2"	902	14'-0"
716	38'-8 3/8"	872	29'-0"	743	34'-10 1/8"	880	25'-0"	767	33'- 0"	884	23'-0"	787	31'- 4 1/2"	887	21'-6"	816	27'-10 5/8"	894	18'-0"	841	23'- 3 3/4"	903	13'-6"
718	38'-7 1/8"	872	29'-0"	745	34'- 7 3/4"	880	25'-0"	768	32'-11 1/8"	884	23'-0"	788	31'- 5 5/8"	887	21'-6"	819	27'- 4 3/4"	895	17'-6"	843	22'-11 1/8"	904	13'-0"
723	37'-10 3/8"	874	28'-0"	749	34'- 3 1/8"	881	24'-6"	770	32'-10 7/8"	884	23'-0"	792	30'-10 3/8"	888	21'-0"	823	27'- 0 1/4"	896	17'-0"	847	22'- 1 7/8"	905	12'-6"
726	37'- 4 1/2"	875	27'-6"	750	34'- 2 3/4"	881	24'-6"	772	32'- 8 1/8"	885	22'-6"	793	30'-10 1/2"	888	21'-0"	825	26'- 7 1/8"	897	16'-6"	851	20'- 8 1/8"	907	11'-0"
728	37'- 3 3/4"	875	27'-6"	754	33'-11 1/8"	882	24'-0"	771	32'- 6 1/4"	885	22'-6"	795	30'- 6 1/8"	889	20'-6"	828	26'- 2 1/8"	897	16'-6"	857	19'-4 3/8"	910	9'-6"
729	37'- 1 1/2"	875	27'-6"	755	33'-10 7/8"	882	24'-0"	774	32'- 5 1/8"	885	22'-6"	799	30'- 1 1/2"	889	20'-6"	829	25'-11 1/4"	898	16'-0"				
733	36'- 4 1/4"	877	26'-6"	757	33'- 8 3/4"	882	24'-0"	777	32'- 4 3/4"	885	22'-6"	800	29'-10 3/8"	890	20'-0"	830	25'- 4"	899	15'-6"				
735	36'- 1"	877	26'-6"	760	33'- 7 3/8"	882	24'-0"	779	32'- 3 5/8"	885	22'-6"	803	29'- 4 3/8"	891	19'-6"	832	24'-11 1/8"	900	15'-0"				



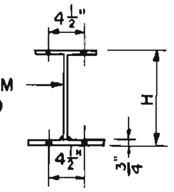
DETAIL OF PLATE SHIM

BILL OF MATERIALS FOR ONE PLATE SHIM MARK 7519 TO 7524

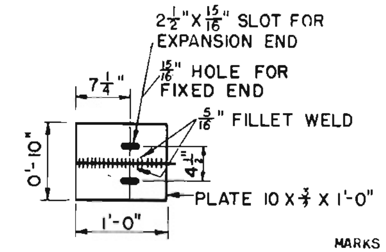
DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)	7519 H = 1/4" QUANTITY	7520 H = 1/2" QUANTITY	7521 H = 2" QUANTITY	7522 H = 2 3/4" QUANTITY	7523 H = 3" QUANTITY	7524 H = 3'4" QUANTITY
PLATE	47-7844.03	10X1/4	1'-0"	8	1					
PLATE	47-7844.05	10X1/2	1'-0"	17		1				
PLATE	47-7844.07	10X3/4	1'-0"	26				1		
PLATE	47-7844.1	10X1	1'-0"	34			2	2	3	1
ANCHOR BOLT	43-2219.08-04	7/8	4"	1.2	2	2				
ANCHOR BOLT	43-2219.08-05	7/8	5"	1.4			2			
ANCHOR BOLT	43-2219.08-07	7/8	7"	1.7						



ELEVATION



END VIEW



SECTION A-A

COMPANION SHEETS

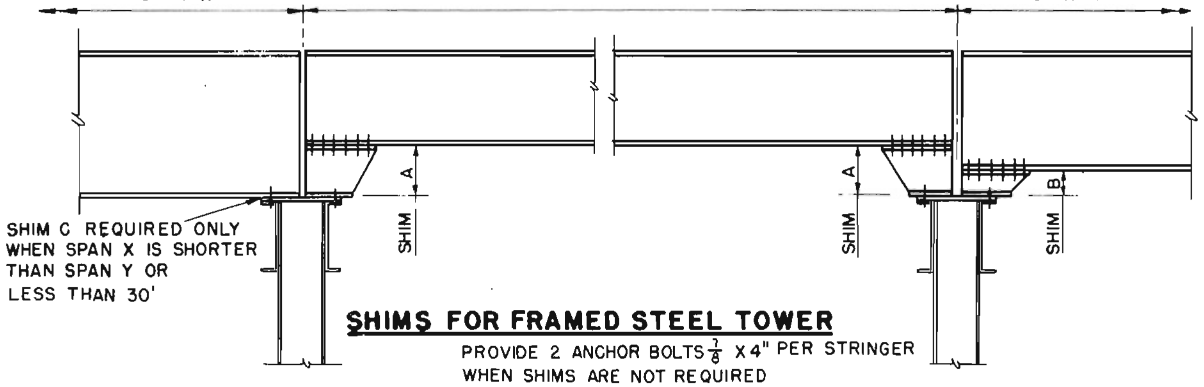
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	12,13
STEEL PILE BENTS AND PIERS, RIVETED	32
STEEL PILE BENTS AND PIERS, WELDED	34

MARKS AND DIMENSIONS FOR BUILT-UP SHIMS

MARK	H	TOTAL WEIGHT (POUNDS)
7525	5 3/4"	57
7526	6'-6"	57
7527	6'-6½"	58
7528	8"	60
7529	8'-8 ¼"	61
7530	8 7/8"	62
7531	9 1/8"	62
7533	11 3/4"	66
7534	12"	66
7536	12 1/2"	67
7537	14"	69
7538	15 1/8"	71
7540	17 1/8"	75
7541	18"	76
7542	18 1/2"	77
7535	12'-4"	67
7543	20"	79
7544	20 1/2"	80

BILL OF MATERIALS FOR ONE BUILT-UP SHIM MARK 7525 TO 7544

DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	QUANTITY
BEAM	48-2900.21-059	21 I 59	1'-6"	1
PLATE	47-7844.07	10 X 3/4	1'-0"	1
RIVET	43-6353.08	7/8	2 3/4"	12
ANCHOR BOLT	43-2219.08-04	7/8	4"	2
ELECTRODE	46-3772.2-7	3/16		



SHIMS FOR FRAMED STEEL TOWER

PROVIDE 2 ANCHOR BOLTS 7/8 X 4" PER STRINGER WHEN SHIMS ARE NOT REQUIRED

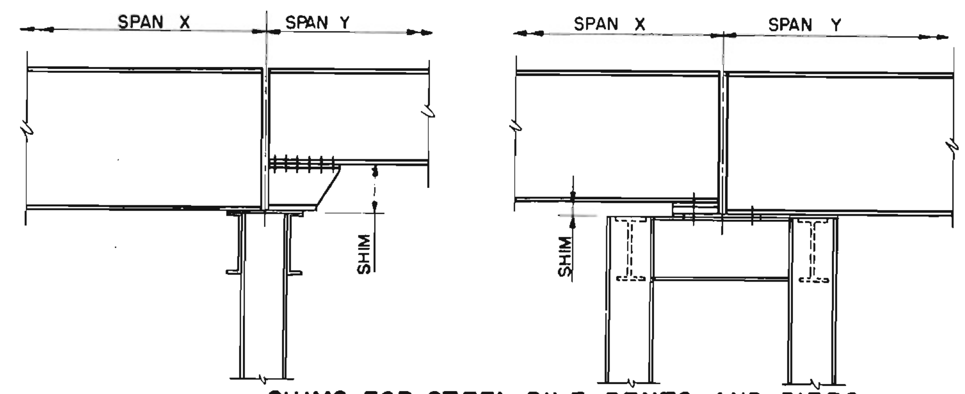
SHIMS FOR FRAMED STEEL TOWERS

SPAN Y	SHIM	SPAN X 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	A	7536	7534	7531	7531	7526	7519			
15'	B	7544	7543	7540	7540	7537	7529	7528	7528	7528
15'	C								7526	7528
20'	A	7536	7534	7531	7531	7526	7519			
20'	B	7542	7541	7538	7538	7534	7526	7526	7526	7526
20'	C								7526	7528
30'	A	7536	7534	7531	7531	7526	7519			
30'	B	7536	7534	7531	7531	7526	7519			
30'	C								7526	7528
40'	A	7536	7534	7531	7531	7526	7519	7519	7519	7519
40'	B	7535	7533	7530	7530	7525				
40'	C							7519	7526	7529
50'	A	7536	7534	7531	7531	7526	7526	7526	7526	7526
50'	B	7527	7526	7524	7523					
50'	C						7525	7526	7534	7537
60'	A	7536	7534	7531	7531	7531	7531	7531	7531	7531
60'	B	7524	7522							
60'	C					7523	7530	7531	7538	7540
70'	A	7536	7534	7531	7531	7531	7531	7531	7531	7531
70'	B	7524	7522							
70'	C					7524	7530	7531	7538	7540
80'	A	7536	7534	7534	7534	7534	7534	7534	7534	7534
80'	B	7520								
80'	C			7522	7522	7526	7533	7524	7541	7543
90'	A	7536	7536	7536	7536	7536	7536	7536	7536	7536
90'	B									
90'	C		7520	7524	7524	7527	7535	7536	7542	7544

BILL OF MATERIALS FOR ANCHOR BOLTS ONLY WITHOUT SHIMS

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)
ANCHOR BOLT	43-2219.08-04	7/8	0'-4"	1.2

TWO BOLTS REQUIRED FOR EACH STRINGER SUPPORT CONSTRUCTION INDICATED BY BLANK SPACES IN TABLES FOR SHIMS



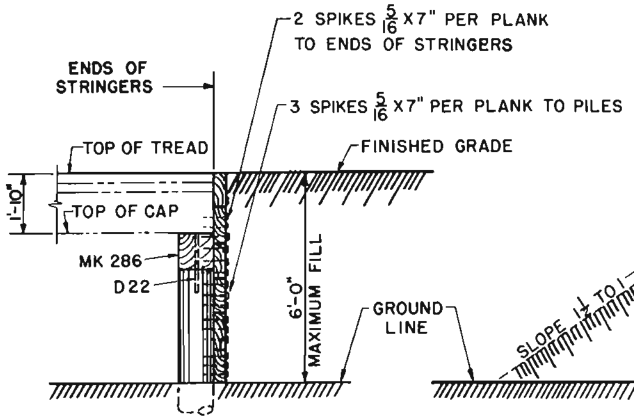
SHIMS FOR STEEL PILE BENTS AND PIERS

SHIMS FOR STEEL PILE BENTS AND PIERS

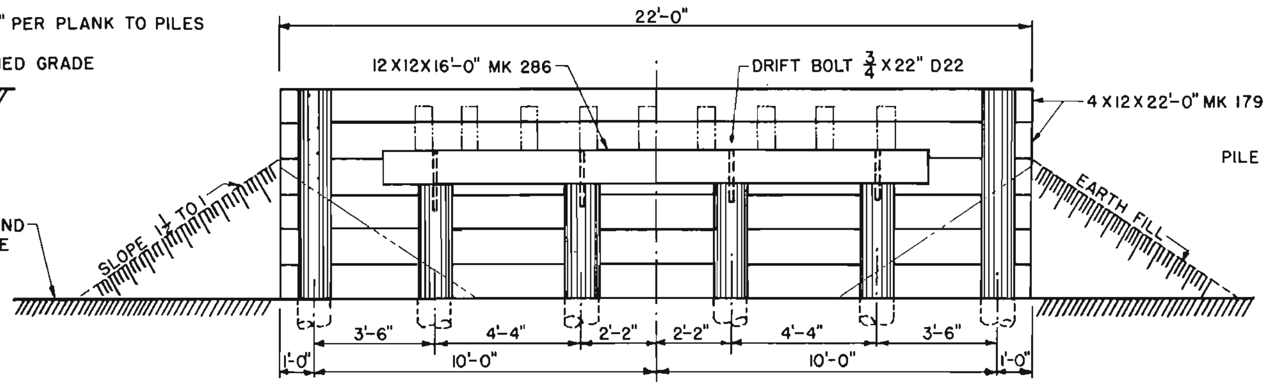
SPAN Y	SPAN X 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	7544	7543	7540	7540	7537	7529	7528	7521	
20'	7542	7541	7538	7538	7534	7526	7526		7521
30'	7536	7534	7531	7531	7526	7519		7526	7528
40'	7535	7533	7530	7530	7525		7519	7526	7529
50'	7527	7526	7524	7523		7525	7526	7534	7537
60'	7524	7522			7523	7530	7531	7538	7540
70'	7524	7522			7524	7530	7531	7538	7540
80'	7520		7522	7522	7526	7533	7534	7541	7543
90'		7520	7524	7524	7527	7535	7536	7542	7544

COMPANION SHEETS

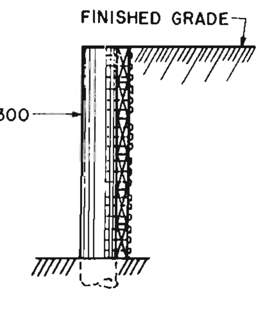
	SHEET
TIMBER ABUTMENTS FOR TIMBER SPANS	22
GENERAL NOTES	154
SYMBOLS	155



SECTION AT CENTERLINE



ELEVATION



END VIEW

TIMBER PILE ABUTMENT SUPPORTING SINGLE-LANE CLASS 50 TIMBER-STRINGER SPANS

MAXIMUM LOAD PER PILE = 8 TONS

MAXIMUM PILE LOADS		
SPAN	TONS PER PILE	
	STRINGERS	
	TIMBER	STEEL
11'	8	
13'	8	
15'	8	8

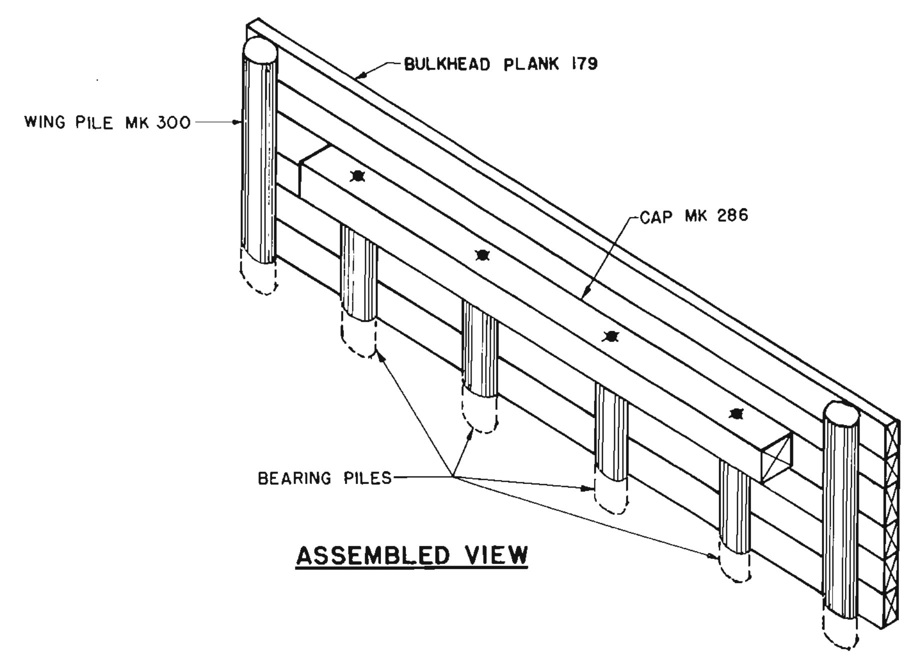
BILL OF MATERIALS FOR ONE ABUTMENT

LINE	TYPE OF ABUTMENT						TIMBER PILE ABUTMENT		TIMBER GRILLAGE ABUTMENT				LINE
	FILL HEIGHT						6' MAXIMUM		6' MAXIMUM		3' MAXIMUM		
	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	
1	1 BULKHEAD PLANK	39-3340.12-22	179	4 X 12	22'-0"	330	6	528	6	528	3	264	1
2	PILE (WING)		300		15'-0"		2						2
3	2 PILE (BEARING)				2		4						3
4	3 POST (WING)	39-3360.08	320	6 X 8	3'-2"	47					2	25	4
5	3 DO	39-3360.08	405	6 X 8	8'-6"	128			2	68			5
6	3 POST (BEARING)	39-6620.1	261	10 X 10	6'-0"	188			4	200			6
7	CAP	39-6620.1-16	266	10 X 10	16'-0"	500			1	133	1	133	7
8	DO	39-6630.12-16	286	12 X 12	16'-0"	720	1	192					8
9	SILL TIMBER	39-3360.08	192	6 X 8	8'-0"	120			3	96	3	96	9
10	DO	39-3360.08-12	194	6 X 8	12'-0"	180			3	144	3	144	10
11	BEARING BLOCK	39-6620.1	400	10 X 10	2'-0"	163			6	17	6	17	11
12	DEADMAN	39-6620.1-22	269	10 X 10	22'-0"	687			1	183			12
13	ANCHOR BLOCK	39-3360.08	407	6 X 8	0'-10"	13			6	20	4	14	13
	STEEL HARDWARE, BLACK												
14	WIRE ROPE	22-4567.4-05		1/2	20'-0"	13			6				14
15	WIRE-ROPE CLIPS	42-3544.5-05		1/2		0.7			24				15
16	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-2	B20	3/4	20	3.1					4		16
17	DRIFT BOLT WITH SQUARE HEAD AND ONE WASHER	43-1636.07-22	D22	3/4	22	3.0	4		4		4		17
18	WIRE SPIKES	42-8488.035-07		5/16	7"	.15	108		120		72		18
19	DO	42-8488.04-1		3/8	10"	.33			72		44		19

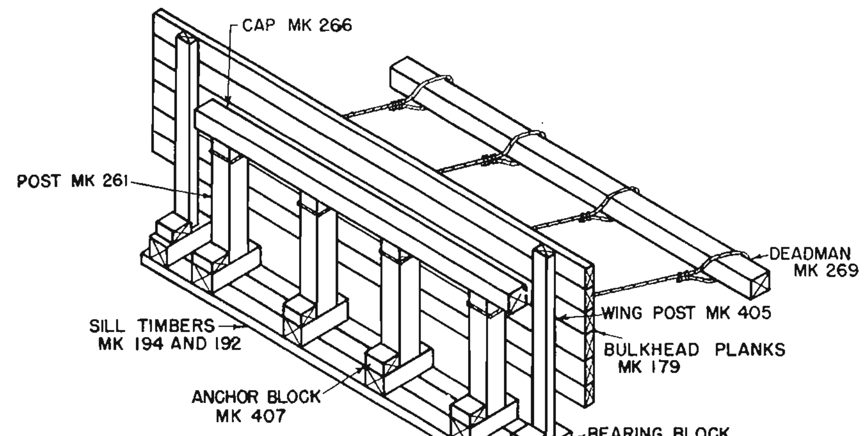
1 NUMBER OF BULKHEAD PLANKS BILLED IS FOR MAXIMUM FILL. USE FEWER PLANKS FOR SHALLOWER FILLS

2 BEARING PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS

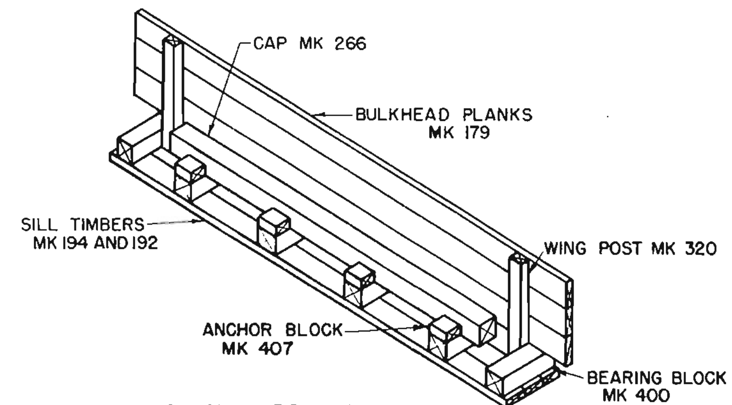
3 CUT TO FIT FOR FILLS UNDER 6'-0"



ASSEMBLED VIEW



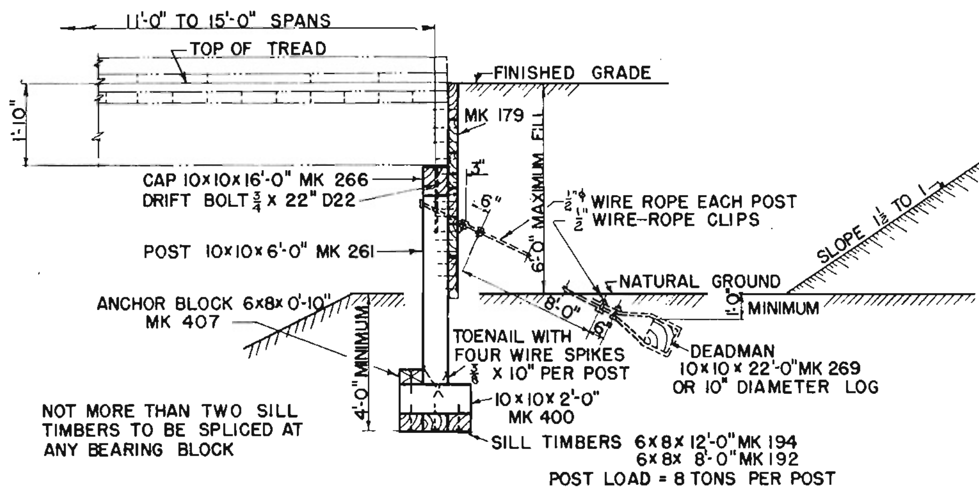
ASSEMBLED VIEW
FOR 6' MAXIMUM FILL



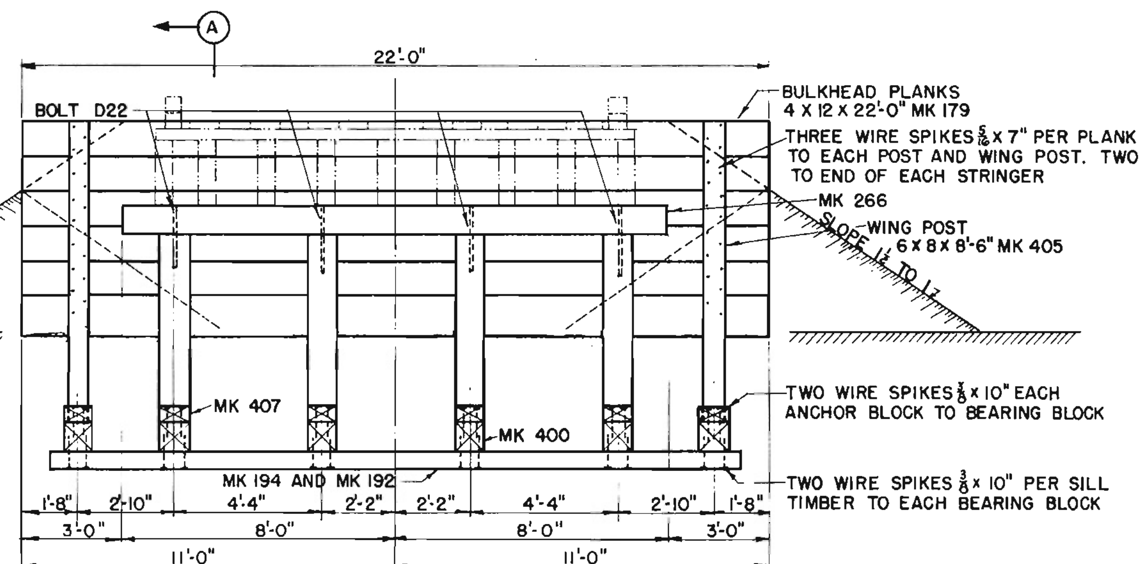
ASSEMBLED VIEW
FOR 3' MAXIMUM FILL

COMPANION SHEETS

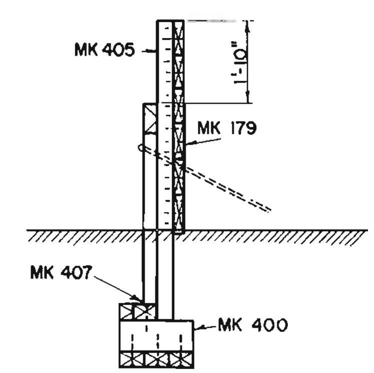
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	21



SECTION A-A

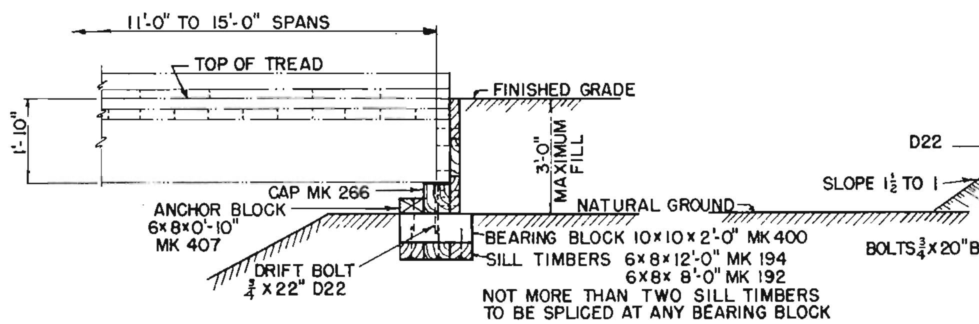


ELEVATION

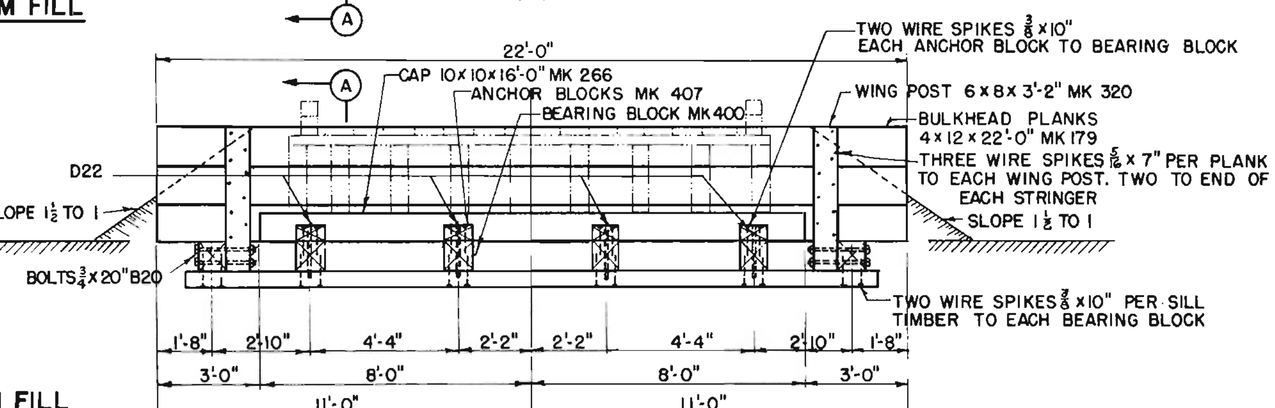


END VIEW

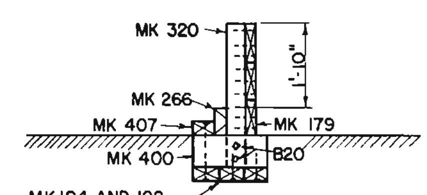
DETAILS FOR 6' MAXIMUM FILL



SECTION A-A



ELEVATION



END VIEW

DETAILS FOR 3' MAXIMUM FILL

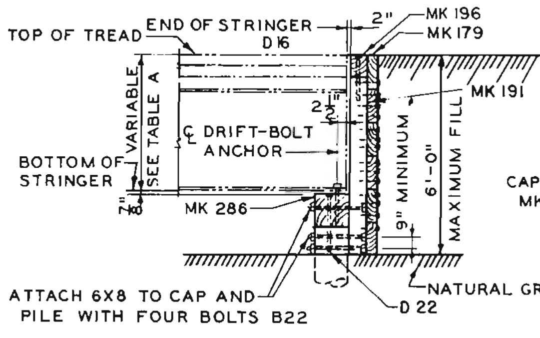
TIMBER-GRILLAGE ABUTMENTS SUPPORTING 11' TO 15' TIMBER-STRINGER SPAN

COMPANION SHEETS

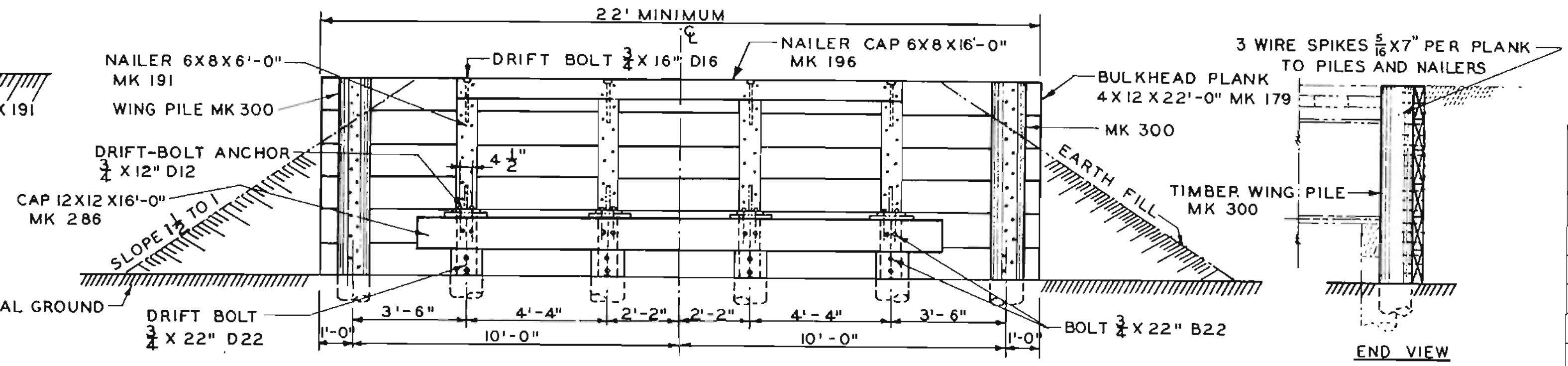
	SHEET
TIMBER ABUTMENTS FOR STEEL SPAN	24
GENERAL NOTES	154
SYMBOLS	155

BILL OF MATERIALS, BEARING PLATES FOR ONE TIMBER ABUTMENT

SPAN	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY
15' TO 90'	47-7844.08	P3500	12X7/8	1'-3"	45	4



SECTION AT CENTER LINE



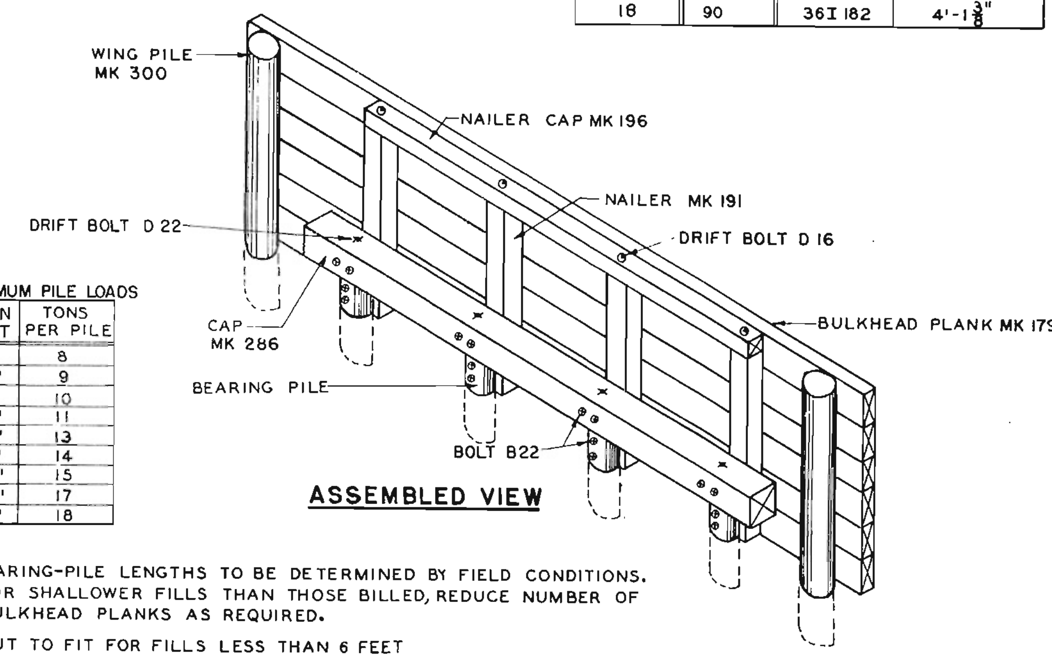
TIMBER PILE ABUTMENT FOR 15' TO 90' SPANS

TABLE A

PILE LOAD TONS	SPAN LENGTH FEET	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
8	15	16 I 36	2'-4 7/8"
9	20	18 I 47	2'-6 7/8"
10	30	24 I 74	3'-0 7/8"
11	40	24 I 87	3'-1 1/8"
13	50	30 I 108	3'-6 7/8"
14	60	33 I 125	3'-10"
15	70	33 I 132	3'-10 1/8"
17	80	36 I 150	4'-0 7/8"
18	90	36 I 182	4'-1 3/8"

MAXIMUM PILE LOADS

SPAN FEET	TONS PER PILE
15'	8
20'	9
30'	10
40'	11
50'	13
60'	14
70'	15
80'	17
90'	18



ASSEMBLED VIEW

BILL OF MATERIALS FOR ONE ABUTMENT

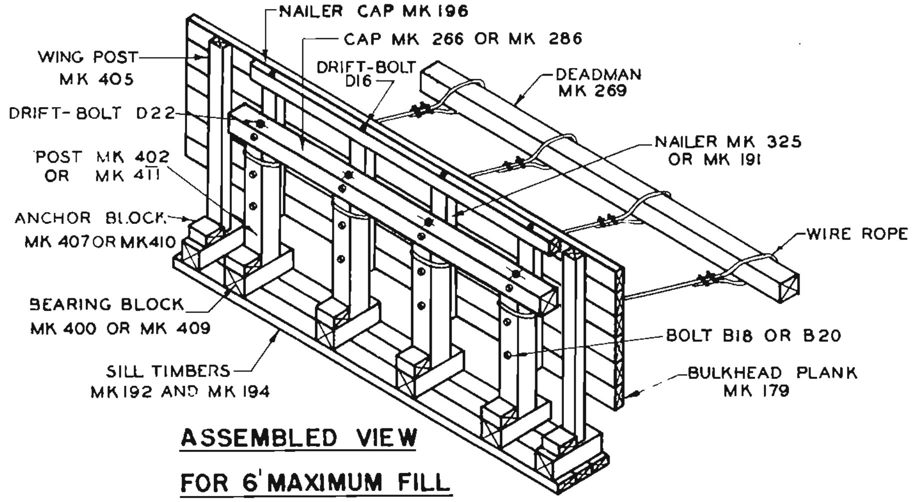
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	PILE ABUTMENT 90' MAXIMUM SPAN 6' MAXIMUM FILL QUANTITY	FBM	GRILLAGE ABUTMENT 15' TO 40' SPAN 6' MAXIMUM FILL QUANTITY	FBM	15' TO 40' SPAN 3' MAXIMUM FILL QUANTITY	FBM	50' TO 90' SPAN 6' MAXIMUM FILL QUANTITY	FBM	50' TO 90' SPAN 3' MAXIMUM FILL QUANTITY	FBM
1	1/BULKHEAD PLANK	39-3340.12-22	179	4X12	22'-0"	330	6	528	6	528	3	264	6	528	4	352
2	CAP	39-6620.1-16	266	10X10	16'-0"	500			1	133	1	133				
3	DO	39-6630.12-16	286	12X12	16'-0"	720	1	192					1	192	1	192
4	2/POST	39-6620.1	402	10X10	5'-4 1/2"	167			4	178						
5	2/ DO	39-6630.12	411	12X12	3'-10 1/4"	173							4	185		
6	2/WING POST	39-3360.08	405	6X8	8'-0"	128			2	68			2	68		
7	DO	39-3360.08	325	6X8	4'-9"	71					2	38				
8	DO	39-3360.08	191	6X8	6'-0"	90									2	46
9	1/PILE, BEARING						4									
10	WING PILE		300		15'-0"		2									
11	NAILER	39-3360.08	325	6X8	4'-9"	71			4	76						
12	DO	39-3360.08	191	6X8	6'-0"	90	4	96					4	96		
13	DO	39-3360.08	321	6X8	4'-2"	63					4	67				
14	DO	39-3360.08	404	6X8	5'-6"	83									4	88
15	NAILER CAP	39-3360.08-16	196	6X8	16'-0"	240	1	64	1	64	1	64	1	64	1	64
16	SILL	39-3360.08	192	6X8	8'-0"	120			3	96	3	96	5	160	5	160
17	DO	39-3360.08-12	194	6X8	12'-0"	180			3	144	3	144	5	240	5	240
18	BEARING BLOCK	39-6620.1	400	10X10	2'-0"	63			6	100	6	100				
19	DO	39-6630.12	409	12X12	3'-6"	158							6	252	6	252
20	ANCHOR BLOCK	39-3360.08	407	6X8	0'-10"	13			6	20	4	14				
21	DO	39-3360.08	410	6X8	1'-0"	15							6	24	4	16
22	DEADMAN	39-6620.1-22	269	10X10	22'-0"	687			1	183			1	183		
23	WIRE ROPE	22-4321.4-05		1/2	20'-0"	13			6				6			
24	WIRE-ROPE CLIP	42-3544.5-05		1/2		0.72			24				24			
25	BOLT WITH NUT AND WASHER	43-2325.07-183	B18	3/4	18"	2.7			12		4					
26	DO	43-2325.07-2	B20	3/4	20"	3.0					12		12		4	
27	DO	43-2325.07-223	B22	3/4	22"	3.0	16								12	
28	DRIFT-BOLT ANCHOR	43-1636.07-12	D12	3/4	12"	12	8		8		8		8		8	
29	DRIFT BOLT	43-1636.07-16	D16	3/4	16"	8	4		4		4		4		4	
30	DO	43-1636.07-22	D22	3/4	22"	13	4		4		4		4		4	
31	SPIKE STANDARD WIRE	42-8488.04-1		3/8	10"	0.33			72		44		96		68	
32	DO	42-8488.035-07		5/16	7"	0.143	108		108		54		108		72	

1/ BEARING-PILE LENGTHS TO BE DETERMINED BY FIELD CONDITIONS. FOR SHALLOWER FILLS THAN THOSE BILLED, REDUCE NUMBER OF BULKHEAD PLANKS AS REQUIRED.

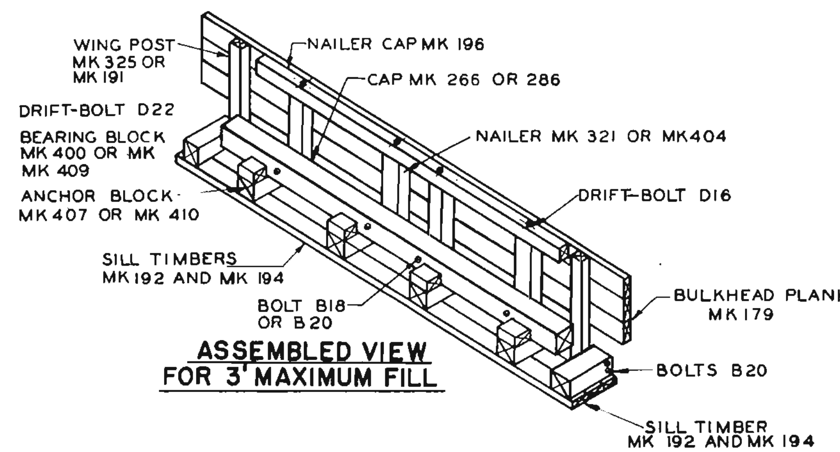
2/ CUT TO FIT FOR FILLS LESS THAN 6 FEET

TABLE A

SPAN (FEET)	DIMENSION X
15'	2'- 4 7/8"
20'	2'- 6 7/8"
30'	3' 6 7/8"
40'	3'-1 1/8"
50'	3' 6 7/8"
60'	3'- 10"
70'	3'-10 1/8"
80'	4'-0 7/8
90'	4'-1 3/8



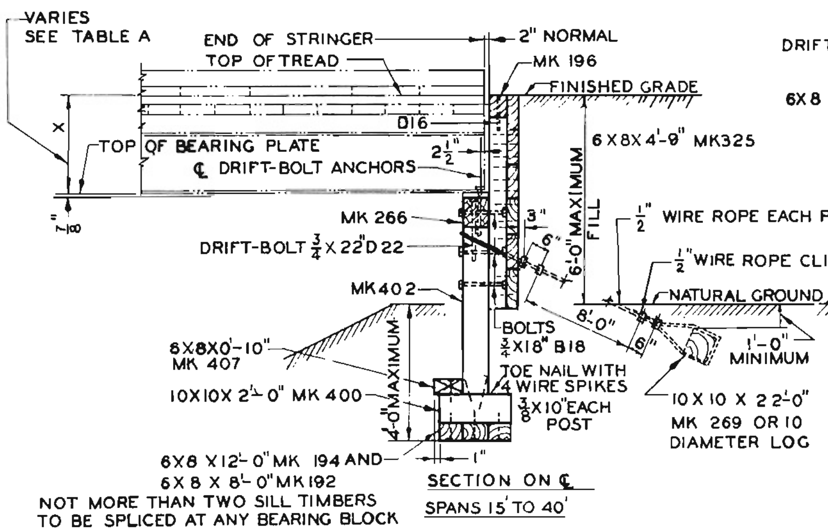
ASSEMBLED VIEW
FOR 6' MAXIMUM FILL

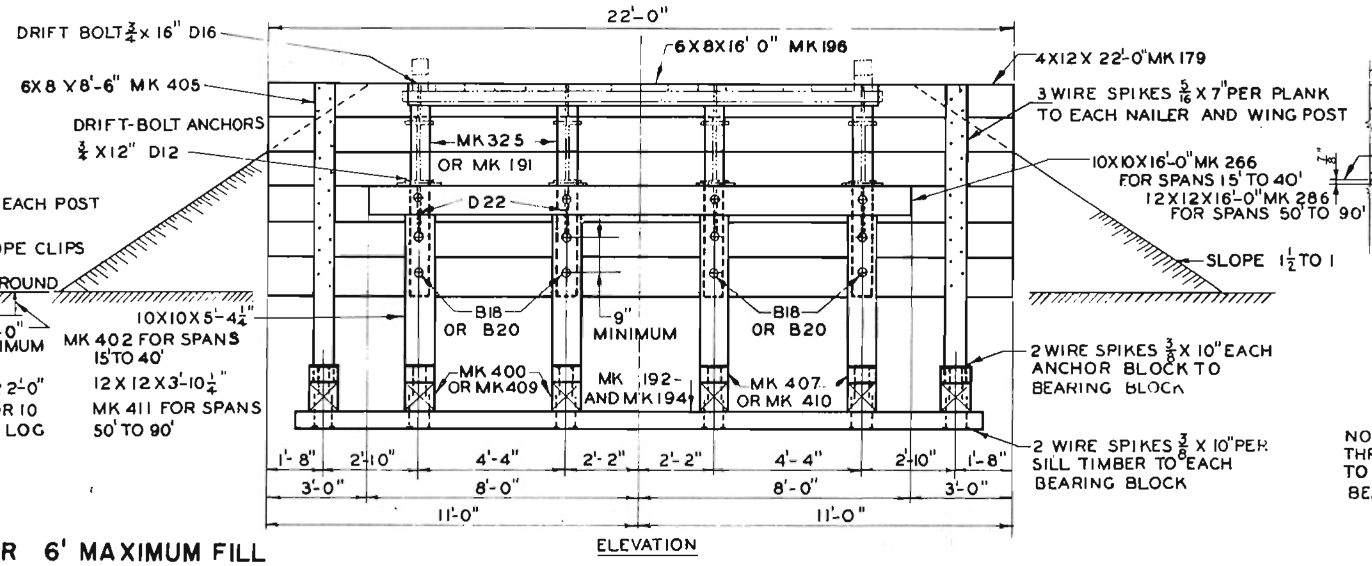


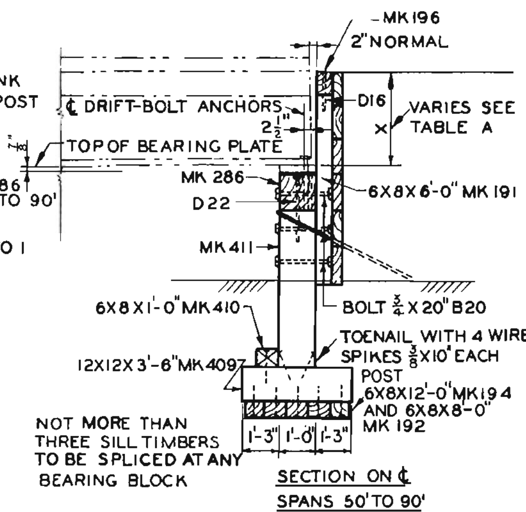
ASSEMBLED VIEW
FOR 3' MAXIMUM FILL

COMPANION SHEETS

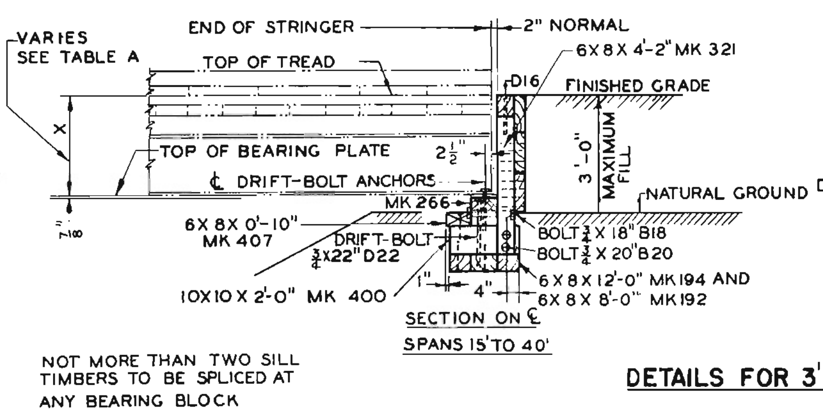
	SHEETS
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENT	23



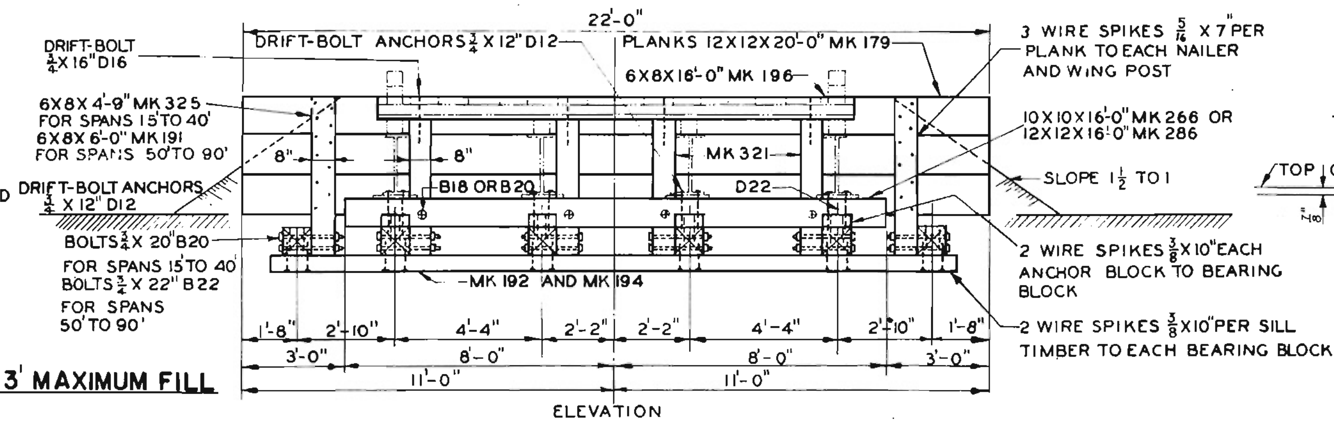


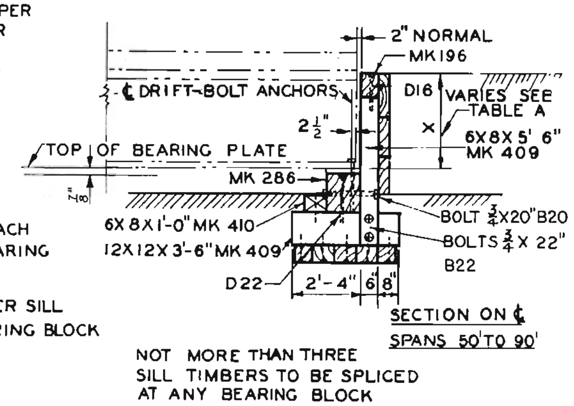


DETAIL FOR 6' MAXIMUM FILL



DETAILS FOR 3' MAXIMUM FILL

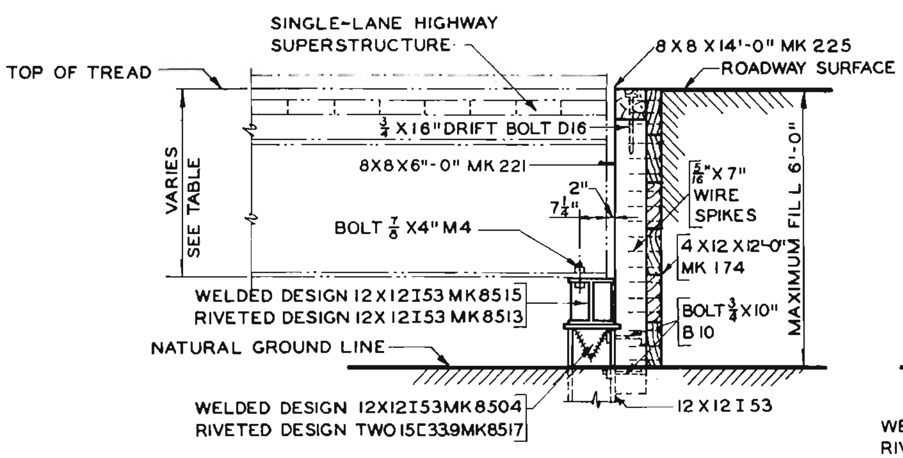




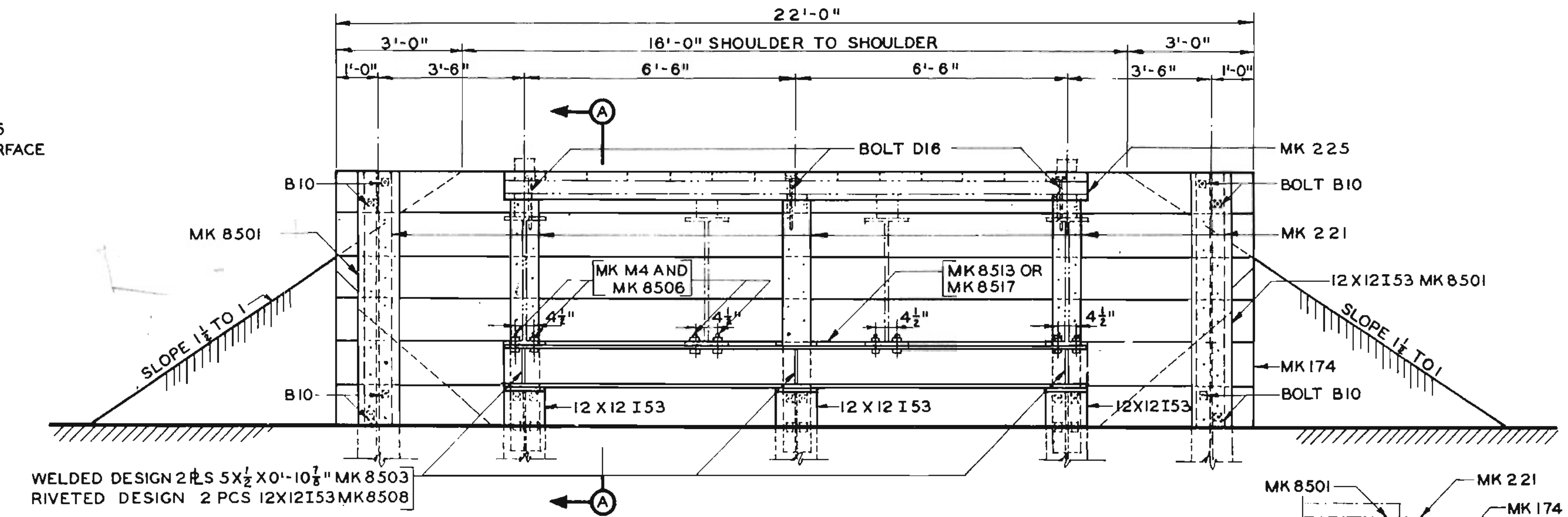
TIMBER GRILLAGE ABUTMENTS SUPPORTING 15' TO 90' STEEL STRINGER SPANS

COMPANION SHEETS

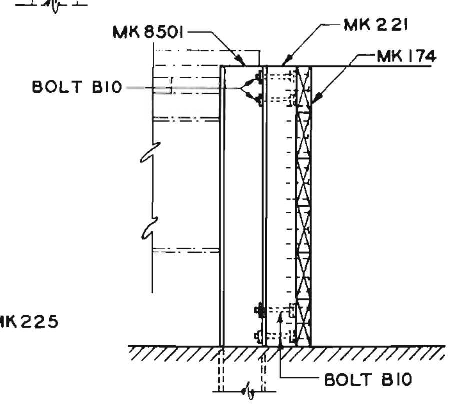
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	26



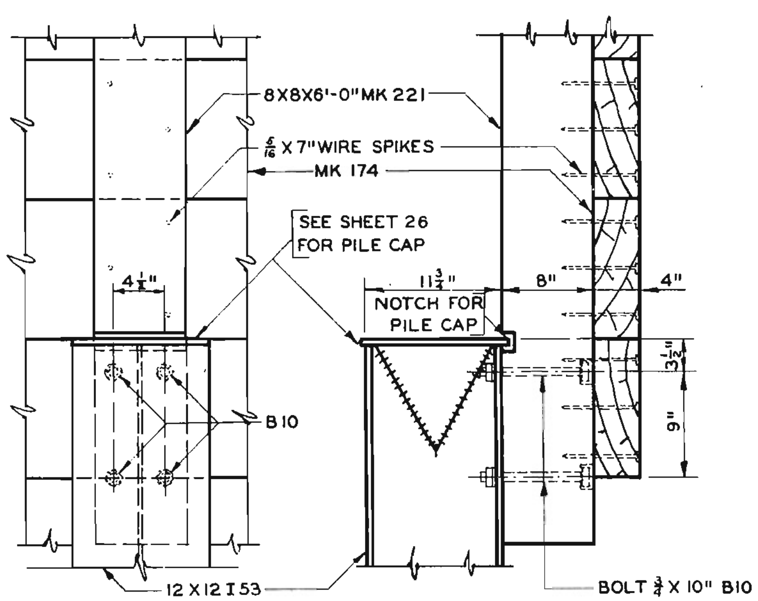
SECTION A-A



TRANSVERSE ELEVATION



END VIEW



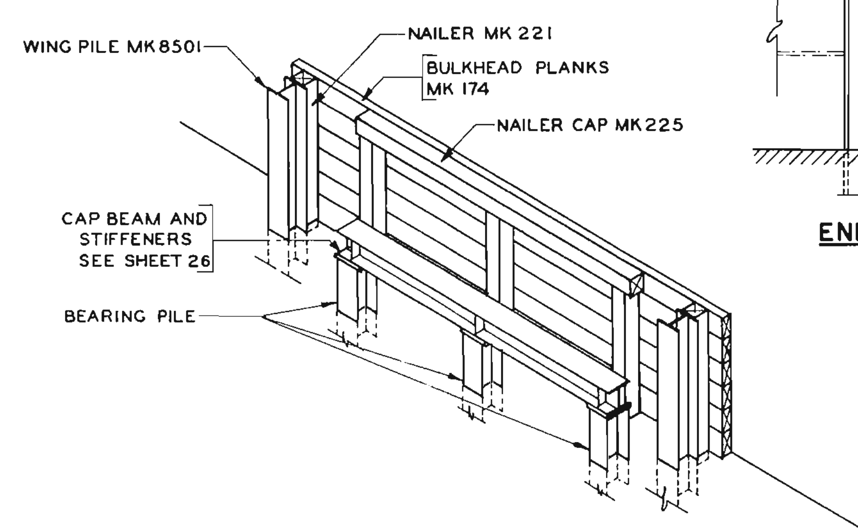
NAILER CONNECTION TO BEARING PILE

MAXIMUM PILE LOADS

SPAN	TONS PER PILE
15'-0"	11
20'-0"	13
30'-0"	15
40'-0"	16
50'-0"	18
60'-0"	20
70'-0"	21
80'-0"	23
90'-0"	25

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS

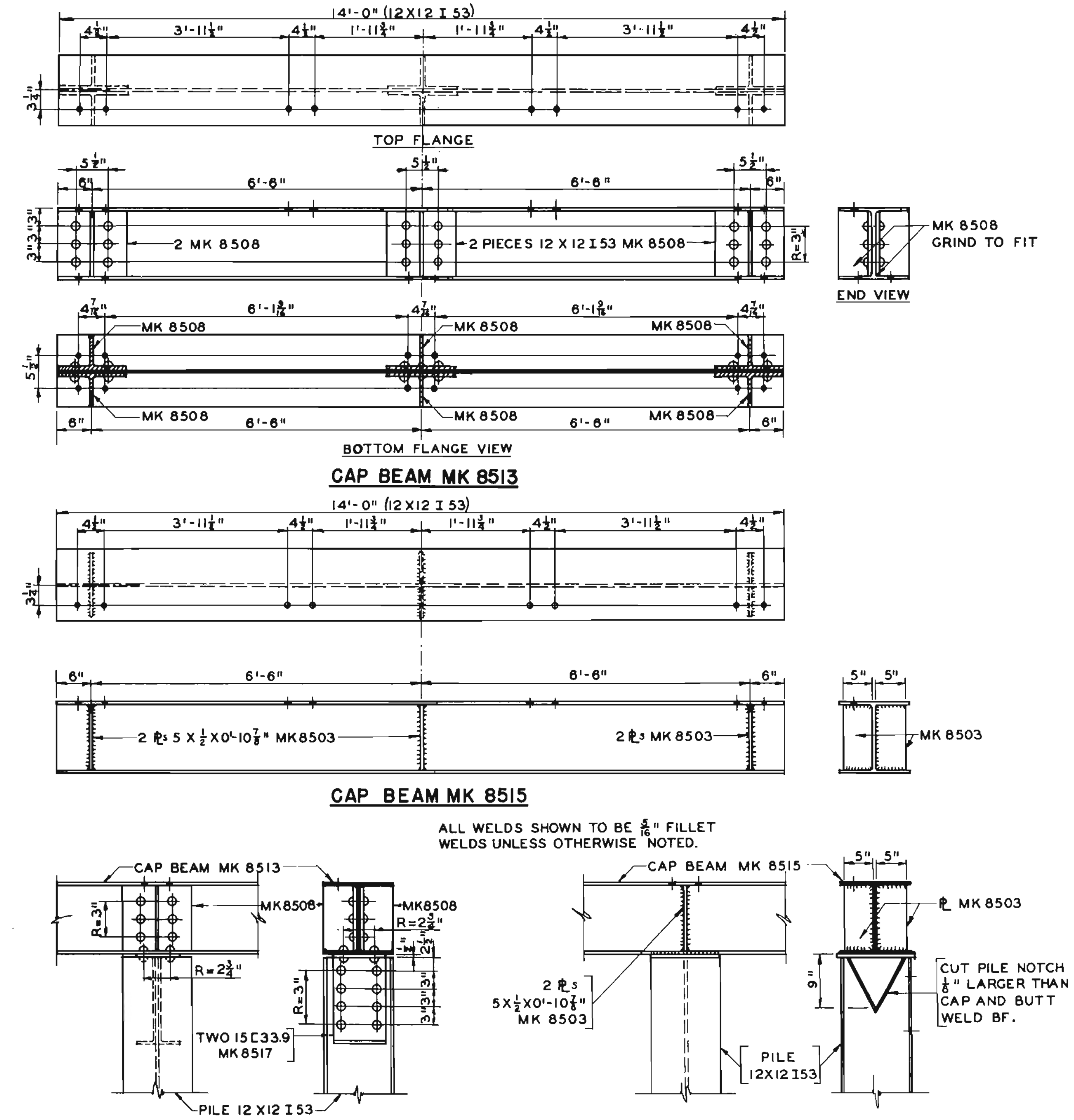
SPAN LENGTH	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
15'-0"	16 I 36	2'-4$\frac{7}{8}$"
20'-0"	18 I 47	2'-6$\frac{7}{8}$"
30'-0"	24 I 74	3'-0$\frac{7}{8}$"
40'-0"	24 I 87	3'-1$\frac{1}{8}$"
50'-0"	30 I 108	3'-6$\frac{7}{8}$"
60'-0"	33 I 125	3'-10"
70'-0"	33 I 132	3'-10$\frac{1}{8}$"
80'-0"	36 I 150	4'-0$\frac{7}{8}$"
90'-0"	36 I 182	4'-1$\frac{3}{8}$"



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	25

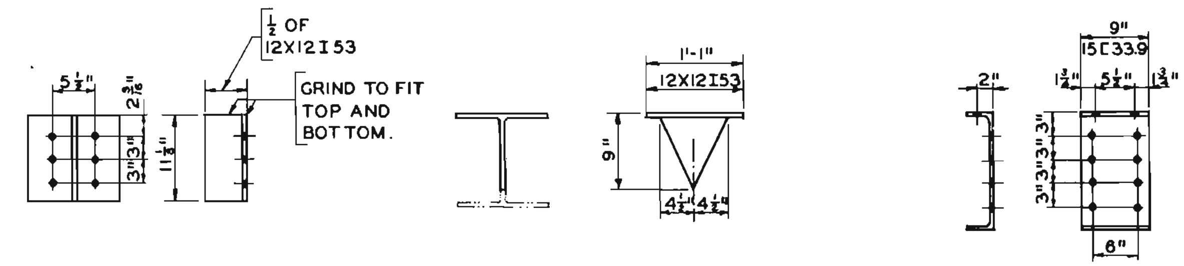


CAP BEAM MK 8513

CAP BEAM MK 8515

RIVETED CONNECTION DETAIL
PILE TO CAP BEAM

WELDED CONNECTION DETAIL
PILE TO CAP BEAM



STIFFENER MK 8508

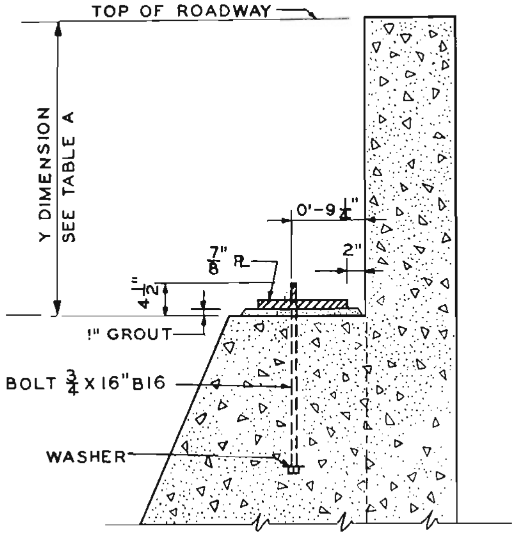
PILE CAP MK 8504

PILE CAP MK 8517

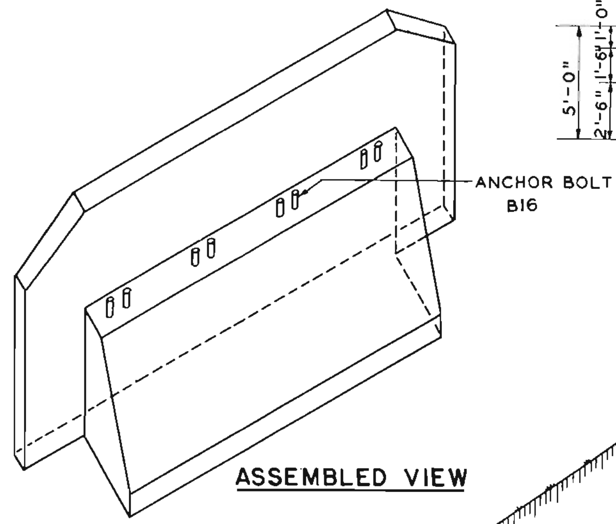
BILL OF MATERIAL FOR ONE ABUTMENT

ITEM COLUMN	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	QUANTITY	FEET BOARD MEASURE	WEIGHT EACH
	ALTERNATE NO 1 WELDED DETAILS							
1	WING PILES		8501	12X12 I 53	15'-0"	2		795
2	CAP BEAM		8515	12X12 I 53	14'-0"	1		742
3	STIFFENERS	47-7844.05	8503	PL 5 X 1/2	10 7/8"	6		8
4	PILE CAP		8504	12X12 I 53	1'-1"	3		29
	ALTERNATE NO 2 RIVETED DETAILS							
5	WING PILES		8501	12X12 I 53	15'-0"	2		795
6	CAP BEAM		8513	12X12 I 53	14'-0"	1		742
7	STIFFENERS		8508	1/2-12X12 I 53	10 7/8"	6		24
8	PILE CAP	48-3750.15-34	8517	15 [33.9	0'-9"	6		26
	LUMBER, SOFT WOOD							
9	NAILERS	39-6616.08	221	8 X 8	6'-0"	5	160	120
10	NAILER CAP	39-6616.08	225	8 X 8	14'-0"	1	75	280
11	BULKHEAD TIMBERS	39-3340.12-12	174	4 X 12	12'-0"	12	576	180
	STEEL HARDWARE, BLACK							
12	BOLTS WITH NUTS AND TWO WASHERS	43-2325.07-1	B10	3/4	10"	20	[1]	35
13	ANCHOR BOLTS WITH NUTS AND TWO WASHERS	43-2219.08-04	M4	7/8	4"	8	[1]	12
14	DRIFT BOLTS WITH WASHERS	43-1636.07-16	D16	3/4	16"	3	[1]	6
15	WIRE SPIKES	42-8488.035-07		5/16	7"	90	[1]	15
16	RIVETS	43-6353.08-25		7/8	2 1/2"	12		.62
17	RIVETS	43-6353.08		7/8	2 3/4"	42		.66
18	WELDING ROD	46-3772.2-7		3/16			[1]	[illegible]

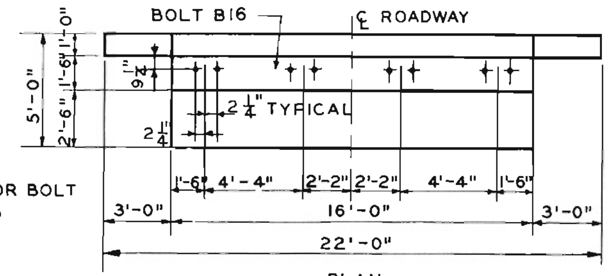
[1] TOTAL WEIGHT



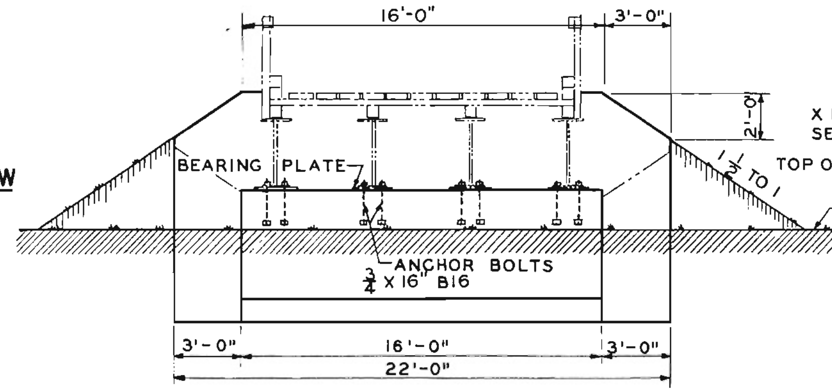
ANCHOR BOLT DETAIL



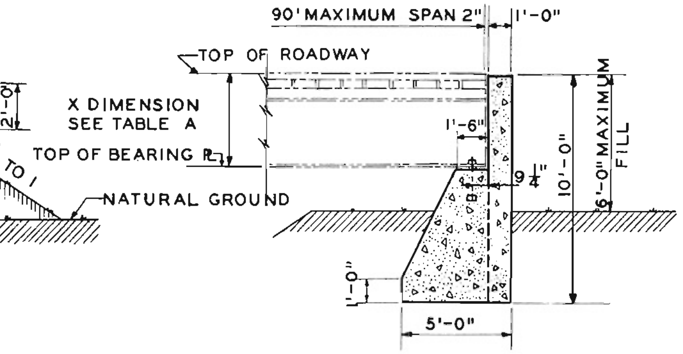
ASSEMBLED VIEW



PLAN



ELEVATION

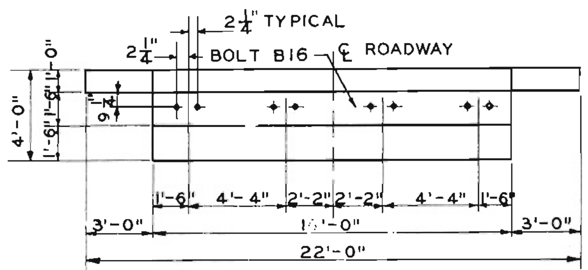


SECTION

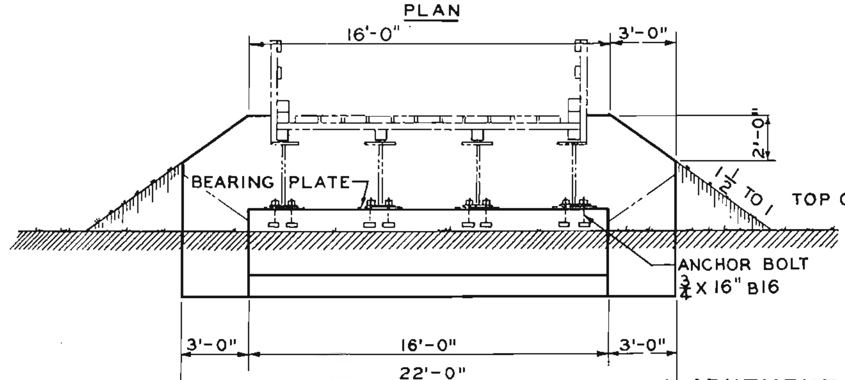
ABUTMENT, 6'-0" MAXIMUM FILL

COMPANION SHEETS

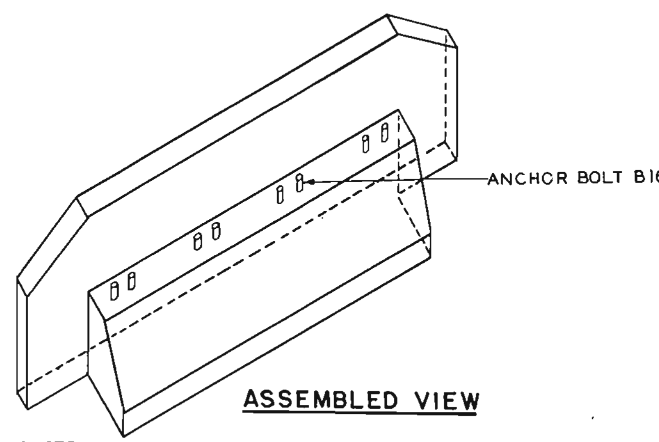
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BEARING PLATES	132



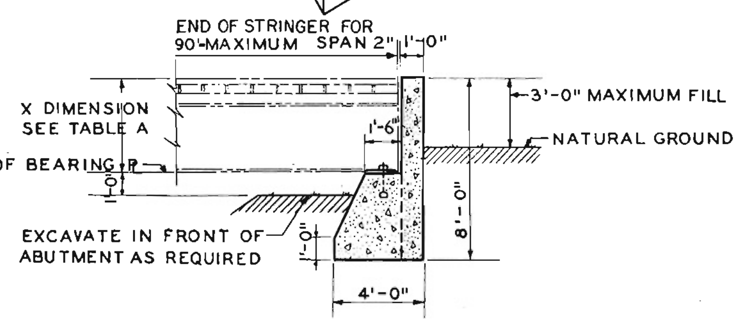
PLAN



ELEVATION



ASSEMBLED VIEW



SECTION

ABUTMENT, 3'-0" MAXIMUM FILL

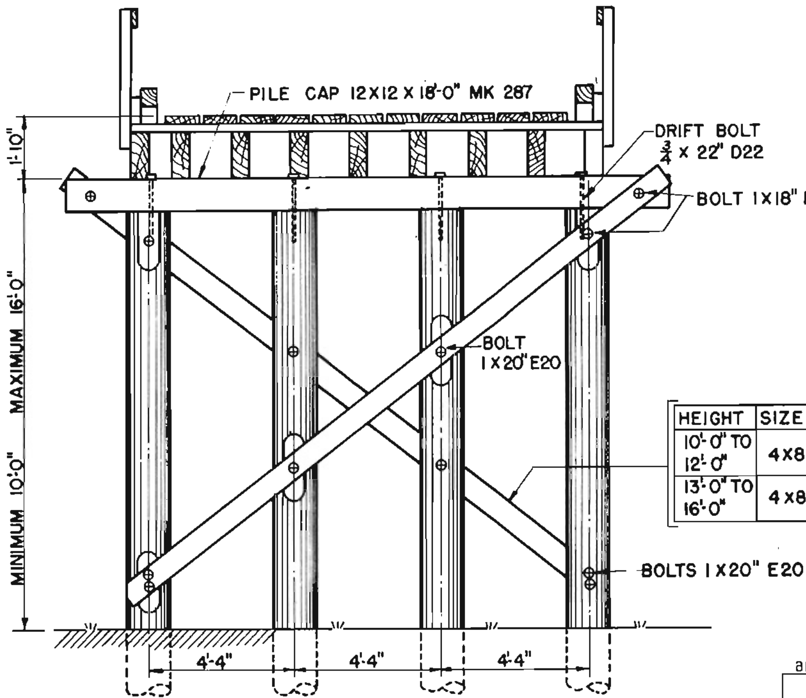
TABLE A - DIMENSIONS AND BILL OF MATERIALS

SPAN FEET	X	Y	ANCHOR BOLTS WITH SQUARE NUT AND TWO WASHERS 3/4 X 16" B16 STOCK NO 43-2325.07-16		CONCRETE	
					6' MAXIMUM FILL	3' MAXIMUM FILL
			QUANTITY	WEIGHT EACH (POUNDS)	CU YDS	CU YDS
15	2'-4 7/8"	2'-6 3/4"	8	3.5	20.8	14.0
20	2'-6 7/8"	2'-8 3/4"	8	3.5	20.5	13.8
30	3'-0 7/8"	3'-2 3/4"	8	3.5	19.7	13.1
40	3'-1 1/8"	3'-3"	8	3.5	19.7	13.1
50	3'-6 7/8"	3'-8 3/4"	8	3.5	18.9	12.5
60	3'-10"	3'-11 7/8"	8	3.5	18.4	12.1
70	3'-10 1/8"	4'-0"	8	3.5	18.4	12.1
80	4'-0 7/8"	4'-2 3/4"	8	3.5	18.1	11.8
90	4'-1 3/8"	4'-3 1/4"	8	3.5	18.0	11.7

BEARING PLATES (SHEET 132)
12 X 7/8 X 1'-3" MK 3500
FOUR REQUIRED FOR EACH ABUTMENT
STOCK NO 47-7844.08

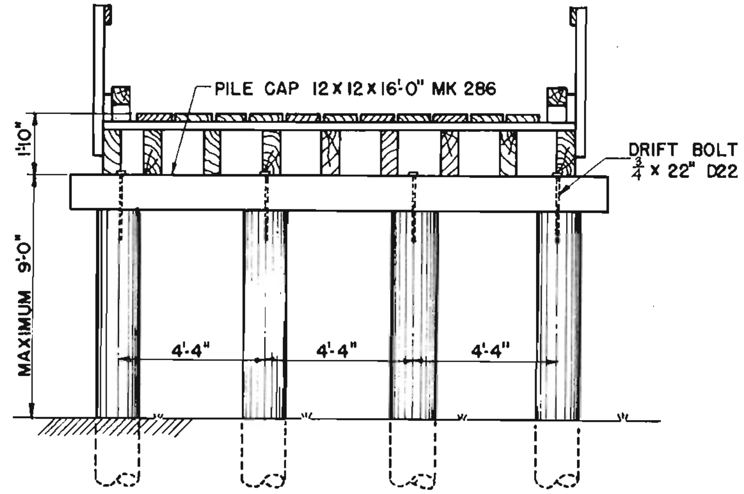
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BENTS 17 TO 28 FEET HIGH	29



HEIGHT	SIZE	LENGTH	MARK
10'-0" TO 12'-0"	4X8	20'-0"	158
13'-0" TO 16'-0"	4X8	22'-0"	159

TYPICAL 4-PILE TRANSVERSE BENT 10'-0" TO 16'-0"



TYPICAL 4-PILE TRANSVERSE BENT 1'-0" TO 9'-0"

BILL OF MATERIALS FOR ONE TRANSVERSE BENT

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	1' TO 9' QUANTITY	1' TO 9' FBM	10' TO 12' QUANTITY	10' TO 12' FBM	13' TO 16' QUANTITY	13' TO 16' FBM	17' TO 20'-6" QUANTITY	17' TO 20'-6" FBM	21' TO 25' QUANTITY	21' TO 25' FBM	26' TO 28' QUANTITY	26' TO 28' FBM	LINE
LUMBER, SOFT WOOD																			
1	TIMBER PILE						4		4		4		4		4		4		1
2	PILE CAP	39-6630.12-16	286	12 X 12	16'-0"	720	1	192											2
3	PILE CAP	39-6630.12-18	287	12 X 12	18'-0"	810			1	216	1	216	1	216	1	216	1	216	3
4	BRACE	39-3340.08-22	159	4 X 8	22'-0"	220					2	117							4
5	DO	39-3340.08-2	158	4 X 8	20'-0"	200			2	107			2	107	2	107	4	213	5
6	DO	39-3340.08-18	157	4 X 8	18'-0"	180									2	96			6
7	DO	39-3340.08-16	155	4 X 8	16'-0"	160							2	85	2	85	2	85	7
8	DO	39-3340.08-12	154	4 X 8	12'-0"	120							4	128					8
STEEL HARDWARE, BLACK																			
9	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-18	E18	1	18"	5.1			4		4		4		4		4		9
10	DO	43-2325.1-2	E20	1	20"	5.6			8		8		24		20		20		10
11	DO	43-2325.1-24	E24	1	24"	6.5							8		6		6		11
12	DRIFT BOLT	43-1636.07-22	E22	3/4	22"	2.8	4		4		4		4		4		4		12

BILL OF MATERIALS FOR ONE PANEL OF LONGITUDINAL BRACING OR STRUTS (*VIEWS ON SHEET 29*)

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	HEIGHT / SPAN / UNIT WEIGHT (POUNDS)	17' TO 20'-6" 15' SPAN QUANTITY	FBM	17' TO 20'-6" 13' SPAN QUANTITY	FBM	17' TO 20'-6" 11' SPAN QUANTITY	FBM	21' TO 25' 15' SPAN QUANTITY	FBM	21' TO 25' 13' SPAN QUANTITY	FBM	21' TO 25' 11' SPAN QUANTITY	FBM	26' TO 28' 15' SPAN QUANTITY	FBM	26' TO 28' 13' SPAN QUANTITY	FBM	26' TO 28' 11' SPAN QUANTITY	FBM	ONE SPAN WITH STRUTS ONLY 15' SPAN QUANTITY	FBM	ONE SPAN WITH STRUTS ONLY 13' SPAN QUANTITY	FBM	ONE SPAN WITH STRUTS ONLY 11' SPAN QUANTITY	FBM	LINE
LUMBER SOFT WOOD																															
1	STRUTS OR BRACE	39-3340.08-22	159	4 X 8	22'-0"	220													2	117											1
2	DO	39-3340.08-2	158	4 X 8	20'-0"	200	2	107					4	213					2	107	2	107									2
3	DO	39-3340.08-18	157	4 X 8	18'-0"	180	4	192	2	96			2	96	4	192	2	96	2	96	2	96	2	96	2	96					3
4	DO	39-3340.08-16	155	4 X 8	16'-0"	160			4	171	2	85			2	85	2	85			2	85	2	85			2	85			4
5	DO	39-3340.08-14	155	4 X 8	14'-0"	140					4	150					2	75					2	75					2	75	5
6	DO	39-3340.08-1	153	4 X 8	10'-0"	100	4	107					8	213	4	107			8	213	4	107	4	107							6
7	DO	39-3340.08-08	152	4 X 8	8'-0"	80	4	85	8	171	8	171			4	85	8	171			4	85	4	85							7
8	SCAB	39-3228.08	324	2 X 8	3'-6"	18	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19							8
9	DO	39-3228.08	81	2 X 8	6'-0"	30	4	32	4	32	4	32	4	32	4	32	4	32	4	32	4	32	4	32							9
STEEL HARDWARE, BLACK																															
10	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-104	E10	1	10"	3,45	20		20		20		20		20		20		20		20		20								10
11	DO	43-2325.1-2	E20	1	20"	5.51	32		32		32		32		32		32		32		32		32								11
12	DO	43-2325.1-24	E24	1	24"	6.48	4		4		4		4		4		4		4		4		4		4		4		4		12

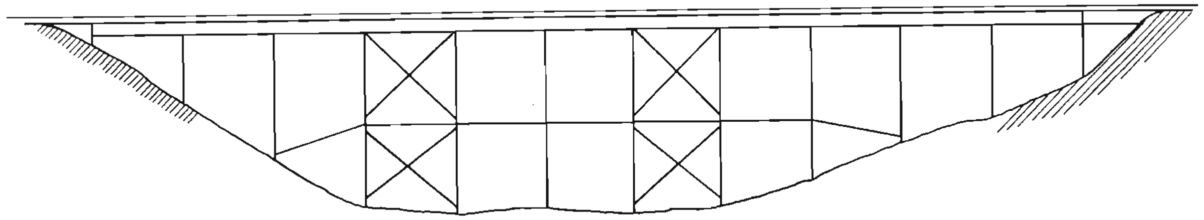


DIAGRAM SHOWING LONGITUDINAL BRACING

TRESTLES OVER 17 FEET HIGH ALL HAVE LONGITUDINAL BRACING IN EVERY THIRD SPAN.
STRUTS ARE CARRIED TO BANK AND FASTENED TO PILE NEAR GROUND LINE

BILL OF MATERIALS ON SHEET 28

LENGTH OF LONGITUDINAL 4X8 BRACING

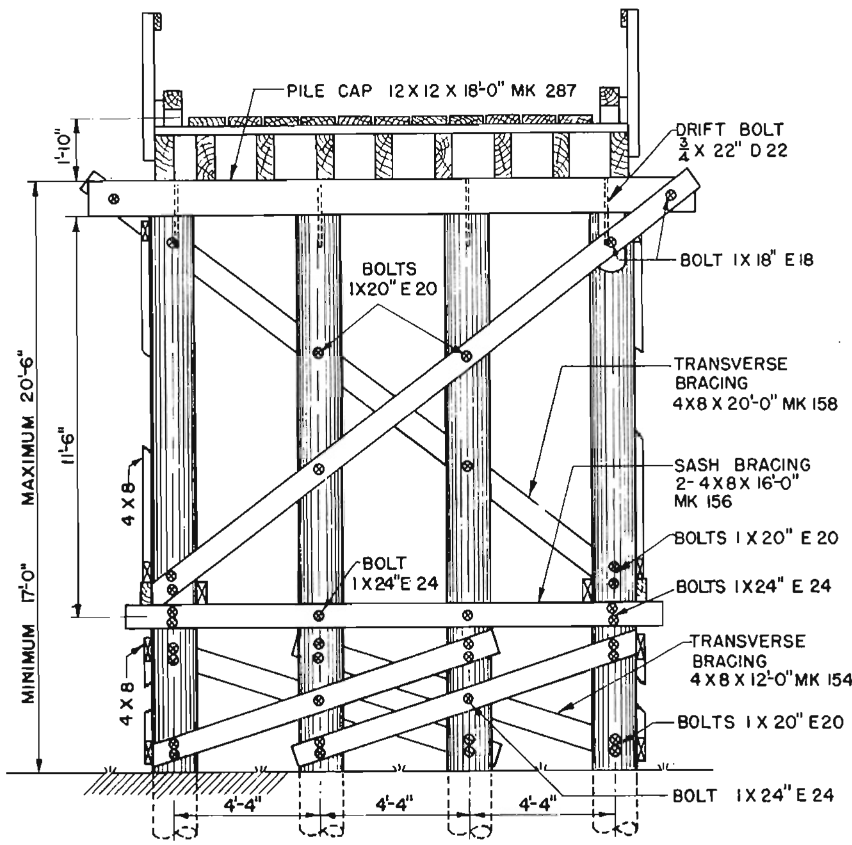
HEGHT	TABLE A 15'-0" SPAN LENGTH	TABLE A 15'-0" SPAN MARK	TABLE A 13'-0" SPAN LENGTH	TABLE A 13'-0" SPAN MARK	TABLE A 11'-0 SPAN LENGTH	TABLE A 11'-0 SPAN MARK	TABLE B 15'-0" SPAN LENGTH	TABLE B 15'-0" SPAN MARK	TABLE B 13'-0" SPAN LENGTH	TABLE B 13'-0" SPAN MARK	TABLE B 11'-0" SPAN LENGTH	TABLE B 11'-0" SPAN MARK
17'-0" TO 20-6"	18'-0"	157	16'-0"	156	14'-0"	155	8'-0"	152	8'-0"	152	8'-0"	152
21'-0" TO 25'-0"	20'-0"	158	18'-0"	157	18'-0"	157	10'-0"	153	10'-0"	153	8'-0"	152
26'-0" TO 28'-0"	22'-0"	159	20'-0"	158	18'-0"	157	10'-0"	153	10'-0"	153	10'-0"	153

COMPANION SHEETS

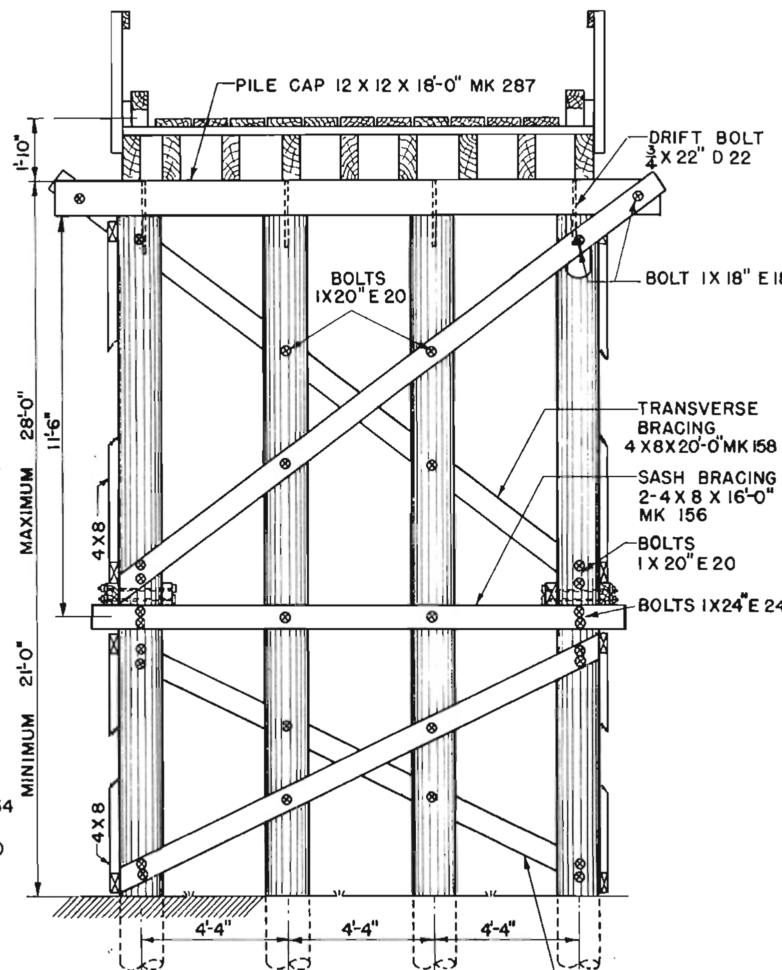
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE BENTS FOR TIMBER SPANS	28

NOTE

REQUIRED PILE BEARING CAPACITY 18 TONS PER PILE.

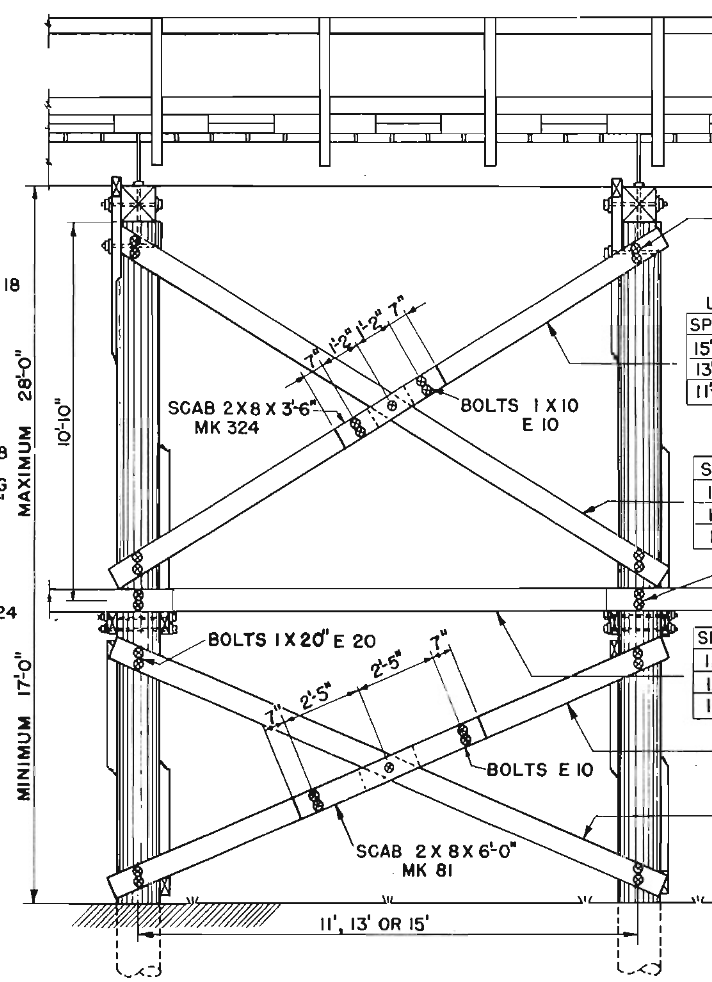


TYPICAL 4-PILE TRANSVERSE BENT 17'-0" TO 20'-6"



HEIGHT	SIZE	LENGTH	MARK
21'-0" TO 25'-0"	4X8	18'-0"	157
26'-0" TO 28'-0"	4X8	20'-0"	158

TYPICAL 4-PILE TRANSVERSE BENT 21'-0" TO 28'-0"



LONGITUDINAL BRACING

SPAN	SIZE	LENGTH	MARK
15'-0"	4X8	10'-0"	153
13'-0"	4X8	8'-0"	152
11'-0"	4X8	8'-0"	152

LONGITUDINAL BRACING

SPAN	SIZE	LENGTH	MARK
15'-0"	4X8	20'-0"	158
13'-0"	4X8	18'-0"	157
11'-0"	4X8	16'-0"	156

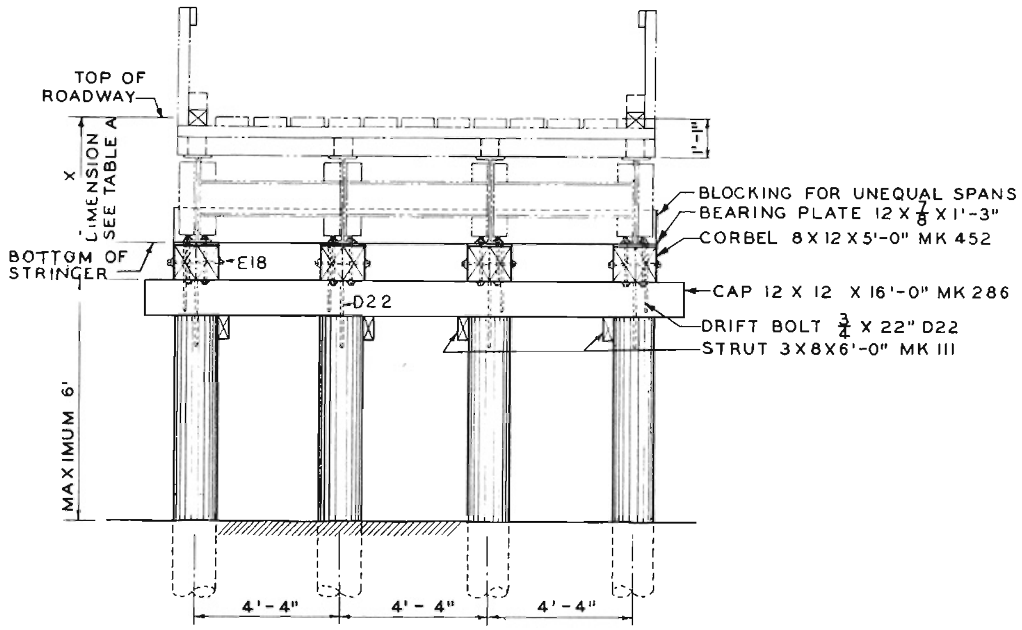
LONGITUDINAL STRUT

SPAN	SIZE	LENGTH	MARK
11'-0"	4X8	14'-0"	155
13'-0"	4X8	16'-0"	156
15'-0"	4X8	18'-0"	156

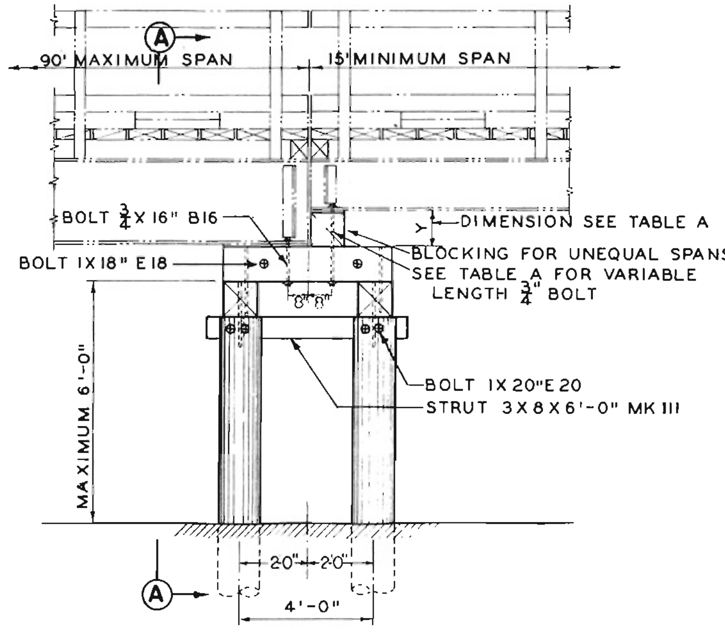
TYPICAL LONGITUDINAL BRACING FOR BENTS 17'-0" TO 28'-0"

COMPANION SHEETS

	SHEET
BILL OF MATERIALS	31
GENERAL NOTES	154
SYMBOLS	155



SECTION A-A FOR PIERS 1' TO 6' HIGH



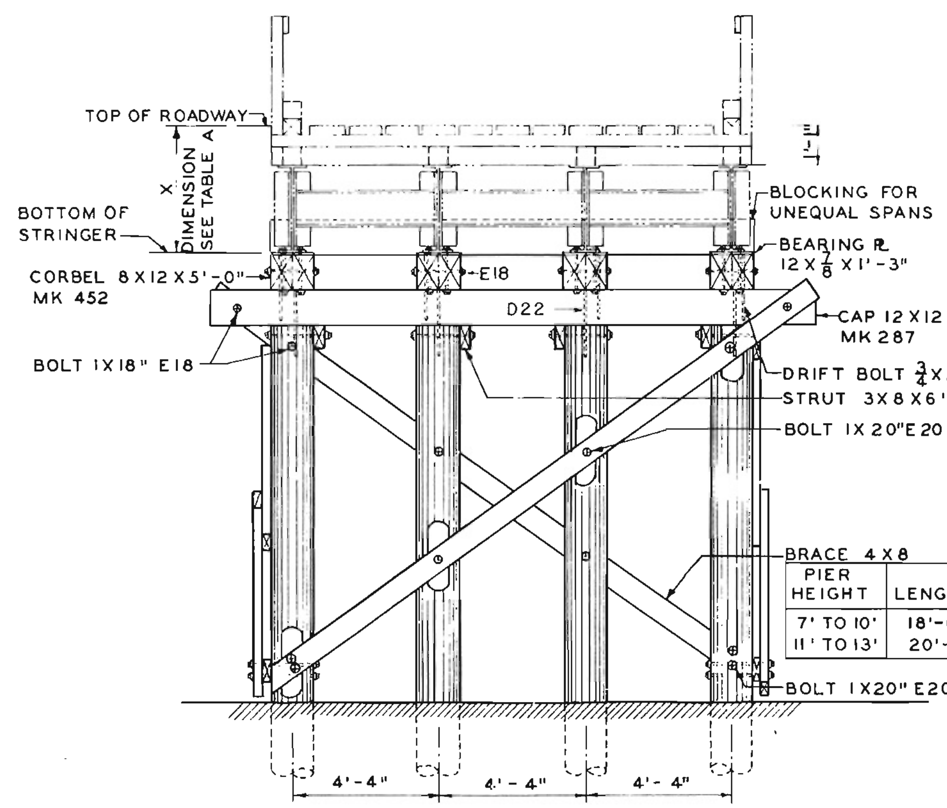
LONGITUDINAL ELEVATION 1' TO 6' HIGH

REQUIRED PILE CAPACITY

TOTAL LENGTH OF TWO ADJACENT SPANS	30'	40'	60'	80'	100'	120'	140'	160'	180'
REQUIRED CAPACITY TONS PER PILE	10	10	12	13	14	15	16	17	18

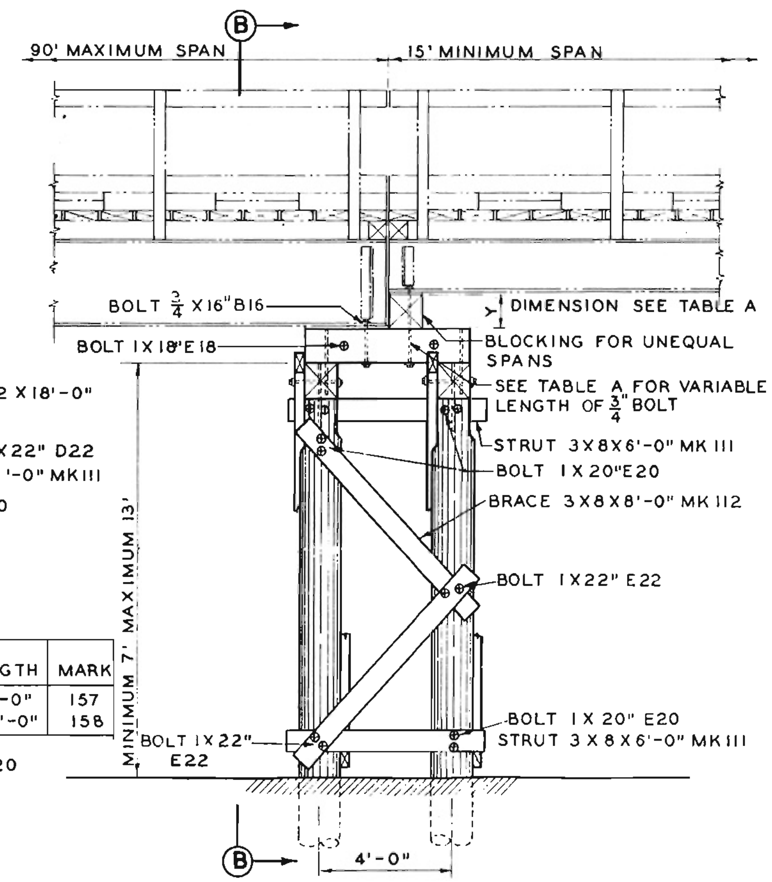
TABLE A — HEIGHT OF BLOCKING AND LENGTH OF 3/4" ANCHOR BOLTS FOR UNEQUAL ADJACENT SPANS

			ADJACENT SPANS								
			90'	80'	70'	60'	50'	40'	30'	20'	15'
TIMBER SPANS	15'	DIMENSION X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"	4'-1 3/4"	3'-7 3/4"	3'-5 3/4"
		DIMENSION Y	2'-4 1/4"	2'-3 3/4"	2'-1"	2'-0 7/8"	1'-9 3/4"	1'-4"	1'-3 3/4"	0'-9 3/4"	0'-7 3/4"
		BOLT LENGTH	42"	42"	38"	38"	36"	30"	30"	24"	22"
STEEL SPANS	15'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"	4'-1 3/4"	3'-7 3/4"	
		Y	1'-8 1/2"	1'-8"	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-8 1/4"	0'-8"	0'-2"	
		DO	36"	36"	32"	32"	30"	24"	24"	18"	
	20'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"	4'-1 3/4"		
		Y	1'-6 1/2"	1'-6"	1'-3 1/4"	1'-3 1/8"	1'-0"	0'-6 1/4"	0'-6"		
		DO	34"	34"	30"	30"	28"	22"	22"		
	30'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-2"			
		Y	1'-0 1/2"	1'-0"	0'-9 1/4"	0'-9 1/8"	0'-6"	0'-0 1/4"			
		DO	28"	28"	24"	24"	22"	16"			
	40'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-7 3/4"				
		Y	1'-0 1/4"	0'-11 3/4"	0'-9"	0'-8 7/8"	0'-5 3/4"				
		DO	28"	28"	24"	24"	22"				
	50'	X	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"					
		Y	0'-6 1/2"	0'-6"	0'-3 1/4"	0'-3 1/8"					
		DO	22"	22"	18"	18"					
	60'	X	5'-2 1/4"	5'-1 3/4"	4'-11"						
		Y	0'-3 3/8"	0'-2 7/8"	0'-0 1/8"						
		DO	20"	18"	16"						
	70'	X	5'-2 1/4"	5'-1 3/4"							
		Y	0'-3 1/4"	0'-2 3/4"							
		DO	20"	18"							
	80'	DIMENSION X	5'-2 1/4"								
		DIMENSION Y	0'-0 1/2"								
		BOLT LENGTH	16"								



PIER HEIGHT	LENGTH	MARK
7' TO 10'	18'-0"	157
11' TO 13'	20'-0"	158

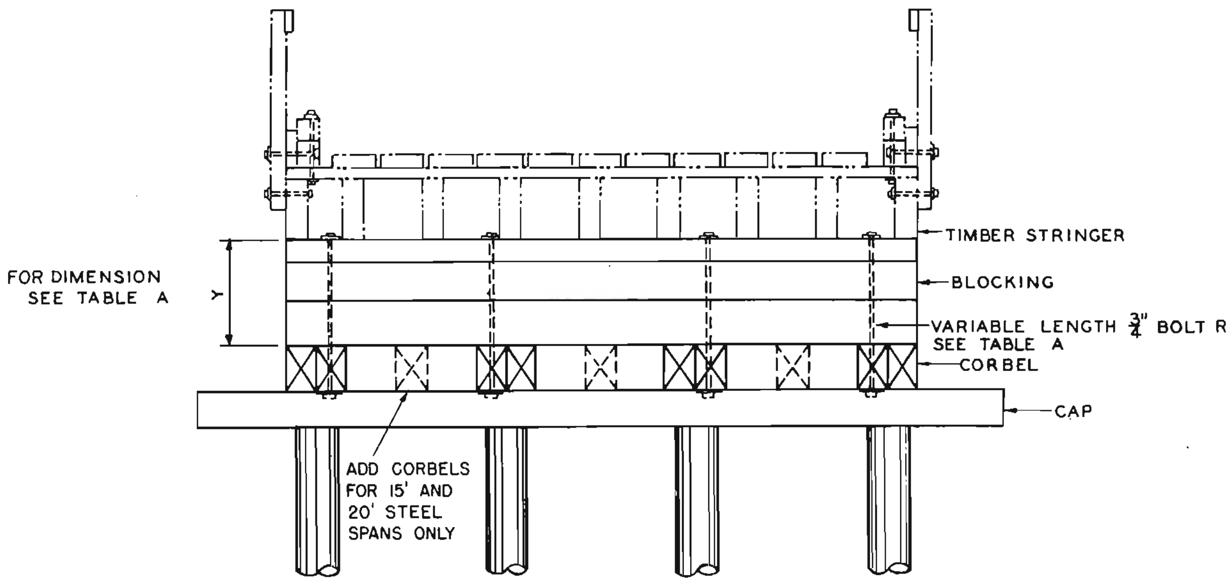
SECTION B-B FOR PIERS 7' TO 13' HIGH



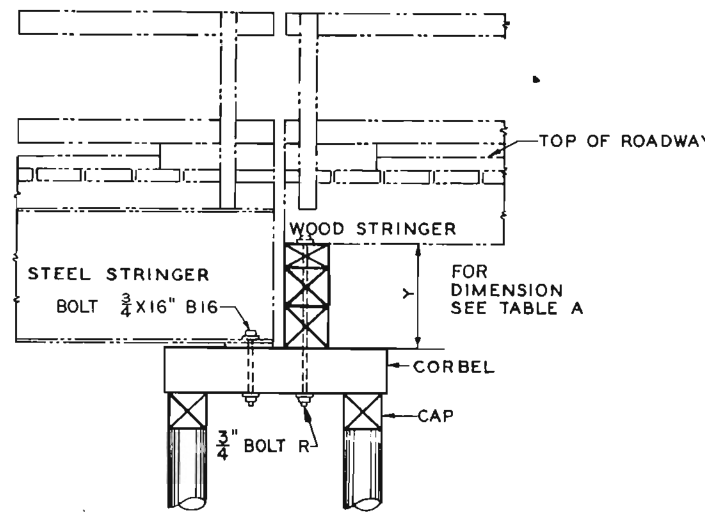
LONGITUDINAL SECTION 7' TO 13' HIGH

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE PIERS FOR STEEL SPANS	30



TRANSVERSE SECTION



LONGITUDINAL ELEVATION

SPECIAL BLOCKING AT JUNCTION OF STEEL AND TIMBER SPANS

TABLE A

STEEL SPAN	DIMENSION Y	BOLT R
15'	0'-7 3/4"	22"
20'	0'-9 3/4"	24"
30'	1'-3 3/4"	30"
40'	1'-4"	30"
50'	1'-9 3/4"	36"
60'	2'-0 7/8"	38"
70'	2'-1"	38"
80'	2'-3 3/4"	42"
90'	2'-4 1/4"	42"

BILL OF MATERIALS FOR ONE PIER

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	PIER HEIGHT 1' TO 6'		PIER HEIGHT 7' TO 10'		PIER HEIGHT 11' TO 13'		
							QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
1	TIMBER PILE						8		8		8		1
2	PILE CAP	39-6630.12-16	286	12 x 12	16'-0"	810	2	384					2
3	DO	39-6630.12-18	287	12 x 12	18'-0"	720			2	432	2	432	3
4	CORBEL	39-6616.12	452	8 x 12	5'-0"	150	8	320	8	320	8	320	4
5	TRANSVERSE BRACE	39-3340.08-18	157	4 x 8	18'-0"	180			4	192			5
6	DO	39-3340.08-2	158	4 x 8	20'-0"	200					4	213	6
7	LONGITUDINAL BRACE	39-3330.08-08	112	3 x 8	8'-0"	60			4	64	4	64	7
8	STRUT	39-3330.08	111	3 x 8	6'-0"	45	4	48	6	72	6	72	8
	STEEL HARDWARE, BLACK												
9	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-22	E22	1	22"	6.1			8		8		9
10	DO	43-2325.1-2	E20	1	20"	5.6	16		40		40		10
11	DO	43-2325.1-18	E18	1	18"	5.2	8		16		16		11
12	DO	43-2325.07-16	B16	3/4	16"	2.6	16		16		16		12
13	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	3.0	16		16		16		13
14	BEARING PLATE	47-7844.08		PL 12 x 7/8	1'-3"	45	8		8		8		14

BILL OF MATERIALS FOR ANCHOR BOLTS

3/4" ANCHOR BOLT WITH SQUARE NUT AND TWO WASHERS
FOR REQUIRED LENGTH SEE TABLE A
FOUR REQUIRED AT EACH SUPPORT FOR EACH TIMBER SPAN
EIGHT REQUIRED AT EACH SUPPORT FOR EACH STEEL SPAN

BOLT LENGTH	STOCK NUMBER
16"	43-2325.07-166
18"	43-2325.07-183
20"	43-2325.07-2
22"	43-2325.07-223
24"	43-2325.07-24
28"	43-2325.07-28
30"	43-2325.07-305
32"	43-2325.07-32
34"	43-2325.07-346
36"	43-2325.07-366
38"	43-2325.07-386
42"	43-2325.07-425

BEARING PLATE 12 x 7/8 x 1'-3" MK P3500 (SHEET 132)
STRUCTURAL STEEL FOUR REQUIRED FOR EACH STEEL SPAN

VARIABLE BLOCKING 12" WIDE x 16'-0" LONG OF DEPTHS REQUIRED AS SHOWN BY DIMENSION Y

RIVETED CONSTRUCTION, BENTS AND PIERS UP TO 20 FEET HIGH, GENERAL VIEWS

COMPANION SHEETS

	SHEET
BILL OF MATERIALS	33
FABRICATION DETAILS	150
GENERAL NOTES	154
SYMBOLS	155

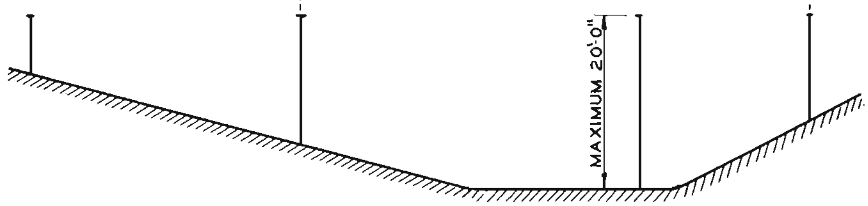


DIAGRAM A
SHOWING HEIGHT AND SPAN LIMITATIONS
PILE BENT

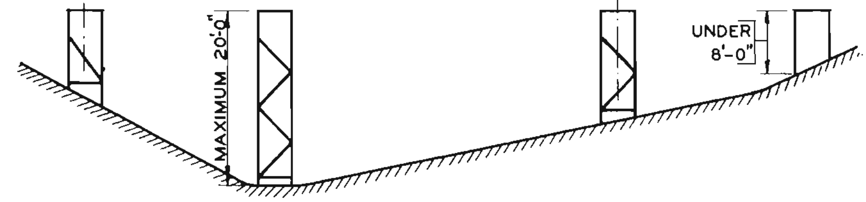


DIAGRAM B
SHOWING HEIGHT AND SPAN LIMITATIONS
PILE PIER

TABLE A

BENT HEIGHT	TRANSVERSE BRACE
20'-0"	MK 8930
18'-0"	MK 8931
16'-0"	MK 8932
14'-0"	MK 8933
12'-0"	MK 8934
10'-0"	MK 8935
8'-0"	MK 8936

MAXIMUM PILE LOAD

TOTAL LOADED LENGTH	TONS PER PILE
30'-0"	16
40'-0"	19
50'-0"	21
60'-0"	24
70'-0"	26
80'-0"	29
90'-0"	32
100'-0"	34

TABLE C

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS

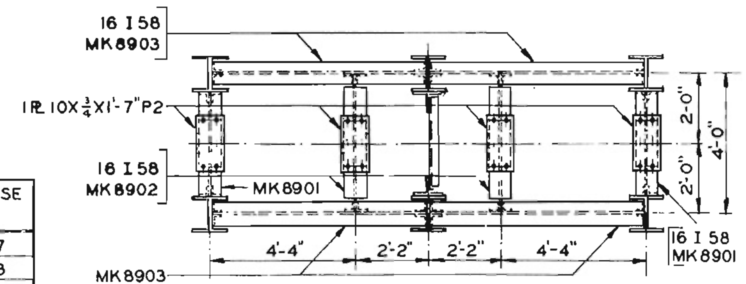
SPAN	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
15'-0"	16 I 36	2'-4 7/8"
20'-0"	18 I 47	2'-6 3/4"
30'-0"	24 I 74	3'-0 7/8"
40'-0"	24 I 87	3'-1 1/8"
50'-0"	30 I 108	3'-6 7/8"
60'-0"	33 I 125	3'-10"
70'-0"	33 I 132	3'-10 1/2"
80'-0"	36 I 150	4'-0 7/8"
90'-0"	36 I 182	4'-1 3/8"

MAXIMUM PILE LOAD

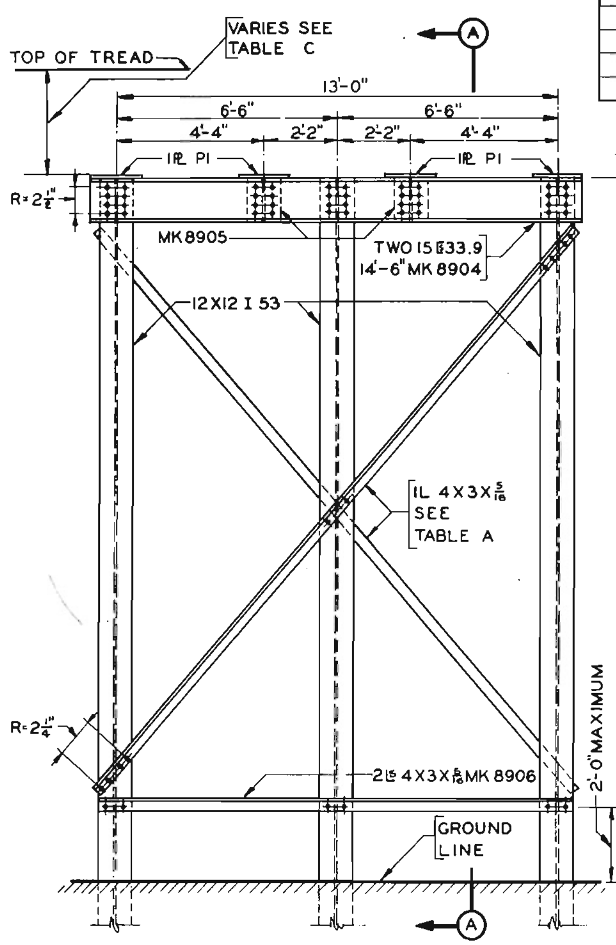
TOTAL LOADED LENGTH	TONS PER PILE
110'-0"	23
120'-0"	24
130'-0"	25
140'-0"	26
150'-0"	28
160'-0"	29
170'-0"	30
180'-0"	32

TABLE B

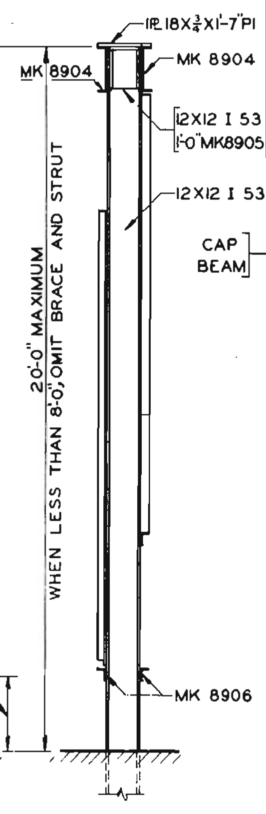
PIER HEIGHT	TRANSVERSE BRACE
20'-0"	MK 8937
18'-0"	MK 8938
16'-0"	MK 8939
14'-0"	MK 8940
12'-0"	MK 8941
10'-0"	MK 8942
8'-0"	MK 8943



TOP PLAN

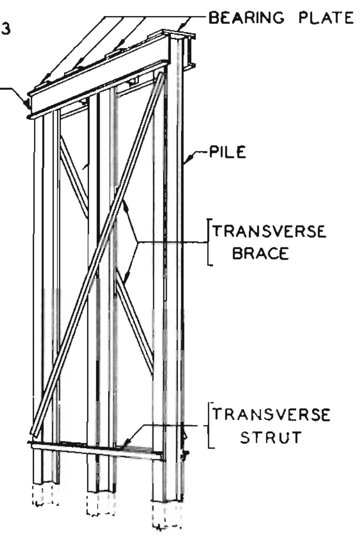


TRANSVERSE ELEVATION

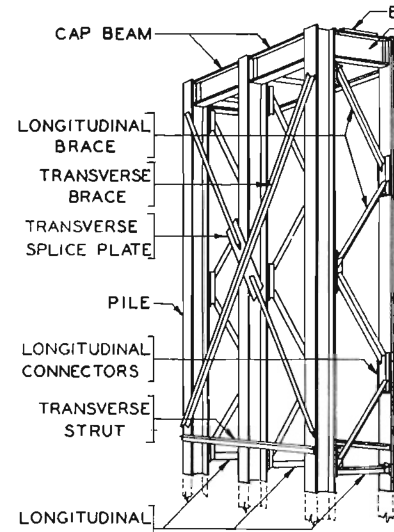


SECTION A-A

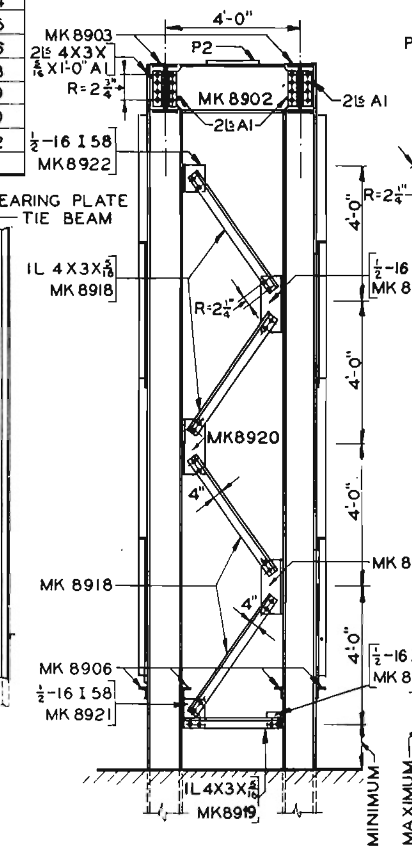
THREE-PILE BENT



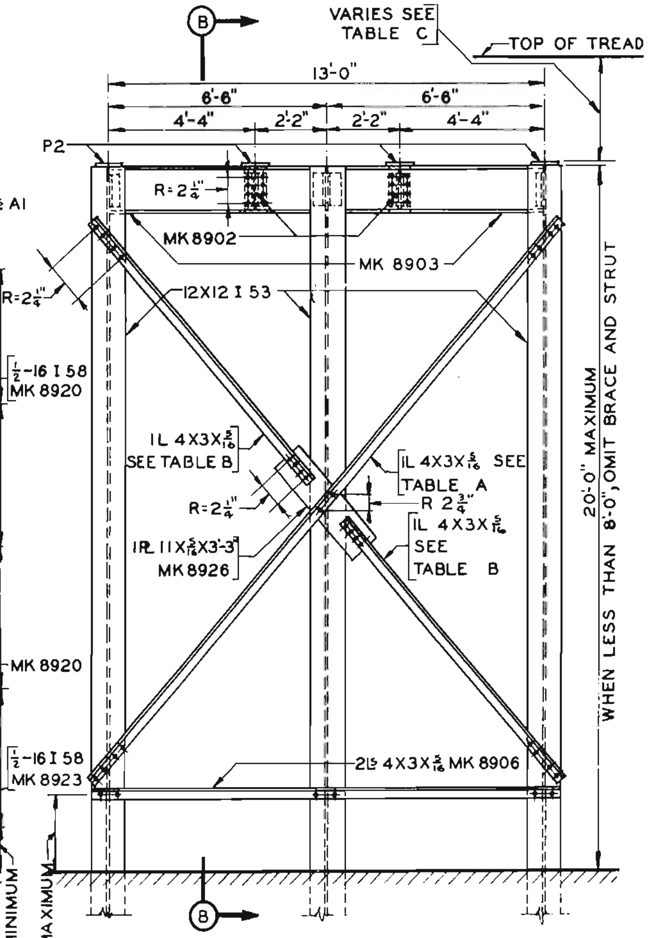
ASSEMBLED VIEW



ASSEMBLED VIEW



SECTION B-B



TRANSVERSE ELEVATION

SIX-PILE PIER

COMPANION SHEETS

	SHEET
STEEL PILE BENTS AND PIERS, RIVETED DETAILS	32
GENERAL NOTES	154
SYMBOLS	155

BILL OF MATERIALS FOR ONE RIVETED STEEL PILE BENT OR PIER

LINE	USE	DESCRIPTION: STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	STEEL PILE BENT HEIGHT 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY	STEEL PILE PIER HEIGHT 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY	LINE
1	CAP BEAM	48-2900.16-058	8903	16 I 58	6'-5"	372									4	4	4	4	4	4	4	4	1
2	DO	48-3790.15-34	8904	15 [33.9	14'-6"	492	2	2	2	2	2	2	2	2									2
3	DIAPHRAGM		8905	12X12 I 53	1'-0"	53	2	2	2	2	2	2	2	2									3
4	DO	48-2900.16-058	8901	16 I 58	2'-11 5/8"	172									2	2	2	2	2	2	2	2	4
5	DO	48-2900.16-058	8902	16 I 58	3'-10 3/4"	226									2	2	2	2	2	2	2	2	5
6	STRUTS AND BRACES	48-2550.4-035	8906	L4 X 3 X 5/16	14'-0"	101	2	2	2	2	2	2	2		4	4	4	4	4	4	4		6
7	DO	48-2550.4-035	8918	L4 X 3 X 5/16	4'-1 1/8"	30									12	9	9	6	6	3	3		7
8	DO	48-2550.4-035	8919	L4 X 3 X 5/16	2'-9 1/4"	20									3	3	3	3	3	3	3		8
9	DO	48-2550.4-035	8930	L4 X 3 X 5/16	21'-1"	152	2								2								9
10	DO	48-2550.4-035	8931	L4 X 3 X 5/16	19'-8"	142		2								2							10
11	DO	48-2550.4-035	8932	L4 X 3 X 5/16	18'-3"	132			2								2						11
12	DO	48-2550.4-035	8933	L4 X 3 X 5/16	17'-1"	123				2								2					12
13	DO	48-2550.4-035	8934	L4 X 3 X 5/16	16'-0"	115					2								2				13
14	DO	48-2550.4-035	8935	L4 X 3 X 5/16	15'-2"	109						2								2			14
15	DO	48-2550.4-035	8936	L4 X 3 X 5/16	14'-6"	105							2								2		15
16	DO	48-2550.4-035	8937	L4 X 3 X 5/16	10'-4"	74									4								16
17	DO	48-2550.4-035	8938	L4 X 3 X 5/16	9'-8"	70										4							17
18	DO	48-2550.4-035	8939	L4 X 3 X 5/16	9'-0"	65											4						18
19	DO	48-2550.4-035	8940	L4 X 3 X 5/16	8'-3"	60												4					19
20	DO	48-2550.4-035	8941	L4 X 3 X 5/16	7'-8"	55													4				20
21	DO	48-2550.4-035	8942	L4 X 3 X 5/16	7'-2"	52														4			21
22	DO	48-2550.4-035	8943	L4 X 3 X 5/16	6'-7"	48															4		22
23	CONNECTOR	48-2900.16-058	8920	1/2 16 I 58	1'-6 1/2"	45									9	6	6	3	3				23
24	DO	48-2900.16-058	8921	1/2 16 I 58	0'-10 1/8"	24									3	3	3	3	3	3	3		24
25	DO	48-2900.16-058	8922	1/2 16 I 58	0'-8 3/4"	21									3	3	3	3	3	3	3		25
26	DO	48-2900.16-058	8923	1/2 16 I 58	0'-6"	15									3	3	3	3	3	3	3		26
27	DO	47-7844.04	8926	PL 11 X 3/8	3'-3"	38									2	2	2	2	2	2	2		27
28	DO	48-2550.4-035	A1	L4 X 3 X 5/16	1'-0"	7									32	32	32	32	32	32	32	32	28
29	BEARING PLATE	47-7844.07	P1	PL 18 X 3/4	1'-7"	73	4	4	4	4	4	4	4	4									29
30	DO	47-7844.07	P2	PL 10 X 3/4	1'-7"	40									4	4	4	4	4	4	4	4	30
31	RIVET	43-6353.08-2		7/8	2"	.53									16	16	16	16	16	16	16	16	31
32	DO	43-6353.08-23		7/8	2 1/4"	.57	32	32	32	32	32	32	32		232	220	220	208	208	196	196	96	32
33	DO	43-6353.08-25		7/8	2 1/2"	.62	80	80	80	80	80	80	80	80	152	140	140	128	128	116	116	80	33
34	DO	43-6353.08-3		7/8	3"	.70	16	16	16	16	16	16	16	16									34
35	PILE			12 X 12 I 53			3	3	3	3	3	3	3	3	6	6	6	6	6	6	6	6	35

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	33
FABRICATION DRAWING	151

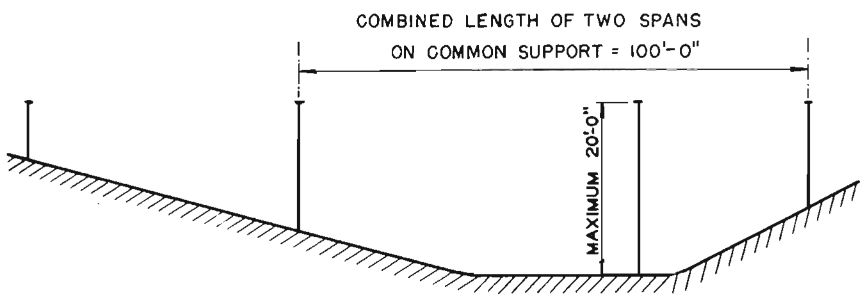


DIAGRAM A
SHOWING HEIGHT AND SPAN LIMITATIONS
PILE BENT

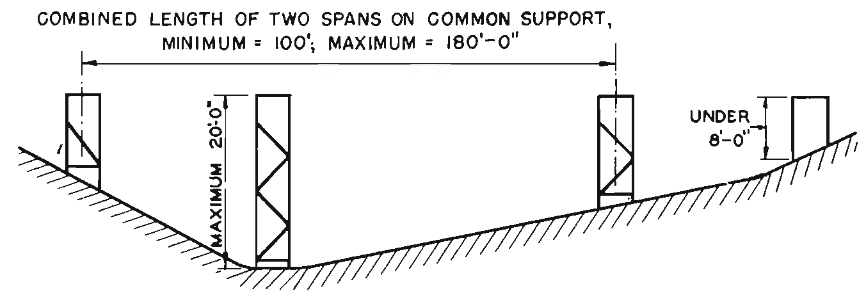


DIAGRAM B
SHOWING HEIGHT AND SPAN LIMITATIONS
PILE PIER

TABLE A

BENT HEIGHT A	TRANSVERSE BRACE
20'-0"	MK 7006
18'-0"	MK 7007
16'-0"	MK 7008
14'-0"	MK 7009
12'-0"	MK 7010
10'-0"	MK 7011
8'-0"	MK 7012

MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
30'-0"	16
40'-0"	19
50'-0"	21
60'-0"	24
70'-0"	26
80'-0"	29
90'-0"	32
100'-0"	34

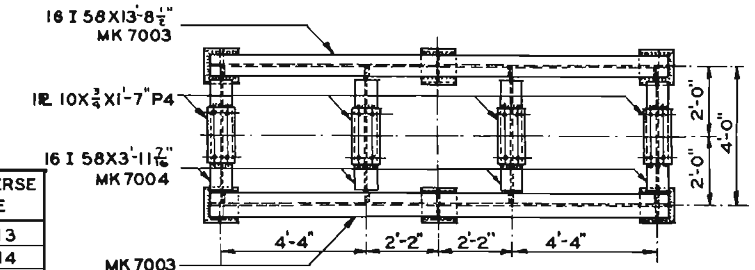
TABLE C

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS		
SPAN	STEEL—STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
15'-0"	16 I 36	2'-4 7/8"
20'-0"	18 I 47	2'-6 7/8"
30'-0"	24 I 74	3'-0 7/8"
40'-0"	24 I 87	3'-1 1/8"
50'-0"	30 I 108	3'-6 7/8"
60'-0"	33 I 125	3'-10"
70'-0"	33 I 132	3'-10 1/8"
80'-0"	36 I 150	4'-0 7/8"
90'-0"	36 I 182	4'-1 3/8"

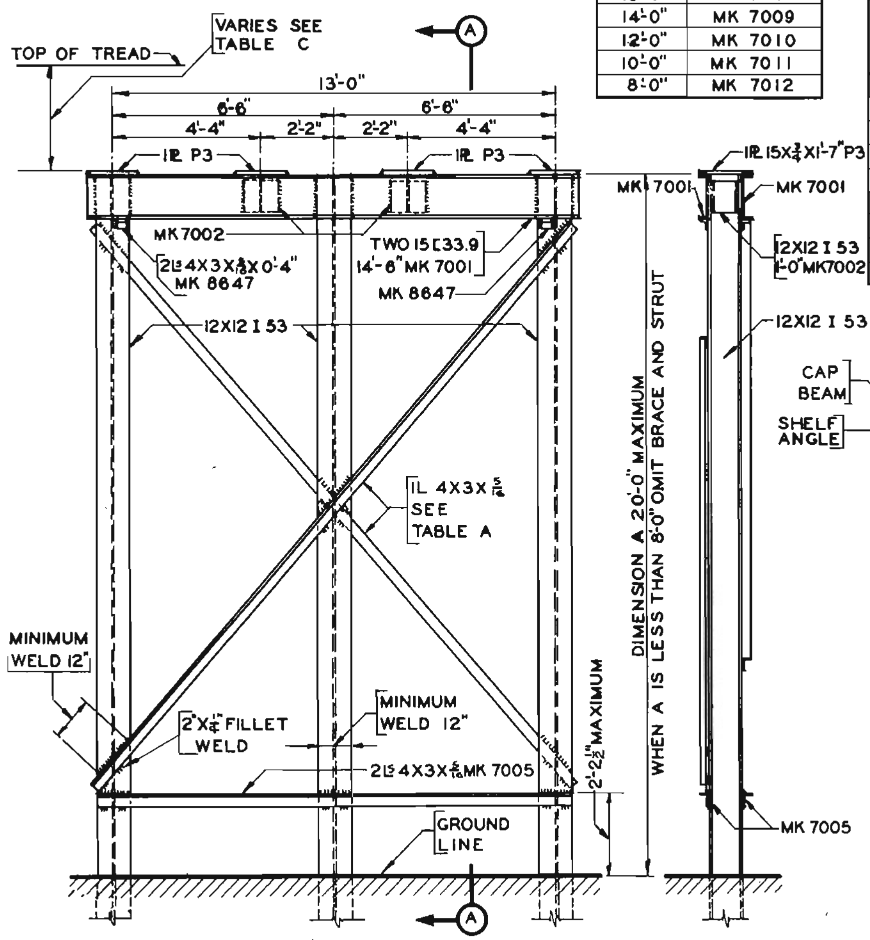
MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
110'-0"	23
120'-0"	24
130'-0"	25
140'-0"	26
150'-0"	28
160'-0"	29
170'-0"	30
180'-0"	32

TABLE B

PIER HEIGHT A	TRANSVERSE BRACE
20'-0"	MK 7013
18'-0"	MK 7014
16'-0"	MK 7015
14'-0"	MK 7016
12'-0"	MK 7017
10'-0"	MK 7018
8'-0"	MK 7019



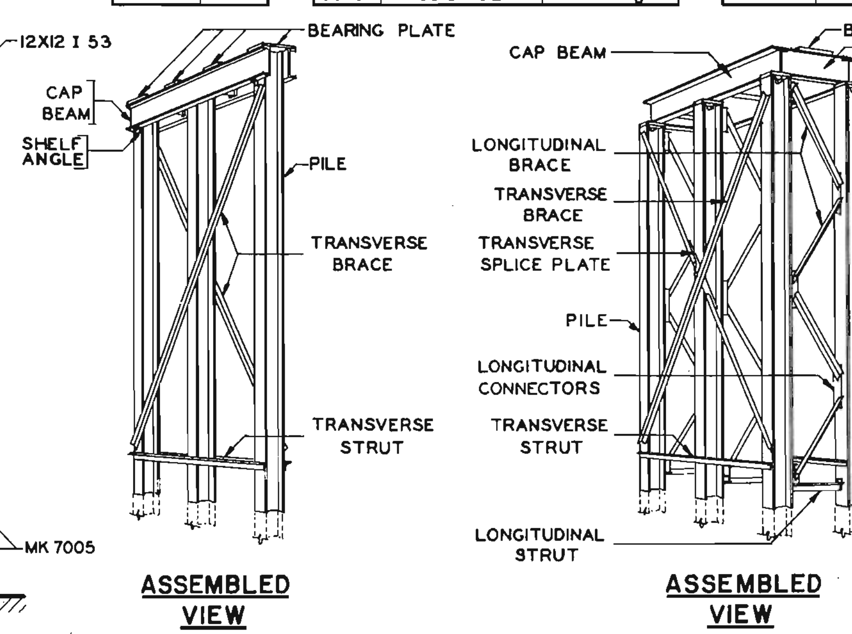
TOP PLAN



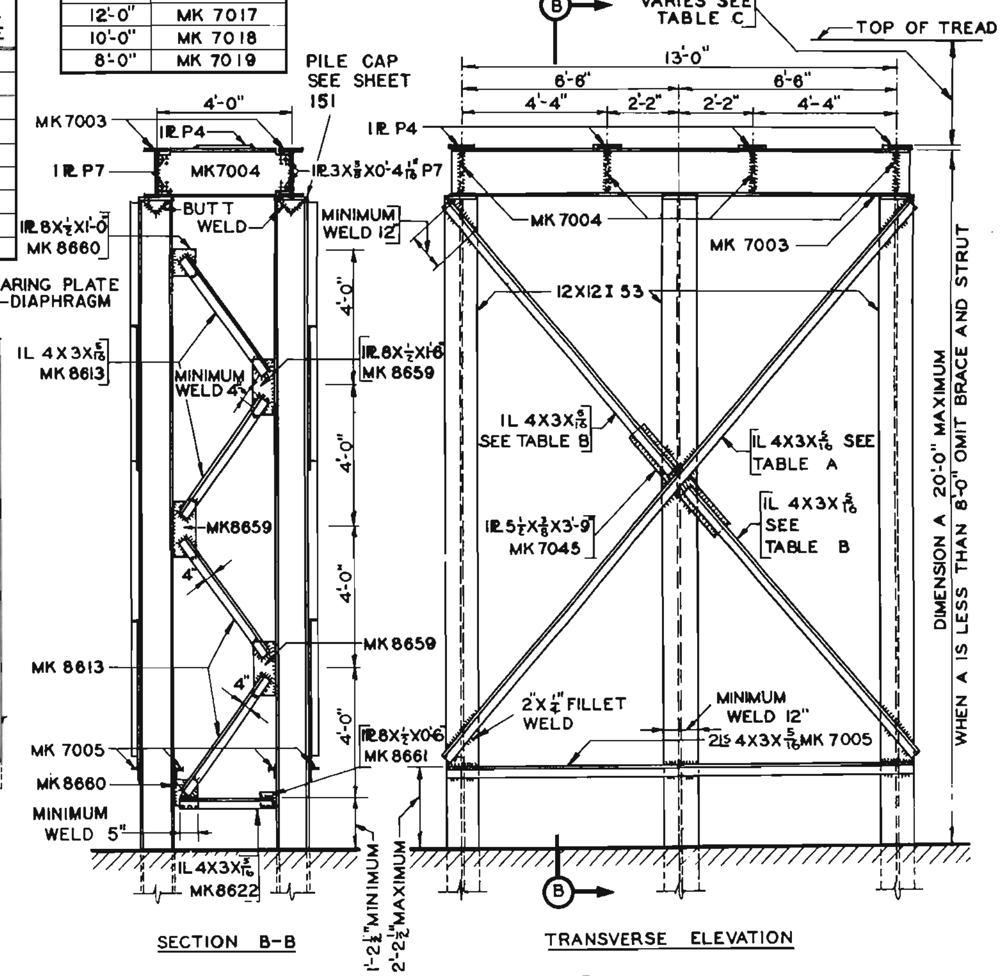
TRANSVERSE ELEVATION

SECTION A-A

THREE-PILE BENT



ALL WELDS SHOWN ARE 1/4" FILLET WELDS UNLESS OTHERWISE INDICATED



SECTION B-B

TRANSVERSE ELEVATION

SIX-PILE PIER

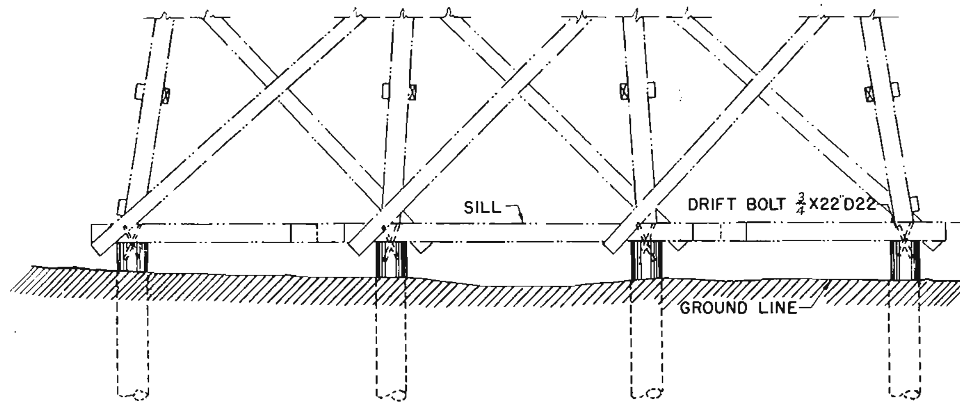
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS	34

BILL OF MATERIALS FOR ONE WELDED STEEL PILE BENT OR PIER

LINE	USE DESCRIPTION	DESCRIPTION					STEEL PILE BENT HEIGHT								STEEL PILE PIER HEIGHT								LINE
		STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	20'	18'	16'	14'	12'	10'	8'	UNDER 8'	20'	18'	16'	14'	12'	10'	8'	UNDER 8'	
							QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	
1	CAP BEAM	48-3790.15-34	7001	15 [33.9	14'-6"	492	2	2	2	2	2	2	2	2									1
2	DO	48-2900.16-045	7003	16 I 58	13'-8 1/2"	792									2	2	2	2	2	2	2	2	2
3	DIAPHRAGM		7002	12X12 I 53	1'-0"	53	2	2	2	2	2	2	2	2									3
4	DO	48-2900.16-045	7004	16 I 58	3'-11 7/16"	229									4	4	4	4	4	4	4	4	4
5	STRUTS AND BRACES	48-2550.4-035	7005	L4 X 3 X 5/16	14'-0"	101	2	2	2	2	2	2	2		4	4	4	4	4	4	4	4	5
6	DO	48-2550.4-035	7006	L4 X 3 X 5/16	21'-1"	152	2								2								6
7	DO	48-2550.4-035	7007	L4 X 3 X 5/16	19'-8"	142		2								2							7
8	DO	48-2550.4-035	7008	L4 X 3 X 5/16	18'-3"	132			2								2						8
9	DO	48-2550.4-035	7009	L4 X 3 X 5/16	17'-1"	123				2								2					9
10	DO	48-2550.4-035	7010	L4 X 3 X 5/16	16'-0"	115					2								2				10
11	DO	48-2550.4-035	7011	L4 X 3 X 5/16	15'-2"	109						2								2			11
12	DO	48-2550.4-035	7012	L4 X 3 X 5/16	14'-6"	105							2								2		12
13	DO	48-2550.4-035	7013	L4 X 3 X 5/16	10'-4"	74									4								13
14	DO	48-2550.4-035	7014	L4 X 3 X 5/16	9'-8"	70										4							14
15	DO	48-2550.4-035	7015	L4 X 3 X 5/16	9'-0"	65											4						15
16	DO	48-2550.4-035	7016	L4 X 3 X 5/16	8'-3"	60												4					16
17	DO	48-2550.4-035	7017	L4 X 3 X 5/16	7'-8"	55													4				17
18	DO	48-2550.4-035	7018	L4 X 3 X 5/16	7'-2"	52														4			18
19	DO	48-2550.4-035	7019	L4 X 3 X 5/16	6'-7"	48															4		19
20	DO	48-2550.4-035	8613	L4 X 3 X 5/16	4'-1 13/16"	30									12	9	9	6	6	3	3		20
21	DO	48-2550.4-035	8622	L4 X 3 X 5/16	2'-9 1/4"	20									3	3	3	3	3	3	3		21
22	CONNECTOR	47-7844.04	7045	PL 5 1/2 X 3/8	3'-9"	26									2	2	2	2	2	2	2		22
23	DO	47-7844.05	8659	PL 8 X 1/2	1'-6"	20									9	6	6	3	3				23
24	DO	47-7844.05	8660	PL 8 X 1/2	1'-0"	14									6	6	6	6	6	6	6		24
25	DO	47-7844.05	8661	PL 8 X 1/2	0'-6"	7									3	3	3	3	3	3	3		25
26	BEARING PLATE	47-7844.07	P3	PL 15 X 3/4	1'-7"	60	4	4	4	4	4	4	4	4									26
27	DO	47-7844.07	P4	PL 10 X 3/4	1'-7"	40									4	4	4	4	4	4	4	4	27
28	BOLTING CLIP	47-7844.04	P7	PL 3 X 3/8	0'-4 1/16"	1									16	16	16	16	16	16	16	16	28
29	SHELF ANGLE	48-2550.4-035	8647	L4 X 3 X 5/16	0'-4"	2	4	4	4	4	4	4	4	4									29
30	WELDING ROD (POUNDS)	46-3772.2		3/16			11	11	11	11	11	11	11	7	33	30	30	27	27	24	24	14	30
31	PILES			12 X 12 I 53	1		3	3	3	3	3	3	3	3	6	6	6	6	6	6	6	6	31
32	PILE CAPS			12 X 12 I 53											6	6	6	6	6	6	6	6	32

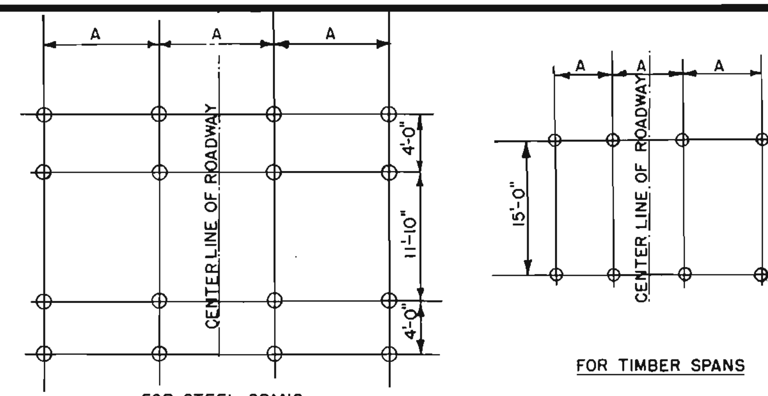
1 PILING LENGTH TO BE DETERMINED BY FIELD CONDITIONS



TRANSVERSE ELEVATION

PILE FOUNDATION ON GROUND

TOWER HEIGHT	DIMENSION A
13'-4"	5'-7$\frac{1}{2}$"
16'	5'-11"
18'	6'-2"
20'	6'-4"
22'	6'-7"
24'	6'-10"
25'-10"	7'-0$\frac{1}{4}$"
28'	7'-3"
30'	7'-6"
32'	7'-8"
34'	7'-11"
36'	8'-2"
38'-4"	8'-4$\frac{7}{8}$"
40'	8'-7"
42'	8'-10"
44'	9'-0"
46'	9'-3"
48'	9'-6"
50'-10"	9'-9$\frac{1}{2}$"
53'	10'-0"
55'	10'-3"
57'	10'-6"
59'	10'-8
61'	10'-11"
63'-4"	11'-2$\frac{1}{4}$"
65'	11'-4"
67'	11'-7"
69'	11'-10"
71'	12'-0"
73'	12'-3"
75	12'-6$\frac{7}{8}$"

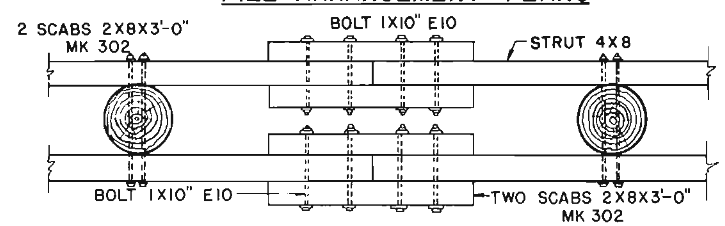


PILE ARRANGEMENT PLANS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155

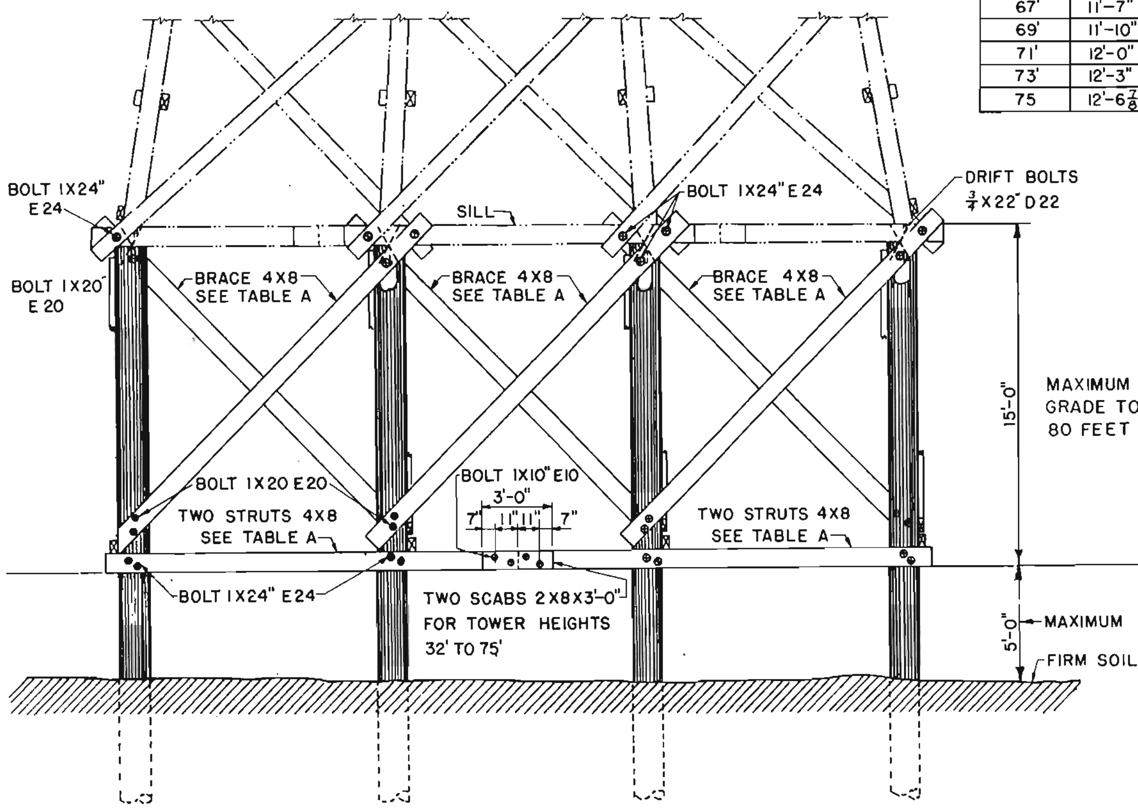
REQUIRED PILE BEARING CAPACITY
18 TONS PER PILE



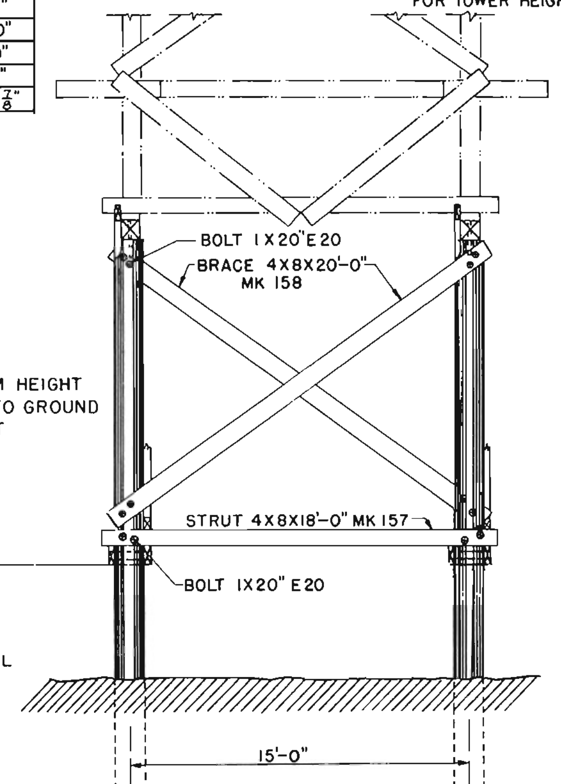
DETAIL OF STRUT SPLICE
FOR TOWER HEIGHT 32' TO 75'

TABLE A

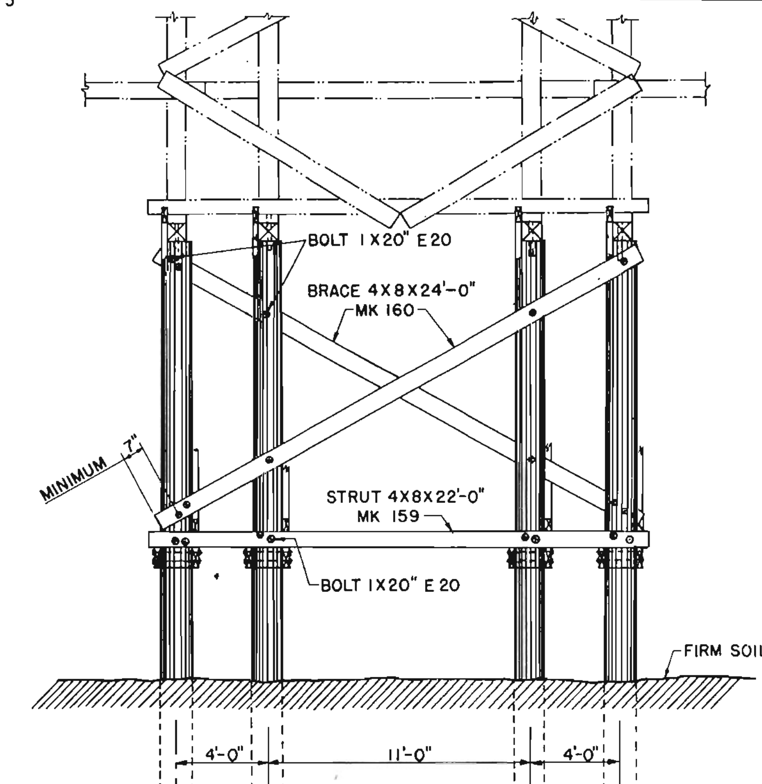
LENGTH OF 4X8 TRANSVERSE BRACING				
TOWER HEIGHT	BRACE		STRUTS	
	LENGTH	MARK	LENGTH	MARK
15' TO 17'	18'-0"	157	20'-0"	158
19' TO 23'	18'-0"	157	22'-0"	159
25' TO 30'	18'-0"	157	24'-0"	160
32' TO 40'	18'-0"	157	14'-0"	155
42' TO 53'	20'-0"	158	16'-0"	156
55' TO 65'	20'-0"	158	18'-0"	157
67' TO 75'	20'-0"	158	20'-0"	158



TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION
TIMBER SPANS

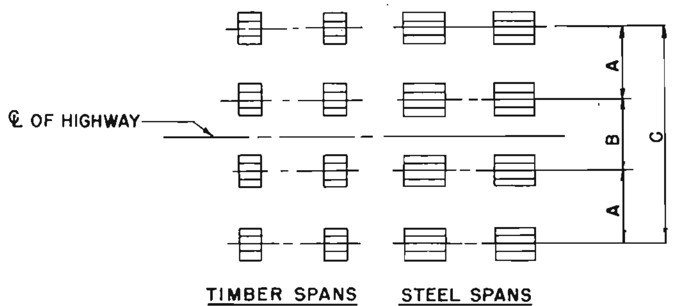


LONGITUDINAL ELEVATION
STEEL SPANS

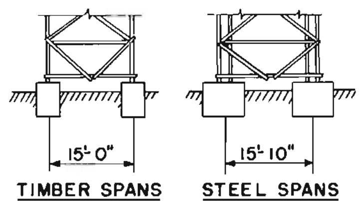
PILE FOUNDATION IN WATER

COMPANION SHEETS

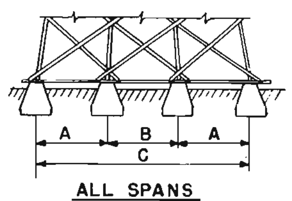
	SHEET
GENERAL NOTES	154
SYMBOLS	155



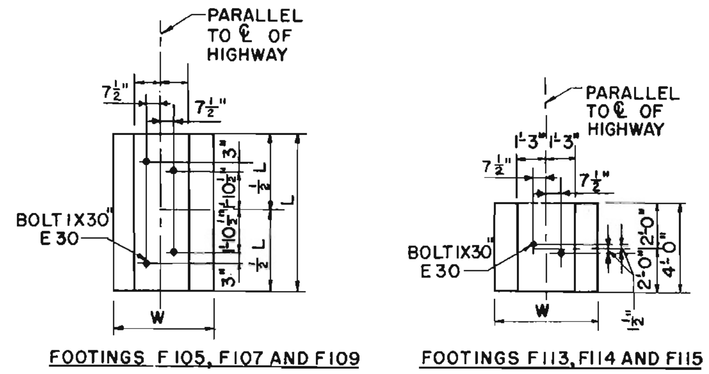
PLAN OF CONCRETE PEDESTALS



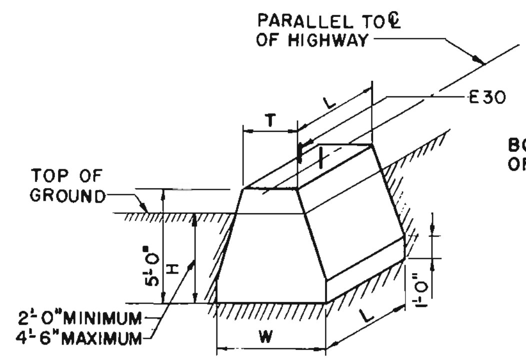
LONGITUDINAL ELEVATIONS



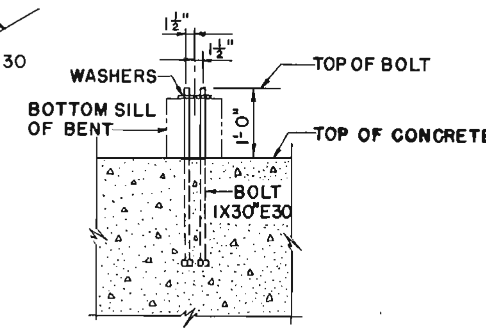
TRANSVERSE ELEVATION



ANCHOR BOLT SETTING PLANS



CONCRETE PEDESTAL



ANCHOR BOLT DETAIL

CONCRETE PEDESTALS

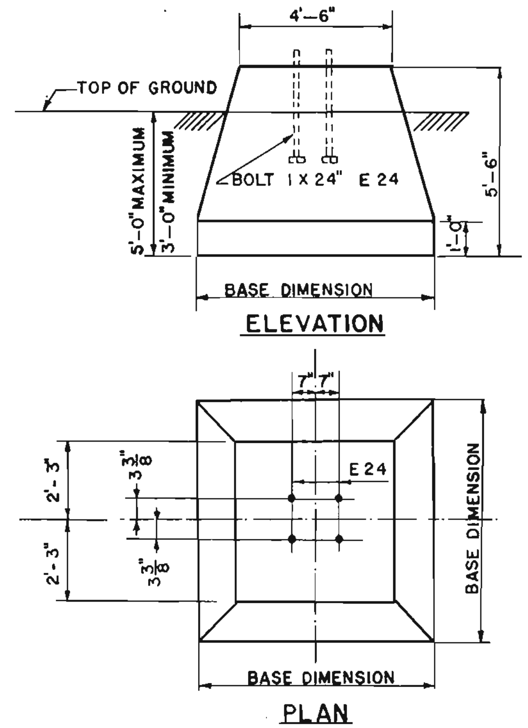
STORIES	TOWER HEIGHT	A	B	C	FOOTING MARK TIMBER SPANS 15'	STEEL SPANS 15' TO 90'
1	13'-4"	5'-7 1/2"	5'-7 1/2"	16'-10 1/2"	F-115	F-109
2	16'	5'-11"	5'-11"	17'-9"	F-115	F-109
	18'	6'-2"	6'-2"	18'-6"	F-115	F-109
	20'	6'-4"	6'-4"	19'-0"	F-115	F-109
	22'	6'-7"	6'-7"	19'-9"	F-115	F-107
	24'	6'-10"	6'-10"	20'-6"	F-115	F-107
	25'-10"	7'-0 1/4"	7'-0 1/4"	21'-0 3/4"	F-115	F-107
3	28'	7'-3"	7'-3"	21'-9"	F-115	F-107
	30'	7'-6"	7'-6"	22'-6"	F-115	F-107
	32'	7'-8"	7'-8"	23'-0"	F-115	F-107
	34'	7'-11"	7'-11"	23'-9"	F-115	F-107
	36'	8'-2"	8'-2"	24'-6"	F-115	F-107
	38'-4"	8'-4 7/8"	8'-4 7/8"	25'-2 5/8"	F-115	F-107
4	40'	8'-7"	8'-7"	25'-9"	F-114	F-107
	42'	8'-10"	8'-10"	26'-6"	F-114	F-107
	44'	9'-0"	9'-0"	27'-0"	F-114	F-107
	46'	9'-3"	9'-3"	27'-9"	F-114	F-107
	48'	9'-6"	9'-6"	28'-6"	F-114	F-107
	50'-10"	9'-9 1/2"	9'-9 1/2"	29'-4 1/2"	F-114	F-105
5	53'	10'-0"	10'-0"	30'-0"	F-114	F-105
	55'	10'-3"	10'-3"	30'-9"	F-114	F-105
	57'	10'-6"	10'-6"	31'-6"	F-114	F-105
	59'	10'-8"	10'-8"	32'-0"	F-114	F-105
	61'	10'-11"	10'-11"	32'-9"	F-113	F-105
	63'-4"	11'-2 1/4"	11'-2 1/4"	33'-6 3/4"	F-113	F-105
6	65'	11'-4"	11'-4"	34'-0"	F-113	F-105
	67'	11'-7"	11'-7"	34'-9"	F-113	F-105
	69'	11'-10"	11'-10"	35'-6"	F-113	F-105
	71'	12'-0"	12'-0"	36'-0"	F-113	F-105
	73'	12'-3"	12'-3"	36'-9"	F-113	F-105
	75'-10"	12'-6 7/8"	12'-6 7/8"	37'-8 5/8"	F-113	F-105

BILL OF MATERIALS FOR ONE
CONCRETE PEDESTAL FOR FRAMED TIMBER TOWERS

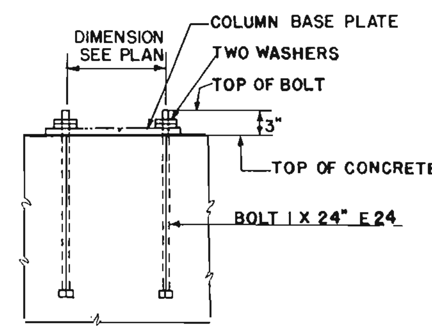
MARK	WIDTH (W)	TOP WIDTH (T)	LENGTH (L)	CONCRETE (CUBIC YARDS MAXIMUM)	MACHINE BOLT 1X30" WITH SQUARE NUT AND TWO WASHERS STOCK NO 43-2325.1-3 QUANTITY	POUNDS
F-105	5'-6"	2'-6"	7'-6"	6.0	4	31
F-107	5'-0"	2'-6"	7'-0"	5.2	4	31
F-109	4'-6"	2'-6"	6'-6"	4.5	4	31
F-113	5'-0"	2'-6"	4'-0"	3.0	2	16
F-114	4'-6"	2'-6"	4'-0"	2.7	2	16
F-115	4'-0"	2'-6"	4'-0"	2.5	2	16

COMPANION SHEETS

	SHEETS
CONCRETE PEDESTALS	39
FRAMED STEEL TOWERS	12,13
GENERAL NOTES	154
SYMBOLS	155



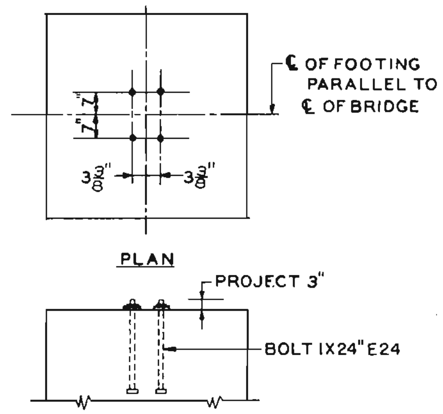
CONCRETE PEDESTALS FOR STEEL TOWERS



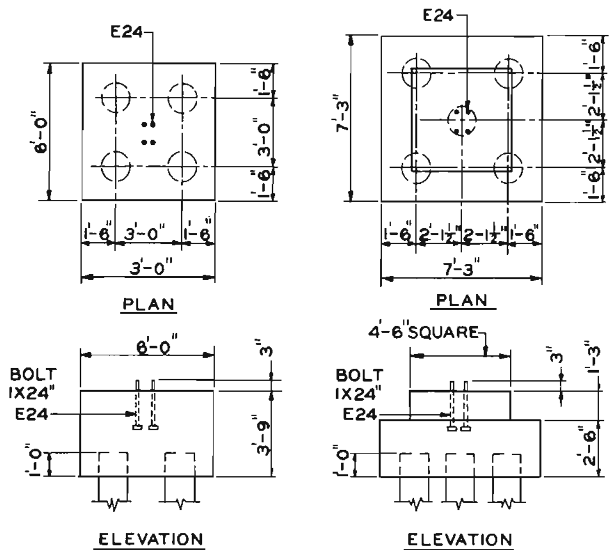
TYPICAL BOLT DETAIL

TABLE OF DIMENSIONS AND
BILL OF MATERIALS FOR ONE PEDESTAL

ADJACENT SPAN	HEIGHT OF TOWER	MARK	BASE DIMENSION	CONCRETE (CUBIC YARDS)	MACHINE BOLT 1X24" WITH SQUARE NUT AND TWO WASHERS STOCK NO 43-2325.1-24	
					QUANTITY	POUNDS
15'	39' OR LOWER	F120	6'-0"	6.0	4	26
	41' TO 77'	F121	7'-0"	7.4	4	26
20'	21' OR LOWER	F120	6'-0"	6.0	4	26
	23' TO 77'	F121	7'-0"	7.4	4	26
30'	21' OR LOWER	F120	6'-0"	6.0	4	26
	23' TO 77'	F121	7'-0"	7.4	4	26
40'	21' OR LOWER	F120	6'-0"	6.0	4	26
	23' TO 77'	F121	7'-0"	7.4	4	26
50'	57' OR LOWER	F121	7'-0"	7.4	4	26
	59' TO 77'	F122	8'-0"	9.1	4	26
60'	39' OR LOWER	F121	7'-0"	7.4	4	26
	41' TO 77'	F122	8'-0"	9.1	4	26
70'	39' OR LOWER	F121	7'-0"	7.4	4	26
	41' TO 77'	F122	8'-0"	9.1	4	26
80'	21' OR LOWER	F121	7'-0"	7.4	4	26
	23' TO 77'	F122	8'-0"	9.1	4	26
90'	21' OR LOWER	F121	7'-0"	7.4	4	26
	23' TO 77'	F122	8'-0"	9.1	4	26



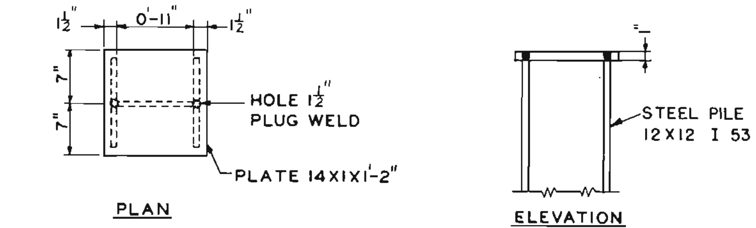
TYPICAL ANCHOR BOLT DETAIL



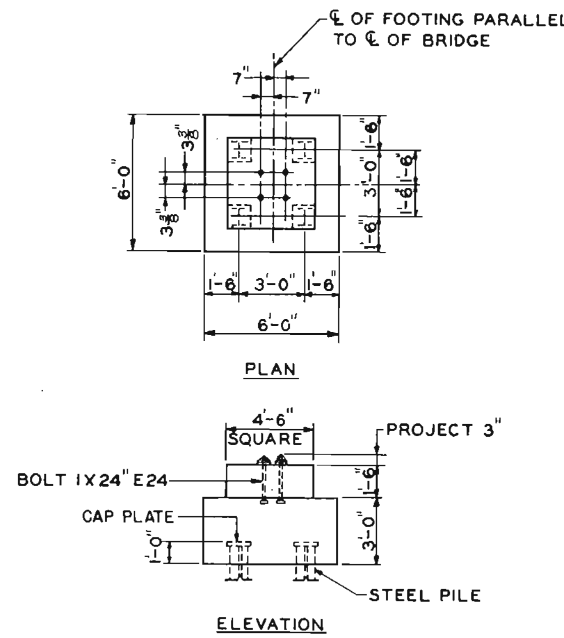
4-PILE FOOTING F134 5-PILE FOOTING F135

BILL OF MATERIALS FOR ONE FOOTING

ADJACENT SPAN (FEET)	HEIGHT OF TOWER (FEET)	FOOTING MARK NUMBER	NUMBER OF PILES	CONCRETE (CUBIC YARDS)	MACHINE BOLT 1X24" E24 WITH SQUARE NUT AND TWO WASHERS, STOCK NUMBER 43-2325.100-24	
					QUANTITY	POUNDS EACH
15'	77' OR LOWER	F134	4	5.0	4	6.5
20'	77' OR LOWER	F134	4	5.0	4	6.5
30'	77' OR LOWER	F134	4	5.0	4	6.5
40'	77' OR LOWER	F134	4	5.0	4	6.5
50'	77' OR LOWER	F134	4	5.0	4	6.5
60'	77' OR LOWER	F134	4	5.0	4	6.5
70'	77' OR LOWER	F134	4	5.0	4	6.5
80'	77' OR LOWER	F134	4	5.0	4	6.5
90'	57' OR LOWER	F134	4	5.0	4	6.5
	59' TO 77'	F135	5	5.8	4	6.5



DETAIL OF CAP PLATE FOR STEEL PILE



STEEL-PILE FOOTING

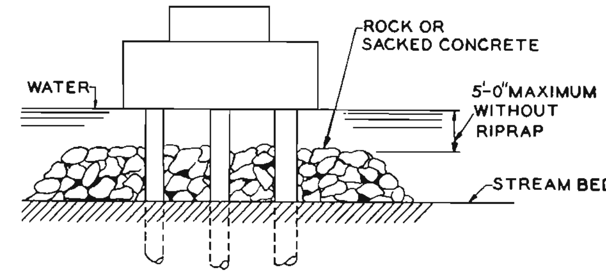
REQUIRED BEARING CAPACITY OF PILES, TONS PER PILE, 4-PILE FOOTING

ADJACENT SPAN	HEIGHT OF TOWER			
	21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
15'	11	12	14	15
20'	11	13	14	16
30'	12	13	15	17
40'	13	14	16	17
50'	14	15	17	18
60'	15	16	18	19
70'	15	17	19	20
80'	16	18	19	21
90'	17	19	20	22 [1]

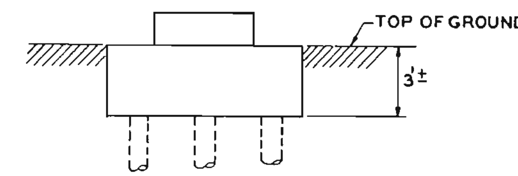
[1] 5-PILE FOOTING 18 TONS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
CONCRETE PEDESTALS	38
FRAMED STEEL TOWERS	12,13



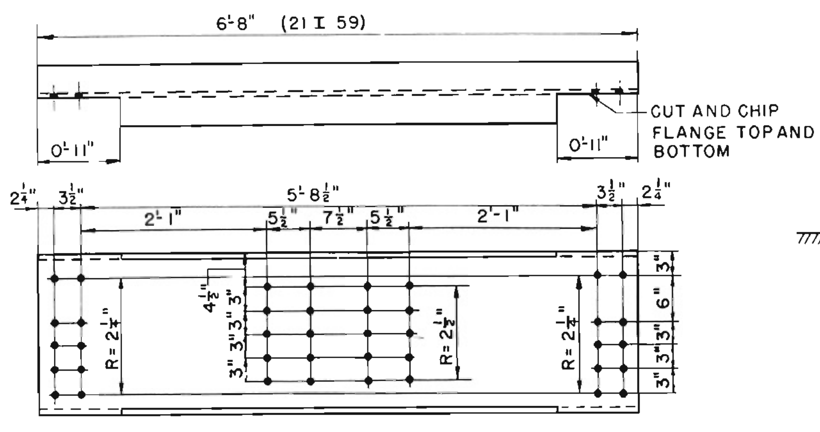
TYPICAL ELEVATION FOR FOOTINGS IN WATER



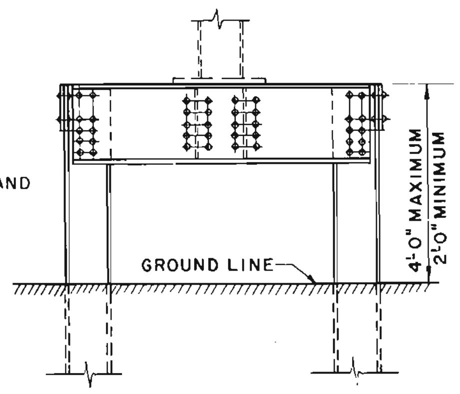
TYPICAL ELEVATION FOR FOOTINGS IN SOIL

COMPANION SHEETS

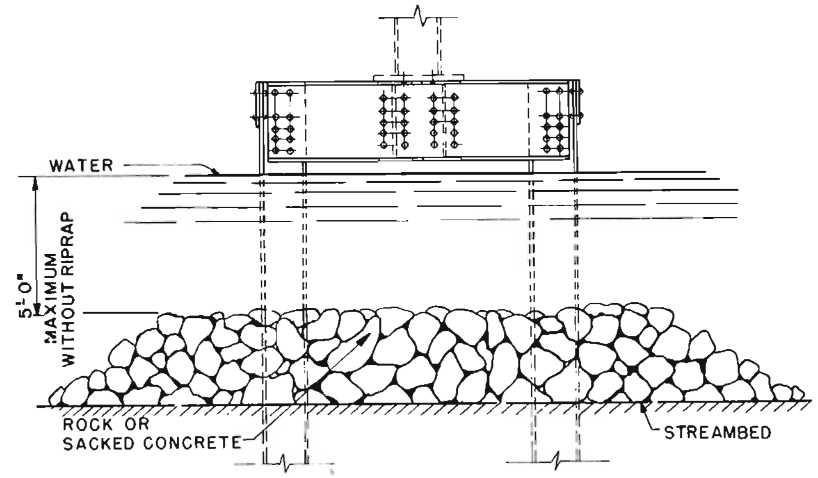
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	12
FRAMED STEEL TOWERS	13



BEAM MK 9052



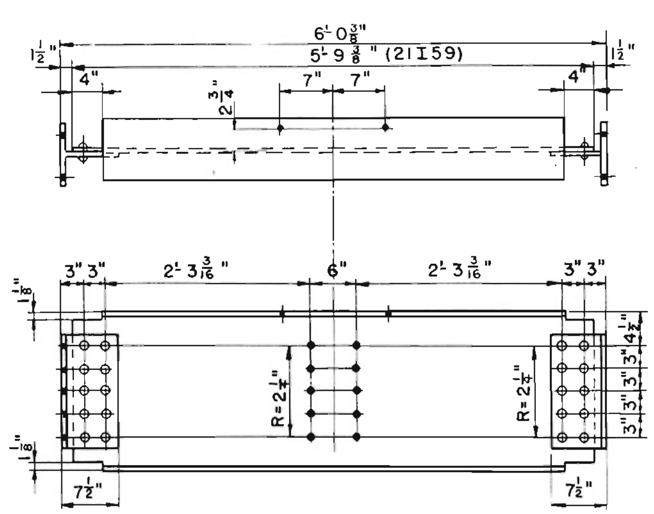
FOOTINGS IN SOIL



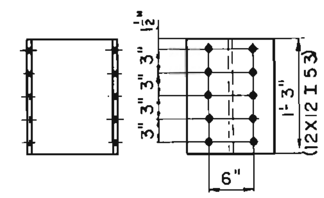
FOOTINGS IN WATER

REQUIRED BEARING CAPACITY OF STEEL PILES, TONS PER PILE

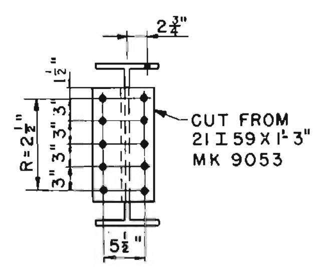
ADJACENT SPAN	HEIGHT OF TOWER			
	21' OR LOWER	23' TO 39'	41' TO 57	59' TO 77'
15'	11	12	14	15
20'	11	13	14	16
30'	12	13	15	17
40'	13	14	16	17
50'	14	15	17	18
60'	15	16	18	19
70'	15	17	19	20
80'	16	18	19	21
90'	17	19	20	22

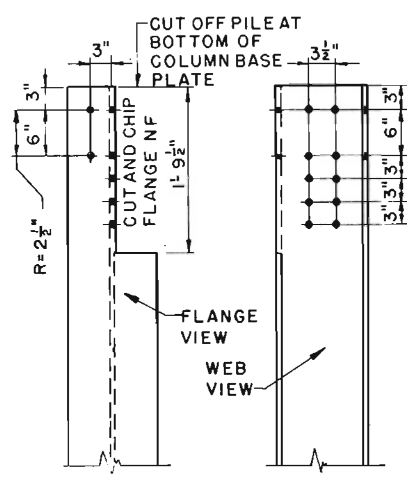


BEAM MK 9051

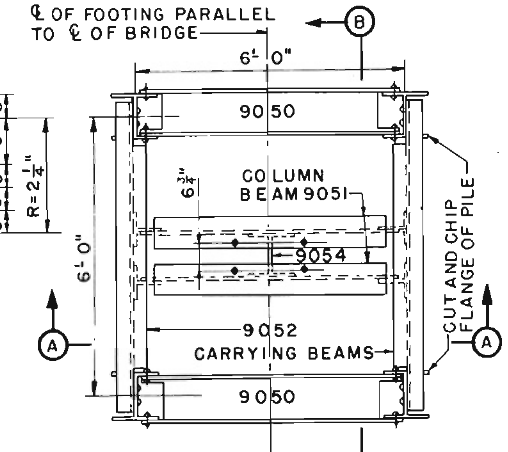


DIAPHRAGM MK 9054

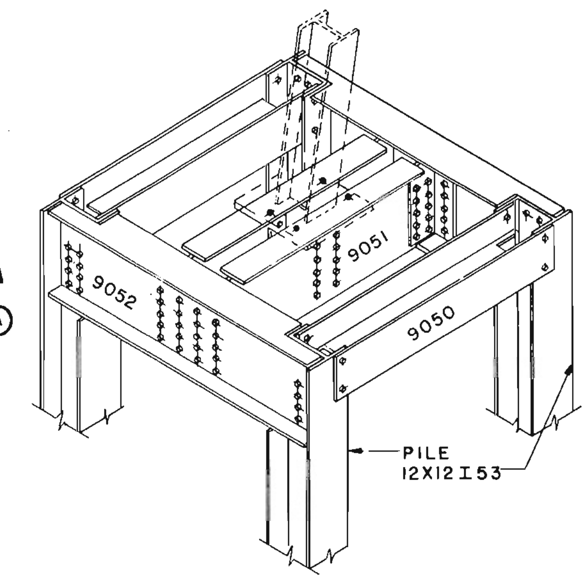




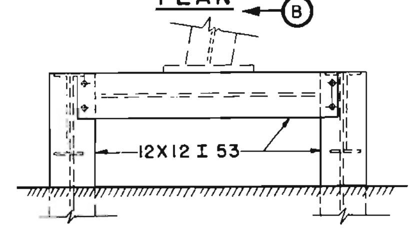
DETAIL AT TOP OF PILE



PLAN



ASSEMBLED VIEW

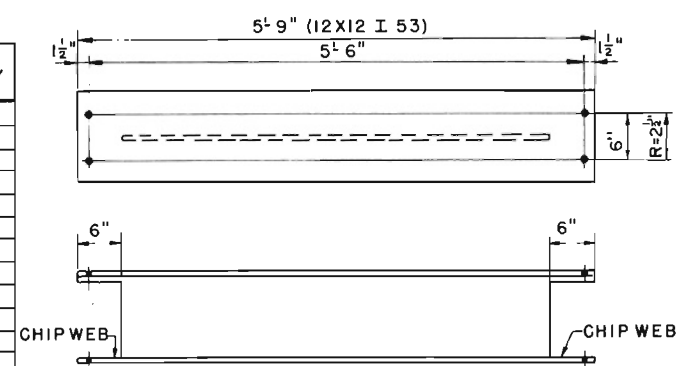


END VIEW

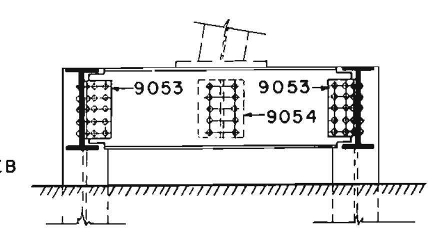
BILL OF MATERIALS FOR ONE FOOTING

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	QUANTITY
1	PILE			12X12 I 53	—	—	4
2	BEAM	48-2900.21-059	9052	21 I 59	6'-8"	390	2
3	BEAM	48-2900.21-059	9051	21 I 59	5'-9½"	339	2
4	BEAM		9050	12X12 I 53	5'-9"	305	2
5	CONNECTION	48-2900.21-059	9053	21 I 59	1'-3"	34	4
6	DIAPHRAGM		9054	12X12 I 53	1'-3"	66	1
7	RIVET	43-6353.08-25		7/8	2½"	.62	40
8	RIVET	43-6353.08-23		7/8	2¼"	.57	116
9	RIVET BOLT WITH NUT		G8	7/8	3"	1.09	4
10	WASHER, STANDARD ROUND	43-9215.5-08		2½ X 5/32		.18	4

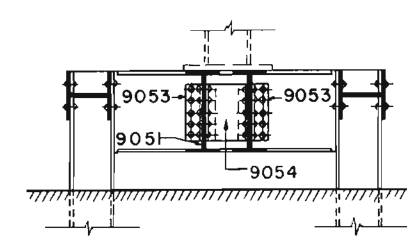
NOTE
LENGTH OF PILES DETERMINED BY CONDITIONS AT THE SITE AND BEARING CAPACITY REQUIRED.



BEAM MK 9050



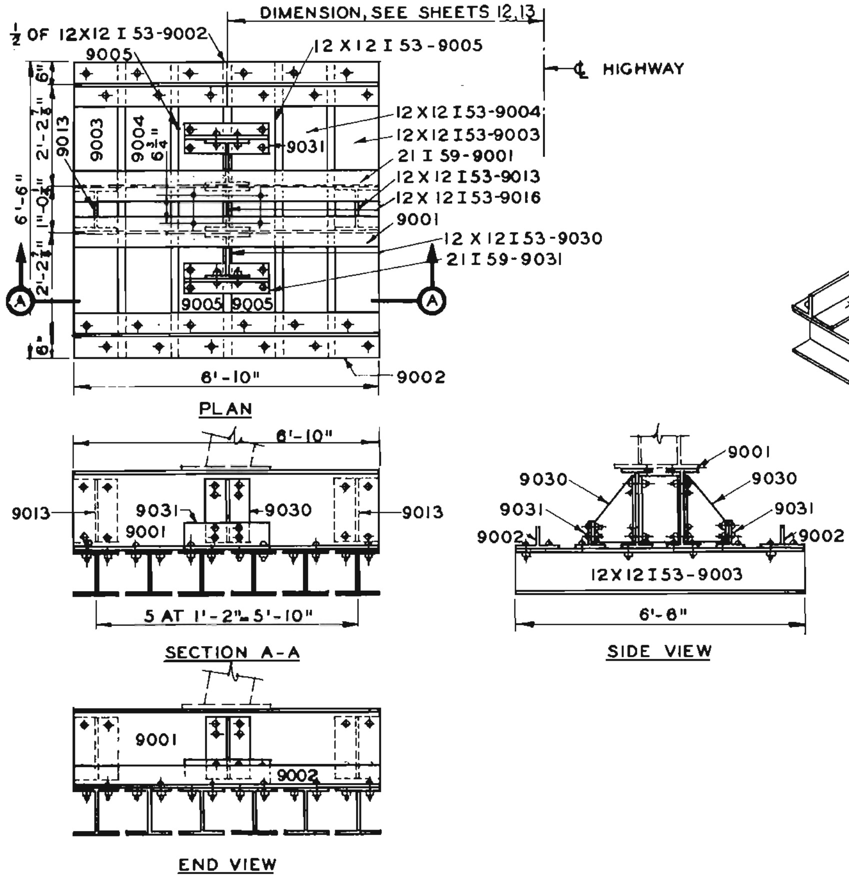
SECTION A-A



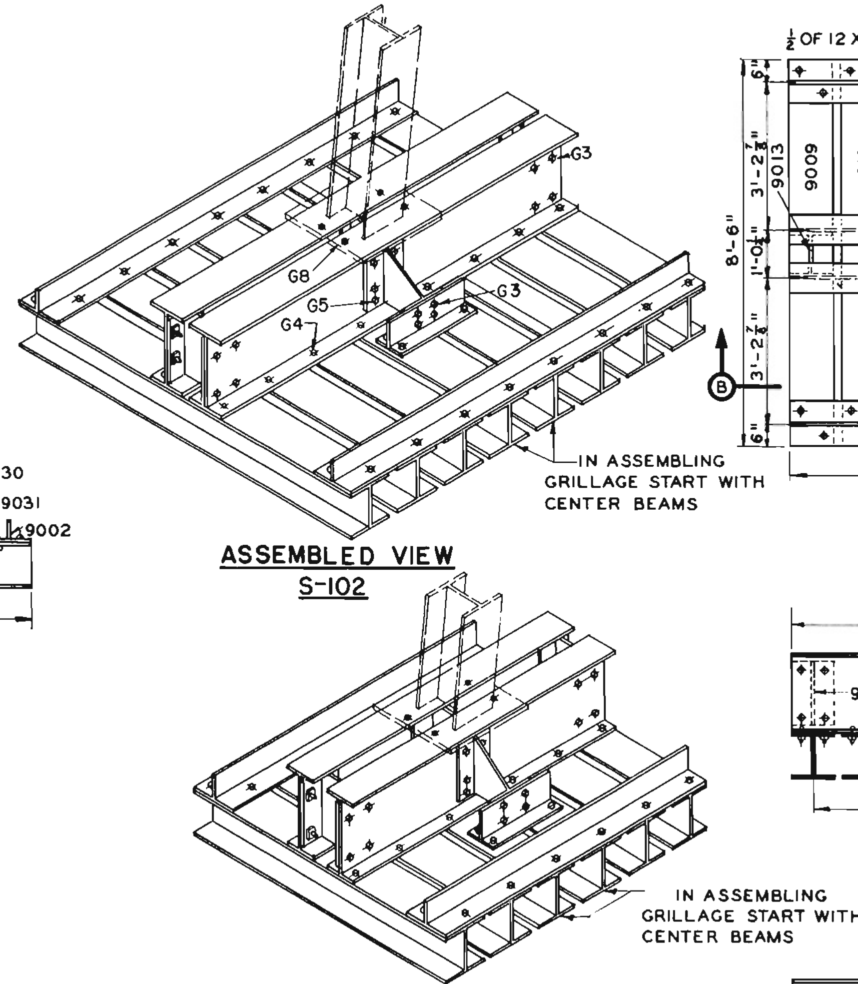
SECTION B-B

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	12,13
FABRICATION DRAWING	152

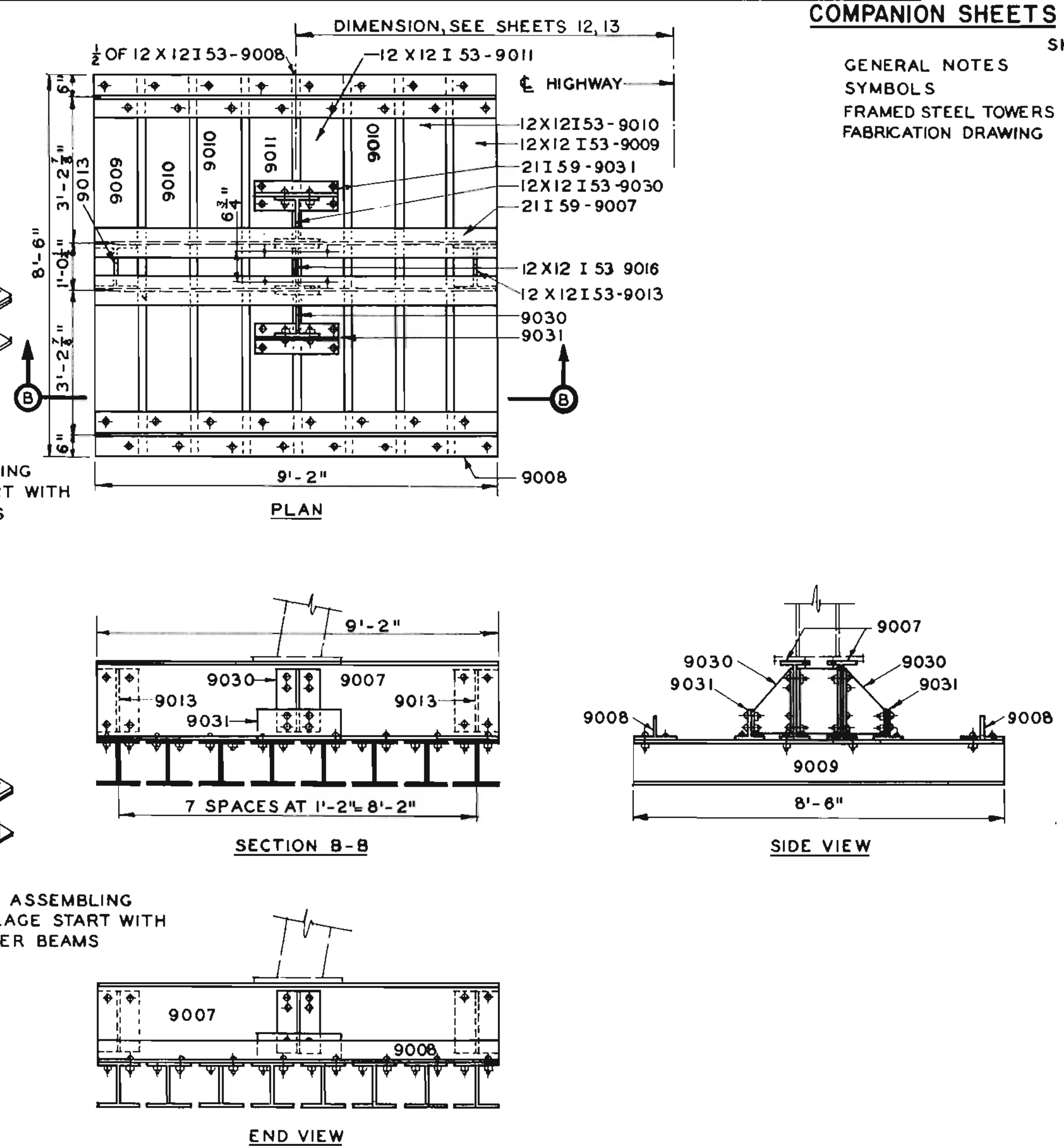


GRILLAGE FOOTING
S-101



ASSEMBLED VIEW
S-102

ASSEMBLED VIEW
S-101



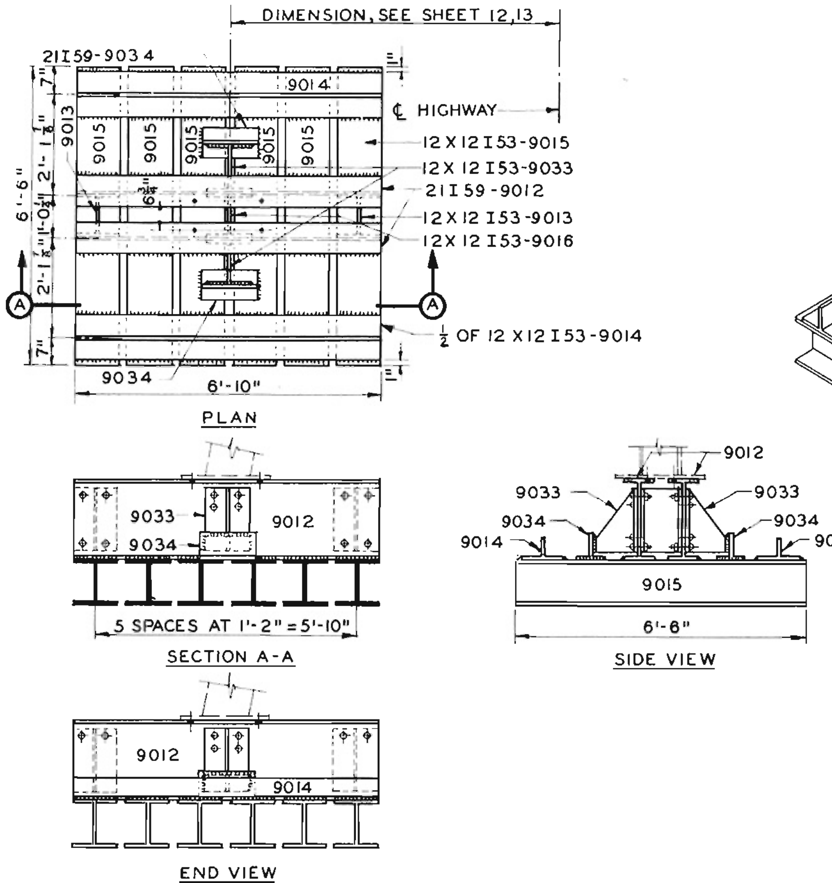
GRILLAGE FOOTING S-102

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

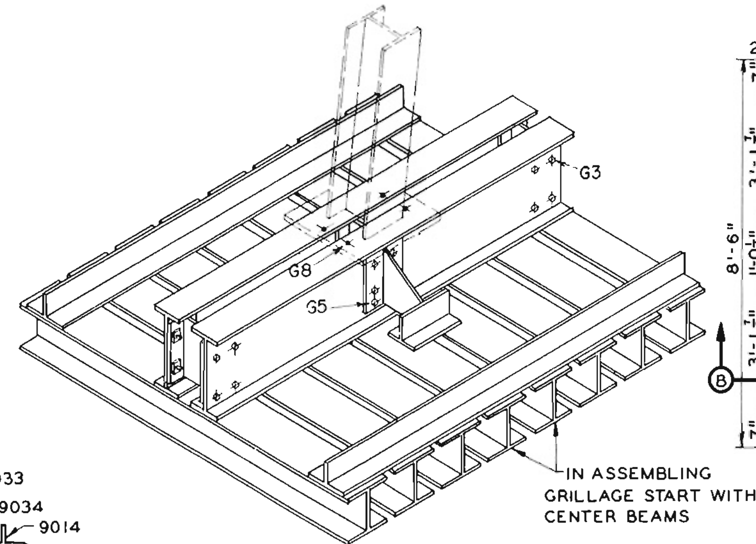
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9001	21 I 59	6'-10"	403	2	
2	TOP TIER HALF BEAM		9002	12X12 I 53	6'-10"	180	2	
3	BOTTOM TIER BEAM		9003	12X12 I 53	6'-6"	345	2	
4	BOTTOM TIER BEAM		9004	12X12 I 53	6'-6"	345	2	
5	BOTTOM TIER BEAM		9005	12X12 I 53	6'-6"	345	2	
6	TOP TIER BEAM	48-2900.21-059	9007	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM		9008	12X12 I 53	9'-2"	243		2
8	BOTTOM TIER BEAM		9009	12X12 I 53	8'-6"	450		2
9	BOTTOM TIER BEAM		9010	12X12 I 53	8'-6"	450		4
10	BOTTOM TIER BEAM		9011	12X12 I 53	8'-6"	450		2
11	SEPARATOR		9013	12X12 I 53	1'-6"	80	2	2
12	SEPARATOR		9016	12X12 I 53	1'-6"	80	1	1
13	BRACE		9030	12X12 I 53	1'-6"	53	2	2
14	BRACE	48-2900.21-059	9031	21 I 59	1'-11"	50	2	2
						TOTAL WEIGHT		
15	RIVET BOLT		G3	$\frac{7}{8}$	$2\frac{1}{16}$"	45	48	58
16	RIVET BOLT		G4	$\frac{7}{8}$	$2\frac{1}{4}$"	23	24	28
17	RIVET BOLT		G5	$\frac{7}{8}$	$2\frac{7}{16}$"	16	16	16
18	RIVET BOLT AND WASHER		G8	$\frac{7}{8}$	3 "	5	4	4

SCHEDULE FOR SELECTION OF GRILLAGE FOOTING FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

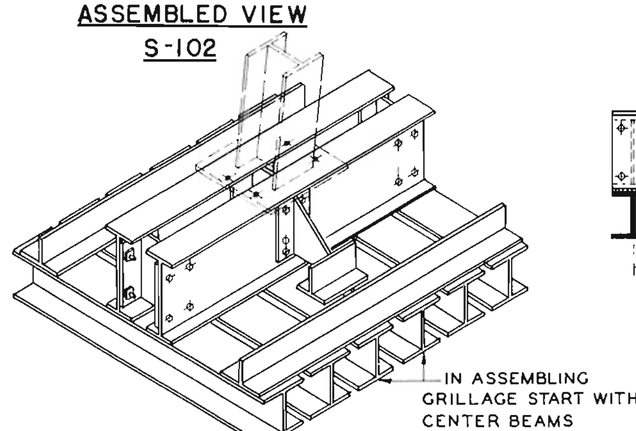
DESCRIPTION	SPAN BETWEEN TOWERS	FOOTINGS ON SOIL				FOOTINGS ON ROCK
		HEIGHT OF TOWER				
		UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	ALL TOWER HEIGHTS
SINGLE LANE CLASS 50	15' TO 50'	S-101	S-101	S-101	S-101	S-101
DO	60'	S-101	S-101	S-101	S-102	S-101
DO	70'	S-101	S-101	S-101	S-102	S-101
DO	80'	S-101	S-101	S-102	S-102	S-101
DO	90'	S-101	S-101	S-102	S-102	S-101



GRILLAGE FOOTING
S-101

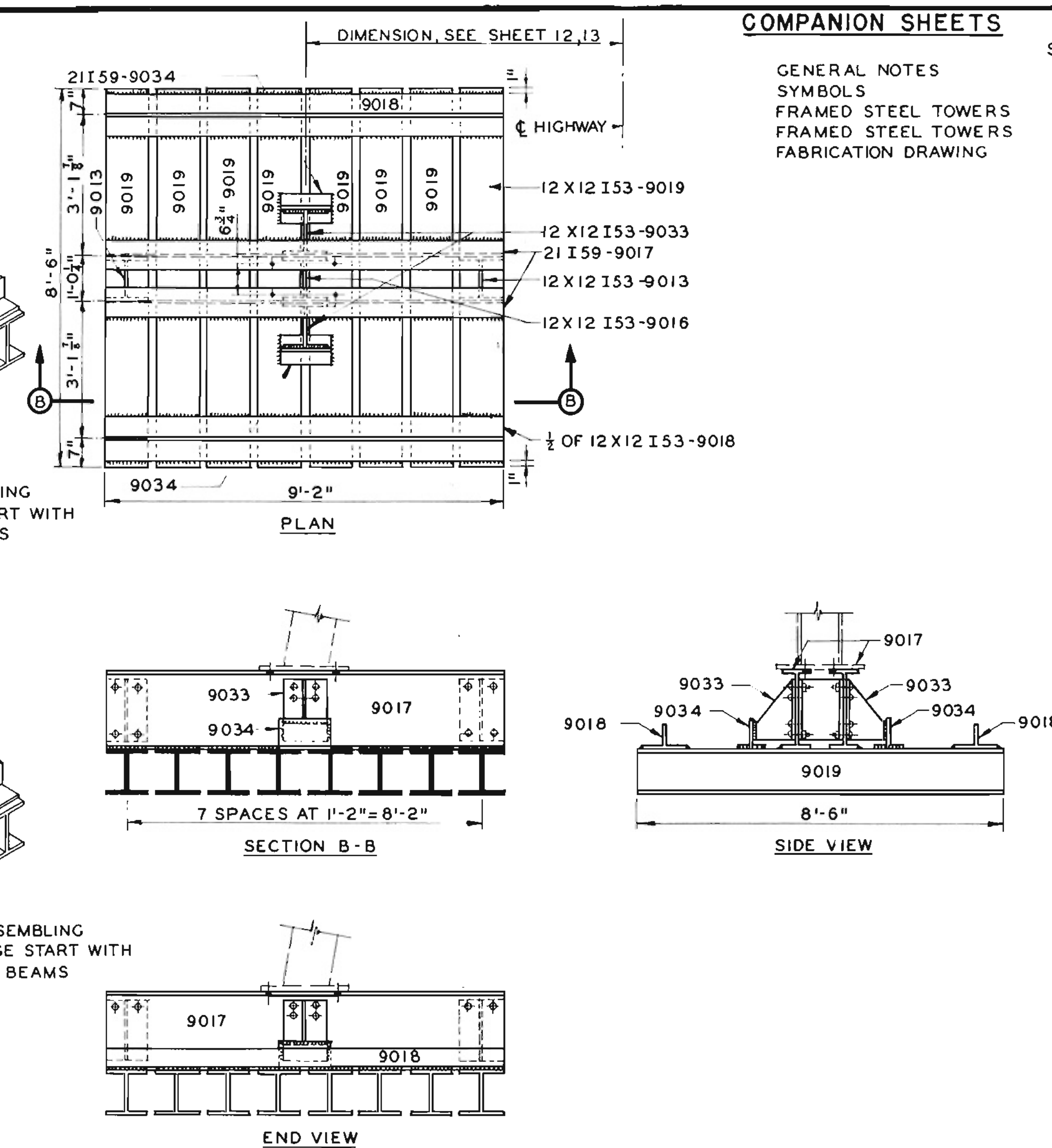


ASSEMBLED VIEW
S-102



ASSEMBLED VIEW
S-101

ALL WELDS SHOWN ARE ¼" FILLET WELDS UNLESS OTHERWISE NOTED



GRILLAGE FOOTING
S-102

COMPANION SHEETS

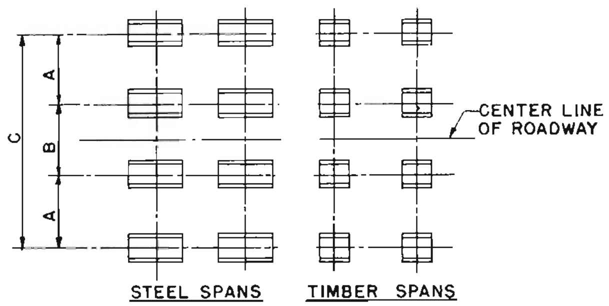
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	12
FRAMED STEEL TOWERS	13
FABRICATION DRAWING	153

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

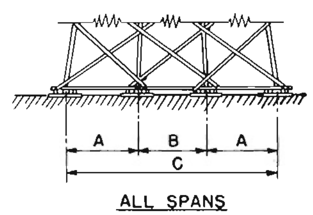
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9012	21 I 59	6'-10"	403	2	
2	SEPARATOR		9013	12X12 I 53	1'-6"	80	2	2
3	TOP TIER HALF BEAM		9014	12X12 I 53	6'-10"	180	2	
4	BOTTOM TIER BEAM		9015	12X12 I 53	6'-6"	345	6	
5	SEPARATOR		9016	12X12 I 53	1'-6"	80	1	1
6	TOP TIER BEAM	48-2900.21-059	9017	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM		9018	12X12 I 53	9'-2"	243		2
8	BOTTOM TIER BEAM		9019	12X12 I 53	8'-6"	450		8
9	BRACE		9033	12X12 I 53	1'-6"	53	2	2
10	BRACE	48-2900.21-059	9034	21 I 59	1'-2"	35	2	2
						TOTAL WEIGHT		
11	RIVET BOLT		G3	⅞	$2\frac{1}{16}$"	15	16	16
12	RIVET BOLT		G5	⅞	$2\frac{7}{16}$"	16	16	16
13	RIVET BOLT AND WASHER		G8	⅞	3"	5	4	4
14	WELDING ELECTRODE	46-3772.2-7		$\frac{3}{16}$	-		9 LBS.	12 LBS.

SCHEDULE FOR SELECTION OF GRILLAGE FOOTINGS FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

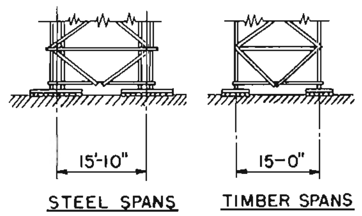
SPAN BETWEEN TOWERS	FOOTINGS ON SOIL — HEIGHT OF TOWER: UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	FOOTINGS ON ROCK — ALL TOWER HEIGHTS
15' TO 50'	S-101	S-101	S-101	S-101	S-101
60'	S-101	S-101	S-101	S-102	S-101
70'	S-101	S-101	S-101	S-102	S-101
80'	S-101	S-101	S-102	S-102	S-101
90'	S-101	S-101	S-102	S-102	S-101



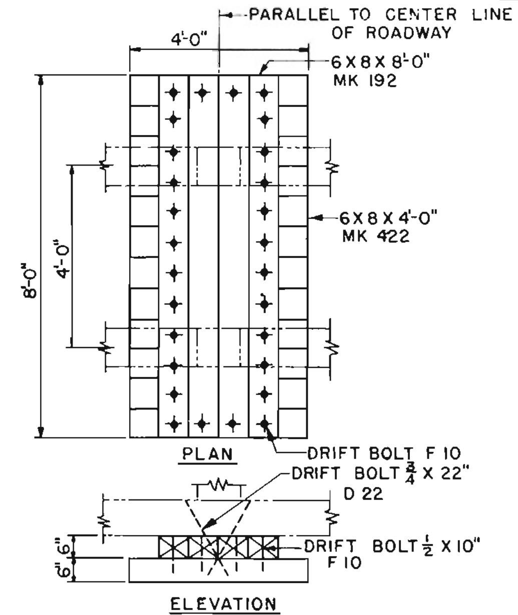
TIMBER GRILLAGES



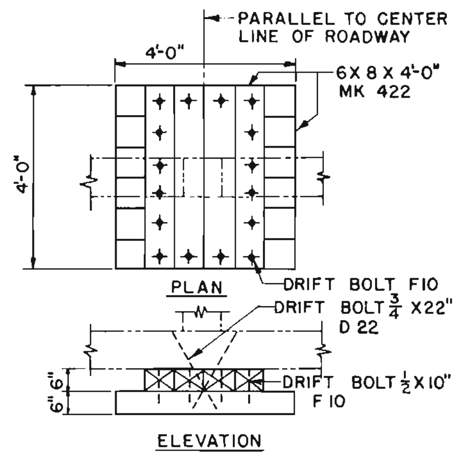
TRANSVERSE ELEVATION



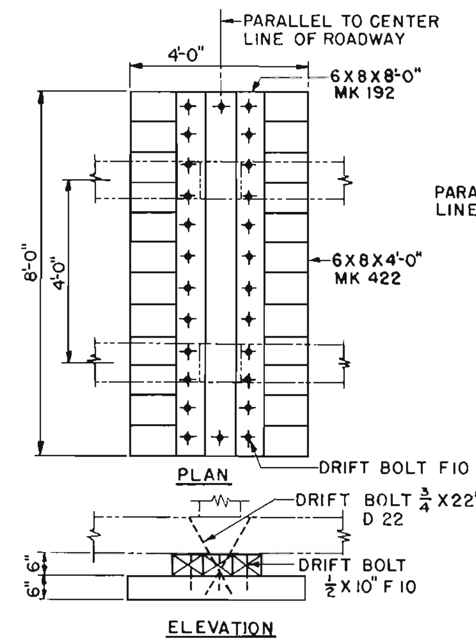
LONGITUDINAL ELEVATIONS



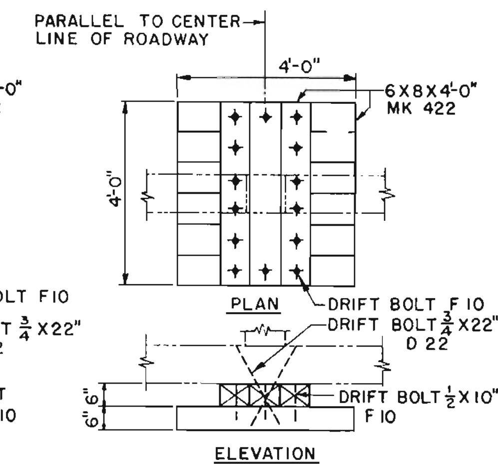
G 113



G 114



G 117



G 118

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155

TIMBER GRILLAGE FOOTINGS

STORIES	TOWER HEIGHT	A	B	C	FOOTING MARK: TIMBER SPANS 15'	FOOTING MARK: STEEL SPANS 15' TO 90'
1	13'-4"	5'-7½"	5'-7½"	16'-10½"	G-118	G-117
2	16'	5'-11"	5'-11"	17'-9"	G-118	G-117
	18'	6'-2"	6'-2"	18'-6"	G-118	G-117
	20'	6'-4"	6'-4"	19'-0"	G-118	G-117
	22'	6'-7"	6'-7"	19'-9"	G-118	G-117
	24'	6'-10"	6'-10"	20'-6"	G-118	G-117
	25'-10"	7-0¼"	7'-0¼"	21'-0¾"	G-118	G-117
3	28'	7'-3"	7'-3"	21'-9"	G-118	G-117
	30'	7'-6"	7'-6"	22'-6"	G-118	G-117
	32'	7'-8"	7'-8"	23'-0"	G-118	G-117
	34'	7'-11"	7'-11"	23'-9"	G-118	G-117
	36'	8'-2"	8'-2"	24'-6"	G-118	G-117
	38'-4"	8'-4⅞"	8-4⅞"	25'-2⅝"	G-118	G-117
4	40'	8'-7"	8'-7"	25'-9"	G-118	G-117
	42'	8'-10"	8'-10"	26'-6"	G-118	G-117
	44'	9'-0"	9'-0"	27'-0"	G-118	G-117
	46'	9'-3"	9'-3"	27'-9"	G-118	G-117
	48'	9'-6"	9'-6"	28'-6"	G-118	G-117
	50'-10'	9'-9½"	9'-9½"	29'-4½"	G-118	G-117
5	53'	10'-0"	10'-0"	30'-0"	G-114	G-113
	55'	10'-3"	10'-3"	30'-9"	G-114	G-113
	57	10'-6"	10'-6"	31'-6"	G-114	G-113
	59'	10'-8"	10'-8"	32'-0"	G-114	G-113
	61'	10'-11"	10'-11"	32'-9"	G-114	G-113
	63'-4"	11'-2¼"	11'-2¼"	33'-6¾"	G-114	G-113
6	65'	11'-4"	11'-4"	34'-0"	G-114	G-113
	67'	11'-7'	11'-7"	34'-9"	G-114	G-113
	69'	11'-10"	11'-10"	35'-6"	G-114	G-113
	71'	12'-0"	12'-0"	36'-0"	G 114	G-113
	73'	12'-3"	12'-3"	36'-9"	G-114	G-113
	75'-10"	12'-6⅞"	12'-6⅞"	37'-8⅝"	G-114	G-113

BILL OF MATERIALS FOR ONE TIMBER GRILLAGE

						GRILLAGE NUMBER	G 113		G 114		G 117		G 118	
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	QUANTITY	FEET B.M.	QUANTITY	FEET B.M.	QUANTITY	FEET B.M.	QUANTITY	FEET B.M.
LUMBER, SOFT WOOD														
1	GRILLAGE	39-9352.680-	192	6X8	8'-0"	120	4	128			3	96		
2	GRILLAGE	39-9352.680-	422	6X8	4'-0"	60	12	192	10	160	12	192	9	144
STEEL HARDWARE, BLACK														
3	DRIFT BOLT	43-1636.07-22	D22	¾	22"	2.75	4		2		4		2	
4	DRIFT BOLT	43-1636.05-10	F 10	½	10"	0.6	28		16		26		14	

SET NUMBER 50D-1

TIMBER SPANS
(11 to 15 feet long)

SHEET	
45	General views
46	Bill of materials
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
154	General notes
155	Structural symbols

SET NUMBER 50D-2

STEEL SPANS
(15 to 90 feet long)

47	General views
48	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
49	Bill of materials: steel for welded construction: lumber and hardware for alternate laminated floor
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
131	Riveted construction: fabrication of stringers 501 to 511 and of diaphragms 527 and 528
132	Riveted construction: fabrication of stringers 516 and 521 and of bearing plates 3500 and 3501
134	Riveted construction: fabrication of stringers 519 and 526
135	Riveted construction: fabrication of stringers 515 and 522
137	Riveted construction: fabrication of stringers 514, 517, and 518
138	Riveted construction: fabrication of stringers 520 and 524
139	Welded construction: fabrication of stringers 501W to 511W and of diaphragms C3 and C4
141	Welded construction: fabrication of stringers 513W, 522W, and 523W
142	Welded construction: fabrication of stringers 514W, 515W, and 516W
144	Welded construction: fabrication of stringers 517W and 526W
145	Welded construction: fabrication of stringers 518W, 519W, and 524W
154	General notes
155	Structural symbols

SET NUMBER 50D-3

TIMBER TOWERS FOR TIMBER SPANS
(15 to 76 feet high)

50	General views
51	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connection and of columns; column dimensions
154	General notes
155	Structural symbols

SET NUMBER 50D-4

TIMBER TOWERS FOR STEEL SPANS
(15 to 76 feet high)

52	Details and bill of materials for connection of spans to towers
53	General views
54	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connections and of columns; column dimensions
149	Details of towers supporting both timber and steel spans
154	General notes
155	Structural symbols

SET NUMBER 50D-5

STEEL TOWERS FOR STEEL SPANS
(15 to 77 feet high)

SHEET	
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
57	Bill of materials common to all towers
58	Bill of materials which vary with tower height
59	Riveted construction: fabrication of cap beam, strut, and pin
60	Riveted construction: fabrication of columns
61	Riveted construction: fabrication of columns and struts
62	Fabrication of rod bracing
63	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
226	Welded construction with rod bracing: cap beams and column splices welded in fabrication and erection
227	Welded construction with welded angle bracing: cap beams and column splices welded in fabrication and erection
154	General notes
155	Structural symbols

NOTE: When welded construction is used in accordance with sheets 226 or 227, bills of materials on sheets 57 and 58 and fabrication details on sheets 59, 60, and 61 must be adjusted in the field. When sheet 227 is used, sheet 62 does not apply.

SET NUMBER 50D-6

TIMBER ABUTMENTS FOR TIMBER SPANS

64	General views of pile abutments; bill of materials for pile and grillage abutments
65	General views of grillage abutments
154	General notes
155	Structural symbols

SET NUMBER 50D-7

ABUTMENTS FOR STEEL SPANS

66	General views of timber pile abutments
67	General views of timber grillage abutments
68	Bill of materials for timber pile and grillage abutments
69	General views of steel pile abutments
70	Fabrication details and bill of materials for steel pile abutments
71	General views and bill of materials for concrete abutments
154	General notes
155	Structural symbols

SET NUMBER 50D-8

TIMBER PILE BENTS FOR TIMBER SPANS
(1 to 28 feet high)

72	Bill of materials; general views of 1- to 16-foot bents
73	General views of 17- to 28-foot bents
154	General notes
155	Structural symbols

SET NUMBER 50D-9

TIMBER PILE PIERS FOR STEEL SPANS
(1 to 13 feet high)

74	General views
75	Bill of materials; details of piers supporting one steel and one timber span
154	General notes
155	Structural symbols

SET NUMBER 50D-10

STEEL PILE BENTS AND PIERS FOR STEEL SPANS
(1 to 20 feet high)

SHEET	
76	Riveted construction: general views of bents
77	Riveted construction: general views of piers
78	Riveted and welded construction: bill of materials
79	Welded construction: general views of bents
80	Welded construction: general views of piers
150	Riveted construction: fabrication of cap beams, corbels, bracing, and connections
151	Welded construction: fabrication of cap beams, corbels, and bearing plates
154	General notes
155	Structural symbols

SET NUMBER 50D-11

TIMBER SILL AND PILE FOUNDATIONS FOR TIMBER TOWERS

81	General views
82	Additional views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER 50D-12

CONCRETE PEDESTALS FOR TIMBER TOWERS

83	General views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER 50D-13

CONCRETE PEDESTALS FOR STEEL TOWERS

SHEET	
84	General views and bill of materials for pedestals on timber piles
85	General views and bill of materials for pedestals on ground and on steel piles
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 50D-14

STEEL FRAME ON STEEL PILE FOUNDATIONS FOR STEEL TOWERS

86	General views and bill of materials
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 50D-15

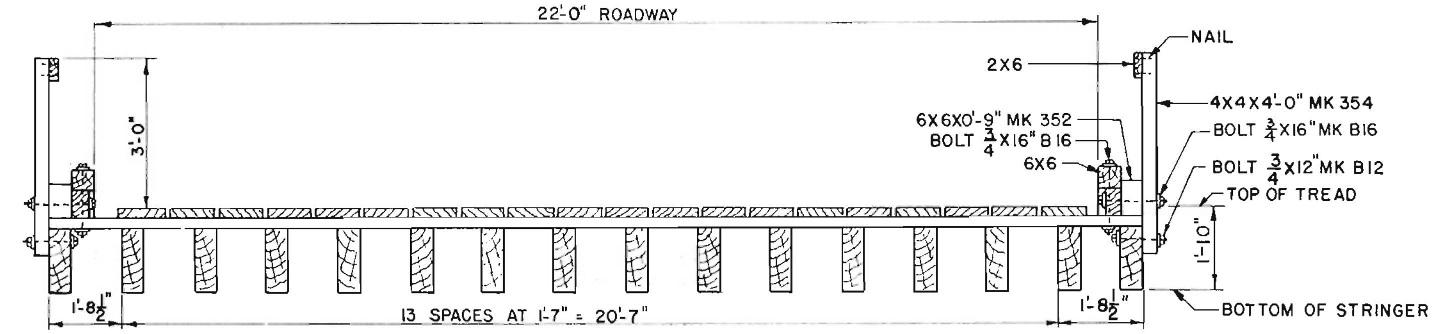
STEEL GRILLAGE FOUNDATIONS FOR STEEL TOWERS

87	Bolted construction: general views and bill of materials
88	Welded construction: general views and bill of materials
152	Bolted construction: fabrication of grillage beams
153	Welded construction: fabrication of grillage beams
55	General views of 69- to 77- foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 50D-16

TIMBER GRILLAGE FOUNDATIONS FOR TIMBER TOWERS

89	General views
90	Additional views and bill of materials
154	General notes
155	Structural symbols



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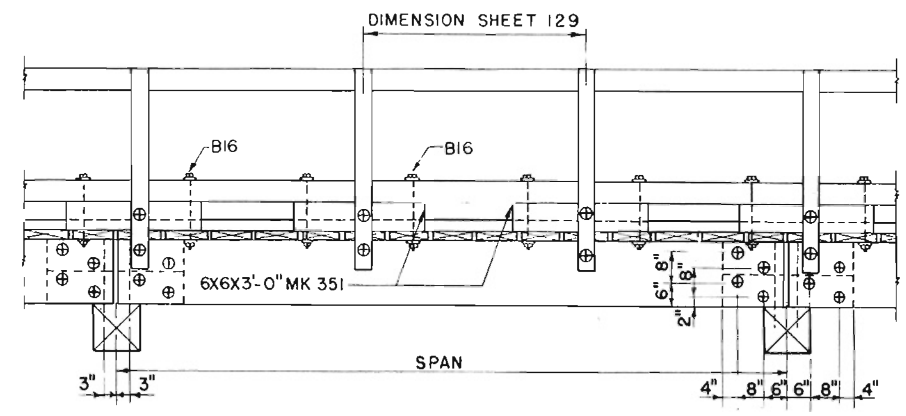

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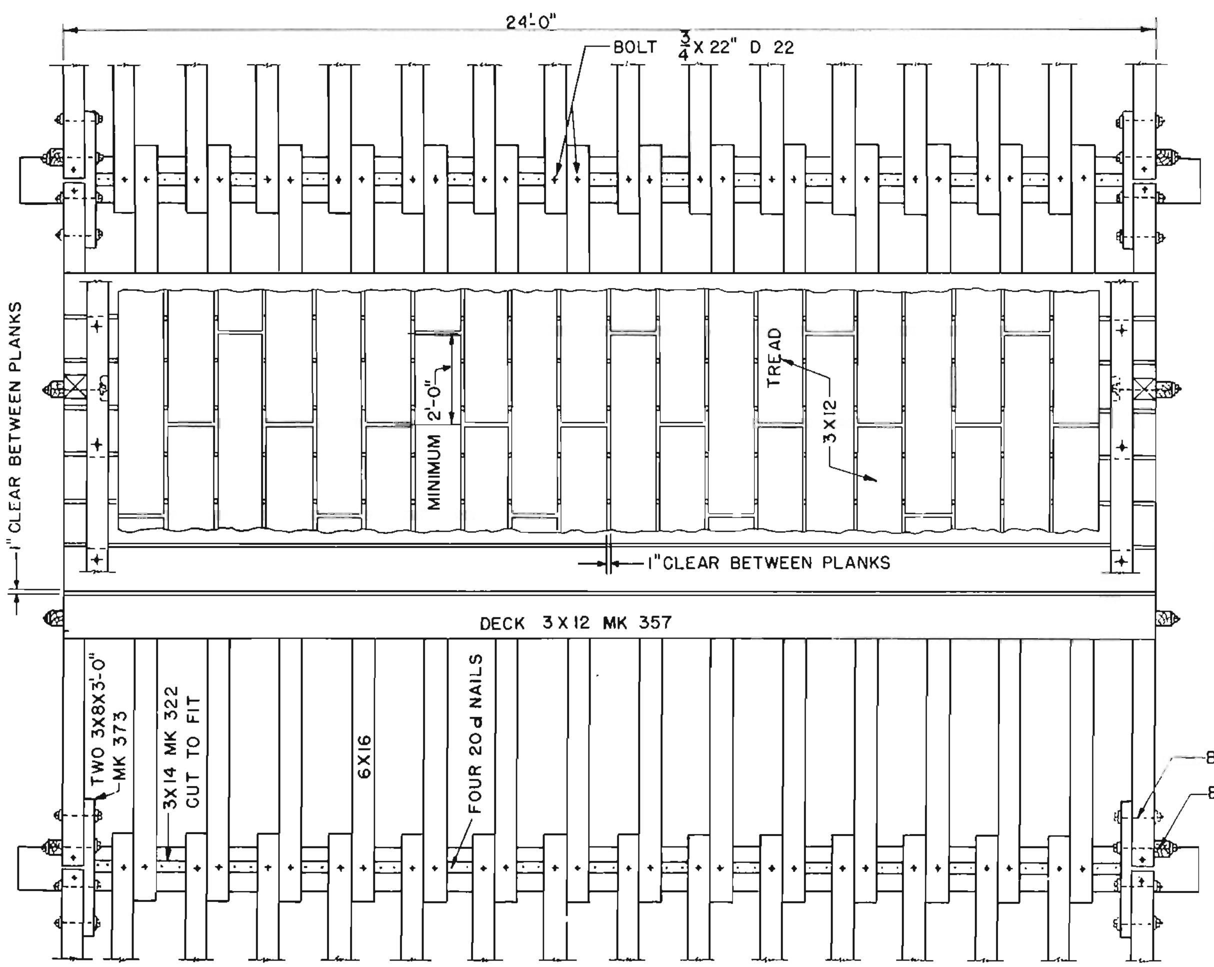
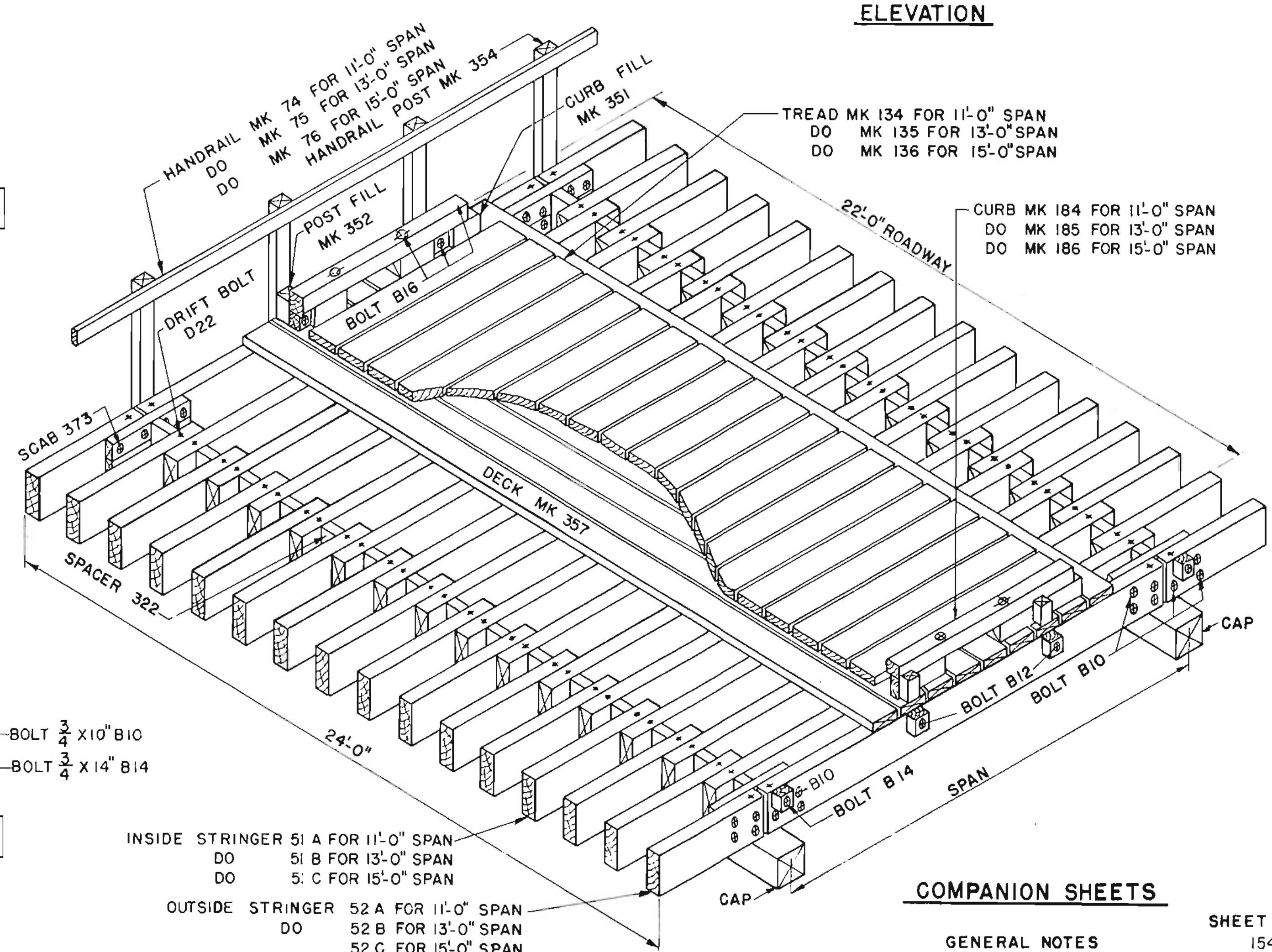


PLAN



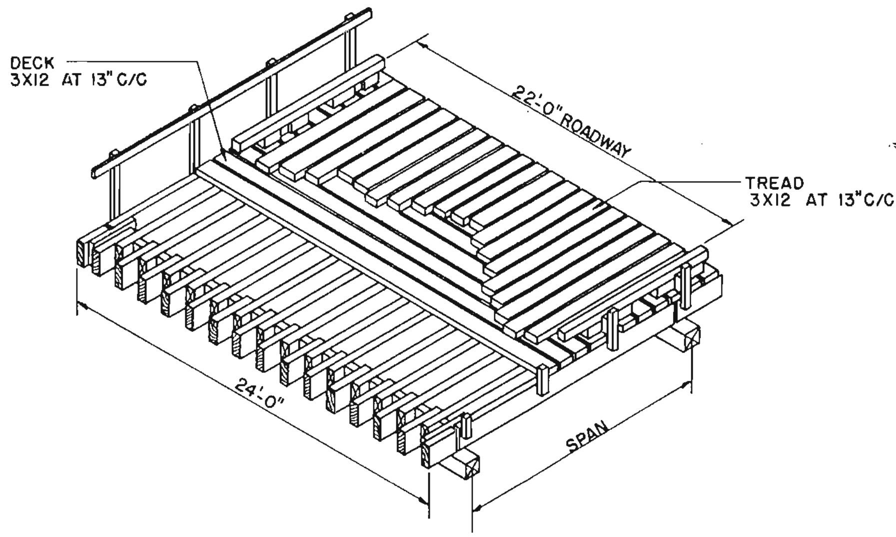
ASSEMBLED VIEW

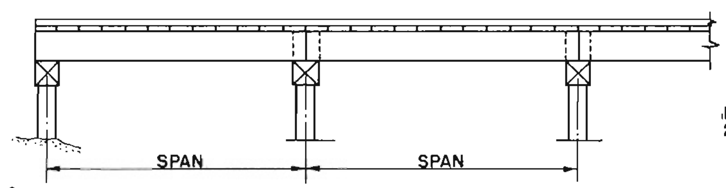
COMPANION SHEETS

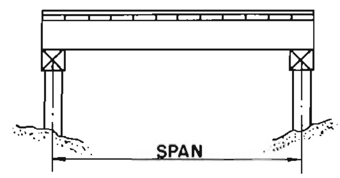
	SHEET
GENERAL NOTES	154
BILLS OF MATERIALS	46
HANDRAIL AND CURB DETAILS	129
NAILING DETAILS	128
WALKWAYS	130
SYMBOLS	155

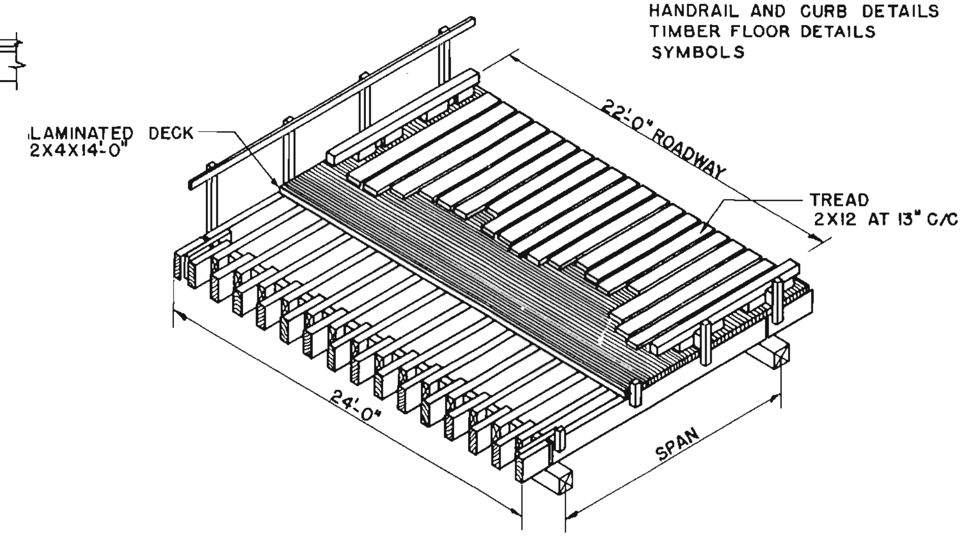
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
ASSEMBLY	45
HANDRAIL AND CURB DETAILS	129
TIMBER FLOOR DETAILS	128
SYMBOLS	155







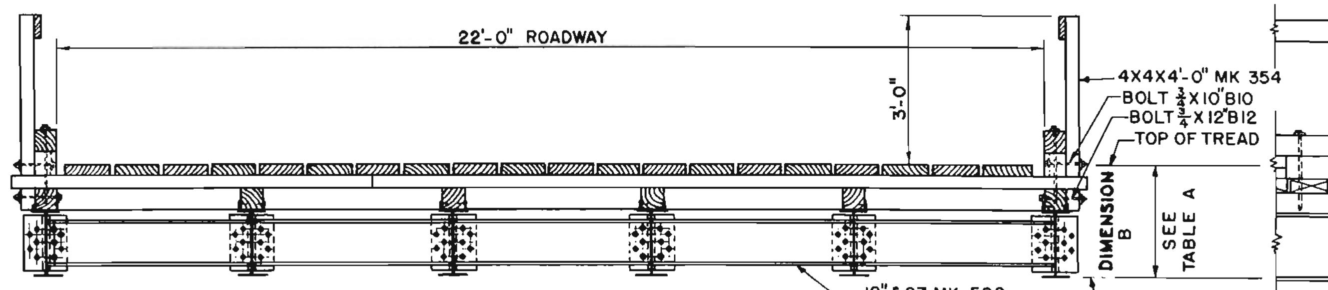


BILL OF MATERIALS FOR STANDARD PLANK FLOOR

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	WEIGHT (POUNDS)	11' SPAN		13' SPAN		15' SPAN	
							QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM
	LUMBER, SOFT WOOD											
1	STRINGERS		51C	6X16	16'-0"	480					14	1792
2	DO		52C	6X16	16'-0"	480					2	256
3	DO		51B	6X16	14'-0"	420			14	1568		
4	DO		52B	6X16	14'-0"	420			2	224		
5	DO		51A	6X16	12'-0"	360	14	1344				
6	DO		52A	6X16	12'-0"	360	2	192				
7	SPACER	39-3330.14-1	322	3X14	10'-0"	131	1	35	1	35	1	35
8	SCAB	39-3330.08	373	3X8	3'-0"	23	4	24	4	24	4	24
9	DECK	39-3952.12	337	3X12	24'-0"	270	10	720	12	864	14	1008
10	TREAD	39-3330.12-16	136	3X12	16'-0"	180					20	960
11	DO	39-3330.12	135	3X12	14'-0"	158			20	840		
12	DO	39-3952.12-12	134	3X12	12'-0"	135	20	720				
13	CURB	39-3360.06-16	186	6X6	16'-0"	180					2	96
14	DO	39-3360.06-14	185	6X6	14'-0"	158			2	84		
15	DO	39-4096.06-12	184	6X6	12'-0"	135	2	72				
16	CURB FILL	39-4096.06	351	6X6	3'-0"	34	4	36	4	36	6	54
17	HANDRAIL POST	39-3340.04	354	4X4	4'-0"	20	4	22	4	22	6	32
18	POST FILL	39-4096.06	352	6X6	0'-9"	8	4	9	4	9	6	13
19	HANDRAIL	39-3880.06-16	76	2X6	16'-0"	60					2	32
20	DO	39-3880.06-14	75	2X6	14'-0"	52			2	28		
21	DO	39-3880,06-12	74	2X6	12'-0"	45	2	24				
	STEEL HARDWARE, BLACK											
22	MACHINE BOLT WITH SQUARE HEAD, NUT, AND TWO WASHERS	43-2325.07-16	B16	3/4	16"	2.52	12		12		18	
23	DO	43-2325.07-144	B14	3/4	14"	2.27	2		2		2	
24	DO	43-2325.07-124	B12	3/4	12"	2.02	2		2		4	
25	DO	43.2325.07-1	B10	3/4	10"	1.77	14		14		14	
26	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	3.00	32		32		32	
27	WIRE NAIL	42-6028.3-5		50d		0.10	260		300		340	
28	DO	42-6028.3-2		20d		0.04	136		136		144	
29	WIRE SPIKE	42-8488.035-07		5/16	7"	0.15	190		222		254	

BILL OF MATERIALS FOR ALTERNATE LAMINATED FLOOR

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	WEIGHT (POUNDS)	11' SPAN		13' SPAN		15' SPAN	
							QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM
	LUMBER, SOFT WOOD											
1	STRINGERS		51C	6X16	16'-0"	480					14	1792
2	DO		52C	6X16	16'-0"	480					2	256
3	DO		51B	6X16	14'-0"	420			14	1568		
4	DO		52B	6X16	14'-0"	420			2	224		
5	DO		51A	6X16	12'-0"	360	14	1344				
6	DO		52A	6X16	12'-0"	360	2	192				
7	SPACER	39-3330.14-1	322	3X14	10'-0"	131	1	35	1	35	1	35
8	SCAB	39-3380.08	373	3X8	3'-0"	23	4	24	4	24	4	24
9	DECK	39-3880.04	360	2X4	24'-0"	60	82	1310	96	1535	111	1775
10	TREAD	39-3880.12-16	106	2X12	16'-0"	120					20	640
11	DO	39-3880.12-14	105	2X12	14'-0"	106			20	560		
12	DO	39-3228.12-12	104	2X12	12'-0"	90	20	480				
13	CURB	39-4096.06	186	6X6	16'-0"	180					2	96
14	DO	39-3360.06	185	6X6	14'-0"	158			2	84		
15	DO	39-4096.06-12	184	6X6	12'-0"	135	2	72				
16	CURB FILL	39-4096.06	351	6X6	3'-0"	34	4	36	4	36	6	54
17	HANDRAIL POST	39-3340.04	354	4X4	4'-0"	20	4	22	4	22	6	32
18	POST FILL	39-4096.06	352	6X6	0'-9"	8	4	9	4	9	6	13
19	HANDRAIL	39-3880.06-16	76	2X6	16'-0"	60					2	32
20	DO	39-3880.06-14	75	2X6	14'-0"	52			2	28		
21	DO	39-3880.06-12	74	2X6	12'-0"	45	2	24				
	STEEL HARDWARE, BLACK											
22	MACHINE BOLT WITH SQUARE HEAD, NUT, AND TWO WASHERS	43-2325.07-16	B16	3/4	16"	2.52	12		12		18	
23	DO	43-2325.07-144	B14	3/4	14"	2.27	2		2		2	
24	DO	43-2325.07-124	B12	3/4	12"	2.02	2		2		4	
25	DO	43-2325.07-1	B10	3/4	10"	1.77	14		14		14	
26	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	3.00	32		32		32	
27	WIRE NAIL	42-6028.3-5		50d		0.10	260		300		340	
28	DO	42-6028.3-3		30d		0.04	2187		2560		2960	
29	DO	42-6028.3-2		20d		0.05	136		136		144	



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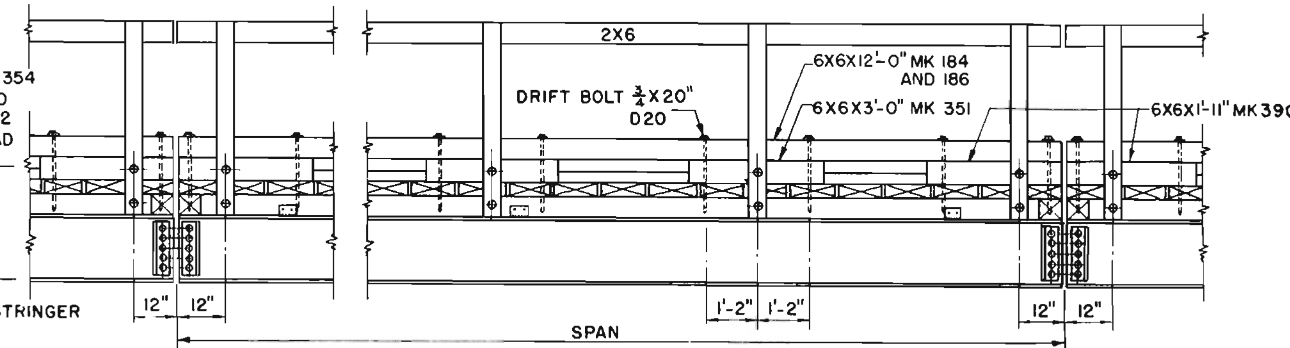

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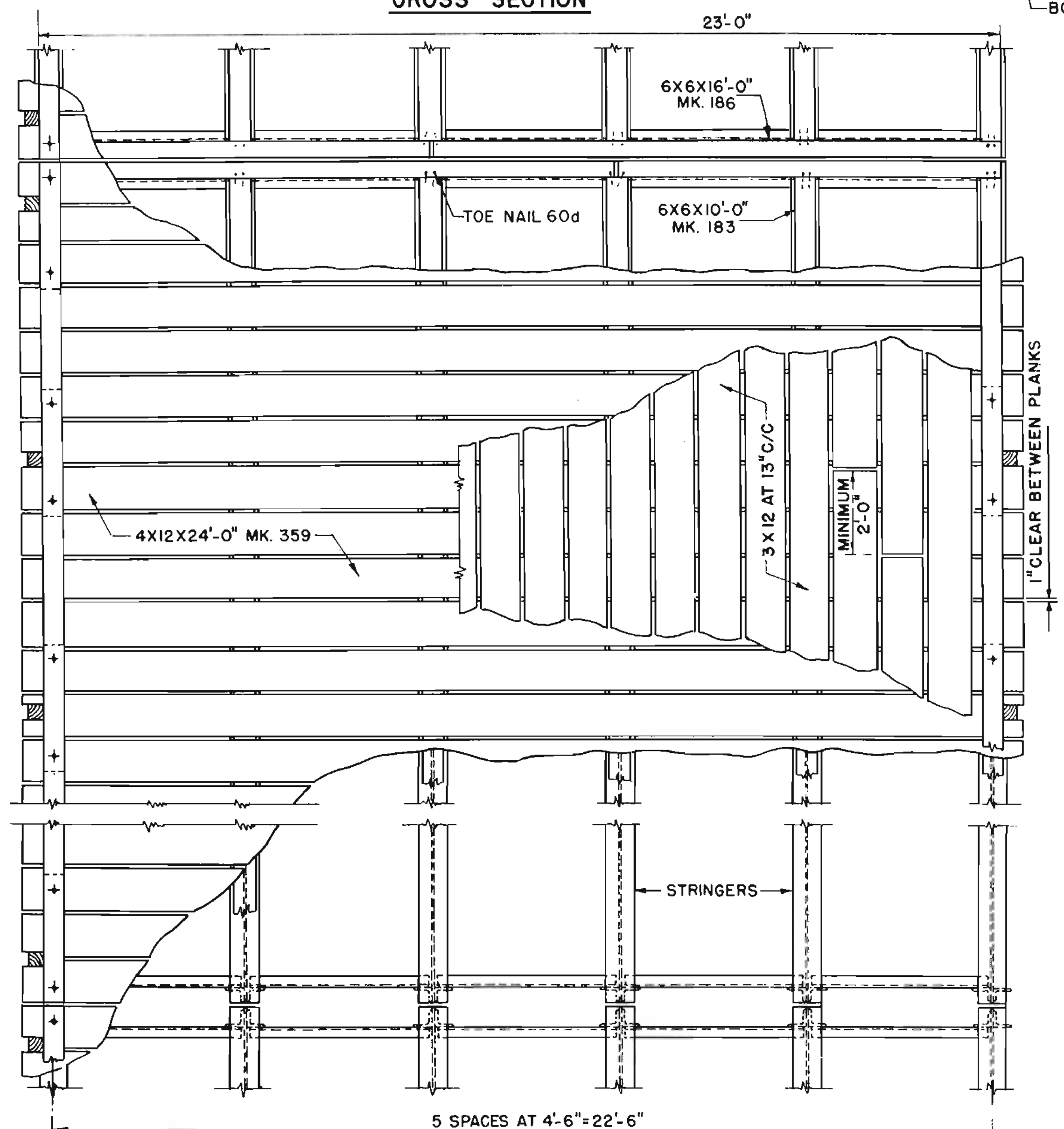
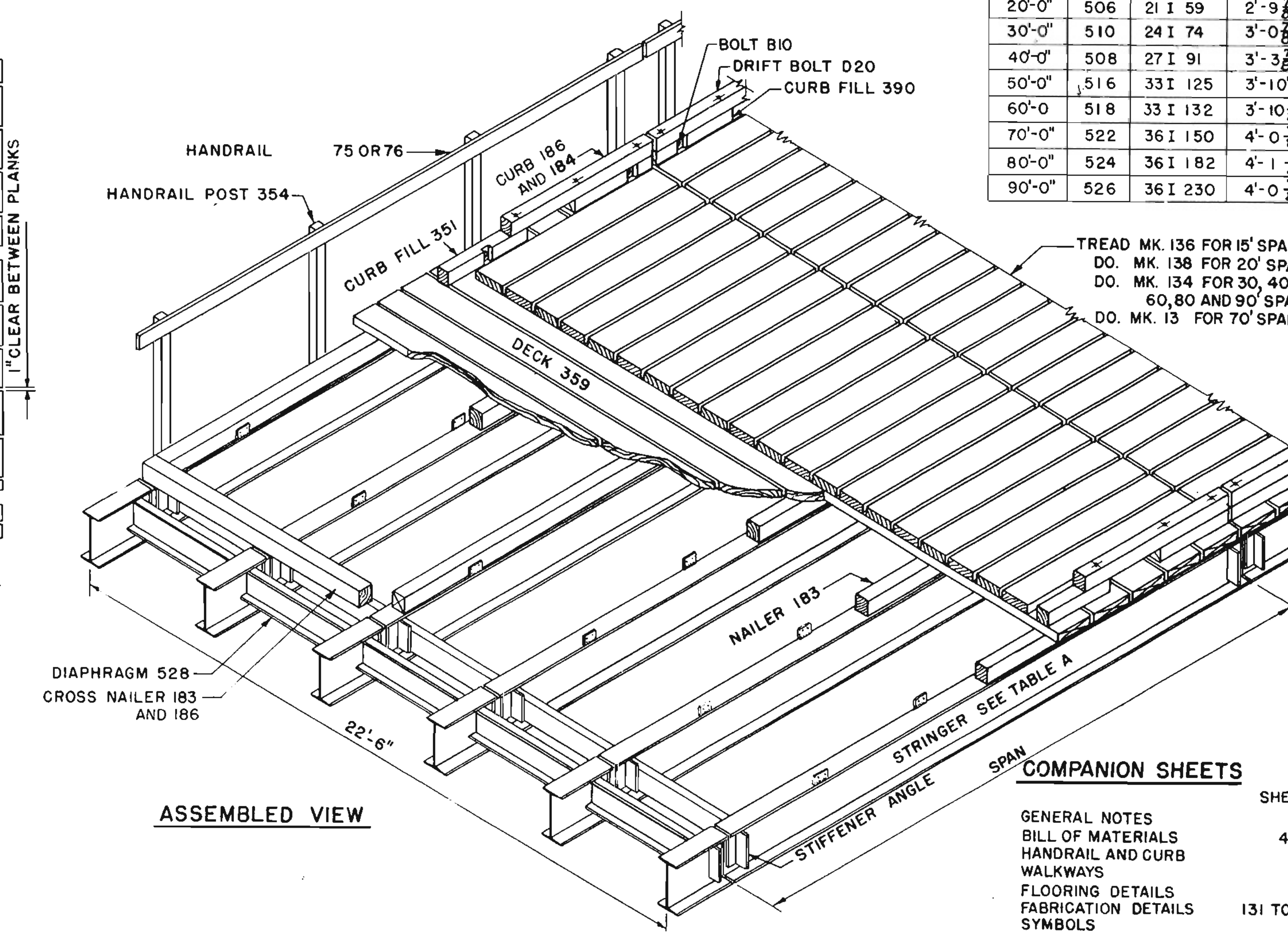


PLAN

TABLE A

SPAN	MARK MK	STRINGER SIZE	B
15'-0"	504	18 I 47	2'-6 7/8"
20'-0"	506	21 I 59	2'-9 7/8"
30'-0"	510	24 I 74	3'-0 7/8"
40'-0"	508	27 I 91	3'-3 7/8"
50'-0"	516	33 I 125	3'-10"
60'-0	518	33 I 132	3'-10 1/8"
70'-0"	522	36 I 150	4'-0 7/8"
80'-0"	524	36 I 182	4'-1 3/8"
90'-0"	526	36 I 230	4'-0 7/8"



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	48,49
HANDRAIL AND CURB	129
WALKWAYS	130
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FABRICATION DETAILS	131 TO 145
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COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 90-FOOT	47
BILL OF MATERIALS, WELDED DETAILS	49
TIMBER FLOOR DETAILS	128
HANDRAIL AND CURB DETAILS	129
WALKWAYS FOR HIGHWAY BRIDGES	130
FABRICATION DRAWINGS	131 TO 145
JUNCTIONS, TIMBER AND STEEL-STRINGER SPANS	149
GENERAL NOTES	154
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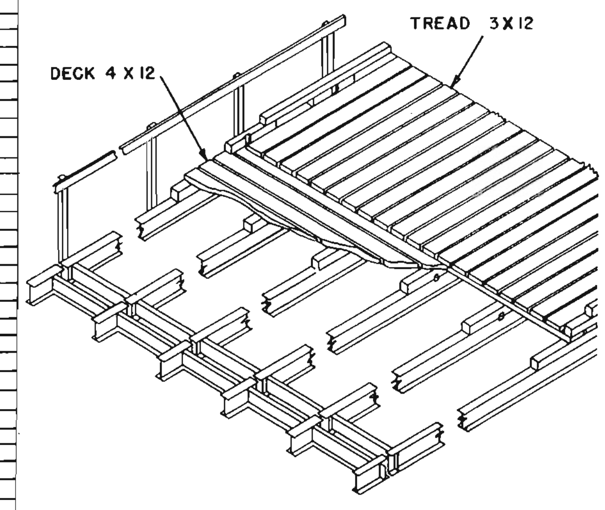
BILL OF MATERIALS – STANDARD PLANK FLOOR

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	30' QUANTITY	30' FBM	40' QUANTITY	40' FBM	50' QUANTITY	50' FBM	50' QUANTITY	50' FBM	70' QUANTITY	70' FBM	80' QUANTITY	80' FBM	90' QUANTITY	90' FBM	LINE
	STRINGER SIZE						18 I 47		21 I 59		24 I 74		27 I 91		33 I 125		33 I 132		36 I 150		36 I 182		36 I 230		
	LUMBER, SOFT WOOD																								
1	FLOOR TREAD	39-3330.12-2	138	3 X 12	20'-0"	225			20	1200					50	3000			70	4200			10	600	1
2	DO	39-3330.12-16	136	3 X 12	16'-0"	180	20	960					20	960							100	4800	100	4800	2
3	DO	39-3952.12-12	134	3 X 12	12'-0"	135					50	1800	40	1440			100	3600							3
4	FLOOR, DECK	39-3340.12-24	339	4 X 12	24'-0"	360	14	1343	19	1825	28	2688	37	3552	46	4416	55	5280	65	6240	74	7104	83	7970	4
5	NAILER	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	5
6	DO	39-3360.06-1	183	6 X 6	10'-0"	112	11	330	14	420	20	600	26	780	32	960	38	1140	44	1320	50	1500	56	1680	6
7	CURB	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	528	12	576	14	672	7
8	DO	39-3360.06-12	184	6 X 6	12'-0"	135					4	144			4	144									8
9	DO	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	9
10	CURB FILL	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	36	8	72	10	90	14	126	16	144	20	180	22	198	26	234	10
11	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	11
12	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	12
13	DO	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	112	9	126	11	154	12	168	14	196	13
	STEEL, STRUCTURAL																								
14	STRINGER	48-2900.36-23	526	36 I 230	40'-0"	9200																	12		14
15	DO	48-2900.36-23	526	36 I 230	9'-9 1/2"	2250																	6		15
16	DO		524	36 I 182	40'-0"	7280															6				16
17	DO		524	36 I 182	19'-10 3/4"	3620															12				17
18	DO	48-2900.36-15	522	36 I 150	40'-0"	6000													6						18
19	DO	48-2900.36-15	522	36 I 150	14'-10 3/4"	2235													12						19
20	DO	48-2900.33-132	518	33 I 132	40'-0"	5280											6								20
21	DO	48-2900.33-132	518	33 I 132	19'-10"	2618											6								21
22	DO	48-2900.33-125	516	33 I 125	40'-0"	5000									6										22
23	DO	48-2900.33-125	516	33 I 125	9'-10"	1229									6										23
24	DO	48-2900.27-091	508	27 I 91	39'-10 1/2"	3629							6												24
25	DO	48-2900.24-074	510	24 I 74	29'-10 1/2"	2211					6														25
26	DO	48-2900.21-059	506	21 I 59	19'-10 1/2"	1173			6																26
27	DO	48-2900.18-047	504	18 I 47	14'-10 1/2"	699	6																		27
28	DIAPHRAGM	48-3790.12-21	528	12 [20.7	4'-4"	90	10		10		15		15		15		20		20		25		25		28
29	ANGLE	48-2240.64-04	A9	6X4X3/8	2'-3"	28									36		48		48		60		60		29
30	DO	48-2240.64-04	A5	6X4X3/8	2'-0"	25							36												30
31	DO	48-2240.64-04	A4	6X4X3/8	1'-9"	22					36														31
32	DO	48-2240.64-04	A6	6X4X3/8	1'-6"	19			24																32
33	DO	48-2240.64-04	A3	6X4X3/8	1'-3"	16	24																		33
34	WEB SPLICE PLATE	47-7844.04	P15, P4	14 X 3/8	2'-3"	40									12		12		24		24		24		34
35	FLANGE SPLICE PLATE	47-7844.08	P16	17 X 7/8	6'-8"	337																	24		35
36	DO	47-7844.08	P17	6 1/2 X 7/8	4'-8"	95																	48		36
37	DO	47-7844.07	P1	12 1/2 X 3/4	3'-11"	125															24				37
38	DO	47-7844.1	P2	5 X 1	3'-11"	67															48				38
39	DO	47-7844.06	P11	12 X 5/8	2'-11"	74													24						39
40	DO	47-7844.08	P12	5 X 7/8	2'-11"	43													48						40
41	DO	47-7844.06	P13	12 X 5/8	4'-6"	115											12								41
42	DO	47-7844.07	P14	4 3/4 X 4 3/4	4'-6"	55											24								42
43	DO	47-7844.05	P18	12 X 1/2	2'-8"	54									12										43
44	DO	47-7844.05	P19	4 3/4 X 1/2	2'-8"	22									24										44
45	RIVET	43-6353.08		7/8	-5"	1.04																	1440		45
46	DO	43-6353.08		7/8	-4 3/4"	1.00															1056				46
47	DO	43-6353.08		7/8	-4 1/4"	.91													768						47
48	DO	43-6353.08		7/8	-4"	.87											480								48
49	DO	43-6353.08		7/8	-3 3/4"	.83									288										49
50	DO	43-6353.08		7/8	-3 1/4"	.74															378		546		50
51	DO	43-6353.08-3		7/8	-3"	.70									294		336		504						51
52	DO	43-6353.08		7/8	-2 3/4"	.66	48		60		108		126												52
53	DO	43-6353.08-23		7/8	-2 1/4"	.57	100		100		150		150		150		200		200		250		250		53
	STEEL HARDWARE, BLACK																								
54	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.1	6		8		12		14		18		20		24		26		30		54
55	DO	43-2325.07-1	B10	3/4	10"	1.8	6		8		12		14		18		20		24		26		30		55
56	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		56
57	STEEL WIRE NAIL	42-6028.3-5		50d		.08	344		444		710		920		1070		1400		1510		1780		1990		57
58	DO	42-6028.3-3		30d		.05	48		60		84		108		132		156		180		204		228		58
59	DO	42-6028.3-2		20d		.04	24		38		58		68		88		98		118		128		148		59
60	DO	42-6028.3-6		60d		.10	14		14		14		14		14		14		14		14		14		60
61	STEEL WIRE SPIKE	42-8488.035-07		5/16	0'-7"	.15	168		228		336		444		552		660		780		888		996		61
62	NAILER ATTACHMENT PLATE	47-7844.03		2 X 1/4	0'-4"	0.6	24		30		42		54		66		78		90		102		114		62
63	ELECTRODE, WELDING	46-3772.2-7		3/16			1.8 LB		2.2 LB		3.1 LB		4.0 LB		4.8 LB		5.8 LB		6.6 LB		7.5 LB		8.4 LB		63



BILL OF MATERIALS
FOR FLOOR AND STRINGER COMBINATIONS

	SHEET
1. STANDARD PLANK FLOOR	48
RIVETED STEEL DETAILS	48
HARDWARE	48
2. STANDARD PLANK FLOOR	48
WELDED STEEL DETAILS	49
HARDWARE	48
3. ALTERNATE LAMINATED FLOOR	49
RIVETED STEEL DETAILS	48
HARDWARE	49
4. ALTERNATE LAMINATED FLOOR	49
WELDED STEEL DETAILS	49
HARDWARE	49

BILL OF MATERIALS FOR ALTERNATE LAMINATED FLOOR AND WELDED STEEL DETAILS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	30' QUANTITY	30' FBM	40' QUANTITY	40' FBM	50' QUANTITY	50' FBM	60' QUANTITY	60' FBM	70' QUANTITY	70' FBM	80' QUANTITY	80' FBM	90' QUANTITY	90' FBM	LINE
	STRINGER SIZE						18 I 47		21 I 59		24 I 74		27 I 91		33 I 125		33 I 132		36 I 150		36 I 182		36 I 230		
	LUMBER, SOFT WOOD																								
1	FLOOR, TREAD	39-3228.12-2	108	2 X 12	20'-0"	150			20	800															1
2	DO	39-3228.12-16	106	2 X 12	16'-0"	120	20	540													100	3200			2
3	DO	39-3228.12-14	105	2 X 12	14'-0"	105									72	2016			100	2800					3
4	DO	39-3228.12-12	104	2 X 12	12'-0"	90					50	1200	67	1608			100	2400					150	3600	4
5	FLOOR, DECK	39-3880.06-14	75	2 X 6	14'-0"	53	111	1554	148	2072	221	3094	295	4130	369	5166	443	6202	516	7224	590	8260	664	9295	5
6	DO	39-3880.06-1	73	2 X 5	10'-0"	37	111	1110	148	1480	221	2210	295	2950	369	3690	443	4430	516	5160	590	5900	664	6640	6
7	NAILER	39-3360.06-15	186	6 X 5	16'-0"	180	2	96	2	96	2	95	2	96	2	96	2	96	2	95	2	96	2	96	7
8	DO	39-3360.06-1	133	6 X 6	10'-0"	112	11	330	14	420	20	600	26	780	32	960	38	1140	44	1320	50	1500	56	1680	8
9	CURB	39-3360.06-15	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	528	12	576	14	672	9
10	DO	39-3360.06-12	134	6 X 5	12'-0"	135					4	144			4	144									10
11	CURB FILL	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	36	8	72	10	90	14	126	16	144	20	180	22	198	26	234	11
12	DO	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	12
13	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	13
14	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	14
15	DO	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	112	9	126	11	154	12	168	14	196	15
	STEEL, STRUCTURAL																								
16	STRINGER	48-2900.36-23	526W	36 I 230	40'-0"	9200																	12		16
17	DO				9'-10 1/2"	2271																	6		17
18	DO		524W	36 I 182	40'-0"	7290															6				18
19	DO				39'-10 1/2"	7257															6				19
20	DO	48-2900.36-15	522W	36 I 150	40'-0"	6000													6						20
21	DO				29'-10 1/2"	4481													6						21
22	DO	48-2900.33-132	518W	33 I 132	40'-0"	5280											6								22
23	DO				19'-10 1/2"	2524											6								23
24	DO	48-2900.33-125	516W	33 I 125	40'-0"	5000									6										24
25	DO				9'-10 1/2"	1234									6										25
26	DO	48-2900.27-091	508W	27 I 91	39'-10 1/2"	3629							6												26
27	DO	48-2900.24-074	510W	24 I 74	29'-10 1/2"	2211					6														27
28	DO	48-2900.21-059	506W	21 I 59	19'-10 1/2"	1173			6																28
29	DO	48-2900.18-047	504W	18 I 47	14'-10 1/2"	699	6																		29
30	DIAPHRAGM	48-3790.12-21	C4	12 [20.7	4'-1"	85	10		10		15		15		15		20		20		25		25		30
31	STIFFENER	47-7844.04	P15	4 X 3/8	2'-6"	13													48		60		60		31
32	DO	47-7844.04	P10, P5	4 X 3/8	2'-0"	10							36		36		48								32
33	DO	47-7844.04	P4	4 X 3/8	1'-9"	9					36														33
34	DO	47-7844.04	P6	4 X 3/8	1'-7"	8			24																34
35	DO	47-7844.04	P3	4 X 3/8	1'-4"	7	24																		35
36	WEB SPLICE PLATE	47-7844.04	P9	12 X 3/8	1'-6"	23									12		12								36
37	DO	47-7844.04	P14	12 X 3/8	1'-9"	27													12		12		24		37
38	FLANGE SPLICE PLATE	47-7844.03	P16	9 X 7/8	3'-7"	96															6				38
39	DO	47-7844.08	P17	10 1/2 X 7/8	8'-0"	250															6				39
40	DO	47-7844.06	P24	10 X 5/8	5'-4"	50													6		6				40
41	DO	47-7844.1	P25	10 X 1	3'-8"	125													6						41
42	DO	47-7844.04	P23	9 X 3/8	1'-8"	19									6										42
43	DO	47-7844.05	P31	8 X 1/2	2'-4"	32													6						43
44	DO	47-7844.06	P34	9 X 5/8	4'-10"	92									6										44
45	DO	47-7844.07	P40	6 X 3/4	2'-0"	31																	24		45
46	DO	47-7844.08	P41	3 X 7/8	1'-0"	9																	24		46
47	DO	47-7844.1	P42	8 X 1	4'-0"	109																	24		47
48	DO	47-7844.1	P43	9 X 1	4'-0"	122											6								48
49	DO	47-7844.05	P8	7 X 1/2	1'-10"	22											6								49
50	DO	47-7844.05	P38	9 X 1/2	4'-4"	65											6								50
51	NAILER ATTACHMENT PLATE	47-7844.03		2 X 1/4	0'-4"	0.6	24		30		42		54		66		78		90		102		114		51
52	WELDING ELECTRODE	46-3772.25-5		7/32											35 LB		118 LB		129 LB		227 LB		773 L		52
53	DO	46-3772.2-7		3/16			35 LB		37 LB		45 LB		50 LB		85 LB		98 LB		108 LB		103 LB		58 LB		53
	STEEL HARDWARE, BLACK																								
54	MACHINE BOLT, SQUARE HEAD, TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.1	6		8		12		14		18		20		24		26		30		54
55	DO	43-2325.07-1	B10	3/4	10"	1.86	6		8		12		14		18		20		24		26		30		55
56	DRIFT BOLT, SQUARE HEAD, WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		56
57	STEEL WIRE NAIL	42-6028.3-6		60d		.10	14		14		14		14		14		14		14		14		14		57
58	DO	42-6028.3-5		50d		.08	344		444		710		920		1070		1400		1510		1780		1990		58
59	DO	42-6028.3-3		30d		.05	1990		2650		3952		5271		6590		7910		9210		10530		11850		59
60	DO	42-6028.3-2		20d		.04	24		38		58		68		88		98		118		128		148		60

COMPANION SHEETS

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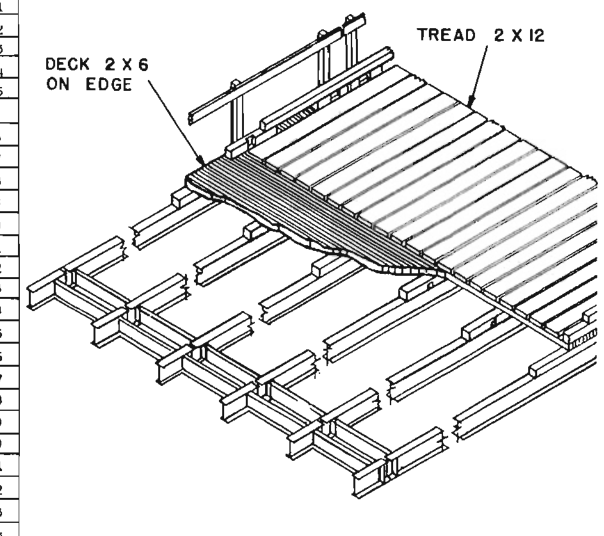

BILL OF MATERIALS
FOR FLOOR AND STRINGER COMBINATIONS

	SHEET
1. STANDARD PLANK FLOOR	48
RIVETED STEEL DETAILS	48
HARDWARE	48
2. STANDARD PLANK FLOOR	48
WELDED STEEL DETAILS	49
HARDWARE	48
3. ALTERNATE LAMINATED FLOOR	49
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COMPANION SHEETS

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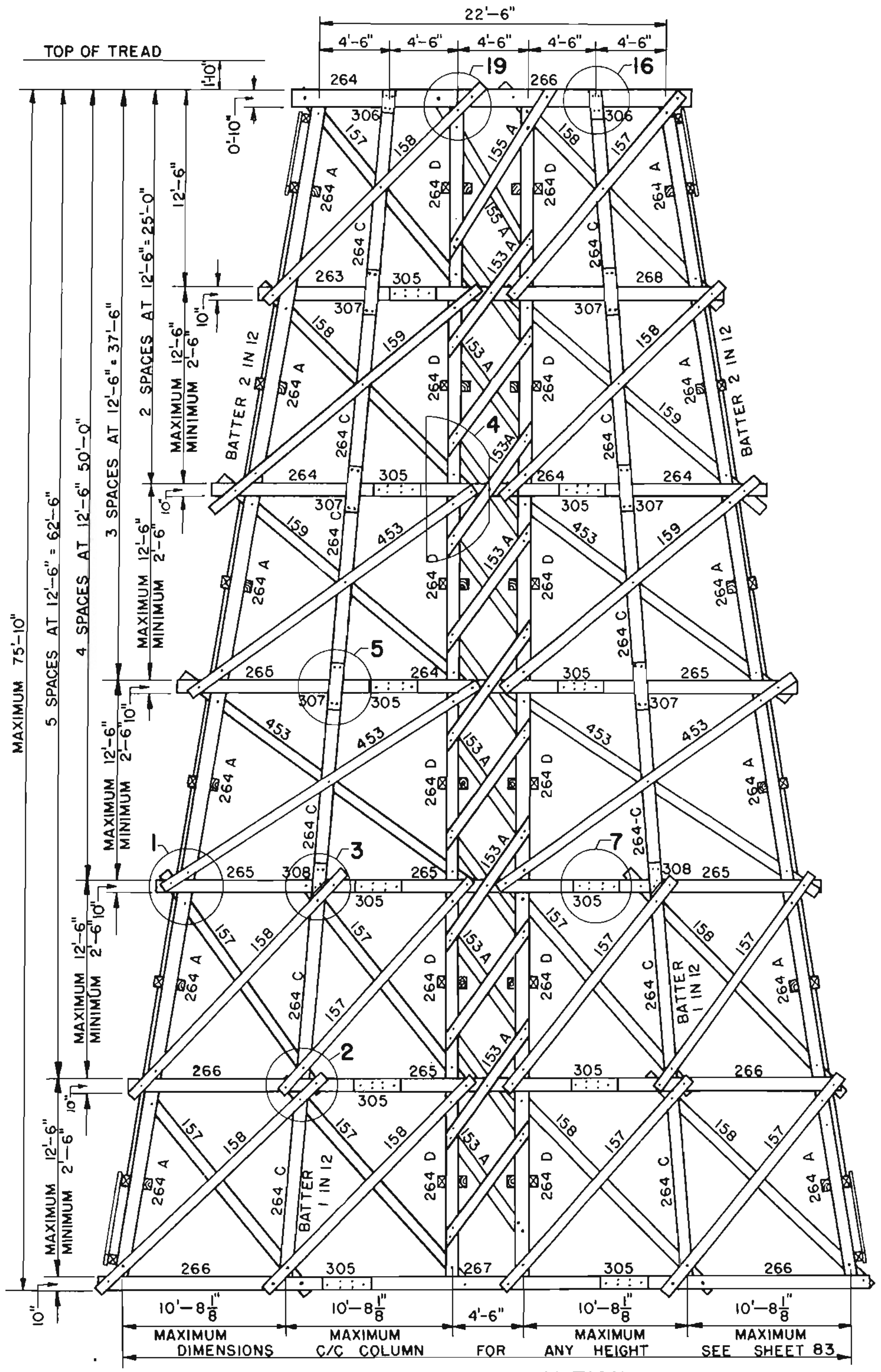
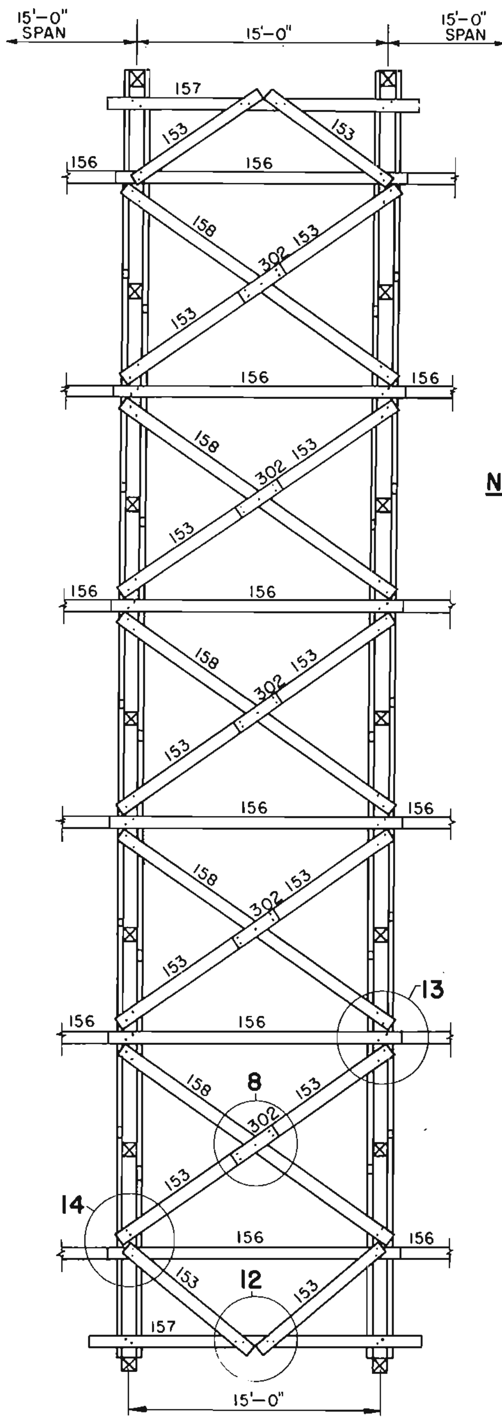


TRANSVERSE ELEVATION

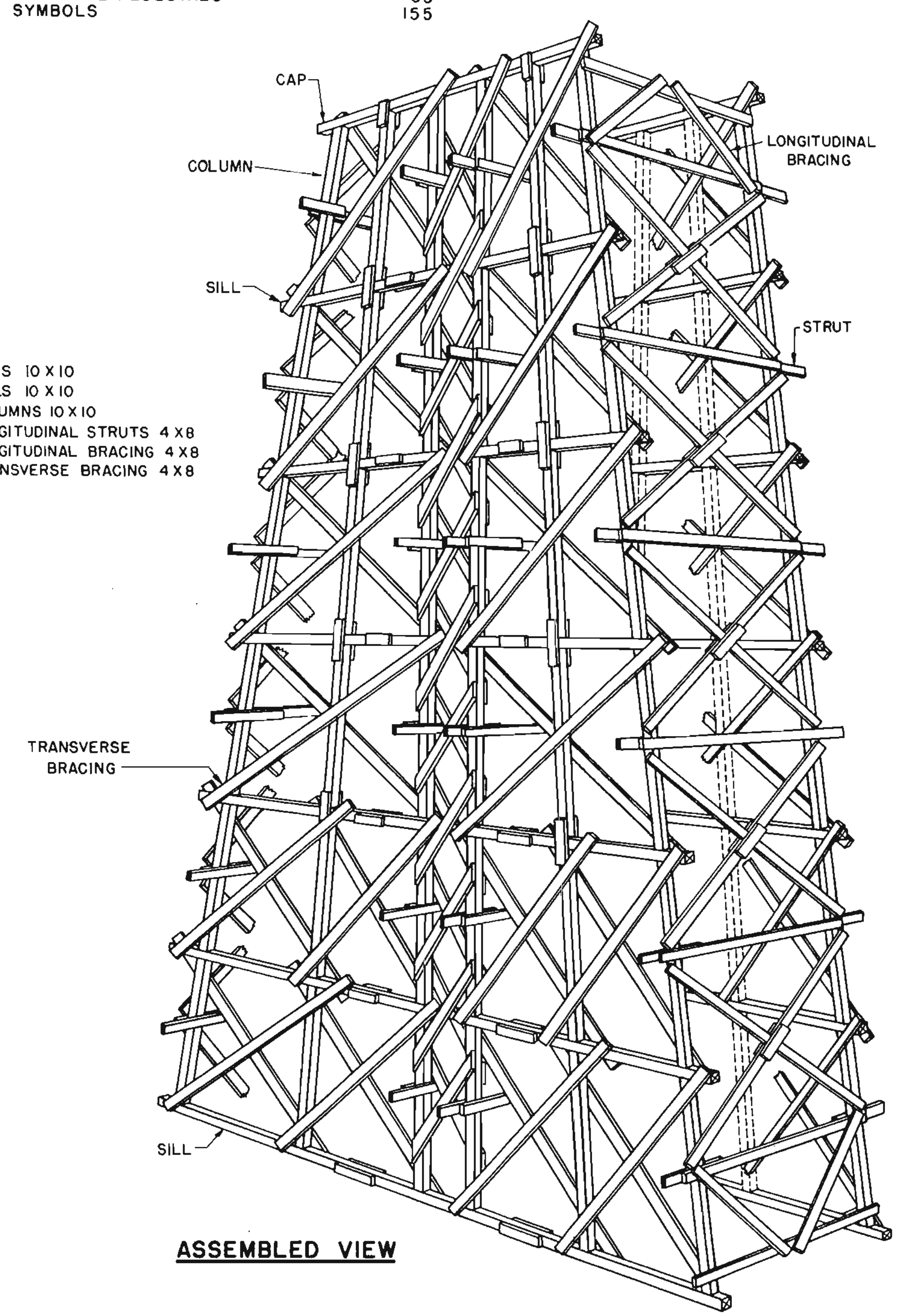


LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH

NOTES

- ALL CAPS 10 X 10
- ALL SILLS 10 X 10
- ALL COLUMNS 10 X 10
- ALL LONGITUDINAL STRUTS 4 X 8
- ALL LONGITUDINAL BRACING 4 X 8
- ALL TRANSVERSE BRACING 4 X 8



ASSEMBLED VIEW

COMPANION SHEETS

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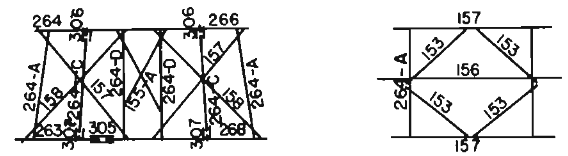
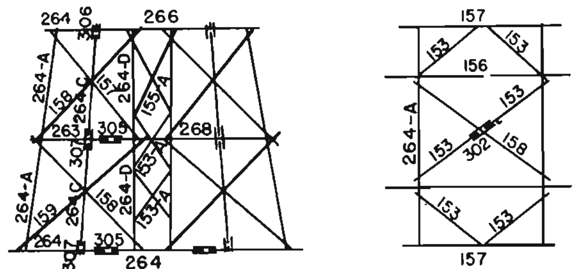
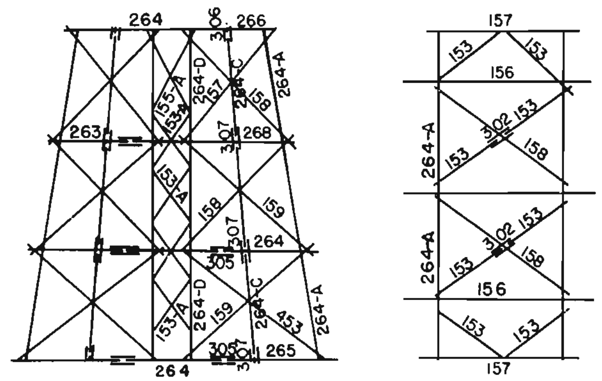


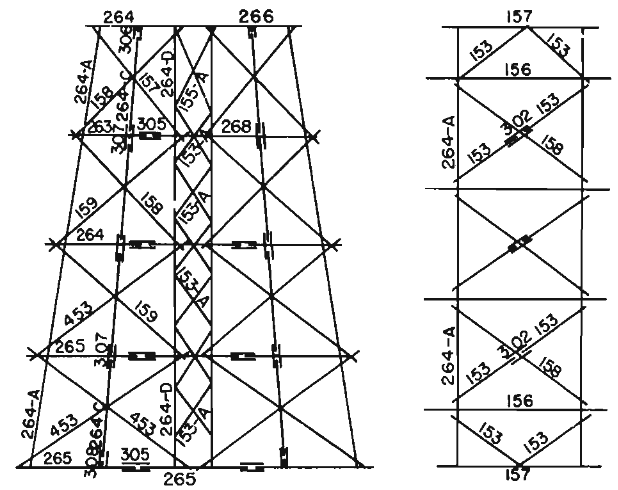
1-STORY TOWER



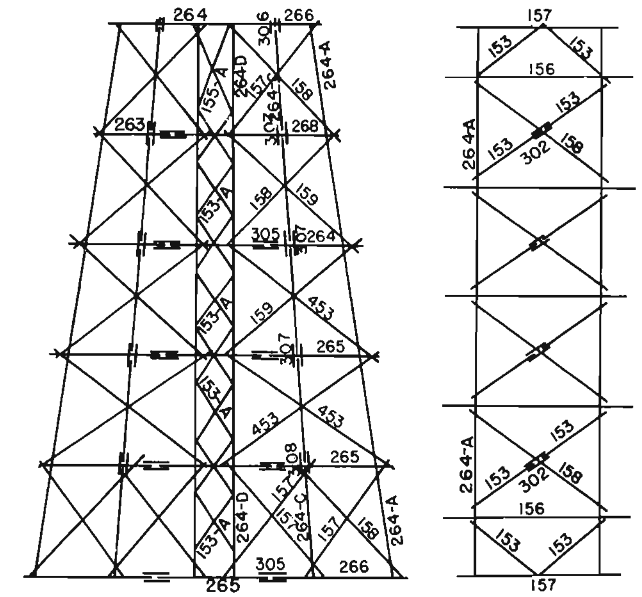
2-STORY TOWER



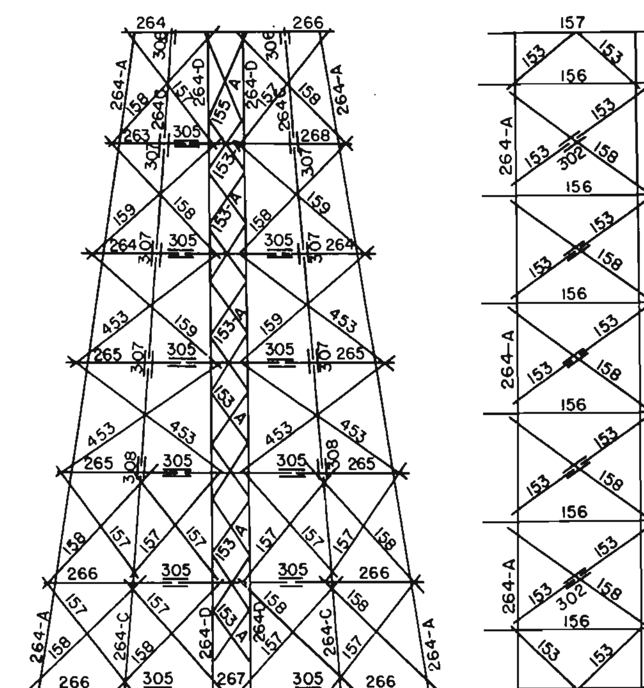
3-STORY TOWER



4-STORY TOWER



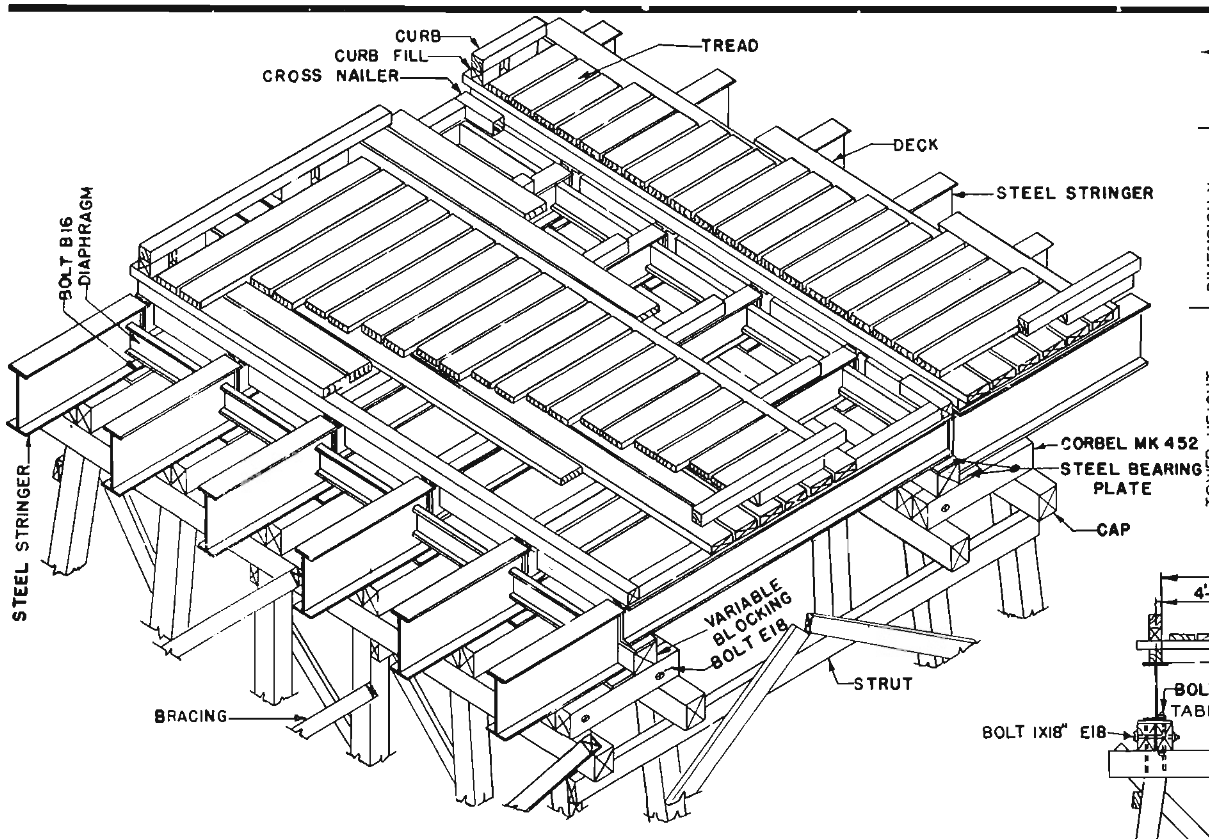
5-STORY TOWER



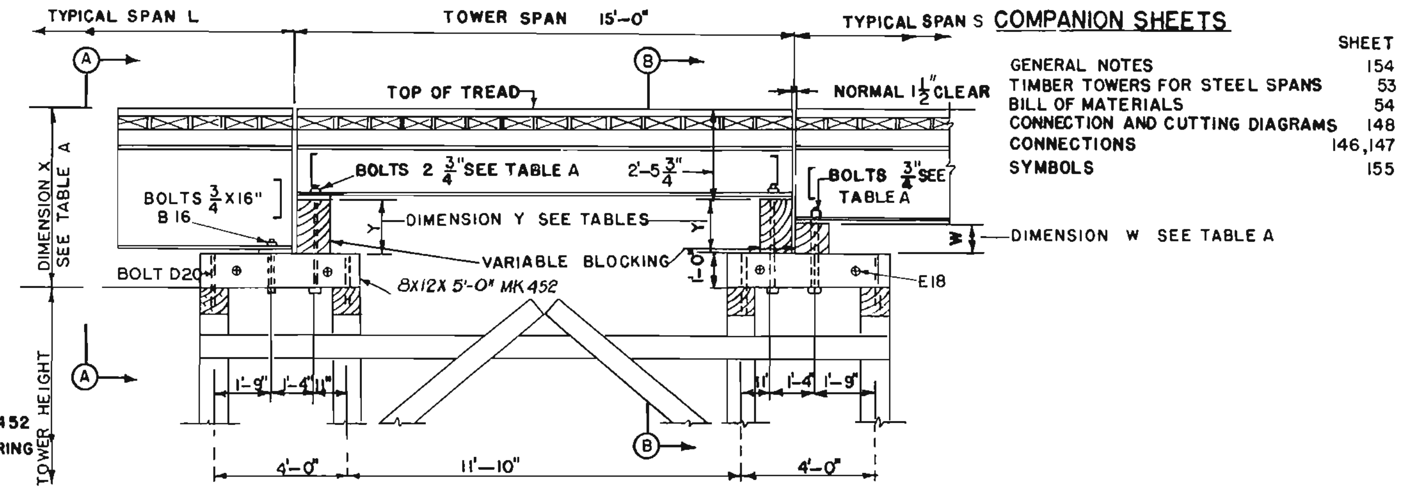
6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

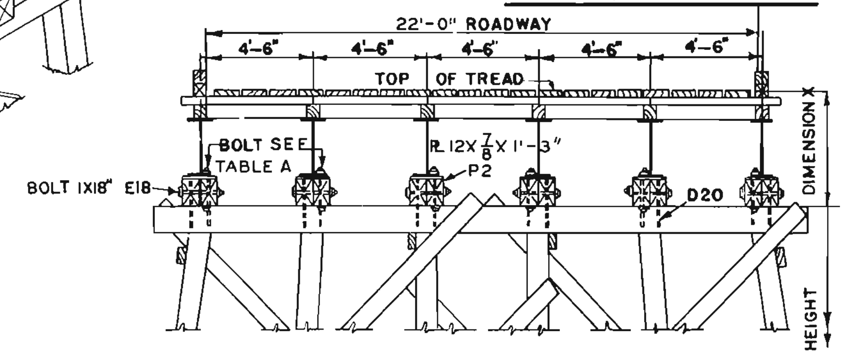
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY FBM	5-STORY 63'-4" QUANTITY	5-STORY FBM	4-STORY 50'-10" QUANTITY	4-STORY FBM	3-STORY 38'-4" QUANTITY	3-STORY FBM	2-STORY 25'-10" QUANTITY	2-STORY FBM	1-STORY 13'-4" QUANTITY	1-STORY FBM
	LUMBER, SOFT-WOOD																	
1	CAP	39-6620.1-16	266	10 X 10	16'-0"	500	2	267	2	267	2	267	2	267	2	267	2	267
2	DO	39-6620.1-12	254	10 X 10	12'-0"	375	2	200	2	200	2	200	2	200	2	200	2	200
3	SILL	39-6620.1-2	268	10 X 10	20'-0"	625	2	333	2	333	2	333	2	333	2	333	2	333
4	DO	39-6620.1-18	267	10 X 10	18'-0"	563	2	300										
5	DO	39-6620.1-16	256	10 X 10	16'-0"	500	8	1057	4	533								
6	DO	39-6620.1-14	255	10 X 10	14'-0"	438	12	1400	12	1400	10	1157	4	467				
7	DO	39-6620.1-12	254	10 X 10	12'-0"	375	8	800	8	800	3	800	8	800	6	600		
8	DO	39-6620.1-1	253	10 X 10	10'-0"	313	2	167	2	167	2	157	2	157	2	167	2	167
9	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	24	2400	20	2000	16	1600	12	1200	8	800	4	400
10	DO	39-6620.1-12	264C	10 X 10	12'-0"	375	24	2400	20	2000	15	1600	12	1200	[illegible]	300	4	400
11	DO	39-6620.1-12	264D	10 X 10	12'-0"	375	24	2400	20	2000	16	1600	12	1200	8	800	4	400
12	STRUT	39-3340.08-18	157	4 X 8	18'-0"	180	4	192	4	192	4	192	4	192	4	192	4	192
13	DO	39-3340.08-16	156	4 X 8	16'-0"	160	48	2048	40	1707	32	1355	24	1024	16	683	8	342
14	BRACING	39-3340.08-24	453	4 X 8	24'-0"	240	12	768	12	768	12	768	4	256				
15	DO	39-3340.08-22	159	4 X 8	22'-0"	220	8	469	8	469	8	469	8	459	4	235		
16	DO	39-3340.08-2	158	4 X 8	20'-0"	200	30	1600	20	1067	14	747	12	640	10	533	4	213
17	DO	39-3340.08-18	157	4 X 8	18'-0"	180	24	1152	16	768	4	192	4	192	4	192	4	192
18	DO	39-3340.08-14	153	4 X 8	10'-0"	100	28	747	24	640	20	533	16	427	12	320	3	213
19	DO	39-3340.08-1	155A	4 X 8	14'-0"	140	4	149	4	149	4	149	4	149	4	149	4	149
20	DO	39-3340.08-.	153A	4 X 8	10'-0"	100	40	1067	32	355	24	640	16	427	9	213		
21	SCAB	39-3340.1	305	4 X 10	3'-0"	33	44	440	36	360	28	280	20	200	12	[illegible]	4	40
22	DO	39-3330.1	306	3 X 10	2'-0"	19	8	40	8	40	3	40	8	40	8	40	8	40
23	DO	39-3952.1	307	3 X 10	3'-0"	23	24	180	24	130	24	180	24	180	16	120	8	60
24	DO	39-3330.1	308	3 X 10	2'-0"	19	8	40	8	40	8	40						
25	DO	39-3228.08	302	2 X 3	3'-4"	17	20	89	16	71	12	53	8	36	4	18		
	STEEL HARDWARE, BLACK																	
26	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-24	E24	1	24"	6.48	16		16		16		16		16		8	
27	DO	43-2325.1-2	E20	1	20"	5.61	382		300		226		156		86		24	
28	DO	43-2325.1-18	E18	1	18"	5.18	80		80		80		64		48		32	
29	DO	43-2325.1-164	E16	1	16"	4.75	240		208		160		128		96		72	
30	DO	43-2325.1-104	E10	1	10"	3.45	66		56		46		36		26		16	
31	DRIFT BOLT, PLAIN	43-1636.07-2	E20	3/4	20"	2.50	186		150		114		86		58		30	



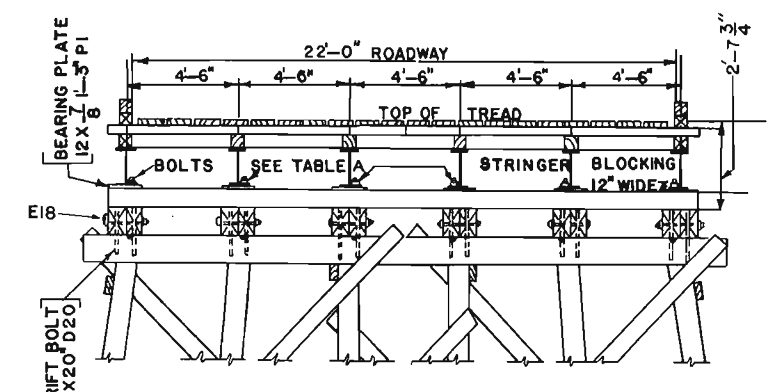
ASSEMBLED VIEW



LONGITUDINAL SECTION



SECTION A-A



SECTION B-B

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TABLE A

			90'	80'	70'	60'	50'	40'	30'	20'	15'
SPAN L		X	5'-1 3/4"	5'-2 1/4"	5'-1 3/4"	4'-11"	4'-10 7/8"	4'-4 3/4"	4'-1 3/4"	3'-10 3/4"	3'-7 3/4"
		Y	1'-6"	1'-6 1/2"	1'-6"	1'-3 1/4"	1'-3 1/8"	0'-9"	0'-6"	0'-3"	0"
TIMBER SPAN		W	2'-2 3/4"	2'-2 1/4"	2'-3 3/4"	2'-1"	2'-0 7/8"	1'-6 3/4"	1'-3 3/4"	1'-0 3/4"	0'-9 3/4"
		BOLT A	42"	42"	42"	38"	38"	32"	30"	26"	24"
SPAN S	15'	W	1'-6"	1'-6 1/2"	1'-6"	1'-3 1/4"	1'-3 1/8"	0'-9"	0'-6"	0'-3"	
		BOLT A	34"	34"	34"	30"	30"	24"	22"	18"	
	20'	W	1'-3"	1'-3 1/2"	1'-3"	1'-0 1/4"	1'-0 1/8"	0'-6"	0'-3"		
		BOLT A	30"	32"	30"	28"	28"	22"	18"		
	30'	W	1'-0"	1'-0 1/2"	1'-0"	0'-9 1/4"	0'-9 1/8"	0'-3"			
		BOLT A	28"	26"	28"	24"	24"	18"			
	40'	W	0'-9"	0'-9 1/2"	0'-9"	0'-6 1/4"	0'-6 1/8"				
		BOLT A	24"	26"	24"	22"	22"				
	50'	W	0'-2 7/8"	0'-3 3/8"	0'-2 7/8"	0'-0 1/8"					
		BOLT A	18"	18"	18"	16"					
	60'	W	0'-2 3/4"	0'-3 1/4"	0'-2 3/4"						
		BOLT A	16"	16"	18"						
	70'	W	0"	0'-0 1/2"							
		BOLT A	16"	16"							
	80'	W	0'-0 1/2"	←	BLOCKING IS UNDER 90' SPAN						
		BOLT A	16"								

BILL OF SUPPLEMENTAL MATERIALS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	30' QUANTITY	30' FBM	40' QUANTITY	40' FBM	50' QUANTITY	50' FBM	60' QUANTITY	60' FBM	70' QUANTITY	70' FBM	80' QUANTITY	80' FBM	90' QUANTITY	90' FBM	LINE
						MAIN SPAN	15'		20'		30'		40'		50'		60'		70'		80'		90'		
						STRINGER SIZE	18 I 47		21 I 59		24 I 74		27 I 91		33 I 125		33 I 132		36 I 150		36 I 182		36 I 230		
						DIMENSION X	3'-7 3/4"		3'-10 3/4"		4'-1 3/4"		4'-4 3/4"		4'-10 7/8"		4'-11"		5'-1 3/4"		5'-2 1/4"		5'-1 3/4"		
						DIMENSION Y	0'-0"		0'-3"		0'-6"		0'-9"		1'-3 1/8"		1'-3 1/4"		1'-6"		1'-6 1/2"		1'-6"		
1	BEARING PLATE	47-7844.08	P2	12 X 7/8	1'-4"	47.6																	12		1
2	DO	47-7844.08	P1	12 X 7/8	1'-3"	44.6	24		24		24		24		24		24		24		24		12		2
	LUMBER, SOFT WOOD																								
3	CORBEL	39-6616.12	452	8 X 12	5'-0"	150	24	960	24	960	24	960	24	960	24	960	24	960	24	960	24	960	24	960	3
4	BLOCKING	39-6630.12-12	284	12 X 12	12'-0"	540									4	576	4	576	4	576	4	576	4	576	4
5	DO	39-3360.12-12	214	6 X 12	12'-0"	270					4	288	4	288					4	288	4	288	4	288	5
6	DO	39-3952.12-12	134	3 X 12	12'-0"	90							4	144	4	144	4	144							6
	STEEL HARDWARE, BLACK																								
7	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-18	E18	1	18"	5.0	24		24		24		24		24		24		24		24		24		7
8	DO	43-2325.07-346	B34	3/4	34"	4.74													12		12		12		8
9	DO	43-2325.07-306	B30	3/4	30"	4.26									12		12								9
10	DO	43-2325.07-24	B24	3/4	24"	3.54							12												10
11	DO	43-2325.07-223	B22	3/4	22"	3.30					12														11
12	DO	43-2325.07-183	B18	3/4	18"	2.82			12																12
13	DO	43-2325.07-16	B16	3/4	16"	2.58	24		12		12		12		12		12		12		12		12		13
14	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	48		48		48		48		48		48		48		48		48		14

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CONNECTIONS	147
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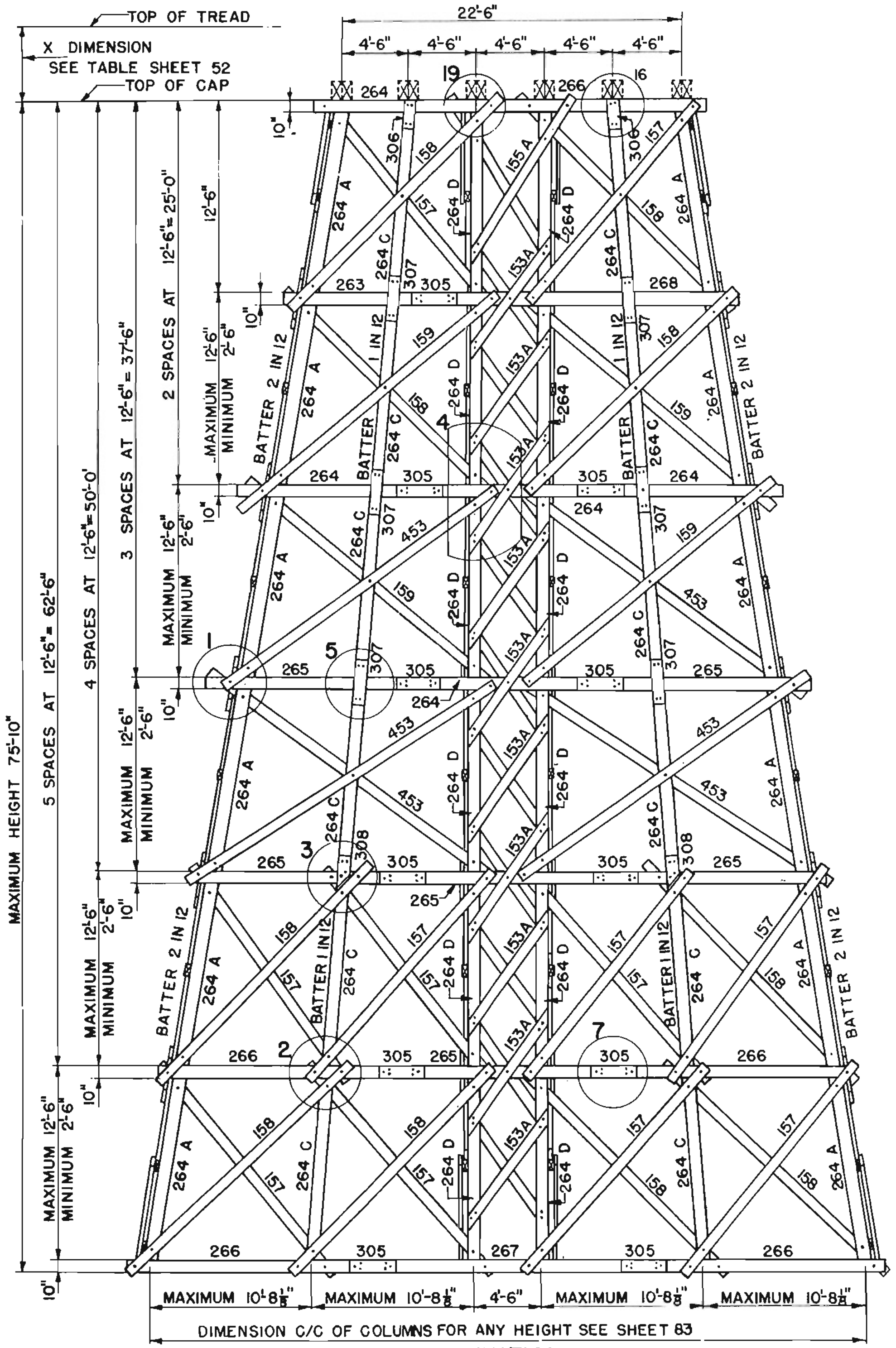
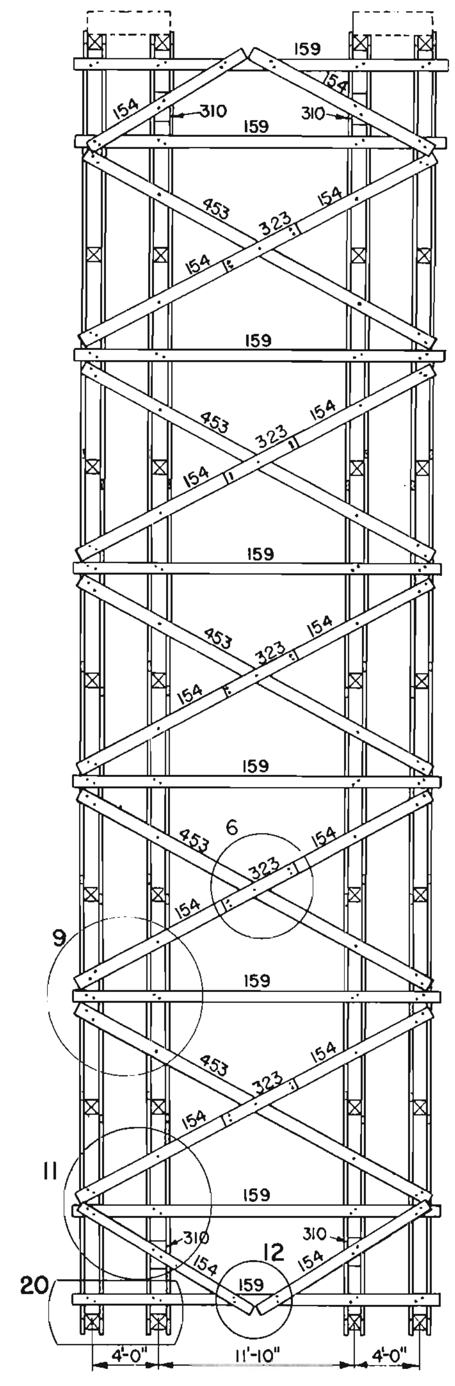
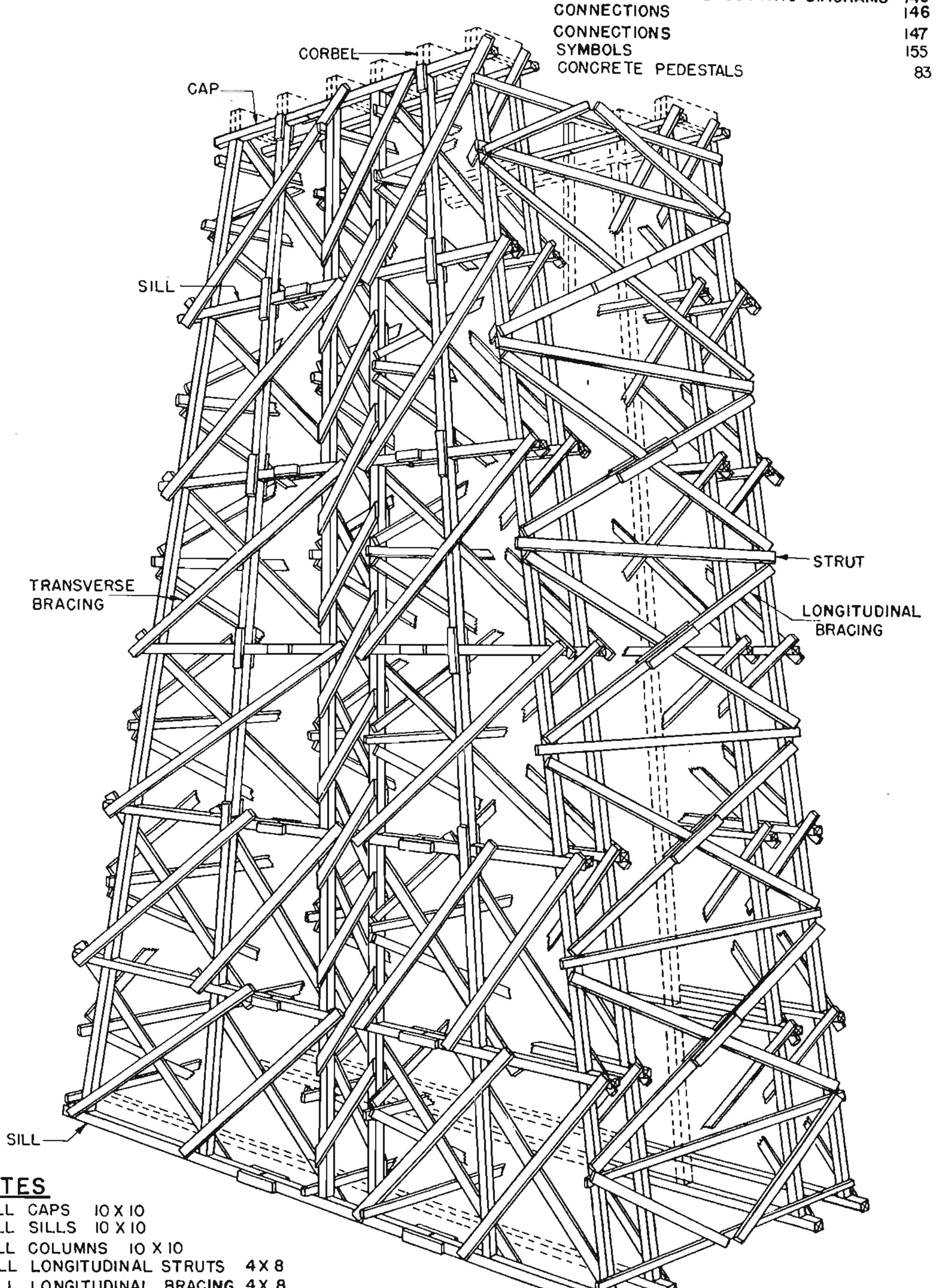


ELEVATION



LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH



NOTES
ALL CAPS 10 X 10
ALL SILLS 10 X 10
ALL COLUMNS 10 X 10
ALL LONGITUDINAL STRUTS 4 X 8
ALL LONGITUDINAL BRACING 4 X 8
ALL TRANSVERSE BRACING 4 X 8

ASSEMBLED VIEW

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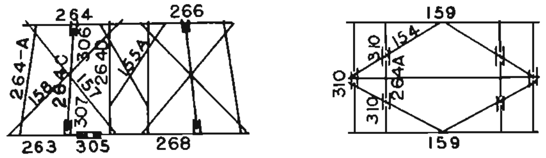
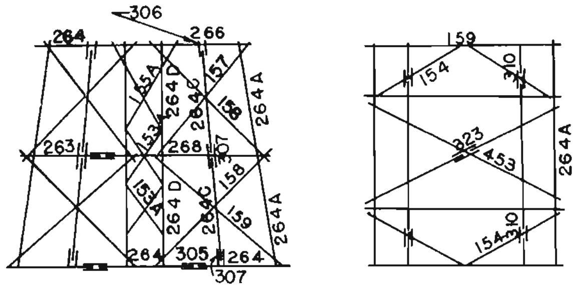
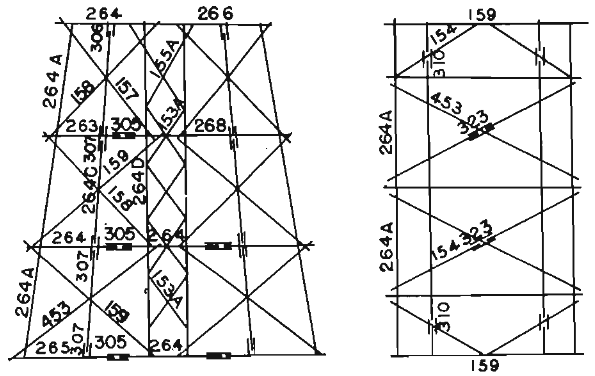


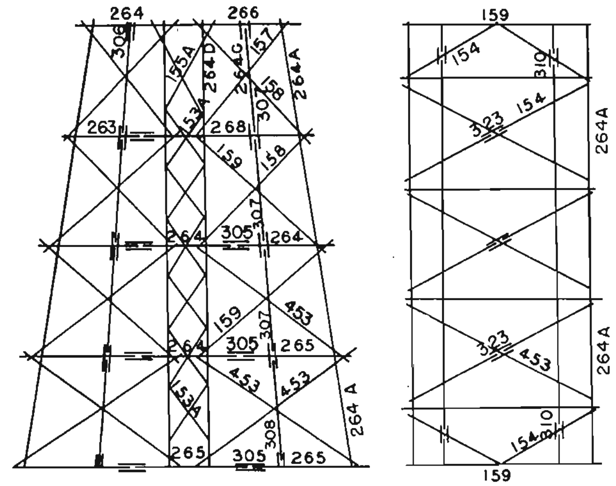
1 STORY TOWER



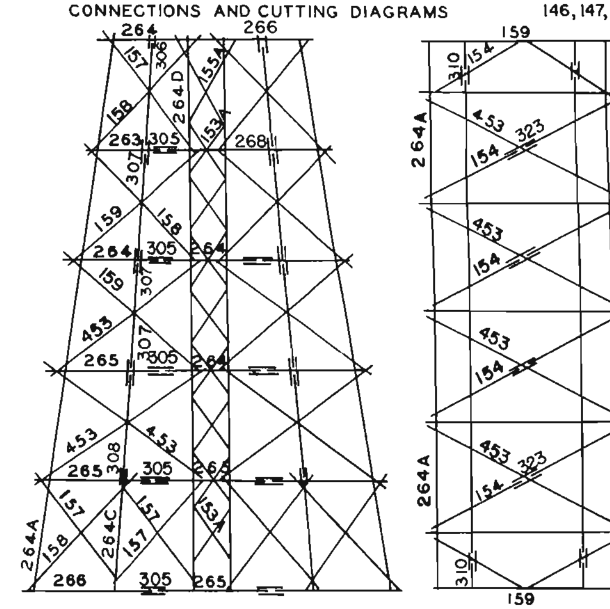
2-STORY TOWER



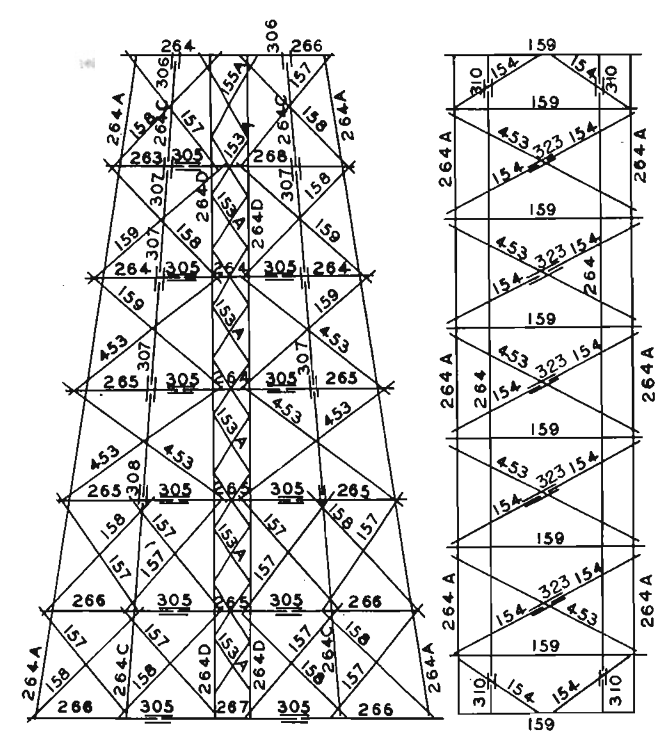
3-STORY TOWER



4-STORY TOWER



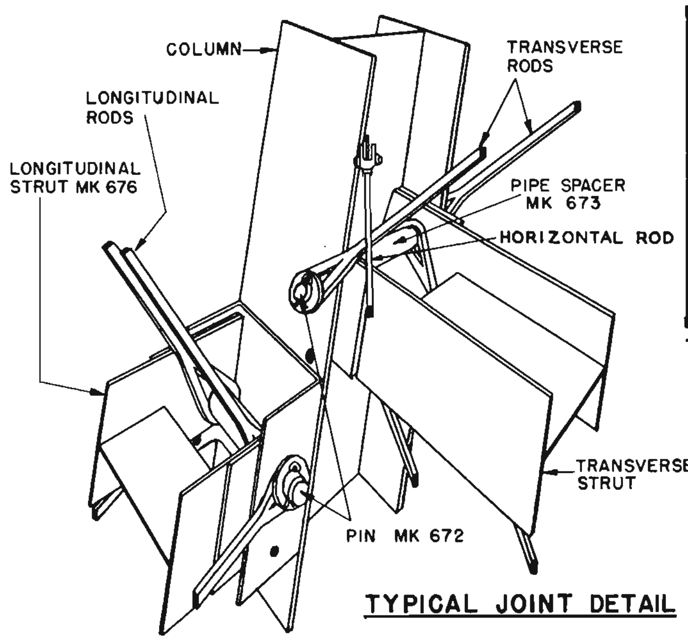
5-STORY TOWER



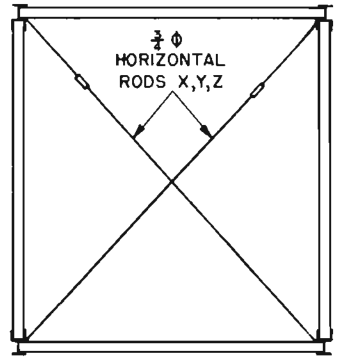
6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY F.B.M.	5-STORY 63'-4" QUANTITY	5-STORY F.B.M.	4-STORY 50'-10" QUANTITY	4-STORY F.B.M	3-STORY 38'-4" QUANTITY	3-STORY F.B.M.	2-STORY 25'-10" QUANTITY	2-STORY F.B.M.	1-STORY 13'-4" QUANTITY	1-STORY F.B.M.
	LUMBER, SOFT-WOOD																	
1	CAP	39-6620.1-16	266	10 X 10	16'-0"	500	4	533	4	533	4	533	4	533	4	533	4	533
2	DO	39-6620.1-12	264	10 X 10	12'-0"	375	4	400	4	400	4	400	4	400	4	400	4	400
3	SILL	39-6620.1-2	268	10 X 10	20'-0"	625	4	667	4	667	4	667	4	667	4	667	4	667
4	DO	39-6620.1-18	267	10 X 10	18'-0"	563	4	600										
5	DO	39-6620.1-16	266	10 X 10	16'-0"	500	16	2133	8	1067								
6	DO	39-6620.1-14	265	10 X 10	14'-0"	438	24	2800	24	2800	20	2333	8	933				
7	DO	39-6620.1-12	264	10 X 10	12'-0"	375	16	1600	16	1600	16	1600	16	1600	12	1200		
8	DO	39-6620.1-1	263	10 X 10	10'-0"	313	4	333	4	333	4	333	4	333	4	333	4	333
9	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	48	4800	40	4000	32	3200	24	2400	16	1600	8	800
10	DO	39-6620.1-12	264C	10 X 10	12'-0"	375	48	4800	40	4000	32	3200	24	2400	16	1600	8	800
11	DO	39-6620.1-12	264D	10 X 10	12'-0"	375	48	4800	40	4000	32	3200	24	2400	16	1600	8	800
12	STRUT	39-3340.08-22	159	4 X 8	22'-0"	220	32	1877	28	1643	24	1408	20	1173	16	939	12	704
13	BRACING	39-3340.08-24	453	4 X 8	24'-0"	240	44	2816	40	2560	36	2304	16	1024	4	256		
14	DO	39-3340.08-22	159	4 X 8	22'-0"	220	16	939	16	939	16	939	16	939	8	469		
15	DO	39-3340.08-2	158	4 X 8	20'-0"	200	40	2133	24	1280	16	853	16	853	16	853	8	427
16	DO	39-3340.08-18	157	4 X 8	18'-0"	180	48	2304	32	1536	8	384	8	384	8	384	8	384
17	DO	39-3340.08-14	155A	4 X 8	14'-0"	140	8	299	8	299	8	299	8	293	8	299	8	299
18	DO	39-3340.08-12	154	4 X 8	12'-0"	120	56	1792	48	1536	40	1280	32	1024	24	768	16	512
19	DO	39-3340.08-1	153A	4 X 8	10'-0"	100	80	2133	64	1707	48	1280	32	853	16	427		
20	SCAB	39-3340.1	305	4 X 10	3'-0"	38	88	880	72	720	56	560	40	400	24	240	8	80
21	DO	39-3330.1	306	3 X 10	2'-0"	19	16	80	16	80	16	80	16	80	16	80	16	80
22	DO	39-3952.1	307	3 X 10	3'-0"	28	48	360	48	360	48	360	48	360	32	240	16	120
23	DO	39-3330.1	308	3 X 10	2'-0"	19	16	80	16	80	16	80						
24	DO	39-3228.08	302	2 X 8	3'-0"	15	40	160	32	128	24	96	16	64	8	32		
25	DO	39-3340.1	310	4 X 10	2'-0"	25	16	107	16	107	16	107	16	107	16	107	24	160
	STEEL HARDWARE, BLACK																	
26	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.61	668		536		420		312		204		96	
27	DO	43-2325.1-18	E18	1	18"	5.18	160		160		160		128		96		64	
28	DO	43-2325.1-164	E16	1	16"	4.75	752		640		496		384		272		176	
29	DO	43-2325.1-104	E10	1	10"	3.45	132		112		92		72		52		32	
30	DRIFT BOLT	43-1636.07-2	D20	3/4	20"	2.50	372		300		228		172		116		60	



TYPICAL JOINT DETAIL



SECTION A-A

DIMENSION "T"	
SPAN LENGTH	TOP OF TREAD TO TOP OF BEARING ℄
15'-0"	2'-6 7/8"
20'-0"	2'-9 7/8"
30'-0"	3'-0 7/8"
40'-0"	3'-3 7/8"
50'-0"	3'-10"
60'-0"	3'-10 1/8"
70'-0"	4'-0 7/8"
80'-0"	4'-1 3/8"
90'-0"	4'-0 7/8"

COMPANION SHEETS

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BILL OF MATERIALS	58
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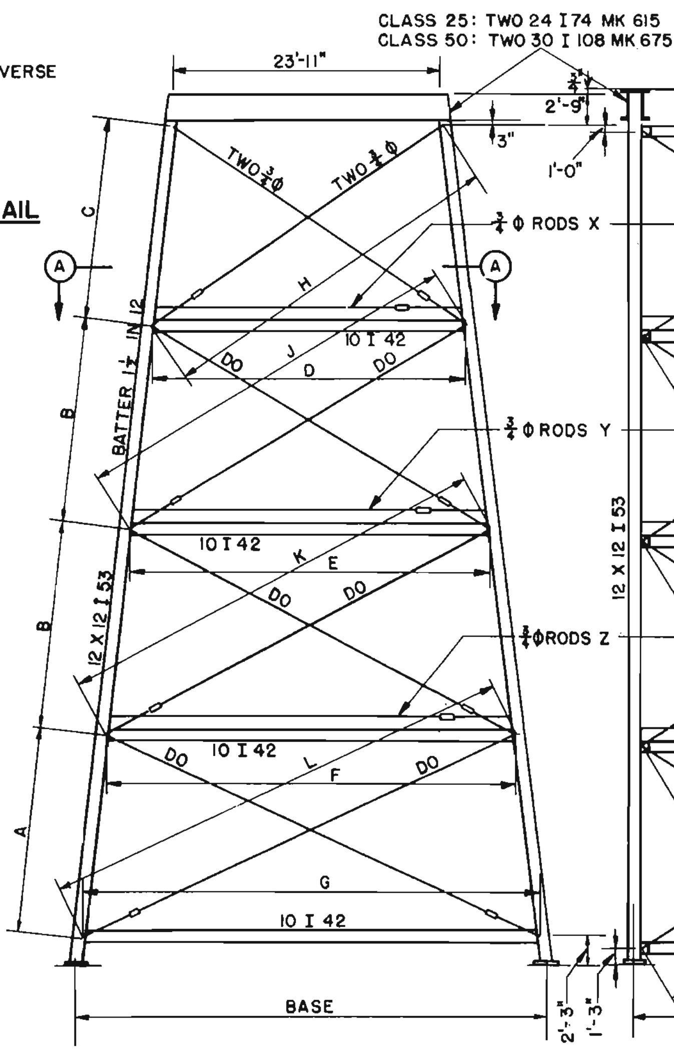
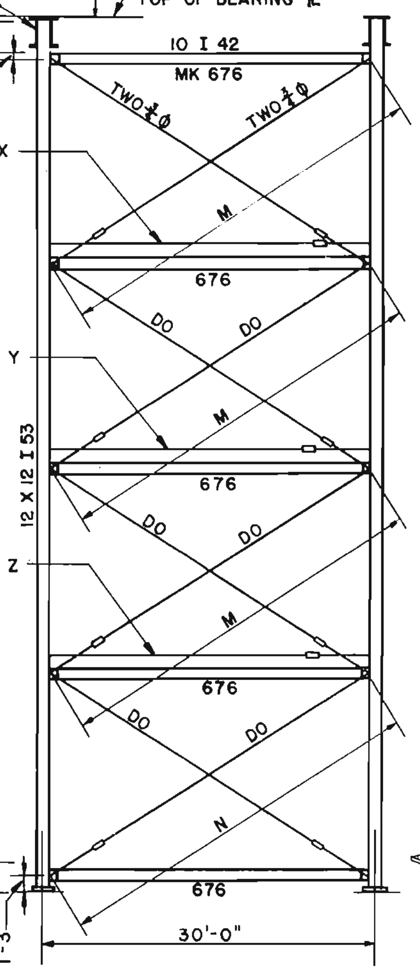
TABULATION OF TOWER DIMENSIONS AND ERECTION MARKS

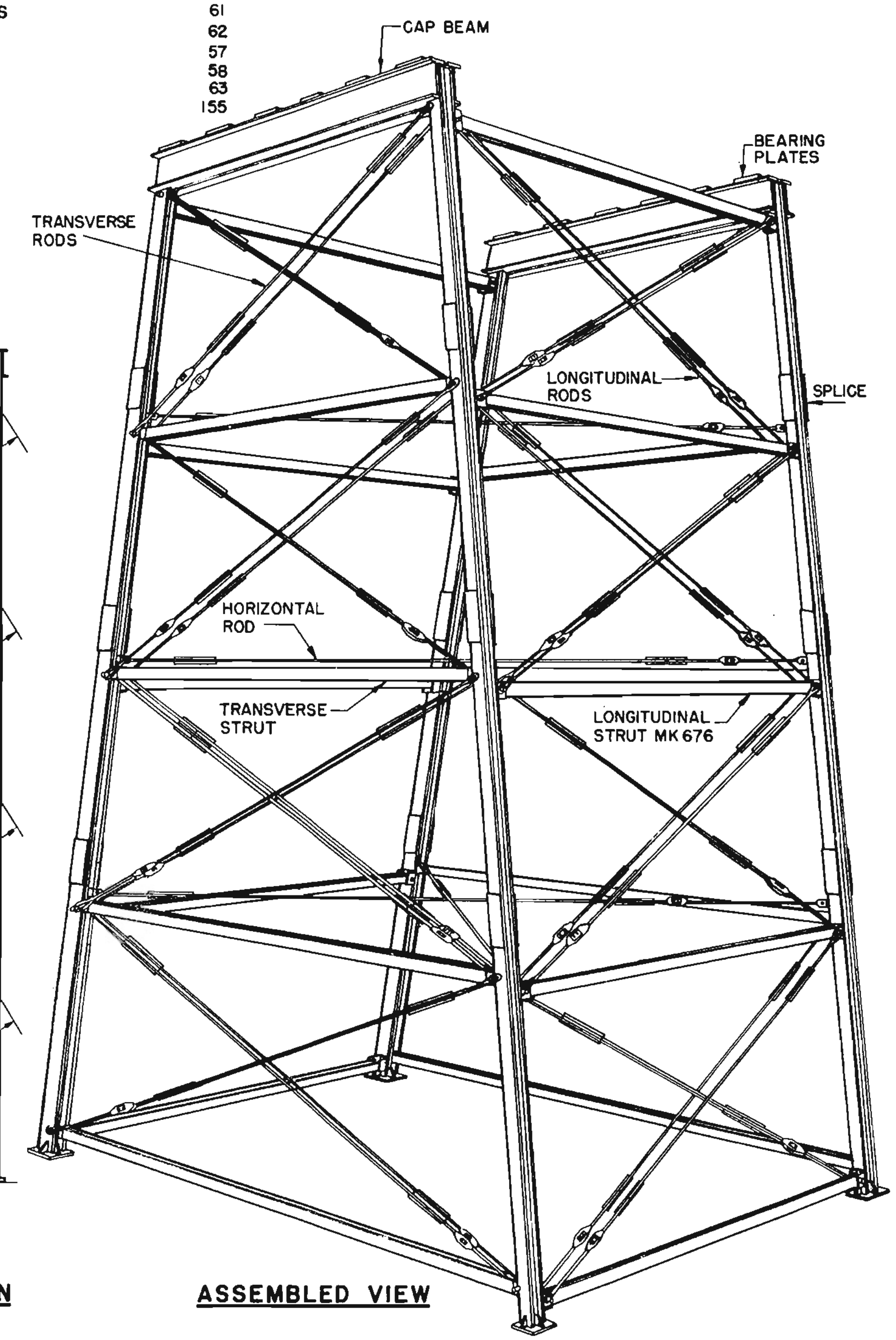
		FOUR-STORY TOWER				
HEIGHT		77'	75'	73'	71'	• 69'
BASE		43'-2"	42'-8"	42'-2"	41'-8"	41'-2"
A	MARK	1637	1638	1639	1640	1641
	DIMENSION	18'-1 5/8"	17'-7 5/8"	17'-1 5/8"	16'-7 1/2"	16'-1 1/2"
B	MARK	1647	1648	1649	1650	1651
	DIMENSION	18'-1 5/8"	17'-7 5/8"	17'-1 5/8"	16'-7 1/2"	16'-1 1/2"
C	MARK	1657	1658	1659	1660	1661
	DIMENSION	18'-1 5/8"	17'-7 5/8"	17'-1 5/8"	16'-7 1/2"	16'-1 1/2"
D	MARK	1623	1624	1625	1626	1627
	DIMENSION	28'-7 1/4"	28'-5 3/4"	28'-4 1/4"	28'-2 3/4"	28'-1 1/4"
E	MARK	1608	1609	1610	1611	1612
	DIMENSION	33'-1 1/4"	32'-10 1/4"	32'-7 1/4"	32'-4 1/4"	32'-1 1/4"
F	MARK	1595	1596	1598	1599	1601
	DIMENSION	37'-7 1/4"	37'-2 3/4"	36'-10 1/4"	36'-5 3/4"	36'-1 1/4"
G	MARK	1586	1587	1588	1589	1590
	DIMENSION	42'-1 1/4"	41'-7 1/4"	41'-1 1/4"	40'-7 1/4"	40'-1 1/4"
H	MARK	783	786	790	792	794
	DIMENSION	31'-11"	31'-7"	31'-3 1/8"	30'-11 1/4"	30'-7 3/8"
J	MARK	737	741	742	747	751
	DIMENSION	35'-8 5/8"	35'-3 3/4"	34'-10 3/4"	34'-5 7/8"	34'-1 1/8"
K	MARK	710	712	717	721	725
	DIMENSION	39'-8 1/8"	39'-2"	38'-8"	38'-2"	37'-8"
L	MARK	700	701	703	704	706
	DIMENSION	43'-8 3/4"	43'-1 1/2"	42'-6 1/4"	41'-11 1/8"	41'-3 7/8"
M	MARK	758	762	766	769	772
	DIMENSION	33'-8 7/8"	33'-5 5/8"	33'-2 1/2"	32'-11 1/4"	32'-8 3/8"
N	MARK	758	762	766	769	772
	DIMENSION	33'-8 7/8"	33'-5 5/8"	33'-2 1/2"	32'-11 1/4"	32'-8 3/8"
X	MARK	934	935	936	937	938
	DIMENSION	39'-6 1/2"	39'-5 1/2"	39'-4 3/8"	39'-3 3/8"	39'-2 3/8"
Y	MARK	920	921	922	923	924
	DIMENSION	42'-9 1/4"	42'-7 1/8"	42'-4 7/8"	42'-2 5/8"	42'-0 1/2"
Z	MARK	912	913	914	915	916
	DIMENSION	46'-2 5/8"	45'-11 1/8"	45'-7 5/8"	45'-4 1/8"	45'-0 5/8"



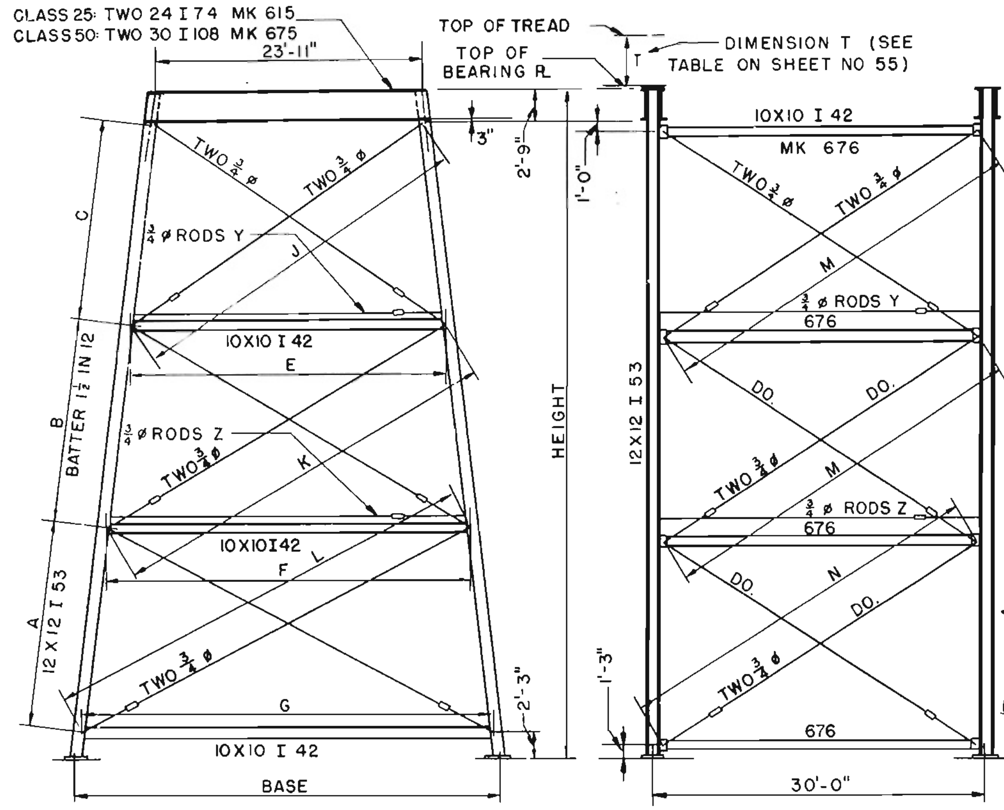
TRANSVERSE ELEVATION

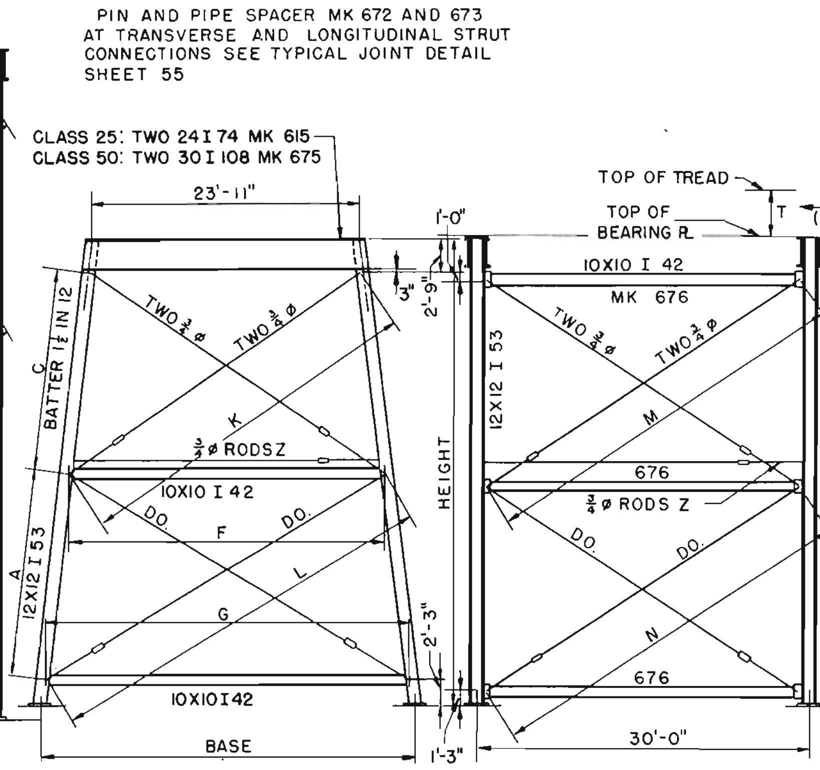


LONGITUDINAL ELEVATION



ASSEMBLED VIEW





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STRUTS AND COLUMNS	61
ROD BRACING	62
BILL OF MATERIALS	57
BILL OF MATERIALS	58
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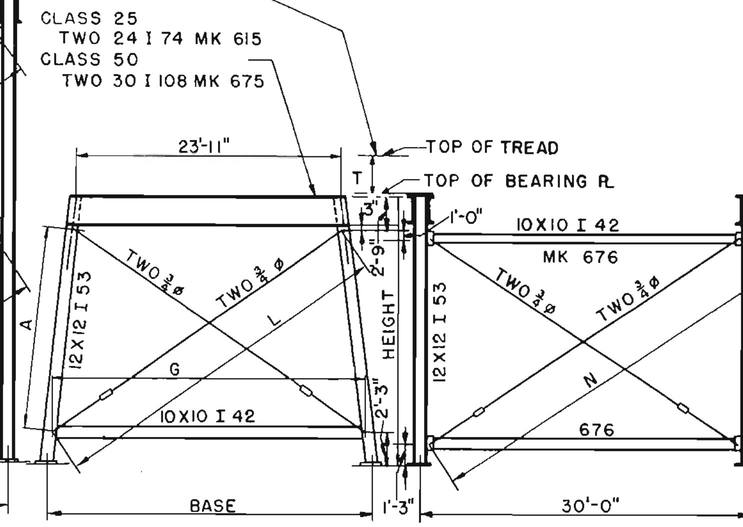

TABULATION OF TOWER DIMENSIONS AND ERECTION MARKS

THREE-STORY TOWER

		67'	65'	63'	61'	59'	57'	55'	53'	51'
BASE		40'-8"	40'-2"	39'-8"	39'-2"	38'-8"	38'-2"	37'-8"	37'-2"	36'-8"
A	MARK DIMENSION	1633 22'-2"	1635 20'-1 7/8"	1636 18'-1 3/4"	1637 18-1 5/8"	1637 18'-1 5/8"	1639 17'-1 5/8"	1639 17'-1 5/8"	1641 16'-1 1/2"	1642 15'-1 3/8"
B	MARK DIMENSION	1644 20'-1 7/8"	1644 20'-1 7/8"	1645 19'-7 7/8"	1646 19'-1 3/4"	1647 18'-1 5/8"	1648 17'-7 5/8"	1650 16'-7 1/2"	1651 16'-1 1/2"	1652 15'-7 1/2"
C	MARK DIMENSION	1654 20'-1 7/8"	1654 20'-1 7/8"	1655 19'-7 7/8"	1656 19'-1 3/4"	1657 18'-1 5/8"	1658 17'-7 5/8"	1660 16'-7 1/2"	1661 16'-1 1/2"	1662 15'-7 1/2"
E	MARK DIMENSION	1618 29'-1 1/4"	1618 29'-1 1/4"	1621 28'-11 3/4"	1622 28'-10 1/4"	1623 28'-7 1/4"	1624 28'-5 3/4"	1626 28'-2 3/4"	1627 28'-1 1/4"	1629 27'-11 3/4"
F	MARK DIMENSION	1605 34'-1 1/4"	1605 34'-1 1/4"	1606 33'-10 1/4"	1607 33'-7 1/4"	1608 33'-1 1/4"	1609 32'-10 1/4"	1611 32'-4 1/4"	1612 32'-1 1/4"	1613 31'-10 1/4"
G	MARK DIMENSION	1591 39'-7 1/4"	1592 39'-1 1/4"	1593 38'-7 1/4"	1594 38'-1 1/4"	1595 37'-7 1/4"	1597 37'-1 1/4"	1600 36'-7 1/4"	1601 36'-1 1/4"	1602 35'-7 1/4"
J	MARK DIMENSION	764 33'-3 3/8"	764 33'-3 3/8"	769 32'-11 1/4"	773 32'-7 1/8"	783 31'-11"	786 31'-7"	792 30'-11 1/4"	794 30'-7 3/8"	797 30'-3 5/8"
K	MARK DIMENSION	727 37'-4 3/4"	727 37'-4 3/4"	730 36'-11 3/4"	732 36'-6 5/8"	737 35'-8 5/8"	741 35'-3 3/4"	747 34'-5 7/8"	751 34'-1 1/8"	759 39'-8 3/8"
L	MARK DIMENSION	702 42'-11"	705 41'-8 1/2"	707 40'-10 7/8"	708 40'-1 3/8"	710 39'-8 1/8"	714 38'-10 3/4"	719 38'-5 1/4"	725 37'-8"	731 36'-11"
M	MARK DIMENSION	743 34'-10 3/8"	743 34'-10 3/8"	746 34'-6 7/8"	1056 34'-3 1/2"	758 33'-8 7/8"	762 33'-5 5/8"	769 32'-11 1/4"	772 32'-8 3/8"	776 32'-5 1/2"
N	MARK DIMENSION	736 36'-0 3/4"	743 34'-10 3/8"	748 34'-3 1/2"	758 33'-8 7/8"	758 33'-8 7/8"	766 33'-2 1/2"	766 33'-2 1/2"	772 32'-8 3/8"	781 32'-2 5/8"
CLEVIS ROD Y	MARK DIMENSION	931 39'-10 5/8"	931 39'-10 5/8"	932 39'-9 5/8"	933 39'-8 5/8"	934 39'-6 1/2"	935 39'-5 1/2"	937 39'-3 3/8"	938 39'-2 3/8"	939 39'-1 3/8"
CLEVIS ROD Z	MARK DIMENSION	917 43'-6 1/4"	917 43'-6 1/4"	918 43'-4"	919 43'-1 3/4"	920 42'-9 1/4"	921 42'-7 1/8"	923 42'-2 5/8"	924 42'-0 1/2"	925 41'-10 1/4"

TWO-STORY TOWER

HEIGHT		49'	47'	45'	43'	41'	39'	37'	35'	33
BASE		36'-2"	35'-8"	35'-2"	34'-8"	34'-2"	33'-8"	33'-2'	32'-8"	32'-2"
A	MARK DIMENSION	1633 22'-2"	1634 21'-2"	1635 20'-1 7/8"	1636 19'-1 3/4'	1637 18'-1 5/8"	1639 17'-1 5/8"	1641 16'-1 1/2"	1642 15'-1 3/8"	1643 14'-1 1/4"
B	MARK DIMENSION									
C	MARK DIMENSION	1652 22'-2"	1653 21'-2"	1654 20'-1 7/8"	1656 19-1 3/4"	1657 18'-1 5/8"	1659 17'-1 5/8"	1661 16'-1 1/2"	1663 15-1 3/8"	1664 14'-1 1/4"
E	MARK DIMENSION									
F	MARK DIMENSION	1619 29'-7 1/4"	1620 29'-4 1/4"	1618 29'-1 1/4"	1622 28'-10 1/4	1623 28'-7 1/4"	1625 28'-4 1/4"	1627 28'-1 1/4"	1630 27'-10 1/4"	1631 27'-7 1/4"
G	MARK DIMENSION	1603 35'-1 1/4"	1604 34'-7 1/4"	1605 34'-1 1/4"	1607 33'-7 1/4"	1608 33'-1 1/4"	1610 32'-7 1/4"	1612 32'-1 1/4"	1614 31'-7 1/4"	1615 31'-1 1/4"
J	MARK DIMENSION									
K	MARK DIMENSION	744 34'-8 5/8"	753 33'-11 7/8"	764 33'-3 3/8"	773 32'-7 1/8"	783 31'-11"	790 31'-3 1/8"	794 30'-7 3/8"	801 30'-0"	806 29'-4 7/8"
L	MARK DIMENSION	713 39'-1 1/2"	720 38'-8 1/8"	727 37'-4 3/4"	732 36'-6 5/8"	737 35'-8 5/8"	742 34'-10 3/4"	751 34'-1 1/8"	764 33'-3 5/8"	774 32'-6 1/4"
M	MARK DIMENSION	736 36'-0 3/4"	739 35'-5 1/2"	743 34'-10 3/8"	1056 34'-3 1/2"	758 33'-8 7/8"	766 33'-2 1/2"	772 32'-8 3/8"	781 32'-2 5/8"	785 31'-9"
N	MARK DIMENSION	736 36'-0 3/4"	739 35'-5 1/2"	743 34'-10 3/8"	1056 34'-3 1/2"	758 33'-8 7/8"	766 33'-2 1/2"	772 32'-8 3/8"	781 32'-2 5/8"	785 31'-9"
CLEVIS ROD Y	MARK DIMENSION									
CLEVIS ROD Z	MARK DIMENSION	929 40'-2 7/8"	930 40'-0 3/4"	931 39'-10 5/8"	933 38'-8 5/8"	934 39'-6 1/2"	936 39'-4 3/8"	938 39'-2 3/8"	940 39'-0 3/8"	942 98'-10 1/4"

ONE-STORY TOWER

HEIGHT		31'	29'	27'	25'	23'	21'	19'	17'	15'
BASE		31'-8"	31'-2"	30'-8"	30'-2"	29'-8"	29'-2"	28'-8"	28'-2"	27'-8"
A	MARK DIMENSION	1665 26'-2 3/8"	1666 24'-2 1/4"	1667 22'-2"	1668 20'-1 7/8"	1669 18'-1 5/8"	1670 16'-1 1/2"	1671 14'-1 1/4"	1672 12'-1 1/8"	1673 10'-0 7/8"
B	MARK DIMENSION									
C	MARK DIMENSION									
E	MARK DIMENSION									
F	MARK DIMENSION									
G	MARK DIMENSION	1616 30'-7 1/4"	1617 30'-1 1/4"	1619 29'-7 1/4"	1618 29'-1 1/4"	1623 28'-7 1/4"	1627 28'-1 1/4"	1631 27'-7 1/4"	1628 27'-1 1/4"	1632 26'-7 1/4"
J	MARK DIMENSION									
K	MARK DIMENSION									
L	MARK DIMENSION	724 37'-8 7/8"	734 36'-2 3/8"	744 34'-8 5/8"	764 33'-3 3/8"	783 31'-11"	794 30'-7 3/8"	806 29'-4 1/8"	815 28'-3 3/8"	820 27'-3"
M	MARK DIMENSION									
N	MARK DIMENSION	717 38'-8"	728 37'-4 1/8"	736 36'-0 3/4"	743 34'-10 3/8"	768 33'-8 7/8"	772 32'-8 3/8"	785 31'-9"	793 30'-11"	798 30'-2 1/8"
CLEVIS ROD Y	MARK DIMENSION									
CLEVIS ROD Z	MARK DIMENSION									

COMPANION SHEETS

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TABLE B – BILL OF MATERIALS COMMON TO ALL TOWERS

LINE	DESCRIPTION	STOCK NO	MARK	DETAILED ON SHEET	SIZE (INCHES)	LENGTH	CLASS 50 TOWER HEIGHT GROUP CLASSIFICATION: 4-STORY 69' TO 79' NUMBER	4-STORY WEIGHT EACH (POUNDS)	3-STORY 51' TO 67' NUMBER	3-STORY WEIGHT EACH (POUNDS)	2-STORY 33' TO 49' NUMBER	2-STORY WEIGHT EACH (POUNDS)	1-STORY 15' TO 31' NUMBER	1-STORY WEIGHT EACH (POUNDS)	CLASS 25 TOWER HEIGHT GROUP CLASSIFICATION: 4-STORY 69' TO 79' NUMBER	4-STORY WEIGHT EACH (POUNDS)	3-STORY 51' TO 67' NUMBER	3-STORY WEIGHT EACH (POUNDS)	2-STORY 33' TO 49' NUMBER	2-STORY WEIGHT EACH (POUNDS)	1-STORY 15' TO 31' NUMBER	1-STORY WEIGHT EACH (POUNDS)	LINE
1	CAP BEAM	48-2900.3-108	675	59	30 I 108	25'-5 1/2"	4	2750	4	2750	4	2750	4	2750									1
2	BEARING PLATE	47-7844.07	P6	59	22 X 3/4	1'-10"	12	103	12	103	12	103	12	103									2
3	DIAPHRAGM		D1	59	12 X 12 I 53	2'-3"	8	119	8	119	8	119	8	119									3
4	CAP BEAM	48-2900.24-074	615	102	24 I 74	25'-4"									4	1875	4	1875	4	1875	4	1875	4
5	BEARING PLATE	47-7844.07	P7	102	21 X 3/4	1'-10"									12	98	12	98	12	98	12	98	5
6	DIAPHRAGM		D2	102	12 X 12 I 53	1'-9"									8	93	8	93	8	93	8	93	6
7	RIVETS IN BEARING PLATES	43-6353.08		59,102	7/8	3 1/4"	96	.79	96	.79	96	.79	96	.79	96	.79	96	.79	96	.79	96	.79	7
8	RIVETS IN WEBS OF CAPS	43-6353.08-25		59,102	7/8	2 1/2"	336	.67	336	.67	336	.67	336	.67	176	.67	176	.67	176	.67	176	.67	8
9	LONGITUDINAL STRUT		676	59	10 I 42	28'-10 7/8"	10	1215	8	1215	6	1215	4	1215	10	1215	8	1215	6	1215	4	1215	9
10	PIN PLATE	47-7844.04	P8	59	9 X 3/8	0'-10"	40	10	32	10	24	10	16	10	40	10	32	10	24	10	16	10	10
11	DO	47-7844.04	P5	61	9 X 3/8	0'-10"	32	10	24	10	16	10	8	10	32	10	24	10	16	10	8	10	11
12	COLUMN BASE PLATE	47-7844.1	P4	60,61	18 X 1	1'-6"	4	92	4	92	4	92	4	92	4	92	4	92	4	92	4	92	12
13	STIFFENERS	47-7844.04	P5,15,16	60	6 X 3/8	1'-5 1/2"							4	11							4	11	13
14	DO	47-7844.04	P9,10,11	61	6 X 3/8	1'-5 1/2"	4	11	4	11	4	11			4	11	4	11	4	11			14
15	BRACING CONNECTOR		C1	60,61	12 X 12 I 53	1'-1 1/4"	20	40	16	40	12	40	8	40	20	40	16	40	12	40	8	40	15
16	DO	47-7844.05	P3	60,61	4 X 1/2	1'-0"	12	7	8	7	4	7			12	7	8	7	4	7			16
17	WEB SPLICE	47-7844.05	P5	60	10 X 1/2	2'-0 1/4"	16	34	8	34					16	34	8	34					17
18	FLANGE SPLICE	47-7844.05	P6	60	12 X 1/2	2'-0 1/4"	16	41	8	41					16	41	8	41					18
19	WEB SPLICE	47-7844.05	P15	61	10 X 1/2	2'-0 1/4"	8	34	8	34	8	34			8	34	8	34	8	34			19
20	FLANGE SPLICE	47-7844.05	P16	61	12 X 1/2	2'-0 1/4"	8	41	8	41	8	41			8	41	8	41	8	41			20
21	RIVETS, WEB SPLICE	43-6353.08		60,61	7/8	3 1/4"	192	.79	128	.79	64	.79			192	.79	128	.79	64	.79			21
22	RIVETS, FLANGE SPLICE	43-6353.08-25		60,61	7/8	2 1/2"	384	.67	256	.67	128	.67			384	.67	256	.67	128	.67			22
23	1) PIN		672	59	1 1/2 ø	1'-4 1/2"	40	8	32	8	24	8	16	8	40	8	32	8	24	8	16	8	23
24	1) COTTER PIN			59	1/4 X 2 1/2		80	.1	64	.1	48	.1	32	.1	80	.1	64	.1	48	.1	32	.1	24
25	1) PIPE SPACER	44-6246.7-02	673	59	2 ø	0'-7"	40	2	32	2	24	2	16	2	40	2	32	2	24	2	16	2	25
26	1) WASHER		658	59	3 3/4 X 1 9/16 HOLE	3 3/4"	144	1.24	128	1.24	112	1.24	96	1.24	144	1.24	128	1.24	112	1.24	96	1.24	26
27	2) LOOP ROD, UPSET		677	62	3/4 □	4'-7"	128	11	96	11	64	11	32	11	128	11	96	11	64	11	32	11	27
28	SPLICE ROD	46-6375.5-07	678	62	3/4 ø	1'-1"	256	1.6	192	1.6	128	1.6	64	1.6	256	1.6	192	1.6	128	1.6	64	1.6	28
29	2) TURNBUCKLE			62	1 1/8	6"	64	2.7	48	2.7	32	2.7	16	2.7	64	2.7	48	2.7	32	2.7	16	2.7	29
30	3) CLEVIS ROD, HORIZONTAL, UPSET		680	62	3/4 □	1'-7"	6	4.3	4	4.3	2	4.3			6	4.3	4	4.3	2	4.3			30
31	3) DO		680	62	3/4 □	1'-3"	6	3.7	4	3.7	2	3.7			6	3.7	4	3.7	2	3.7			31
32	SPLICE ROD	46-6375.5-07	678	62	3/4 ø	1'-1"	24	1.6	16	1.6	8	1.6			24	1.6	16	1.6	8	1.6			32
33	3) TURNBUCKLE			62	1 1/8	6"	6	2.7	4	2.7	2	2.7			6	2.7	4	2.7	2	2.7			33
34	3) CLEVIS			62	NO 3 FOR 1 1/8 THREAD	5"	12	4.0	8	4.0	4	4.0			12	4.0	8	4.0	4	4.0			34
35	3) PIN, HEADED, CLEVIS,			62	1 3/16 ø	3 1/4"	12	1.5	8	1.5	4	1.5			12	1.5	8	1.5	4	1.5			35
36	3) COTTER PIN			62	1/4 X 2 1/2		12	.1	8	.1	4	.1			12	.1	8	.1	4	.1			36
37	WELDING ELECTRODE	46-3772.2 46-3772.25			3/16 & 7/32			330 LBS		260 LBS		180 LBS		100 LBS		330 LBS		260 LBS		180 LBS		100 LBS	37

1) CONNECTOR PIN ASSEMBLY, 1½"
2) LOOP ROD ASSEMBLY, ¾"
3) CLEVIS ROD ASSEMBLY, ¾"

TABLE A - BILL OF MATERIALS FOR PIECES WHICH VARY FOR DIFFERENT TOWER HEIGHTS

DESCRIPTION	LINE	DETAILED ON SHEET	NUMBER	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)
		TOWER HEIGHT		77'			75'			73'			71'			69'		
TOWER COLUMNS 12 X 12 I 53 STOCK NO	1	61	2	1637R	23'-11"	1270	1638R	23'-5"	1240	1639R	22'-11"	1215	1640R	22'-4 7/8"	1190	1641R	21'-10 7/8"	1160
	2		2	1637L	23'-11"	1270	1638L	23'-5"	1240	1639L	22'-11"	1215	1640L	22'-4 7/8"	1190	1641L	21'-10 7/8"	1160
	3		4	1647R	18'-1 3/8"	960	1648R	17'-7 3/8"	935	1649R	17'-1 3/8"	905	1650R	16'-7 1/4"	880	1651R	16'-1 1/4"	855
	4	60	4	1647L	18'-1 3/8"	960	1648L	17'-7 3/8"	935	1649L	17'-1 3/8"	905	1650L	16'-7 1/4"	880	1651L	16'-1 1/4"	855
	5		2	1657R	17'-3 1/2"	915	1658R	15'-9 1/2"	890	1659R	16'-3 1/2"	865	1650R	15'-9 3/8"	835	1661R	15'-3 3/8"	810
	6		2	1657L	17'-3 1/2"	915	1658L	16'-9 1/2"	890	1659L	16'-3 1/2"	865	1650L	15'-9 3/8"	835	1661L	15'-3 3/8"	810
TRANSVERSE STRUTS 10 I 42 STOCK NO	7		2	1623	29'-0 1/4"	1220	1624	28'-10 3/4"	1215	1625	28'-9 1/4"	1210	1626	28'-7 3/4"	1205	1627	28'-6 1/4"	1200
	8	61	2	1608	33'-6 1/4"	1410	1609	33'-3 1/4"	1400	1610	33'-0 1/4"	1385	1611	32'-9 1/4"	1375	1612	32'-6 1/4"	1365
	9		2	1595	38'-0 1/4"	1595	1596	37'-7 3/4"	1580	1598	37'-3 1/4"	1565	1599	36'-10 3/4"	1550	1601	36'-5 1/4"	1535
	10		2	1586	42'-6 1/4"	1785	1587	42'-0 1/4"	1765	1588	41'-6 1/4"	1745	1589	41'-0 1/4"	1720	1590	40'-5 1/4"	1700
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	11		8	887	22'-0"	33	887	22'-0"	33	888	21'-6"	32	889	21'-0"	32	889	21'-0"	32
	12	62	8	879	26'-0"	39	880	25'-6"	38	881	25'-0"	38	882	24'-6"	37	882	24'-6"	37
	13		8	871	30'-0"	45	872	29'-6"	44	873	29'-0"	44	874	28'-6"	43	875	28'-0"	42
	14		8	863	34'-0"	51	864	33'-6"	50	866	32'-6"	49	867	32'-0"	48	868	31'-6"	47
LONGITUDINAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	15	62	24	883	24'-0"	36	884	23'-6"	35	884	23'-6"	35	885	23'-0"	35	885	23'-0"	35
	16		8	883	24'-0"	36	884	23'-6"	35	884	23'-6"	35	885	23'-0"	35	885	23'-0"	35
HORIZONTAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	17		2	1000	35'-6"	53	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53
	18	62	2	995	38'-6"	58	995	38'-6"	58	996	38'-0"	57	996	38'-0"	57	996	38'-0"	57
	19		2	990	42'-0"	63	991	41'-6"	62	991	41'-6"	62	992	41'-0"	62	992	41'-0"	62

DESCRIPTION	LINE	DETAILED ON SHEET	NUMBER	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)
		TOWER HEIGHT		67'			65'			63'			61'			59'			57'			55'			53'			51'		
TOWER COLUMNS 12 X 12 I 53 STOCK NO	20	61	2	1633R	27'-11 3/8"	1480	1635R	25'-11 1/4"	1380	1636R	24'-11 1/8"	1320	1637R	23'-11"	1270	1637R	23'-11"	1270	1639R	22'-11"	1215	1639R	22'-11"	1215	1641R	21'-10 3/8"	1160	1642R	20'-10 3/4"	1110
	21		2	1633L	27'-11 3/8"	1480	1635L	25'-11 1/4"	1380	1636L	24'-11 1/8"	1320	1637L	23'-11"	1270	1637L	23'-11"	1270	1639L	22'-11"	1215	1639L	22'-11"	1215	1641L	21'-10 3/8"	1160	1642L	20'-10 3/4"	1110
	22		2	1644R	20'-1 5/8"	1070	1644R	20'-1 5/8"	1070	1645R	19'-7 5/8"	1040	1646R	19'-1 1/2"	1015	1647R	18'-1 3/8"	960	1648R	17'-7 3/8"	935	1650R	16'-7 1/4"	880	1651R	16'-1 1/4"	855	1652R	15'-7 1/4"	830
	23	60	2	1644L	20'-1 5/8"	1070	1644L	20'-1 5/8"	1070	1645L	19'-7 5/8"	1040	1646L	19'-1 1/2"	1015	1647L	18'-1 3/8"	960	1648L	17'-7 3/8"	935	1650L	16'-7 1/4"	880	1651L	16'-1 1/4"	855	1652L	15'-7 1/4"	830
	24		2	1654R	19'-3 3/4"	1025	1654R	19'-3 3/4"	1025	1655R	18'-9 3/4"	1000	1656R	18'-3 5/8"	970	1657R	17'-3 1/2"	915	1658R	16'-9 1/2"	890	1660R	15'-9 3/8"	835	1661R	15'-3 3/8"	810	1662R	14'-9 3/8"	785
	25		2	1654L	19'-3 3/4"	1025	1654L	19'-3 3/4"	1025	1655L	18'-9 3/4"	1000	1656L	18'-3 5/8"	970	1657L	17'-3 1/2"	915	1658L	16'-9 1/2"	890	1660L	15'-9 3/8"	835	1661L	15'-3 3/8"	810	1662L	14'-9 3/8"	785
TRANSVERSE STRUTS 10 I 42 STOCK NO	26		2	1618	29'-6 1/4"	1240	1618	29'-6 1/4"	1240	1621	29'-4 3/4"	1235	1622	29'-3 1/4"	1230	1623	29'-0 1/4"	1220	1624	28'-10 3/4"	1215	1626	28'-7 3/4"	1205	1627	28'-6 1/4"	1200	1629	28'-4 3/4"	1195
	27	61	2	1605	34'-6 1/4"	1450	1605	34'-6 1/4"	1450	1606	34'-3 1/4"	1440	1607	34'-0 1/4"	1430	1608	33'-6 1/4"	1410	1609	33'-3 1/4"	1400	1611	32'-9 1/4"	1375	1612	32'-6 1/4"	1370	1613	32'-3 1/4"	1360
	28		2	1591	40'-0 1/4"	1680	1592	39'-6 1/4"	1660	1593	39'-0 1/4"	1640	1594	38'-6 1/4"	1620	1595	36'-0 1/4"	1600	1597	37'-6 1/4"	1580	1600	37'-0 1/4"	1555	1601	36'-6 1/4"	1535	1602	36'-0 1/4"	1515
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	29		8	884	23'-6"	35	884	23'-6"	35	885	23'-0	35	885	23'-0"	35	887	22'-0"	33	887	22'-0"	33	889	21'-0"	32	889	21'-0"	32	890	20'-6"	31
	30	62	8	876	27'-6"	41	876	27'-6"	41	877	27'-0"	41	878	26'-6"	40	879	26'-0"	29	880	25'-6"	38	882	24'-6"	37	882	24'-6"	37	883	24'-0"	36
	31		8	865	33'-0"	50	887	32'-0"	48	869	31'-0"	47	870	30'-6"	46	871	30'-0"	45	873	29'-0"	44	874	28'-6"	43	875	28'-0"	42	877	27'-0"	41
LONGITUDINAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	32	62	16	881	25'-0"	38	581	25'-0"	38	881	25'-0"	38	882	24'-6"	37	883	24'-0"	36	884	23'-6"	35	885	23'-0"	35	885	23'-0"	35	886	22'-6"	34
	33		8	879	26'-0"	39	881	25'-0"	38	882	24'-6"	37	883	24'-0"	36	883	24'-0"	36	884	23'-6"	35	884	23'-6"	35	885	23'-0"	35	886	22'-6"	34
HORIZONTAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	34	62	2	1000	35'-6"	53	1000	35'-6"	53	1000	35'-6"	53	1000	35'-6"	53	1000	35'-6"	53	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53
	35		2	993	39'-6"	59	993	39'-6"	59	994	39'-0"	59	994	39'-0"	59	995	38'-6"	58	995	38'-6"	58	996	38'-0"	57	996	38'-0"	57	997	37'-6"	56

DESCRIPTION	LINE	DETAILED ON SHEET	NUMBER	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)
		TOWER HEIGHT		49'			47'			45'			43'			41'			39'			37'			35'			33'		
TOWER COLUMNS 12 X 12 I 53 STOCK NO	36	61	2	1633R	27'-11 3/8"	1480	1634R	26'-11 3/8"	1430	1635R	25'-11 1/4"	1375	1636R	24'-11 1/8"	1320	1637R	23'-11"	1270	1639R	22'-11"	1215	1641R	21'-10 7/8"	1160	1642R	20'-10 3/4"	1110	1643R	19'-10 5/8"	1065
	37		2	1633L	27'-11 3/8"	1480	1634L	26'-11 3/8"	1430	1635L	25'-11 1/4"	1375	1636L	24'-11 1/8"	1320	1637L	23'-11"	1270	1639L	22'-11"	1215	1641L	21'-10 7/8"	1160	1642L	20'-10 3/4"	1110	1643L	19'-10 5/8"	1065
	38	60	2	1772R	21'-3 7/8"	1130	1653R	20'-3 7/8"	1080	1654R	19'-3 3/4"	1025	1656R	18'-3 5/8"	970	1657R	17'-3 1/2"	940	1659R	16'-3 1/2"	865	1661R	15'-3 3/8"	810	1663R	14'-3 1/4"	755	1664R	13'-3 1/8"	705
	39		2	1772L	21'-3 7/8"	1130	1653L	20'-3 7/8"	1080	1654L	19'-3 3/4"	1025	1656L	18'-3 5/8"	970	1657L	17'-3 1/2"	940	1659L	16'-3 1/2"	865	1661L	15'-3 3/8"	810	1663L	14'-3 1/4"	755	1664L	13'-3 1/8"	705
TRANSVERSE STRUTS 10 I 42 STOCK NO	40	61	2	1619	30'-0 1/4"	1260	1620	29'-9 1/4"	1250	1618	29'-6 1/4"	1240	1622	29'-3 1/4"	1220	1623	29'-0 1/4"	1220	1625	28'-9 1/4"	1210	1627	28'-6 1/4"	1200	1630	28'-3 1/4"	1190	1631	28'-0 1/4"	1180
	41		2	1603	35'-6 1/4"	1490	1604	35'-0 1/4"	1470	1605	34'-6 1/4"	1450	1607	34'-0 1/4"	1430	1608	33'-6 1/4"	1410	1610	33'-0 1/4"	1390	1612	32'-6 1/4"	1370	1614	32'-0 1/4"	1345	1615	31'-6 1/4"	1325
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	42	62	8	881	25'-0"	38	883	24'-0"	36	884	23'-6"	35	885	23'-0"	35	887	22'-0"	33	888	21'-6"	32	889	21'-0"	32	891	20'-0"	30	892	19'-6"	29
	43		8	872	29'-6"	44	874	28'-6"	43	876	27'-6"	41	878	26'-6"	40	879	26'-0"	39	881	25'-0"	38	882	24'-6"	37	884	23'-6"	35	886	22'-6"	34
LONGITUDINAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	44	62	8	879	26'-0"	39	880	25'-6"	38	881	25'-0"	38	882	24'-6"	37	883	24'-0"	36	884	23'-6"	35	885	23'-0"	35	886	22'-6"	34	887	22'-0"	33
	45		8	879	26'-0"	39	880	25'-6"	38	881	25'-0"	38	882	24'-6"	37	883	24'-0"	36	884	23'-6"	35	885	23'-0"	35	886	22'-6"	34	887	22'-0"	33
HORIZONTAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	46	62	2	999	36'-0"	54	999	36'-0"	54	1000	35'-6"	53	1000	35'-6"	53	1000	35'-6"	53	1001	35'-0"	53	1001	35'-0"	53	1001	35'-0"	53	1002	34'-6"	52

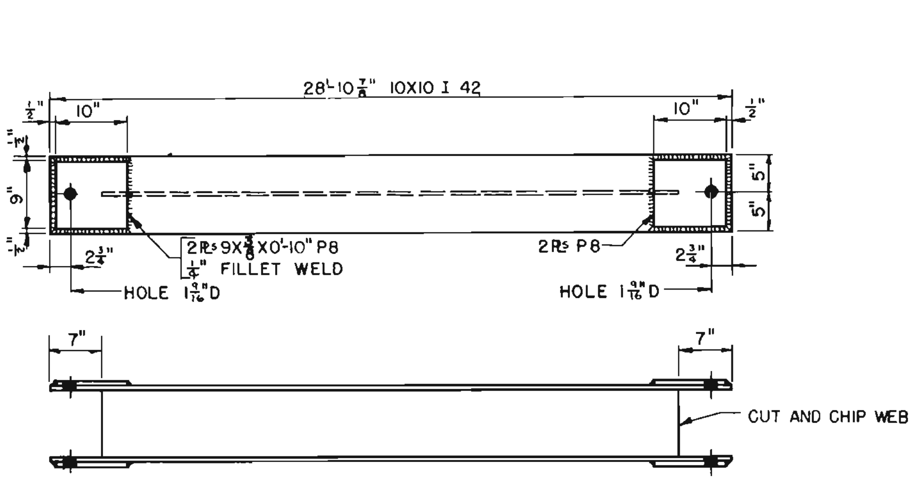
DESCRIPTION	LINE	DETAILED ON SHEET	NUMBER	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)	MARK	REQUISITIONED LENGTH	UNIT WEIGHT (POUNDS)
		TOWER HEIGHT		31'			29'			27'			25'			23'			21'			19'			17'			15'		
TOWER COLUMNS 12 X 12 I 53 STOCK NO	47	60	2	1665R	31'-1 7/8"	1650	1666R	29'-1 3/4"	1490	1667R	27'-1 1/2"	1440	1668R	25'-1 3/8"	1330	1669R	23'-1 1/8"	1225	1670R	21'-1"	1120	1671R	19'-0 3/4"	1010	1672R	17'-0 5/8"	905	1673R	15'-0 3/8"	800
	48		2	1665L	31'-1 7/8"	1650	1666L	29'-1 3/4"	1490	1667L	27'-1 1/2"	1440	1668L	25'-1 3/8"	1330	1669L	23'-1 1/8"	1225	1670L	21'-1"	1120	1671L	19'-0 3/4"	1010	1672L	17'-0 5/8"	905	1673L	15'-0 3/8"	800
TRANSVERSE STRUTS 12 I 42 STOCK NO	49	61	2	1616	31'-0 1/4"	1300	1617	30'-6 1/4"	1280	1619	30'-0 1/4"	1260	1618	29'-6 1/4"	1240	1623	29'-0 1/4"	1220	1627	28'-6 1/4"	1200	1631	28'-0 1/4"	1180	1628	27'-6 1/4"	1160	1632	27'-0 1/4"	1135
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	50	62	8	875	28'-0"	42	878	26'-6"	40	881	25'-0"	38	884	23'-6"	35	887	22'-0"	33	889	21'-0"	32	892	19'-6"	29	893	18'-6"	28	895	17'-6"	26
LONGITUDINAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	51	62	8	873	29'-0"	44	876	27'-6"	41	879	26'-0"	39	881	25'-0"	38	883	24'-0"	36	885	23'-0"	35	887	22'-0"	33	889	21'-0"	32	890	20'-6"	31

COMPANION SHEETS

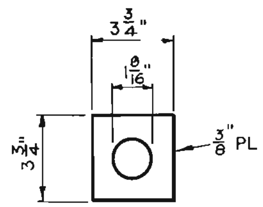
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	57
TOWER DETAILS	59 TO 62

COMPANION SHEET

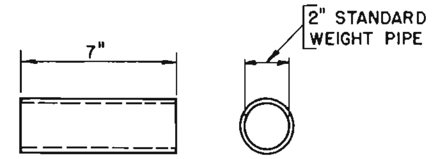
	SHEET
GENERAL NOTES	154
SYMBOLS	155
GENERAL VIEWS AND DIMENSIONS	55, 56
BILL OF MATERIALS	57, 58



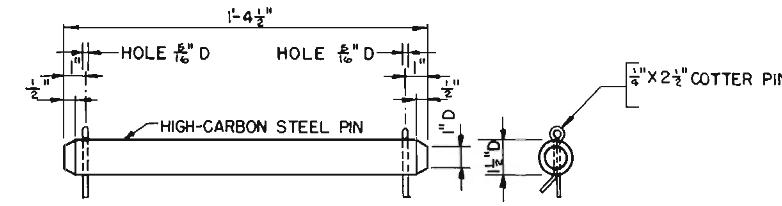
STRUT MK 676



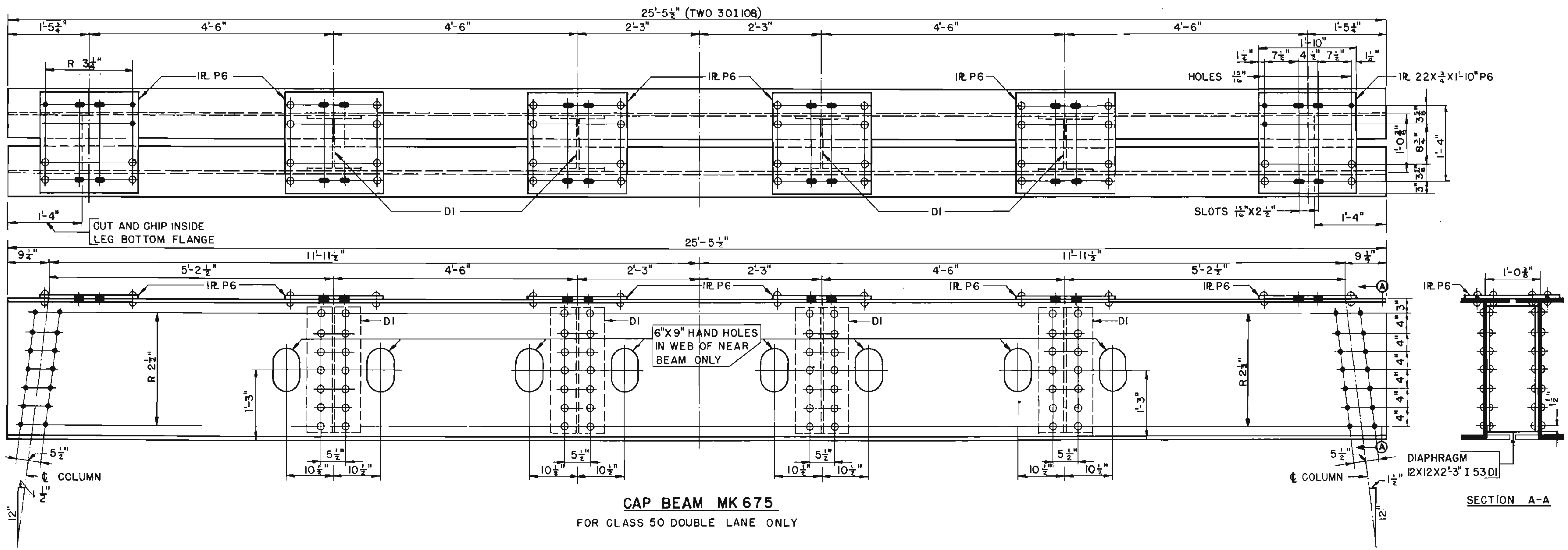
WASHER MK 658



PIPE SPACER MK673

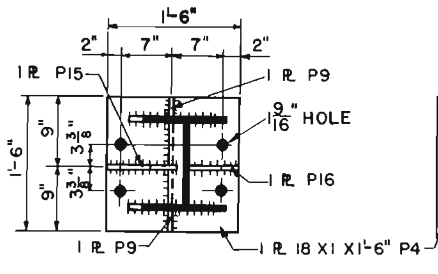


PIN AND COTTER *PIN* MK672

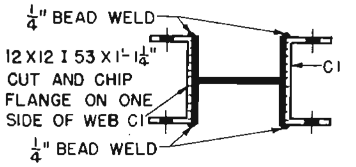


CAP BEAM MK 675

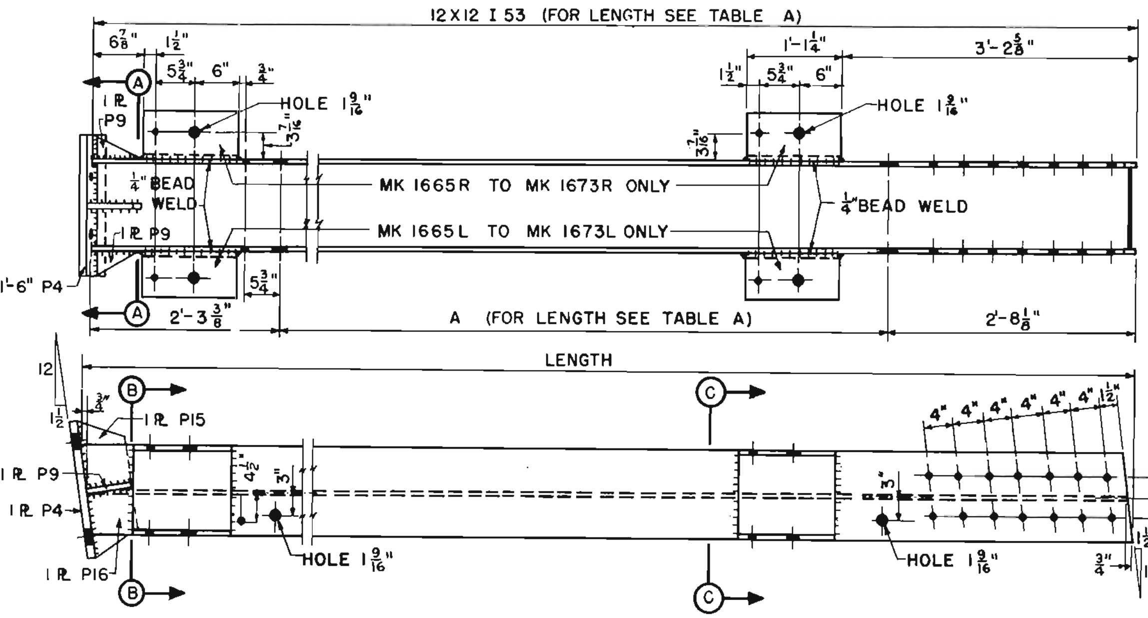
FOR CLASS 50 DOUBLE LANE ONLY



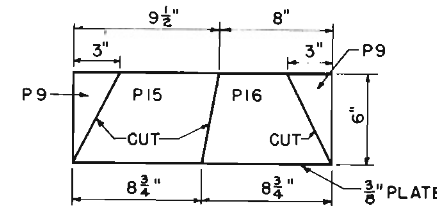
SECTION A-A



SECTION B-B AND C-C



COLUMN MK 1665R TO MK 1673R INCLUSIVE
COLUMN MK 1665L TO MK 1673L INCLUSIVE



BEARING PLATE STIFFENERS
MK P9, P15, P16

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	55,56
BILL OF MATERIALS	57,58
SYMBOLS	155

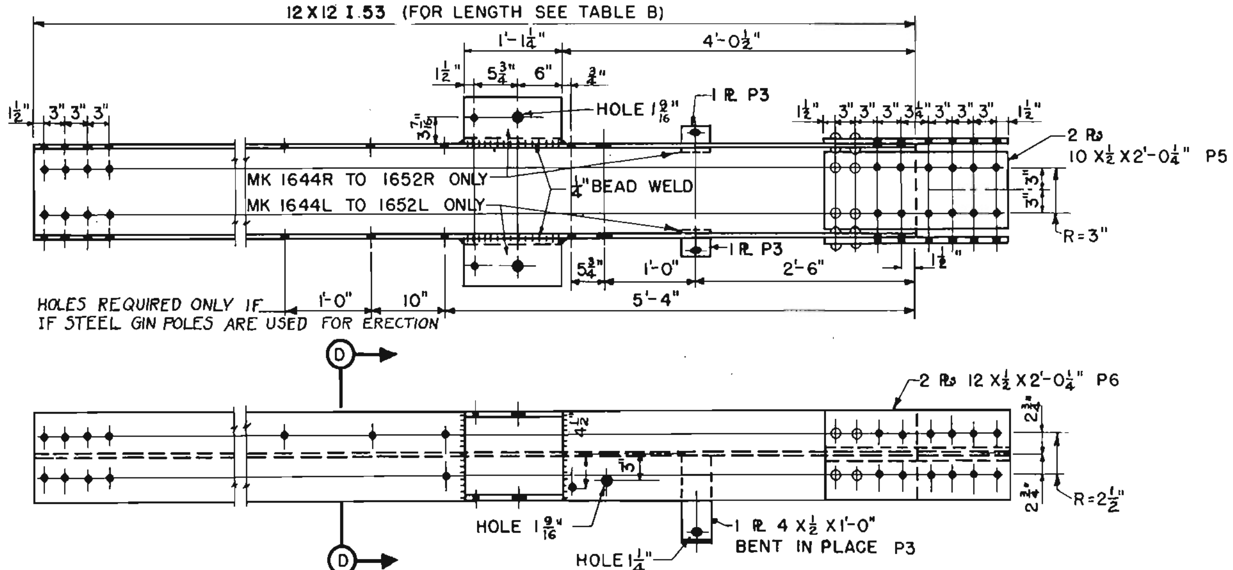
TABLE A

MARK	A	LENGTH	WEIGHT
1665	26'-2 3/8"	31'-1 7/8"	1835
1666	24'-2 1/4"	29'-1 3/4"	1730
1667	22'-2"	27'-1 1/2"	1625
1668	20'-1 7/8"	25'-1 3/8"	1520
1669	18'-1 5/8"	23'-1 1/8"	1415
1670	16'-1 1/2"	21'-1"	1305
1671	14'-1 1/4"	19'-0 3/4"	1200
1672	12'-1 1/8"	17'-0 5/8"	1095
1673	10'-0 7/8"	15'-0 3/8"	985

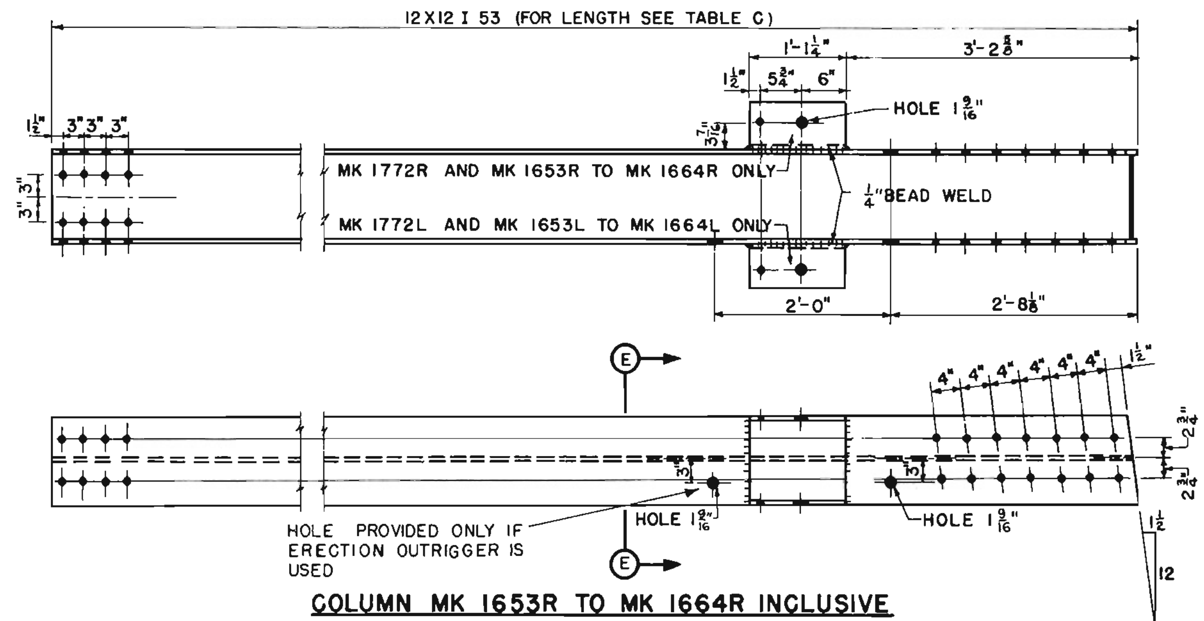
ALL WELD SHOWN TO BE 1/4" FILLET WELD UNLESS NOTED

ALL RIVETS 7/8" ϕ

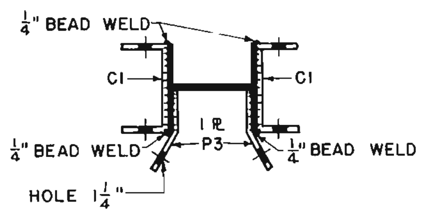
ALL HOLES 15/16" ϕ UNLESS NOTED



COLUMN MK 1644R TO MK 1652R INCLUSIVE
COLUMN MK 1644L TO MK 1652L INCLUSIVE



COLUMN MK 1653R TO MK 1664R INCLUSIVE
COLUMN MK 1653L TO MK 1664L INCLUSIVE
COLUMN MK 1772R AND MK 1772L



SECTION D-D

TABLE B

MARK	LENGTH	WEIGHT
1644	20'-1 5/8"	1295
1645	19'-7 7/8"	1260
1646	19'-1 1/2"	1240

TABLE B

MARK	LENGTH	WEIGHT
1647	18'-1 3/8"	1185
1648	17'-7 3/8"	1160
1649	17'-1 3/8"	1135

TABLE B

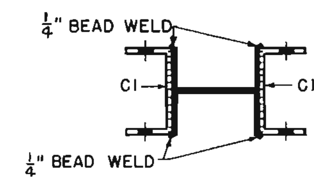
MARK	LENGTH	WEIGHT
1650	16'-7 1/4"	1105
1651	16'-1 1/4"	1080
1652	15'-7 1/4"	1050

TABLE C

MARK	LENGTH	WEIGHT
1653	20'-3 7/8"	1114
1654	19'-3 3/4"	1061
1655	18'-9 3/4"	1034
1656	18'-3 5/8"	1007
1657	17'-3 1/2"	954
1656	16'-9 1/2"	927
1659	16'-3 1/2"	901

TABLE C

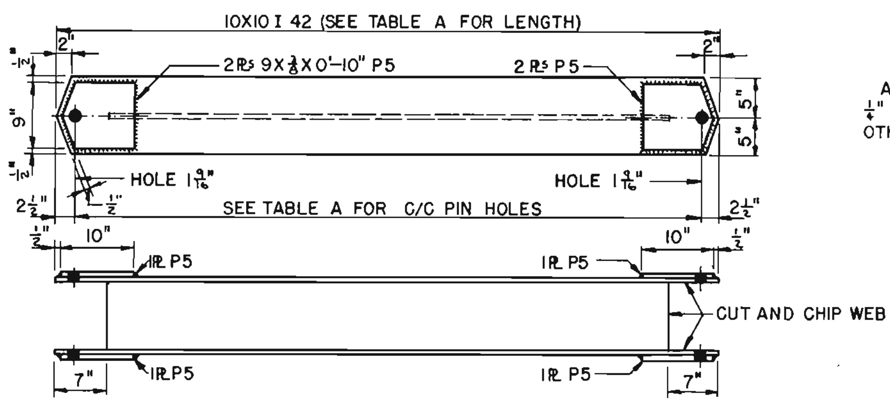
MARK	LENGTH	WEIGHT
1660	15'-9 3/8"	874
1661	15'-3 3/8"	847
1662	14'-9 3/8"	820
1663	14'-3 1/4"	794
1664	13'-3 1/8"	740
1772	21'-3 7/8"	1168



SECTION E-E

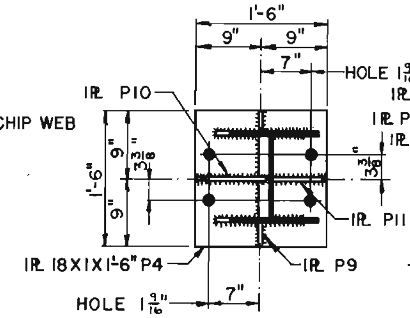
COMPANION SHEETS

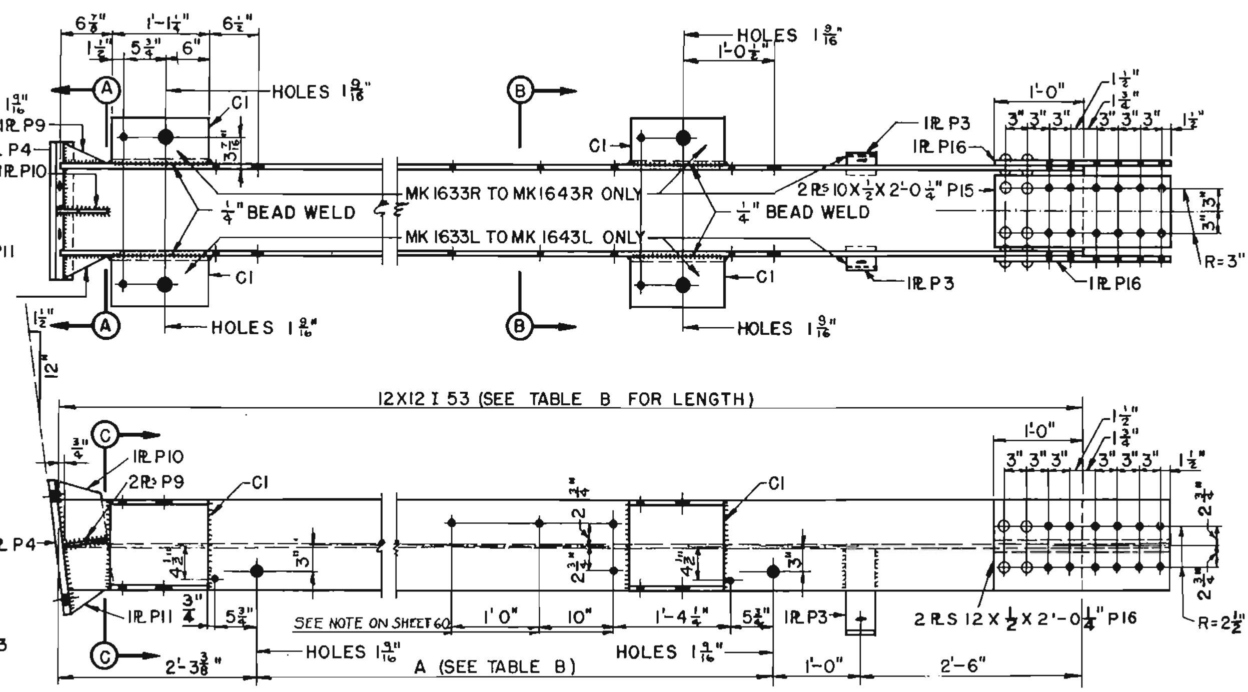
	SHEET
GENERAL NOTES	154
SYMBOLS	155
GENERAL VIEWS AND DIMENSIONS	55, 56
BILL OF MATERIALS	57, 58



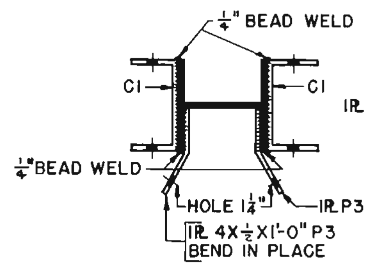
STRUTS MK 1586 TO 1632, INCLUSIVE

ALL WELDS SHOWN TO BE ¼" FILLET WELDS UNLESS OTHERWISE INDICATED





COLUMNS MK 1633R TO 1643R INCLUSIVE
COLUMNS MK 1633L TO 1643L INCLUSIVE



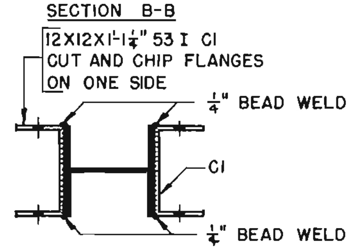
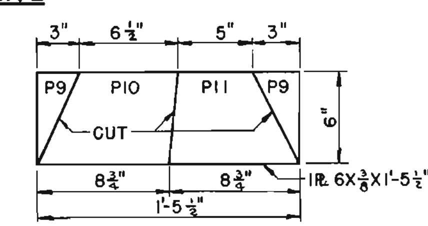


TABLE A

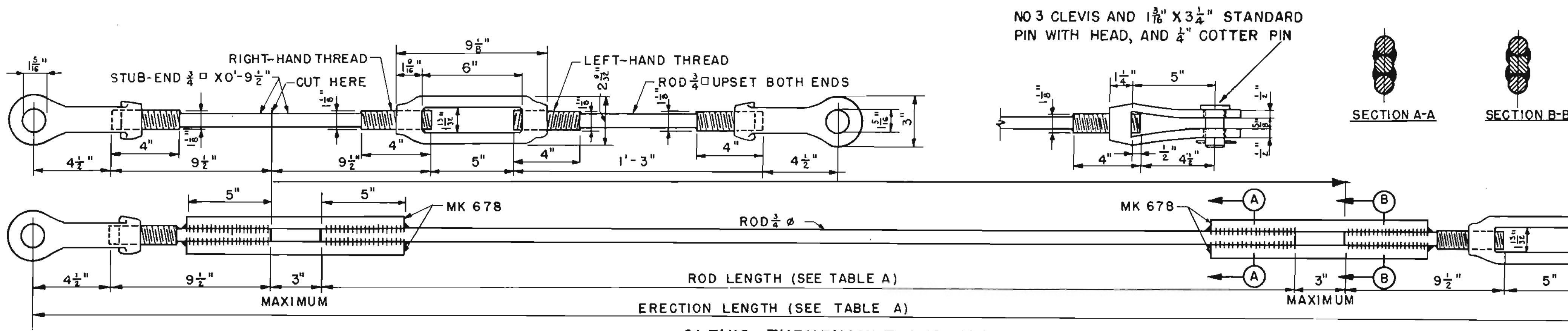
MARK	C/C PIN HOLE	LENGTH	WEIGHT
1586	42'- 1¼"	42'- 6¼"	1795
1587	41'- 7¼"	42'- 0¼"	1775
1588	41'- 1¼"	41'- 6¼"	1755
1589	40'- 7¼"	41'- 0¼"	1734
1590	40'- 1¼"	40'- 6¼"	1713
1591	39'- 7¼"	40'- 0¼"	1692
1592	39'- 1¼"	39'- 6¼"	1671
1593	38'- 7¼"	39'- 0¼"	1650
1594	38'- 1¼"	38'- 6¼"	1639
1595	37'- 7¼"	38'- 0¼"	1608
1596	37'- 2¾"	37'- 7¾"	1592
1597	37'- 1¼"	37'- 6¼"	1587
1598	36'-10¼"	37'- 3¼"	1576
1599	36'- 5¾"	36'-10¾"	1561
1600	36'- 7¼"	37'- 0¼"	1566
1601	36'- 1¼"	36'- 6¼"	1545
1602	35'- 7¼"	36'- 0¼"	1524
1603	35'- 1¼"	35'- 6¼"	1503
1604	34'- 7¼"	35'- 0¼"	1482
1605	34'- 1¼"	34'- 6¼"	1461
1606	33'-10¼"	34'- 3¼"	1445
1607	33'- 7¼"	34'- 0¼"	1441
1608	33'- 1¼"	33'- 6¼"	1419
1609	32'-10¼"	33'- 3¼"	1408
1610	32'- 7¼"	33'- 0¼"	1398
1611	32'- 4¼"	32'- 9¼"	1387
1612	32'- 1¼"	32'- 6¼"	1377
1613	31'-10¼"	32'- 3¼"	1366
1614	31'- 7¼"	32'- 0¼"	1355
1615	31'- 1¼"	31'- 6¼"	1335
1616	30'- 7¼"	31'- 0¼"	1314
1617	30'- 1¼"	30'- 6¼"	1293
1618	29'- 1¼"	29'- 6¼"	1251
1619	29'- 7¼"	30'- 0¼"	1272
1620	29'- 4¼"	29'- 9¼"	1261
1621	28'-11¾"	29'- 4¾"	1246
1622	28'-10¼"	29'- 3¼"	1240
1623	28'- 7¼"	29'- 0¼"	1230
1624	28'- 5¾"	28'-10¾"	1225
1625	28'- 4¼"	28'- 9¼"	1219
1626	28'- 2¾"	28'- 7¾"	1214
1627	28'- 1¼"	28'- 6¼"	1209
1628	27'- 1¼"	27'- 6¼"	1167
1629	27'-11¾"	28'- 4¾"	1204
1630	27'-10¼"	28'- 3¼"	1198
1631	27'- 7¼"	28'- 0¼"	1189
1632	26'- 7¼"	27'- 0¼"	1146

TABLE B

MARK	A	LENGTH	WEIGHT
1633	22'- 2"	27'-11⅜"	1850
1634	21'- 2"	26'-11⅜"	1795
1635	20'- 1⅞"	25'-11¼"	1740
1636	19'- 1¾"	24'-11⅛"	1690
1637	18'- 1⅝"	23'-11"	1635
1638	17'- 7⅝"	23'- 5"	1610
1639	17'- 1⅝"	22'-11"	1580
1640	16'- 7½"	22'- 4⅞"	1555
1641	16'- 1½"	21'-10⅞"	1525
1642	15'- 1⅜"	20'-10¾"	1475
1643	14'- 1¼"	19'-10⅝"	1425



BEARING PLATE STIFFENERS
P9, P10, P11.



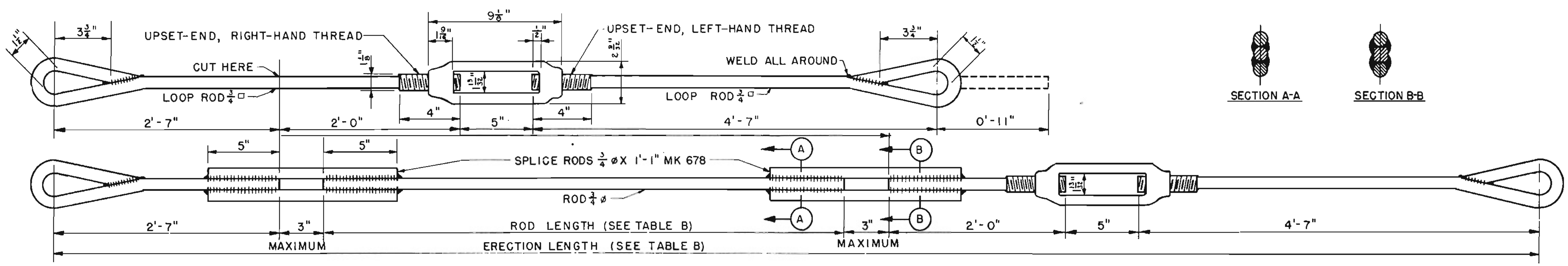
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	56,55
SYMBOLS	155
BILL OF MATERIALS	58,57

CLEVIS, TURNBUCKLE, AND STUB-END ROD MK 680

TABLE A

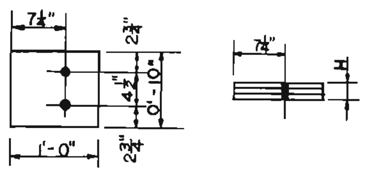
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
912	46'-2 5/8"	990	42'-0"	917	43'-6 1/4"	993	39'-6"	922	42'-4 7/8"	996	38'-0"	930	40'-0 3/4"	999	36'-0"	935	39'-5 1/2"	1001	35'-0"	940	39'-0 3/8"	1001	35'-0"
913	45'-11 1/8"	991	41'-6"	918	43'-4"	994	39'-0"	923	42'-2 5/8"	996	38'-0"	931	39'-10 5/8"	1000	35'-6"	936	39'-4 3/8"	1001	35'-0"	942	38'-10 1/4"	1002	34'-6"
914	45'-7 5/8"	991	41'-6"	919	43'-1 3/4"	994	39'-0"	924	42'-0 1/2"	996	38'-0"	932	39'-9 5/8"	1000	35'-6"	937	39'-3 3/8"	1001	35'-0"				
915	45'-4 1/8"	992	41'-0"	920	42'-9 1/4"	995	38'-6"	925	41'-10 1/4"	997	37'-6"	933	39'-8 5/8"	1000	35'-6"	938	39'-2 3/8"	1001	35'-0"				
916	45'-0 5/8"	992	41'-0"	921	42'-7 1/8"	995	38'-6"	929	40'-2 7/8"	999	36'-0"	934	39'-6 1/2"	1000	35'-6"	939	39'-1 3/8"	1001	35'-0"				



LOOP ROD WITH TURNBUCKLE MK 677

TABLE B

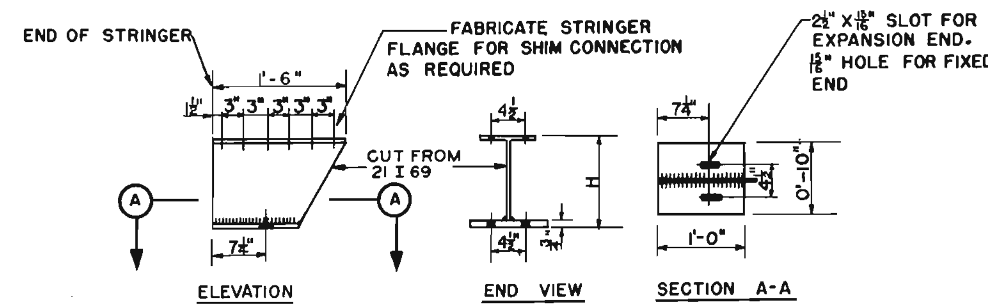
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
700	43'-8 3/4"	863	34'-0"	713	39'-1 1/2"	872	29'-6"	731	36'-11"	877	27'-0"	747	34'-5 7/8"	882	24'-6"	773	32'-7 1/8"	885	23'-0"	797	30'-3 5/8"	890	20'-6"
701	43'-1 1/2"	864	33'-6"	714	38'-10 3/4"	873	29'-0"	732	36'-6 5/8"	878	26'-6"	748	34'-3 1/2"	882	24'-6"	774	32'-6 1/4"	886	22'-6"	798	30'-2 1/8"	890	20'-6"
702	42'-11"	865	33'-0"	717	38'-8"	873	29'-0"	734	36'-2 3/8"	878	26'-6"	751	34'-1 1/8"	882	24'-6"	776	32'-5 1/2"	886	22'-6"	801	30'-0"	891	20'-0"
703	42'-6 1/4"	866	32'-6"	719	38' 5 1/4"	874	28'-6"	736	36'-0 3/4"	879	26'-0"	753	33'-11 7/8"	883	24'-0"	781	32'-2 5/8"	886	22'-6"	806	29'-4 7/8"	892	19'-6"
704	41'-11 1/8"	867	32'-0"	720	38'-3 1/8"	874	28'-6"	737	35'-8 3/8"	879	26'-0"	758	33'-8 7/8"	883	24'-0"	783	31'-11"	887	22'-0"	815	28'-3 3/8"	893	18'-6"
705	41'-8 1/2"	867	32'-0"	721	38'-2"	874	28'-6"	739	35'-5 1/2"	880	25'-6"	759	33'-8 3/8"	883	24'-0"	785	31'-9"	887	22'-0"	820	27'-3"	895	17'-6"
706	41'-3 7/8"	868	31'-6"	724	37'-8 7/8"	875	28'-0"	741	35'-3 3/4"	880	25'-6"	762	33'-5 5/8"	884	23'-6"	786	31'-7"	887	22'-0"				
707	40'-10 7/8"	869	31'-0"	725	37'-8"	875	28'-0"	742	34'-10 3/4"	881	25'-0"	764	33'-3 3/8"	884	23'-6"	790	31'-3 1/8"	888	21'-6"				
708	40'-1 3/8"	870	30'-6"	727	37'-4 3/4"	876	27'-6"	743	34'-10 3/8"	881	25'-0"	766	33'-2 1/2"	884	23'-6"	792	30'-11 1/4"	889	21'-0"				
710	39'-8 1/8"	871	30'-0"	728	37'-4 1/8"	876	27'-6"	744	34'-8 5/8"	881	25'-0"	769	32'-11 1/4"	885	23'-0"	793	30' 11"	889	21'-0"				
712	39'-2"	872	29'-6"	730	36'-11 3/4"	877	27'-0"	746	34'-6 7/8"	881	25'-0"	772	32'-8 3/8"	885	23'-0"	794	30'-7 3/8"	889	21'-0"				



DETAIL OF PLATE SHIM

BILL OF MATERIALS FOR ONE PLATE SHIM

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	7520 H = 1/2" QUANTITY	7522 H=2 3/4" QUANTITY	7523 H = 3" QUANTITY	7524 H=3 1/4" QUANTITY
PLATE	47-7844.05	10X1/2	1'-0"	17	1			
DO	47-7844.07	10X3/4	1'-0"	26		1		3
DO	47-7844.1	10X1	1'-0"	34		2	3	1
ANCHOR BOLT	43-2219.08-04	7/8	4"	1.2	2			
DO	43-2219.08-07	7/8	7"	1.7		2	2	2



DETAIL OF BUILT-UP SHIM

BILL OF MATERIALS FOR ONE BUILT-UP SHIM

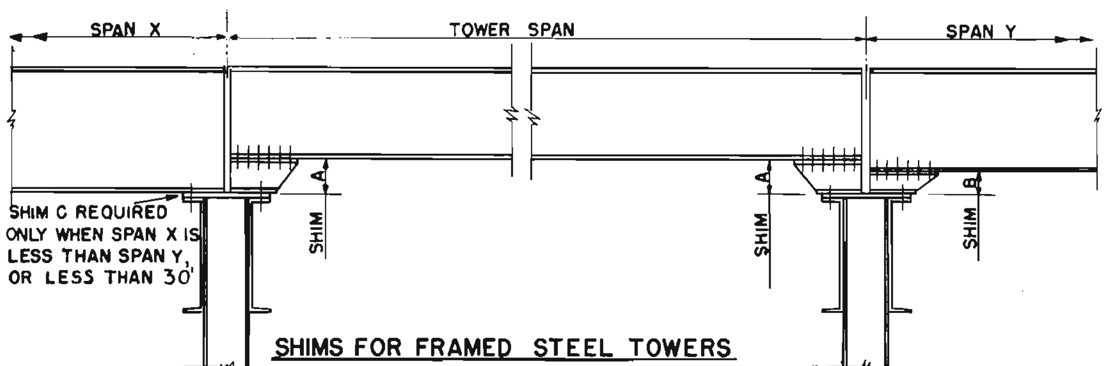
DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	QUANTITY
BEAM	48-2900.21-059	21 I 59	1'-6"	1
PLATE	47-7844.07	10X3/4	1'-0"	1
RIVET	43-6353.08	7/8	2 3/4"	12
ANCHOR BOLT	43-2219.08-04	7/8	4"	2
ELECTRODE	46-3772.2-7	3/16		1 LB

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS, RIVETED	76,77
STEEL PILE BENTS AND PIERS, WELDED	79,80
FRAMED STEEL TOWERS	55,56

MARKS AND DIMENSIONS FOR BUILT-UP SHIMS

MARK	H	TOTAL WEIGHT (POUNDS)
7526	6 1/8"	57
7530	8 7/8"	62
7531	9 1/8"	62
7532	9 1/2"	63
7534	12"	66
7535	12 1/4"	67
7536	12 1/2"	67
7538	15 1/8"	71
7539	15 1/2"	72
7541	18"	76
7542	18 1/2"	77



SHIMS FOR FRAMED STEEL TOWERS

PROVIDE 2 ANCHOR BOLTS 7/8 X 4" PER STRINGER WHEN SHIMS ARE NOT REQUIRED

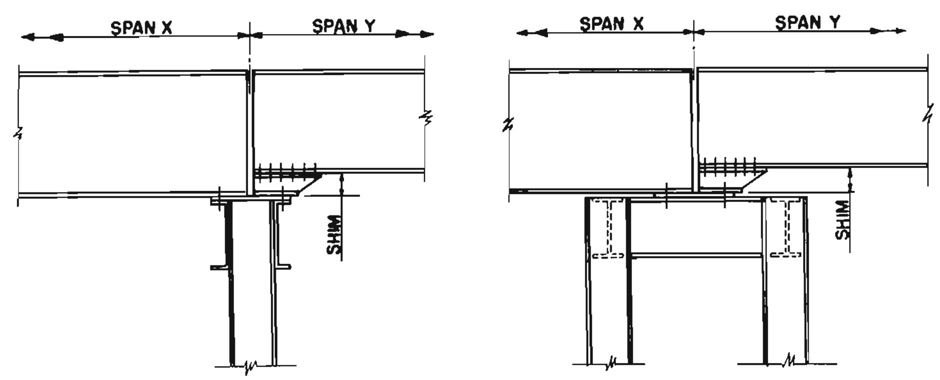
SHIMS FOR FRAMED STEEL TOWERS

SPAN Y		SPAN X: 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	A	7534	7536	7534	7531	7531	7523			
	B	7541	7542	7541	7538	7538	7530	7526	7526	7526
	C								7523	7526
20'	A	7534	7536	7534	7531	7531	7523			
	B	7538	7539	7538	7535	7534	7526	7523	7523	7523
	C								7523	7526
30'	A	7534	7536	7534	7531	7531	7523			
	B	7534	7536	7534	7531	7531	7523			
	C								7523	7526
40'	A	7534	7536	7534	7531	7531	7523	7523	7523	7523
	B	7530	7532	7530	7526	7526				
	C							7523	7526	7530
50'	A	7534	7536	7534	7531	7531	7531	7531	7531	7531
	B	7522	7524	7522						
	C						7526	7531	7534	7538
60'	A	7534	7536	7534	7531	7531	7531	7531	7531	7531
	B	7522	7524	7522						
	C						7528	7531	7535	7538
70'	A	7534	7536	7534	7534	7534	7534	7534	7534	7534
	B		7520							
	C				7522	7522	7530	7534	7538	7541
80'	A	7536	7536	7536	7536	7536	7536	7536	7536	7536
	B									
	C	7520		7520	7524	7524	7532	7536	7539	7542
90'	A	7534	7536	7534	7534	7534	7534	7534	7534	7534
	B		7520							
	C				7522	7522	7530	7534	7538	7541

BILL OF MATERIALS FOR ANCHOR BOLTS ONLY WITHOUT SHIMS

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)
ANCHOR BOLT	43-2219.08-04	7/8	0'-4"	1.2

TWO BOLTS REQUIRED FOR EACH STRINGER SUPPORT
CONSTRUCTION INDICATED BY BLANK SPACES IN TABLES FOR SHIMS



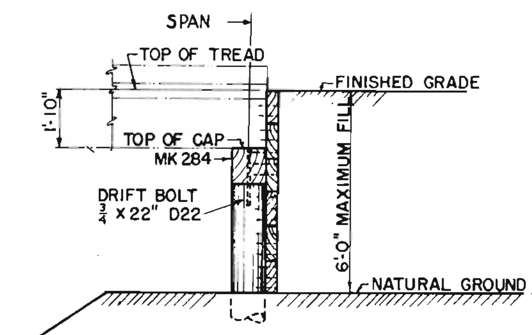
SHIMS FOR STEEL PILE BENTS AND PIERS

SHIMS FOR STEEL PILE BENTS AND PIERS

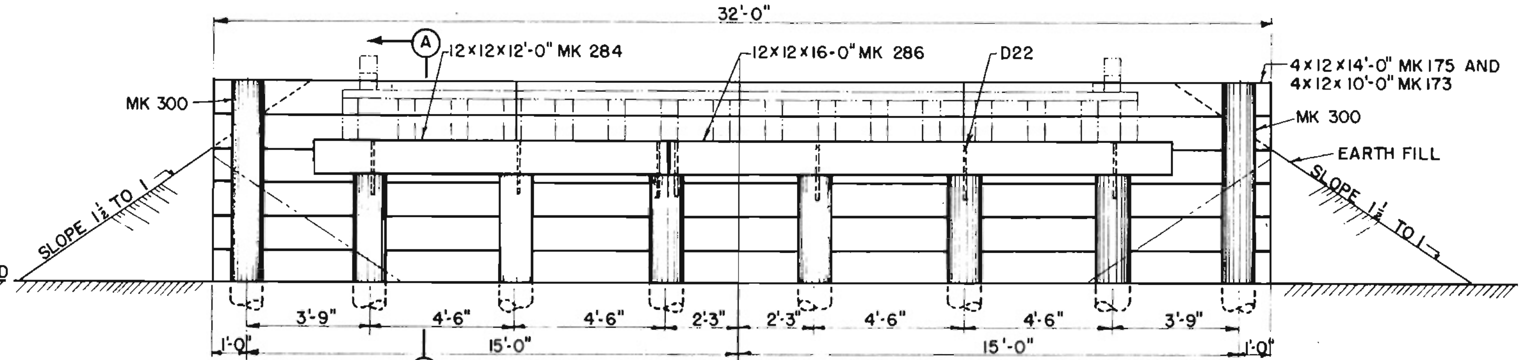
SPAN Y	SPAN X: 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	7541	7542	7541	7538	7538	7530	7526	7523	
20'	7538	7539	7538	7535	7534	7526	7523		7523
30'	7534	7536	7534	7531	7531	7523		7523	7526
40'	7530	7532	7530	7526	7526		7523	7526	7530
50'	7522	7524	7522			7526	7531	7534	7538
60'	7522	7524	7522			7526	7531	7535	7538
70'		7520		7522	7522	7530	7534	7538	7541
80'	7520		7520	7524	7524	7532	7536	7539	7542
90'		7520		7522	7522	7530	7534	7538	7541

COMPANION SHEETS

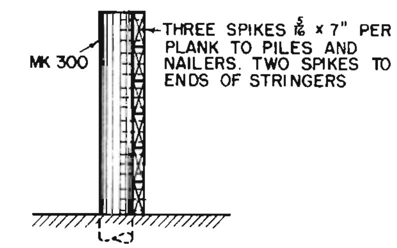
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	65



SECTION A-A



ELEVATION

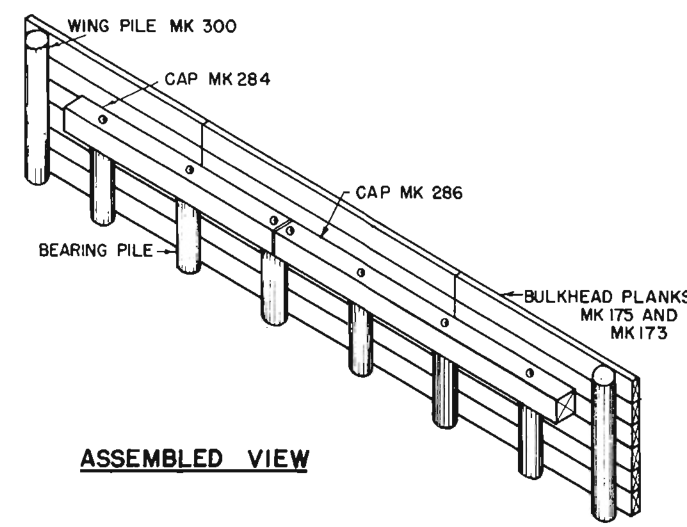


END VIEW

TIMBER PILE ABUTMENT SUPPORTING 11' TO 15' TIMBER-STRINGER SPANS

BILL OF MATERIALS FOR ONE ABUTMENT

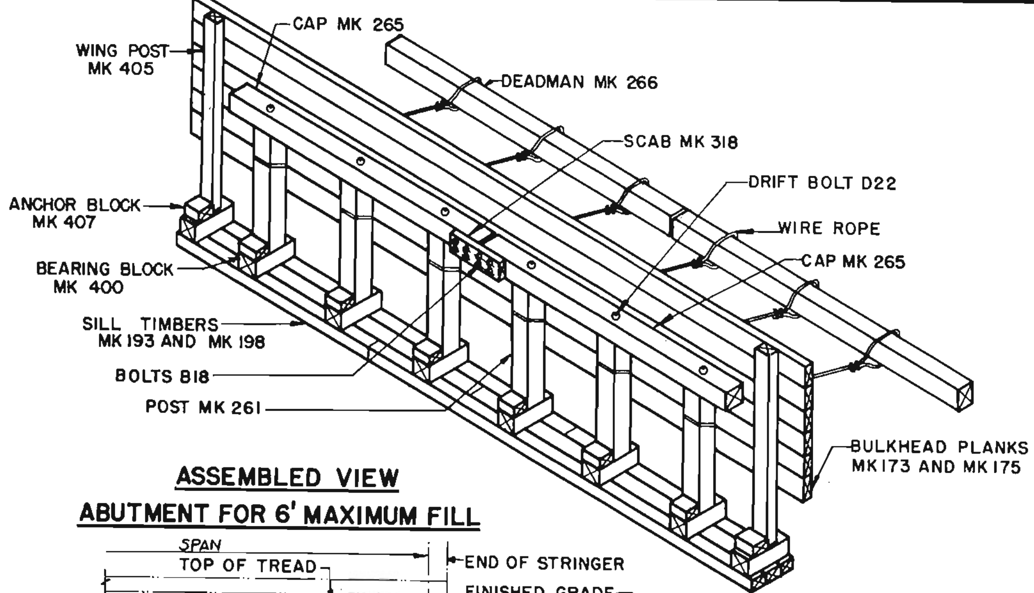
LINE	TYPE OF ABUTMENT						TIMBER PILE ABUTMENT		TIMBER GRILLAGE ABUTMENT				LINE
	FILL HEIGHT						6' MAXIMUM		6' MAXIMUM		3' MAXIMUM		
	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	
1	3] BULKHEAD PLANK	39-3340.12-14	175	4 X 12	14'-0"	210	6	336	6	336			1
2	3] DO	39-3340.12-12	174	4 X 12	12'-0"	180					3	144	2
3	3] DO	39-3340.12	173	4 X 12	10'-0"	150	12	480	12	480	6	240	3
4	PILE (WING)		300		15'-0"		2						4
5	2] PILE (BEARING)				2]		6						5
6	1] POST (WING)	39-3360.08	405	6 X 8	8'-6"	128			2	68			6
7	1] DO	39-3360.08	320	6 X 8	3'-2"	47					2	25	7
8	1] POST (BEARING)	39-6620.1	261	10 X 10	6'-0"	188			6	300			8
9	CAP	39-6630.12-16	286	12 X 12	16'-0"	720	1	192					9
10	DO	39-6630.12-12	284	12 X 12	12'-0"	540	1	144					10
11	DO	39-6620.1-14	265	10 X 10	14'-0"	437			2	233	2	233	11
12	SCAB	39-3330.1	318	3 X 10	2'-8"	25			2	13			12
13	DO	39-3330.1	306	3 X 10	2'-0"	19					2	10	13
14	SILL TIMBER	39-3360.08	193	6 X 8	10'-0"	150			3	120	3	120	14
15	DO	39-3360.08-2	198	6 X 8	20'-0"	300			3	240	3	240	15
16	BEARING BLOCK	39-6620.1	400	10 X 10	2'-0"	63			8	133	8	133	16
17	DEADMAN	39-6620.1-16	266	10 X 10	16'-0"	500			2	267			17
18	ANCHOR BLOCK	39-3360.08	407	6 X 8	0'-10"	13			8	26	6	20	18
	STEEL HARDWARE, BLACK												
19	WIRE ROPE	22-4567.4-05		1/2	20'-0"	13			8				19
20	WIRE-ROPE CLIP	42-3544.5-05		1/2		0.72			32				20
21	MACHINE BOLT WITH NUT AND WASHER	43-2325.07-2	B20	3/4	20"	3.06					4		21
22	DO	43-2325.07-183	B18	3/4	18"	2.82			8		8		22
23	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	2.76	7		6		6		23
24	STANDARD WIRE SPIKE	42-8488.04-1		3/8	10"	0.33			96		60		24
25	DO	42-8488.035-07		5/16	7"	0.143	196		196		76		25
1]	CUT TO FIT FOR FILLS UNDER 6-FOOT.												
2]	BEARING PILE LENGTHS TO BE DETERMINED BY FIELD CONDITIONS.												
3]	NUMBER OF BULKHEAD TIMBERS BILLED IS FOR MAXIMUM FILL. USE FEWER PLANKS FOR SHALLOWER FILLS.												



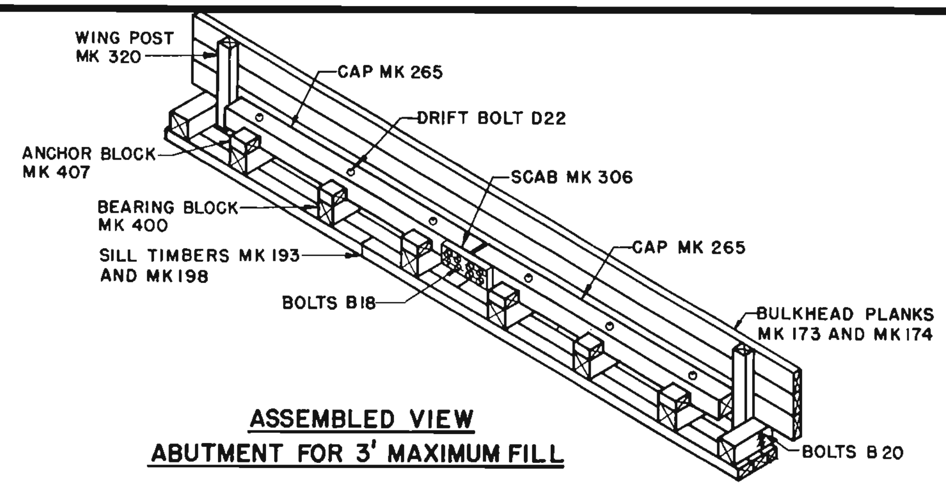
ASSEMBLED VIEW

COMPANION SHEETS

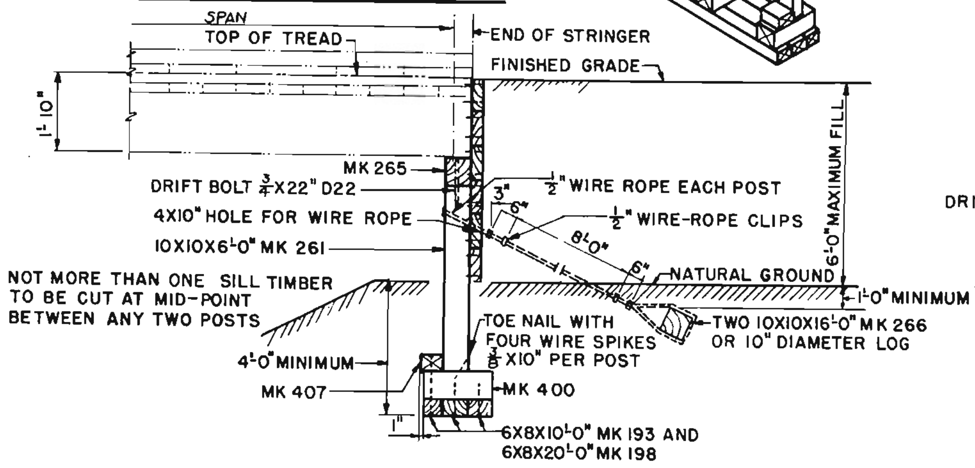
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	64



ASSEMBLED VIEW
ABUTMENT FOR 6' MAXIMUM FILL

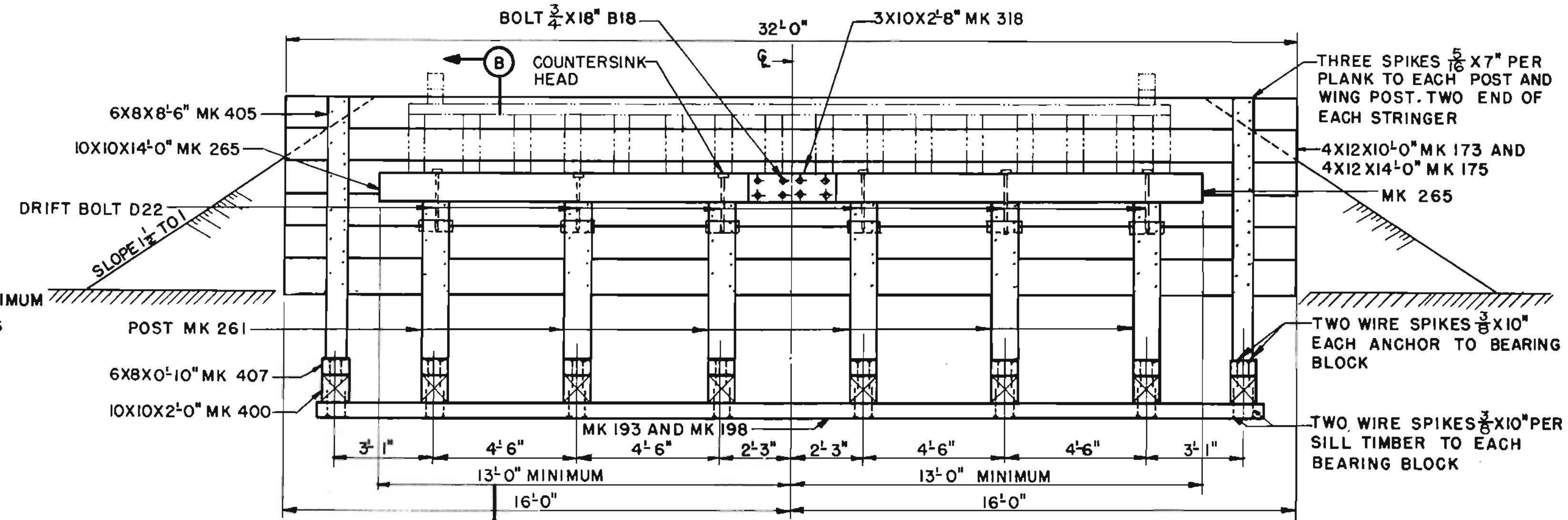


ASSEMBLED VIEW
ABUTMENT FOR 3' MAXIMUM FILL

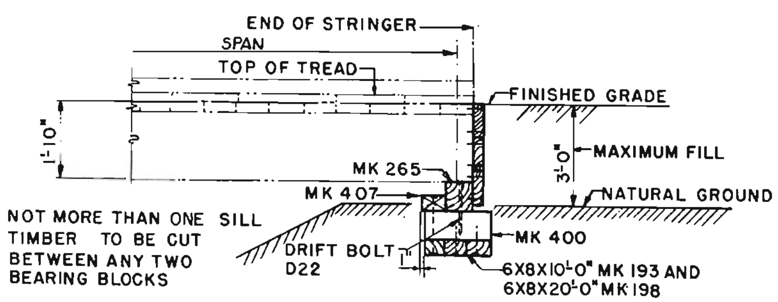


SECTION B-B

DETAILS FOR 6' MAXIMUM FILL

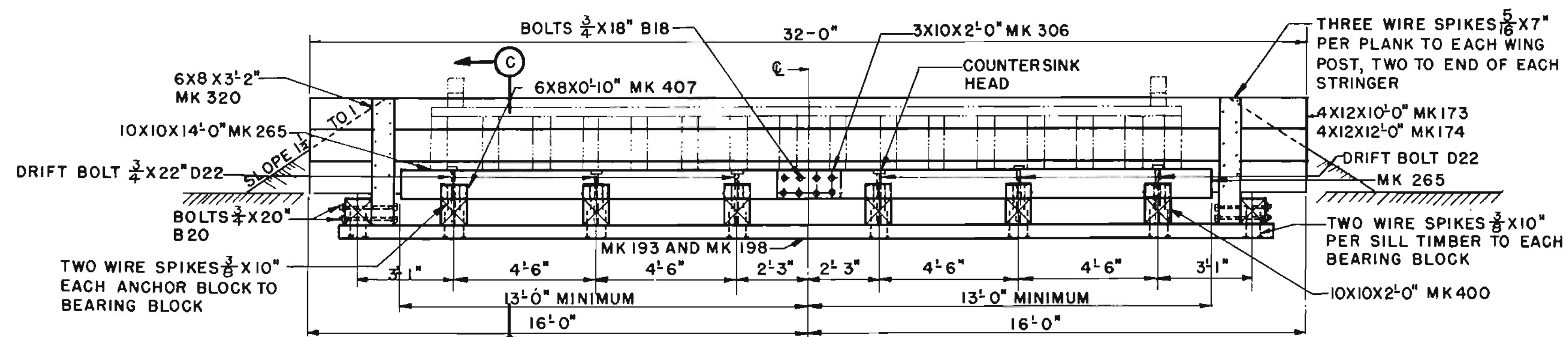


ELEVATION



SECTION C-C

DETAILS FOR 3' MAXIMUM FILL

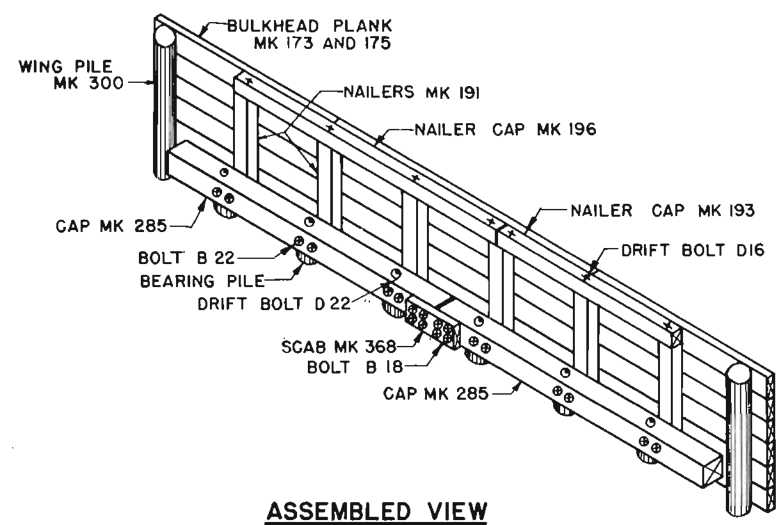


ELEVATION

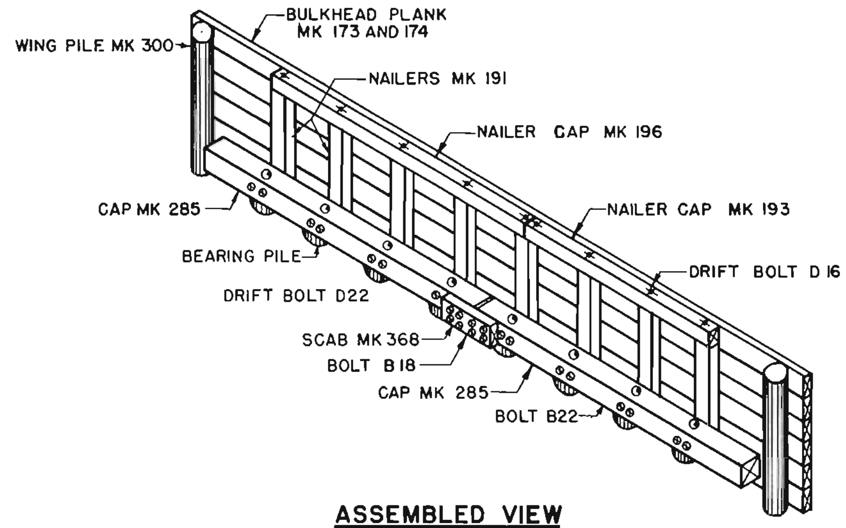
TIMBER GRILLAGE ABUTMENTS SUPPORTING 11' TO 15' TIMBER-STRINGER SPANS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	67,68



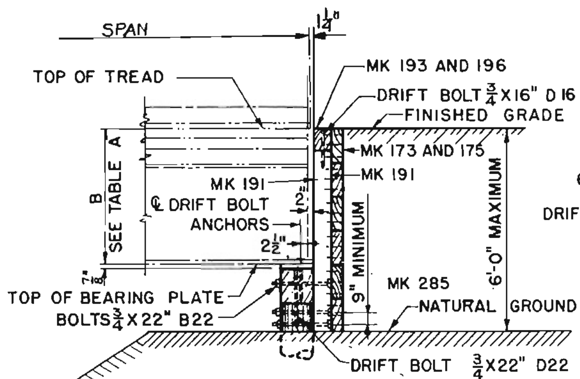
ASSEMBLED VIEW
ABUTMENT FOR 15' TO 50' SPAN



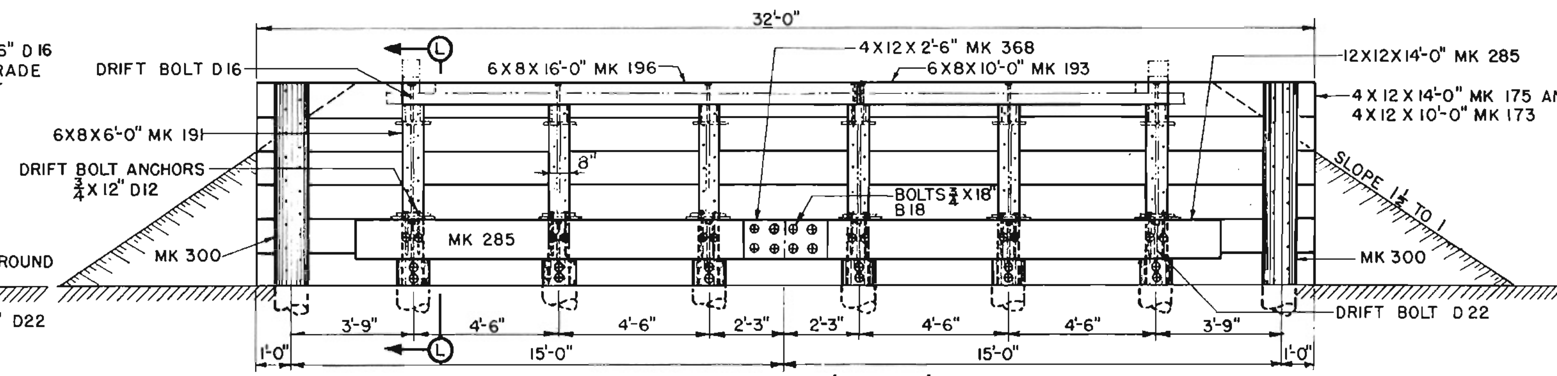
ASSEMBLED VIEW
ABUTMENT FOR 60' TO 90' SPAN

TABLE A

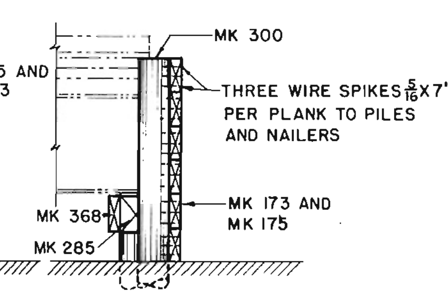
SPAN	DIMENSION B
15 '	2'- 4 7/8"
20 '	2'- 6 7/8"
30 '	3'- 0 7/8"
40 '	3'- 1 1/8"
50 '	3'- 6 7/8"
60 '	3'- 10"
70 '	3'- 10 1/8"
80 '	4'- 0 7/8"
90 '	4'- 1 1/8"



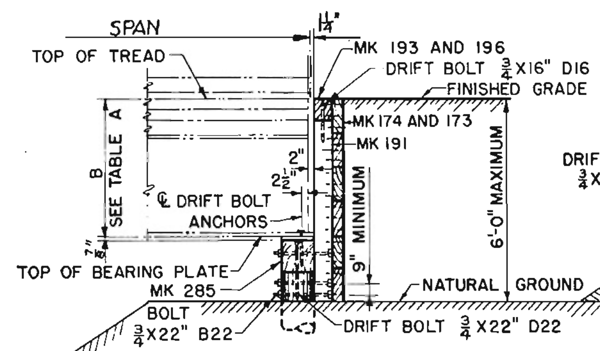
SECTION L-L



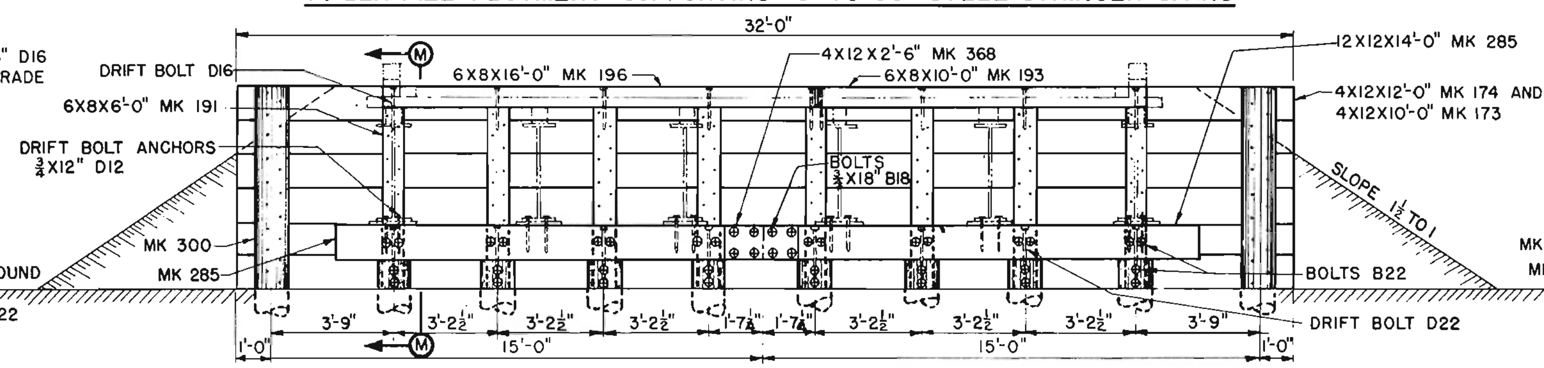
TIMBER PILE ABUTMENT SUPPORTING 15' TO 50' STEEL-STRINGER SPANS



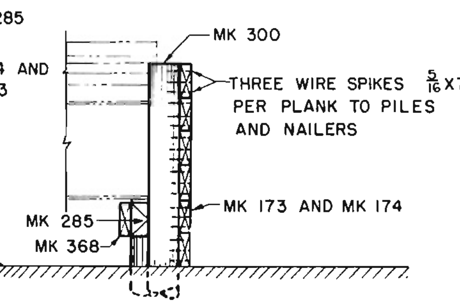
END VIEW



SECTION M-M



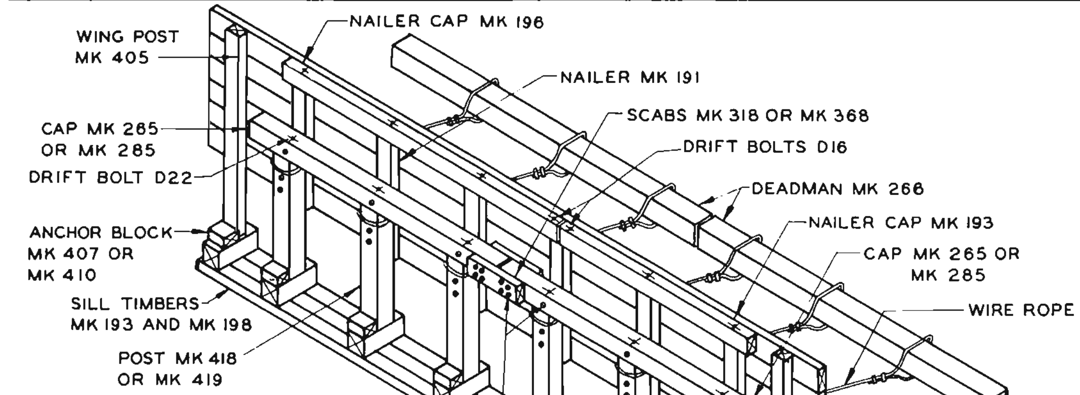
TIMBER PILE ABUTMENT SUPPORTING 60' TO 90' STEEL-STRINGER SPANS



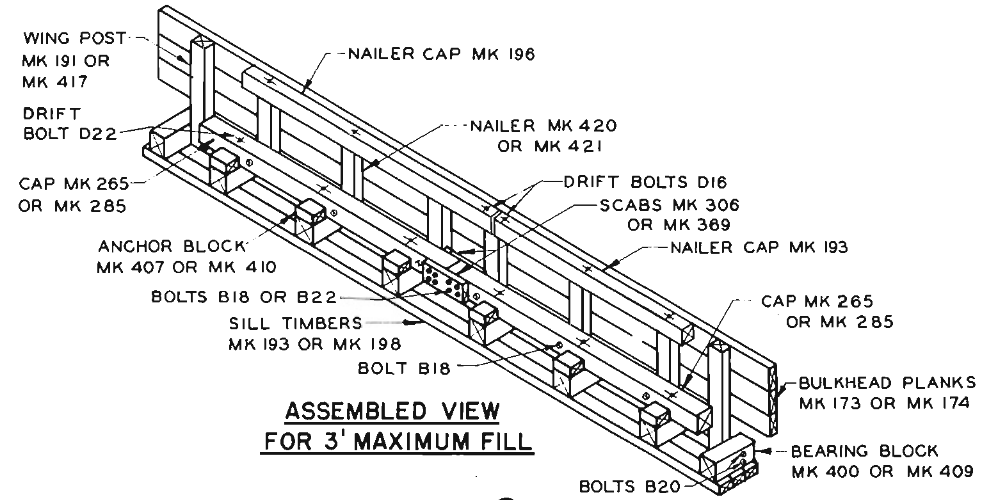
END VIEW

COMPANION SHEETS

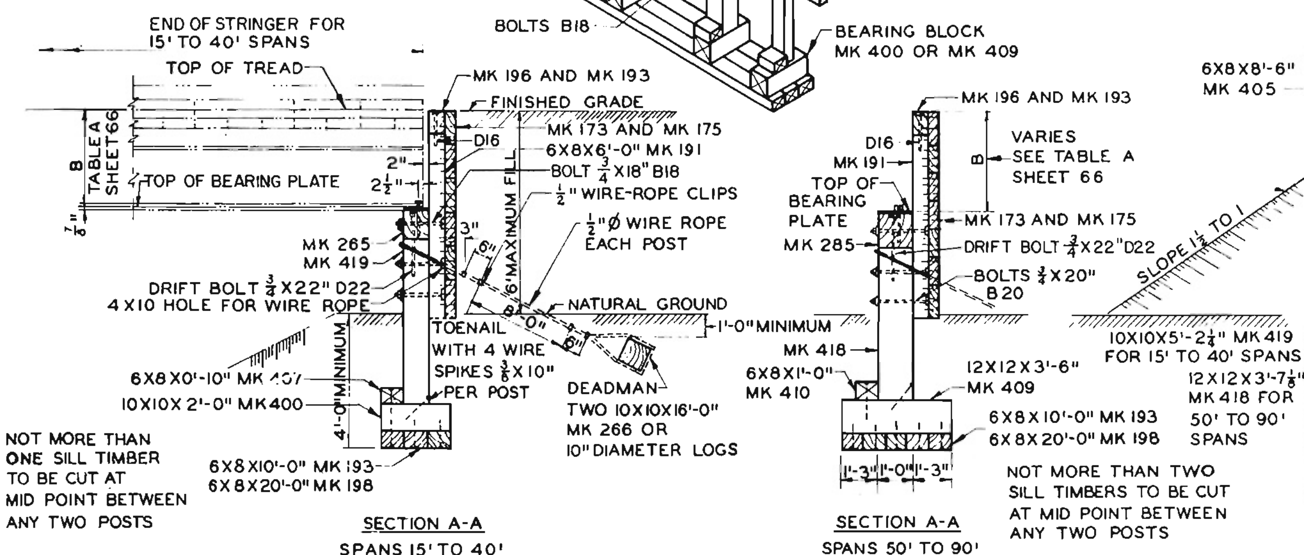
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	66
BILL OF MATERIALS	68

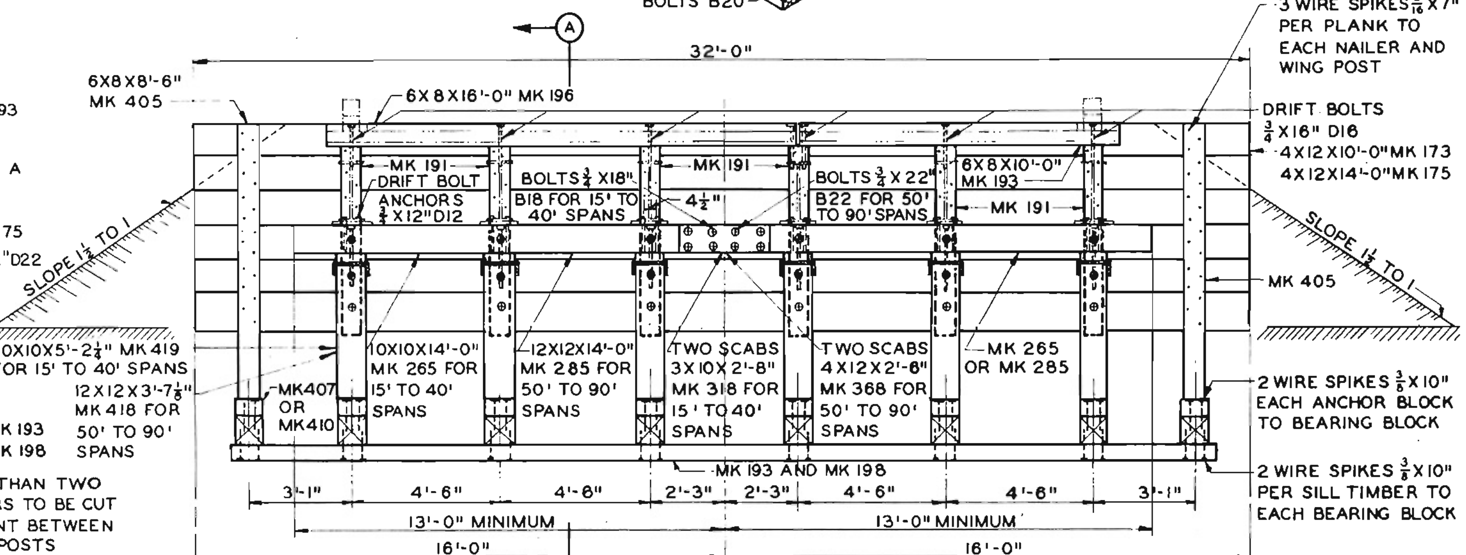


ASSEMBLED VIEW
FOR 6' MAXIMUM FILL

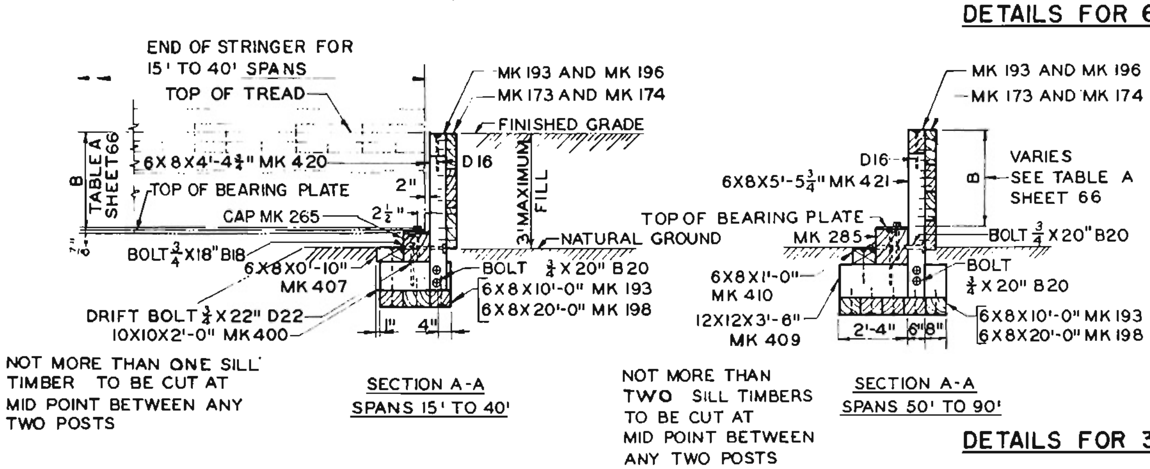


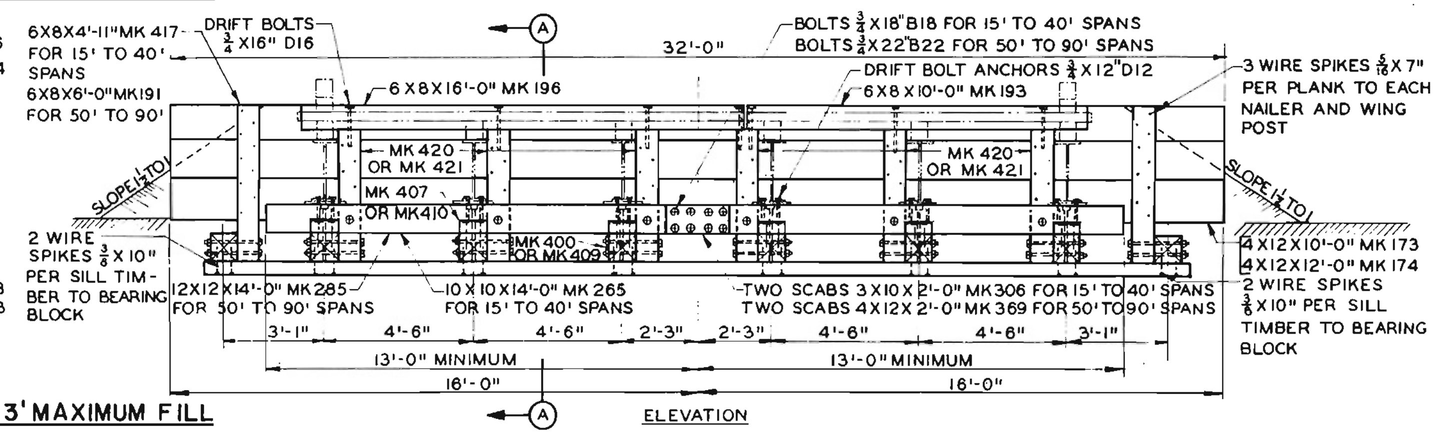
ASSEMBLED VIEW
FOR 3' MAXIMUM FILL





DETAILS FOR 6' MAXIMUM FILL





DETAILS FOR 3' MAXIMUM FILL

TIMBER GRILLAGE ABUTMENTS SUPPORTING 15' TO 90' STEEL-STRINGER SPAN

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED ABUTMENTS	66, 67

BILL OF MATERIALS, BEARING PLATES FOR ONE TIMBER ABUTMENT

SPAN	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY
15' TO 80'	47-7844.08	P3500	12X7/8	1'-3"	45	6
90'	47-7844.08	P3501	12X7/8	1'-4"	48	6

BILL OF MATERIALS FOR ONE ABUTMENT

	TYPE OF ABUTMENT						TIMBER PILE ABUTMENT				TIMBER GRILLAGE ABUTMENT								
	SPAN LENGTH						15' TO 50' SPAN		60' TO 90' SPAN		15' TO 40' SPAN				50' TO 90' SPAN				
	FILL HEIGHT						6' MAXIMUM		6' MAXIMUM		6' MAXIMUM		3' MAXIMUM		6' MAXIMUM		3' MAXIMUM		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
1	[2] BULKHEAD, PLANK	39-3340.12	173	4 X 12	10'-0"	150	12	480	6	240	12	480	6	240	12	480	8	320	1
2	[2] DO	39-3340.12-12	174	4 X 12	12'-0"	180			12	576			3	144			4	192	2
3	[2] DO	39-3340.12-14	175	4 X 12	14'-0"	210	6	336			6	336			6	336			3
4	PILE (WING)		300		15'-0"		2		2										4
5	[1] PILE (BEARING)				[1]		6		8										5
6	[3] POST (WING)	39-3360.08	417	6 X 8	4'-11"	74							2	39					6
7	[3] DO	39-3360.08	191	6 X 8	6'-0"	90											2	48	7
8	[3] DO	39-3360.08	405	6 X 8	8'-6"	128					2	68			2	68			8
9	[3] POST (BEARING)	39-6620.1	419	10 X 10	5'-2 1/4"	162					6	259							9
10	[3] DO	39-6630.12	418	12 X 12	3'-7 1/8"	161									6	258			10
11	CAP	39-6630.12-14	285	12 X 12	14'-0"	630	2	336	2	336					2	336	2	336	11
12	DO	39-6620.1-14	265	10 X 10	14'-0"	437					2	233	2	233					12
13	SCAB	39-3340.12	369	4 X 12	2'-0"	30											2	16	13
14	DO	39-3340.12	368	4 X 12	2'-6"	38	1	10	1	10					2	20			14
15	DO	39-3330.1	318	3 X 10	2'-8"	25					2	13							15
16	DO	39-3330.1	306	3 X 10	2'-0"	20							2	10					16
17	[3] NAILER	39-3360.08	191	6 X 8	6'-0"	90	6	144	8	192	6	144			6	144			17
18	[3] DO	39-3360.08	420	6 X 8	4'-4 3/4"	66							6	106					18
19	[3] DO	39-3360.08	421	6 X 8	5'-5 3/4"	82											6	132	19
20	NAILER CAP	39-3360.08	193	6 X 8	10'-0"	150	1	40	1	40	1	40	1	40	1	40	1	40	20
21	DO	39-3360.08	196	6 X 8	16'-0"	240	1	64	1	64	1	64	1	64	1	64	1	64	21
22	SILL TIMBERS	39-3360.08	190	6 X 8	20'-0"	300									5	400			22
23	DO	39-3360.08	193	6 X 8	10'-0"	150	1	40	1	40	3	120	3	120	5	200	5	200	23
24	DO	39-3360.08	198	6 X 8	20'-0"	300					3	240	3	240	5	400	5	400	24
25	BEARING BLOCK	39-6620.1	400	10 X 10	2'-0"	63					8	133	8	133					25
26	DO	39-6630.12	409	12 X 12	3'-6"	158									8	336	8	336	26
27	DEADMAN	39-6620.1-16	266	10 X 10	16'-0"	500					2	267			2	267			27
28	ANCHOR BLOCK	39-3360.08	410	6 X 8	1'-0"	15									8	32	6	24	28
29	DO	39-3360.08	407	6 X 8	0'-10"	13					8	26	6	20					29
	STEEL HARDWARE, BLACK																		
30	WIRE ROPE	22-4567.4-05		1/2"	20'-0"	13					8				8				30
31	WIRE-ROPE CLIP	42-3544.5-05		1/2"		0.72					32				32				31
32	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-223	B22	3/4"	22"	3.30	24		32										32
33	DO	43-2325.07-2	B20	3/4"	20"	3.06							16		18				33
34	DO	43-2325.07-183	B18	3/4"	18"	2.82	8		8		18		6						34
35	DRIFT BOLT	43-1636.07-22	D22	3/4"	22"	2.76	6		8		6		6		6		6		35
36	DO	43-1636.07-16	D16	3/4"	16"	2.00	7		9		7		7		7		7		36
37	DRIFT BOLT ANCHOR	43-1636.07-12	D12	3/4"	12"	1.50	12		12		12		12		12		12		37
38	STANDARD WIRE SPIKE	42-8488.04-1		3/8"	10"	0.33					96		60		128		92		38
39	DO	42-8488.035-07		5/16"	7"	0.143	180		216		180		90		160		120		39

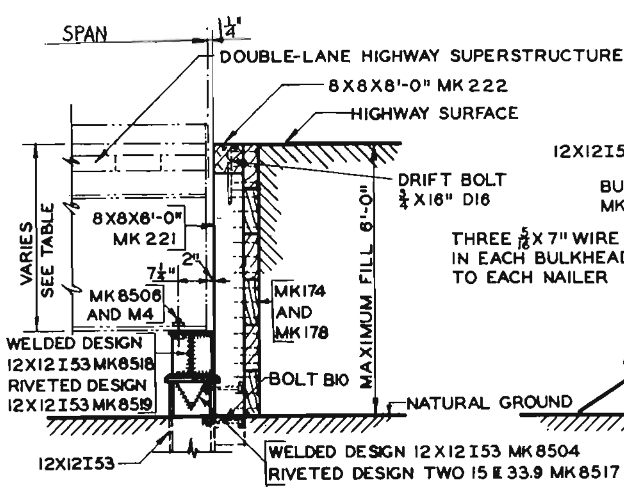
[1] BEARING PILE LENGTHS TO BE DETERMINED BY FIELD CONDITIONS.

[2] NUMBER OF BULKHEAD PLANKS BILLED IS FOR MAXIMUM FILL AND MAXIMUM SPAN. USE FEWER PLANKS FOR SHALLOWER FILLS AND SHORTER SPANS.

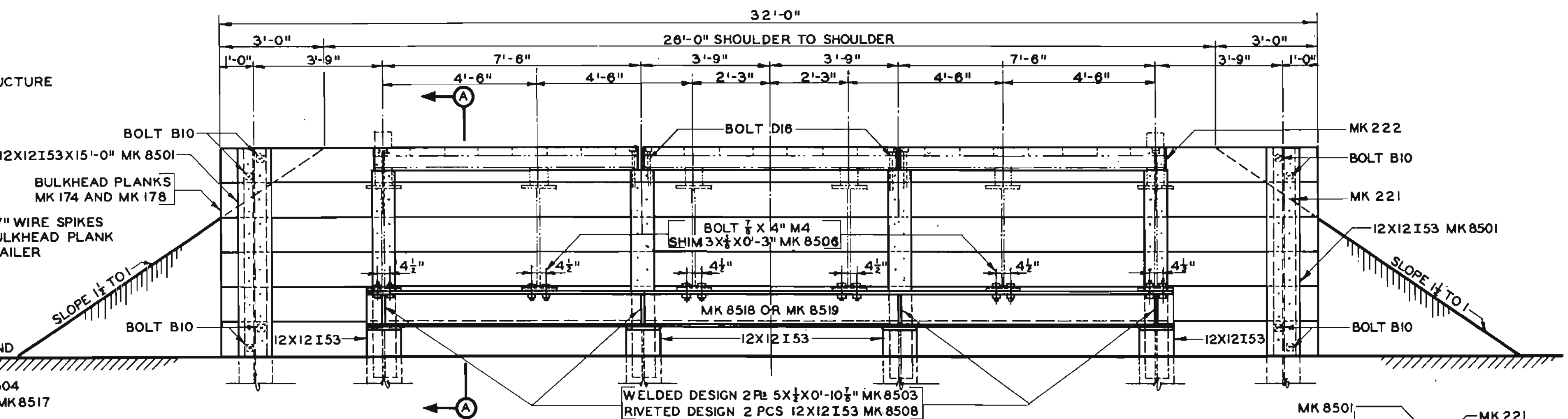
[3] BILL OF MATERIALS IS MADE FOR MAXIMUM FILL AND MINIMUM SPAN. CUT TO FIT WHEN FILL IS LESS THAN MAXIMUM OR SPAN IS GREATER THAN MINIMUM.

COMPANION SHEETS

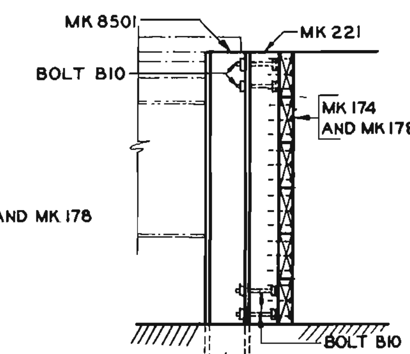
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	70



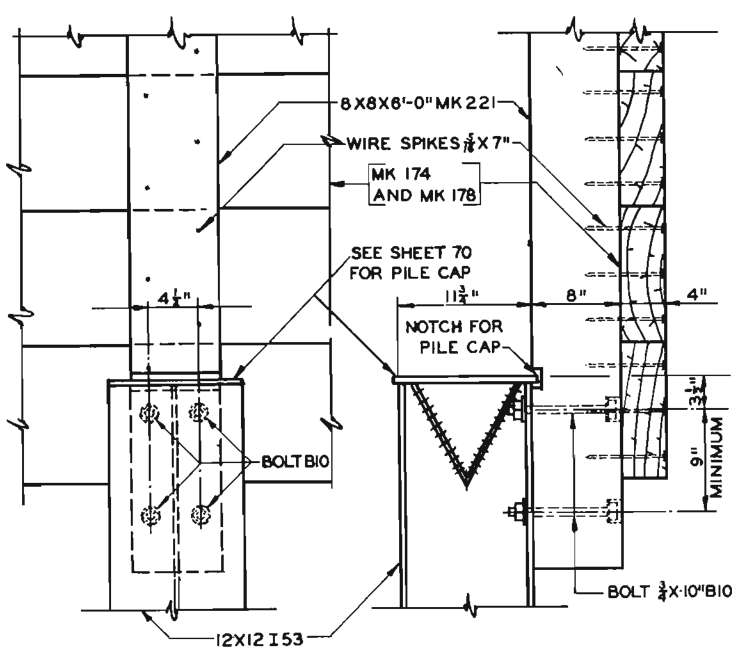
SECTION A-A



TRANSVERSE ELEVATION



END VIEW



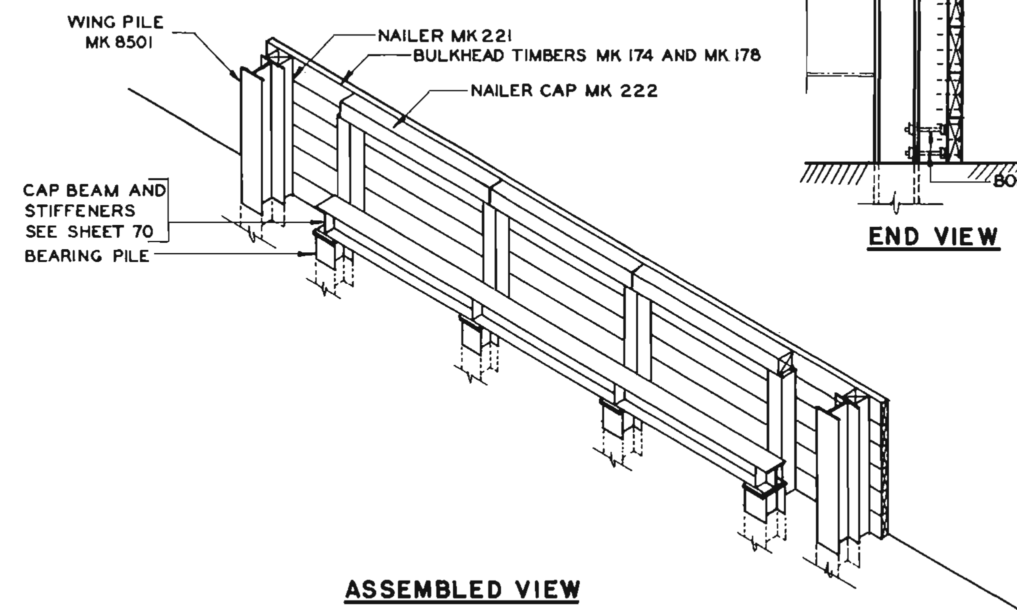
NAILER CONNECTION TO BEARING PILE

MAXIMUM PILE LOADS

SPAN	TONS PER PILE
15'-0"	15
20'-0"	18
30'-0"	22
40'-0"	24
50'-0"	26
60'-0"	28
70'-0"	30
80'-0"	32
90'-0"	35

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS

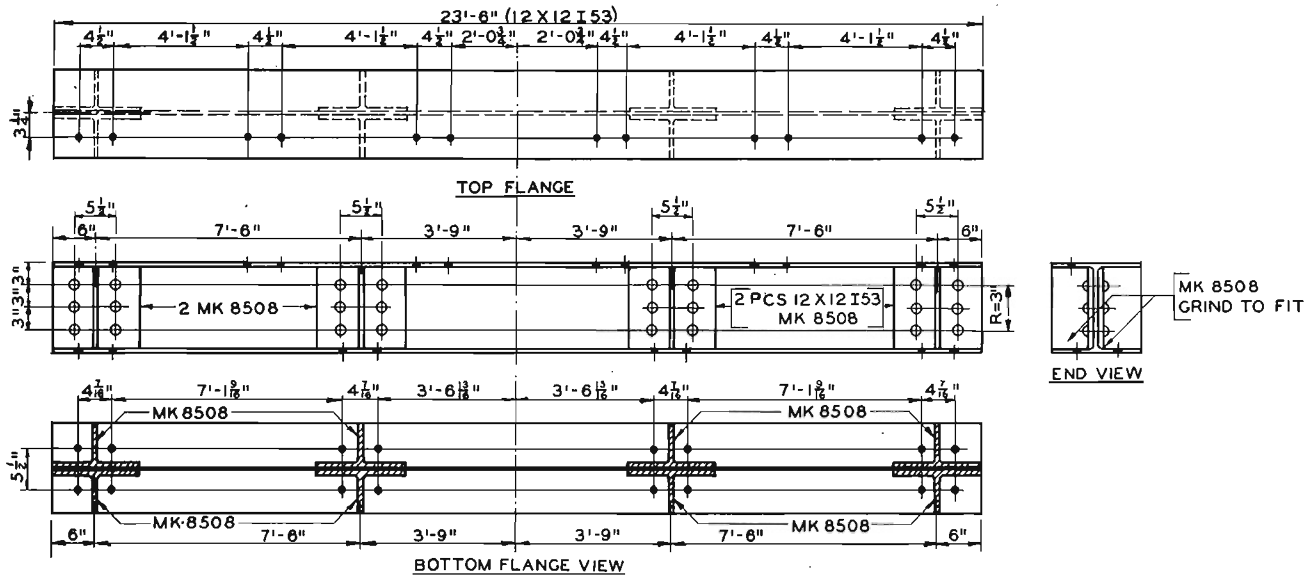
SPAN LENGTH	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
15'-0"	18 I 47	2'-6⅞"
20'-0"	21 I 59	2'-9⅞"
30'-0"	24 I 74	3'-0⅞"
40'-0"	27 I 91	3'-3⅞"
50'-0"	33 I 125	3'-10"
60'-0"	33 I 132	3'-10⅛"
70'-0"	36 I 150	4'-0⅞"
80'-0"	36 I 182	4'-1⅝"
90'-0"	36 I 230	4'-0⅞"



ASSEMBLED VIEW

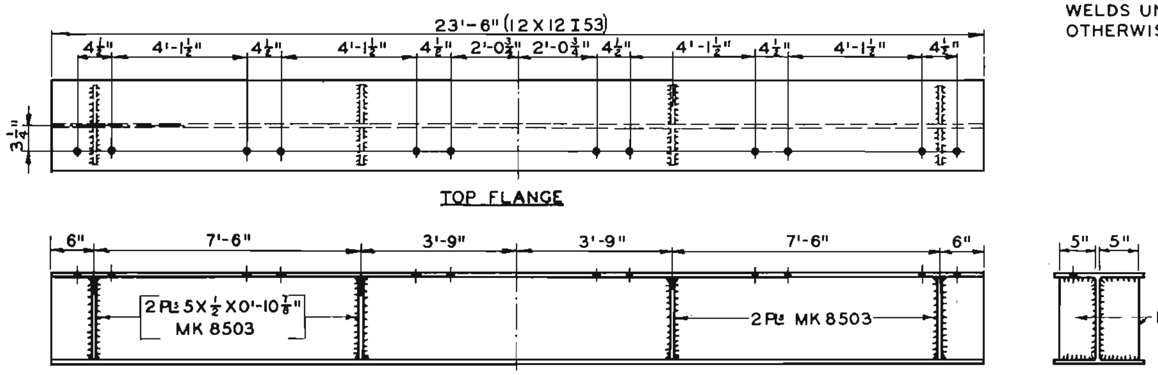
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	69

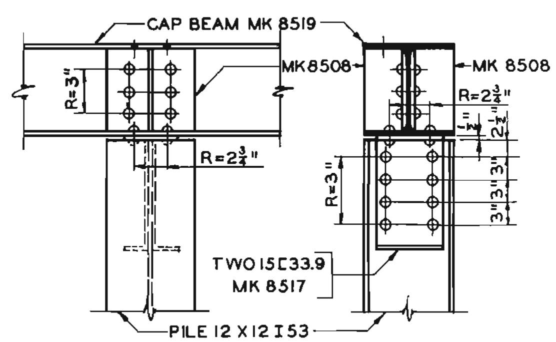


CAP BEAM MK 8519

ALL WELDS SHOWN ARE $\frac{5}{16}$" FILLET WELDS UNLESS OTHERWISE NOTED

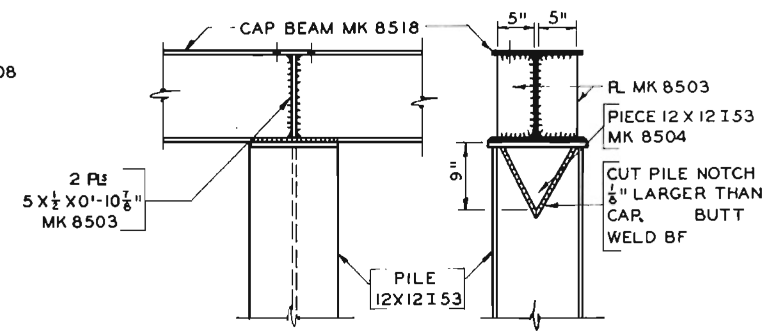


CAP BEAM MK 8518



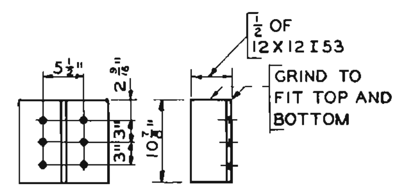
RIVETED CONNECTION DETAILS

PILE TO CAP BEAM

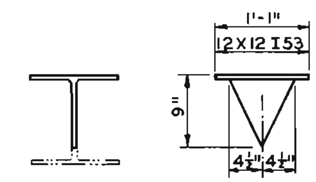


WELDED CONNECTION DETAILS

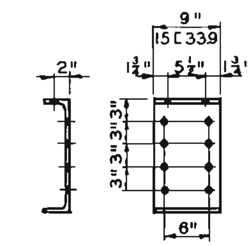
PILE TO CAP BEAM



STIFFENER MK 8508



PILE CAP MK 8504

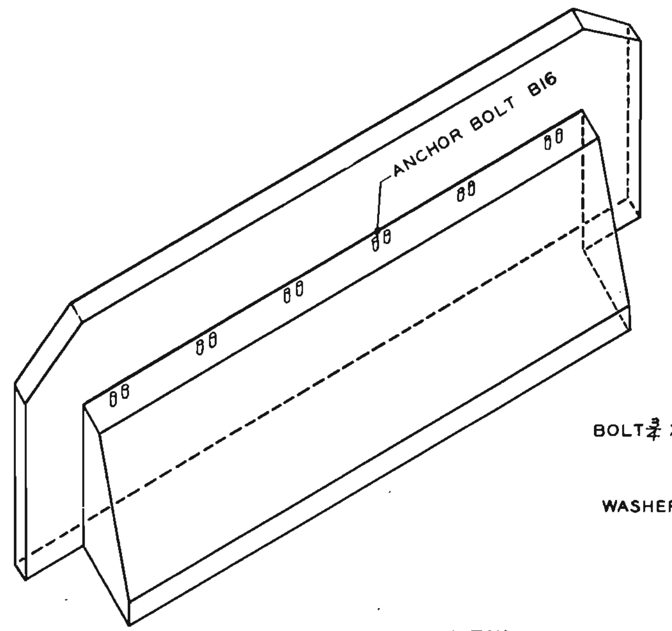


PILE CAP MK 8517

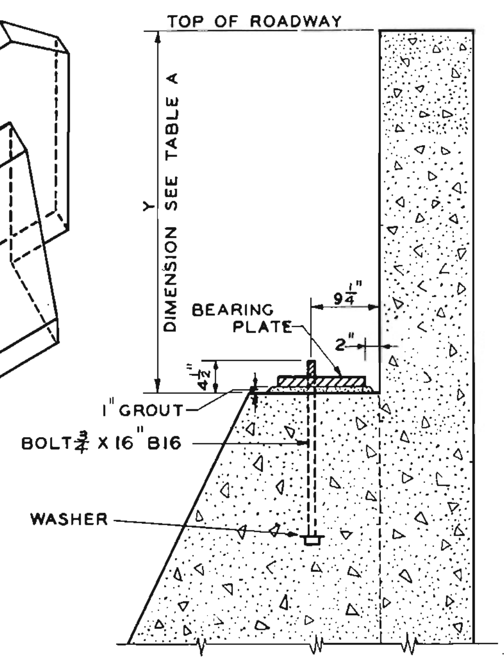
BILL OF MATERIAL FOR ONE ABUTMENT

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	QUANTITY	FBM	WEIGHT EACH (POUNDS)
ALTERNATE NO 1 WELDED DETAILS								
1	WING PILES		8501	12 X 12 I 53	15'-0"	2		795
2	CAP BEAM		8518	12 X 12 I 53	23'-6"	1		1245
3	STIFFENERS	47-7844.05	8503	PL 5 X 1/2	10 7/8"	8		8
4	PILE CAP		8504	12 X 12 I 53	1'-1"	4		29
ALTERNATE NO 2 RIVETED DETAILS								
5	WING PILES		8501	12 X 12 I 53	15'-0"	2		795
6	CAP BEAM		8519	12 X 12 I 53	23'-6"	1		1245
7	STIFFENERS		8508	1/2-12X12 I 53	10 7/8"	8		24
8	PILE CAP	48-3790.15-34	8517	15 [33.9	0'-9"	8		26
LUMBER, SOFT WOOD								
9	NAILERS	39-6616.08	221	8 X 8	6'-0"	6	192	120
10	NAILER CAPS	39-6616.08	222	8 X 8	8'-0"	3	128	160
11	BULKHEAD TIMBERS	39-3340.12-2	178	4 X 12	20'-0"	6	480	300
12	DO	39-3340.12-12	174	4 X 12	12'-0"	6	288	180
STEEL HARDWARE, BLACK								
13	BOLTS WITH NUTS AND TWO WASHERS	43-2325.07-1	B10	3/4	10"	24		[1] 45
14	ANCHOR BOLTS WITH NUTS AND TWO WASHERS	43-2219.08-04	M4	7/8	4"	12		[1] 17
15	DRIFT BOLTS WITH WASHERS	43-1636.07-16	D16	3/4	16"	4		[1] 8
16	WIRE SPIKES	42-8488.035-07		5/16	7"	108		[1] 18
17	RIVETS	43-6353.08-25		7/8	2 1/2"	16		.62
18	DO	43-6353.08		7/8	2 3/4"	56		.66
19	WELDING ROD (POUNDS)	46-3772.2.7		3/16				[1] 18

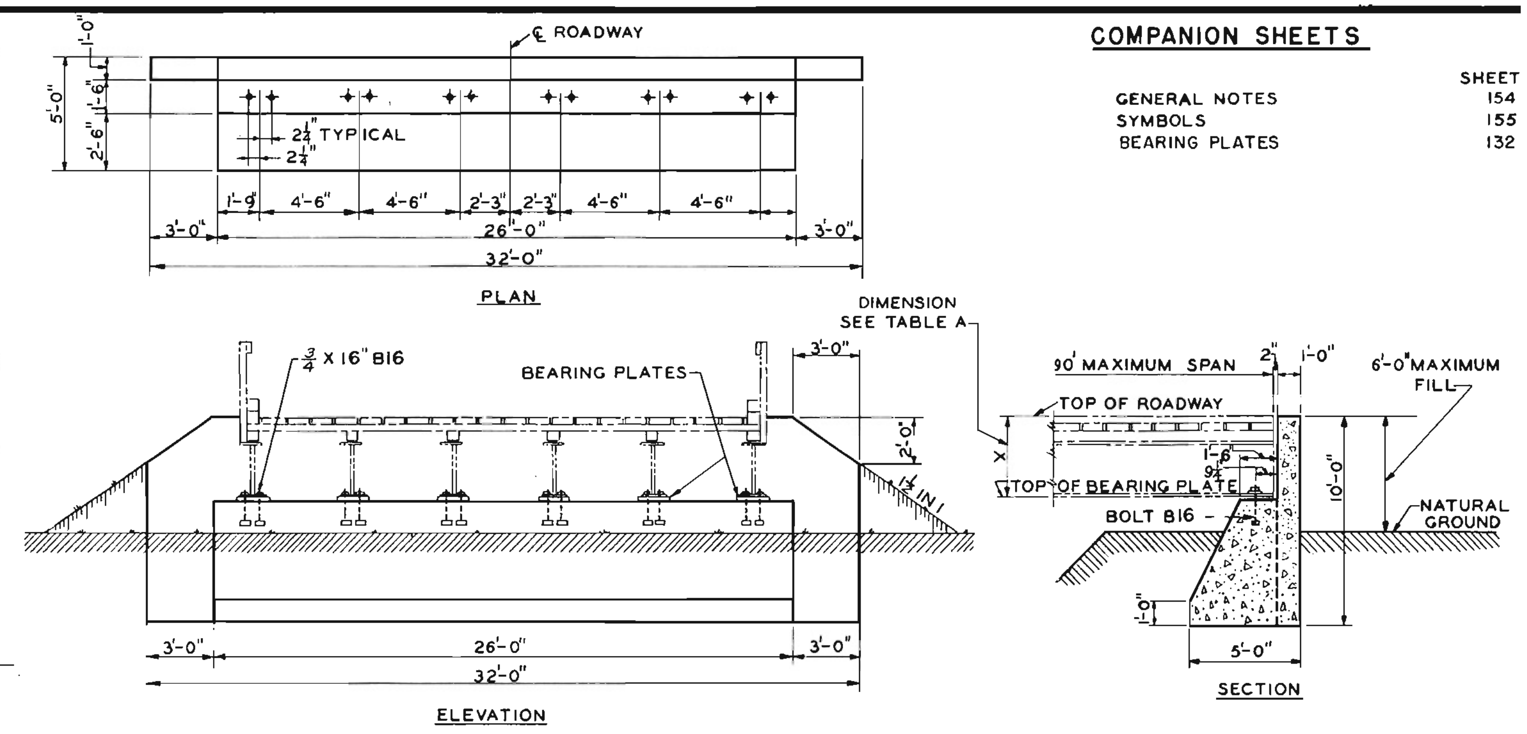
[1] TOTAL WEIGHT



ASSEMBLED VIEW



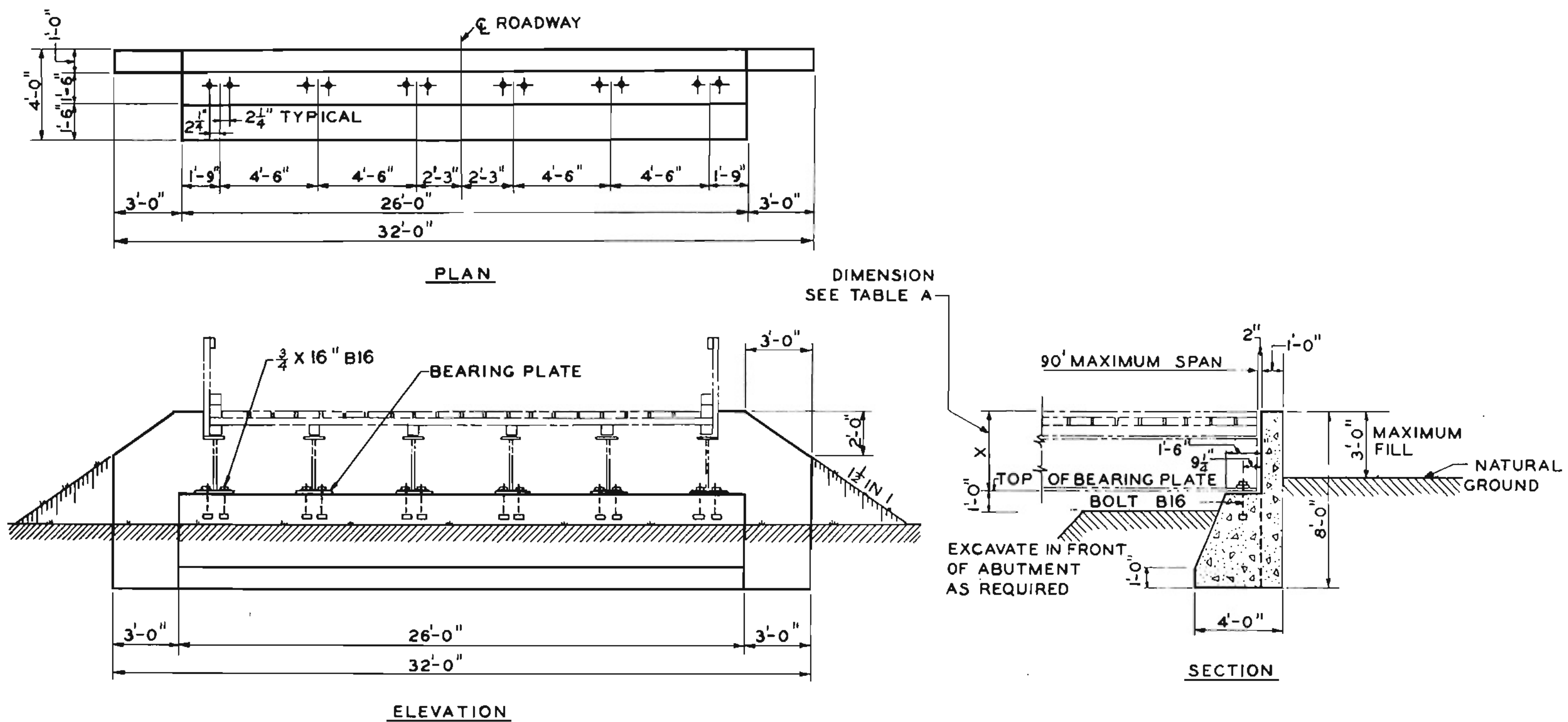
ANCHOR BOLT DETAIL



ABUTMENT 6'-0" MAXIMUM FILL

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BEARING PLATES	132

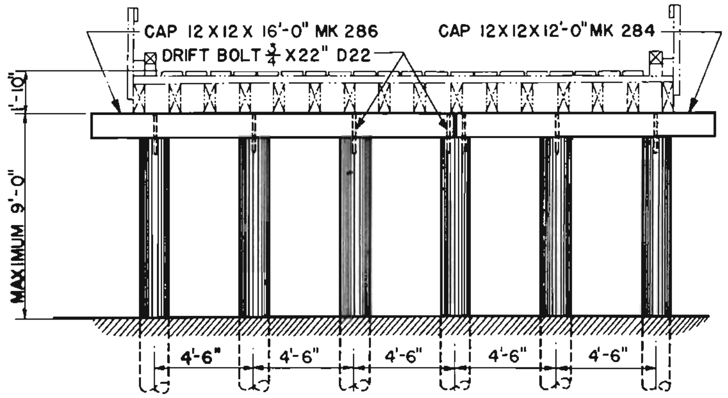


ABUTMENT 3'-0" MAXIMUM FILL

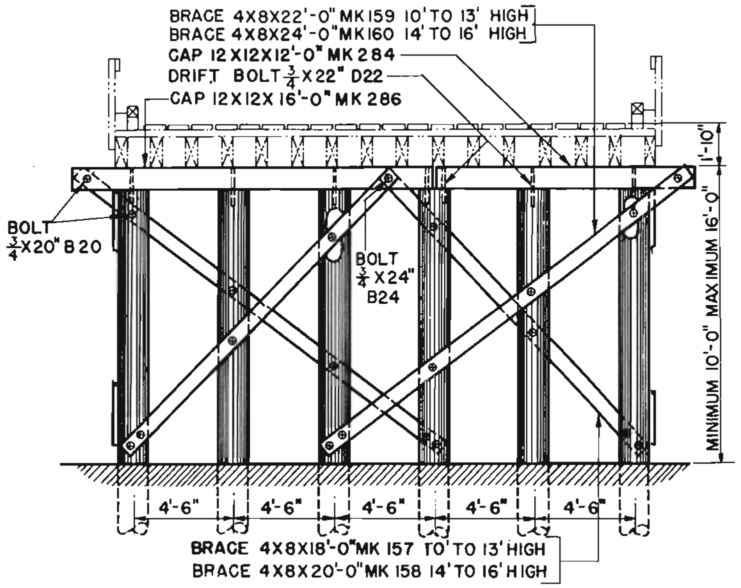
TABLE A DIMENSIONS AND BILL OF MATERIALS

SPAN FEET	X	Y	ANCHOR BOLTS WITH SQUARE NUT AND TWO WASHERS $\frac{3}{4}$ X 16" B16 STOCK NO 43-2325.07-16		CONCRETE	
					6' MAXIMUM FILL	3' MAXIMUM FILL
			QUANTITY	WEIGHT EACH (POUNDS)	CU YDS	CU YDS
15	2'-6$\frac{7}{8}$"	2'-8$\frac{3}{4}$"	12	3.5	32.1	21.4
20	2'-9$\frac{7}{8}$"	2'-11$\frac{3}{4}$"	12	3.5	31.4	20.9
30	3'-0$\frac{7}{8}$"	3'-2$\frac{3}{4}$"	12	3.5	30.8	20.2
40	3'-3$\frac{7}{8}$"	3'-5$\frac{3}{4}$"	12	3.5	30.1	19.8
50	3'-10"	3'-11$\frac{7}{8}$"	12	3.5	28.8	18.7
60	3'-10$\frac{1}{8}$"	4'-0"	12	3.5	28.8	18.7
70	4'-0$\frac{7}{8}$"	4'-2$\frac{3}{4}$"	12	3.5	28.1	18.2
80	4'-1$\frac{3}{8}$"	4'-3$\frac{1}{4}$"	12	3.5	28.0	18.1
90	4'-0$\frac{7}{8}$"	4'-2$\frac{3}{4}$"	12	3.5	28.1	18.2

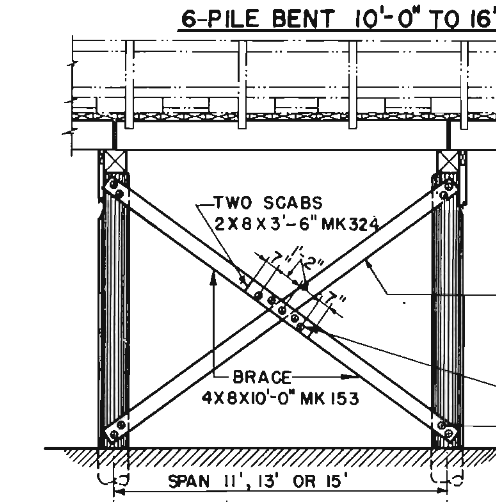
BEARING PLATES (SHEET 132)
12 X $\frac{7}{8}$ X 1'-3" MK 3500 FOR 15 TO 80 FOOT SPANS
12 X $\frac{7}{8}$ X 1'-4" MK 3501 FOR 90 FOOT SPAN
SIX REQUIRED EACH ABUTMENT, STOCK NO 47-7844.08



6-PILE BENT 0'-0" TO 9'-0" HIGH

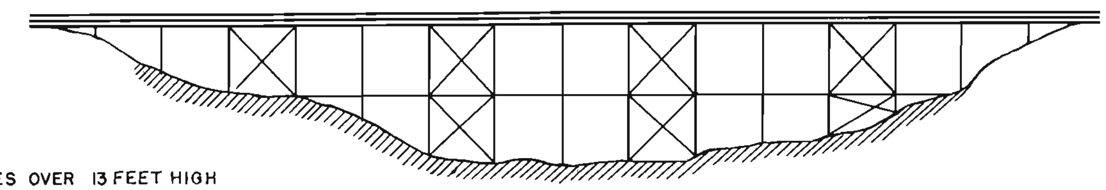


6-PILE BENT 10'-0" TO 16'-0" HIGH



4X8 LONGITUDINAL BRACING		
SPAN	LENGTH	MARK
11'	20'-0"	158
13'	20'-0"	158
15'	22'-0"	159

LONGITUDINAL ELEVATION 13'-0" TO 16'-0" HIGH



TRESTLES OVER 13 FEET HIGH HAVE LONGITUDINAL CROSS BRACING EVERY THIRD SPAN

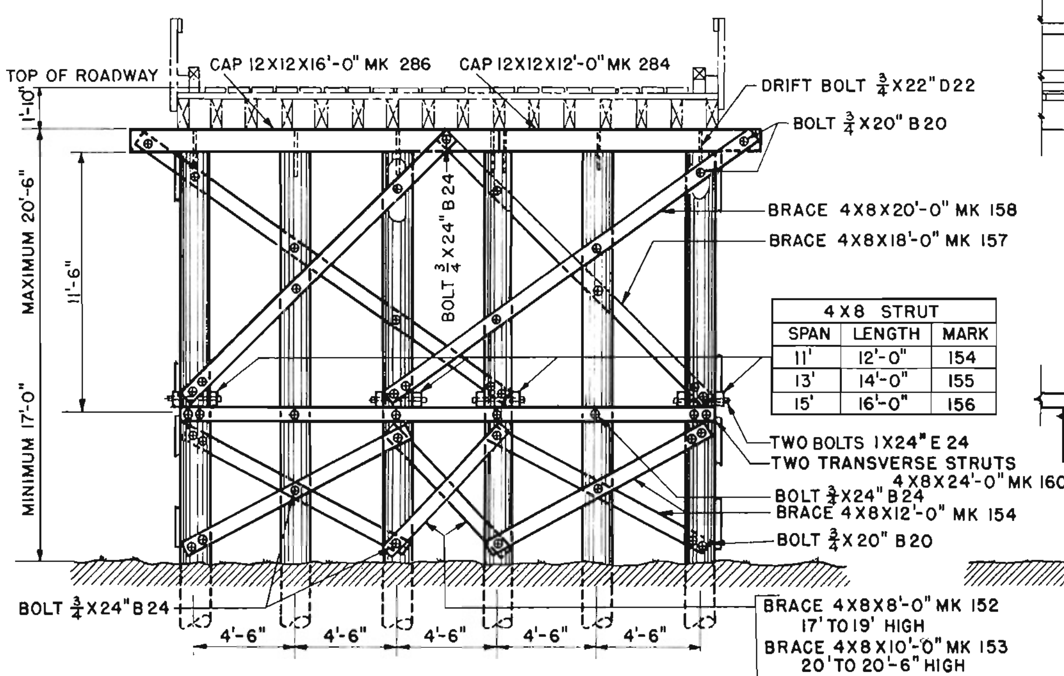
LONGITUDINAL BRACING DIAGRAM

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE BENTS	73

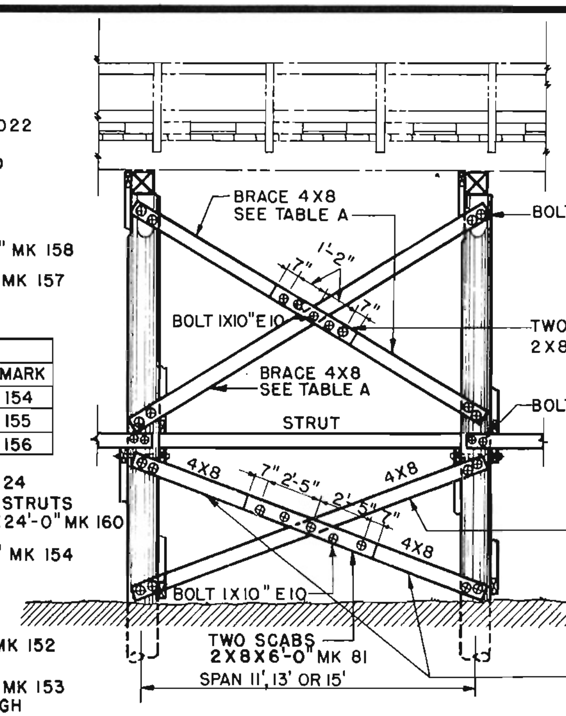
BILL OF MATERIALS FOR ONE TRANSVERSE BENT

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	0' TO 9' QUANTITY	0' TO 9' FBM	10' TO 13' QUANTITY	10' TO 13' FBM	14' TO 16' QUANTITY	14' TO 16' FBM	17' TO 19' QUANTITY	17' TO 19' FBM	20' TO 20'-6" QUANTITY	20' TO 20'-6" FBM	21' TO 22' QUANTITY	21' TO 22' FBM	23' TO 25' QUANTITY	23' TO 25' FBM	26' TO 28' QUANTITY	26' TO 28' FBM	LINE
	BILL OF MATERIALS FOR ONE BENT																						
1	PILE						6		6		6		6		6		6		6		6		1
	LUMBER, SOFT WOOD																						
2	CAP	39-6630.12-12	284	12X12	12'-0"	540	1	144	1	144	1	144	1	144	1	144	1	144	1	144	1	144	2
3	CAP	39-6630.12-16	286	12X12	16'-0"	720	1	192	1	192	1	192	1	192	1	192	1	192	1	192	1	192	3
4	SASH BRACE	39-3340.08-24	160	4X8	24'-0"	240							2	128	2	128	2	128	2	128	2	128	4
5	BRACE	39-3340.08-08	152	4X8	8'-0"	80							2	43									5
6	DO	39-3340.08-1	153	4X8	10'-0"	100									2	53							6
7	DO	39-3340.08-12	154	4X8	12'-0"	120							4	128	4	128							7
8	DO	39-3340.08-18	157	4X8	18'-0"	180			2	96			2	96	2	96	6	288	6	288	6	288	8
9	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107	2	107	2	107	2	107	2	107	6	320	9
10	DO	39-3340.08-22	159	4X8	22'-0"	220			2	117													10
11	DO	39-3340.08-24	160	4X8	24'-0"	240					2	128											11
	STEEL HARDWARE, BLACK							POUNDS		POUNDS		POUNDS		POUNDS		POUNDS		POUNDS		POUNDS		POUNDS	
12	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-22	D22	3/4	22"	3.0	7	21	7	21	7	21	7	21	7	21	7	21	7	21	7	21	12
13	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-2	B20	3/4	20"	3.06			20	61	20	61	28	86	28	86	44	135	44	135	44	135	13
14	DO	43-2325.07-24	B24	3/4	24"	3.54			1	4	1	4	15	53	15	53	9	32	9	32	9	32	14
	BILL OF MATERIALS FOR ONE SPAN OF STRUTS																						
	STEEL HARDWARE, BLACK																						
15	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-24	E24	1	24"	6.48							8	52	8	52	8	52	8	52	8	52	15
	LUMBER, SOFT WOOD													FBM		FBM		FBM		FBM		FBM	
16	STRUT FOR 11'-0" SPAN	39-3340.08-12	154	4X8	12'-0"	120							4	128	4	128	4	128	4	128	4	128	16
17	STRUT FOR 13'-0" SPAN	39-3340.08-14	155	4X8	14'-0"	140							4	149	4	149	4	149	4	149	4	149	17
18	STRUT FOR 15'-0" SPAN	39-3340.08-16	156	4X8	16'-0"	160							4	171	4	171	4	171	4	171	4	171	18
	BILL OF MATERIALS FOR ONE SPAN OF LONGITUDINAL BRACING																						
	STEEL HARDWARE, BLACK FOR 11', 13' AND 15' SPANS											POUNDS		POUNDS		POUNDS		POUNDS		POUNDS		POUNDS	
19	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-104	E10	1	10"	3.45					10	35	20	69	20	69	20	69	20	69	20	69	19
20	DO	43-2325.1-2	E20	1	20"	5.61					16	90	32	179	32	179	32	179	32	179	32	179	20
	LUMBER, SOFT WOOD FOR 11', 13' AND 15' SPANS											FBM		FBM		FBM		FBM		FBM		FBM	
21	SCAB	39-2228.08	324	2X8	3'-6"	18					4	19	4	19	4	19	4	19	4	19	4	19	21
22	DO	39-2228.06	81	2X8	6'-0"	30							4	32	4	32	4	32	4	32	4	32	22
	LUMBER SOFT WOOD FOR 11'-0" SPAN																						
23	BRACE	39-3340.08-08	152	4X8	8'-0"	80							8	171	8	171	8	171	4	85	4	85	23
24	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107							4	107	4	107	24
25	DO	39-3340.08-14	155	4X8	14'-0"	140							2	75	2	75							25
26	DO	39-3340.08-16	156	4X8	16'-0"	160							2	85	2	85	4	171	2	85	2	85	26
27	DO	39-3340.08-18	157	4X8	18'-0"	180													2	96			27
28	DO	39-3340.08-20	158	4X8	20'-0"	200					2	107									2	107	28
	LUMBER, SOFT WOOD FOR 13'-0" SPAN																						
29	BRACE	39-3340.08-08	152	4X8	8'-0"	80							4	85	4	85							29
30	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107	4	107	4	107	8	213	8	213	8	213	30
31	DO	39-3340.08-16	156	4X8	16'-0"	160							2	85	2	85							31
32	DO	39-3340.08-18	157	4X8	18'-0"	180							2	96	2	96	4	192	2	96	2	96	32
33	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107							2	107			33
34	DO	39-3340.08-22	159	4X8	22'-0"	220															2	117	34
	LUMBER, SOFT WOOD FOR 15'-0" SPAN																						
35	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107	8	213	8	213	8	213	8	213	4	107	35
36	DO	39-3340.08-12	154	4X8	12'-0"	120															4	128	36
37	DO	39-3340.08-18	157	4X8	18'-0"	180							2	96	2	96							37
38	DO	39-3340.08-2	158	4X8	20'-0"	200							2	107	2	107	4	213	4	213	2	107	38
39	DO	39-3340.08-22	159	4X8	22'-0"	220					2	117									2	117	39



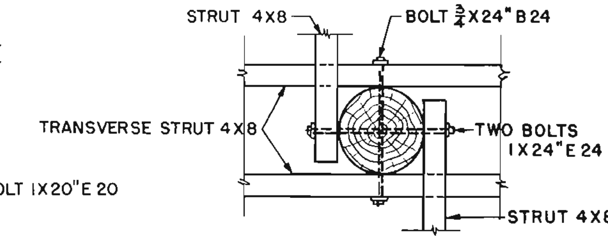
4X8 STRUT		
SPAN	LENGTH	MARK
11'	12'-0"	154
13'	14'-0"	155
15'	16'-0"	156

TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION

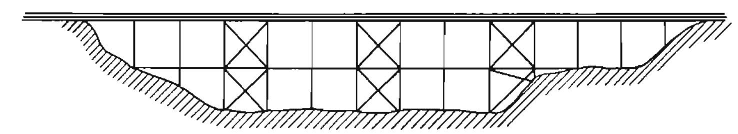
6-PILE BENT 17'-0" TO 20'-6" HIGH



DETAIL OF STRUT CONNECTION

COMPANION STEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	72

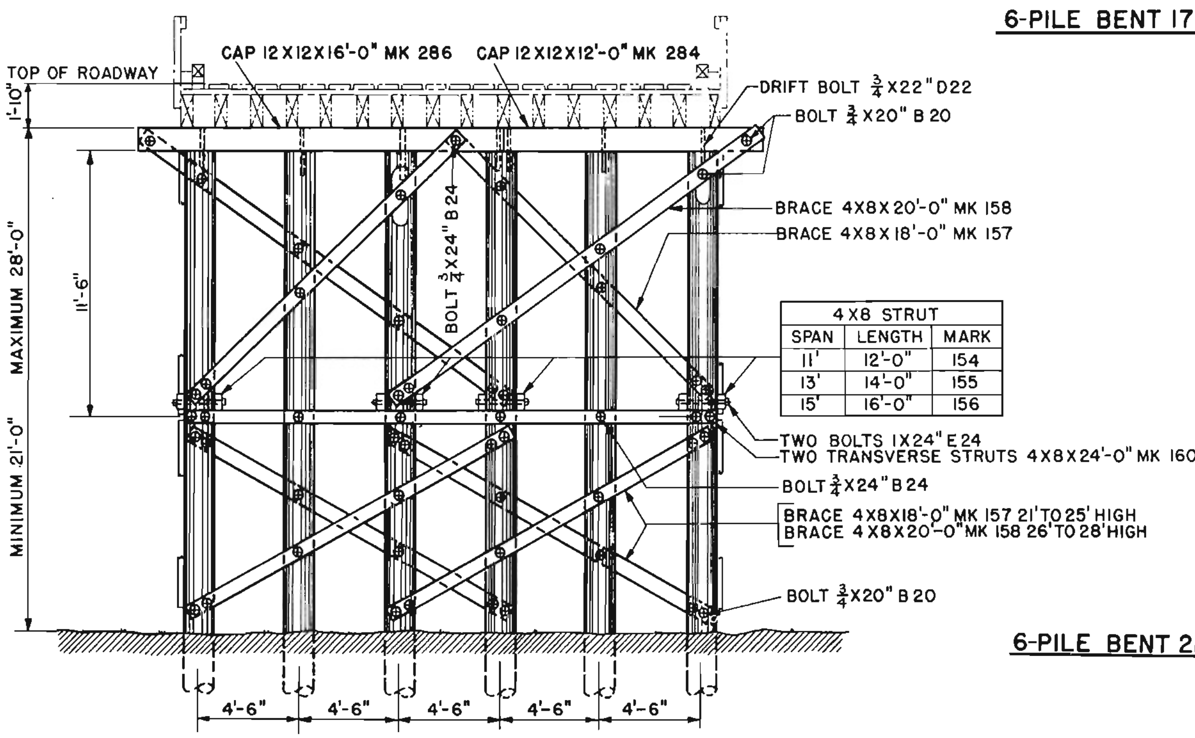


LONGITUDINAL BRACING DIAGRAM

BENTS OVER 13 FEET HIGH HAVE LONGITUDINAL CROSS BRACING EVERY THIRD SPAN. LONGITUDINAL STRUTS ARE CARRIED TO BANK AND FASTENED TO BENT NEAR GROUND LINE

HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 19'	14'-0"	155	15'-0"	156	18'-0"	157
20' TO 20'-6"	14'-0"	155	16'-0"	156	18'-0"	157

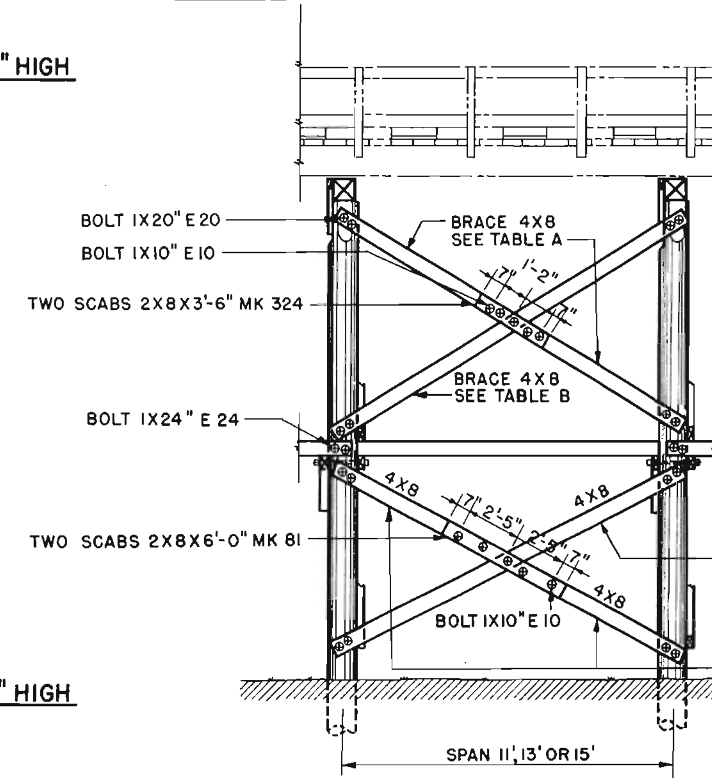
HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 19'	8'-0"	152	8'-0"	152	10'-0"	153
20' TO 20'-6'	8'-0"	152	8'-0"	152	10'-0"	153



4X8 STRUT		
SPAN	LENGTH	MARK
11'	12'-0"	154
13'	14'-0"	155
15'	16'-0"	156

TRANSVERSE ELEVATION

6-PILE BENT 21'-0" TO 28'-0" HIGH



LONGITUDINAL ELEVATION

TABLE A

HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 28	8'-0"	152	10'-0"	153	10'-0"	153

TABLE B

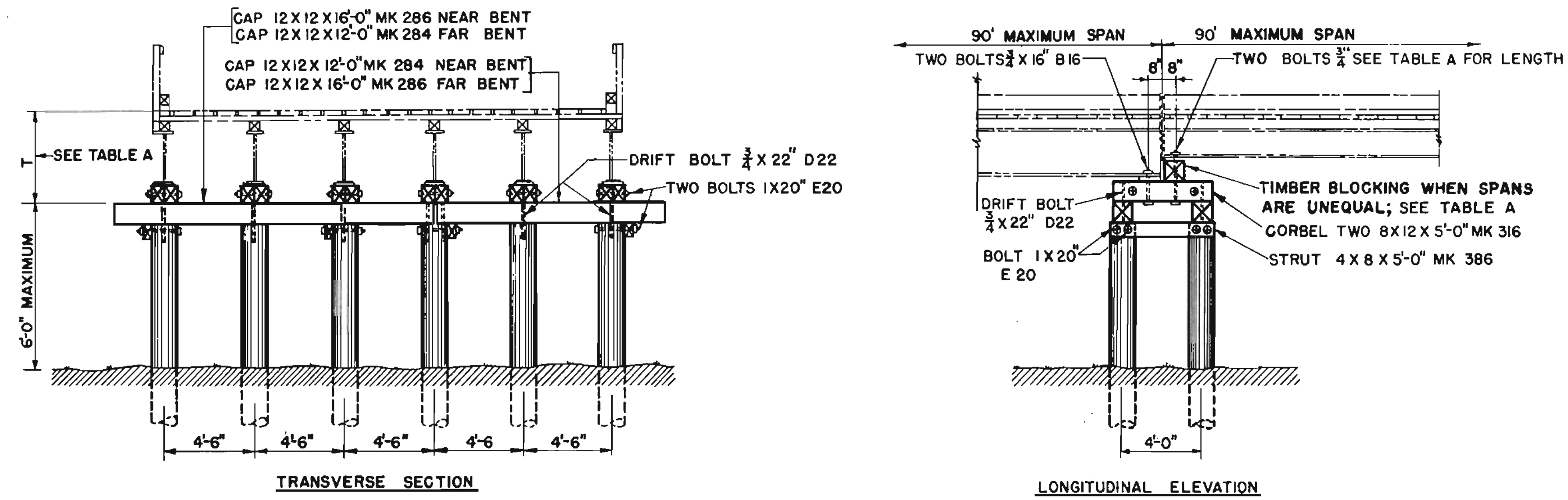
HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 28'	16'-0"	156	18'-0"	157	20'-0"	158

HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
21' TO 22'	16'-0"	156	18'-0"	157	20'-0"	158
23' TO 25	18'-0"	157	20'-0"	158	20'-0"	158
26' TO 28	20'-0"	158	22'-0"	159	22'-0"	159

HEIGHT	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
21' TO 22'	8'-0"	152	10'-0"	153	10'-0"	153
23' TO 25'	10'-0"	153	10'-0"	153	10'-0"	153
26' TO 28'	10'-0"	153	10'-0"	153	12'-0"	154

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	75



12 PILE PIER 0'-0" TO 6'-0"

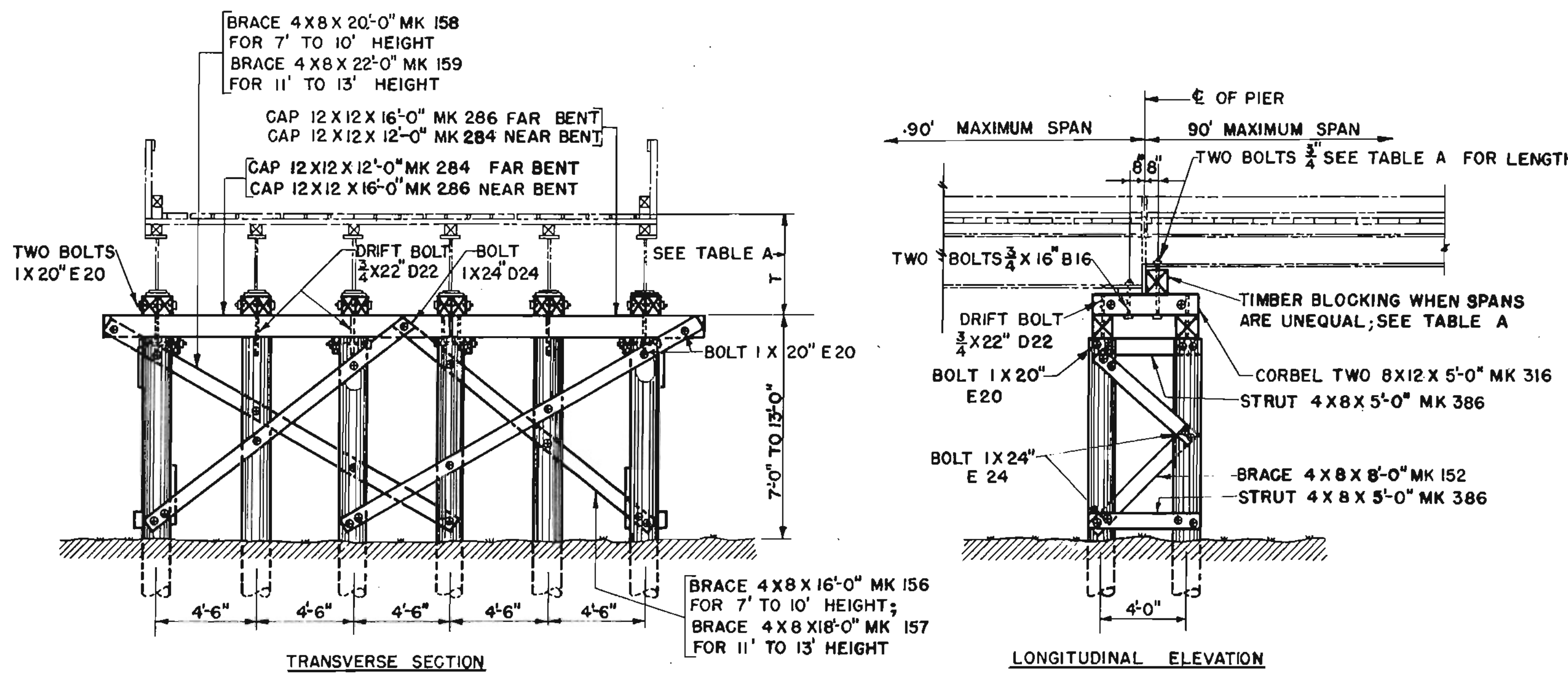
REQUIRED PILE CAPACITY

TOTAL LENGTH OF TWO ADJACENT SPANS	30'	40'	60'	80'	100'	120'	140'	160'	180'
TONS PER PILE	10	10	12	14	15	17	18	18	18

TABLE A

DEPTH OF BLOCKING AND LENGTH OF ANCHOR BOLT WHEN ADJACENT SPANS ARE NOT EQUAL

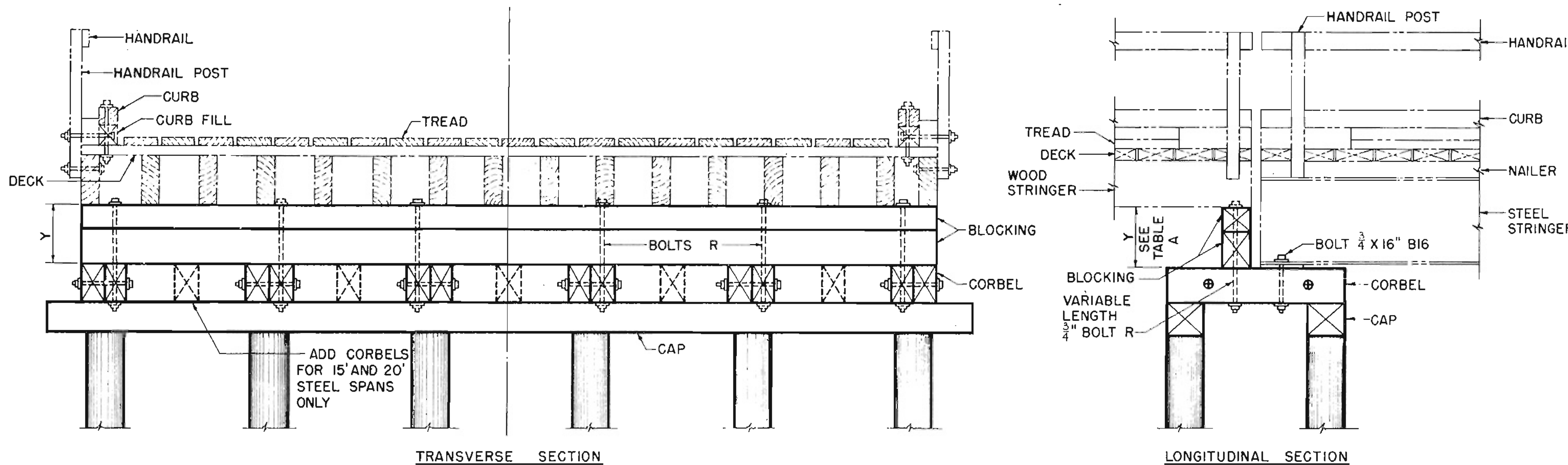
SPAN	T		TIMBER SPAN	STEEL SPAN					
			15'	15'	20'	30'	40'	50'	60'
90'	5'-1 3/4"	BLOCKING BOLT	2'-4 42"	1'-6" 34"	1'-3" 32"	1'-0" 28"	0'-9" 26"	0'-3" 20"	0'-3" 20"
80'	5'-2 1/4"	BLOCKING BOLT	2'-4" 42"	1'-6" 34"	1'-3" 32"	1'-0" 28"	0'-9" 26"	0'-3" 20"	0'-3 20"
70'	5'-1 3/4"	BLOCKING BOLT	2'-4" 42"	1'-6" 34"	1'-3" 32"	1'-0" 28"	0'-9" 26"	0'-3" 20"	0'-3" 20"
60'	4'-11"	BLOCKING BOLT	2'-1" 40"	1'-3" 32"	1'-0" 28"	0'-9" 26"	0'-6" 22"		
50'	4'-10 7/8"	BLOCKING BOLT	2'-1" 40"	1'-3" 32"	1'-0" 28"	0'-9" 26"	0'-6" 22"		
40'	4'-4 3/4"	BLOCKING BOLT	1'-7" 34"	0'-9" 26"	0'-6" 22"	0'-3" 20"			
30'	4'-1 3/4"	BLOCKING BOLT	1'-4" 30"	0'-6" 22"	0'-3" 20"				
20'	3'-10 3/4"	BLOCKING BOLT	1'-1" 28"	0'-3" 20"					
15'	3'-7 3/4"	BLOCKING BOLT	0'-10" 24"						



12-PILE PIER 7'-0" TO 13'-0"

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE PIERS FOR STEEL SPANS	74



SPECIAL BLOCKING AT JUNCTION OF STEEL AND TIMBER SPANS

BILL OF MATERIALS FOR ANCHOR BOLTS AND BEARING PLATES

3/4" ANCHOR BOLT WITH SQUARE NUT AND TWO WASHERS
FOR REQUIRED LENGTH SEE TABLE A SHEET 74
SIX REQUIRED AT EACH SUPPORT FOR EACH TIMBER SPAN
TWELVE REQUIRED AT EACH SUPPORT FOR EACH STEEL SPAN

BOLT LENGTH	STOCK NUMBER
20"	43-2325.07-2
22"	43-2325.07-223
24"	43-2325.07-24
26"	43-2325.07-265
28"	43-2325.07-28
30"	43-2325.07-306
32"	43-2325.07-32
34"	43-2325.07-346
40"	43-2325.07-406
42"	43-2325.07-425

BEARING PLATES 12 X 7/8 X 1'-3" P350C FOR 15 TO 80 FOOT SPAN
BEARING PLATES 12 X 7/8 X 1'-4" P3501 FOR 90 FOOT SPAN
SIX REQUIRED FOR EACH STEEL SPAN AT EACH SUPPORT
STOCK NUMBER 40-7844.08

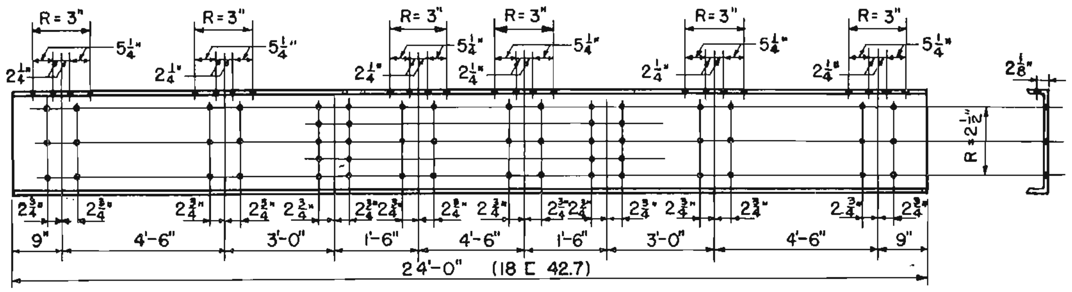
VARIABLE BLOCKING 12" WIDE X 12'-0" LONG OF DEPTHS REQUIRED AS SHOWN BY DIMENSION Y

BILL OF MATERIAL FOR ONE TIMBER PIER

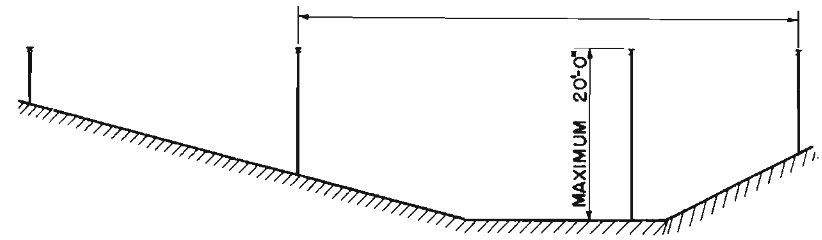
CLASS 50 - DOUBLE LANE							PIER HEIGHT					
							0' TO 6'		7' TO 10'		11' TO 13'	
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM
1	PILE						12		12		12	
	LUMBER, SOFT WOOD											
2	CAP	39-6630.12-12	284	12 X 12	12'-0"	540	2	288	2	288	2	288
3	DO	39-6630.12-16	286	12 X 12	16'-0"	720	2	384	2	384	2	384
4	CORBEL	39-6616.12	316	8 X 12	5'-0"	150	12	480	12	480	12	480
5	STRUT	39-3340.08	386	4 X 8	5'-0"	50	4	53	6	80	6	80
6	BRACE	39-3340.08-08	152	4 X 8	8'-0"	80			4	86	4	86
7	DO	39-3340.08-16	156	4 X 8	16'-0"	160			4	171		
8	DO	39-3340.08-18	157	4 X 8	18'-0"	180					4	192
9	DO	35-3340.08-2	158	4 X 8	20'-0"	200			4	213		
10	DO	39-3340.08-22	159	4 X 8	22'-0"	220					4	235
	STEEL HARDWARE, BLACK											
11	DRIFT BOLT WITH SQUARE HEAD AND ONE WASHER	43-1636.07-22	D22	3/4	22"	3.0	26		26		26	
12	MACHINE BOLT WITH SQUARE HEAD AND ONE WASHER	43-2325.1-2	E20	1	20"	5.6	28		76		76	
13	DO	43-2325.1-24	E24	1	24"	6.5			10		10	
14	DO	43-2325.07-16	B16	3/4	16"	2.6	24		24		24	

TABLE A

STEEL SPAN	DIMENSION Y	BOLT R
15'	0'-9 3/4"	24"
20'	1'-0 3/4"	26"
30'	1'-3 3/4"	30"
40'	1'-6 3/4"	32"
50'	2'-0 1/8"	38"
60'	2'-1"	38"
70'	2'-3 3/4"	42"
80'	2'-4 1/4"	42"
90'	2'-3 3/4"	42"



CAP BEAM MK 8917

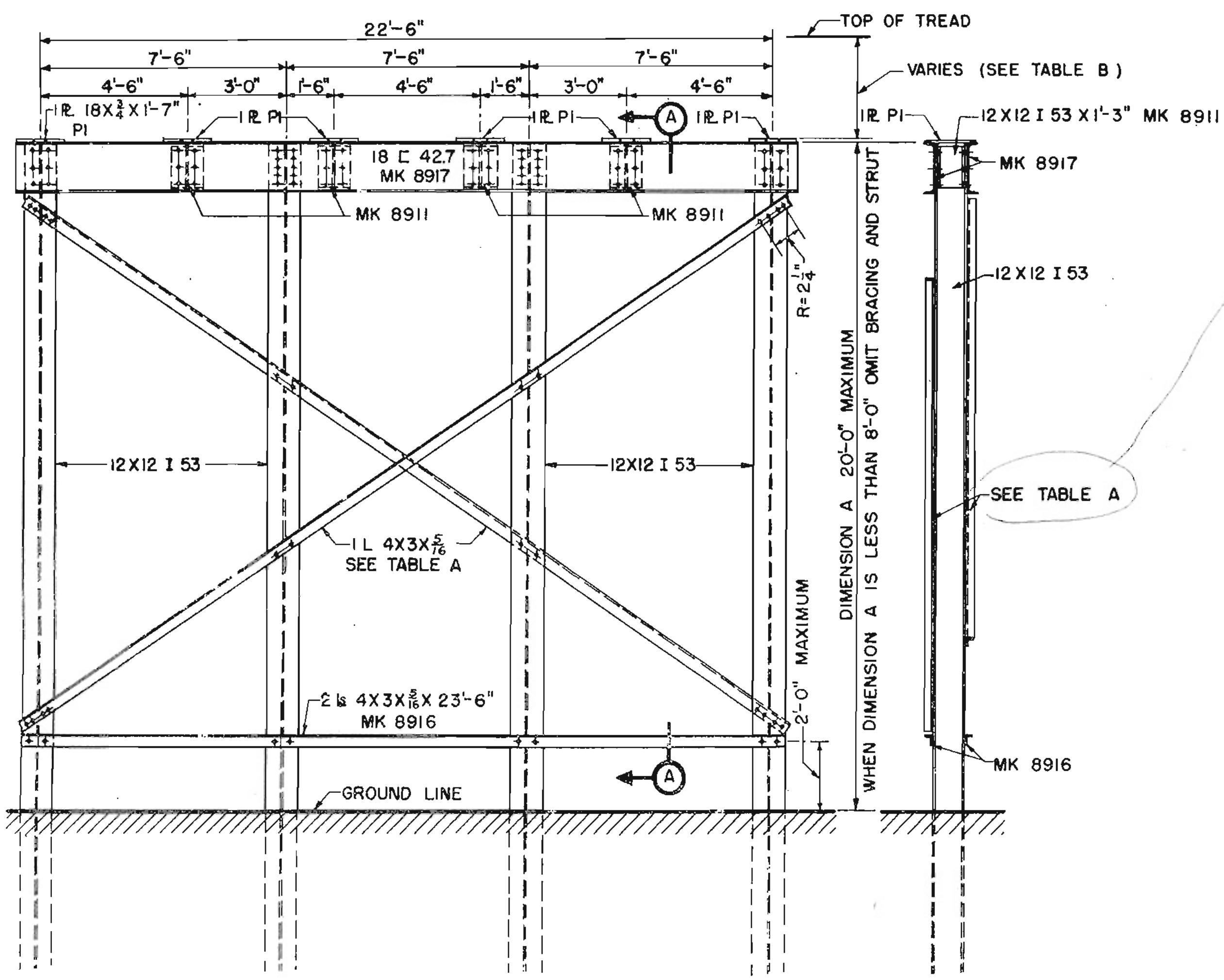


DIAGRAM

SHOWING HEIGHT AND SPAN LIMITATIONS
PILE BENT

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	78
FABRICATION DETAILS	150



TRANSVERSE ELEVATION

SECTION A-A

FOUR-PILE BENT

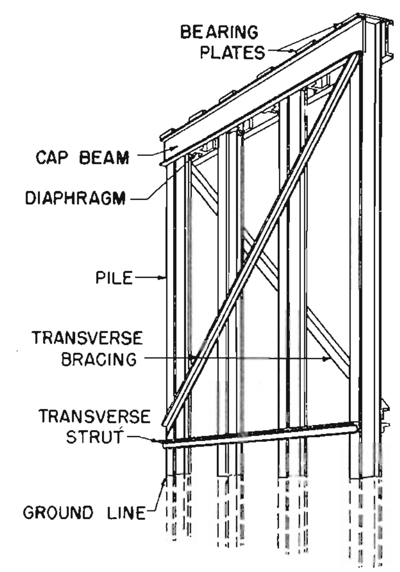
TABLE A

BENT HEIGHT	TRANSVERSE BRACE
20'-0"	MK 8944
18'-0"	MK 8945
16'-0"	MK 8946
14'-0"	MK 8947
12'-0"	MK 8948
10'-0"	MK 8949
8'-0"	MK 8950

MAXIMUM PILE LOADS	
TOTAL LOADED LENGTH	TONS PER PILE
30'-0"	20
40'-0"	23
50'-0"	25
60'-0"	28
70'-0"	30
80'-0"	33
90'-0"	35
100'-0"	38

TABLE B

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS		
SPAN	STEEL-STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
15'-0"	18 I 47	2'-$6\frac{7}{8}$"
20'-0"	21 I 59	2'-$9\frac{7}{8}$"
30'-0"	24 I 74	3'-$0\frac{7}{8}$"
40'-0"	27 I 91	3'-$3\frac{7}{8}$"
50'-0"	33 I 125	3'-10"
60'-0"	33 I 132	3'-$10\frac{1}{8}$"
70'-0"	36 I 150	4'-$0\frac{3}{8}$"
80'-0"	36 I 182	4'-$1\frac{3}{8}$"
90'-0"	36 I 230	4'-$0\frac{3}{8}$"

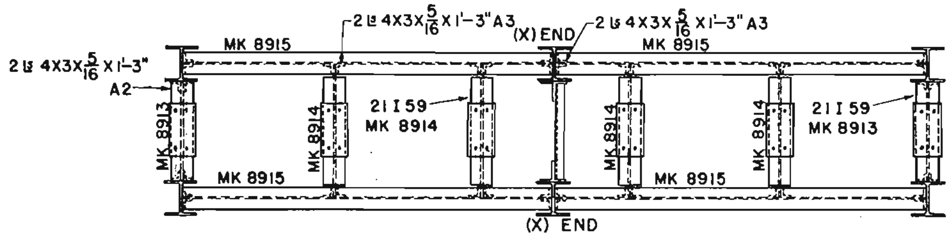


ASSEMBLED VIEW

RIVETED CONSTRUCTION, PIERS UP TO 20 FEET HIGH, GENERAL VIEWS

COMPANION SHEETS

	SHEET
STEEL PILE BENTS AND PIERS	76
BILL OF MATERIALS	78
FABRICATION DRAWINGS	150
GENERAL NOTES	154
SYMBOLS	155



PLAN AT TOP OF PIER

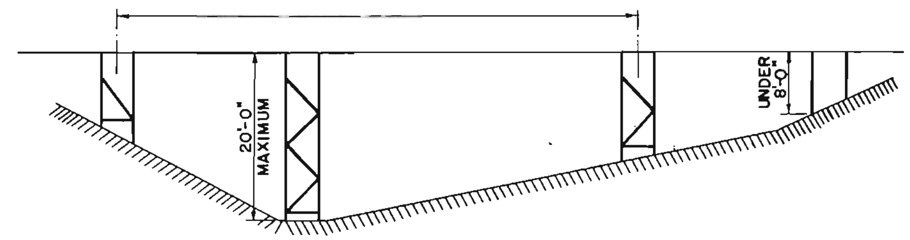
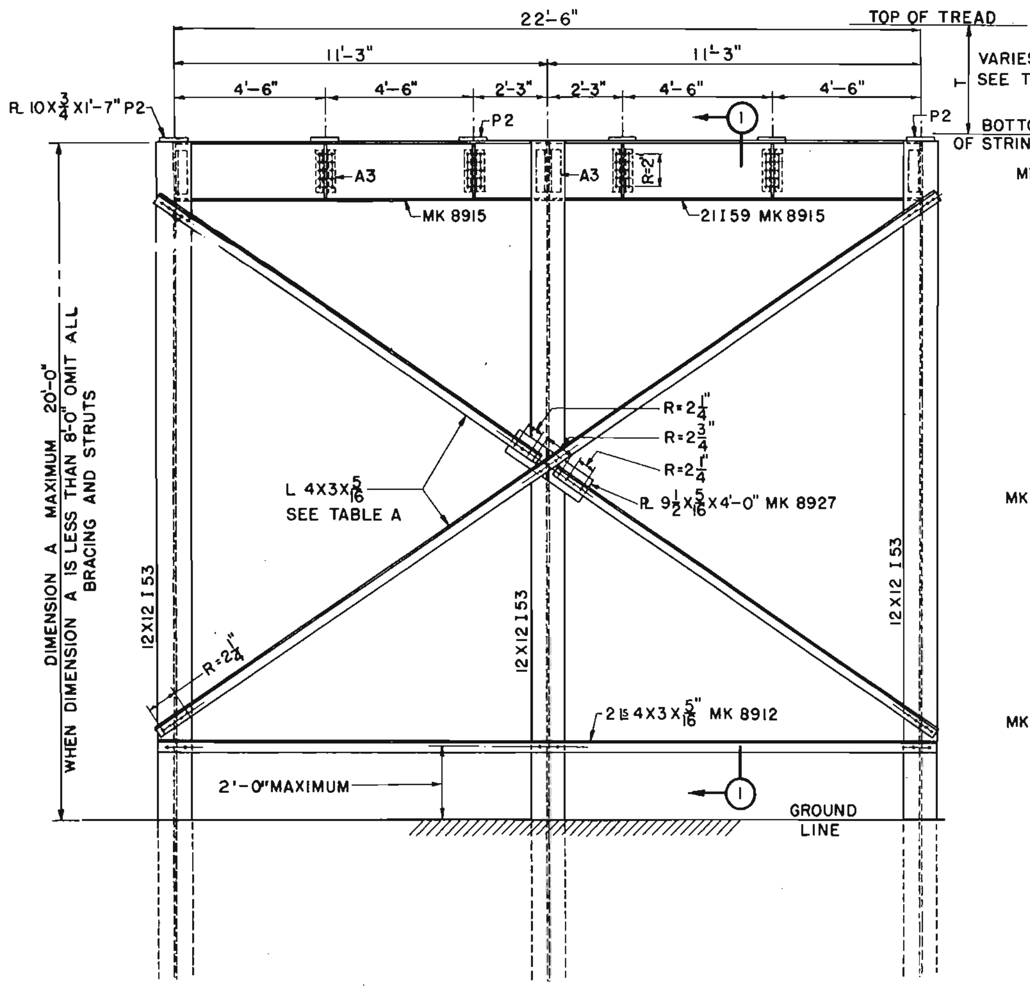
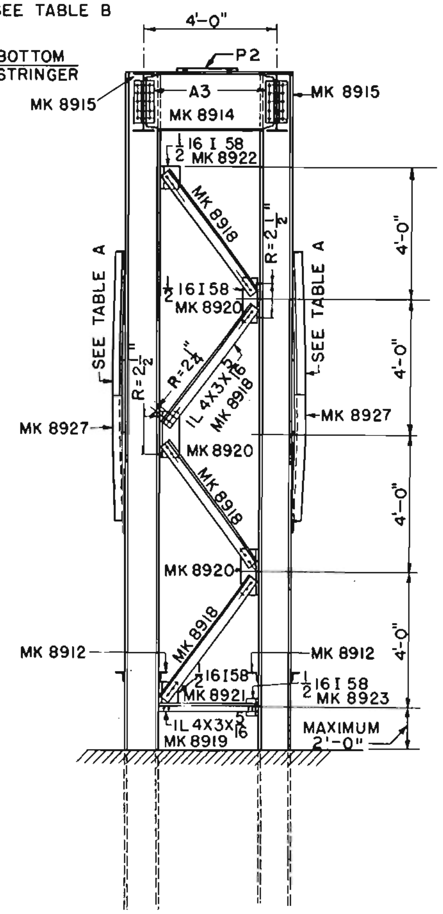


DIAGRAM
SHOWING HEIGHT AND SPAN LIMITATIONS



SIX-PILE PIER



SECTION 1-1

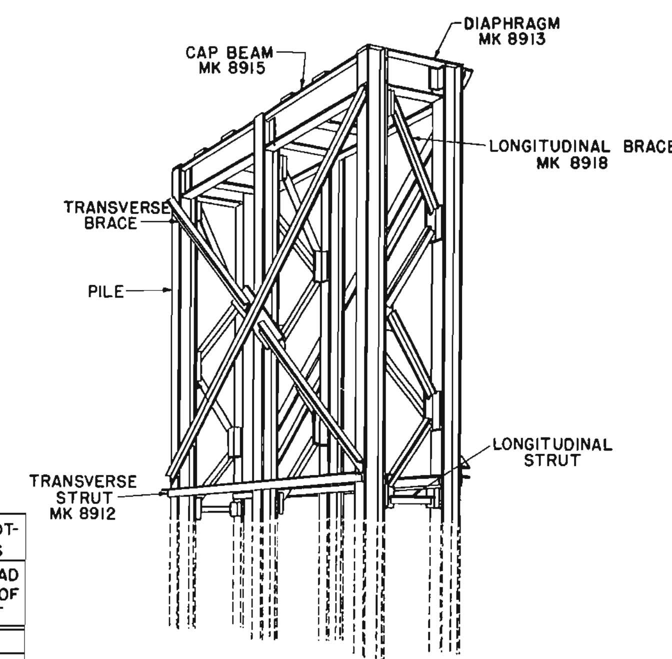
MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
110	32
120	34
130	35
140	37
150	39
160	40
170	42
180	44

TABLE A

PIER HEIGHT A	TRANSVERSE BRACE MARK	
8'-0"	8950	8951
10'-0"	8949	8952
12'-0"	8948	8953
14'-0"	8947	8954
16'-0"	8946	8955
18'-0"	8945	8956
20'-0"	8944	8957

TABLE B

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGER FOR VARIOUS SPANS		
SPAN	STEEL-STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER T
15'-0"	18 I 47	2'-6 7/8"
20'-0"	21 I 59	2'-9 7/8"
30'-0"	24 I 74	3'-0 7/8"
40'-0"	27 I 91	3'-3 7/8"
50'-0"	33 I 125	3'-10"
60'-0"	33 I 132	3'-10 1/8"
70'-0"	36 I 150	4'-0 7/8"
80'-0"	36 I 182	4'-1 3/8"
90'-0"	36 I 230	4'-0 7/8"



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS	76
STEEL PILE BENTS AND PIERS	77
STEEL PILE BENTS AND PIERS	79
STEEL PILE BENTS AND PIERS	80

BILL OF MATERIALS FOR ONE RIVETED PILE BENT OR PIER

LINE	USE	DESCRIPTION: STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	STEEL PILE BENT HEIGHT (SEE SHEET 76) 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY	STEEL PILE PIER HEIGHT (SEE SHEET 77) 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY	LINE
1	CAP BEAM	48-2900.21-059	8195	21 I 59	11'-2"	659									4	4	4	4	4	4	4	4	1
2	DO	48-3790.18-43	8917	18 [42.7	24'-0"	1025	2	2	2	2	2	2	2	2									2
3	DIAPHRAGM		8911	12X12 I 53	1'-3"	66	4	4	4	4	4	4	4	4									3
4	DO	48-2900.21-059	8913	21 I 59	2'-11 5/8"	175									2	2	2	2	2	2	2	2	4
5	DO	48-2900.21-059	8914	21 I 59	3'-11"	231									4	4	4	4	4	4	4	4	5
6	CONNECTION ANGLE	48-2550.4-035	A2	L4X3X5/16	1'-3"	9									16	16	16	16	16	16	16	16	6
7	DO	48-2550.4-035	A3	L4X3X5/16	1'-3"	9									24	24	24	24	24	24	24	24	7
8	CONNECTOR	48-2900.16-058	8920	1/2 16 I 58	1'-6 1/2"	45									9	6	6	3	3				8
9	DO	48-2900.16-058	8921	1/2 16 I 58	0'-10 1/8"	24									3	3	3	3	3	3	3		9
10	DO	48-2900.16-058	8922	1/2 16 I 58	0'-8 3/4"	21									3	3	3	3	3	3	3		10
11	DO	48-2900.16-058	8923	1/2 16 I 58	0'-6"	15									3	3	3	3	3	3	3		11
12	DO	47-7844.04	8927	PL5 1/2X3/8	4'-0"	40									2	2	2	2	2	2	2		12
13	BEARING PLATE	47-7844.07	P1	PL 18 X 3/4	1'-7"	73	6	6	6	6	6	6	6	6									13
14	DO	47-7844.07	P2	PL 10 X 3/4	1'-7"	40									6	6	6	6	6	6	6	6	14
15	STRUTS AND BRACES	48-2550.4-035	8912	L4X3X5/16	23'-6"	169									4	4	4	4	4	4	4		15
16	DO	48-2550.4-035	8916	L4X3X5/16	23'-6"	170	2	2	2	2	2	2	2										16
17	DO	48-2550.4-035	8918	L4X3X5/16	4'-1 11/16"	30									12	9	9	6	6	3	3		17
18	DO	48-2550.4-035	8919	L4X3X5/16	2'-9 1/4"	20									3	3	3	3	3	3	3		18
19	DO	48-2550.4-035	8944	L4X3X5/16	28'-5"	205	2								2								19
20	DO	48-2550.4-035	8945	L4X3X5/16	27'-4"	197		2								2							20
21	DO	48-2550.4-035	8946	L4X3X5/16	26'-4"	190			2								2						21
22	DO	48-2550.4-035	8947	L4X3X5/16	25'-6"	184				2								2					22
23	DO	48-2550.4-035	8948	L4X3X5/16	24'-10"	179					2								2				23
24	DO	48-2550.4-035	8949	L4X3X5/16	24'-3"	175						2								2			24
25	DO	48-2550.4-035	8950	L4X3X5/16	23'-10"	172							2								2		25
26	DO	48-2550.4-035	8951	L4X3X5/16	11'-0"	79															4		26
27	DO	48-2550.4-035	8952	L4X3X5/16	11'-4"	82														4			27
28	DO	48-2550.4-035	8953	L4X3X5/16	11'-10"	86													4				28
29	DO	48-2550.4-035	8954	L4X3X5/16	12'-4"	89												4					29
30	DO	48-2550.4-035	8955	L4X3X5/16	12'-10"	93											4						30
31	DO	48-2550.4-035	8956	L4X3X5/16	13'-4"	96										4							31
32	DO	48-2550.4-035	8957	L4X3X5/16	13'-9"	99									4								32
33	RIVET	43-6353.08-2		7/8	2"	.53									24	24	24	24	24	24	24	24	33
34	DO	43-6353.08-23		7/8	2 1/4"	.57	40	40	40	40	40	40	40		260	248	248	236	236	224	224	128	34
35	DO	43-6353.08-25		7/8	2 1/2"	.62	112	112	112	112	112	112	112	112	216	192	192	168	168	144	144	104	35
36	DO	43-6353.08-3		7/8	3"	.70	24	24	24	24	24	24	24	24									36
37	PILE			12X12 I 53	1		4	4	4	4	4	4	4	4	6	6	6	6	5	6	6	6	37

1 PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS.

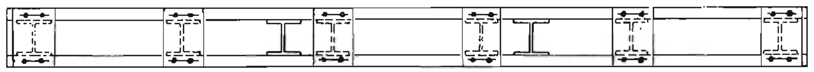
BILL OF MATERIALS FOR ONE WELDED PILE BENT OR PIER

LINE	USE	DESCRIPTION: STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	STEEL PILE BENT HEIGHT (SEE SHEET 79) 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY	STEEL PILE PIER HEIGHT (SEE SHEET 80) 20' QUANTITY	18' QUANTITY	16' QUANTITY	14' QUANTITY	12' QUANTITY	10' QUANTITY	8' QUANTITY	UNDER 8' QUANTITY
1	CAP BEAM	48-3790.18-43	7023	18 [42.7	24'-0"	1025	2	2	2	2	2	2	2	2								
2	DO	48-2900.21-059	7043	21 I 59	23'-2 1/4"	1368									2	2	2	2	2	2	2	2
3	DIAPHRAGM		7024	12X12 I 53	1'-3"	66	4	4	4	4	4	4	4	4								
4	DO	48-2900.21-059	7044	21 I 59	3'-11 5/8"	234									6	6	6	6	6	6	6	6
5	BOLTING CLIP	47-7844.04	P7	PL 3 X 3/8	0'-4 1/16"	1									24	24	24	24	24	24	24	24
6	BEARING PLATE	47-7844.07	P3	PL 15 X 3/4	1'-7"	60	6	6	6	6	6	6	6	6								
7	DO	47-7844.07	P4	PL 10 X 3/4	1'-7"	40									6	6	6	6	6	6	6	6
8	PILE CAP			1/2 12X12 I 53	1'-0"	26									6	6	6	6	6	6	6	6
9	CONNECTOR	47-7844.05	8659	PL 8 X 1/2	1'-6"	20									9	6	6	3	3			
10	DO	47-7844.05	8660	PL 8 X 1/2	1'-0"	14									6	6	6	6	6	6	6	
11	DO	47-7844.05	8661	PL 6 X 1/2	0'-6"	7									3	3	3	3	3	3	3	
12	DO	47-7844.04	7045	PL 5 1/2 X 3/8	3'-9"	26									2	2	2	2	2	2	2	
13	SHELF ANGLE	48-2550.4-035	8647	L 4X3X5/16	0'-4"	2	4	4	4	4	4	4	4	4								
14	STRUTS AND BRACES	48-2550.4-035	7026	L 4X3X5/16	28'-5"	205	2								2							
15	DO	48-2550.4-035	7025	L 4X3X5/16	23'-6"	169	2	2	2	2	2	2	2		4	4	4	4	4	4	4	
16	DO	48-2550.4-035	7027	L 4X3X5/16	27'-4"	197		2								2						
17	DO	48-2550.4-035	7028	L 4X3X5/16	26'-4"	190			2								2					
18	DO	48-2550.4-035	7029	L 4X3X5/16	25'-6"	184				2								2				
19	DO	48-2550.4-035	7030	L 4X3X5/16	24'-10"	179					2								2			
20	DO	48-2550.4-035	7031	L 4X3X5/16	24'-3"	175						2								2		
21	DO	48-2550.4-035	7032	L 4X3X5/16	23'-10"	172							2								2	
22	DO	48-2550.4-035	7035	L 4X3X5/16	13'-9"	99									4							
23	DO	48-2550.4-035	7036	L 4X3X5/16	13'-4"	96										4						
24	DO	48-2550.4-035	7037	L 4X3X5/16	12'-10"	93											4					
25	DO	48-2550.4-035	7038	L 4X3X5/16	12'-4"	89												4				
26	DO	48-2550.4-035	7039	L 4X3X5/16	11'-10"	86													4			
27	DO	48-2550.4-035	7040	L 4X3X5/16	11'-4"	82														4		
28	DO	48-2550.4-035	7041	L 4X3X5/16	11'-0"	79															4	
29	DO	48-2550.4-035	8613	L 4X3X5/16	4'-1 13/16"	30									12	9	9	6	6	3	3	
30	DO	48-2550.4-035	8622	L 4X3X5/16	2'-9 1/4"	20									3	3	3	3	3	3	3	
31	WELDING ROD (POUNDS)	46-3772.2-7		3/16			17	17	17	17	17	17	17	12	40	37	37	34	34	31	31	20
32	PILE			12X12 I 53	1		4	4	4	4	4	4	4	4	6	6	6	6	6	6	6	6

1 PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS.

COMPANION SHEETS

	SHEET
BILL OF MATERIALS	78
FABRICATION DRAWING	151
GENERAL NOTES	154
SYMBOLS	155
SHIMS	63



PLAN

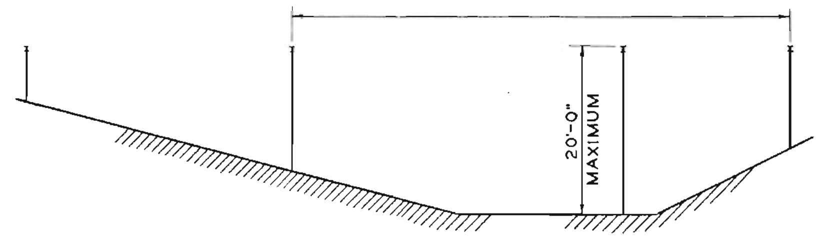
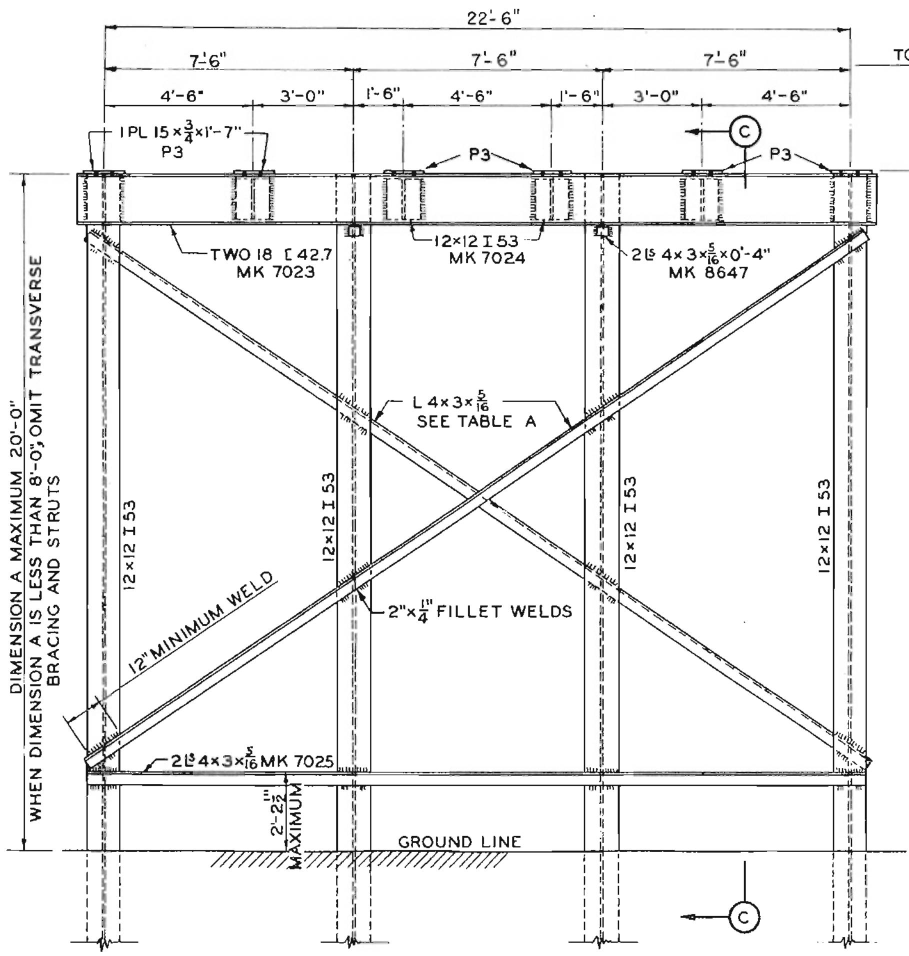
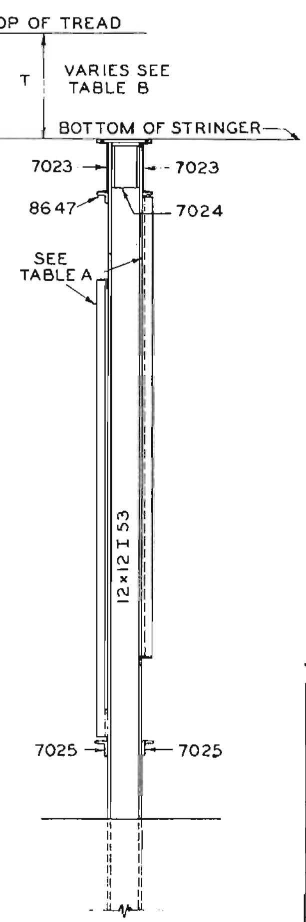


DIAGRAM
SHOWING HEIGHT AND SPAN LIMITATIONS

ALL WELDS SHOWN ARE $\frac{1}{4}$" FILLET WELDS UNLESS OTHERWISE NOTED



FOUR PILE BENT



SECTION C-C

MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
30'	20
40'	23
50'	25
60'	28
70'	30
80'	33
90'	35
100'	38

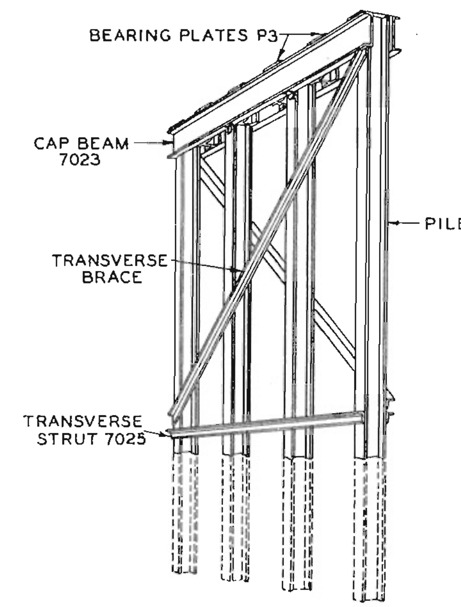
TABLE A

BENT HEIGHT A	TRANSVERSE BRACE MARK
8'-0"	7032
10'-0"	7031
12'-0"	7030
14'-0"	7029
16'-0"	7028
18'-0"	7027
20'-0"	7026

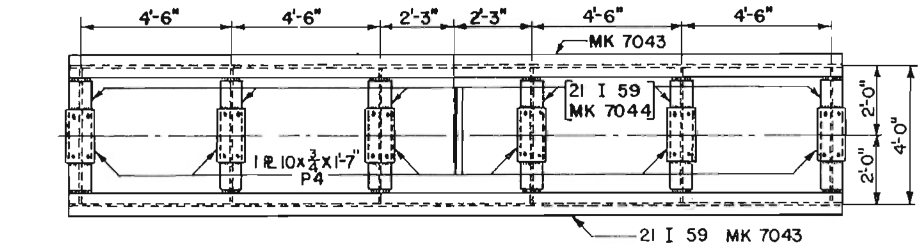
TABLE B

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS

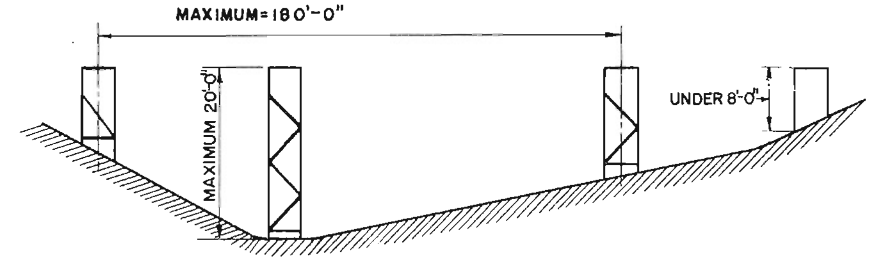
SPAN	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER T
15'-0"	18 I 47	2'-6 $\frac{7}{8}$"
20'-0"	21 I 59	2'-9 $\frac{7}{8}$"
30'-0"	24 I 74	3'-0 $\frac{7}{8}$"
40-0"	24 I 91	3'-3 $\frac{7}{8}$"
50'-0"	33 I 125	3'-10"
60'-0"	33 I 132	3-10 $\frac{1}{8}$"
70'-0"	36 I 150	4'-0 $\frac{7}{8}$"
80'-0"	36 I 182	4'-1 $\frac{3}{8}$"
90'-0"	36 I 230	4'-0 $\frac{7}{8}$"



ASSEMBLED VIEW



TOP PLAN



DIAGRAM

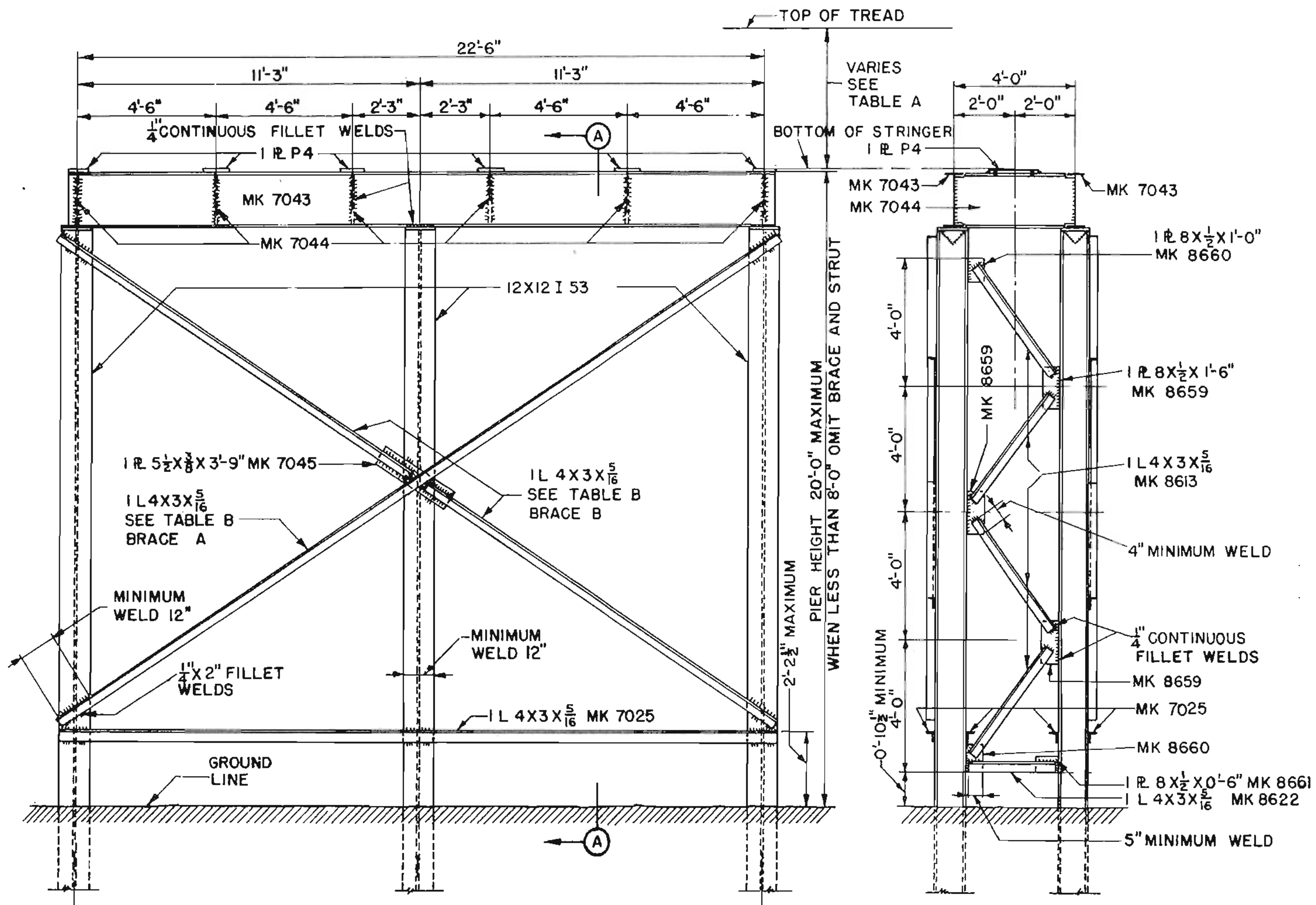
SHOWING HEIGHT AND SPAN LIMITATIONS

PILE PIER

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	78
FABRICATION DRAWING	151
SHIMS	63

ALL WELDS SHOWN ARE 1/4" FILLET WELDS UNLESS OTHERWISE NOTED



TRANSVERSE ELEVATION

SECTION A-A

SIX PILE PIER

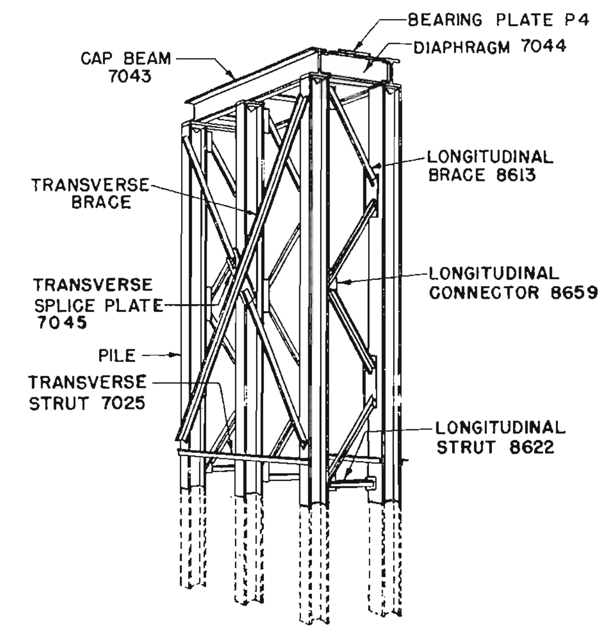
TABLE A

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS		
SPAN	STEEL-STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER
50'-0"	33 I 125	3'-10"
60'-0"	33 I 132	3'-10 1/8"
70'-0"	36 I 150	4'-0 7/8"
80'-0"	36 I 182	4'-1 3/8"
90'-0"	36 I 230	4'-0 7/8"

TABLE B

PIER HEIGHT	TRANSVERSE	
	BRACE A	BRACE B
20'-0"	MK 7026	MK 7035
18'-0"	MK 7027	MK 7036
16'-0"	MK 7028	MK 7037
14'-0"	MK 7029	MK 7038
12'-0"	MK 7030	MK 7039
10'-0"	MK 7031	MK 7040
8'-0"	MK 7032	MK 7041

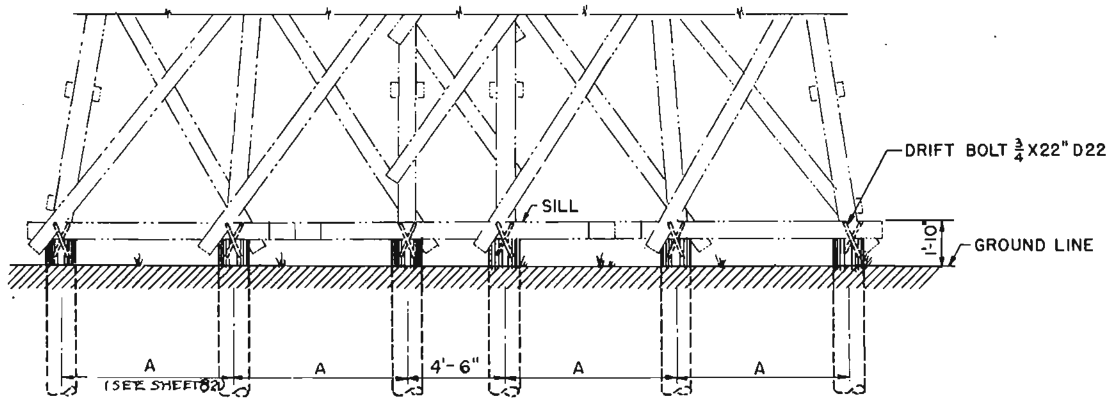
MAXIMUM PILE LOADS	
TOTAL LOADED LENGTH	TONS PER PILE
110'-0"	32
120'-0"	34
130'-0"	35
140'-0"	37
150'-0"	39
160'-0"	40
170'-0"	42
180'-0"	44



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	82



TRANSVERSE ELEVATION

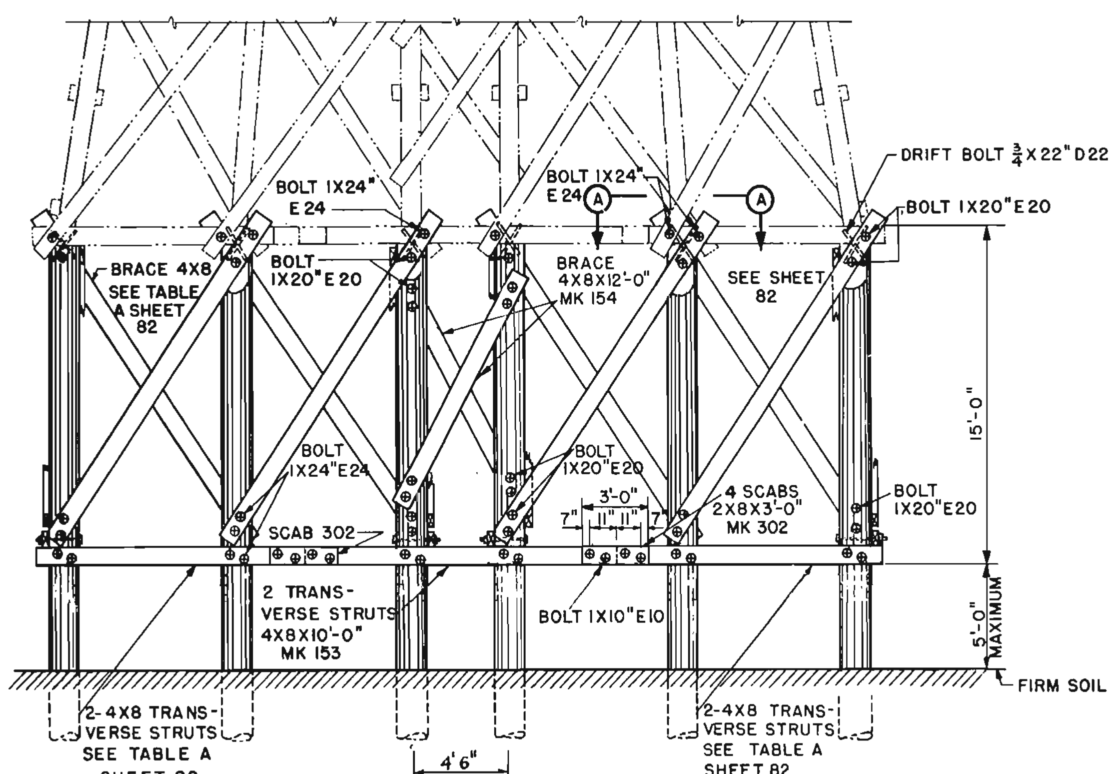
PILE FOUNDATION ON GROUND

MAXIMUM HEIGHT OF STRUCTURE GRADE TO GROUND = 80 FEET

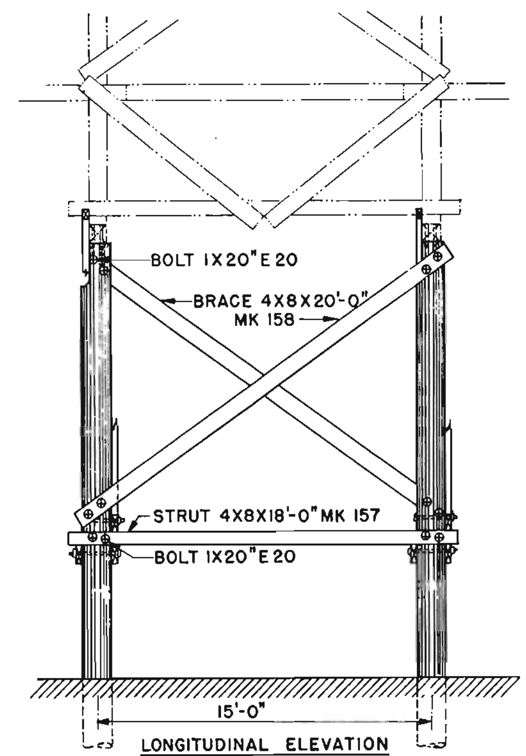
REQUIRED BEARING CAPACITY OF PILES 18 TONS PER PILE

FOR SECTION A-A SEE SHEET 82

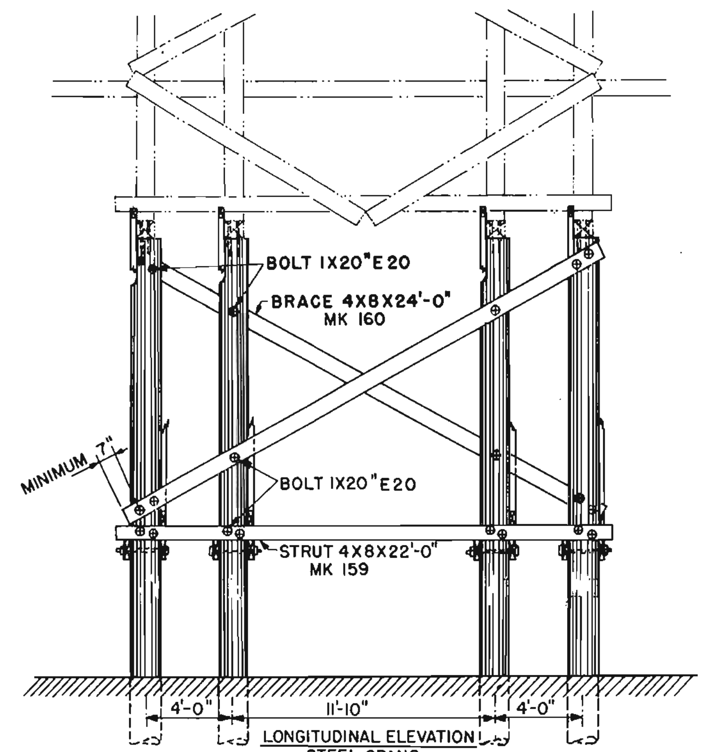
FOR DETAIL OF TRANSVERSE STRUT SPLICE, SEE SHEET 82



TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION TIMBER SPANS

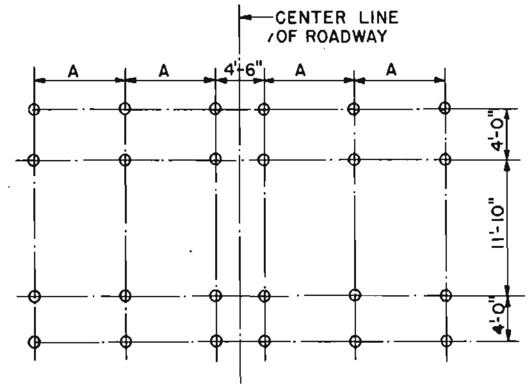


LONGITUDINAL ELEVATION STEEL SPANS

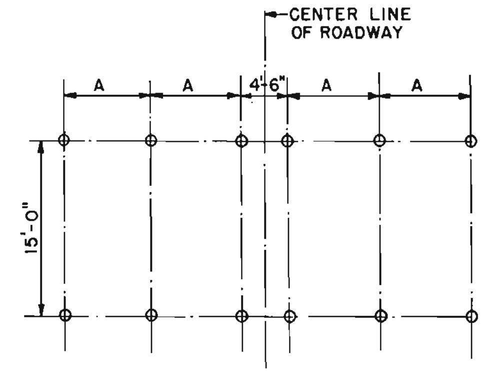
PILE FOUNDATION IN WATER

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER SILL, TIMBER PILES	81



STEEL SPANS

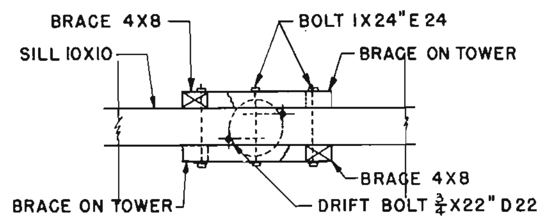


TIMBER SPANS

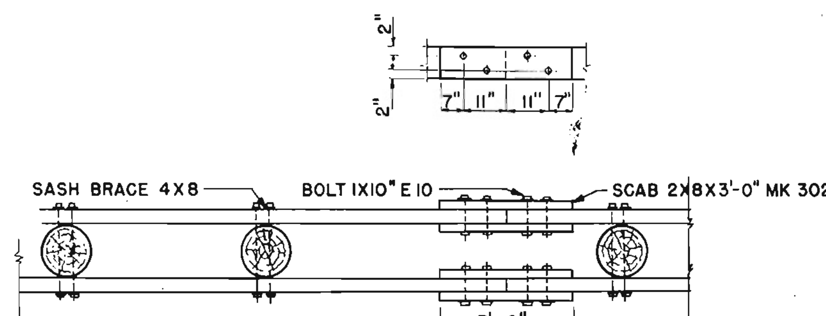
PILE ARRANGEMENT PLANS

REQUIRED BEARING CAPACITY OF PILES
18 TONS PER PILE

TOWER HEIGHT	DIMENSION A
13'-4"	5'-5$\frac{5}{8}$"
16'	5'-8"
18'	5'-10"
20'	6'-0"
22'	6'-2"
24'	6'-4"
25'-10"	6'-6$\frac{1}{8}$"
28'	6'-8"
30'	6'-10"
32'	7'-0"
34'	7'-2"
36'	7'-4"
38'-4"	7'-6$\frac{5}{8}$"
40'	7'-8"
42'	7'-10"
44'	8'-0"
46'	8'-2"
48'	8'-4"
50'-10"	8'-7$\frac{1}{8}$"
53'	8'-9"
55'	8'-11"
57'	9'-1"
59'	9'-3"
61'	9'-5"
63'-4"	9'-7$\frac{5}{8}$"
65'	9'-9"
67'	9'-11"
69'	10'-1"
71'	10'-3"
73'	10'-5"
75'-10"	10'-8$\frac{1}{8}$"



SECTION A-A



PLAN

DETAIL OF TRANSVERSE STRUT SPLICE

TABLE A

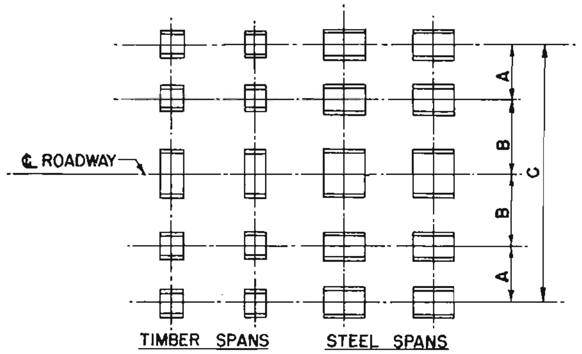
LENGTH OF 4X8 TRANSVERSE BRACING				
TOWER HEIGHT	BRACE		STRUT	
	LENGTH	MARK	LENGTH	MARK
15' TO 21'	16'-0"	156	10'-0"	153
23' TO 32'	18'-0"	157	12'-0"	154
34' TO 44'	18'-0"	157	14'-0"	155
46' TO 57'	18'-0"	157	16'-0"	156
59' TO 69'	20'-0"	158	18'-0"	157
71' TO 75	20'-0"	158	20'-0"	158

BILL OF MATERIALS MATERIALS FOR FOUNDATIONS UNDER ONE TOWER

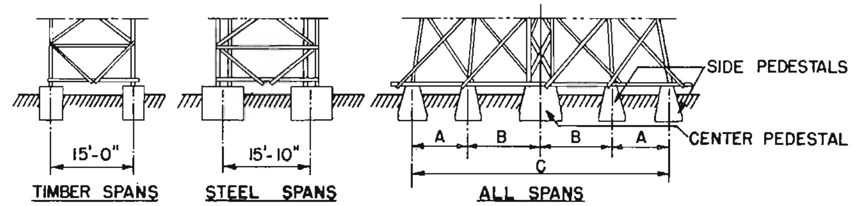
LINE	DESCRIPTION	STOCK NO.	MARK	SIZE	LENGTH	UNIT WEIGHT	12 PILE FOUNDATION		24 PILE FOUNDATION	
							QUANTITY	WEIGHT	QUANTITY	WEIGHT
1	PILE						12		24	
2	DRIFT BOLT	43-1636.07-22	D 22	$\frac{3}{4}$	22"	3	24	72	48	144

COMPANION SHEETS

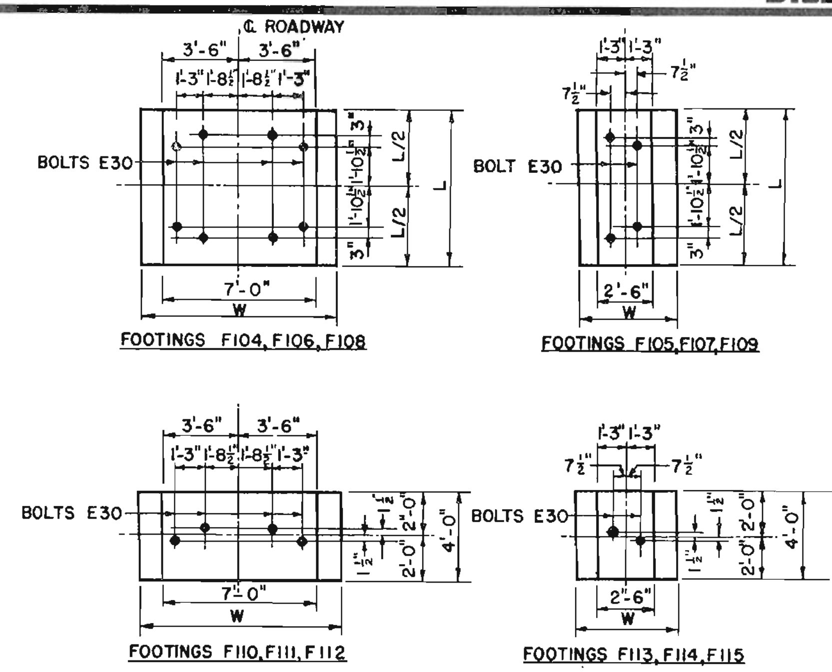
	SHEET
GENERAL NOTES	154
SYMBOLS	155



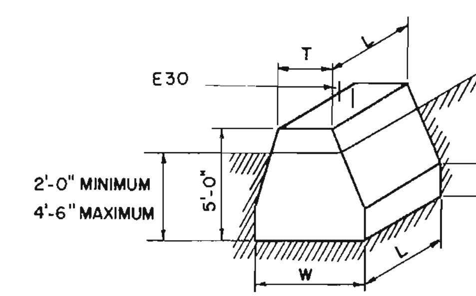
PLAN OF CONCRETE PEDESTALS



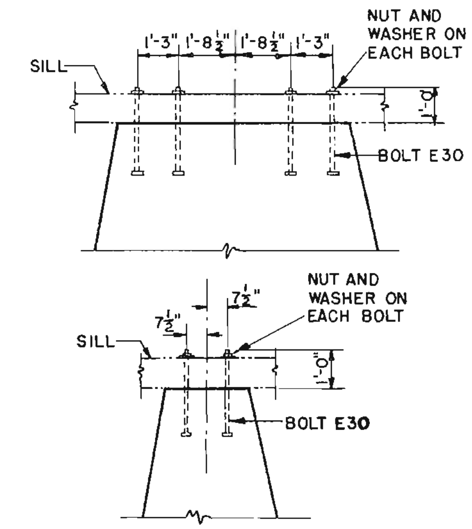
LONGITUDINAL ELEVATIONS TRANSVERSE ELEVATION



ANCHOR BOLT SETTING PLANS
FRAMED TIMBER TOWERS FOR HIGHWAY SPANS



CONCRETE PEDESTAL



TYPICAL ANCHOR BOLT DETAILS

CONCRETE PEDESTALS

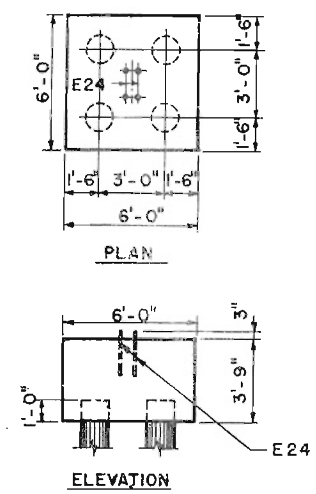
STORY	TOWER HEIGHT	A	B	C	FOOTING MARK: TIMBER SPAN 15': END PEDESTAL	TIMBER SPAN 15': CENTER PEDESTAL	STEEL SPANS 15' TO 90': END PEDESTAL	STEEL SPANS 15' TO 90': CENTER PEDESTAL
1	13'-4"	5'-5 5/8"	7'-8 1/8"	26'-4 1/2"	F 115	F 112	F 109	F 108
2	16'-0"	5'-8"	7'-11"	27'-2"	F 115	F 112	F 109	F 108
	18'-0"	5'-10"	8'-1"	27'-10"	F 115	F 112	F 109	F 108
	20'-0"	6'-0"	8'-3"	28'-6"	F 115	F 112	F 109	F 108
	22'-0"	6'-2"	8'-5"	29'-2"	F 115	F 112	F 109	F 108
	24'-0"	6'-4"	8'-7"	29'-10"	F 115	F 112	F 109	F 108
	25'-10"	6'-6 1/8"	8'-9 1/8"	30'-6 1/2"	F 115	F 112	F 109	F 108
3	28'-0"	6'-8"	8'-11"	31'-2"	F 115	F 112	F 109	F 106
	30'-0"	6'-10"	9'-1"	31'-10"	F 115	F 112	F 109	F 106
	32'-0"	7'-0"	9'-3"	32'-6"	F 115	F 112	F 107	F 106
	34'-0"	7'-2"	9'-5"	33'-2"	F 115	F 112	F 107	F 106
	36'-0"	7'-4"	9'-7"	33'-10"	F 115	F 112	F 107	F 106
	38'-4"	7'-6 5/8"	9'-9 5/8"	34'-8 1/2"	F 115	F 112	F 107	F 106
4	40'-0"	7'-8"	9'-11"	35'-2"	F 114	F 111	F 107	F 106
	42'-0"	7'-10"	10'-1"	35'-10"	F 114	F 111	F 107	F 106
	44'-0"	8'-0"	10'-3"	36'-6"	F 114	F 111	F 107	F 106
	46'-0"	8'-2"	10'-5"	37'-2"	F 114	F 111	F 107	F 106
	48'-0"	8'-4"	10'-7"	37'-10"	F 114	F 111	F 107	F 106
	50'-10"	8'-7 1/8"	10'-10 1/8"	38'-10 1/2"	F 114	F 111	F 107	F 106
5	53'-0"	8'-9	11'-0"	39'-6"	F 114	F 111	F 107	F 104
	55'-0"	8'-11"	11'-2"	40'-2"	F 114	F 111	F 107	F 104
	57'-0"	9'-1"	11'-4"	40'-10"	F 114	F 111	F 107	F 104
	59'-0"	9'-3"	11'-6"	41'-6"	F 114	F 111	F 105	F 104
	61'-0"	9'-5"	11'-8"	42'-2"	F 113	F 110	F 105	F 104
	63'-4"	9'-7 5/8"	11'-10 5/8"	43'-0 1/2"	F 113	F 110	F 105	F 104
6	65'-0"	9'-9"	12'-0"	43'-6"	F 113	F 110	F 105	F 104
	67'-0"	9'-11"	12'-2"	44'-2"	F 113	F 110	F 105	F 104
	69'-0"	10'-1"	12'-4"	44'-10"	F 113	F 110	F 105	F 104
	71'-0"	10'-3"	12'-6"	45'-6"	F 113	F 110	F 105	F 104
	73'-0"	10'-5"	12'-8"	46'-2"	F 113	F 110	F 105	F 104
	75'-10"	10'-8 1/8"	12'-11 1/8"	47'-2 1/2"	F 113	F 110	F 105	F 104

TABLE OF DIMENSIONS AND
BILL OF MATERIALS FOR ONE PEDESTAL

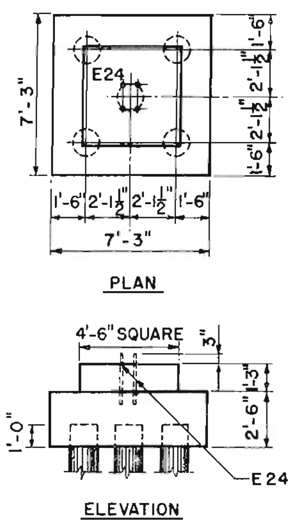
MARK	WIDTH (W)	TOP WIDTH (T)	LENGTH (L)	CONCRETE (CUBIC YARDS MAXIMUM)	MACHINE BOLT 1X30" E30 WITH SQUARE NUT AND TWO WASHERS STOCK NO 43-2325.1-30: QUANTITY	POUNDS
F104	9'-0"	7'-0"	7'-6"	11.4	8	62
F105	5'-6"	2'-6"	7'-6"	6.0	4	31
F106	8'-6"	7'-0"	7'-0"	10.2	8	62
F107	5'-0"	2'-6"	7'-0"	5.2	4	31
F108	8'-0"	7'-0"	6'-6"	9.1	8	62
F109	4'-6"	2'-6"	6'-6"	4.5	4	31
F110	9'-0"	7'-0"	4'-0"	6.1	4	31
F111	8'-6"	7'-0"	4'-0"	5.9	4	31
F112	8'-0"	7'-0"	4'-0"	5.6	4	31
F113	5'-0"	2'-6"	4'-0"	3.0	2	16
F114	4'-6"	2'-6"	4'-0"	2.7	2	16
F115	4'-0"	2'-6"	4'-0"	2.5	2	16

COMPANION SHEETS

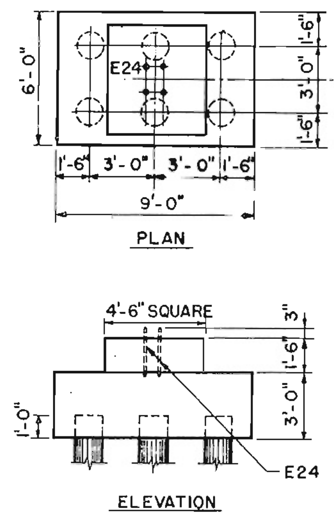
	SHEET
GENERAL NOTES	154
SYMBOLS	155



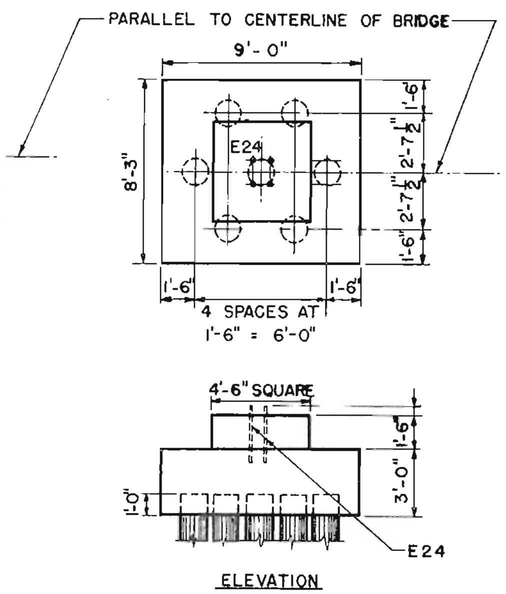
F134
4-PILE FOOTING



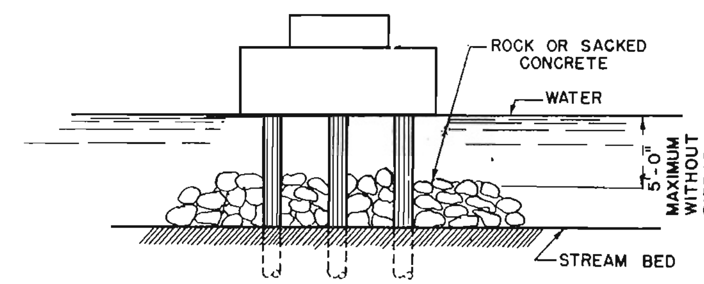
F135
5-PILE FOOTING



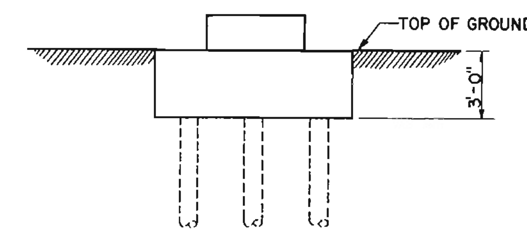
F136
6-PILE FOOTING



F137
7-PILE FOOTING



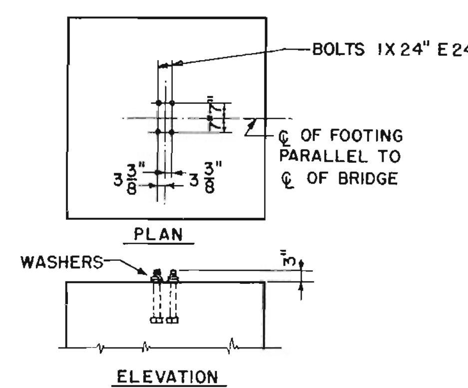
TYPICAL ELEVATION
FOOTINGS IN WATER



TYPICAL ELEVATION
FOOTINGS IN SOIL

BILL OF MATERIALS FOR ONE FOOTING PILE BEARING CAPACITY 18 TONS

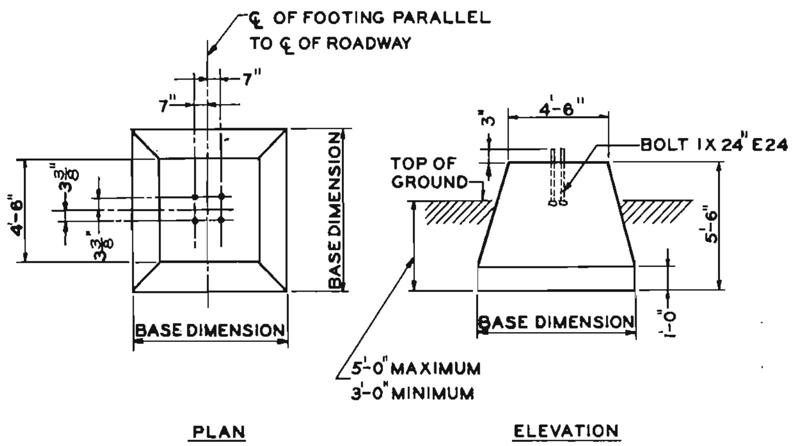
ADJACENT SPAN (FEET)	HEIGHT OF TOWER	FOOTING MARK NUMBER	NUMBER OF PILES	CONCRETE (CUBIC YARDS)	MACHINE BOLT 1 X 24" E24 WITH SQUARE NUT AND TWO WASHERS. STOCK NUMBER 43-2325.1-24	
					QUANTITY	POUNDS EACH
15'	57' OR LOWER	F 134	4	5.0	4	6.5
	59' TO 77'	F 135	5	5.8	4	6.5
20'	57' OR LOWER	F 134	4	5.0	4	6.5
	59' TO 77'	F 135	5	5.8	4	6.5
30'	57' OR LOWER	F 134	4	5.0	4	6.5
	59' TO 77'	F 135	5	5.8	4	6.5
40'	39' OR LOWER	F 134	4	5.0	4	6.5
	41' TO 77'	F 135	5	5.8	4	6.5
50'	21' OR LOWER	F 134	4	5.0	4	6.5
	23' TO 77'	F 135	5	5.8	4	6.5
60'	57' OR LOWER	F 135	5	5.8	4	6.5
	59' TO 77'	F 136	6	7.1	4	6.5
70'	39' OR LOWER	F 135	5	5.8	4	6.5
	41' TO 77'	F 136	6	7.1	4	6.5
80'	21' OR LOWER	F 135	5	5.8	4	6.5
	23' TO 77'	F 136	6	7.1	4	6.5
90'	57' OR LOWER	F 136	6	7.1	4	6.5
	59' TO 77'	F 137	7	9.3	4	6.5



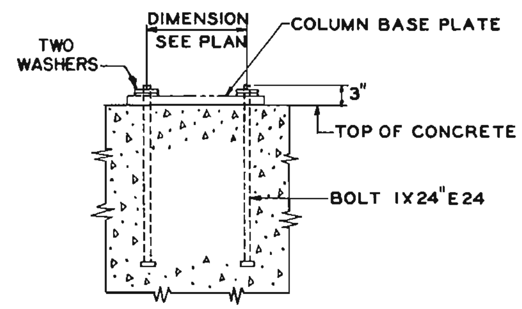
ANCHOR BOLT DETAIL

COMPANION SHEETS

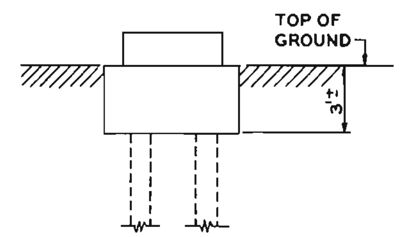
	SHEET
GENERAL NOTES	154
SYMBOLS	155
CONCRETE FOOTINGS	84
FRAMED STEEL TOWERS	55,56



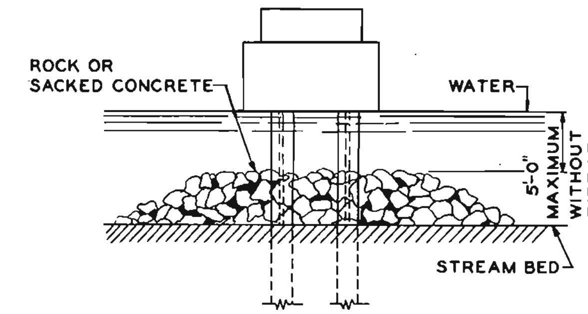
CONCRETE PEDESTALS



TYPICAL ANCHOR BOLT DETAIL



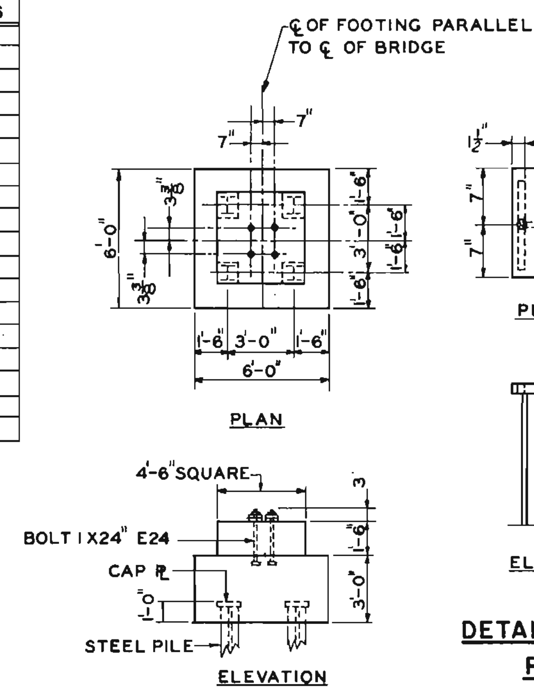
FOOTINGS IN SOIL



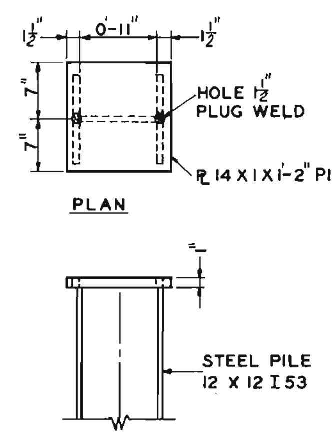
FOOTINGS IN WATER

TABLE OF DIMENSIONS AND BILL OF MATERIALS FOR ONE PEDESTAL WITHOUT PILES

ADJACENT SPAN (FEET)	HEIGHT OF TOWER	MARK	BASE DIMENSION (FEET)	CONCRETE (CUBIC YARDS)	MACHINE BOLT 1X24", SQUARE NUT AND TWO WASHERS STOCK NO 43-2325.100-240 QUANTITY	POUNDS
15	39' OR LOWER	F 121	7-0	7.4	4	26
	41' TO 77'	F 122	8-0	9.1	4	26
20	21' OR LOWER	F 121	7-0	7.4	4	26
	23' TO 77'	F 122	8-0	9.1	4	26
30	21' OR LOWER	F 121	7-0	7.4	4	26
	23' TO 77'	F 122	8-0	9.1	4	26
40	57' OR LOWER	F 122	8-0	9.1	4	26
	59' TO 77'	F 123	9-0	10.8	4	26
50	57' OR LOWER	F 122	8-0	9.1	4	26
	59' TO 77'	F 123	9-0	10.8	4	26
60	39' OR LOWER	F 122	8-0	9.1	4	26
	41' TO 77'	F 123	9-0	10.8	4	26
70	21' OR LOWER	F 122	8-0	9.1	4	26
	23' TO 77'	F 123	9-0	10.8	4	26
80	57' OR LOWER	F 123	9-0	10.8	4	26
	59' TO 77'	F 124	10-0	12.9	4	26
90	57' OR LOWER	F 123	9-0	10.8	4	26
	59' TO 77'	F 124	10-0	12.9	4	26



4-PILE FOOTING



DETAIL OF CAP PLATE

REQUIRED BEARING CAPACITY OF PILES, TONS PER PILE, 4-PILE FOOTING

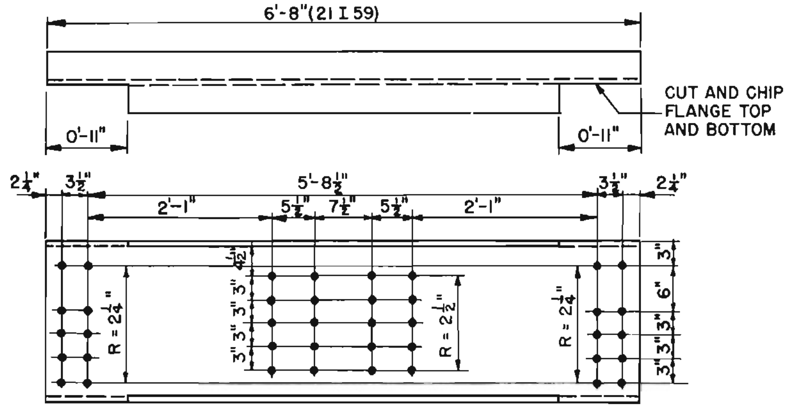
ADJACENT SPAN	HEIGHT OF TOWER 21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
15'	16	18	19	21
20'	17	18	20	22
30'	18	20	22	24
40'	19	21	23	25
50'	20	22	24	26
60'	22	24	26	28
70'	23	25	27	29
80'	24	26	28	31
90'	25	28	30	32

BILL OF MATERIALS FOR ONE FOOTING WITH STEEL PILES

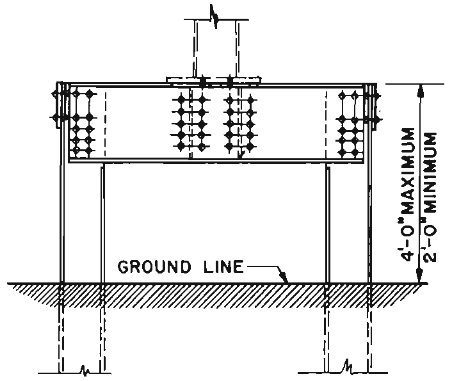
DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	NUMBER OF PIECES	UNIT	AMOUNT
CONCRETE							CU.YDS.	5.1
PILE			12X12 I 53			4		
CAP PLATE	47-7844.1	P1	14X1	1'-2"	55	4		
MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43- 2325100-240	E24	1	24"	6.40	4	POUNDS	26
WELDING ELECTRODE	46-3772.25-5		7/32				POUNDS	4

COMPANION SHEETS

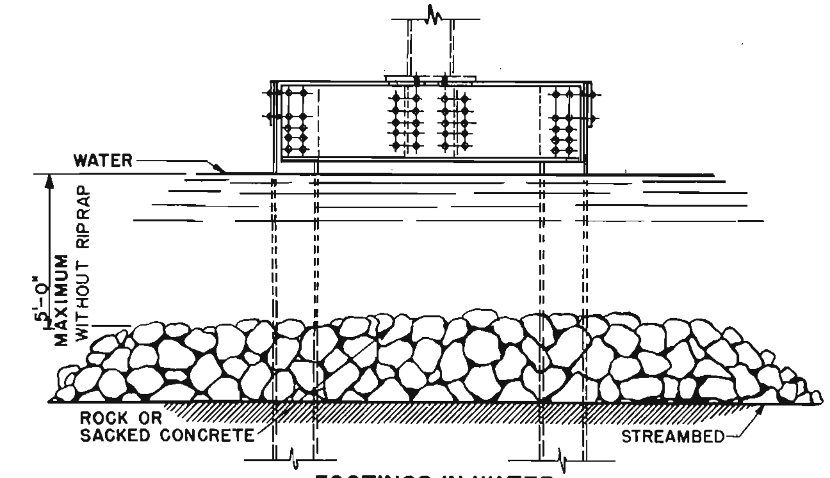
	SHEET
GENERAL NOTES	154
SYMBOLS	155



BEAM MK 9052



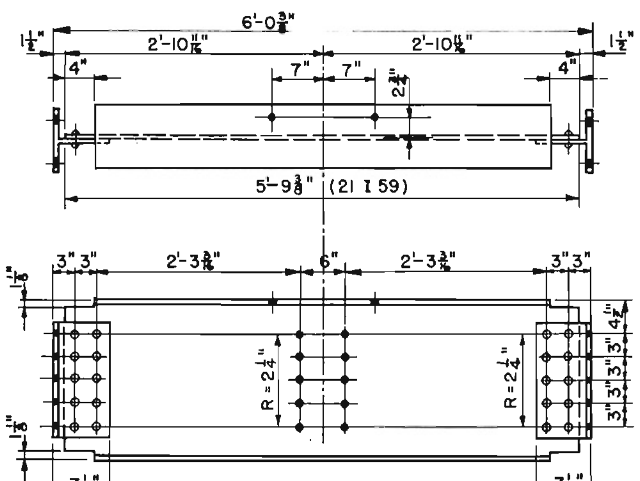
FOOTINGS IN SOIL



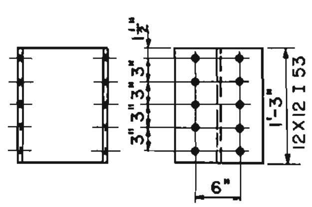
FOOTINGS IN WATER

REQUIRED BEARING CAPACITY OF STEEL PILES, TONS PER PILE

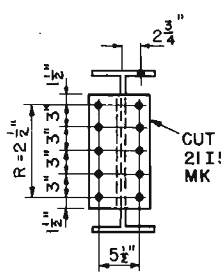
ADJACENT SPAN	HEIGHT OF TOWER			
	21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
15'	16	18	19	21
20'	17	18	20	22
30'	18	20	22	24
40'	19	21'	23	25
50'	20	22	24	26
60'	22	24	26	28
70'	23	25	27	29
80'	24	26	28	31
90'	25	28	30	32

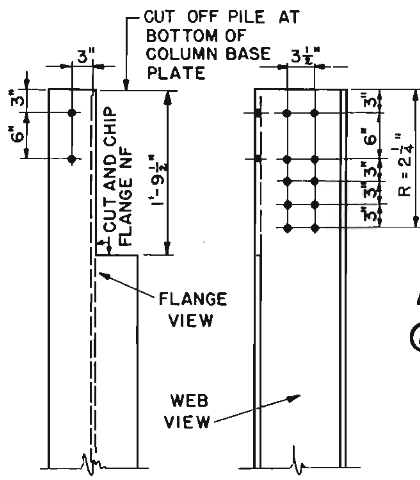


BEAM MK 9051

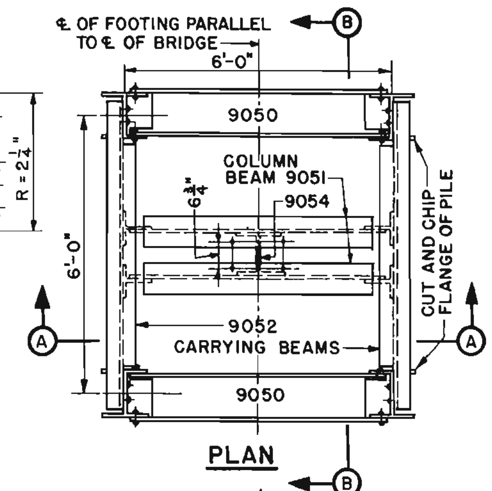


DIAPHRAGM MK 9054

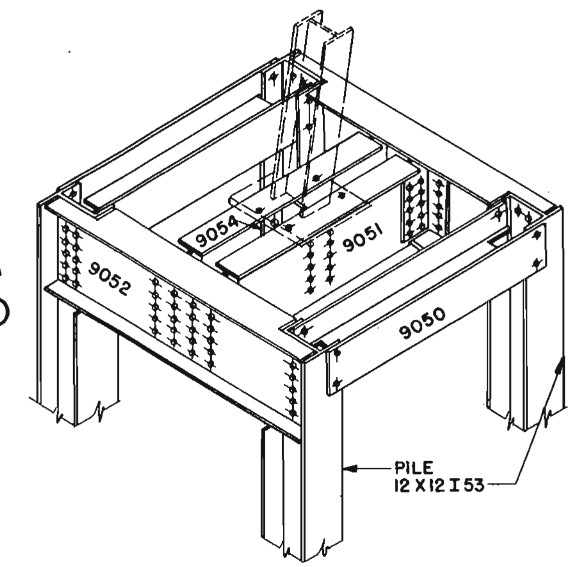




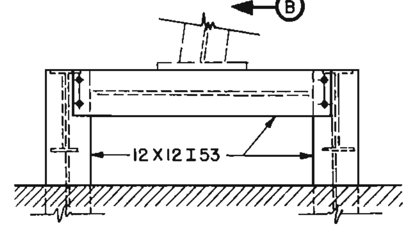
DETAIL AT TOP OF PILE



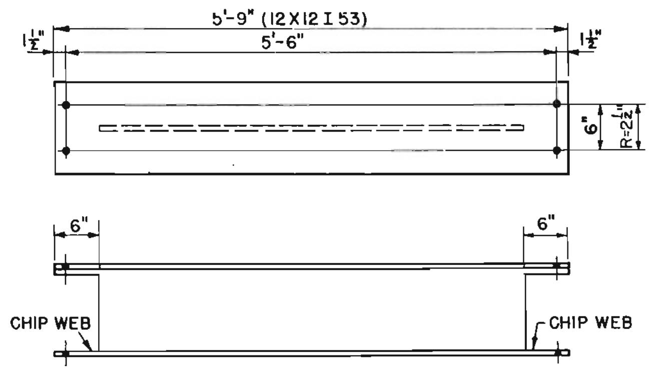
PLAN



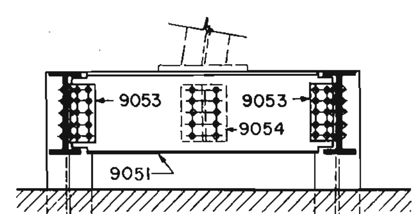
ASSEMBLED VIEW



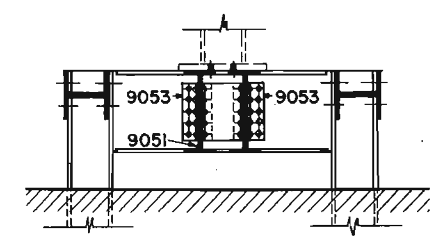
END VIEW



BEAM MK 9050



SECTION A-A

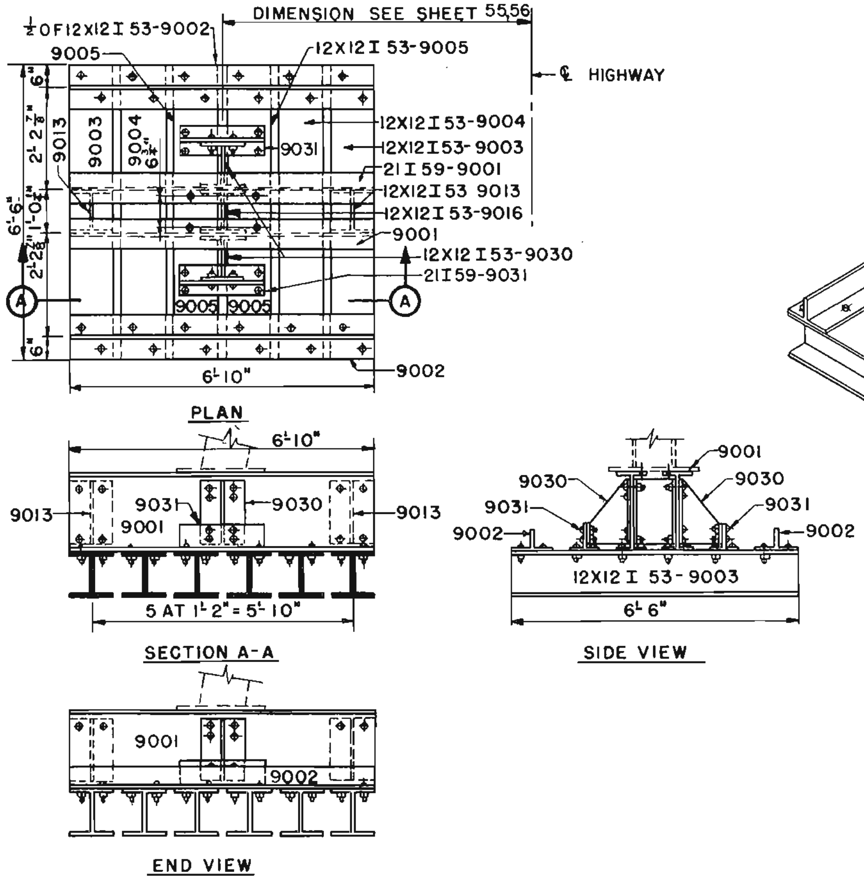


SECTION B-B

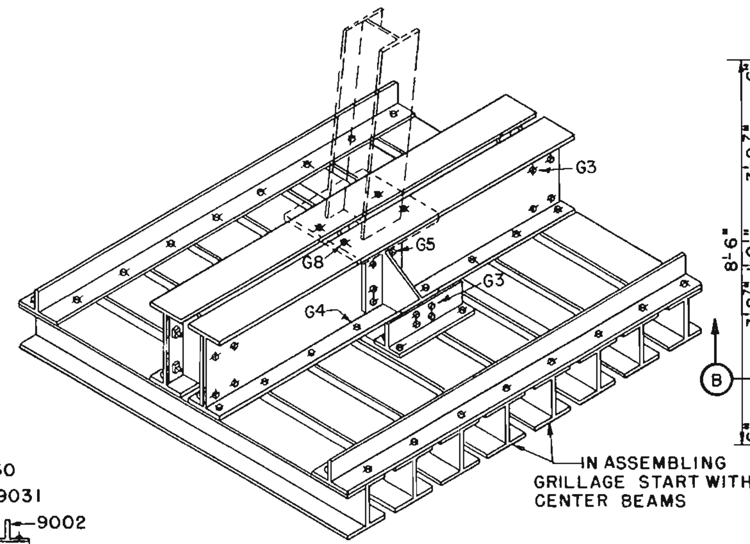
BILL OF MATERIALS FOR ONE FOOTING

	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	QUANTITY
1	PILE			12X12 I 53	—	—	4
2	BEAM	48-2900.21-059	9052	21 I 59	6'-8"	390	2
3	BEAM	48-2900.21-059	9051	21 I 59	5'-9½"	339	2
4	BEAM		9050	12X12 I 53	5'-9"	305	2
5	CONNECTION	48-2900.21-059	9053	21 I 59	1'-3"	34	4
6	DIAPHRAGM		9054	12X12 I 53	1'-3"	66	1
7	RIVET	43-6353.08-25		⅞	2½"	.62	40
8	RIVET	43-6353.08-23		⅞	2¼"	.57	116
9	RIVET BOLT WITH NUT		G8	⅞	3"	1.24	4
10	WASHER, STANDARD, ROUND	43-9215.5-1		2½ X 5/32			4

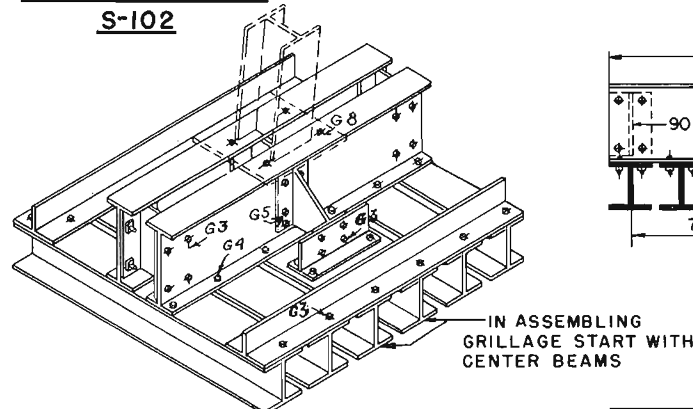
NOTE:
LENGTH OF PILES WILL BE DETERMINED BY CONDITIONS AT SITE AND BEARING CAPACITY REQUIRED.



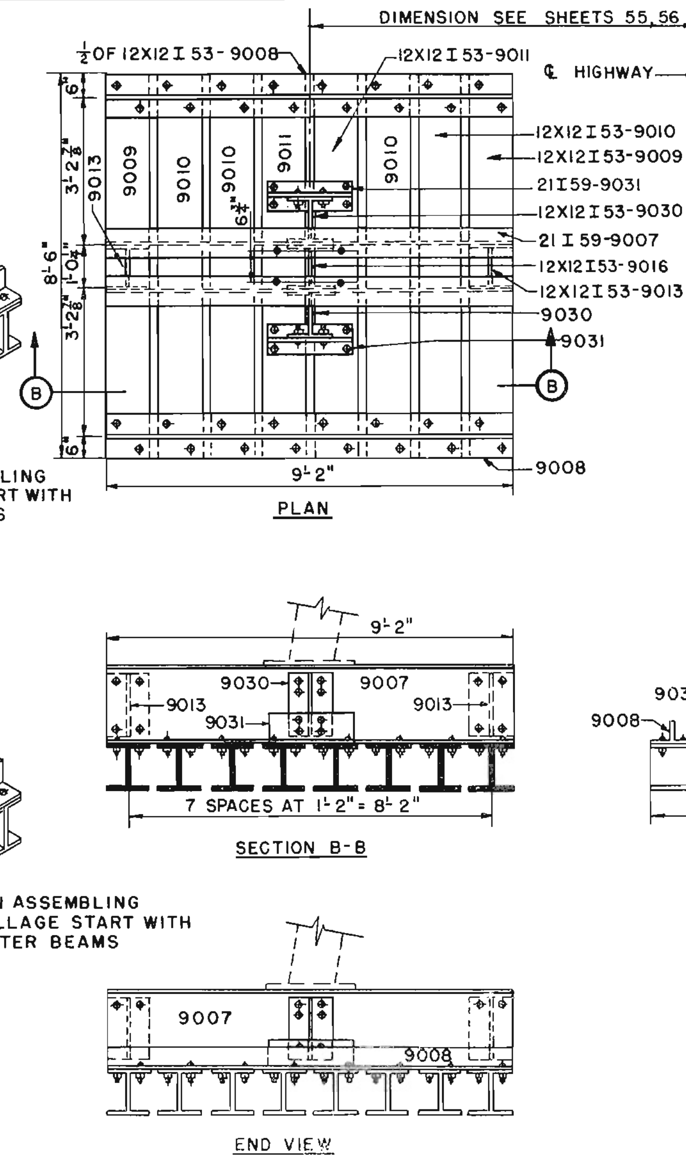
GRILLAGE FOOTING S-101

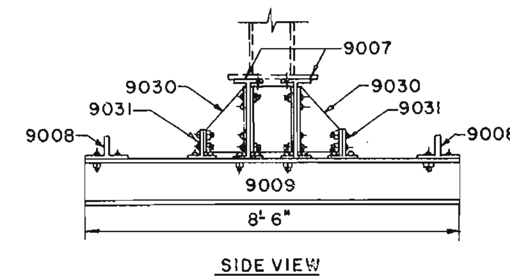


ASSEMBLED VIEW S-102



ASSEMBLED VIEW S-101





GRILLAGE FOOTING S-102

COMPANION SHEETS

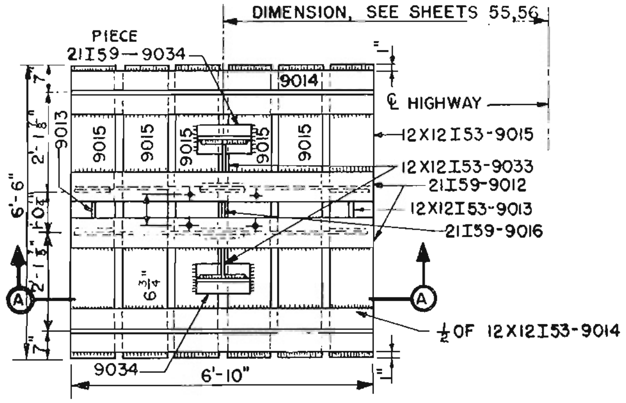
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	55
FRAMED STEEL TOWERS	56
FABRICATION DRAWING	152

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

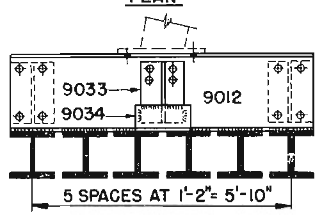
	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9001	21 I 59	6'-10"	403	2	
2	TOP TIER HALF BEAM		9002	12X12 I 53	6'-10"	180	2	
3	BOTTOM TIER BEAM		9003	12X12 I 53	6'-6"	345	2	
4	BOTTOM TIER BEAM		9004	12X12 I 53	6'-6"	345	2	
5	BOTTOM TIER BEAM		9005	12X12 I 53	6'-6"	345	2	
6	TOP TIER BEAM	48-2900.21-059	9007	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM		9008	12X12 I 53	9'-2"	243		2
8	BOTTOM TIER BEAM		9009	12X12 I 53	8'-6"	450		2
9	BOTTOM TIER BEAM		9010	12X12 I 53	8'-6"	450		4
10	BOTTOM TIER BEAM		9011	12X12 I 53	8'-6"	450		2
11	SEPARATOR		9013	12X12 I 53	1'-6"	80	2	2
12	SEPARATOR		9016	12X12 I 53	1'-6"	80	1	1
13	BRACE		9030	12X12 I 53	1'-6"	53	2	2
14	BRACE	48-2900.21-059	9031	21 I 59	1'-11"	50	2	2
						UNIT WEIGHT		
15	RIVET BOLT		G3	7/8	2 1/16"	.94	48	56
16	RIVET BOLT		G4	7/8	2 1/4"	.97	24	28
17	RIVET BOLT		G5	7/8	2 7/16"	1.00	16	16
18	RIVET BOLT AND WASHER		G8	7/8	3"	1.09	4	4

SCHEDULE FOR SELECTION OF GRILLAGE FOOTING FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

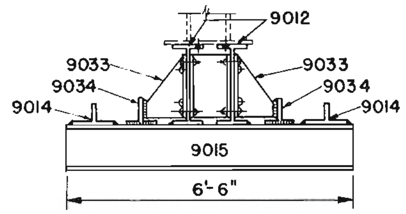
DESCRIPTION	SPAN BETWEEN TOWERS	FOOTINGS ON SOIL — HEIGHT OF TOWER: UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	FOOTINGS ON ROCK — ALL TOWER HEIGHTS
DOUBLE LANE CLASS 50	15'	S-101	S-101	S-102	S-102	S-101
DO	20'	S-101	S-101	S-102	S-102	S-101
DO	30'	S-101	S-102	S-102	S-102	S-101
DO	40'	S-101	S-102	S-102	S-102	S-101
DO	50' TO 90'	S-102	S-102	S-102	S-102	S-101



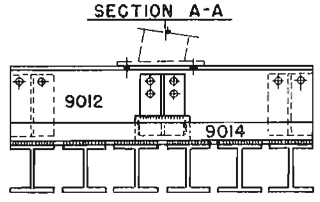
PLAN



SECTION A-A

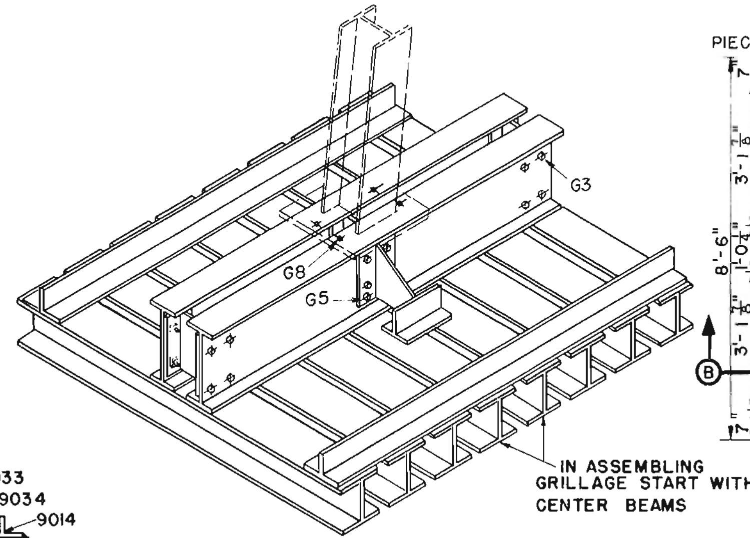


SIDE VIEW

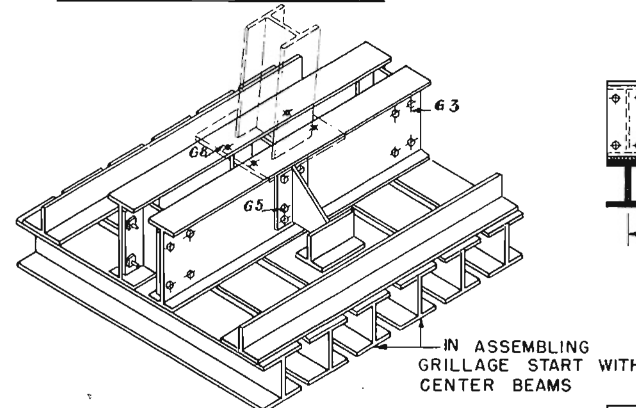


END VIEW

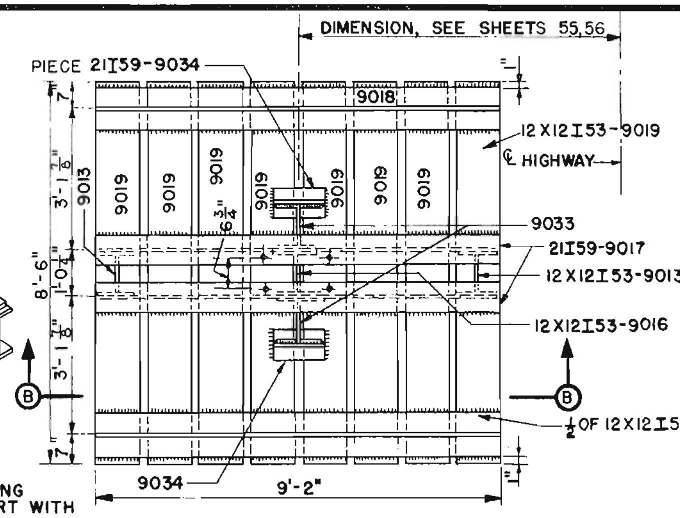
GRILLAGE FOOTING
S-101



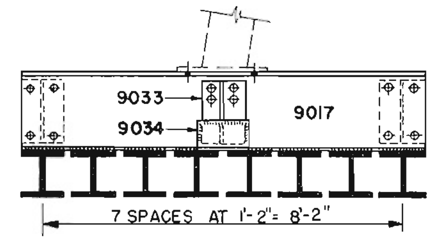
ASSEMBLED VIEW S-102



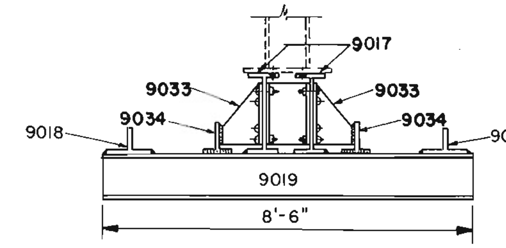
ASSEMBLED VIEW S-101



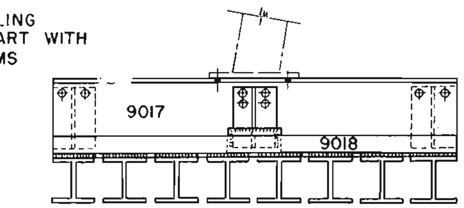
PLAN



SECTION B-B



SIDE VIEW



END VIEW

GRILLAGE FOOTING
S-102

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	153
FRAME STEEL TOWERS	55,56

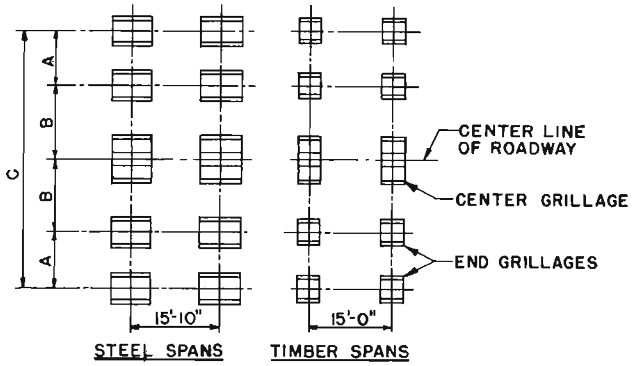
ALL WELDS SHOWN ARE $\frac{1}{4}$" FILLET WELDS UNLESS OTHERWISE NOTED

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

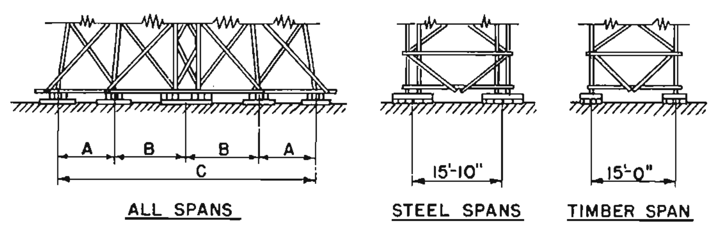
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9012	21I 59	6'-10"	403	2	
2	SEPARATOR		9013	12X12I53	1'-6"	80	2	2
3	TOP TIER HALF BEAM		9014	12X12I53	6'-10"	180	2	
4	BOTTOM TIER BEAM		9015	12X12I53	6'-6"	345	6	
5	SEPARATOR		9016	12X12I53	1'-6"	80	1	1
6	TOP TIER BEAM	48-2900.21-059	9017	21I59	9'-2"	541		2
7	TOP TIER HALF BEAM		9018	12X12I53	9'-2"	243		2
8	BOTTOM TIER BEAM		9019	12X12I53	8'-6"	450		8
9	BRACE		9033	12X12I53	1'-6"	53	2	2
10	BRACE	48-2900.21-059	9034	21I59	1'-2"	35	2	2
						TOTAL WEIGHT		
11	RIVET BOLT		G3	$\frac{7}{8}$	$2\frac{1}{16}$"	15	16	16
12	RIVET BOLT		G5	$\frac{7}{8}$	$2\frac{1}{16}$"	16	16	16
13	RIVET BOLT AND WASHER		G8	$\frac{7}{8}$	3"	5	4	4
14	WELDING ELECTRODE	46-3772.2-7		$\frac{3}{16}$			9LBS	12LBS

SCHEDULE FOR SELECTION OF GRILLAGE FOOTINGS FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

SPAN BETWEEN TOWERS	FOOTINGS ON SOIL — HEIGHT OF TOWER: UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	FOOTINGS ON ROCK: ALL TOWER HEIGHTS
15'	S-101	S-101	S-102	S-102	S-101
20'	S-101	S-101	S-102	S-102	S-101
30'	S-101	S-102	S-102	S-102	S-101
40'	S-101	S-102	S-102	S-102	S-101
50' TO 90'	S-102	S-102	S-102	S-102	S-101



TIMBER GRILLAGES

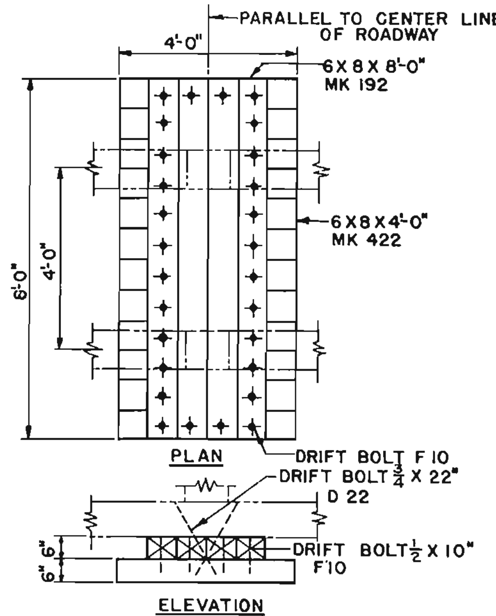


TRANSVERSE ELEVATION

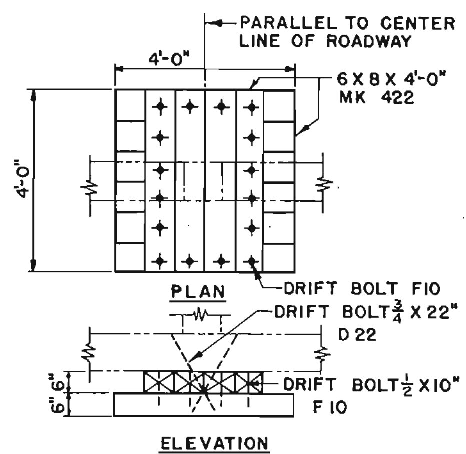
LONGITUDINAL ELEVATIONS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER GRILLAGE AND BILL OF MATERIALS	90



G 113



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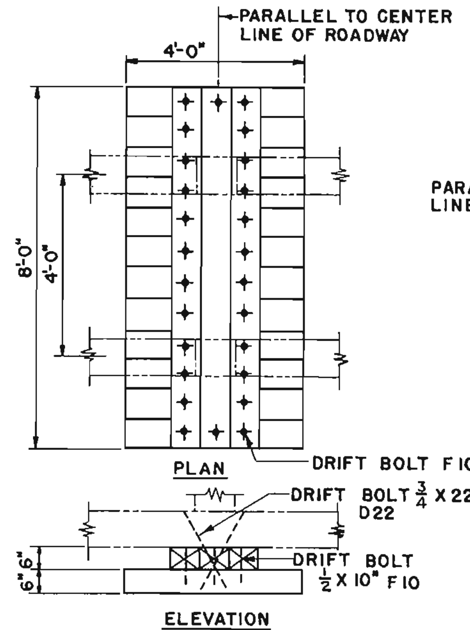
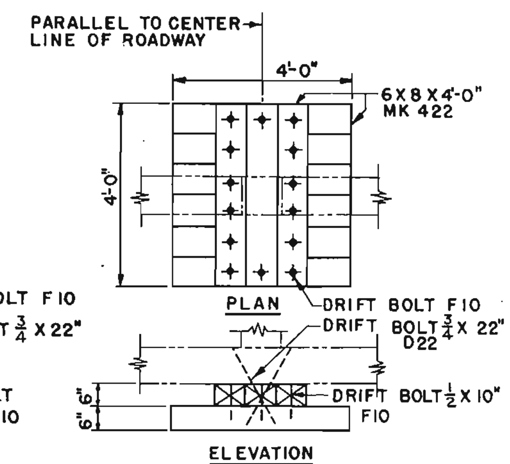


G 117



G 118

TIMBER GRILLAGE FOOTINGS

STORIES	TOWER HEIGHT	A	P	C	FOOTING MARK			
					TIMBER SPAN 15'		STEEL SPAN 15' TO 90'	
					END GRILLAGE	CENTER GRILLAGE	END GRILLAGE	CENTER GRILLAGE
1	13'-4"	5'-5 5/8"	7'-8 5/8"	26'-4 1/2"	G-118	G-120	G-117	G-119
2	16'	5'-8"	7'-11"	27'-2"	G-118	G-120	G-117	G-119
	18'	5'-10"	8'-1"	27'-10"	G-118	G-120	G-117	G-119
	20'	6'-0"	8'-3"	28'-6"	G-118	G-120	G-117	G-119
	22'	6'-2"	8'-5"	29'-2"	G-118	G-120	G-117	G-119
	24'	6'-4"	8'-7"	29'-10"	G-118	G-120	G-117	G-119
	25'-10"	6'-6 1/8"	8'-9 1/8"	30'-6 1/2"	G-118	G-120	G-117	G-119
3	28'	6'-8"	8'-11"	31'-2"	G-118	G-120	G-117	G-119
	30'	6'-10"	9'-1"	31'-10"	G-118	G-120	G-117	G-119
	32'	7'-0"	9'-3"	32'-6"	G-118	G-120	G-117	G-119
	34'	7'-2"	9'-5"	33'-2"	G-118	G-120	G-117	G-119
	36'	7'-4"	9'-7"	33'-10"	G-118	G-120	G-117	G-119
	38'-4"	7'-6 5/8"	9'-9 5/8"	34'-8 1/2"	G-118	G-120	G-117	G-119
4	40'	7'-8"	9'-11"	35'-2"	G-118	G-120	G-117	G-119
	42'	7'-10"	10'-1"	35'-10"	G-118	G-120	G-117	G-119
	44'	8'-0"	10'-3"	36'-6"	G-118	G-120	G-117	G-119
	46'	8'-2"	10'-5"	37'-2"	G-118	G-120	G-117	G-119
	48'	8'-4"	10'-7"	37'-10"	G-118	G-120	G-117	G-119
	50'-10"	8'-7 1/8"	10'-10 1/8"	38'-10 1/2"	G-118	G-120	G-117	G-119
5	53'	8'-9"	11'-0"	39'-6"	G-114	G-116	G-113	G-115
	55'	8'-11"	11'-2"	40'-2"	G-114	G-116	G-113	G-115
	57'	9'-1"	11'-4"	40'-10"	G-114	G-116	G-113	G-115
	59'	9'-3"	11'-6"	41'-6"	G-114	G-116	G-113	G-115
	61'	9'-5"	11'-8"	42'-2"	G-114	G-116	G-113	G-115
	63'-4"	9'-7 5/8"	11'-10 5/8"	43'-0 1/2"	G-114	G-116	G-113	G-115
6	65'	9'-9"	12'-0"	43'-6"	G-114	G-116	G-113	G-115
	67'	9'-11"	12'-2"	44'-2"	G-114	G-116	G-113	G-115
	69'	10'-1"	12'-4"	44'-10"	G-114	G-116	G-113	G-115
	71'	10'-3"	12'-6"	45'-6"	G-114	G-116	G-113	G-115
	73'	10'-5"	12'-8"	46'-2"	G-114	G-116	G-113	G-115
	75'-10"	10'-8 1/8"	12'-11 1/8"	47'-2 1/2"	G-114	G-116	G-113	G-115

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
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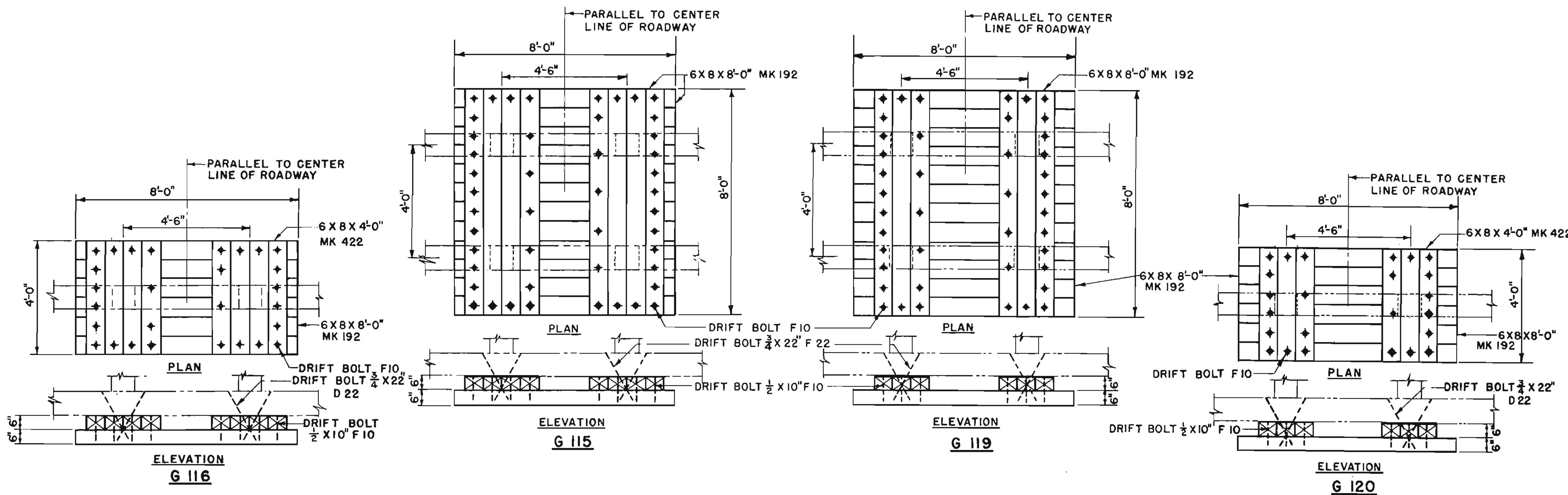


BILL OF MATERIALS FOR ONE TIMBER GRILLAGE

LINE	GRILLAGE NUMBER						G113		G114		G115		G116		G117		G118		G119		G120		LINE
	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	
	LUMBER, SOFT WOOD																						
1	GRILLAGE	39-3360.09	192	6 X 8	8'-0"	120	4	128			20	640	6	192	3	96			18	576	6	192	1
2	DO	39-3360.08	422	6 X 8	4'-0"	60	12	192	10	160			8	128	12	192	9	144			6	96	2
	STEEL HARDWARE, BLACK																						
3	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	2.75	4		2		8		4		4		2		8		4		3
4	DO	43-1636.05-1	F10	1/2	10"	0.6	28		16		46		28		26		14		42		24		4

SET NUMBER 25D-1

TIMBER SPANS
(11 to 15 feet long)

SHEET	
92	General views
93	Bill of materials
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
154	General notes
155	Structural symbols

SET NUMBER 25D-2

STEEL SPANS
(15 to 90 feet long)

SHEET	
94	General views
95	Bill of materials: steel for riveted construction; lumber and hardware for standard plank floor
96	Bill of materials: steel for welded construction; lumber and hardware for alternate laminate floor
128	Details of floor construction and attachment of nailers to steel stringers
129	Details of handrail and curb
130	General views and bill of materials for walkway
131	Riveted construction: fabrication of stringers 501 to 511 and of diaphragms 527 and 528
132	Riveted construction: fabrication of stringers 516 and 521 and of bearing plates 3500 and 3501
133	Riveted construction: fabrication of stringers 513 and 523
135	Riveted construction: fabrication of stringers 515 and 522
136	Riveted construction: fabrication of stringers 512 and 525
138	Riveted construction: fabrication of stringers 520 and 524
139	Welded construction: fabrication of stringers 501W to 511W, and of diaphragms C3 and C4
140	Welded construction: fabrication of stringers 512W and 525W
141	Welded construction: fabrication of stringers 513W, and 522W, and 523W
142	Welded construction: fabrication of stringers 514W, 515W, and 516W
143	Welded construction: fabrication of stringers 520W and 521W
154	General notes
155	Structural symbols

SET NUMBER 25D-3

TIMBER TOWERS FOR TIMBER SPANS
(15 to 76 feet high)

SHEET	
97	General views
98	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connections and of columns; column dimensions
154	General notes
155	Structural symbols

SET NUMBER 25D-4

TIMBER TOWERS FOR STEEL SPANS
(15 to 76 feet high)

SHEET	
99	Details and bill of materials for connection of spans to towers
100	General views
101	Bill of materials
146	Details of bracing connections
147	Details of bracing connections
148	Details of bracing connections and of columns; column dimensions
149	Details of towers supporting both timber and steel spans
154	General notes
155	Structural symbols

SET NUMBER 25D-5

STEEL TOWERS FOR STEEL SPANS
(15 to 77 feet high)

SHEET	
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
57	Bill of materials common to all towers
58	Bill of materials which vary with tower height
59	Riveted construction: fabrication of cap beam, strut, and pin
102	Riveted construction: fabrication of cap beam
60	Riveted construction: fabrication of columns
61	Riveted construction: fabrication of columns and struts
62	Fabrication of rod bracing
103	Details and bill of materials for shims under stringers of different depths; superstructure anchor belts
226	Welded construction with rod bracing: cap beams and column splices welded in fabrication and erection
227	Welded construction with welded angle bracing; cap beams and column splices welded in fabrication and erection
154	General notes
155	Structural symbols

NOTE: When welded construction is used in accordance with sheets 226 or 227, bills of materials on sheets 57 and 58 and fabrication details on sheets 59, 60, and 61 must be adjusted in the field. When sheet 227 is used, sheet 62 does not apply.

SET NUMBER 25D-6

TIMBER ABUTMENTS FOR TIMBER SPANS

SHEET	
104	General views of pile abutments; bill of materials for pile and grillage abutments
105	General views of grillage abutments
154	General notes
155	Structural symbols

SET NUMBER 25D-7

ABUTMENTS FOR STEEL SPANS

SHEET	
106	General views of timber pile abutments; bill of materials for timber pile and timber grillage abutments
107	General views of timber grillage abutments for 3-foot maximum fill
108	General views of timber grillage abutments for 6-foot maximum fill
109	General views of steel pile abutments
110	Fabrication details and bill of materials for steel pile abutments
111	General views and bill of materials for concrete abutments
154	General notes
155	Structural symbols

SET NUMBER 25D-8

TIMBER PILE BENTS FOR TIMBER SPANS
(1 to 28 feet high)

SHEET	
112	Bill of materials; general views of 1- to 16-foot bents
113	General views of 17- to 28-foot bents
154	General notes
155	Structural symbols

SET NUMBER 25D-9

TIMBER PILE PIERS FOR STEEL SPANS
(1 to 13 feet high)

SHEET	
114	General views
115	Bill of materials; details of piers supporting one steel and one timber span
154	General notes
155	Structural symbols

SET NUMBER 25D-10

STEEL PILE BENTS AND PIERS FOR STEEL SPANS
(1 to 20 feet high)

SHEET	
116	Riveted construction: general views of bents
117	Riveted construction: general views of piers
118	Riveted and welded construction: bill of materials
119	Welded construction: general views of bents
120	Welded construction: general views of piers
150	Riveted construction: fabrication of cap beams, corbels, bracing, and connections
151	Welded construction: fabrication of cap beams, corbels, and bearing plates
154	General notes
155	Structural symbols

SET NUMBER 25D-11

TIMBER SILL AND PILE FOUNDATIONS FOR TIMBER TOWERS

SHEET	
121	General views
154	General notes
155	Structural symbols

SET NUMBER 25D-12

CONCRETE PEDESTALS FOR TIMBER TOWERS

SHEET	
122	General views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER 25D-13

CONCRETE PEDESTALS FOR STEEL TOWERS

SHEET	
123	General views and bill of materials
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 25D-14

STEEL FRAME ON STEEL PILE FOUNDATIONS FOR STEEL TOWERS

SHEET	
124	General views and bill of materials
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 25D-15

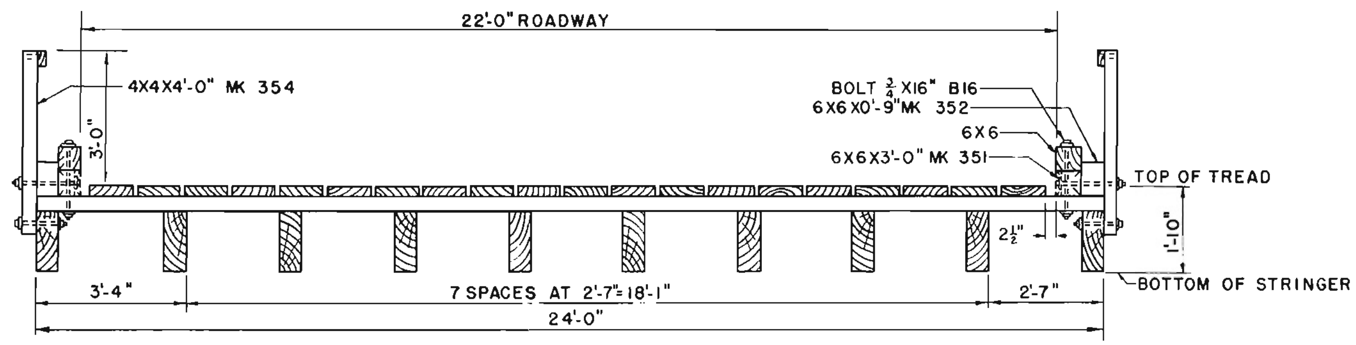
STEEL GRILLAGE FOUNDATIONS FOR STEEL TOWERS

SHEET	
125	Bolted construction: general views and bill of materials
126	Welded construction: general views and bill of materials
152	Bolted construction: fabrication of grillage beams
153	Welded construction: fabrication of grillage beams
55	General views of 69- to 77-foot towers
56	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER 25D-16

TIMBER GRILLAGE FOUNDATIONS FOR TIMBER TOWERS

SHEET	
127	General views and bill of materials
154	General notes
155	Structural symbols



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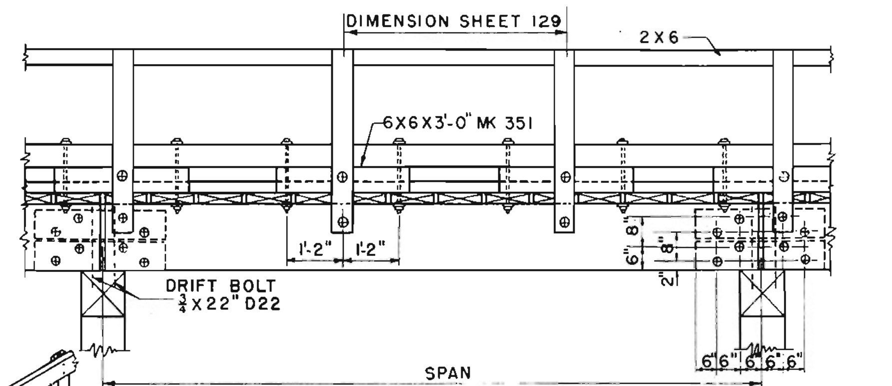
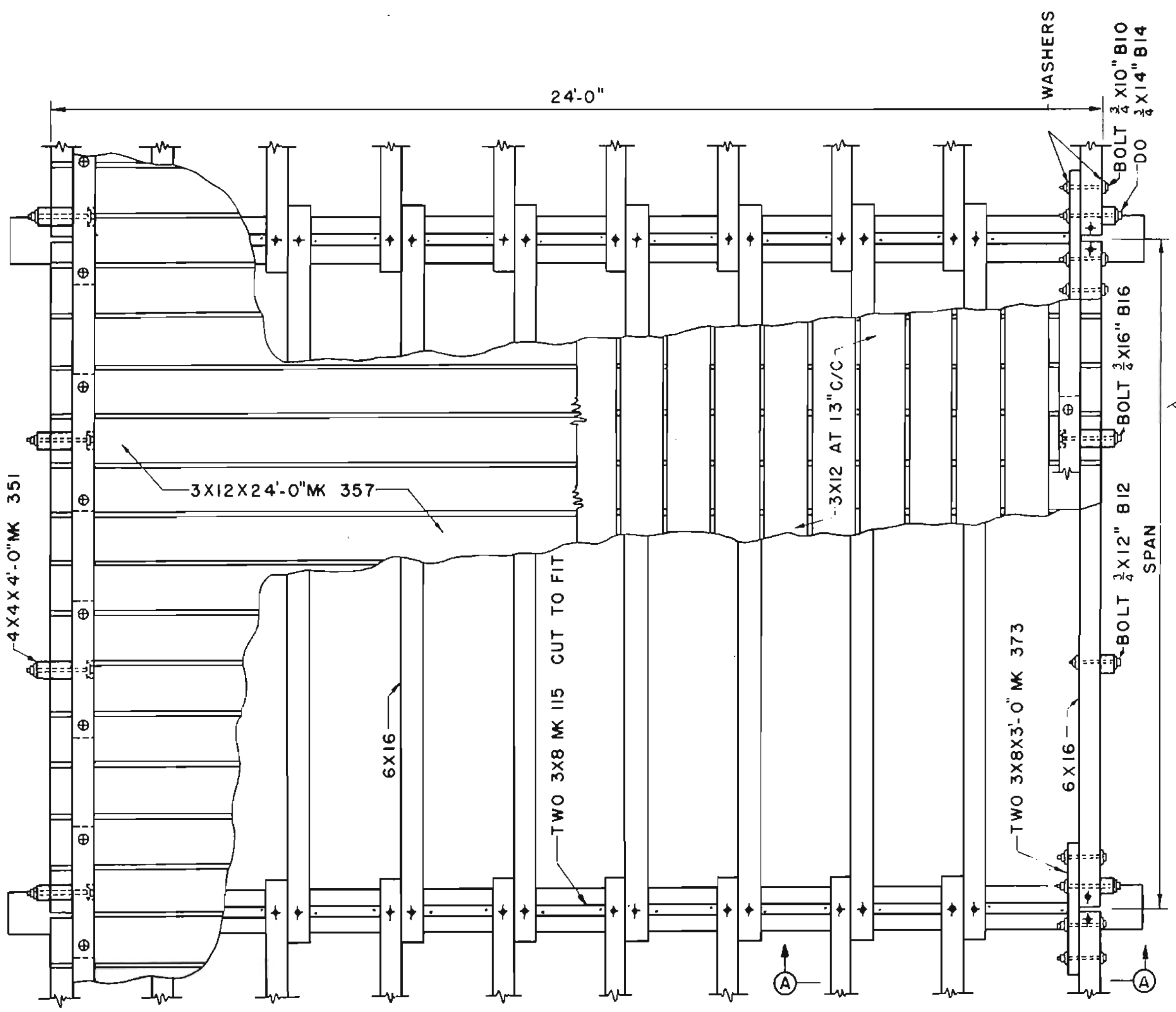
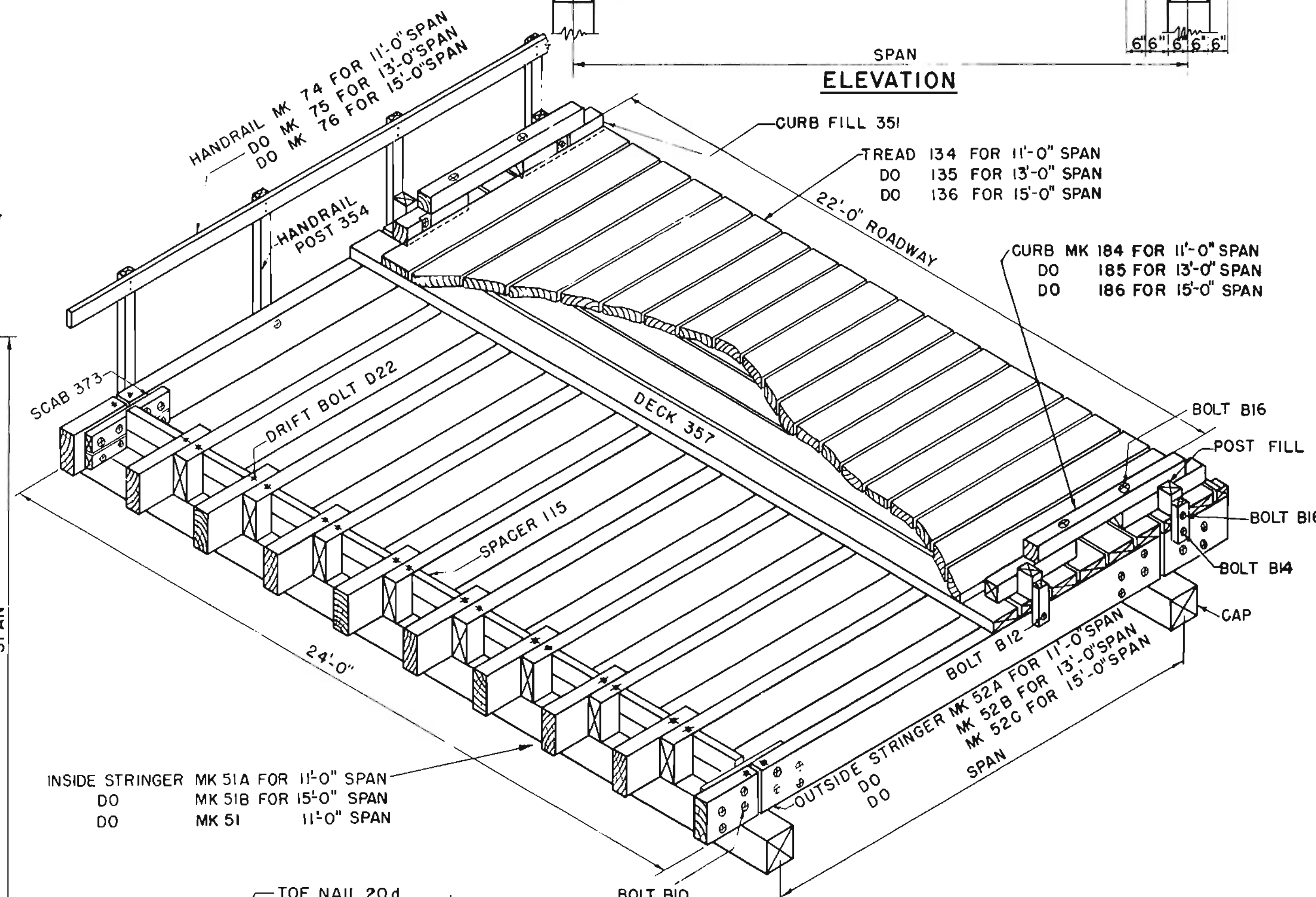


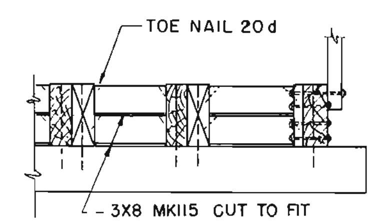
ELEVATION



PLAN



ASSEMBLED VIEW



SECTION A-A

COMPANION SHEETS

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CURB AND HANDRAIL DETAILS	129
TIMBER AND NAILING DETAILS	128
WALKWAYS	130
SYMBOLS	155

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
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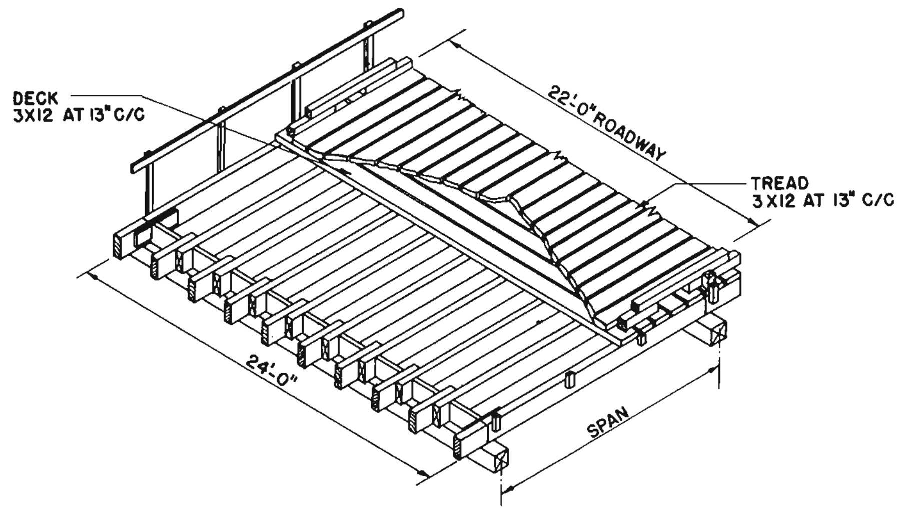
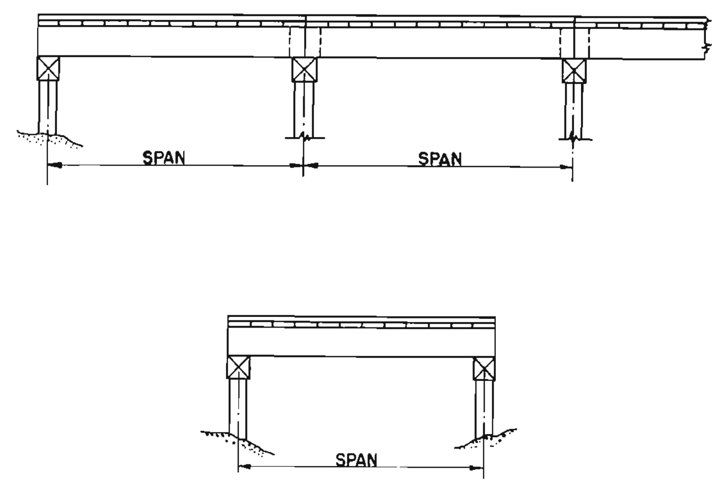
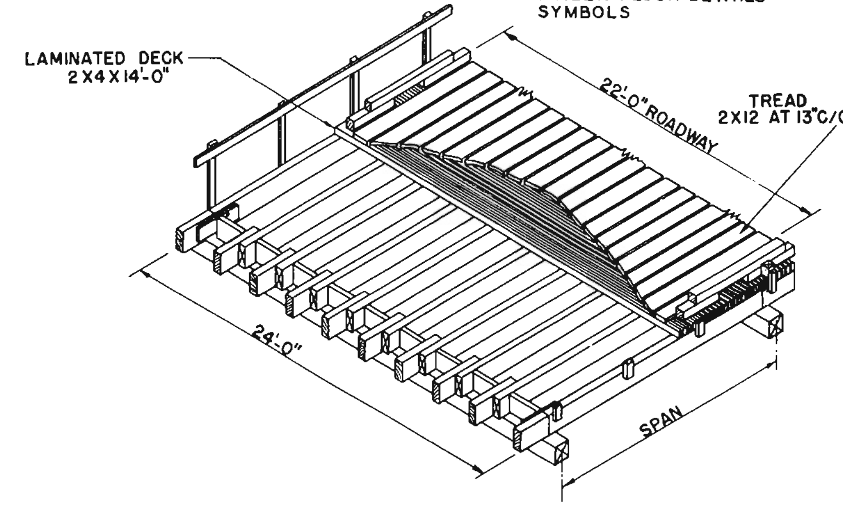
HANDRAIL AND CURB DETAILS	129
TIMBER FLOOR DETAILS	128
SYMBOLS	153







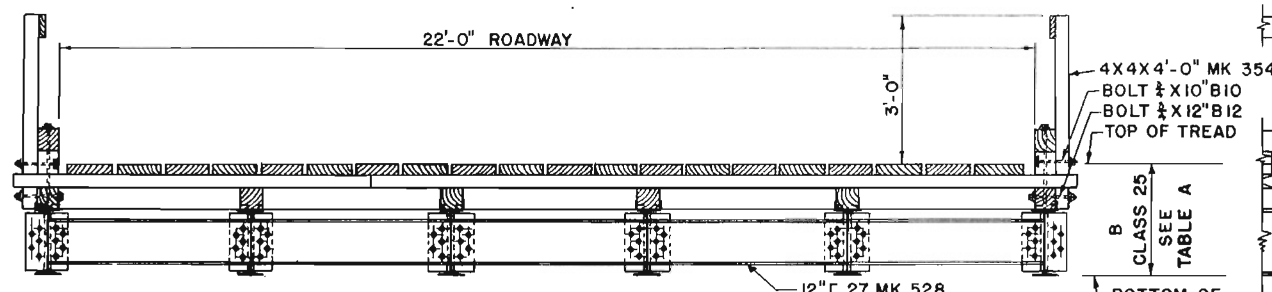
STANDARD PLANK FLOOR – BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	MARK	WEIGHT (POUNDS)	11'0" SPAN QUANTITY	11'0" SPAN FBM	13'0" SPAN QUANTITY	13'0" SPAN FBM	15'0" SPAN QUANTITY	15'0" SPAN FBM
	LUMBER, SOFTWOOD											
1	STRINGERS		6 X 16	16'0"	51C	480					8	1024
2	DO		6 X 16	16'0"	52C	480					2	256
3	DO		6 X 16	14'0"	51B	420			8	896		
4	DO		6 X 16	14'0"	52B	420			2	224		
5	DO		6 X 16	12'0"	51A	360	8	768				
6	DO		6 X 16	12'0"	52A	360	2	192				
7	SPACER (STRINGER)	39-3330.08	3 X 8	14'0"	115	105	2	56	2	56	2	56
8	SCAB	39-3330.08	3 X 8	3'0"	373	23	4	24	4	24	4	24
9	DECK	39-3952.12	3 X 12	24'0"	357	270	⊔ 10	720	⊔ 12	864	⊔ 14	1008
10	TREAD	39-3330.12-16	3 X 12	16'0"	136						20	960
11	DO	39-3330.12	3 X 12	14'0"	135	158			20	840		
12	DO	39-3952.12-12	3 X 12	12'0"	134	135	20	720				
13	CURB	39-3360.06-16	6 X 6	16'0"	186	180					2	96
14	DO	39-3360.06-14	6 X 5	14'0"	185	158			2	84		
15	DO	39-3360.06-12	6 X 6	12'0"	134	135	2	72				
16	CURB FILL	39-3360.06	6 X 6	3'0"	351	34	4	36	4	36	6	54
17	HANDRAIL POST	39-3340.04	4 X 4	4'0"	354	20	4	22	4	22	6	32
18	POST FILL	39-3360.06	6 X 6	0'9"	352	8	4	9	4	9	6	14
19	HANDRAIL	39-3880.06-16	2 X 6	16'0"	76	60					2	32
20	DO	39-3880.06-14	2 X 6	14'0"	75	52			2	28		
21	DO	39-3880.06-12	2 X 6	12'0"	74	45	2	24				
	STEEL HARDWARE, BLACK											
22	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-16	3/4	16"	B16	2.52	12		12		18	
23	DO	43-2325.07-144	3/4	14"	B14	2.27	2		2		2	
24	DO	43-2325.07-124	3/4	12"	B12	2.02	2		2		4	
25	DO	43-2325.07-1	3/4	10"	B10	1.77	14		14		14	
26	DRIFT BOLTS	43-1636.07-22	3/4	22"	D22	3.0	20		20		20	
27	WIRE SPIKE	42-8488.035-07-	5/16 X 7			.15	100		120		140	
28	WIRE NAIL	42-6028.3-5	50 d			.10	200		240		280	
29	WIRE NAIL	42-6028.3-2	20 d			.04	24		24		32	

NOTE: PROVIDE TWO ADDITIONAL HANDRAIL POSTS, TWO CURB FILLS, TWO SPACERS AND TWO POST FILLS FOR EACH BRIDGE. ⊔ – FOR SINGLE SPANS, ADD ONE PLANK.

ALTERNATE LAMINATED FLOOR – BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NUMBER	SIZE (INCHES)	LENGTH	MARK	WEIGHT (POUNDS)	11'0" SPAN QUANTITY	11'0" SPAN FBM	13'0" SPAN QUANTITY	13'0" SPAN FBM	15'0" SPAN QUANTITY	15'0" SPAN FBM
	LUMBER, SOFTWOOD											
1	STRINGERS		6 X 16	16'0"	51C	480					8	1024
2	DO		6 X 16	16'0"	52C	480					2	256
3	DO		6 X 16	14'0"	51B	420			8	896		
4	DO		6 X 15	14'0"	52B	420			2	224		
5	DO		6 X 16	12'0"	51A	360	8	768				
6	DO		6 X 16	12'0"	52A	360	2	192				
7	SPACER (STRINGER)	39-3330.09	3 X 8	14'0"	115	105	2	56	2	56	2	56
8	SCAB	39-3330.08	3 X 8	3'0"	373	23	4	24	4	24	4	24
9	DECK	39-3880.04	2 X 4	24'0"	360	60	82	1312	96	1535	111	1773
10	TREAD	39-3228.12-12	2 X 12	12'0"	104	90	20	480				
11	DO	39-3228.12-14	2 X 12	14'0"	105	105			20	560		
12	DO	39-3228.12-16	2 X 12	15'0"	106	120					20	640
13	CURB	39-3360.06-12	6 X 6	12'0"	184	135	2	72				
14	DO	39-3360.06-14	6 X 6	14'0"	185	158			2	84		
15	DO	39-3350.06-16	6 X 6	16'0"	186	180					2	96
16	CURBFILL	39-3360.06	6 X 6	3'0"	351	34	4	36	4	36	6	54
17	HANDRAIL POST	39-3340.04-08	4 X 4	4'0"	354	20	4	22	4	22	4	22
18	POST FILL	39-3360.06	6 X 6	0'9"	352	8	4	9	4	9	6	14
19	HANDRAIL	39-3880.06-12	2 X 6	12'0"	74	45	2	24				
20	DO	39-3880.06-14	2 X 6	14'0"	75	52			2	28		
21	DO	39-3880.06-16	2 X 6	16'0"	76	60					2	32
	STEEL HARDWARE, BLACK											
22	MACHINE BOLT WITH SQUARE NUT AND 2 WASHERS	43-2325.07-16	3/4	16"	B16	2.52	12		12		18	
23	DO	43-2325.07-144	3/4	14"	B14	2.27	2		2		2	
24	DO	43-2325.07-124	3/4	12"	B12	2.02	2		2		4	
25	DO	43-2325.07-1	3/4	10"	B10	1.77	14		14		14	
26	DRIFT BOLT	43-1636.07-22	3/4	22"	D22	3.00	20		20		20	
27	WIRE NAIL	42-6028.3-5	50 d			.11	1800		2100		2400	
28	WIRE NAIL	42-6028.3-2	20 d			.04	12		12		16	



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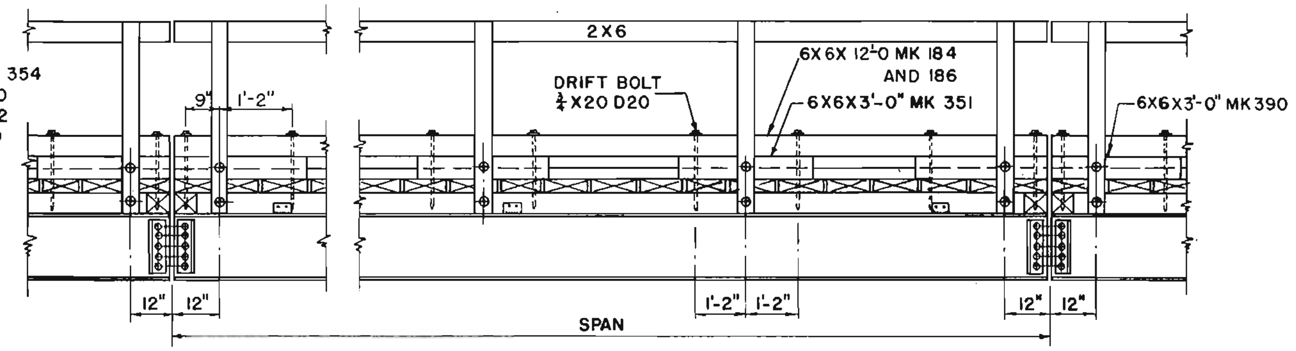
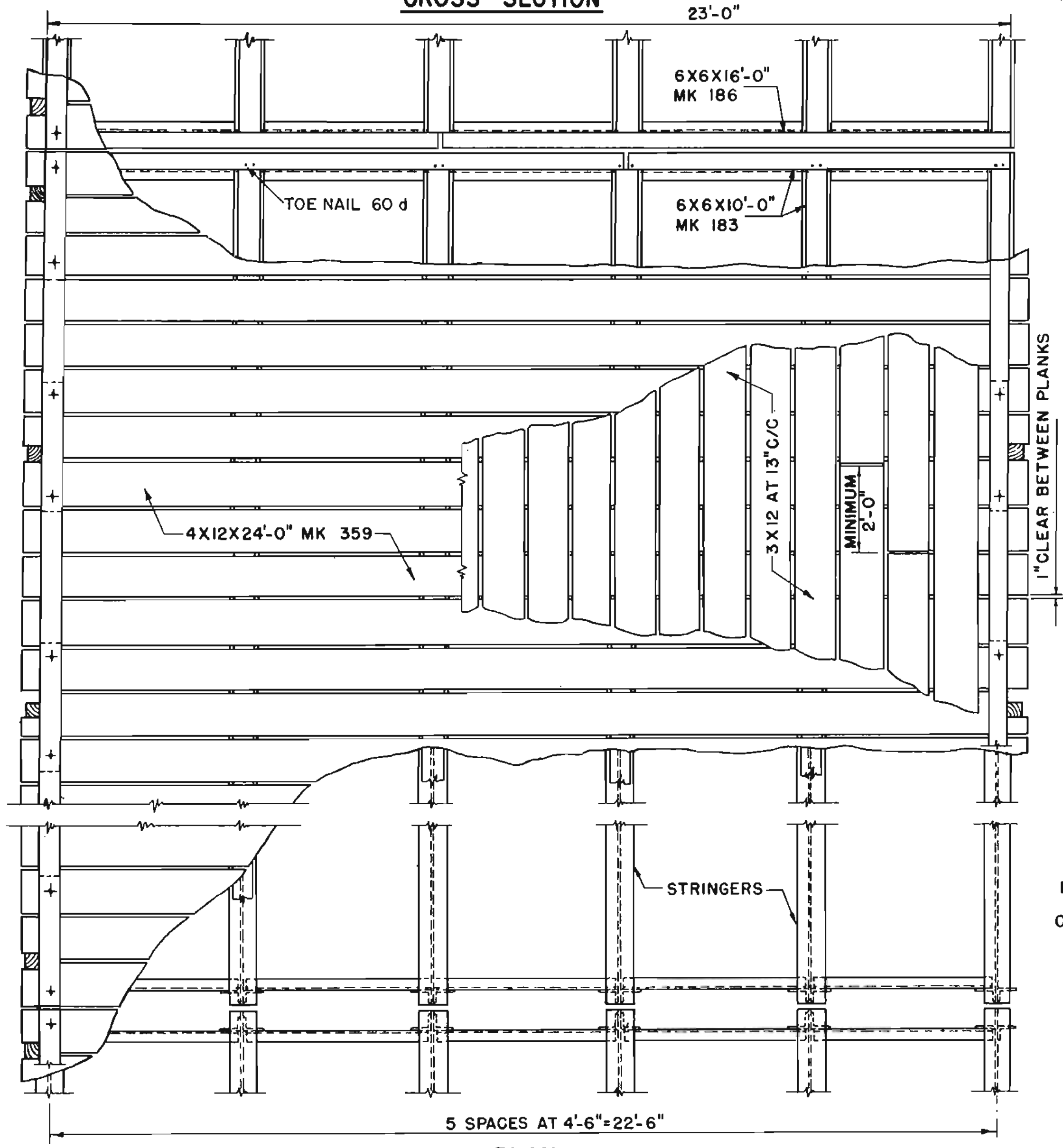
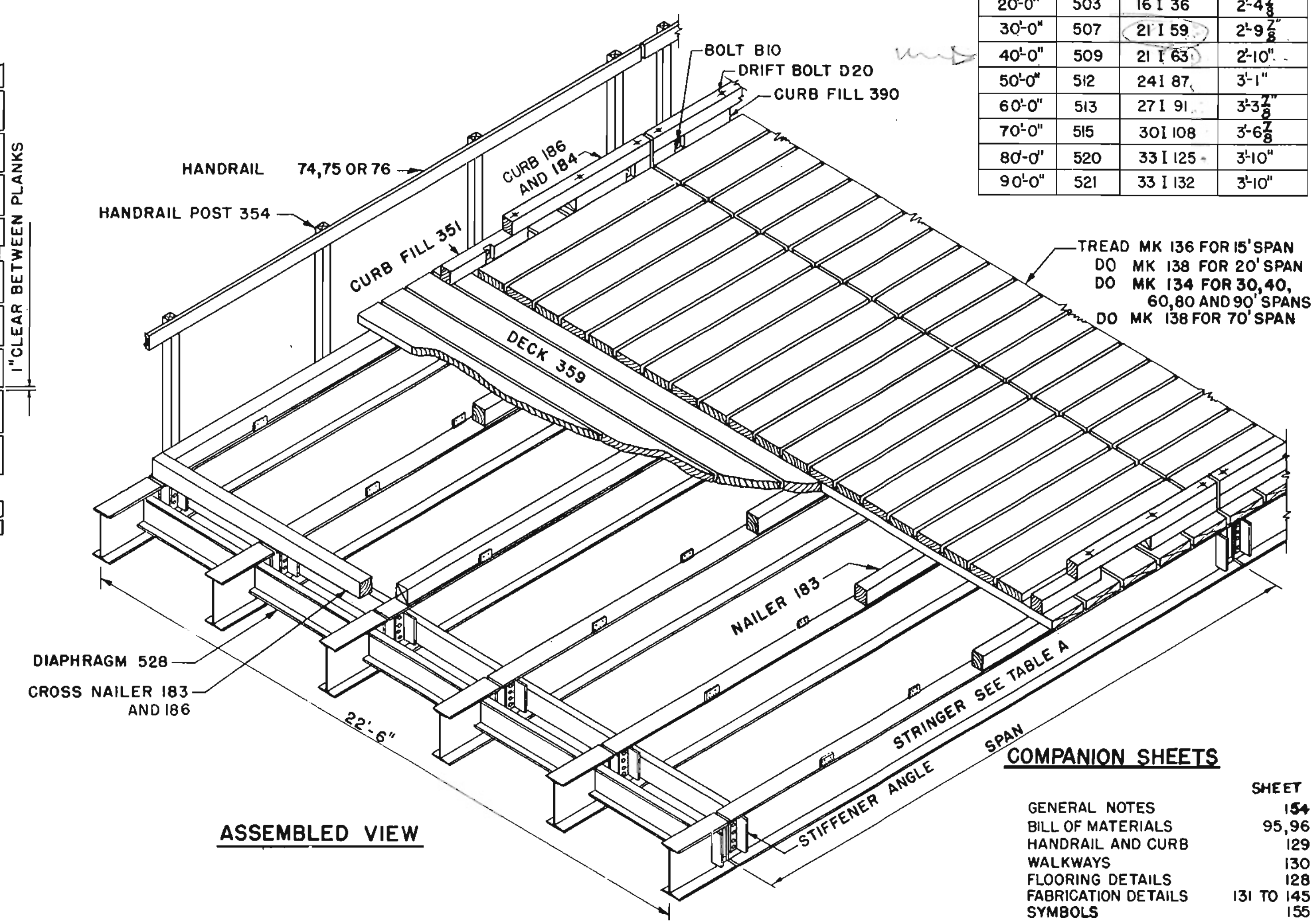


ELEVATION



PLAN

TABLE A			
SPAN	MARK MK	STRINGER SIZE	B
15'-0"	501	14 I 30	2'-2⅞"
20'-0"	503	16 I 36	2'-4⅞"
30'-0"	507	21 I 59	2'-9⅞"
40'-0"	509	21 I 63	2'-10"
50'-0"	512	24 I 87	3'-1"
60'-0"	513	27 I 91	3'-3⅞"
70'-0"	515	30 I 108	3'-6⅞
80'-0"	520	33 I 125	3'-10"
90'-0"	521	33 I 132	3'-10"



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BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' (14 I 30) QUANTITY	FBM	20' (16 I 36) QUANTITY	FBM	30' (21 I 59) QUANTITY	FBM	40' (21 I 63) QUANTITY	FBM	50' (24 I 87) QUANTITY	FBM	60' (27 I 91) QUANTITY	FBM	70' (30 I 108) QUANTITY	FBM	80' (33 I 125) QUANTITY	FBM	90' (33 I 132) QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																								
1	FLOOR, TREAD	39-3330.12-2	138	3 X 12	20'-0"	225			20	1200			50	3000	50	3000	70	4200	70	4200			10	600	1
2	DO	39-3330.12-16	136	3 X 12	16'-0"	180	20	960					20	960							100	4800	100	4800	2
3	DO	39-3952.12-12	134	3 X 12	12'-0"	135					50	1800	40	1440			100	3600							3
4	FLOOR, DECK	39-3340.12-24	359	4 X 12	24'-0"	360	14	344	19	1824	22	2685	37	3552	46	4416	55	5280	65	6240	74	7104	83	7968	4
5	NAILER	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	5
6	DO	39-3360.06-1	183	6 X 6	10'-0"	113	11	330	14	420	20	600	26	780	32	960	38	1140	44	1320	60	1500	56	1680	6
7	CURB	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	538	12	576	14	672	7
8	DO	39-3360.06-12	184	6 X 6	12'-0"	135					4	144			4	144									8
9	CURB FILL	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	9
10	DO	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	36	8	72	10	90	14	126	16	144	20	180	22	198	26	234	10
11	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	11
12	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	12
13	DO	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	112	9	126	11	154	12	168	14	196	13
	STEEL, STRUCTURAL																								
14	STRINGER	48-2900.33-132	521	33 I 132	40'-0"	5280																	6		14
15	DO	48-2900.33-132	521	33 I 132	24'-10 3/4"	3285																	12		15
16	DO	48-2900.33-125	520	33 I 125	40'-0"	5000															6				16
17	DO	48-2900.33-125	520	33 I 125	39'-10"	4980															6				17
18	DO	48-2900.3-108	515	30 I 108	40'-0"	4520													6						18
19	DO	48-2900.3-108	515	30 I 108	14'-10 3/4"	1610													12						19
20	DO	48-2900.27-091	513	27 I 91	40'-0"	3640											6								20
21	DO	48-2900.27-091	513	27 I 91	19'-10"	1805											6								21
22	DO	48-2900.24-087	512	24 I 87	40'-0"	3480									6										22
23	DO	48-2900.24-087	512	24 I 87	9'-10"	855									6										23
24	DO	48-2900.21-063	509	21 I 63	39'-10 1/2"	2510							6												24
25	DO	48-2900.21-059	507	21 I 59	29'-10 1/2"	1760					6														25
26	DO	48-2900.16-036	503	16 I 36	19'-10 1/2"	715			6																26
27	DO	48-2900.14-03	501	14 I 30	14'-10 1/2"	445	6																		27
28	DIAPHRAGM	48-3790.12-21	528	12 [20.7	4'-4"	90	10		10		15		15		15		20		20		25		25		28
29	ANGLE	48-2240.64-04		6 X 4 X 3/8	2'-3"	28															60		60		29
30	DO	48-2240.64-04		6 X 4 X 3/8	1'-9"	22											48		48						30
31	DO	48-2240.64-04		6 X 4 X 3/8	1'-6"	18					36		36		36										31
32	DO	48-2240.64-04		6 X 4 X 3/8	1'-2"	14			24																32
33	DO	48-2240.64-04		6 X 4 X 3/8	1'-0"	12	24																		33
34	WEB SPLICE PLATE	47-7844.04-	P15	14 X 3/8	2'-3"	40															12		24		34
35	DO	47-7844.04	P8, P10	14 X 3/8	1'-9"	31											12		24						35
36	DO	47-7844.04	P6	14 X 3/8	1'-6"	27									12										36
37	FLANGE SPLICE PLATE	47-7844.06	P13	12 X 5/8	4'-4"	110																	24		37
38	DO	47-7844.07	P14	4 3/4 X 3/4	4'-4"	53																	48		38
39	DO	47-7844.06	P13	12 X 5/8	4'-5"	113															12				39
40	DO	47-7844.07	P14	4 3/4 X 3/4	4'-5"	54															24				40
41	DO	47-7844.08	P7	11 X 7/8	2'-10"	93													24						41
42	DO	47-7844.08	P9	10 1/2 X 7/8	5'-7"	175											12								42
43	DO	47-7844.07	P5	9 X 3/4	4'-1"	94									12										43
44	RIVET	43-6353.08		7/8	4"	.87															480		960		44
45	DO	43-6353.08		7/8	3 3/4"	.83															42				45
46	DO	43-6353.08		7/8	3 1/4"	.74									384		528		960						46
47	DO	43-6353.08-3		7/8	3"	.70															294		546		47
48	DO	43-6353.08		7/8	2 3/4"	.66	48		48		90		90		252		216		432						48
49	DO	43-6353.08-23		7/8	2 1/4"	.57	100		100		150		150		150		200		200		250		250		49
50	NAILER ATTACHMENT PLATES	47-7844.03		2 X 1/4	4"	0.6	24		30		42		54		66		78		90		102		114		50
51	WELDING ELECTRODE	46-3772.2-7		3/16			1.8 LB		2.2 LB		3.1 LB		4.0 LB		4.8 LB		5.8 LB		6.6 LB		7.5 LB		8.4 LB		51
	STEEL HARDWARE, BLACK																								
52	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.1	6		8		12		14		18		20		24		26		30		52
53	DO	43-2325.07-1	B10	3/4	10"	1.9	6		8		12		14		18		20		24		26		30		53
54	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		54
55	STEEL WIRE SPIKE	42-8488.035-07		5/16 X 7		.15	168		228		336		444		552		660		780		888		996		55
56	STEEL WIRE NAIL	42-6028.3-6		60d		.10	14		14		14		14		14		14		14		14		14		56
57	DO	42-6028.3-5		50d		.08	344		444		710		910		1070		1400		1510		1780		1990		57
58	DO	42-6028.3-3		30d		.05	48		60		84		108		132		156		180		204		228		58
59	DO	42-6028.3-2		20d		.04	24		38		58		68		88		98		118		128		148		59

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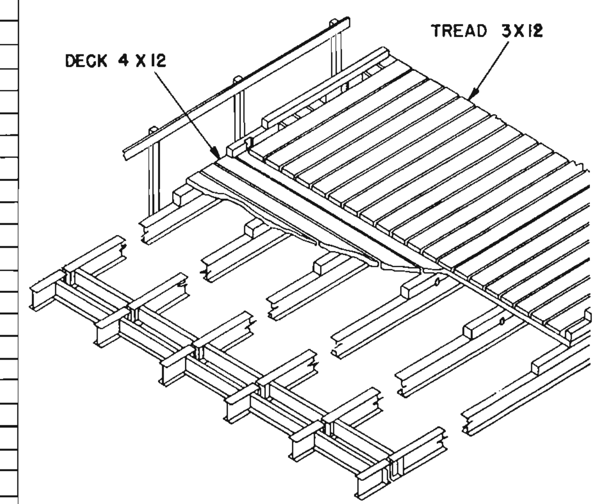

BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	30' QUANTITY	30' FBM	40' QUANTITY	40' FBM	50' QUANTITY	50' FBM	60' QUANTITY	60' FBM	70' QUANTITY	70' FBM	80' QUANTITY	80' FBM	90' QUANTITY	90' FBM	LINE
					STRINGER SIZE		14 I 30		16 I 36		21 I 59		21 I 63		24 I 87		27 I 91		30 I 108		33 I 125		33 I 132		
	LUMBER, SOFT WOOD																								
1	FLOOR, TREAD	39-3228.12-2	108	2 X 12	20'-0"	150			20	800															1
2	DO	39-3228.12-16	106	2 X 12	16'-0"	120	20	640													100	3200			2
3	DO	39-3228.12-14	105	2 X 12	14'-0"	105									72	2016			100	2800					3
4	DO	39-3228.12-12	104	2 X 12	12'-0"	90					50	1200	67	1608			100	2400					150	3600	4
5	FLOOR, DECK	39-3228.06-14	75	2 X 6	14'-0"	53	111	1554	148	2072	221	3094	295	4130	369	5166	443	6202	516	7224	590	8260	664	9296	5
6	DO	39-3228.06-1	73	2 X 6	10'-0"	38	111	1110	148	1480	221	2210	295	2950	369	3690	443	4430	516	5160	590	5900	664	6640	6
7	NAILER	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	2	96	7
8	DO	39-3360.06-1	183	6 X 6	10'-0"	113	11	330	14	420	20	600	26	780	32	960	38	1140	44	1320	50	1500	56	1680	8
9	CURB	39-3360.06-16	186	6 X 6	16'-0"	180	2	96	3	144	1	48	6	288	4	192	9	432	11	528	12	576	14	672	9
10	DO	39-3360.06-12	18"	6 X 6	12'-0"	135					4	144			4	144									10
11	CURB FILL	39-3360.06	390	6 X 6	3'-0"	34	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	4	36	11
12	DO	39-3360.06	351	6 X 6	3'-0"	34	2	18	4	36	8	72	10	90	14	126	16	144	20	180	22	198	26	234	12
13	HANDRAIL POST	39-3340.04	354	4 X 4	4'-0"	20	6	32	8	43	12	64	14	75	18	96	20	107	24	128	26	139	30	160	13
14	HANDRAIL	39-3880.06-16	76	2 X 6	16'-0"	60	2	32																	14
15	DO	39-3880.06-14	75	2 X 6	14'-0"	53			3	42	5	70	6	84	8	113	9	126	11	154	12	168	14	196	15
	STEEL, STRUCTURAL																								
16	STRINGER	48-2900.33-132	521W	33 I 132	40'-0"	5280																	12		16
17	DO				9'-10 1/2"	1304																	6		17
18	DO	48-2900.33-125	520W	33 I 125	39'-10 1/2"	4984															6				18
19	DO				40'-0"	5000															6				19
20	DO	48-2900.3-108	515W	30 I 108	40'-0"	4320													6						20
21	DO				29'-10 1/2"	3227													6						21
22	DO	48-2900.27-091	513W	27 I 91	40'-0"	3640											6								22
23	DO				19'-10 1/2"	1809											6								23
24	DO	48-2900.24-087	512W	24 I 87	40'-0"	3480									6										24
25	DO				9'-10 1/2"	859									6										25
26	DO	48-2900.21-063	509W	21 I 63	39'-10 1/2"	2510							6												26
27	DO	48-2900.21-059	507W	21 I 59	29'-10 1/2"	1763					6														27
28	DO	48-2900.16-036	503W	16 I 36	19'-10 1/2"	715			6																28
29	DO	48-2900.14-030	501W	14 I 30	14'-10 1/2"	446	6																		29
30	DIAPHRAGM	48-3790.12-21	C4	12 [20.7	4'-1"	85	10		10		15		15		15		20		20		25		25		30
31	STIFFENER PLATE	47-7844.04	P10	4 X 3/8	2'-0"	10													48		60		60		31
32	DO	47-7844.04	P23	4 X 3/8	1'-9"	9											48								32
33	DO	47-7844.04	P20	4 X 3/8	1'-6"	8									36										33
34	DO	47-7844.04	P6	4 X 3/8	1'-7"	8					36		36												34
35	DO	47-7844.04	P2	4 X 3/8	1'-2"	6			24																35
36	DO	47-7844.04	P1	4 X 3/8	1'-0"	5	24																		36
37	WEB SPLICE PLATE	47-7844.04	P9	12 X 3/8	1'-6"	23													12		12		24		37
38	DO	47-7844.04	P19	9 X 3/8	1'-0"	11									12										38
39	DO	47-7844.04	P22	9 X 3/8	1'-3"	14											12								39
40	FLANGE SPLICE PLATE	47-7844.1	P43	9 X 1	4'-0"	122																	12		40
41	DO	47-7844.05	P8	7 X 1/2	1'-10"	22																	12		41
42	DO	47-7844.05	P11	9 X 1/2	3'-0"	46															6				42
43	DO	47-7844.06	P18	7 X 5/8	4'-0"	60									6										43
44	DO	47-7844.04	P21	8 X 3/8	2'-0"	20											6								44
45	DO	47-7844.04	P26	9 X 3/8	3'-0"	34													6						45
46	DO	47-7844.1	P27	9 X 1	2'-4"	71													6						46
47	DO	47-7844.1	P29	9 X 1	2'-8"	82															6				47
48	DO	47-7844.05	P30	9 X 1/2	3'-10"	59																	12		48
49	DO	47-7844.1	P32	8 X 1	3'-6"	95											6								49
50	DO	47-7844.04	P37	7 X 3/8	2'-0"	18									6										50
51	NAILER ATTACHMENT PLATE	47-7844.03		2 X 1/4	0'-4"	0.6	24		30		42		54		66		78		90		102		114		51
52	WELDING ELECTRODE	46-3772.25-5		7/32											28 LB		77 LB		89 LB		138 LB		119 LB		52
53	DO	46-3772.2-7		3/16			22 LB		24 LB		40 LB		43 LB		66 LB		59 LB		71 LB		60 LB		98 LB		53
	STEEL HARDWARE, BLACK																								
54	MACHINE BOLT, SQUARE NUT, TWO WASHERS	43-2325.07-124	B12	3/4	12"	2.1	6		8		12		14		18		20		24		26		30		54
55	DO	43-2325.07-1	B10	3/4	10"	1.86	6		8		12		14		18		20		24		26		30		55
56	DRIFT BOLT, SQUARE HEAD, WASHER	43-1636.07-2	D20	3/4	20"	3.0	12		16		24		28		36		40		48		52		60		56
57	STEEL WIRE NAIL	42-6028.3-6		60d		.10	14		14		14		14		14		14		14		14		14		57
58	DO	42-6028.3-5		50d		.08	344		444		710		920		1070		1400		1510		1780		1990		58
59	DO	42-6028.3-3		30d		.05	1990		2650		3952		5271		6590		7910		9210		10530		11850		59
60	DO	42-6028.3-2		20d		.04	24		38		58		68		88		98		118		128		148		60

COMPANION SHEETS

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STEEL SPANS, 15-TO 90-FOOT	94
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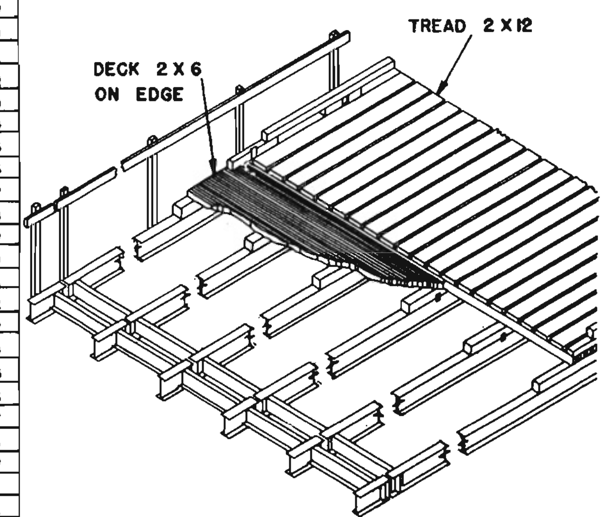

BILL OF MATERIALS FOR FLOOR AND STRINGER COMBINATIONS

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HARDWARE	96
4. ALTERNATE LAMINATED FLOOR	96
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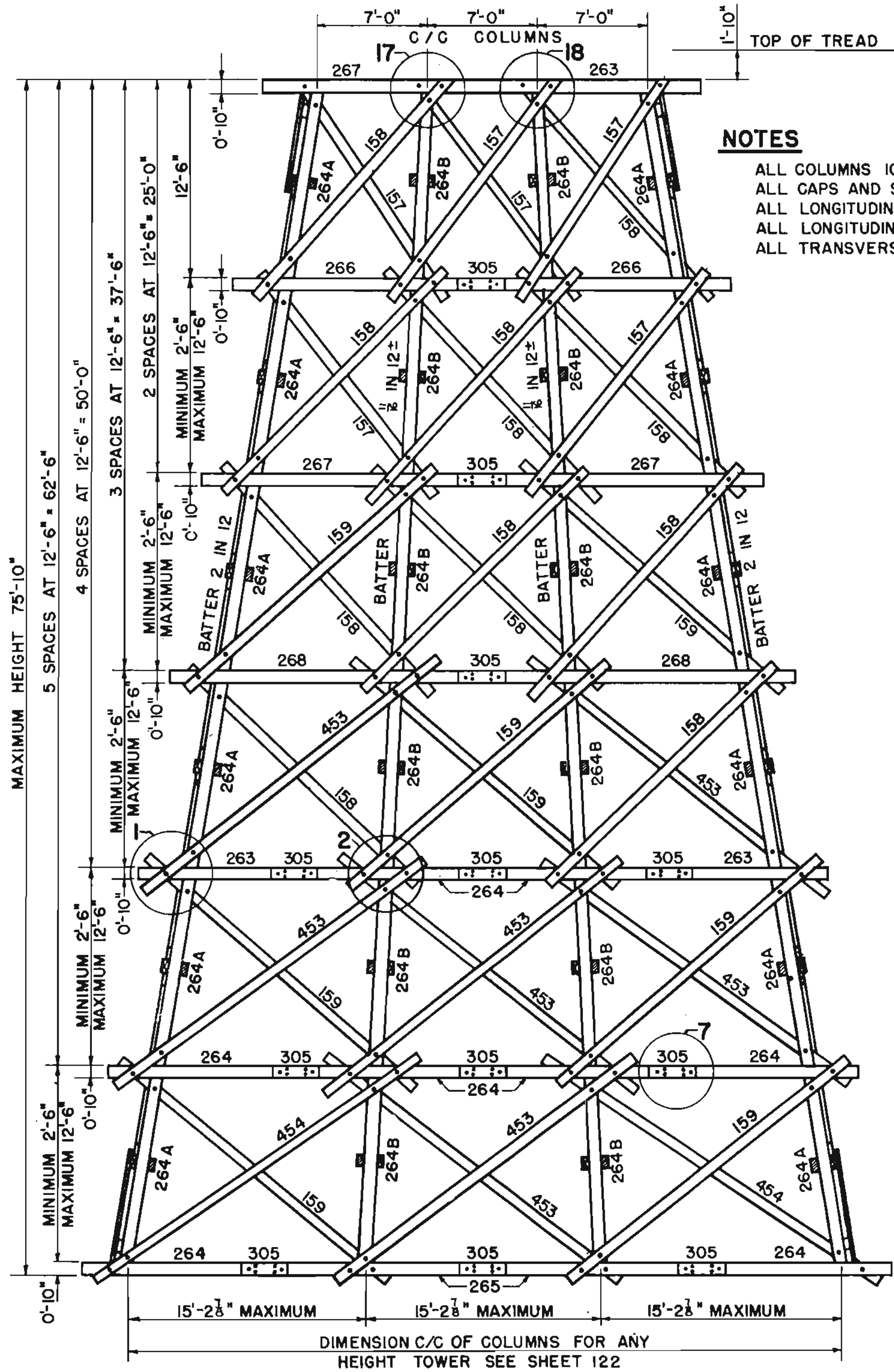
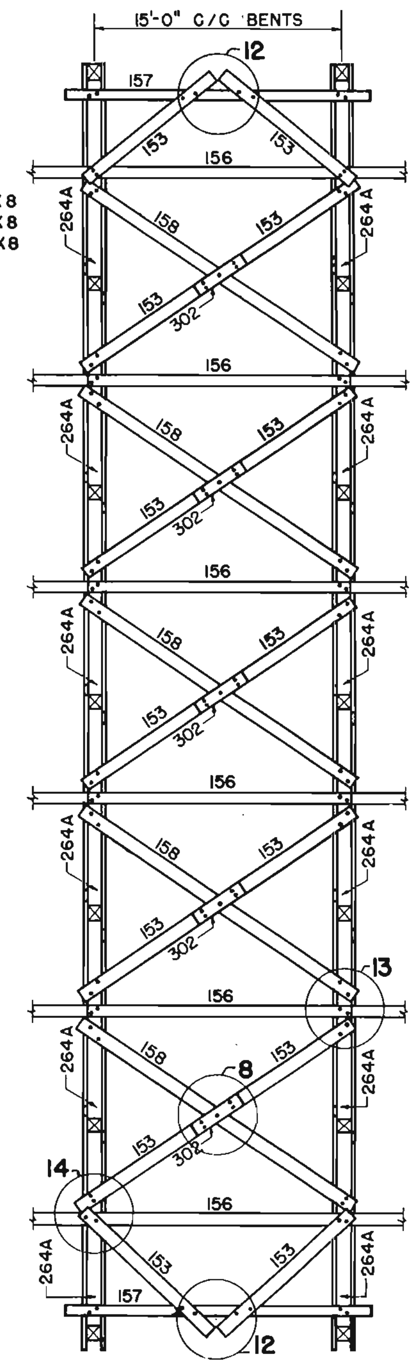


TRANSVERSE ELEVATION

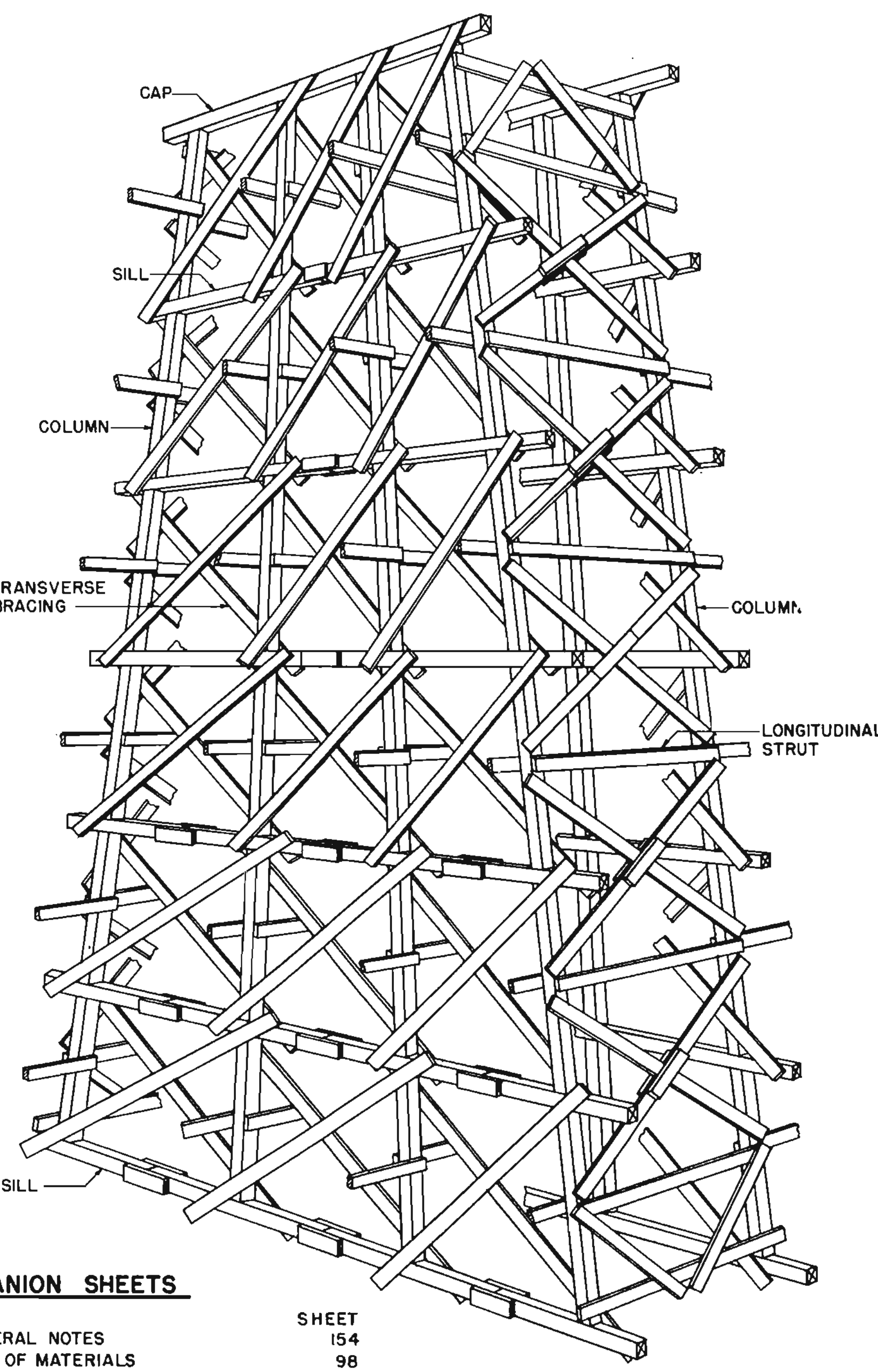
NOTES

ALL COLUMNS 10 X 10
ALL CAPS AND SILLS 10 X 10
ALL LONGITUDINAL STRUTS 4 X 8
ALL LONGITUDINAL BRACING 4 X 8
ALL TRANSVERSE BRACING 4 X 8



LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH



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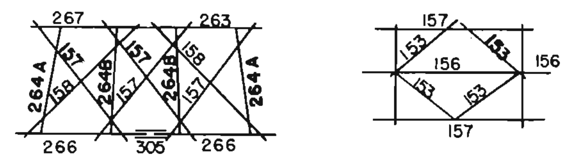
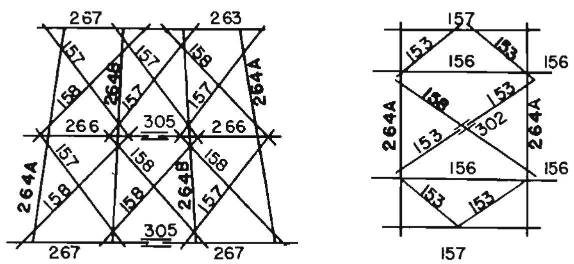
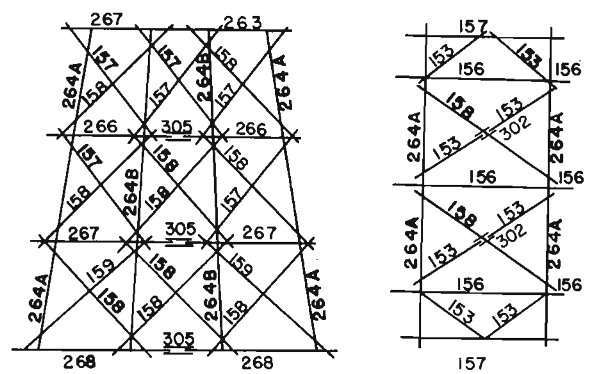


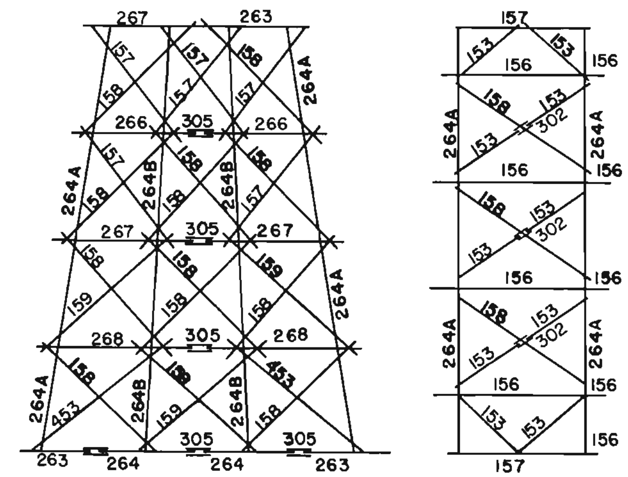
1-STORY TOWER



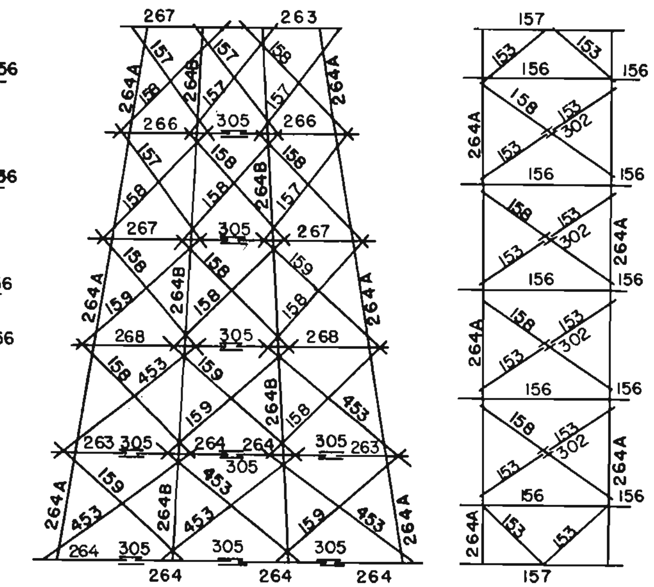
2-STORY TOWER



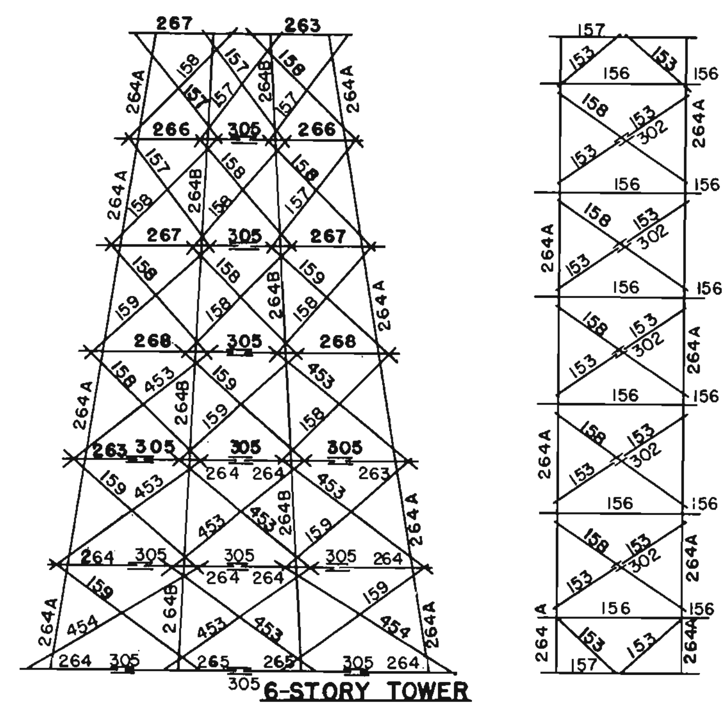
3-STORY TOWER



4-STORY TOWER



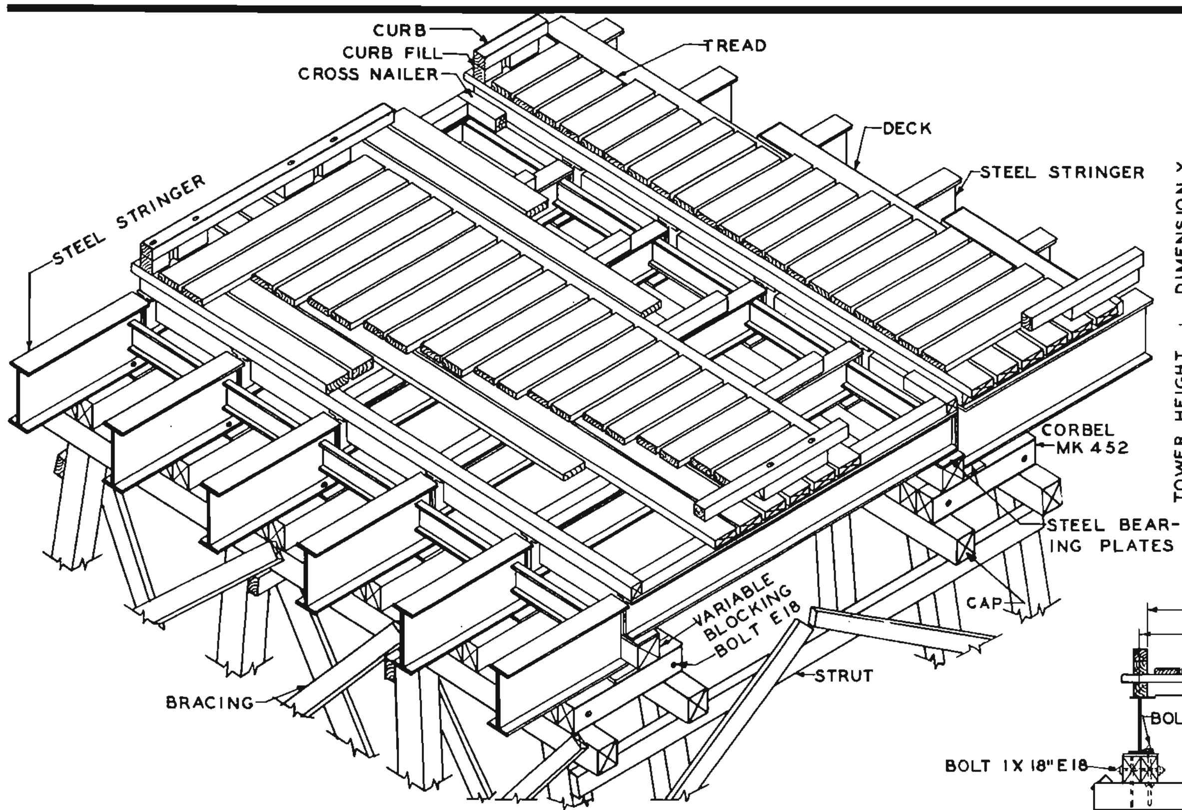
5-STORY TOWER



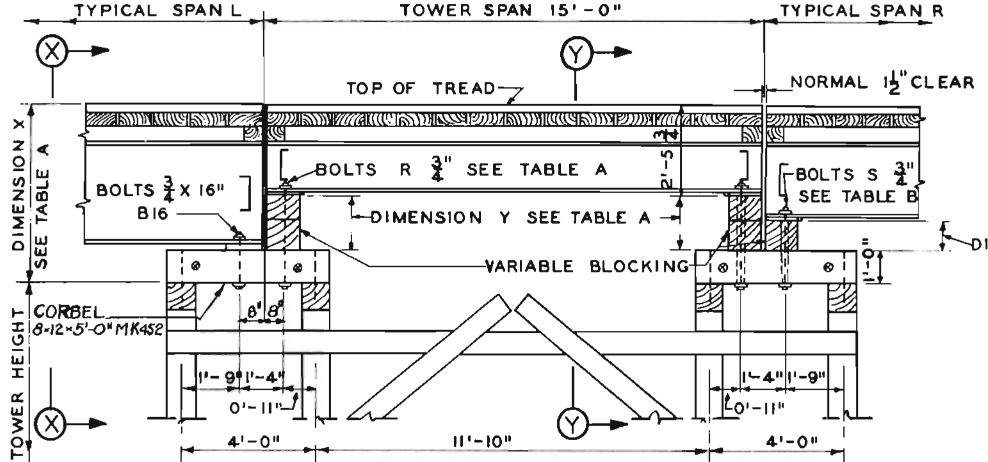
6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY FBM	5-STORY 63'-4" QUANTITY	5-STORY FBM	4-STORY 50'-10" QUANTITY	4-STORY FBM	3-STORY 38'-4" QUANTITY	3-STORY FBM	2-STORY 25'-10" QUANTITY	2-STORY FBM	1-STORY 13'-4" QUANTITY	1-STORY FBM
	LUMBER, SOFT WOOD																	
1	CAP	39-6620.1-18	267	10 X 10	18'-0"	563	2	300	2	300	2	300	2	300	2	300	2	300
2	DO	39-6620.1-1	263	10 X 10	10'-0"	313	2	157	2	167	2	167	2	157	2	167	2	167
3	SILL	39-6620.1-2	268	10 X 10	20'-0"	625	4	667	4	657	4	667	4	557				
4	DO	39-6620.1-18	267	10 X 10	18'-0"	563	4	600	4	600	4	600	4	500	4	600		
5	DO	39-6620.1-16	266	10 X 10	15'-0"	500	4	533	4	533	4	533	4	533	4	533	4	533
6	DO	39-6620.1-14	265	10 X 10	14'-0"	438	4	467										
7	DO	39-6620.1-12	264	10 X 10	12'-0"	375	16	1600	12	1200	4	400						
8	DO	39-6620.1-1	263	10 X 10	10'-0"	313	4	333	4	333	4	333						
9	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	24	2400	20	2000	16	1500	12	1200	8	800	4	400
10	DO	39-6620.1-12	264B	10 X 10	12'-0"	375	24	2400	20	2000	16	1500	12	1200	8	800	4	400
11	STRUT	39-3340.08-18	157	4 X 8	18'-0"	180	4	192	4	192	4	192	4	192	4	192	4	192
12	DO	39-3340.08-16	156	4 X 8	16'-0"	160	48	2048	40	1707	32	1365	24	1024	15	583	8	341
13	BRACING	39-3340.08-26	454	4 X 8	26'-0"	260	4	277										
14	DO	39-3340.08-24	453	4 X 8	24'-0"	240	16	1024	12	768	4	256						
15	DO	39-3340.08-22	159	4 X 8	22'-0"	220	15	939	12	704	8	459	4	235				
16	DO	39-3340.08-2	158	4 X 8	20'-0"	200	34	1813	32	1707	30	1600	24	1280	14	747	4	213
17	DO	39-3340.08-18	157	4 X 8	18'-0"	180	12	576	12	576	12	575	12	575	12	576	8	384
18	DO	39-3340.08-1	153	4 X 8	10'-0"	100	28	747	24	640	20	533	16	427	12	320	8	213
19	SCAB	39-3340.1	305	4 X 10	3'-0"	38	48	480	36	360	24	240	12	120	8	80	4	40
20	DO	39-3228.08	302	2 X 8	3'-4"	17	20	89	16	71	12	53	8	36	4	18		
	STEEL HARDWARE, BLACK																	
21	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-24	E24	1	24"	6.40	16		16		16		16		16		8	
22	DO	43-2325.1-2	E20	1	20"	5.61	332		260		189		116		69		28	
23	DO	43-2325.1-164	E16	1	16"	4.75	168		144		120		96		72		56	
24	DO	43-2325.1-104	E10	1	10"	3.45	66		56		46		36		26		16	
25	DRIFT BOLT, PLAIN	43-1636.07-2	D20	3/4	20"	2.5	146		122		98		74		50		26	



ASSEMBLED VIEW



LONGITUDINAL SECTION

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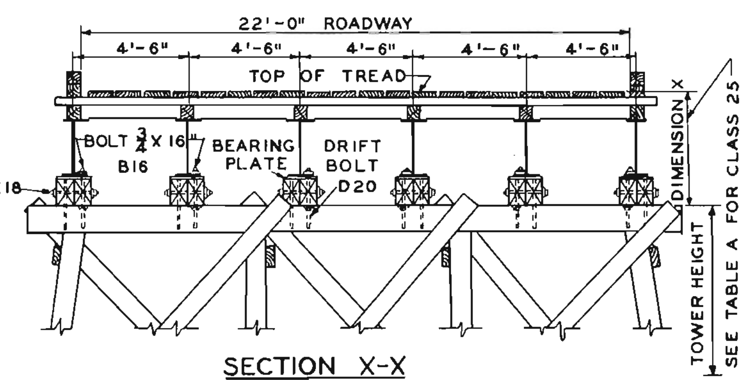
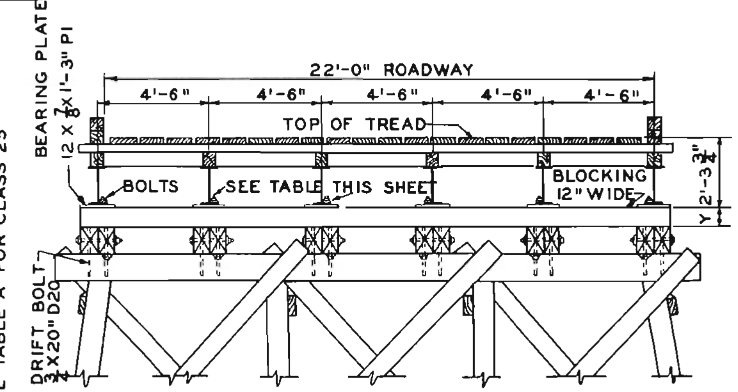


SECTION X-X



SECTION Y-Y

BILL OF SUPPLEMENTAL MATERIALS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	30' QUANTITY	30' FBM	40' QUANTITY	40' FBM	50' QUANTITY	50' FBM	60' QUANTITY	60' FBM	70' QUANTITY	70' FBM	80' QUANTITY	80' FBM	90' QUANTITY	90' FBM
						MAIN SPAN	15'		20'		30'		40'		50'		60'		70'		80'		90'	
						STRINGER SIZE	14 I 30		16 I 36		21 I 59		21 I 63		24 I 87		27 I 91		30 I 108		33 I 125		33 I 132	
						DIMENSION X	3'-3 3/4"		3'-5 3/4"		3'-10 3/4"		3'-10 7/8"		4'-2"		4'-4 3/4"		4'-7 3/4"		4'-10 7/8"		4'-11"	
						DIMENSION Y	0'-0"		0'-2"		0'-7"		0'-7 1/8"		0'-10 1/4"		1'-1"		1'-4"		1'-7 1/8"		1'-7 1/4"	
1	BEARING PLATE	47-7844.08	P1	12 X 7/8	1'-3"	44.6	24		24		24		24		24		24		24		24		24	
	LUMBER, SOFT WOOD																							
2	CORBEL	39-6616.12	452	8 X 12	5'-0"	150	24	960	24	960	24	960	24	960	24	960	24	960	24	960	24	960	24	960
3	BLOCKING	39-6630.12-12	284	12 X 12	12'-0"	540													4	576	4	576	4	576
4	DO	39-6620.12-12	274	10 X 12	12'-0"	450									4	480	4	480						
5	DO	39-6616.12-16	246	8 X 12	16'-0"	480					4	512	4	512							4	512	4	512
6	DO	39-3340.12-12	174	4 X 12	12'-0"	180													4	192				
7	DO	39-3952.12-12	134	3 X 12	12'-0"	135											4	144						
8	DO	39-3228.12-12	104	2 X 12	12'-0"	90			4	96														
	STEEL HARDWARE, BLACK																							
9	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-346	B34	3/4	34"	4.7															12		12	
10	DO	43-2325.07-32	B32	3/4	32"	4.5													12					
11	DO	43-2325.07-28	B28	3/4	28"	4.0											12							
12	DO	43-2325.07-266	B26	3/4	26"	3.8									12									
13	DO	43-2325.07-223	B22	3/4	22"	3.3					12		12											
14	DO	43-2325.07-183	B18	3/4	18"	2.8			12															
15	DO	43-2325.07-16	B16	3/4	16"	2.6	24		12		12		12		12		12		12		12		12	
16	DO	43-2325.1-18	E18	1	18"	5.0	24		24		24		24		24		24		24		24		24	
17	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-2	D20	3/4	20"	3.0	48		48		48		48		48		48		48		48		48	

TABLE A

		SPAN L	90'	80'	70'	60'	50'	40'	30'	20'	15'
		X	4'-11"	4'-10 7/8"	4'-7 3/4"	4'-4 3/4"	4'-2"	3'-10 7/8"	3'-10 3/4"	3'-5 3/4"	3'-3 3/4"
		Y	1'-7 1/4"	1'-7 1/8"	1'-4"	1'-1"	0'-10 1/4"	0'-7 1/8"	0'-7"	0'-2"	0"
TIMBER SPANS		W	2'-1"	2'-0 7/8"	1'-9 3/4"	1'-6 3/4"	1'-4"	1'-0 7/8"	1'-0 3/4"	0'-7 3/4"	0'-5 3/4"
TIMBER SPANS		BOLT A	38"	38"	36"	32"	30"	26"	26"	22"	20"
SPAN S	15'	W	1'-7 1/4"	1'-7 1/8"	1'-4"	1'-1"	0'-10 1/4"	0'-7 1/8"	0'-7"	0'-2"	
SPAN S	15'	BOLT A	34"	34"	32"	28"	26"	22"	22"	18"	
SPAN S	20'	W	1'-5 1/4"	1'-5 1/8"	1'-2"	0'-11"	0'-8 1/4"	0'-5 1/8"	0'-5"		
SPAN S	20'	BOLT A	32"	32"	30"	26"	24"	20"	20"		
SPAN S	30'	W	1'-0 1/4"	1'-0 1/8"	0'-9"	0'-6"	0'-3 1/4"	0'-0 1/8"			
SPAN S	30'	BOLT A	28"	28"	24"	22"	18"	16"			
SPAN S	40'	W	1'-0 1/8"	1'-0"	0'-8 7/8"	0'-5 7/8"	0'-3 1/8"				
SPAN S	40'	BOLT A	28"	28"	24"	22"	18"				
SPAN S	50'	W	0'-9"	0'-8 7/8"	0'-5 3/4"	0'-2 3/4"					
SPAN S	50'	BOLT A	24"	24"	22"	18"					
SPAN S	60'	W	0'-6 1/4"	0'-6 1/8"	0'-3"						
SPAN S	60'	BOLT A	22"	22"	18"						
SPAN S	70'	W	0'-3 1/4"	0'-3 1/8"							
SPAN S	70'	BOLT A	18"	18"							
SPAN S	80'	W	0'-0 1/8"								
SPAN S	80'	BOLT A	16"								

NOTE

ALL CAPS 10 X 12
ALL SILLS 10 X 10
ALL COLUMNS 10 X 10
ALL LONGITUDINAL STRUTS 4 X 8
ALL LONGITUDINAL BRACING 4 X 8
ALL TRANSVERSE BRACING 4 X 8

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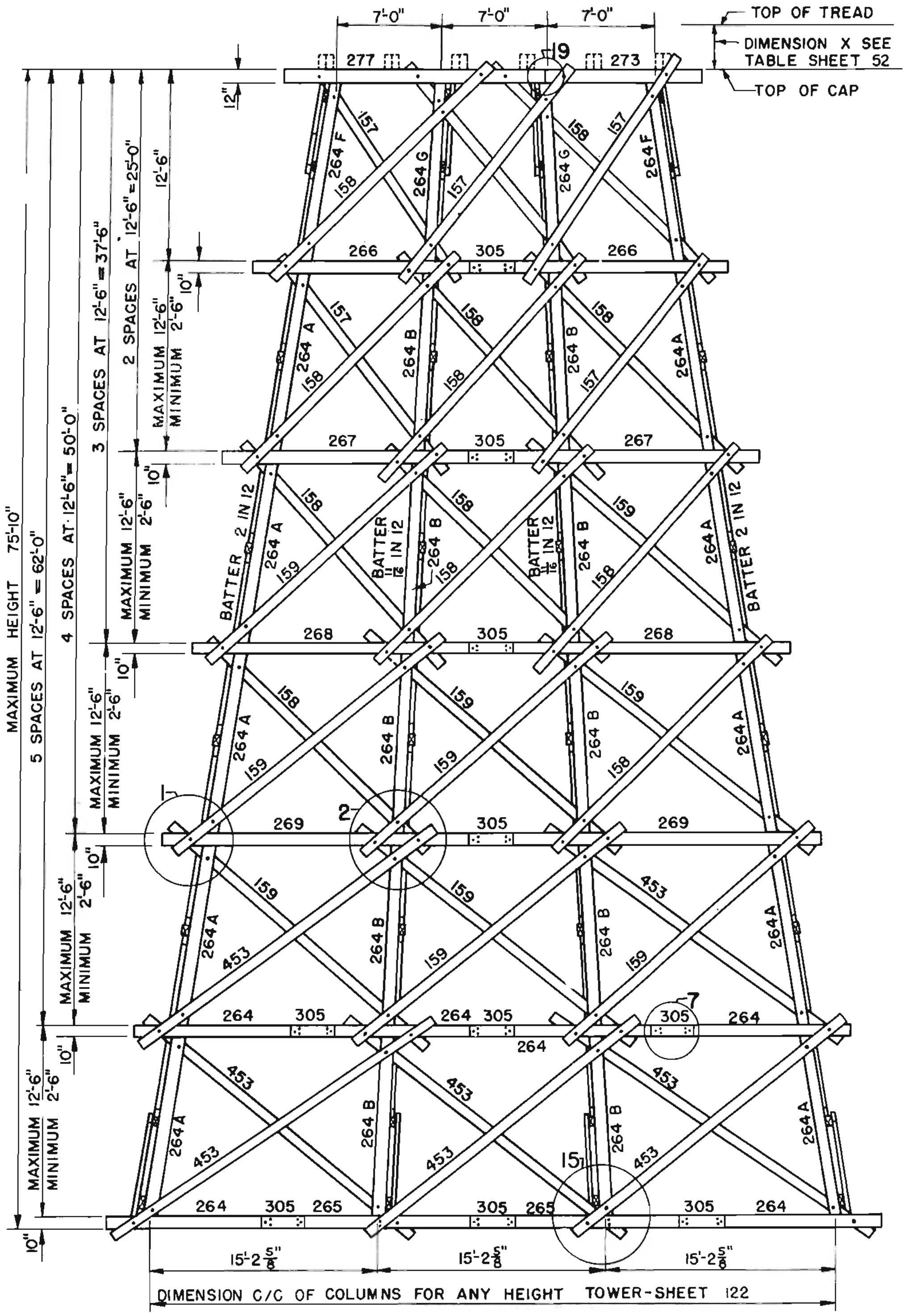
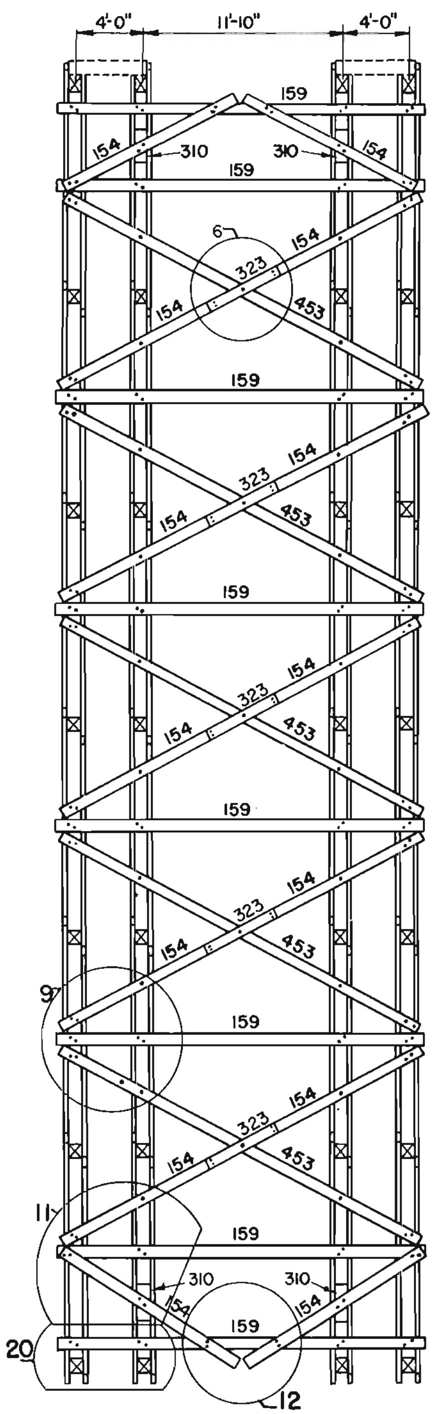
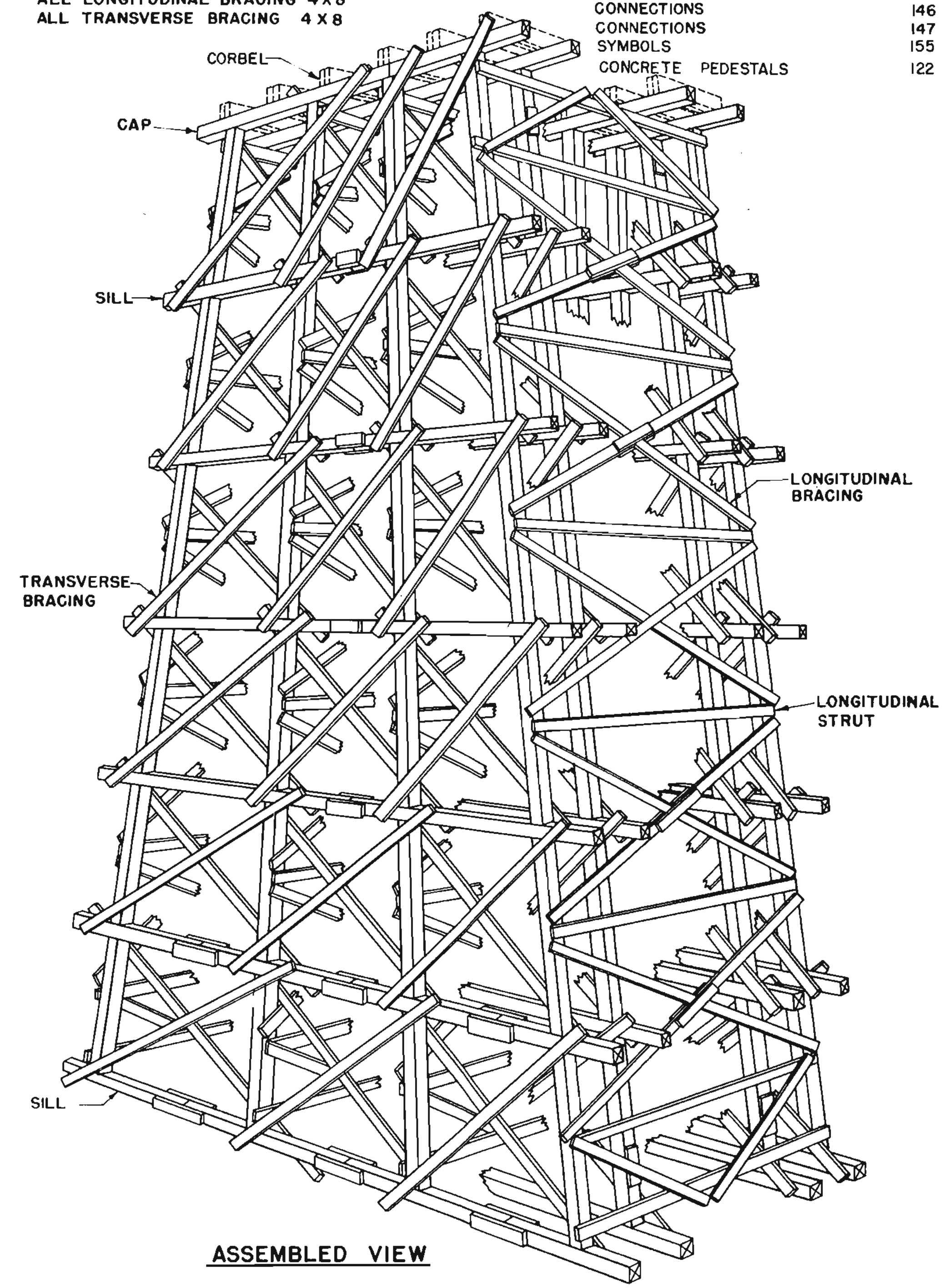


TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH



ASSEMBLED VIEW

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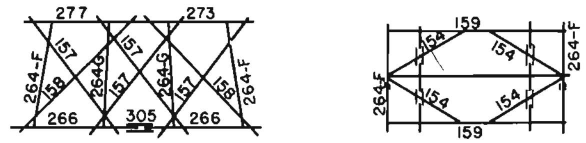
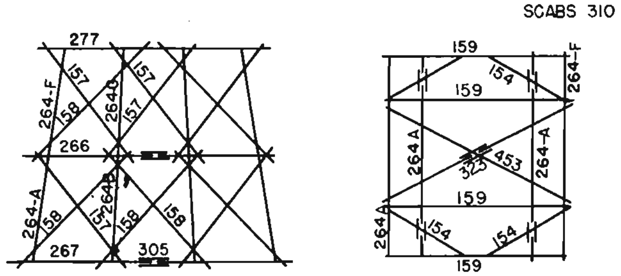
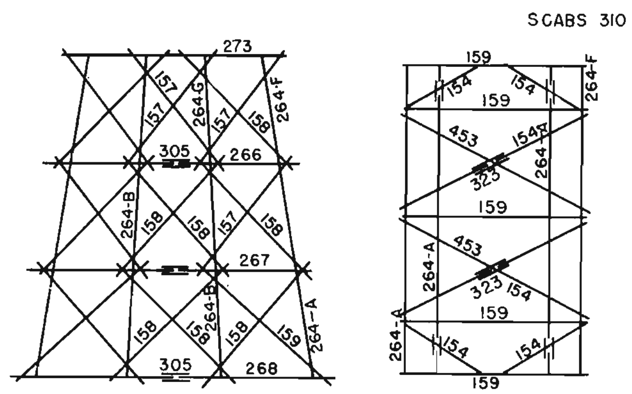


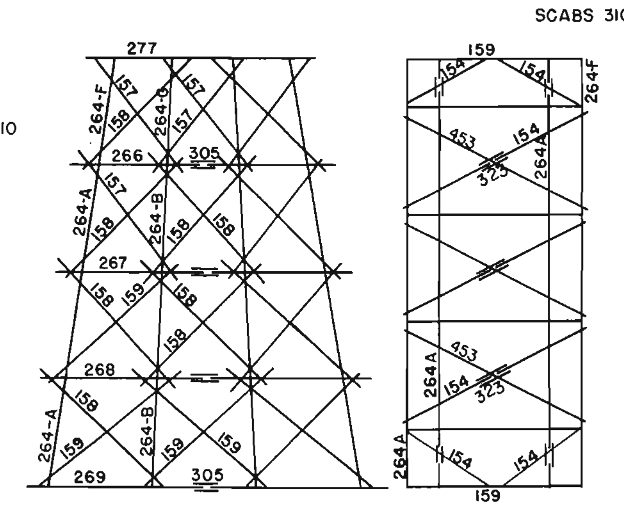
I STORY TOWER



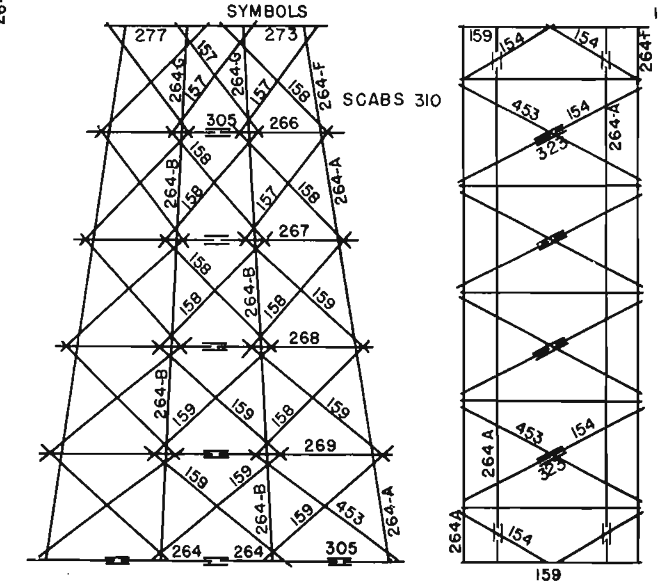
2-STORY TOWER



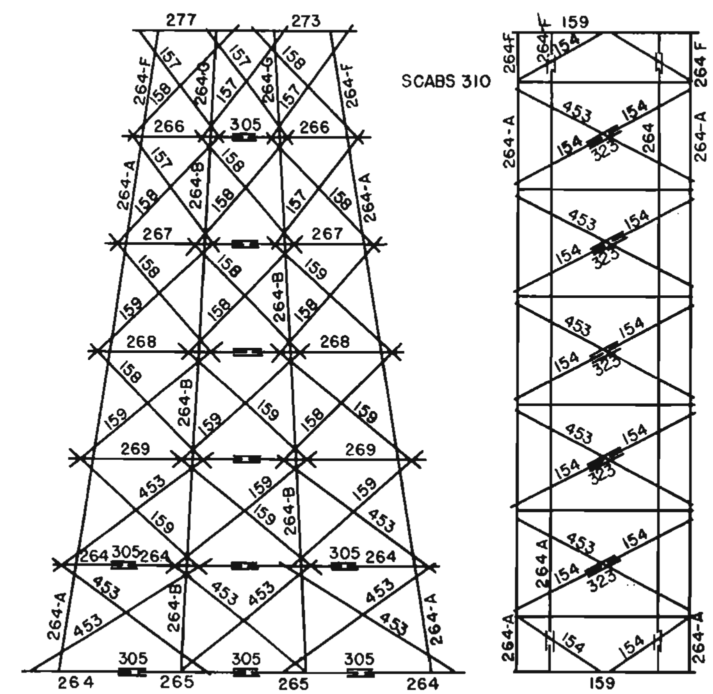
3-STORY TOWER



4-STORY TOWER



5-STORY TOWER



6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY 75'-10" QUANTITY	6-STORY FBM	5-STORY 63'-4" QUANTITY	5-STORY FBM	4-STORY 50'-10" QUANTITY	4-STORY FBM	3-STORY 38'-4" QUANTITY	3-STORY FBM	2-STORY 25'-10" QUANTITY	2-STORY FBM	1-STORY 13'-4" QUANTITY	1-STORY FBM
	LUMBER, SOFT WOOD																	
1	CAP	39-6630.12	277	10 X 12	18'-0"	675	4	720	4	720	4	720	4	720	4	720	4	720
2	DO	39-6630.12	273	10 X 12	10'-0"	375	4	400	4	400	4	400	4	400	4	400	4	400
3	SILL	39-6620.1-22	269	10 X 10	22'-0"	688	8	1467	8	1467	8	1467						
4	DO	39-6620.1-2	268	10 X 10	20'-0"	625	8	1333	8	1333	8	1333	8	1333				
5	DO	39-6620.1-18	267	10 X 10	18'-0"	563	8	1200	8	1200	8	1200	8	1200	8	1200		
6	DO	39-6620.1-16	266	10 X 10	16'-0"	500	8	1067	8	1067	8	1067	8	1067	8	1067	8	1067
7	DO	39-6620.1-14	265	10 X 10	14'-0"	438	8	933										
8	DO	39-6620.1-12	264	10 X 10	12'-0"	375	24	2400	16	1600								
9	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	40	4000	32	3200	24	2400	16	1600	8	800		
10	DO	39-6620.1-12	264B	10 X 10	12'-0"	375	40	4000	32	3200	24	2400	16	1600	8	800		
11	DO	39-6620.1-12	264F	10 X 10	12'-0"	375	8	800	8	800	8	800	8	800	8	800	8	800
12	DO	39-6620.1-12	264G	10 X 10	12'-0"	375	8	800	8	800	8	800	8	800	8	800	8	800
13	STRUT	39-3340.08-22	159	4 X 8	22'-0"	220	32	1877	28	1643	24	1408	20	1173	16	939	12	704
14	BRACING	39-3340.08-24	453	4 X 8	24'-0"	240	52	3328	24	1536	12	768	8	512	4	256		
15	DO	39-3340.08-22	159	4 X 8	22'-0"	220	40	2347	40	2347	24	1408	8	469				
16	DO	39-33[illegible].08-2	158	4 X 8	20'-0"	200	48	2560	48	2560	48	2560	40	2133	24	1280	8	427
17	DO	39-3340.08-18	157	4 X 8	18'-0"	180	24	1152	24	1152	24	1152	24	1152	24	1152	16	768
18	DO	39-3340.08-12	154	4 X 8	12'-0"	120	56	1792	48	1536	40	1280	32	1024	24	768	16	512
19	SCAB	39-3340.1	305	4 X 10	3'-0"	38	80	800	56	560	32	320	24	240	16	160	8	80
20	DO	39-3340.1	310	4 X 10	2'-0"	25	16	107	16	107	16	107	16	107	16	107	24	160
21	DO	39-3880.08	323	2 X 8	3'-8"	18	40	196	32	156	24	117	16	78	8	39		
	STEEL HARDWARE, BLACK																	
22	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.6	512		400		288		224		160		96	
23	DO	43-2325.1-164	E16	1	16"	4.7	624		528		432		336		240		160	
24	DO	43-2325.1-104	E10	1	10"	3.4	132		112		92		72		52		32	
25	DRIFT BOLT, PLAIN	43-1636.07-2	D20	3/4	20"	2.5	292		244		196		148		100		52	

NOTES

ALL DETAILS FOR CLASS 50 DOUBLE-LANE TOWERS ARE TO BE USED FOR CLASS 25 DOUBLE-LANE TOWERS, EXCEPT AS FOLLOWS:

1. USE CAP BEAM MK 615 SHOWN ON THIS SHEET INSTEAD OF CAP BEAM MK 675 SHOWN ON SHEET 59.
2. USE SHIMS ON SHEET 103 INSTEAD OF SHIMS ON SHEET 63.

FOR BILL OF MATERIALS FOR ONE CLASS 25 DOUBLE-LANE TOWER SEE:

1. SHEET 57, MATERIALS COMMON TO ALL TOWER HEIGHTS
2. SHEET 58, MATERIALS FOR PIECES WHICH VARY WITH DIFFERENT TOWER HEIGHTS

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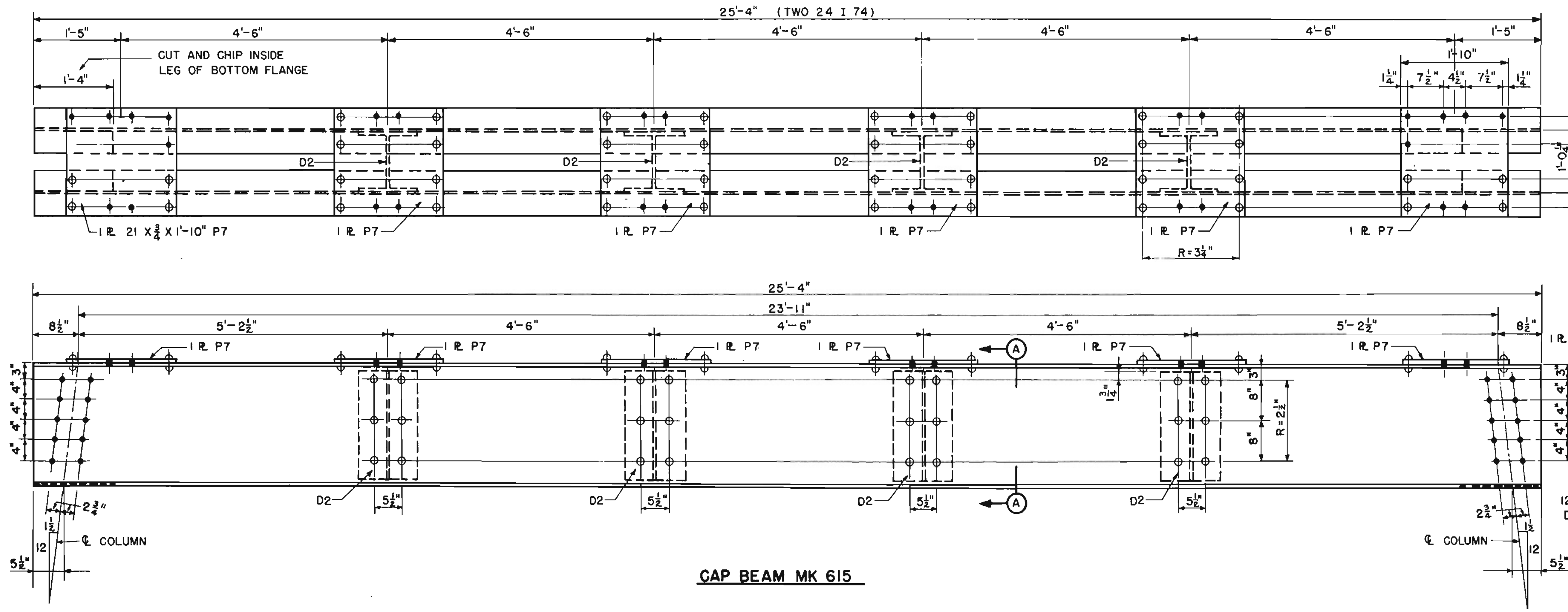
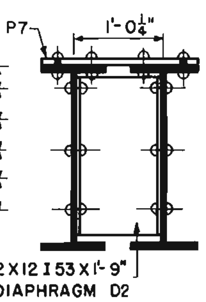
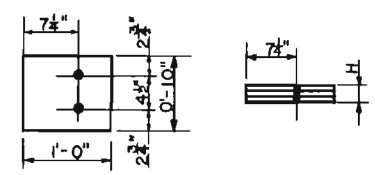


CAP BEAM MK 615



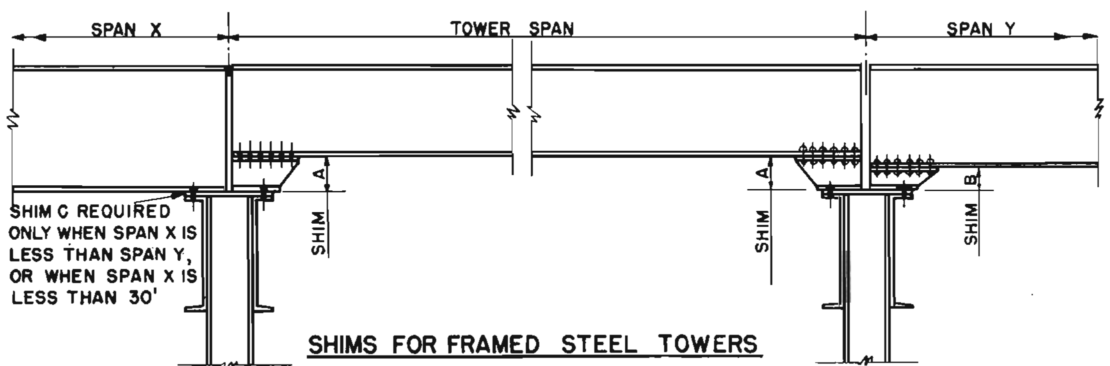
SECTION A-A



DETAIL OF PLATE SHIM

BILL OF MATERIALS FOR ONE PLATE SHIM

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	7501 H = 2" QUANTITY	7502 H = 2 3/4" QUANTITY	7503 H = 3 1/8" QUANTITY	
PLATE	47-7844.07	10X3/4	1'-0"	26		1	3	
DO	47-7844.08	10X7/8	1'-0"	30			1	
DO	47-7844.1	10 X 1	1'-0"	34	2	2		
ANCHOR BOLT	43-2219.08-05	7/8	5"	1.2	2			
DO	43-2219.08-07	7/8	7"	1.7		2	2	

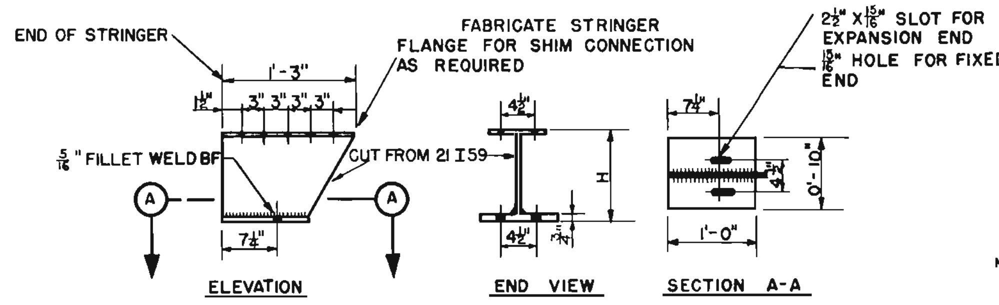


SHIMS FOR FRAMED STEEL TOWERS

PROVIDE 2 ANCHOR BOLTS ⅞ X 4" PER STRINGER WHEN SHIMS ARE NOT REQUIRED

SHIMS FOR FRAMED STEEL TOWERS

SPAN Y		SPAN X: 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	A	7513	7512	7509	7505	7503				
	B	7518	7518	7516	7514	7510	7507	7507	7507	7507
	C								7504	7507
20'	A	7513	7512	7509	7505	7503				
	B	7517	7517	7515	7511	7508	7504	7504	7504	7504
	C								7504	7507
30'	A	7513	7512	7509	7505	7503				
	B	7513	7512	7509	7505	7503				
	C								7504	7507
40'	A	7513	7512	7509	7505	7503				
	B	7512	7512	7509	7505	7503				
	C								7504	7507
50'	A	7513	7512	7509	7505	7503	7503	7503	7503	7503
	B	7509	7509	7505	7502					
	C						7503	7503	7508	7510
60'	A	7513	7512	7509	7505	7505	7505	7505	7505	7505
	B	7506	7506	7503						
	C					7502	7505	7505	7511	7514
70'	A	7513	7512	7509	7509	7509	7509	7509	7509	7509
	B	7503	7503							
	C				7503	7505	7509	7509	7515	7516
80'	A	7513	7512	7512	7512	7512	7512	7512	7512	7512
	B									
	C			7503	7506	7509	7512	7512	7517	7518
90'	A	7513	7513	7513	7513	7513	7513	7513	7513	7513
	B									
	C			7503	7506	7509	7512	7513	7517	7518



DETAIL OF BUILT-UP SHIM

BILL OF MATERIALS FOR ONE BUILT-UP SHIM

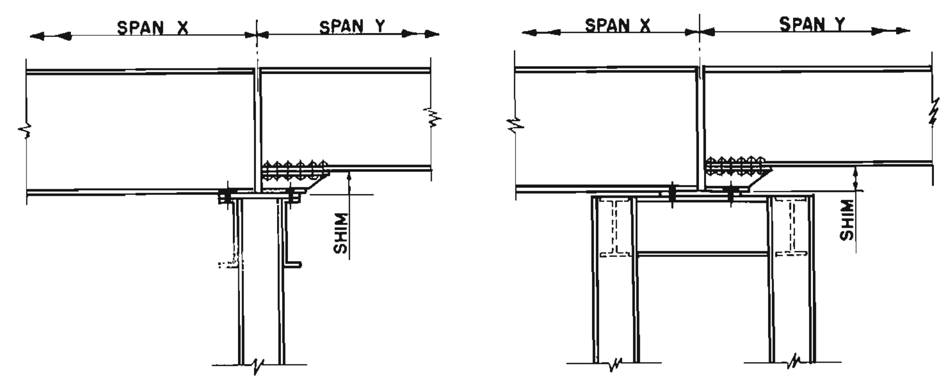
DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	QUANTITY
BEAM	48-2600.21-059	21 I 59	1'-3"	1
PLATE	47-7844.07	10X3/4	1'-0"	1
RIVET	43-6353.08	7/8	2 3/4"	10
ANCHOR BOLT	43-2219.08-04	7/8	4"	2
ELECTRODE	46-3772.2-7	3/16		1-LB

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS, RIVETED	116,117
STEEL PILE BENTS AND PIERS, WELDED	119,120
FRAMED STEEL TOWERS	55,56

MARKS AND DIMENSIONS FOR BUILT-UP SHIMS

MARK	H	TOTAL WEIGHT (POUNDS)
7504	5"	52
7505	5 7/8"	53
7506	6 1/4"	54
7507	7"	54
7508	8 1/4"	57
7509	8 7/8"	58
7510	10 1/4"	60
7511	11"	61
7512	12"	62
7513	12 1/4"	63
7514	13"	64
7515	14"	65
7516	16"	68
7517	17 1/8"	70
7518	19 1/8"	73



SHIMS FOR STEEL PILE BENTS AND PIERS

BILL OF MATERIALS FOR ANCHOR BOLTS ONLY WITHOUT SHIMS

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)
ANCHOR BOLT	43-2219.08-04	7/8	0'-4"	1.2

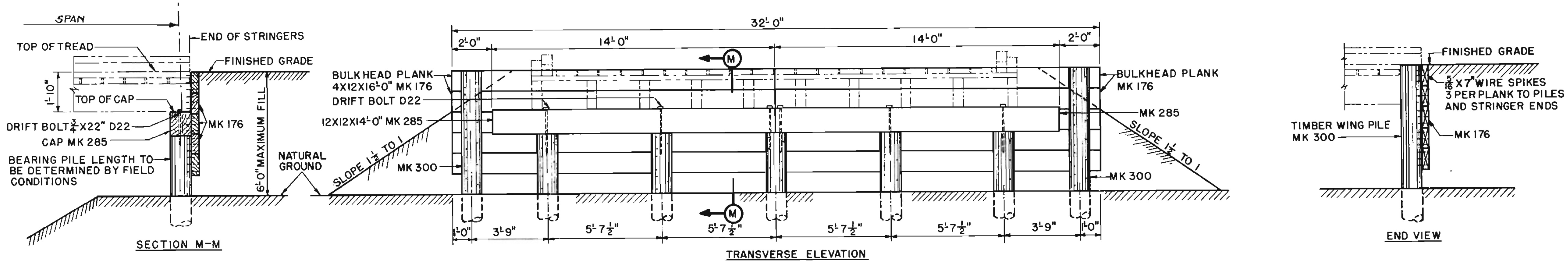
TWO BOLTS REQUIRED FOR EACH STRINGER SUPPORT
CONSTRUCTION INDICATED BY BLANK SPACES IN TABLES FOR SHIMS

SHIMS FOR STEEL PILE BENTS AND PIERS

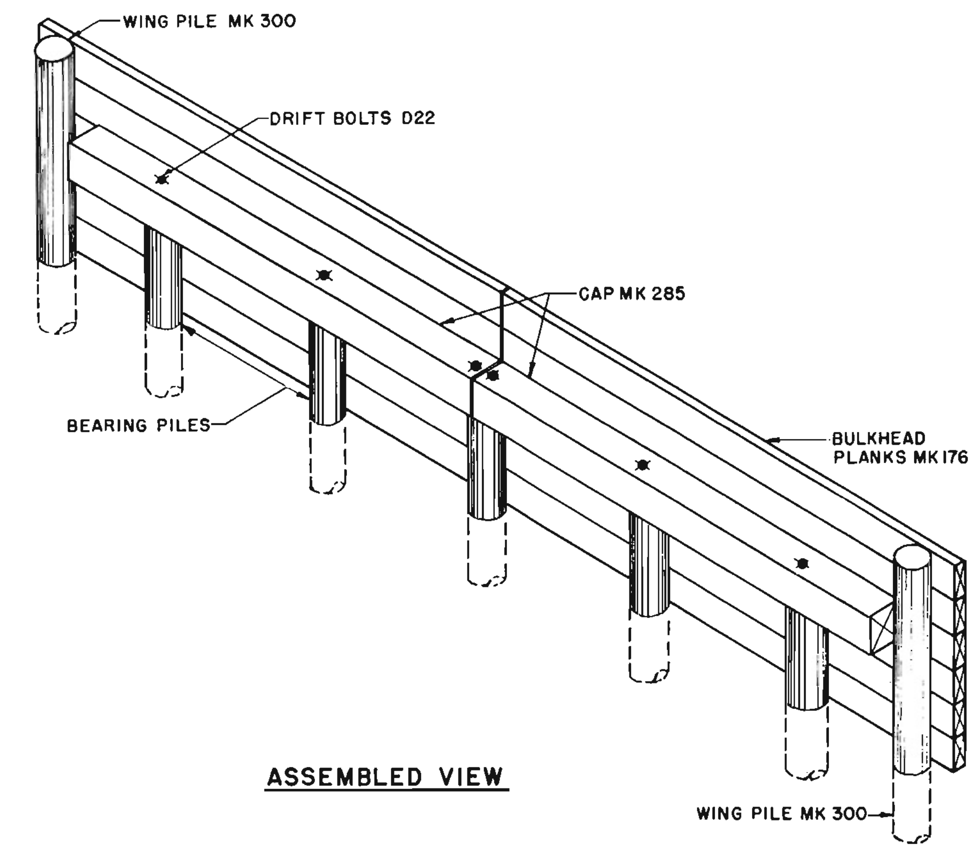
SPAN Y	SPAN X: 90'	80'	70'	60'	50'	40'	30'	20'	15'
15'	7518	7518	7516	7514	7510	7507	7507	7501	
20'	7517	7517	7515	7511	7508	7504	7504		7501
30'	7513	7512	7509	7505	7503			7504	7507
40'	7512	7512	7509	7505	7503			7504	7507
50'	7509	7509	7505	7502		7503	7503	7508	7510
60'	7506	7506	7503		7502	7505	7505	7511	7514
70'	7503	7503		7503	7505	7509	7509	7515	7516
80'			7503	7506	7509	7512	7512	7517	7518
90'			7503	7506	7509	7512	7513	7517	7518

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	105



TIMBER PILE ABUTMENT SUPPORTING 11' TO 15' TIMBER-STRINGER SPANS



ASSEMBLED VIEW

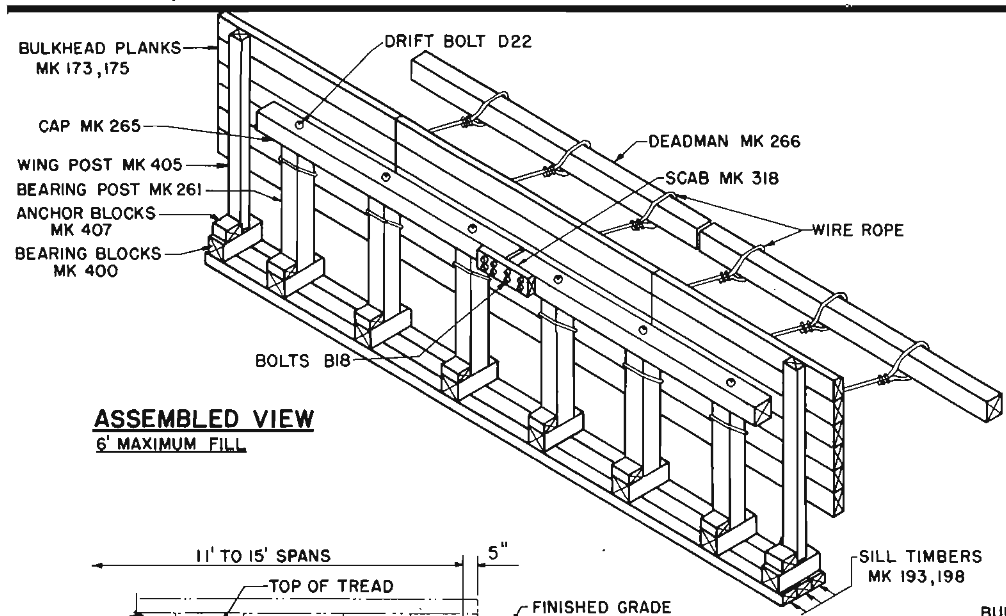
BILL OF MATERIALS FOR ONE ABUTMENT

LINE	TYPE OF ABUTMENT						TIMBER PILE ABUTMENT		TIMBER GRILLAGE ABUTMENT				LINE
	FILL HEIGHT						6' MAXIMUM		6' MAXIMUM		3' MAXIMUM		
	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	
1	3/ BULKHEAD PLANK	39-3340.12-16	176	4 X 12	16'-0"	240	12	768					1
2	3/ DO	39-3340.12-14	175	4 X 12	14'-0"	210			6	336			2
3	3/ DO	39-3340.12-12	174	4 X 12	12'-0"	180					3	144	3
4	3/ DO	39-3340.12	173	4 X 12	10'-0"	150			12	480	6	240	4
5	PILE (WING)		300		15'-0"		2						5
6	1/ PILE (BEARING)				1/		5						6
7	2/ POST (WING)	39-3360.08	405	6 X 8	8'-6"	128			2	68			7
8	2/ DO	39-3360.08	320	6 X 8	3'-2"	47					2	25	8
9	2/ POST (BEARING)	39-6620.1	261	10 X 10	6'-0"	188			6	300			9
10	CAP	39-6630.12-14	285	12 X 12	14'-0"	630	2	336					10
11	DO	39-6630.1-14	265	10 X 10	14'-0"	437			2	233	2	233	11
12	SCAB	39-3330.1	318	3 X 10	2'-8"	25			2	13			12
13	DO	39-3330.1	306	3 X 10	2'-0"	19					2	10	13
14	GRILLAGE TIMBERS	39-3360.08	193	6 X 8	10'-0"	150			3	120	3	120	14
15	DO	39-3360.08-2	198	6 X 8	20'-0"	300			3	240	3	240	15
16	BEARING BLOCK	39-6620.1	400	10 X 10	2'-0"	63			8	133	8	133	16
17	DEADMAN	39-6620.1-16	266	10 X 10	16'-0"	500			2	267			17
18	ANCHOR BLOCK	39-3360.08	407	6 X 8	0'-10"	13			8	26	6	20	18
	STEEL HARDWARE, BLACK												
19	WIRE ROPE	22-4567.4-05		1/2	20'-0"	13			8				19
20	WIRE-ROPE CLIP	42-3544.5-05		1/2		0.72			32				20
21	MACHINE BOLT WITH NUT AND TWO WASHERS	43-2325.07-2	B20	3/4	20"	3.06					4		21
22	DO	43-2325.07-183	B18	3/4	18"	2.92			8		8		22
23	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	2.76	6		6		6		23
24	STANDARD WIRE SPIKE	42-8488.04-1		3/8	10"	0.33			96		60		24
25	DO	42-8488.035-07		5/16	7"	0.14	136		172		52		25

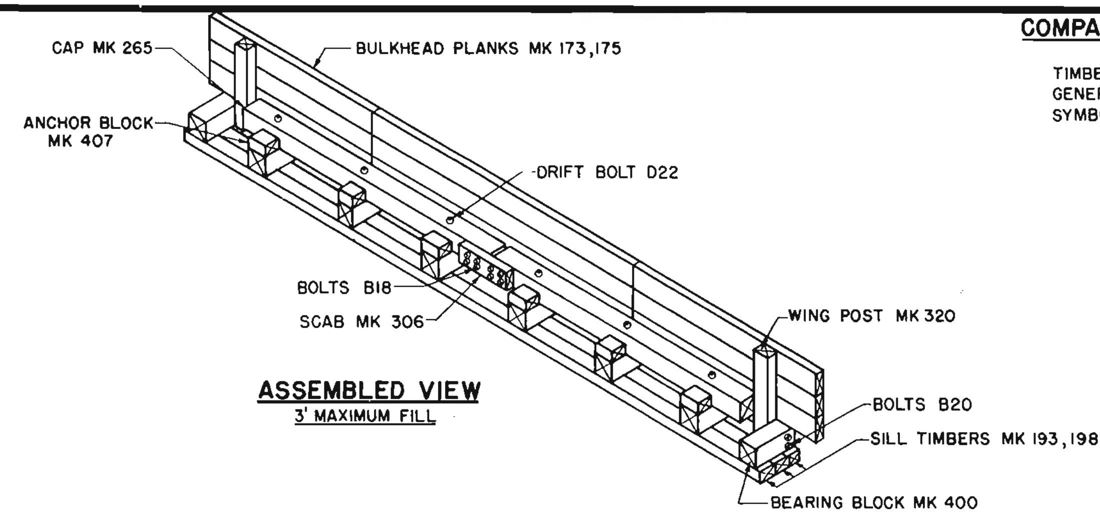
1/ BEARING PILE LENGTHS TO BE DETERMINED BY FIELD CONDITIONS.
2/ CUT TO FIT FOR FILLS LESS THAN 6 FEET.
3/ NUMBER OF BULKHEAD PLANKS BILLED IS FOR MAXIMUM FILL; USE FEWER PLANKS FOR SHALLOWER FILLS.

COMPANION SHEETS

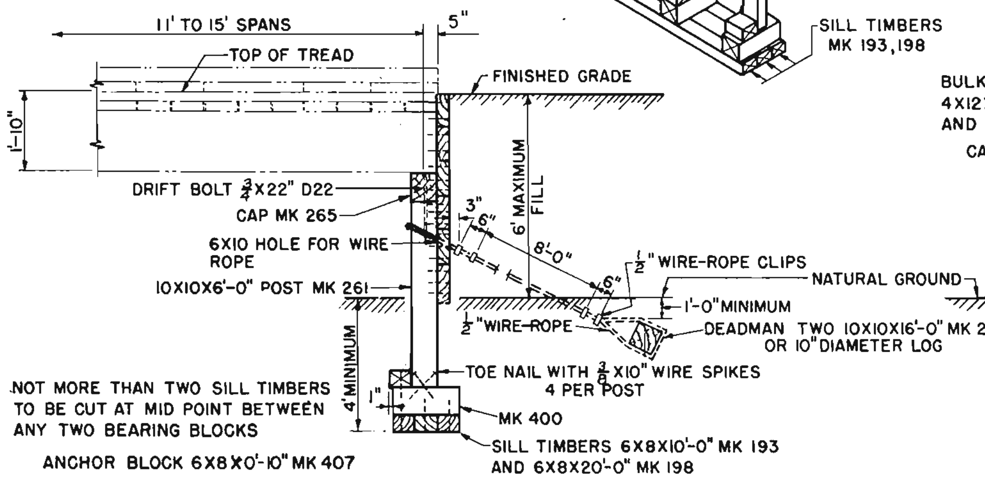
	SHEET
TIMBER ABUTMENTS FOR TIMBER SPANS	104
GENERAL NOTES	154
SYMBOLS	155



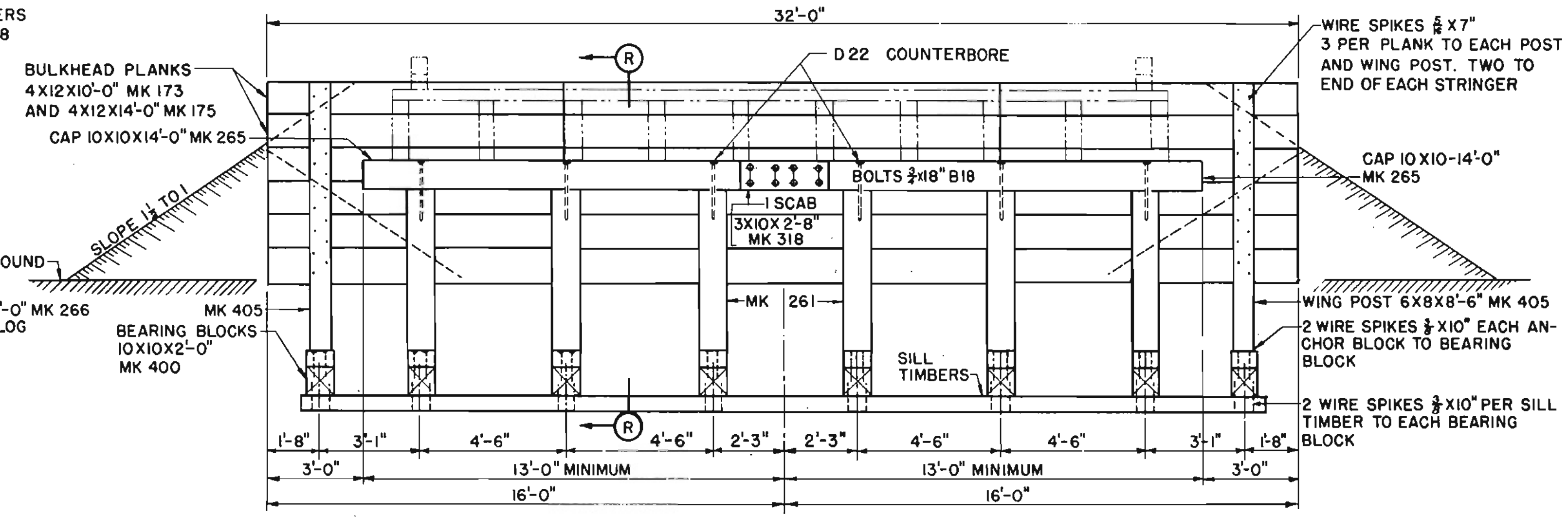
ASSEMBLED VIEW
6' MAXIMUM FILL



ASSEMBLED VIEW
3' MAXIMUM FILL

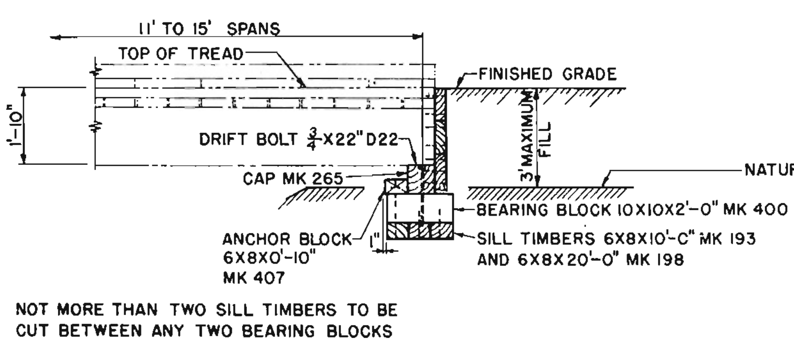


SECTION R-R

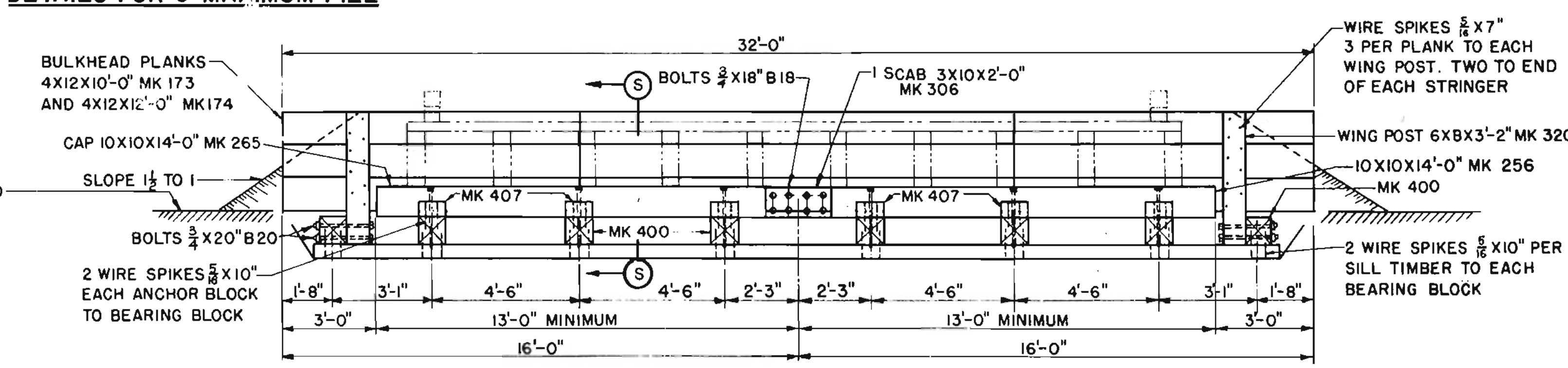


TRANSVERSE ELEVATION

DETAILS FOR 6' MAXIMUM FILL



SECTION S-S



TRANSVERSE ELEVATION

DETAILS FOR 3' MAXIMUM FILL

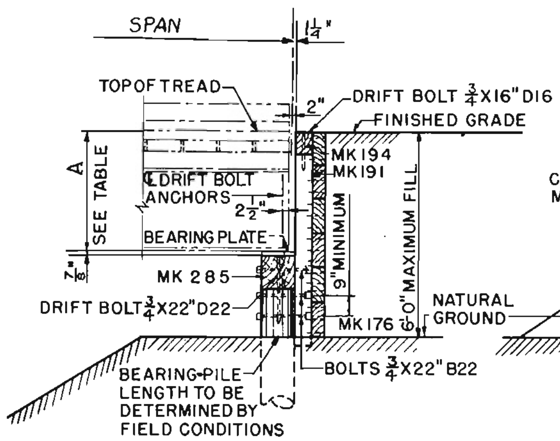
TIMBER GRILLAGE ABUTMENTS SUPPORTING 11' TO 15' TIMBER-STRINGER SPAN

BILL OF MATERIALS, BEARING PLATES FOR ONE TIMBER ABUTMENT

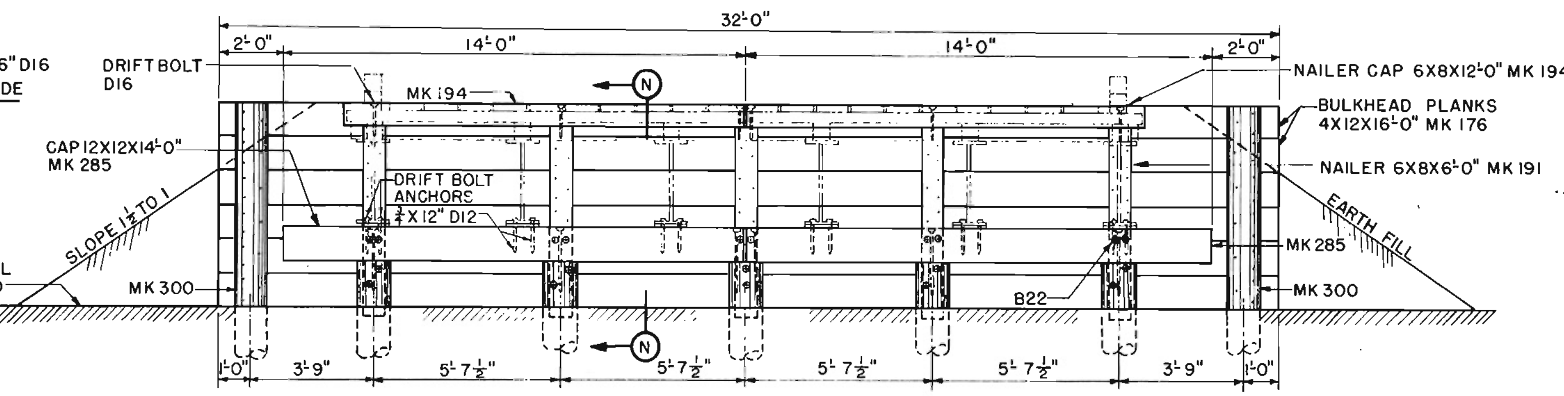
SPAN	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY
15' TO 90'	47-7844.08	P3500	12X7/8	1'-3"	45	6

COMPANION SHEETS

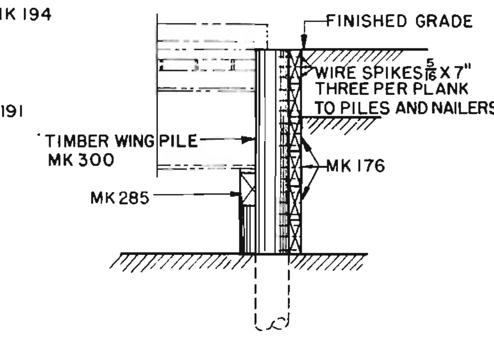
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	107
TIMBER ABUTMENTS	108



SECTION N-N



TRANSVERSE ELEVATION



END VIEW

TIMBER PILE ABUTMENT SUPPORTING 15' TO 90' STEEL-STRINGER SPAN

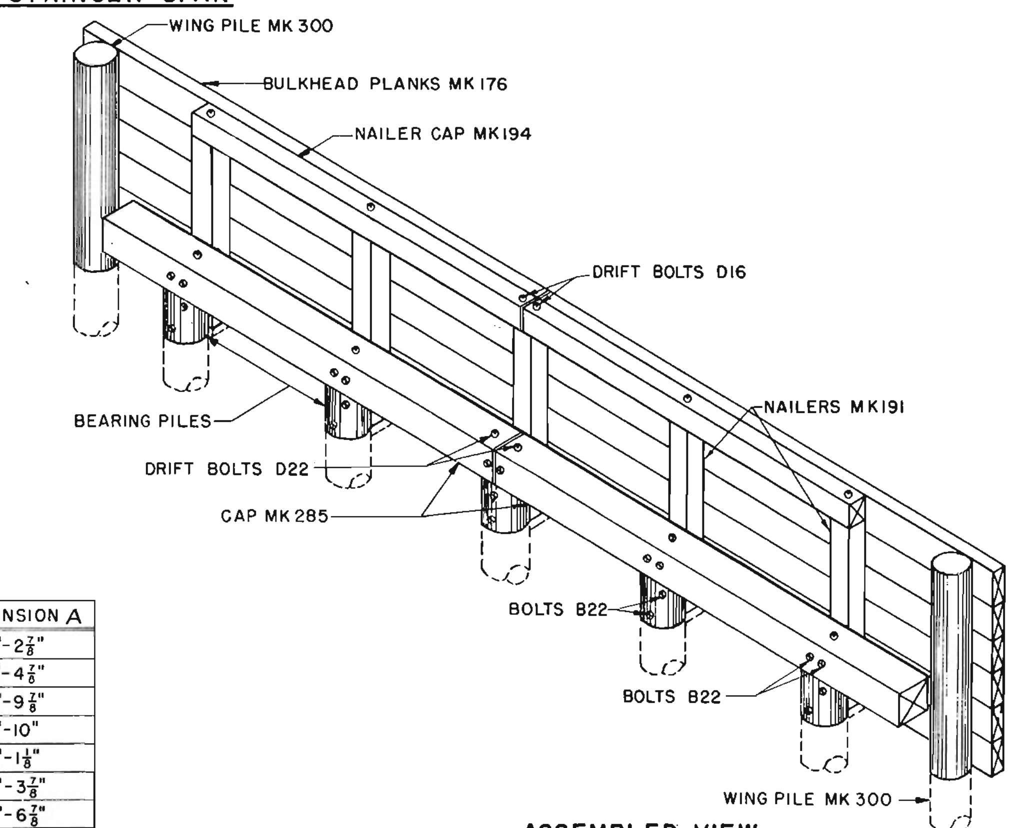
BILL OF MATERIALS FOR ONE ABUTMENT

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	TIMBER PILE ABUTMENT, 6' MAXIMUM: QUANTITY	TIMBER PILE ABUTMENT, 6' MAXIMUM: FBM	TIMBER GRILLAGE ABUTMENT, 6' MAXIMUM: QUANTITY	TIMBER GRILLAGE ABUTMENT, 6' MAXIMUM: FBM	TIMBER GRILLAGE ABUTMENT, 3' MAXIMUM: QUANTITY	TIMBER GRILLAGE ABUTMENT, 3' MAXIMUM: FBM	LINE
1	[3] BULKHEAD PLANK	39-3340.12	173	4 X 12	10'-0"	150			12	480	8	320	1
2	[3] DO	39-3340.12-12	174	4 X 12	12'-0"	180					4	192	2
3	[3] DO	39-3340.12-14	175	4 X 12	14'-0"	210			6	336			3
4	[3] DO	39-3340.12-16	176	4 X 12	16'-0"	240	12	768					4
5	PILE (WING)		300		15'-0"		2						5
6	[2] PILE (BEARING)				[2]		5						6
7	[1] POST (WING)	39-3360.08	405	6 X 8	8'-6"	128			2	68			7
8	[1] DO	39-3360.08	404	6 X 8	5'-6"	83					2	44	8
9	[1] POST (BEARING)	39-6620.1	416	10 X 10	5'-6 1/4"	172			6	275			9
10	CAP	39-6630.12-14	285	12 X 12	14'-0"	630	2	336					10
11	DO	39-6620.1-14	265	10 X 10	14'-0"	437			2	233	2	233	11
12	SCAB	39-3330.1	318	3 X 10	2'-8"	25			2	13			12
13	DO	39-3330.1	306	3 X 10	2'-0"	19					2	10	13
14	[1] NAILER	39-3360.08	191	6 X 8	6'-0"	90	5	120	6	144			14
15	DO	39-3360.08	417	6 X 8	4'-11"	74					6	118	15
16	NAILER CAP	39-3360.08	193	6 X 8	10'-0"	150			1	40	1	40	16
17	DO	39-3360.08-12	194	6 X 8	12'-0"	180	2	96					17
18	DO	39-3360.08-16	196	6 X 8	16'-0"	240			1	64	1	64	18
19	GRILLAGE TIMBERS	39-3360.08	193	6 X 8	10'-0"	150			3	120	3	120	19
20	DO	39-3360.08-2	198	6 X 8	20'-0"	300			3	240	3	240	20
21	BEARING BLOCK	39-6620.1	400	10 X 10	2'-0"	63			8	133	8	133	21
22	DEADMAN	39-6620.1-16	266	10 X 10	16'-0"	500			2	267			22
23	ANCHOR BLOCK	39-3360.08	407	6 X 8	0'-10"	13			8	26	6	20	23
	STEEL HARDWARE, BLACK												
24	WIRE ROPE	22-4567.4-05		1/2	20'-0"	13			8				24
25	WIRE-ROPE CLIP	42-3544.5-05		1/2		0.72			32				25
26	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-223	B22	3/4	22"	3.30	20						26
27	DO	43-2325.07-2	B20	3/4	20"	3.06					16		27
28	DO	43-2325.07-183	B18	3/4	18"	2.82			26		14		28
29	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	2.76	6		6		6		29
30	DO	43-1636.07-16	D16	3/4	16"	2.00	6		7		7		30
31	DRIFT BOLT ANCHOR	43-1636.07-12	D12	3/4	12"	1.50	12		12		12		31
32	STANDARD WIRE SPIKE	42-8488.04-1		3/8	10"	0.33			96		60		32
33	DO	42-8488.035-07		5/16	7"	0.143	144		180		120		33

[1] CUT TO FIT FOR FILLS UNDER 6 FEET.
[2] LENGTH OF BEARING PILE TO BE DETERMINED BY FIELD CONDITIONS.
[3] NUMBER OF BULKHEAD TIMBERS BILLED IS FOR MAXIMUM FILL; USE FEWER PLANKS FOR SHALLOWER FILLS.

TABLE·A

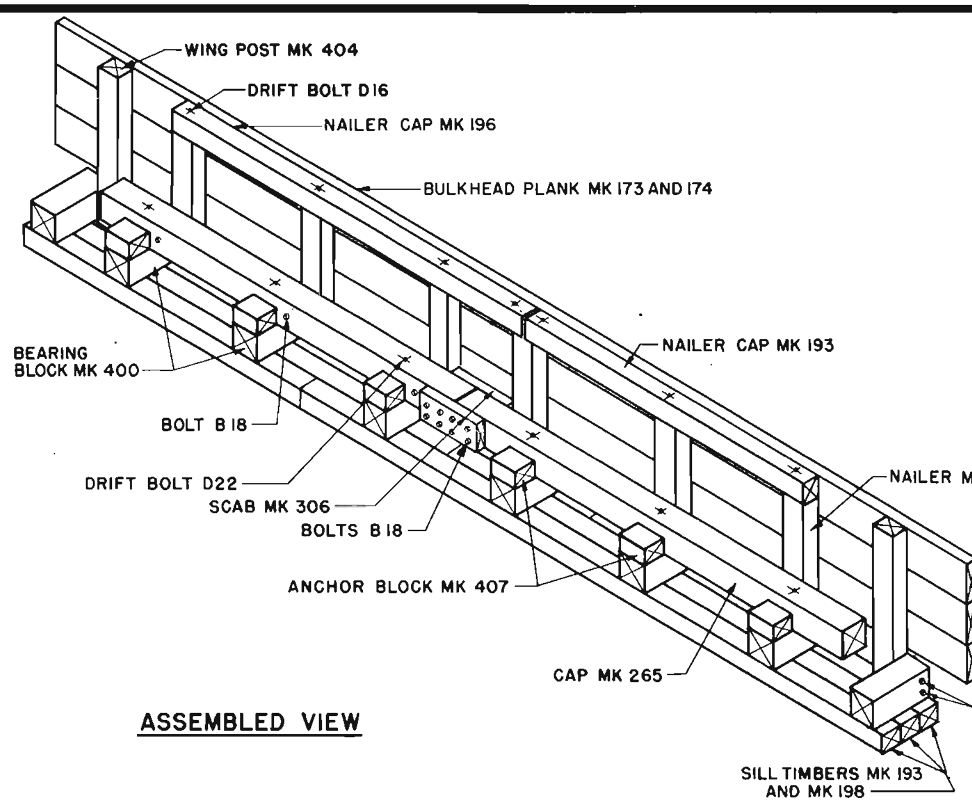
SPAN	DIMENSION A
15	2'-2⅞"
20	2'-4⅞"
30	2'-9⅞"
40	2'-10"
50	3'-1⅛"
60	3'-3⅞"
70	3'-6⅞"
80	3'-10"
90	3'-10⅝"



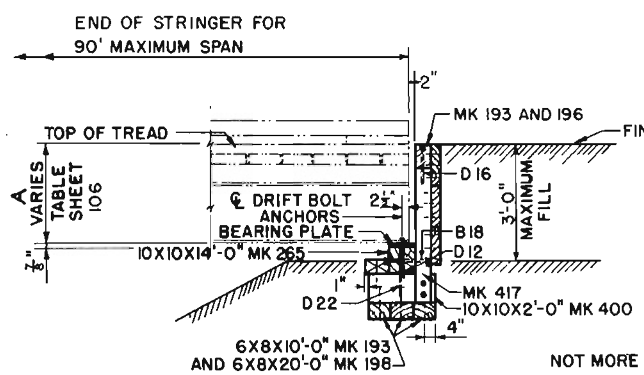
ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	106,108
BEARING PLATES	132

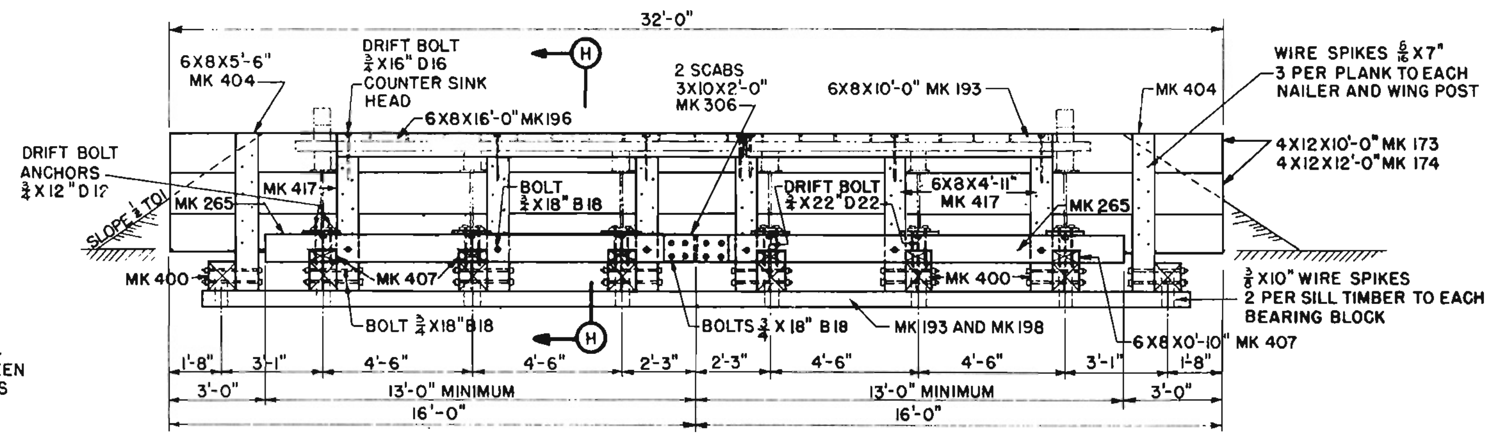


ASSEMBLED VIEW



NOT MORE THAN ONE SILL TIMBER TO BE CUT BETWEEN ANY TWO BEARING BLOCKS

SECTION H-H

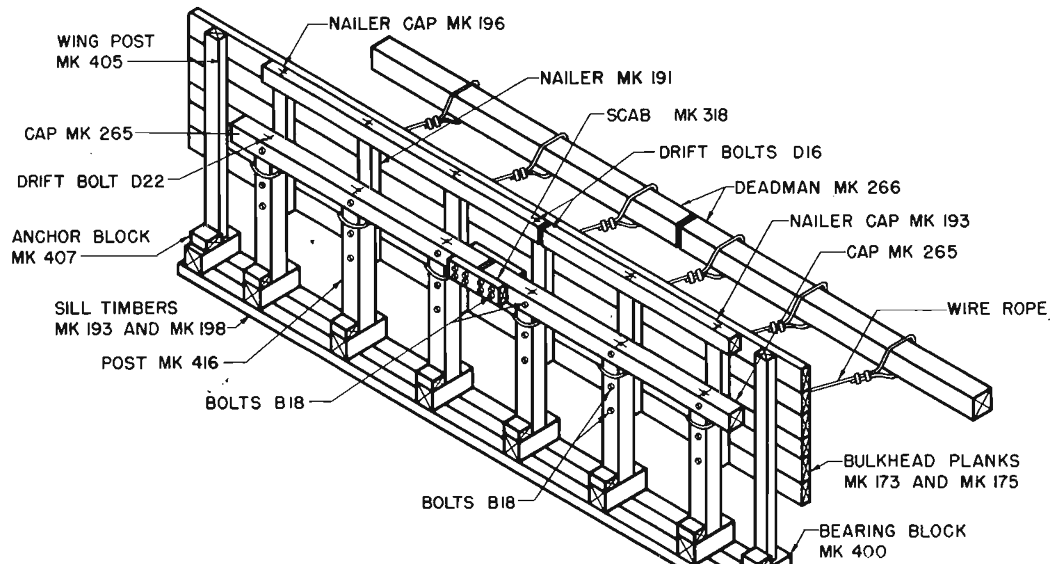


TRANSVERSE ELEVATION

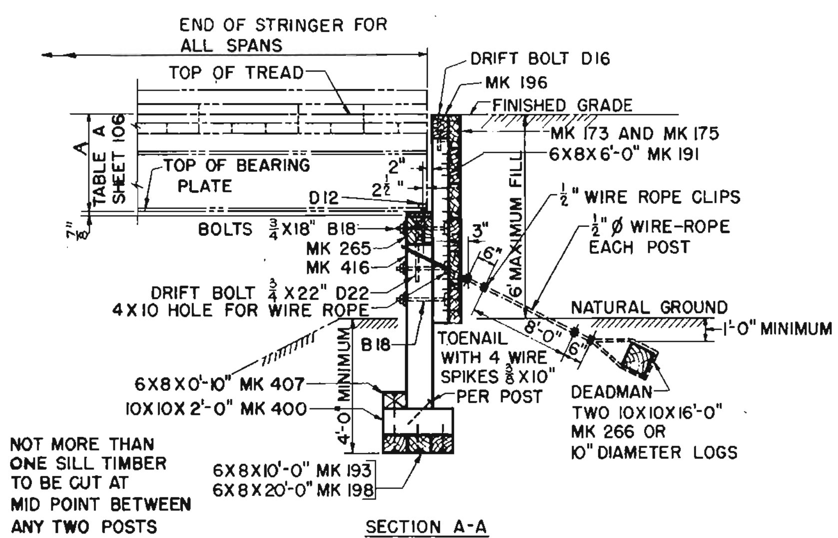
TIMBER GRILLAGE ABUTMENTS SUPPORTING 90' MAXIMUM STEEL-STRINGER SPAN

COMPANION SHEETS

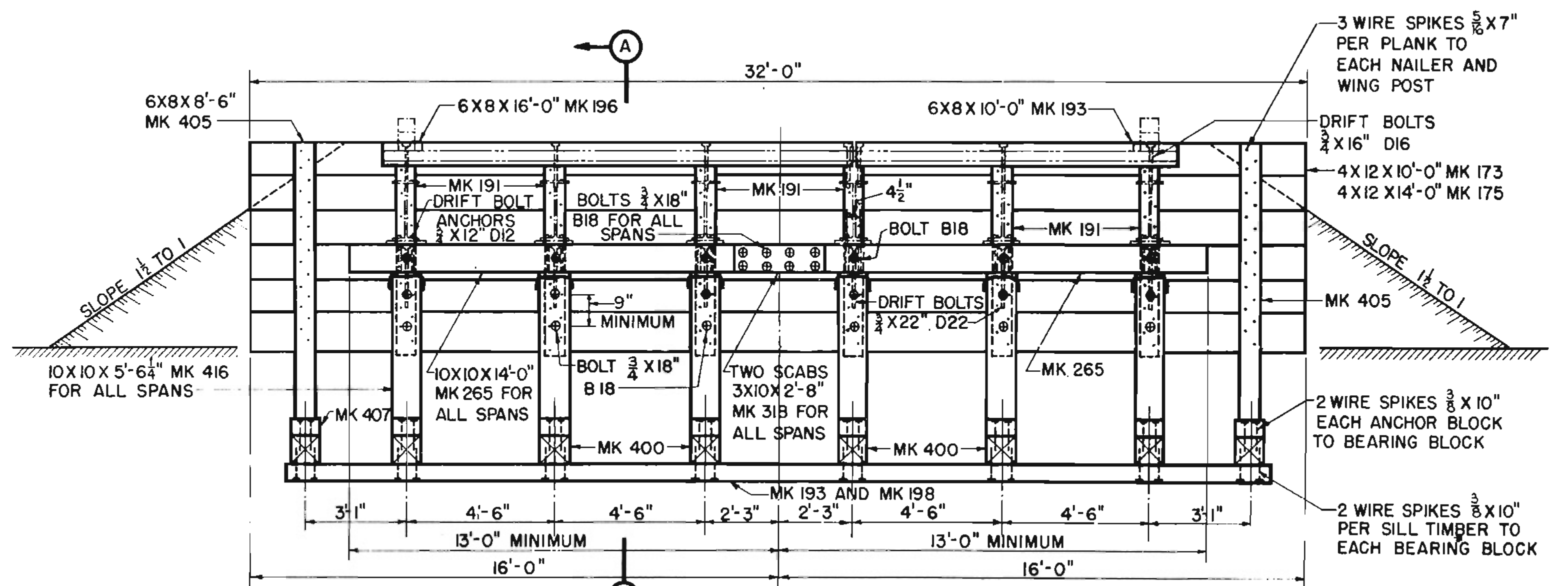
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER ABUTMENTS	106, 107



ASSEMBLED VIEW
FOR 6' MAXIMUM FILL



SECTION A-A
FOR ALL SPANS



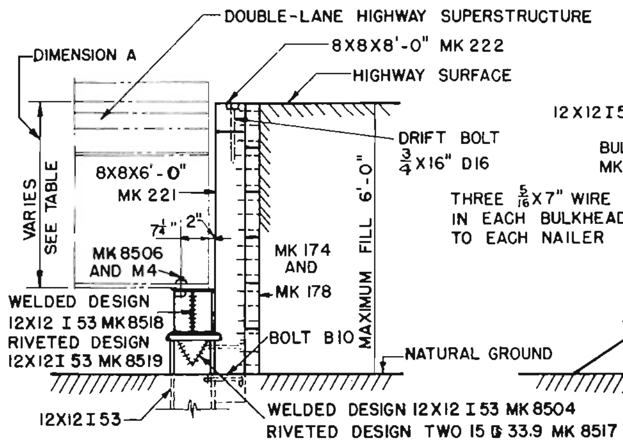
ELEVATION

DETAILS FOR 6' MAXIMUM FILL

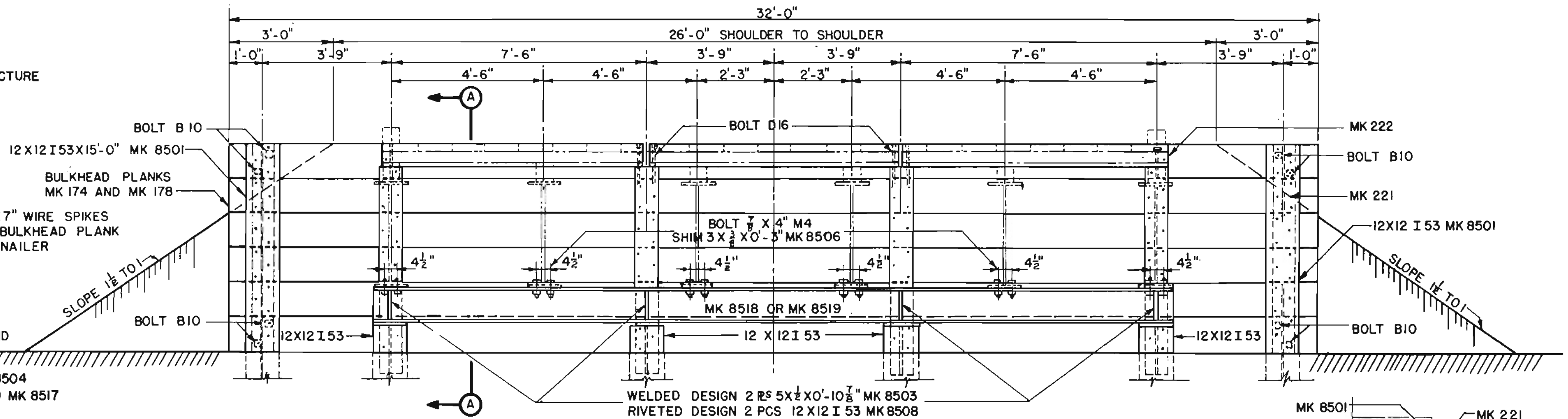
TIMBER GRILLAGE ABUTMENTS SUPPORTING 15' TO 90' STEEL-STRINGER SPAN

COMPANION SHEETS

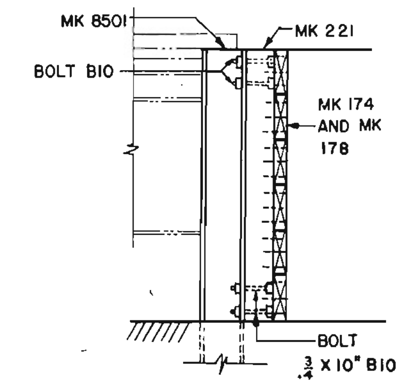
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	110



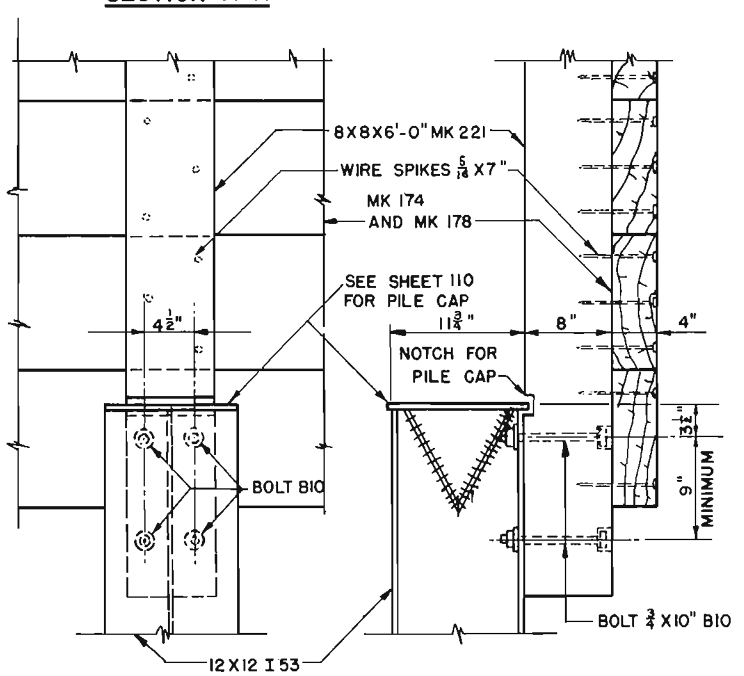
SECTION A-A



TRANSVERSE ELEVATION

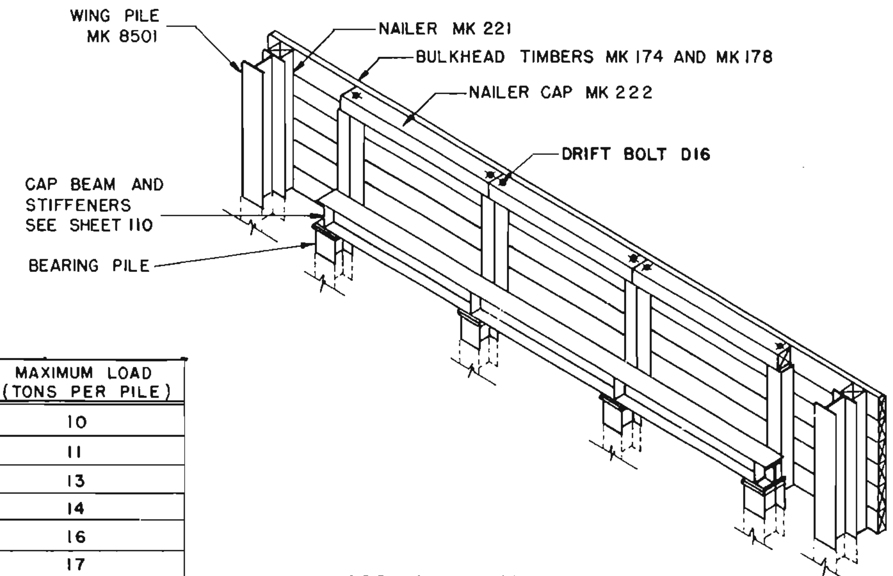


END VIEW



NAILER CONNECTION TO BEARING PILE

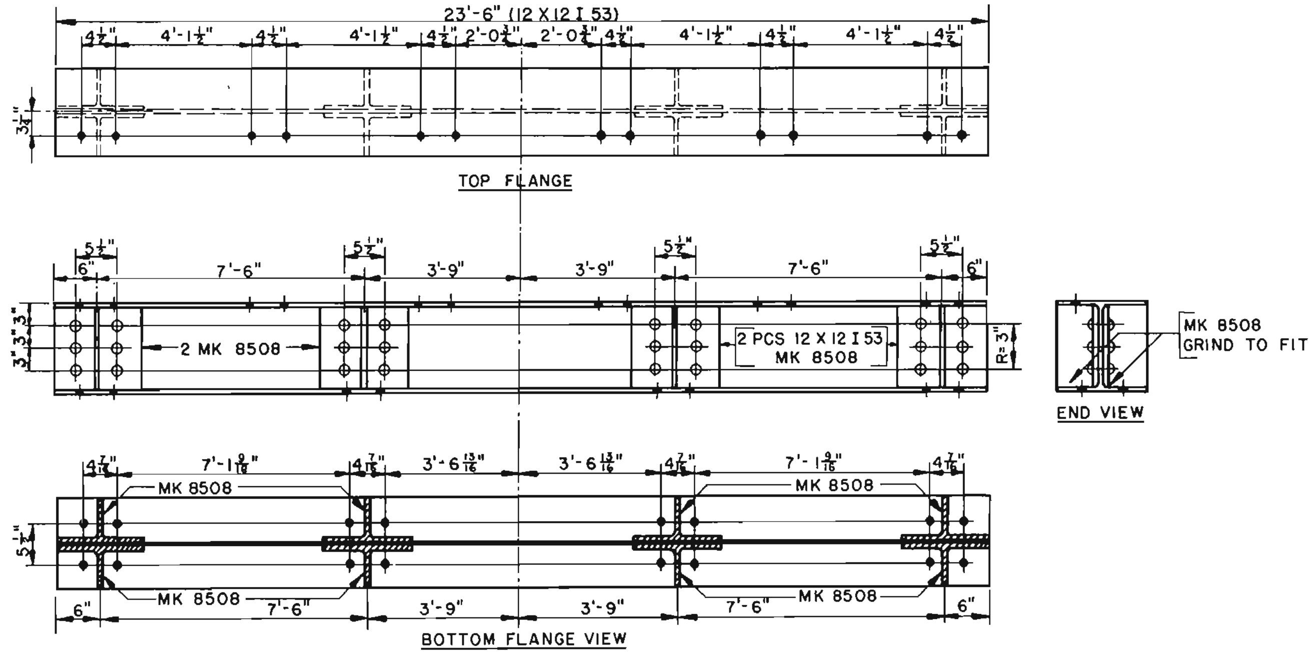
SPAN	STRINGER SIZE	DIMENSION A	MAXIMUM LOAD (TONS PER PILE)
15'	14 I 30	2'-2⅞"	10
20'	16 I 36	2'-4⅞"	11
30'	21 I 59	2'-9⅞"	13
40'	21 I 63	2'-10"	14
50'	24 I 87	3'-1⅛"	16
60'	27 I 91	3'-3⅞"	17
70'	30 I 108	3'-6⅞"	18
80'	33 I 125	3'-10"	20
90'	33 I 132	3'-10⅛"	21



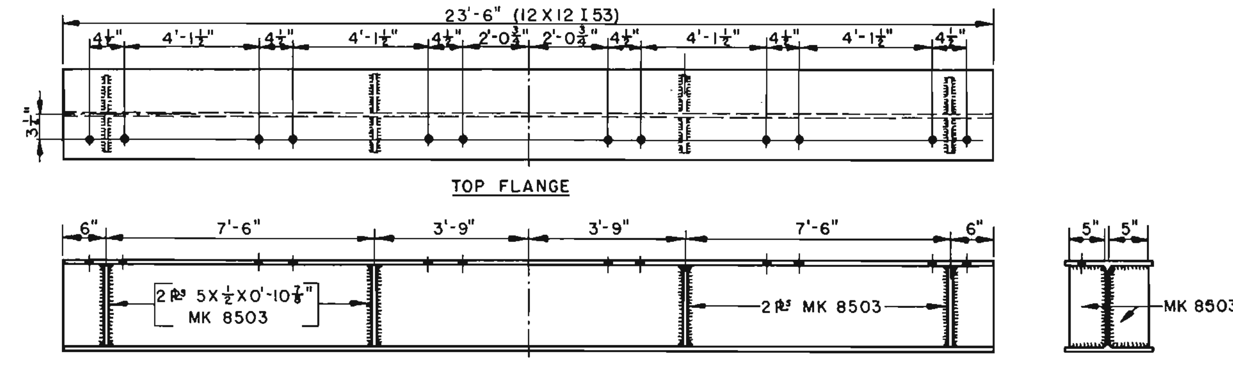
ASSEMBLED VIEW

COMPANION SHEETS

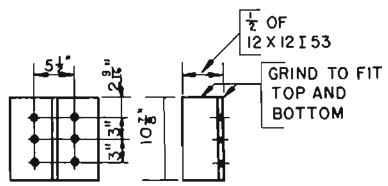
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	109



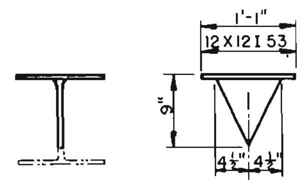
CAP BEAM MK 8519



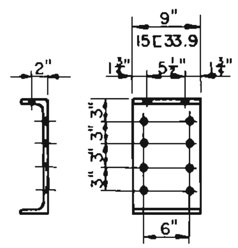
CAP BEAM MK 8518



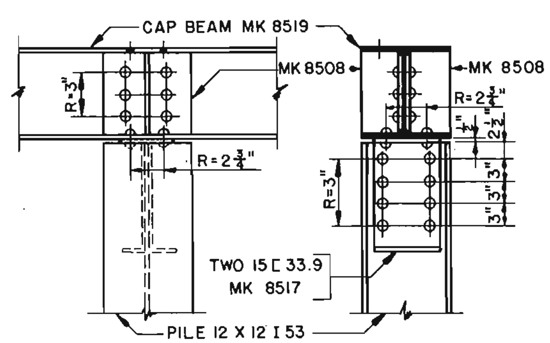
STIFFENER MK 8508



PILE CAP MK 8504

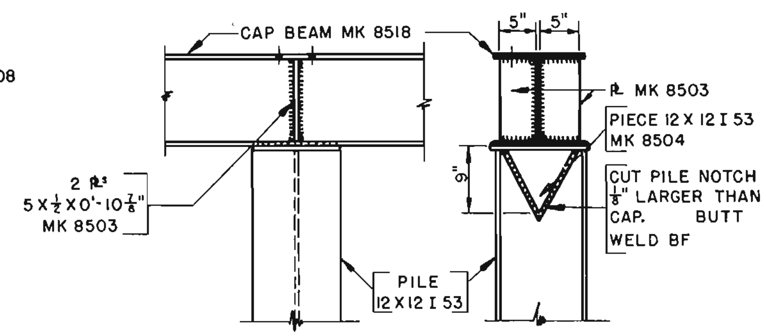


PILE CAP MK 8517



RIVETED CONNECTION DETAILS

PILE TO CAP BEAM



WELDED CONNECTION DETAILS

PILE TO CAP BEAM

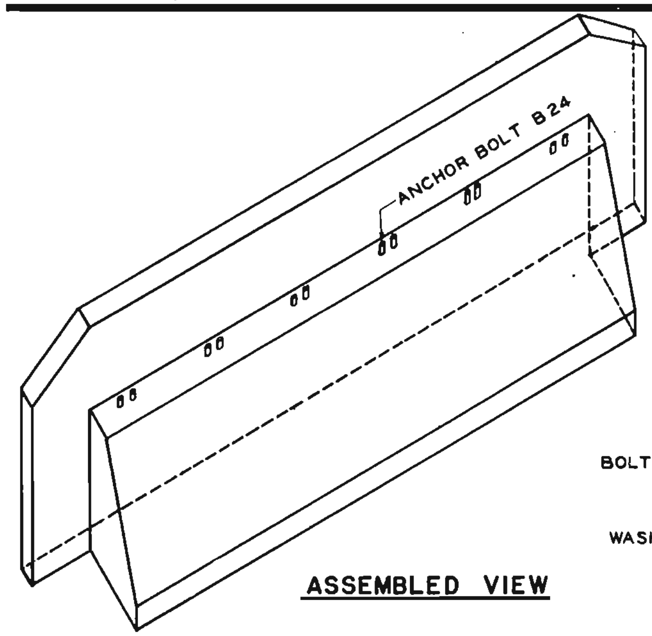
BILL OF MATERIALS FOR ONE ABUTMENT

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	QUANTITY	FBM	WEIGHT EACH (POUNDS)
ALTERNATE NO 1 WELDED DETAILS								
1	WING PILES		8501	12X12 I 53	15'-0"	2		795
2	CAP BEAM		8518	12X12 I 53	23'-6"	1		1245
3	STIFFENERS	47-7844.05	8503	PL 5 X 1/2	10 7/8"	8		8
4	PILE CAP		8504	12X12 I 53	1'-1"	4		29
ALTERNATE NO 2 RIVETED DETAILS								
5	WING PILES		8501	12X12 I 53	15'-0"	2		795
6	CAP BEAM		8519	12X12 I 53	23'-0"	1		1245
7	STIFFENERS		8508	1/2 12X12 I 53	10 7/8"	8		24
8	PILE CAP	48-3790.15-34	8517	15 [33.9	0'-9"	8		26
LUMBER, SOFT WOOD ALT NO1 AND NO2								
9	NAILERS	39-6616.08	221	8 X 8	6'-0"	6	192	120
10	NAILER CAPS	39-6616.08	222	8 X 8	8'-0"	3	128	160
11	BULKHEAD TIMBERS	39-3340.12-2	178	4 X 12	20'-0"	6	480	300
12	DO	39-3340.12-12	174	4 X 12	12'-0"	6	288	180
STEEL HARDWARE, BLACK								
13	BOLTS WITH NUTS AND TWO WASHERS	43-2325.07-1	B10	3/4	10"	24		[1] 45
14	ANCHOR BOLTS WITH NUTS AND TWO WASHERS	43-2219.08-04	M4	7/8	4"	12		[1] 17
15	DRIFT BOLTS WITH WASHERS	43-1636.07-16	D16	3/4	16"	4		[1] 8
16	WIRE SPIKES	42-8488.035-07		5/16	7"	108		[1] 18
17	RIVETS	43-6353.08-25		7/8	2 1/2"	16		.62
18	DO	43-6353.08		7/8	2 3/4"	56		.66
19	WELDING ROD	46-3772.2-7		3/16				[1] 18

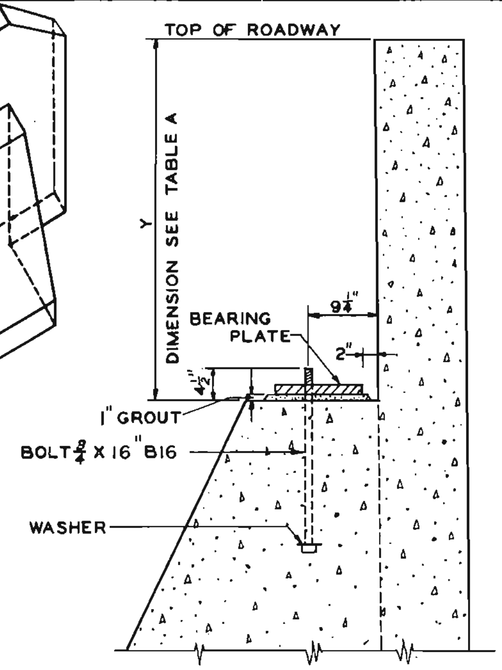
[1] TOTAL WEIGHT.

COMPANION SHEETS

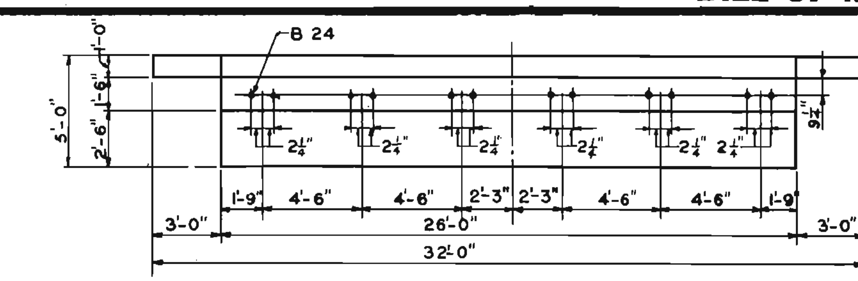
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BEARING PLATES	132



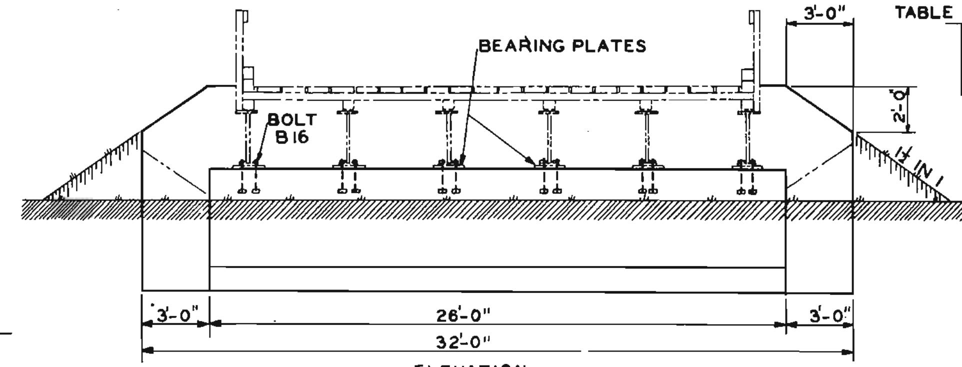
ASSEMBLED VIEW



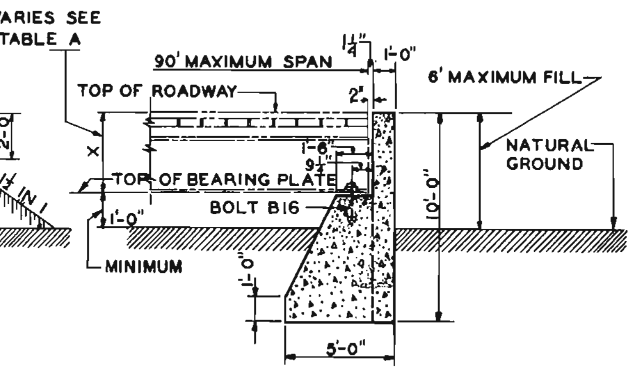
ANCHOR-BOLT DETAIL



PLAN

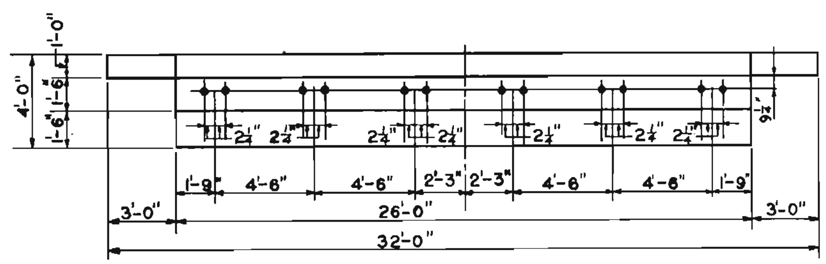


ELEVATION

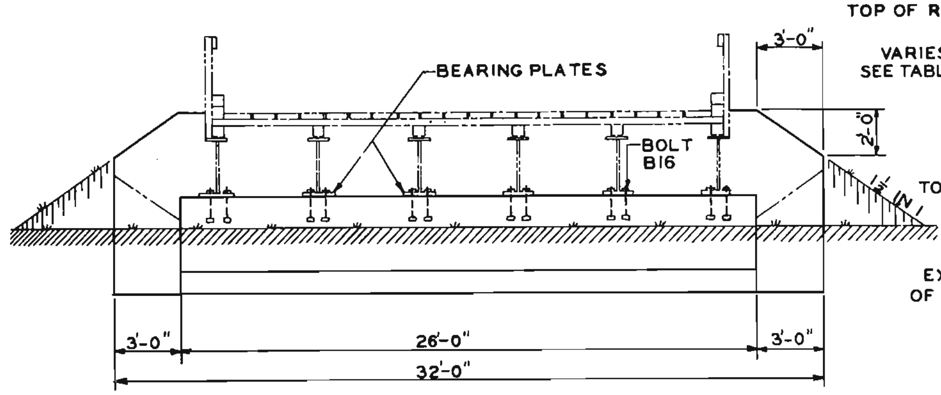


SECTION

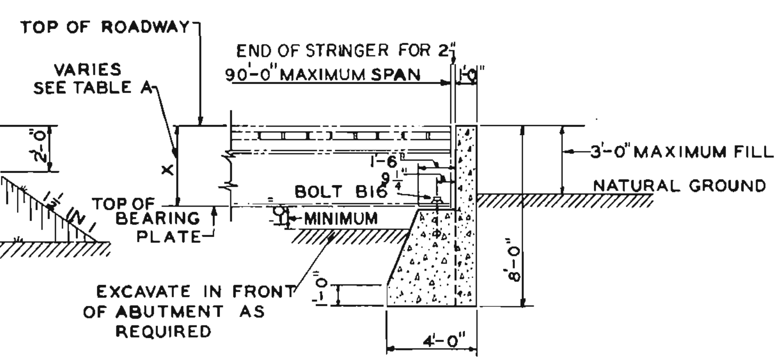
ABUTMENT, 6'-0" MAXIMUM FILL



PLAN



ELEVATION



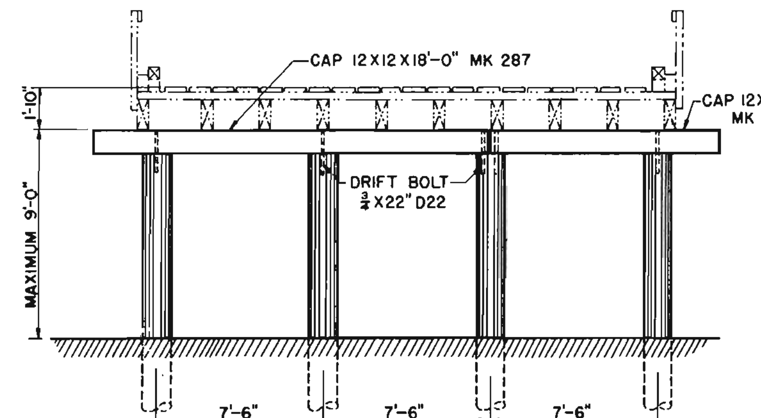
SECTION

ABUTMENT 3'-0", MAXIMUM FILL

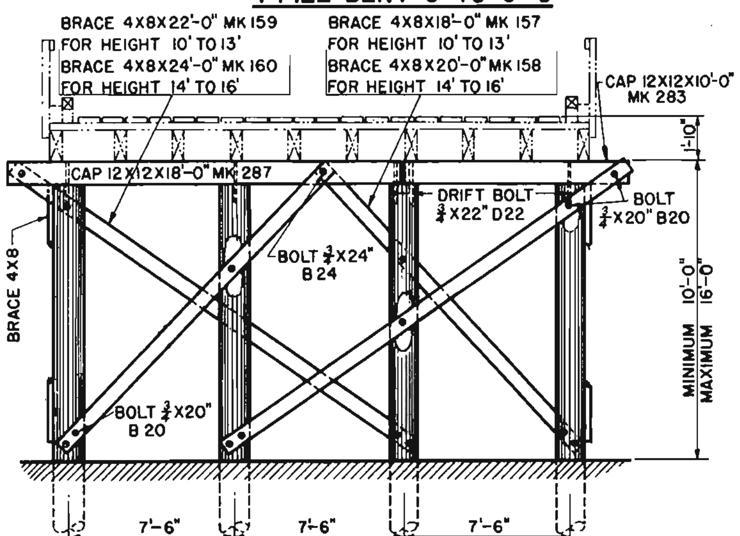
TABLE A DIMENSIONS AND BILL OF MATERIALS

SPAN FEET	X	Y	BOLT WITH SQUARE NUT AND WASHER, STOCK NO 43-2325.07-16 3/4 X 16" B 16		CONCRETE	
					6' MAXIMUM FILL	3' MAXIMUM FILL
			QUANTITY	WEIGHT EACH (POUNDS)	CU YDS	CU YDS
15	2'-2 7/8"	2'-4 3/4"	12	3.5	33.0	22.1
20	2'-4 7/8"	2'-6 3/4"	12	3.5	32.5	21.8
30	2'-9 7/8"	2'-11 3/4"	12	3.5	31.4	20.9
40	2'-10"	2'-11 7/8"	12	3.5	31.4	20.9
50	3'-1 1/8"	3'-3"	12	3.5	30.7	20.3
60	3'-3 7/8"	3'-5 3/4"	12	3.5	30.1	19.8
70	3'-6 7/8"	3'-8 3/4"	12	3.5	29.5	19.3
80	3'-10"	3'-11 7/8"	12	3.5	28.8	18.7
90	3'-10 1/8"	4'-0"	12	3.5	28.8	18.7

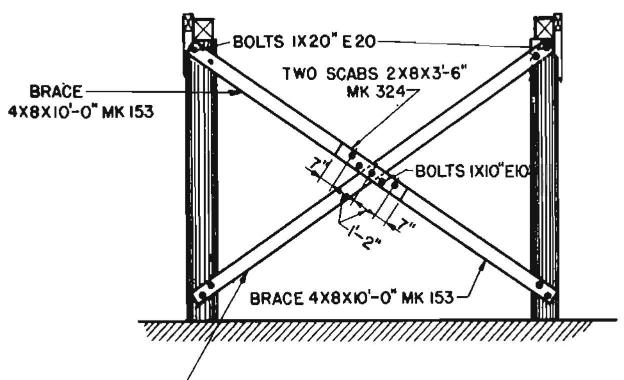
BEARING PLATES (SHEET 132)
12 X 7/8 X 1'-3" MK 3500
SIX REQUIRED FOR EACH ABUTMENT
STOCK NO 47-7844.08



4-PILE BENT 0' TO 9'-0"



4-PILE BENT 10'-0" TO 16'-0"



HEIGHT	11' SPAN		13' SPAN		15' SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
14' TO 16'	20'-0"	158	20'-0"	158	22'-0"	159

LONGITUDINAL ELEVATION

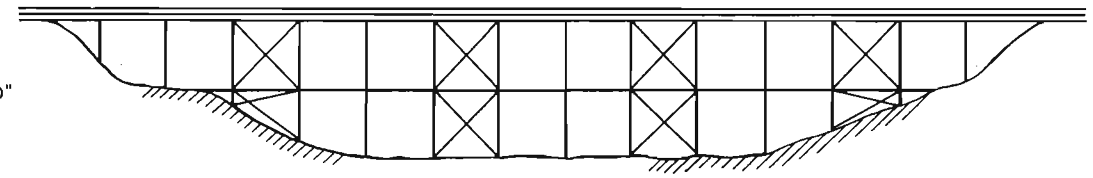


DIAGRAM SHOWING LONGITUDINAL BRACING

TRESTLES OVER 13 FEET HIGH HAVE LONGITUDINAL CROSS BRACING EVERY THIRD SPAN. LONGITUDINAL STRUTS ARE CARRIED TO BANK AND FASTENED TO BENT NEAR GROUND LINE.

COMPANION SHEETS

	SHEET
TIMBER PILE BENTS FOR TIMBER SPANS	113
GENERAL NOTES	154
SYMBOLS	155

BILL OF MATERIALS FOR LONGITUDINAL BRACING FOR ONE BENT OR ONE SPAN

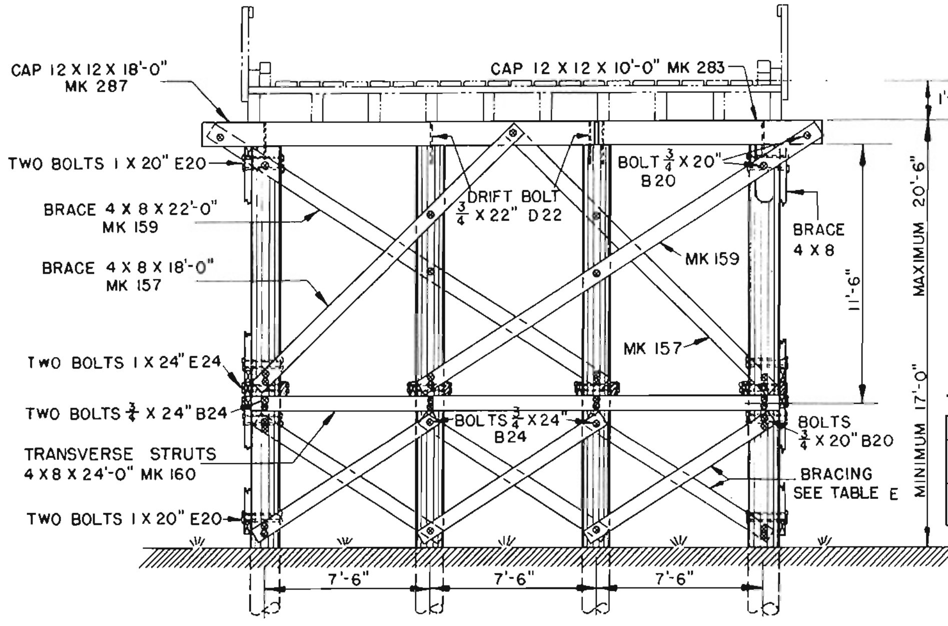
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	0' TO 9' QUANTITY	0' TO 9' FBM	10' TO 13' QUANTITY	10' TO 13' FBM	14' TO 16' QUANTITY	14' TO 16' FBM	17' TO 19' QUANTITY	17' TO 19' FBM	20' TO 20'-6" QUANTITY	20' TO 20'-6" FBM	21' TO 22' QUANTITY	21' TO 22' FBM	23' TO 25' QUANTITY	23' TO 25' FBM	26' TO 28' QUANTITY	26' TO 28' FBM
1	PILE						4		4		4		4		4		4		4		4	
2	CAP, LUMBER, SOFT WOOD	39-6630.12-12	283	12X12	10'-0"	450	1	120	1	120	1	120	1	120	1	120	1	120	1	120	1	120
3	DO	39-6630.12-18	287	12X12	18'-0"	810	1	216	1	216	1	216	1	216	1	216	1	216	1	216	1	216
4	BRACE, LUMBER, SOFT WOOD	39-3340.08-1	153	4X8	10'-0"	100							6	160								
5	DO	39-3340.08-12	154	4X8	12'-0"	120									6	192						
6	DO	39-3340.08-18	157	4X8	18'-0"	180			2	96			2	96	2	96	6	288	2	96	2	96
7	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107							4	213		
8	DO	39-3340.08-22	159	4X8	22'-0"	220			2	117			2	117	2	117	2	117	2	117	6	352
9	DO	39-3340.08-24	160	4X8	24'-0"	240					2	128										
10	STRUT, LUMBER, SOFT WOOD	39-3340.08-24	160	4X8	24'-0"	240							2	128	2	128	2	128	2	128	2	128
	STEEL HARDWARE, BLACK																					
11	DRIFT BOLT WITH SQUARE HEAD AND ONE WASHER	43-1636.07-22	D22	3/4	22"	3.0	5		5		5		5		5		5		5		5	
12	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-2	B20	3/4	20"	3.0			16		16		24		24		32		32		32	
13	DO	43-2325.07-24	B24	3/4	24"	3.6			1		1		11		11		9		9		9	
14	DO	43-2325.1-24	E24	1	24"	5.5					8		8		8		8		8		8	

MATERIALS REQUIRED FOR LONGITUDINAL BRACING FOR VARIOUS SPANS, STRUTS ONLY

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	0' TO 9' QUANTITY	0' TO 9' FBM	10' TO 13' QUANTITY	10' TO 13' FBM	14' TO 16' QUANTITY	14' TO 16' FBM	17' TO 19' QUANTITY	17' TO 19' FBM	20' TO 20'-6" QUANTITY	20' TO 20'-6" FBM	21' TO 22' QUANTITY	21' TO 22' FBM	23' TO 25' QUANTITY	23' TO 25' FBM	26' TO 28' QUANTITY	26' TO 28' FBM
	11' SPAN																					
15	STRUT, LUMBER, SOFT WOOD	39-3340.08-12	154	4X8	12'-0"	120							4	128	4	128	4	128	4	128	4	128
	13' SPAN																					
16	STRUT, LUMBER, SOFT WOOD	39-3340.08-14	155	4X8	14'-0"	140							4	149	4	149	4	149	4	149	4	149
	15' SPAN																					
17	STRUT, LUMBER, SOFT WOOD	39-3340.08-16	156	4X8	16'-0"	160							4	171	4	171	4	171	4	171	4	171

MATERIALS REQUIRED FOR LONGITUDINAL BRACING FOR VARIOUS SPANS, STRUTS AND BRACES

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	0' TO 9' QUANTITY	0' TO 9' FBM	10' TO 13' QUANTITY	10' TO 13' FBM	14' TO 16' QUANTITY	14' TO 16' FBM	17' TO 19' QUANTITY	17' TO 19' FBM	20' TO 20'-6" QUANTITY	20' TO 20'-6" FBM	21' TO 22' QUANTITY	21' TO 22' FBM	23' TO 25' QUANTITY	23' TO 25' FBM	26' TO 28' QUANTITY	26' TO 28' FBM
	11' SPAN																					
18	BRACE, LUMBER, SOFT WOOD	39-3340.08-08	152	4X8	8'-0"	80							8	171	8	171	8	171	4	85	4	85
19	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107							4	107	4	107
20	DO	39-3340.08-14	155	4X8	14'-0"	140							2	75	2	75						
21	DO	39-3340.08-16	156	4X8	16'-0"	160							2	85	2	85	4	171	2	85	2	85
22	DO	39-3340.08-18	157	4X8	18'-0"	180													2	96		
23	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107									2	107
24	STRUT, LUMBER, SOFT WOOD	39-3340.08-12	154	4X8	12'-0"	120					4	128	4	128	4	128	4	128	4	128	4	128
	13' SPAN																					
25	BRACE, LUMBER, SOFT WOOD	39-3340.08-08	152	4X8	3'-0"	180							4	85	4	85						
26	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107	4	107	4	107	8	213	8	213	8	213
27	DO	39-3340.08-16	156	4X8	16'-0"	160							2	85	2	85						
28	DO	39-3340.08-13	157	4X8	18'-0"	180							2	95	2	96	4	192	2	96	2	96
29	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107							2	107		
30	DO	39-3340.08-22	159	4X8	22'-0"	220															2	117
31	STRUT, LUMBER, SOFT WOOD	39-3340.08-14	155	4X8	14'-0"	140					4	149	4	149	4	149	4	149	4	149	4	149
	15' SPAN																					
32	BRACE, LUMBER, SOFT WOOD	39-3340.08-1	153	4X8	10'-0"	100					4	107	8	213	8	213	8	213	8	213	4	107
33	DO	39-3340.03-12	154	4X8	12'-0"	120															4	128
34	DO	39-3340.08-18	157	4X8	18'-0"	180							2	96	2	96						
35	DO	39-3340.08-2	158	4X8	20'-0"	200							2	107	2	107	4	213	4	213	2	107
36	DO	39-3340.08-22	159	4X8	22'-0"	220					2	117										
37	STRUT, LUMBER, SOFT WOOD	39-3340.08-16	156	4X8	16'-0"	160					4	171	4	171	4	171	4	171	4	171	4	171
	ALL SPANS																					
38	SCAB, LUMBER, SOFT WOOD	39-3880.08	324	2X8	3'-6"	18					4	19	4	19	4	19	4	19	4	19	4	19
39	DO	39-3880.08	81	2X8	6'-0"	30							4	32	4	32	4	32	4	32	4	32
	STEEL HARDWARE, BLACK																					
40	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-104	E10	1	10"	3.5					10		20		20		20		20		20	
41	DO	43-2325.1-2	E20	1	20"	5.5					16		32		32		32		32		32	



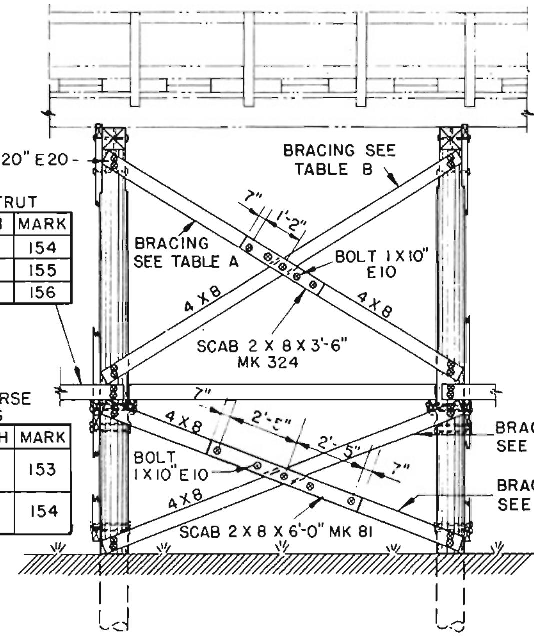
4-PILE BENT 17'-0" TO 20'-6"

LONGITUDINAL STRUT

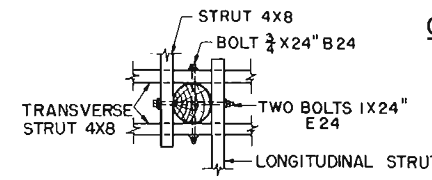
SPAN	SIZE	LENGTH	MARK
11'-0"	4 X 8	12'-0"	154
13'-0"	4 X 8	14'-0"	155
15'-0"	4 X 8	16'-0"	156

TABLE E TRANSVERSE BRACING

HEIGHT	SIZE	LENGTH	MARK
17'-0" TO 19'-0"	4 X 8	10'-0"	153
20'-0" TO 20'-6"	4 X 8	12'-0"	154



LONGITUDINAL BRACING FOR
BENTS 17'-0" TO 20'-6"



DETAIL OF
STRUT CONNECTION

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	112

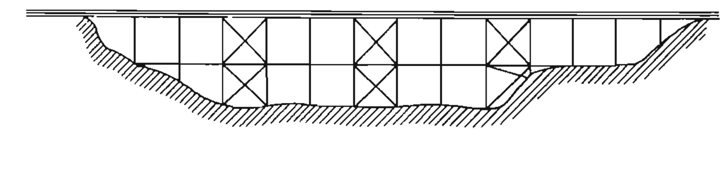


DIAGRAM SHOWING LONGITUDINAL BRACING

TRESTLES OVER 13'-0" IN HEIGHT HAVE LONGITUDINAL CROSS BRACING EVERY THIRD SPAN. LONGITUDINAL STRUTS ARE CARRIED TO BANK AND FASTENED TO BENT NEAR GROUND LINE

TABLE A LONGITUDINAL BRACING

SPAN	SIZE	LENGTH	MARK
11'-0"	4 X 8	8'-0"	152
13'-0"	4 X 8	10'-0"	153
15'-0"	4 X 8	10'-0"	153

TABLE B LONGITUDINAL BRACING

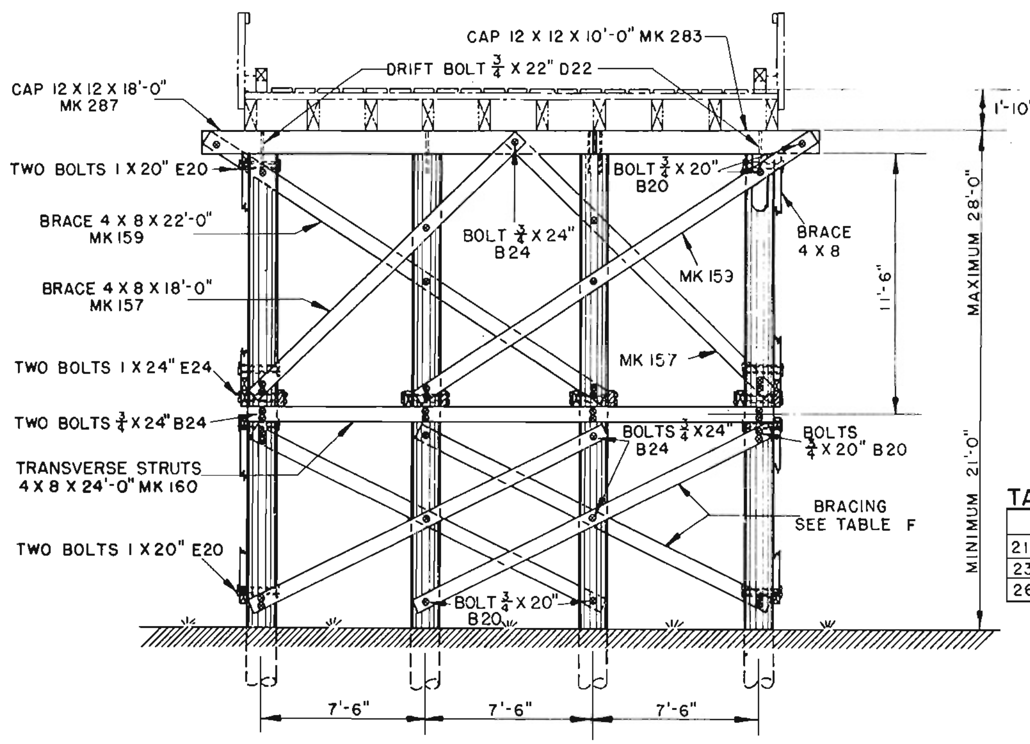
SPAN	SIZE	LENGTH	MARK
11'-0"	4 X 8	16'-0"	156
13'-0"	4 X 8	18'-0"	157
15'-0"	4 X 8	20'-0"	158

TABLE C LONGITUDINAL BRACING

	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
HEIGHT	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17'-0" TO 19'-0"	14'-0"	155	16'-0"	156	18'-0"	157
20'-0" TO 20'-6"	14'-0"	155	16'-0"	156	18'-0"	157
21'-0" TO 22'-0"	16'-0"	156	18'-0"	157	20'-0"	158
23'-0" TO 25'-0"	18'-0"	157	20'-0"	158	20'-0"	158
26'-0" TO 28'-0"	20'-0"	158	22'-0"	159	22'-0"	159

TABLE D LONGITUDINAL BRACING

	11'-0" SPAN		13'-0" SPAN		15'-0" SPAN	
HEIGHT	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17'-0" TO 19'-0"	8'-0"	152	8'-0"	152	10'-0"	153
20'-0" TO 20'-6"	8'-0"	152	8'-0"	152	10'-0"	153
21'-0" TO 22'-0"	8'-0"	152	10'-0"	153	10'-0"	153
23'-0" TO 25'-0"	10'-0"	153	10'-0"	153	10'-0"	153
26'-0" TO 28'-0"	10'-0"	153	10'-0"	153	12'-0"	154



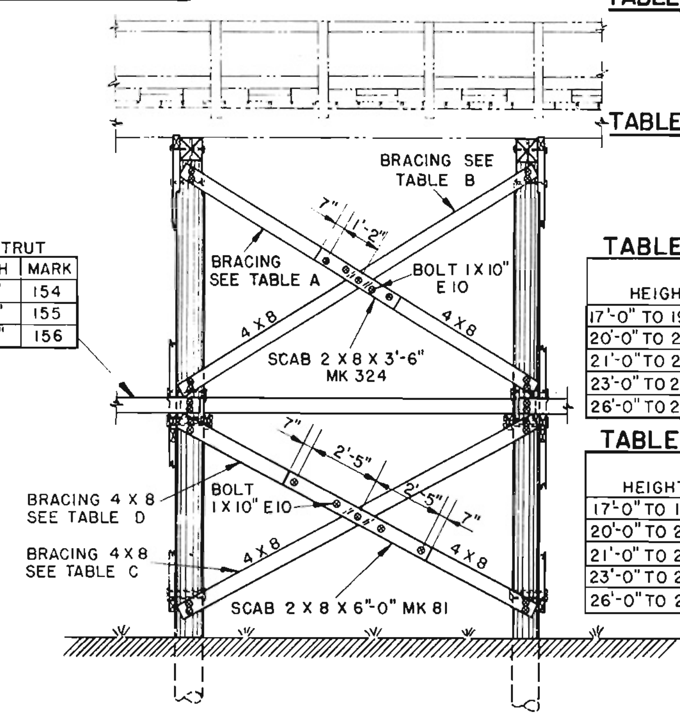
4-PILE BENT 21'-0" TO 28'-0"

LONGITUDINAL STRUT

SPAN	SIZE	LENGTH	MARK
11'-0"	4 X 8	12'-0"	154
13'-0"	4 X 8	14'-0"	155
15'-0"	4 X 8	16'-0"	156

TABLE F TRANSVERSE BRACING

HEIGHT	SIZE	LENGTH	MARK
21'-0" TO 22'-0"	4 X 8	18'-0"	157
23'-0" TO 25'-0"	4 X 8	20'-0"	158
26'-0" TO 28'-0"	4 X 8	22'-0"	159

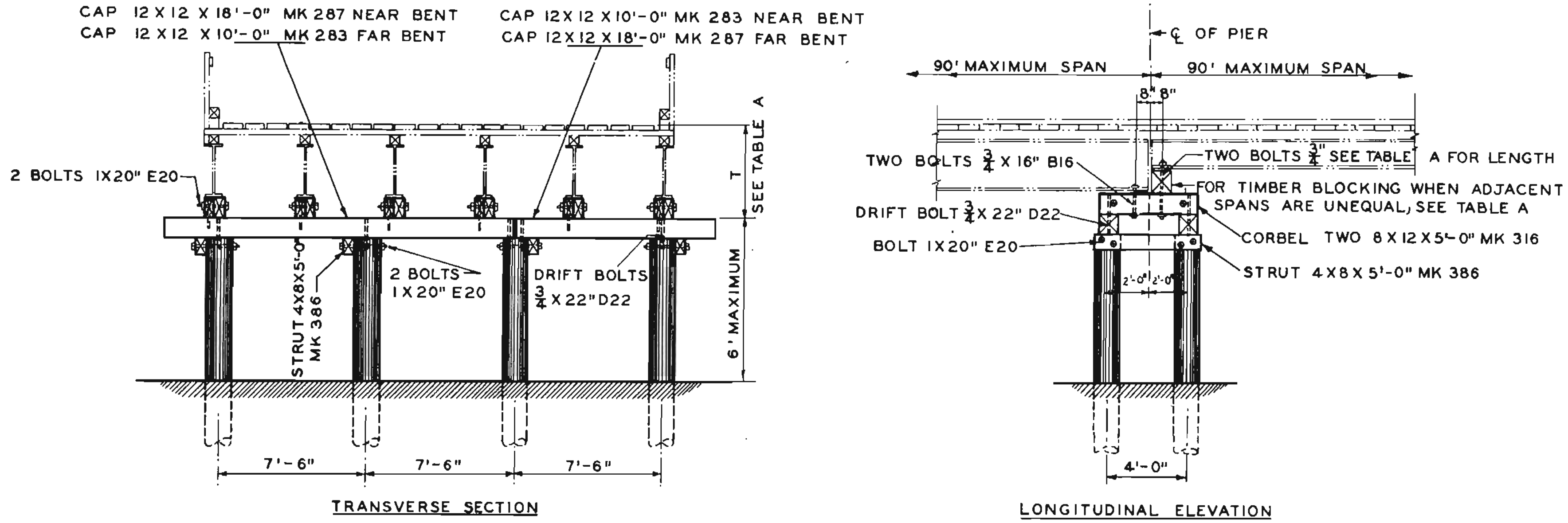


LONGITUDINAL BRACING FOR

BENTS 21'-0" TO 28'-0"

COMPANION SHEETS

	SHEET
TIMBER PILE PIERS FOR STEEL SPANS	115
GENERAL NOTES	154
SYMBOLS	155
BEARING PLATES	132



8-PILE PIER 0'-0" TO 6'-0"

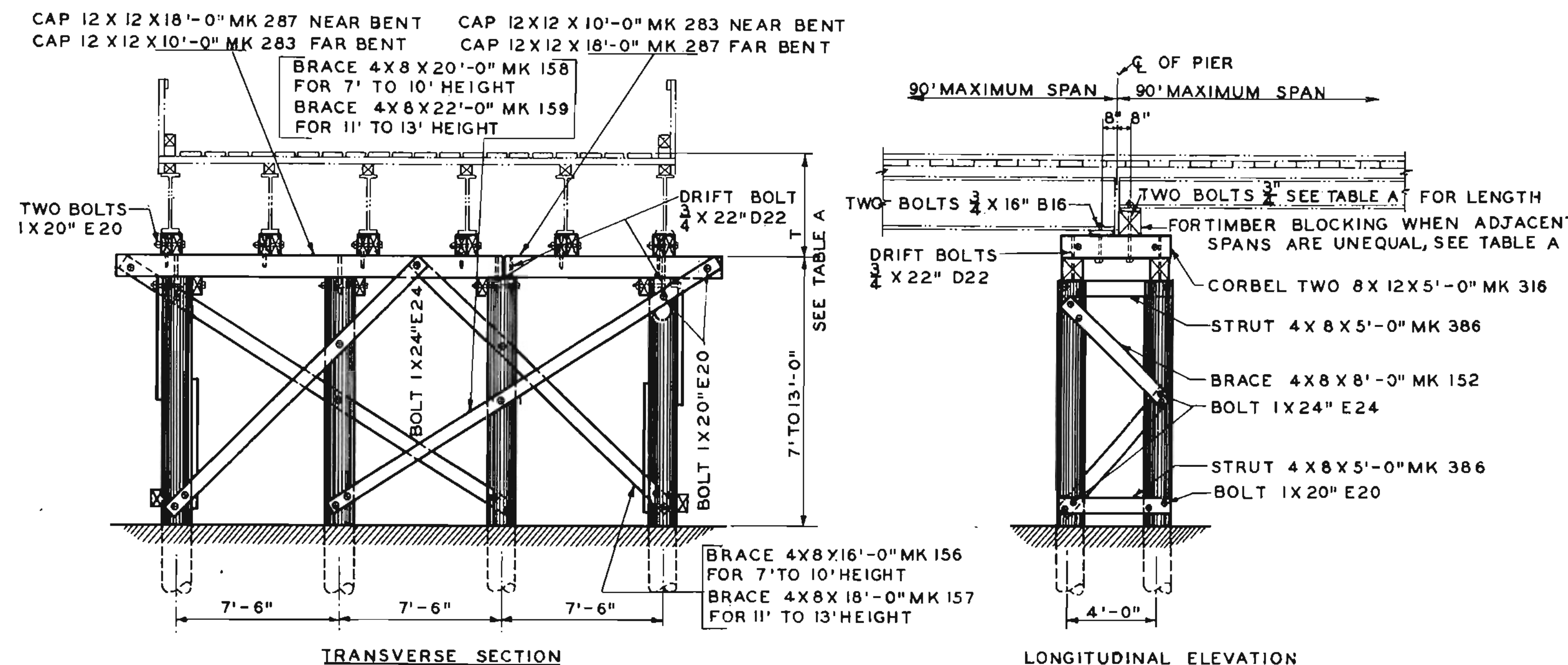
REQUIRED PILE CAPACITY

TOTAL LENGTH OF TWO ADJACENT SPANS	30'	40'	60'	80'	100'	120'	140'	160'	180'
TONS PER PILE	10	10	12	13	15	16	18	18	18

TABLE A

DEPTH OF BLOCKING AND LENGTH OF 3/4" ANCHOR BOLT WHEN ADJACENT SPANS ARE NOT EQUAL

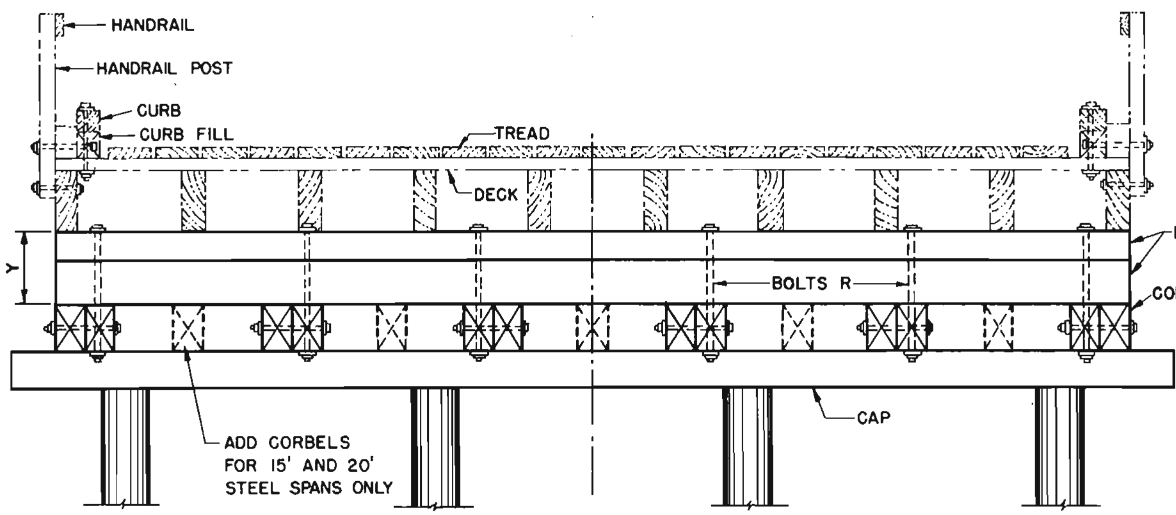
SPAN	T		TIMBER SPAN	STEEL SPAN						
			15'	15'	20'	30'	40'	50'	60'	70'
90	4'-11"	BLOCKING	2'-1"	1'-7"	1'-5"	1'-0"	1'-0"	0'-9"	0'-6"	0'-3"
		BOLT	40"	36"	34"	28"	28"	26"	22"	20"
80'	4'-10 7/8"	BLOCKING	2'-1"	1'-7"	1'-5"	1'-0"	1'-0"	0'-9"	0'-6"	0'-3"
		BOLT	40"	36"	34"	28"	28"	26"	22"	20"
70'	4'-7 3/4"	BLOCKING	1'-10"	1'-4"	1'-2"	0'-9"	0'-9"	0'-6"	0'-3"	
		BOLT	36"	32"	30"	26"	26"	22"	20"	
60'	4'-4 3/4"	BLOCKING	1'-7"	1'-1"	0'-11"	0'-6"	0'-6"	0"-3"		
		BOLT	34"	30"	28"	22"	22"	20"		
50'	4'-2"	BLOCKING	1'-4"	0'-10"	0'-8"	0'-3"	0'-3"			
		BOLT	30"	26"	24"	20"	20"			
40'	3'-10 7/8"	BLOCKING	1'-1"	0'-7"	0'-5"					
		BOLT	28"	24"	22"					
30'	3'-10 3/4"	BLOCKING	1'-1"	0'-7"	0'-5"					
		BOLT	28"	24"	22"					
20'	3'-5 3/4"	BLOCKING	0'-8"	0'-2"						
		BOLT	22"	18"						
15'	3'-3 3/4"	BLOCKING	0'-6"							
		BOLT	22"							



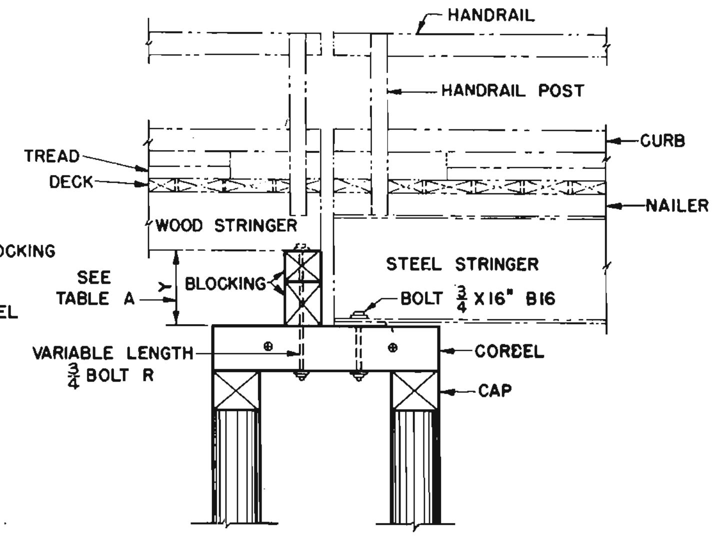
8-PILE PIER 7'-0" TO 13'-0"

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE PIERS FOR STEEL SPANS	114



TRANSVERSE SECTION



LONGITUDINAL ELEVATION

SPECIAL BLOCKING AT JUNCTION OF STEEL AND TIMBER SPANS

TABLE A

STEEL SPAN	DIMENSION Y	BOLT R
15'	0'-5$\frac{3}{4}$"	20"
20'	0'-7$\frac{3}{4}$"	22"
30'	1'-0$\frac{3}{4}$"	26"
40'	1'-0$\frac{7}{8}$"	26"
50'	1'-4"	30"
60'	1'-6$\frac{3}{4}$"	32"
70'	1'-9$\frac{3}{4}$"	36"
80'	2'-0$\frac{7}{8}$"	38"
90'	2'-1"	38"

BILL OF MATERIALS FOR ANCHOR BOLTS AND BEARING PLATES

3/4" ANCHOR BOLT WITH SQUARE NUT AND TWO WASHERS
FOR REQUIRED LENGTH SEE TABLE A SHEET 114
SIX REQUIRED AT EACH SUPPORT FOR EACH TIMBER SPAN
TWELVE REQUIRED AT EACH SUPPORT FOR EACH STEEL SPAN

BOLT LENGTH	STOCK NUMBER
18"	43-2325.07-183
20"	43-2325.07-2
22"	43-2325.07-223
24"	43-2325.07-24
26"	43-2325.07-266
28"	43-2325.07-28
30"	43-2325.07-305
32"	43-2325.07-32
34"	43-2325.07-346
36"	43-2325.07-366
40"	43-2325.07-405

BEARING PLATE 12 X 7/8 X 1'-3" MK P3500 (SHEET 132)
STRUCTURAL STEEL SIX REQUIRED FOR EACH STEEL SPAN
AT EACH SUPPORT STOCK NUMBER 48-7844.00

VARIABLE BLOCKING 12" WIDE X 12'-0" LONG OF
DEPTHS REQUIRED AS SHOWN BY DIMENSION Y

BILL OF MATERIALS FOR ONE TIMBER PIER

CLASS 25-DOUBLE LANE							PIER HEIGHT						
							0' TO 6'		7' TO 10'		11' TO 13'		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
1	PILE						8		8		8		1
	LUMBER, SOFT WOOD												
2	CAP	39-6630.12-1	283	12 X 12	10'-0"	450	2	240	2	240	2	240	2
3	DO.	39-6630.12-18	287	12 X 12	18'-0"	810	2	432	2	432	2	432	3
4	CORBEL	39-6616.12	316	8 X 12	5'-0"	150	12	480	12	480	12	480	4
5	STRUT	39-3340.08	386	4 X 8	5'-0"	50	4	53	6	80	6	80	5
6	BRACE	39-3340.08-08	152	4 X 8	8'-0"	80			4	86	4	86	6
7	DO	39-3340.08-16	156	4 X 8	16'-0"	160			4	171			7
8	DO	39-3340.08-18	157	4 X 8	18'-0"	180					4	192	8
9	DO	39-3340.08-2	158	4 X 8	20'-0"	200			4	213			9
10	DO	39-3340.08-22	159	4 X 8	22'-0"	220					4	235	10
	STEEL HARDWARE, BLACK												
11	DRIFT BOLT WITH SQUARE HEAD AND ONE WASHER	43-1636.07-22	D22	3/4	22"	3.0	22		22		22		11
12	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.6	28		68		68		12
13	DO	43-2325.1-24	E24	1	24"	6.5			10		10		13
14	DO	43-2325.07-16	B16	3/4	16"	2.6	24		24		24		14

COMPANION SHEETS

	SHEET
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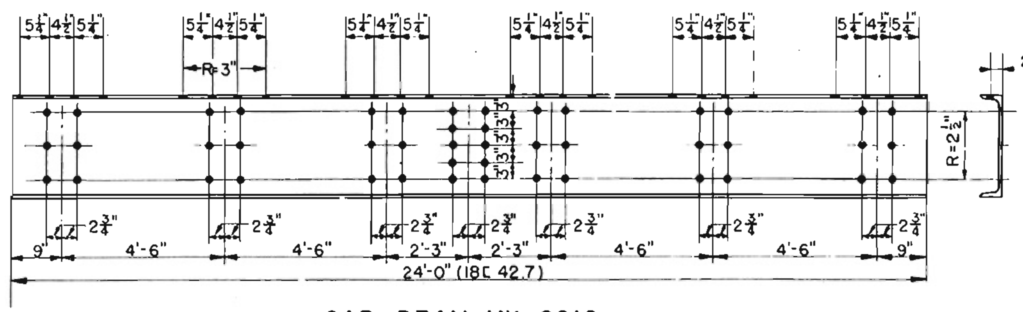
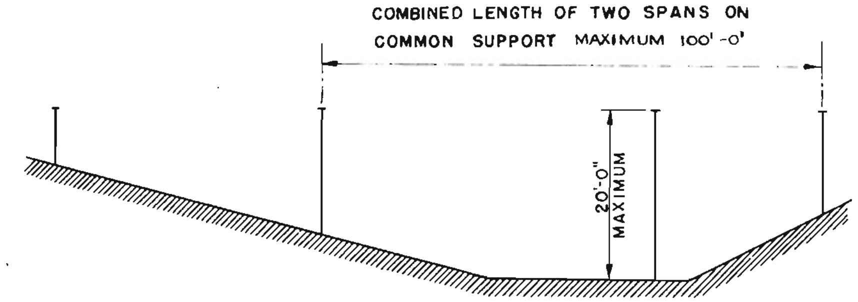
SYMBOLS	155
FABRICATION DRAWING	150
BILL OF MATERIALS	118

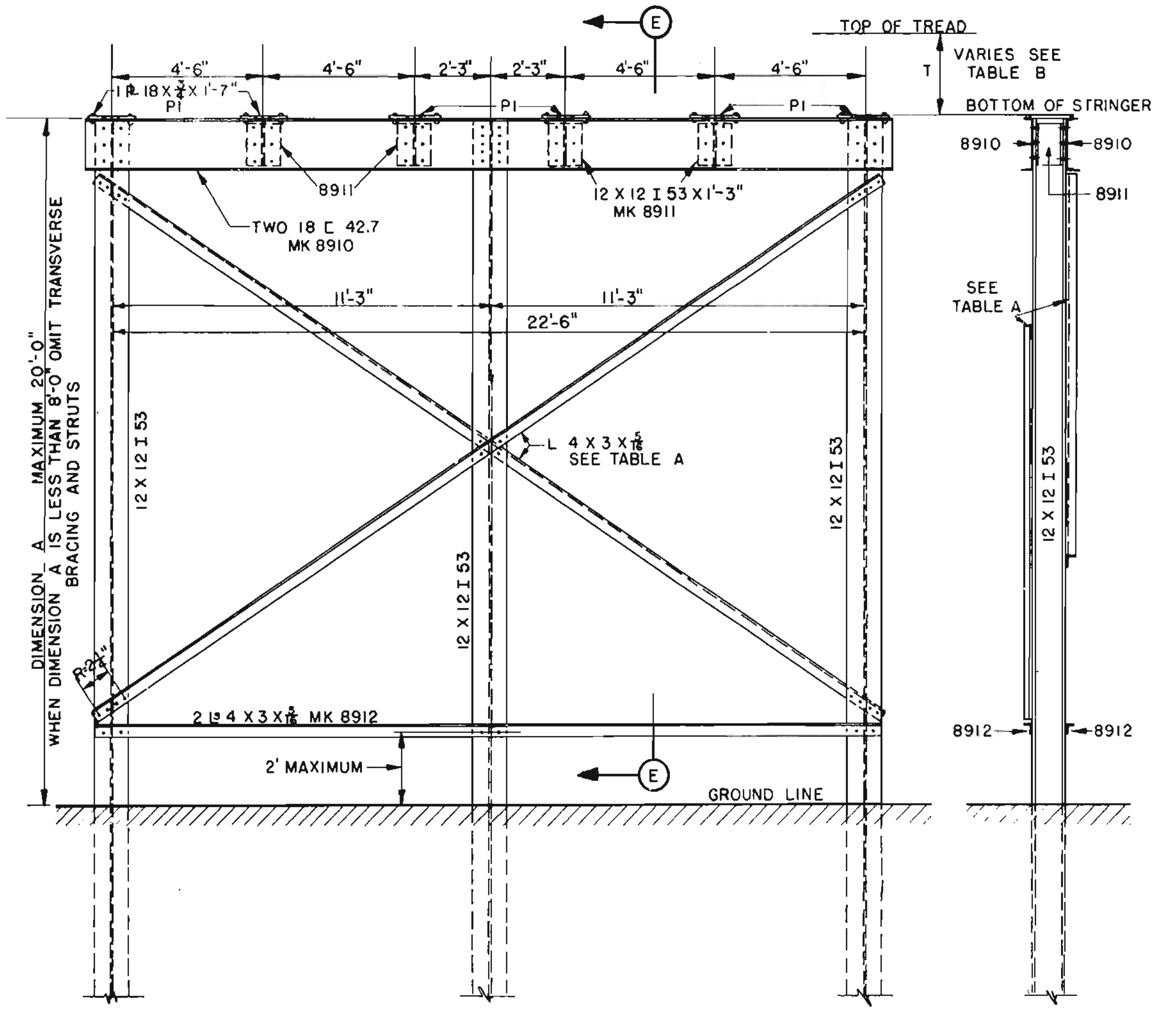


CAP BEAM MK 8910



DIAGRAM

SHOWING HEIGHT AND SPAN LIMITATIONS



THREE PILE BENT

SECTION E-E

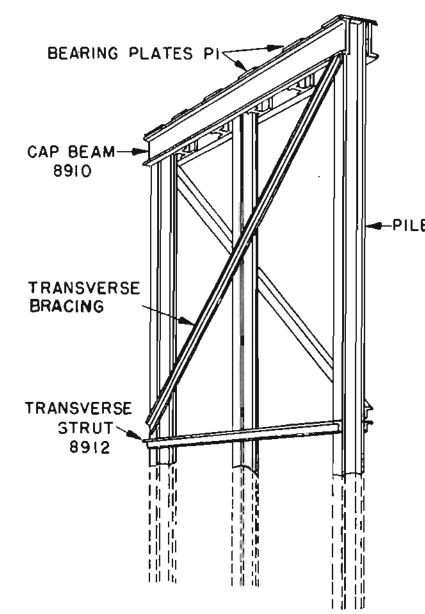
MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
30'	15
40'	18
50'	20
60'	22
70'	24
80'	27
90'	29
100'	31

TABLE A

BENT HEIGHT A	TRANSVERSE BRACE MARK
8'-0"	8950
10'-0"	8949
12'-0"	8948
14'-0"	8947
16'-0"	894C
18'-0"	8945
20'-0"	8944

TABLE B

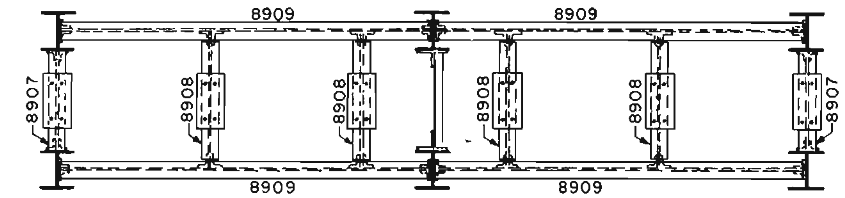
DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS		
SPAN	STEEL-STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER T
15'-0"	14 I 30	2'-2⅞"
20'-0"	16 I 36	2'-4⅞"
30'-0"	21 I 59	2'-9⅞"
40'-0"	21 I 63	2'-10"
50'-0"	24 I 87	3'-1⅛"
60'-0"	27 I 91	3'-3⅞"
70'-0"	30 I 108	3'-6⅞"
80'-0"	33 I 125	3'-10"
90'-0"	33 I 132	3'-10⅛"



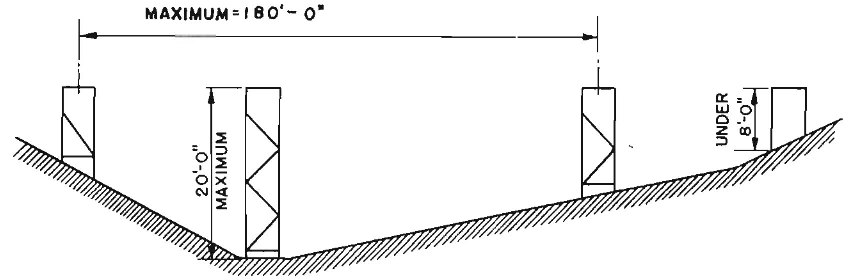
ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	118
FABRICATION DRAWING	150
SHIMS	103

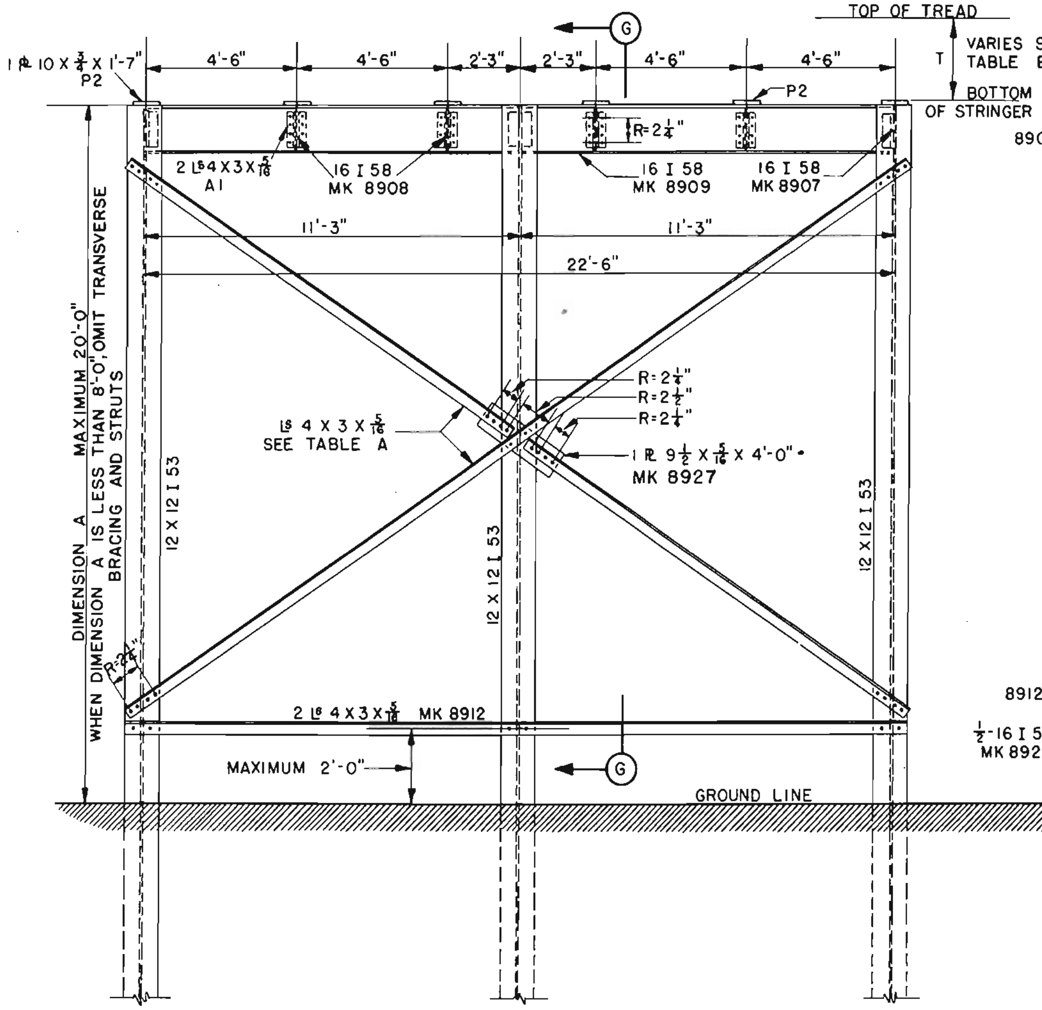


TOP PLAN

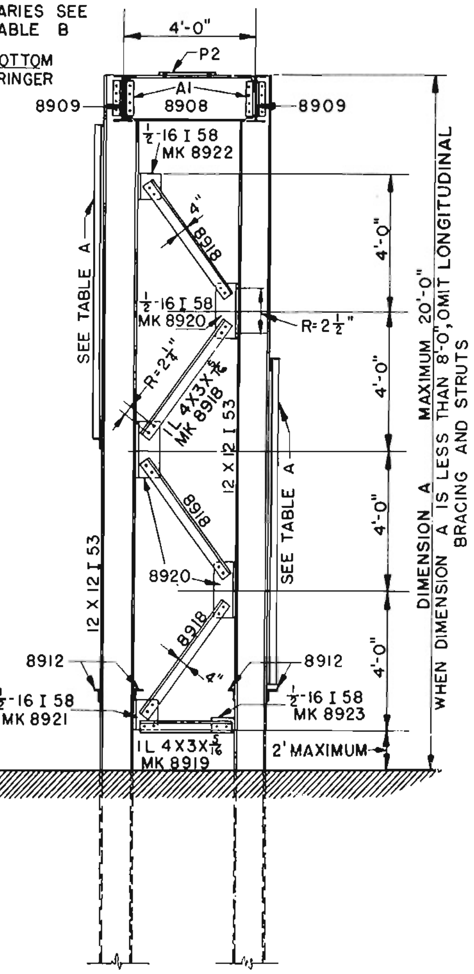


DIAGRAM

SHOWING HEIGHT AND SPAN LIMITATIONS



SIX PILE PIER



SECTION G-G

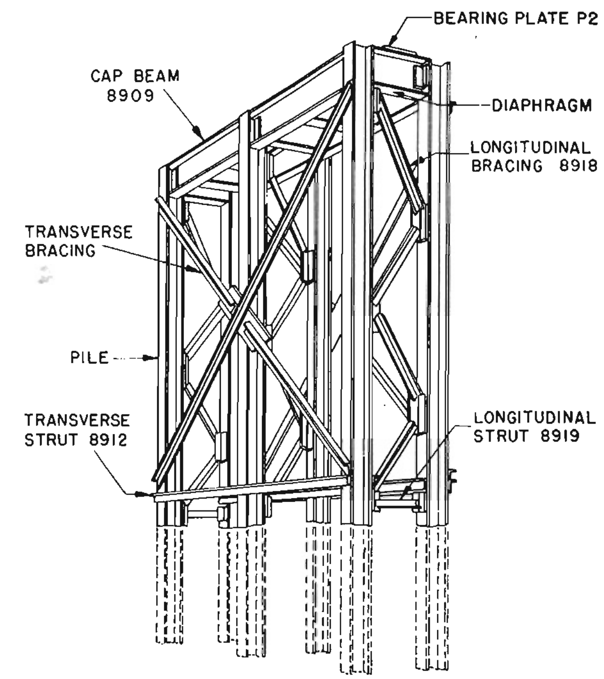
MAXIMUM PILE LOAD	
TOTAL LOADED LENGTH	TONS PER PILE
110'	20
120'	22
130'	23
140'	24
150'	25
160'	26
170'	27
180'	28

TABLE A

BENT HEIGHT A	TRANSVERSE BRACE MARK	
8'-0"	8950	8951
10'-0"	8949	8952
12'-0"	8948	8953
14'-0"	8947	8954
16'-0"	8946	8955
18'-0"	8945	8956
20'-0"	8944	8957

TABLE B

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS, FOR VARIOUS SPANS		
SPAN	STEEL STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER T
15'-0"	14 I 30	2'-2 7/8"
20'-0"	16 I 36	2'-4 7/8"
30'-0"	21 I 59	2'-9 7/8"
40'-0"	21 I 63	2'-10"
50'-0"	24 I 87	3'-1 1/8"
60'-0"	27 I 91	3'-3 7/8"
70'-0"	30 I 108	3'-6 7/8"
80'-0"	33 I 125	3'-10"
90'-0"	33 I 132	3'-10 1/8"



ASSEMBLED VIEW

COMPANION SHEETS

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STEEL PILE BENTS AND PIERS	117
STEEL PILE BENTS AND PIERS	119
STEEL PILE BENTS AND PIERS	120

BILL OF MATERIALS FOR ONE RIVETED STEEL BENT OR PIER

LINE	DESCRIPTION: USE	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	STEEL PILE BENT HEIGHT 20' QUANTITY	BENT 18' QUANTITY	BENT 16' QUANTITY	BENT 14' QUANTITY	BENT 12' QUANTITY	BENT 10' QUANTITY	BENT 8' QUANTITY	BENT UNDER 8' QUANTITY	STEEL PILE PIER HEIGHT 20' QUANTITY	PIER 18' QUANTITY	PIER 16' QUANTITY	PIER 14' QUANTITY	PIER 12' QUANTITY	PIER 10' QUANTITY	PIER 8' QUANTITY	PIER UNDER 8' QUANTITY	LINE
1	CAP BEAM	48-2900.16-058	8909	16 I 58	11'-2"	648									4	4	4	4	4	4	4	4	1
2	DO	48-3790.18-43	8910	18 [42.7	24'-0"	1025	2	2	2	2	2	2	2	2									2
3	DIAPHRAGM		8911	12X12 I 53	1'-3"	66	4	4	4	4	4	4	4	4									3
4	DO	48-2900.16-058	8907	16 I 58	2'-11 5/8"	172									2	2	2	2	2	2	2	2	4
5	DO	48-2900.16-058	8908	16 I 58	3'-11"	227									4	4	4	4	4	4	4	4	5
6	CONNECTION ANGLE	48-2550.4-035	A1	4X3 X 5/16	1'-0"	7									40	40	40	40	40	40	40	40	6
7	CONNECTOR	48-2900.16-058	8920	1/2 16 I 58	1'-6 1/2"	45									9	6	6	3	3				7
8	DO	48-2900.16-058	8921	1/2 16 I 58	0'-10 1/8"	24									3	3	3	3	3	3	3		8
9	DO	48-2900.16-058	8922	1/2 16 I 58	0'-8 3/4"	21									3	3	3	3	3	3	3		9
10	DO	48-2900.16-058	8923	1/2 16 I 58	0'-6"	15									3	3	3	3	3	3	3		10
11	DO	47-7844.04	8927	PL 9 1/2 X 3/8	4'-0"	40									2	2	2	2	2	2	2		11
12	BEARING PLATE	47-7844.07	P1	PL 18 X 3/4	1'-7"	73	6	6	6	6	6	6	6	6									12
13	DO	47-7844.07	P2	PL 10 X 3/4	1'-7"	40									6	6	6	6	6	6	6	6	13
14	STRUTS AND BRACES	48-2550.4-035	8912	L4X3X5/16	23'-5"	169	2	2	2	2	2	2	2		4	4	4	4	4	4	4	4	14
15	DO	48-2550.4-035	8918	L4X3X5/15	4'-1 11/15"	30									12	9	9	6	6	3	3		15
16	DO	48-2550.4-035	8919	L4X3X5/16	2'-9 1/4"	20									3	3	3	3	3	3	3		16
17	DO	48-2550.4-035	8944	L4X3X5/16	28'-5"	205	2								2								17
18	DO	48-2550.4-035	8945	L4X3X5/16	27'-4"	197		2								2							18
19	DO	48-2550.4-035	8946	L4X3X5/16	26'-4"	190			2								2						19
20	DO	48-2550.4-035	8947	L4X3X5/16	25'-6"	184				2								2					20
21	DO	48-2550.4-035	8948	L4X3X5/16	24'-10"	179					2								2				21
22	DO	48-2550.4-035	8949	L4X3X5/16	24'-3"	175						2								2			22
23	DO	48-2550.4-035	8950	L4X3X5/16	23'-10"	172							2								2		23
24	DO	48-2550.4-035	8951	L4X3X5/16	11'-0"	79															4		24
25	DO	48-2550.4-035	8952	L4X3X5/16	11'-4"	82														4			25
26	DO	48-2550.4-035	8953	L4X3X5/16	11'-10"	86													4				26
27	DO	48-2550.4-035	8954	L4X3X5/16	12'-4"	89												4					27
28	DO	48-2550.4-035	8955	L4X3X5/16	12'-10"	93											4						28
29	DO	48-2550.4-035	8956	L4X3X5/16	13'-4"	96										4							29
30	DO	48-2550.4-035	8957	L4X3X5/15	13'-9"	99									4								30
31	RIVETS	43-6353.08-2		7/8	2"	.53									24	24	24	24	24	24	24	24	31
32	DO	43-6353.08-23		7/8	2 1/4"	.57	32	32	32	32	32	32	32		256	244	244	232	232	220	220	128	32
33	DO	43-6353.08-25		7/8	2 1/2"	.62	92	92	92	92	92	92	92	92	176	164	164	152	152	140	140	96	33
34	DO	43-6353.08-3		7/8	3"	.70	24	24	24	24	24	24	24	24									34
35	PILE			12X12 I 53	1		3	3	3	3	3	3	3	3	6	6	6	6	6	6	6	6	35

1 PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS.

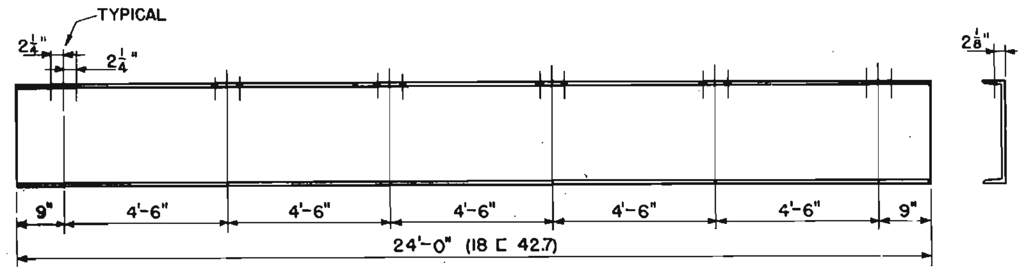
BILL OF MATERIALS FOR ONE WELDED STEEL PILE BENT OR PIER

LINE	DESCRIPTION: USE	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	STEEL PILE BENT HEIGHT 20' QUANTITY	BENT 18' QUANTITY	BENT 16' QUANTITY	BENT 14' QUANTITY	BENT 12' QUANTITY	BENT 10' QUANTITY	BENT 8' QUANTITY	BENT UNDER 8' QUANTITY	STEEL PILE PIER HEIGHT 20' QUANTITY	PIER 18' QUANTITY	PIER 16' QUANTITY	PIER 14' QUANTITY	PIER 12' QUANTITY	PIER 10' QUANTITY	PIER 8' QUANTITY	PIER UNDER 8' QUANTITY	LINE
1	CAP BEAM	48-3790.18-43	7023	18 [42.7	24'-0"	1025	2	2	2	2	2	2	2	2									1
2	DO	48-2900.21-059	7033	21 I 59	23'-2 1/4"	1368									2	2	2	2	2	2	2	2	2
3	DIAPHRAGM	48-2900.21-059	7034	21 I 59	3'-11 1/2"	234									6	6	6	6	6	6	6	6	3
4	DO		7024	12X12 I 53	1'-3"	66	4	4	4	4	4	4	4	4									4
5	CONNECTOR	47-7844.04	7045	PL 5 1/2 X 3/8	3'-9"	26									2	2	2	2	2	2	2		5
6	DO	47-7844.05	8659	PL 8 X 1/2	1'-6"	20									9	6	6	3	3				6
7	DO	47-7844.05	8660	PL 8 X 1/2	1'-0"	14									6	6	6	6	6	6	6		7
8	DO	47-7844.05	8661	PL 8 X 1/2	0'-6"	7									3	3	3	3	3	3	3		8
9	BOLTING CLIPS	47-7844.04	P7	PL 3 X 3/8	0'-4 1/16"	1									24	24	24	24	24	24	24	24	9
10	SHELF ANGLE	48-2550.4-035	8647	L 4X3X5/16	0'-4"	2	4	4	4	4	4	4	4	4									10
11	BEARING PLATE	47-7844.07	P3	PL 15 X 3/4	1'-7"	60	6	6	6	6	6	6	6	6									11
12	DO	47-7844.07	P4	PL 10 X 3/4	1'-7"	40									6	6	6	6	6	6	6	6	12
13	STRUTS AND BRACES	48-2550.4-035	7025	L 4X3X5/16	23'-6"	169	2	2	2	2	2	2	2		3	3	3	3	3	3	3		13
14	DO	48-2550.4-035	7026	L 4X3X5/16	28'-5"	205	2								2								14
15	DO	48-2550.4-035	7027	L 4X3X5/16	27'-4"	197		2								2							15
16	DO	48-2550.4-035	7028	L 4X3X5/16	26'-4"	190			2								2						16
17	DO	48-2550.4-035	7029	L 4X3X5/16	25'-6"	184				2								2					17
18	DO	48-2550.4-035	7030	L 4X3X5/16	24'-10"	179					2								2				18
19	DO	48-2550.4-035	7031	L 4X3X5/16	24'-3"	175						2								2			19
20	DO	48-2550.4-035	7032	L 4X3X5/16	23'-10"	172							2								2		20
21	DO	48-2550.4-035	7035	L 4X3X5/16	13'-9"	99									4								21
22	DO	48-2550.4-035	7036	L 4X3X5/16	13'-4"	96										4							22
23	DO	48-2550.4-035	7037	L 4X3X5/16	12'-10"	93											4						23
24	DO	48-2550.4-035	7038	L 4X3X5/16	12'-4"	89												4					24
25	DO	48-2550.4-035	7039	L 4X3X5/16	11'-10"	86													4				25
26	DO	48-2550.4-035	7040	L 4X3X5/15	11'-4"	82														4			26
27	DO	48-2550.4-035	7041	L 4X3X5/16	11'-0"	79															4		27
28	DO	48-2550.4-035	8613	L 4X3X5/16	4'-1 13/16"	30									12	9	9	6	6	3	3		28
29	DO	48-2550.4-035	8622	L 4X3X5/16	2'-9 1/4"	20									3	3	3	3	3	3	3		29
30	WELDING ROD (POUNDS)	46-3772.2-7		3/16			15	15	15	15	15	15	15	11	40	37	37	34	34	31	31	20	30
31	PILE			12X12 I 53	1		3	3	3	3	3	3	3	3	6	6	6	6	6	6	6	6	31
32	PILE CAP														6	6	6	6	6	6	6	6	32

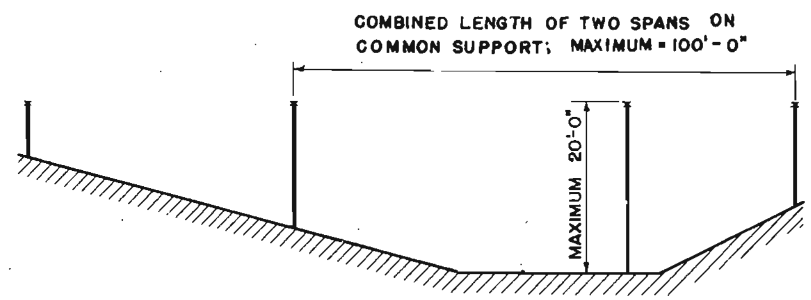
1 PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	118
FABRICATION DRAWING	151
SHIMS	103



CAP BEAM MK 7023

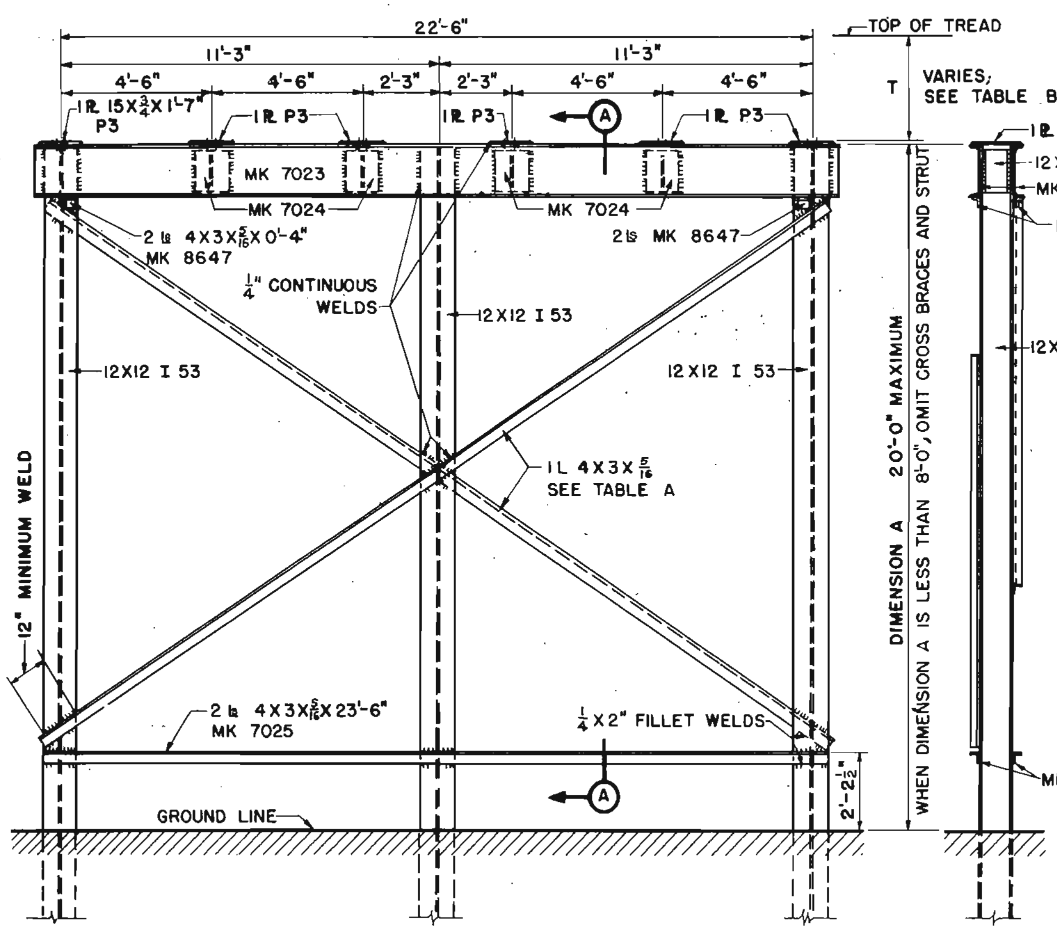


DIAGRAM

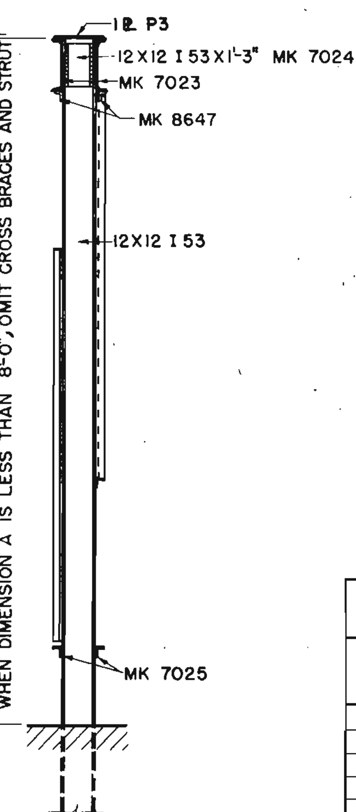
SHOWING HEIGHT AND SPAN LIMITATIONS
THREE-PILE BENT

TABLE A

BENT HEIGHT A	TRANSVERSE BRACING
20'-0"	MK 7026
18'-0"	MK 7027
16'-0"	MK 7028
14'-0"	MK 7029
12'-0"	MK 7030
10'-0"	MK 7031
8'-0"	MK 7032



TRANSVERSE ELEVATION



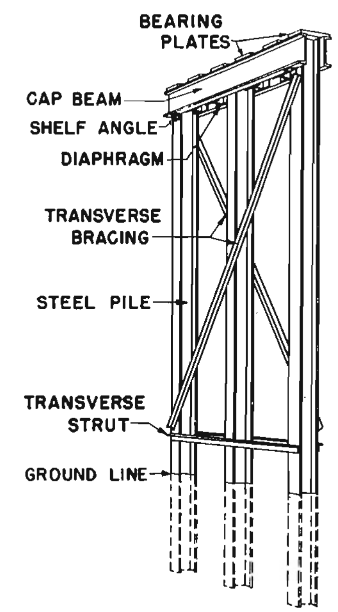
SECTION A-A

THREE-PILE BENT

MAXIMUM PILE LOADS	
TOTAL LOADED LENGTH	TONS PER PILE
30'-0"	15
40'-0"	18
50'-0"	20
60'-0"	22
70'-0"	24
80'-0"	27
90'-0"	29
100'-0"	31

TABLE B

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGER FOR VARIOUS SPANS		
SPAN	STEEL—STRINGER SIZE	TOP OF TREAD TO BOTTOM OF STRINGER T
15'-0"	14 I 30	2'-2⅞"
20'-0"	16 I 36	2'-4⅞"
30'-0"	21 I 59	2'-9⅞"
40'-0"	21 I 63	2'-10"
50'-0"	24 I 87	3-1⅛"
60'-0"	27 I 91	3'-3⅞"
70'-0"	30 I 108	3'-6⅞"
80'-0"	33 I 125	3'-10"
90'-0"	33 I 132	3'-10⅛"



ASSEMBLED VIEW

COMPANION SHEETS

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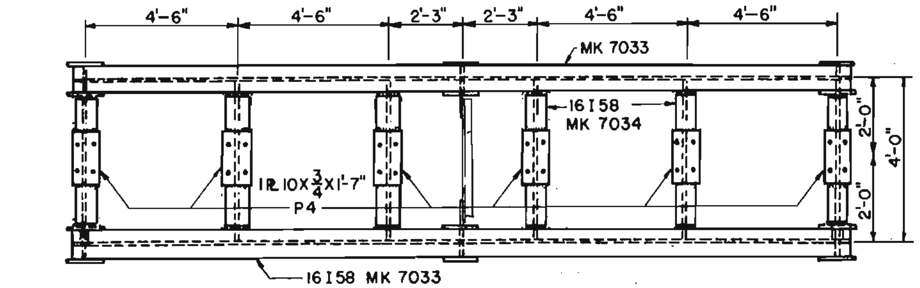
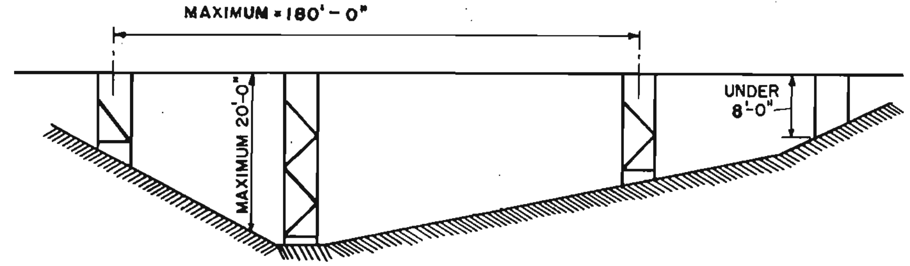
SYMBOLS	155
BILL OF MATERIALS	118

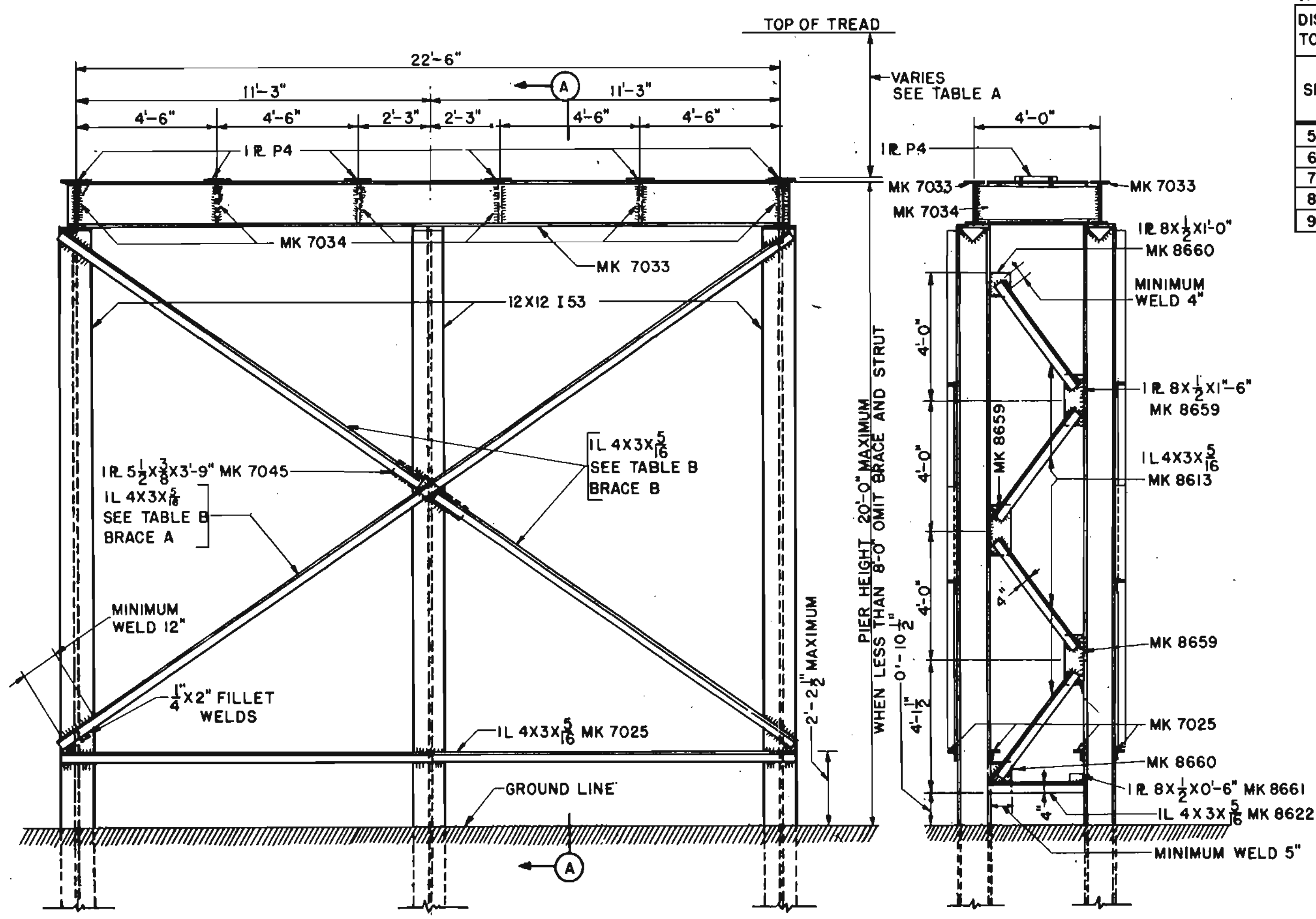


TOP PLAN



DIAGRAM

SHOWING HEIGHT AND SPAN LIMITATIONS SIX-PILE PIER



TRANSVERSE ELEVATION | SECTION A-A

SIX-PILE PIER

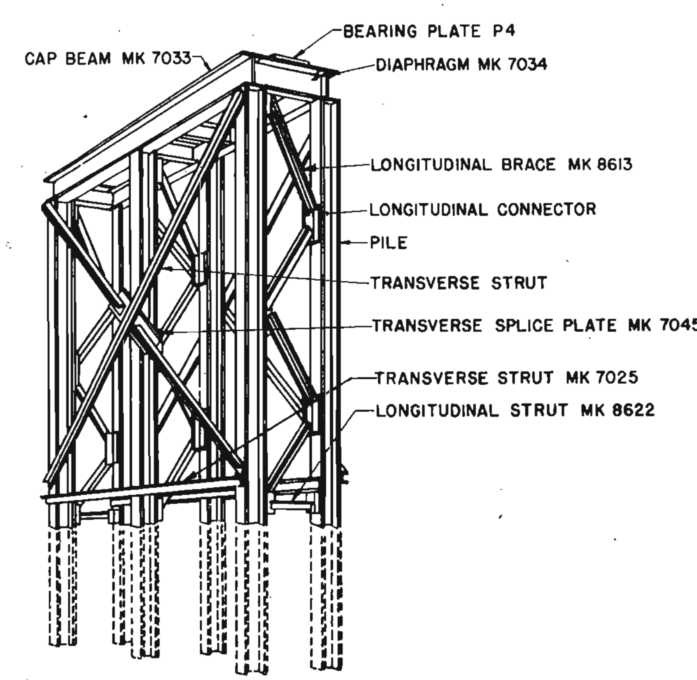
TABLE A

DISTANCE FROM TOP OF TREAD TO BOTTOM OF STRINGERS FOR VARIOUS SPANS		
SPAN	STEEL-STRINGER SIZE (INCHES)	TOP OF TREAD TO BOTTOM OF STRINGER
50'-0"	24 I 87	3'-1 1/8"
60'-0"	27 I 91	3'-3 7/8"
70'-0"	30 I 108	3'-6 7/8"
80'-0"	33 I 125	3'-10"
90'-0"	33 I 132	3'-10 1/8"

TABLE B

PIER HEIGHT	TRANSVERSE BRACE A	TRANSVERSE BRACE B
20'-0"	MK 7026	MK 7035
18'-0"	MK 7027	MK 7036
16'-0"	MK 7028	MK 7037
14'-0"	MK 7029	MK 7038
12'-0"	MK 7030	MK 7039
10'-0"	MK 7031	MK 7040
8'-0"	MK 7032	MK 7041

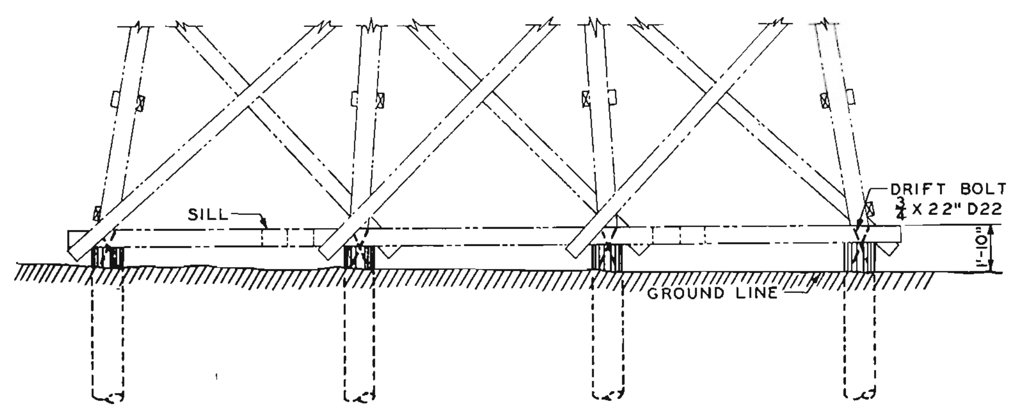
MAXIMUM PILE LOADS	
TOTAL LOADED LENGTH	TONS PER PILE
110'-0"	20
120'-0"	22
130'-0"	23
140'-0"	24
150'-0"	25
160'-0"	26
170'-0"	27
180'-0"	28



ASSEMBLED VIEW

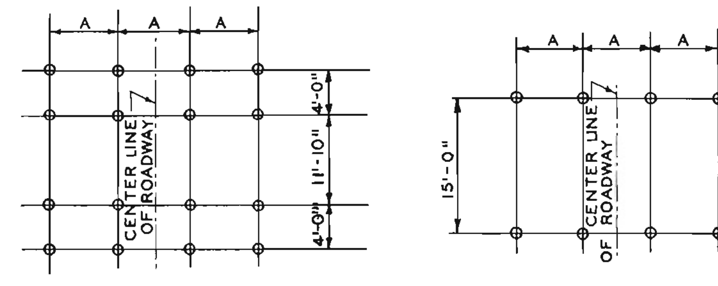
UNBRACED AND BRACED PILES UNDER SILLS, GENERAL VIEWS AND DIMENSIONS

TOWER HEIGHT	DIMENSION A
13'-4"	8'-3"
16'	8'-7"
18'	8'-10"
20'	9'-0"
22'	9'-3"
24'	9'-6"
25'-10"	9'-8"
28'	9'-11"
30'	10'-2"
32'	10'-4"
34'	10'-7"
36'	10'-10"
38'-4"	11'-1"
40'	11'-3"
42'	11'-6"
44'	11'-8"
46'	11'-11"
48'	12'-2"
50'-10"	12'-5"
53'	12'-8"
55'	12'-11"
57'	13'-2"
59'	13'-4"
61'	13'-7"
63'-4"	13'-10"
65'	14'-0"
67'	14'-3"
69'	14'-6"
71'	14'-8"
73'	14'-11"
75'-10"	15'-3"



TRANSVERSE ELEVATION

PILE FOUNDATION ON GROUND



STEEL SPANS

TIMBER SPANS

PILE ARRANGEMENT PLANS

COMPANION SHEETS

	SHEET
TIMBER TOWERS FOR TIMBER SPANS	97
TIMBER TOWERS FOR STEEL SPANS	100
GENERAL NOTES	154
SYMBOLS	155

BILL OF MATERIALS FOR ONE TOWER

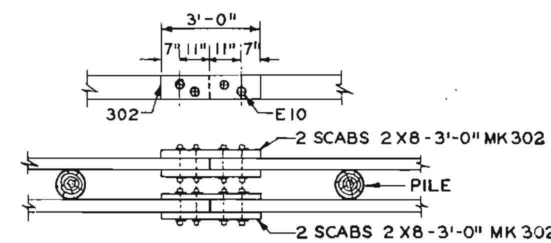
STEEL SPANS		TIMBER SPANS	
PILES	DRIFT BOLTS	PILES	DRIFT BOLTS
16	32	8	16

REQUIRED PILE BEARING CAPACITY 18 TONS PER PILE

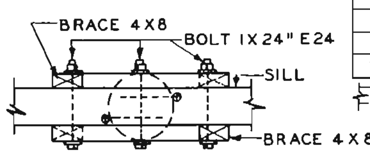
TABLE A

LENGTH OF 4X8 TRANSVERSE BRACING

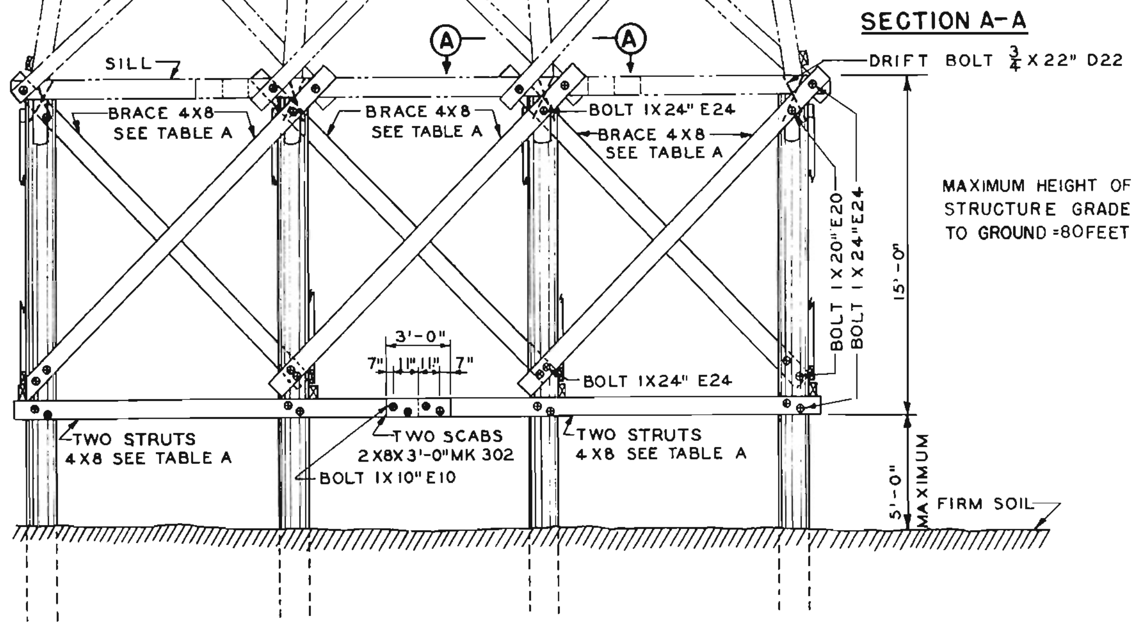
TOWER HEIGHT	BRACE		STRUTS	
	LENGTH	MARK	LENGTH	MARK
15' TO 21'	18'-0"	157	16'-0"	156
23' TO 28'	20'-0"	158	16'-0"	156
30' TO 40'	20'-0"	158	18'-0"	157
42' TO 50	20'-0"	158	20'-0"	158
50' TO 63'	22'-0"	159	22'-0"	159
65' TO 75'	22'-0"	159	24'-0"	160



DETAIL OF STRUT SPLICE

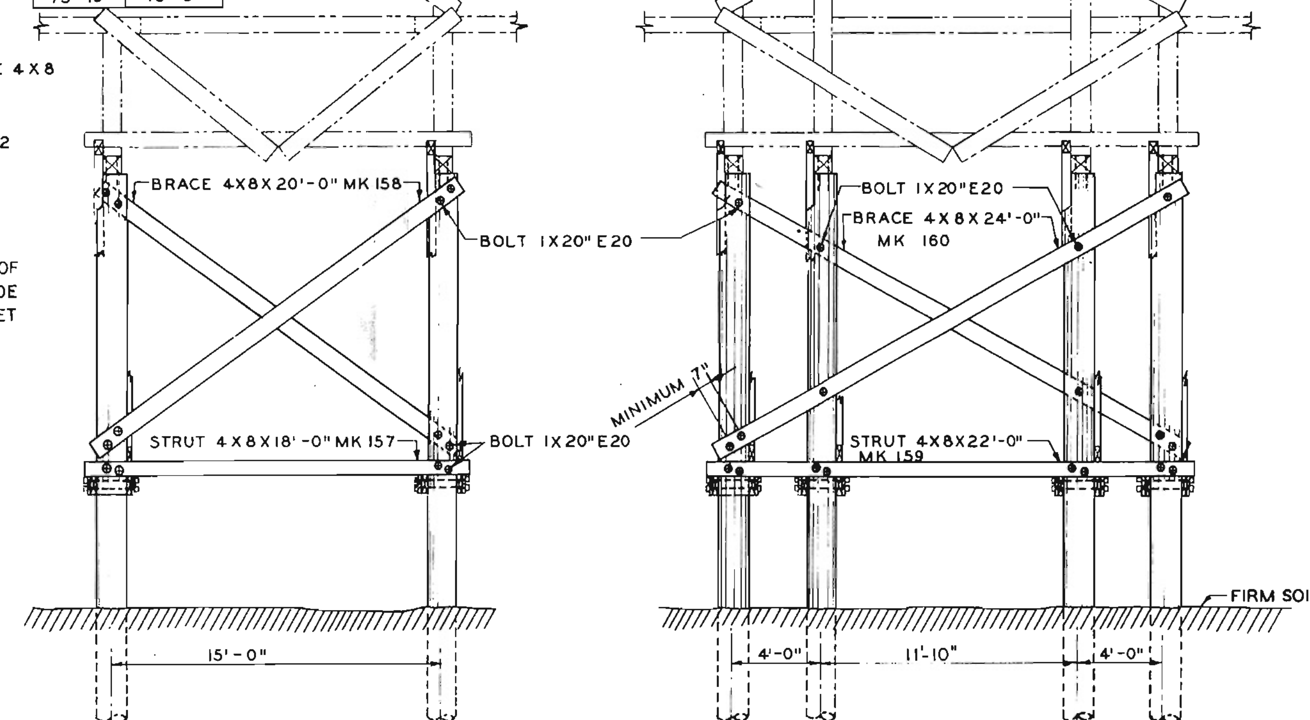


SECTION A-A



TRANSVERSE ELEVATION

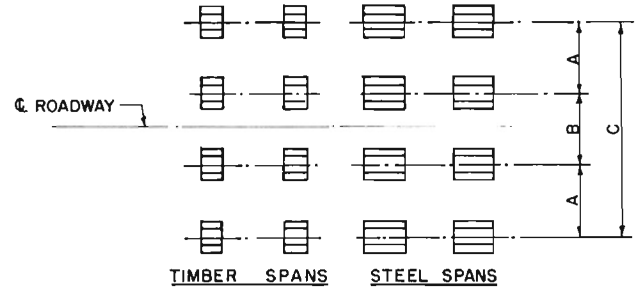
PILE FOUNDATION IN WATER



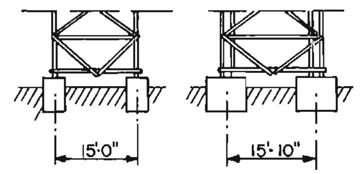
LONGITUDINAL ELEVATION TIMBER SPANS

LONGITUDINAL ELEVATION STEEL SPANS

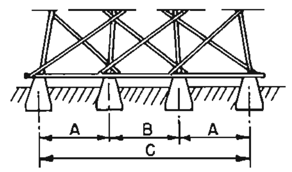
PILE FOUNDATION IN WATER



PLAN OF CONCRETE PEDESTALS



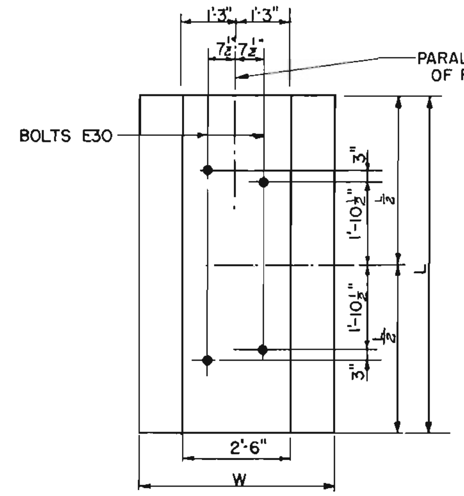
LONGITUDINAL ELEVATIONS



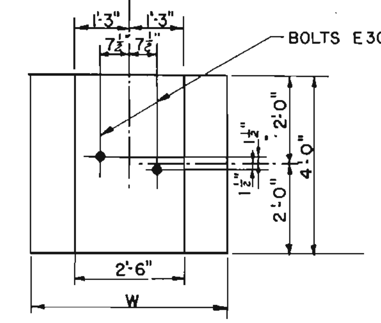
TRANSVERSE ELEVATION

CONCRETE PEDESTALS

STORY HEIGHT	TOWER HEIGHT	STEEL SPANS A	STEEL SPANS B	STEEL SPANS C	TIMBER SPANS A	TIMBER SPANS B	TIMBER SPANS C	FOOTING MARK TIMBER SPAN 15'-0"	FOOTING MARK STEEL SPAN 15'-0" TO 90'-0"
1	13'-4"	8'-3 3/8"	8'-3 3/8"	24'-10 1/8"	8'-3 1/2"	8'-3 1/2"	24'-10 1/2"	F115	F109
2	16'-0"	8'-7"	8'-7"	25'-9"	8'-7"	8'-7"	25'-9"	F115	F109
	18'-0"	8'-10"	8'-10"	26'-6"	8'-10"	8'-10"	26'-6"	F115	F109
	20'-0"	9'-0"	9'-0"	27'-0"	9'-0"	9'-0"	27'-0"	F115	F109
	22'-0"	9'-3"	9'-3"	27'-9"	9'-3"	9'-3"	27'-9"	F115	F107
	24'-0"	9'-6"	9'-6"	28'-6"	9'-6"	9'-6"	28'-6"	F115	F107
	25'-10"	9'-8"	9'-8"	29'-0"	9'-8 1/4"	9'-8 1/4"	29'-0 3/4"	F115	F107
3	28'-0"	9'-11"	9'-11"	29'-9"	9'-11"	9'-11"	29'-9"	F115	F107
	30'-0"	10'-2"	10'-2"	30'-6"	10'-2"	10'-2"	30'-6"	F115	F107
	32'-0"	10'-4"	10'-4"	31'-0"	10'-4"	10'-4"	31'-0"	F114	F107
	34'-0"	10'-7"	10'-7"	31'-9"	10'-7"	10'-7"	31'-9"	F114	F107
	36'-0"	10'-10"	10'-10"	32'-6"	10'-10"	10'-10"	32'-6"	F114	F107
	38'-4"	11'-0 5/8"	11'-0 5/8"	33'-1 7/8"	11'-0 7/8"	11'-0 7/8"	33'-2 5/8"	F114	F107
4	40'-0"	11'-3"	11'-3"	33'-9"	11'-3"	11'-3"	33'-9"	F114	F107
	42'-0"	11'-6"	11'-6"	34'-6"	11'-6"	11'-6"	34'-6"	F114	F107
	44'-0"	11'-8"	11'-8"	35'-0"	11'-8"	11'-8"	35'-0"	F114	F107
	46'-0"	11'-11"	11'-11"	35'-9"	11'-11"	11'-11"	35'-9"	F114	F107
	48'-0"	12'-2"	12'-2"	36'-6"	12'-2"	12'-2"	36'-6"	F114	F107
	50'-10"	12'-5 3/8"	12'-5 3/8"	37'-4 1/8"	12'-5 1/2"	12'-5 1/2"	37'-4 1/2"	F114	F105
5	53'-0"	12'-8"	12'-8"	38'-0"	12'-8"	12'-8"	38'-0"	F113	F105
	55'-0"	12'-11"	12'-11"	38'-9"	12'-11"	12'-11"	38'-9"	F113	F105
	57'-0"	13'-2"	13'-2"	39'-6"	13'-2"	13'-2"	39'-6"	F113	F105
	59'-0"	13'-4"	13'-4"	40'-0"	13'-4"	13'-4"	40'-0"	F113	F105
	61'-0"	13'-7"	13'-7"	40'-9"	13'-7"	13'-7"	40'-9"	F113	F105
	63'-4"	13'-10"	13'-10"	41'-6"	13'-10 1/4"	13'-10 1/4"	41'-6 3/4"	F113	F105
6	65'-0"	14'-0"	14'-0"	42'-0"	14'-0"	14'-0"	42'-0"	F113	F105
	67'-0"	14'-3"	14'-3"	42'-9"	14'-3"	14'-3"	42'-9"	F113	F105
	69'-0"	14'-6"	14'-6"	43'-6"	14'-6"	14'-6"	43'-6"	F113	F105
	71'-0"	14'-8"	14'-8"	44'-0"	14'-8"	14'-8"	44'-0"	F113	F105
	73'-0"	14'-11"	14'-11"	44'-9"	14'-11"	14'-11"	44'-9"	F113	F105
	75'-10"	15'-2 5/8"	15'-2 5/8"	45'-7 7/8"	15'-2 7/8"	15'-2 7/8"	45'-8 5/8"	F113	F105



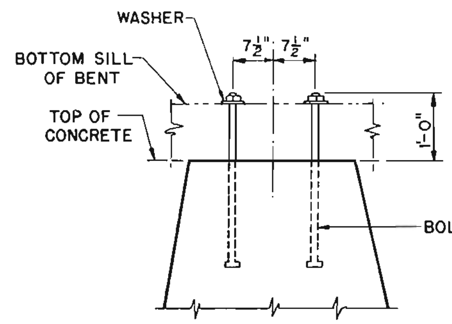
FOOTINGS F105, F107, F109



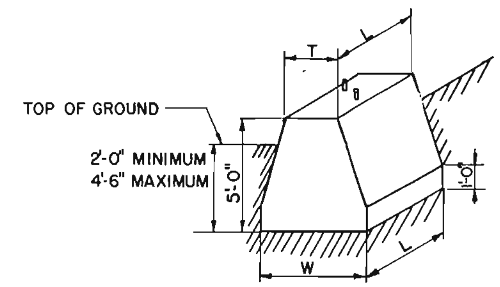
FOOTINGS F113, F114, F115

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155



TYPICAL ANCHOR BOLT DETAIL

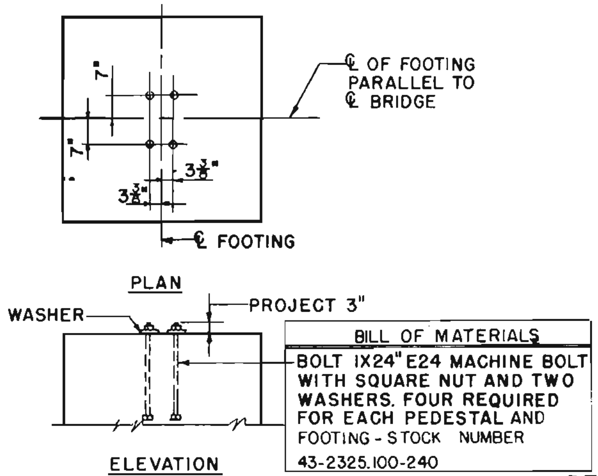


CONCRETE PEDESTAL FOR FRAMED TIMBER TOWERS

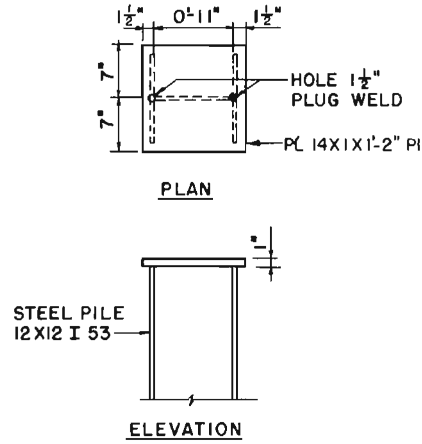
CONCRETE PEDESTALS FOR FRAMED TIMBER TOWERS

MARK	WIDTH (W)	TOP (T)	LENGTH (L)	CONCRETE CUBIC YARDS	MACHINE BOLT 1x30" WITH SQUARE NUT, E30, AND TWO WASHERS STOCK NO 43-2325.1-3 QUANTITY	POUNDS
F105	5'-6"	2'-6"	7'-6"	6.0	4	31
F107	5'-0"	2'-6"	7'-0"	5.2	4	31
F109	4'-6"	2'-6"	6'-6"	4.5	4	31
F113	5'-0"	2'-6"	4'-0"	3.0	2	16
F114	4'-6"	2'-6"	4'-0"	2.7	2	16
F115	4'-0"	2'-6"	4'-0"	2.5	2	16

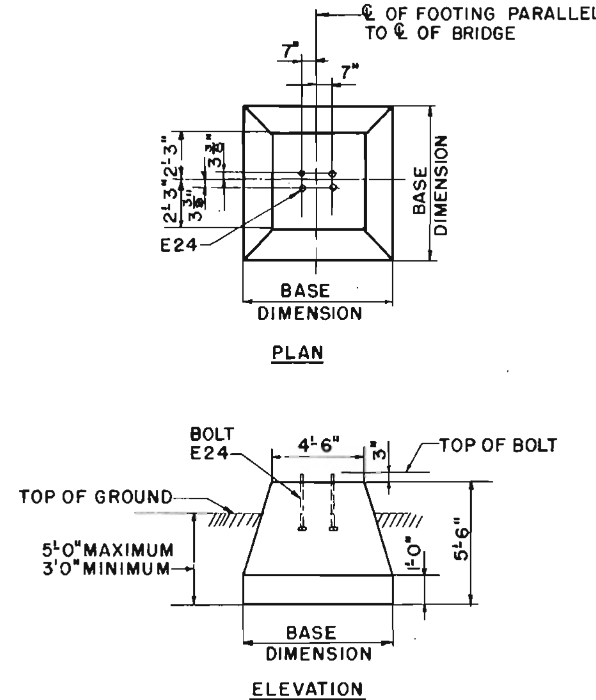
920303 O - 50 - 29



ANCHOR BOLT DETAIL



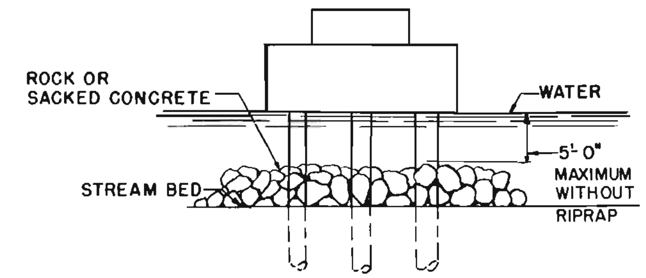
DETAIL OF STEEL PILE CAP PLATE



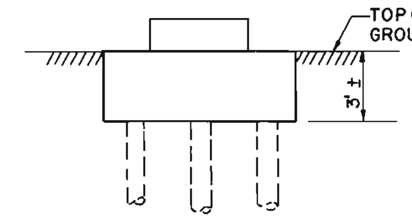
CONCRETE PEDESTALS WITHOUT PILES

COMPANION SHEETS

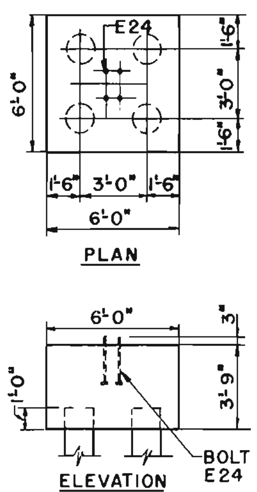
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	55
FRAMED STEEL TOWERS	56



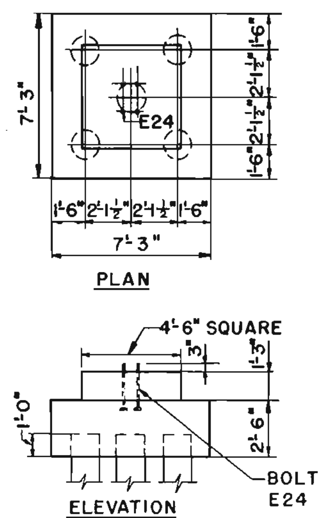
TYPICAL ELEVATION
TIMBER PILE FOOTINGS IN WATER



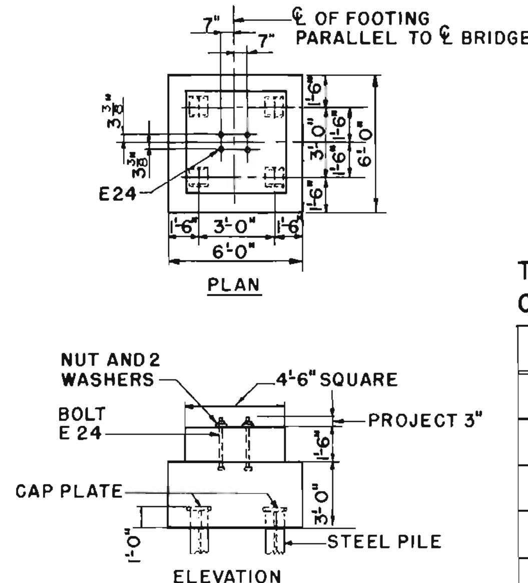
TYPICAL ELEVATION
TIMBER PILE FOOTINGS IN SOIL



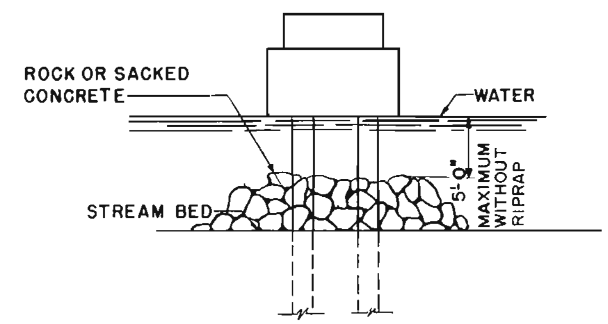
F134
4-PILE FOOTING



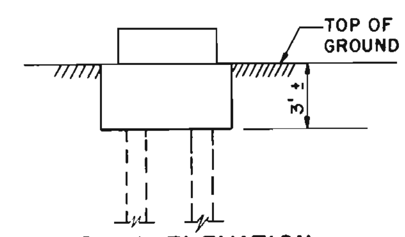
F135
5-PILE FOOTING



4-PILE FOOTING



TYPICAL ELEVATION
STEEL PILE FOOTINGS IN WATER



TYPICAL ELEVATION
STEEL PILE FOOTINGS IN SOIL

TABLE OF DIMENSIONS AND BILL OF MATERIALS FOR ONE PEDESTAL WITH TIMBER PILES

ADJACENT SPAN	HEIGHT OF TOWER	FOOTING MARK	NUMBER OF PILES PER FOOTING	CONCRETE (CUBIC YARDS)
15'	77' OR LOWER	F134	4	5.0
20'	77' OR LOWER	F134	4	5.0
30'	77' OR LOWER	F134	4	5.0
40'	77' OR LOWER	F134	4	5.0
50'	77' OR LOWER	F134	4	5.0
60'	77' OR LOWER	F134	4	5.0
70'	77' OR LOWER	F134	4	5.0
80'	57' OR LOWER	F134	4	5.0
	59' TO 77'	F135	5	5.8
90'	57' OR LOWER	F134	4	5.0
	59' TO 77'	F135	5	5.8

REQUIRED BEARING CAPACITY OF PILES, TONS PER PILE 4-PILE FOOTING

ADJACENT SPAN	HEIGHT OF TOWER 21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
15'	12	13	14	16
20'	12	13	15	17
30'	13	14	16	18
40'	14	15	17	19
50'	14	16	18	20
60'	15	17	19	21
70'	16	18	20	22
80'	17	19	21	23
90'	18	20	22	24 [1]

[1] 5-PILE FOOTING 18 TONS

TABLE OF DIMENSIONS AND BILL OF MATERIALS FOR ONE PEDESTAL WITHOUT PILES

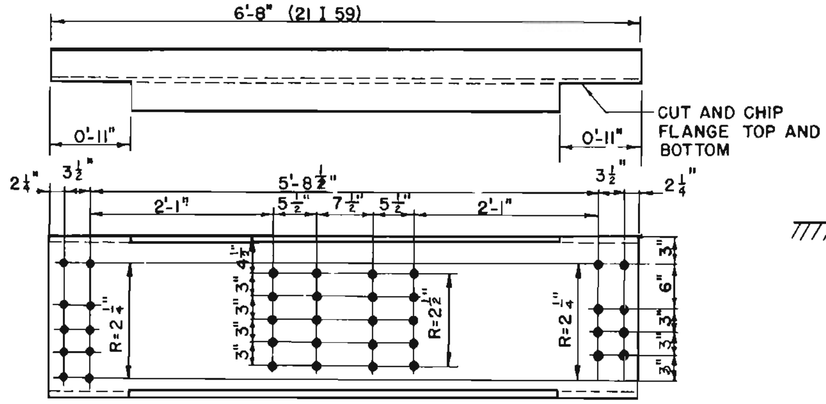
ADJACENT SPAN	HEIGHT OF TOWER	FOOTING MARK	BASE DIMENSION	CONCRETE (CUBIC YARDS)
15'	39' OR LOWER	F 120	6'-0"	6.0
	41' TO 77'	F 121	7'-0"	7.4
20'	21' OR LOWER	F 120	6'-0"	6.0
	23' TO 77'	F 121	7'-0"	7.4
30'	21' OR LOWER	F 120	6'-0"	6.0
	23' TO 77'	F 121	7'-0"	7.4
40'	57' OR LOWER	F 121	7'-0"	7.4
	59' TO 77'	F 122	8'-0"	9.1
50'	39' OR LOWER	F 121	7'-0"	7.4
	41' TO 77'	F 122	8'-0"	9.1
60'	39' OR LOWER	F 121	7'-0"	7.4
	41' TO 77'	F 122	8'-0"	9.1
70'	21' OR LOWER	F 121	7'-0"	7.4
	23' TO 77'	F 122	8'-0"	9.1
80'	21' OR LOWER	F 121	7'-0"	7.4
	23' TO 77'	F 122	8'-0"	9.1
90'	57' OR LOWER	F 122	8'-0"	9.1
	59' TO 77'	F 123	9'-0"	10.8

BILL OF MATERIALS FOR ONE FOOTING WITH STEEL PILES

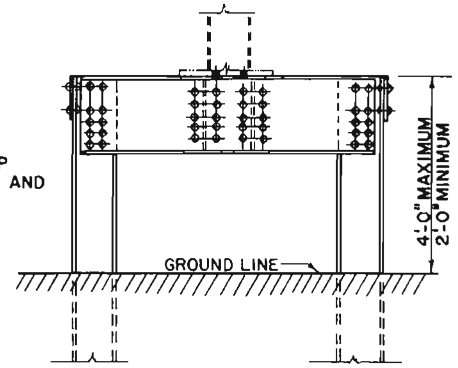
DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	WEIGHT EACH	QUANTITY
CONCRETE						5.1 CU YD
PILE			12X12I53			4
CAP PLATE	47-7844.1	Pl	14X1	1'-2"	55LB	4
WELDING ELECTRODE	46-3772.25-5		7/32			4 POUNDS

COMPANION SHEETS

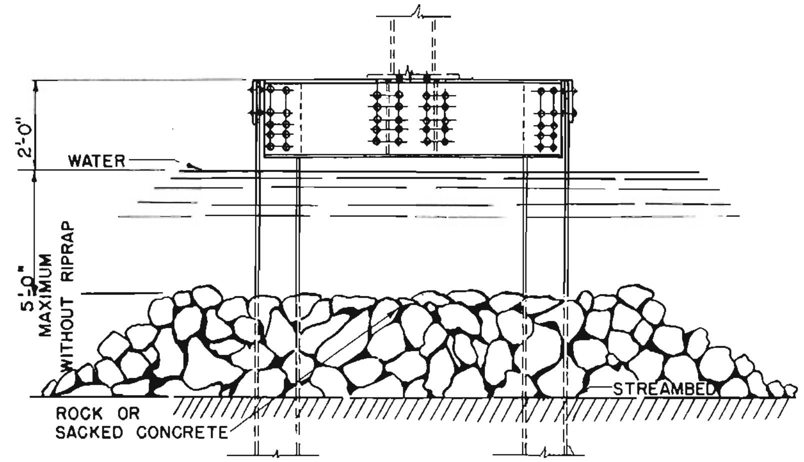
	SHEET
GENERAL NOTES	154
SYMBOLS	155



BEAM MK 9052



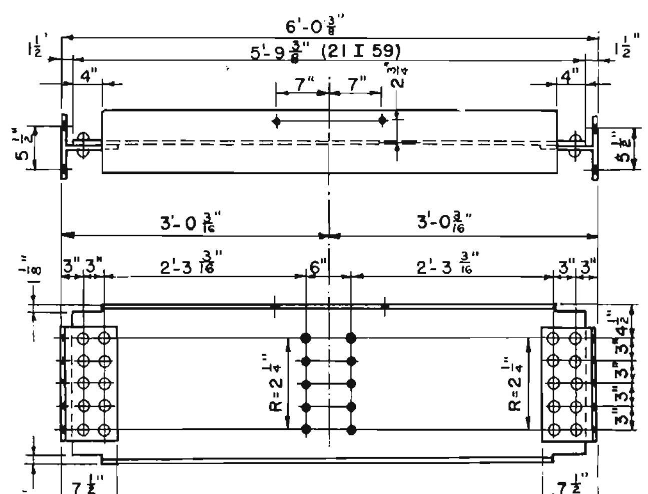
FOOTINGS IN SOIL



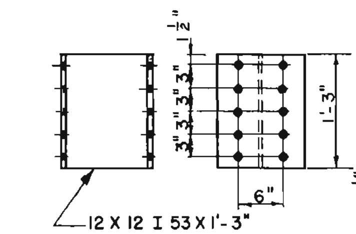
FOOTINGS IN WATER

REQUIRED BEARING CAPACITY OF STEEL PILES, TONS PER PILE

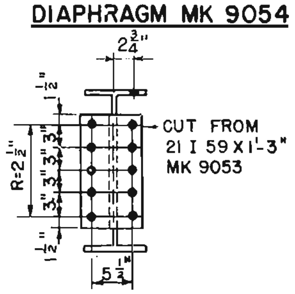
ADJACENT SPAN	HEIGHT OF TOWER			
	21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
15'	12	13	14	16
20'	12	13	15	17
30'	13	14	16	18
40'	14	15	17	19
50'	14	16	18	20
60'	15	17	19	21
70'	16	18	20	22
80'	17	19	21	23
90'	18	20	22	24

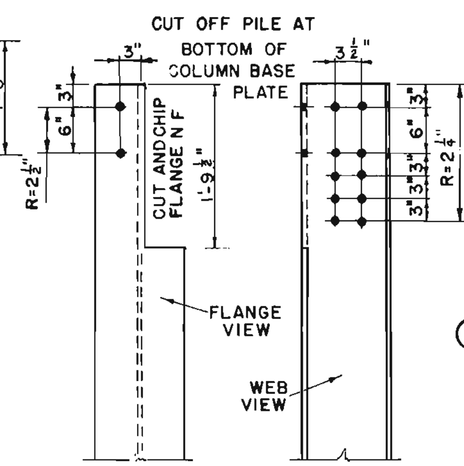


BEAM MK 9051

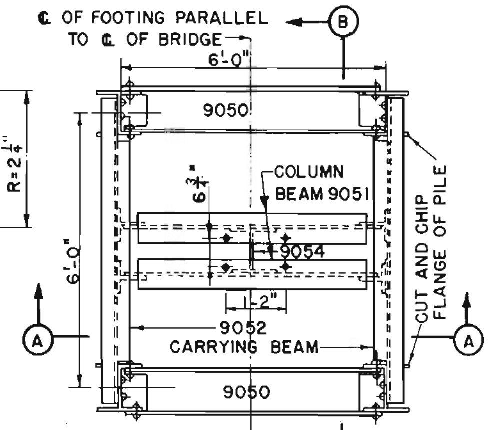


DIAPHRAGM MK 9054

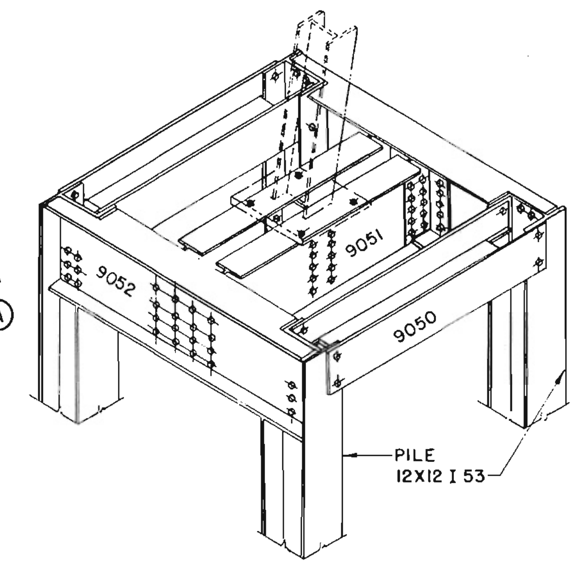




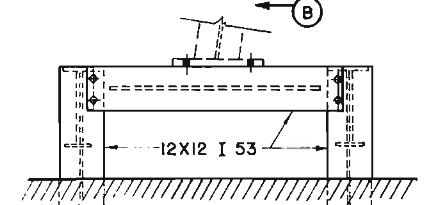
DETAIL AT TOP OF PILE



PLAN



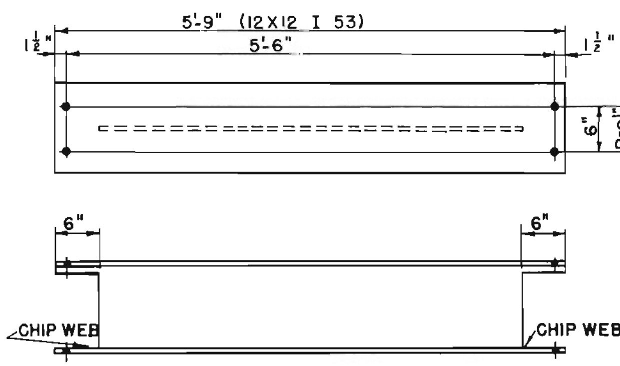
ASSEMBLED VIEW



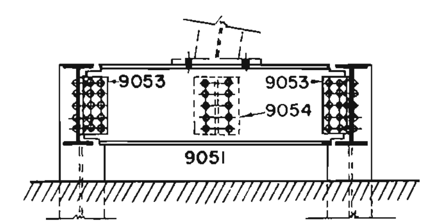
END VIEW

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	WEIGHT EACH	QUANTITY
1	PILE		-	12X12 I 53	-	-	4
2	BEAM	48-2900.21-059	9052	21 I 59	6'-8"	390 LBS	2
3	BEAM	48-2900.21-059	9051	21 I 59	5'-9 3/8"	339 LBS	2
4	BEAM		9050	12X12 I 53	5'-9"	305 LBS	2
5	CONNECTION	48-2900.21-059	9053	21 I 59	1'-3"	34 LBS	4
6	DIAPHRAGM		9054	12X12 I 53	1'-3"	66 LBS	1
7	RIVET	43-6353.08-25		7/8	2 1/2"	.62	40
8	RIVET	43-6353.08-23		7/8	2 1/4"	.57	116
9	RIVET BOLT WITH NUT		G8	7/8	3"	1.24	4
10	WASHER, STANDARD ROUND	43-9215.5-1		2 1/2 X 5/32			4

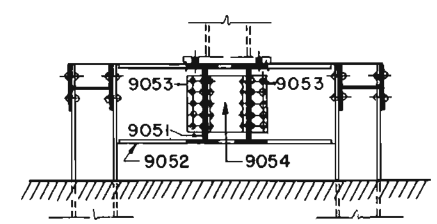
LENGTH OF PILES WILL BE DETERMINED BY CONDITIONS AT THE SITE AND BEARING CAPACITY REQUIRED



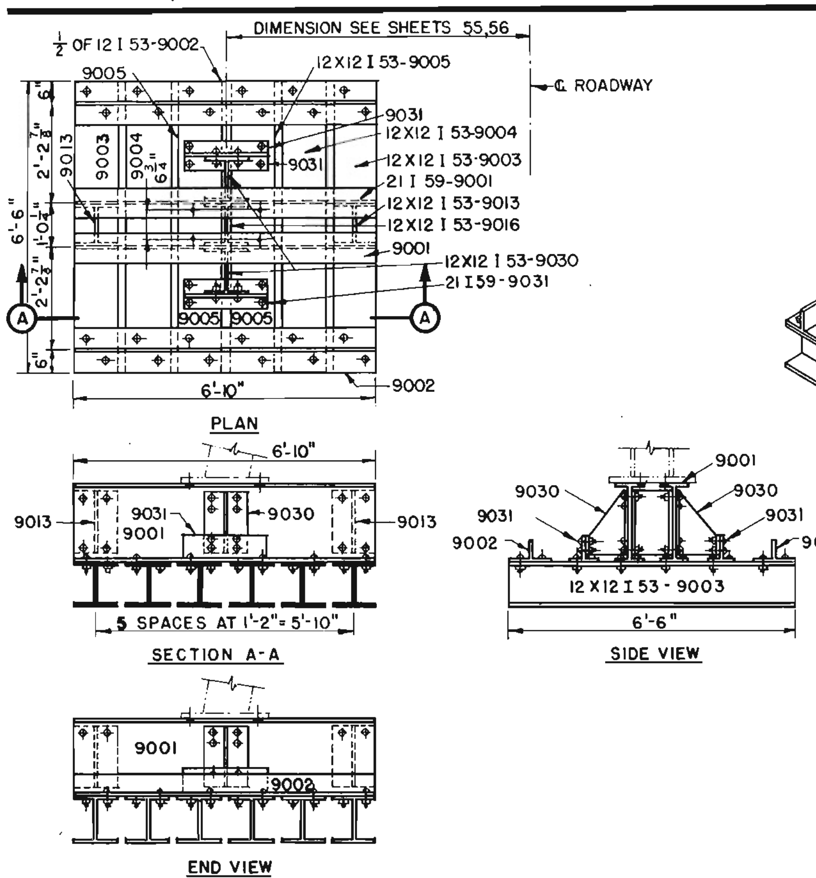
BEAM MK 9050



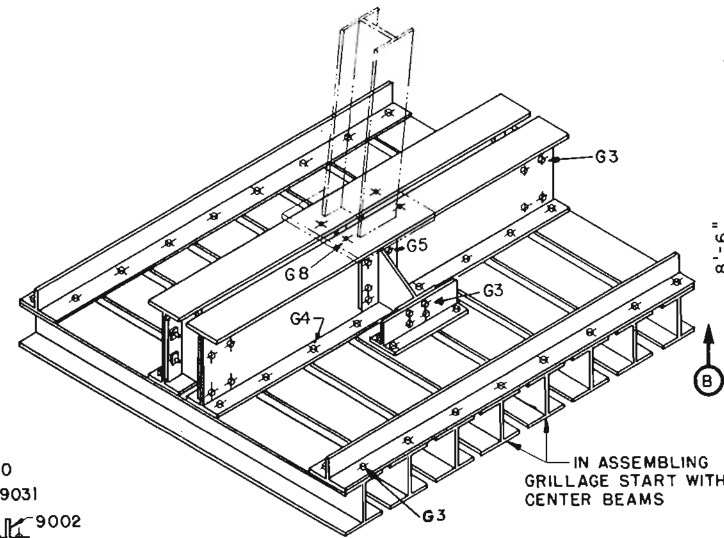
SECTION A-A



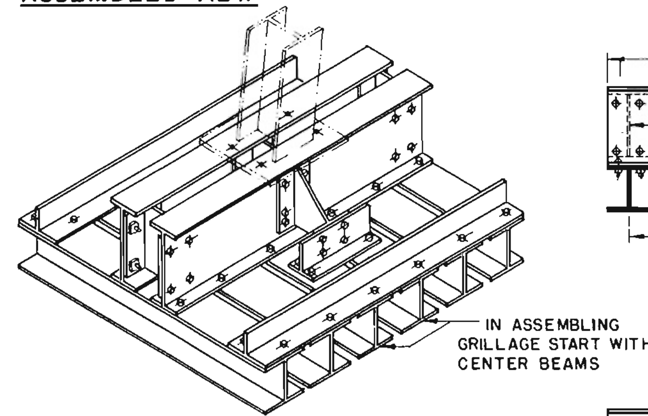
SECTION B-B



GRILLAGE FOOTING
S-101



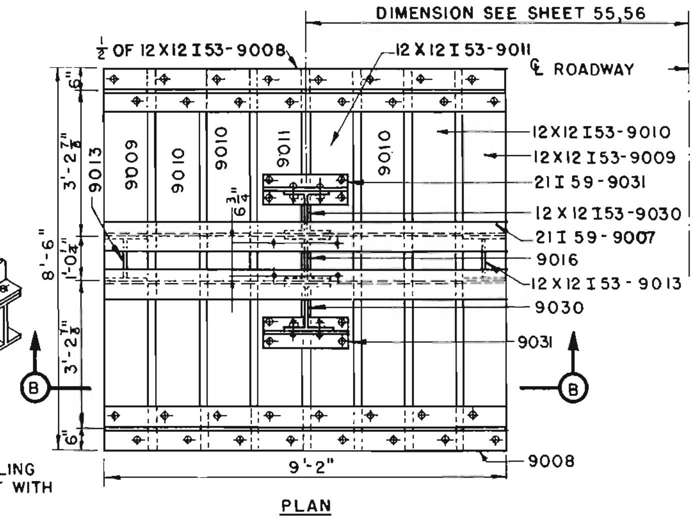
ASSEMBLED VIEW

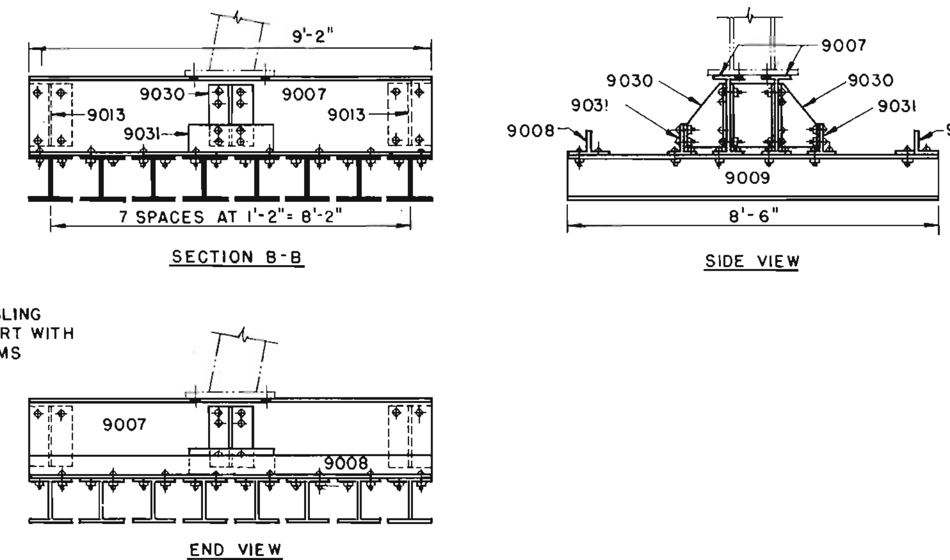


ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	55
FRAMED STEEL TOWERS	56





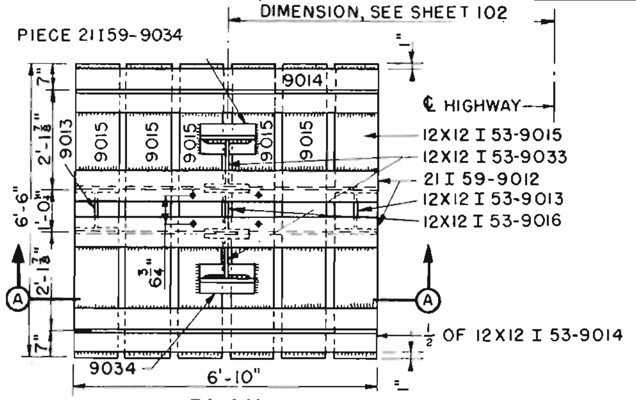
GRILLAGE FOOTING
S-102

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

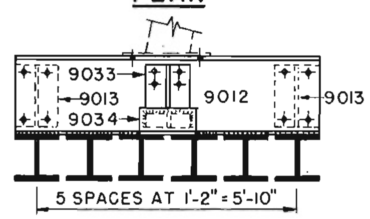
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH (INCHES)	WEIGHT EACH (LBS)	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9001	21 I 59	6'-10"	403	2	
2	TOP TIER HALF BEAM		9002	12X12I53	6'-10"	180	2	
3	BOTTOM TIER BEAM		9003	12X12I53	6'-6"	345	2	
4	BOTTOM TIER BEAM		9004	12X12I53	6'-6"	345	2	
5	BOTTOM TIER BEAM		9005	12 X12I53	6'-6"	345	2	
6	TOP TIER BEAM	48-2900.21-059	9007	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM		9008	12X12I53	9'-2"	243		2
8	BOTTOM TIER BEAM		9009	12X12I53	8'-6"	450		2
9	BOTTOM TIER BEAM		9010	12X12I53	8'-6"	450		4
10	BOTTOM TIER BEAM		9011	12X12I53	8'-6"	450		2
11	SEPARATOR		9013	12X12I53	1'-6"	80	2	2
12	SEPARATOR		9016	12 X12I53	1'-6"	80	1	1
13	BRACE		9030	12 X12I53	1'-6"	53	2	2
14	BRACE	48-2900.21-059	9031	21 I 59	1'-11"	50	2	2
						UNIT WEIGHT		
15	RIVET BOLT		G3	7/8	2 1/16"	.94	48	56
16	RIVET BOLT		G4	7/8	2 1/4"	.97	24	28
17	RIVET BOLT		G5	7/8	2 7/16"	1.00	16	16
18	RIVET BOLT AND WASHER		G8	7/8	3 "	1.09	4	4

SCHEDULE FOR SELECTION OF GRILLAGE FOOTING FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

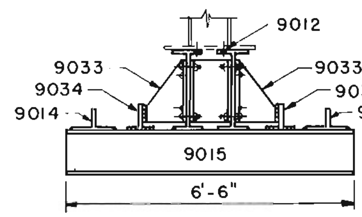
DESCRIPTION	SPAN BETWEEN TOWERS	FOOTINGS ON SOIL, HEIGHT OF TOWER: UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	FOOTINGS ON ROCK: ALL TOWER HEIGHTS
DOUBLE LANE CLASS 25	15' TO 40'	S-101	S-101	S-101	S-101	S-101
DO	50'	S-101	S-101	S-101	S-102	S-101
DO	60'	S-101	S-101	S-101	S-102	S-101
DO	70'	S-101	S-101	S-101	S-102	S-101
DO	80'	S-101	S-101	S-102	S-102	S-101
DO	90'	S-101	S-101	S-102	S-102	S-101



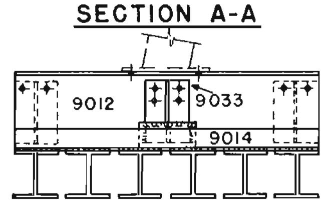
PLAN



SECTION A-A

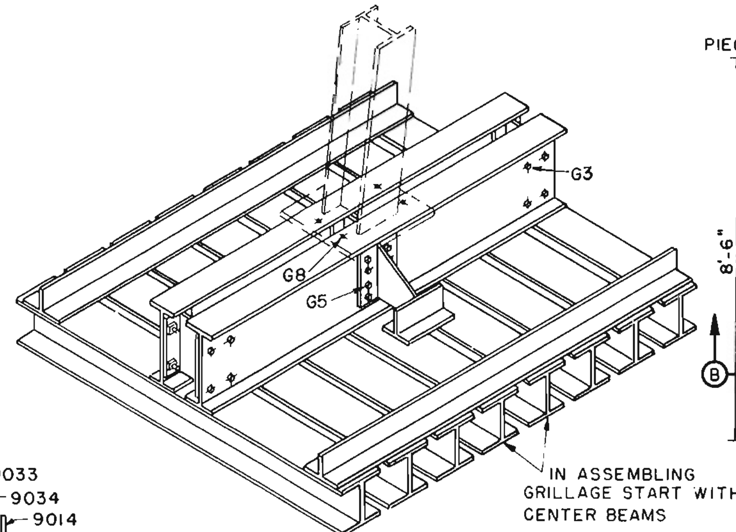


SIDE VIEW

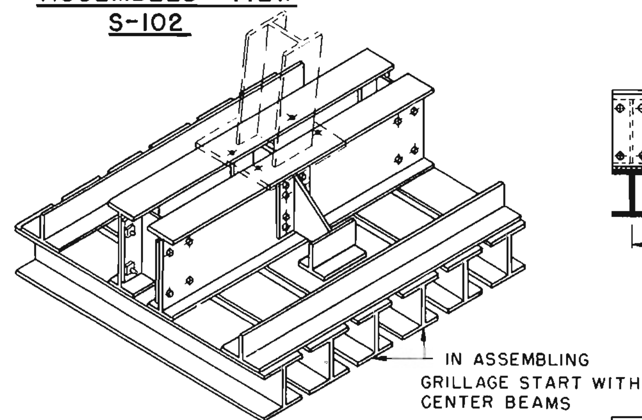


END VIEW

GRILLAGE FOOTING
S-101

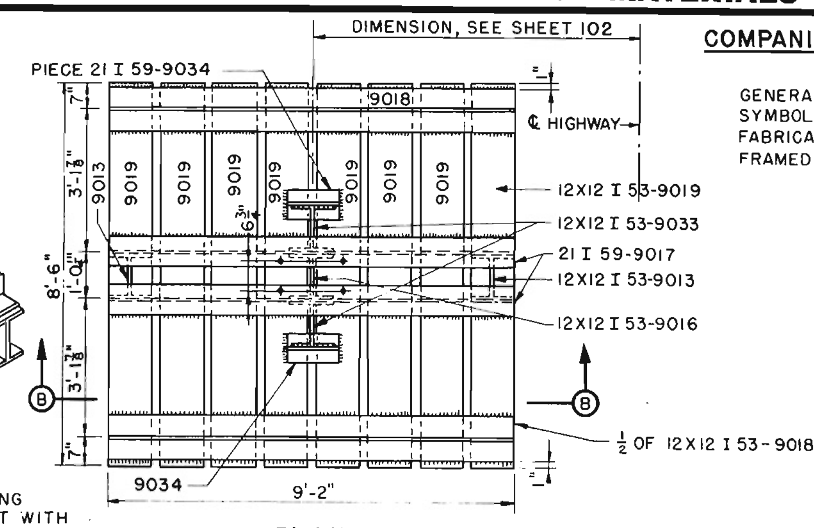


ASSEMBLED VIEW
S-102

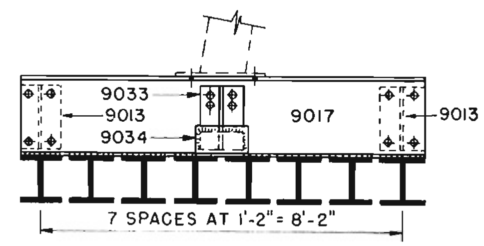


ASSEMBLED VIEW
S-101

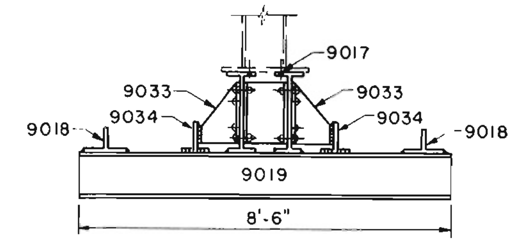
ALL WELDS SHOWN ARE ¼" FILLET WELDS UNLESS OTHERWISE NOTED



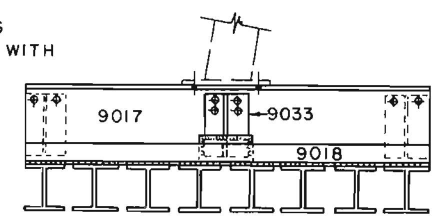
PLAN



SECTION B-B



SIDE VIEW



END VIEW

GRILLAGE FOOTING
S-102

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	153
FRAMED STEEL TOWER	55,56

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

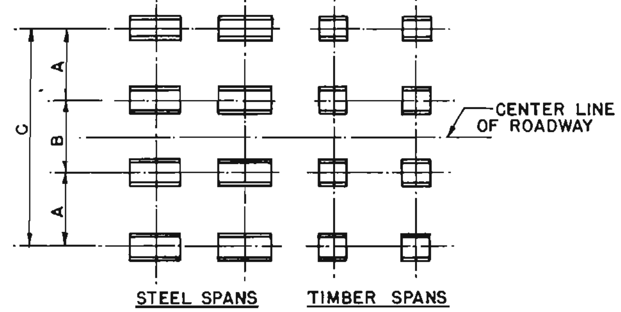
	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9012	21 I 59	6'-10"	403	2	
2	SEPARATOR		9013	12X12 I 53	1'-6"	80	2	2
3	TOP TIER HALF BEAM		9014	12X12 I 53	6'-10"	180	2	
4	BOTTOM TIER BEAM		9015	12X12 I 53	6'-6"	345	6	
5	SEPARATOR		9016	12X12 I 53	1'-6"	80	1	1
6	TOP TIER BEAM	48-2900.21-059	9017	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM		9018	12X12 I 53	9'-2"	243		2
8	BOTTOM TIER BEAM		9019	12X12 I 53	8'-6"	450		8
9	BRACE		9033	12X12 I 53	1'-6"	53	2	2
10	BRACE	48-2900.21-059	9034	21 I 59	1'-2"	35	2	2
						TOTAL WEIGHT		
11	RIVET BOLT		G3	7/8	2 1/16"	15	16	16
12	RIVET BOLT		G5	7/8	2 7/16"	16	16	16
13	RIVET BOLT AND WASHER		G8	7/8	3"	5	4	4
14	WELDING ELECTRODE	46-3772.2-7		3/16			9 LBS	12 LBS.

SCHEDULE FOR SELECTION OF GRILLAGE FOOTINGS FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

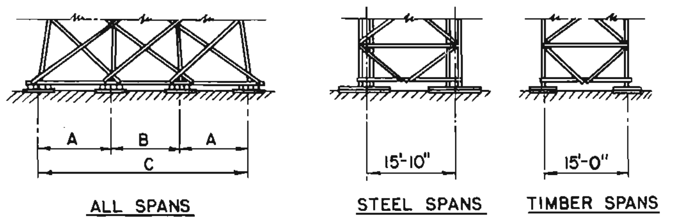
SPAN BETWEEN TOWERS	FOOTINGS ON SOIL — HEIGHT OF TOWER				FOOTINGS ON ROCK
	UP TO 21'	23' TO 39'	41' TO 57'	59' TO 77'	•ALL TOWER HEIGHTS
15' TO 40'	S-101	S-101	S-101	S-101	S-101
50'	S-101	S-101	S-101	S-102	S-101
60'	S-101	S-101	S-101	S-102	S-101
70'	S-101	S-101	S-101	S-102	S-101
80'	S-101	S-101	S-102	S-102	S-101
90'	S-101	S-101	S-102	S-102	S-101

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155



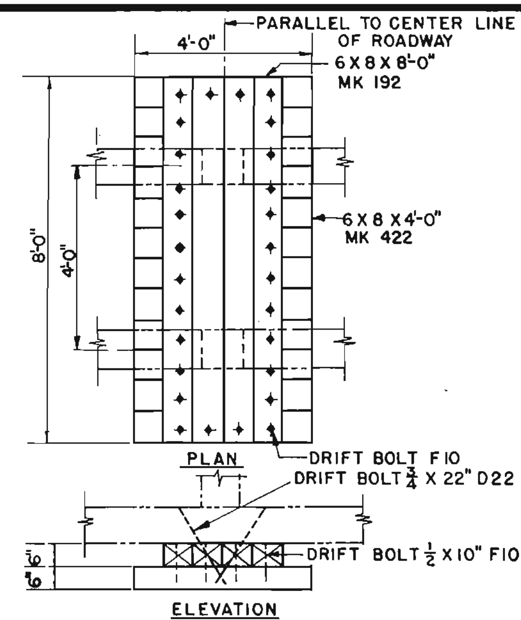
TIMBER GRILLAGES



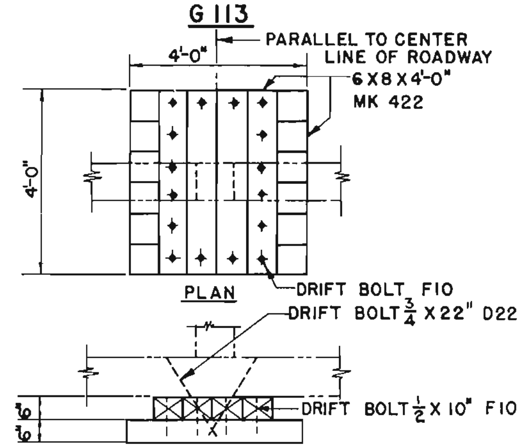
TRANSVERSE ELEVATION   LONGITUDINAL ELEVATIONS

TIMBER GRILLAGE FOOTINGS

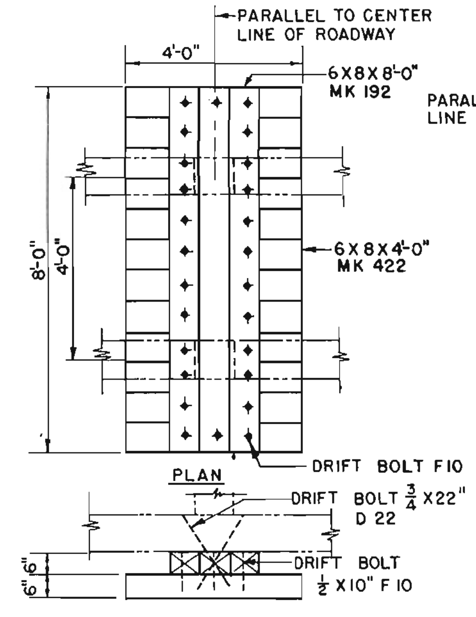
STORIES	TOWER HEIGHT	STEEL SPANS A	STEEL SPANS B	STEEL SPANS C	TIMBER SPANS A	TIMBER SPANS B	TIMBER SPANS C	FOOTING MARK TIMBER SPANS 15'	FOOTING MARK STEEL SPANS 15' TO 90'
1	13'-4"	8-3 3/8"	8'-3 3/8"	24-10 1/8"	8'-3 1/2"	8-3 1/2"	24'-10 1/2"	G 118	G 117
2	16'	8'-7"	8'-7"	25'-9"	8'-7"	8'-7"	25'-9"	G 118	G 117
	18'	8'-10"	8'-10"	26'-6"	8'-10"	8'-10"	26'-6"	G 118	G 117
	20'	9'-0"	9'-0"	27'-0"	9'-0"	9-0"	27'-0"	G 118	G 117
	22'	9'-3"	9'-3"	27'-9"	9'-3"	9'-3"	27'-9"	G 118	G 117
	24	9'-6"	9'-6"	28'-6"	9'-6"	9'-6"	28'-6"	G 118	G 117
	25'-10"	9'-8"	9'-8"	29'-0"	9'-8 1/4"	9-8 1/4"	29'-0 3/4"	G 118	G 117
3	28'	9'-11"	9'-11"	29'-9"	9'-11"	9'-11"	29'-9"	G 118	G 117
	30'	10'-2"	10'-2"	30'-6"	10'-2"	10'-2"	30'-6"	G 118	G 117
	32'	10'-4"	10'-4"	31'-0"	10'-4"	10'-4"	31'-0"	G 118	G 117
	34'	10'-7"	10'-7"	31'-9"	10'-7"	10'-7"	31'-9"	G 118	G 117
	36'	10'-10"	10'-10"	32'-6"	10'-10"	10'-10"	32'-6"	G 118	G 117
	38'-4"	11'-0 5/8"	11'-0 5/8"	33'-1 7/8"	11'-0 7/8"	11'-0 7/8"	33'-2 5/8"	G 118	G 117
4	40'	11'-3"	11'-3"	33'-9"	11'-3"	11'-3"	33'-9"	G 118	G 117
	42'	11'-6"	11'-6'	34'-6"	11'-6"	11'-6"	34'-6"	G 118	G 117
	44'	11'-8"	11'-8"	35'-0"	11'-8"	11'-8"	35'-0"	G 118	G 117
	46'	11'-11"	11'-11"	35'-9"	11'-11"	11'-11"	35'-9"	G 118	G 117
	48'	12'-2"	12'-2"	36'-6"	12'-2"	12'-2"	36'-6"	G 118	G 117
	50'-10"	12'-5 3/8"	12'-5 3/8"	37'-4 1/8"	12'-5 1/2"	12'-5 1/2"	37'-4 1/2"	G 118	G 117
5	53'	12'-8"	12'-8"	38'-0"	12'-8"	12'-8"	38'-0"	G 114	G 113
	55'	12'-11"	12'-11"	38'-9"	12'-11"	12'-11"	38'-9"	G 114	G 113
	57'	13'-2"	13'-2"	39'-6"	13'-2"	13'-2"	39'-6"	G 114	G 113
	59'	13'-4"	13'-4"	40'-0"	13'-4"	13'-4"	40'-0"	G 114	G 113
	61'	13'-7"	13'-7"	40'-9"	13'-7"	13'-7"	40'-9"	G 114	G 113
	63'-4"	13-10"	13'-10"	41'-6"	13'-10 1/4"	13'-10 1/4"	41'-6 3/4"	G 114	G 113
6	65'	14-0"	14'-0"	42'-0"	14'-0"	14'-0"	42'-0"	G 114	G 113
	67'	14'-3"	14'-3"	42'-9"	14'-3"	14'-3"	42'-9"	G 114	G 113
	69'	14'-6"	14'-6"	43'-6"	14'-6"	14'-6"	43'-6"	G 114	G 113
	71'	14'-8"	14'-8"	44'-0"	14'-8"	14'-8"	44'-0"	G 114	G 113
	73'	14'-11"	14'-11"	44'-9"	14'-11"	14'-11"	44'-9"	G 114	G 113
	75'-10"	15'-2 3/8"	15'-2 5/8"	45'-7 7/8"	15'-2 7/8"	15'-2 7/8"	45'-8 5/8"	G 114	G 113



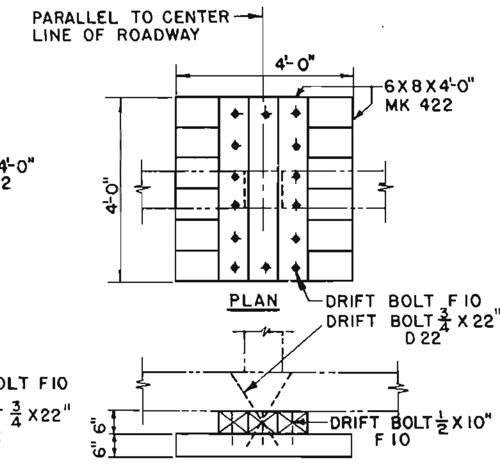
G 113



G 114



G 117



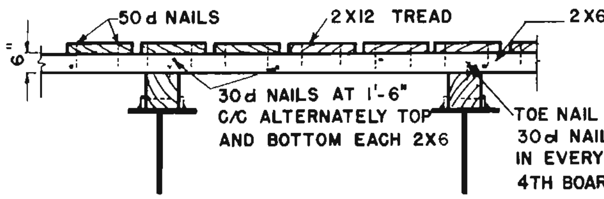
G 118

BILL OF MATERIALS FOR ONE TIMBER GRILLAGE

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	WEIGHT EACH (LBS)	G 113 QUANTITY	G 113 FBM	G 114 QUANTITY	G 114 FBM	G 117 QUANTITY	G 117 FBM	G 118 QUANTITY	G 118 FBM
LUMBER, SOFT WOOD														
1	GRILLAGE	39-3360.08	192	6X8	8'-0"	120	4	128			3	96		
2	GRILLAGE	39-3360.08	422	6X8	4'-0"	60	12	192	10	160	12	192	9	144
STEEL HARDWARE, BLACK														
3	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	2.75	4		2		4		2	
4	DRIFT BOLT	43-1636.05-1	F10	1/2	10"	0.6	28		16		26		14	

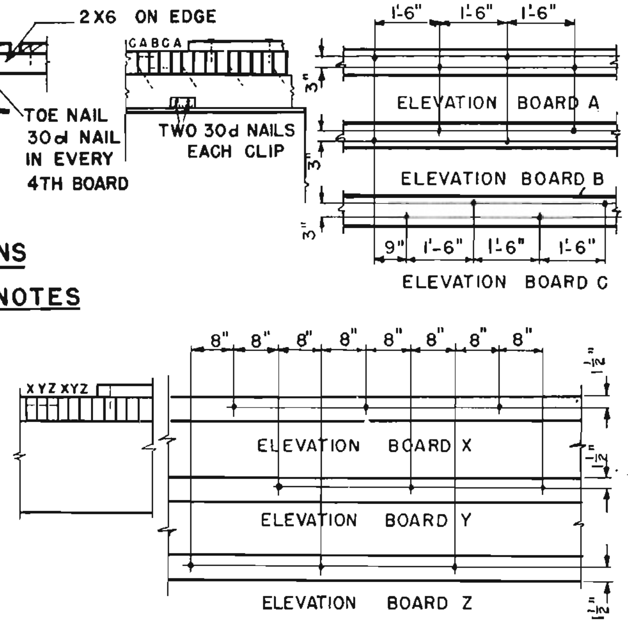
COMPANION SHEETS

TIMBER SPANS 11, 13, AND 15-FOOT	45
BILL OF MATERIAL	46
HANDRAIL AND CURB DETAILS	129
WALKWAY FOR HIGHWAY BRIDGES	130
GENERAL NOTES	154
SYMBOLS	155

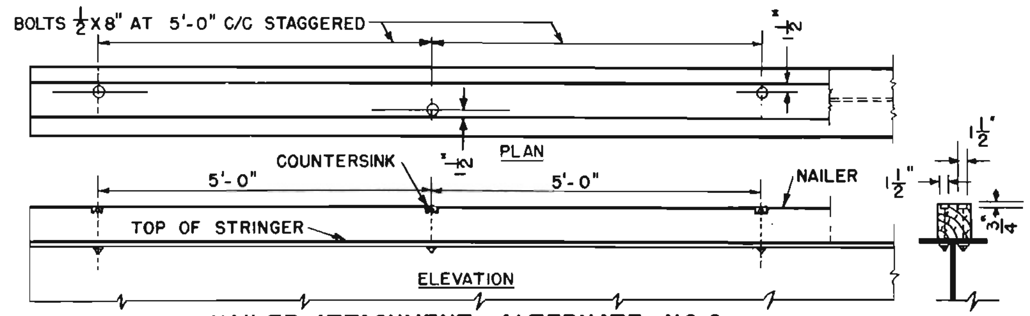


LAMINATED DECK, STEEL SPANS

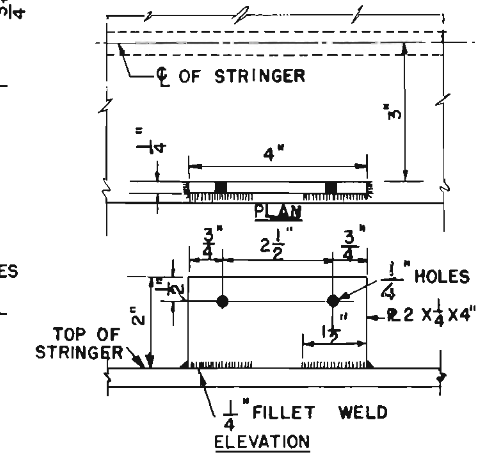
NOTES



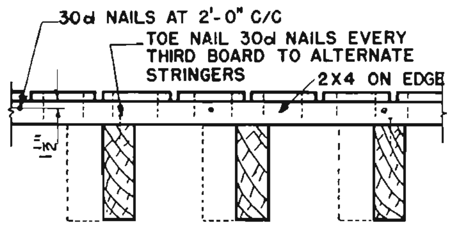
NAILING DETAILS



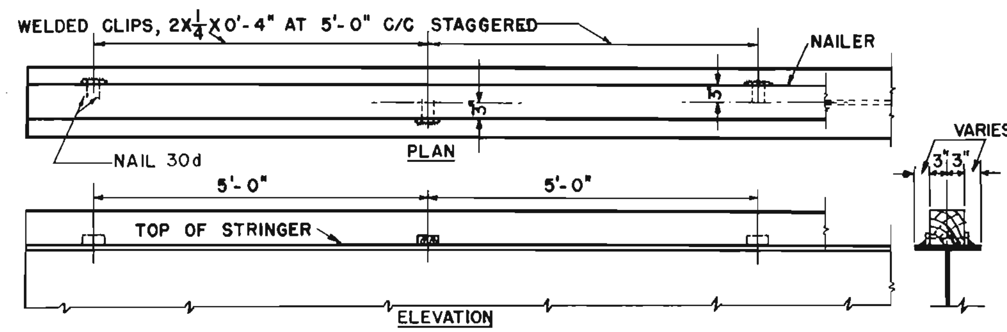
NAILER ATTACHMENT - ALTERNATE NO.2



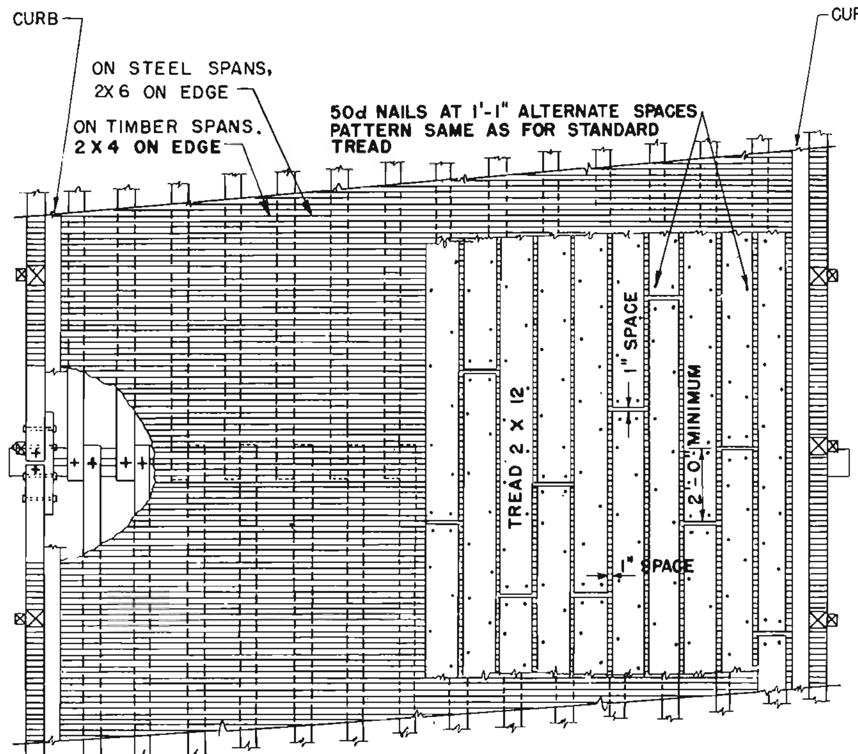
WELDED CLIP DETAIL



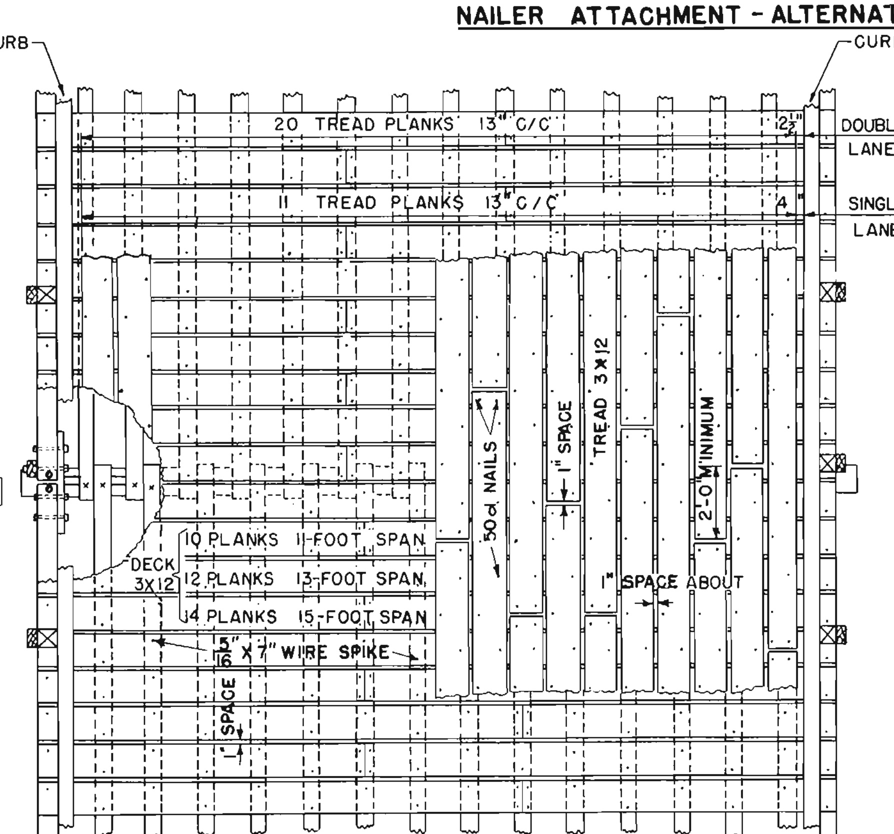
LAMINATED DECK, TIMBER SPANS



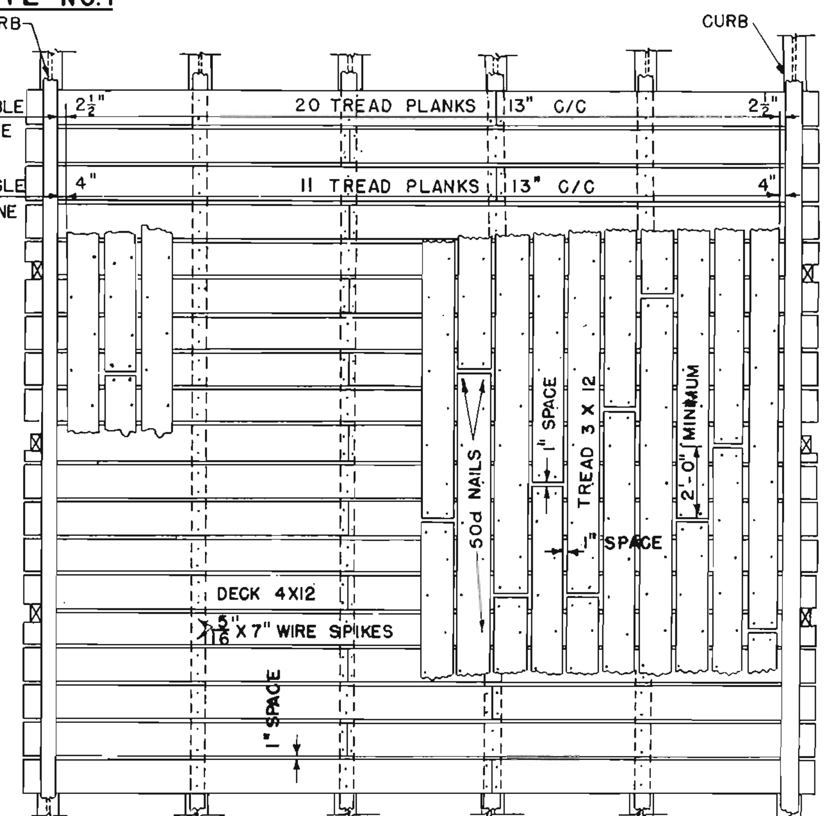
NAILER ATTACHMENT - ALTERNATE NO.1



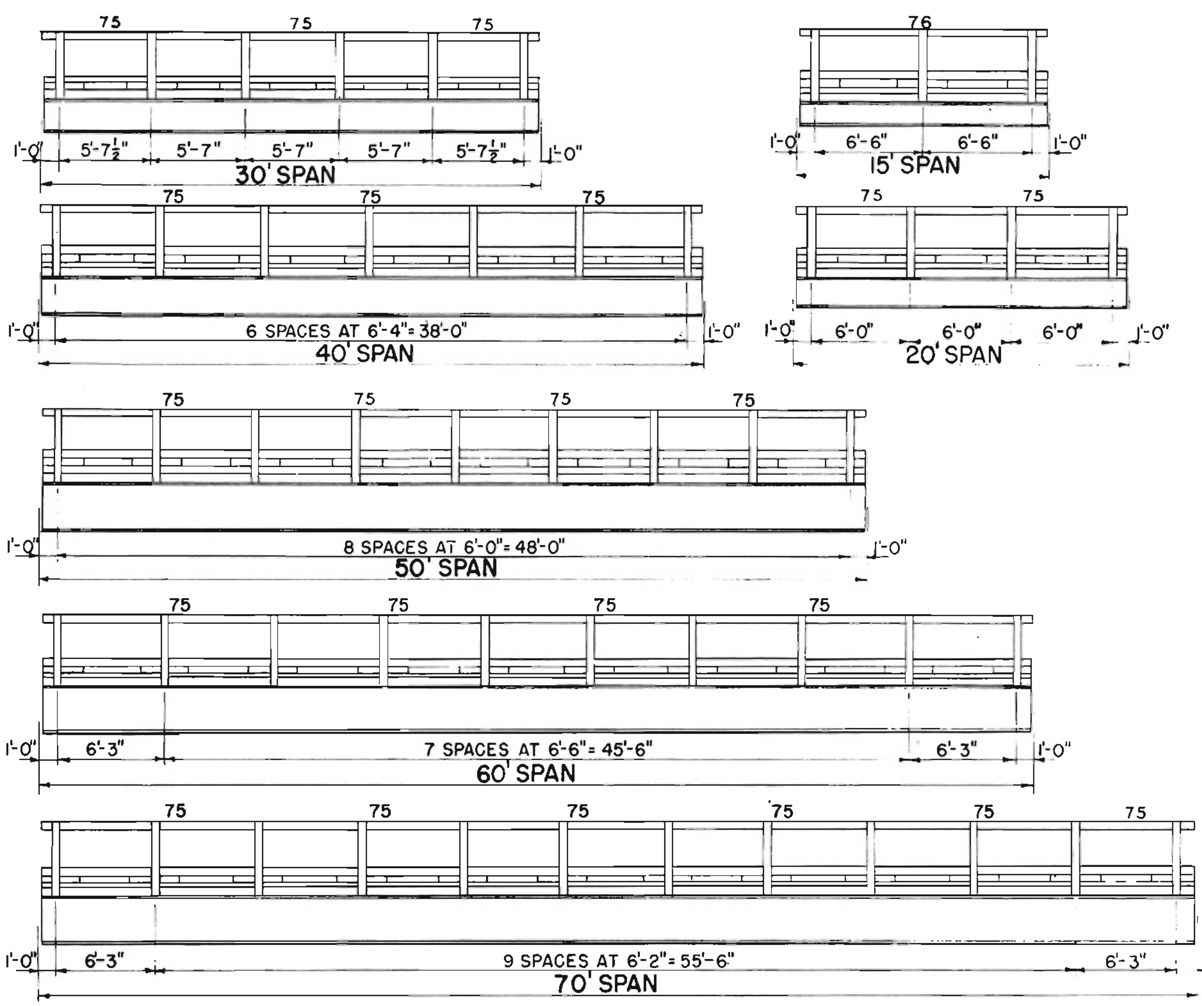
ALTERNATE-LAMINATED DECK
TYPICAL PLAN

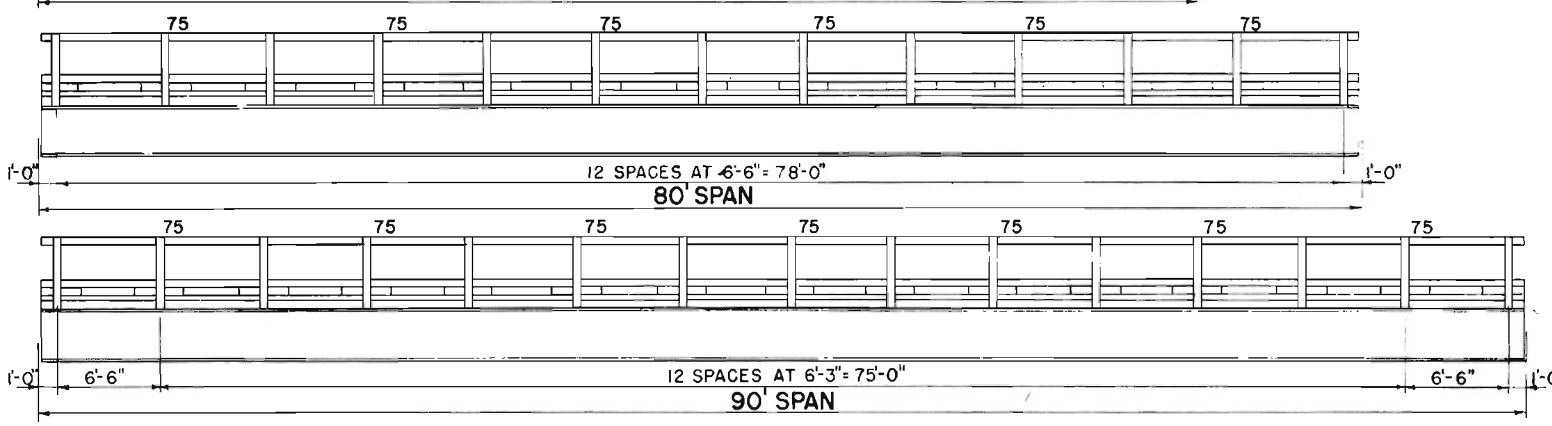


TYPICAL PLAN FOR TIMBER SPANS

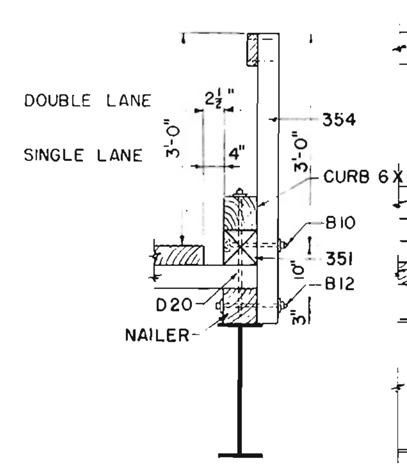


TYPICAL PLAN FOR STEEL SPANS

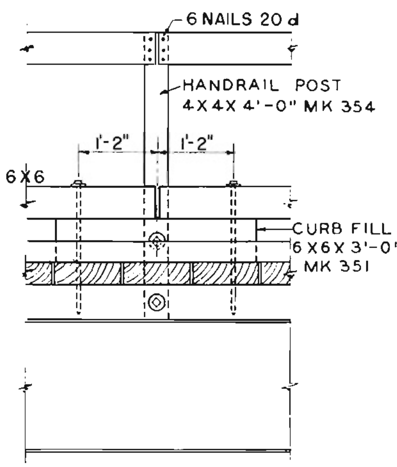




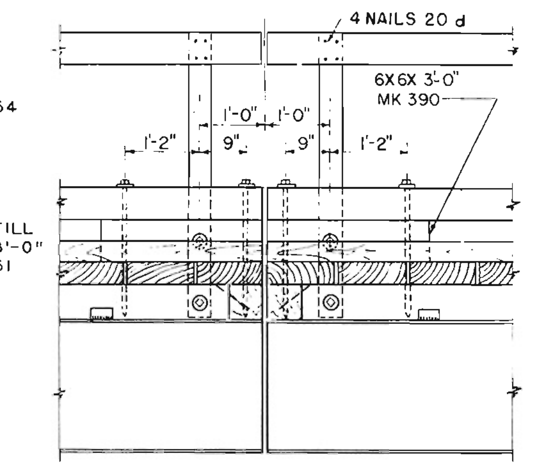
HANDRAIL POST SPACING FOR STEEL SPANS



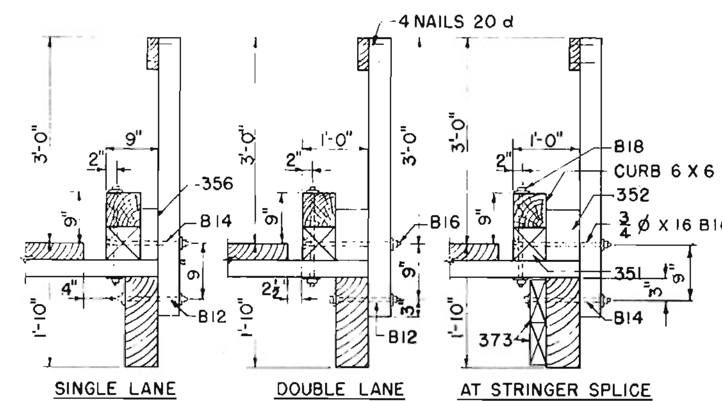
CONSTRUCTION WITH STEEL STRINGERS



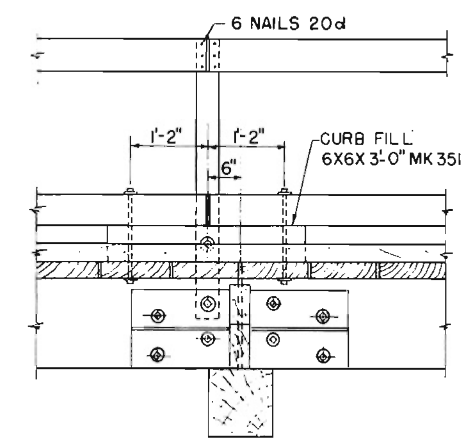
HANDRAIL AND CURB SPLICE



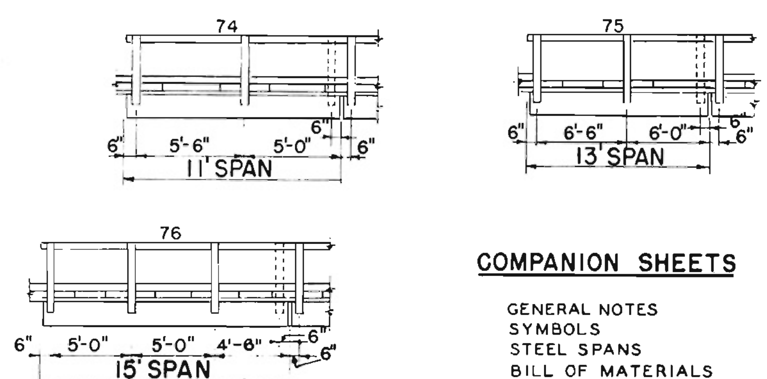
STEEL-SPAN END DETAIL



CONSTRUCTION WITH TIMBER STRINGERS



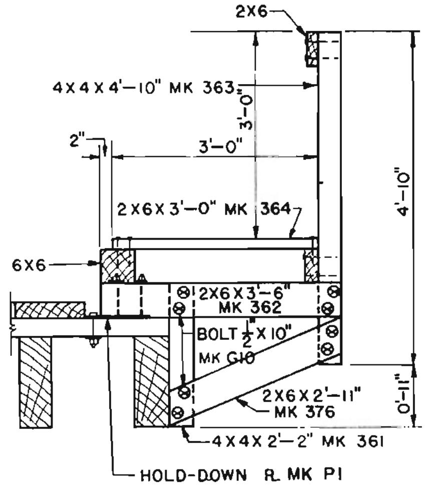
TIMBER-SPAN END DETAIL



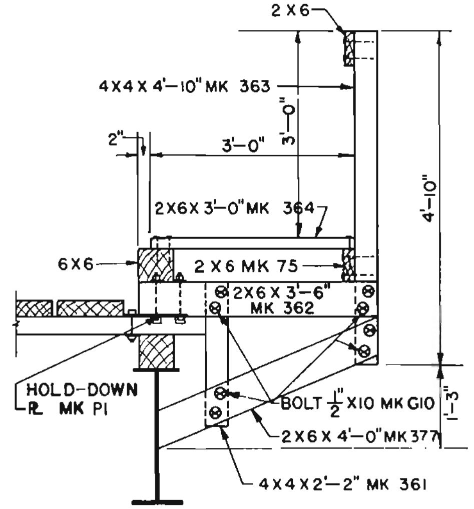
NOTE HANDRAIL LUMBER LENGTHS SHOWN ARE FOR BILL OF MATERIALS ONLY, RANDOM LENGTHS MAY BE USED

COMPANION SHEETS

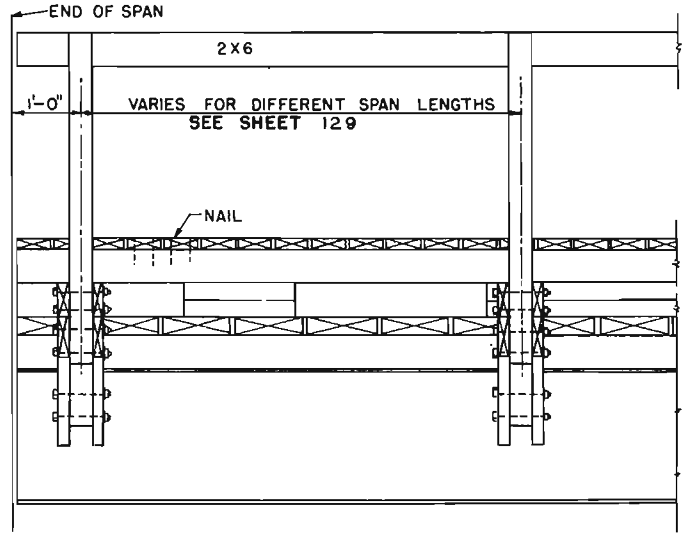
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,94
BILL OF MATERIALS	5,6,48,49,95,96
TIMBER SPANS	2,45,92
BILL OF MATERIALS	3,46,93



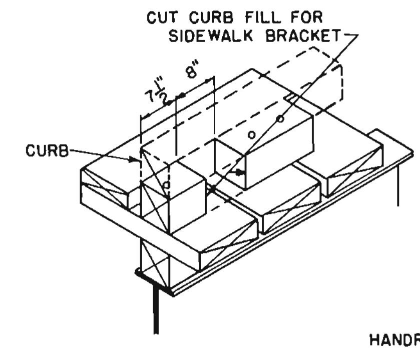
SECTION WALKWAY
TIMBER-STRINGER BRIDGE



SECTION WALKWAY
STEEL-STRINGER BRIDGE



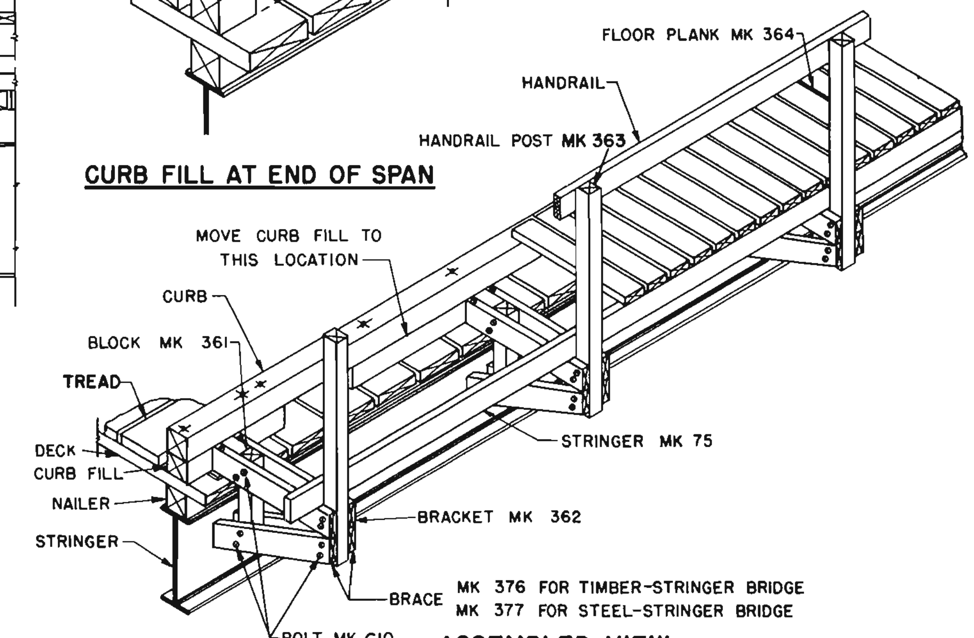
ELEVATION OF WALKWAY



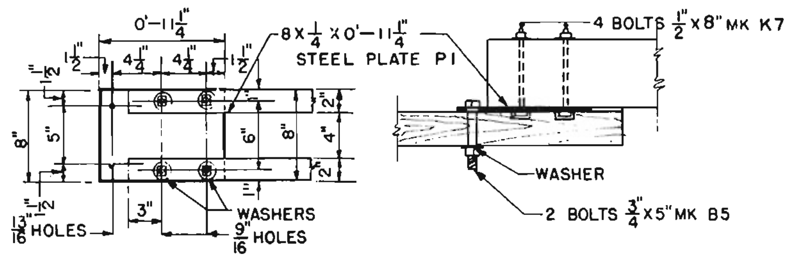
CURB FILL AT END OF SPAN

COMPANION SHEETS

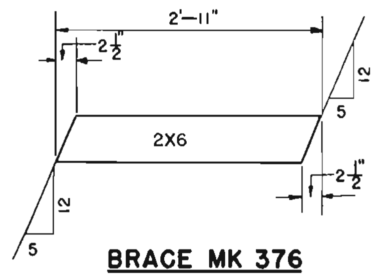
	SHEET
GENERAL NOTES	154
HANDRAIL AND CURB DETAILS	129
SYMBOLS	155



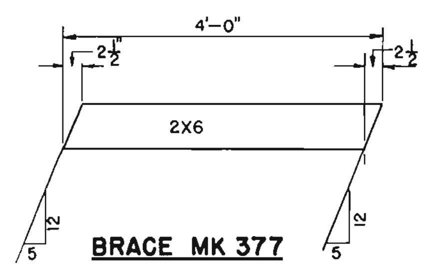
ASSEMBLED VIEW



DETAILS OF HOLD-DOWN PLATE P1



BRACE MK 376



BRACE MK 377

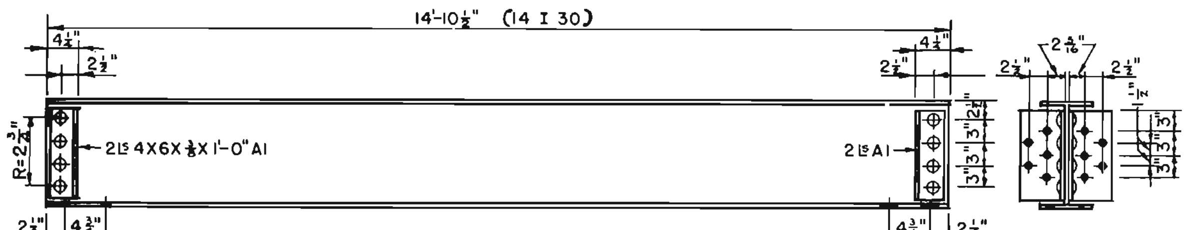
BILLS OF MATERIALS FOR ONE WALKWAY FOR 11-, 13-, AND 15-FOOT TIMBER SPANS AND FOR 15-TO 90-FOOT STEEL SPANS

							WALKWAY FOR BRIDGE WITH TIMBER STRINGERS						WALKWAY FOR BRIDGE WITH STEEL STRINGERS																	
							11'-0" SPAN		13'-0" SPAN		15'-0" SPAN		15'-0" SPAN		20'-0" SPAN		30'-0" SPAN		40'-0" SPAN		50'-0" SPAN		60'-0" SPAN		70'-0" SPAN		80'-0" SPAN		90'-0" SPAN	
ITEM	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM
	LUMBER, SOFT WOOD																													
1	BLOCK	39-3340.04	361	4 X 4	2'-2"	11	2	6	2	6	3	9	3	9	4	12	6	18	7	21	9	26	10	29	12	35	13	38	15	44
2	BRACKET	39-3228.06	362	2 X 6	3'-6"	13	4	14	4	14	6	21	6	21	8	28	12	42	14	49	18	63	20	70	24	84	26	91	30	105
3	HANDRAIL POST	39-3340.04	363	4 X 4	4'-10"	24	2	13	2	13	3	20	3	20	4	26	6	39	7	45	9	58	10	65	12	78	13	84	15	97
4	FLOOR PLANK	39-3228.06	364	2 X 6	3'-0"	11	19	57	23	69	26	78	26	78	35	105	52	156	69	207	87	261	104	312	121	363	138	414	155	465
5	BRACE	39-3228.06	376	2 X 6	2'-11"	11	4	12	4	12	3	18																		
6	BRACE	39-3228.06	377	2 X 6	4'-0"	15							6	24	8	32	12	48	14	56	18	72	20	80	24	96	26	104	30	120
7	STRINGER	39-3228.06-14	75	2 X 6	14'-0"	53			1	14									3	42	4	56	5	70	6	84	6	84	7	98
8	STRINGER	39-3228.06-12	74	2 X 6	12'-0"	45	1	12							2	24	3	36												
9	STRINGER	39-3880.04-16	76	2 X 6	16'-0"	60					1	16	1	16																
	STEEL HARDWARE, BLACK																													
10	HOLD-DOWN PLATE	47-7844.03		8 X 1/4	11 1/4"	64	2		2		3		3		4		6		7		9		10		12		13		15	
11	BOLT WITH SQUARE NUT AND WASHER	43-2325.07-05	B5	3/4	5"	1.0	4		4		6		6		8		12		14		18		20		24		26		30	
12	BOLT, SQUARE HEAD WITH SQUARE NUT AND WASHER	43-2325.05-08	K7	1/2	8"	0.5	8		8		12		12		16		24		28		36		40		48		52		60	
13	BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.05-1	G10	1/2	10"	0.7	16		16		24		24		32		48		56		72		80		96		104		120	
14	NAILS	42-6028.3-2		20d		0.04	84		100		116		116		156		232		304		384		456		532		604		680	

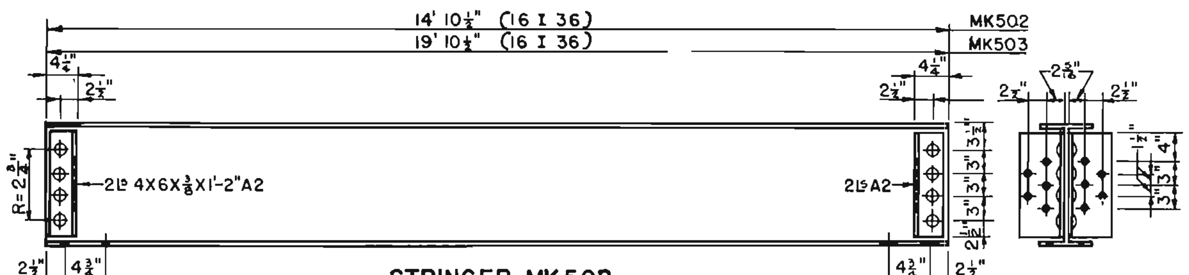
RIVETED CONSTRUCTION, FABRICATION OF STRINGERS 501 TO 511, DIAPHRAGMS 527 AND 528

COMPANION SHEETS

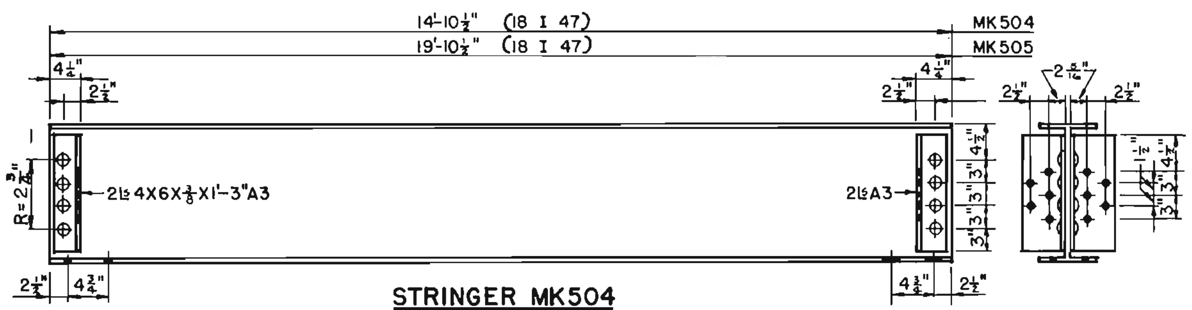
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPAN	4, 47, 94
BILL OF MATERIALS	5, 48, 95



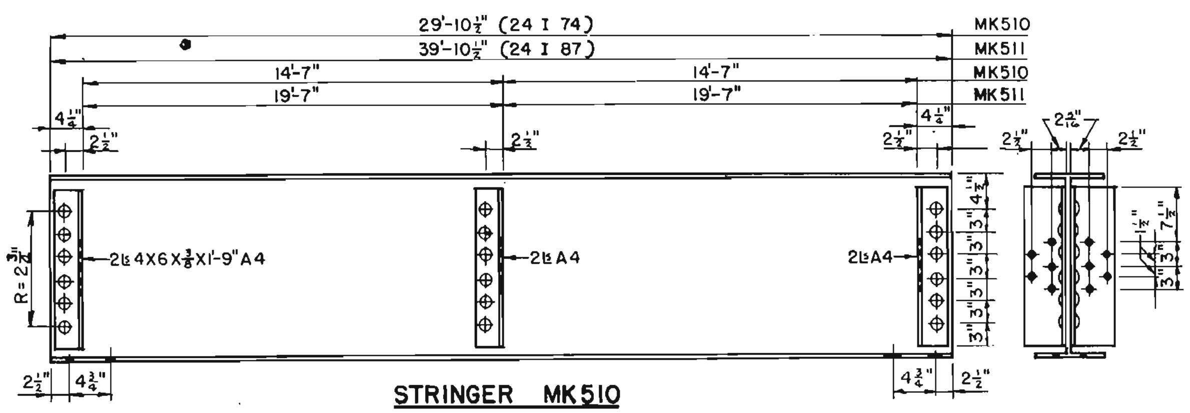
STRINGER MK501



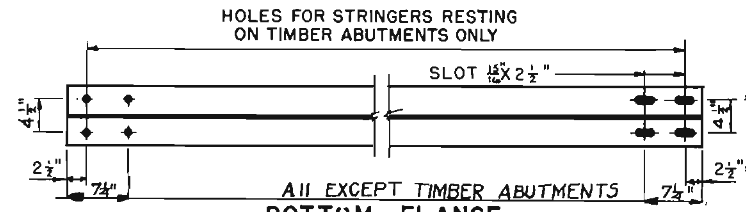
STRINGER MK502
STRINGER MK503



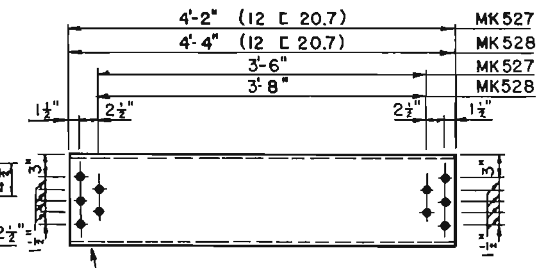
STRINGER MK504
STRINGER MK505



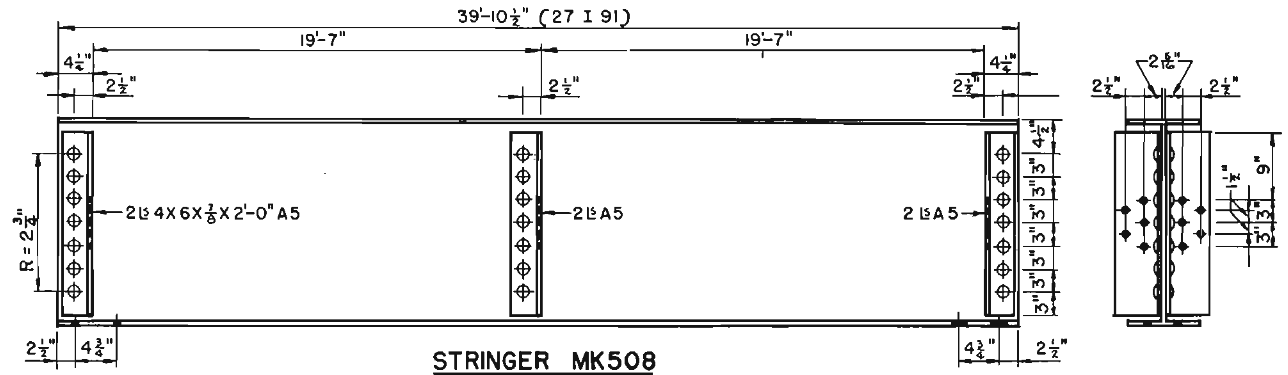
STRINGER MK510
STRINGER MK511



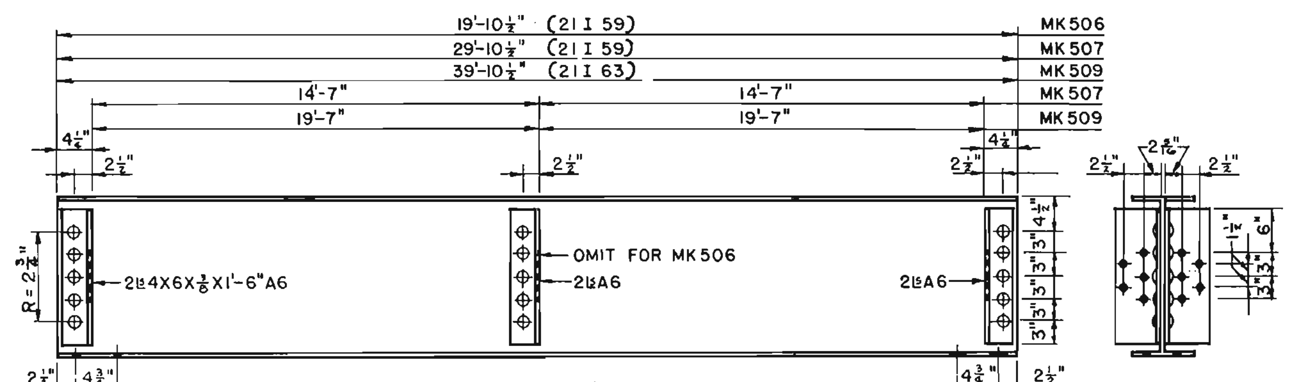
BOTTOM FLANGE
TYPICAL FOR ALL BEAMS
TWO HOLES ONLY EACH END



DIAPHRAGM MK527
DIAPHRAGM MK528



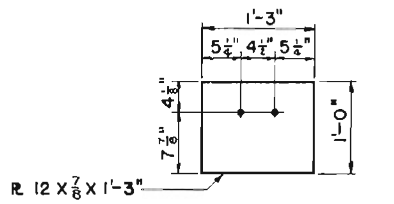
STRINGER MK508



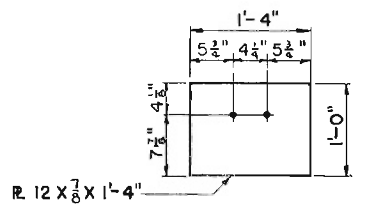
STRINGER MK506
STRINGER MK507
STRINGER MK509

COMPANION SHEETS

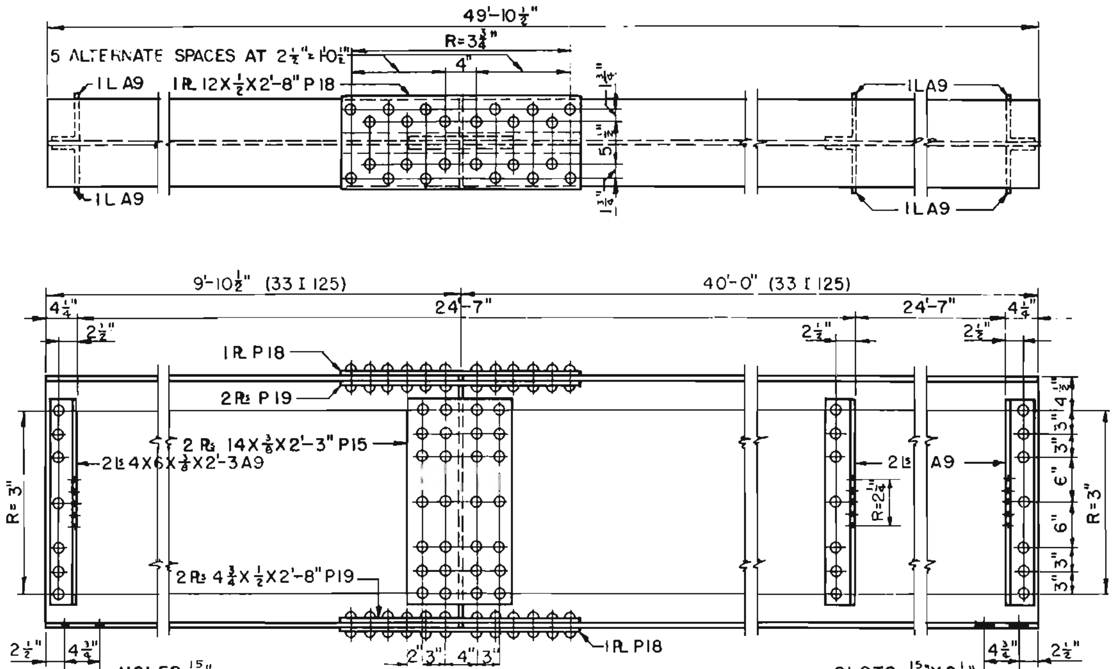
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4, 47, 94
BILL OF MATERIALS	5, 48, 95



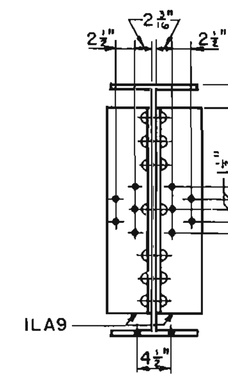
BEARING PLATE P 3500

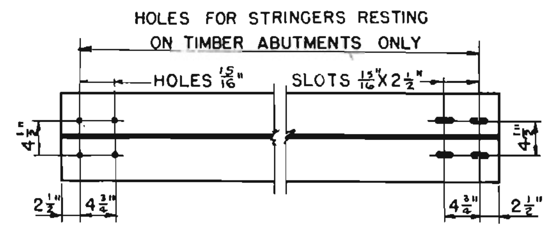


BEARING PLATE P 3501



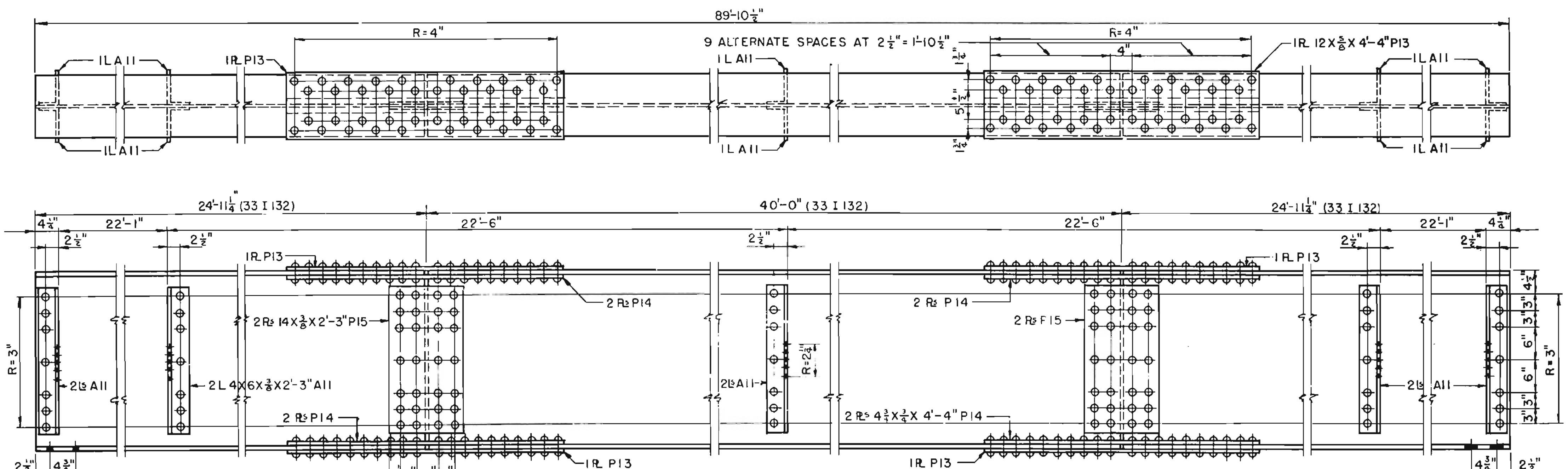
STRINGER MK516



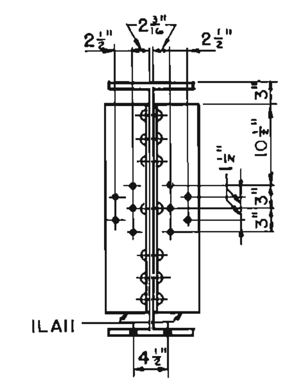


TYPICAL BOTTOM FLANGE VIEW

TWO HOLES ONLY EACH END

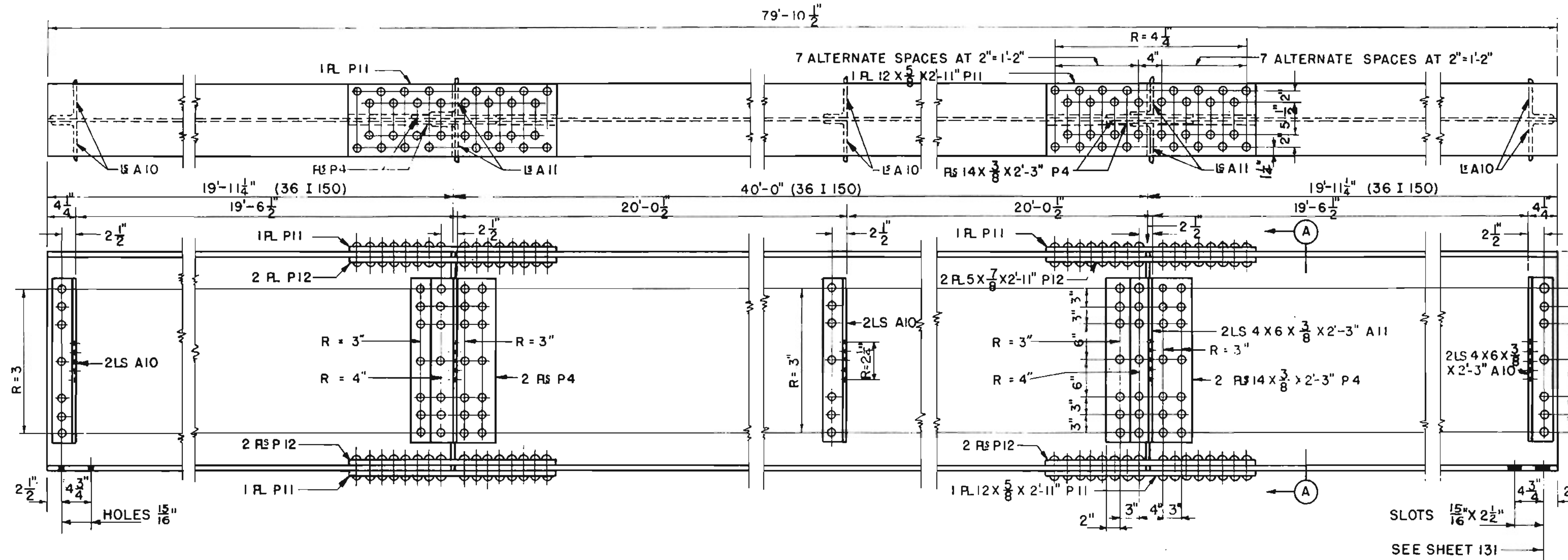


STRINGER MK521

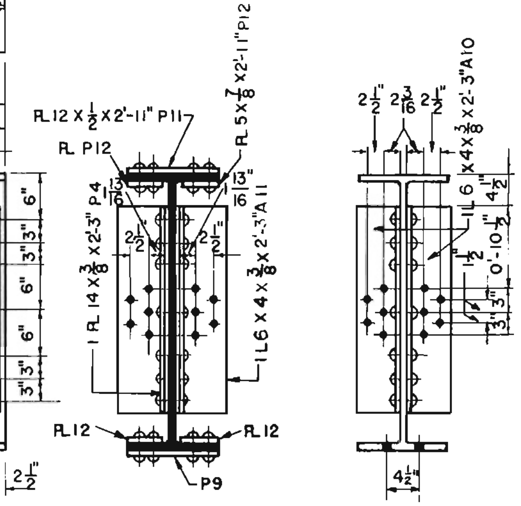


COMPANION SHEETS

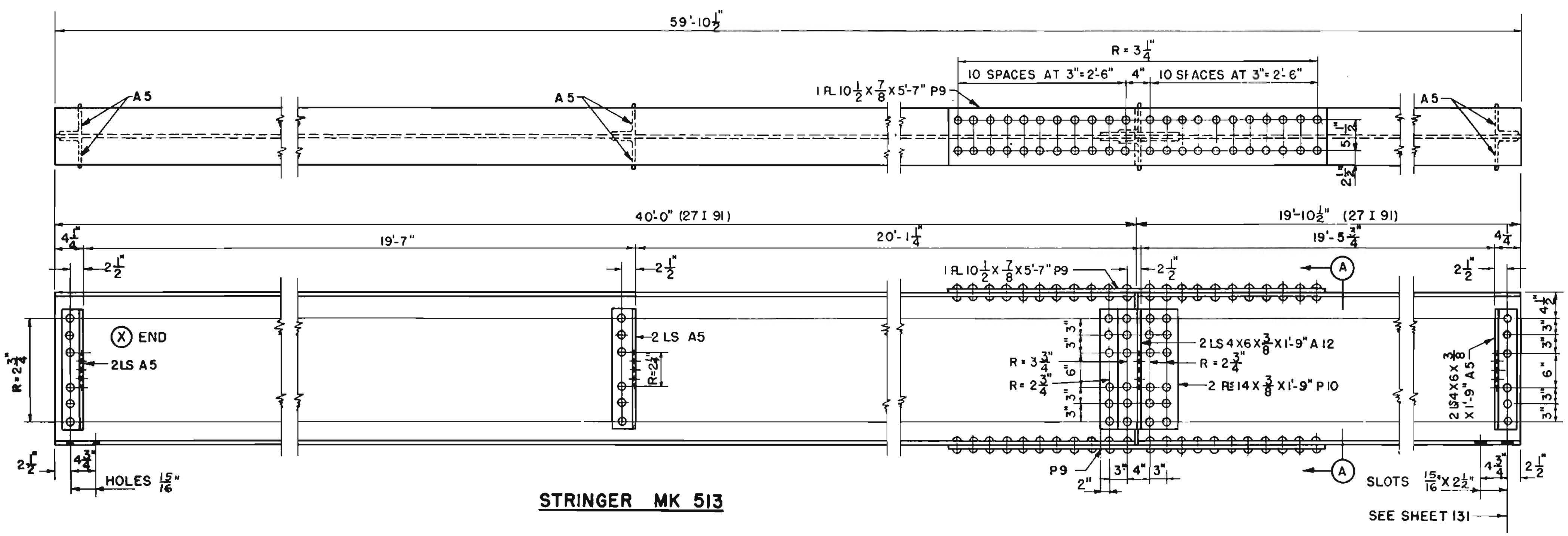
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,34
BILL OF MATERIALS	5,48,95
FABRICATION DRAWING	131



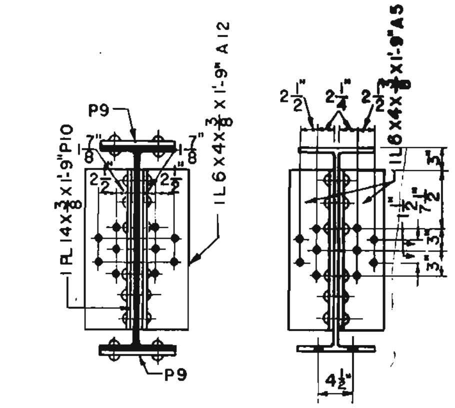
STRINGER MK 523



SECTION A-A



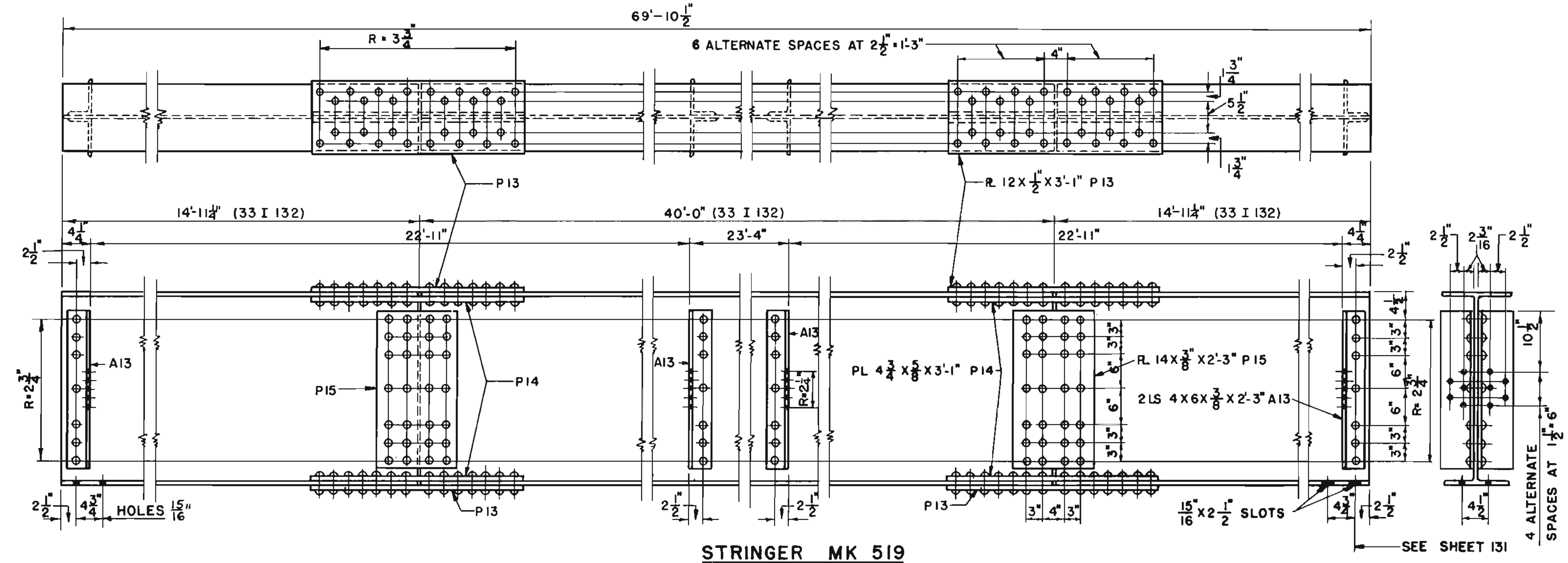
STRINGER MK 513

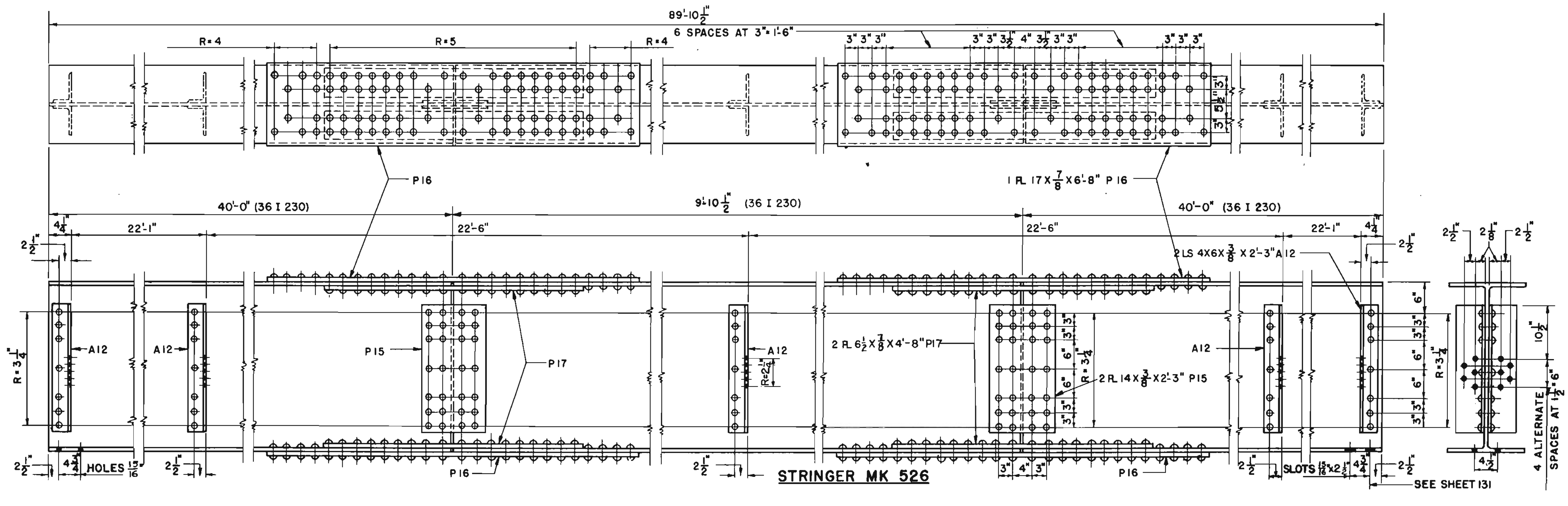


SECTION A-A

COMPANION SHEETS

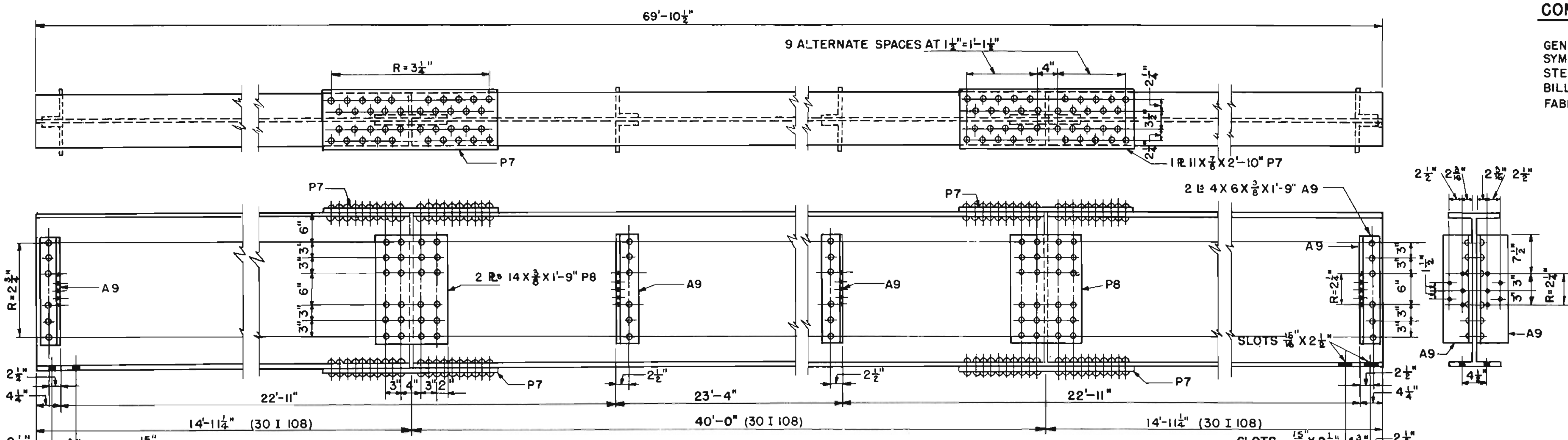
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4, 47, 94
BILL OF MATERIALS	5, 48, 95
FABRICATION DRAWING	131



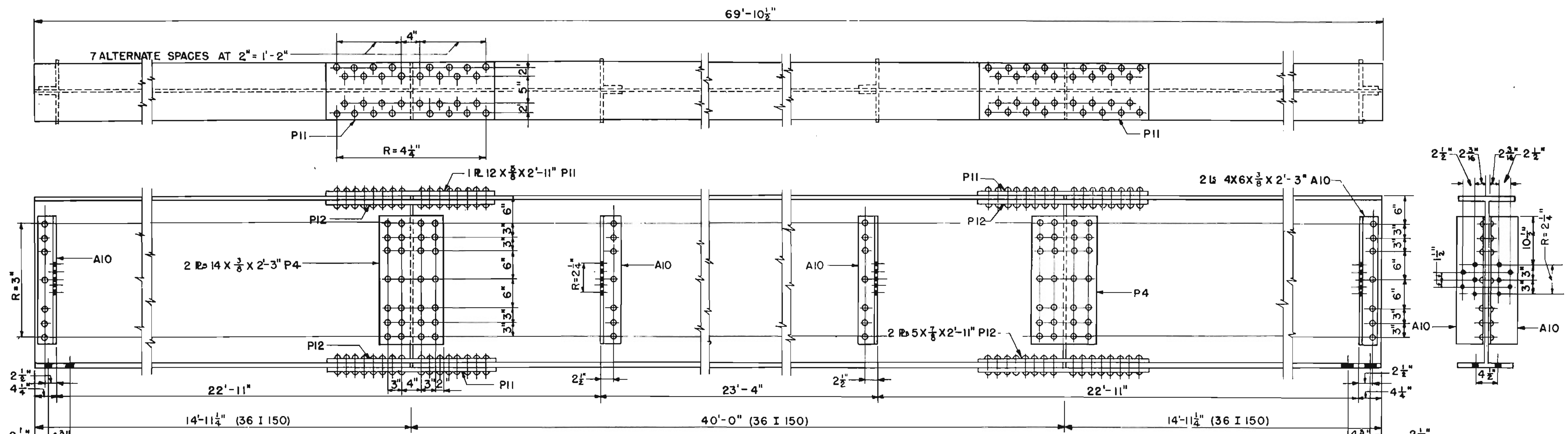


COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,94
BILL OF MATERIALS	5,48,95
FABRICATION DRAWING	131



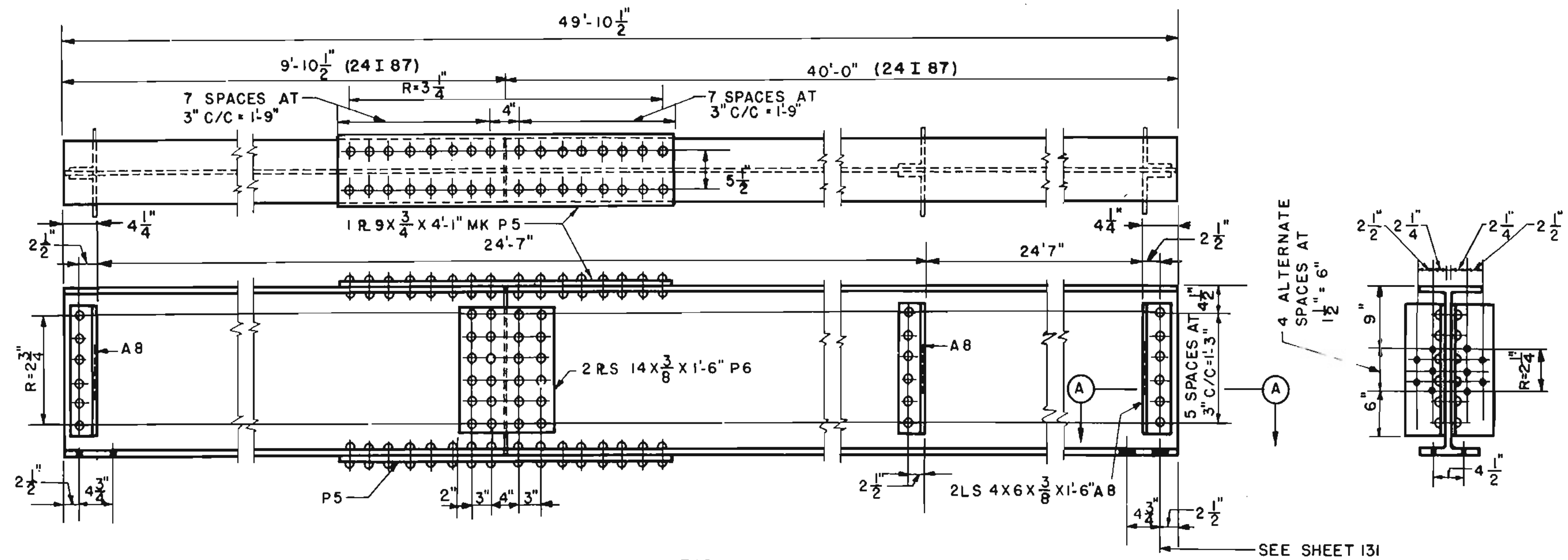
STRINGER MARK 515



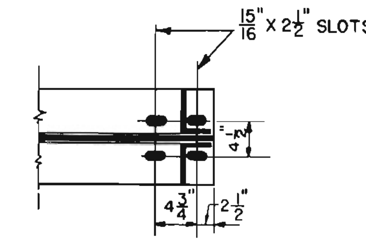
STRINGER MARK 522

COMPANION SHEETS

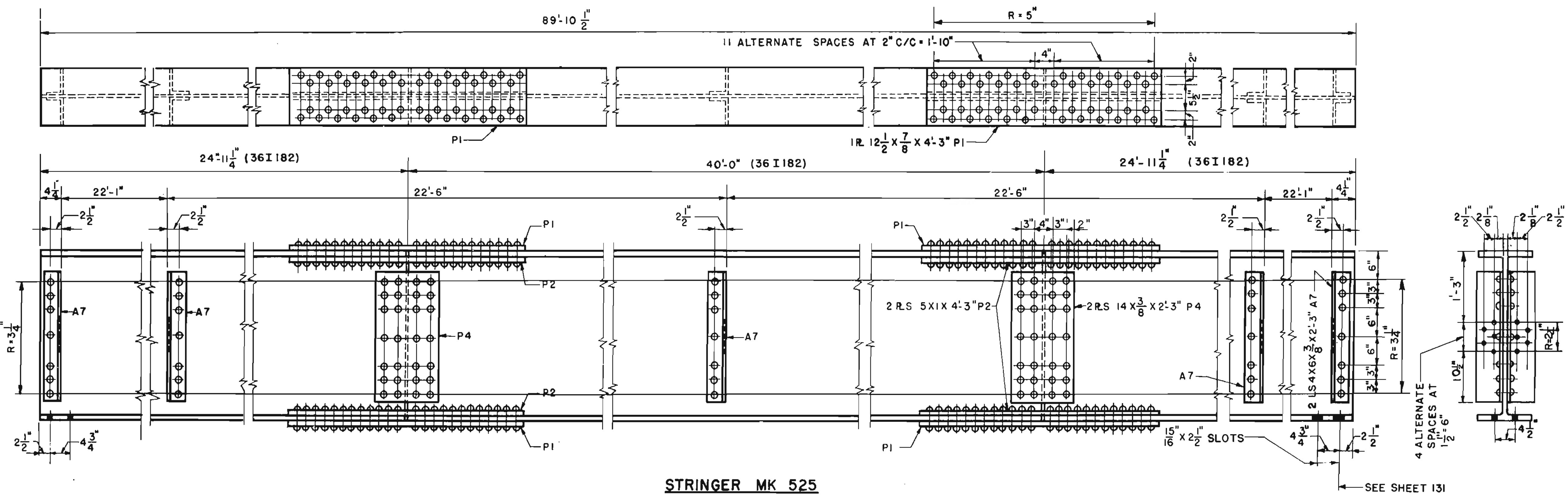
	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	5, 49, 96
STEEL SPAN	4, 47, 94
SYMBOLS	155
FABRICATION DRAWING	131



STRINGER MK 512



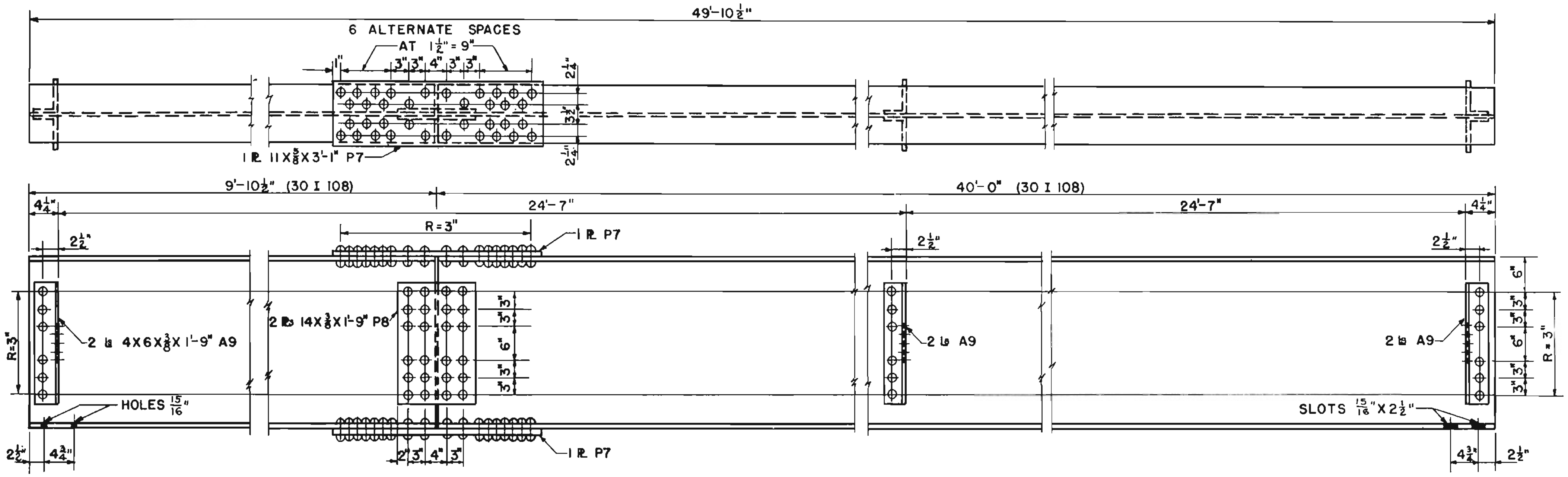
SECTION A-A

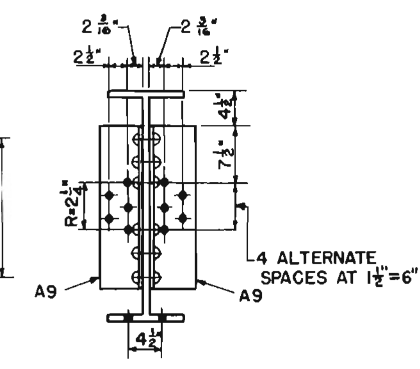


STRINGER MK 525

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	5, 48, 95
STEEL SPAN	4, 47, 94
SYMBOLS	155

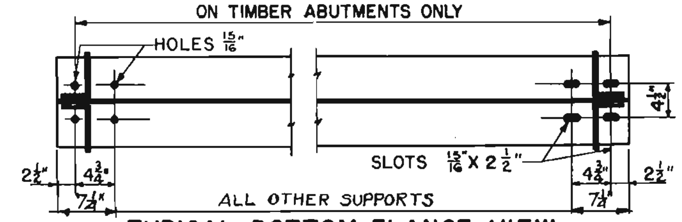




STRINGER MK 514

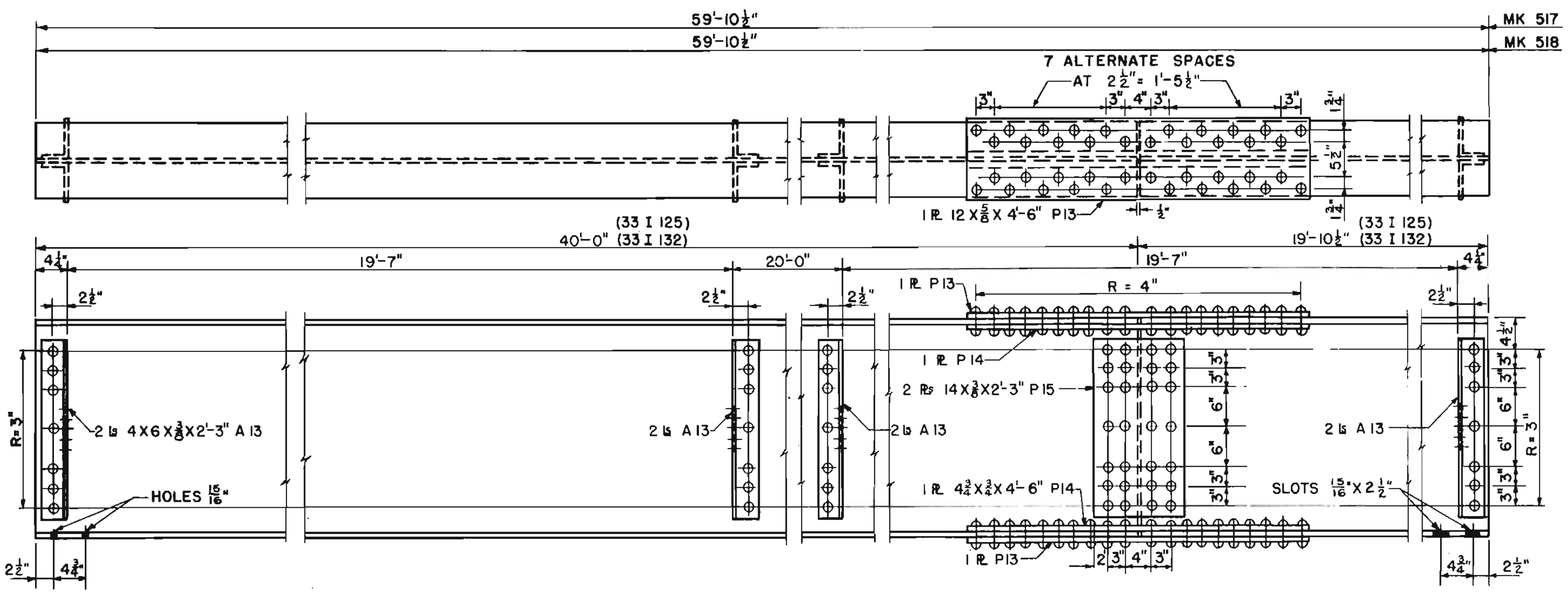
END VIEW

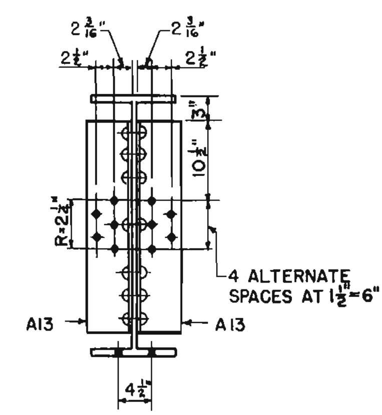
HOLES FOR STRINGERS RESTING ON TIMBER ABUTMENTS ONLY



TYPICAL BOTTOM FLANGE VIEW

TWO HOLES ONLY EACH END





STRINGER MK 517

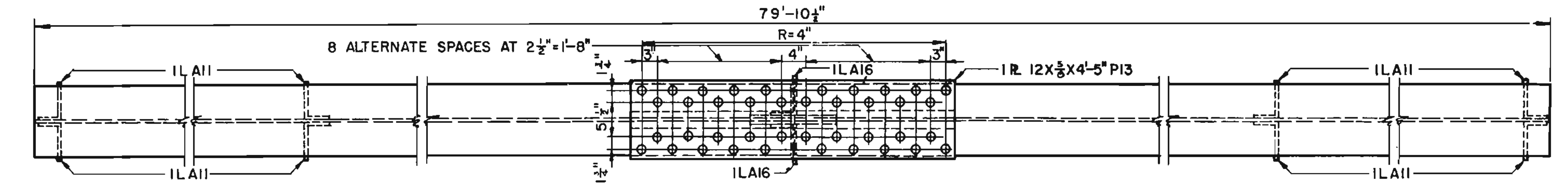
STRINGER MK 518

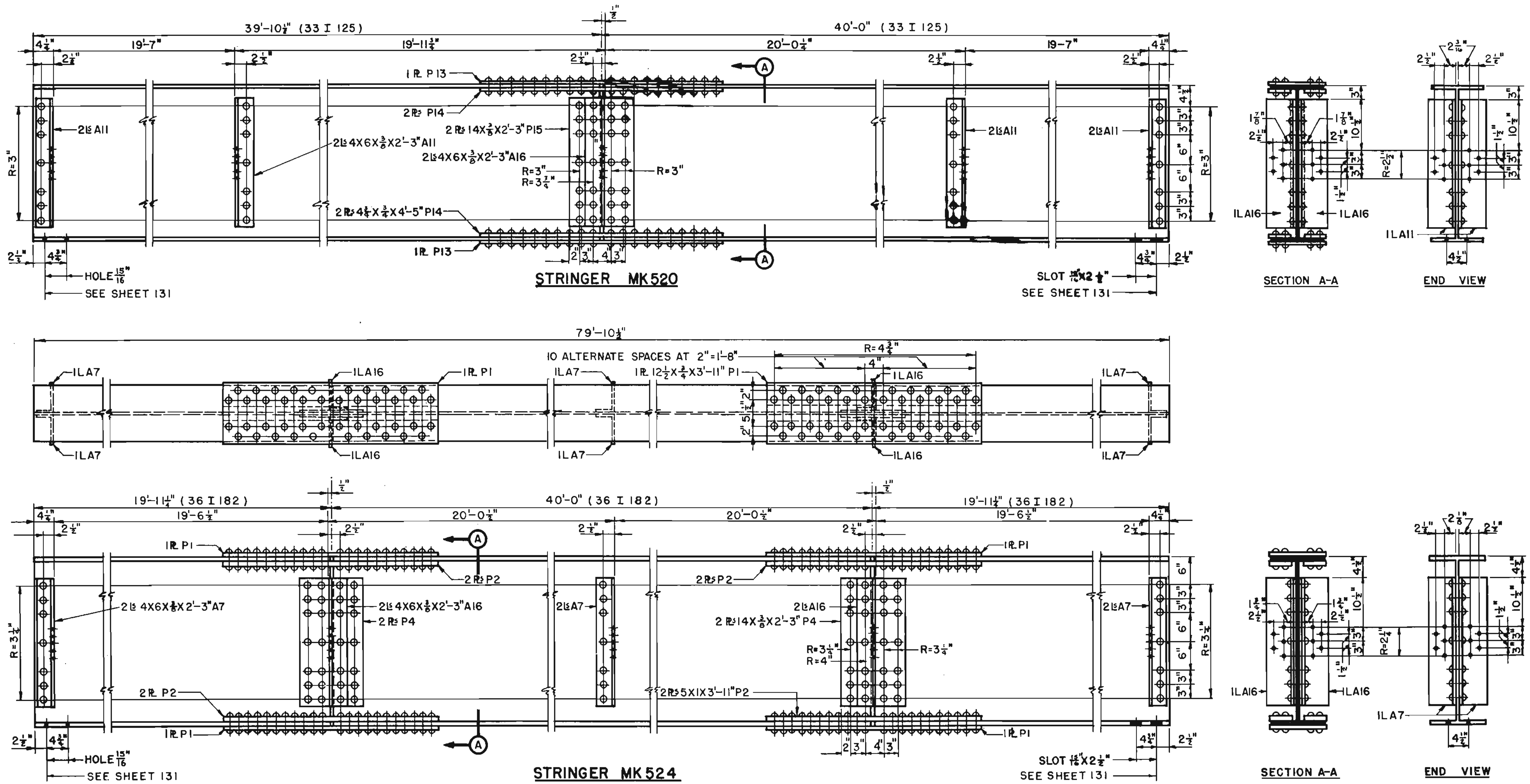
END VIEW

RIVETED CONSTRUCTION, FABRICATION OF STRINGERS 520 AND 524

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	5, 48, 95
STEEL SPAN	4, 47, 94
SYMBOLS	155
FABRICATION DRAWING	131

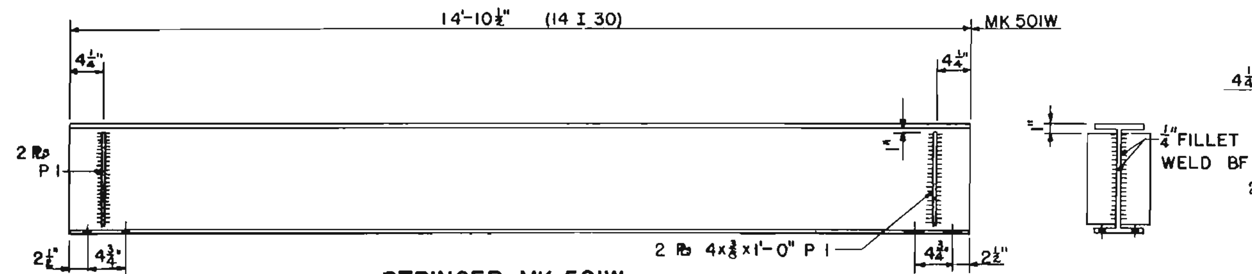




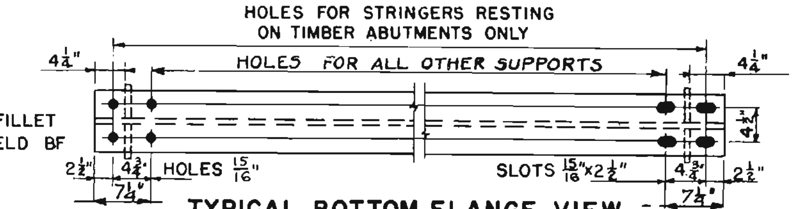
WELDED CONSTRUCTION, FABRICATION OF STRINGERS 501W TO 511W AND DIAPHRAGMS C3 AND C4

COMPANION SHEETS

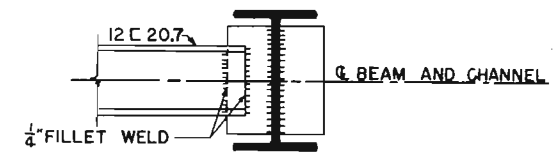
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,94
BILL OF MATERIALS	5,49,96



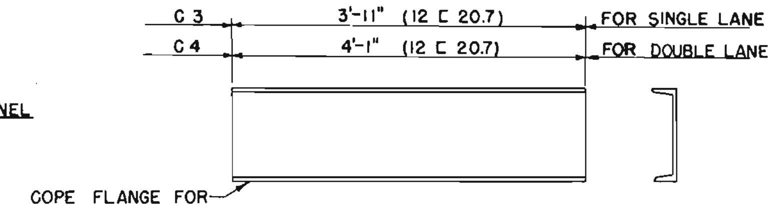
STRINGER MK 501W



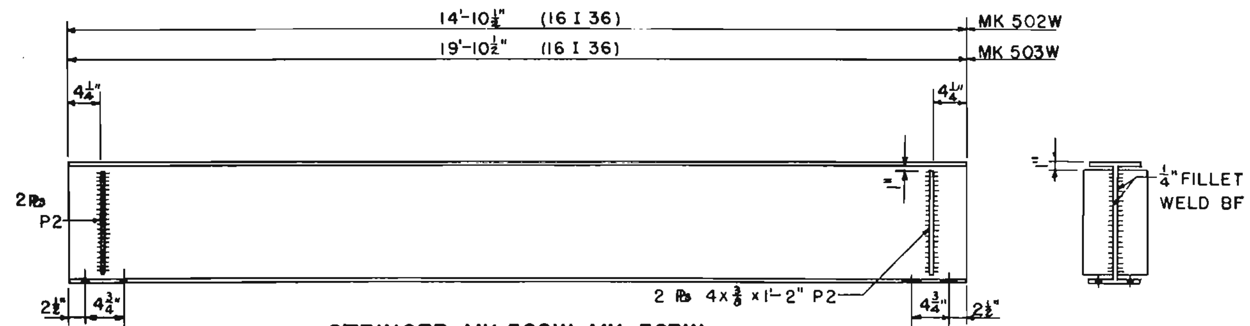
TYPICAL BOTTOM FLANGE VIEW
TWO HOLES ONLY EACH END



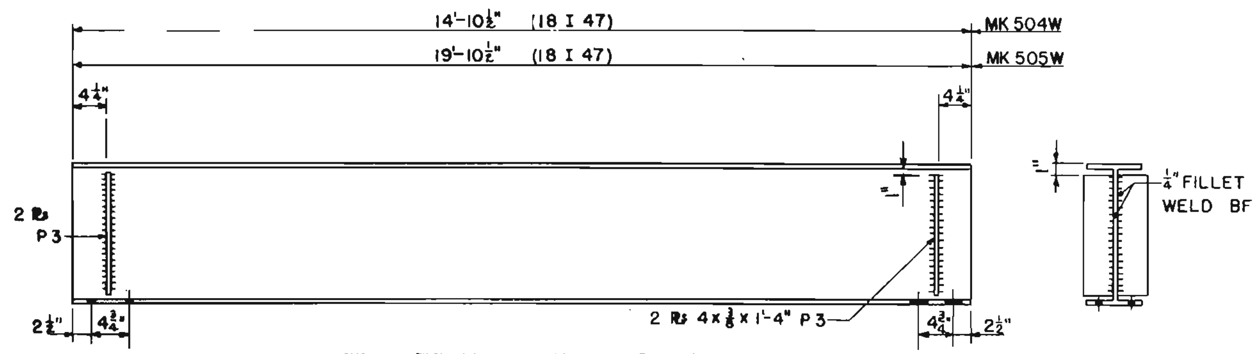
TYPICAL WELDED DIAPHRAGM CONNECTION



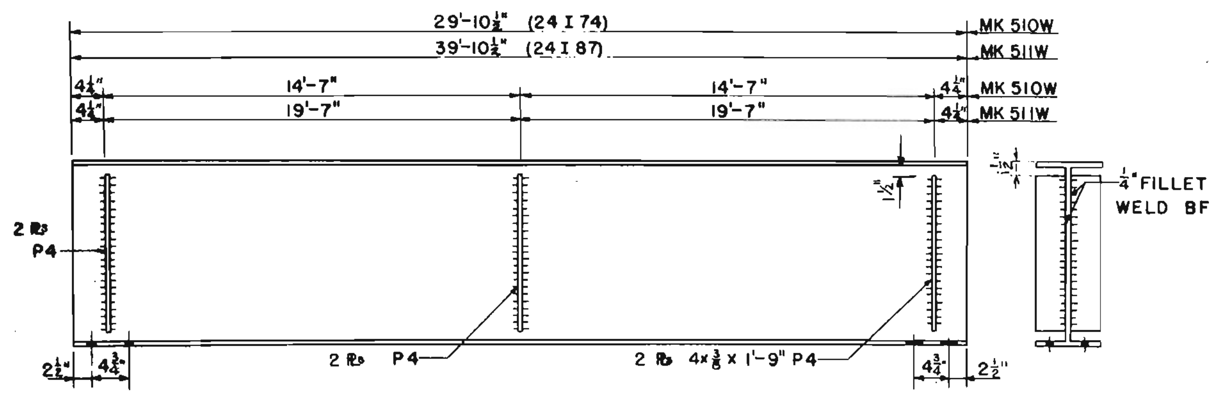
DETAILS OF DIAPHRAGM
SINGLE AND DOUBLE LANE HIGHWAY



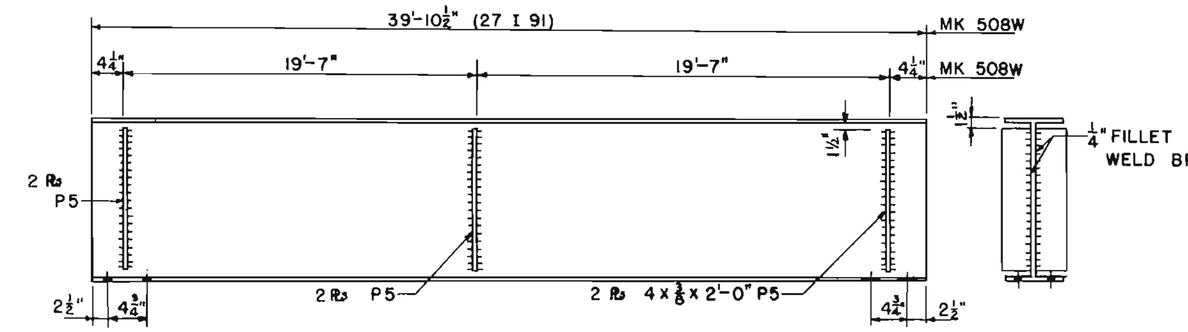
STRINGER MK 502W, MK 503W



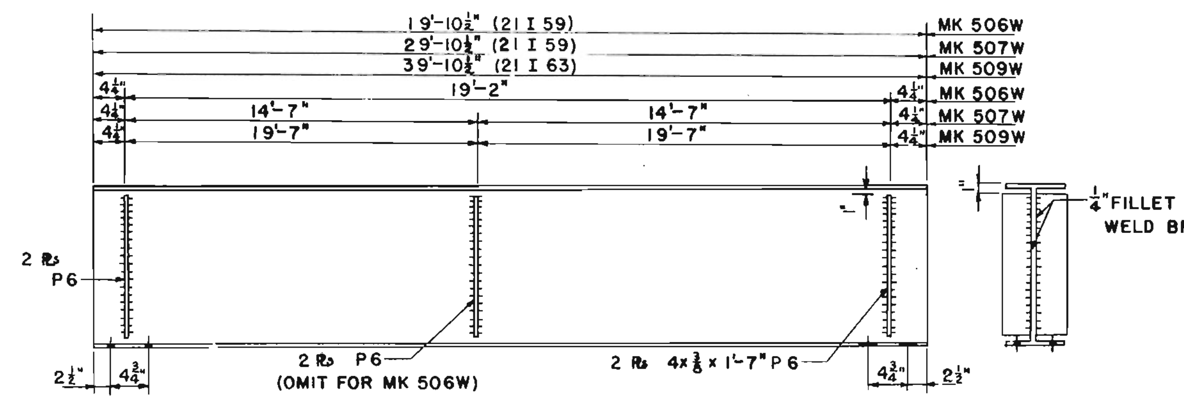
STRINGER MK 504W, MK 505W



STRINGER MK 510W, MK 511W



STRINGER MK 508W

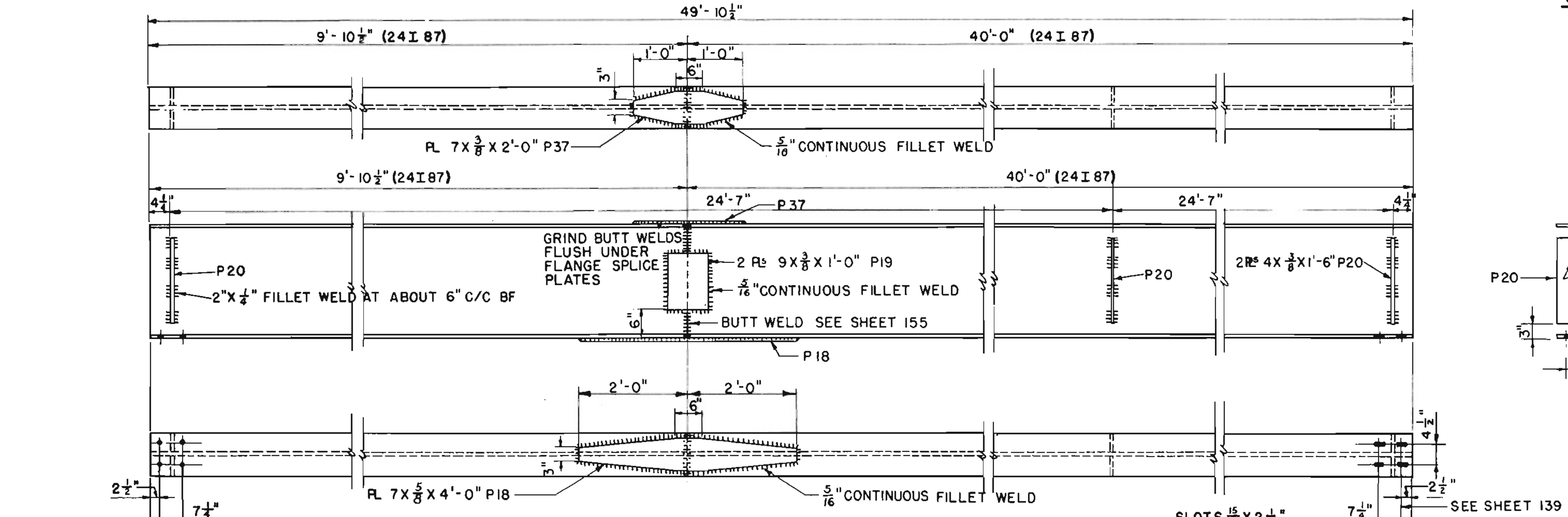


STRINGER MK 506W, MK 507W, MK 509W

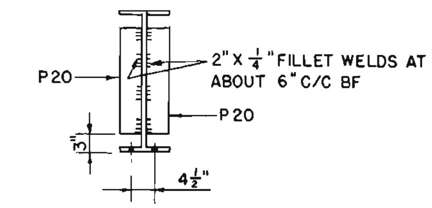
WELDED CONSTRUCTION, FABRICATION OF STRINGERS 512W AND 525W

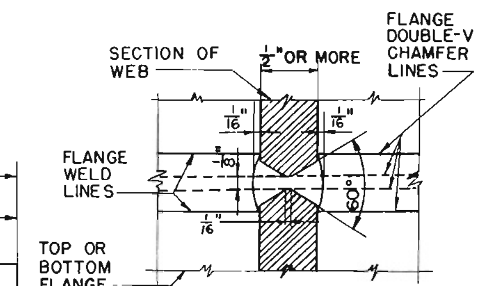
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	5,49,96
STEEL SPANS	4,47,94
FABRICATION DRAWINGS	139

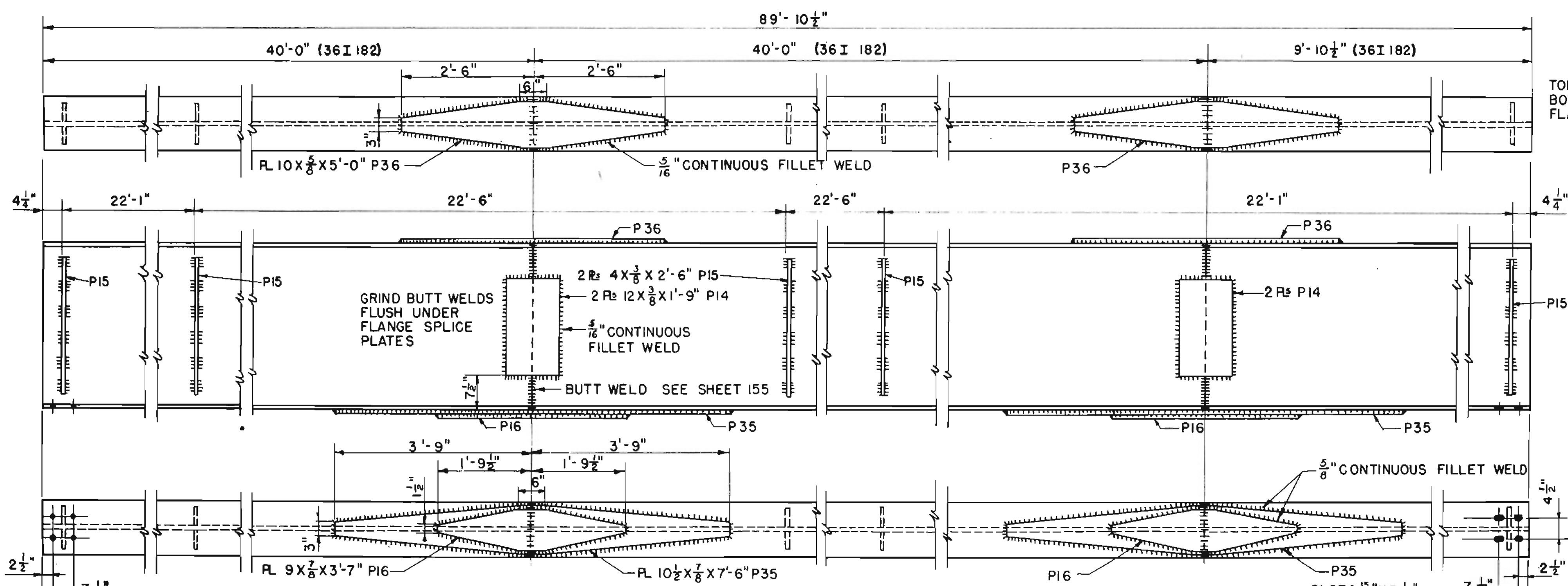


STRINGER MK 512 W

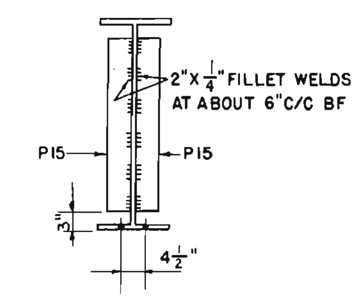




TYPICAL INTERSECTION
WEB AND FLANGE BUTT WELD



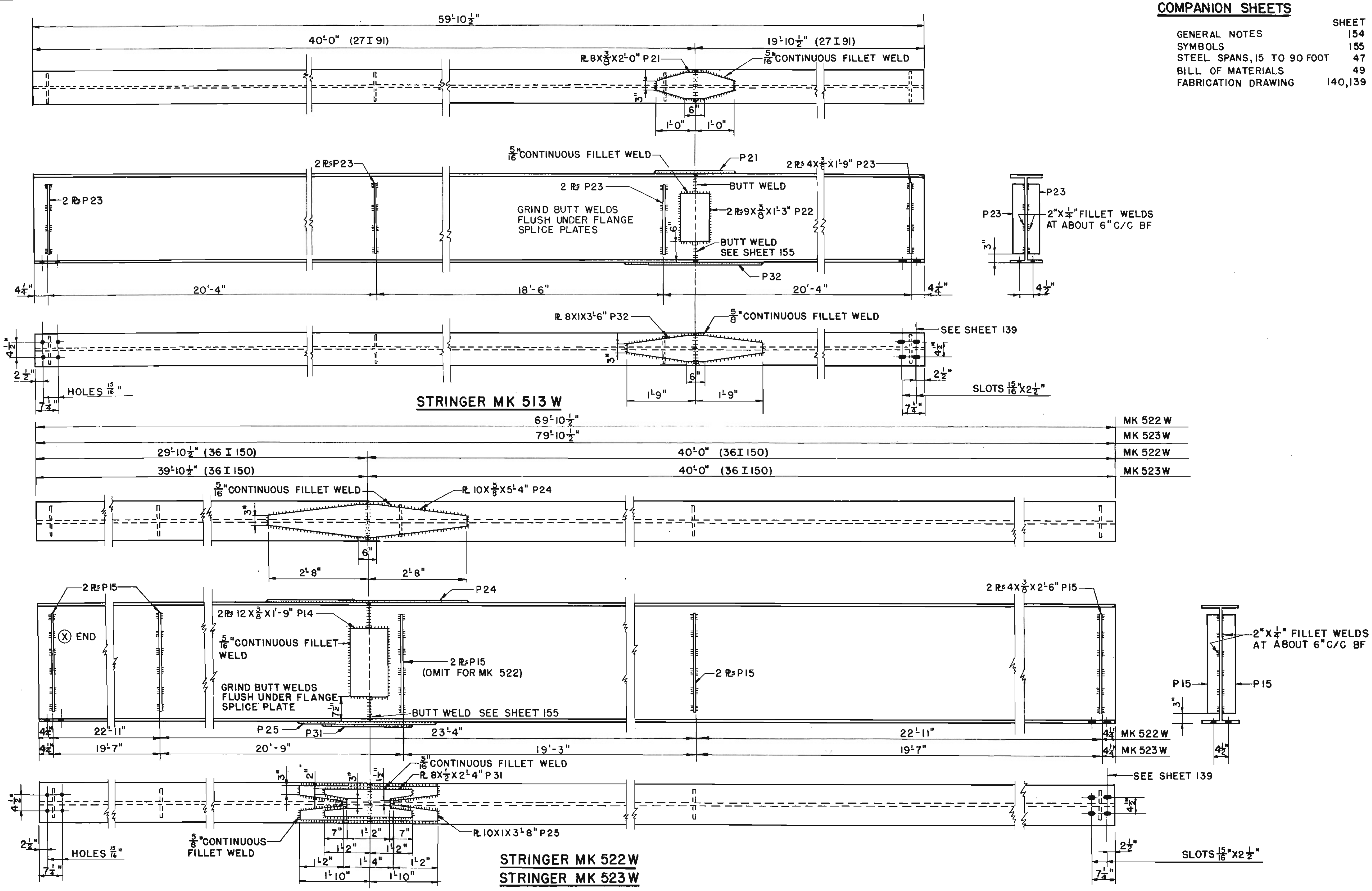
STRINGER MK 525 W



WELDED CONSTRUCTION, FABRICATION OF STRINGERS 513W, 522W, AND 523W

COMPANION SHEETS

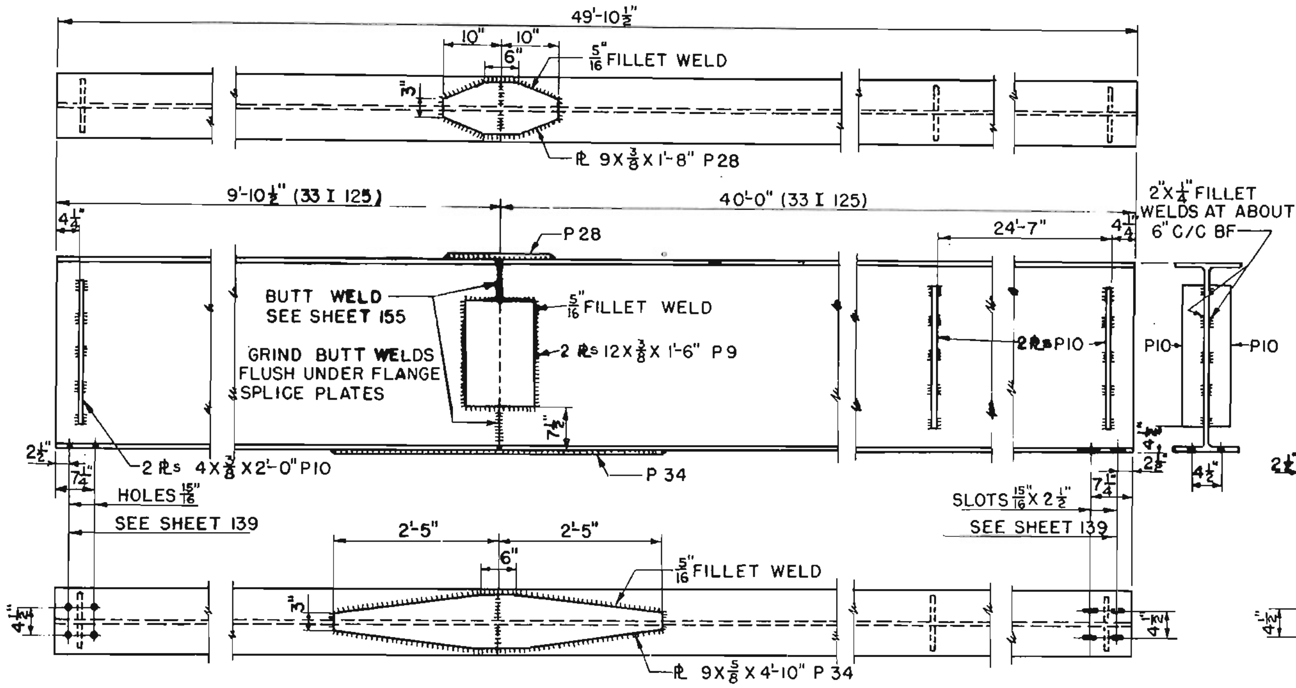
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS, 15 TO 90 FOOT	47
BILL OF MATERIALS	49
FABRICATION DRAWING	140,139



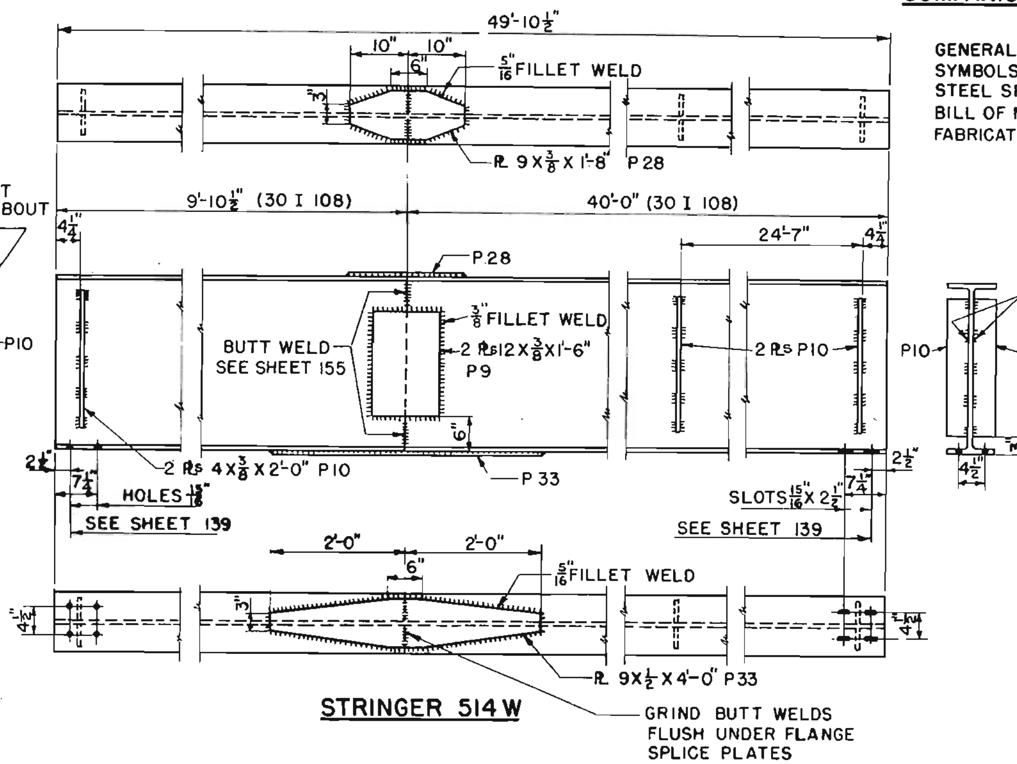
WELDED CONSTRUCTION, FABRICATION OF STRINGERS 514W, 515W, AND 516W

COMPANION SHEETS

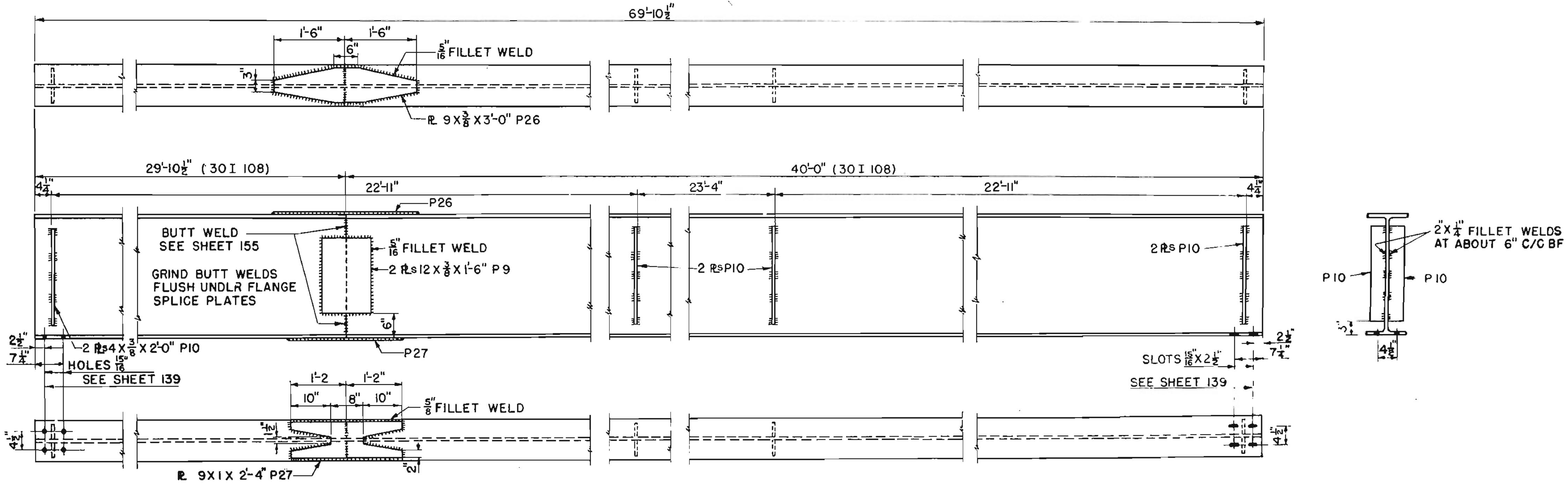
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,94
BILL OF MATERIALS	6,49,96
FABRICATION DRAWING	140,139



STRINGER MK 516 W



STRINGER 514 W

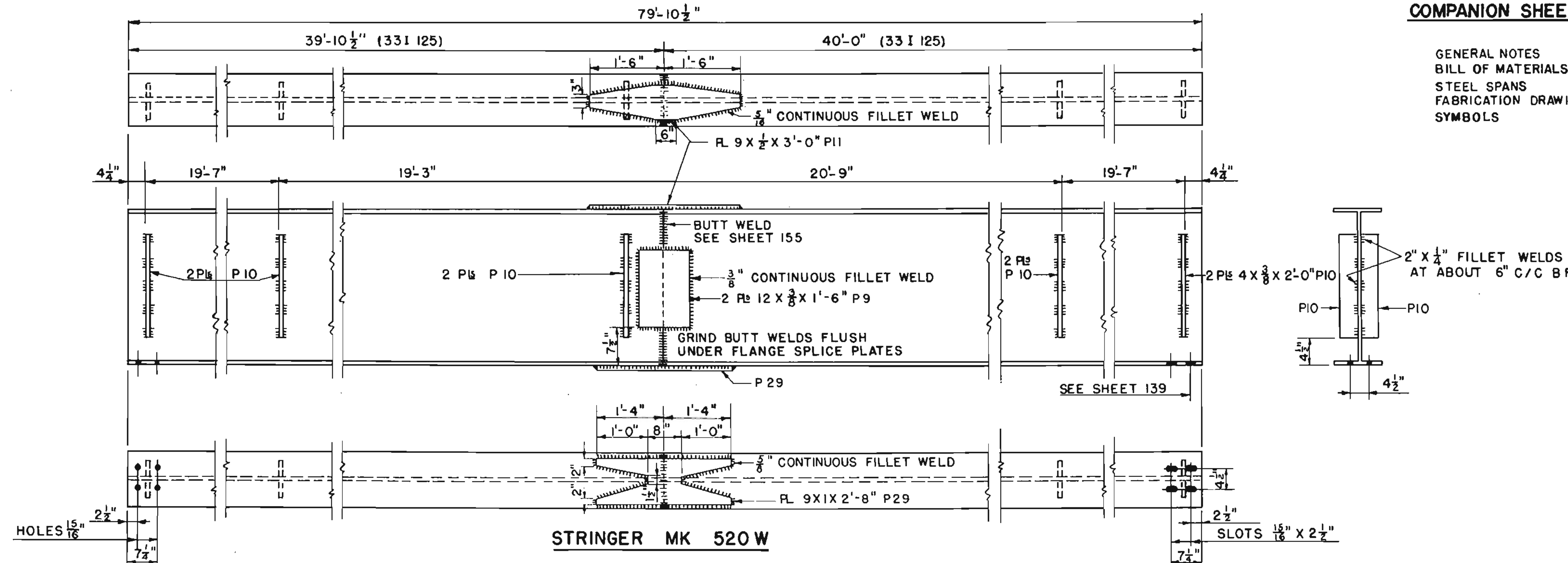


STRINGER MK 515 W

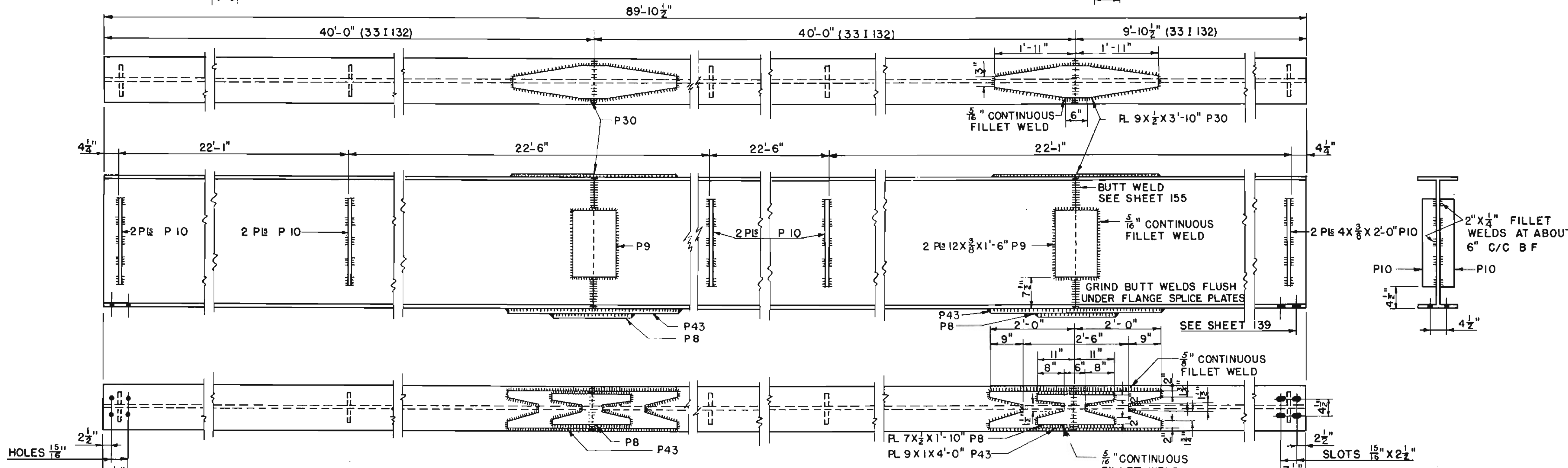
WELDED CONSTRUCTION, FABRICATION OF STRINGERS 520W AND 521W

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	6,49,96
STEEL SPANS	4,47,94
FABRICATION DRAWINGS	140,139
SYMBOLS	155



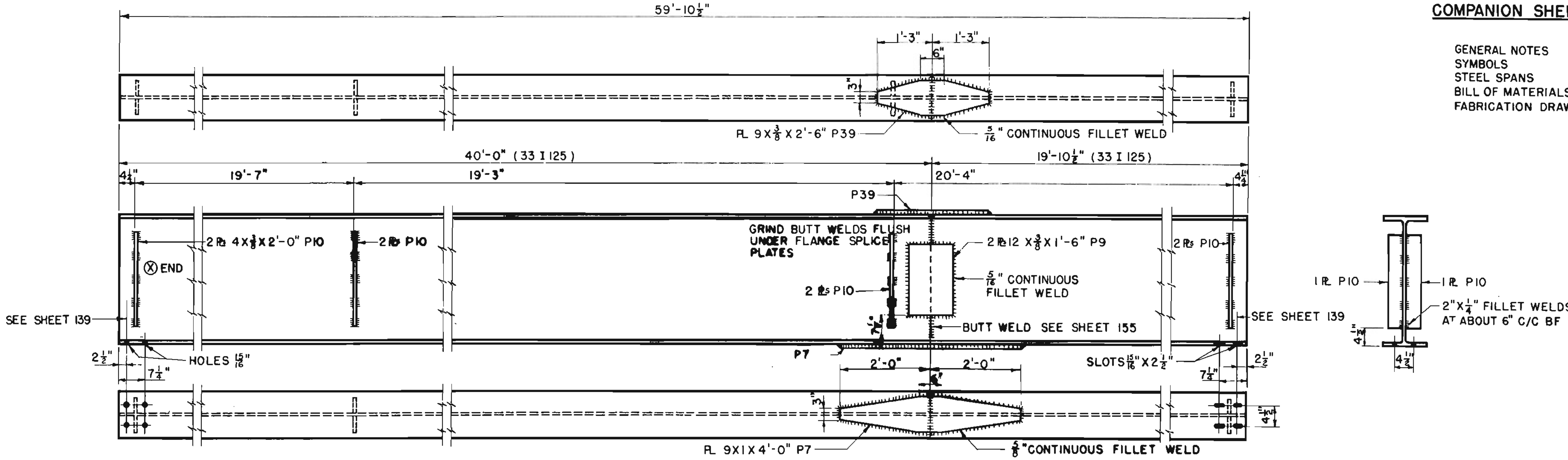
STRINGER MK 520 W



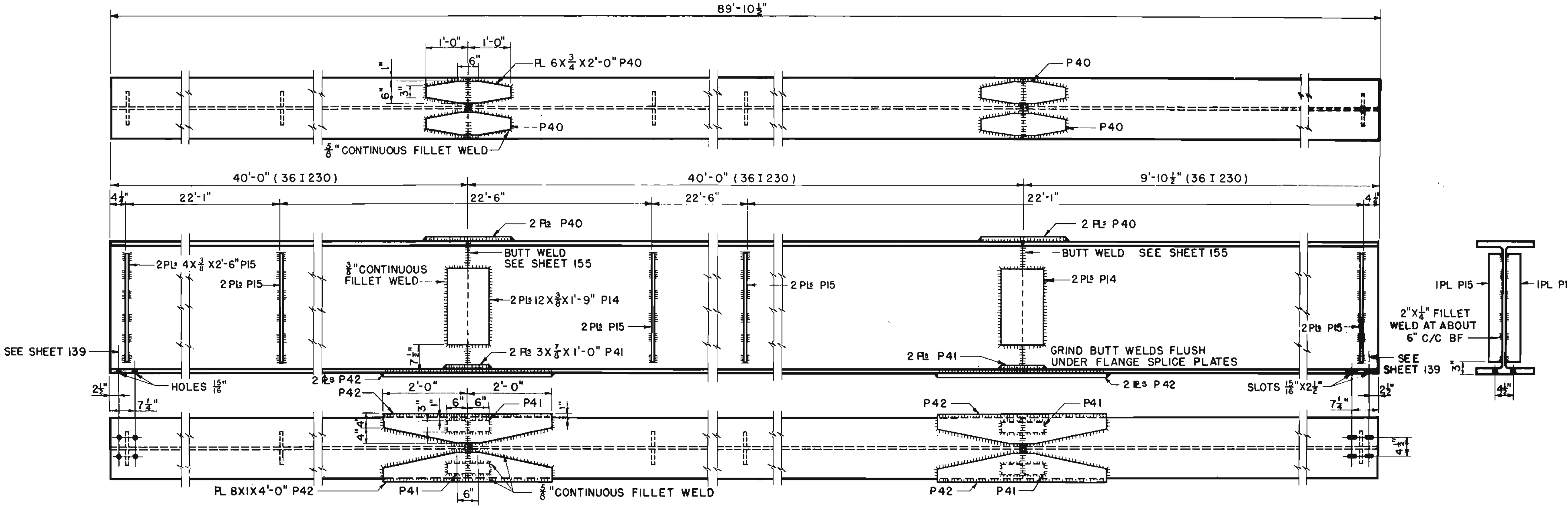
STRINGER MK 521 W

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS	4,47,94
BILL OF MATERIALS	6,49,96
FABRICATION DRAWING	140,139



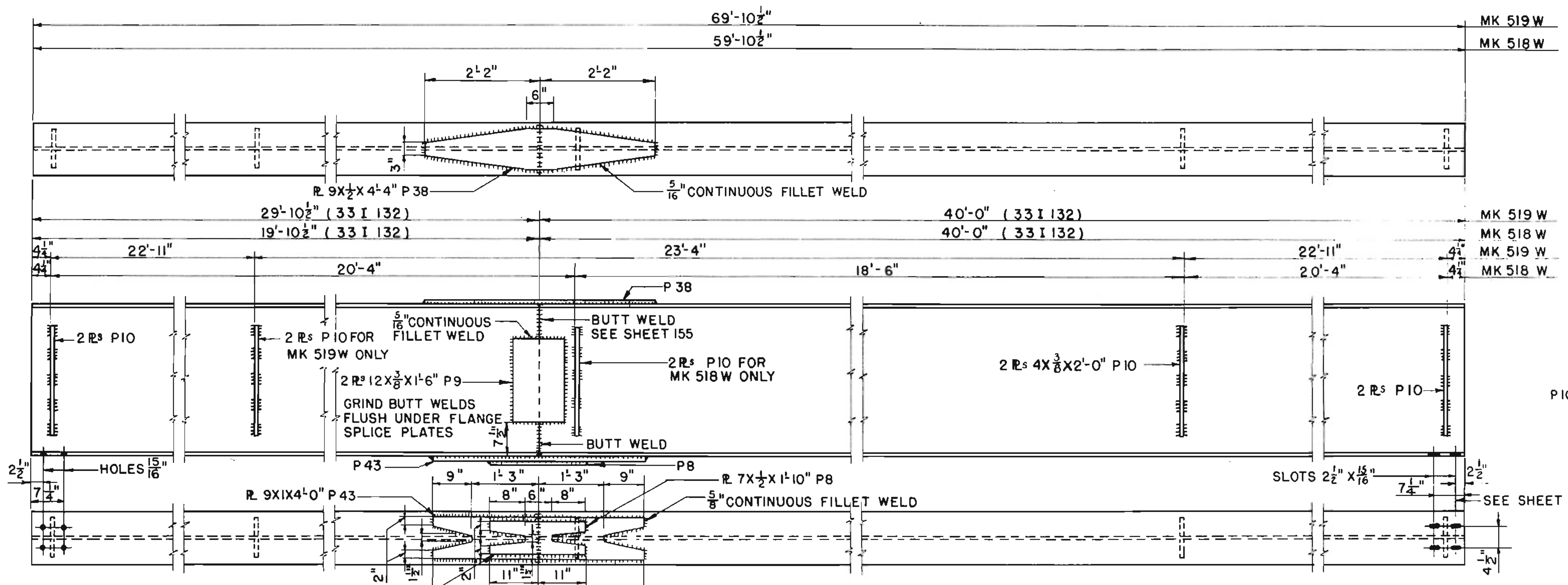
STRINGER MK 517 W

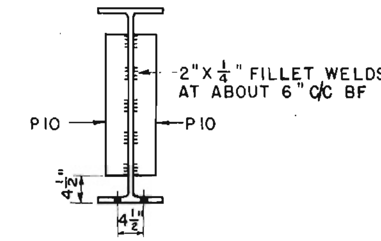


STRINGER MK 526 W

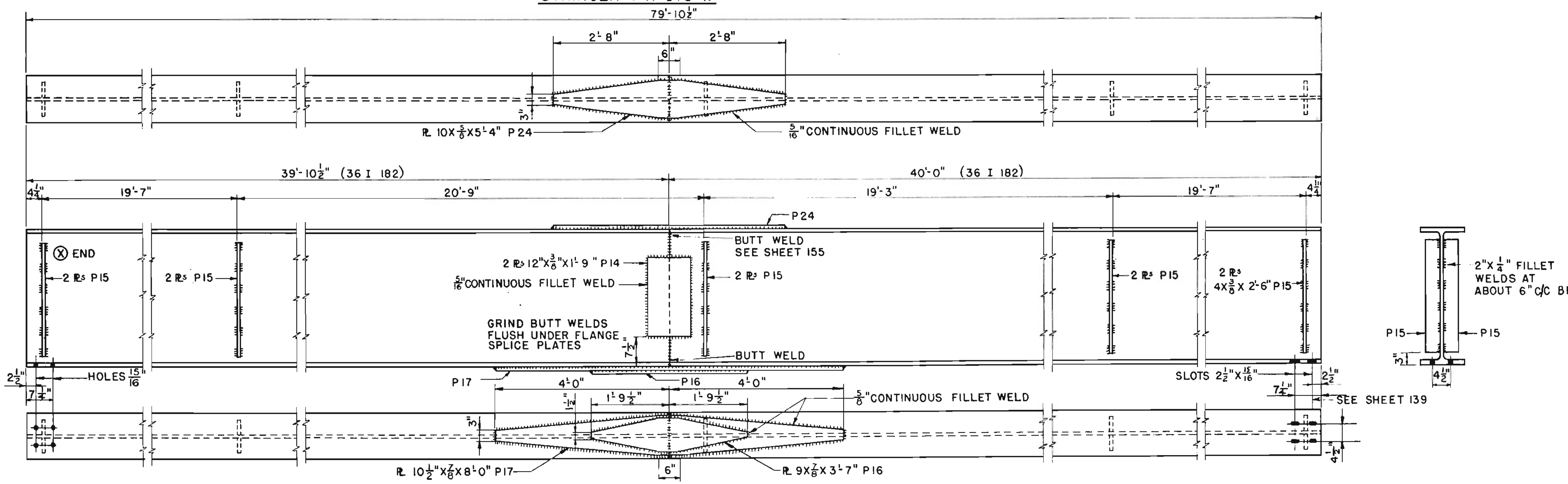
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	6,49,96
STEEL SPANS	4,47,94
FABRICATION DRAWING	140,139
SYMBOLS	155





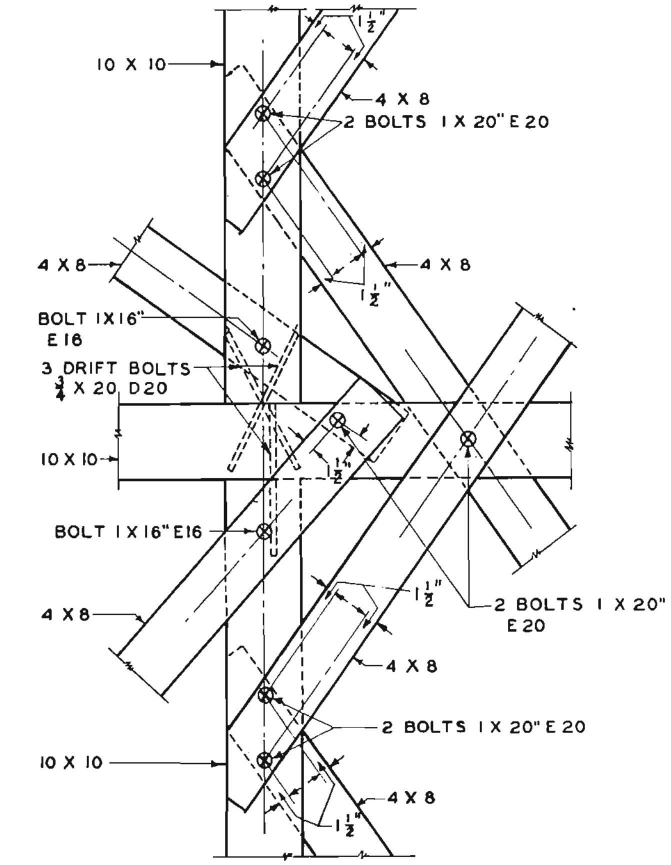
STRINGER MK 519 W
STRINGER MK 518 W



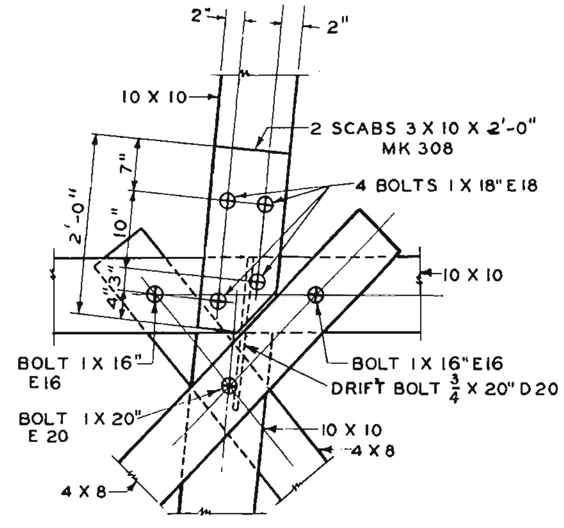
STRINGER MK 524 W

COMPANION SHEETS

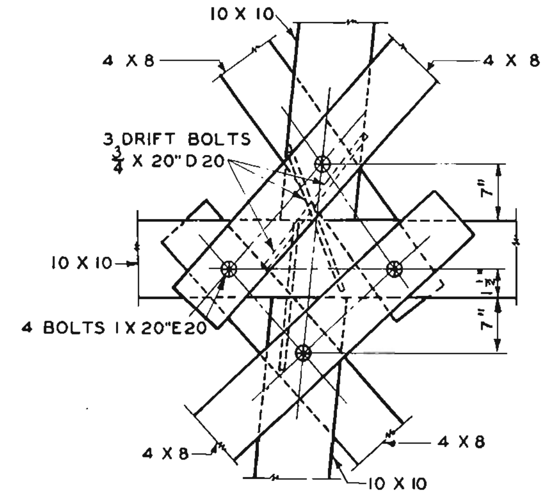
	SHEET
TIMBER TOWERS FOR TIMBER SPANS	7,50,97
BILLS OF MATERIAL	8,51,98
GENERAL NOTES	154
SYMBOLS	155



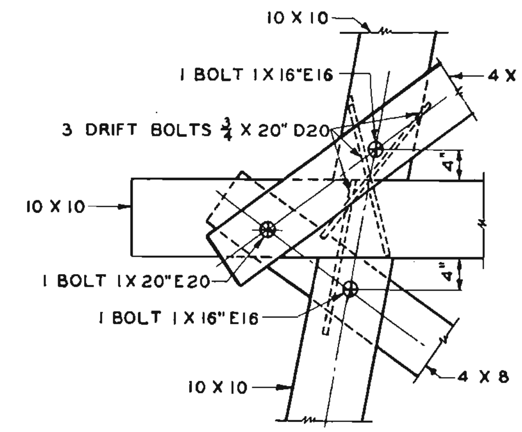
DETAIL 4



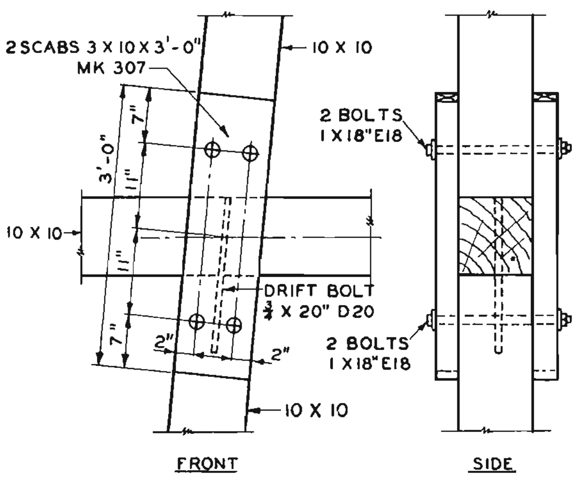
DETAIL 3



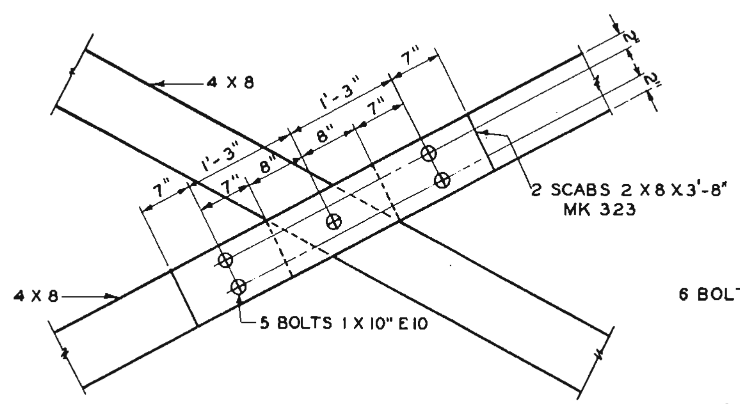
DETAIL 2



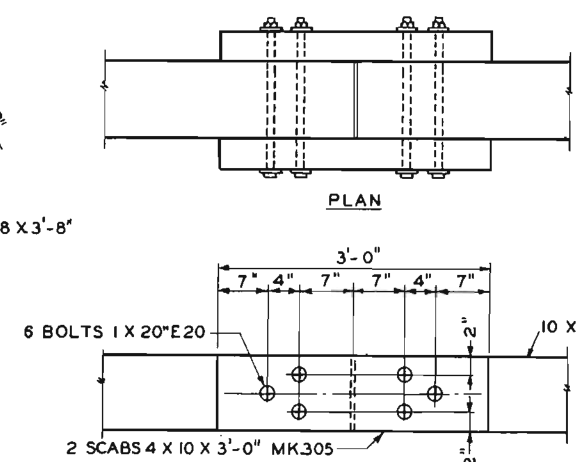
DETAIL 1



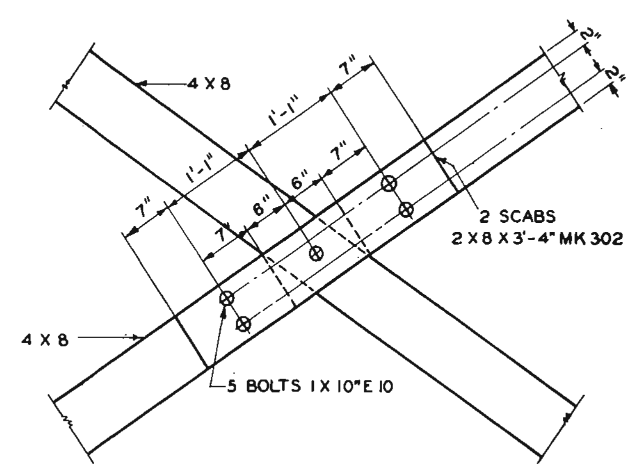
DETAIL 5



DETAIL 6



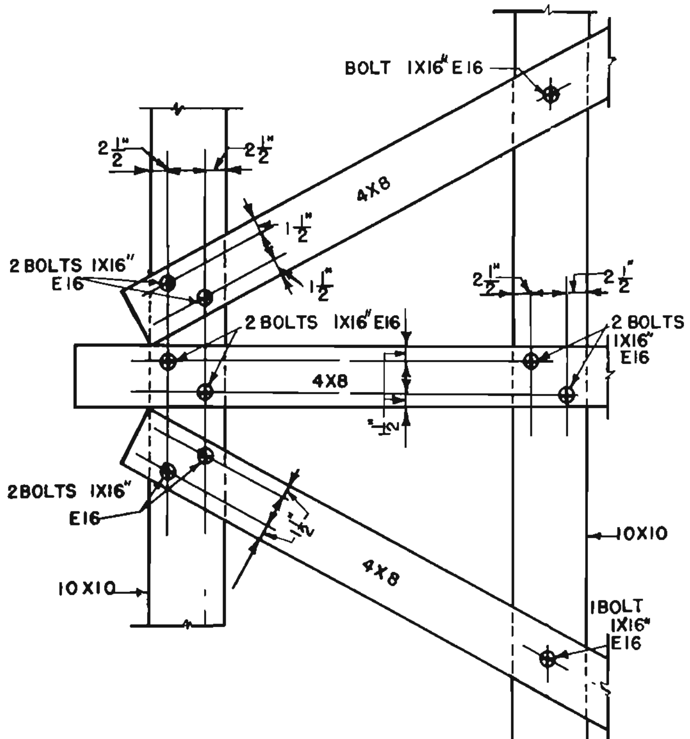
DETAIL 7



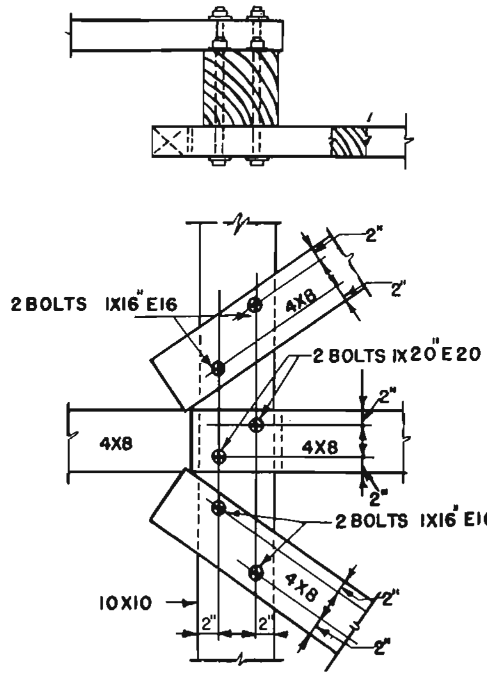
DETAIL 8

COMPANION SHEETS

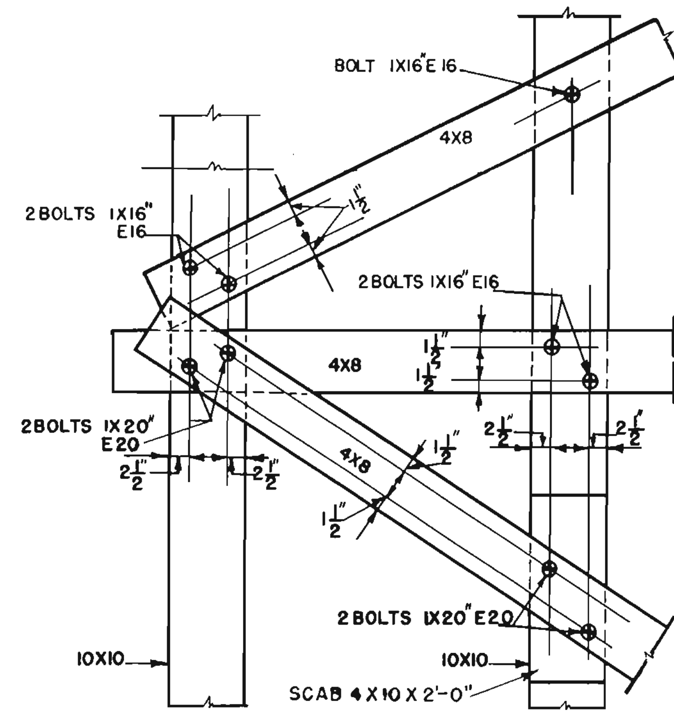
	SHEET
TIMBER TOWERS FOR TIMBER SPANS	7, 50, 97
BILL OF MATERIALS	8, 51, 98
CONNECTIONS	147
CONNECTIONS	148
GENERAL NOTES	154
SYMBOLS	155



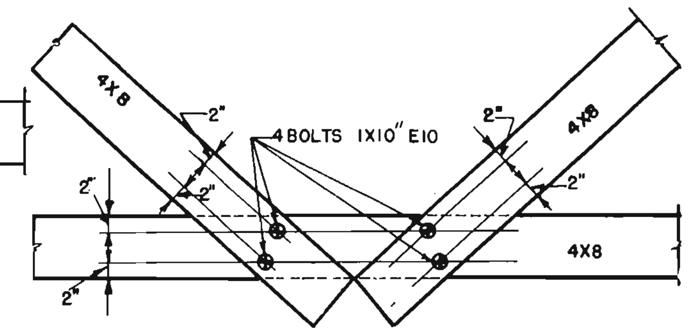
DETAIL 9



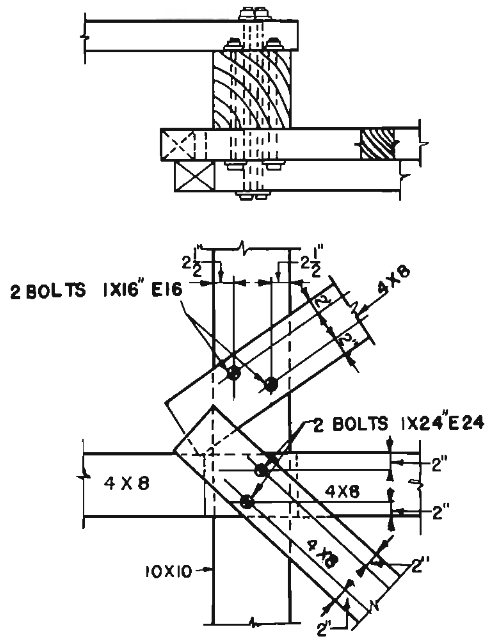
DETAIL 13



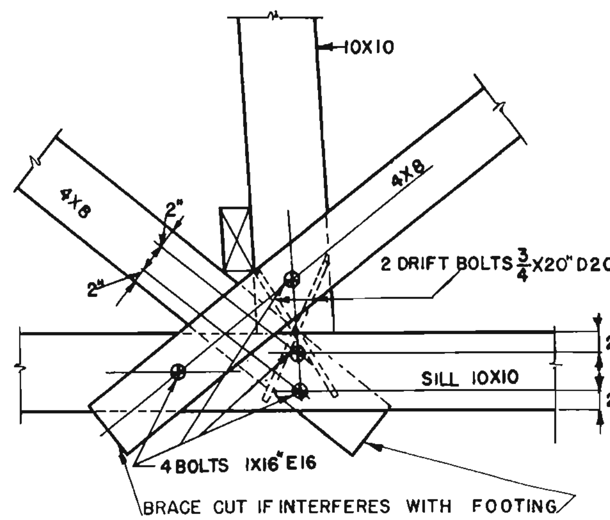
DETAIL 11



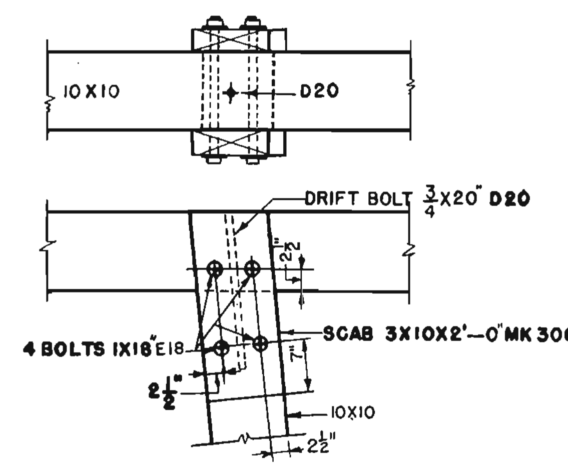
DETAIL 12



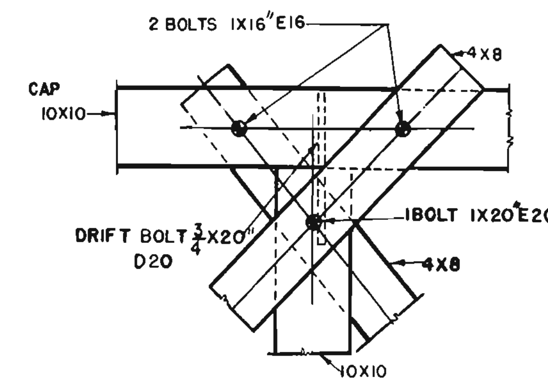
DETAIL 14



DETAIL 15



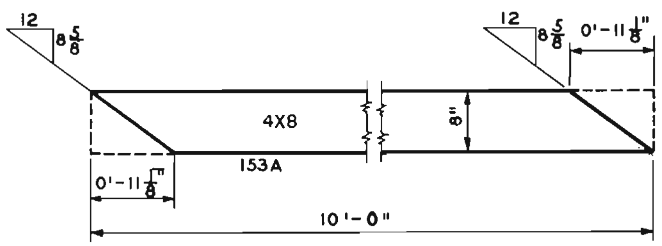
DETAIL 16



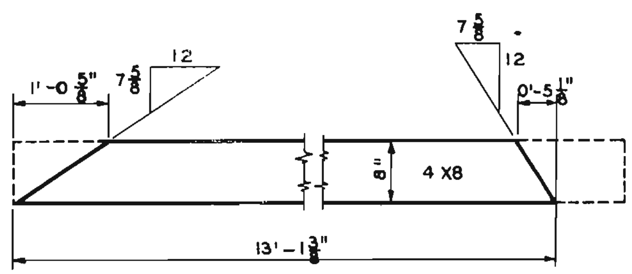
DETAIL 17

COMPANION SHEETS

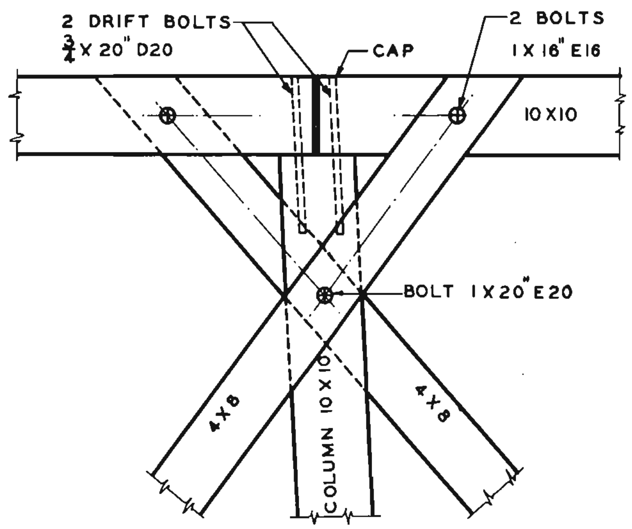
	SHEET
TIMBER TOWER FOR TIMBER SPANS	7, 50, 97
BILL OF MATERIALS	8, 51, 98
GENERAL NOTES	154
SYMBOLS	155



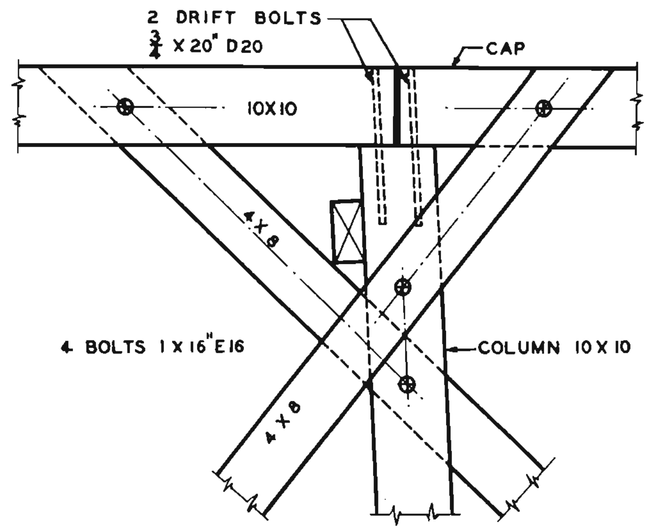
153A



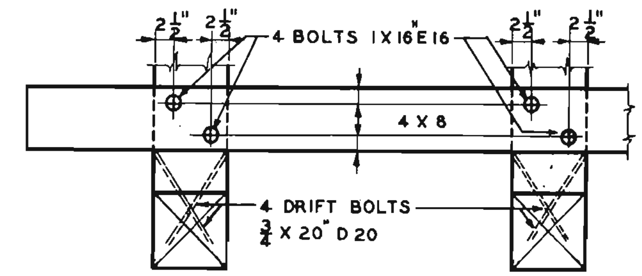
155A



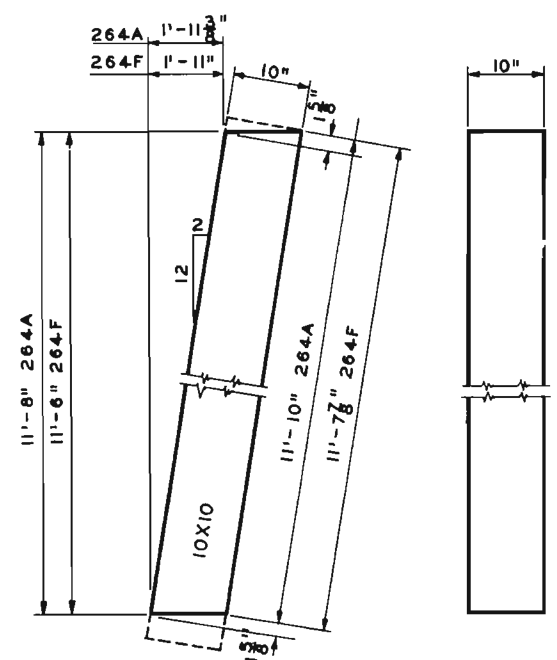
DETAIL 18



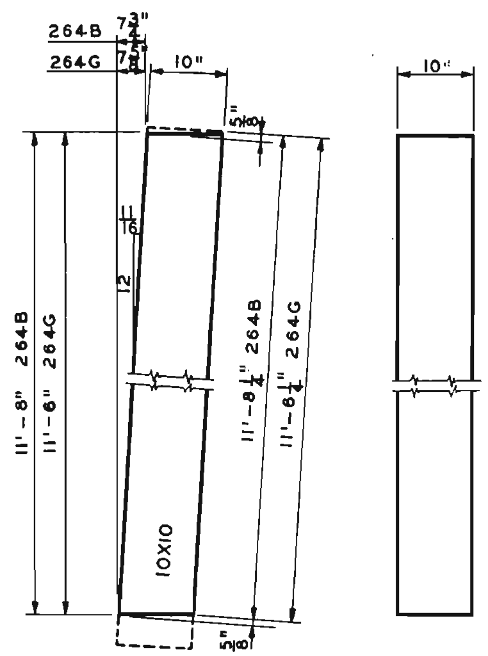
DETAIL 19



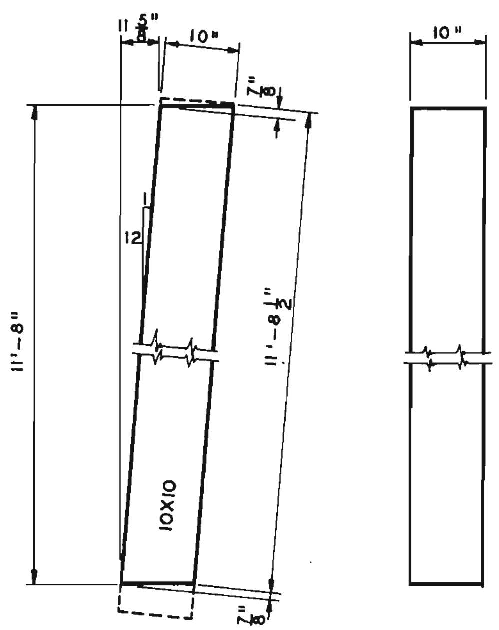
DETAIL 20



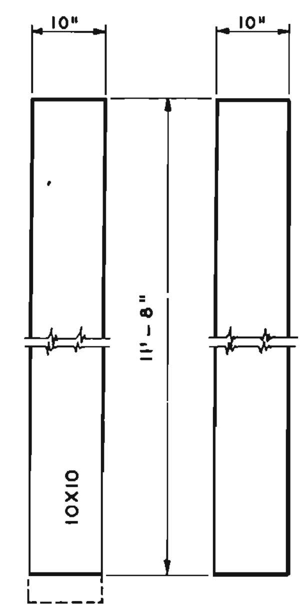
COLUMN 264A
COLUMN 264F



COLUMN 264B
COLUMN 264G



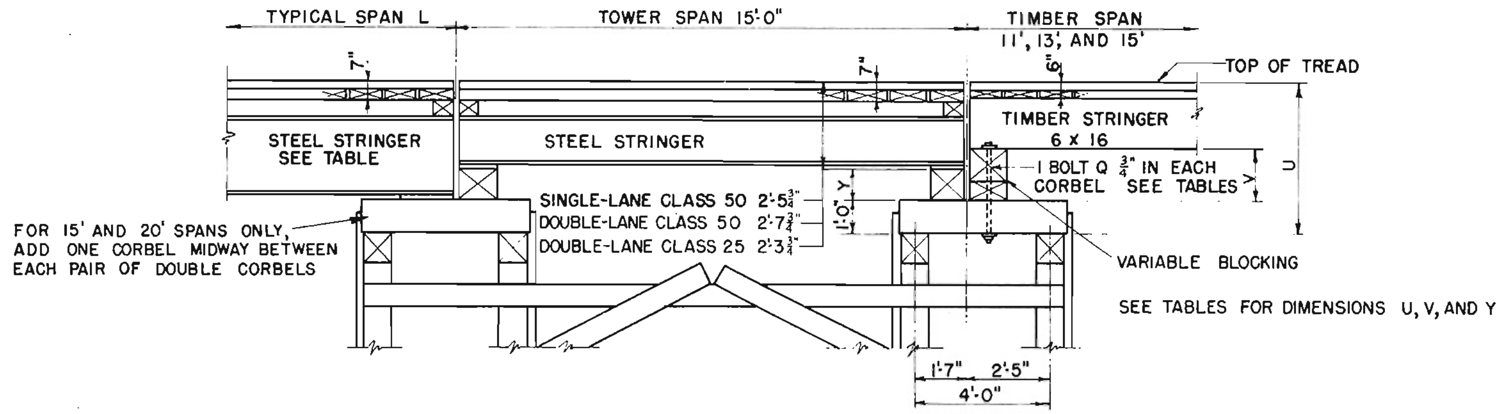
COLUMN 264C



COLUMN 264D

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL SPANS 15' TO 90'	4,47,94
SUPPLEMENTAL MATERIALS, TIMBER TOWERS	9, 52,99
TIMBER TOWER FOR STEEL SPANS	10, 53,100



LONGITUDINAL ELEVATION SHOWING JUNCTION OF TIMBER-AND STEEL-STRINGER SPANS ON TOWER

TABLE A SINGLE-LANE CLASS 50

TYPICAL SPAN L	STEEL STRINGER	DIMENSIONS			
		U	Y	V	BOLT Q
15'	16 I 36	3'-5 3/4"	0'-0"	0'-7 3/4"	22"
20'	18 I 47	3'-7 3/4"	0'-2"	0'-9 3/4"	24"
30'	24 I 74	4'-1 3/4"	0'-8"	1'-3 3/4"	30"
40'	24 I 87	4'-2"	0'-8 1/4"	1'-4"	30"
50'	30 I 108	4'-7 3/4"	1'-2"	1'-9 3/4"	36"
60'	33 I 125	4'-10 7/8"	1'-5 1/8"	2'-0 7/8"	40"
70'	33 I 132	4'-11"	1'-5 1/4"	2'-1"	40"
80'	36 I 150	5'-1 3/4"	1'-8"	2'-3 3/4"	42"
90'	36 I 182	5'-2 1/4"	1'-8 1/2"	2'-4 1/4"	42"

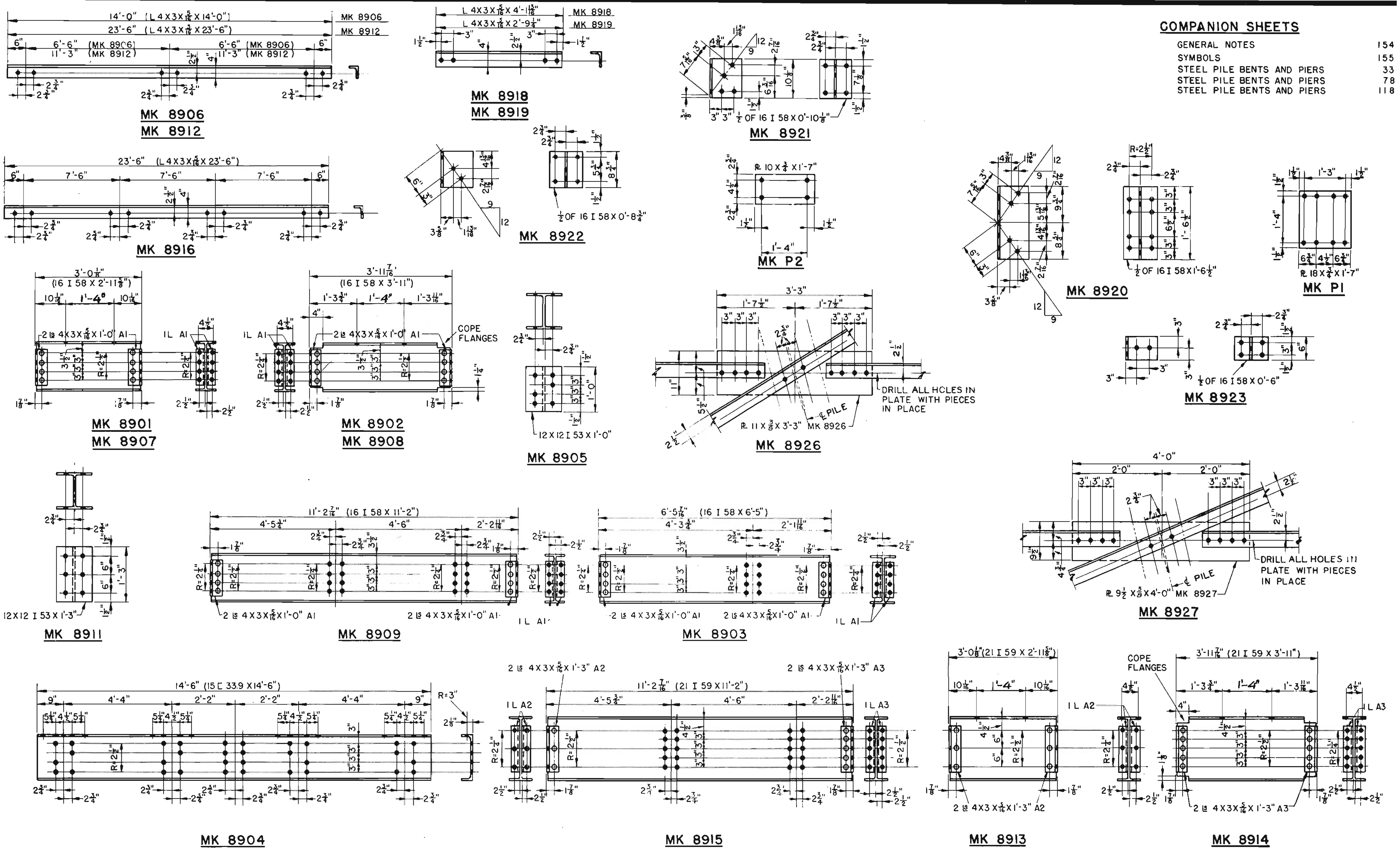
TABLE B DOUBLE-LANE CLASS 50

TYPICAL SPAN L	STEEL STRINGER	DIMENSIONS			
		U	Y	V	BOLT Q
15'	18 I 47	3'-7 3/4"	0'-0"	0'-9 3/4"	24"
20'	21 I 59	3'-10 3/4"	0'-3"	1'-0 3/4"	28"
30'	24 I 74	4'-1 3/4"	0'-6"	1'-3 3/4"	30"
40'	27 I 91	4'-4 3/4"	0'-9"	1'-6 3/4"	34"
50'	33 I 125	4'-10 7/8"	1'-3 1/8"	2'-0 7/8"	40"
60'	33 I 132	4'-11"	1'-3 1/4"	2'-1"	40"
70'	36 I 150	5'-1 3/4"	1'-6"	2'-3 3/4"	42"
80'	36 I 182	5'-2 1/4"	1'-6 1/2"	2'-4 1/4"	42"
90'	36 I 230	5'-1 3/4"	1'-6"	2'-3 3/4"	42"

TABLE C DOUBLE-LANE CLASS 25

TYPICAL SPAN L	STEEL STRINGER	DIMENSIONS			
		U	Y	V	BOLT Q
15'	14 I 30	3'-3 3/4"	0'-0"	0'-5 3/4"	20"
20'	16 I 36	3'-5 3/4"	0'-2"	0'-7 3/4"	22"
30'	21 I 59	3'-10 3/4"	0'-7"	1'-0 3/4"	28"
40'	21 I 63	3'-10 7/8"	0'-7 1/8"	1'-0 7/8"	28"
50'	24 I 87	4'-2"	0'-10 1/4"	1'-4"	30"
60'	27 I 91	4'-4 3/4"	1'-1"	1'-6 3/4"	34"
70'	30 I 108	4'-7 3/4"	1'-4"	1'-9 3/4"	36"
80'	33 I 125	4'-10 7/8"	1'-7 1/8"	2'-0 7/8"	40"
90'	33 I 132	4'-11"	1'-7 1/4"	2'-1"	40"

WHEN LAMINATED FLOOR IS USED IN PLACE OF STANDARD FLOOR, ADD ONE INCH TO DIMENSIONS U AND V GIVEN IN TABLES A, B AND C

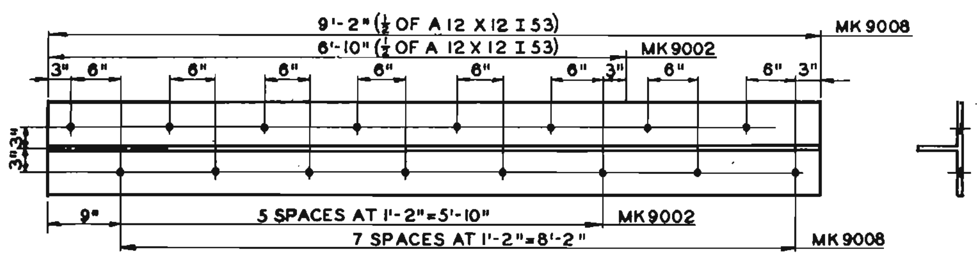


COMPANION SHEETS

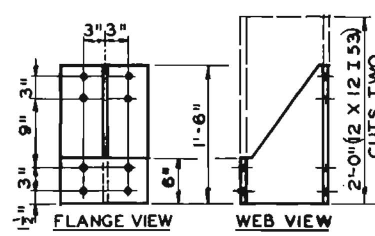
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS	33
STEEL PILE BENTS AND PIERS	78
STEEL PILE BENTS AND PIERS	118

COMPANION SHEETS

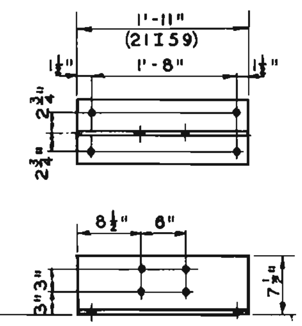
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL GRILLAGES, BOLTED	41
STEEL GRILLAGES, BOLTED	87
STEEL GRILLAGES, BOLTED	125



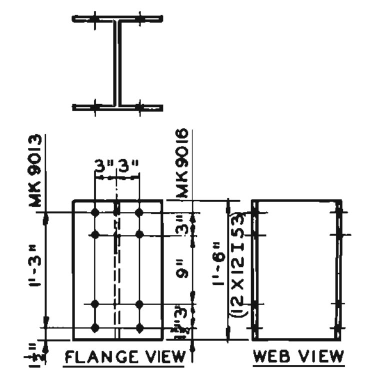
HALF BEAM MK 9002
HALF BEAM MK 9008



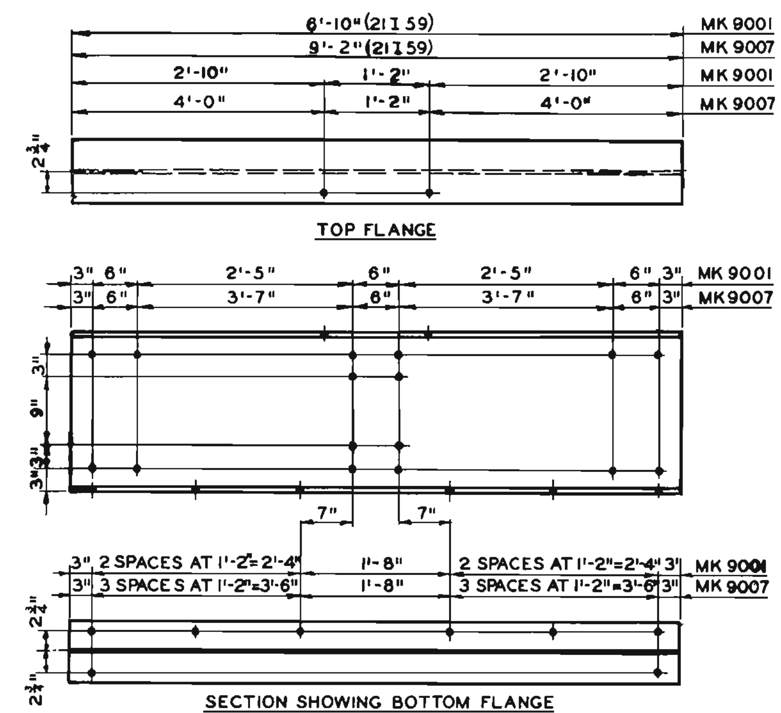
BRACE MK 9030



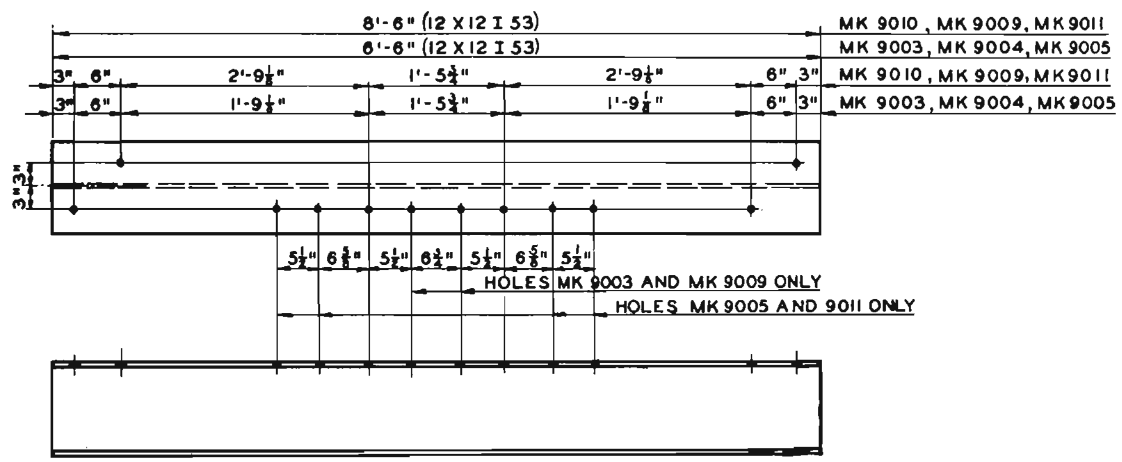
BRACE MK 9031



SEPARATOR MK 9013
SEPARATOR MK 9016



BEAM MK 9001
BEAM MK 9007

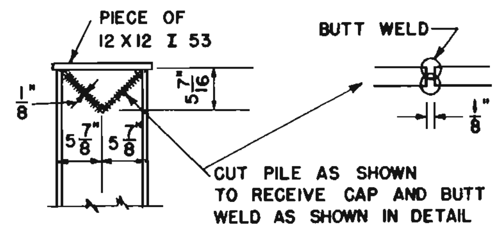


BEAM MK 9003
BEAM MK 9004
BEAM MK 9005

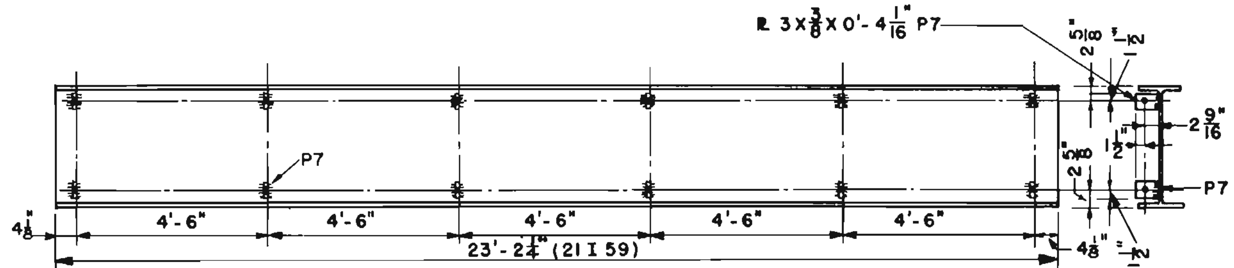
BEAM MK 9009
BEAM MK 9010
BEAM MK 9011

COMPANION SHEETS

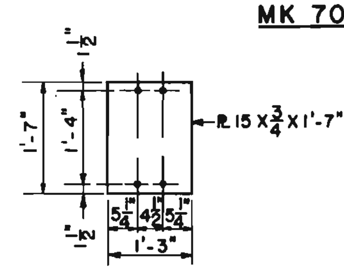
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	35,78,118



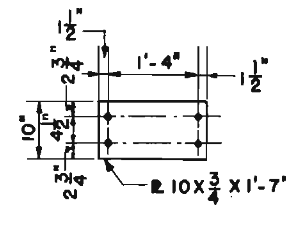
DETAIL SHOWING CONNECTION OF PILE CAP TO PILE



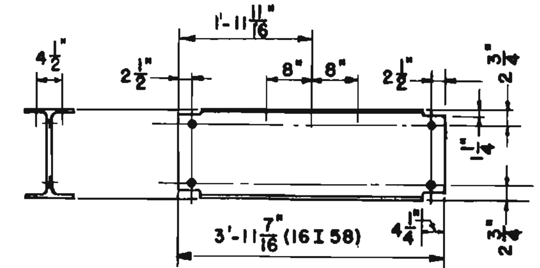
MK 7043



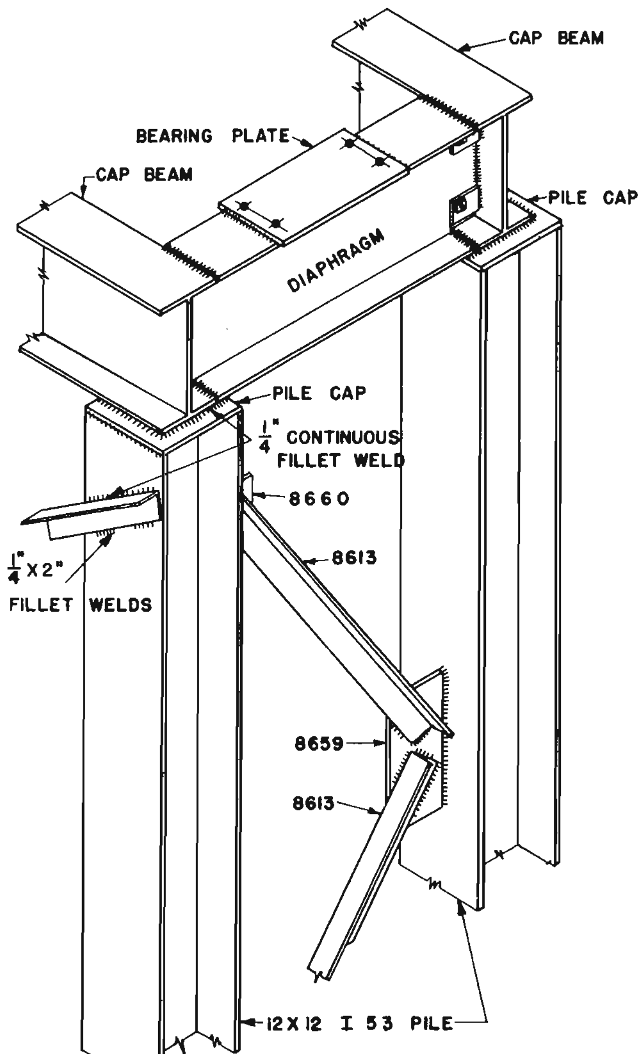
BEARING PLATE P3



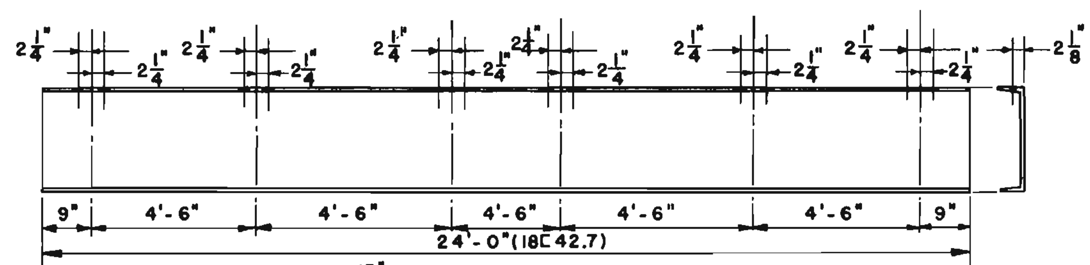
BEARING PLATE P4



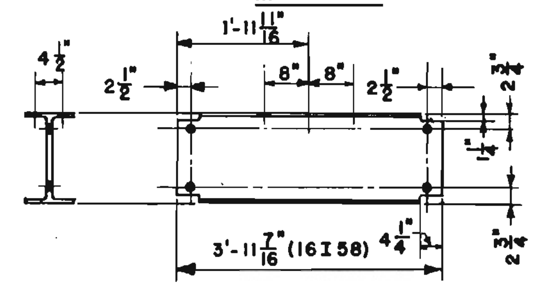
MK 7004



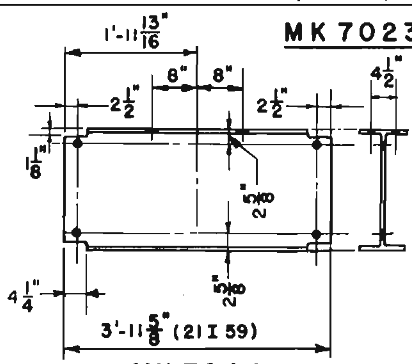
PART ASSEMBLED VIEW OF STEEL PILE PIER



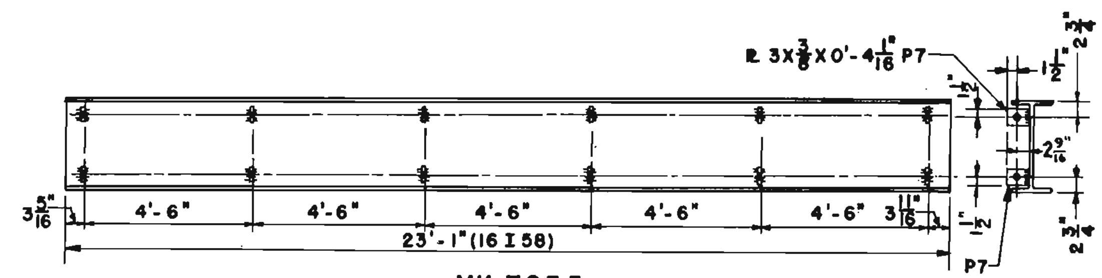
MK 7023



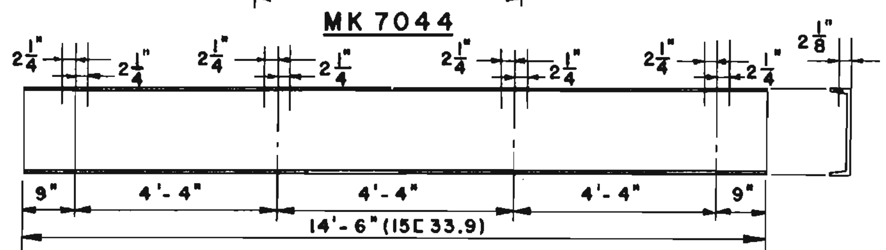
MK 7034



MK 7044



MK 7033



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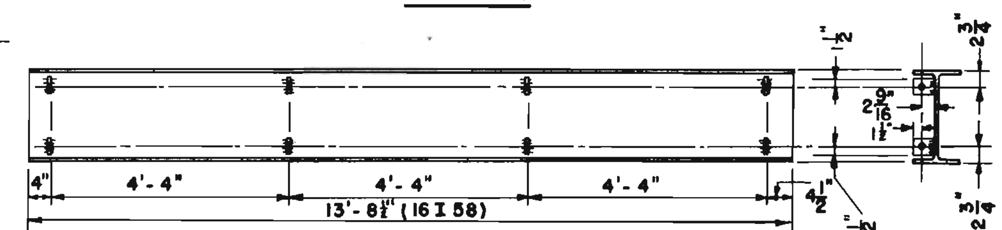
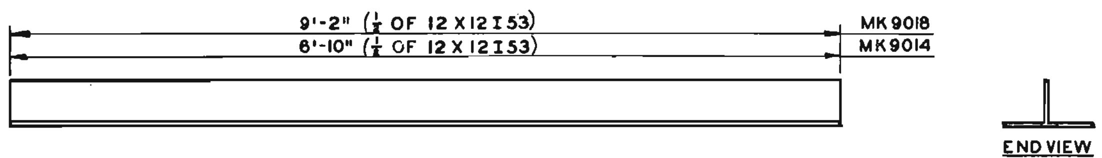


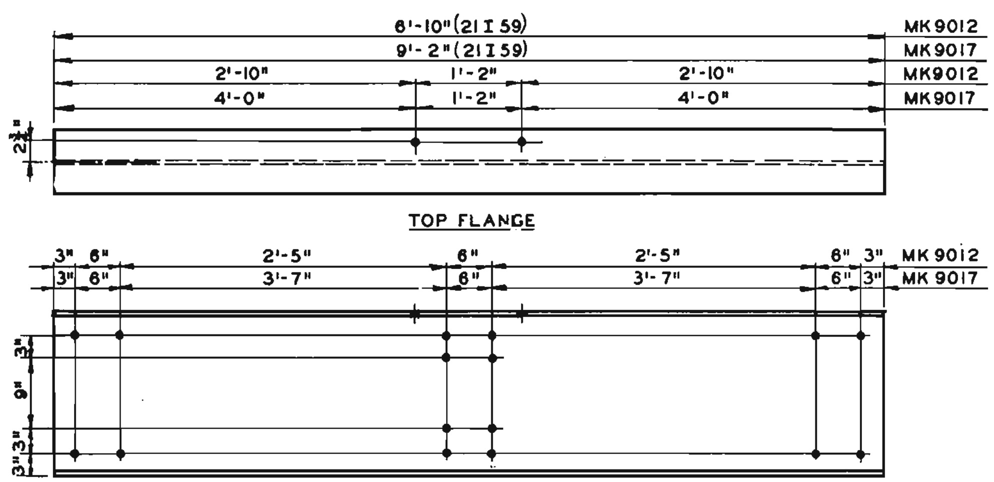
MK 7003

COMPANION SHEETS

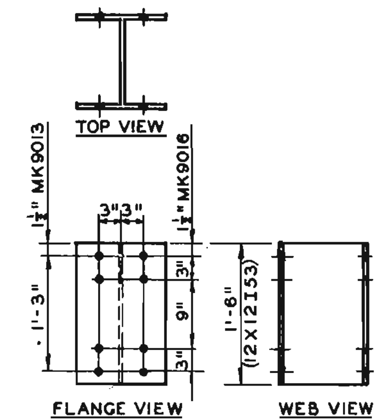
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL GRILLAGES, WELDED	42
STEEL GRILLAGES, WELDED	88
STEEL GRILLAGES, WELDED	126



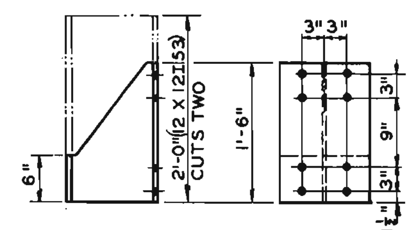
HALF BEAM MK 9014
HALF BEAM MK 9018



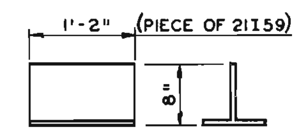
BEAM MK 9012
BEAM MK 9017



SEPARATOR MK 9013
SEPARATOR MK 9016



BRACE MK 9033



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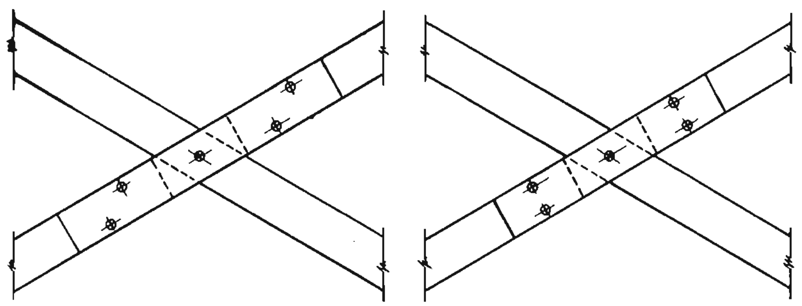
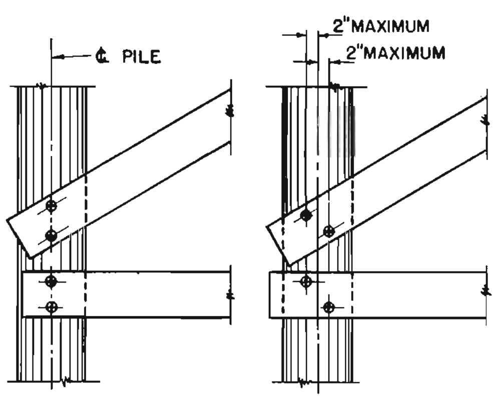


PREFERRED ALTERNATE

BOLT PATTERN FOR TIMBER BRACING SPLICES



PREFERRED ALTERNATE

BRACING CONNECTION TO TIMBER PILES

STEEL FABRICATION WITH RIVETS AND BOLTS

All rivets are ⅞-inch diameter. Structural ribbed ⅞-inch bolts may be substituted for any ⅞-inch rivet. The rivet length R in inches is shown on fabrication drawings for all riveted connections. Table XLIV shows corresponding lengths of structural ribbed bolts substituted for rivets.

All holes in steel are 15/16-inch diameter unless otherwise shown on drawings.

The distance from any hole to sheared edge is 1½ inches unless otherwise shown on the drawings. This end distance is used in marking hole centers not otherwise dimensioned.

The minimum distance from center of any hole to edge of steel is 1¼ inches for 15/16-inch holes.

The minimum distance between centers of 15/16-inch holes is 3 inches.

All holes in steel may be drilled full size. If necessary to obtain accurate fit, 15/16-inch holes may be subdrilled to 13/16-inch diameter and reamed to 15/16-inch size with taper bridge reamer.

All holes must be clean, with even edges, cylindrical, and perpendicular to the steel surface.

The location of all open holes for field connections should be within 1/32 inch of the position shown on drawings.

Reaming is done after the steel members are positioned in correct alignment with the steel surfaces held in close contact.

Temporary field connections made before riveting or bolting must have at least half of the holes filled with driftpins or machine bolts.

Slotted holes shown in the bottom flanges of stringers and in bearing plates, and 1-9/16-inch holes in steel-tower-column base plates for ⅞-inch or 1-inch anchor bolt are flame-cut.

Machine bolts may be used instead of structural ribbed bolts as anchor bolts between steel grillages and steel tower columns.

WELDING

Welds are ¼-inch fillet welds unless otherwise indicated.

Welds 5/16 inch and smaller may be made with a single pass of the electrode. Welds over 5/16 inch are made in two or more passes, each depositing an approximately equal volume of weld.

Butt welds between steel edges not over ¼ inch thick may be deposited between square-cut edges. Edges of steel from 5/16 to 9/16 inch thick are beveled for butt welding on one side at an angle of 60° to the metal surface. Edges of metal over 9/16 inch thick are beveled for butt welding on both sides at an angle of 60° to the metal surface.

Steel edges to be welded may be flame-cut and beveled and are cleaned to remove mill scale, corrosion, and other foreign matter within ½ inch of the edge.

TIMBER

Timber may be furnished rough, sawn to full dimension, or dressed dimension. The nominal size is shown on the drawings.

Holes for driftbolts and machine bolts are bored the same diameter as the bolt.

Threaded bolts used for timber connections are steel machine bolts threaded with American standard coarse threads (NCTS—formerly USS thread) class 2 fit, finished black with square nuts. Two standard round iron or steel washers must be provided with each machine bolt.

For 1-inch bolts, diameter 2½ inches, thickness 5/32 inch, stock number 43-9215.5-100.

For ¾-inch bolts, diameter 2 inches, thickness ⅛ inch, stock number 43-9215.5-07.

For ½-inch bolts, diameter 1⅜ inches, thickness 3/32 inch, stock number 43-9215.5-05.

The minimum distance from the center of any bolt to edge of timber is one and one-half times the diameter of the bolt.

The minimum distance from the center of any bolt to end of timber is seven times the diameter of the bolt.

Standard methods of bolting scabs at timber bracing splices are shown on sketches on this sheet. Standard methods of connecting braces to timber piles are shown in sketches on this sheet.

MISCELLANEOUS

All I-beams are wide-flange sections, no American-standard I-beams being used in the designs in this manual. Plates and channels with skew cuts are cut from long lengths to save cutting work and material.

Open holes are shown in bearing plates and beams of cap beam at top of steel towers. These connections are made after erection so the beams may be spread to enter over the tower columns.

Steel stringers are so placed on supports that slotted holes in the stringers are all at one end of the span. Expansion ends and fixed ends alternate.

Steel-stringer splices are designed on the basis of actual moments and shear at the point of splice. Location of splices should be changed only on direction of officers experienced in design.

Driftbolts without heads may be used where plain driftbolts are indicated to avoid counterboring for heads to obtain unobstructed timber surface.

Stock numbers shown in bills of materials are those contained in Engineer Supply Catalog issued March, 1944. The stock number subdecimal indicating length of timber, or size of plate, has been omitted for pieces which may be cut from random length timber or from different sizes of plates. Items for which no stock number is given were not class IV material at the time these drawings were prepared.

The quantities listed in bills of materials are net requirements for finished structures; they include no allowance for waste or loss.

Fabrication drawings for steel stringers show total lengths of individual stringer sections. No deduction is shown for clearance between ends of sections at splices.

At riveted splices, clearance between ends of stringers should not exceed ½ inch. Stringer sections, except 40-foot lengths, are listed in the bills of materials ½ inch shorter than shown on fabrication drawings, providing plus ½ inch cutting tolerance without trimming.

At welded splices, clearance between ends of stringers should not exceed ⅛ inch. Stringer sections are listed in the bills of materials the same length as shown on fabrication drawings, providing minus ⅛ inch cutting tolerance without trimming. If 40-foot stringer sections are not of exact length, dimensions of adjacent sections must be adjusted accordingly.

Bills of materials for timber piers for highway steel spans include anchor bolts for attaching uniform-depth spans. Only one-half the listed quantity of anchor bolts is used for each span where steel and timber spans or steel stringers of different depths meet on one pier. Timber blocking and anchor bolts for steel stringers of different depths are shown on sheets 30, 74, and 114 showing supplemental materials for highway piers and billed on sheet 203 for railway piers.

Riprap is shown on drawings of foundation piles with concrete pedestals or steel frames. See text for information and directions as to use of riprap.

Fabrication drawings for highway steel stringers show four holes in the bottom flange at each end of the stringer. However, only two holes are needed at each end.

The holes are 2½ inches from the end on stringers resting on timber abutments.

Holes are 7¼ inches from the end on beams resting on any other support.

COMPANION SHEET

	SHEET
SYMBOLS	155

Sheets 20, 63, 103, and 192 show fabricated shims for steel stringers of nonuniform depth. When these shims are required, holes must be provided for bolts connecting them to steel-stringer bottom flanges unless welded connections are used.

BEARING PLATES, BLOCKING, AND SHIMS

No bearing plates are used under timber stringers or under steel stringers on steel pile abutments. Bearing plates on steel towers are detailed and listed with other tower material.

Bearing plates on steel pile bents and piers are detailed and listed with other bent and pier materials.

Bearing plates under steel stringers on timber towers, timber pile piers, timber abutments, and concrete abutments are listed on the same sheets as tower, pier, or abutment materials, and are detailed on sheet 132 for highway and on sheet 178 for railway bridges.

Blocking under bearing plates supporting steel stringers of nonuniform-depth spans on timber towers is dimensioned and listed on sheets listing supplemental tower materials.

Sheet 9	Class 50, single-lane
Sheet 52	Class 50, double-lane
Sheet 99	Class 25, double-lane
Sheet 178	Railway

Blocking under bearing plates supporting stringers of nonuniform-depth spans on timber pile piers is dimensioned on pier drawings. Bills of materials must be prepared in the field, except for blocking under 15-foot standard railway spans between braced piers which is listed with other pier materials.

Shims under steel stringers of nonuniform-depth spans on steel towers, bents, and piers are detailed and listed on:

Sheet 20	Class 50, single-lane
Sheet 63	Class 50, double-lane
Sheet 103	Class 25, double-lane
Sheet 192	Railway

ANCHOR BOLTS

Anchor driftbolts for timber stringers are shown and listed with superstructure materials.

Anchor bolts for steel stringers are shown and listed with substructure materials:

- On steel towers: on drawings of shims for support of maximum depth spans.
- On abutments, and for uniform-depth steel-stringer spans on timber towers, timber pile piers, and steel pile bents and piers: on drawings with abutment, tower, and pier material.
- On steel pile bents and piers, for nonuniform-depth steel-stringer spans: on drawings of shims for support of nonuniform-depth spans.

Anchor bolts for support of nonuniform-depth steel-stringer spans on timber towers and timber pile piers are dimensioned on drawings showing supplemental tower materials and blocking on piers, but are not listed. Bills of materials for these anchor bolts must be prepared in the field; the anchor bolts which are not used but are listed in bills of materials on these drawings may be deducted.

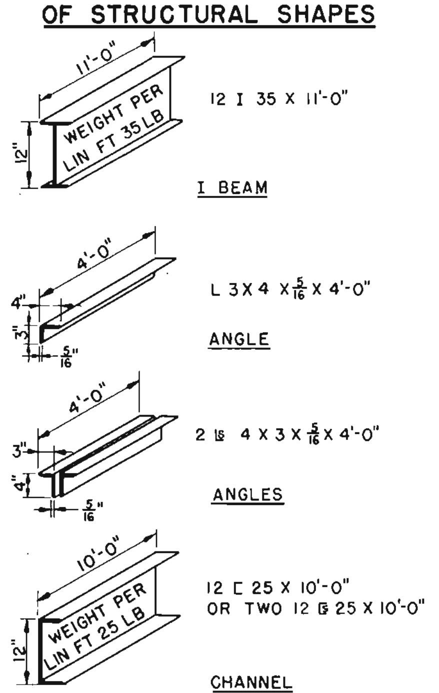
SYMBOLS USED FOR DRAWINGS AND BILLS OF MATERIALS

I OR Is	STRUCTURAL STEEL BEAM OR BEAMS
L OR Ls	ANGLE OR ANGLES
[OR [s	STRUCTURAL STEEL CHANNEL OR CHANNELS
⊥ OR ⊥s	STRUCTURAL STEEL TEE OR TEES
PL OR PLs	STRUCTURAL STEEL PLATE OR PLATES
	BOLT THREADS
∅	ROUND ROD, BOLT, ETC
□	SQUARE ROD, ETC
⊕	BOLT, NUT, AND WASHERS IN TIMBER
	DRIFT BOLT
⊠	HOOK BOLT, NUT, AND WASHER
	FABRICATION RIVET OR RIBBED BOLT
	OPEN HOLE, FIELD BOLT, OR FIELD RIVET
MK	IDENTIFIES MARK NUMBER ON DRAWING
X	BY, (2 X 4), 2" BY 4"
℄	CENTERLINE
BF	BOTH FACES
NF	NEAR FACE
FF	FAR FACE
R	RIVET LENGTH

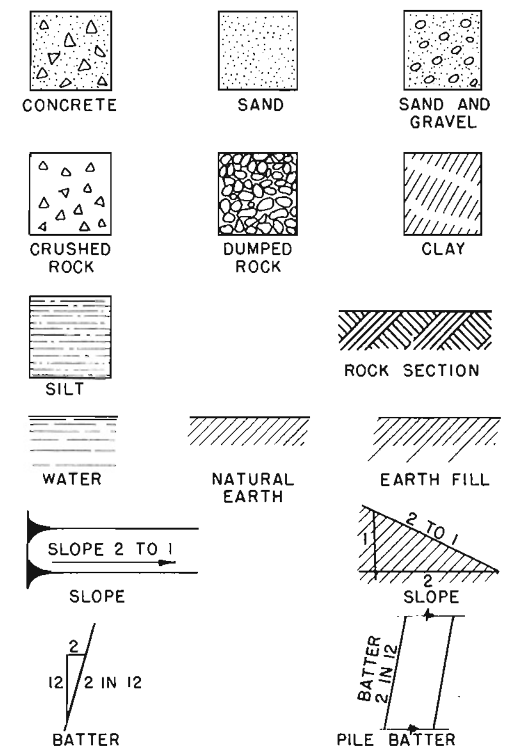

SECTION REFERENCE
ARROWS INDICATE DIRECTION OF SIGHT

BREAK LINES (DOES NOT AFFECT DIMENSION SHOWN)

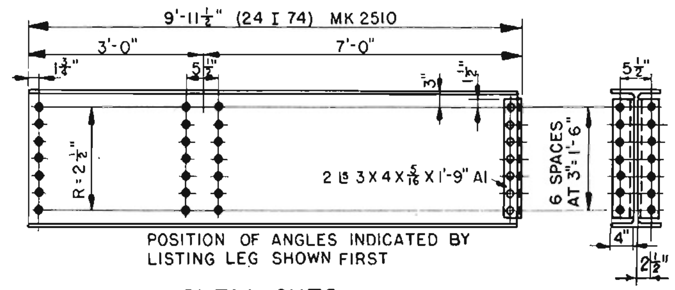
METHODS OF INDICATION OF STRUCTURAL SHAPES



STANDARD SYMBOLS

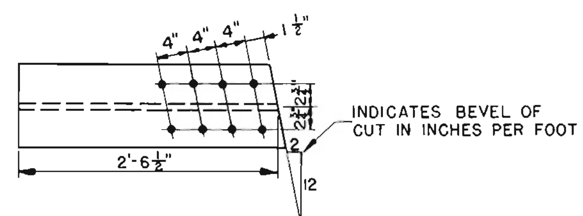


STEEL I BEAM DRAWING

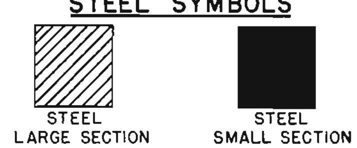


POSITION OF ANGLES INDICATED BY LISTING LEG SHOWN FIRST

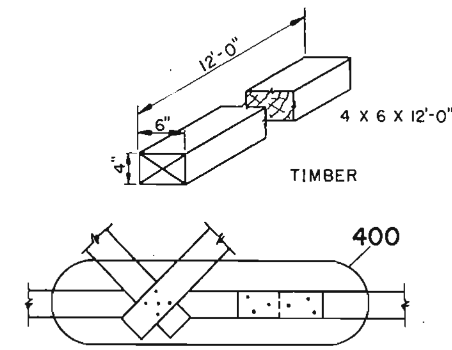
SKEW CUTS



STEEL SYMBOLS



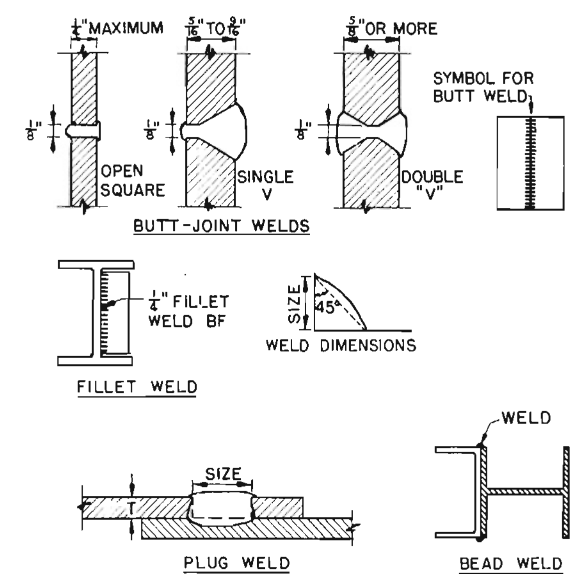
TIMBER DRAWINGS



TIMBER CONNECTION DETAIL
(DETAIL SHOWN BY NUMBER ON DETAIL SHEET)

WOOD SYMBOLS

TYPES OF WELDS



Ⓕ DENOTES FIELD WELD

SET NUMBER RR-1

TIMBER SPANS
(12 to 16 feet long)

SHEET	
157	General views and bill of materials
174	General views and bill of materials for refuge bay and walkway
154	General notes
155	Structural symbols

SET NUMBER RR-2

STEEL SPANS
(15 to 50 feet long)

SHEET	
158	General views of 15- and 45-foot spans; assembly diagrams for riveted construction
159	General views of 50-foot span
160	Bill of materials: structural steel for riveted construction
161	Bill of materials: structural steel for welded construction, lumber, and deck hardware
162	Riveted construction: fabrication of lateral braces
163	Riveted construction: fabrication of stringers 401, 402, 403, and 420, and of diaphragms
164	Riveted construction: fabrication of stringers 404, 405, 406, and 407
165	Riveted construction: fabrication of stringers 408, 409, 410, and 411
166	Riveted construction: fabrication of stringers 412, 413, 418, and 419
167	Riveted construction: fabrication of stringers 414, 415, 416, and 417
168	Welded construction: assembly diagrams and fabrication of lateral bruces
169	Welded construction: fabrication of stringers 401W, 402W, 403W, and 420W, and of diaphragms
170	Welded construction: fabrication of stringers 404W, 405W, 406W, and 407W
171	Welded construction: fabrication of stringers 408W, 409W, 410W, and 411W
172	Welded construction: fabrication of stringers 412W, 413W, 414W, and 415W
173	Welded construction: fabrication of stringers 416W, 417W, 418W, and 419W
174	General views and bill of materials for refuge bay and walkway
154	General notes
155	Structural symbols

SET NUMBER RR-3

TIMBER TOWERS FOR TIMBER SPANS
(15 to 76 feet high)

SHEET	
175	General views
176	Bill of materials
181	Details of bracing connections
182	Details of bracing connections
183	Details of bracing connections and of columns; column dimensions
154	General notes
155	Structural symbols

SET NUMBER RR-4

TIMBER TOWERS FOR STEEL SPANS
(15 to 76 feet high)

SHEET	
177	Details of connection of spans to towers
178	Details and bill of materials for conection of spans to towers
179	General views
180	Bill of materials
181	Details of bracing connections
182	Details of bracing connections
183	Details of bracing connections and of columns; column dimensions
154	General notes
155	Structural symbols

SET NUMBER RR-5

STEEL TOWERS FOR STEEL SPANS
(15 to 77 feet high)

SHEET	
184	General views of 69- to 77-foot towers
185	General views of 15- and 67-foot towers
186	Bill of materials common to all towers
187	Bill of materials which vary with tower height
188	Riveted construction: fabrication of cap beam, strut, and pin
189	Riveted construction: fabrication of columns
190	Riveted construction: fabrication of columns and struts
191	Fabrication of rod bracing
192	Details and bill of materials for shims under stringers of different depths; superstructure anchor bolts
226	Welded construction with rod bracing: cap beams and column splices welded in fabrication and erection
227	Welded construction with welded angle bracing: cap beams and column splices welded in fabrication and erection
154	General notes
155	Structural symbols

NOTE: When welded construction is used in accordance with sheets 226 or 227, bills of materials on sheets 186 and 187, and fabrication details on sheets 188, 189, and 190 must be adjusted in the field. When sheet 227 is used sheet 191 does not apply.

SET NUMBER RR-6

TIMBER ABUTMENTS FOR TIMBER SPANS

SHEET	
193	General views of pile abutments; bill of materials for pile and grillage abutments
194	General views of grillage abutments
154	General notes
155	Structural symbols

SET NUMBER RR-7

ABUTMENTS FOR STEEL SPANS

SHEET	
195	General views of timber pile abutments
196	Bill of materials for timber abutments; general views of timber grillage abutments
197	General views of steel pile abutments
198	Fabrication details and bill of materials for steel pile abutments
199	General views and bill of materials for concrete abutments
154	General notes
155	Structural symbols

SET NUMBER RR-8

TIMBER PILE BENTS FOR TIMBER SPANS
(1 to 28 feet high)

SHEET	
200	General views
201	Additional views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER RR-9

TIMBER PILE PIERS FOR STEEL SPANS
(1 to 11 feet high)

SHEET	
202	General views
203	Bill of materials
154	General notes
155	Structural symbols

SET NUMBER RR-10

STEEL PILE BENTS AND PIERS FOR STEEL SPANS
(1 to 20 feet high)

SHEET	
204	Riveted construction: general views of bents
205	Riveted construction: general views of piers
206	Riveted construction: fabrication of cap beams, corbels, and bracing connections
207	Riveted construction: bill of materials
208	Welded construction: bill of materials
209	Welded construction: general views of bents
210	Welded construction: general views of piers
211	Welded construction: fabrication of cap beams, corbels, and bracing connections
154	General notes
155	Structural symbols

SET NUMBER RR-11

TIMBER SILL AND PILE FOUNDATIONS FOR TIMBER TOWERS

SHEET	
212	General views and bill of materials
213	General views
154	General notes
155	Structural symbols

SET NUMBER RR-12

CONCRETE PEDESTALS FOR TIMBER TOWERS

SHEET	
214	General views and bill of materials
154	General notes
155	Structural symbols

SET NUMBER RR-13

CONCRETE PEDESTALS FOR STEEL TOWERS

SHEET	
215	General views and bill of materials for pedestals on timber piles
216	General views and bill of materials for pedestals on ground and on steel piles
184	General views of 69- to 77-foot towers
185	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER RR-14

STEEL FRAME ON STEEL PILE FOUNDATIONS FOR STEEL TOWERS

SHEET	
217	General views and bill of materials
184	General views of 69- to 77-foot towers
185	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

SET NUMBER RR-15

STEEL GRILLAGE FOUNDATIONS FOR STEEL TOWERS

SHEET	
218	Bolted construction: general views and bill of materials for grillages S101 and S102
219	Bolted construction: general views and bill of materials for grillage S103
220	Welded construction: general views and bill of materials for grillage S103 (S101 and S102 are similar)
221	Bolted construction: fabrication
222	Welded construction: fabrication
184	General views of 69- to 77-foot towers
185	General views of 15- to 67-foot towers
154	General notes
155	Structural symbols

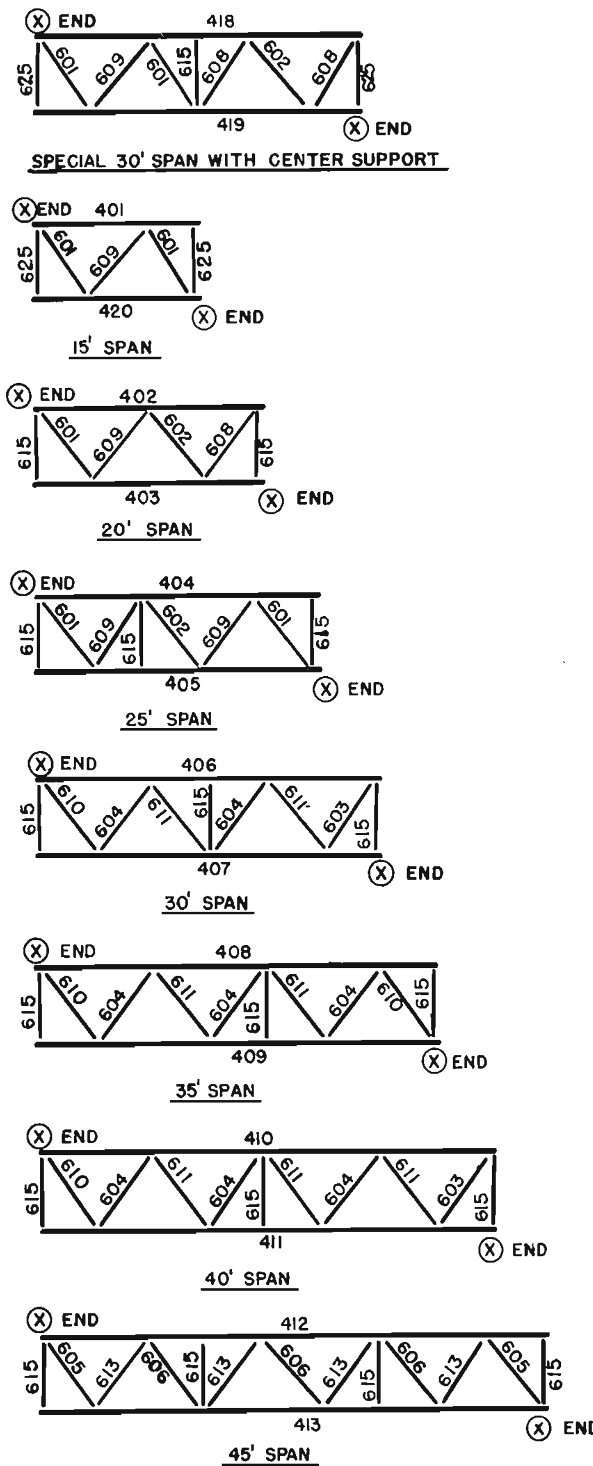
SET NUMBER RR-16

TIMBER GRILLAGE FOUNDATIONS FOR TIMBER TOWERS

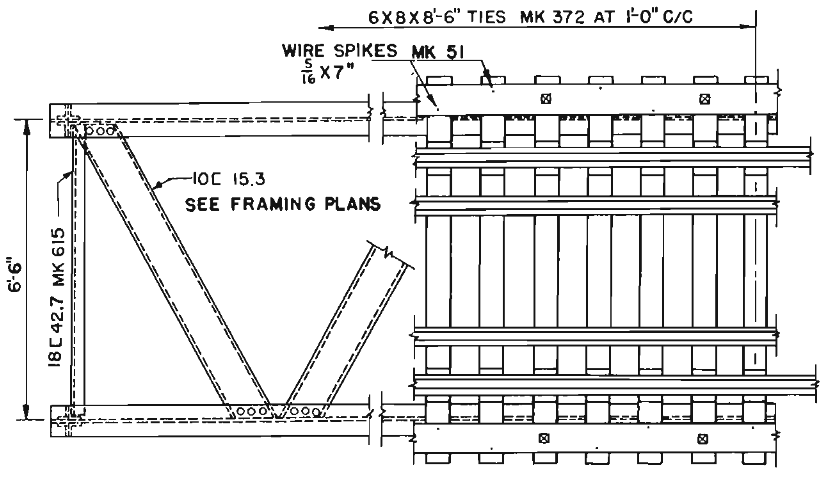
SHEET	
223	General views
224	Additional views and bill of materials
225	Additional views
154	General notes
155	Structural symbols

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	160 ; 161
SYMBOLS	155
FABRICATION DRAWINGS	160 TO 173
WALKWAYS AND REFUGE BAYS	174



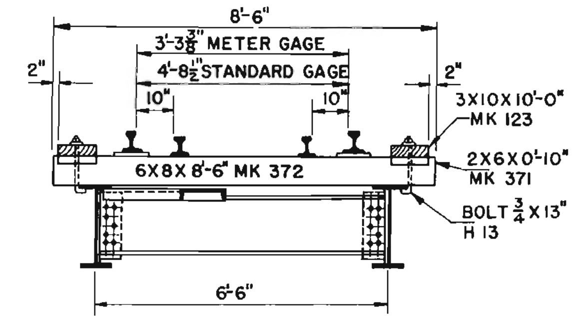
SPAN FRAMING PLANS



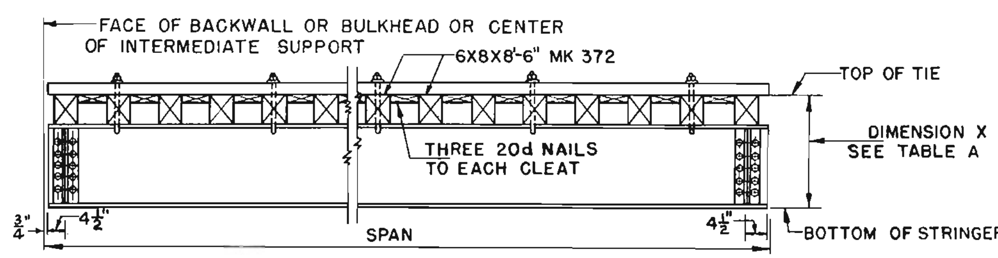
PLAN

TABLE A

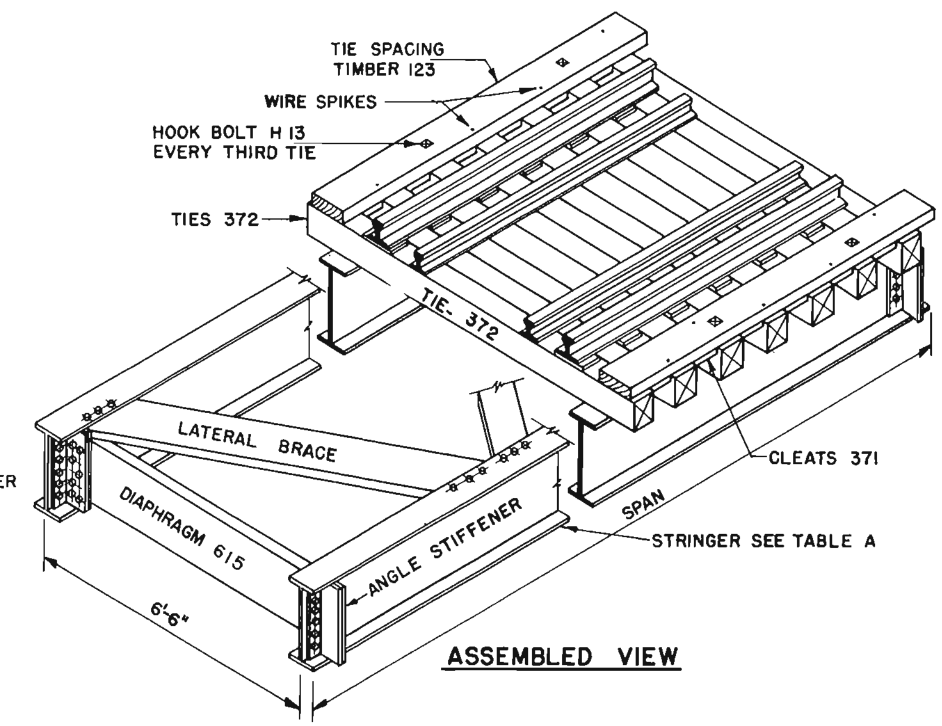
STEEL STRINGER				
SPAN	SIZE	MARK		DIMENSION X
15'-0"	21 I 63	401	420	2'-5"
20'-0"	27 I 91	402	403	2'-10 7/8"
25'-0"	30 I 108	404	405	3'-1 7/8"
30'-0"	33 I 132	406	407	3'-5 1/8"
SPECIAL 30'-0"	21 I 63	418	419	2'-5"
35'-0"	36 I 150	408	409	3'-7 7/8"
40'-0"	36 I 182	410	411	3'-8 3/8"
45'-0"	36 I 230	412	413	3'-7 5/8"



TYPICAL SECTION



ELEVATION



ASSEMBLED VIEW

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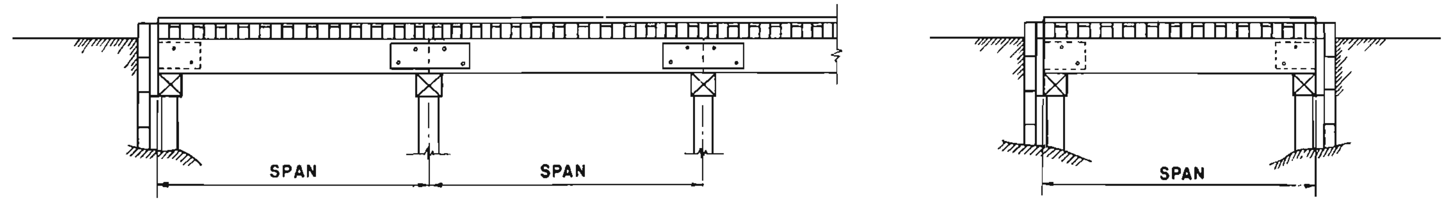
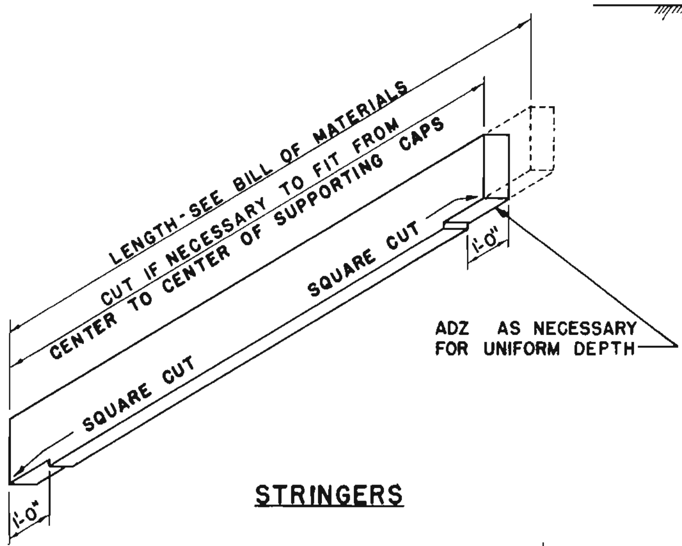
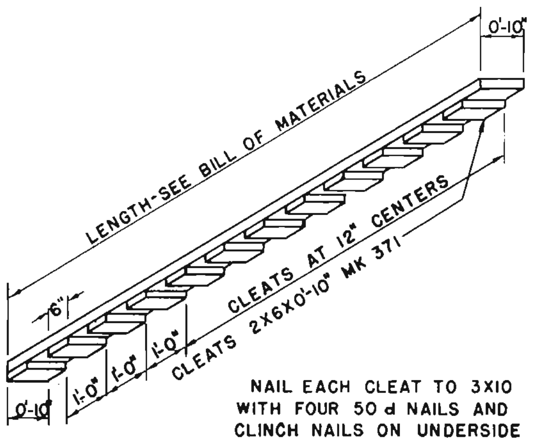


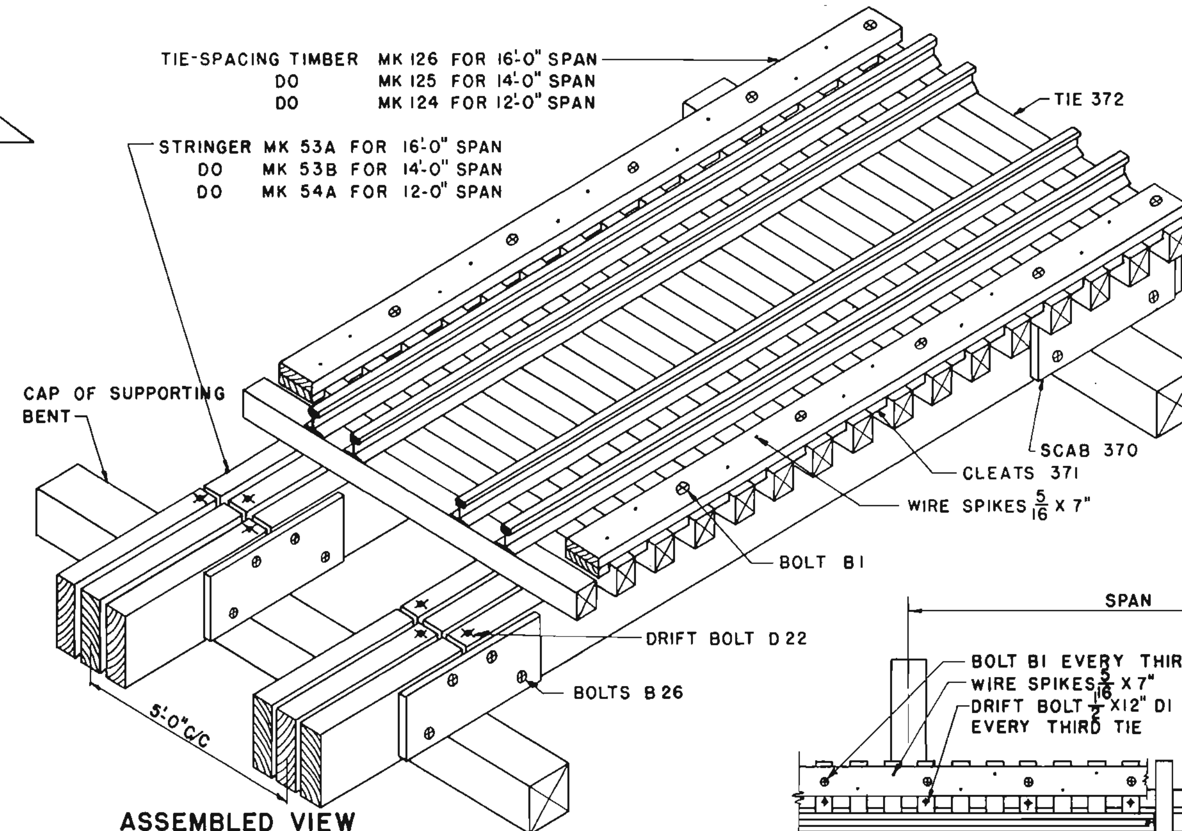
SPAN LENGTH DESIGNATION



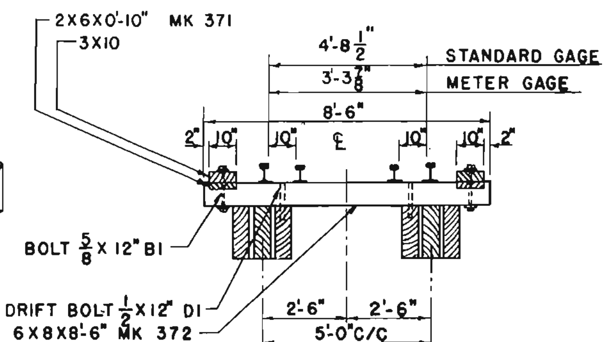
STRINGERS



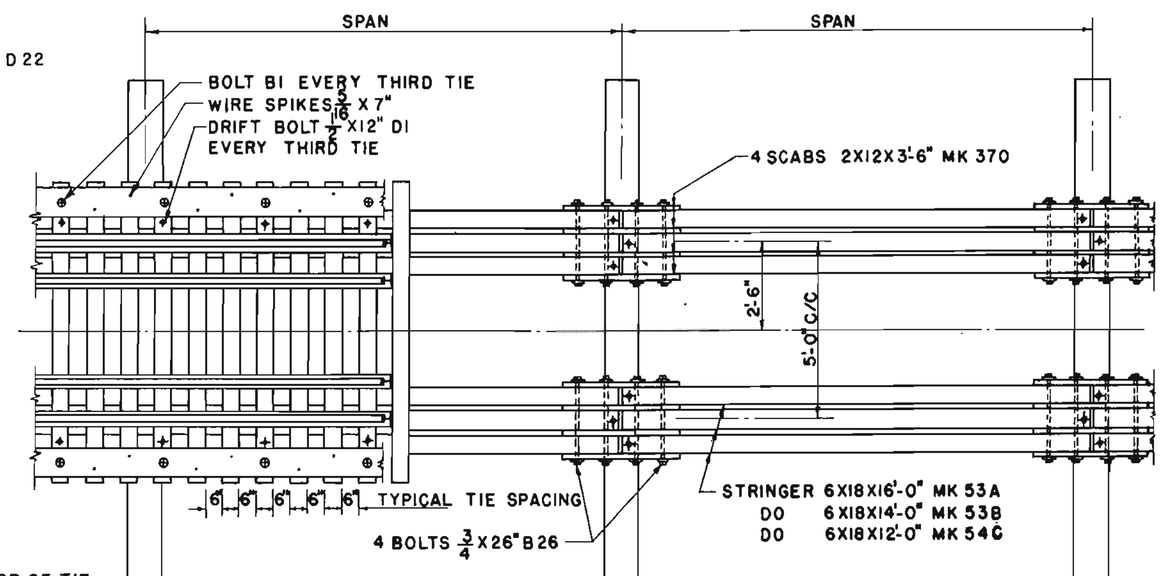
TIE-SPACING TIMBER



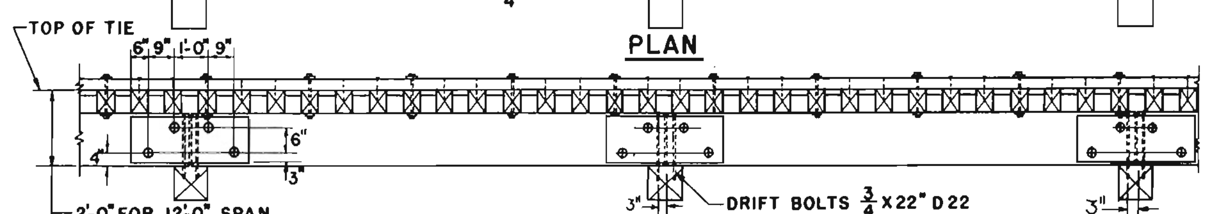
ASSEMBLED VIEW



SECTION



PLAN



ELEVATION

BILL OF MATERIALS FOR ONE SPAN

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	12' SPAN		14' SPAN		16' SPAN	
							QUANTITY	F.B.M.	QUANTITY	F.B.M.	QUANTITY	F.B.M.
	LUMBER, SOFTWOOD											
1	STRINGER		53A	6X18	16'0"	540					6	864
2	DO		53B	6X18	14'0"	472			6	756		
3	DO		53C	6X16	12'0"	360	6	576				
4	STRINGER SCAB	39-3228.12	370	2X12	3'6"	22	8	56	8	56	8	56
5	TIE, SAWN, UNTREATED	39-9352.68-085	372	6X8	8'5"	128	12	408	14	476	16	544
6	TIE-SPACING TIMBER	39-3330.1-16	126	3X10	16'0"	150					2	80
7	DO	39-3330.1-14	125	3X10	14'0"	131			2	70		
8	DO	39-3952.1-12	126	3X10	12'0"	112	2	60				
9	CLEAT	39-3880.04-99	371	2X6	0'10"	3	24	10	28	12	32	14
	STEEL HARDWARE, BLACK											
10	MACHINE BOLTS WITH SQUARE NUTS AND TWO WASHERS	43-2325.07-266	B25	3/4	25"		8		8		8	
11	DO	43-2325.06-12	B1	5/8	12"		8		8		8	
12	DRIFT BOLT	43-1636.07-22	D22	3/4	22"		6		6		6	
13	DO	42-1636.05-12	D1	1/2	12"		8		10		12	
14	WIRE SPIKE	42-8488.035-07		5/16	7"	.15	16		18		20	
15	WIRE NAIL	42-6028.3-5		50d		.08	95		112		128	

CONSTRUCTION, GENERAL VIEWS, STRINGER AND BRACING ASSEMBLY DIAGRAMS

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WALKWAYS AND REFUGE BAYS	174
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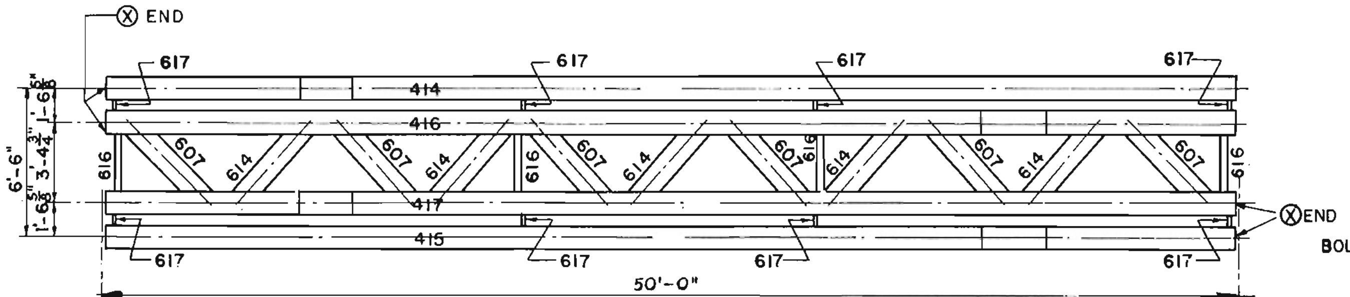
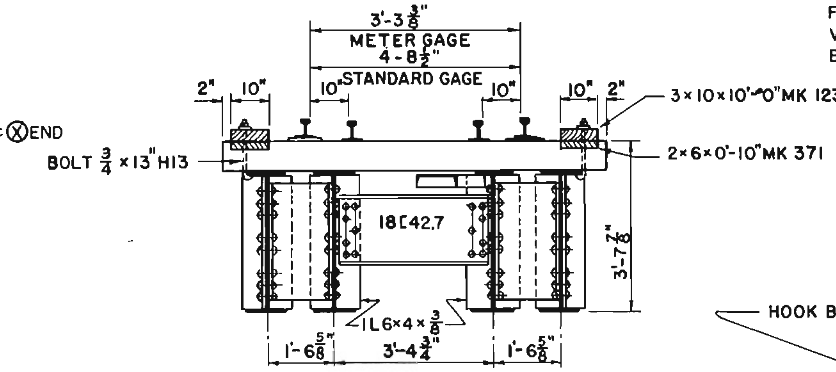
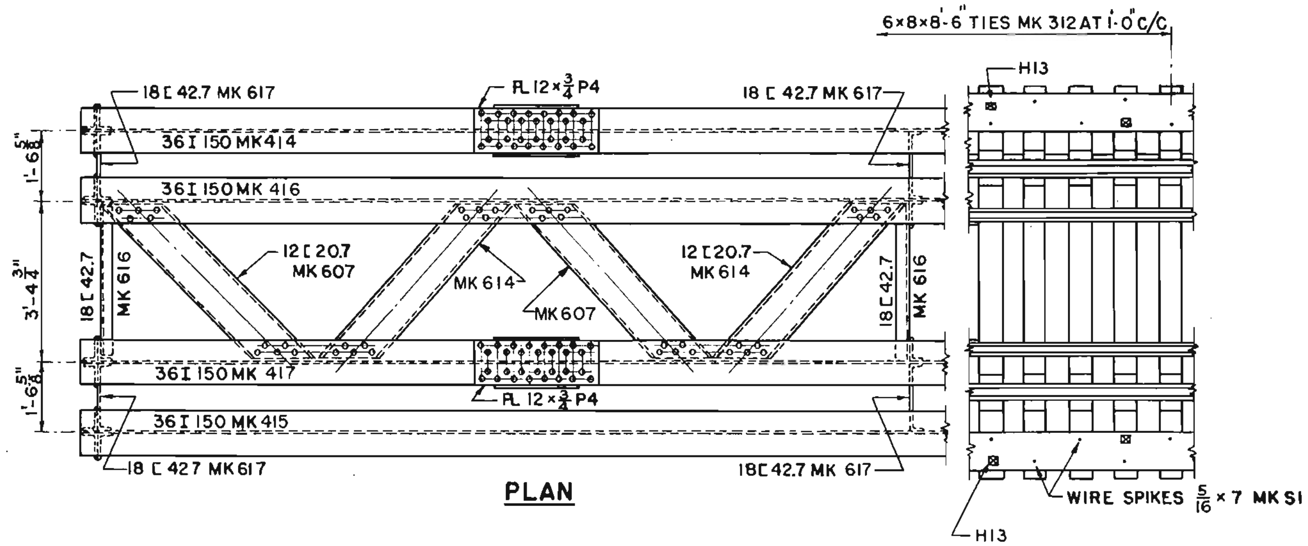


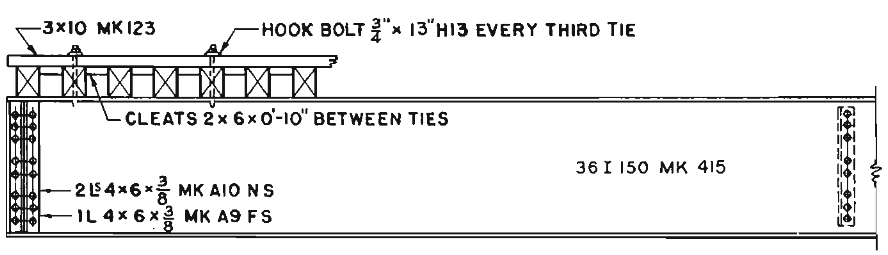
FRAMING PLAN



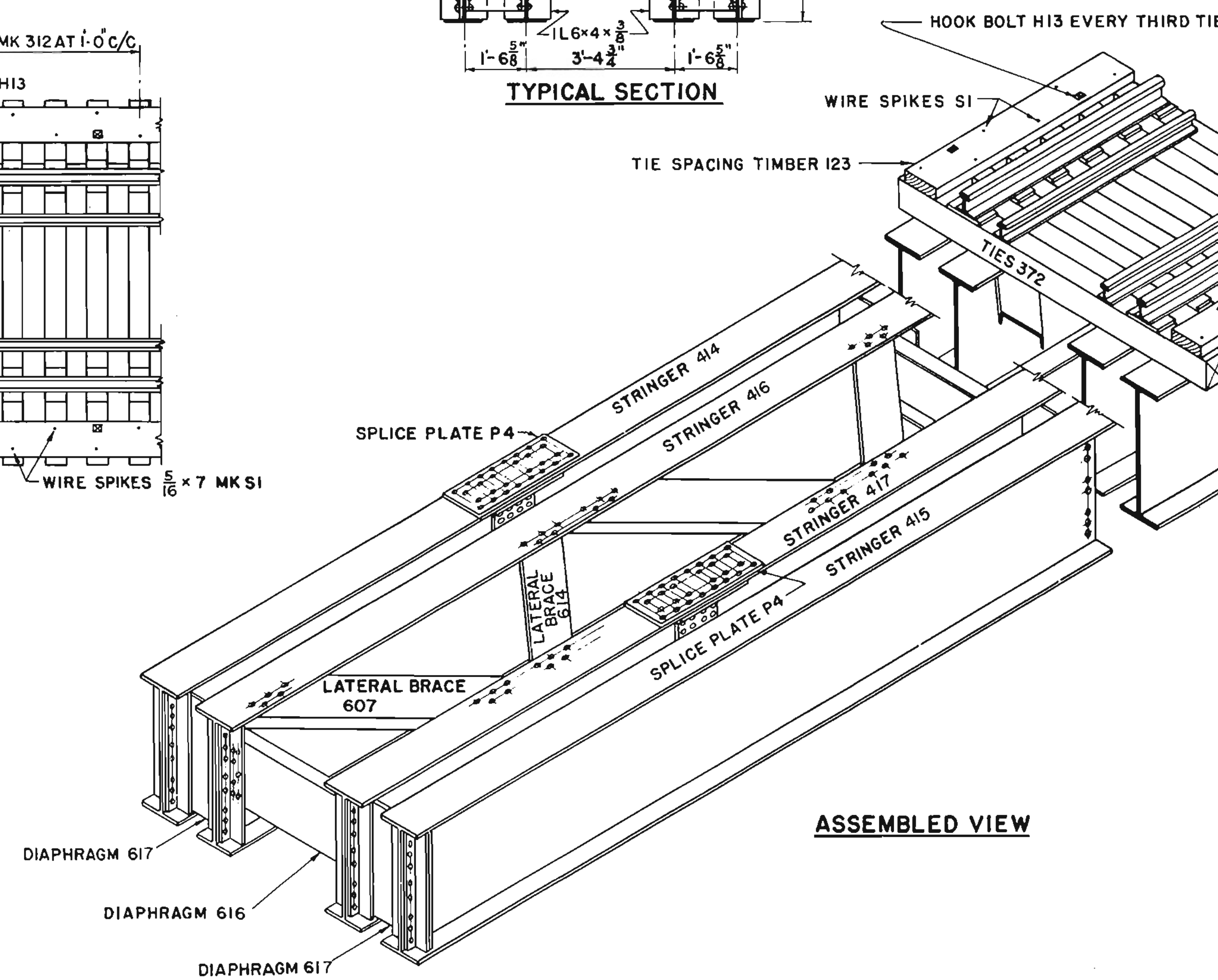
TYPICAL SECTION



PLAN



ELEVATION



ASSEMBLED VIEW

COMPANION SHEETS

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BILL OF MATERIALS FOR ONE RIVETED STEEL STRINGER SPAN

	SPAN LENGTH						15'		20'		25'		30'		30' SPECIAL		35'		40'		45'		50'		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	STRUCTURAL STEEL																								
1	STRINGER	48-2900.36-23	413	36 I 230	40'-0"	9186															1				1
2	DO		412																		1				2
3	DO	48-2900.36-23	423	36 I 230	4'-10"	1143															1				3
4	DO		422																		1				4
5	DO		411	36 I 182	39'-10 1/2"	7256													1						5
6	DO		410																1						6
7	DO	48-2900.36-15	417	36 I 150	40'-0"	5991																	1		7
8	DO		416																				1		8
9	DO		415																				1		9
10	DO		414																				1		10
11	DO	48-2900.36-15	427	36 I 150	9'-10"	1496																	1		11
12	DO		426																				1		12
13	DO		425																				1		13
14	DO		424																				1		14
15	DO	48-2900.36-15	409	36 I 150	34'-10 1/2"	5222											1								15
16	DO		408														1								16
17	DO	48-2900.33-132	407	33 I 132	29'-10 1/2"	3943							1												17
18	DO		406										1												18
19	DO	48-2900.3-108	405	30 I 108	24'-10 1/2"	2686					1														19
20	DO		404								1														20
21	DO	48-2900.27-091	403	27 I 91	19'-10 1/2"	1808			1																21
22	DO		402						1																22
23	DO	48-2900.21-063	418	21 I 63	29'-10 1/2"	1882									1										23
24	DO		419												1										24
25	DO	48-2900.21-063	420	21 I 63	14'-10 1/2"	937	1																		25
26	DO		401				1																		26
27	TOP LATERAL BRACE	48-3790.12-21	614	12 [20.7	5'-3 7/16"	110																	5		27
28	DO		607																				6		28
29	DO	48-3790.1-15	613	10 [15.3	7'-11 1/2"	122															4				29
30	DO		606																		3				30
31	DO	48-3790.1-15	604	10 [15.3	7'-11 1/4"	122							2				3		3						31
32	DO		611										2				2		3						32
33	DO	48-3790.1-15	609	10 [15.3	7'-11"	121	1		1		2				1										33
34	DO		602						1		1				1										34
35	DO	48-3790.1-15	605	10 [15.3	7'-8 7/16"	118															2				35
36	DO	48-3790.1-15	603	10 [15.3	7'-8"	117							1						1						36
37	DO		610										1				2		1						37
38	DO	48-3790.1-15	608	10 [15.3	7'-6 1/8"	115			1						2										38
39	DO		601				2		1		2				2										39
40	DIAPHRAGM	48-3790.18-43	635 625	18 [42.7	6'-4"	270	2		2		3		3		3		3		3		4				40
41	DO	48-3790.18-43	616	18 [42.7	3'-2 3/4"	138																	4		41
42	DO	48-3790.18-43	617	18 [42.7	2'-6"	107																	8		42
43	STIFFENER	48-2240.64-04	A16	L 6X4X3/8	2'-10"	35																	8		43
44	DO		A15																				16		44
45	DO		A12														8		8						45
46	DO		A11														8		8						46
47	DO	48-2240.64-04	A14	L 6X4X3/8	2'-9 3/8"	34															8				47
48	DO		A13																		8				48
49	DO	48-2240.64-04	A9	L 6X4X3/8	2'-7 3/8"	32							8												49
50	DO		A8										8												50
51	DO	48-2240.64-04	A10	L 6X4X3/8	2'-6"	31							2				2		2		4		4		51
52	DO	48-2240.64-04	A6	L 6X4X3/8	2'-4 1/4"	29					8														52
53	DO		A5								8														53
54	DO	48-2240.64-04	A7	L 6X4X3/8	2'-3"	28					2														54
55	DO	48-2240.64-04	A4	L 6X4X3/8	2'-1 1/2"	26			8																55
56	DO		A3						8																56
57	DO	48-2240.64-04	A2	L 6X4X3/8	1'-7 3/4"	20	8								12										57
58	DO		A1				8								12										58
59	PLATE	47-7844.05	P1	17 X 1/2	2'-1"	60															4				59
60	DO	47-7844.05	P4	12 X 1/2	2'-9"	56																	8		60
61	DO	47-7344.05	P2	6 X 1/2	1'-7"	16															8				61
62	DO	47-7844.05	P5	5 X 1/2	1'-11"	16																	16		62
63	DO	47-7844.04	P3	13 X 3/8	2'-6"	42															4		8		63
64	RIVETS	43-6353.08-23		7/8	2 1/4"	0.57					14		14				14		14		28		28		64
65	DO	43-6353.08-25		7/8	2 1/2"	0.62	18		24		46		16		36		16								65
66	DO	43-6353.08		7/8	2 3/4"	0.66	76		92		28		76		114		84		44		60		170		66
67	DO	43-6353.08-3		7/8	3"	0.70					64		64				64		64				352		67
68	DO	43-6353.08		7/8	3 1/4"	0.74													64		248				68
69	DO	43-6353.08		7/8	3 3/4"	0.83																	160		69
70	DO	43-6353.08		7/8	4"	0.87															96				70

BILL OF MATERIALS FOR ONE SPAN WITH WELDED STEEL DETAILS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	15' QUANTITY	15' FBM	20' QUANTITY	20' FBM	25' QUANTITY	25' FBM	30' QUANTITY	30' FBM	30' SPECIAL QUANTITY	30' SPECIAL FBM	35' QUANTITY	35' FBM	40' QUANTITY	40' FBM	45' QUANTITY	45' FBM	50' QUANTITY	50' FBM	LINE
	LUMBER, SOFT WOOD																								
1	TIE	39-9352.68-085	372	6 X 8	8'-6"	128	15	270	20	360	25	450	30	540	30	540	35	630	40	720	45	810	50	900	1
2	TIE SPACER	39-3952.1	123	3 X 10	10'-0"	94	3	75	4	100	5	125	6	150	6	150	7	175	8	200	9	225	10	250	2
3	CLEAT	39-3880.06	371	2 X 6	0'-10"	3	28	23	38	32	48	40	58	48	58	48	68	57	78	65	88	73	98	82	3
	DECK, HARDWARE																								
4	HOOK BOLT WITH WASHER AND NUT		H13	3/4	1'-1"	2.1	10		14		16		20		20		24		26		30		34		4
5	WIRE SPIKE	42-8488.035-07	51	5/16	0'-7"	0.15	20		26		34		40		40		46		54		60		66		5
6	NAILS	42-6028.3-2		20d	0'-4"	0.032	84		114		144		174		174		204		234		264		294		6
	STEEL, STRUCTURAL																								
7	STRINGER	48-2900.36-23	412W	36 I 230	40'-0"	9200															1				7
8	DO		412W		4'-10 1/2"	1121															1				8
9	DO	48-2900.36-23	413W	36 I 230	40'-0"	9200															1				9
10	DO		413W		4'-10 1/2"	1121															1				10
11	DO		410W	36 I 182	39'-10 1/2"	7257													1						11
12	DO		411W																1						12
13	DO	48-2900.36-15	414W	36 I 150	40'-0"	6000																	1		13
14	DO		414W		9'-10 1/2"	1481																	1		14
15	DO		415W		40'-0"	6000																	1		15
16	DO		415W		9'-10 1/2"	1481																	1		16
17	DO		416W		40'-0"	6000																	1		17
18	DO		416W		9'-10 1/2"	1481																	1		18
19	DO		417W		40'-0"	6000																	1		19
20	DO		417W		9'-10 1/2"	1481																	1		20
21	DO		409W		34'-10 1/2"	5222											1								21
22	DO		408W														1								22
23	DO	48-2900.33-132	407W	33 I 132	29'-10 1/2"	3943							1												23
24	DO		406W										1												24
25	DO	48-2900.3-108	405W	30 I 108	24'-10 1/2"	2686					1														25
26	DO		404W								1														26
27	DO	48-2900.27-091	403W	27 I 91	19'-10 1/2"	1808			1																27
28	DO		402W						1																28
29	DO	48-2900.21-063	418W	21 I 63	29'-10 1/2"	1882									1										29
30	DO		419W												1										30
31	DO		420W		14'-10 1/2"	937	1																		31
32	DO		401W				1																		32
33	TOP LATERAL BRACES	48-3790.12-21	440W	12 [20.7	4'-9"	98																	5		33
34	DO		435W																				6		34
35	DO	48-3790.1-15	437W	10 [15.3	7'-7 1/2"	117	1		1		2		3		1		3		4						35
36	DO		432W						1		1		2		1		2		3						36
37	DO	48-3790.1-15	436W		7'-1 5/8"	109			1						2										37
38	DO		431W				2		1		2		1		2		2		1						38
39	DO	48-3790.1-15	439W		7'-0 1/8"	107															4				39
40	DO		434W																		3				40
41	DO		433W																		2				41
42	DIAPHRAGM	48-3790.18-43	421W 422W	18 [42.7	6'-0 1/2"	258	2		2		3		3		3		3		3		4				42
43	DO		422W		2'-11 1/4"	126																	4		43
44	DO	47-7844.05	423W	PL 13 1/8 X 1/2	2'-8"	60																	8		44
45	TOP LATERAL BRACE PLATES	47-7844.04	P21W	10 X 3/8	1'-5"	18																	22		45
46	DO	47-7844.04	P1W	9 X 3/8	0'-9 3/4"	9	6		8		10		12		12		14		16		18				46
47	STIFFENER PLATES	47-7844.06	P14W	5 1/2 X 5/8	2'-10"	33											4		4				4		47
48	DO		P13W														4		4				12		48
49	DO	47-7844.06	P17W	5 1/2 X 5/8	2'-9 3/8"	33															4				49
50	DO		P16W																		4				50
51	DO	47-7844.06	P11W	5 1/2 X 5/8	2'-7 1/2"	31							4												51
52	DO		P10W										4												52
53	DO	47-7844.06	P8W	5 1/2 X 5/8	2'-4 3/8"	28					4														53
54	DO		P7W								4														54
55	DO	47-7844.06	P6W	5 1/2 X 5/8	2'-1 1/2"	25			4																55
56	DO		P5W						4																56
57	DO	47-7844.06	P4W	5 1/2 X 5/8	1'-7 3/4"	19	4																		57
58	DO		P3W				4																		58
59	DO	47-7844.05	P15W	5 1/2 X 1/2	2'-8"	25											2		2				12		59
60	DO	47-7844.05	P18W	5 1/2 X 1/2	2'-7"	24															4				60
61	DO	47-7844.05	P12W	5 1/2 X 1/2	2'-6"	23							2												61
62	DO	47-7844.05	P9W	5 1/2 X 1/2	2'-2"	20					2														62
63	DO	47-7844.04	P28W	21 X 3/8	1'-9"	47															4				63
64	FLANGE SPLICE PLATE	47-7844.07	P25W	10 X 3/4	3'-0"	77																	4		64
65	DO	47-7844.05	P24W	10 X 1/2	2'-6"	43																	4		65
66	DO	47-7844.07	P27W	12 X 3/4	3'-6"	107															2				66
67	DO	47-7844.04	P26W	12 X 3/8	2'-0"	31															2				67
68	WEB SPLICE PLATE	47-7844.04	P23W	18 X 3/8	1'-9"	40																	8		68
69	WELDING ELECTRODE	46-3772.2-7		3/16			13 LB		16 LB		20 LB		23 LB		25 LB		27 LB		29 LB		58 LB		84 LB		69

COMPANION SHEETS

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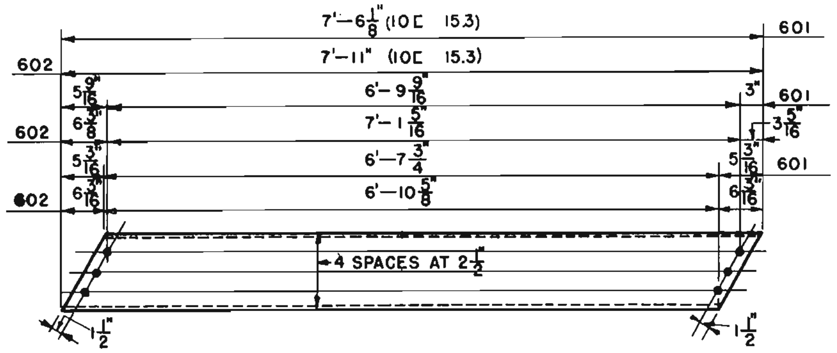
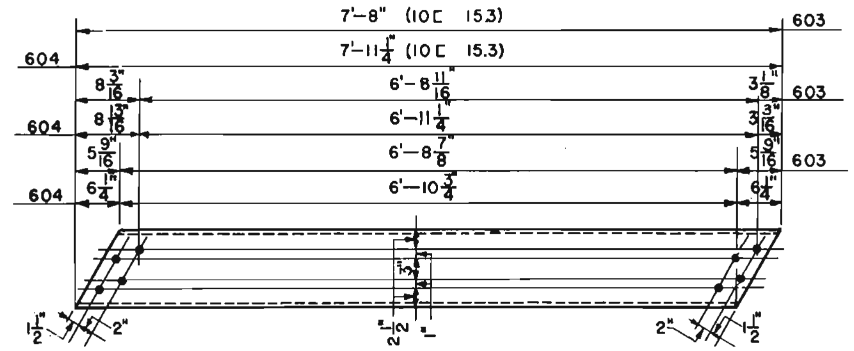
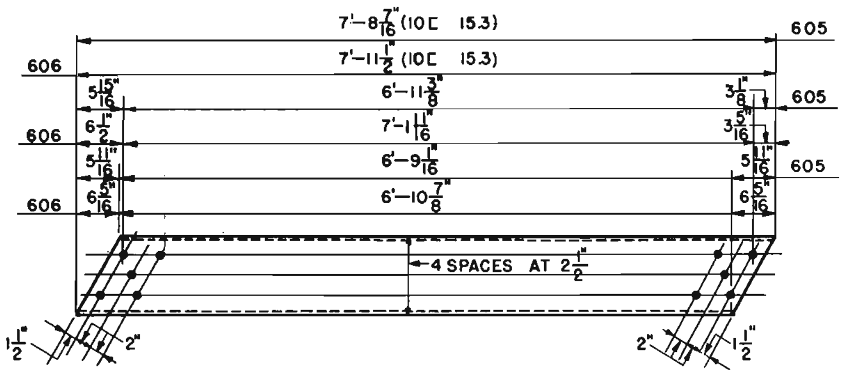


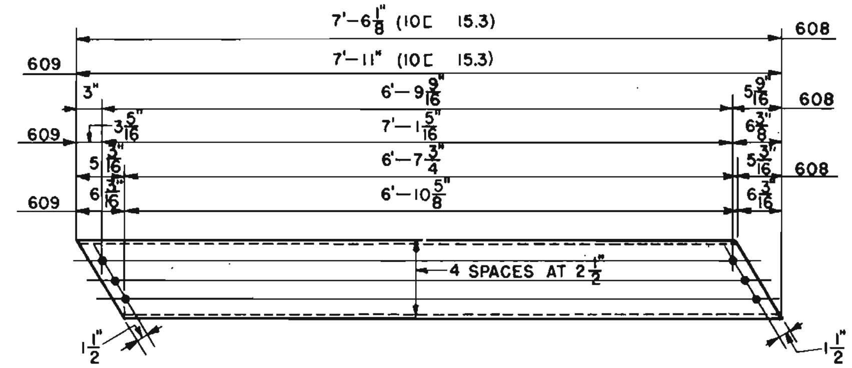
TOP LATERAL BRACE MK 601
TOP LATERAL BRACE MK 602



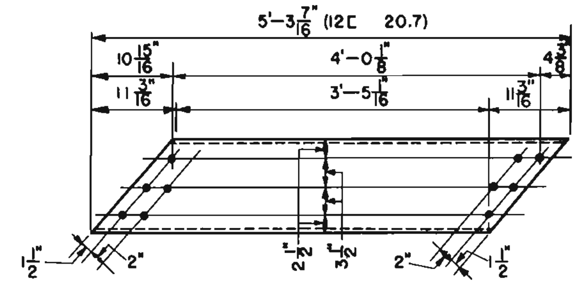
TOP LATERAL BRACE MK 603
TOP LATERAL BRACE MK 604



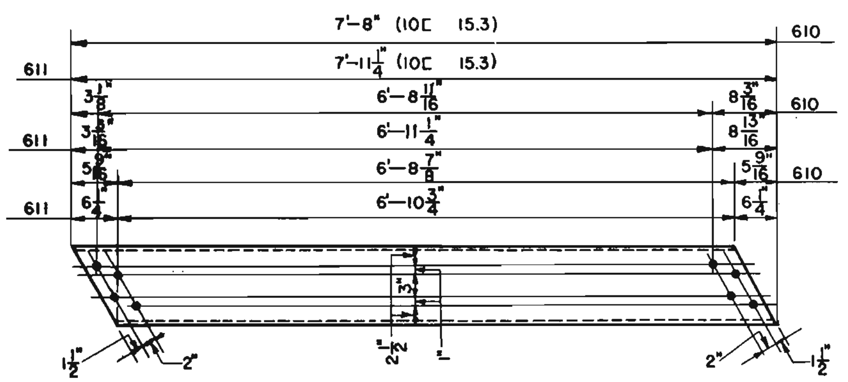
TOP LATERAL BRACE MK 605
TOP LATERAL BRACE MK 606



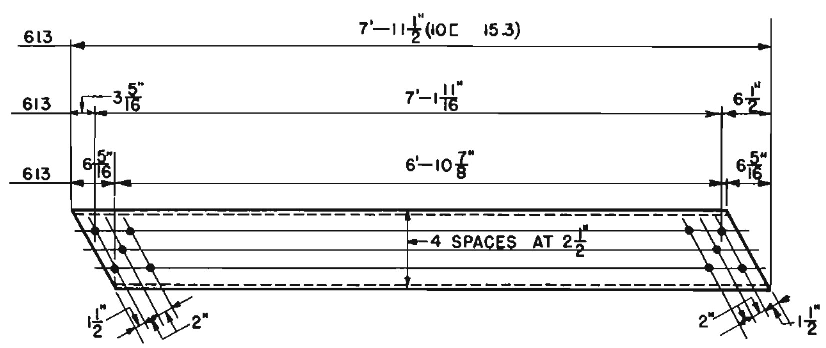
TOP LATERAL BRACE MK 608
TOP LATERAL BRACE MK 609



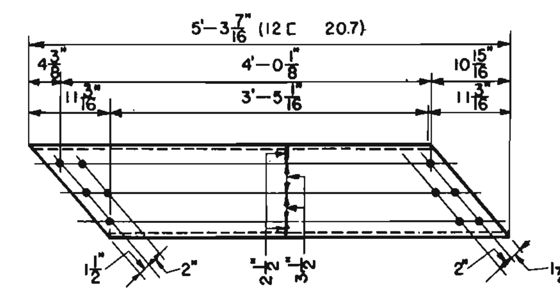
TOP LATERAL BRACE MK 607



TOP LATERAL BRACE MK 610
TOP LATERAL BRACE MK 611



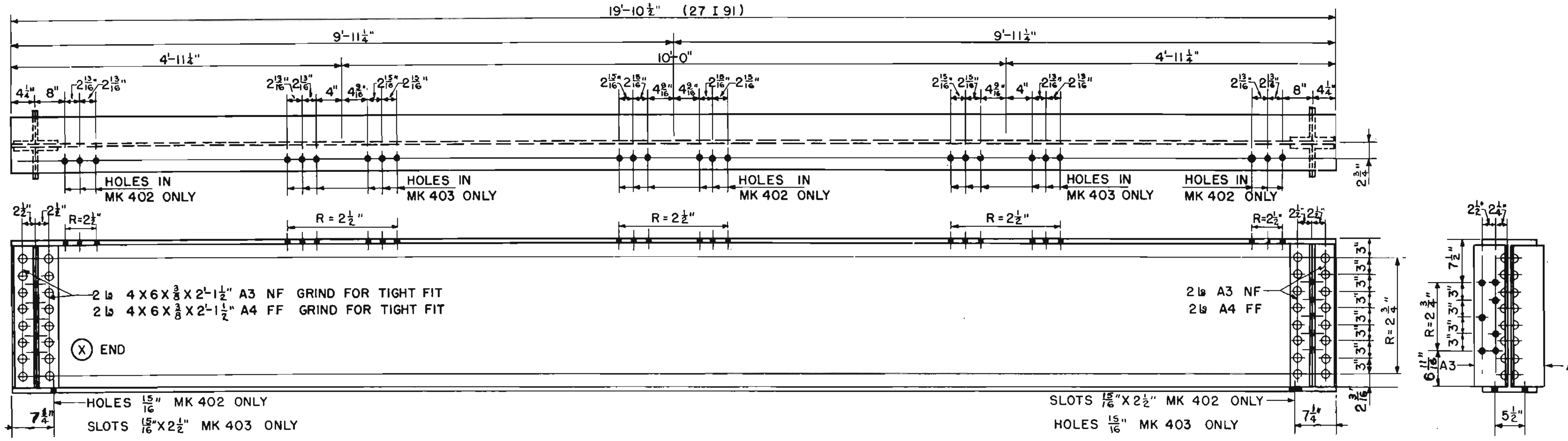
TOP LATERAL BRACE MK 613



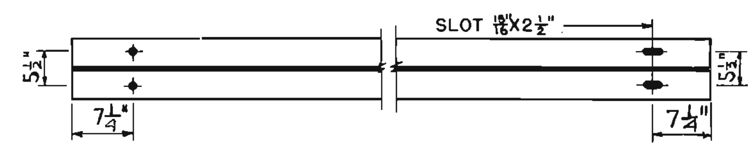
TOP LATERAL BRACE MK 614

COMPANION SHEETS

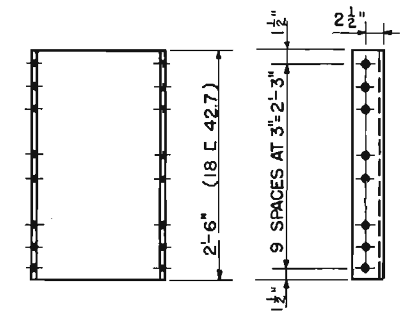
	SHEET
GENERAL NOTES	154
ASSEMBLY DRAWING	158
BILL OF MATERIALS	160
SYMBOLS	175



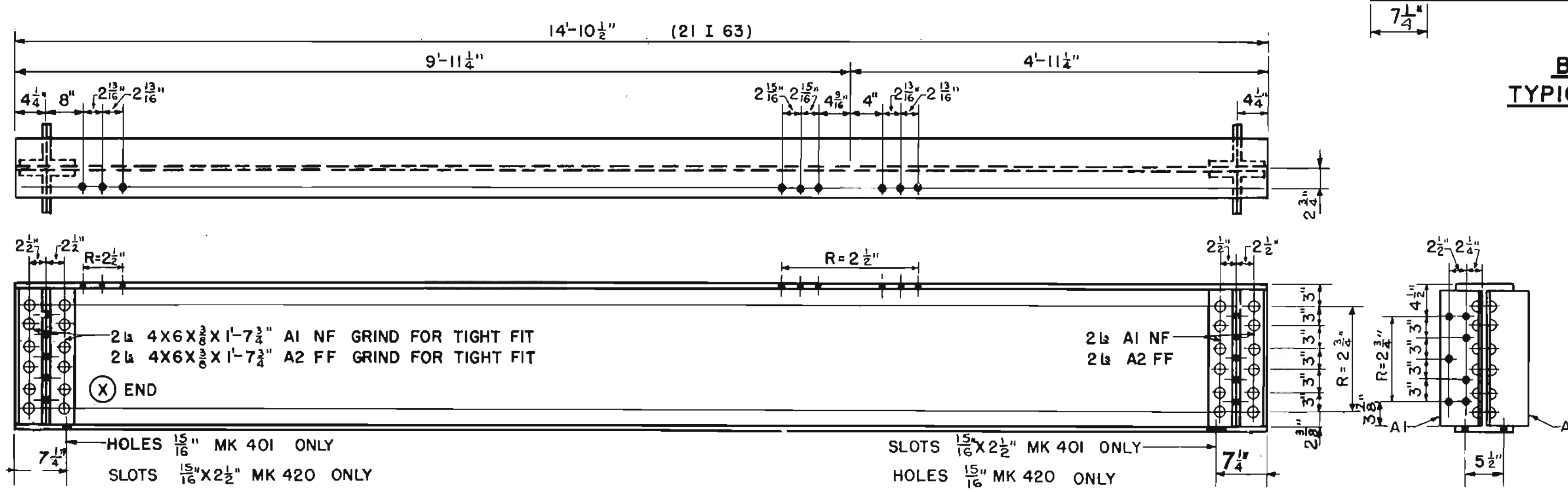
STRINGER MK 402
STRINGER MK 403



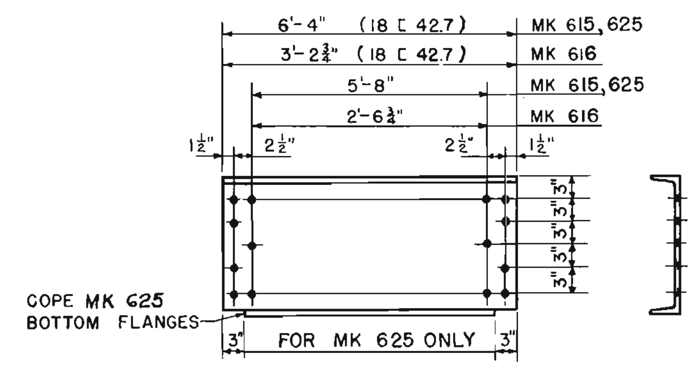
BOTTOM FLANGE
TYPICAL FOR ALL BEAMS



DIAPHRAGM MK 617



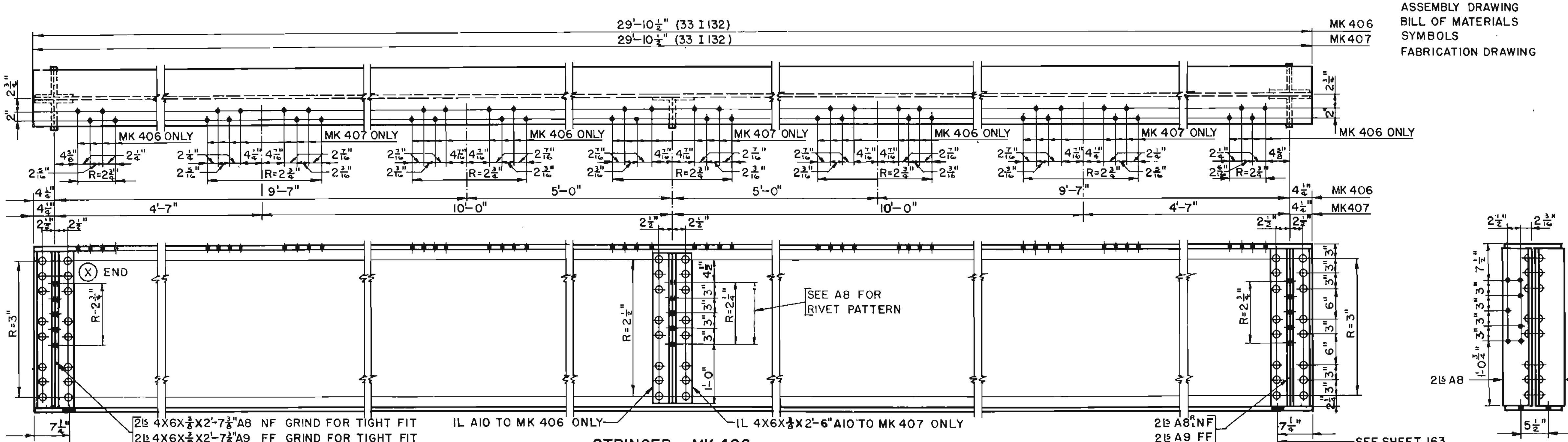
STRINGER MK 401
STRINGER MK 420



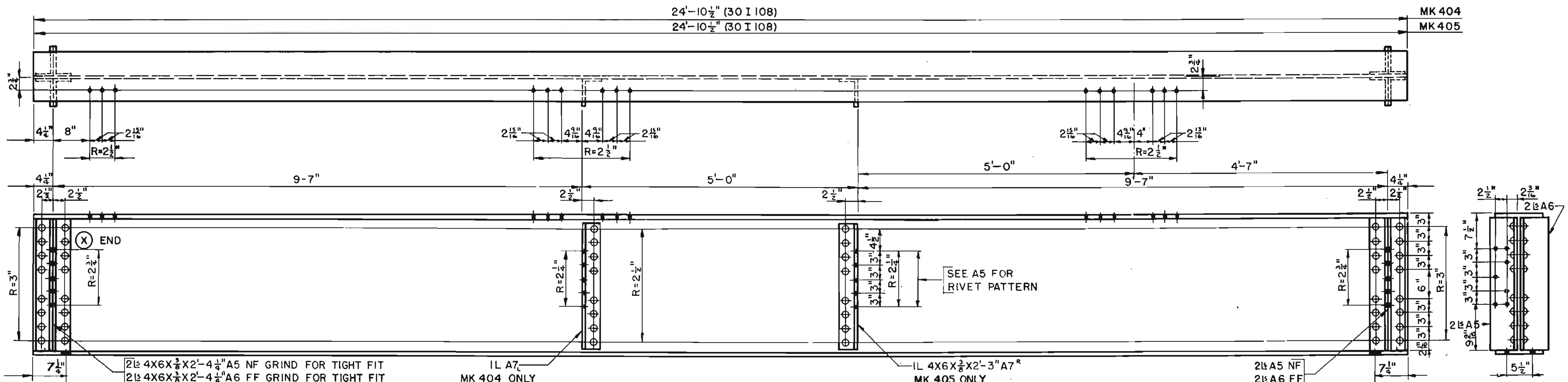
DIAPHRAGM MK 615
DIAPHRAGM MK 616
DIAPHRAGM MK 625

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
ASSEMBLY DRAWING	158
BILL OF MATERIALS	160
SYMBOLS	155
FABRICATION DRAWING	163



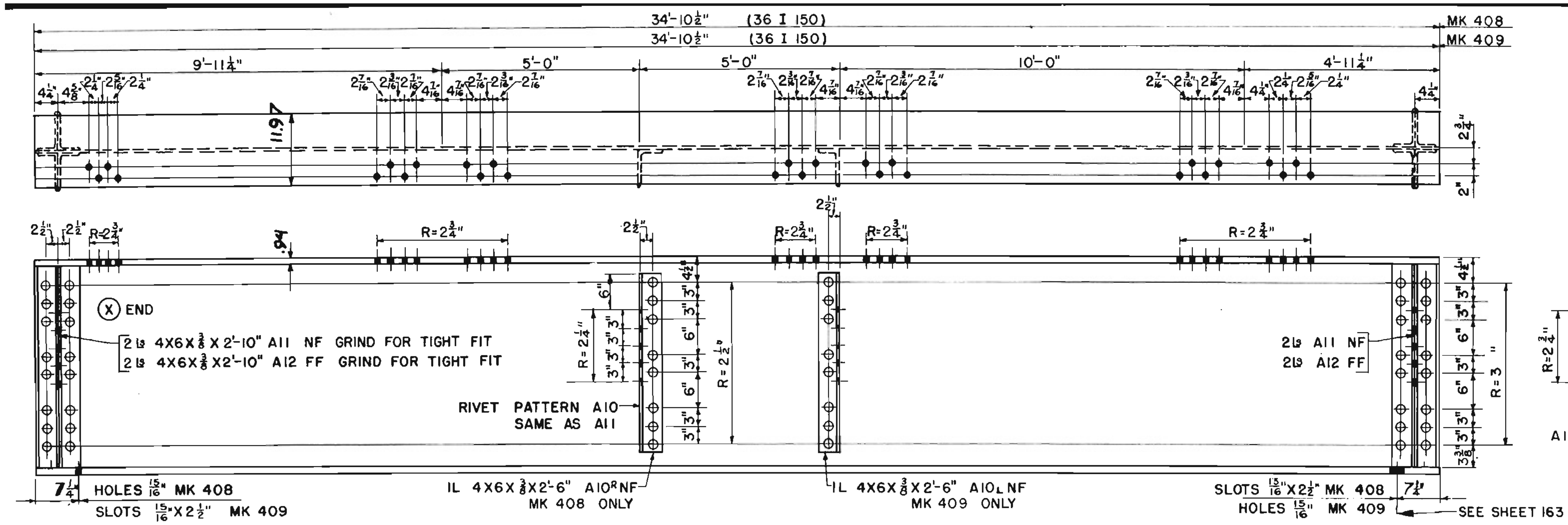
STRINGER MK 406
STRINGER MK 407



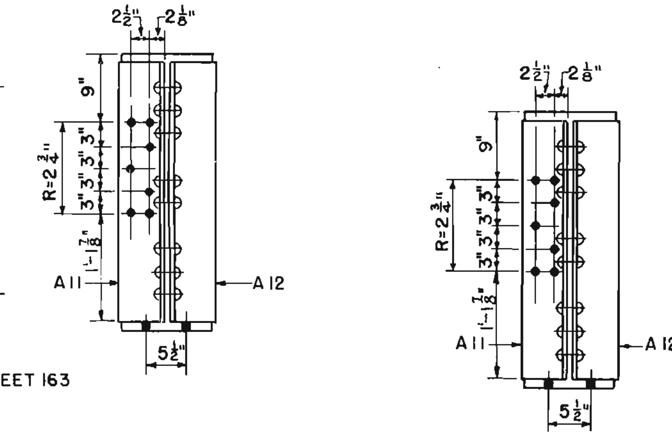
STRINGER MK 404
STRINGER MK 405

COMPANION SHEETS

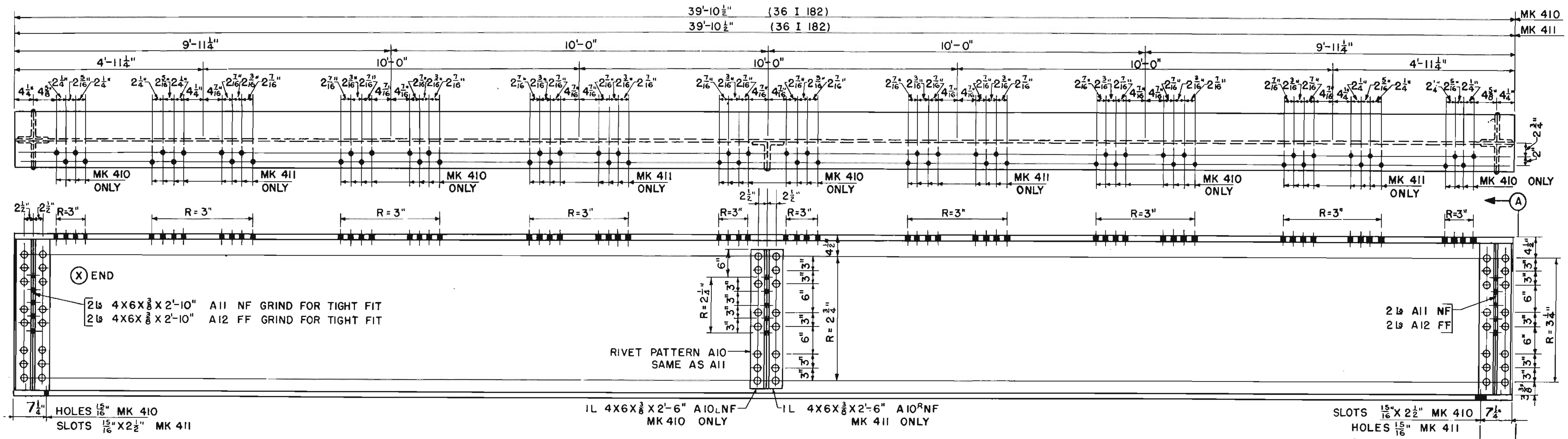
	SHEET
GENERAL NOTES	154
ASSEMBLY DRAWING	158
BILL OF MATERIALS	160
SYMBOLS	155
FABRICATION DRAWING	163



STRINGER MK 408
STRINGER MK 409



VIEW A-A
MK 410 AND MK 411

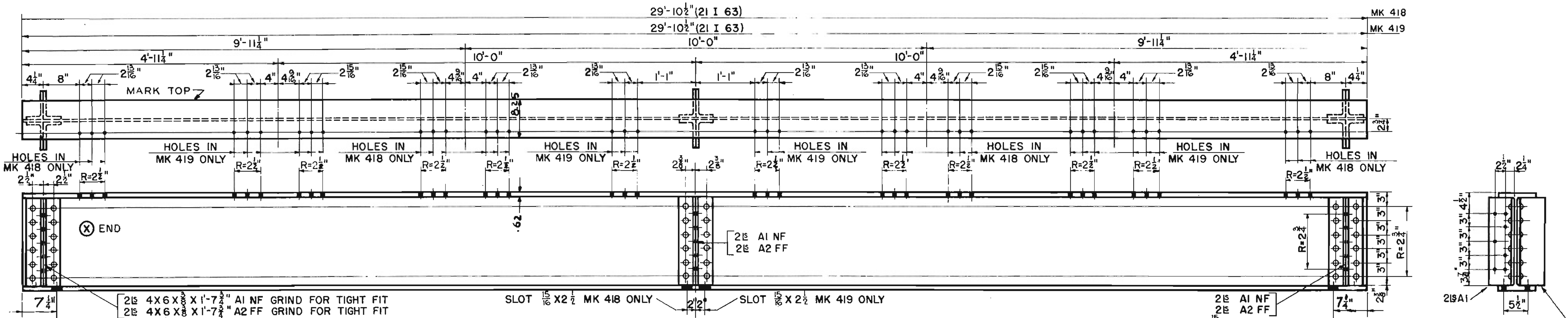


STRINGER MK 410
STRINGER MK 411

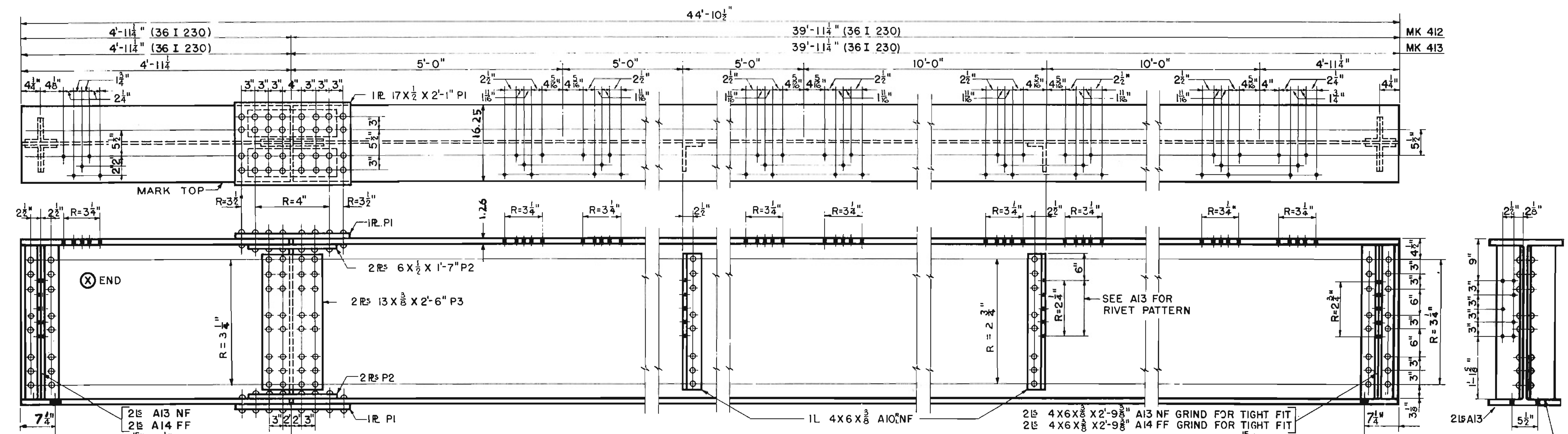
RIVETED CONSTRUCTION, FABRICATION OF STRINGERS 412, 413, 418, AND 419

COMPANION SHEETS

	SHEET
STEEL SPANS, 15- TO 45-FOOT	158
BILL OF MATERIALS	160
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	163



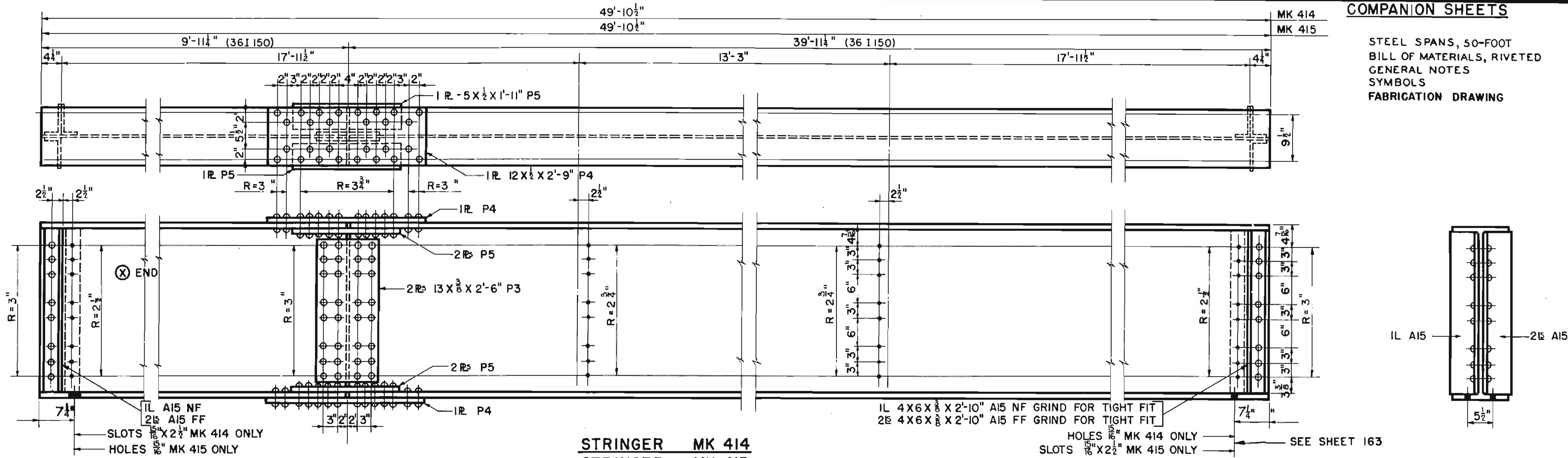
SPECIAL STRINGER MK 418
SPECIAL STRINGER MK 419



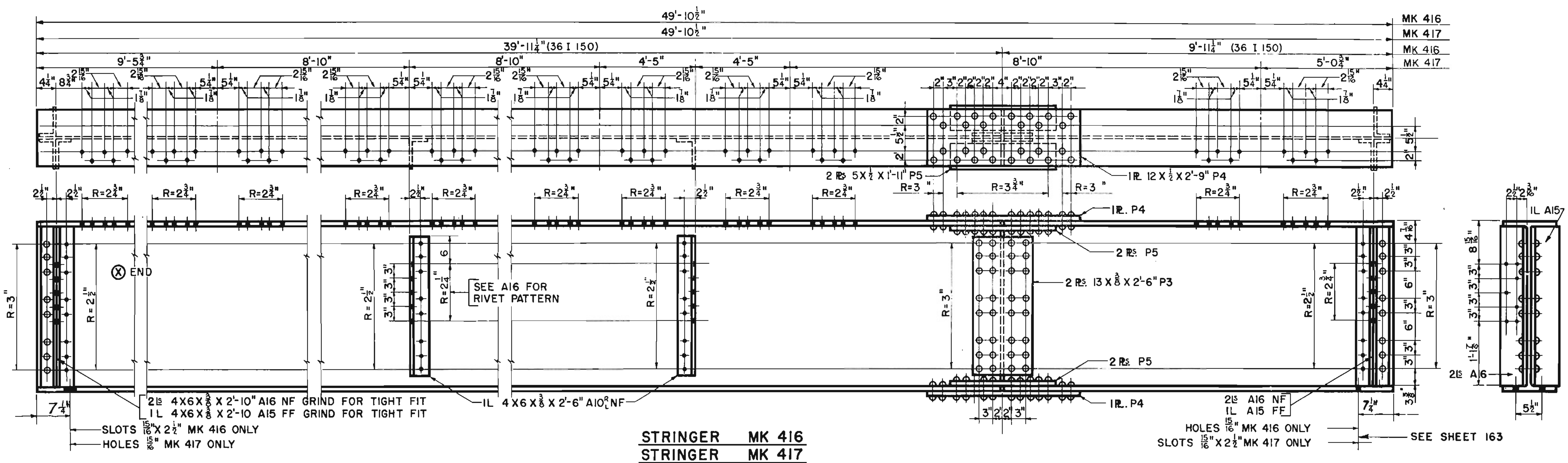
STRINGER MK 412
STRINGER MK 413

COMPANION SHEETS

	SHEET
STEEL SPANS, 50-FOOT	159
BILL OF MATERIALS, RIVETED	160
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	163



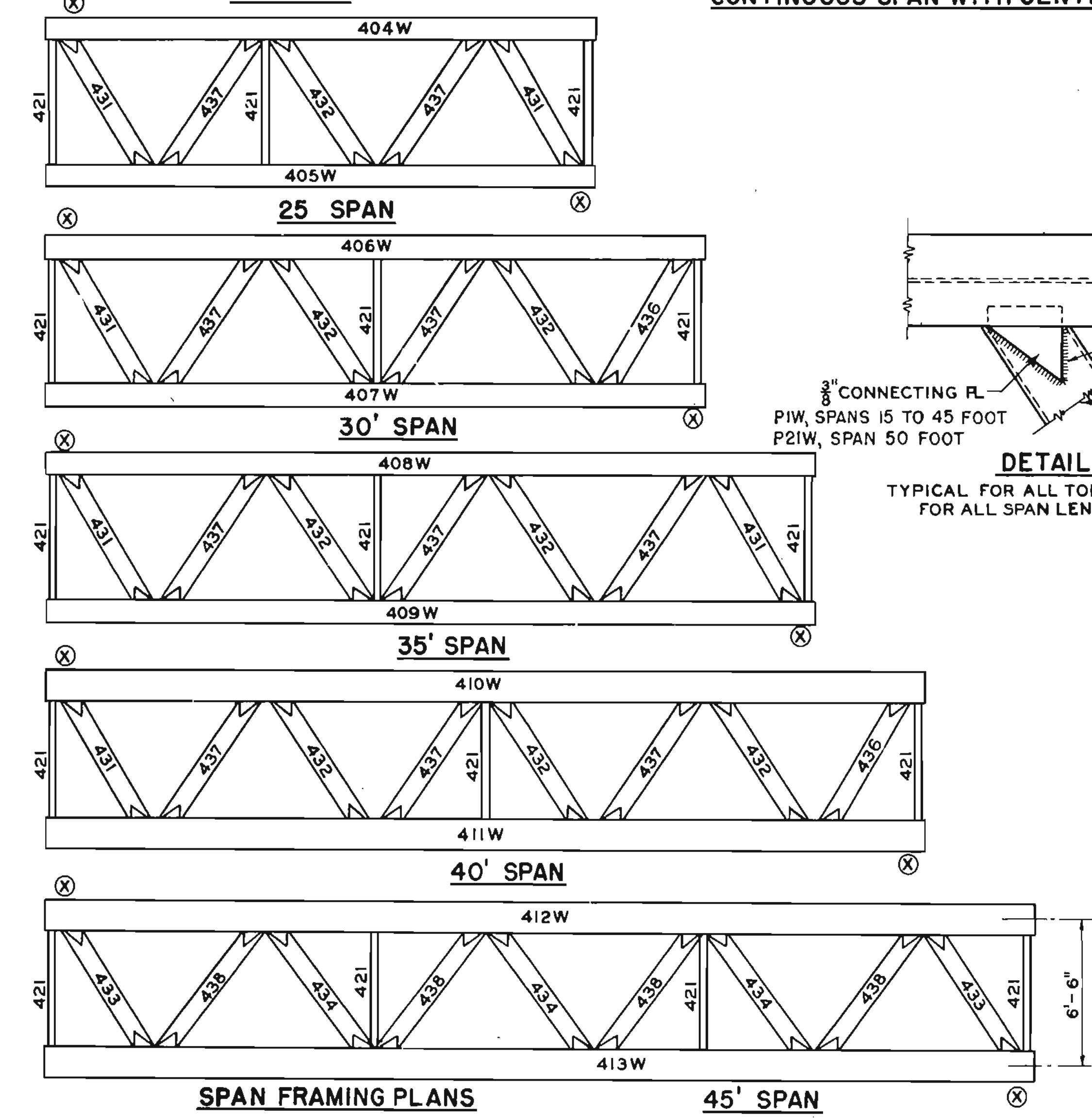
STRINGER MK 414
STRINGER MK 415

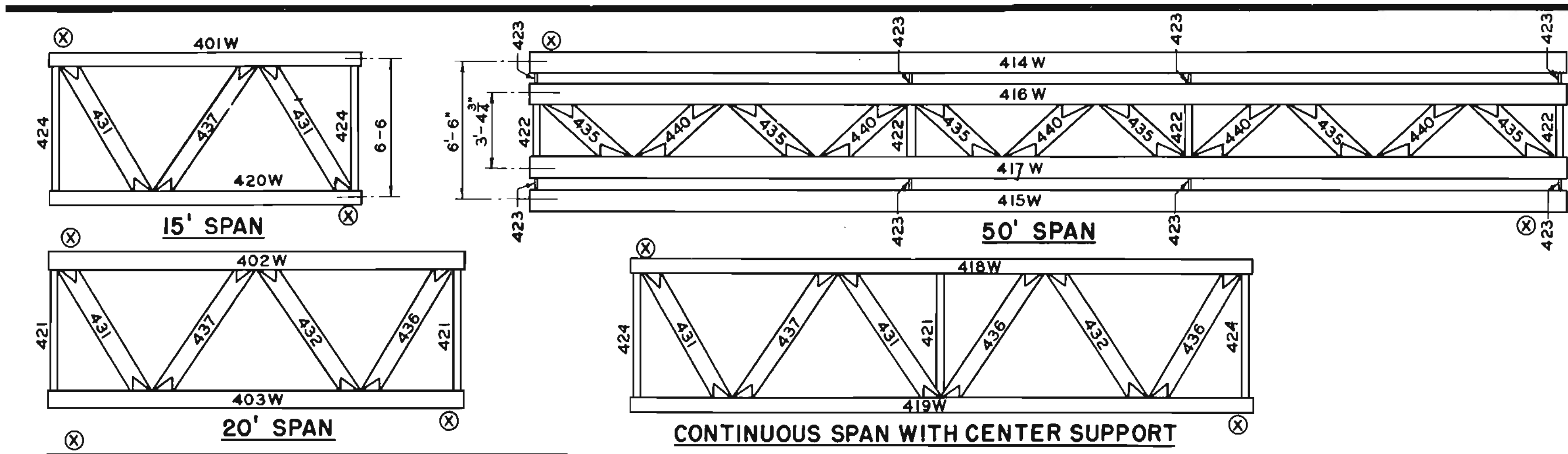


STRINGER MK 416
STRINGER MK 417

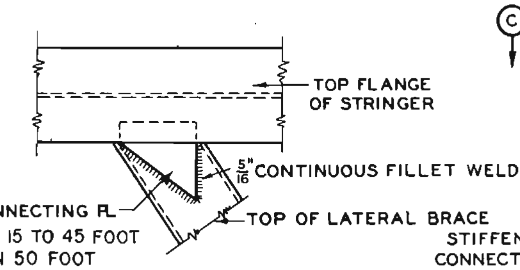
COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 45-FOOT	158
STEEL SPANS, 50 FOOT	159
BILL OF MATERIALS, WELDED	161
GENERAL NOTES	154
SYMBOLS	155



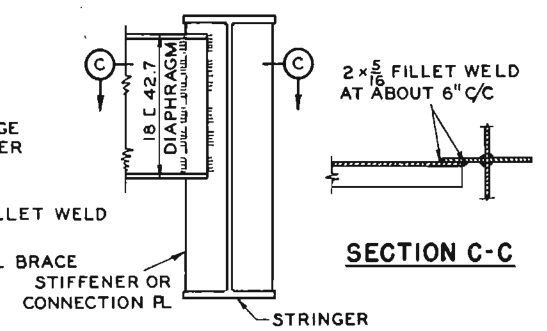


SPAN FRAMING PLANS

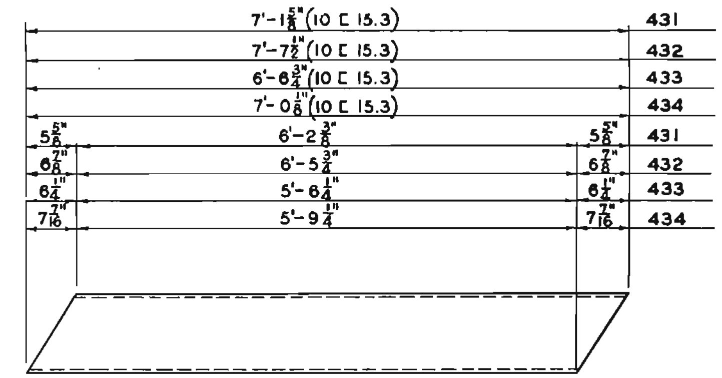


DETAIL A

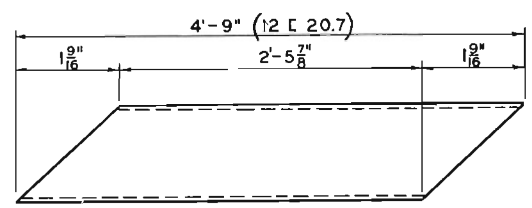
TYPICAL FOR ALL TOP LATERALS FOR ALL SPAN LENGTHS



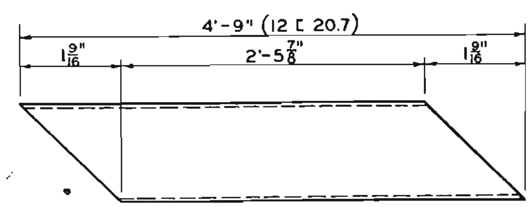
SECTION C-C



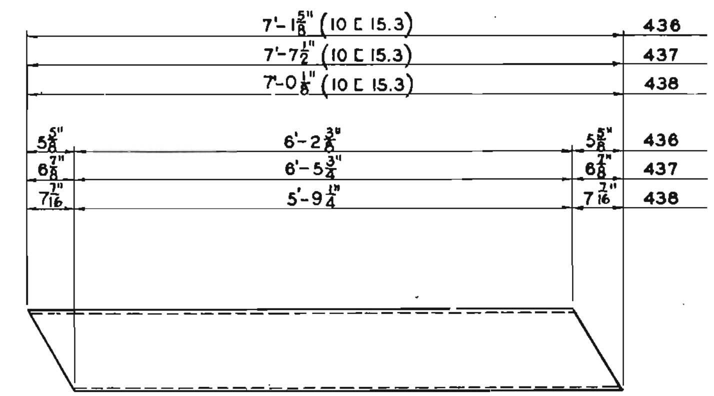
TOP LATERAL BRACE MK 431 W
TOP LATERAL BRACE MK 432W
TOP LATERAL BRACE MK 433W
TOP LATERAL BRACE MK 434W



TOP LATERAL BRACE MK 435W



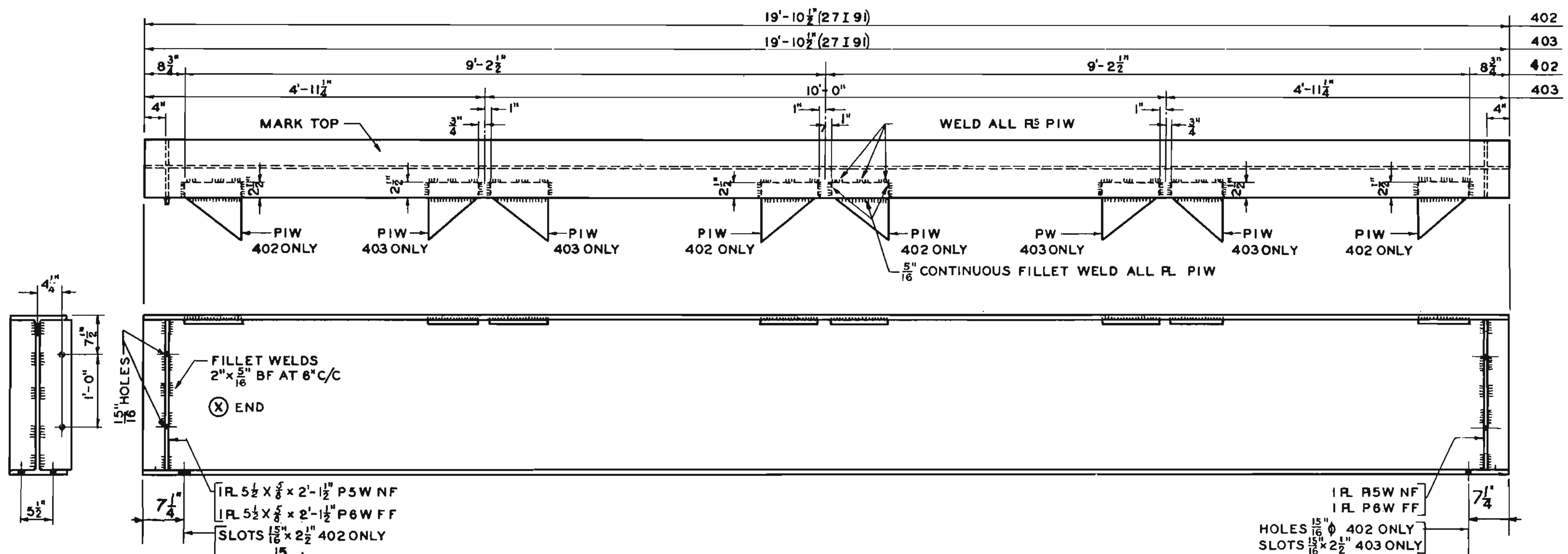
TOP LATERAL BRACE MK 440W



TOP LATERAL BRACE MK 436 W
TOP LATERAL BRACE MK 437 W
TOP LATERAL BRACE MK 438 W

COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 45-FOOT	158
BILL OF MATERIALS	161
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	163



STRINGER MK 402W
STRINGER MK 403W

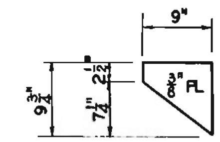


PLATE P1W

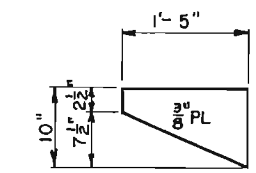
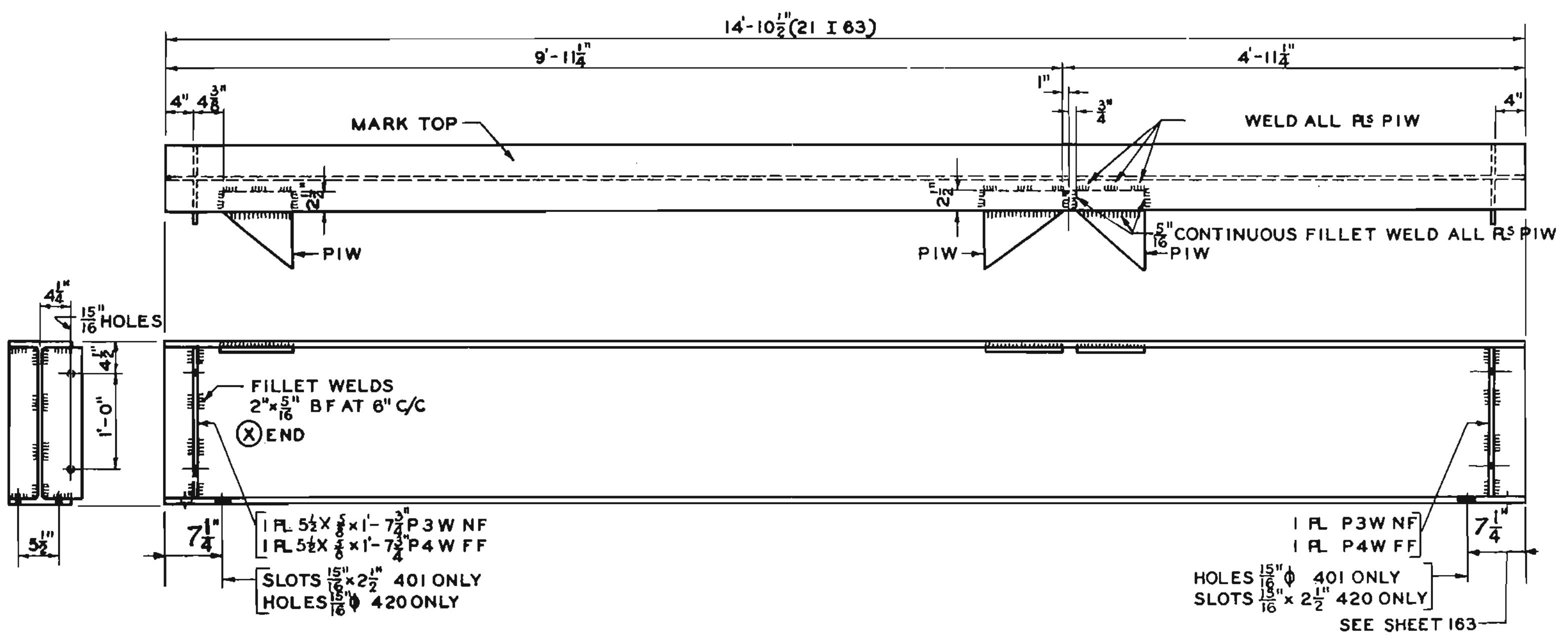
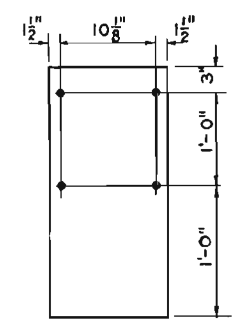


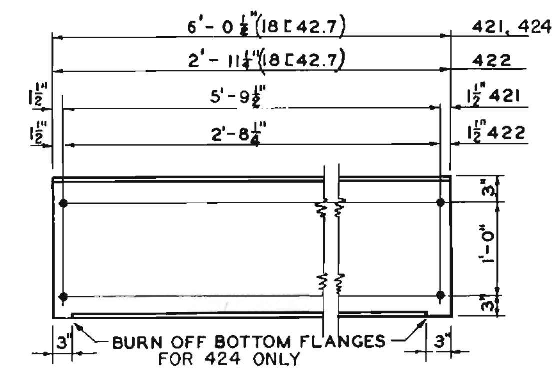
PLATE P2IW



STRINGER MK 401W
STRINGER MK 420W



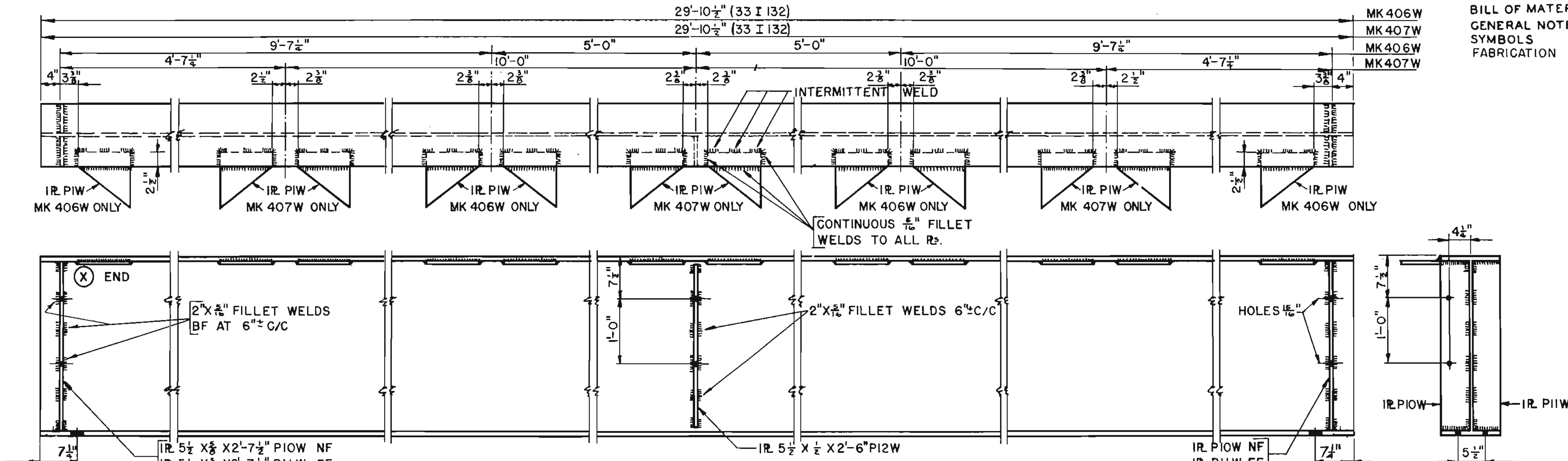
PL. 13⅛ × ½ × 2'-8" MK. 423W



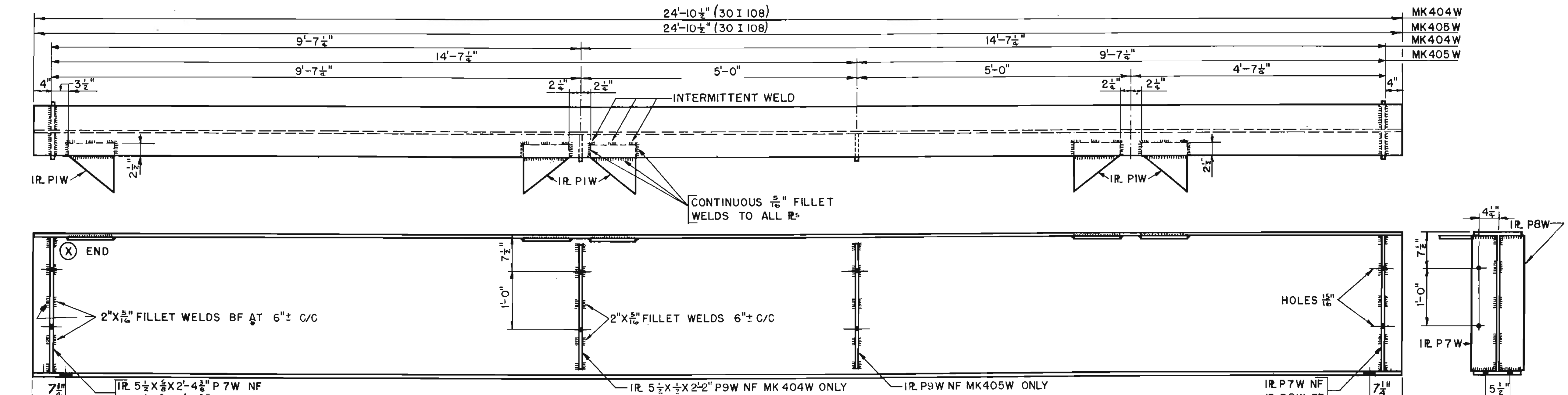
DIAPHRAGM MK 421W
DIAPHRAGM MK 422W
DIAPHRAGM MK 424W

COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 45-FOOT	158
BILL OF MATERIALS, WELDED	161
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	163



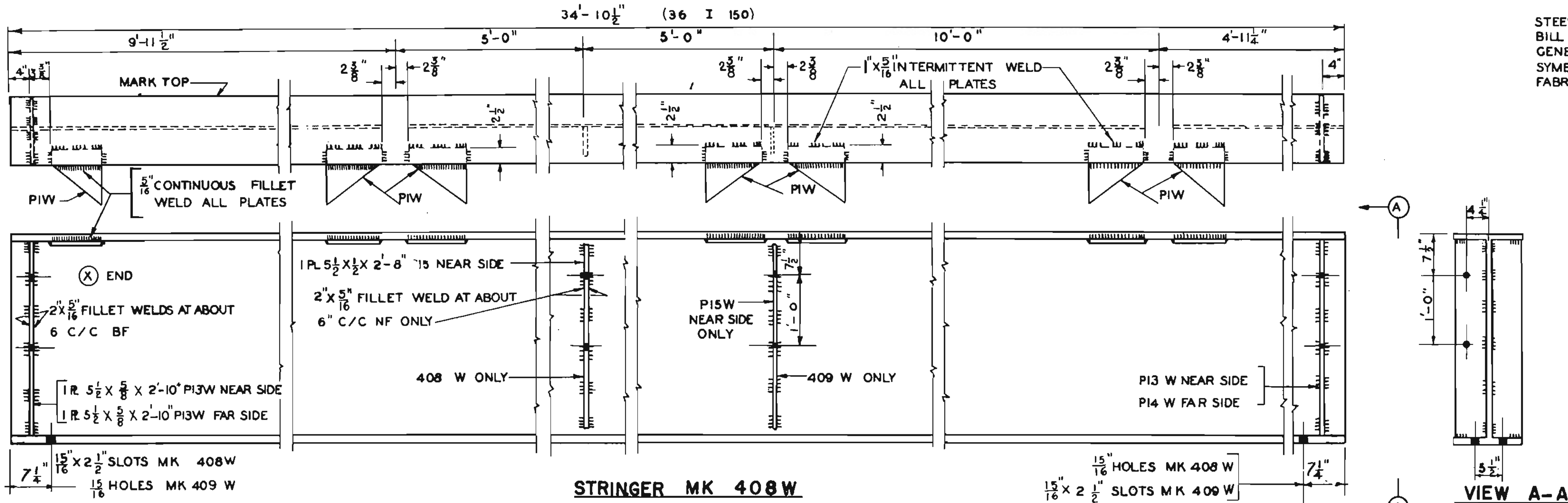
STRINGER MK 406W
STRINGER MK 407W



STRINGER MK404W
STRINGER MK405W

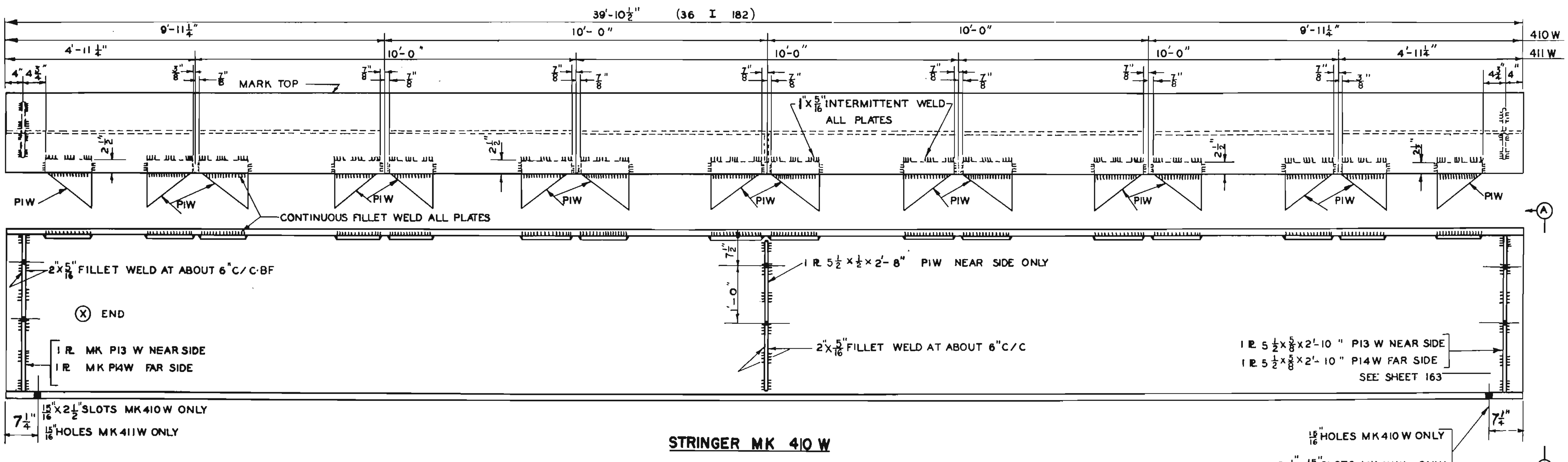
COMPANION SHEETS

	SHEET
STEEL SPANS, 15-TO 45-FOOT	138
BILL OF MATERIALS WELDED	151
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	163



STRINGER MK 408W

STRINGER MK 409W

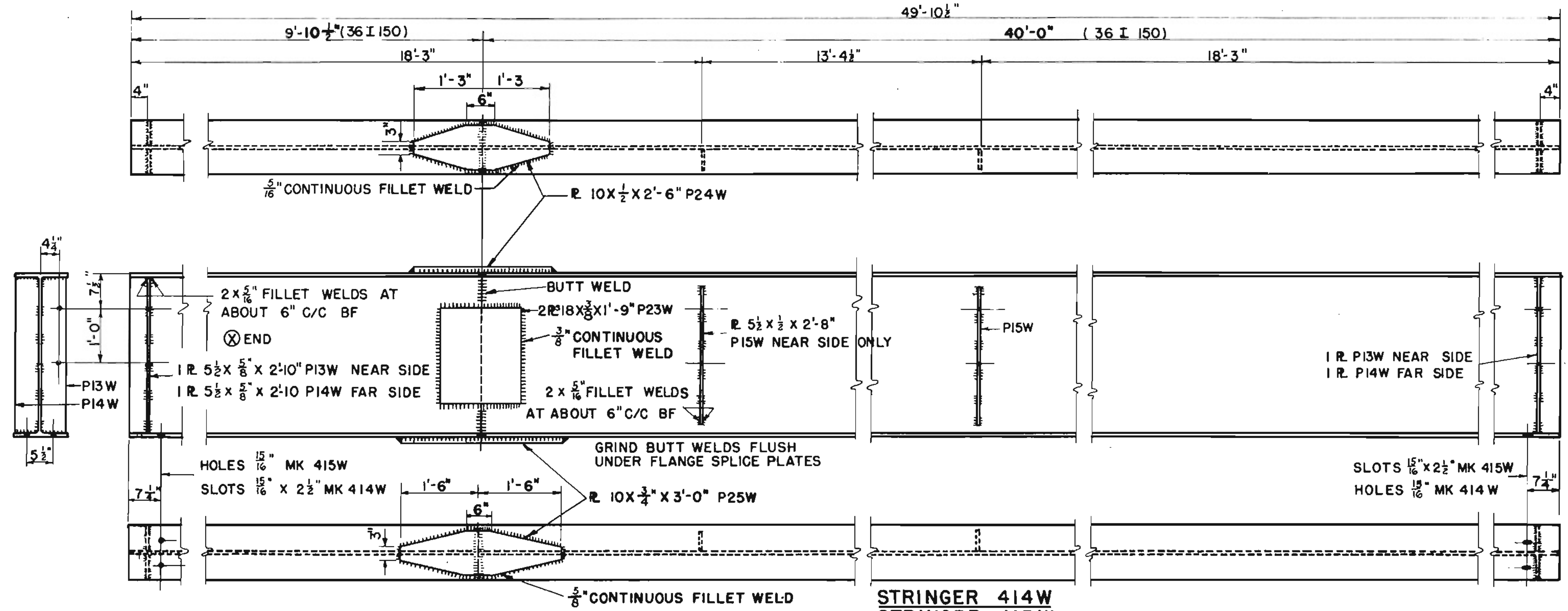


STRINGER MK 410W

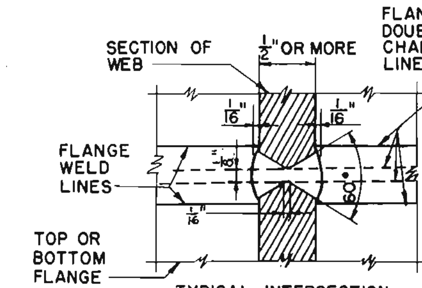
STRINGER MK 411W

COMPANION SHEETS

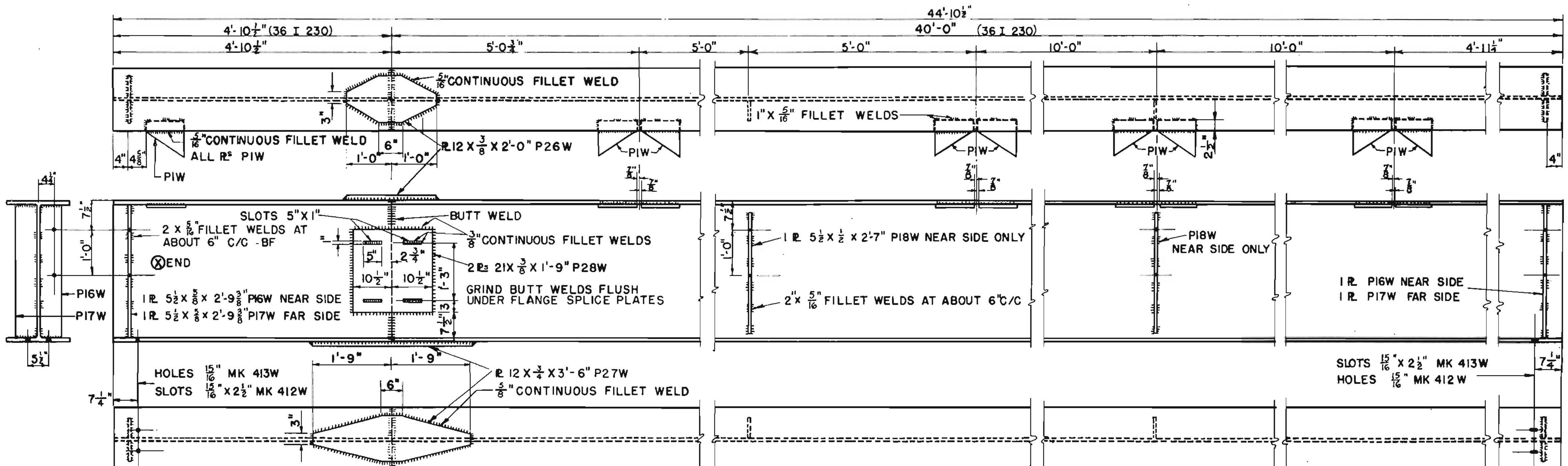
	SHEET
STEEL SPANS, 15-TO 45-FOOT	158
STEEL SPANS, 50- FOOT	159
BILL OF MATERIALS, WELDED	161
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	169



STRINGER 414W
STRINGER 415W



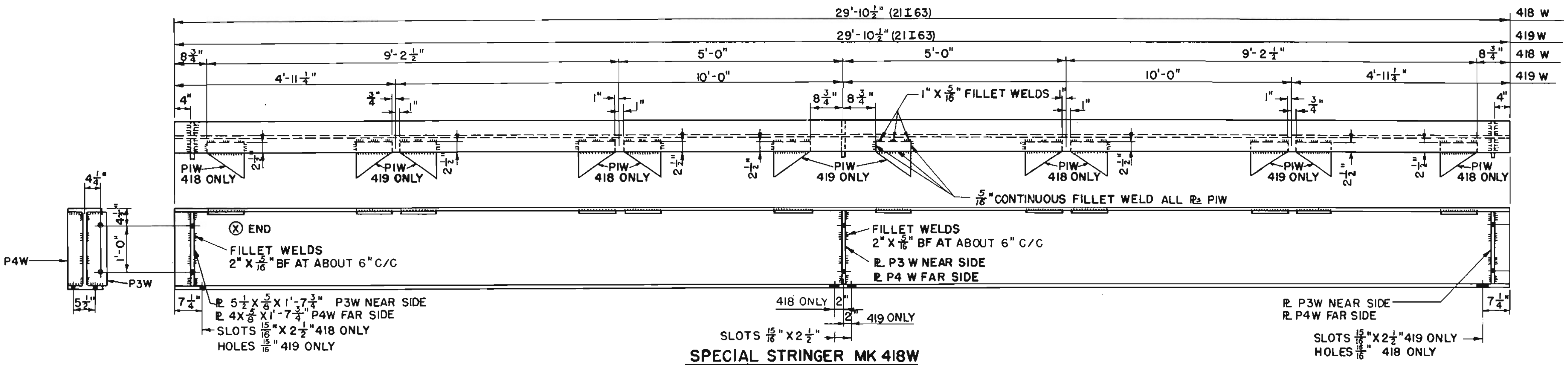
TYPICAL INTERSECTION
WEB AND FLANGE BUTT WELD



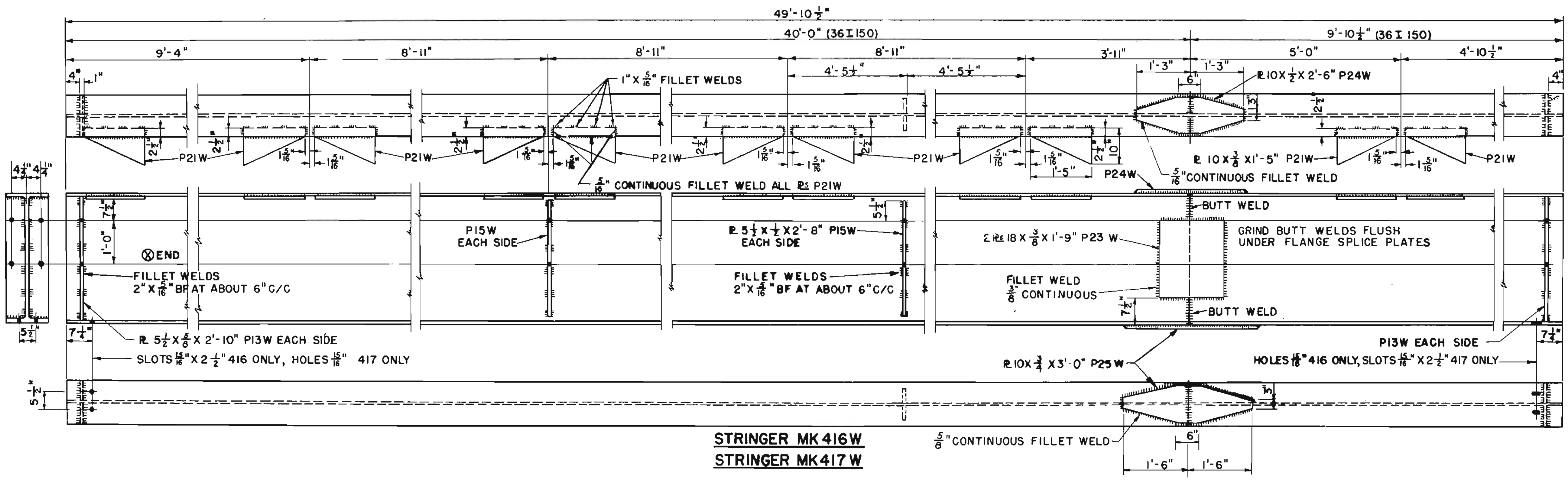
STRINGER 412W
STRINGER 413W

COMPANION SHEETS

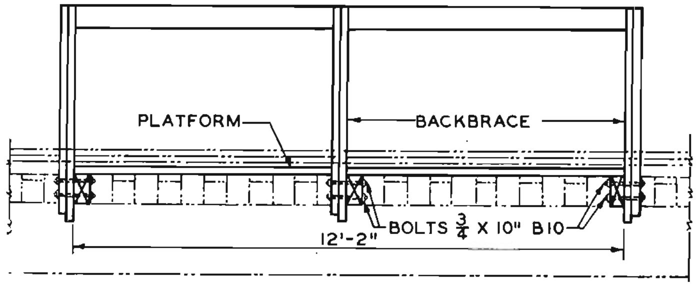
	SHEET
GENERAL NOTES	154
ASSEMBLY DRAWINGS	158,159
BILL OF MATERIALS	161
SYMBOLS	155
FABRICATION DRAWING	172,169



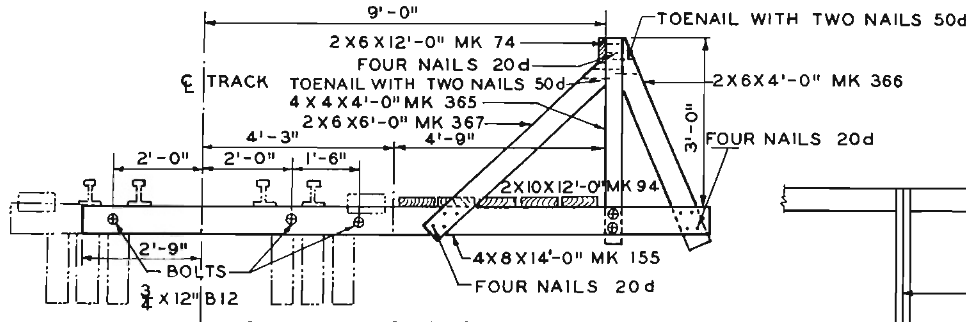
SPECIAL STRINGER MK 418W
SPECIAL STRINGER MK 419W



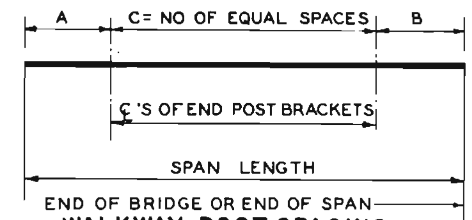
STRINGER MK 416W
STRINGER MK 417W



ELEVATION OF REFUGE BAY



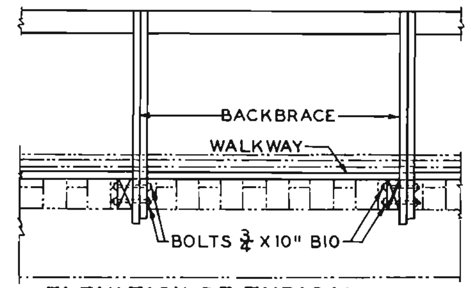
SECTION THROUGH REFUGE BAY



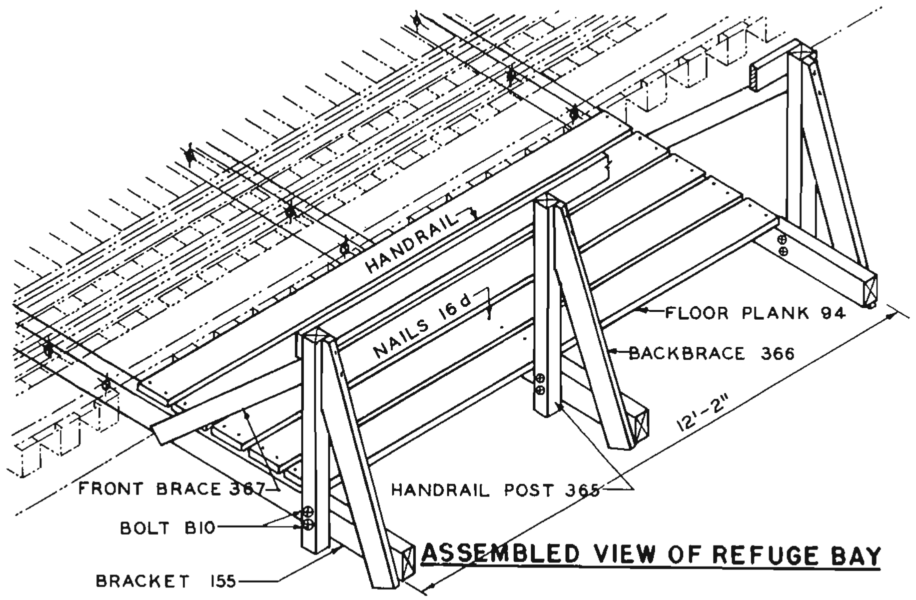
WALKWAY POST SPACING

TABLE OF WALKWAY POST SPACING FOR SINGLE AND MULTIPLE SPANS

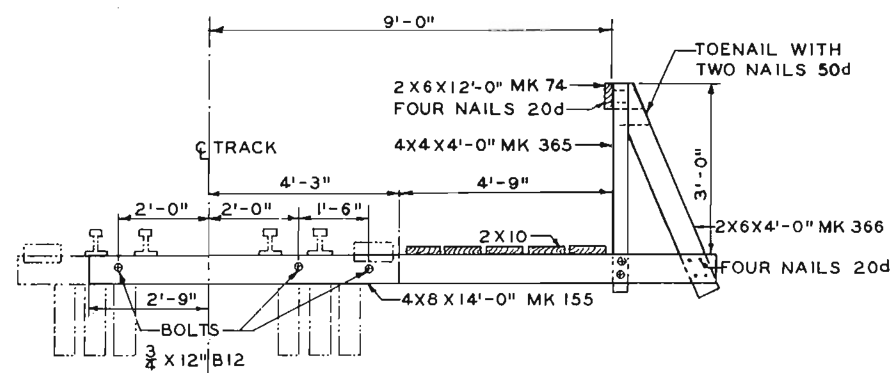
SPAN LENGTH	TYPE OF STRINGER	A	B	C	MAXIMUM SPACE
INTERIOR SPAN					
12'-0"	TIMBER	0'-11"	0'-11"	2 SPACES	5'-2"
14'-0"	DO	0'-11"	0'-11"	2 DO	6'-2"
16'-0"	DO	1'-11"	1'-11"	2 DO	6'-2"
SINGLE SPAN					
12'-0"	TIMBER	1'-11"	1'-11"	2 SPACES	4'-2"
14'-0"	DO	2'-11"	0'-11"	2 DO	5'-2"
16'-0"	DO	2'-11"	1'-11"	2 DO	6'-0"
END SPAN					
12'-0"	TIMBER	1'-11"	1'-11"	2 SPACES	4'-2"
14'-0"	DO	1'-11"	1'-11"	2 DO	5'-2"
15'-0"	STEEL	0'-11"	0'-11"	2 DO	7'-0"
16'-0"	TIMBER	2'-11"	2'-11"	2 DO	5'-2"
20'-0"	STEEL	0'-11"	0'-11"	3 DO	6'-2"
25'-0"	DO	0'-11"	0'-11"	4 DO	6'-0"
30'-0"	DO	0'-11"	0'-11"	5 DO	6'-0"
35'-0"	DO	0'-11"	0'-11"	5 DO	7'-0"
40'-0"	DO	0'-11"	0'-11"	6 DO	7'-0"
45'-0"	DO	0'-11"	0'-11"	7 DO	6'-10"
50'-0"	DO	0'-11"	0'-11"	8 DO	6'-2"



ELEVATION OF TYPICAL WALKWAY PANEL



ASSEMBLED VIEW OF REFUGE BAY

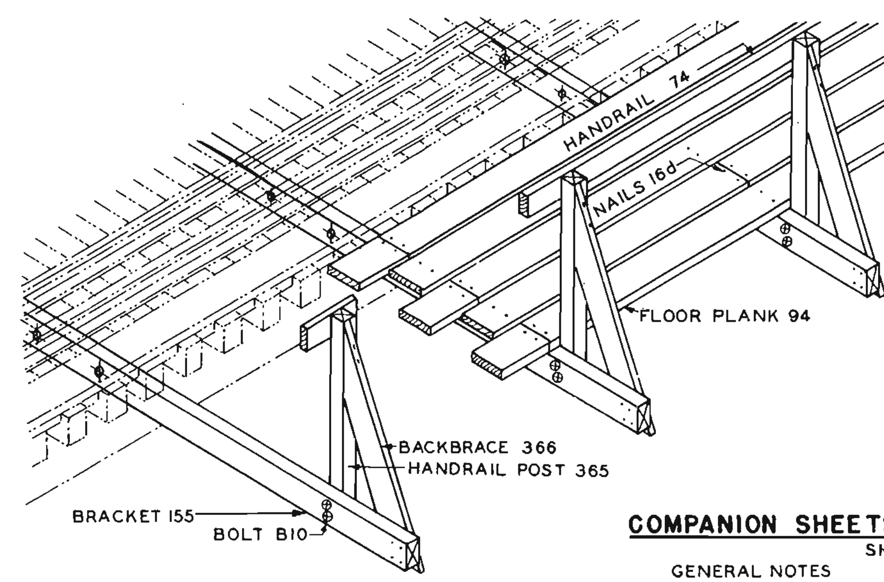


SECTION THROUGH TYPICAL WALKWAYS

TIMBER AND STEEL SPANS

BILL OF MATERIALS

ITEM	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	REFUGE BAY ALL SPANS / WALKWAY 12-FT SPAN 14-FT SPAN QUANTITY	FBM	WALKWAY 15-FT SPAN 16-FT SPAN QUANTITY	FBM	20-FT SPAN QUANTITY	FBM	25-FT SPAN QUANTITY	FBM	30-FT SPAN 35-FT SPAN QUANTITY	FBM	40-FT SPAN QUANTITY	FBM	45-FT SPAN QUANTITY	FBM	50-FT SPAN QUANTITY	FBM
	LUMBER, SOFT WOOD																					
1	WALKWAY BEARER	39-3340.08-14	155	4X8	14'-0"	140	3	112	3	112	4	150	5	187	6	224	7	261	8	300	9	336
2	HANDRAIL POST	39-3340.08	365	4X4	4'-0"	20	3	16	3	16	4	21	5	27	6	32	7	37	8	43	9	48
3	BACK BRACE	39-3228.06	366	2X6	4'-0"	15	3	12	3	12	4	16	5	20	6	24	7	28	8	32	9	36
4	HANDRAIL	39-3228.06-14	75	2X6	14'-0"	53	1	14			2	28	2	28	3	42	3	42	4	56	4	56
5	DO	39-3880.06-16	76	2X6	16'-0"	60			1	16												
6	END RAILS-END SPANS	39-3228.06	367	2X6	6'-0"	23	2	12	2	12	2	12	2	12	2	12	2	12	2	12	2	12
7	FLOOR PLANKS	39-3228.1-14	94	2X10	14'-0"	88	5	117			8	186	10	233	13	303	15	350	18	420	20	467
8	DO	39-3228.1-16		2X10	16'-0"	100			5	133												
	STEEL HARDWARE, BLACK																					
9	MACHINE BOLT WITH SQUARE																					
	NUT AND TWO WASHERS	43-2325.07-1	B10	3/4	10"	1.77	6		6		8		10		12		14		16		18	
10	DO	43-2325.07-124	B12	3/4	12"	2.52	9		9		12		15		18		21		24		27	
11	WIRE NAIL	42-6028.3-2		20d		.04	65		65		85		105		125		145		165		185	
12	DO	42-6028.3-5		50d		.08	10		10		12		14		16		18		20		22	



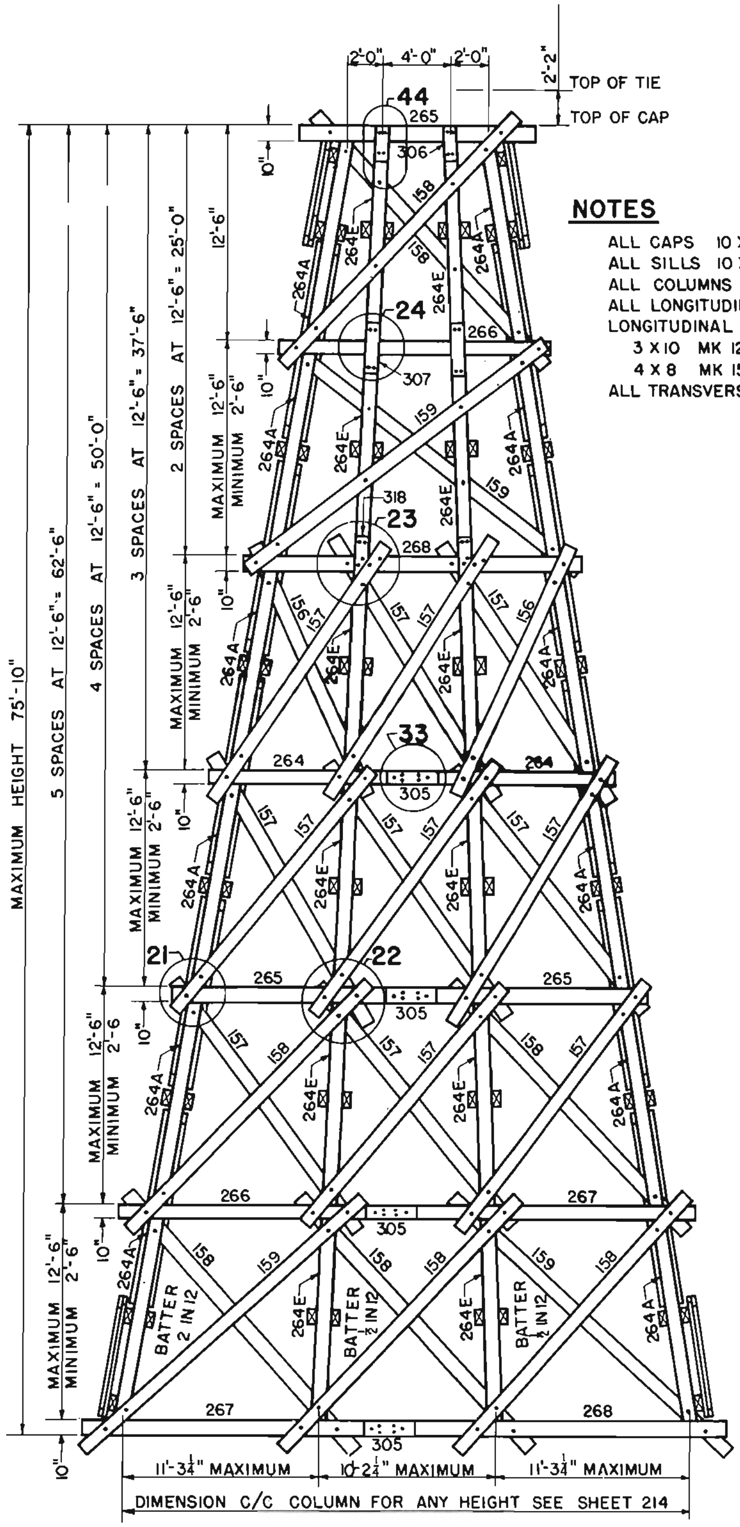
ASSEMBLED VIEW OF TYPICAL WALKWAY PANELS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155

COMPANION SHEETS

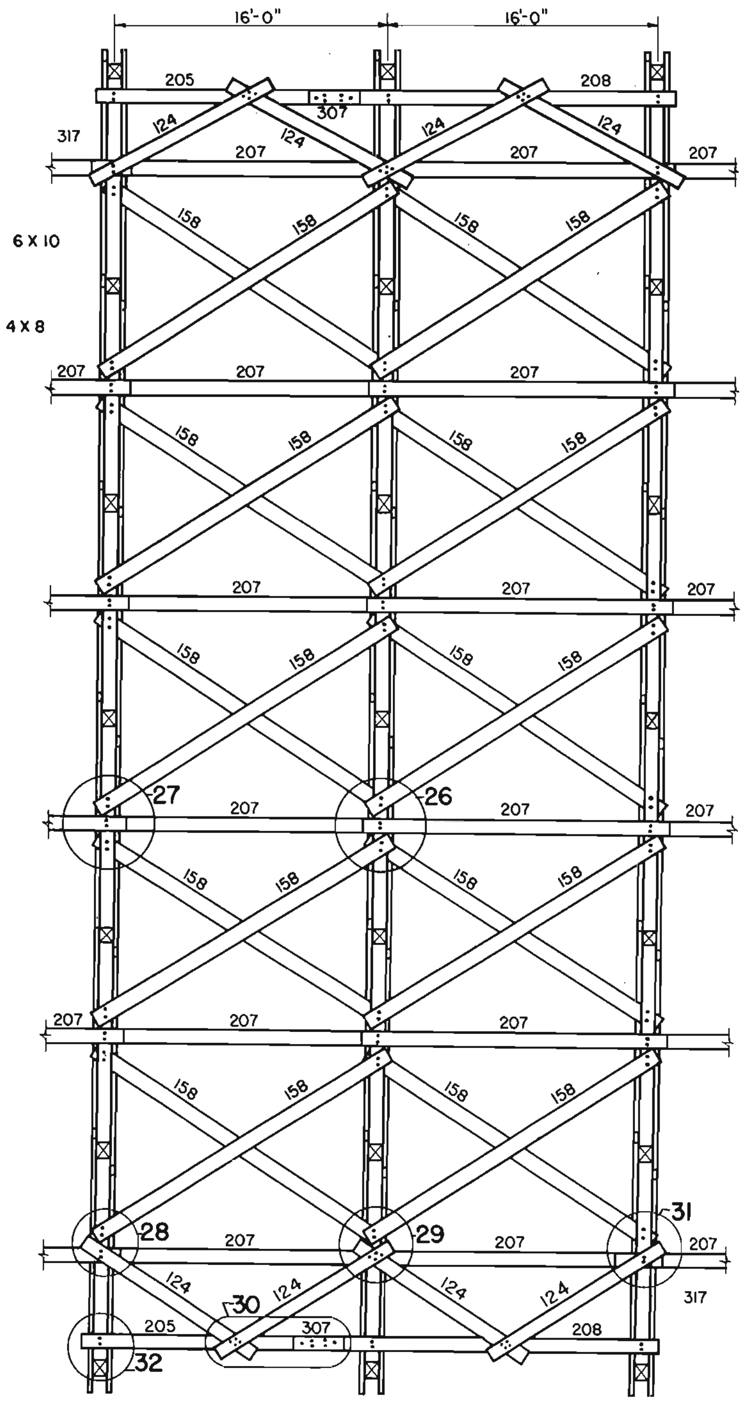
	SHEET
GENERAL NOTES	154
BILL OF MATERIALS	176
CONNECTIONS	181
CONNECTIONS	182
CONNECTIONS	183
SYMBOLS	155
CONCRETE PEDESTALS	214



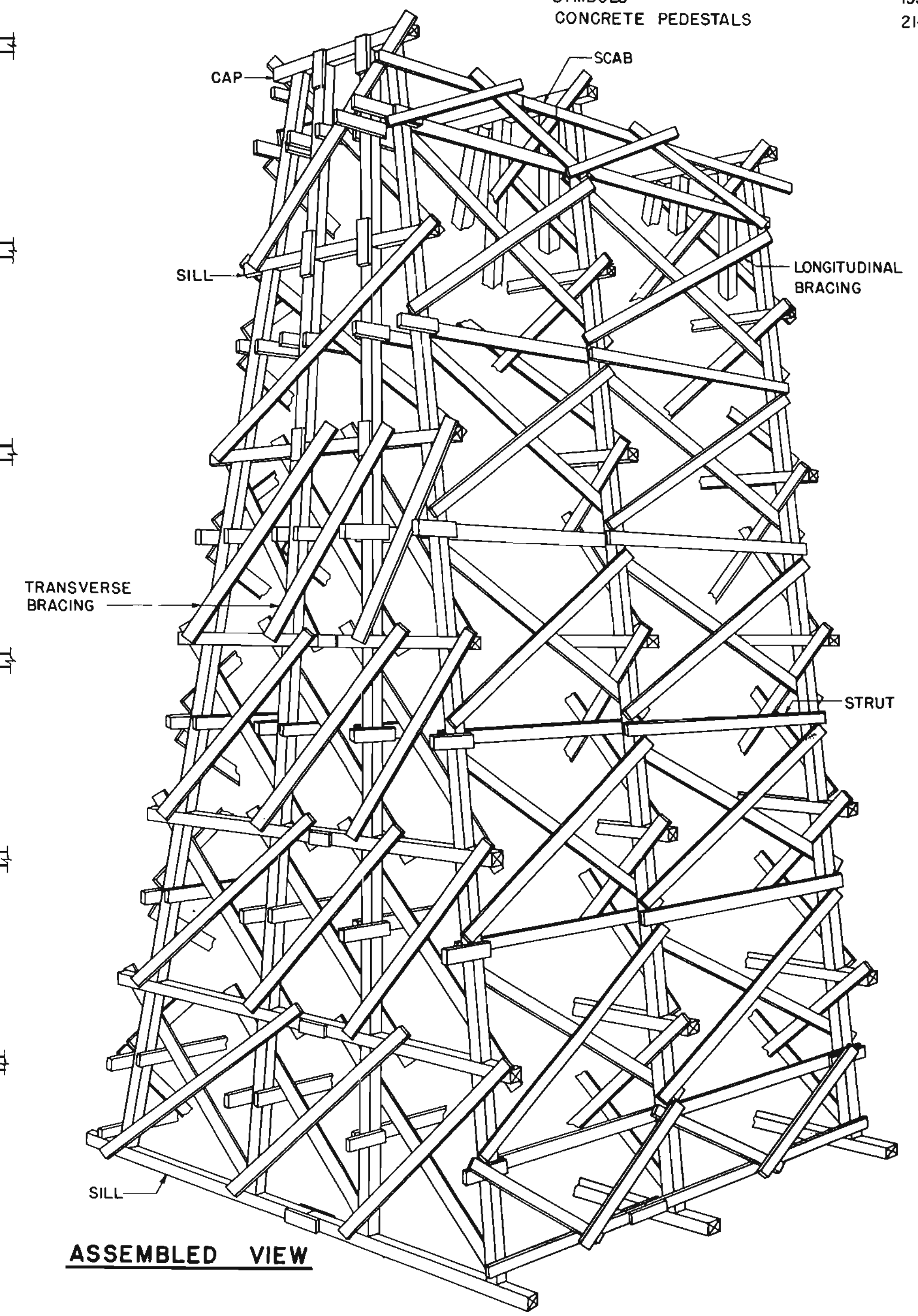
TRANSVERSE ELEVATION

NOTES

ALL CAPS 10 X 10
ALL SILLS 10 X 10
ALL COLUMNS 10 X 10
ALL LONGITUDINAL STRUTS 6 X 10
LONGITUDINAL BRACING:
3 X 10 MK 124
4 X 8 MK 158
ALL TRANSVERSE BRACING 4 X 8



LONGITUDINAL ELEVATION



ASSEMBLED VIEW

TIMBER TOWER 13'-4" TO 75'-10" HIGH

COMPANION SHEETS

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CONNECTIONS	183
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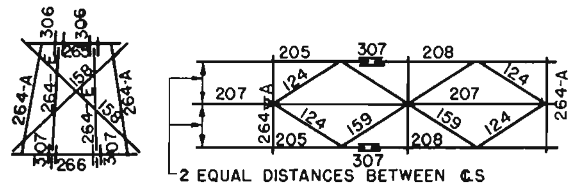
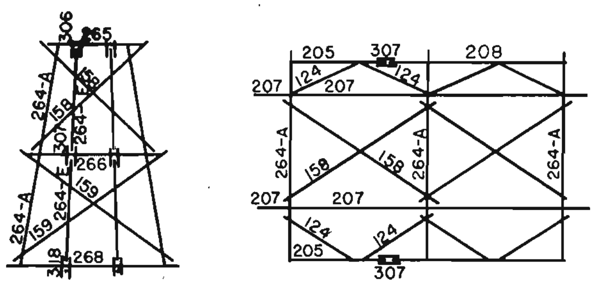
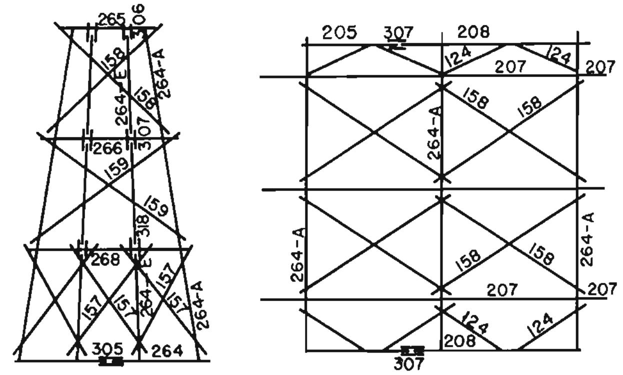


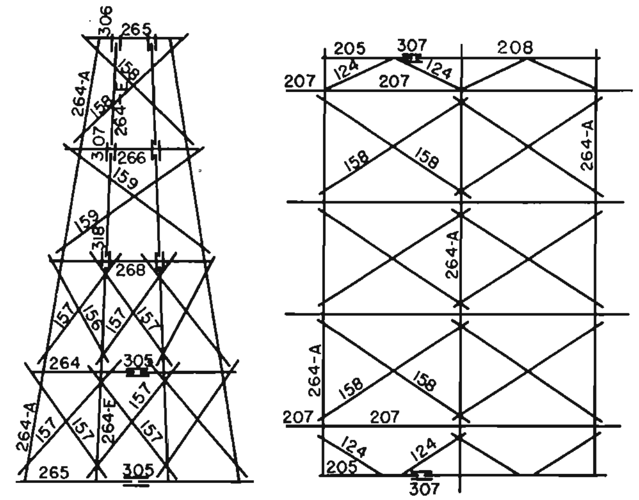
1-STORY TOWER



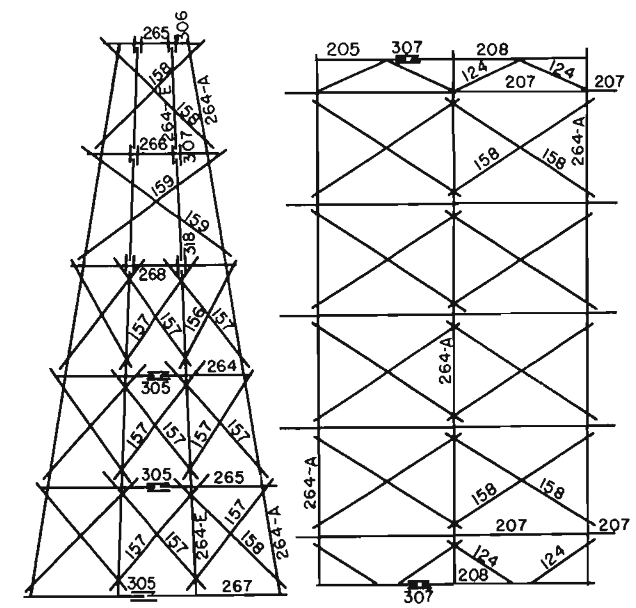
2-STORY TOWER



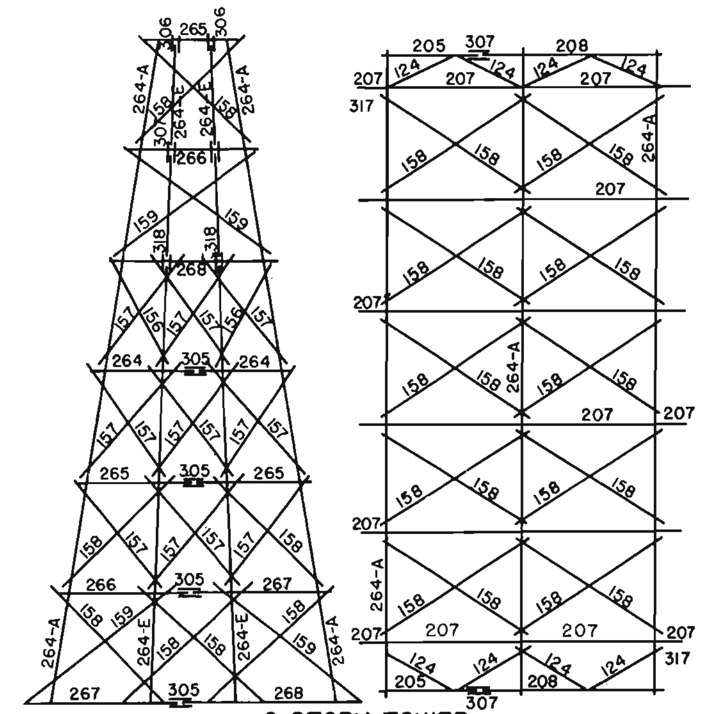
3-STORY TOWER



4-STORY TOWER



5-STORY TOWER



6-STORY TOWER

BILL OF MATERIAL FOR ONE TOWER OF THE NUMBER OF STORIES INDICATED

LINE	NUMBER OF STORIES						6-STORY		5-STORY		4-STORY		3-STORY		2-STORY		1-STORY	
	TOWER HEIGHT						75'-10"		63'-4"		50'-10"		38'-4"		25'-10"		13'-4"	
	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM
	LUMBER, SOFT WOOD																	
1	CAP	39-6620.1-14	265	10 X 10	14'-0"	438	3	350	3	350	3	350	3	350	3	350	3	350
2	SILL	39-6620.1-2	268	10 X 10	20'-0"	625	6	1000	3	500	3	500	3	500	3	500		
3	DO	39-6620.1-18	267	10 X 10	18'-0"	563	6	900	3	450								
4	DO	39-6620.1-16	266	10 X 10	16'-0"	500	6	800	6	800	3	400	3	400	3	400	3	400
5	DO	39-6620.1-14	265	10 X 10	14'-0"	438	6	700	6	700	6	700						
6	DO	39-6620.1-12	264	10 X 10	12'-0"	375	6	600	6	600	6	600	6	600				
7	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	36	3600	30	3000	24	2400	18	1800	12	1200	6	600
8	DO	39-6620.1-12	264E	10 X 10	12'-0"	375	35	3600	30	3000	24	2400	18	1800	12	1200	6	600
9	STRUT	39-3360.1-2	208	6 X 10	20'-0"	375	4	400	4	400	4	400	4	400	4	400	4	400
10	DO	39-3360.1-18	207	6 X 10	18'-0"	338	72	6480	50	5400	48	4320	36	3240	24	2160	12	1080
11	DO	39-3360.1-14	205	6 X 10	14'-0"	263	4	280	4	280	4	280	4	280	4	280	4	280
12	BRACING	39-3340.08-22	159	4 X 8	22'-0"	220	12	704	6	352	6	352	6	352	6	352	4	235
13	DO	39-3340.08-2	158	4 X 8	20'-0"	200	64	3413	44	2347	30	1600	22	1173	14	747	6	320
14	DO	39-3340.08-18	157	4 X 8	18'-0"	180	42	2016	42	2016	30	1440	12	576				
15	DO	39-3340.08-16	156	4 X 8	16'-0"	160	6	256	6	256	6	256	6	255				
16	DO	39-3952.1-12	124	3 X 10	12'-0"	113	16	480	16	480	16	480	16	480	16	480	8	240
17	SCAB	39-3340.1	305	4 X 10	3'-0"	38	24	240	18	180	12	120	6	60				
18	DO	39-3330.1	307	3 X 10	3'-0"	28	20	150	20	150	20	150	20	150	20	150	20	150
19	DO	39-3952.1	318	3 X 10	2'-8"	25	12	80	12	80	12	80	12	80	12	80		
20	DO	39-3330.1	306	3 X 10	2'-0"	19	12	60	12	60	12	60	12	60	12	60	12	60
21	DO	39-3330.1	317	3 X 10	1'-6"	14	4	15	4	15	4	15	4	15	4	15		
	STEEL HARDWARE, BLACK																	
22	MACHINE BOLT WITH NUT AND TWO WASHERS	43-2325.1-3	E30	1	30"	7.8	24		24		24		24		24		16	
23	DO	43-2325.1-28	E28	1	28"	7.4	8		8		8		8		8			
24	DO	43-2325.1-24	E24	1	24"	6.5	120		96		72		48		24		12	
25	DO	43-2325.1-2	E20	1	20"	5.6	238		182		126		70		14			
26	DO	43-2325.1-18	E18	1	18"	5.1	90		90		90		90		96		72	
27	DO	43-2325.1-164	E16	1	16"	4.7	212		184		156		128		76		36	
28	DO	43-2325.1-144	E14	1	14"	4.3	56		56		56		56		56		56	
29	DRIFT BOLT, PLAIN	43-1636.07-2	D20	3/4	20"	2.5	192		156		120		84		48		24	

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
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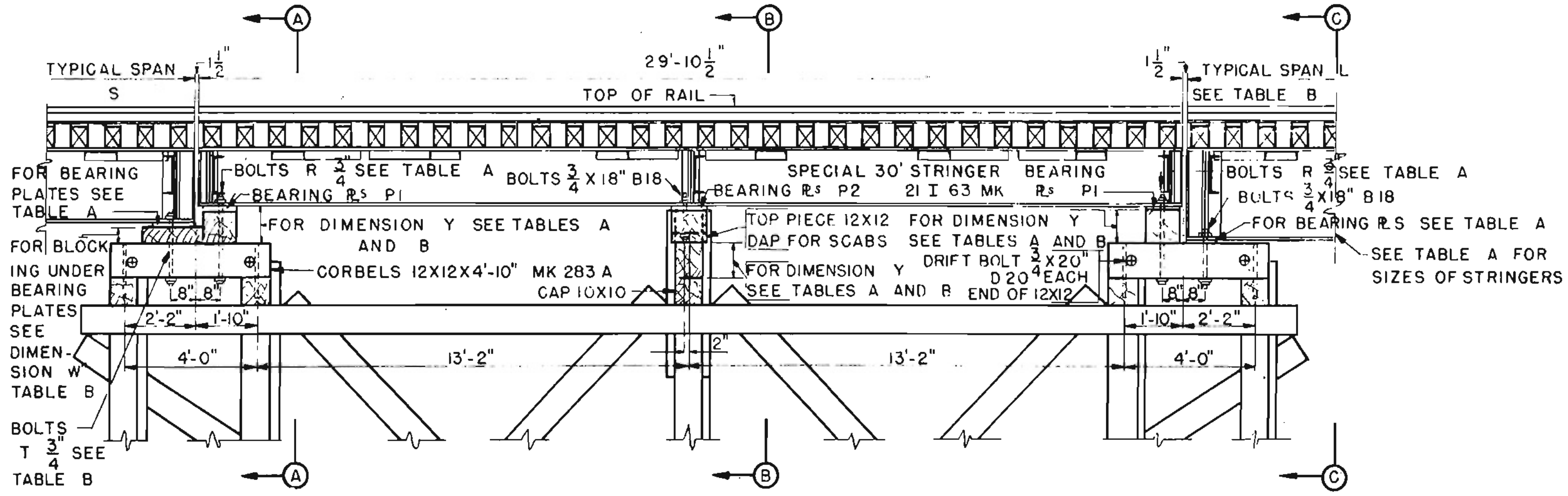
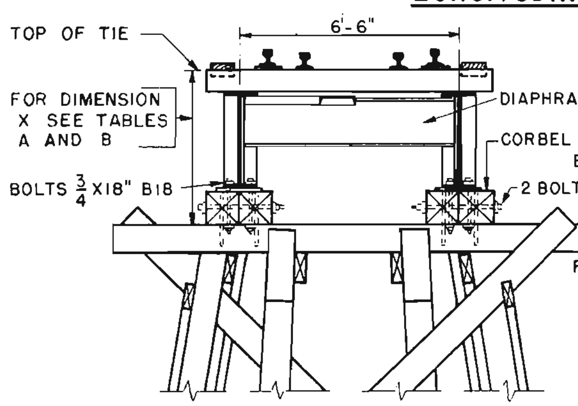
TIMBER TOWER ASSEMBLY	179
BILL OF MATERIALS, TABLES A AND B	178
BILL OF MATERIALS	180

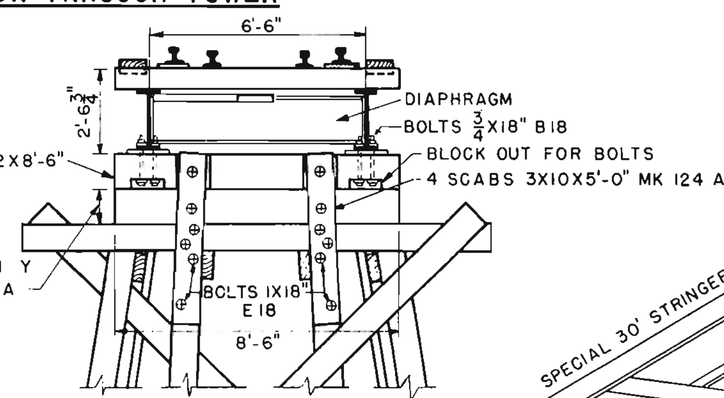


LONGITUDINAL SECTION THROUGH TOWER

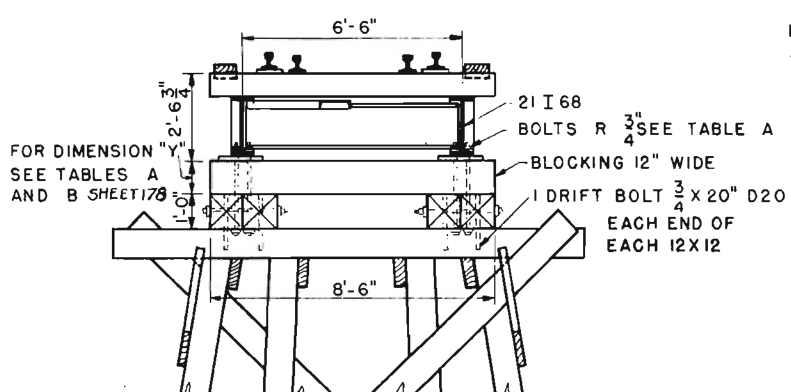


SECTION C-C

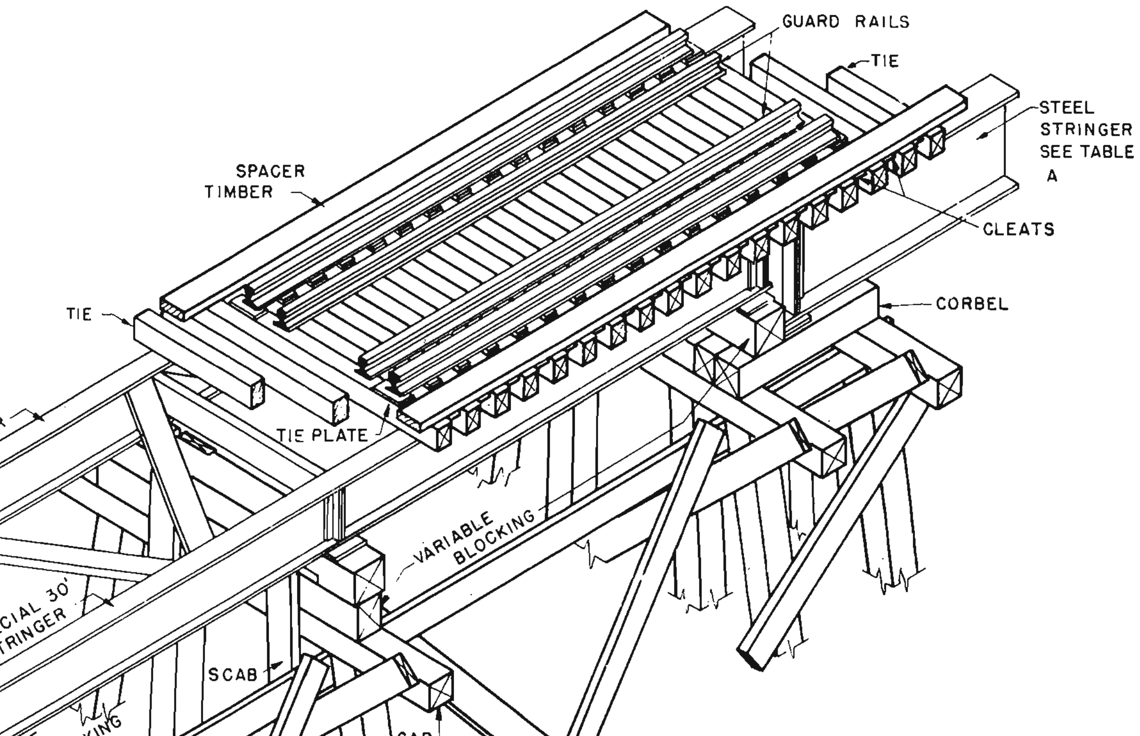
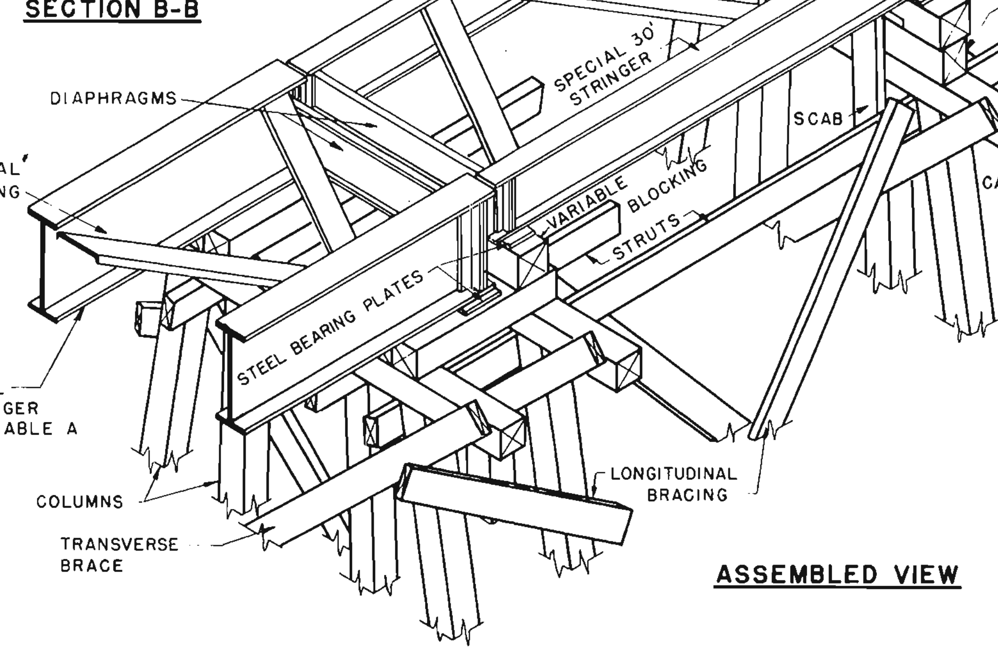
FOR 15' TO 45' SPANS



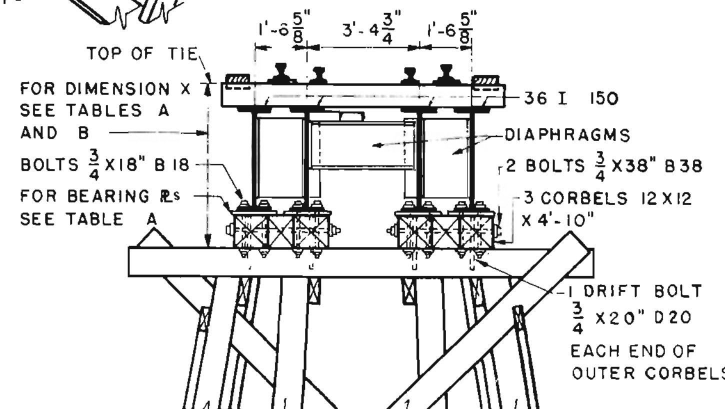
SECTION B-B



SECTION A-A

ASSEMBLED VIEW



SECTION C-C (FOR 50' SPAN)

COMPANION SHEETS

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GENERAL NOTES	154
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SUPPLEMENTAL MATERIALS	177
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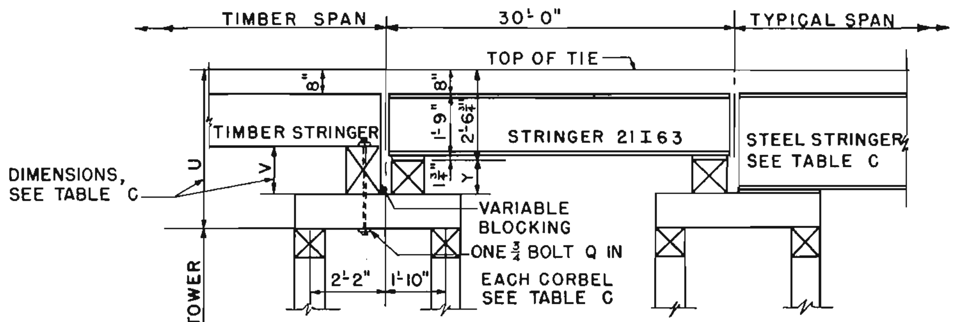
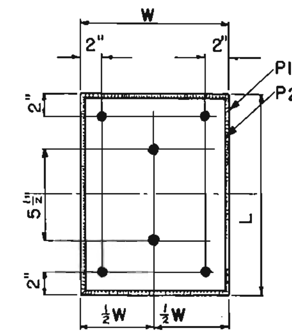


SECTION SHOWING JUNCTION OF TIMBER AND STEEL STRINGER SPANS ON TOWER



BEARING PLATES

SPAN (FEET)	W (INCHES)	L (INCHES)	P1	P2
15, 50	12	16	12X1X1'-4"	11X3/4"X1'-3"
20,25	12	20	12X1X 1'-8"	11X1X1'-7"
30, 35	15	20	15X1X 1'-8"	14X1X 1'-7"
40, 45	16	21	16X1X 1-9"	15X1X 1'-8"

TABLE B-SEE SHEET 177

TYPICAL SPAN S		TYPICAL SPAN L 50'	45'	40'	35'	30'	25'	20'
15'	X	4'-9 3/8"	4'-9 7/8"	4'-10 3/8"	4'-9 7/8"	4'-7 1/8"	4'-3 7/8"	4'-0 7/8"
	Y	1'-2 5/8"	1'-3 1/8"	1'-3 5/8"	1'-3 1/8"	1'-0 3/8"	0'-9 1/8"	0'-6 1/8"
	W	1'-2 5/8"	1'-3 1/8"	1'-3 5/8"	1'-3 1/8"	1'-0 3/8"	0'-9 1/8"	0'-6 1/8"
	BOLTS T	32"	32"	32"	32"	30"	26"	22"
20'	X	4'-9 3/8"	4'-9 7/8"	4'-10 3/8"	4'-9 7/8"	4'-7 1/8"	4'-3 7/8"	
	Y	1'-2 5/8"	1'-3 1/8"	1'-3 5/8"	1'-3 1/8"	1'-0 3/8"	0'-9 1/8"	
	W	0'-8 1/2"	0'-9"	0'-9 1/2"	0'-9"	0'-6 1/4"	0'-3"	
	BOLTS T	24"	26"	26"	26"	24"	20"	
25'	X	4'-9 3/8"	4'-9 7/8"	4'-10 3/8"	4'-9 7/8"	4'-7 1/8"		
	Y	1'-2 5/8"	1'-3 1/8"	1'-3 5/8"	1'-3 1/8"	1'-0 3/8"		
	W	0'-5 1/2"	0'-6"	0'-6 1/2"	0'-6"	0'-3 1/4"		
	BOLTS T	22"	24"	24"	22"	20"		
30'	X	4'-9 3/8"	4'-9 7/8"	4'-10 3/8"	4'-9 7/8"			
	Y	1'-2 5/8"	1'-3 1/8"	1'-3 5/8"	1'-3 1/8"			
	W	0'-2 1/4"	0'-2 3/4"	0'-3 1/4"	0'-2 3/4"			
	BOLTS T	18"	20"	20"	20"			
35'	X	4'-9 7/8"	4'-9 7/8"	4'-10 3/8"				
	Y	1'-3 1/8"	1'-3 1/8"	1'-3 5/8"				
	W	0'-0 1/2"	0'-0"	0'-0 1/2"				
	BOLTS T	18"	18"	18"				
40'	X	4'-10 3/8"	4'-10 3/8"					
	Y	1'-3 5/8"	1'-3 5/8"					
	W	0'-1"	0'-0 1/2"					
	BOLTS T	18"	18"					
45'	X	4'-9 7/8"						
	Y	1'-3 1/8"						
	W	0'-0 1/2"						
	BOLTS T	18"						

TABLE C-FOR KNOWN STEEL-STRINGER SPAN

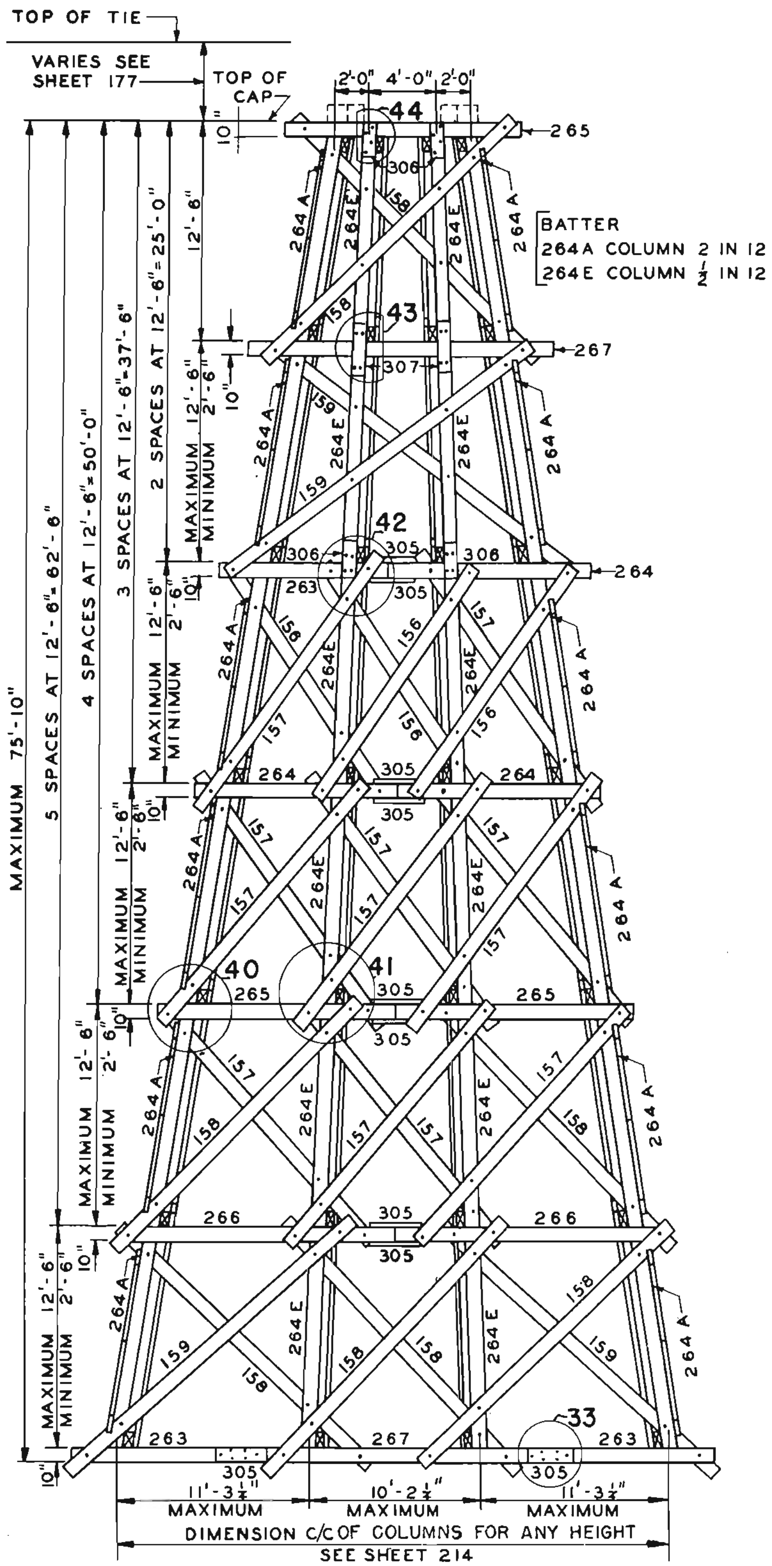
TYPICAL SPAN	STEEL STRINGERS	DIMENSIONS U	Y	16" TIMBER STRINGERS V	16" TIMBER STRINGERS BOLT Q	18" TIMBER STRINGERS V	18" TIMBER STRINGERS BOLT Q
15'	21 I 63	3'-6 3/4"	0'-0"	0'-6 3/4"	20"	0'-4 3/4"	18"
20'	27 I 91	4'-0 7/8"	0'-6 1/8"	1'-0 7/8"	26"	0'-10 7/8"	24"
25'	30 I 108	4'-3 7/8"	0'-9 1/8"	1'-3 7/8"	30"	1'-1 7/8"	28"
30'	33 I 132	4'-7 1/8"	1'-0 3/8"	1'-7 1/8"	32"	1'-5 1/8"	30"
35'	36 I 150	4'-9 7/8"	1'-3 1/8"	1'-9 7/8"	36"	1'-7 7/8"	34"
40'	36 I 182	4'-10 3/8"	1'-3 5/8"	1'-10 3/8"	36"	1'-8 3/8"	34"
45'	36 I 230	4'-9 7/8"	1'-3 1/8"	1'-9 7/8"	36"	1'-7 7/8"	34"
50'	36 I 150	4'-9 3/8"	1'-2 5/8"	1'-9 3/8"	36"	1'-7 3/8"	34"

TABLE A-SEE SHEET 177

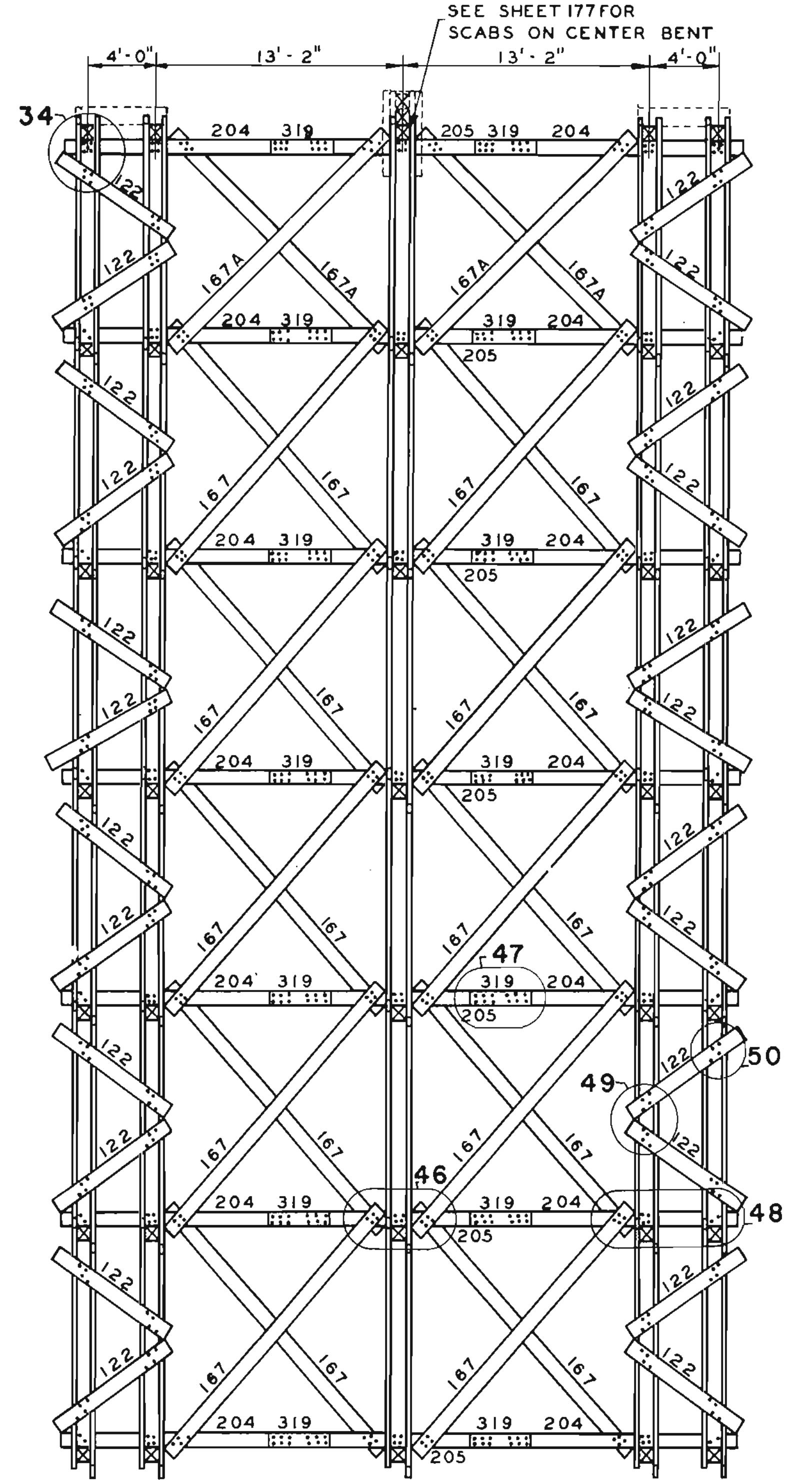
TYPICAL SPAN L	STEEL STRINGERS	BEARING PLATES MARK	DIMENSIONS U	DIMENSIONS Y	BOLTS R LENGTH
15'	21 I 63		3'-6 3/4"	0'-0"	18"
20'	27 I 91		4'-0 7/8"	0'-6 1/8"	22"
25'	30 I 108		4'-3 7/8"	0'-9 1/8"	26"
30'	33 I 132		4'-7 1/8"	1'-0 3/8"	30"
35'	36 I 150		4'-9 7/8"	1'-3 1/8"	32"
40'	36 I 182		4'-10 3/8"	1'-3 5/8"	32"
45'	36 I 230		4'-9 7/8"	1'-3 1/8"	32"
50'	36 I 150		4'-9 3/8"	1'-2 5/8"	32"

BILL OF MATERIALS FOR VARIABLE BLOCKING FOR ONE SPAN

						SPAN ADJOINING TOWER	15'		20'		25'		30'		35'		40'		45'		50'		
						STRINGER SIZE	21 I 63		27 I 91		30 I 108		33 I 132		36 I 160		36 I 182		36 I 230		36 I 150		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																						
1	CORBEL	39-6630.12	283A	12 X 12	4'-10"	218	8	480	8	480	8	480	8	480	8	480	8	480	8	480	12	720	1
2	BLOCKING ON CENTER BENT	39-6616.1	233A	8 X 10	8'-5"	210			1	67			1	67	1	67	1	57	1	67	2	134	2
3	DO	39-6620.1	263A	10 X 10	8'-6"	270					1	83			1	83	1	83	1	83			3
4	DO	39-3360.1	233A	6 X 10	8'-6"	180							1	50									4
5	BLOCKING ON END BENTS	39-6616.12	248A	8 X 12	8'-6"	250			2	160			1	80	2	160	2	160	2	160	2	160	5
6	DO	39-6620.12	248A	10 X 12	8'-6"	320					2	200			2	200	2	200	2	200	2	200	6
7	DO	39-3360.12	248A	6 X 12	8'-5"	190							1	120									7
8	TOP PIECE CENTER BENT	39-6630.12	283A	12 X 12	8'-6"	380	1	120	1	120	1	120	1	120	1	120	1	120	1	120	1	120	8
9	SCAB	39-3952.1	1244	3 X 10	5'-0"	50	4	60	4	60	4	60	4	60	4	60	4	60	4	60	4	60	9
	STRUCTURAL STEEL																						
10	BEARING PLATE	47-7844.1	P1	12 X 1	1'-4"	50	8		6		6		6		6		6		6		10		10
11	DO	47-7844.07	P2	11 X 3/4	1'-3"	35	8		6		6		6		6		6		6		10		11
12	DO	47-7844.1	P1	12 X 1	1'-8"	64			2		2												12
13	DO	47-7844.1	P2	11 X 1	1'-7"	60			2		2												13
14	DO	47-7844.1	P1	15 X 1	1'-8"	85							2		2								14
15	DO	47-7844.1	P2	14 X 1	1'-7"	75							2		2								15
16	DO	47-7844.1	P1	16 X 1	1'-9"	95											2		2				16
17	DO	47-7844.1	P2	15 X 1	1'-8"	85											2		2				17
	STEEL HARDWARE, BLACK																						
18	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-183	B18	3/4	18"	2.6	20		12		12		12		12		12		12		24		18
19	DO	43-2325.07-223	B22	3/4	22"	3.0			8														19
20	DO	43-2325.07-266	B26	3/4	26"	3.6	8		8		16		8		8		8		8				20
21	DO	43-2325.07-306	B30	3/4	30"	4.0							8								8		21
22	DO	43-2325.07-32	B32	3/4	32"	4.2									8		8		8				22
23	DO	43-2325.07-386	B38	3/4	38"	5.0															8		23
24	DO	43-2325.1-18	E18	1	18"	4.8	10		12		12		12		12		12		12		12		24
25	DRIFT BOLT	43-1636.07-2	D20	3/4	20"	2.6	16		16		16		16		16		16		16		16		25



TRANSVERSE ELEVATION



LONGITUDINAL ELEVATION

TIMBER TOWER 13'-4" TO 75'-10" HIGH

COMPANION SHEETS

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SUPPLEMENTAL MATERIALS	178
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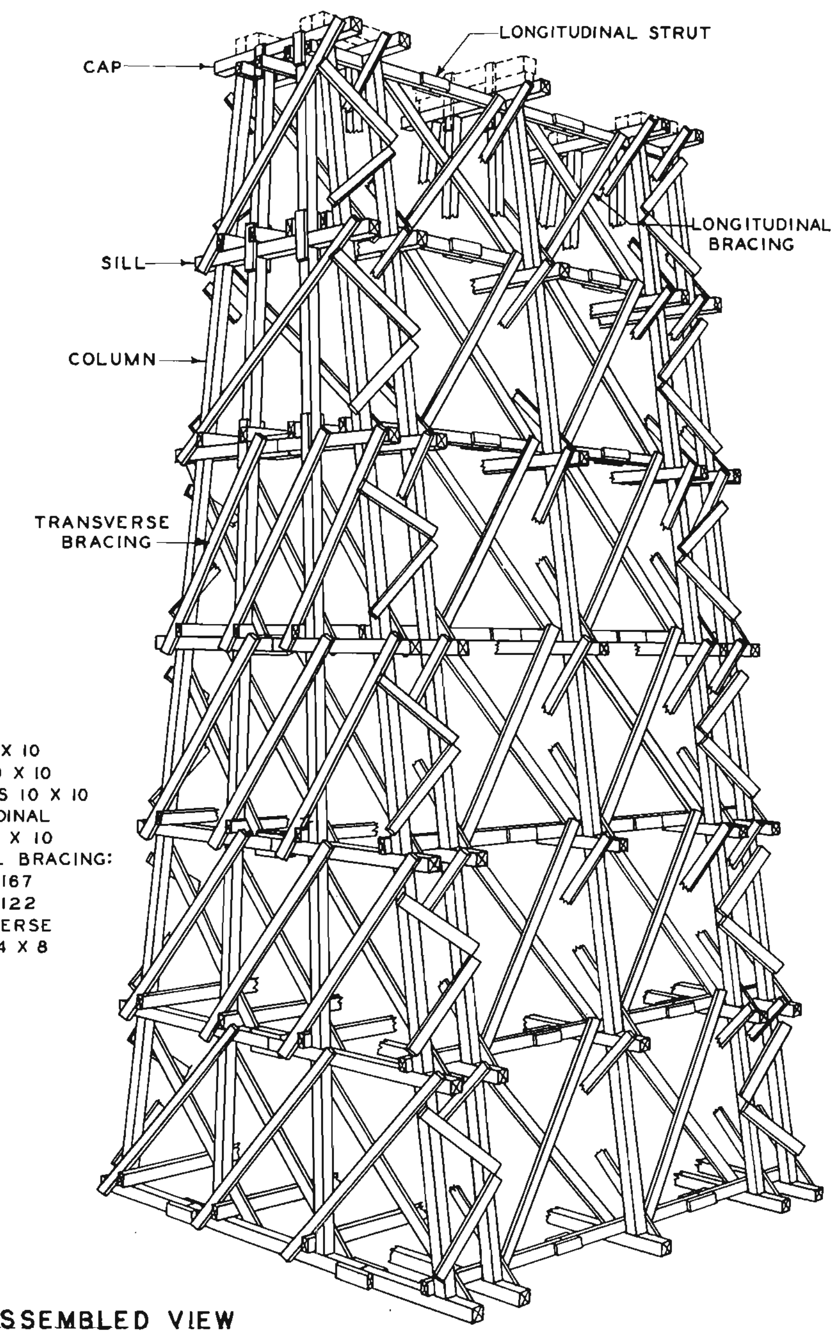
CONCRETE PEDESTALS	214



ASSEMBLED VIEW

NOTES

ALL CAPS 10 X 10
ALL SILLS 10 X 10
ALL COLUMNS 10 X 10
ALL LONGITUDINAL STRUTS 6 X 10
LONGITUDINAL BRACING:
4 X 10 MK 167
3 X 10 MK 122
ALL TRANSVERSE BRACING 4 X 8

COMPANION SHEETS

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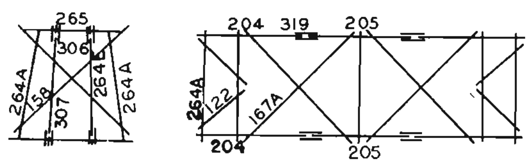
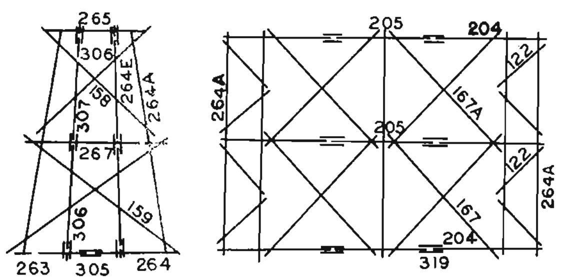
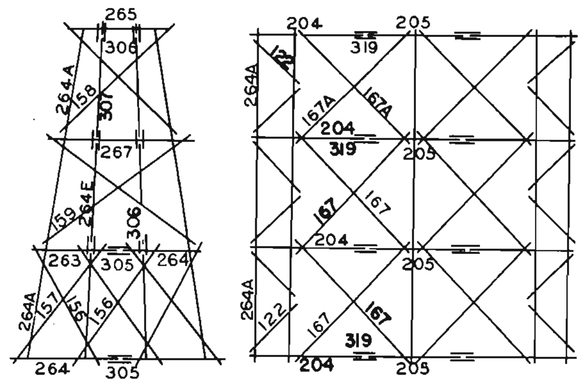


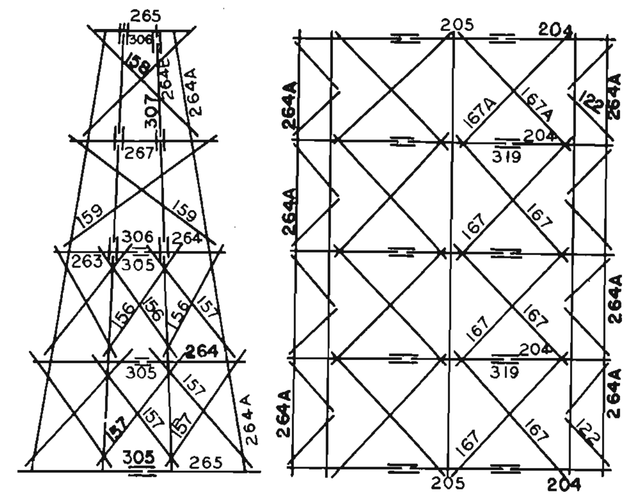
1-STORY TOWER



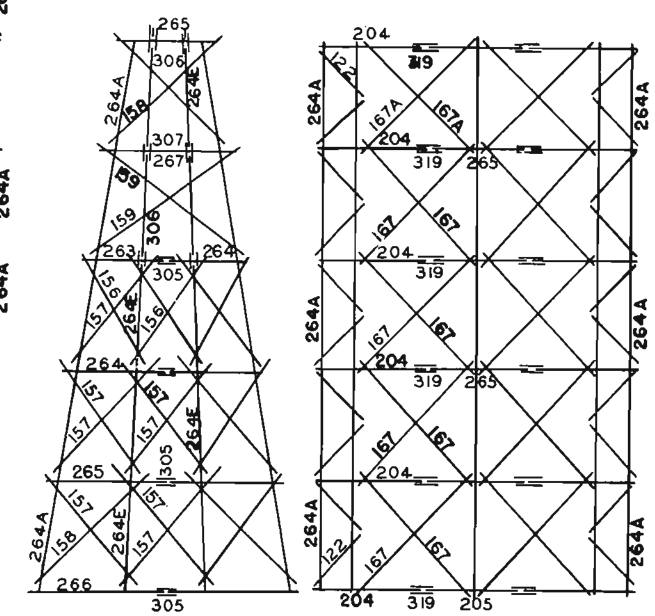
2-STORY TOWER



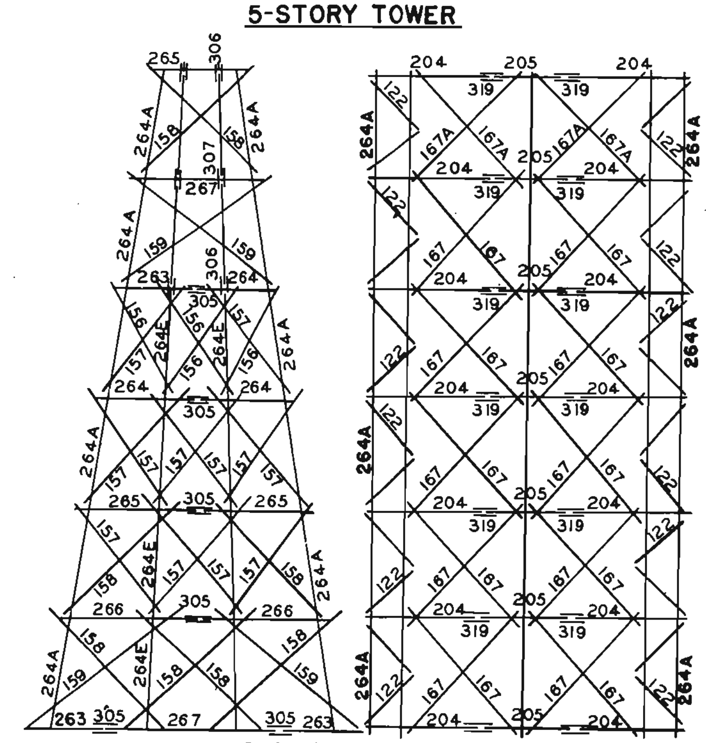
3-STORY TOWER



4-STORY TOWER



5-STORY TOWER



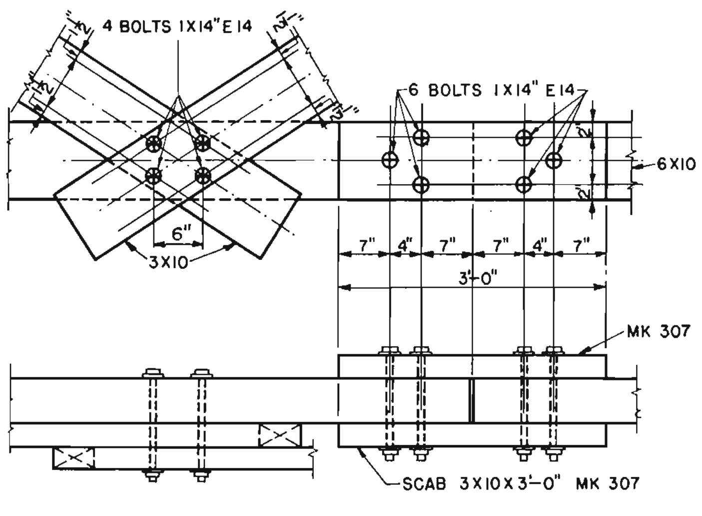
6-STORY TOWER

BILL OF MATERIALS FOR ONE TOWER OF NUMBER OF STORIES INDICATED

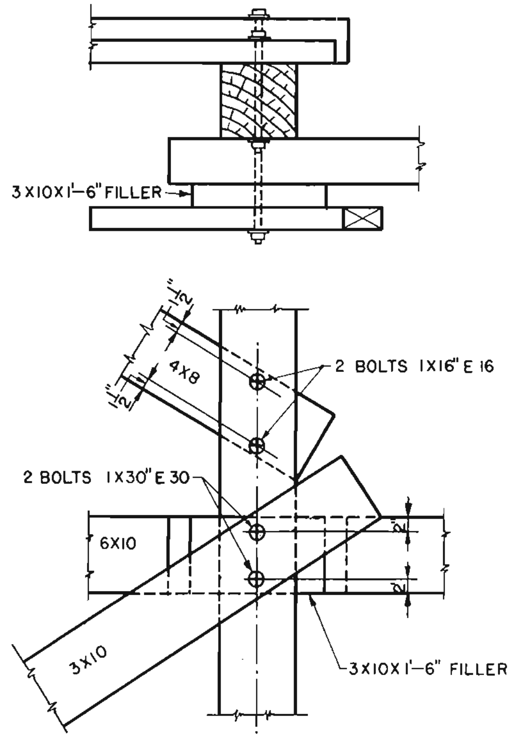
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	6-STORY QUANTITY	6-STORY FBM	5-STORY QUANTITY	5-STORY FBM	4-STORY QUANTITY	4-STORY FBM	3-STORY QUANTITY	3-STORY FBM	2-STORY QUANTITY	2-STORY FBM	1-STORY QUANTITY	1-STORY FBM
	HEIGHT OF TOWER						75'-10"		63'-4"		50'-10"		38'-4"		25'-10"		13'-4"	
	LUMBER, SOFT WOOD																	
1	CAP	39-6620.1-14	265	10 X 10	14'-0"	438	5	583	5	583	5	583	5	583	5	583	5	593
2	SILL	39-6620.1-18	267	10 X 10	18'-0"	563	10	1500	5	750	5	750	5	750	5	750	5	750
3	DO	39-6620.1-16	266	10 X 10	16'-0"	500	10	1333	10	1333								
4	DO	39-6620.1-14	265	10 X 10	14'-0"	438	10	1167	10	1167	10	1167						
5	DO	39-6620.1-12	264	10 X 10	12'-0"	375	15	1500	15	1500	15	1500	15	1500	5	500		
6	DO	39-6620.1-1	263	10 X 10	10'-0"	313	15	1250	5	417	5	417	5	417	5	417		
7	COLUMN	39-6620.1-12	264A	10 X 10	12'-0"	375	60	6000	50	5000	40	4000	30	3000	20	2000	10	1000
8	DO	39-6620.1-12	264E	10 X 10	12'-0"	375	60	6000	50	5000	40	4000	30	3000	20	2000	10	1000
9	STRUT	39-3360.1-14	204	6 X 10	14'-0"	263	56	3920	48	3360	40	2800	32	2240	24	1680	16	1120
10	DO	39-3360.1-12	205	6 X 10	12'-0"	225	28	1680	24	1440	20	1200	16	960	12	720	8	480
11	BRACING	39-3330.1-08	122	3 X 10	8'-0"	75	48	960	40	800	32	640	24	480	16	320	8	160
12	DO	39-3340.08-22	159	4 X 8	22'-0"	220	20	1173	10	587	10	587	10	587	10	587		
13	DO	39-3340.08-2	158	4 X 8	20'-0"	200	40	2133	20	1067	10	533	10	533	10	533	10	533
14	DO	39-3340.08-18	157	4 X 8	18'-0"	180	60	2880	60	2880	40	1920	10	480				
15	DO	39-3340.08-16	156	4 X 8	16'-0"	160	20	853	20	853	20	853	20	853				
16	DO	39-3340.1-18	167A	4 X 10	18'-0"	225	16	960	16	960	16	960	16	960	16	960	16	960
17	DO	39-3340.1-18	167	4 X 10	18'-0"	225	80	4800	64	3840	48	2880	32	1920	16	960		
18	SCAB	39-3340.1	305	4 X 10	3'-0"	38	60	600	40	400	30	300	20	200	10	100		
19	DO	39-3330.1	319	3 X 10	3'-8"	34	112	1027	96	880	80	733	64	587	48	440	32	293
20	DO	39-3952.1	307	3 X 10	3'-0"	28	20	150	20	150	20	150	20	150	20	150	20	150
21	DO	39-3330.1	306	3 X 10	2'-0"	19	36	180	36	180	36	180	36	180	36	180	16	80
	STEEL HARDWARE, BLACK																	
22	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.6	300		210		150		90		40			
23	DO	43-2325.1-18	E18	1	18"	5.1	488		436		384		332		280		186	
24	DO	43-2325.1-164	E16	1	16"	4.7	984		812		640		468		276		124	
25	DO	43-2325.1-144	E14	1	14"	4.3	672		576		480		384		288		192	
26	DO	43-2325.1-124	E12	1	12"	3.8	96		96		96		96		96		96	
27	DRIFT BOLT, PLAIN	43-2325.07-2	D20	3/4	20"	2.5	320		260		200		140		80		40	

COMPANION SHEETS

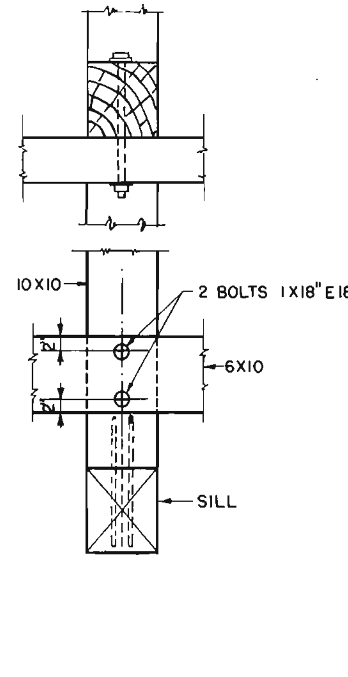
	SHEET
TIMBER TOWERS FOR TIMBER SPANS	175
TIMBER TOWERS FOR STEEL SPANS	179
BILL OF MATERIALS	176
BILL OF MATERIALS	180
GENERAL NOTES	154
SYMBOLS	155



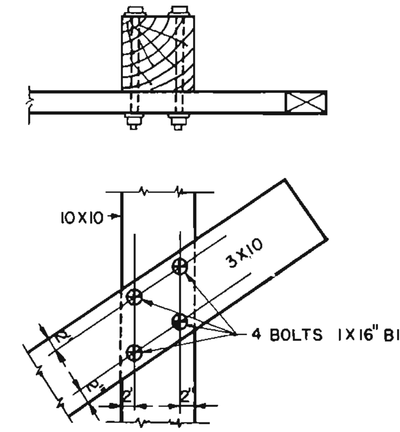
DETAIL 30



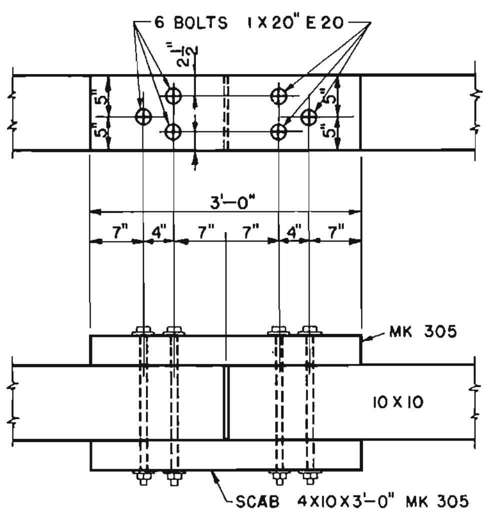
DETAIL 31



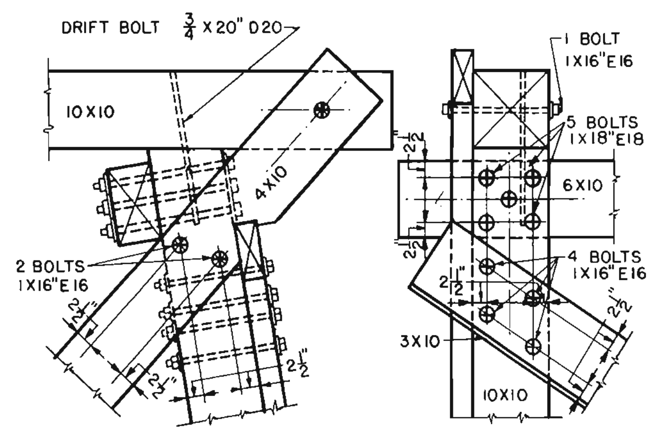
DETAIL 32



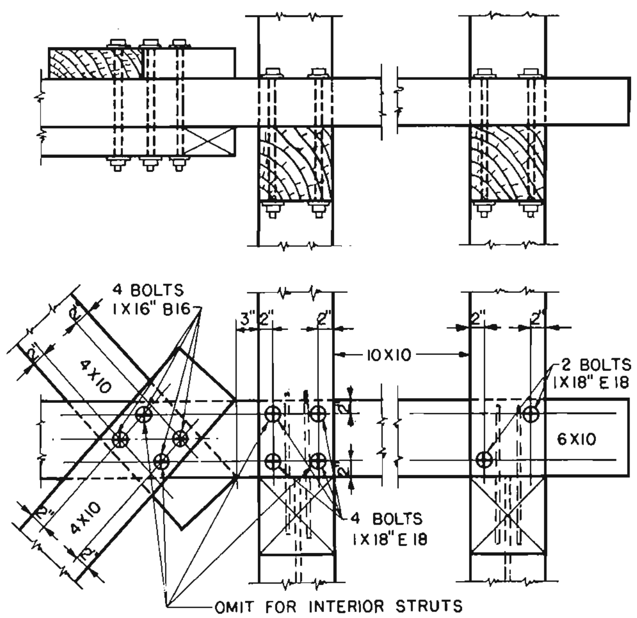
DETAIL 50



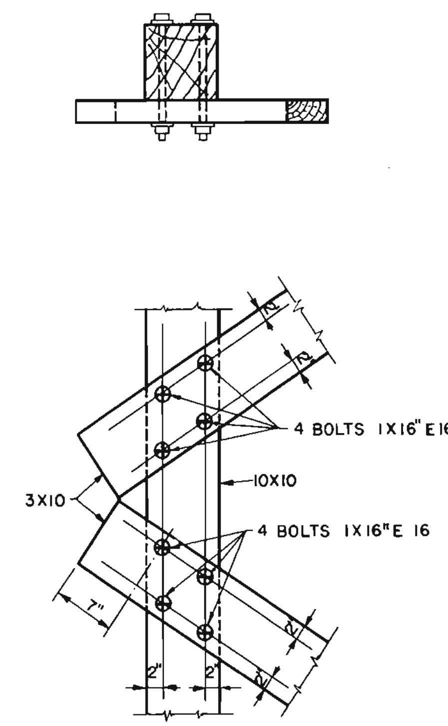
DETAIL 33



DETAIL 34



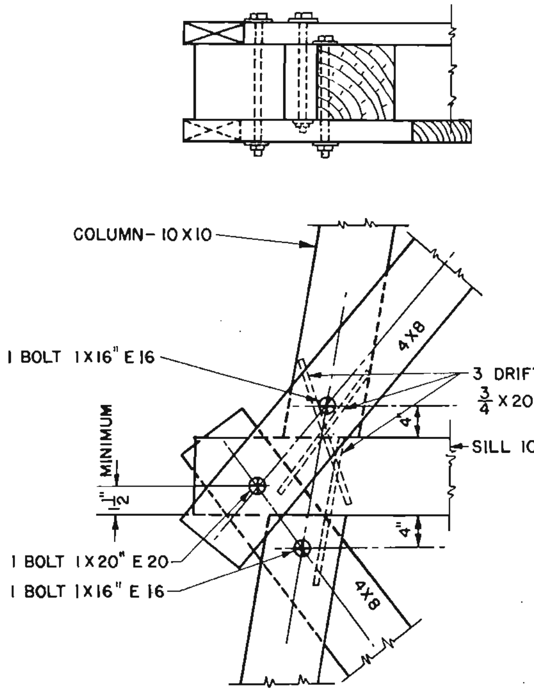
DETAIL 48



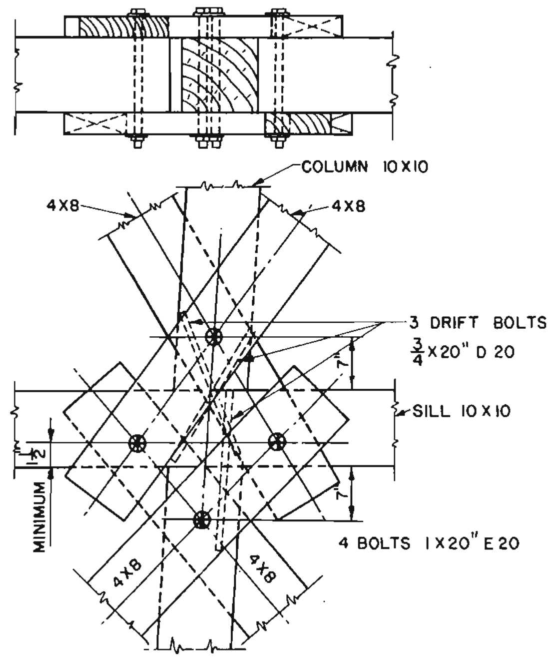
DETAIL 49

COMPANION SHEETS

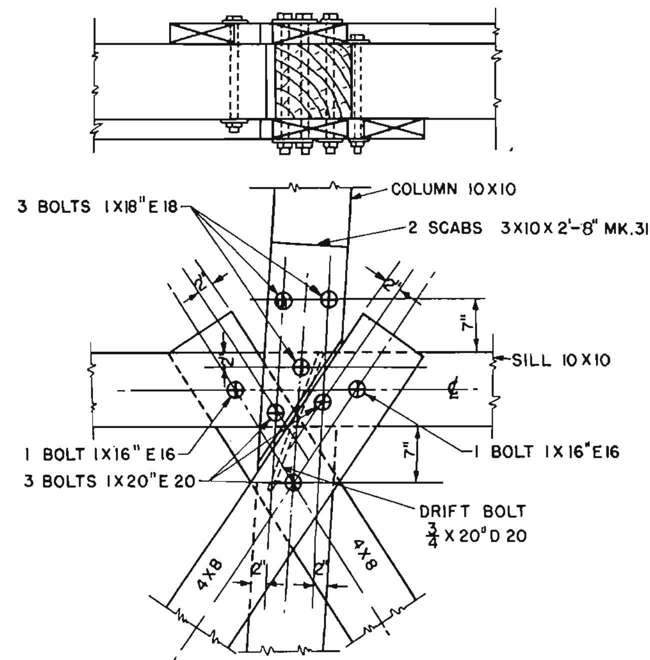
	SHEET
TIMBER TOWERS FOR TIMBER SPANS	175
TIMBER TOWERS FOR STEEL SPANS	179
BILL OF MATERIAL	176 AND 180
GENERAL NOTES	154
SYMBOLS	155



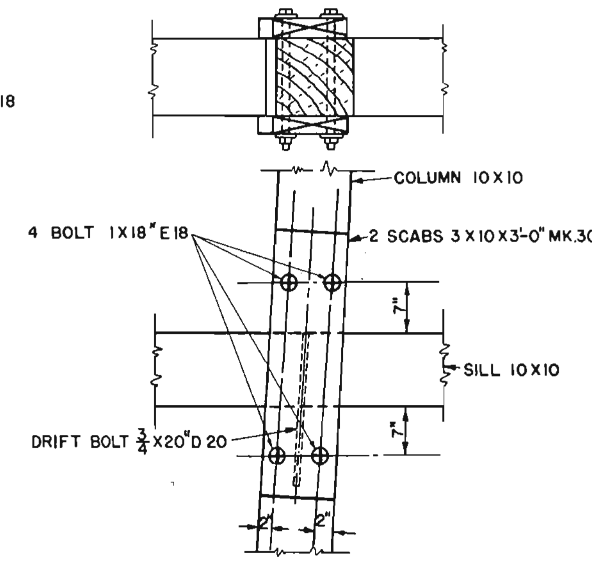
DETAIL 21



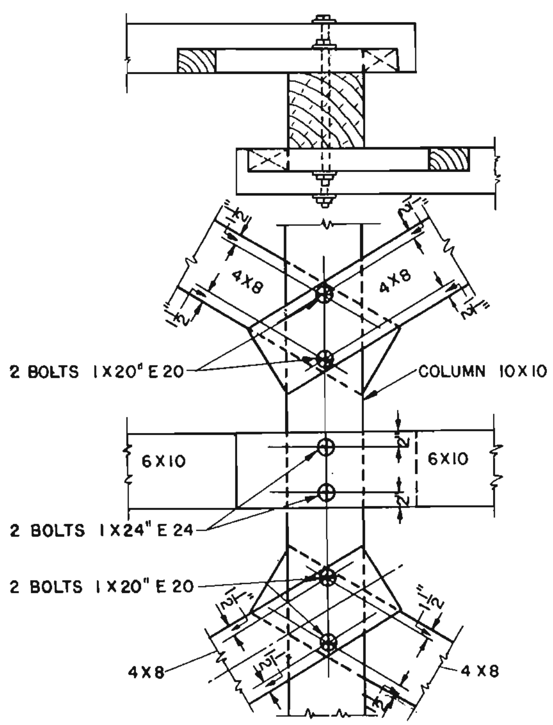
DETAIL 22



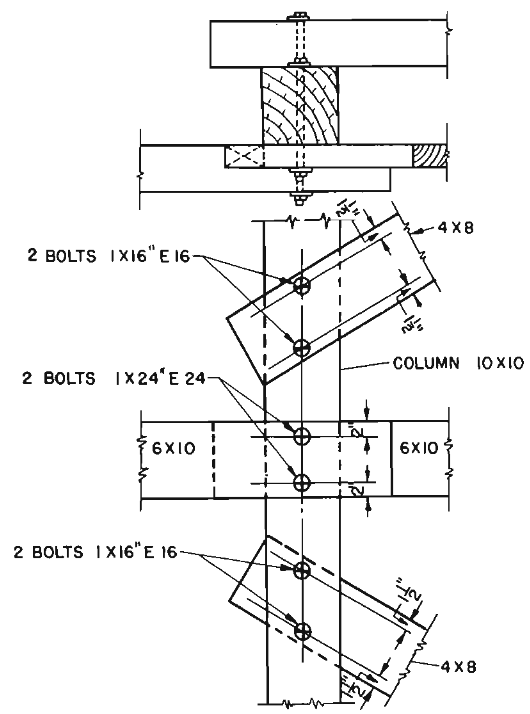
DETAIL 23



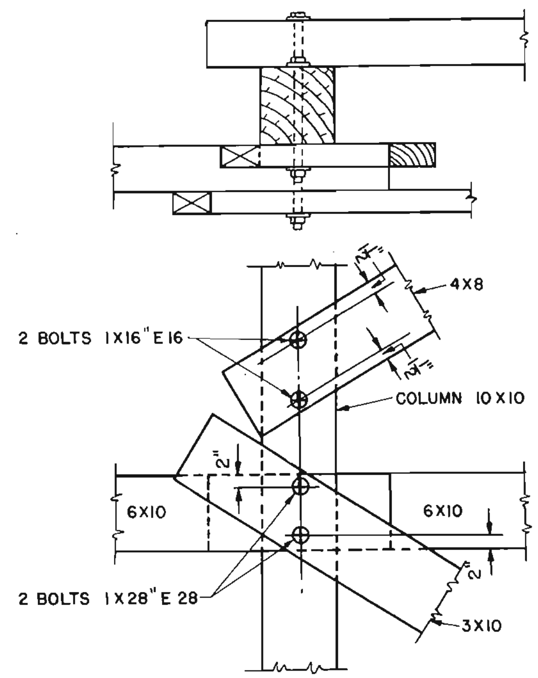
DETAIL 24



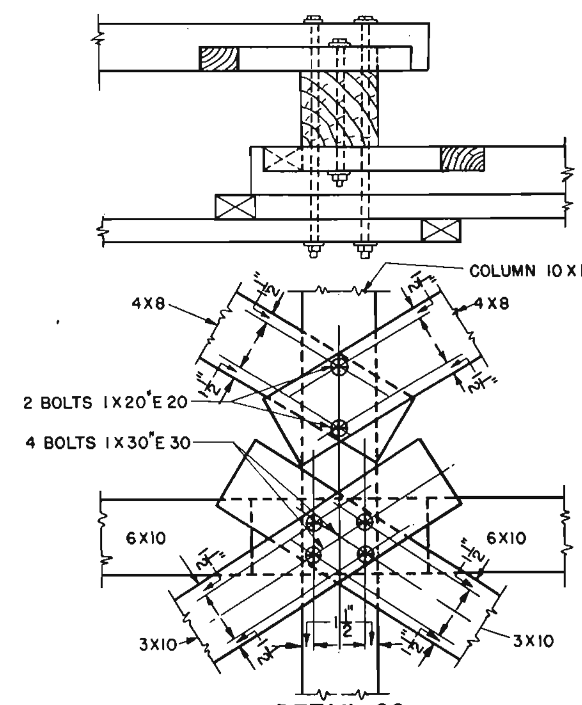
DETAIL 26



DETAIL 27



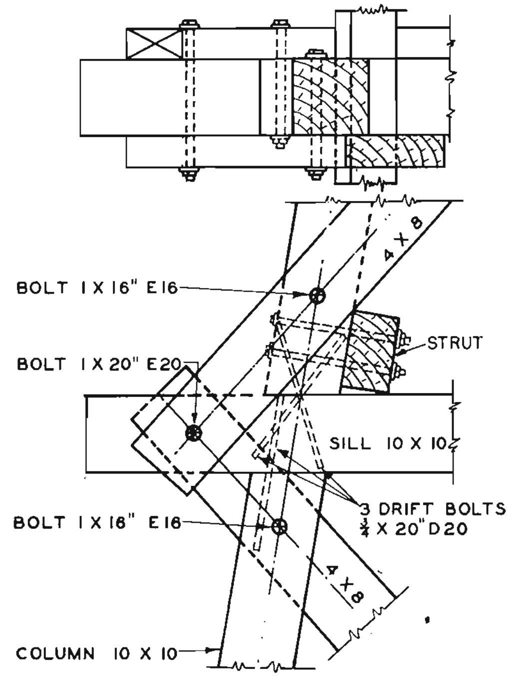
DETAIL 28



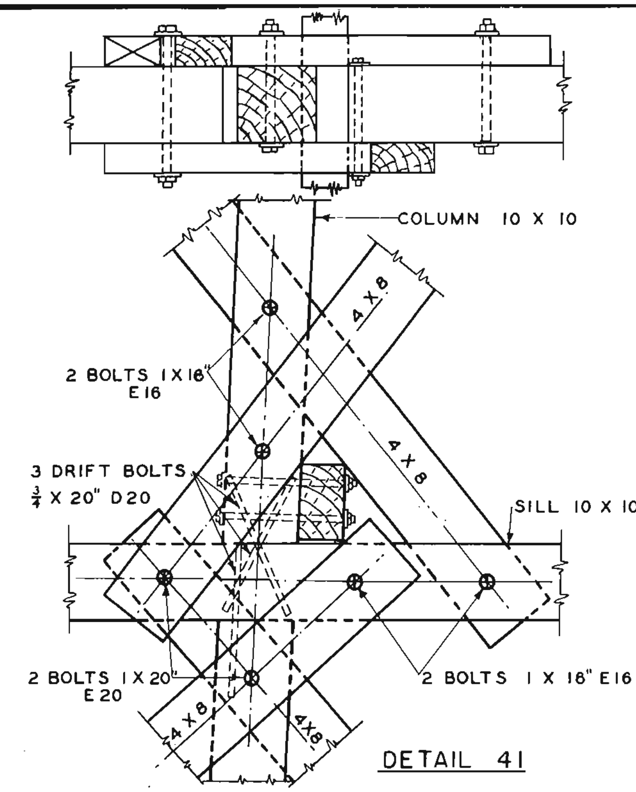
DETAIL 29

COMPANION SHEETS

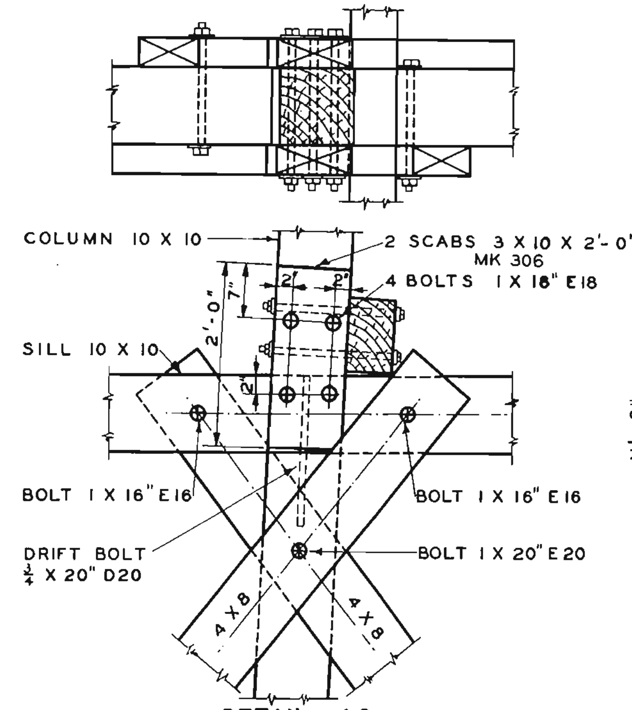
	SHEET
TIMBER TOWERS FOR TIMBER SPANS	175
TIMBER TOWERS FOR STEEL SPANS	179
BILL OF MATERIALS TIMBER TOWERS	180
SUPPLEMENTAL MATERIALS	177,178
CONNECTIONS AND CUTTING DIAGRAMS	181,182
GENERAL NOTES	154
SYMBOLS	155



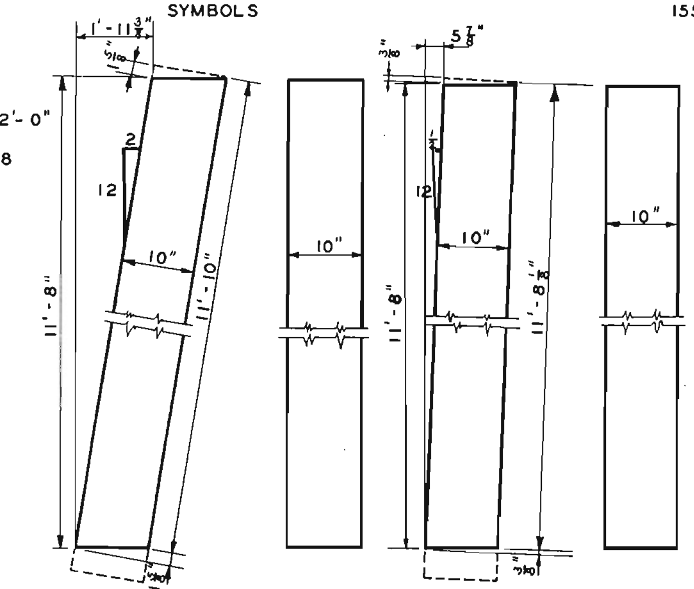
DETAIL 40



DETAIL 41

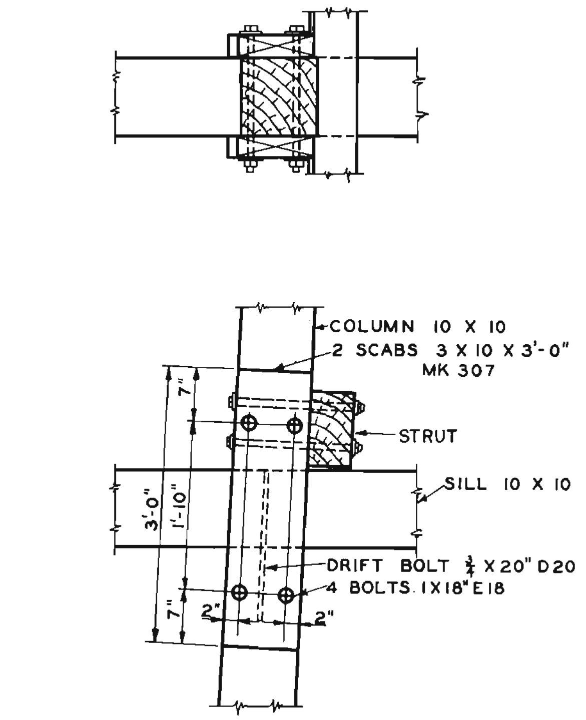


DETAIL 42

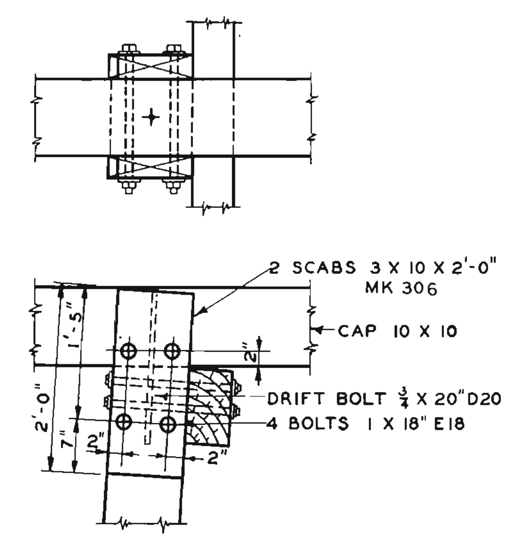


COLUMN 264A

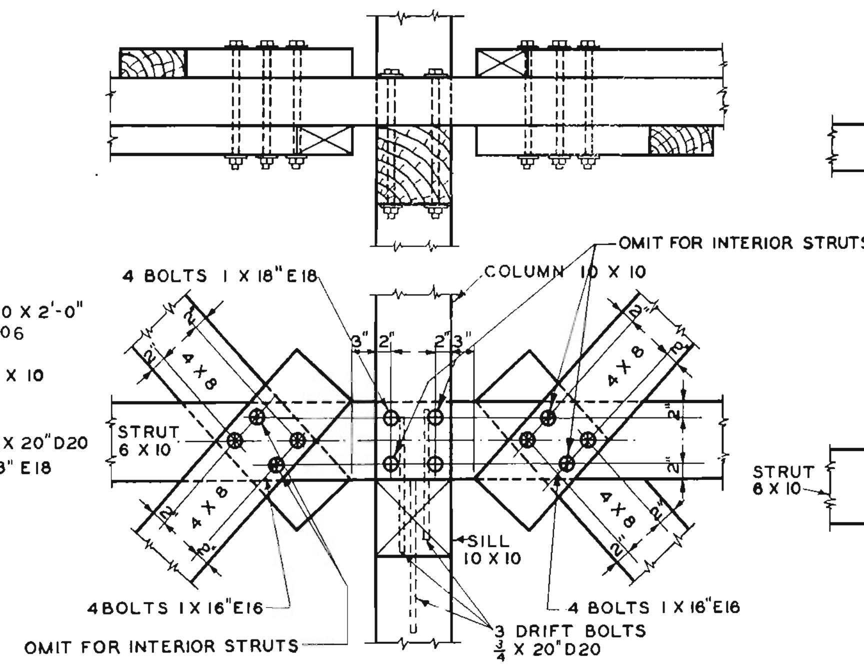
COLUMN 264E



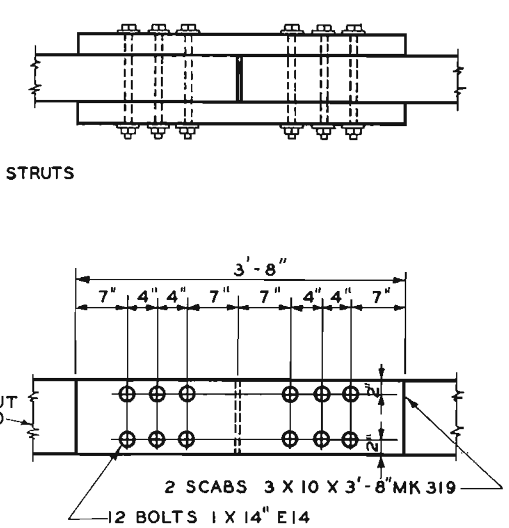
DETAIL 43



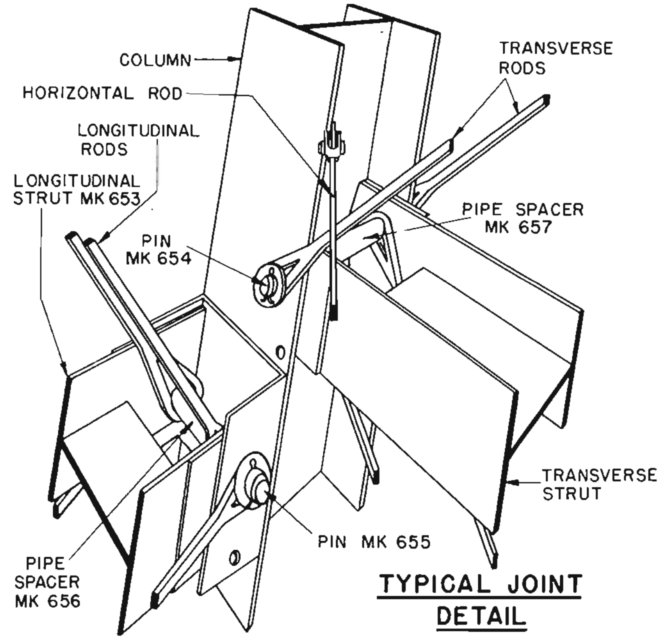
DETAIL 44



DETAIL 46



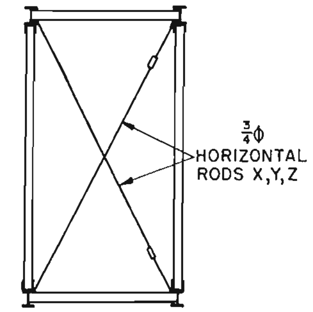
DETAIL 47



TYPICAL JOINT DETAIL

TABULATION OF TOWER DIMENSIONS AND ERECTION MARKS

		FOUR STORY TOWER				
HEIGHT		77'	75'	73'	71'	69'
BASE		34'-3"	33'-7"	32'-11"	32'-3"	31'-7"
A	MARK	1728	1730	1729	1731	1732
	DIMENSION	18'-3"	17'-8 7/8"	17'-2 7/8"	16'-8 3/4"	16'-2 5/8"
B	MARK	1741	1742	1743	1751	1752
	DIMENSION	18'-3"	17'-8 7/8"	17'-2 7/8"	16'-8 3/4"	16'-2 5/8"
C	MARK	1756	1760	1761	1757	1762
	DIMENSION	18'-3"	17'-8 7/8"	17'-2 7/8"	16"-8 3/4"	16'-2 5/8"
D	MARK	1709	1710	1711	1712	1713
	DIMENSION	14'-9"	14'-7"	14'-5"	14'-3"	14'-1"
E	MARK	1694	1695	1696	1698	1697
	DIMENSION	20'-9"	20'-5"	20'-1"	19'-9"	19'-5"
F	MARK	1681	1771	1685	1686	1687
	DIMENSION	26'-9"	26'-3"	25'-9"	25'-3"	24'-9"
G	MARK	1674	1675	1676	1769	1770
	DIMENSION	32'-9"	32'-1"	31'-5"	30'-9"	30'-1"
H	MARK	848	850	852	853	854
	DIMENSION	21'-6"	21'-0 3/8"	20'-6 7/8"	20'-1 3/8"	19'-7 7/8"
J	MARK	831	833	836	838	842
	DIMENSION	25'-3 3/8"	24'-9"	24'-2 5/8"	23'-8 1/4"	23'-2"
K	MARK	803	807	812	816	820
	DIMENSION	29'-9 5/8"	29'-2"	28'-6 3/8"	27'-10 7/8"	27'-3 1/4"
L	MARK	743	752	765	775	785
	DIMENSION	34'-9 1/4"	34'-0 1/8"	33'-3 1/8"	32'-6"	31'-8 7/8"
M	MARK	1028	1030	1031	1032	1033
	DIMENSION	29'-8 1/4"	29'-4 1/2"	29'-0 7/8"	28'-9 3/8"	28'-5 7/8"
N	MARK	1028	1030	1031	1032	1033
	DIMENSION	29'-8 1/4"	29'-4 1/2"	29'-0 7/8"	28'-9 3/8"	28'-5 7/8"
X	MARK	981	982	983	984	985
	DIMENSION	27'-0 7/8"	26'-11 7/8"	26'-10 7/8"	26'-9 7/8"	26'-9"
Y	MARK	968	969	970	971	973
	DIMENSION	30'-6 1/8"	30'-3 5/8"	30'-1 1/8"	29'-10 5/8"	29'-8 1/8"
Z	MARK	955	959	960	963	964
	DIMENSION	34'-7 3/4"	34'-3 1/4"	33'-11"	33'-6 5/8"	33'-2 3/8"

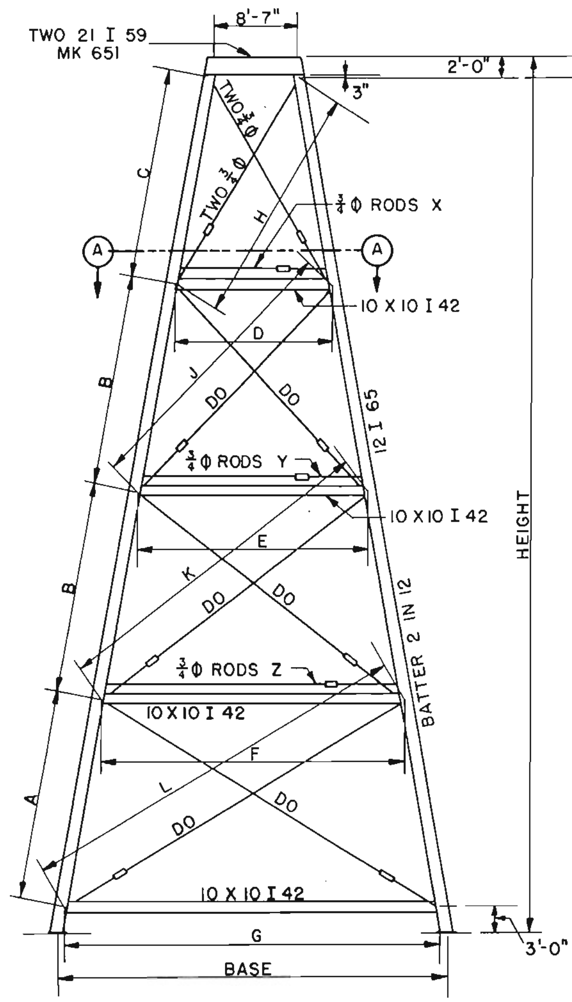


SECTION A-A

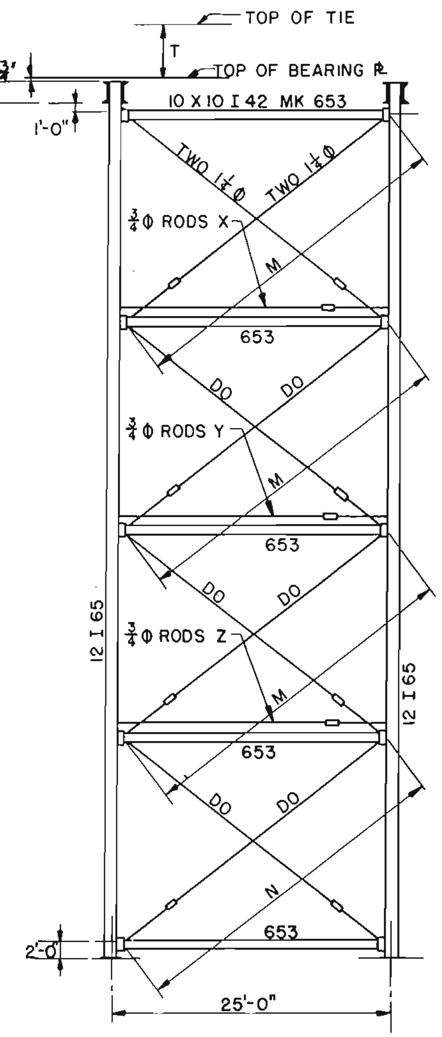
DIMENSION T	
SPAN LENGTH	TOP OF TIE TO TOP OF BEARING ℙ
15'-0"	2'-5"
20'-0"	2'-10 7/8"
25'-0"	3'-5"
30'-0"	3'-7 7/8"
SPECIAL 30'-0"	2'-5"
35'-0"	3'-8 3/8"
40'-0"	3'-8 3/8"
45'-0"	3'-7 7/8"

COMPANION SHEETS

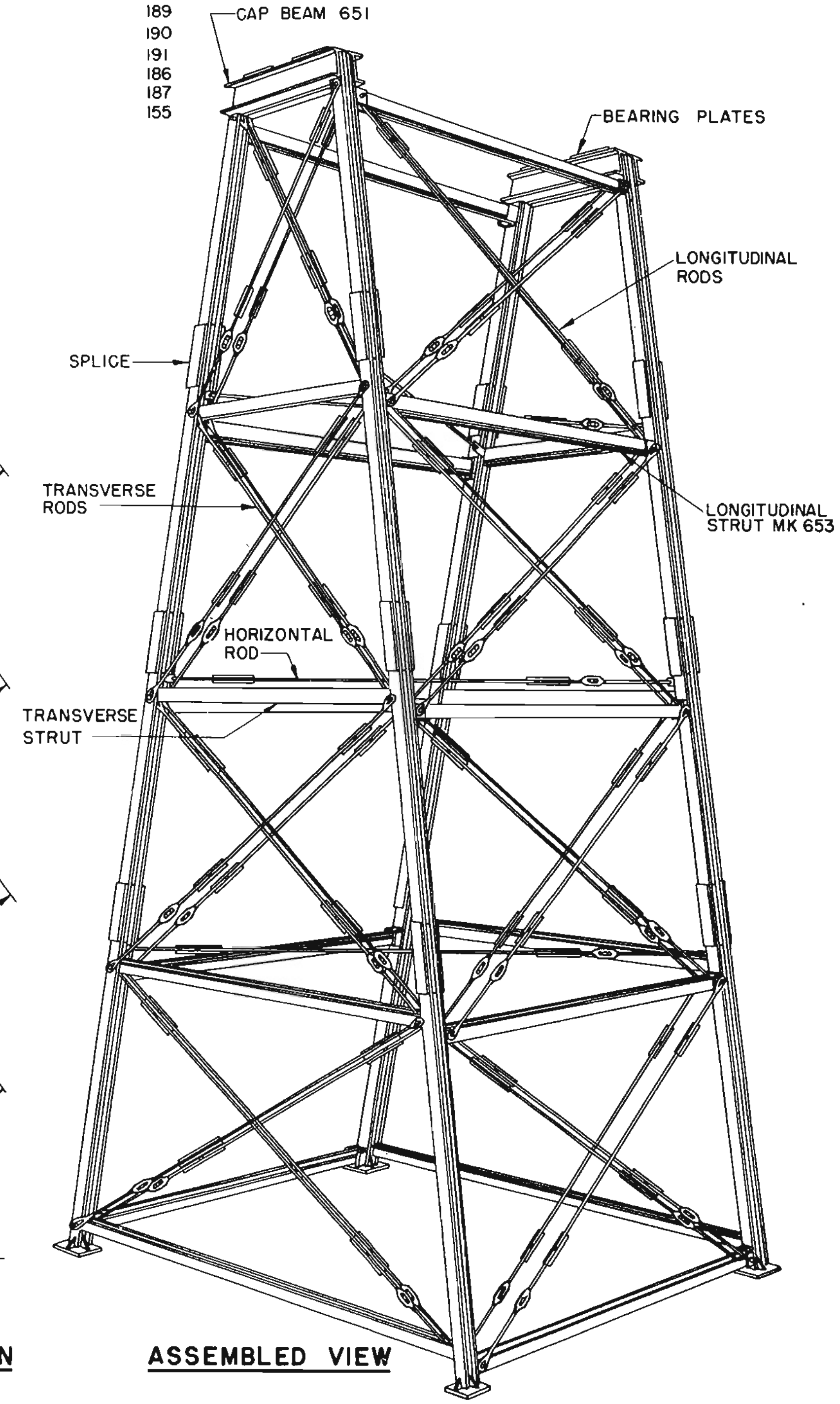
	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	185
TOWER MEMBERS	188
COLUMNS	189
STRUTS AND COLUMNS	190
ROD BRACING	191
BILL OF MATERIALS	186
BILL OF MATERIALS	187
SYMBOLS	155



TRANSVERSE ELEVATION

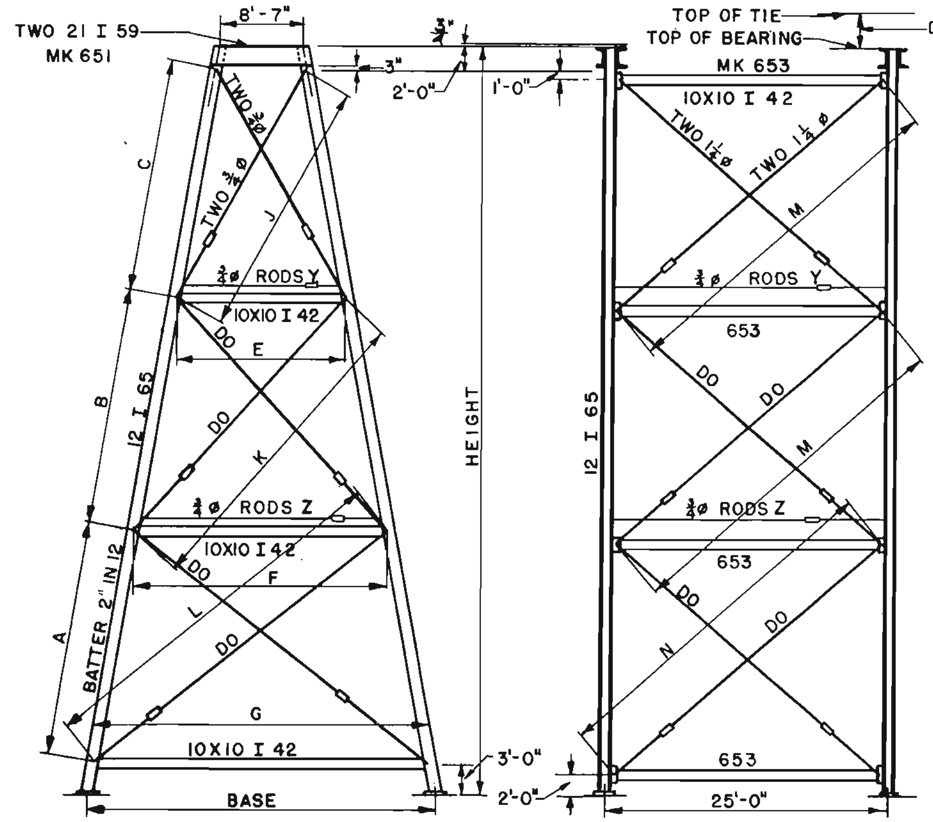


LONGITUDINAL ELEVATION

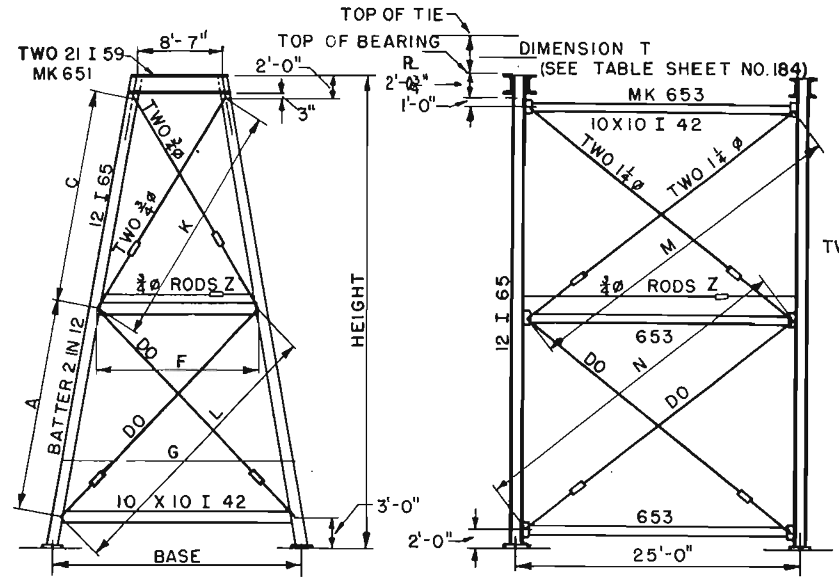


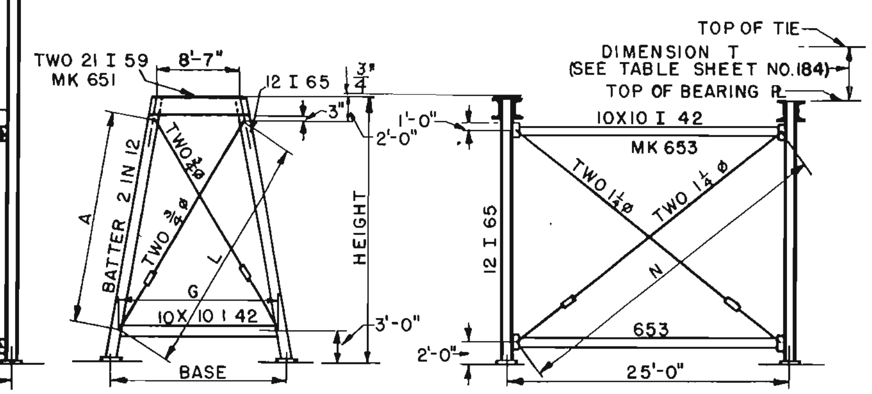
ASSEMBLED VIEW

ONE- TO THREE-STORY TOWERS, 15 TO 67 FEET HIGH, GENERAL VIEWS AND DIMENSIONS



PIN AND PIPE SPACER MARK 655 AND 656
ON LONGITUDINAL STRUT CONNECTIONS
PIN AND PIPE SPACER MARK 654 AND 657
AT TRANSVERSE STRUT CONNECTIONS
SEE TYPICAL JOINT DETAIL SHEET 184





COMPANION SHEETS

	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	184
TOWER MEMBERS	188
COLUMNS	189
STRUTS AND COLUMNS	190
ROD BRACING	191
BILL OF MATERIALS	186
BILL OF MATERIALS	187
SHIMS	192
SYMBOLS	155

TABULATION OF TOWER DIMENSIONS AND ERECTION MARKS

THREE-STORY TOWER

HEIGHT		67'	65'	63'	61'	59'	57'	55'	53'	51'
BASE		30'-11"	30'-3"	29'-7"	28'-11"	28'-3"	27'-7"	26'-11"	26'-3"	25'-7"
A	MARK	1734	1735	1736	1728	1728	1729	1729	1732	1733
	DIMENSION	22'-3 5/8"	20'-3¼"	11'-3 1/8"	18'-3"	18'-3"	17'-2 7/8"	17'-2 7/8"	16'-2 5/8"	15'-2½"
B	MARK	1746	1746	1747	1748	1749	1750	1751	1752	1753
	DIMENSION	20'-3¼"	20'-3¼"	19'-9¼"	19'-3 1/8"	18'-3"	17'-8 7/3"	16'-8 3/4"	16'-2 5/8"	15'-8 5/8"
C	MARK	1767	1767	1758	1759	1756	1760	1757	1762	1763
	DIMENSION	20'-3¼"	20'-3¼"	19'-9¼"	19'-3 1/8"	18'-3"	17'-8 7/3"	16'-8 3/4"	16'-2 5/8"	15'-8 5/8"
E	MARK	1706	1706	1707	1708	1709	1710	1712	1713	1714
	DIMENSION	15'-5"	15'-5"	15'-3"	15'-1"	14'-9"	14'-7"	14'-3"	14'-1"	13'-11"
F	MARK	1691	1691	1692	1693	1694	1695	1698	1697	1699
	DIMENSION	22'-1"	22'-1"	21'-9"	21'-5"	20'-9"	20'-5"	19'-9"	19'-5"	19'-1"
G	MARK	1677	1678	1679	1680	1681	1683	1684	1687	1688
	DIMENSION	29'-5"	28'-9"	28'-1"	27'-5"	26'-9"	26'-1"	25'-5"	25'-9"	24'-1"
J	MARK	839	839	844	846	848	850	853	854	858
	DIMENSION	23'-4 3/8"	23'-4 3/8"	22'-10 3/4"	22'-5 1/8"	21'-6"	21'-0 3/8"	20'-1 3/8"	19'-7 7/8"	19'-2 3/8"
K	MARK	817	822	824	826	831	833	838	842	845
	DIMENSION	27'-5 3/8"	27'-5"	26'-10½"	26'-4 1/8"	25'-3 3/8"	24'-9"	23'-8¼"	23'-2"	22'-7 5/8"
L	MARK	756	778	789	796	803	810	815	820	827
	DIMENSION	33'-10¼"	32'-4 1/8"	31'-4"	30'-4"	29'-9 5/8"	28'-9 5/8"	28'-3¼"	27'-3¼"	26'-3 3/8"
M	MARK	1025	1025	1027	1026	1028	1030	1032	1033	1035
	DIMENSION	30'-11 3/4"	30'-11 3/4"	30'-7 3/4"	30'-3 7/8"	29'-8¼"	29'-4½"	28'-9 3/8"	28'-5 7/8"	28'-2 3/8"
N	MARK	1023	1025	1026	1028	1028	1031	1031	1033	1036
	DIMENSION	32'-4 1/8"	30'-11 3/4"	30'-3 7/8"	29'-8¼"	29'-8¼"	29'-0 7/8"	29'-0 7/8"	28'-5 7/8"	27'-11"
CLEVIS ROD Y	MARK	978	978	979	980	981	982	984	985	987
	DIMENSION	27'-5"	27'-5"	27'-3 7/8"	27'-2 7/8"	27'-0 7/8"	26'-11 7/8"	26'-10"	26'-9"	26'-8"
CLEVIS ROD Z	MARK	965	965	966	967	968	969	971	973	975
	DIMENSION	31'-4½"	31'-4½"	31'-1 7/8"	30'-11¼"	30'-6 1/8"	30'-3 5/8"	29'-10 5/8"	29'-8 1/8"	29'-5 3/4"

TWO-STORY TOWER

HEIGHT		49'	47'	45'	43'	41'	39'	37'	35'	33'
BASE		24'-11"	24'-3"	23'-7"	22'-11"	22'-3"	21'-7"	20'-11"	20'-3"	19'-7"
A	MARK	1734	1738	1735	1739	1728	1729	1732	1733	1740
	DIMENSION	22'-3 5/8"	21'-3½"	20'-3¼"	19'-3 1/8"	18'-3"	17'-2 3/4"	16'-2 5/8"	15'-2½"	14'-2 3/8"
B	MARK									
	DIMENSION									
C	MARK	1765	1766	1767	1759	1756	1761	1762	1764	1768
	DIMENSION	22'-3 5/8"	21'-3½"	20'-3¼"	19'-3 1/8"	18'-3"	17'-2 3/4"	16'-2 5/8"	15'-2½"	14'-2 1/8"
E	MARK									
	DIMENSION									
F	MARK	1704	1705	1706	1708	1709	1711	1713	1715	1716
	DIMENSION	16'-1"	15'-9"	15'-5"	15'-1"	14'-9"	14'-5"	14'-1"	13'-9"	13'-5"
G	MARK	1689	1690	1691	1693	1694	1696	1697	1700	1701
	DIMENSION	23'-5"	22'-9"	22'-1"	21'-5"	20'-9"	20'-1"	19'-5"	18'-9"	18'-1"
J	MARK									
	DIMENSION									
K	MARK	831	835	839	846	848	852	854	859	860
	DIMENSION	25'-3 3/8"	24'-3 3/4"	23'-4 3/8"	22'-5 1/8"	21'-6"	20'-6 7/8"	19'-7 7/8"	18'-9"	17'-10¼"
L	MARK	804	813	818	826	831	836	842	847	849
	DIMENSION	29'-6 3/4"	28'-5 7/8"	27'-5"	26'-4 1/8"	25'-3 3/8"	24'-2 5/8"	23'-2"	22'-1 3/8"	21'-0 7/8"
M	MARK	1023	1024	1025	1026	1028	1031	1033	1036	1037
	DIMENSION	32'-4 1/8"	31'-7 3/4"	30'-11 3/4"	30'-3 7/8"	29'-8¼"	29'-0 7/8"	28'-5 7/8"	27'-11"	27'-4 5/8"
N	MARK	1023	1024	1025	1026	1028	1031	1033	1036	1037
	DIMENSION	32'-4 1/8"	31'-7 3/4"	30'-11 3/4"	30'-3 7/8"	29-8¼"	29'-0 7/8"	28'-5 7/8"	27'-11"	27'-4 5/8"
CLEVIS ROD Y	MARK									
	DIMENSION									
CLEVIS ROD Z	MARK	976	977	978	980	981	983	985	986	988
	DIMENSION	27'-9 1/8"	27'-7"	27'-5"	27'-2 7/8"	27'-0 7/8"	26'-10 7/8"	26'-9"	26'-7"	26'-5"

ONE-STORY TOWER

HEIGHT		31'	29'	27'	25'	23'	21'	19'	17'	15'
BASE		18'-11"	18'-3"	17'-7"	16'-11"	16'-3"	15'-7"	14'-11"	14'-3"	13'-7"
A	MARK	1719	1720	1721	1722	1723	1724	1725	1726	1727
	DIMENSION	26'-4¼"	24'-4"	22'-3 5/8"	20'-3¼"	18'-3"	16'-2 5/8"	14'-2 3/8"	12'-2"	10'-1 5/8"
B	MARK									
	DIMENSION									
C	MARK									
	DIMENSION									
E	MARK									
	DIMENSION									
F	MARK									
	DIMENSION									
G	MARK	1702	1703	1704	1706	1709	1713	1716	1717	1718
	DIMENSION	17'-5"	16'-9"	16'-1"	15'-5"	14'-9"	14'-1"	13'-5"	12'-9"	12'-1"
J	MARK									
	DIMENSION									
K	MARK									
	DIMENSION									
L	MARK	808	821	831	839	848	854	860	861	862
	DIMENSION	29'-1¼"	27'-2 1/8"	25'-3 3/8"	23'-4 3/8"	21'-6"	19'-7 7/8"	17'-10¼"	16'-1 3/8"	14'-5¼"
M	MARK									
	DIMENSION									
N	MARK	1021	1022	1023	1025	1028	1033	1037	1038	1039
	DIMENSION	35'-3 1/8"	33'-9¼"	32'-4 1/8"	30'-11 3/4"	29'-8¼"	28'-5 7/8"	27'-4 5/8"	26'-4 5/8"	25'-6¼"
CLEVIS ROD Y	MARK									
	DIMENSION									
CLEVIS ROD Z	MARK									
	DIMENSION									

COMPANION SHEETS

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TABLE B – BILL OF MATERIALS COMMON TO ALL TOWERS

LINE	DESCRIPTION	STOCK NUMBER	MARK	DETAILED ON SHEET NO	SIZE (INCHES)	LENGTH	TOWER HEIGHT GROUP CLASSIFICATION: 4-STORY 69' TO 79'		3-STORY 51' TO 67'		2-STORY 33' TO 49'		ONE-STORY 15' TO 31'	
							NUMBER	UNIT WEIGHT (POUNDS)	NUMBER	UNIT WEIGHT (POUNDS)	NUMBER	UNIT WEIGHT (POUNDS)	NUMBER	UNIT WEIGHT (POUNDS)
1	CAP BEAM	48-2900.21-059	651	188	21 I 59	10'-3"	4	605	4	605	4	605	4	605
2	BEARING PLATE	47-7844.07-7	P6	188	PL 21 X 3/4	3'-4"	4	179	4	179	4	179	4	179
3	DIAPHRAGM	48-2900.12-065	D1	188	12 I 65	1'-6"	4	98	4	98	4	98	4	98
4	RIVETS IN BEARING PLATE	43-6353.08		188	7/8	2' 3/4"	32	.66	32	.66	32	.66	32	.66
5	RIVETS IN WEB OF CAP	43-6353.08-25		188	7/8	2 1/2"	176	.62	176	.62	176	.62	176	.62
6	LONGITUDINAL STRUT		653	188	10 I 42	23'-10"	10	1000	8	1000	6	1000	4	1000
7	PIN PLATE	47-7844.04-1	P8	188	PL 9 X 3/8	0'-10"	40	10	32	10	24	10	16	10
8	PIN PLATE	47-7844.04-1	P5	190	PL 9 X 3/8	0'-10"	32	10	24	10	16	10	8	10
9	COLUMN BASE PLATE	47-7844.1-5	P4	189.190	PL 24 X 1	2'-0"	4	163	4	163	4	163	4	163
10	STIFFENERS	47-7844.04-14	P9.10.11	189	PL 6 X 3/8	1'-11½"	4	15	4	15	4	15		
11	STIFFENERS	47-7844.04-14	P12.13.14	190	PL 6 X 3/8	1'-11½"							4	15
12	BRACING CONNECTOR	48-2900.12-065	C1	189.190	12 I 65	1'-1 1/4"	20	46	16	46	12	45	8	46
13	DO	47-7844.05-22	P3	189	PL 4 X 1/2	1'-0"	12	7	8	7	4	7		
14	WEB SPLICE	47-7844.05-22	P1	189	PL 10 X 1/2	3'-0 1/2"	24	52	16	52	8	52		
15	FLANGE SPLICE	47-7844.05-22	P2	189	PL 12 X 1/2	3'-6 1/2"	24	72	16	72	8	72		
16	RIVETS, WEB SPLICE	43-6353.08-3		189	7/8	3"	288	.70	192	.70	96	.70		
17	RIVETS, FLANGE SPLICE	43-6353.08		189	7/8	2 3/4"	672	.66	448	.66	224	.66		
18	[1] PIN		654	188	1 1/2	1'-4 1/2"	20	8	16	8	12	8	8	8
19	[2] PIN		655	188	2	1'-5 1/2"	20	16	16	16	12	16	8	16
20	[1] COTTER PIN			188	1/4 X 2 1/2		40	.1	32	.1	24	.1	16	.1
21	[2] COTTER PIN			188	3/8 X 3		40	.25	32	.25	24	.25	16	.25
22	[2] PIPE SPACER	44-6246.7-02	656	188	4	0'-6 1/8"	20	5.5	16	5.5	12	5.5	8	5.5
23	[1] PIPE SPACER	44-6246.7-08	657	188	2	0'-6 5/8"	20	2	16	2	12	2	8	2
24	[1] WASHER		658	188	3 3/4 X 1 9/16 HOLE	3¾	72	1.24	64	1.24	56	1.24	48	1.24
25	[2] WASHER		659	188	4 3/4 X 2 1/16 HOLE	4¾	88	1.97	80	1.97	72	1.97	64	1.97
26	[3] LOOP ROD, LONGITUDINAL, UPSET			188	1 1/8 □	4'-7"	64	26	48	26	32	26	16	26
27	SPLICE ROD	46-6375.5-13		188	1 1/4 ⌀	1'-1"	128	4.5	96	4.5	64	4.5	32	4.5
28	[3] TURNBUCKLE			188	1 5/8	6"	32	5.9	24	5.9	16	5.9	8	5.9
29	[4] LOOP ROD TRANSVERSE, UPSET		677	191	3/4 □	4'-7"	64	11	48	11	32	11	16	11
30	SPLICE ROD	46-6375.5-07	678	191	3/4 ⌀	1'-1"	128	1.6	96	1.6	64	1.6	32	1.6
31	[4] TURNBUCKLE			191	1 1/8	6"	32	2.7	24	2.7	16	2.7	8	2.7
32	[5] CLEVIS ROD, HORIZONTAL, UPSET		680	191	3/4 □	1'-7"	6	4.3	4	4.3	2	4.3		
33	[5] DO		680	191	3/4 □	1'-3"	6	3.7	4	3.7	2	3.7		
34	SPLICE ROD	46-6375.5-07	678	191	3/4 ⌀	1'-1"	24	1.6	16	1.6	8	1.6		
35	[5] TURNBUCKLE			191	1 1/8	6"	6	2.7	4	2.7	2	2.7		
36	[5] CLEVIS			191	NO. 3 FOR 1⅛" THR	5"	12	4.0	8	4.0	4	4.0		
37	[5] PIN, HEADED, CLEVIS,			191	1 3/16"	3 1/4"	12	1.5	8	1.5	4	1.5		
38	[5] COTTER PIN			191	1/4 X 2 1/2		12	.1	8	.1	4	.1		
39	WELDING ROD	46-3772.2						420 LB		320 LB		220 LB		120 LB

1) CONNECTOR PIN ASSEMBLY, 1½"
2) CONNECTOR PIN ASSEMBLY, 2"
3) LOOP ROD ASSEMBLY, 1⅛"
4) LOOP ROD ASSEMBLY, ¾"
5) CLEVIS ROD ASSEMBLY, ¾"

TABLE A - BILL OF MATERIALS FOR PIECES WHICH VARY FOR DIFFERENT TOWER HEIGHTS

DESCRIPTION	LINE	DETAILED ON SHEET	QUANTITY	77' MARK	77' REQUISITIONED LENGTH	77' UNIT WEIGHT (POUNDS)	75' MARK	75' REQUISITIONED LENGTH	75' UNIT WEIGHT (POUNDS)	73' MARK	73' REQUISITIONED LENGTH	73' UNIT WEIGHT (POUNDS)	71' MARK	71' REQUISITIONED LENGTH	71' UNIT WEIGHT (POUNDS)	69' MARK	69' REQUISITIONED LENGTH	69' UNIT WEIGHT (POUNDS)
TOWER COLUMNS 12 I 65 STOCK NO 46-2900.12-065	1	189	2	1728R	24'-10"	1615	1730R	24'-3 7/8"	1580	1729R	23'-9 7/8"	1550	1731R	23'-3 3/4"	1515	1732R	22'-9 5/8"	1480
	2		2	1728L	24'-10"	1615	1730L	24'-3 7/8"	1580	1729L	23'-9 7/8"	1550	1731L	23'-3 3/4"	1515	1732L	22'-9 5/8"	1480
	3		4	1741R	18'-2 3/4"	1185	1742R	17'-8 5/8"	1150	1743R	17'-2 5/8"	1120	1751R	16'-8 1/2"	1090	1752R	16'-2 3/8"	1050
	4		4	1741L	18'-2 3/4"	1185	1742L	17'-8 5/8"	1150	1743L	17'-2 5/8"	1120	1751L	16'-8 1/2"	1090	1752L	16'-2 3/8"	1050
	5		2	1756R	16'-8 3/8"	1085	1760R	16'-2 1/4"	1050	1761R	15'-8 1/4"	1020	1757R	15'-2 1/8"	985	1762R	14'-8"	955
	6		2	1756L	16'-8 3/8"	1085	1760L	16'-2 1/4"	1050	1761L	15'-8 1/4"	1020	1757L	15'-2 1/8"	985	1762L	14'-8"	955
TRANSVERSE STRUTS 10 I 42 STOCK NO	7	190	2	1709	15'-2"	637	1710	15'-0"	630	1711	14'-10"	624	1712	14'-8"	616	1713	14'-6"	610
	8		2	1694	21'-2"	887	1695	20'-10"	875	1696	20'-6"	861	1698	20'-2"	845	1697	19'-10"	834
	9		2	1681	27'-2"	1140	1771	26'-8"	1120	1665	26'-2"	1100	1686	25'-8"	1080	1687	25'-2"	1060
	10		2	1674	33'-2"	1390	1675	32'-6"	1365	1676	31'-10"	1340	1769	31'-2"	1310	1770	30'-6"	1280
TRANSVERSE RODS 3/4 Ø RODS STOCK NO 46-6375.5-07	11	191	8	905	11'-6"	17	907	11'-0"	17	907	11'-0"	17	908	10'-6"	16	909	10'-0"	15
	12		8	899	15'-6"	23	900	15'-0"	23	901	14'-6"	22	902	14'-0"	21	903	13'-6"	20
	13		8	890	20'-0"	30	891	19'-6"	29	893	18'-6"	28	894	18'-0"	27	895	17'-6"	26
	14		8	880	25'-0"	38	882	24'-0"	36	883	23'-6"	35	885	22'-6"	34	885	22'-0"	33
LONGITUDINAL RODS 1 1/4 Ø RODS STOCK NO 46-6375.5-13	15	188	24	1046	20'-0"	83	1047	19'-6"	81	1047	19'-6"	81	1048	19'-0"	79	1048	19'-0"	79
	16		8	1046	20'-0"	83	1047	19'-6"	81	1047	19'-6"	81	1048	19'-0"	79	1048	19'-0"	79
HORIZONTAL RODS 3/4 Ø RODS STOCK NO 46-6375.5-07	17	191	2	1017	23'-0"	35	1017	23'-0"	35	1018	22'-6"	34	1018	22'-6"	34	1018	22'-6"	34
	18		2	1013	26'-6"	40	1014	26'-0"	39	1014	26'-0"	39	1015	25'-6"	38	1015	25'-6"	38
	19		2	1007	30'-6"	46	1008	30'-0"	45	1008	30'-0"	45	1009	29'-6"	44	1010	29'-0"	44

DESCRIPTION	LINE	DETAILED ON SHEET	QUANTITY	67' MARK	67' REQUISITIONED LENGTH	67' UNIT WEIGHT (POUNDS)	65' MARK	65' REQUISITIONED LENGTH	65' UNIT WEIGHT (POUNDS)	63' MARK	63' REQUISITIONED LENGTH	63' UNIT WEIGHT (POUNDS)	61' MARK	61' REQUISITIONED LENGTH	61' UNIT WEIGHT (POUNDS)	59' MARK	59' REQUISITIONED LENGTH	59' UNIT WEIGHT (POUNDS)	57' MARK	57' REQUISITIONED LENGTH	57' UNIT WEIGHT (POUNDS)	55' MARK	55' REQUISITIONED LENGTH	55' UNIT WEIGHT (POUNDS)	53' MARK	53' REQUISITIONED LENGTH	53' UNIT WEIGHT (POUNDS)	51' MARK	51' REQUISITIONED LENGTH	51' UNIT WEIGHT (POUNDS)
TOWER COLUMNS 12 I 65 STOCK NO 46-2900.12-065	20	189	2	1734R	26'-10 5/8"	1880	1735R	26'-10 1/4"	1750	1736R	25'-10 1/8"	1680	1728R	24'-10"	1620	1728R	24'-10"	1620	1729R	23'-9 7/8"	1550	1729R	23'-9 7/8"	1550	1732R	22'-9 5/8"	1480	1733R	21'-9 1/2"	1415
	21		2	1734L	26'-10 5/8"	1880	1735L	26'-10 1/4"	1750	1736L	25'-10 1/8"	1680	1728L	24'-10"	1620	1728L	24'-10"	1620	1729L	23'-9 7/8"	1550	1729L	23'-9 7/8"	1550	1732L	22'-9 5/8"	1480	1733L	21'-9 1/2"	1415
	22		2	1748R	20'-3"	1320	1746R	20'-3"	1320	1747R	19'-9"	1285	1748R	19'-2 7/8"	1250	1749R	18'-2 3/4"	1190	1750R	17'-8 5/8"	1150	1751R	16'-8 1/2"	1085	1752R	16'-2 3/8"	1050	1753R	15'-8 3/8"	1020
	23		2	1746L	20'-3"	1320	1746L	20'-3"	1320	1747L	19'-9"	1285	1748L	19'-2 7/8"	1250	1749L	18'-2 3/4"	1190	1750L	17'-8 5/8"	1150	1751L	16'-8 1/2"	1085	1752L	16'-2 3/8"	1050	1753L	15'-8 3/8"	1020
	24		2	1767R	18'-8 5/8"	1220	1767R	18'-8 5/8"	1220	1758R	18'-2 5/8"	1185	1759R	17'-8 1/2"	1150	1756R	16'-8 3/8"	1085	1760R	16'-2 1/4"	1050	1757R	15'-2 1/8"	990	1762R	14'-8"	955	1763R	14'-2"	920
	25		2	1767L	18'-8 5/8"	1220	1767L	18'-8 5/8"	1220	1758L	18'-2 5/8"	1185	1759L	17'-8 1/2"	1150	1756L	16'-8 3/8"	1085	1760L	16'-2 1/4"	1050	1757L	15'-2 1/8"	990	1762L	14'-8"	955	1763L	14'-2"	920
TRANSVERSE STRUTS 10 I 42 STOCK NO	26	190	2	1706	15'-10"	685	1706	15'-10"	665	1707	15'-6"	660	1708	15'-6"	650	1709	15'-2"	635	1710	15'-0"	630	1712	14'-8"	615	1713	14'-6"	610	1714	14'-4"	600
	27		2	1691	22'-6"	945	1691	22'-6"	945	1692	22'-2"	930	1693	21'-10"	920	1694	21'-2"	885	1695	20'-10"	875	1698	20'-2"	845	1697	19'-10"	835	1699	19'-6"	820
	28		2	1677	29'-10"	1255	1678	29'-2"	1220	1679	28'-6"	1200	1680	27'-10"	1170	1681	27'-2"	1140	1683	26'-6"	1115	1684	25'-10"	1085	1687	25'-2"	1060	1638	24'-6"	1030
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	29	191	8	903	13'-6"	20	903	13'-6"	20	904	13'-0"	20	905	12'-6"	19	906	11'-6"	17	907	11'-0"	17	908	10'-6"	16	909	10'-0"	15	910	9'-6"	14
	30		8	896	17'-6"	26	895	17'-6"	26	896	17'-0"	26	897	16'-6"	25	899	15'-6"	23	900	15'-0"	23	902	14'-0"	21	903	13'-6"	20	904	13'-0"	20
	31		8	882	24'-0"	36	885	22'-6"	34	881	21'-6"	32	889	20'-6"	31	890	20'-0"	30	892	19'-0"	29	893	18'-6"	28	895	17'-6"	26	897	16'-6"	25
LONGITUDINAL RODS 1 1/4 Ø ROD STOCK NO 46-6375.5-13	32	188	16	1044	21'-0"	88	1044	21'-0"	88	1044	21'-0"	88	1045	20'-6"	86	1046	20'-0"	83	1047	19'-6"	81	1048	19'-0"	79	1048	19'-0"	79	1049	18'-6"	77
	33		8	1042	22'-6"	94	1044	21'-0"	88	1045	20'-6"	86	1046	20'-0"	83	1046	20'-0"	83	1047	19'-6"	81	1047	19'-6"	81	1048	19'-0"	79	1049	18'-6"	77
HORIZONTAL RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	34	191	2	1017	23'-0"	35	1017	23'-0"	35	1017	23'-0"	35	1017	23'-0"	35	1017	23'-0"	35	1017	23'-0"	35	1018	22'-6"	34	1018	22'-6"	34	1018	22'-6"	34
	35		2	1012	27'-0"	41	1012	27'-0"	41	1012	27'-0"	41	1112	27'-0"	41	1013	26'-6"	40	1014	26'-0"	39	1015	25'-6"	38	1015	25'-6"	38	1015	25'-6"	38

DESCRIPTION	LINE	DETAILED ON SHEET	QUANTITY	49' MARK	49' REQUISITIONED LENGTH	49' UNIT WEIGHT (POUNDS)	47' MARK	47' REQUISITIONED LENGTH	47' UNIT WEIGHT (POUNDS)	45' MARK	45' REQUISITIONED LENGTH	45' UNIT WEIGHT (POUNDS)	43' MARK	43' REQUISITIONED LENGTH	43' UNIT WEIGHT (POUNDS)	41' MARK	41' REQUISITIONED LENGTH	41' UNIT WEIGHT (POUNDS)	39' MARK	39' REQUISITIONED LENGTH	39' UNIT WEIGHT (POUNDS)	37' MARK	37' REQUISITIONED LENGTH	37' UNIT WEIGHT (POUNDS)	35' MARK	35' REQUISITIONED LENGTH	35' UNIT WEIGHT (POUNDS)	33' MARK	33' REQUISITIONED LENGTH	33' UNIT WEIGHT (POUNDS)
TOWER COLUMNS 12 I 65 STOCK NO 46-2900.12-065	36	189	2	1734R	28'-10 5/8"	1880	1738R	27'-10 1/2"	1815	1735R	26'-10 1/4"	1750	1739R	25'-10 1/8"	1680	1728R	24'-10"	1615	1729R	23'-9 7/8"	1550	1732R	22'-9 5/8"	1480	1733R	21'-9 1/2"	1415	1740R	20'-9 3/8"	1350
	37		2	1734L	28'-10 5/8"	1880	1738L	27'-10 1/2"	1815	1735L	26'-10 1/4"	1750	1739L	25'-10 1/8"	1680	1728L	24'-10"	1615	1729L	23'-9 7/8"	1550	1732L	22'-9 5/8"	1480	1733L	21'-9 1/2"	1415	1740L	20'-9 3/8"	1350
	38		2	1765R	20'-9"	1350	1766R	19'-8 7/8"	1285	1767R	18'-8 5/8"	1220	1759R	17'-8 1/2"	1150	1756R	16'-8 3/8"	1090	1761R	15'-8 1/4"	1020	1762R	14'-8"	955	1764R	13'-7 7/8"	890	1766R	12'-7 3/4"	825
	39		2	1765L	20'-9"	1350	1766L	19'-8 7/8"	1285	1767L	18'-8 5/8"	1220	1759L	17'-8 1/2"	1150	1756L	16'-8 3/8"	1090	1761L	15'-8 1/4"	1020	1762L	14'-8"	955	1764L	13'-7 7/8"	890	1768L	12'-7 3/4"	825
TRANSVERSE STRUTS 10 I 42 STOCK NO	40	190	2	1704	16'-6"	695	1705	16'-2"	660	1706	15'-10"	665	1708	15'-6"	650	1709	15'-2"	635	1711	14'-10"	625	1713	14'-6"	610	1715	14'-2"	595	1716	13'-10"	580
	41		2	1689	23'-10"	1000	1690	23'-2"	976	1691	22'-6"	945	1693	21'-10"	920	1694	21'-2"	890	1695	20'-6"	860	1697	19'-10"	830	1700	19'-2"	805	1701	18'-6"	775
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	42	191	8	899	15'-6"	23	901	14'-6"	22	903	13'-6"	20	905	12'-6"	19	906	11'-6"	17	907	11'-0"	17	909	10'-0"	15	911	9'-0"	14	912	8'-0"	12
	43		8	891	19'-6"	29	893	18'-6"	28	895	17'-6"	26	897	16'-6"	25	899	15'-6"	23	901	14'-6"	22	903	13'-6"	20	906	12'-6"	19	906	11'-6"	17
LONGITUDINAL RODS 1 1/4 Ø ROD STOCK NO 46-6375.5-13	44	188	8	1042	22'-6"	94	1043	22'-0"	92	1044	21'-0"	88	1045	20'-6"	85	1046	20'-0"	63	1047	19'-6"	81	1048	19'-0"	79	1049	18'-6"	77	1050	17'-6"	73
	45		8	1042	22'-6"	94	1043	22'-0"	92	1044	21'-0"	88	1045	20'-6"	85	1046	20'-0"	83	1047	19'-6"	81	1048	19'-0"	79	1049	18'-6"	77	1050	17'-6"	73
HORIZONTAL RODS 3/4 Ø RODS STOCK NO 46-6375.5-07	46	191	2	1016	23'-6"	35	1016	23'-6"	35	1017	23'-0"	35	1017	23'-0"	35	1017	23'-0"	35	1018	22'-6"	34	1016	22'-6"	34	1016	22'-6"	34	1018	22'-6"	34

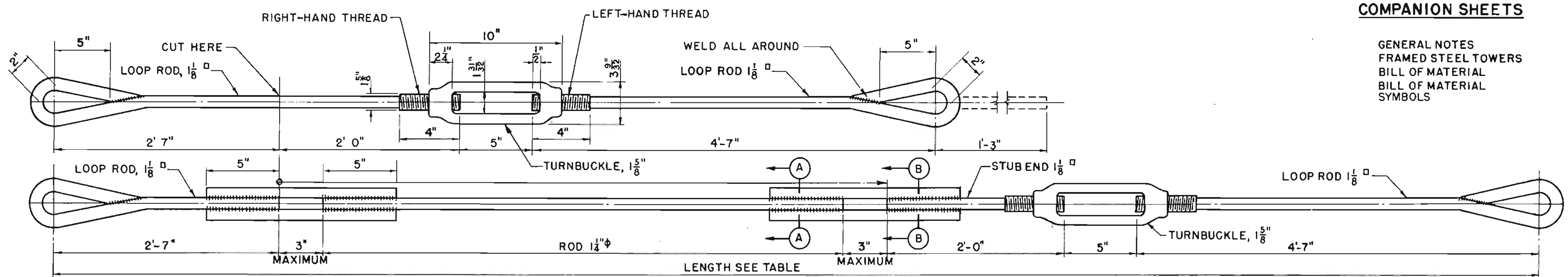
DESCRIPTION	LINE	DETAILED ON SHEET	QUANTITY	31' MARK	31' REQUISITIONED LENGTH	31' UNIT WEIGHT (POUNDS)	29' MARK	29' REQUISITIONED LENGTH	29' UNIT WEIGHT (POUNDS)	27' MARK	27' REQUISITIONED LENGTH	27' UNIT WEIGHT (POUNDS)	25' MARK	25' REQUISITIONED LENGTH	25' UNIT WEIGHT (POUNDS)	23' MARK	23' REQUISITIONED LENGTH	23' UNIT WEIGHT (POUNDS)	21' MARK	21' REQUISITIONED LENGTH	21' UNIT WEIGHT (POUNDS)	19' MARK	19' REQUISITIONED LENGTH	19' UNIT WEIGHT (POUNDS)	17' MARK	17' REQUISITIONED LENGTH	17' UNIT WEIGHT (POUNDS)	15' MARK	15' REQUISITIONED LENGTH	15' UNIT WEIGHT (POUNDS)
TOWER COLUMNS 12 I 65 STOCK NO 46-2900.12-065	47	190	2	1719R	31'-4 7/8"	2040	1720R	29'-4 5/8"	1910	1721R	27'-4 1/4"	1780	1722R	25'-3 7/8"	1650	1723R	23'-3 5/8"	1515	1724R	21'-3 1/4"	1385	1725R	19'-3"	1250	1726R	17'-2 5/8"	1120	1727R	15'-2 1/4"	985
	48		2	1719L	31'-4 7/8"	2040	1720L	29'-4 5/8"	1910	1721L	27'-4 1/4"	1780	1722L	25'-3 7/8"	1650	1723L	23'-3 5/8"	1515	1724L	21'-3 1/4"	1385	1725L	19'-3"	1250	1726L	17'-2 5/8"	1120	1727L	15'-2 1/4"	985
TRANSVERSE STRUTS 10 I 42 STOCK NO	49		2	1702	17'-10"	750	1703	17'-2"	720	1704	16'-6"	695	1706	15'-10"	685	1709	15'-2"	635	1713	14'-6"	610	1716	13'-10"	580	1717	13'-2"	555	1718	12'-6"	525
TRANSVERSE RODS 3/4 Ø ROD STOCK NO 46-6375.5-07	50	191	8	891	19'-6"	29	895	17'-6"	26	899	15'-6"	23	903	13'-6"	20	906	11'-6"	17	909	10'-0"	15	912	8'-0"	12	913	6'-6"	10	914	4'-6"	7
LONGITUDINAL RODS 1-1/4 Ø ROD STOCK NO 46-6375.5-13	51	188	8	1040	25'-6"	106	1041	24'-0"	100	1042	22'-6"	94	1044	21'-0"	88	1046	20'-0"	83	1048	19'-0"	79	1050	17'-6"	73	1051	16'-6"	69	1052	16'-0"	67

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	184,185
BILL OF MATERIALS	186
FABRICATION DRAWING	188 TO 191

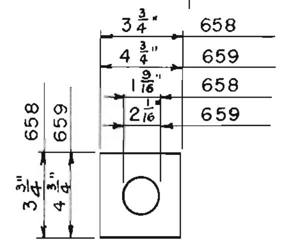
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
FRAMED STEEL TOWERS	184,185
BILL OF MATERIAL	186
BILL OF MATERIAL	187
SYMBOLS	155



LOOP ROD WITH STUB END AND TURNBUCKLE

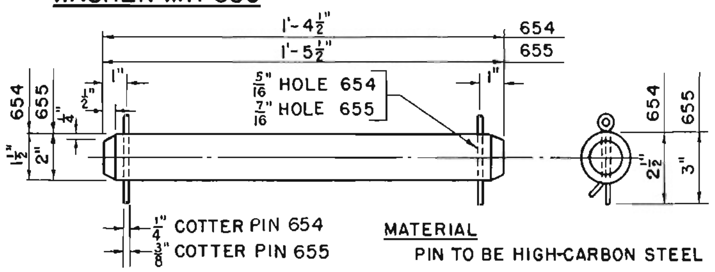
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
1021	35'-3⅛"	1040	25'-6"	1026	30'-3⅞"	1045	20'-6"	1035	28'-2⅜"	1049	18'-6"
1022	33'-9¼"	1041	24'-0"	1028	29'-8¼"	1046	20'-0"	1036	27'-11"	1049	18'-6"
1023	32'-4⅛"	1042	22'-6"	1030	29'-4½"	1047	19'-6"	1037	27'-4⅝"	1050	17'-6"
1024	31'-7¾"	1043	22'-0"	1031	29'-0⅞"	1047	19'-6"	1038	26'-4⅝"	1051	16'-6"
1027	30'-7¾"	1044	21'-0"	1032	28'-9⅜"	1048	19'-0"	1039	25'-6¼"	1052	16'-0"
1025	30'-11¾"	1044	21'-0"	1033	28'-5⅞"	1048	19'-0"				



WASHER MK 658
WASHER MK 659

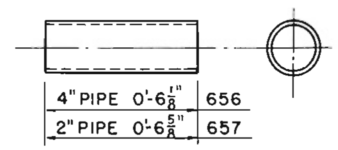
SECTION A-A

SECTION B-B



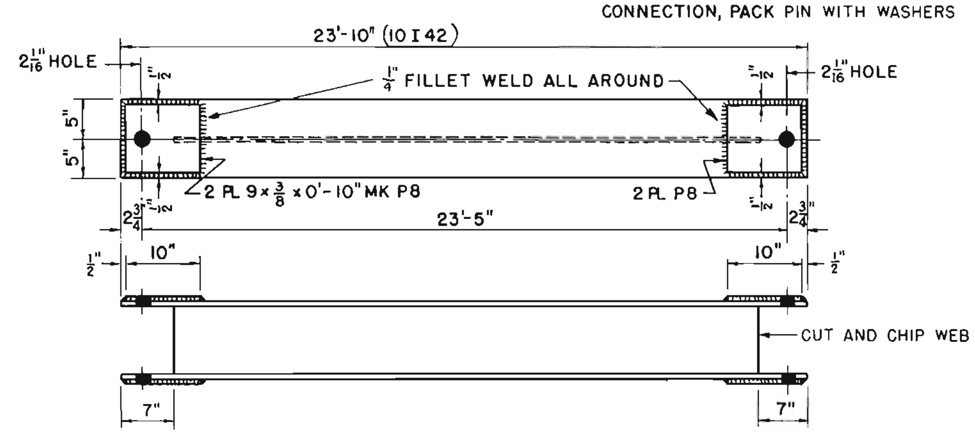
MATERIAL
PIN TO BE HIGH-CARBON STEEL

PIN AND COTTERS

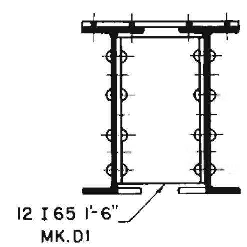


PIPE SPACER MK 656
PIPE SPACER MK 657

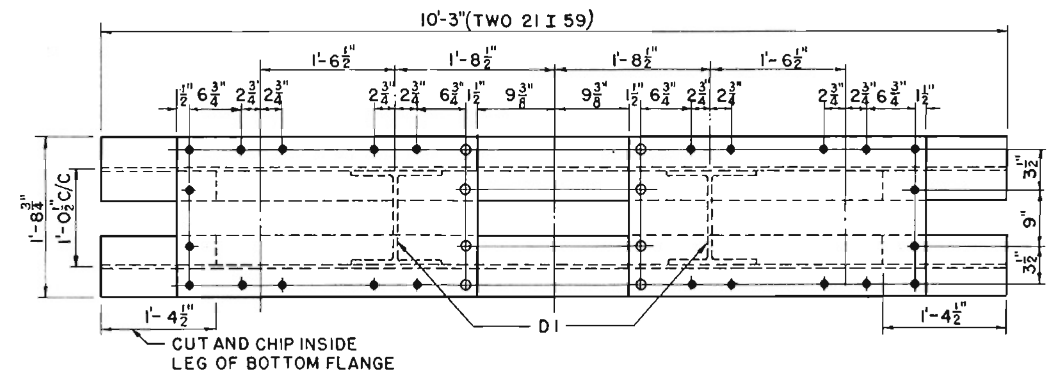
NOTE:
WHERE ONLY TWO BRACE RODS OCCUR AT A PIN CONNECTION, PACK PIN WITH WASHERS

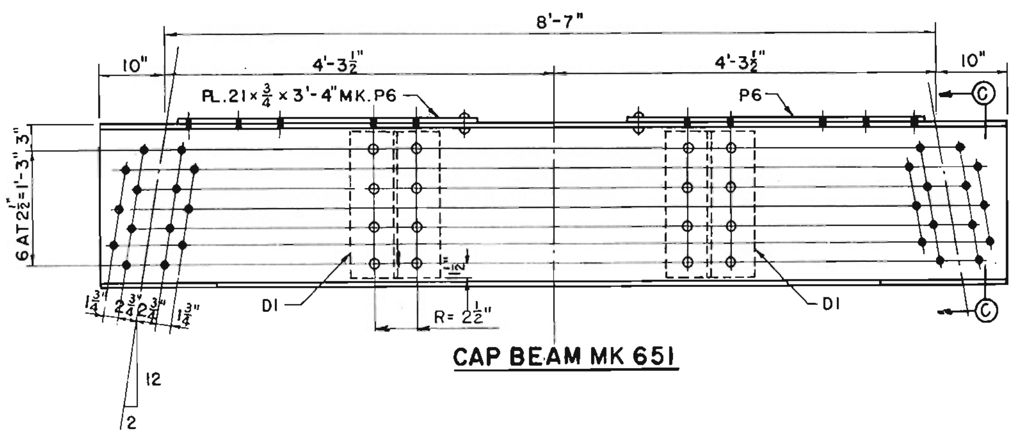


LONGITUDINAL STRUT MK 653

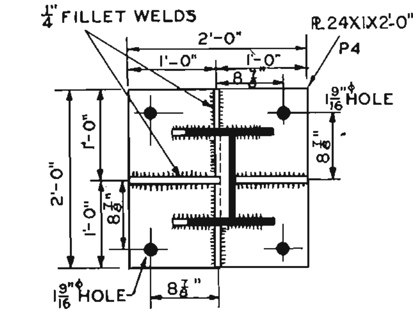


SECTION C-C

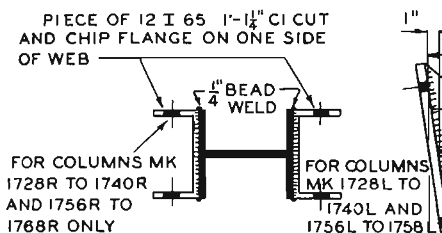




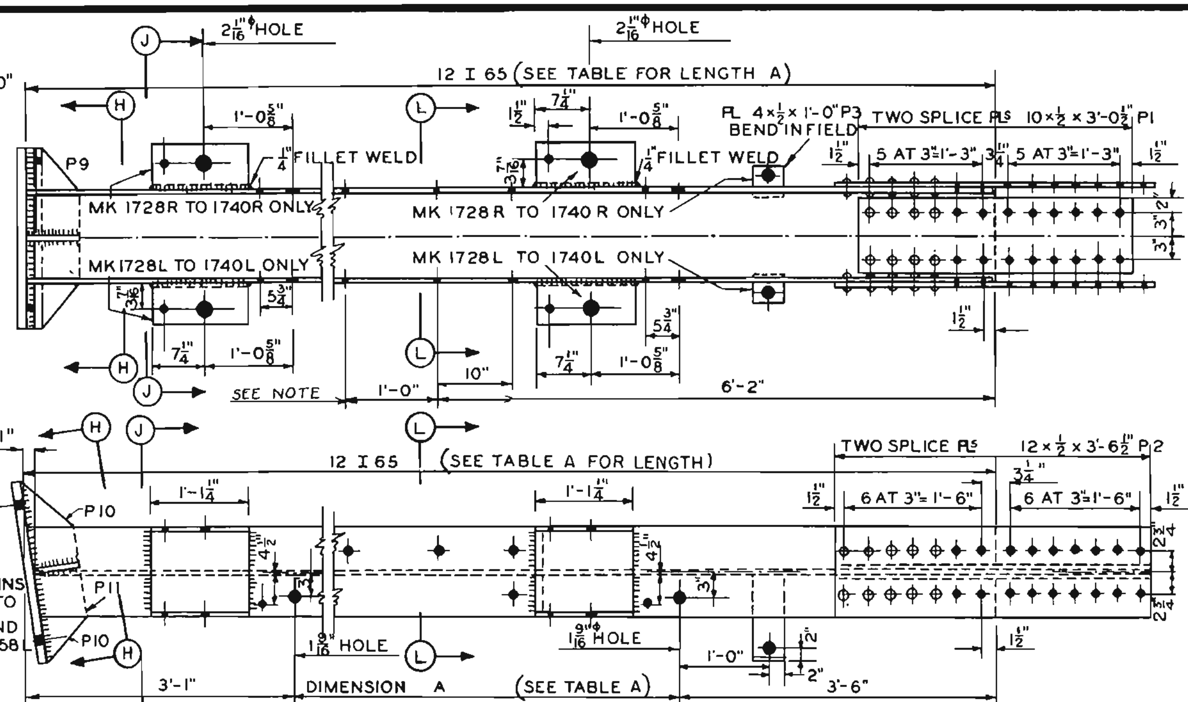
CAP BEAM MK 651



SECTION H-H



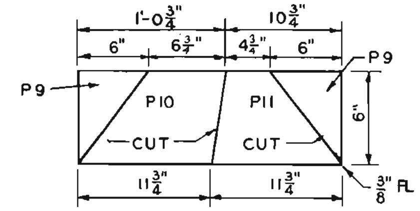
SECTION J-J



COLUMN MK 1728R TO 1740R
COLUMN MK 1728L TO 1740L

COMPANION SHEETS

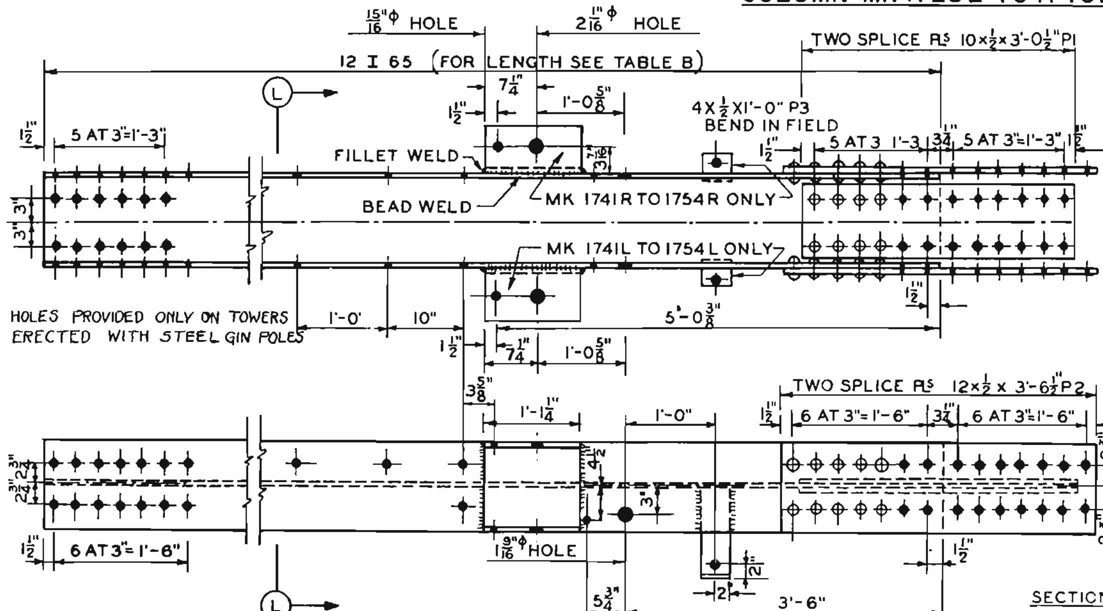
	SHEET
GENERAL NOTES	154
SYMBOLS	155
GENERAL VIEWS AND DIMENSIONS	184, 185
BILL OF MATERIALS	186, 187



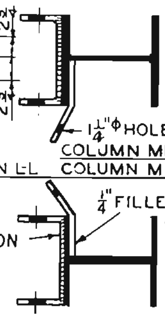
BEARING PLATE STIFFENERS P9, P10, P11

TABLE A

MARK	A	LENGTH	WEIGHT
1728	18'-3"	24'-10"	2180
1729	17'-2 7/8"	23'-9 7/8"	2115
1730	17'-8 7/8"	24'-3 7/8"	2145
1731	16'-8 3/4"	23'-3 3/4"	2085
1732	16'-2 5/8"	22'-9 5/8"	2050
1733	15'-2 1/2"	21'-9 1/2"	1980
1734	22'-3 5/8"	28'-10 5/8"	2445
1735	20'-3 1/4"	26'-10 1/4"	2315
1736	19'-3 1/8"	25'-10 1/8"	2250
1738	21'-3 1/2"	27'-10 1/2"	2380
1739	19'-3 1/8"	25'-10 1/8"	2250
1740	14'-2 3/8"	20'-9 3/8"	1920



COLUMN MK 1741R TO 1754R
COLUMN MK 1741L TO 1754L



SECTION L-L COLUMN MK 1728R TO 1740R, COLUMN MK 1741R TO 1754R

PIECE OF 12 I 65 1'-1 1/4" CI CUT AND CHIP FLANGES ON ONE SIDE OF WEB

SECTION L-L COLUMN MK 1741L TO 1754L, COLUMN MK 1728L TO 1754L

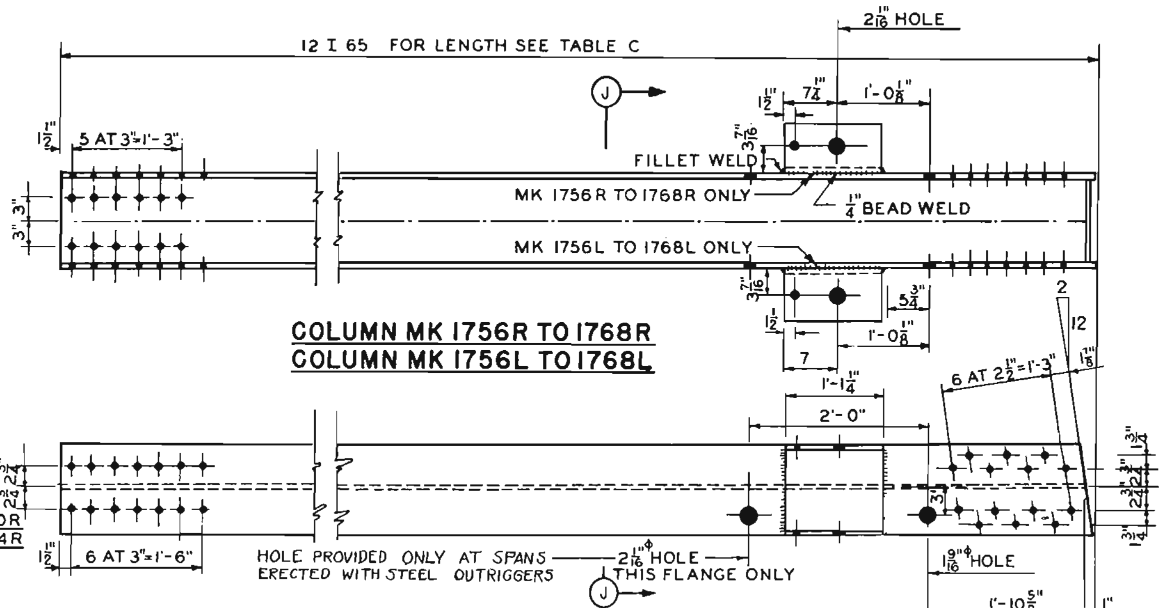
TABLE B

MARK	LENGTH	WEIGHT
1741	18'-2 3/4"	1530
1742	17'-8 5/8"	1505
1743	17'-2 5/8"	1465

MARK	LENGTH	WEIGHT
1746	20'-3"	1660
1747	19'-9"	1630
1748	19'-2 7/8"	1595
1749	18'-2 3/4"	1530
1750	17'-8 5/8"	1505

TABLE B

MARK	LENGTH	WEIGHT
1751	16'-8 1/2"	1435
1752	16'-2 3/8"	1400
1753	15'-8 3/8"	1370



COLUMN MK 1756R TO 1768R
COLUMN MK 1756L TO 1768L

TABLE C

MARK	LENGTH	WEIGHT
1756	16'-8 3/8"	1164
1757	15'-2 1/8"	1065
1758	18'-2 5/8"	1263
1759	17'-8 1/2"	1230
1760	16'-2 1/4"	1131

TABLE C

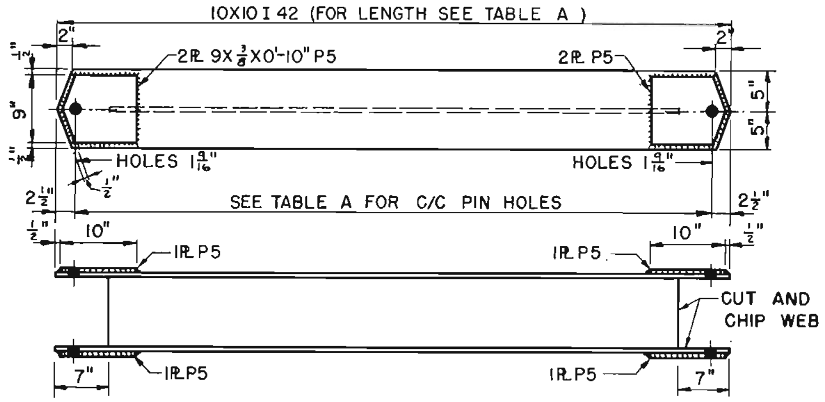
MARK	LENGTH	WEIGHT
1761	15'-8 1/4"	1058
1762	14'-8"	1032
1763	14'-2"	999
1764	13'-7 7/8"	966
1765	20'-9"	1427

TABLE C

MARK	LENGTH	WEIGHT
1766	19'-8 7/8"	1361
1767	18'-8 5/8"	1295
1768	12'-7 3/4"	891

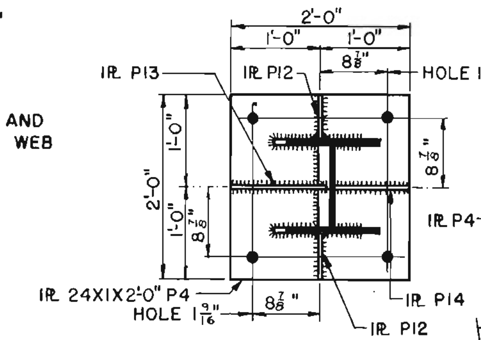
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
GENERAL VIEWS AND DIMENSIONS	184, 185
BILL OF MATERIALS	186, 187

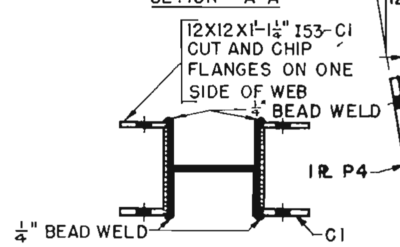


STRUTS MK 1674 TO 1681, INCLUSIVE
STRUTS MK 1683 TO 1718, INCLUSIVE
STRUTS MK 1769 TO 1771, INCLUSIVE

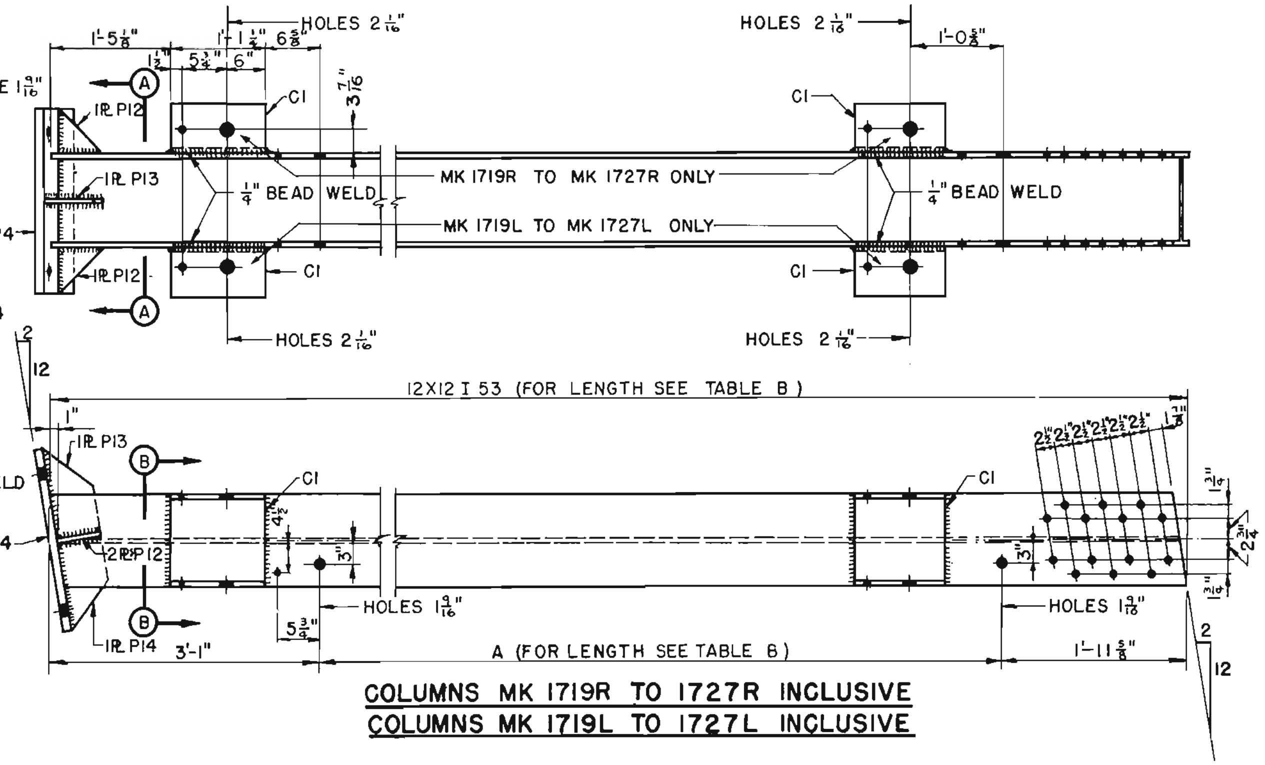
ALL WELDS SHOWN ARE TO BE 1/4" FILLET WELDS UNLESS OTHERWISE INDICATED



SECTION A-A



SECTION B-B



COLUMNS MK 1719R TO 1727R INCLUSIVE
COLUMNS MK 1719L TO 1727L INCLUSIVE

TABLE A

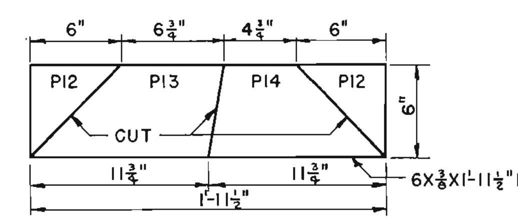
MARK	C/C PIN HOLES	LENGTH	WEIGHT
1674	32'–9"	33'–2"	1430
1675	32'–1"	32'–6"	1402
1676	31'–5"	31'–10"	1374
1677	29'–5"	29'–10"	1290
1678	28'–9"	29'–2"	1262
1679	28'–1"	28'–6"	1234
1680	27'–5"	27'–10"	1206
1681	26'–9"	27'–2"	1178
1683	26'–1"	26'–6"	1150
1684	25'–5"	25'–10"	1122
1685	25'–9"	26'–2"	1136
1686	25'–3"	25'–8"	1115
1687	24'–9"	25'–2"	1095
1688	24'–1"	24'–6"	1066
1689	23'–5"	23'–10"	1038
1690	22'–9"	23'–2"	1010
1691	22'–1"	22'–6"	982
1692	21'–9"	22'–2"	968
1693	21'–5"	21'–10"	954
1694	20'–9"	21'–2"	926
1695	20'–5"	20'–10"	912
1696	20'–1"	20'–6"	898
1697	19'–5"	19'–10"	870
1698	19'–9"	20'–2"	884

TABLE A

MARK	C/C PIN HOLES	LENGTH	WEIGHT
1699	19'–1"	19'–6"	856
1700	18'–9"	19'–2"	842
1701	18'–1"	18'–6"	814
1702	17'–5"	17'–10"	786
1703	16'–9"	17'–2"	758
1704	16'–1"	16'–6"	730
1705	15'–9"	16'–2"	716
1706	15'–5"	15'–10"	702
1707	15'–3"	15'–8"	694
1708	15'–1"	15'–6"	688
1709	14'–9"	15'–2"	674
1710	14'–7"	15'–0"	667
1711	14'–5"	14'–10"	660
1712	14'–3"	14'–8"	653
1713	14'–1"	14'–6"	646
1714	13'–11"	14'–4"	639
1715	13'–9"	14'–2"	632
1716	13'–5"	13'–10"	618
1717	12'–9"	13'–2"	590
1718	12'–1"	12'–6"	562
1769	30'–9"	31'–2"	1346
1770	30'–1"	30'–6"	1318
1771	26'–3"	26'–8"	1157

TABLE B

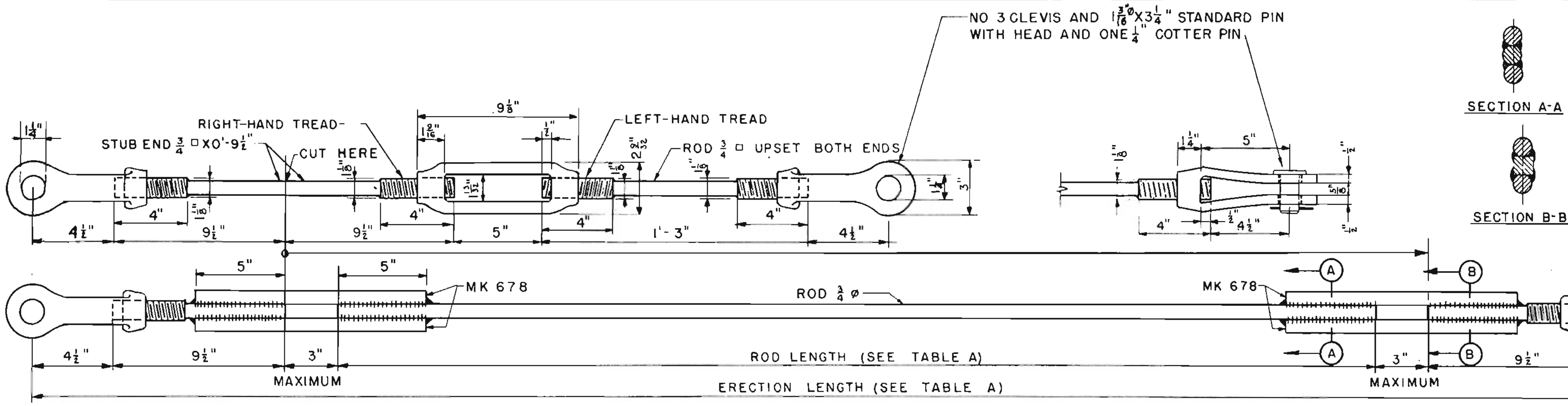
MARK	A	LENGTH	WEIGHT
1719	26'–4 1/4"	31'–4 7/8"	2315
1720	24'–4"	29'–4 5/8"	2185
1721	22'–3 5/8"	27'–4 1/4"	2055
1722	20'–3 1/4"	25'–3 7/8"	1920
1723	18'–3"	23'–3 5/8"	1790
1724	16'–2 5/8"	21'–3 1/4"	1655
1725	14'–2 3/8"	19'–3"	1525
1726	12'–2"	17'–2 5/8"	1395
1727	10'–1 5/8"	15'–2 1/4"	1260



BEARING PLATE STIFFENERS P12, P13, P14.

COMPANION SHEETS

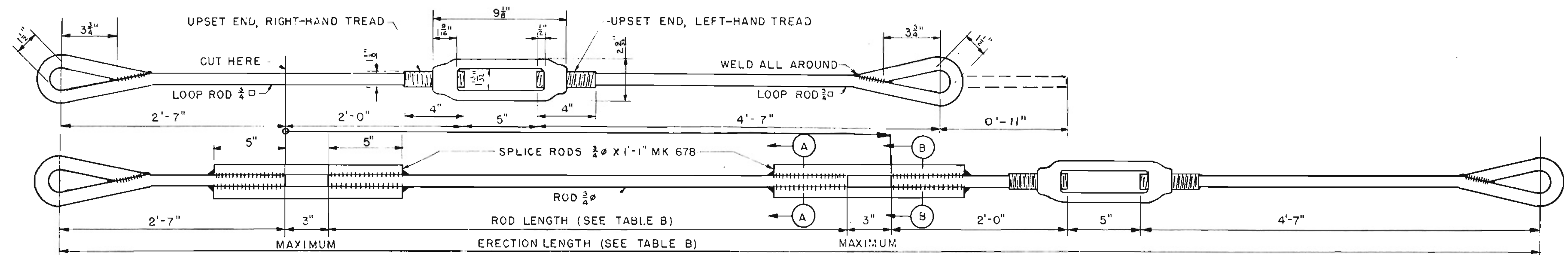
	SHEET
GENERAL NOTES	154
GENERAL VIEWS AND DIMENSIONS	185, 184
BILL OF MATERIALS	187, 186
SYMBOLS	155



CLEVIS, TURNBUCKLE, AND STUB-END ROD MK 680

TABLE A

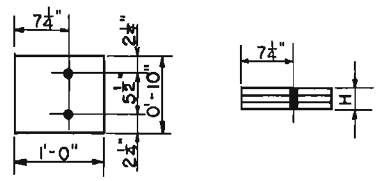
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
955	34'-$7\frac{3}{4}$"	1007	30'-6"	965	31'-$4\frac{1}{2}$"	1012	27'-0"	970	30'-$1\frac{1}{8}$"	1014	26'-0"	977	27'-7"	1016	23'-6"	982	26'-$11\frac{7}{8}$"	1017	23'-0"	987	26'-8"	1018	22'-6"
959	34'-$3\frac{1}{4}$"	1008	30'-0"	966	31'-$1\frac{7}{8}$"	1012	27'-0"	971	29'-$10\frac{5}{8}$"	1015	25'-6"	978	27'-5"	1017	23'-0"	983	26'-$10\frac{7}{8}$"	1018	22'-6"	988	26'-5"	1018	22'-6"
960	33'-11"	1008	30'-0"	967	30'-$11\frac{1}{4}$"	1012	27'-0"	973	29'-$8\frac{1}{8}$"	1015	25'-6"	979	27'-$3\frac{7}{8}$"	1017	23'-0"	984	26'-$9\frac{7}{8}$"	1018	22'-6"				
963	33'-$6\frac{5}{8}$"	1009	29'-6"	968	30'-$6\frac{1}{8}$"	1013	26'-6"	975	29'-$5\frac{3}{4}$"	1015	25'-6"	980	27'-$2\frac{7}{8}$"	1017	23'-0"	985	26'-9"	1018	22'-6"				
964	33'-$2\frac{3}{8}$"	1010	29'-0"	969	30'-$3\frac{5}{8}$"	1014	26'-0"	976	27'-$9\frac{1}{8}$"	1016	23'-6"	981	27'-$0\frac{7}{8}$"	1017	23'-0"	986	26'-7"	1018	22'-6"				



LOOP ROD WITH TURNBUCKLE MK 677

TABLE B

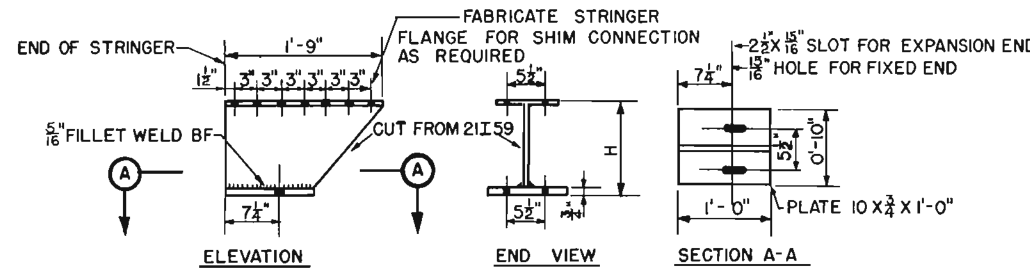
ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH	ERECTION MARK	ERECTION LENGTH	ROD MARK	ROD LENGTH
743	34'-$9\frac{1}{4}$"	880	25'-0"	804	29'-$6\frac{3}{4}$"	891	19'-6"	820	27'-$3\frac{1}{4}$"	895	17'-6"	838	23'-$8\frac{1}{4}$"	902	14'-0"	852	20'-$6\frac{7}{8}$"	907	11'-0"
752	34'-$0\frac{1}{8}$"	882	24'-0"	807	29'-2"	891	19'-6"	821	27'-$2\frac{3}{8}$"	895	17'-6"	839	23'-$4\frac{3}{8}$"	903	13'-6"	853	20'-$1\frac{3}{8}$"	908	10'-6"
756	33'-$10\frac{1}{4}$"	882	24'-0"	808	29'-$1\frac{1}{4}$"	891	19'-6"	822	27'-5"	895	17'-6"	842	23'-2"	903	13'-6"	854	19'-$7\frac{7}{8}$"	909	10'-0"
765	33'-$3\frac{1}{8}$"	883	23'-6"	810	28'-$9\frac{5}{8}$"	892	19'-0"	824	26'-$10\frac{1}{2}$"	896	17'-0"	844	22'-$10\frac{1}{4}$"	904	13'-0"	858	19'-$2\frac{3}{8}$"	910	9'-6"
775	32'-6"	885	22'-6"	812	28'-$6\frac{3}{8}$"	893	18'-6"	826	26'-$4\frac{1}{8}$"	897	16'-6"	845	22'-$7\frac{5}{8}$"	904	13'-0"	859	18'-9"	911	9'-0"
778	32'-$4\frac{1}{8}$"	885	22'-6"	813	28'-$5\frac{7}{8}$"	893	18'-6"	827	26'-$3\frac{3}{8}$"	897	16'-6"	846	22'-$5\frac{1}{8}$"	905	12'-6"	860	17'-$10\frac{1}{4}$"	912	8'-0"
785	31'-$8\frac{7}{8}$"	886	22'-0"	815	28'-$3\frac{1}{4}$"	893	18'-6"	831	25'-$3\frac{3}{8}$"	899	15'-6"	847	22'-$1\frac{3}{8}$"	905	12'-6"	861	16'-$1\frac{3}{8}$"	913	6'-6"
789	31'-4"	881	21'-6"	816	27'-$10\frac{7}{8}$"	894	18'-0"	833	24'-9"	900	15'-0"	848	21'-6"	906	11'-6"	862	14'-$5\frac{1}{4}$"	914	4'-6"
796	30'-4"	889	20'-6"	817	27'-$5\frac{3}{8}$"	895	17'-6"	835	24'-$3\frac{3}{4}$"	901	14'-6"	849	21'-$0\frac{7}{8}$"	906	11'-6"				
803	29'-$9\frac{5}{8}$"	890	20'-0"	818	27'-5"	895	17'-6"	836	24'-$2\frac{5}{8}$"	901	14'-6"	850	21'-$0\frac{3}{8}$"	907	11'-0"				



DETAIL OF PLATE SHIM

BILL OF MATERIALS FOR ONE PLATE SHIM

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)	7545 H = 1/2" QUANTITY	7546 H = 2 3/4" QUANTITY	7547 H = 3" QUANTITY	7548 H = 3 1/4" QUANTITY
PLATE	47-7844.05	10X1/2	1'-0"	17	1			
DO	47-7844.07	10X3/4	1'-0"	26		1		3
DO	47-7844.1	10X1	1'-0"	34		2	3	1
ANCHOR BOLT	43-2219.08-04	7/8	4"	1.2	2			
DO	43-2219.08-07	7/8	7"	1.7		2	2	2



DETAIL OF BUILT-UP SHIM

BILL OF MATERIALS FOR ONE BUILT-UP SHIM

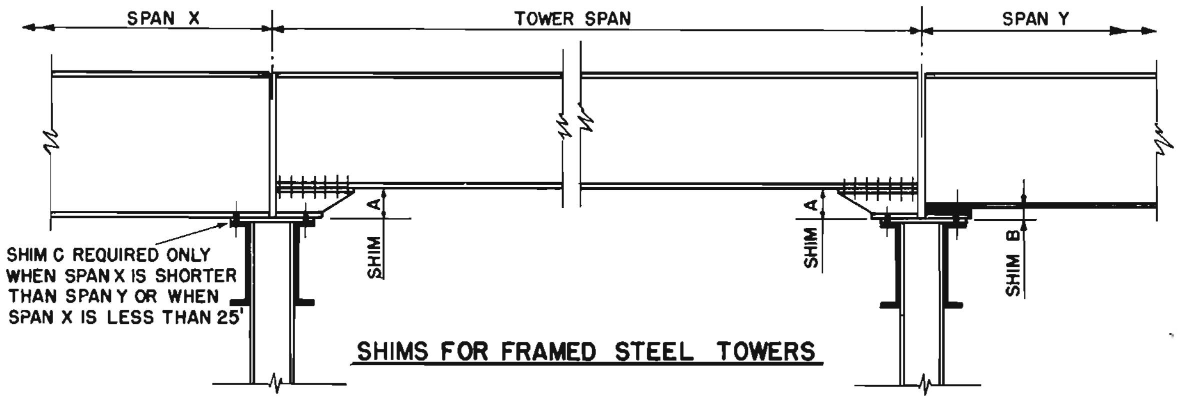
DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	QUANTITY
BEAM	48-2900.21-059	21 I 59	1'-9"	1
PLATE	47-7884.07	10 X 3/4	1'-0"	1
RIVET	43-6333.08	7/8	2-3/4"	14
ANCHOR BOLT	43-2219.08-04	7/8	4"	2
ELECTRODE	46-3772.2-7	3/16		1 LB

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS, RIVETED	204, 205,206
STEEL PILE BENTS AND PIERS, WELDED	209, 210,211
FRAMED STEEL TOWERS	184,185

MARKS AND DIMENSIONS FOR BUILT-UP SHIMS

MARK	H	TOTAL WEIGHT (POUNDS)
7549	5-7/8"	62
7550	6-1/4"	63
7551	6-1/2"	64
7552	8-7/8"	67
7553	9-1/2"	68
7554	12-1/0"	73
7555	14-7/8"	77
7556	15-3/8"	78



SHIMS FOR FRAMED STEEL TOWERS

PROVIDE 2 ANCHOR BOLTS ⅞X4" PER STRINGER WHEN SHIMS ARE NOT REQUIRED

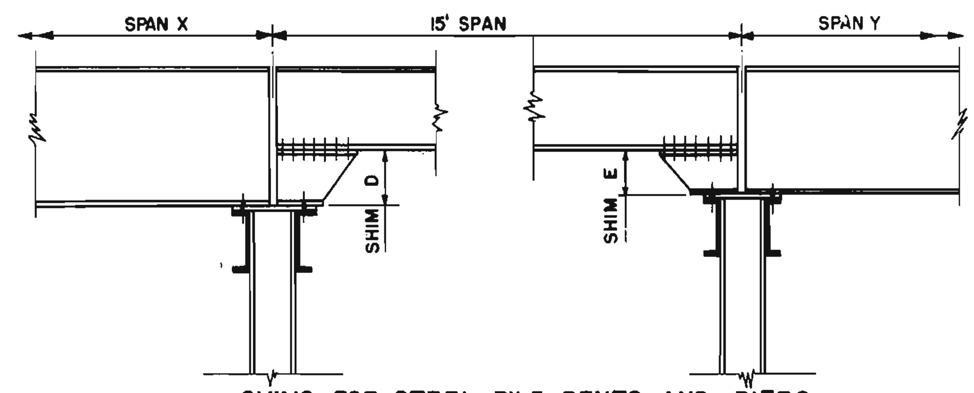
SHIMS FOR FRAMED STEEL TOWERS

SPAN Y		SPAN X	50'	45'	40'	35'	30'	25'	20'	15'
	15'	A	7549	7549	7551	7549	7548			
		B	7555	7555	7556	7555	7554	7552	7552	7552
		C							7547	7552
	20'	A	7549	7549	7551	7549	7548			
		B	7552	7552	7553	7552	7550	7547	7547	7547
		C							7547	7552
	25'	A	7549	7549	7551	7549	7548			
		B	7549	7549	7551	7549	7548			
		C							7547	7552
	30'	A	7549	7549	7551	7549	7548	7548	7548	7548
		B	7546	7546	7548	7546				
		C						7548	7550	7554
	35'	A	7549	7549	7551	7549	7549	7549	7549	7549
		B			7545					
		C					7546	7549	7552	7555
	40'	A	7551	7551	7551	7551	7551	7551	7551	7551
		B								
		C	7545	7545		7545	7548	7551	7553	7556
	45'	A	7549	7549	7551	7549	7549	7549	7549	7549
		B			7545					
		C					7546	7549	7552	7555
	50'	A	7549	7549	7551	7549	7549	7549	7549	7549
		B			7545					
		C					7546	7549	7552	7555

BILL OF MATERIALS FOR ANCHOR BOLTS ONLY WITHOUT SHIMS

DESCRIPTION	STOCK NO	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)
ANCHOR BOLT	43-2219.08-04	7/8	0'-4"	1.2

TWO BOLTS REQUIRED FOR EACH STRINGER SUPPORT
CONSTRUCTION INDICATED BY BLANK SPACES IN TABLES FOR SHIMS

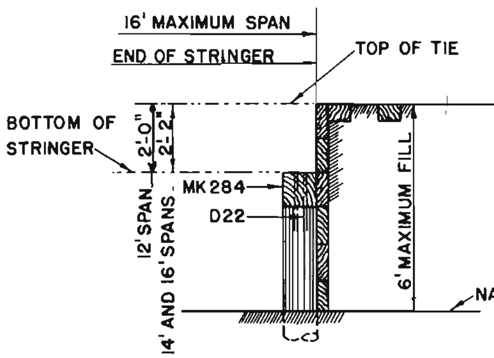


SHIMS FOR STEEL PILE BENTS AND PIERS

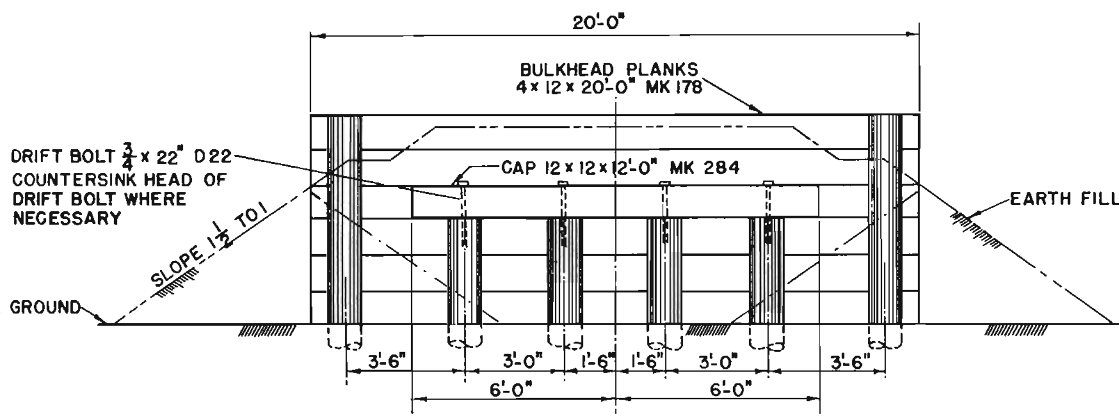
SHIMS FOR STEEL PILE BENTS AND PIERS

SPAN Y		SPAN X	50'	45'	40'	35'	30'	25'	20'	15'
	15'	D	7555	7555	7556	7555	7554	7552	7549	
		E								
	20'	D	7555	7555	7556.	7555	7554	7552	7549	
		E	7549	7549	7549	7549	7549	7549	7549	7549
	25'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7552	7552	7552	7552	7552	7552	7552	7552
	30'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7554	7554	7554	7554	7554	7554	7554	7554
	35'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7555	7555	7555	7555	7555	7555	7555	7555
	40'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7556	7556	7556	7556	7556	7556	7556	7556
	45'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7555	7555	7555	7555	7555	7555	7555	7555
	50'	D	7555	7555	7556	7555	7554	7552	7549	
		E	7555	7555	7555	7555	7555	7555	7555	7555

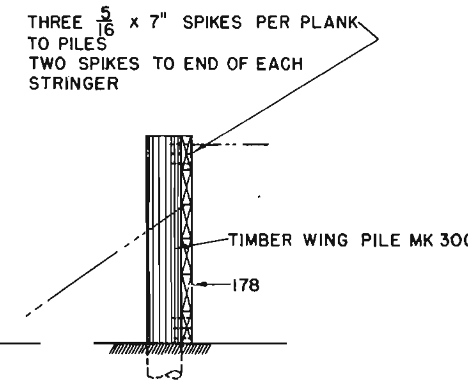
COMPANION SHEETS	SHEET
TIMBER ABUTMENT FOR TIMBER SPAN	194
GENERAL NOTES	154
SYMBOLS	155



SECTION AT ℄



ELEVATION



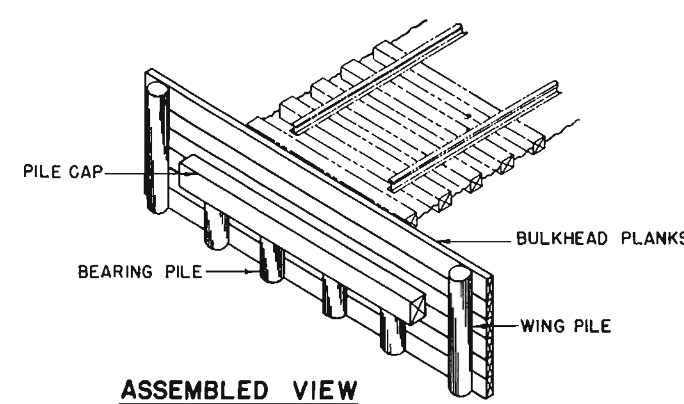
END VIEW

MAXIMUM PILE LOAD

SPAN LENGTH	12'	14'	16'
TONS PER PILE	13	13	13

BILL OF MATERIALS FOR ONE ABUTMENT

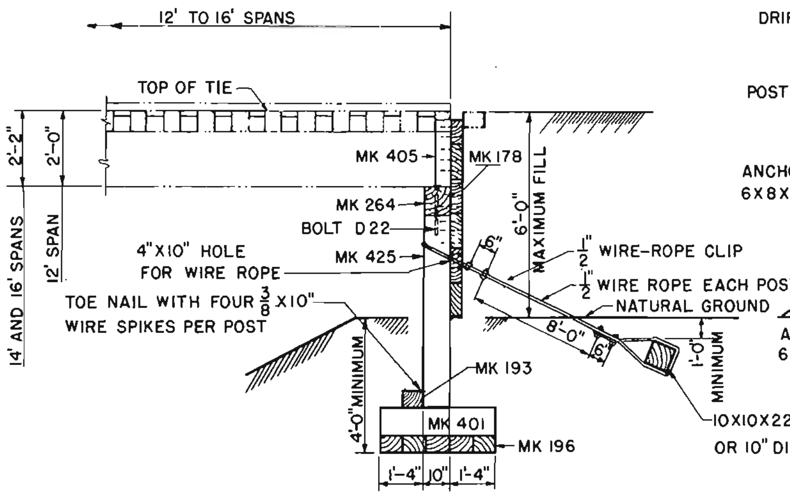
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	TIMBER PILE 6' MAXIMUM FILL QUANTITY	TIMBER PILE 6' MAXIMUM FILL FBM	TIMBER PILE 3' MAXIMUM FILL QUANTITY	TIMBER PILE 3' MAXIMUM FILL FBM	TIMBER POST 6' MAXIMUM FILL QUANTITY	TIMBER POST 6' MAXIMUM FILL FBM	TIMBER POST 3' MAXIMUM FILL QUANTITY	TIMBER POST 3' MAXIMUM FILL FBM	LINE
1	1 BULKHEAD PLANK	39-3340.12-2	178	4X12	20'-0"	300	6	480	5	400	6	480	2	160	1
2	CAP	39-6630.12-12	284	12X12	12'-0"	540	1	144	1	144					2
3	DO	39-6620.1-12	264	10X10	12'-0"	375					1	100	1	100	3
4	PILE, WING		300		15'-0"		2		2						4
5	2 POST, WING	39-3360.08	405	6X8	8'-6"	128					2	68			5
6	DO	39-3360.08	320	6X8	3'-2"	47							2	25	6
7	3 PILE, BEARING						4		4						7
8	2 POST, BEARING	39-6620.1	425	10X10	5'-10"	179					4	194			8
9	SILL	39-3360.08-16	196	6X8	16'-0"	240					5	320	5	320	9
10	BEARING BLOCK	39-6620.1	401	10X10	3'-6"	109					6	175	6	175	10
11	DEADMAN	39-6620.1-22	269	10X10	22'-0"	687					1	183			11
12	ANCHOR BLOCK	39-3360.08	193	6X8	10'-0"	150					1	40	1	40	12
13	DO	39-3360.08	407	6X8	0'-10"	13					2	7			13
14	WIRE ROPE	22-3460.4-05		1/2	20'-0"	13					6				14
15	WIRE-ROPE CLIP	42-3544.5-05		1/2							24				15
16	BOLT WITH NUT AND TWO WASHERS	43-2325.07-2	820	3/4	20"								4		16
17	DRIFT BOLT	43-6316.07-22	D22	3/4	22"		4		4		4		4		17
18	WIRE SPIKE	42-8488.04-1		3/8	10"	.33					96		68		18
19	DO	42-8488.035-07		5/16	7"	.15	108		90		108		36		19
1	NUMBER OF BULKHEAD PLANKS BILLED IS FOR MAXIMUM FILL. USE FEWER PLANKS FOR SHALLOWER FILL.														
2	CUT TO FIT FOR FILLS UNDER 6 FEET AND FOR SPANS OVER 12 FEET.														
3	BEARING PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS.														



ASSEMBLED VIEW

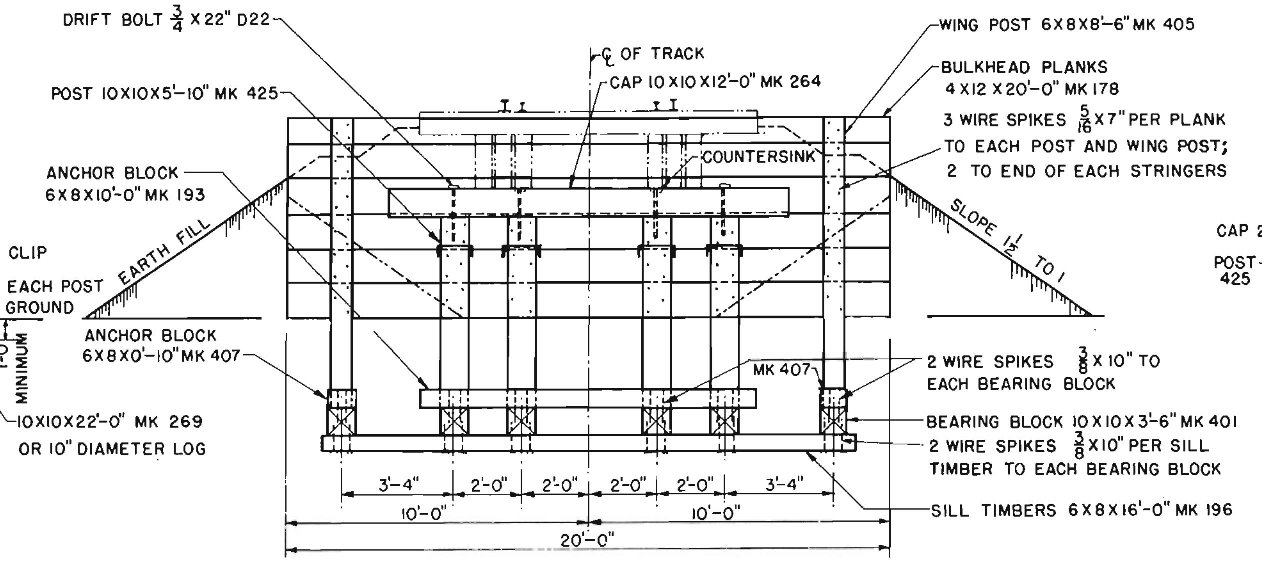
COMPANION SHEETS

	SHEET
BILL OF MATERIALS	196
GENERAL NOTES	154
SYMBOL	155

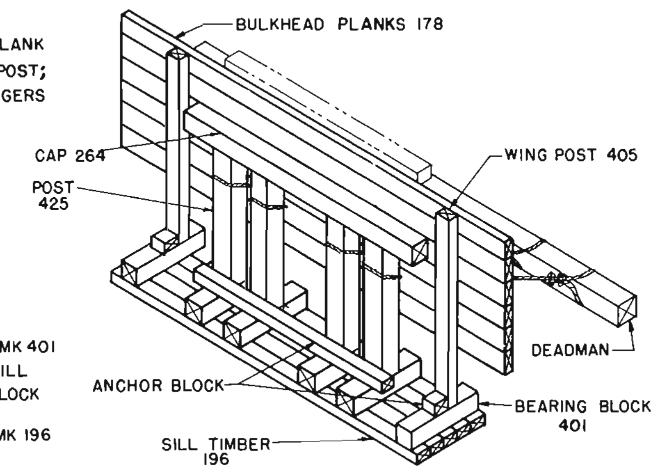


SECTION AT ℄

MAXIMUM POST LOAD = 13 TONS PER POST

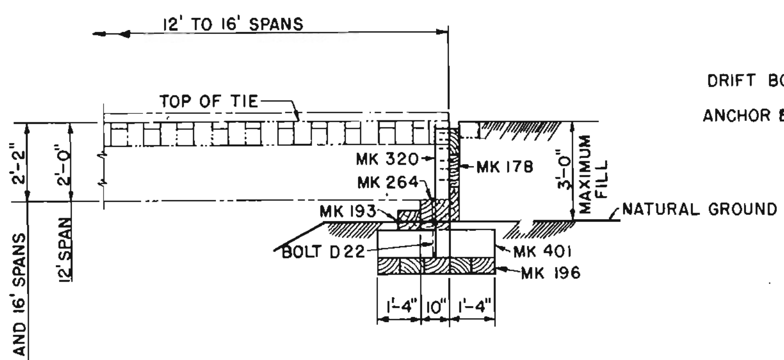


ELEVATION

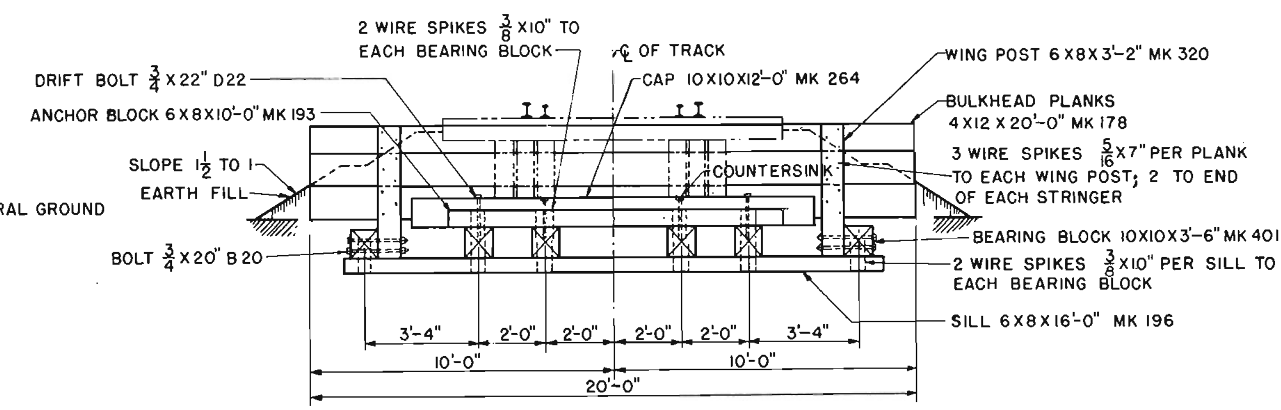


ASSEMBLED VIEW

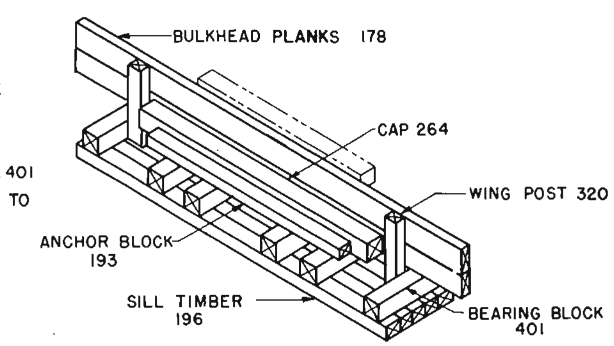
ABUTMENT FOR 6' MAXIMUM FILL



SECTION AT ℄



ELEVATION

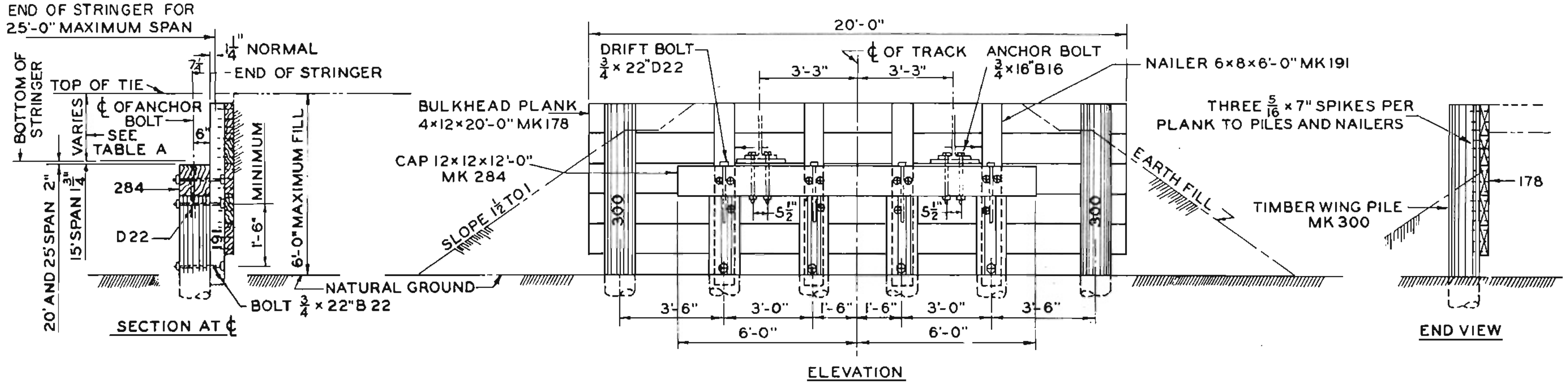


ASSEMBLED VIEW

ABUTMENT FOR 3' MAXIMUM FILL

COMPANION SHEETS

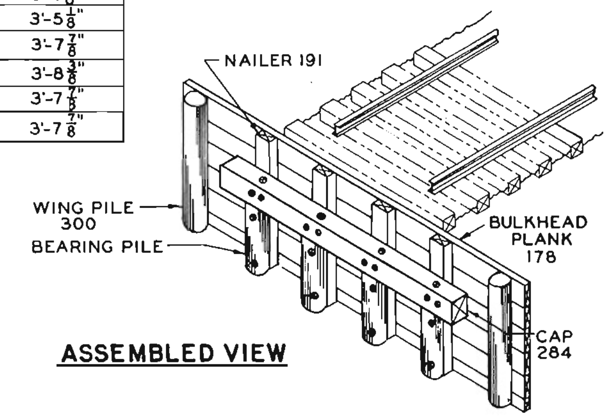
	SHEET
BILL OF MATERIALS	196
GENERAL NOTES	154
SYMBOLS	155



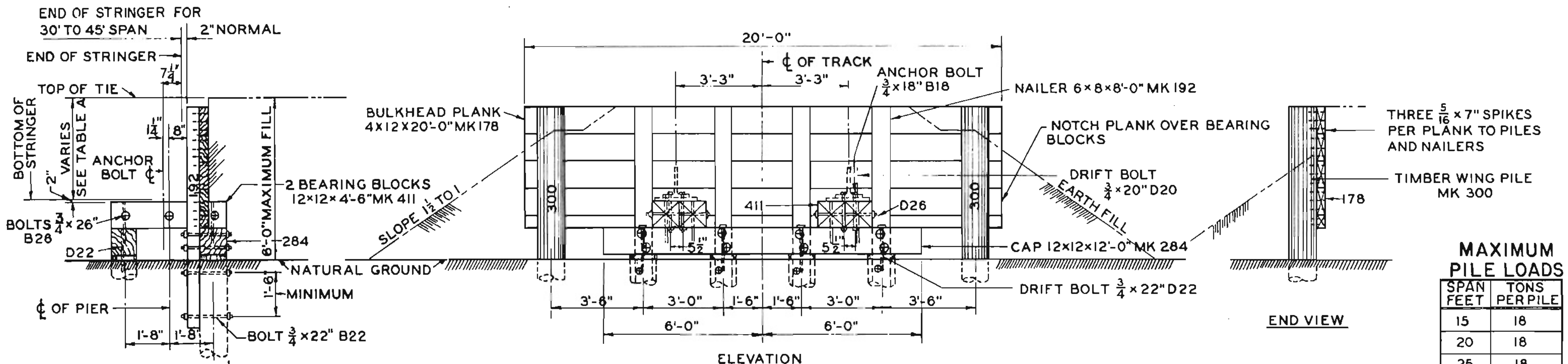
ABUTMENT FOR 15',20',AND 25' SPANS

TABLE A

SPAN FEET	STEEL STRINGER SIZE	TOP OF TIE TO BOTTOM OF STRINGER
15	21 I 63	2'-5"
20	27 I 91	2'-10 7/8"
25	30 I 108	3'-1 7/8"
30	33 I 132	3'-5 1/8"
35	36 I 150	3'-7 7/8"
40	36 I 182	3'-8 3/8"
45	36 I 230	3'-7 7/8"
50	2-36 I 150	3'-7 7/8"



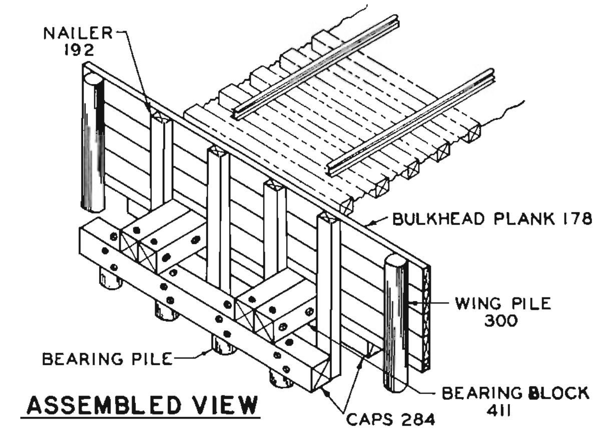
ASSEMBLED VIEW



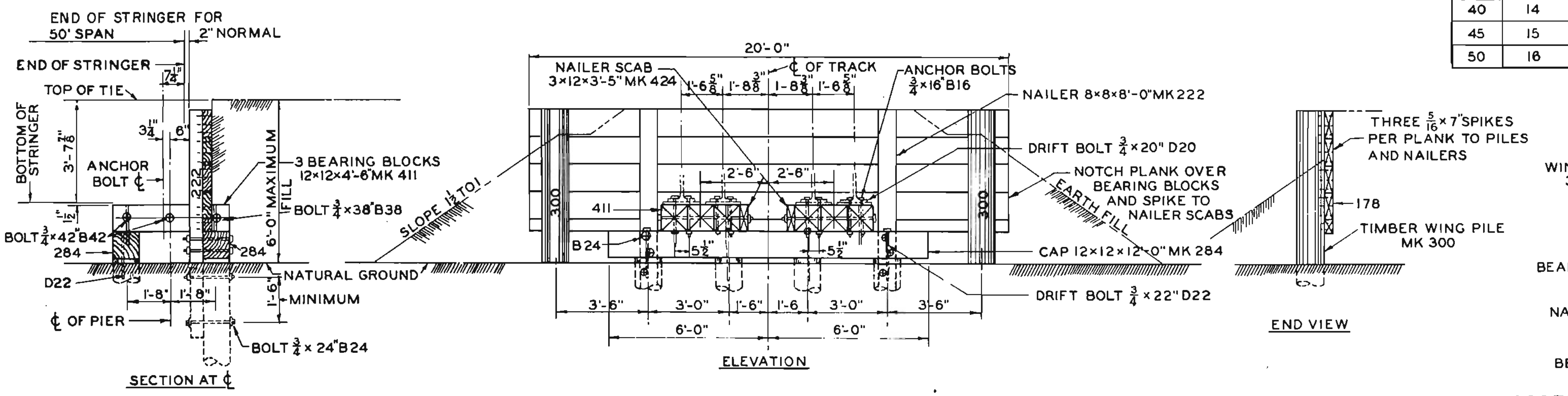
ABUTMENT FOR 30',35',40' AND 45' SPANS

MAXIMUM PILE LOADS

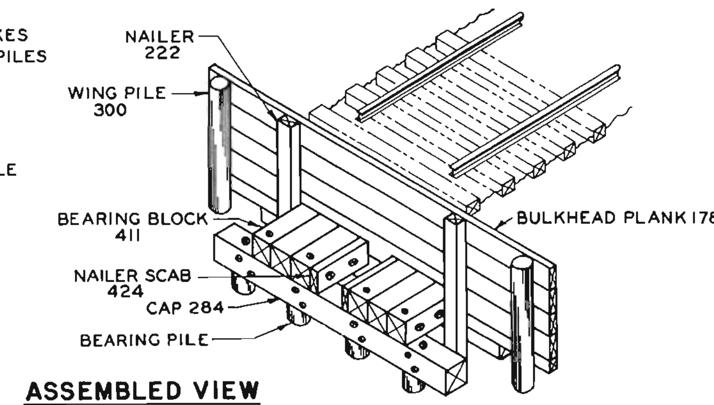
SPAN FEET	TONS PER PILE
15	18
20	18
25	18
30	12
35	13
40	14
45	15
50	16



ASSEMBLED VIEW



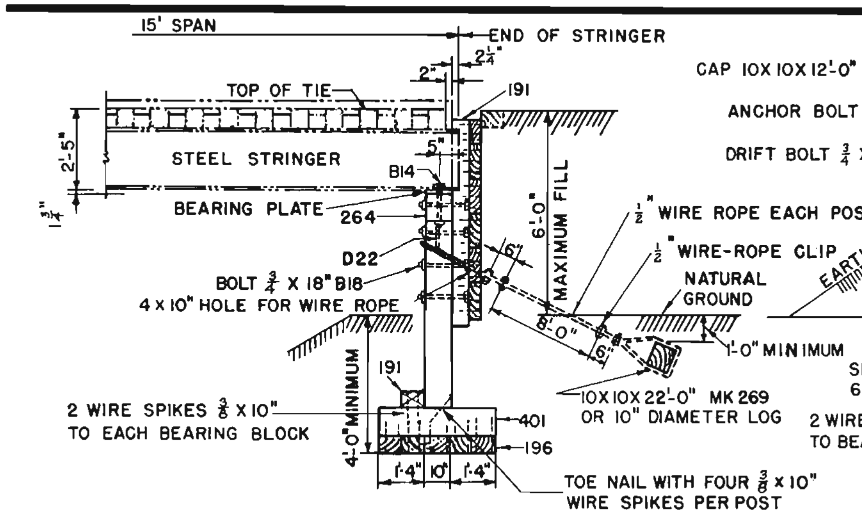
ABUTMENT FOR 50' SPAN



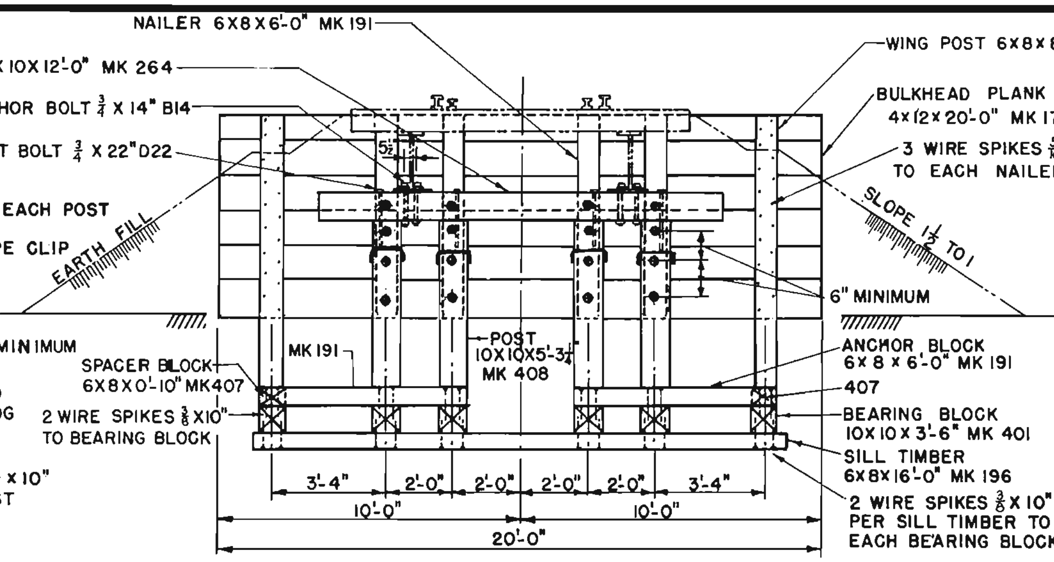
ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155

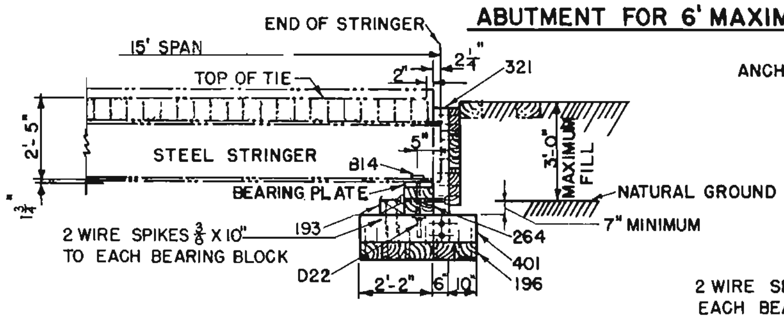


SECTION AT ℄

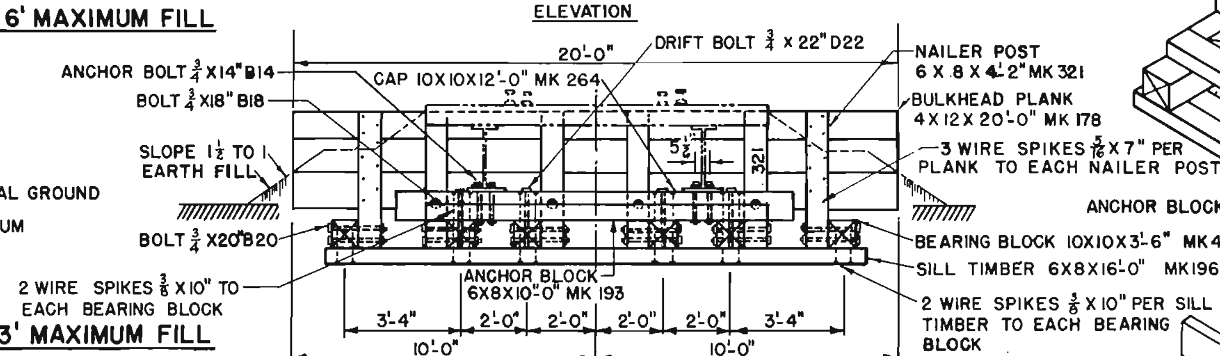


ELEVATION

ABUTMENT FOR 6' MAXIMUM FILL

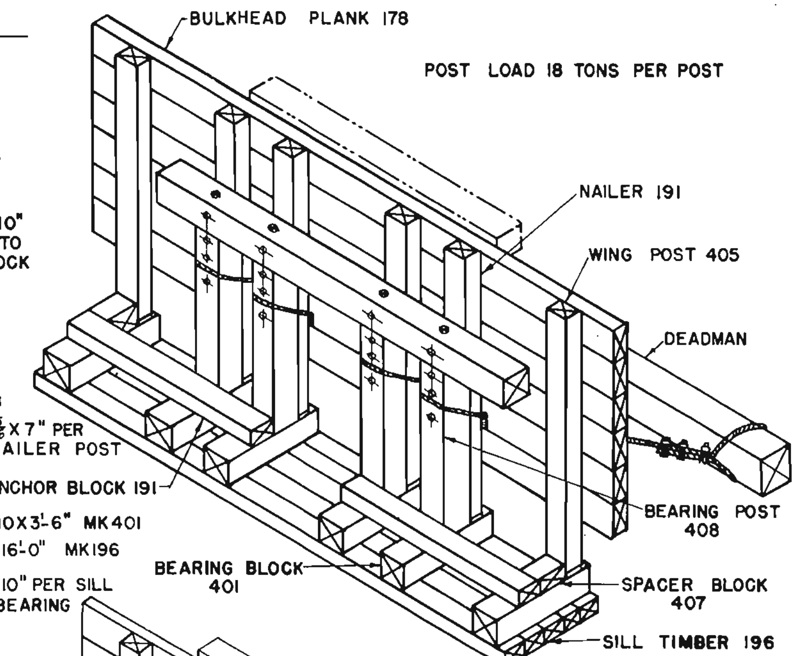


SECTION AT ℄

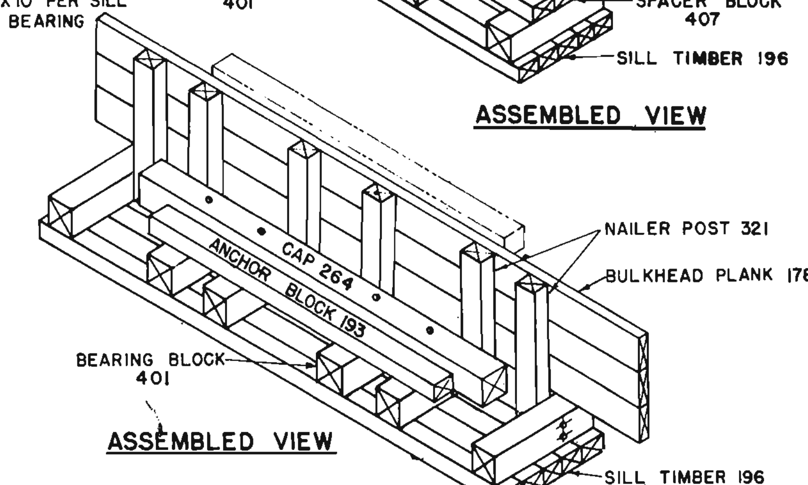


ELEVATION

ABUTMENT FOR 3' MAXIMUM FILL



ASSEMBLED VIEW



ASSEMBLED VIEW

BILL OF MATERIALS FOR ONE ABUTMENT

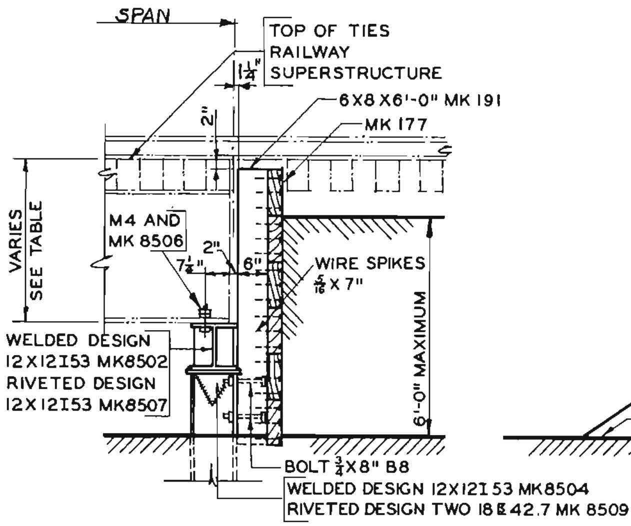
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	WEIGHT EACH (POUNDS)	TIMBER ABUTMENT: 6' MAXIMUM FILL QUANTITY	6' MAXIMUM FILL FBM	3' MAXIMUM FILL QUANTITY	3' MAXIMUM FILL FBM	TIMBER PILE ABUTMENT: 15', 20' AND 25' SPANS QUANTITY	15', 20' AND 25' SPANS FBM	30', 35', 40' AND 45' SPANS QUANTITY	30', 35', 40' AND 45' SPANS FBM	50' SPAN QUANTITY	50' SPAN FBM	LINE
1	BULKHEAD PLANK	39-3340.12-2	178	4X12	20'-0"	300	6	480	3	240	6	480	5	400	5	400	1
2	CAP	39-6620.1-12	264	10X10	12'-0"	375	1	100	1	100							2
3	DO	39-6630.12-12	284	12X12	12'-0"	540					1	144	2	288	2	288	3
4	POST, BEARING	39-6620.1	408	10X10	5'-3 1/4"	165	4	176									4
5	PILE, BEARING										4		8		8		5
6	WING POST	39-3360.08	405	6X8	8'-6"	128	2	68									6
7	WING PILE		300		15'-0"						2		2		2		7
8	NAILER POST	39-3360.08	321	6X8	4'-2"	63			6	100							8
9	NAILER	39-3360.08	191	6X8	6'-0"	90	4	96			4	96					9
10	DO	39-6616.08-08	222	8X8	8'-0"	160									2	85	10
11	DO	39-3360.08	192	6X8	8'-0"	120							4	128			11
12	SILL	39-3360.08-16	196	6X8	16'-0"	240	5	320	5	320							12
13	BEARING BLOCK	39-6620.1	401	10X10	3'-6"	109	6	175	6	175							13
14	DO	39-6630.12	411	12X12	4'-6"	203							4	216	6	324	14
15	DEADMAN	39-6620.1-22	269	10X10	22'-0"	687	1	183									15
16	ANCHOR BLOCK	39-3360.08	191	6X8	6'-0"	90	2	48									16
17	DO	39-3360.08	193	6X8	10'-0"	150			1	40							17
18	SPACER BLOCK	39-3360.08	407	6X8	0'-10"	13	2	7									18
19	NAILER SCABS	39-3330.12	424	3X12	3'-5"	38									2	21	19
20	WIRE ROPE	22-4567.4-05		1/2"	20'-0"	13	6										20
21	WIRE-ROPE CLIP	42-3544.5-05		1/2"		.75	24										21
22	BOLT WITH NUT AND TWO WASHERS	43-2325.07-426	B42	3/4	42"	5.78									4		22
23	DO	43-2325.07-386	B38	3/4	38"	5.28									2		23
24	DO	43-2325.07-266	B26	3/4	26"	3.78							6				24
25	DO	43-2325.07-24	B24	3/4	24"	3.54									8		25
26	DO	43-2325.07-223	B22	3/4	22"	3.30					16		16				26
27	DO	43-2325.07-2	B20	3/4	20"	3.06			12								27
28	DO	43-2325.07-183	B18	3/4	18"	2.82	16		4				4				28
29	DO	43-2325.07-16	B16	3/4	16"	2.57					4				8		29
30	DO	43-2325.07-144	B14	3/4	14"	2.32	4		4								30
31	DRIFT BOLT	43-1636.07-22	D22	3/4	22"	3.30	4		4		4		8		8		31
32	DO	43-1636.07-2	D20	3/4	20"	3.05							8		8		32
33	WIRE SPIKE	42-8488.04-1		3/8	10"	.33	100		68								33
34	DO	42-8488.035-07		5/16	7"	.15	108		54		108		108		60		34

BEARING PLATES (SEE SHEET 178)

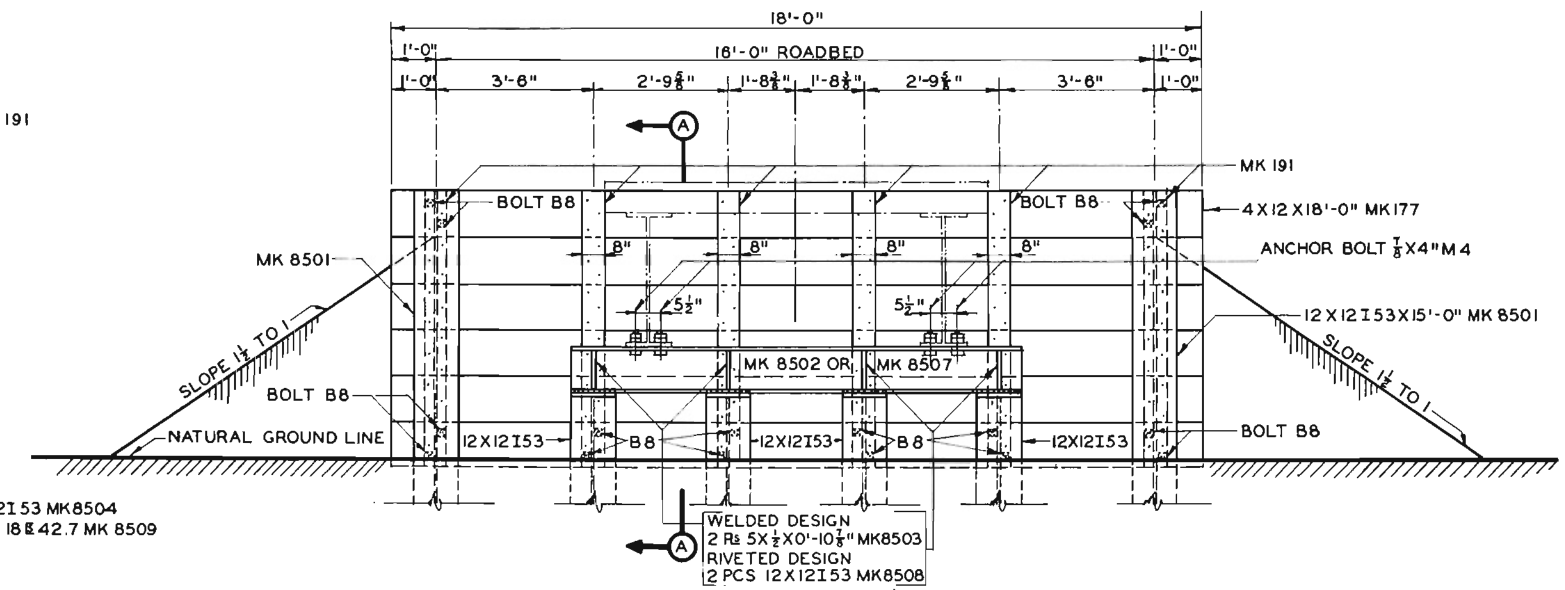
SPAN FEET	STOCK NO	QUANTITY	SIZE (INCHES)	LENGTH	WEIGHT (POUNDS)
15	47-7844.1 47-7844.07	2	12X1 11X3/4	1'-4" 1'-3"	90
20, 25	47-7844.1	2	12X1 11X1	1'-8" 1'-7"	129
30, 35	47-7844.1	2	15X1 14X1	1'-8" 1'-7"	161
40, 45	47-7844.1	2	16X1 15X1	1'-9" 1'-8"	181
50	47-7844.1 47-7844.07	4	12X1 11X3/4	1'-4" 1'-3"	90

COMPANION SHEETS

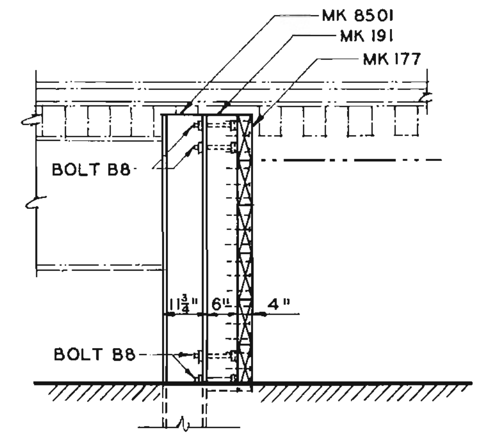
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	198



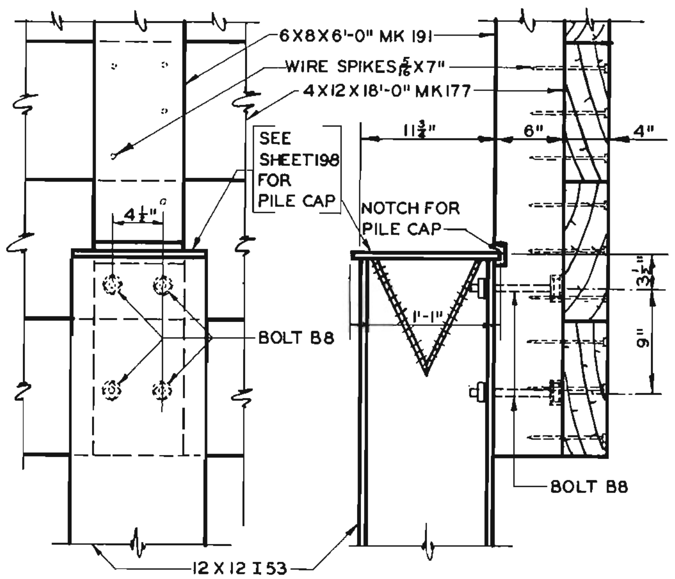
SECTION A-A



TRANSVERSE ELEVATION



END VIEW



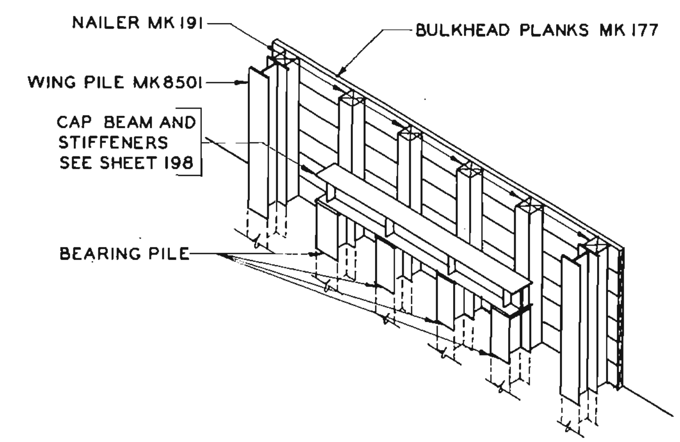
NAILER CONNECTION TO BEARING PILE

MAXIMUM
PILE LOADS

SPAN	TONS PER PILE
15'-0"	15
20'-0"	15
25'-0"	18
30'-0"	20
35'-0"	22
40'-0"	24
45'-0"	26
50'-0"	28

DISTANCE FROM TOP OF TIE
TO BOTTOM OF STRINGER

SPAN LENGTH	STEEL STRINGER SIZE	TOP OF TIE TO BOTTOM OF STRINGER
15'-0"	21 I 63	2'-5"
20'-0"	27 I 91	2'-10 7/8"
25'-0"	30 I 108	3'-1 7/8"
30'-0"	33 I 132	3'-5 1/8"
35'-0"	36 I 150	3'-7 7/8"
40'-0"	36 I 182	3'-8 3/8"
45'-0"	36 I 230	3'-7 7/8"
50'-0"	2-36 I 150	3'-7 7/8"

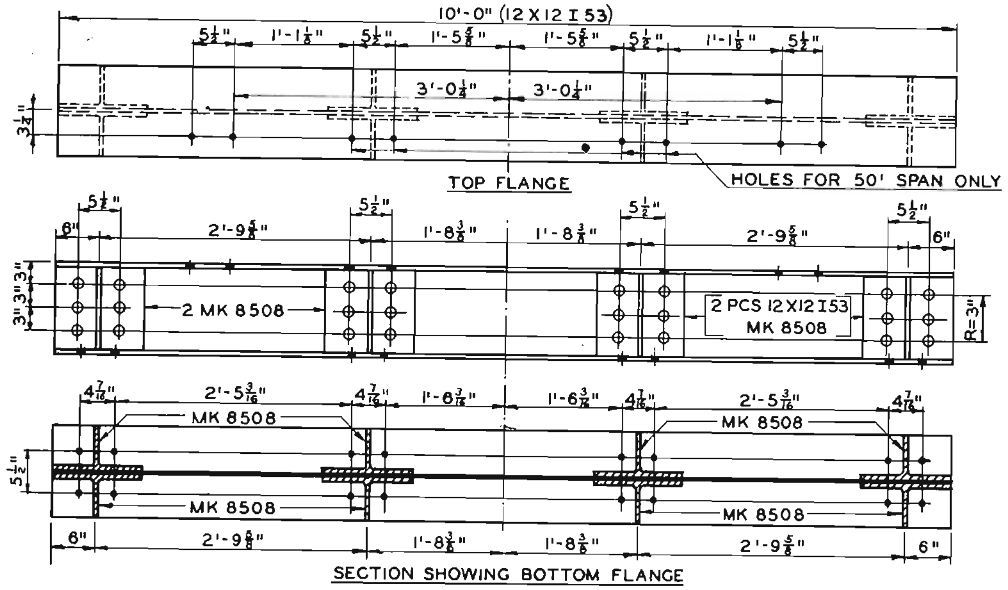


ASSEMBLED VIEW

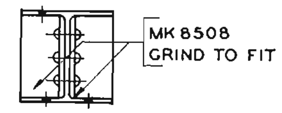
RIVETED AND WELDED CONSTRUCTION, FABRICATION OF STEEL PILE AND TIMBER ABUTMENT BILL OF MATERIALS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE ABUTMENTS	197

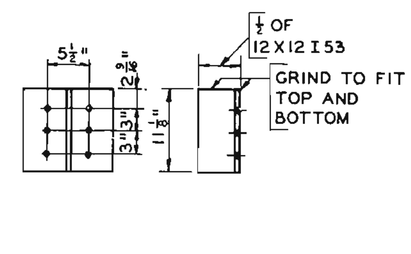


CAP BEAM MK 8507

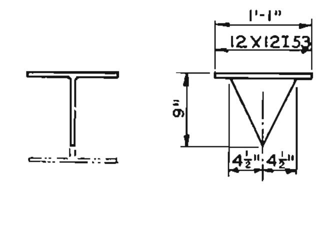


END VIEW

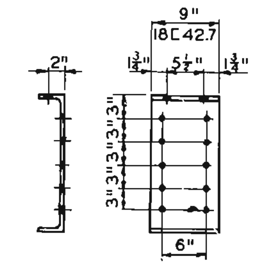
ALL WELDS SHOWN ARE 5/16" FILLET WELDS UNLESS OTHERWISE NOTED



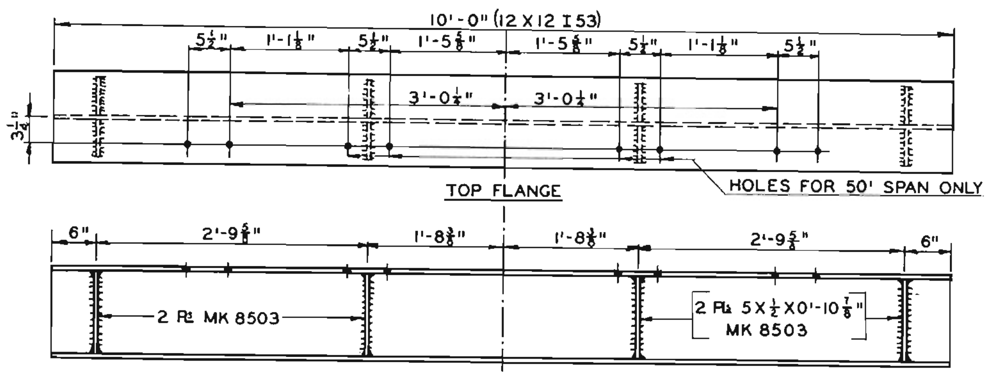
STIFFENER MK 8508



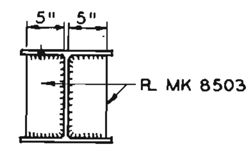
PILE CAP MK 8504



PILE CAP MK 8509



CAP BEAM MK 8502

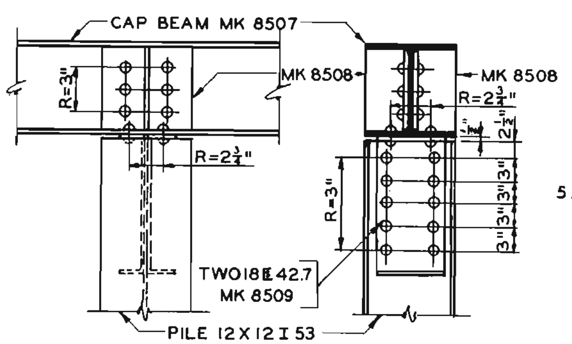


END VIEW

BILL OF MATERIALS FOR ONE ABUTMENT

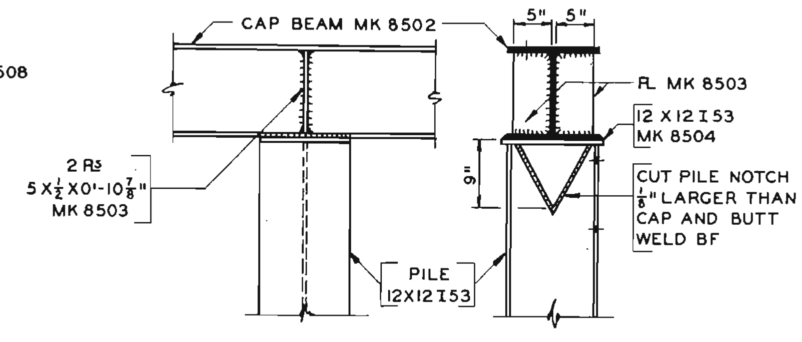
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	QUANTITY	FBM	WEIGHT EACH (POUNDS)
ALTERNATE NO 1 WELDED DETAILS								
1	WING PILE		8501	12X12 I 53	15'-0"	2		795
2	CAP BEAM		8502	12X12 I 53	10'-0"	1		530
3	STIFFENER	47-7844.05	8503	PL 5 X 1/2	10 7/8"	8		8
4	PILE CAP		8504	12X12 I 53	1'-1"	4		29
ALTERNATE NO 2 RIVETED DETAILS								
5	WING PILE		6501	12X12 I 53	15'-0"	2		795
6	CAP BEAM		8507	12X12 I 53	10'-0"	1		530
7	STIFFENER		8508	1/2 12X12 I 53	10 7/8"	8		24
8	PILE CAP	48-3790.18-43	8509	18 [42.7	0'-9"	8		32
9	RIVETS	43-6353.08-25		7/8	2 1/2"	16		.62
10	DO	43-6353.08		7/8	2 3/4"	64		.66
LUMBER, SOFT WOOD								
11	NAILERS	39-3360.08	191	6 X 8	6'-0"	6	144	90
12	BULKHEAD TIMBER	39-3340.12	177	4 X 12	18'-0"	6	432	270
STEEL HARDWARE, BLACK								
13	BOLT WITH NUTS AND TWO WASHERS	43-2325.07-08	88	3/4	8"	24		[1] 39
14	ANCHOR BOLT WITH NUTS AND TWO WASHERS-15' TO 45' SPAN	43-2219.08-04	M4	7/3	4"	4		[1] 6
15	ANCHOR BOLT WITH NUTS AND TWO WASHERS-50' SPAN	43-2215.08-04	M4	7/8	4"	8		[1] 12
16	WIRE SPIKE	42-8483.035-07		5/16	7"	108		[1] 16
17	WELDING ROD	46-3772.2-7		3/16				[1] 18

[1] TOTAL WEIGHT



RIVETED CONNECTION DETAIL

PILE TO CAP BEAM

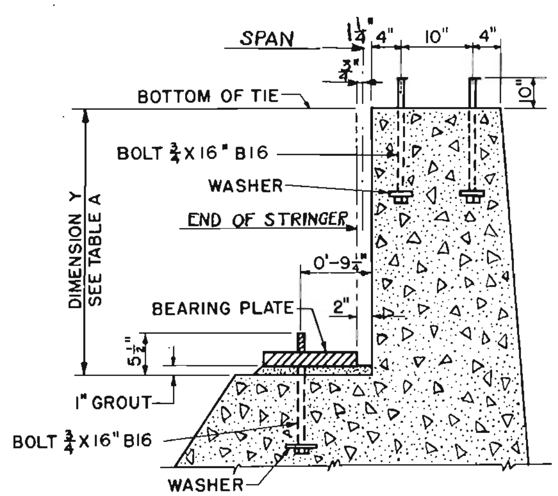


WELDED CONNECTION DETAIL

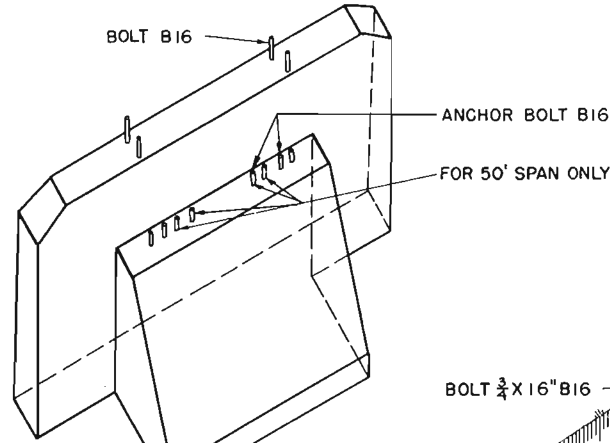
PILE TO CAP BEAM

COMPANION SHEETS

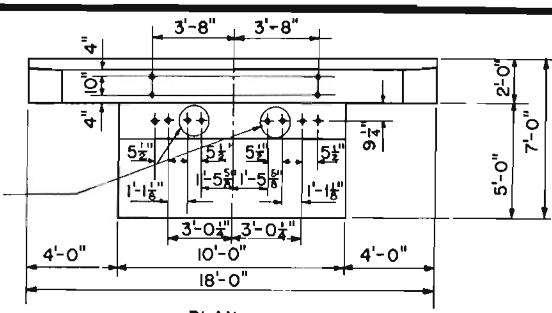
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BEARING PLATES	178



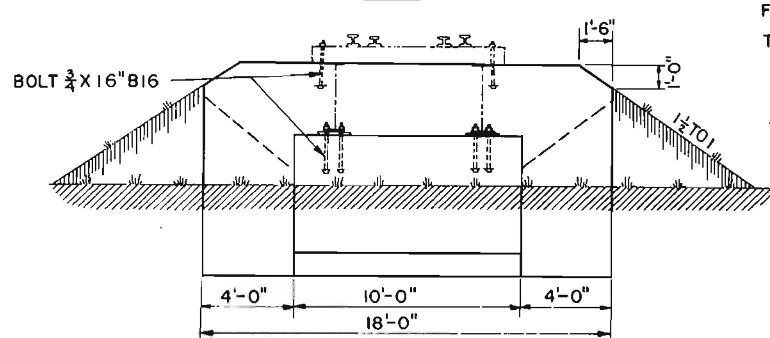
ANCHOR BOLT DETAIL



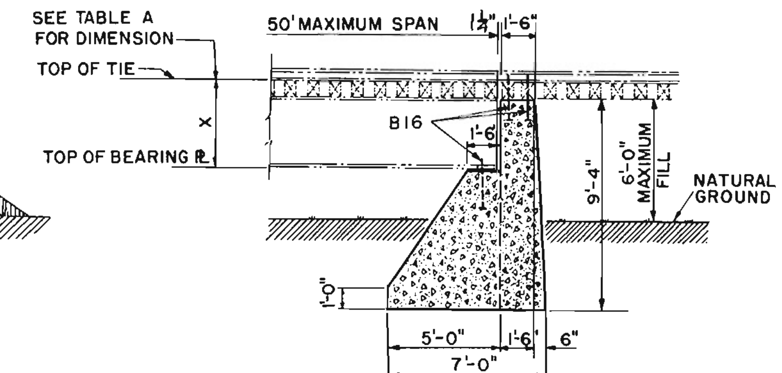
ASSEMBLED VIEW



PLAN

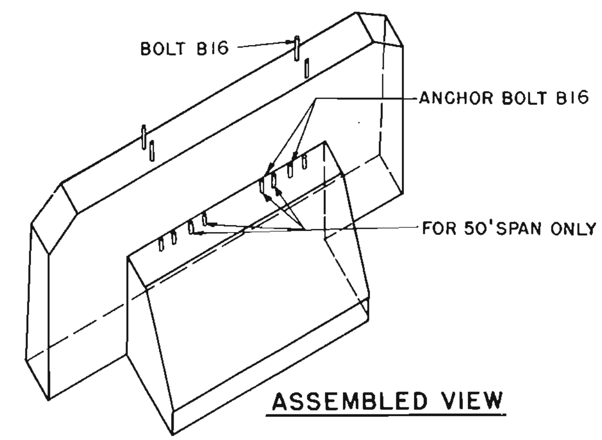


ELEVATION

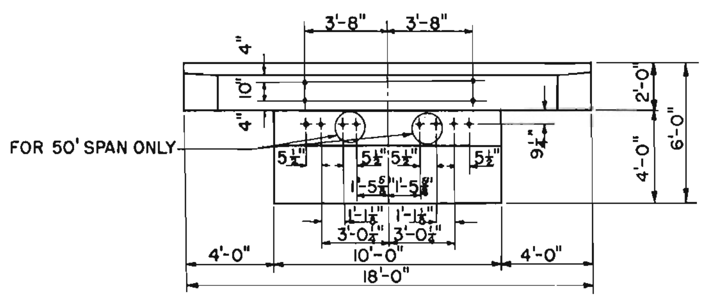


SECTION

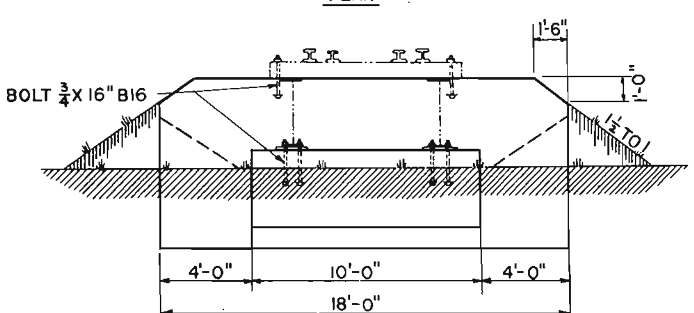
ABUTMENT, 6'-0" MAXIMUM FILL



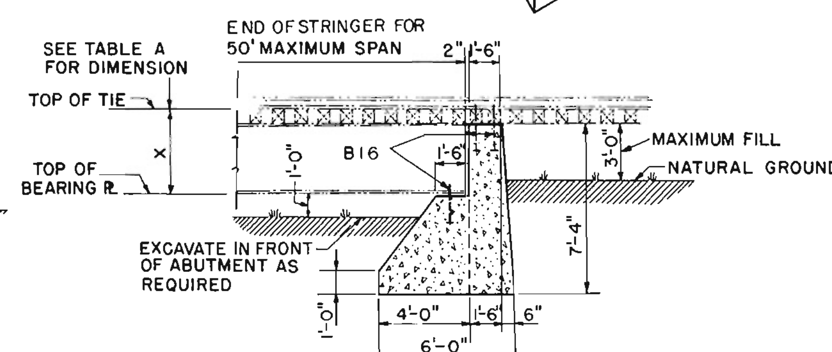
ASSEMBLED VIEW



PLAN



ELEVATION



SECTION

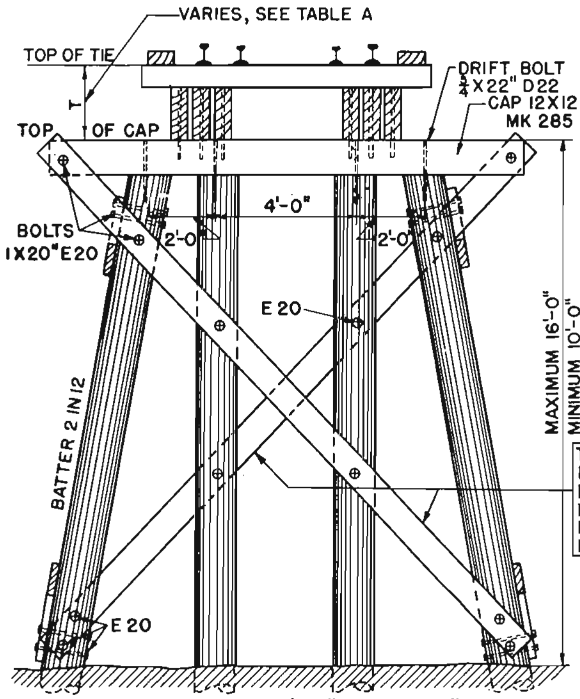
ABUTMENT, 3'-0" MAXIMUM FILL

TABLE A - DIMENSIONS AND BILL OF MATERIALS

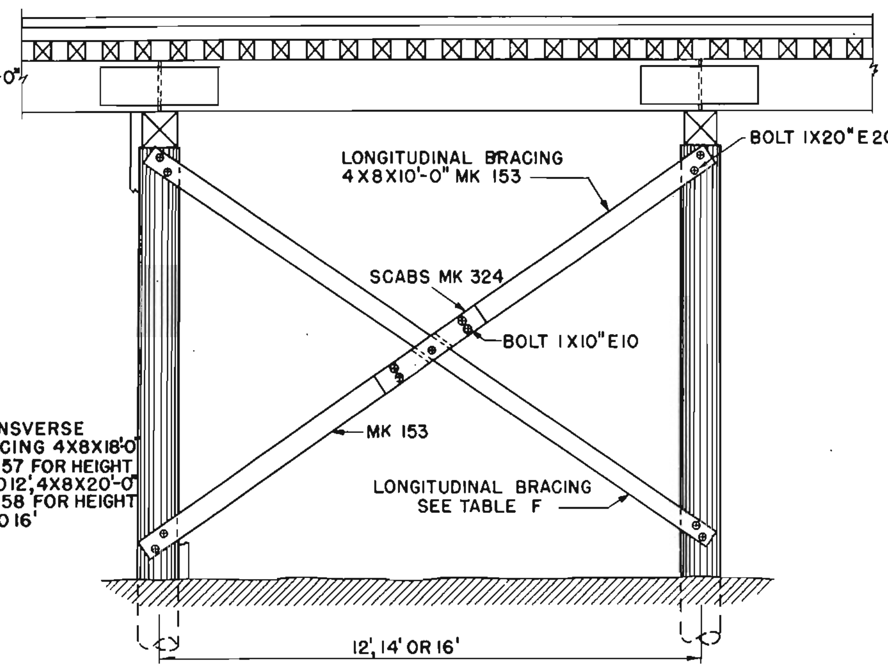
SPAN FEET	X	Y	ANCHOR BOLTS WITH SQUARE NUT AND TWO WASHERS ¾ X 16" B16 STOCK NO 43-2325.07-16		CONCRETE	
					6' MAXIMUM FILL	3' MAXIMUM FILL
			QUANTITY	WEIGHT EACH (POUNDS)	CU YDS	CU YDS
15	2'-5"	1'-1½"	8	3.5	20.4	14.4
20	2'-10⅞"	2'-5⅝"	8	3.5	19.8	14.3
25	3'-1⅞"	2'-8⅜"	8	3.5	19.5	13.7
30	3'-5⅛"	2'-11⅞"	8	3.5	19.2	13.4
35	3'-7⅞"	3'-2⅜"	8	3.5	18.9	13.1
40	3'-8⅜"	3'-3⅜"	8	3.5	18.8	13.1
45	3'-7⅞"	3'-2⅞"	8	3.5	18.9	13.1
50	3'-7⅞"	3'-2⅜"	12	3.5	18.9	13.1

BEARING PLATES (SEE SHEET 178)

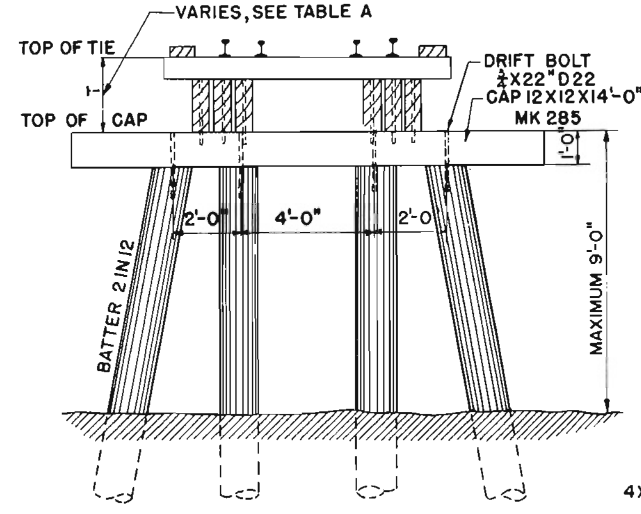
SPAN	STOCK NO	QUANTITY	SIZE (INCHES)	LENGTH	WEIGHT (POUNDS)
15	47-7844.1 47-7844.07	2	12X1 11X¾	1'-4" 1'-3"	90
20, 25	47-7844.1	2	12X1 11X1	1'-8" 1'-7"	129
30, 35	47-7844.1	2	15X1 14X1	1'-8" 1'-7"	161
40, 45	47-7844.1	2	16X1 15X1	1'-9" 1'-8"	181
50	47-7844.1 47-7844.07	4	12X1 11X¾	1'-4" 1'-3"	90



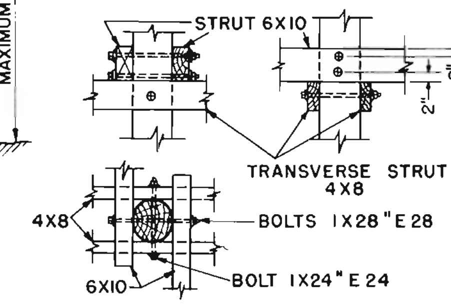
4-PILE BENT 10'-0" TO 16'-0"



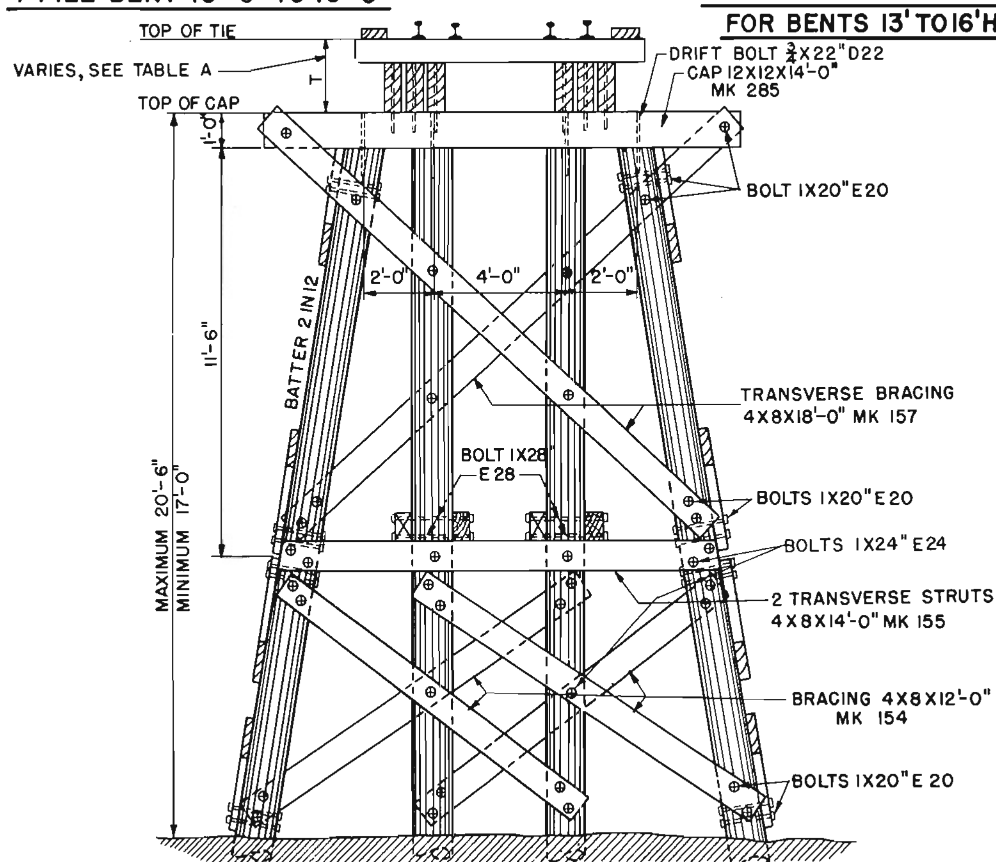
TYPICAL LONGITUDINAL ELEVATION FOR BENTS 13' TO 16' HIGH



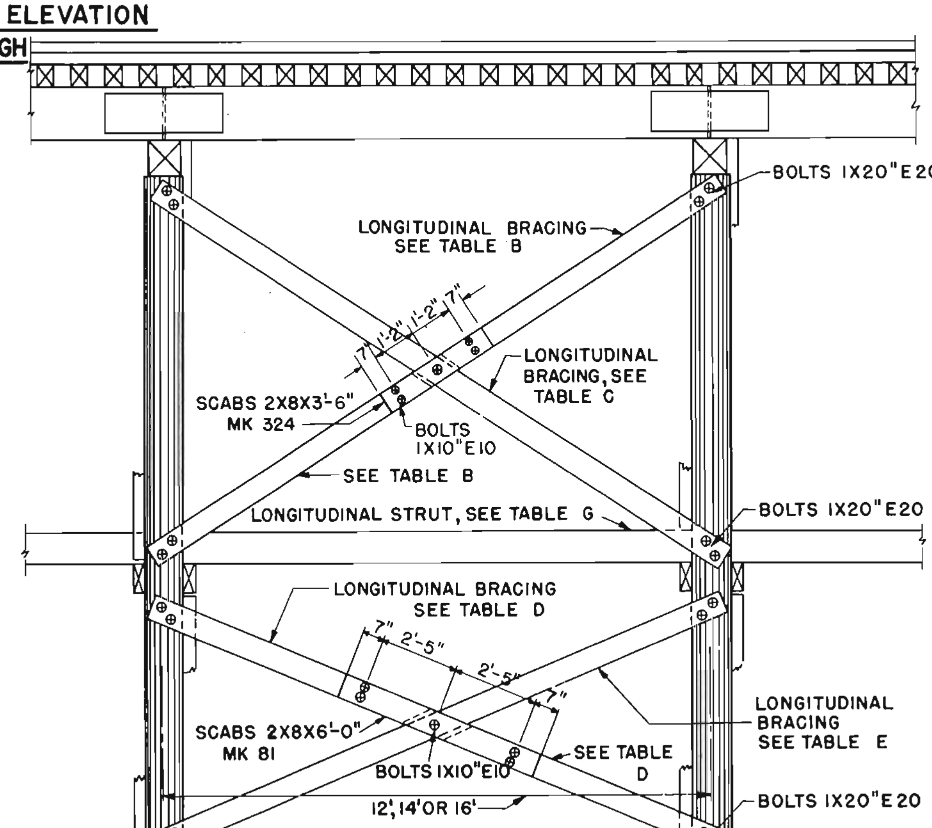
4-PILE BENT 1'-0" TO 9'-0"



STRUT CONNECTION DETAILS



4-PILE BENT 17'-0" TO 20'-6"



TYPICAL LONGITUDINAL ELEVATION FOR BENTS 17' TO 28' HIGH

COMPANION SHEET

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	201

TABLE A

SPAN	T
12'-0"	2'-0"
14'-0"	2'-2"
16'-0"	2'-2"

TABLE B

LONGITUDINAL BRACING 4X8		
SPAN	LENGTH	MARK
12'-0"	8'-0"	152
14'-0"	10'-0"	153
16'-0"	10'-0"	153

TABLE C

LONGITUDINAL BRACING 4X8		
SPAN	LENGTH	MARK
12'-0"	18'-0"	157
14'-0"	18'-0"	157
16'-0"	20'-0"	158

TABLE F

LONGITUDINAL BRACING 4X8		
SPAN	LENGTH	MARK
12'-0"	18'-0"	157
14'-0"	20'-0"	158
16'-0"	22'-0"	159

TABLE G

LONGITUDINAL STRUT 6X10		
SPAN	LENGTH	MARK
12'-0"	14'-0"	205
14'-0"	16'-0"	206
16'-0"	18'-0"	207

TABLE D

HEIGHT	LONGITUDINAL BRACING 4X8					
	12' SPAN		14' SPAN		16' SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 20'-6"	8'-0"	152	8'-0"	152	10'-0"	153
21' TO 23'	8'-0"	152	10'-0"	153	10'-0"	153
24' TO 25'	10'-0"	153	10'-0"	153	10'-0"	153
26' TO 28'	10'-0"	153	10'-0"	153	10'-0"	153

TABLE E

HEIGHT	LONGITUDINAL BRACING 4X8					
	12' SPAN		14' SPAN		16' SPAN	
	LENGTH	MARK	LENGTH	MARK	LENGTH	MARK
17' TO 20'-6"	14'-0"	155	16'-0"	156	18'-0"	157
21' TO 23'	16'-0"	156	18'-0"	157	20'-0"	158
24' TO 25'	18'-0"	157	20'-0"	158	20'-0"	158
26' TO 28'	20'-0"	158	20'-0"	158	22'-0"	159

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE BENTS	200

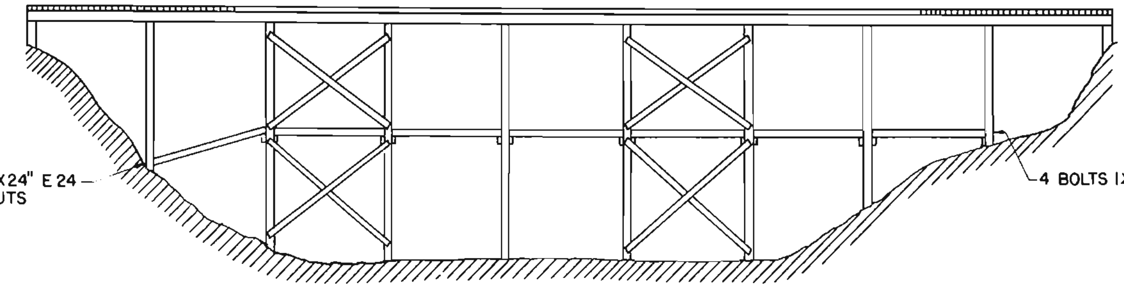
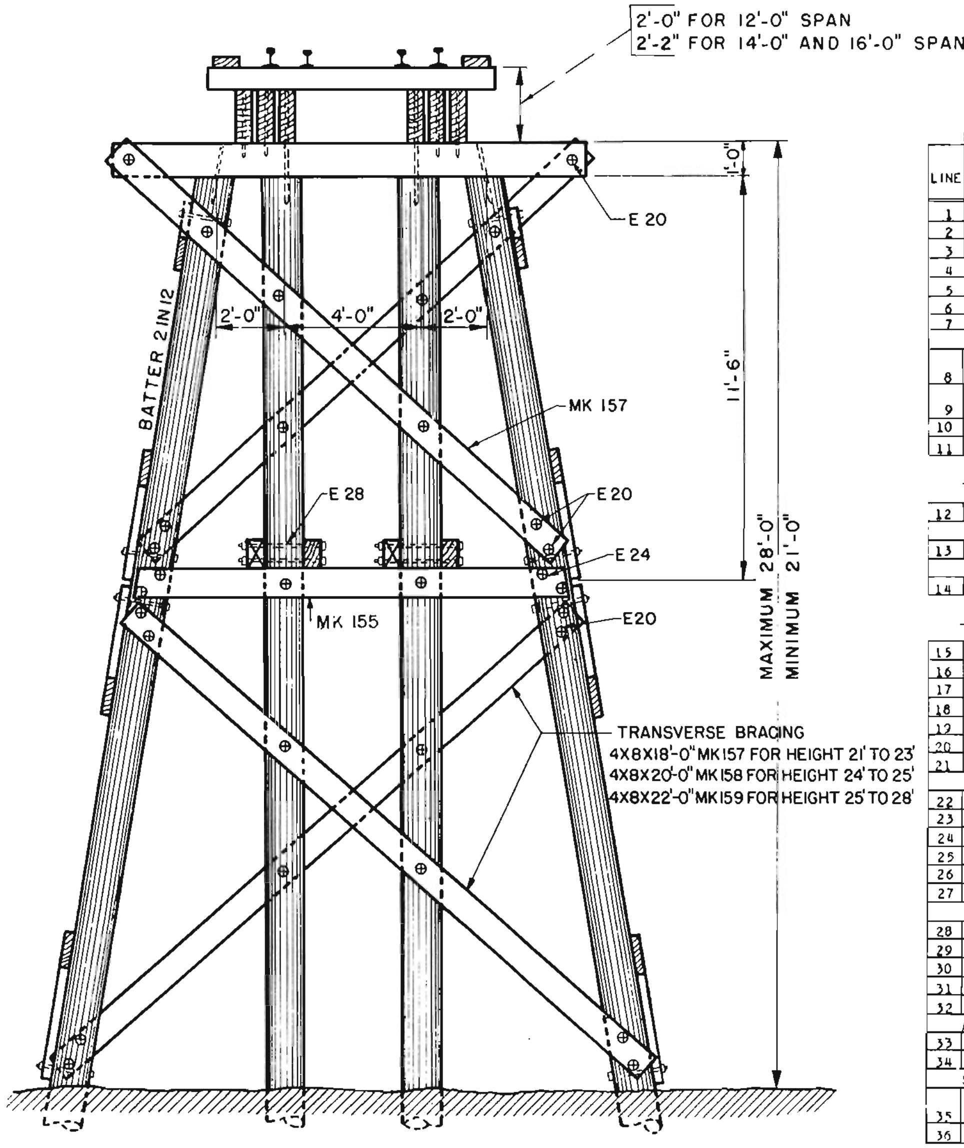


DIAGRAM SHOWING LONGITUDINAL BRACING

FOR BENTS 13 FEET HIGH OR OVER, EVERY THIRD PANEL HAS LONGITUDINAL BRACING. LONGITUDINAL STRUTS ARE CARRIED TO BANK AND FASTENED TO BENT NEAR GROUND LINE.

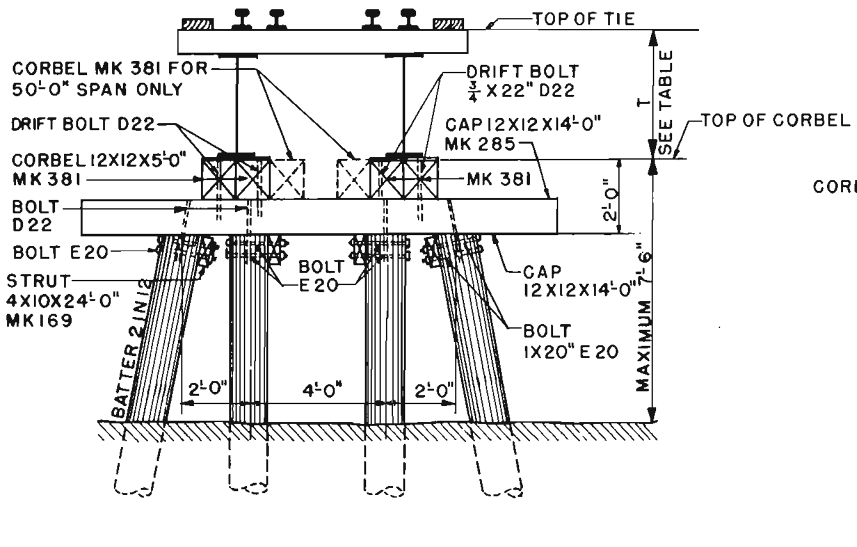


4-PILE BENT 21'-0" TO 28'-0"

BILL OF MATERIALS FOR ONE TIMBER PILE BENT OR ONE PANEL OF LONGITUDINAL BRACING

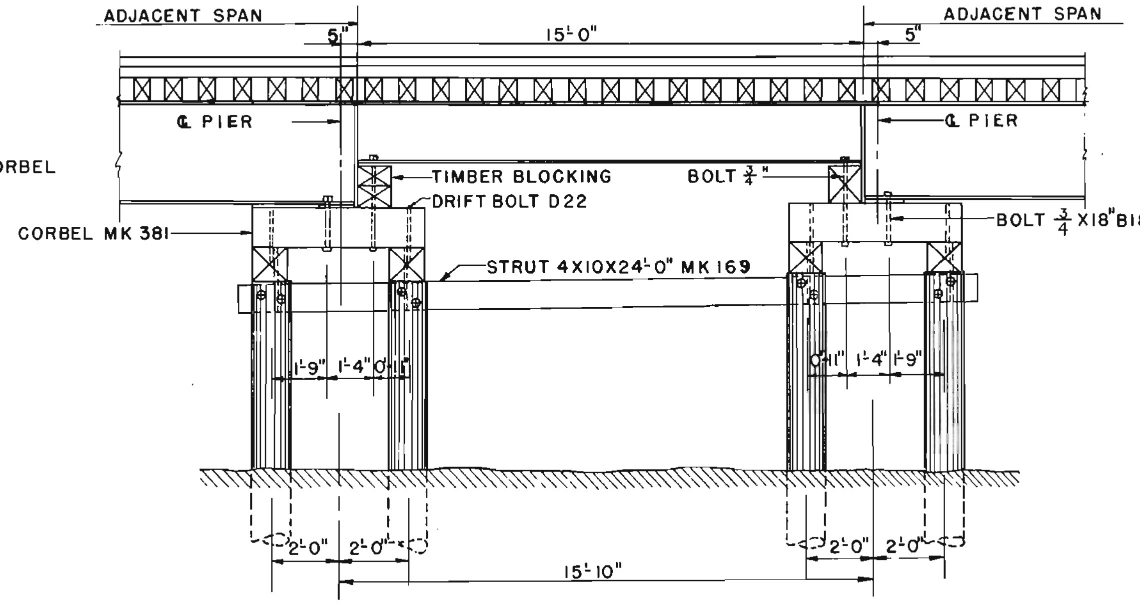
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	BENT HEIGHT 0' TO 9' QUANTITY	FBM	BENT HEIGHT 10' TO 12' QUANTITY	FBM	BENT HEIGHT 13' TO 16' QUANTITY	FBM	BENT HEIGHT 17' TO 20' QUANTITY	FBM	BENT HEIGHT 21' TO 23' QUANTITY	FBM	BENT HEIGHT 24' TO 25' QUANTITY	FBM	BENT HEIGHT 26' TO 28' QUANTITY	FBM	LINE
1	TIMBER PILE						4		4		4		4		4		4		4		1
2	CAP, LUMBER, SOFT WOOD	39-6530.12-14	285	12X12	14'-0"	630	1	168	1	168	1	168	1	168	1	168	1	168	1	168	2
3	BRACE, LUMBER, SOFT WOOD	39-3340.08-12	154	4X8	12'-0"	120							4	128							3
4	DO	39-3340.08-18	157	4X8	18'-0"	180			2	96			2	96	4	192	2	96	2	96	4
5	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107					2	107			5
6	DO	39-3340.08-22	159	4X8	22'-0"	220													2	117	6
7	STRUT, LUMBER, SOFT WOOD	39-3340.08-14	155	4X8	14'-0"	140							2	75	2	75	2	75	2	75	7
	STEEL HARDWARE, BLACK																				
8	DRIFT BOLT WITH SQUARE HEAD AND ONE WASHER	43-1636.07-22	D22	3/4	22"	3.0	4		4		4		4		4		4		4		8
9	MACHINE BOLT WITH SQUARE HEAD, NUT AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.6			12		12		28		24		24		24		9
10	DO	43-2325.1-24	E24	1	24"	5.5							8		6		6		6		10
11	DO	43-2325.1-28	E28	1	28"	7.4							4		4		4		4		11
	MATERIAL REQUIRED FOR LONGITUDINAL BRACING FOR VARIOUS SPANS, STRUTS ONLY																				
	12' SPAN																				
12	STRUT, LUMBER, SOFT WOOD	39-3360.1-14	205	6X10	14'-0"	262							2	140	2	140	2	140	2	140	12
	14' SPAN																				
13	STRUT, LUMBER, SOFT WOOD	39-3360.1-16	206	6X10	16'-0"	300							2	160	2	160	2	160	2	160	13
	16' SPAN																				
14	STRUT, LUMBER, SOFT WOOD	39-3360.1-18	207	6X10	18'-0"	338							2	180	2	180	2	180	2	180	14
	MATERIAL REQUIRED FOR LONGITUDINAL BRACING FOR VARIOUS SPANS, BRACES AND STRUTS																				
	12' SPAN																				
15	BRACE, LUMBER, SOFT WOOD	39-3340.08-08	152	4X8	8'-0"	80							8	171	8	171	4	85	4	85	15
16	DO	39-3340.08-1	153	4X8	10'-0"	100					4	107					4	107	4	107	16
17	DO	39-3340.08-14	155	4X8	14'-0"	140							2	75							17
18	DO	39-3340.08-16	156	4X8	16'-0"	160									2	35					18
19	DO	39-3340.08-18	157	4X8	18'-0"	180					2	96	2	95	2	96	4	192	2	96	19
20	DO	39-3340.08-2	158	4X8	20'-0"	200													2	107	20
21	STRUT, LUMBER, SOFT WOOD	39-3360.1-14	205	6X10	14'-0"	262							2	140	2	140	2	140	2	140	21
	14' SPAN																				
22	BRACE, LUMBER SOFT WOOD	39-3340.08-08	152	4X8	8'-0"	80							4	85							22
23	DO	39-3340.08-10	153	4X8	10'-0"	100					4	107	4	107	8	213	8	213	8	213	23
24	DO	39-3340.08-16	156	4X8	16'-0"	160							2	85							24
25	DO	39-3340.08-18	157	4X8	18'-0"	180							2	96	4	192	2	96	2	96	25
26	DO	39-3340.08-2	158	4X8	20'-0"	200					2	107					2	107	2	107	26
27	STRUT, LUMBER SOFT WOOD	39-3360.1-16	206	6X10	16'-0"	300							2	160	2	160	2	160	2	160	27
	16' SPAN																				
28	BRACING, LUMBER, SOFT WOOD	39-3340.08-1	153	4X8	10'-0"	100					4	107	8	213	8	213	8	213	8	213	28
29	DO	39-3340.08-18	157	4X8	18'-0"	180							2	96							29
30	DO	39-3340.08-2	158	4X8	20'-0"	200							2	107	4	213	4	213	2	107	30
31	DO	39-3340.08-18	159	4X8	22'-0"	220					2	117							2	117	31
32	STRUT, LUMBER, SOFT WOOD	39-3360.1-18	207	6X10	18'-0"	338							2	180	2	180	2	180	2	180	32
	ALL SPAN																				
33	SCAB, LUMBER, SOFT WOOD	39-3228.08	81	2X8	6'-0"	30							4	32	4	32	4	32	4	32	33
34	DO	39-3228.08	324	2X8	3'-6"	18					4	19	4	19	4	19	4	19	4	19	34
	STEEL HARDWARE, BLACK																				
35	MACHINE BOLT WITH SQUARE HEAD, NUT, AND TWO WASHERS	43-2325.1-104	E10	1	10"	3.5					10		20		20		20		20		35
36	DO	43-2325.1-2	E20	1	20"	5.6					16		32		32		32		32		36

PIERS UP TO 11 FEET HIGH, GENERAL VIEWS, BLOCKING FOR STRINGERS OF DIFFERENT DEPTHS, DIMENSIONS



TRANSVERSE ELEVATION

16-PILE TIMBER TOWER UNDER 7'-6" HIGH

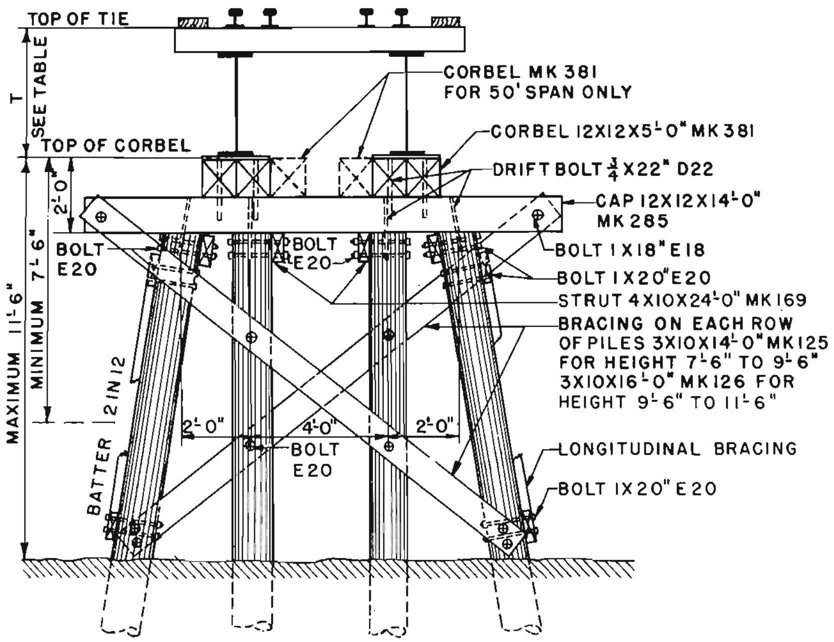


LONGITUDINAL ELEVATION

16-PILE TIMBER TOWER UNDER 7'-6" HIGH

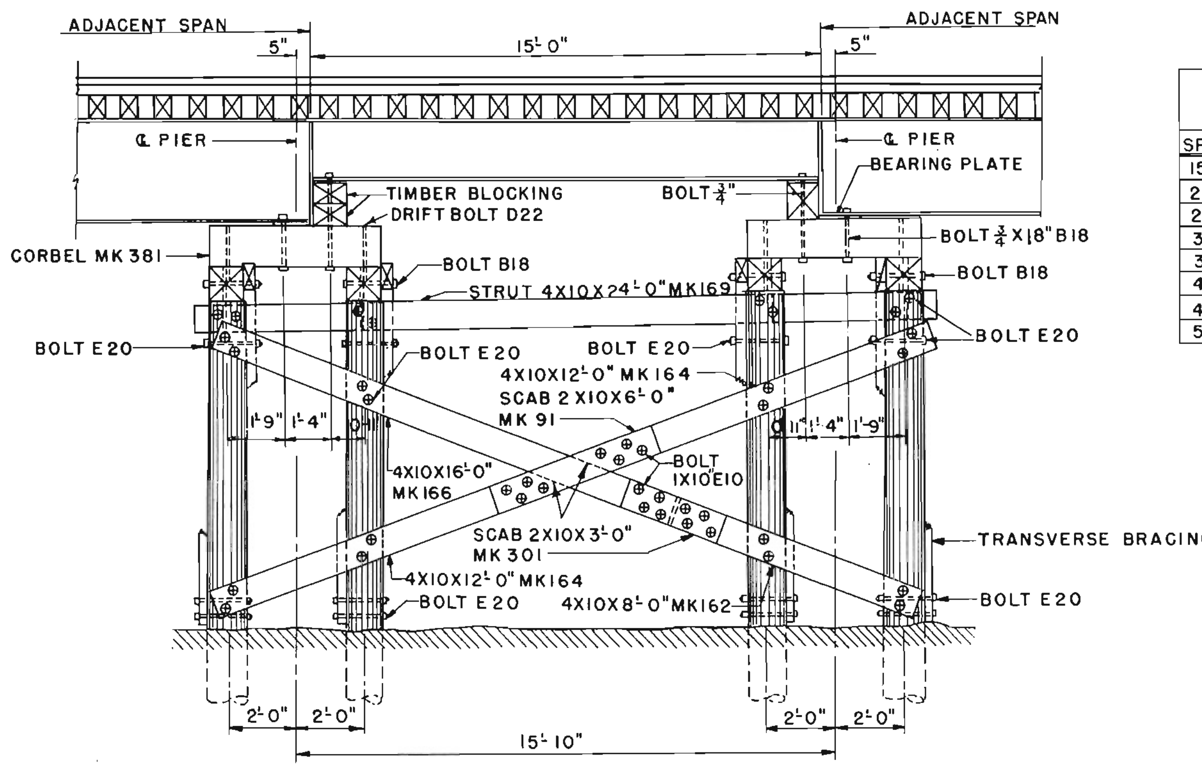
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	203
BEARING PLATES	178



TRANSVERSE ELEVATION

16-PILE TIMBER TOWER 7'-6" TO 11'-6" HIGH



LONGITUDINAL ELEVATION

16-PILE TIMBER TOWER 7'-6" TO 11'-6" HIGH

ADJACENT SPAN		DEPTH OF BLOCKING	T	REQUIRED PILE BEARING CAPACITY
SPAN	SECTION			
15'-0"	21 I 63	———	2'-6 3/4"	11 TONS
20'-0"	27 I 91	0'-6 1/8"	3'-0 7/8"	12 "
25'-0"	30 I 108	0'-9 1/8"	3'-3 7/8"	13 "
30'-0"	33 I 132	1'-0 3/8"	3'-7 1/8"	14 "
35'-0"	36 I 150	1'-3 1/8"	3'-9 7/8"	15 "
40'-0"	36 I 182	1'-3 5/8"	3'-10 3/8"	16 "
45'-0"	36 I 230	1'-3 1/8"	3'-9 7/8"	17 "
50'-0"	36 I 150	1'-2 5/8"	3'-9 3/8"	18 "

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER PILE PIERS FOR STEEL SPANS	202

BILL OF MATERIALS FOR ONE TIMBER PILE PIER 7'-6" OR LESS IN HEIGHT

	PIER HEIGHT						7'-6" OR UNDER										
	SPAN						15'		20'		25'		30'		35' TO 45'		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																
1	CORBEL	39-5630.12	381	12 X 12	5'-0"	225	8	480	8	480	8	480	8	480	8	480	1
2	CAP	39-5630.12-14	285	12 X 12	14'-0"	630	4	672	4	672	4	572	4	672	4	672	2
3	STRUT	39-3340.1-24	169	4 X 10	24'-0"	300	4	320	4	320	4	320	4	320	4	320	3
4	TIMBER PILE				1]		16		16		16		16		16		4
5	BLOCKING	39-5630.12	382	12 X 12	8'-6"	383							1	102			5
6	DO	39-6620.12	383	10 X 12	8'-6"	319					1	85					6
7	DO	39-6616.12	384	8 X 12	8'-6"	255									2	136	7
8	DO	39-3350.12	385	6 X 12	8'-6"	191			1	51							8
	STEEL HARDWARE, BLACK																
9	MACHINE BOLT WITH SQUARE HEAD, NUT, AND TWO WASHERS	43-2325.07-223	B22	3/4	22"	3.30			4								9
10	DO	43-2325.07-266	B26	3/4	26"	3.78					4						10
11	DO	43-2325.07-306	B30	3/4	30"	4.26							4				11
12	DO	43-2325.07-32	B32	3/4	32"	4.50									4		12
13	DO	43-2325.07-183	B18	3/4	18"	2.82	8		4		4		4		4		13
14	DO	43-2325.1-2	E20	1	20"	5.51	32		32		32		32		32		14
15	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-22	D22	3/4	22"	3.0	32		32		32		32		32		15

1] LENGTH OF PILES TO BE DETERMINED BY FIELD CONDITIONS.

BEARING PLATES (SEE SHEET 178)				
SPAN	QUANTITY EACH SUPPORT	SIZE (INCHES)	LENGTH	STOCK NO
15'	2	12X1 11X3/4	1'-4" 1'-3"	47-7844.1 47-7844.07
20', 25'	2	12X1 11X1	1'-8" 1'-7"	47-7844.1
30', 35'	2	15X1 14X1	1'-8" 1'-7"	47-7844.1
40', 45'	2	16X1 15X1	1'-9" 1'-8"	47-7844.1
50'	4	12X1 11X3/4	1'-4" 1'-3"	47-7844.1 47-7844.07

BILL OF MATERIALS FOR ONE TIMBER PILE PIER 7'-6" TO 11'-6" HIGH

	PIER HEIGHT						7'-6" TO 9'-5"												9'-6" TO 11'-6"												
	SPAN						15'		20'		25'		30'		35' TO 45'		50'		15'		20'		25'		30'		35' TO 45'		50'		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																														
1	CORBEL	39-6630.12	381	12 X 12	5'-0"	225	8	480	8	480	8	480	8	430	8	480	8	490	8	480	8	480	8	480	8	480	8	480	10	600	1
2	CAP	39-6530.12-14	285	12 X 12	14'-0"	630	4	672	4	672	4	672	4	672	4	672	4	672	4	672	4	672	4	672	4	672	4	672	4	672	2
3	STRUT	39-3340.1-24	169	4 X 10	24'-0"	300	4	320	4	320	4	320	4	320	4	320	4	320	4	320	4	320	4	320	4	320	4	320	4	320	3
4	BRACE	39-3330.1-16	126	3 X 10	16'-0"	150													8	320	8	320	8	320	8	320	8	320	8	320	4
5	DO	39-3330.1-14	125	3 X 10	14'-0"	131	8	280	8	280	8	280	8	280	8	280	8	280													5
6	DO	39-3340.1-16	166	4 X 10	16'-0"	200	4	213	4	213	4	213	4	213	4	213	4	213	4	213	4	213	4	213	4	213	4	213	4	213	6
7	DO	39-3340.1-12	164	4 X 10	12'-0"	150	8	320	8	320	8	320	8	320	8	320	8	320	8	320	8	320	8	320	8	320	8	320	8	320	7
8	DO	39-3340.1-08	162	4 X 10	8'-0"	100	4	107	4	107	4	107	4	107	4	107	4	107	4	107	4	107	4	107	4	107	4	107	4	107	8
9	SCAB	39-3880.1	91	2 X 10	6'-0"	38	8	80	8	80	8	80	8	80	8	80	8	80	8	80	8	80	8	80	8	80	8	80	8	80	9
10	DO	39-3880.1	301	2 X 10	3'-0"	19	8	40	8	40	8	40	8	40	8	40	8	40	8	40	8	40	8	40	8	40	8	40	8	40	10
11	BLOCKING	39-6630.12	382	12 X 12	8'-6"	383							1	102											1	102					11
12	DO	39-6620.12	383	10 X 12	8'-6"	319					1	85											1	85							12
13	DO	39-6616.12	384	8 X 12	8'-6"	255									2	136	2	136									2	136	2	136	13
14	DO	39-3360.12	385	6 X 12	8'-6"	191			1	51											1	51									14
15	TIMBER PILE				1]		16		16		16		16		16		16		16		16		16		16		16		16		15
	STEEL HARDWARE, BLACK																														
16	MACHINE BOLT WITH SQUARE HEAD, NUT, AND TWO WASHERS	43-2325.1-2	E20	1	20"	5.51	144		144		144		144		144		144		144		144		144		144		144		144		16
17	DO	43-2325.1-104	E10	1	10"	3.45	64		64		64		64		64		64		64		64		64		64		64		64		17
18	DO	43-2325.07-223	B22	3/4	22"	3.30			4												4										18
19	DO	43-2325.07-255	B26	3/4	26"	3.78					4												4								19
20	DO	43-2325.07-306	B30	3/4	30"	4.26							4												4						20
21	DO	43-2325.07-32	B32	3/4	32"	4.50									4		4										4		4		21
22	DO	43-2325.07-183	B18	3/4	18"	2.82	8		4		4		4		4		8		8		4		4		4		4		8		22
23	DRIFT BOLT WITH SQUARE HEAD AND WASHER	43-1636.07-22	D22	3/4	22"	3.00	32		32		32		32		32		32		32		32		32		32		32		34		23

1] LENGTH OF PILES TO BE DETERMINED BY FIELD CONDITIONS.

COMPANION SHEETS

	SHEET
SHIMS	192
BILL OF MATERIALS	207
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DETAILS	206

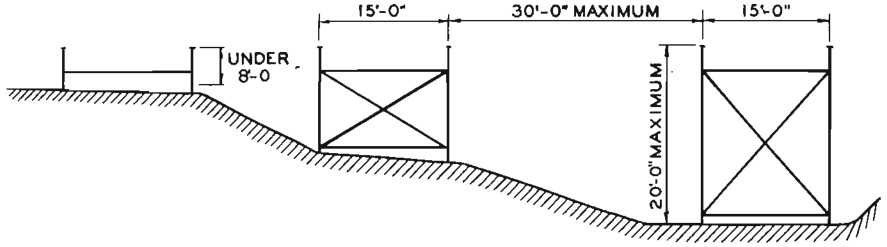


DIAGRAM SHOWING LONGITUDINAL BRACING AND HEIGHT AND SPAN LIMITATIONS OF TOWERS

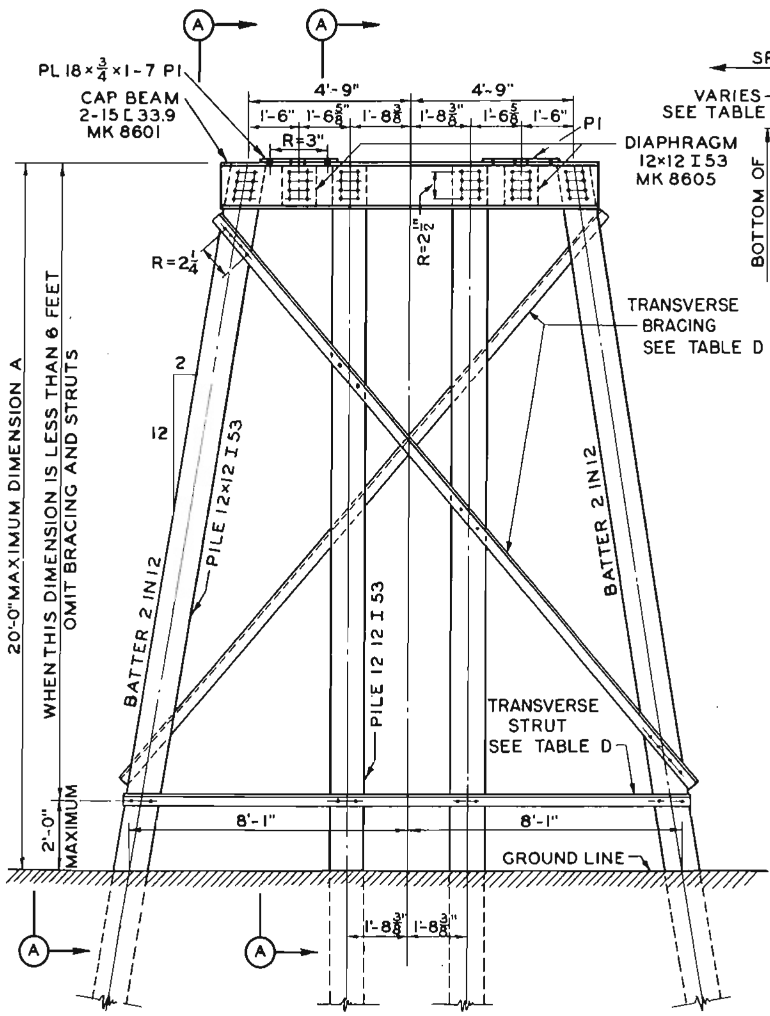
TABLE D

TOWER HEIGHT A	PIECE MARK		
	TRANSVERSE		LONGITUDINAL
	STRUT	BRACE	BRACE
8'-0"	8630	8630	8632
10'-0"	8632	8632	8634
12'-0"	8633	8634	8635
14'-0"	8635	8637	8637
16'-0"	8636	8641	8640
18'-0"	8638	8643	8642
20'-0"	8640	8646	8645

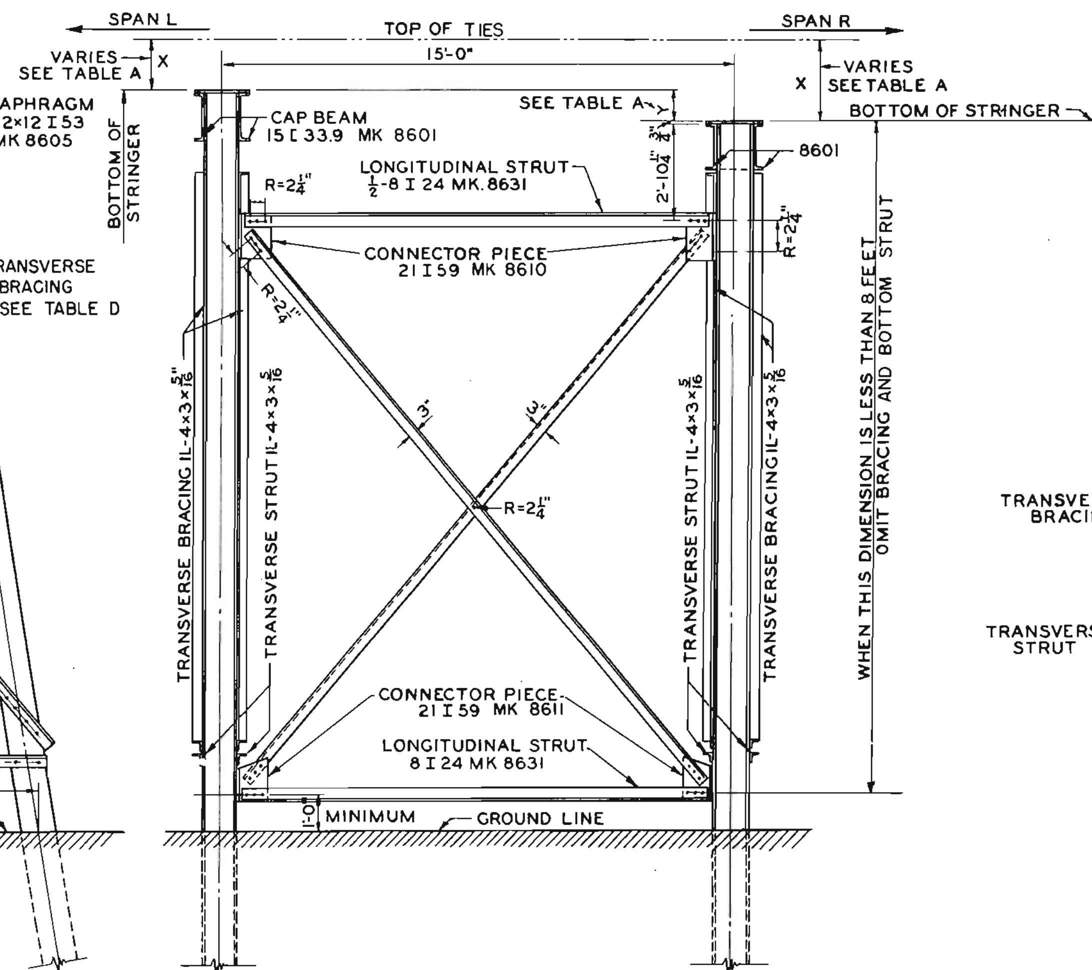
TABLE A

SPAN R	15'-0"	20'-0"	25'-0"	30'-0"
STRINGER	21 I 63	27 I 91	30 I 108	27 I 132
X	2'-5"	2'-10 7/8"	3'-1 7/8"	3'-5 1/8"
SPAN L	Y	Y	Y	Y
15'-0"	0'-0"	0'-5 7/8"	0'-8 7/8"	1'-0 1/8"
20'-0"	0'-5 7/8"	0'-0"	0'-3"	0'-6 1/4"
25'-0"	0'-8 7/8"	0'-3"	0'-0"	0'-3 1/4"
30'-0"	1'-0 1/8"	0'-6 1/4"	0'-3 1/4"	0'-0"

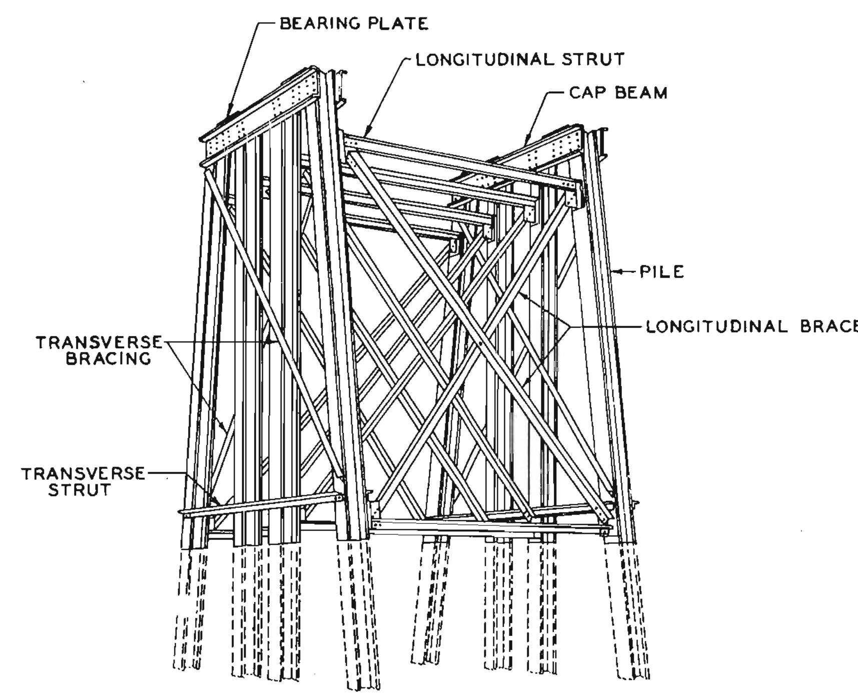
MAXIMUM PILE LOADS	
SPAN BETWEEN TOWERS	TONS PER PILE
15	27
20	30
25	33
30	35



TRANSVERSE ELEVATION
(20' HEIGHT SHOWN)



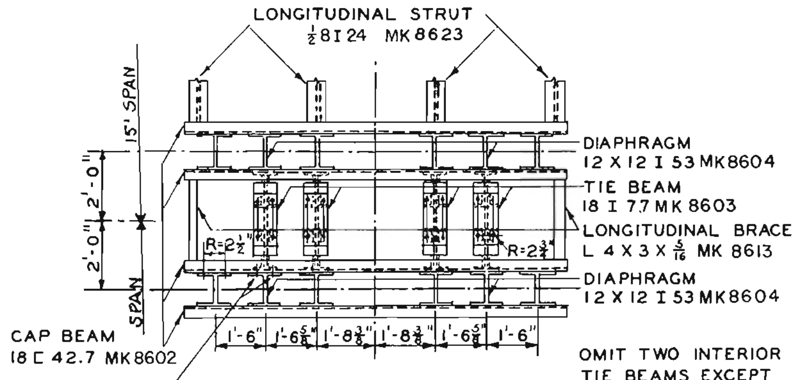
ELEVATION A-A AND SECTION A-A
(20' HEIGHT SHOWN)



ASSEMBLED VIEW

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	207
FABRICATION DETAILS	206

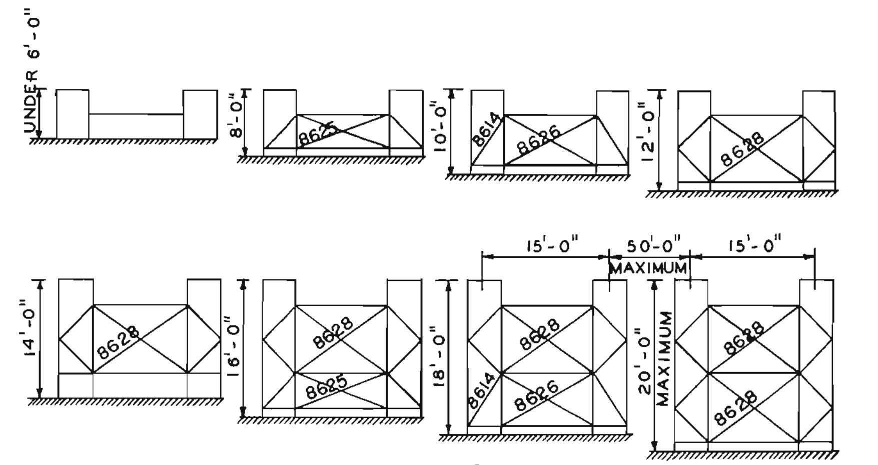


TOP PLAN

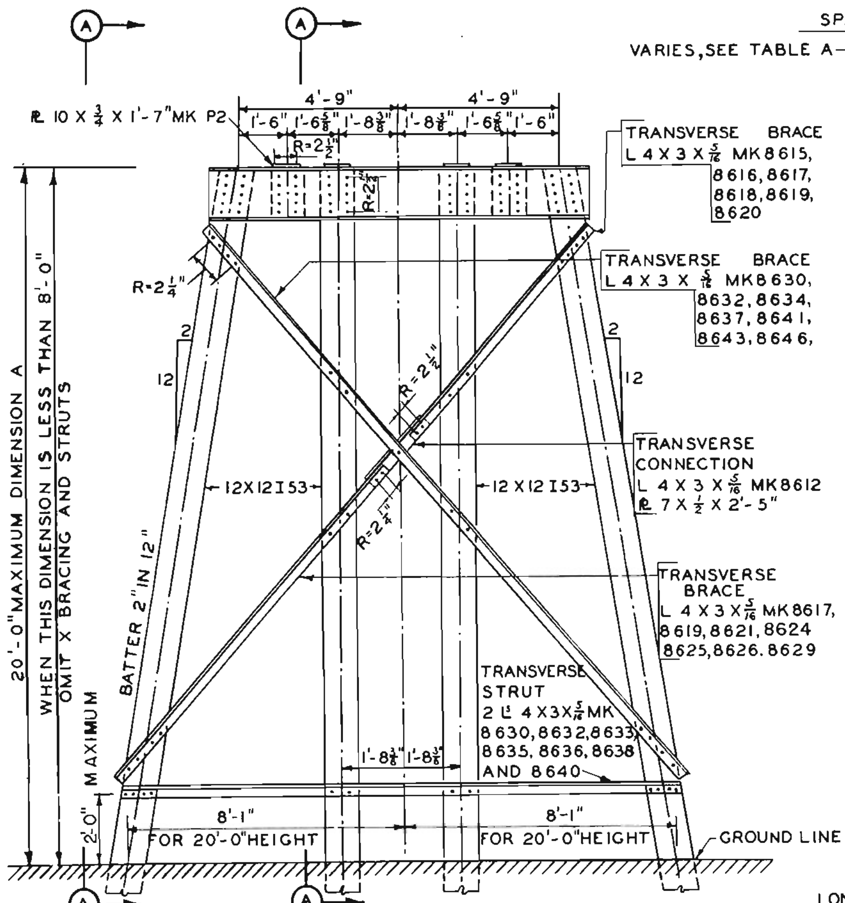
MAXIMUM PILE LOADS	
SPAN BETWEEN TOWERS	TONS PER PILE
35'	20
40'	21
45'	23
50'	26

TABLE A

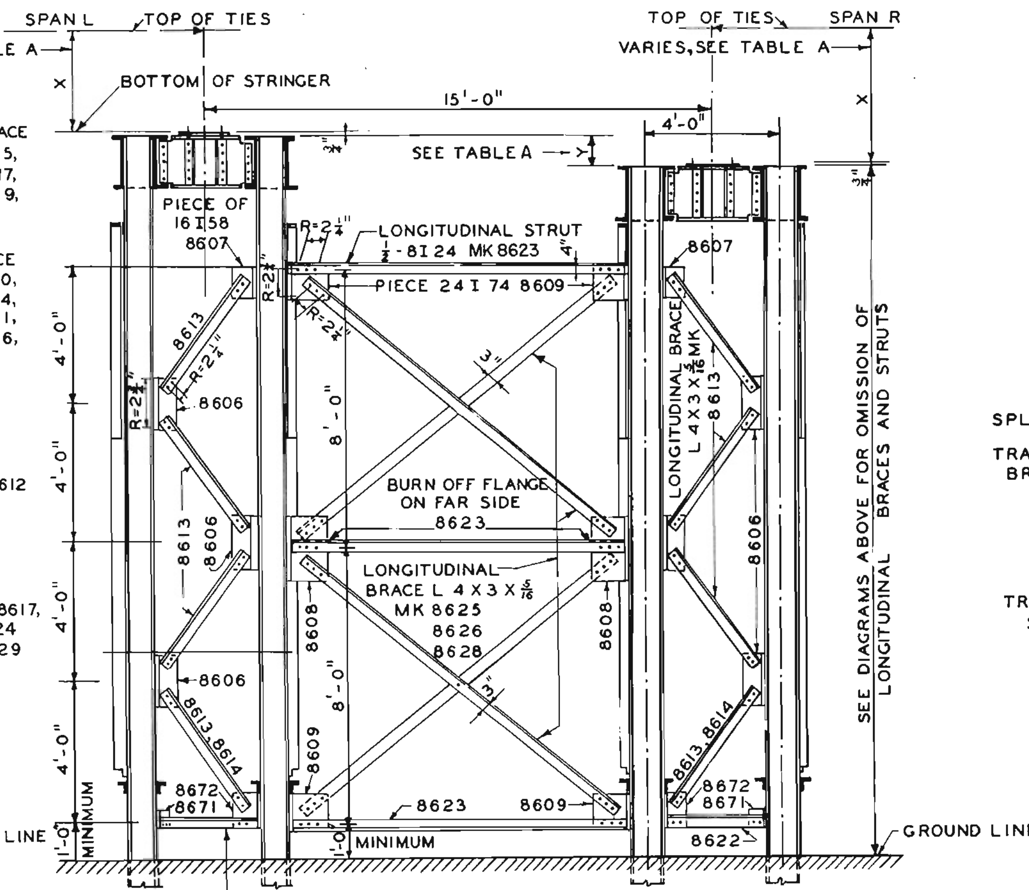
SPAN R	35'-0"	40'-0"	45'-0"	50'-0"
STRINGER SIZE	36I150	36I182	36 I 230	2-36 I 150
X	3'-7⅞"	3'-8⅜"	3'-7⅞"	3'-7⅞"
SPAN L	Y	Y	Y	Y
15'-0"	1'-2⅞"	1'-3⅜"	1'-2⅞"	1'-2⅞"
20'-0"	0'-9"	0'-9½"	0'-9"	0'-9"
25'-0"	0'-6"	0'-6½"	0'-6"	0'-6"
30'-0"	0'-2¾"	0'-3¼"	0'-2¾"	0'-2¾"
35'-0"	0'-0"	0'-0½"	0'-0"	0'-0"
40'-0"	0'-0½"	0'-0"	0'-0½"	0'-0½"
45'-0"	0'-0"	0'-0½"	0'-0"	0'-0"
50'-0"	0'-0"	0'-0½"	0'-0"	0'-0"



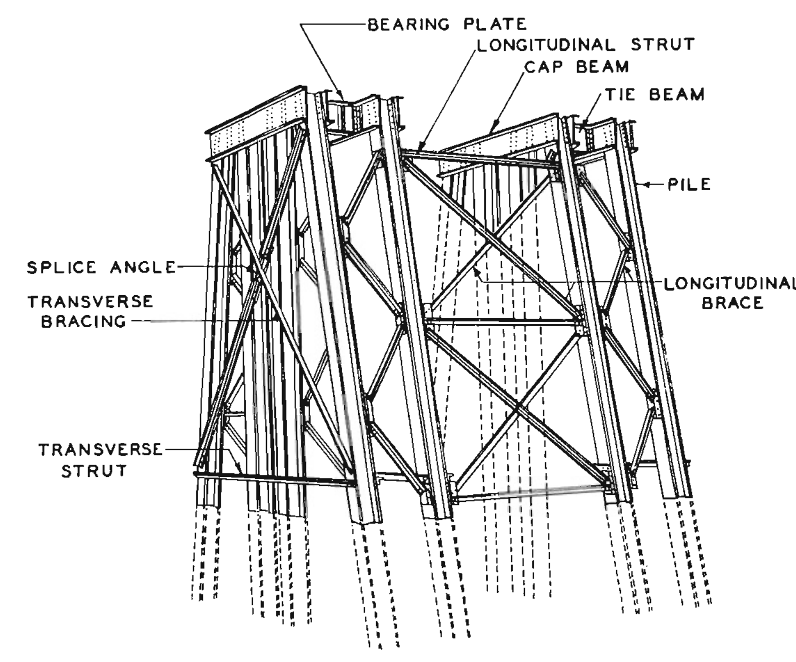
DIAGRAMS SHOWING LONGITUDINAL BRACING AND HEIGHT AND SPAN LIMITATIONS OF TOWERS



TRANSVERSE ELEVATION
(20' HEIGHT SHOWN)



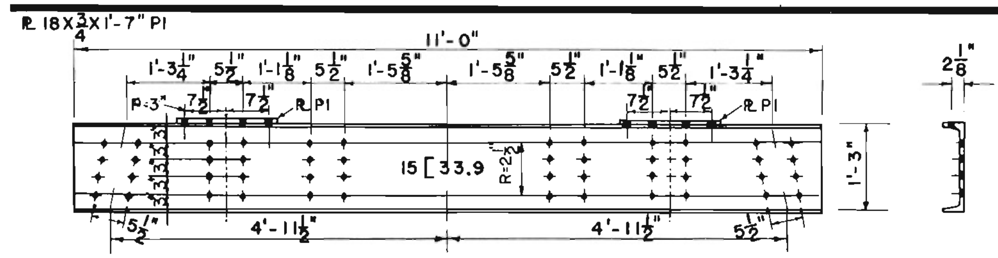
ELEVATION A-A AND SECTION A-A
(20' HEIGHT SHOWN)



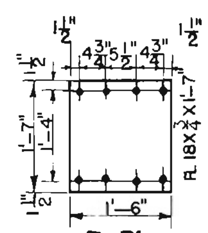
ASSEMBLED VIEW

COMPANION SHEETS

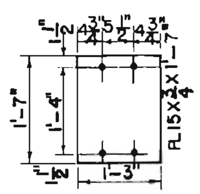
	SHEET
STEEL PILE BENTS AND PIERS, RIVETED DETAILS	205
BILL OF MATERIALS	207
GENERAL NOTES	154
SYMBOLS	155



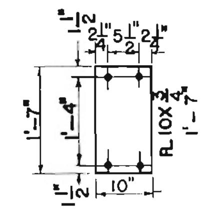
CAP BEAM MK 8601



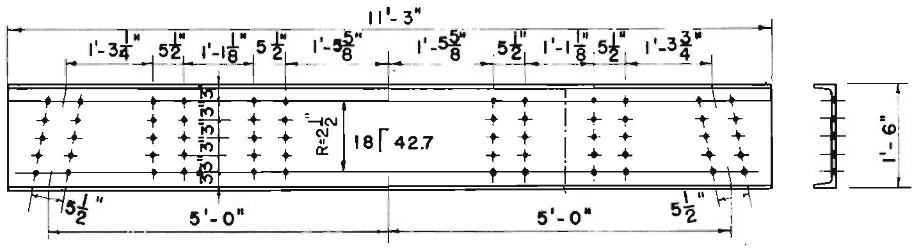
PL P1



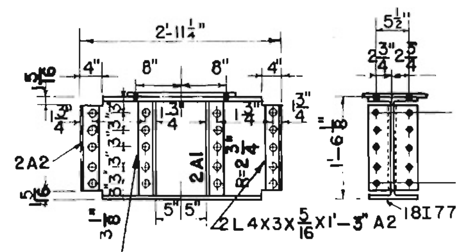
PL P3



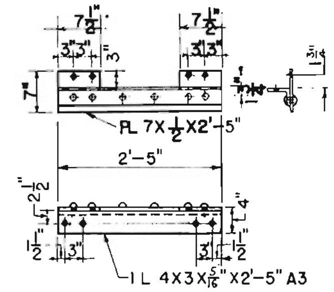
PL P4



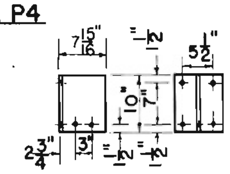
CAP BEAM MK 8602

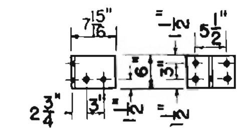


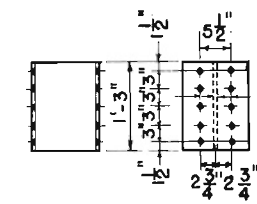
2 L 4X3X5/16X1'-4 1/2 A1 GRIND TO BEAR TOP AND BOTTOM
TIE BEAM MK 8603



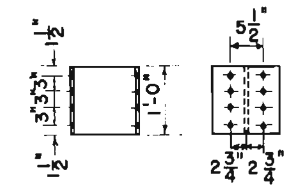
CONNECTOR 8612


PIECE 16I58 X0'-10"
CONNECTOR 8672

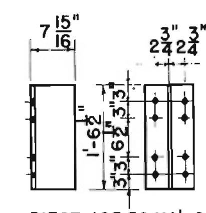

PIECE 16I58X0'-6"
CONNECTOR 8671

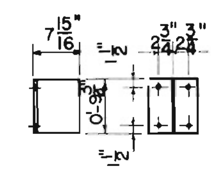


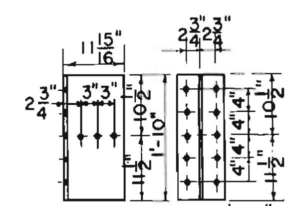
12X12 I 53X1'-3"
DIAPHRAGM 8604



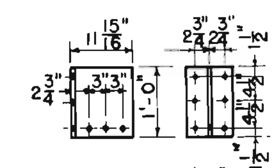
12X12 I 53 X 1'-0"
DIAPHRAGM 8605


PIECE 16I58 X1'-6 1/2"
CONNECTOR 8606

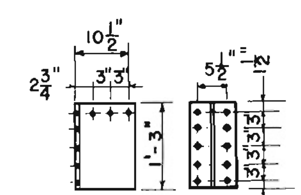

PIECE 16 I 58X0'-9 3/4"
CONNECTOR 8607



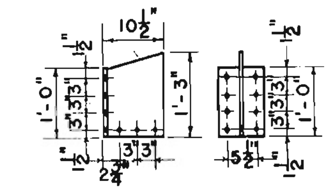
PIECE 24I74 X 1'-10"
CONNECTOR 8608



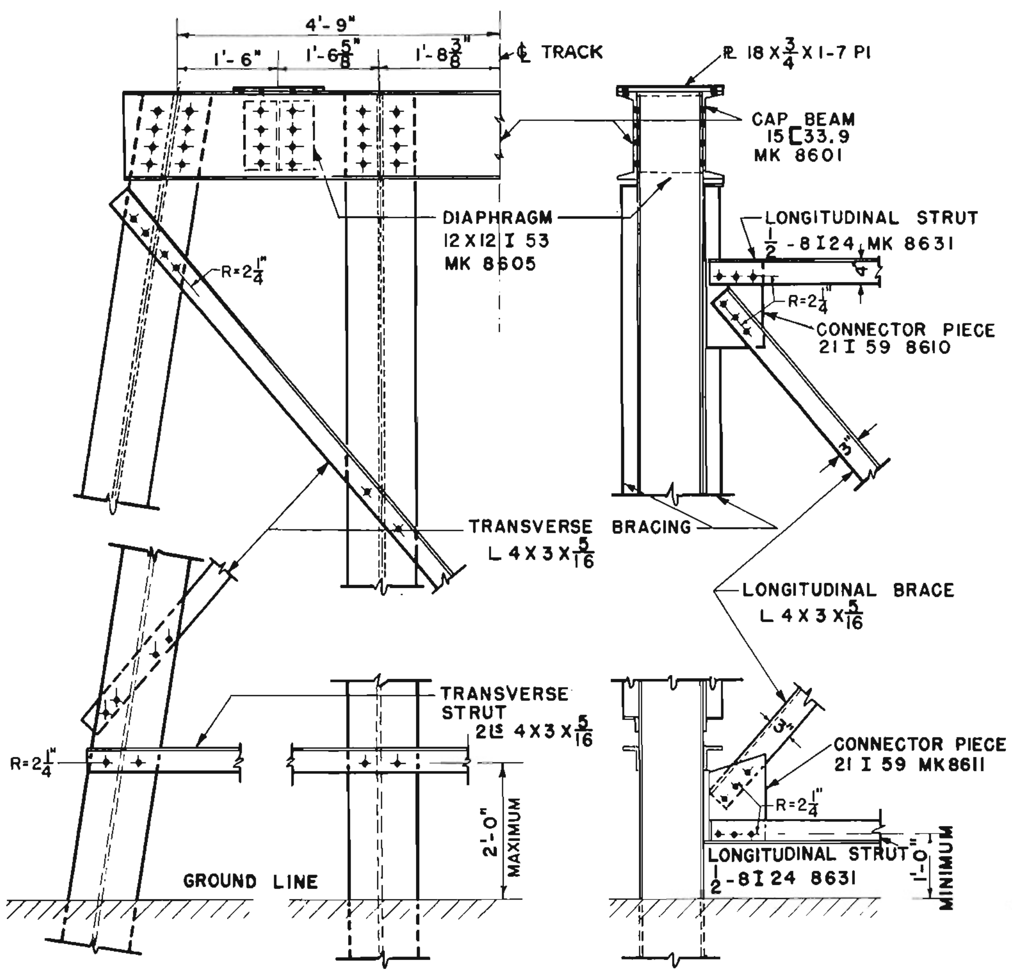
PIECE 24I74 X1'-0"
CONNECTOR 8609



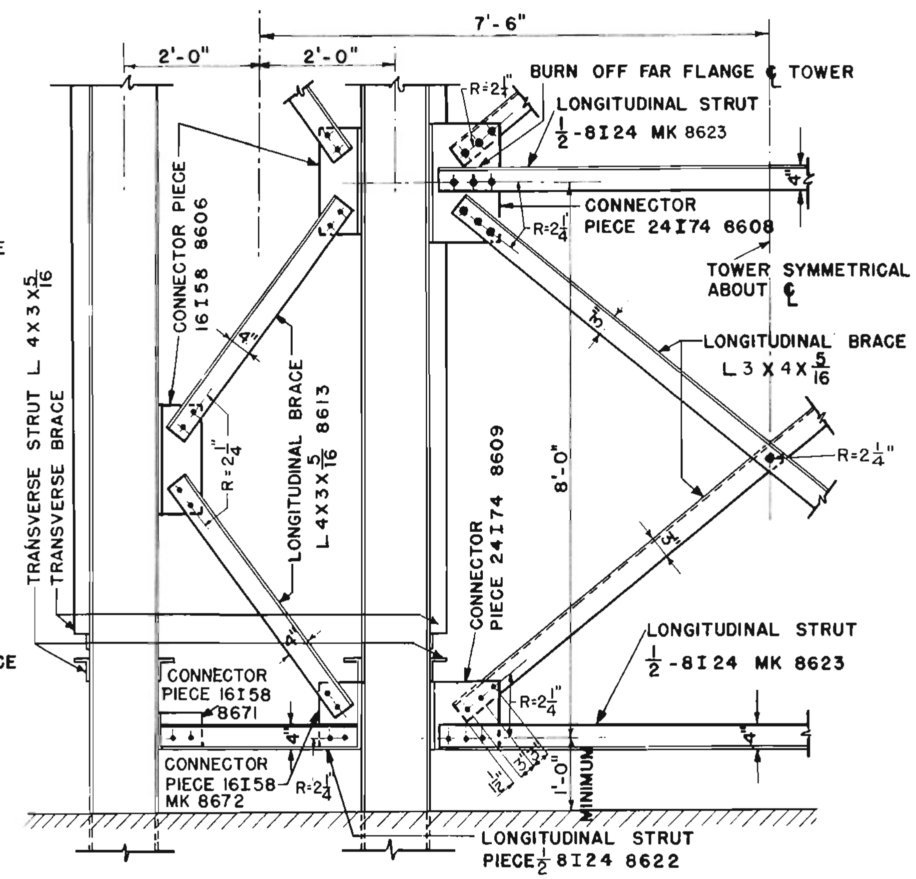
PIECE 21I59 X 1'-3"
CONNECTOR 8610



PIECE 21I59 X 1'-3"
CONNECTOR 8611



CONNECTION DETAILS 15' TO 30' SPANS



CONNECTION DETAILS 35' TO 50' SPANS

BILL OF MATERIALS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS	204,205,206

BILL OF MATERIALS FOR TWO RIVETED STEEL PILE BENTS OR PIERS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	BRACED STEEL PILE BENTS FOR 15' TO 30' SPANS									BRACED STEEL PILE PIERS FOR 35' TO 45' SPANS									BRACED STEEL PILE PIERS FOR 50' SPANS									LINE
						BENT OR PIER HEIGHT →	20'	18'	16'	14'	12'	10'	8'	6'	4'	20'	18'	16'	14'	12'	10'	8'	6'	4'	20'	18'	16'	14'	12'	10'	8'	6'	4'	
							QUANTITY									QUANTITY									QUANTITY									
1	CAP BEAM	48-3790.15-34	8601	15[33.9	11'-0"	372	4	4	4	4	4	4	4	4	4																			1
2	DO	48-3790.18-43	8602	18[42.7	11'-3"	480										8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	2
3	DIAPHRAGM	48-2900.18-077	8603	18 I 77	2'-10 3/4"	225										4	4	4	4	4	4	4	4	4	8	8	8	8	8	8	8	8	8	3
4	DO		8604	12X12 I 53	1'-3"	66										8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4
5	DO		8605	12X12 I 53	1'-0"	53	4	4	4	4	4	4	4	4	4																			5
6	CONNECTOR	48-2900.16-058	8606	1/2 16 I 58	1'-6 1/2"	45										24	16	16	8	8					24	16	16	8	8					6
7	DO	48-2900.16-058	8607	1/2 16 I 58	0'-9 3/4"	24										8	8	8	8	8	8	8			8	8	8	8	8	8	8			7
8	DO	48-2900.24-074	8608	1/2 24 I 74	1'-10"	68										8	8	8							8	8	8							8
9	DO	48-2900.24-074	8609	1/2 24 I 74	1'-0"	37										16	16	16	16	16	16	16	8	8	16	16	16	16	16	16	16	8	8	9
10	DO	48-2900.21-059	8610	1/2 21 I 59	1'-3"	37	8	8	8	8	8	8	8	8	8																			10
11	DO	48-2900.21-059	8611	1/2 21 I 59	1'-3"	37	8	8	8	8	8	8	8																					11
12	DO	47-7844.05	8612	PL 7 X 1/2	2'-5"	29										4	4	4	4	4	4	4			4	4	4	4	4	4	4			12
13	DO	48-2900.16-058	8671	1/2 16 I 58	0'-6"	15										8	8	8	8	8	8	8			8	8	8	8	8	8	8			13
14	DO	48-2900.16-058	8672	1/2 16 I 58	0'-10"	24										8	8	8	8	8	8	8			8	8	8	8	8	8	8			14
15	SPLICE ANGLE	48-2500.4-035	A3	L4 X 3 X 5/16	2'-5"	17										4	4	4	4	4	4	4			4	4	4	4	4	4	4			15
16	STIFFENER ANGLE	48-2500.4-035	A1	L4 X 3 X 5/16	1'-4 1/2"	10										16	16	16	16	16	16	16	16	15	32	32	32	32	32	32	32	32	32	16
17	CONNECTION ANGLE	48-2500.4-035	A2	L4 X 3 X 5/16	1'-3"	9										16	16	16	16	16	16	16	16	16	32	32	32	32	32	32	32	32	32	17
18	BRACES AND STRUTS	48-2500.4-035	8613	L4 X 3 X 5/15	4'-2"	30										32	16	24	16	16		8			32	16	24	16	16		8			18
19	DO	48-2500.4-035	8614	L4 X 3 X 5/16	5'-10"	41											8				8					8				8				19
20	DO	48-2500.4-035	8615	L4 X 3 X 5/16	5'-6"	40																4									4			20
21	DO	48-2500.4-035	8616	L4 X 3 X 5/16	6'-0"	43															4									4				21
22	DO	48-2500.4-035	8617	L4 X 3 X 5/16	6'-6"	47													4	4		4						4	4		4			22
23	DO	48-2500.4-035	8618	L4 X 3 X 5/16	7'-0"	50												4									4							23
24	DO	48-2500.4-035	8619	L4 X 3 X 5/16	7'-6"	54											4				4					4				4				24
25	DO	48-2500.4-035	8620	L4 X 3 X 5/16	8'-0"	58										4									4									25
26	DO	48-2500.4-035	8621	L4 X 3 X 5/16	8'-6"	61														4									4					26
27	DO	48-2500.4-035	8622	L4 X 3 X 5/16	2'-10"	20										8	8	8	8	8	8	8			8	8	8	8	8	8	8			27
28	DO	48-2500.08-024	8623	1/2 8 I 24	9'-10"	118										12	12	12	8	8	8	8	4	4	12	12	12	8	8	8	8	4	4	28
29	DO	48-2500.4-035	8624	L4 X 3 X 5/16	9'-6"	68													4									4						29
30	DO	48-2500.4-035	8625	L4 X 3 X 5/16	10'-6"	76												12				8					12				8			30
31	DO	48-2500.4-035	8626	L4 X 3 X 5/16	11'-6"	84											12				8					12				8				31
32	DO	48-2500.4-035	8628	L4 X 3 X 5/16	12'-6"	90										16	8	8	8	8					16	8	8	8	8					32
33	DO	48-2500.4-035	8629	L4 X 3 X 5/16	13'-0"	95										4									4									33
34	DO	48-2500.4-035	8630	L4 X 3 X 5/16	13'-6"	97							8									12									12			34
35	DO	48-2900.08	8631	1/2 8 I 24	14'-0"	168	8	8	8	8	8	8	8	4	4																			35
36	DO	48-2550.4-035	8632	L4 X 3 X 5/16	14'-6"	105						8	8								12									12				36
37	DO	48-2550.4-035	8633	L4 X 3 X 5/16	15'-0"	108					4									8									8					37
38	DO	48-2550.4-035	8634	L4 X 3 X 5/16	15'-6"	112					4	8								4									4					38
39	DO	48-2550.4-035	8635	L4 X 3 X 5/16	16'-0"	115				4	8								8									8						39
40	DO	48-2550.4-035	8636	L4 X 3 X 5/16	16'-6"	119			4									8									8							40
41	DO	48-2550.4-035	8637	L4 X 3 X 5/16	17'-0"	123				12									4									4						41
42	DO	48-2550.4-035	8638	L4 X 3 X 5/16	17'-6"	127		4									8									8								42
43	DO	48-2550.4-035	8640	L4 X 3 X 5/16	18'-6"	134	4		8							8									8									43
44	DO	48-2550.4-035	8641	L4 X 3 X 5/16	19'-0"	137			4									4									4							44
45	DO	48-2550.4-035	8642	L4 X 3 X 5/16	19'-6"	140		8																										45
46	DO	48-2550.4-035	8643	L4 X 3 X 5/16	20'-6"	148		4									4									4								46
47	DO	48-2550.4-035	8645	L4 X 3 X 5/16	21'-6"	155	8																											47
48	DO	48-2550.4-035	8646	L4 X 3 X 5/16	22'-0"	158	4									4									4									48
49	BEARING PLATE	47-7844.07	P1	PL 18 X 3/4	1'-7"	72	4	4	4	4	4	4	4	4	4																			49
50	DO	47-7844.07	P2	PL 10 X 3/4	1'-7"	40										4	4	4	4	4	4	4	4	4	8	8	8	8	8	8	8	8	8	50
51	RIVET	43-6353.08-23		7/8	2 1/4"	.57	324	324	324	324	324	324	324	104	104	548	516	516	408	408	476	476	24	24	543	516	516	408	408	376	376	24	24	51
52	DO	43-6353.08-25		7/8	2 1/2"	.62	192	192	192	192	192	192	192	192	192	432	432	432	432	432	432	432	416	416	369	368	368	368	368	368	368	352	352	52
53	DO	43-6353.08		7/8	2 3/4"	.66										624	560	560	416	416	352	352	208	208	784	720	720	576	576	512	512	368	368	53
54	DO	43-6353.08-3		7/8	3"	.70	16	16	16	16	16	16	16	16	16																			54
55	PILE			12X12 I 53	[1]		8	8	8	8	8	8	8	8	8	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	55

[1] PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILE BENTS AND PIERS	209,210,211

BILL OF MATERIALS FOR TWO WELDED STEEL PILE BENTS OR PIERS

LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	BRACED STEEL PILE BENTS FOR 15' TO 30' SPANS									BRACED STEEL PILE PIERS FOR 35' TO 45' SPANS									STEEL PILE TOWER FOR 50' SPAN									LINE
						BENT OR PIER HEIGHT →	20'	18'	16'	14'	12'	10'	8'	6'	4'	20'	18'	16'	14'	12'	10'	8'	6'	4	20'	18'	16'	14'	12'	10'	8'	6'	4'	
							QUANTITY									QUANTITY									QUANTITY									
1	CAP BEAM	48-2900.18-047	8649	18 I 42.7	11'-3"	480										4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1
2	CONNECTION PLATE	47-7844.05	P5	5 1/2 X 1/2	1'-3 1/4"	13										8	8	8	8	8	8	8	8	8	16	16	16	16	16	16	16	16	16	2
3	CAP BEAM	48-3790.18-43	8650	18 ⊏ 42.7	11'-3"	480										4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
4	DO	48-3790.15-34	8651	15 ⊏ 33.9	11'-0"	372	4	4	4	4	4	4	4	4	4																			4
5	DIAPHRAGM		8653	12X12 I 53	1'-3"	66										8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	5
6	DO		8654	12X12 I 53	1'-0"	53	4	4	4	4	4	4	4	4	4																			6
7	DO	48-2900.18-077	8652	18 I 77	2'-6 1/2"	196										4	4	4	4	4	4	4	4	4	8	8	8	8	8	8	8	8	8	7
8	STIFFENER PLATE	47-7844.05	P6	PL 4 X 1/2	1'-4 1/2"	9										16	16	16	16	16	16	16	16	16	32	32	32	32	32	32	32	32	32	8
9	SHELF ANGLE	48-2550.4-035	8647	L4 X 3 X 5/16	0'-4"	2	8	8	8	8	8	8	8	8	8	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	9
10	BEARING PLATE	47-7844.07	P3	PL 15 X 3/4	1'-7"	60	4	4	4	4	4	4	4	4	4																			10
11	DO	47-7844.07	P4	PL 10 X 3/4	1'-7"	40										4	4	4	4	4	4	4	4	4	8	8	8	8	8	8	8	8	8	11
12	SPLICE ANGLE	48-2550.4-035	8648	L4 X 3 X 5/16	2'-0"	14										4	4	4	4	4	4	4			4	4	4	4	4	4	4			12
13	CONNECTOR	47-7844.05	8655	PL 12 X 1/2	1'-8"	34										8	8	8							8	8	8							13
14	DO	47-7844.05	8656	PL 12 X 1/2	1'-3"	26	8	8	8	8	8	8	8	8	8																			14
15	DO	47-7844.05	8657	PL 12 X 1/2	1'-3"	26	8	8	8	8	8	8	8																					15
16	DO	47-7844.05	8658	PL 12 X 1/2	1'-0"	20										16	16	16	16	16	16	16	8	8	16	16	16	16	16	16	16	16	8	16
17	DO	47-7844.05	8659	PL 8 X 1/2	1'-6"	20										24	16	16	8	8					24	16	16	8	8					17
18	DO	47-7844.05	8660	PL 8 X 1/2	1'-0"	14										16	16	16	16	16	16	16			16	16	16	16	16	16	16	16		18
19	DO	47-7844.05	8661	PL 8 X 1/2	0'-5"	7										8	8	8	8	8	8	8			8	8	8	8	8	8	8	8		19
20	STRUTS AND BRACES	48-2900.08-024	8623	1/2 8 I 24	9'-10"	118										12	12	12	8	8	8	8	4	4	12	12	12	8	8	8	8	8	4	20
21	DO	48-2900.08-024	8631	1/2 8 I 24	14'-0"	168	8	8	8	8	8	8	8	4	4																			21
22	DO	48-2550.4-035	8613	L4 X 3 X 5/16	4'-2"	30										32	16	24	16	16		8			32	16	24	16	16		8			22
23	DO	48-2550.4-035	8614	L4 X 3 X 5/16	5'-10"	41											8				8					8				8				23
24	DO	48-2550.4-035	8622	L4 X 3 X 5/16	2'-10"	29										8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8		24
25	DO	48-2550.4-035	8625	L4 X 3 X 5/16	10'-6"	76												8				8					8				8	8		25
26	DO	48-2550.4-035	8626	L4 X 3 X 5/16	11'-6"	84											8				8					8				8				26
27	DO	48-2550.4-035	8628	L4 X 3 X 5/16	12'-6"	90										16	8	8	8	8					16	8	8	8	8					27
28	DO	48-2550.4-035	8630	L4 X 3 X 5/16	13'-6"	97							8									16									16			28
29	DO	48-2550.4-035	8632	L4 X 3 X 5/16	14'-6"	105						8	8								16									16				29
30	DO	48-2550.4-035	8633	L4 X 3 X 5/16	15'-0"	108					4									8									8					30
31	DO	48-2550.4-035	8634	L4 X 3 X 5/16	15'-6"	112					4	8								8									8					31
32	DO	48-2550.4-035	8635	L4 X 3 X 5/16	16'-0"	115				4	8								8									8						32
33	DO	48-2550.4-035	8636	L4 X 3 X 5/16	16'-6"	119			4									8									8							33
34	DO	48-2550.4-035	8637	L4 X 3 X 5/16	17'-0"	123				12									8									8						34
35	DO	48-2550.4-035	8638	L4 X 3 X 5/16	17'-0"	127		4									8									8								35
36	DO	48-2550.4-035	8640	L4 X 3 X 5/16	18'-6"	134	4		8							8									8									36
37	DO	48-2550.4-035	8641	L4 X 3 X 5/16	19'-0"	137			4									8									8							37
38	DO	48-2550.4-035	8642	L4 X 3 X 5/16	19'-6"	140		8																										38
39	DO	48-2550.4-035	8643	L4 X 3 X 5/16	20'-6"	148		4									8									8								39
40	DO	48-2550.4-035	8645	L4 X 3 X 5/16	21'-6"	155	8																											40
41	DO	48-2550.4-035	8646	L4 X 3 X 5/16	22'-0"	158	4									8									8									41
42	WELDING ROD (POUNDS)	46-3772.2-7		3/16			45	45	45	45	45	45	45	30	25	145	136	136	125	125	115	115	83	61	170	161	161	150	150	140	140	108	86	42
43	PILE			12X12 I 53	[1]		8	8	8	8	8	8	8	8	8	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	43

[1] PILE LENGTH TO BE DETERMINED BY FIELD CONDITIONS.

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	208
FABRICATION DRAWING	211

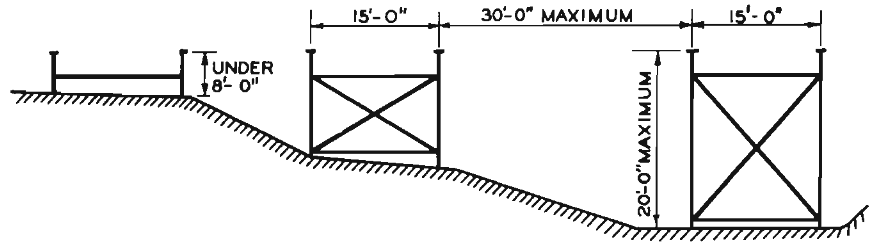


DIAGRAM SHOWING LONGITUDINAL BRACING AND HEIGHT AND SPAN LIMITATIONS OF BENTS

TABLE A

DIMENSION X				
SPAN L	SPAN R			
	15'-0"	20'-0"	25'-0"	30'-0"
15'-0"	0"	5 7/8"	8 7/8"	1'-0 1/8"
20'-0"	5 7/8"	0"	3"	6 1/4"
25'-0"	8 7/8"	3"	0"	3 1/4"
30'-0"	1'-0 1/8"	6 1/4"	3 1/4"	0"

TABLE B

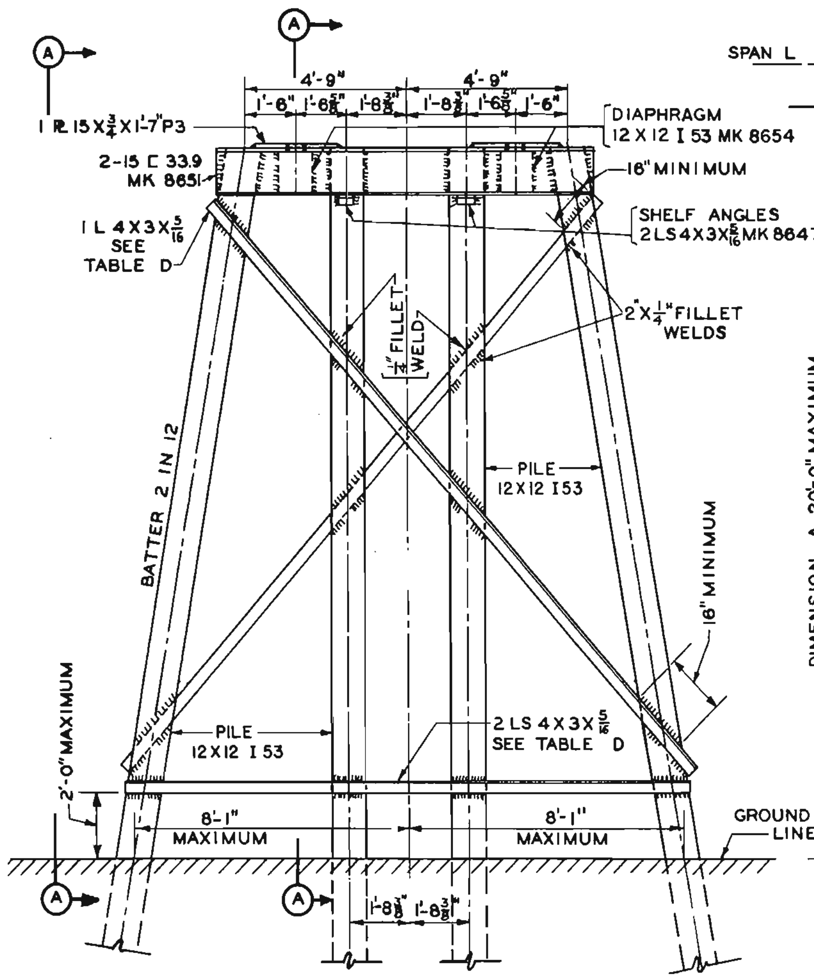
DISTANCE FROM TOP OF TIE TO BOTTOM OF STRINGER FOR VARIOUS SPANS		
SPAN LENGTH	STEEL-STRINGER SIZE	TOP OF TIE TO BOTTOM OF STRINGER
15'-0"	21 I 63	2'-5"
20'-0"	27 I 91	2'-10 7/8"
25'-0"	30 I 108	3'-1 7/8"
30'-0"	33 I 132	3'-5 1/8"

TABLE C

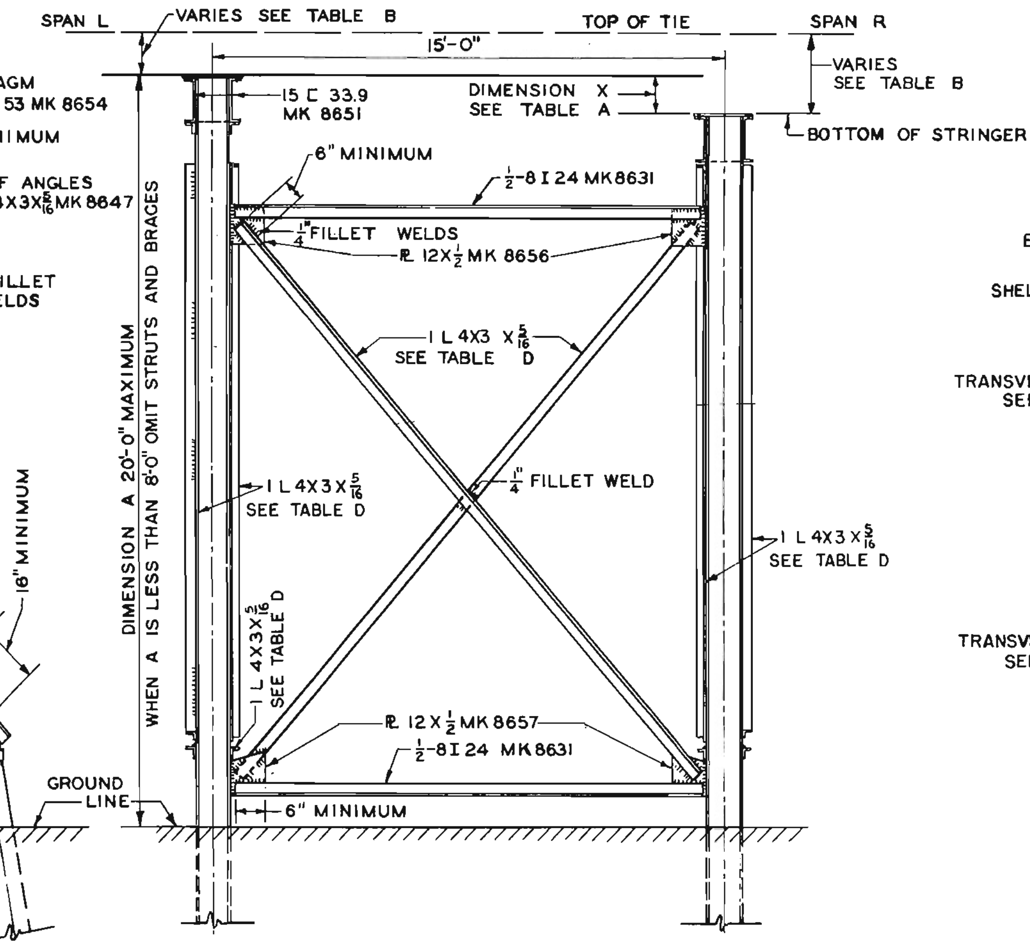
MAXIMUM PILE LOAD	
SPAN BETWEEN TOWERS	TONS PER PILE
15'-0"	27
20'-0"	30
25'-0"	33
30'-0"	35

TABLE D

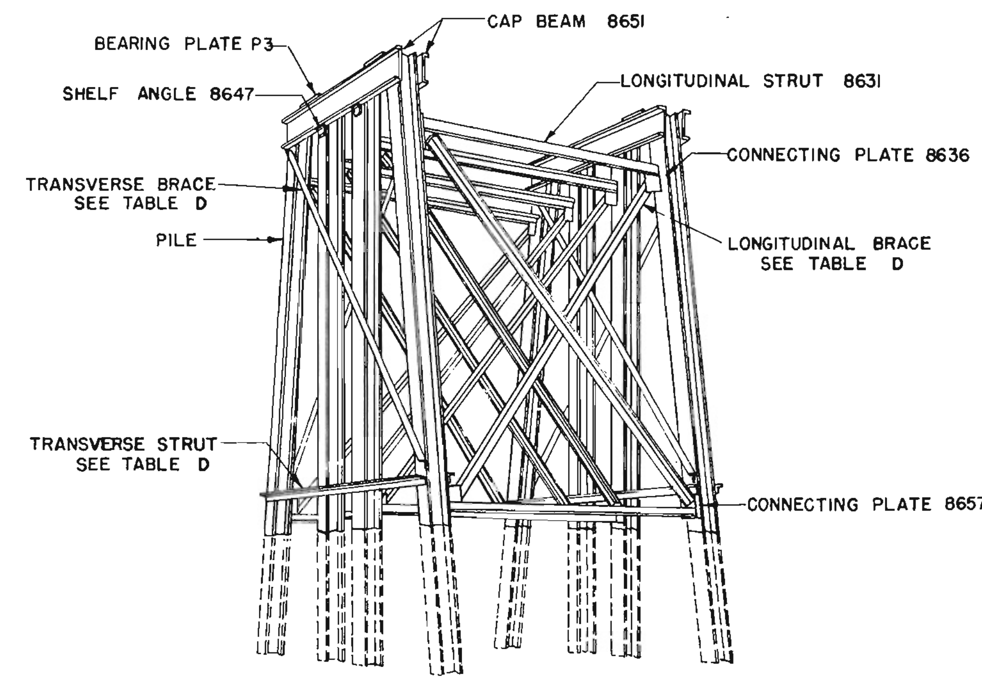
TOWER HEIGHT	PIECE MARK		
	TRANSVERSE		LONGITUDINAL
	STRUT	BRACE	BRACE
8'-0"	8630	8630	8632
10'-0"	8632	8632	8634
12'-0"	8633	8634	8635
14'-0"	8635	8637	8637
16'-0"	8636	8641	8640
18'-0"	8638	8643	8642
20'-0"	8640	8646	8645



TRANSVERSE ELEVATION



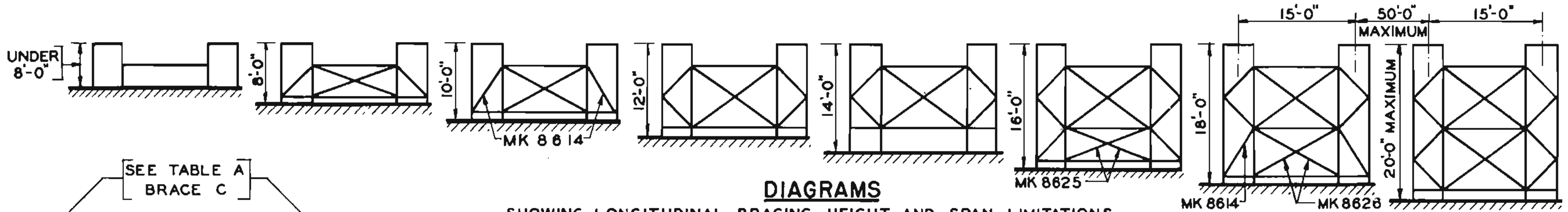
ELEVATION A-A



ASSEMBLED VIEW

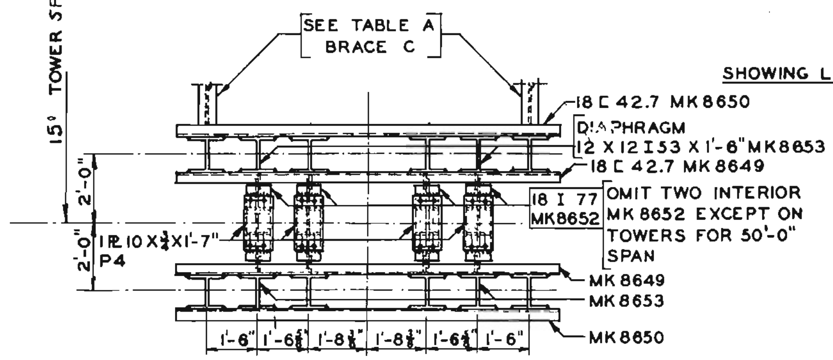
COMPANION SHEETS

	SHEET
STEEL PILE BENTS AND PIERS, WELDED DETAILS	209,211
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	208



DIAGRAMS

SHOWING LONGITUDINAL BRACING, HEIGHT, AND SPAN LIMITATIONS



TOP PLAN

TABLE A

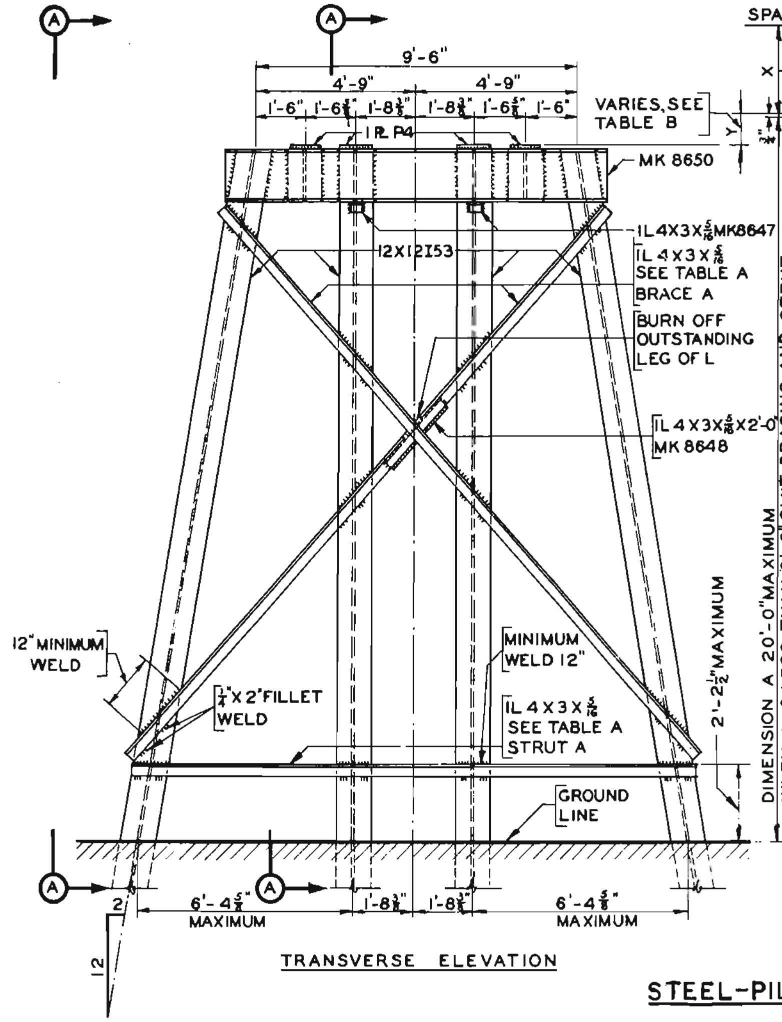
TOWER HEIGHT	TRANSVERSE		LONGITUDINAL			
	STRUT A	BRACE A	STRUT B	BRACE B	STRUT C	BRACE C
20'-0"	MK 8640	MK 8646	MK 8622	MK 8613	MK 8623	MK8628
18'-0"	MK 8638	MK 8643	MK 8622	MK 8613 MK 8614	MK 8623	MK8628 MK8626
16'-0"	MK 8636	MK 8641	MK 8622	MK 8613	MK 8623	MK8628 MK8625
14' 0"	MK 8635	MK 8637	MK 8622	MK 8613	MK 8623	MK8628
12'-0"	MK 8633	MK 8634	MK 8622	MK 8613	MK 8623	MK8628
10'-0"	MK 8632	MK 8632	MK 8622	MK 8614	MK 8623	MK8626
8'-0"	MK 8630	MK 8630	MK 8622	MK 8613	MK 8623	MK8625

ALL WELDS SHOWN TO BE 1/4" CONTINUOUS FILLET WELDS UNLESS OTHERWISE INDICATED

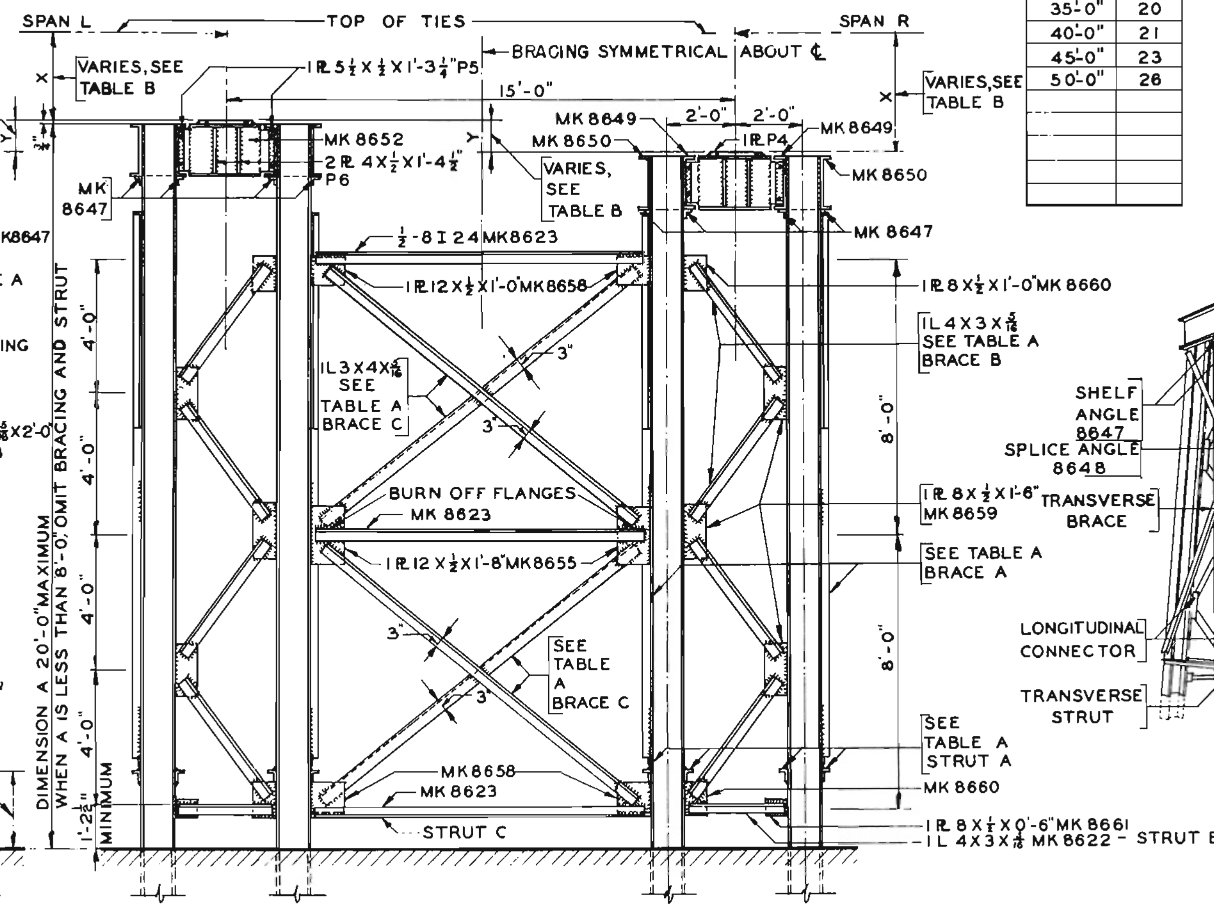
MAXIMUM PILE LOAD	
SPAN BETWEEN TOWERS	TONS PER PILE
35'-0"	20
40'-0"	21
45'-0"	23
50'-0"	26

TABLE B

SPAN R	35'-0"	40'-0"	45'-0	50'-0"
SIZE	36 I 150	36 I 182	36 I 230	TWO 36 I 150
X	3'-7 7/8"	3-8 3/8"	3'-7 7/8"	3'-7 7/8"
SPAN L	Y	Y	Y	Y
15'-0"	1'-2 7/8"	1'-3 3/8"	1'-2 7/8"	1'-2 7/8"
20'-0"	0'-9"	0'-9 1/2"	0'-9"	0'-9"
25'-0"	0'-6"	0'-6 1/2"	0'-6"	0'-6"
30'-0"	0'-2 3/4"	0'-6 1/2"	0'-2 3/4"	0'-2 3/4"
35'-0"	0"	0'-0 1/2"	0"	0'-0"
40'-0"	0'-0 1/2"	0"	0'-0 1/2"	0'-0 1/2"
45'-0"	0"	0'-0 1/2"	0"	0"
50'-0"	0"	0'-0 1/2"	0"	0"

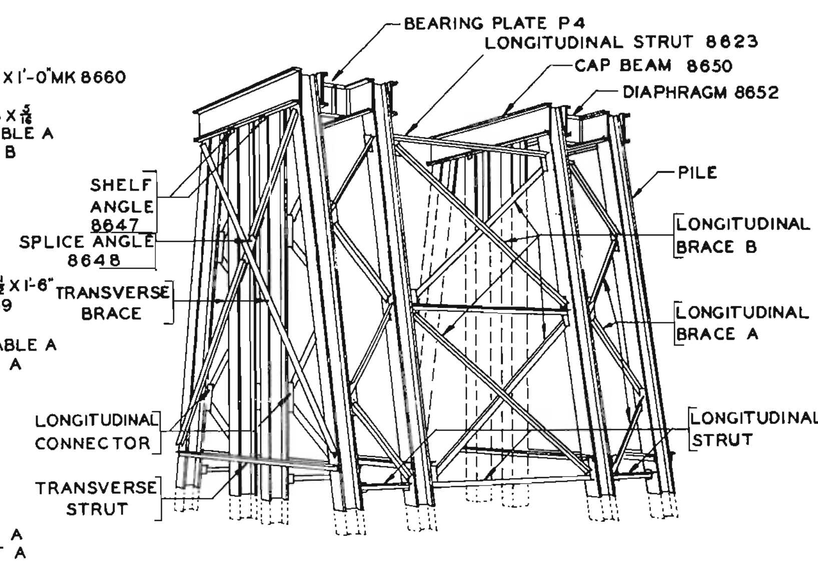


TRANSVERSE ELEVATION



VIEW A-A

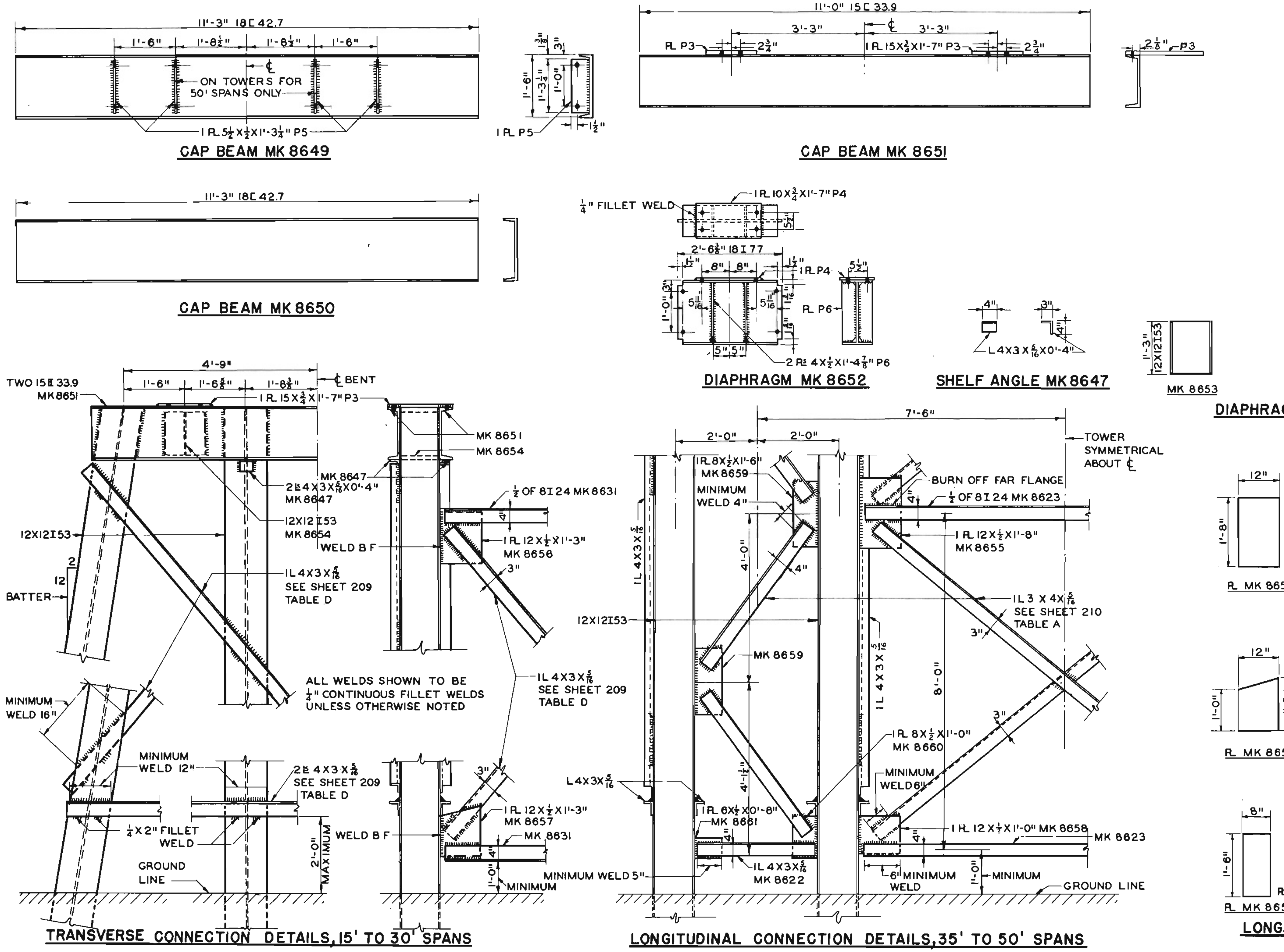
STEEL-PILE TOWER

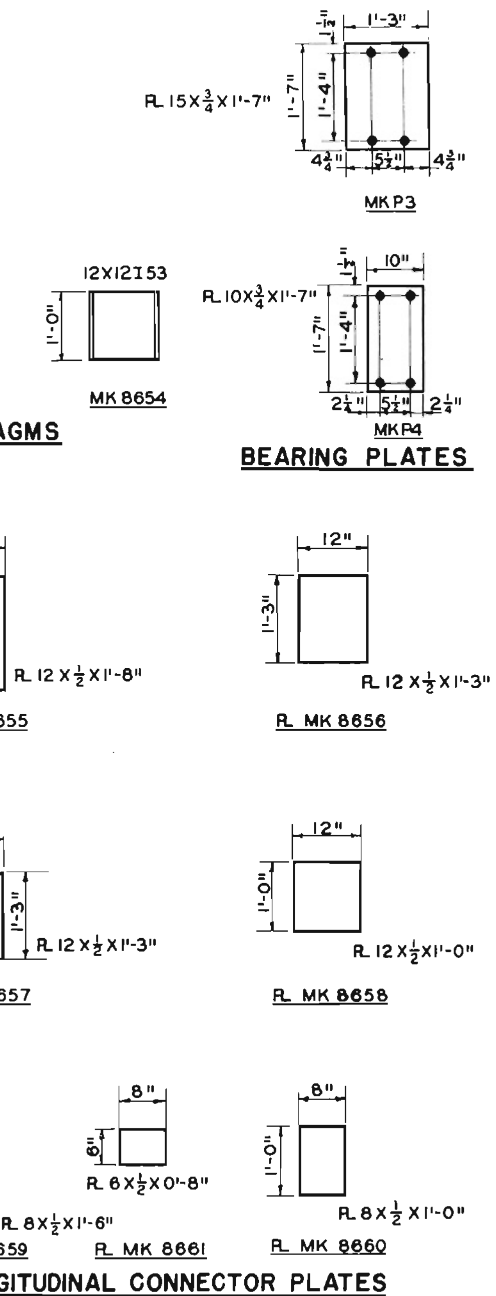


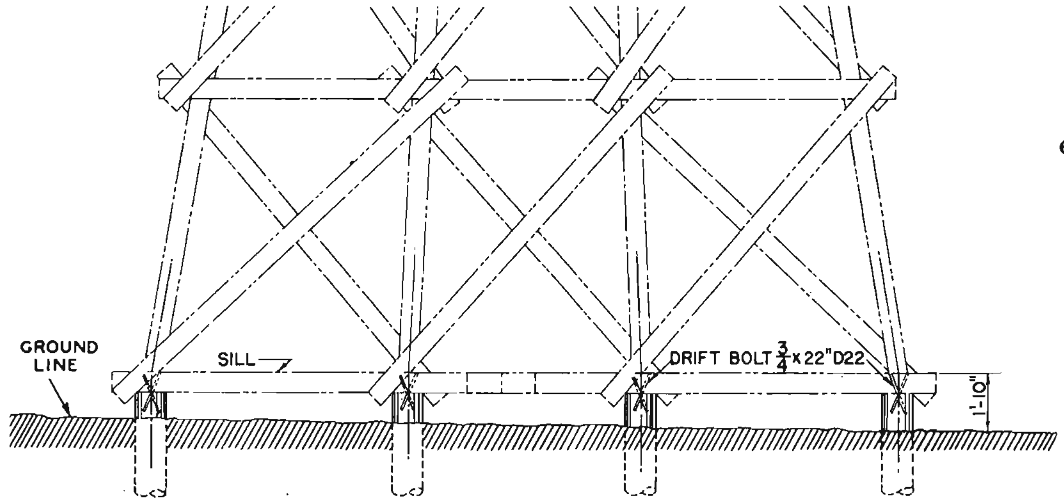
ASSEMBLED VIEW

COMPANION SHEETS

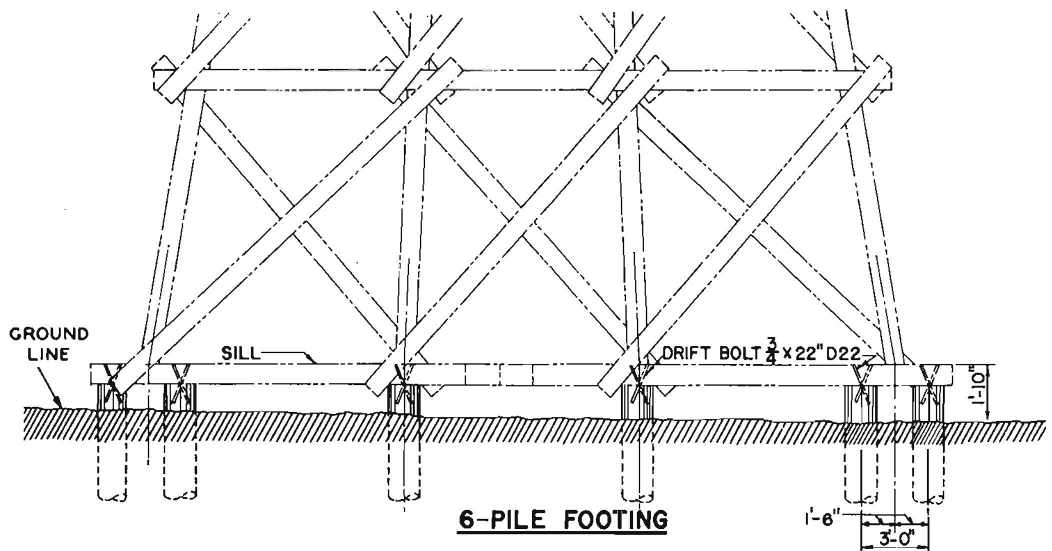
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL PILES BENTS AND PIERS	209
STEEL PILES BENTS AND PIERS	210



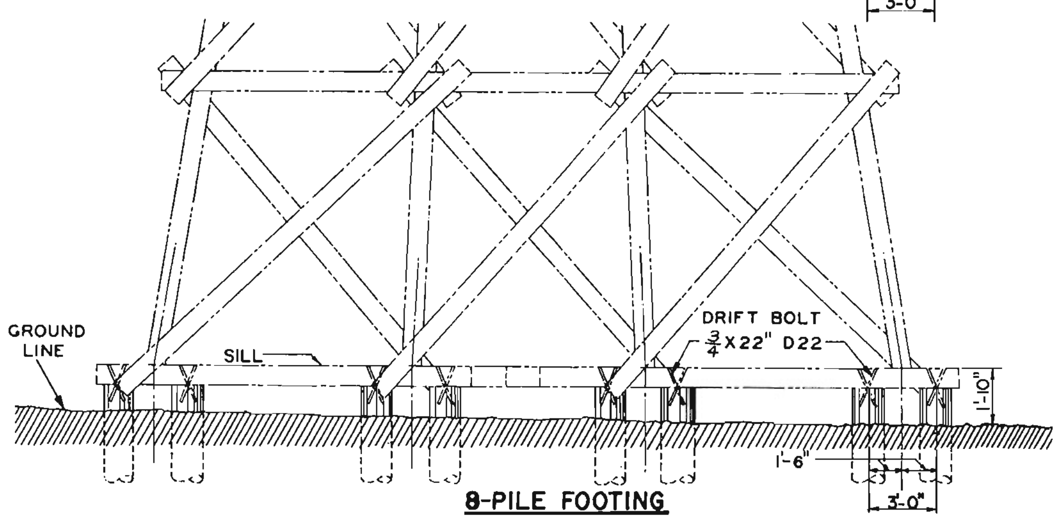




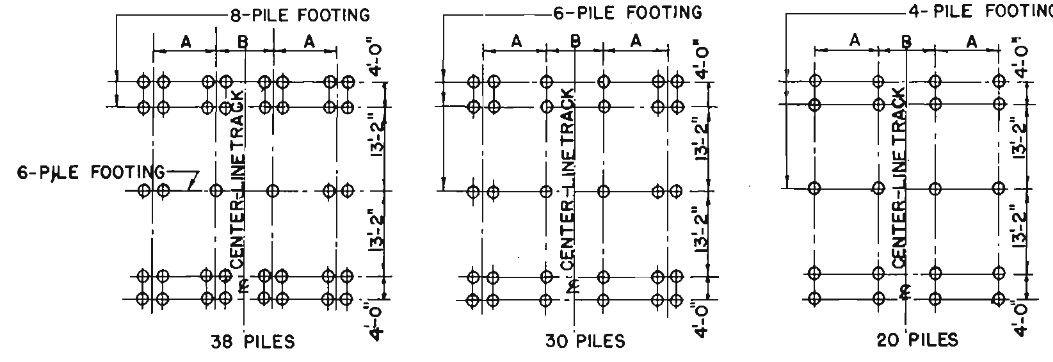
4-PILE FOOTING



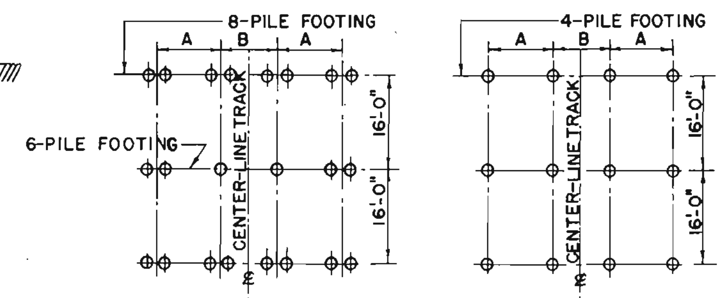
6-PILE FOOTING



8-PILE FOOTING



PILE ARRANGEMENT PLANS STEEL SPANS



PILE ARRANGEMENT PLANS TIMBER SPANS

22-PILE FOUNDATION FOR TOWERS 20' TO 80' HIGH
12-PILE FOUNDATION FOR TOWERS 15' TO 20' HIGH

COMPANION SHEETS

	SHEET
TIMBER TOWERS FOR TIMBER SPANS	175
TIMBER TOWERS FOR STEEL SPANS	179
GENERAL NOTES	154
SYMBOLS	155

PILE SCHEDULE FOR TOWERS WITH STEEL SPANS

SPAN LENGTH	TOWER HEIGHT	PILES PER TOWER
50'	30' TO 80'	38
	20' TO 30'	30
	15' TO 20'	20
45'	35' TO 80'	38
	25' TO 35'	30
	15' TO 25'	20
40'	40' TO 80'	38
	30' TO 40'	30
	15' TO 30'	20
35'	45' TO 80'	38
	35' TO 45'	30
	15' TO 35'	20
30'	55' TO 80'	38
	40' TO 55'	30
	15' TO 40'	20
25'	65' TO 80'	38
	45' TO 65'	30
	15' TO 45'	20
20'	55' TO 80'	30
	15' TO 55'	20

TOWER HEIGHT AND DIMENSIONS

HEIGHT OF TOWER	A	B	HEIGHT OF TOWER	A	B
13'-4"	3'-5 1/2"	4'-11 3/4"	46'	7'-6 1/2"	7'-8"
16'	3'-9 1/2"	5'-2"	48'	7'-9 1/2"	7'-10"
18'	4'-0 1/2"	5'-4"	50'-10"	8'-1 3/4"	8'-1 1/4"
20'	4'-3 1/2"	5'-6"	53'	8'-5"	8'-3"
22'	4'-6 1/2"	5'-8"	55'	8'-8"	8'-5"
24'	4'-9 1/2"	5'-10"	57'	8'-11"	8'-7"
25'-10"	5'-0 1/4"	6'-0 1/4"	59'	9'-2"	8'-9"
28'	5'-3 1/2"	6'-2"	61'	9'-5"	8'-11"
30'	5'-6 1/2"	6'-4"	63'-4"	9'-8 1/2"	9'-1 3/4"
32'	5'-9 1/2"	6'-6"	65'	9'-11"	9'-3"
34'	6'-0 1/2"	6'-8"	67'	10'-2"	9'-5"
36'	6'-3 1/2"	6'-10"	69'	10'-5"	9'-7"
38'-4"	6'-7"	7'-0 3/4"	71'	10'-8"	9'-9"
40'	6'-9 1/2"	7'-2"	73'	10'-11"	9'-11"
42'	7'-0 1/2"	7'-4"	75'-10"	11'-3 1/4"	10'-2 1/4"
44'	7'-3 1/2"	7'-6"			

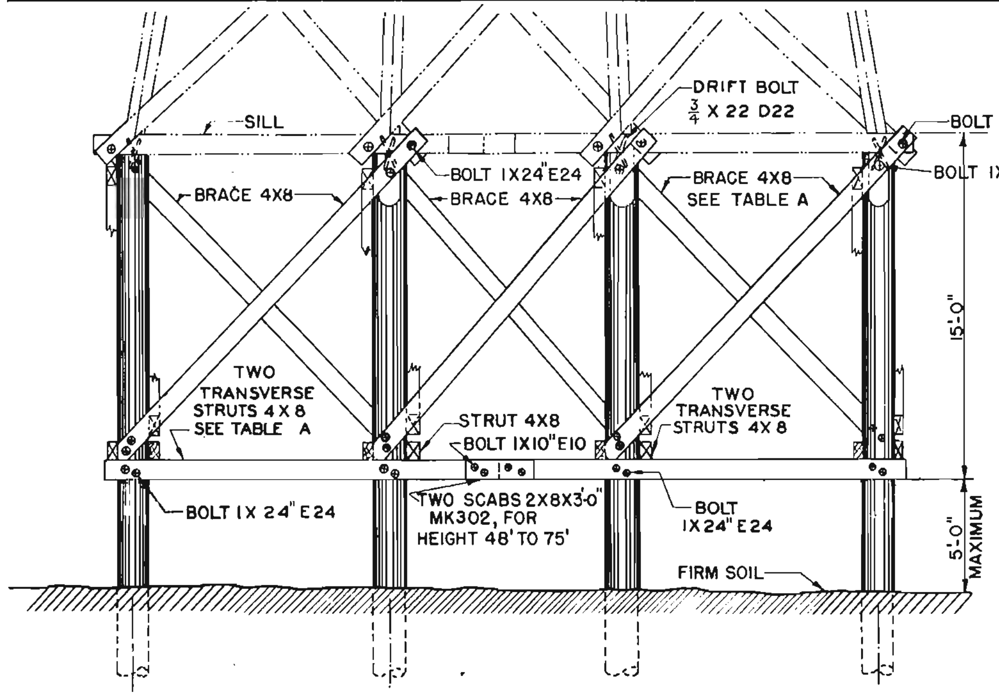
BILL OF MATERIALS

MATERIALS FOR FOUNDATION UNDER ONE TOWER

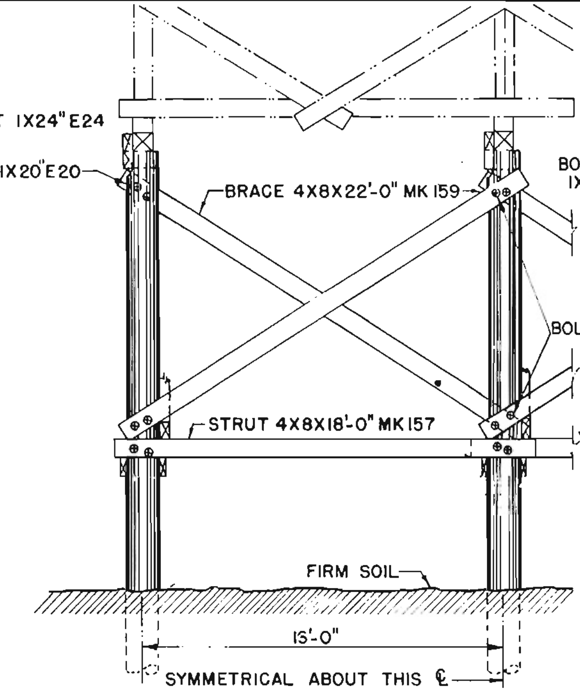
LINE	DESCRIPTION	STOCK NO	MARK	SIZE	LENGTH	UNIT WEIGHT	12-PILE FOUNDATION		22-PILE FOUNDATION		20-PILE FOUNDATION		30-PILE FOUNDATION		38-PILE FOUNDATION	
							QUANTITY	WEIGHT	QUANTITY	WEIGHT	QUANTITY	WEIGHT	QUANTITY	WEIGHT	QUANTITY	WEIGHT
1	PILE						12		22		20		30		38	
2	DRIFT BOLT	43-1636.0722	D 22	3/4	22"	3 LB	24	72 LB	44	132 LB	40	120 LB	60	180 LB	76	228 LB

COMPANION SHEETS

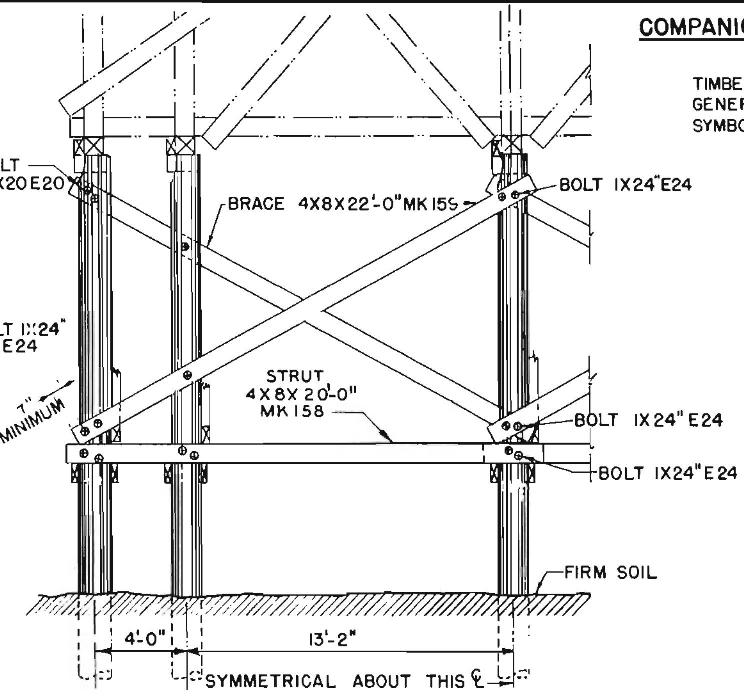
	SHEET
TIMBER SILLS, TIMBER PILES	212
GENERAL NOTES	154
SYMBOLS	155



4-PILE FOOTING



HALF LONGITUDINAL ELEVATION-TIMBER SPANS



HALF LONGITUDINAL ELEVATION- STEEL SPANS

TABLE A 4-PILE FOOTING

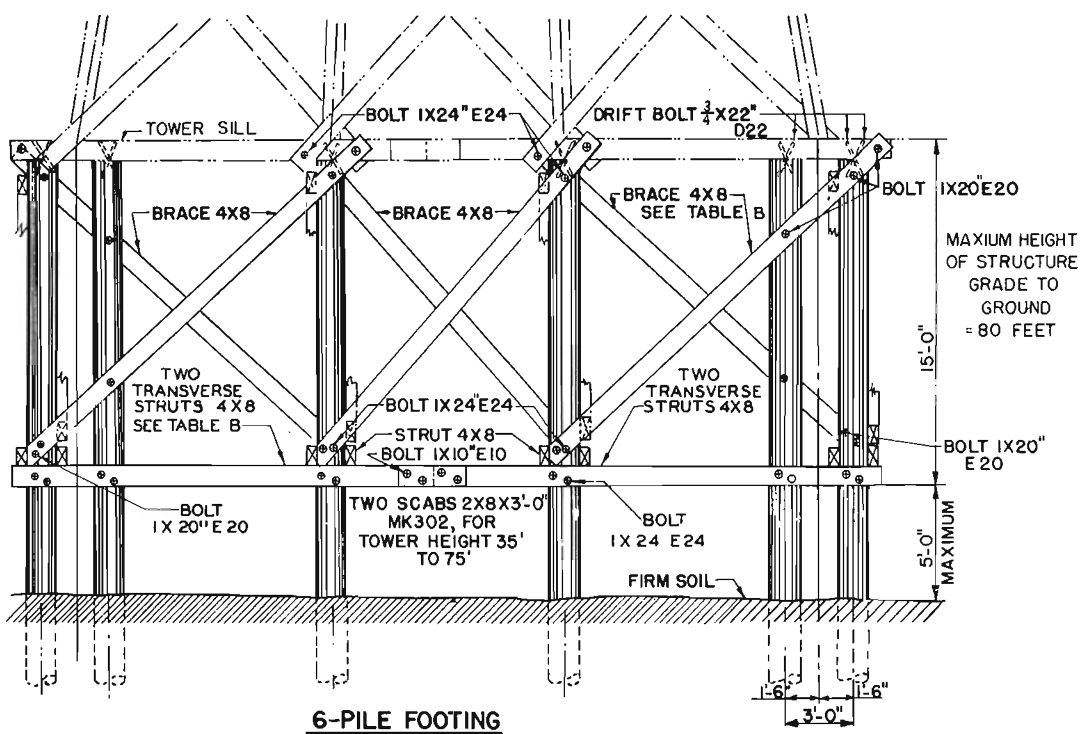
LENGTH OF TRANSVERSE BRACING				
TOWER	BRACE		STRUT	
HEIGHT	LENGTH	MARK	LENGTH	MARK
15'TO21'	16'-0"	156	16'-0"	156
23'TO27'	16'-0"	156	18'-0"	157
29'TO33'	16'-0"	156	20'-0"	158
35'TO40'	18'-0"	157	22'-0"	159
42'TO46'	18'-0"	157	24'-0"	160
48'TO56'	18'-0"	157	14'-0"	155
58'TO69'	20'-0"	158	16'-0"	156

TABLE B 6-PILE FOOTING

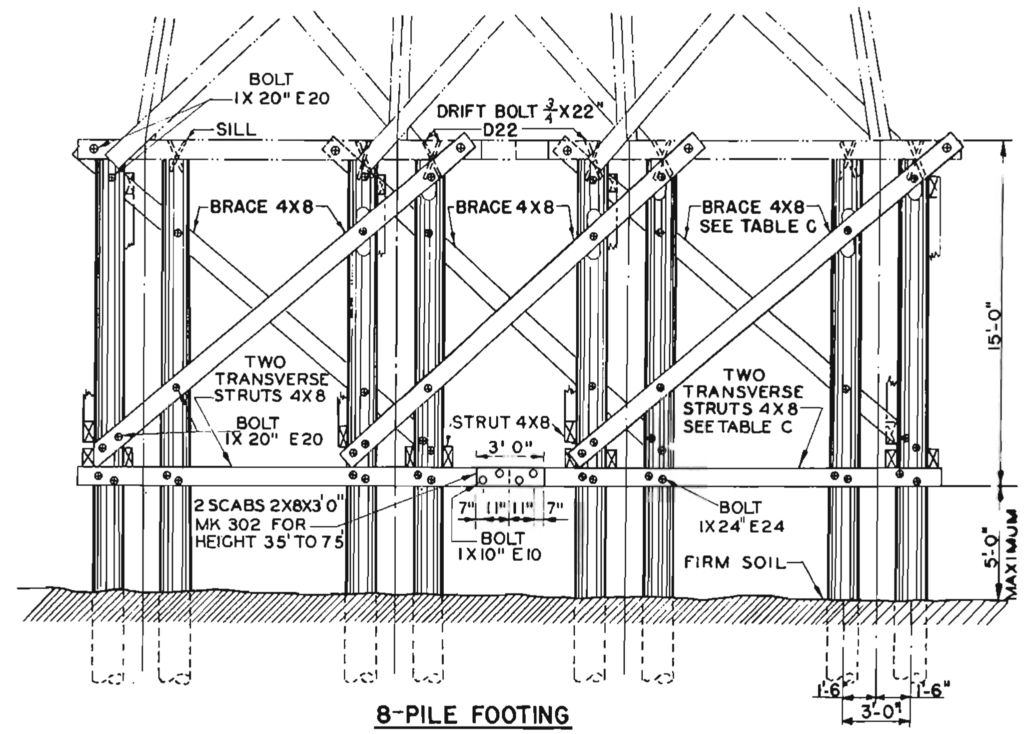
LENGTH OF TRANSVERSE BRACING				
TOWER	BRACE		STRUT	
HEIGHT	LENGTH	MARK	LENGTH	MARK
15'TO21'	16'-0"	156	20'-0"	158
23'TO27'	18'-0"	157	22'-0"	159
29'TO33'	18'-0"	157	24'-0"	160
35'TO40'	18'-0"	157	14'-0"	155
42'TO46'	18'-0"	157	14'-0"	155
48'TO56'	20'-0"	158	16'-0"	156
58'TO69'	20'-0"	158	18'-0"	157

TABLE C 8-PILE FOOTING

LENGTH OF TRANSVERSE BRACING				
TOWER	BRACE		STRUT	
HEIGHT	LENGTH	MARK	LENGTH	MARK
15'TO21'	18'-0"	157	20'-0"	158
23'TO27'	18'-0"	157	22'-0"	159
29'TO33'	20'-0"	158	24'-0"	160
35'TO40'	20'-0"	158	14'-0"	155
42'TO46'	20'-0"	158	14'-0"	155
48'TO56'	20'-0"	158	16'-0"	156
58'TO69'	22'-0"	159	18'-0"	157



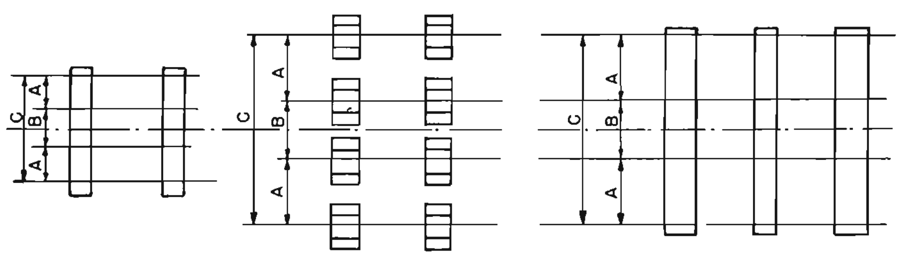
6-PILE FOOTING



8-PILE FOOTING

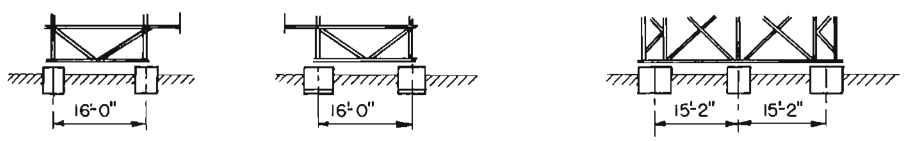
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER TOWERS FOR STEEL SPANS	158
TIMBER TOWERS FOR STEEL SPANS	159
TIMBER TOWERS FOR TIMBER SPANS	175



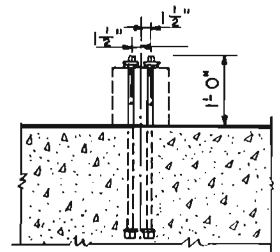
TIMBER SPANS
FOR TOWER HEIGHTS UNDER 36' — FOR TOWER HEIGHTS 36' AND HIGHER

PLAN OF CONCRETE PEDESTALS



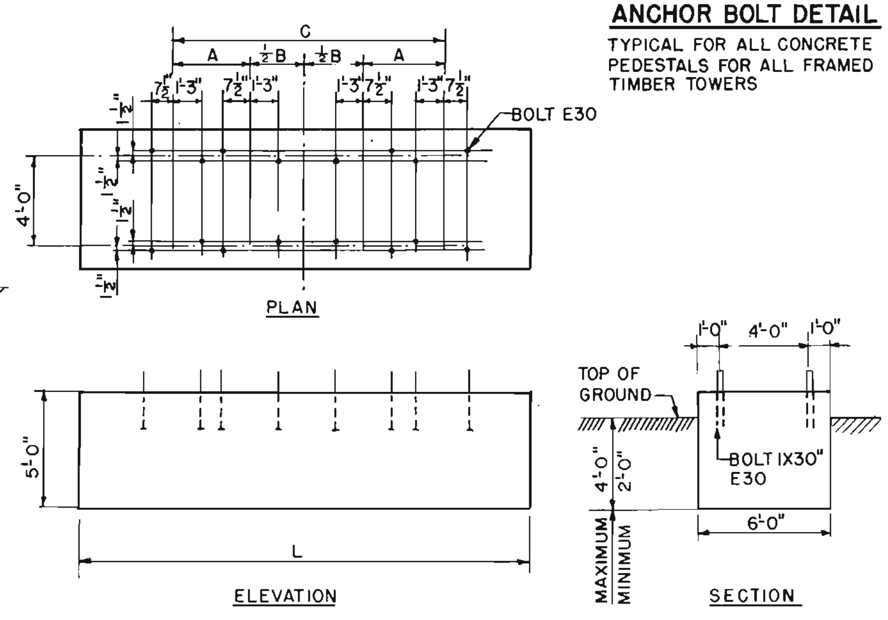
TIMBER SPANS — STEEL SPANS

LONGITUDINAL ELEVATIONS

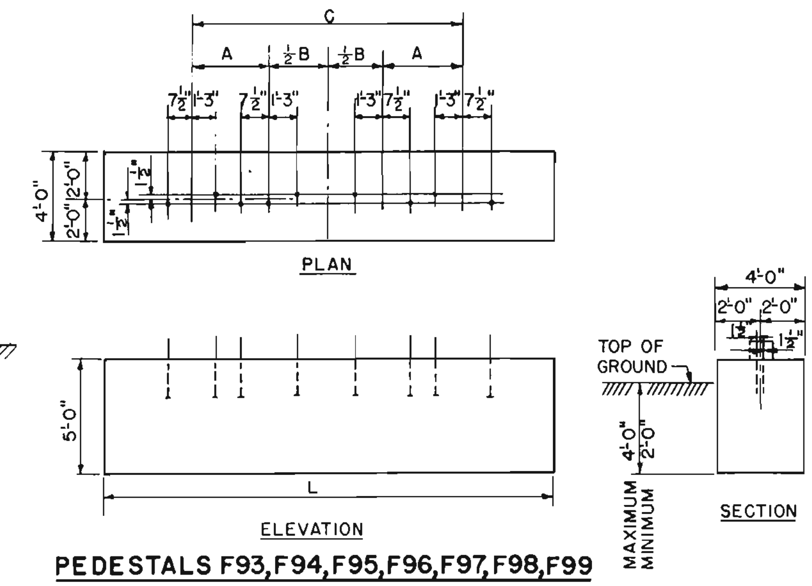


ANCHOR BOLT DETAIL

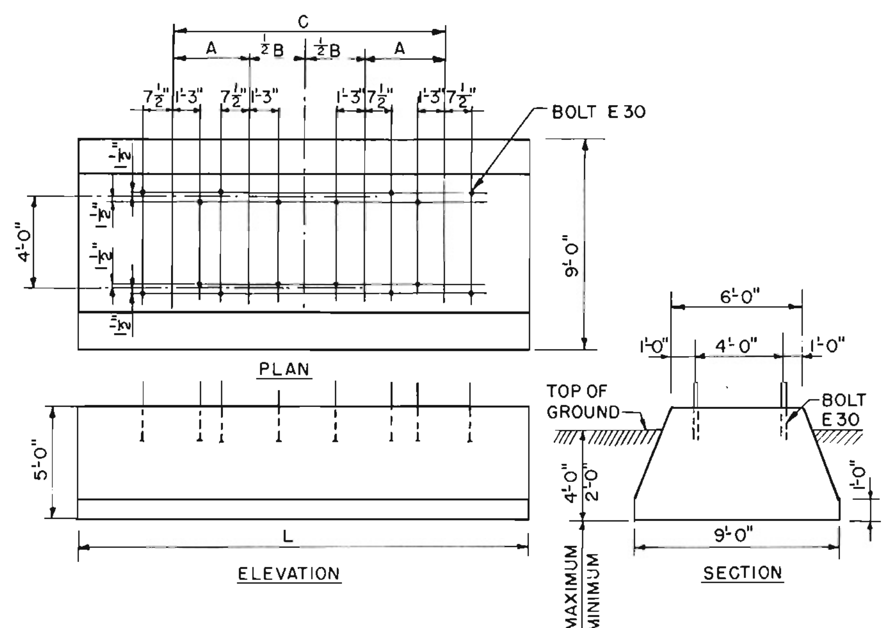
TYPICAL FOR ALL CONCRETE PEDESTALS FOR ALL FRAMED TIMBER TOWERS



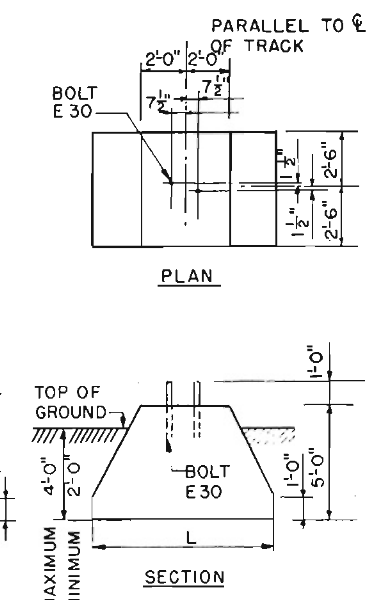
PEDESTALS F 87, F 88, F 89, F 90, F 91, F 92



PEDESTALS F93, F94, F95, F96, F97, F98, F99



PEDESTALS F81, F82, F83, F84, F85, F86



PEDESTALS F101, F102, F103

CONCRETE PEDESTALS

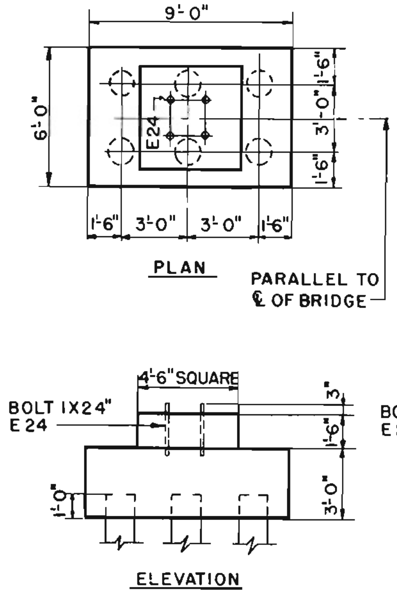
STORIES	HEIGHT OF TOWER	A	B	C	TIMBER SPANS	STEEL SPANS 50', 45', 40', 35' DOUBLE BENT	STEEL SPANS 50', 45', 40', 35' SINGLE BENT	STEEL SPANS 30', 25', 20', 15' DOUBLE BENT	STEEL SPANS 30', 25', 20', 15' SINGLE BENT
1	13'-4"	3'-5 1/2"	4'-11 3/4"	11'-10 3/4"	F 99	F 86	F 99	F 92	F 99
2	16'	3'-9 1/2"	5'-2"	12'-9"	F 99	F85	F 97	F 91	F 97
	18'	4'-0 1/2"	5'-4"	13'-5"					
	20'	4'-3 1/2"	5'-6"	14'-1"					
	22'	4'-6 1/2"	5'-8"	14'-9"					
	24'	4'-9 1/2"	5'-10"	15'-5"					
	25'-10"	5'-0 1/4"	6'-0 1/4"	16'-0 3/4"					
3	28'	5'-3 1/2"	6'-2"	16'-9"	F 98	F 84	F 96	F90	F 96
	30'	5'-6 1/2"	6'-4"	17'-5"					
	32'	5'-9 1/2"	6'-6"	18'-1"					
	34'	6'-0 1/2"	6'-8"	18'-9"					
	36'	6'-3 1/2"	6'-10"	19'-5"	F 103				
	38'-4"	6'-7"	7'-0 3/4"	20'-2 3/4"					
4	40'	6'-9 1/2"	7'-2"	20'-9"	F 103	F 83	F 95	F89	F 95
	42'	7'-0 1/2"	7'-4"	21'-5"					
	44'	7' 3 1/2"	7'-6"	22'-1"	F102				
	46'	7'-6 1/2"	7'-8"	22'-9"					
	48'	7'-9 1/2"	7'-10"	23'-5"					
	50'-10"	8'-1 3/4"	8'-1 1/4"	24'-4 3/4"					
5	53'	8'-5"	8'-3"	25'-1"	F102	F 82	F 94	F 88	F 94
	55'	8'-8"	8'-5"	25'-9"					
	57'	8'-11"	8'-7"	26'-5"					
	59'	9'-2"	8'-9"	27'-1"					
	61'	9'-5"	8'-11"	27'-9"	F 101				
	63'-4"	9'-8 1/2"	9'-1 3/4"	28'-6 3/4"					
6	65'	9'-11"	9'-3"	29'-1"	F 101	F 81	F 93	F87	F93
	67'	10'-2"	9'-5"	29'-9"					
	69'	10'-5"	9'-7"	30'-5"					
	71'	10'-8"	9'-9"	31'-1"					
	73'	10'-11"	9'-11"	31'-9"					
	75'-10"	11'-3 1/4"	10'-2 1/4"	32'-8 3/4"					

TABLE OF DIMENSIONS AND BILL OF MATERIAL FOR ONE PEDESTAL

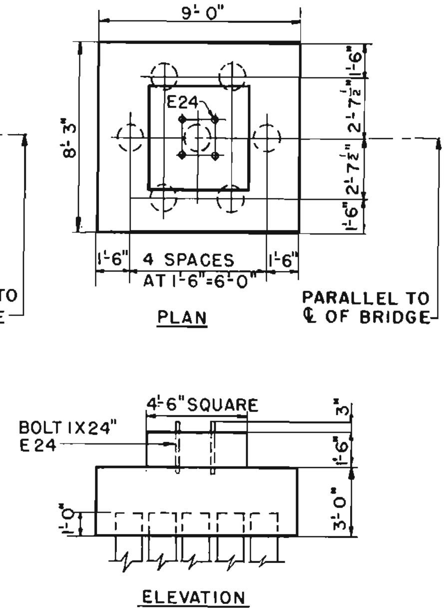
FOOTING MARK	L	CONCRETE CUBIC YARDS PER FOOTING	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS NO. 43-2325.1-3 QUANTITY	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS NO. 43-2325.1-3 POUNDS
F 81	36'-0"	52	16	125
F 82	32'-0"	46	16	125
F 83	29'-0"	42	16	125
F 84	26'-0"	38	16	125
F 85	23'-0"	33	16	125
F 86	20'-0"	29	16	125
F 87	36'-0"	40	16	125
F 88	32'-0"	36	16	125
F 89	29'-0"	32	16	125
F 90	26'-0"	29	16	125
F 91	23'-0"	26	16	125
F 92	20'-0"	22	16	125
F 93	36'-0"	27	8	62
F 94	32'-0"	24	8	62
F 95	24'-0"	22	8	62
F 96	26'-0"	19	8	62
F 97	23'-0"	17	8	62
F 98	22'-0"	16	8	62
F 99	20'-0"	15	8	62
F 101	8'-0"	5.9	2	16
F 102	7'-0"	5.4	2	16
F 103	6'-0"	4.8	2	16

COMPANION SHEETS

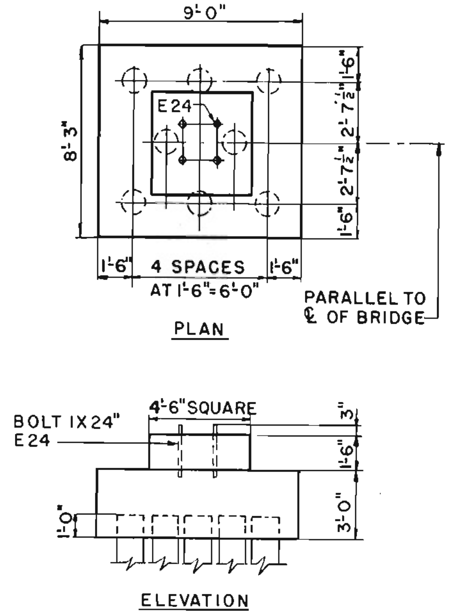
	SHEET
GENERAL NOTES	154
SYMBOLS	155
CONCRETE PEDESTALS	216
FRAMED STEEL TOWERS	184
FRAMED STEEL TOWERS	185



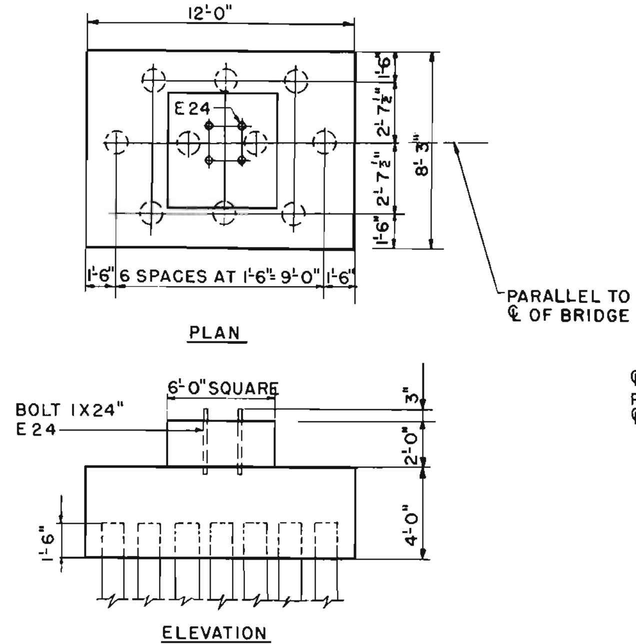
F136
6-PILE FOOTING



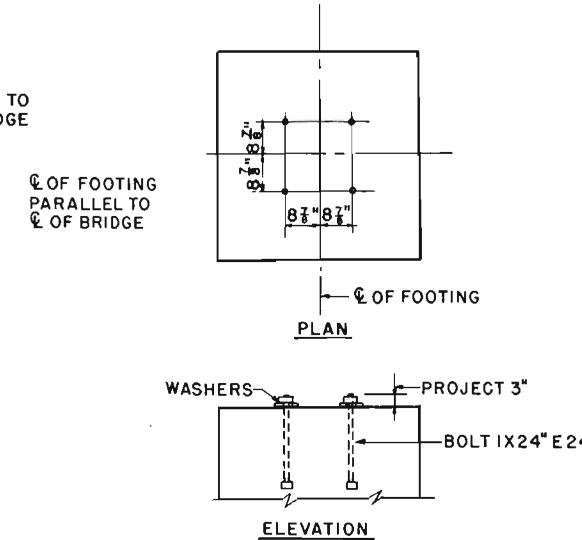
F137
7-PILE FOOTING



F138
8-PILE FOOTING

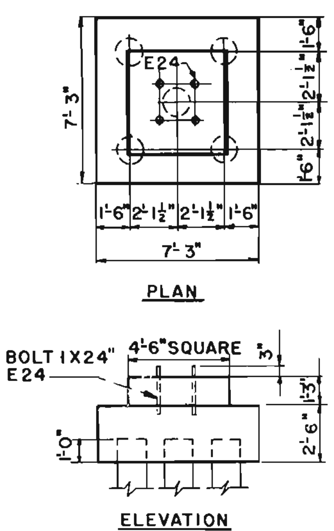


F139
10-PILE FOOTING



ANCHOR BOLT DETAIL

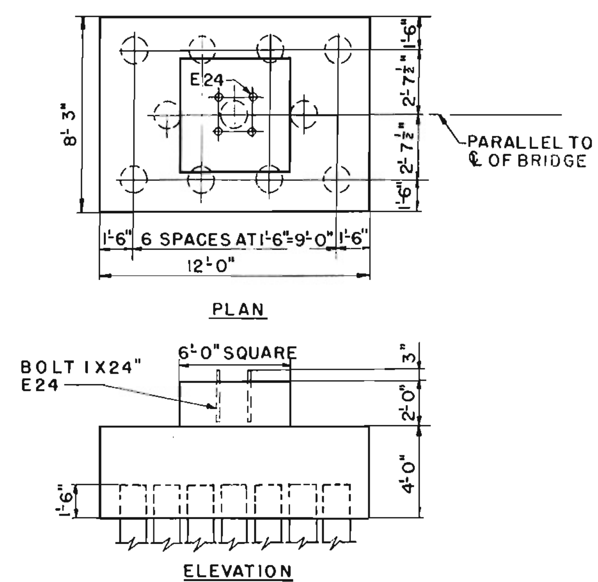
MAXIMUM PILE LOADS 18 TONS EACH



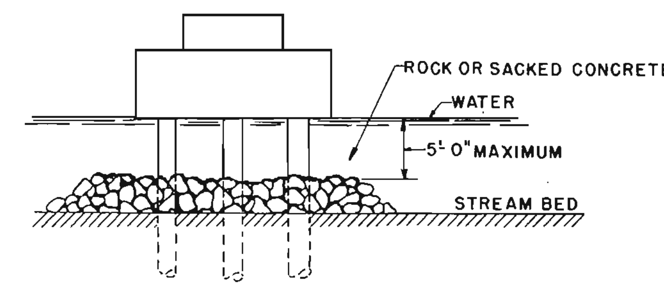
F135
5-PILE FOOTING

BILL OF MATERIAL FOR ONE FOOTING

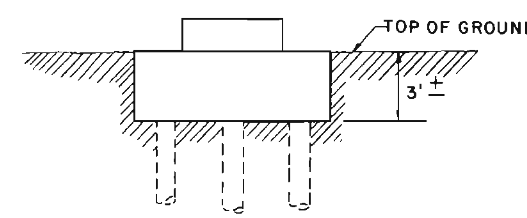
ADJACENT SPAN	HEIGHT OF TOWER	FOOTING MARK NUMBER	NUMBER OF PILES	CONCRETE (CUBIC YARDS)	MACHINE BOLT 1X24" E24 WITH SQUARE NUT AND TWO WASHERS STOCK NUMBER 43-2325.1 -24	
					QUANTITY	POUNDS EACH
25'	41' OR LOWER	F 135	5	5.8	4	6.5
	43' TO 57'	F 136	6	7.1	4	6.5
	59' TO 77'	F 137	7	9.3	4	6.5
30'	21' OR LOWER	F 135	5	5.8	4	6.5
	23' TO 41'	F 136	6	7.1	4	6.5
	43' TO 77'	F 137	7	9.3	4	6.5
35'	21' OR LOWER	F 135	5	5.8	4	6.5
	23' TO 41'	F 136	6	7.1	4	6.5
	43' TO 57'	F 137	7	9.3	4	6.5
	59' TO 77'	F 138	8	9.3	4	6.5
40'	21' OR LOWER	F 136	6	7.1	4	6.5
	23' TO 41'	F 137	7	9.3	4	6.5
	43' TO 77'	F 138	8	9.3	4	6.5
45'	21' OR LOWER	F 137	7	9.3	4	6.5
	23' TO 57'	F 138	8	9.3	4	6.5
	59' TO 77'	F 139	10	17.3	4	6.5
50'	41' OR LOWER	F 138	8	9.3	4	6.5
	43' TO 57'	F 139	10	17.3	4	6.5
	59' TO 77'	F 140	11	17.3	4	6.5



F140
11-PILE FOOTING



TYPICAL ELEVATION
FOOTINGS IN WATER



TYPICAL ELEVATION
FOOTINGS IN SOIL

COMPANION SHEETS

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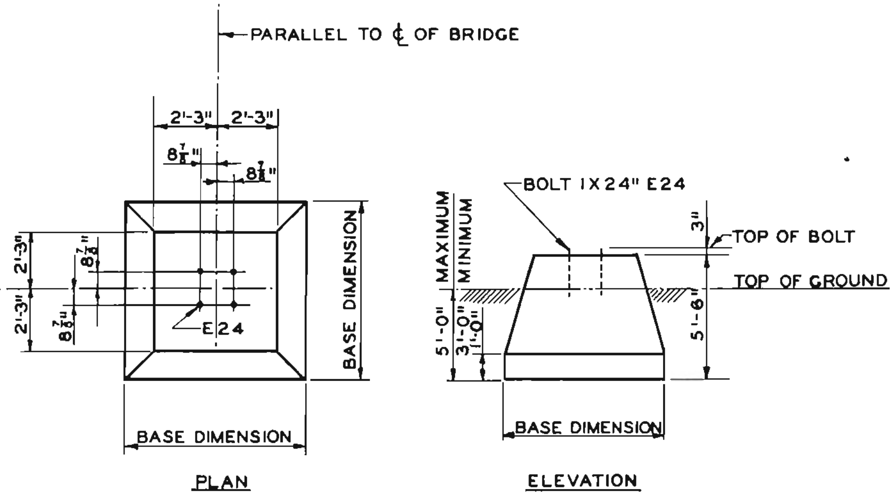
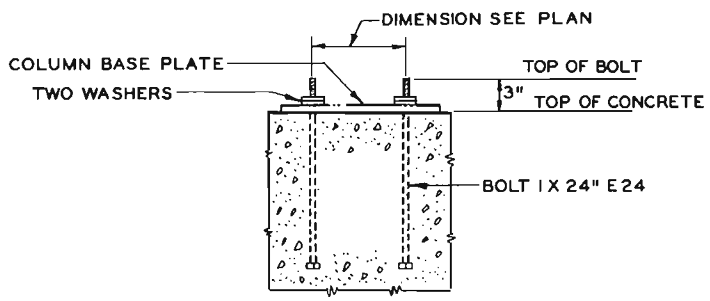
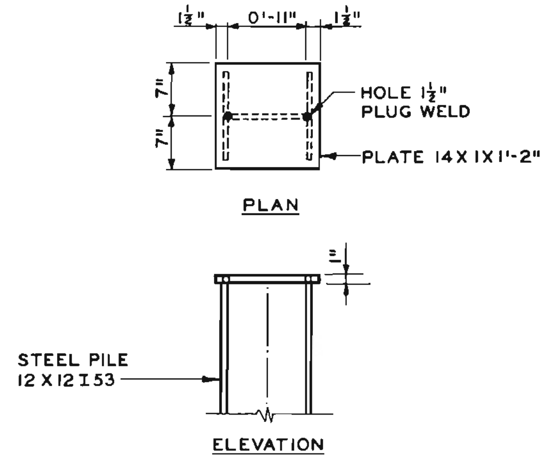
SYMBOLS	155



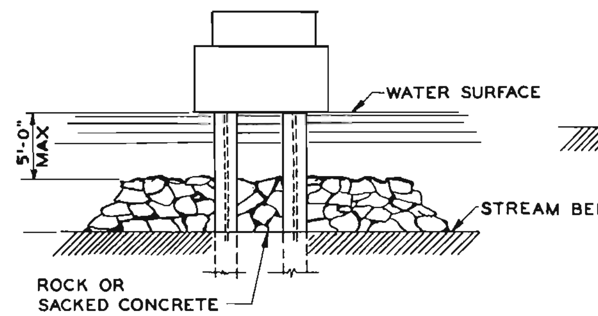
CONCRETE PEDESTAL FOR STEEL TOWERS



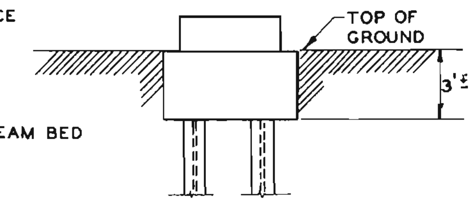
TYPICAL ANCHOR BOLT DETAIL



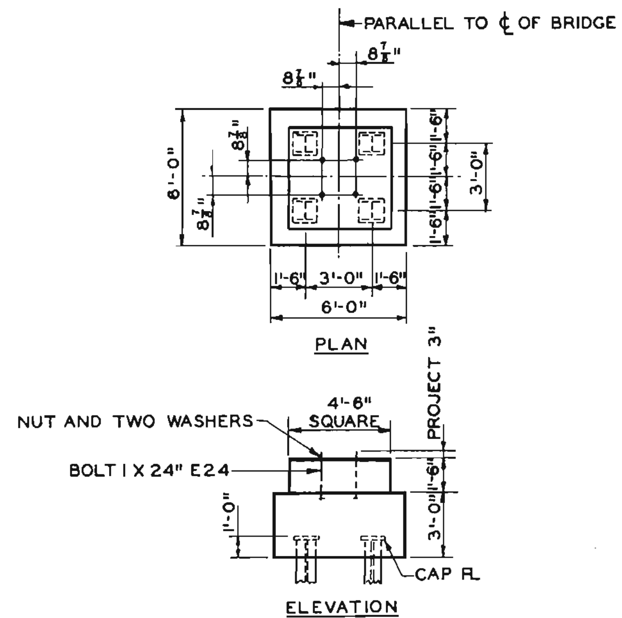
DETAIL OF CAP PLATE
FOR STEEL PILE



FOOTING IN WATER



FOOTING IN SOIL



4-PILE FOOTING

REQUIRED BEARING CAPACITY OF PILES

TONS PER PILE

ADJACENT SPAN (FEET)	HEIGHT OF TOWER 21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
25'	23	26	29	32
30'	25	29	32	36
35'	28	32	35	39
40'	30	35	39	43
45'	33	37	42	47
50'	35	40	45	50

TABLE OF DIMENSIONS FOR ONE PEDESTAL

ADJACENT SPAN (FEET)	HEIGHT OF TOWER	MARK	BASE DIMENSION	CUBIC YARDS CONCRETE	MACHINE BOLT 1X24" WITH SQUARE NUT AND TWO WASHERS STOCK NO 43.2325.100-240 QUANTITY	POUNDS
25	39' OR LOWER	F123	9'-0"	10.8	4	26
	41' TO 77'	F124	10'-0"	12.9	4	26
30	39' OR LOWER	F123	9'-0"	10.8	4	26
	41' TO 77'	F124	10'-0"	12.9	4	26
35	21' OR LOWER	F123	9'-0"	10.8	4	26
	23' TO 57'	F124	10'-0"	12.9	4	26
	59' TO 77'	F125	11'-0"	15.1	4	26
40	39' OR LOWER	F124	10'-0"	12.9	4	26
	41' TO 77'	F125	11'-0"	15.1	4	26
45	21' OR LOWER	F124	10'-0"	12.9	4	26
	23' TO 77'	F125	11'-0"	15.1	4	26
50	21' OR LOWER	F124	10'-0"	12.9	4	26
	23' TO 77'	F125	11'-0"	15.1	4	26

BILL OF MATERIALS FOR ONE FOOTING WITH STEEL PILES

DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH POUNDS	NUMBER OF PIECES	UNIT	AMOUNT
CONCRETE							CU YDS	5.1
PILE	48-6020.120.053		12X12I53			4		
CAP PLATE	47-7844.1		14X1	1'-2"	55	4		
MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.100-240	E24	1	24"	6.4	4	POUNDS	26
WELDING ELECTRODE	46-3772.25-5		$\frac{7}{32}$				POUNDS	4

LENGTH OF PILES DETERMINED BY CONDITIONS AT SITE
AND BEARING CAPACITY REQUIRED.

COMPANION SHEETS

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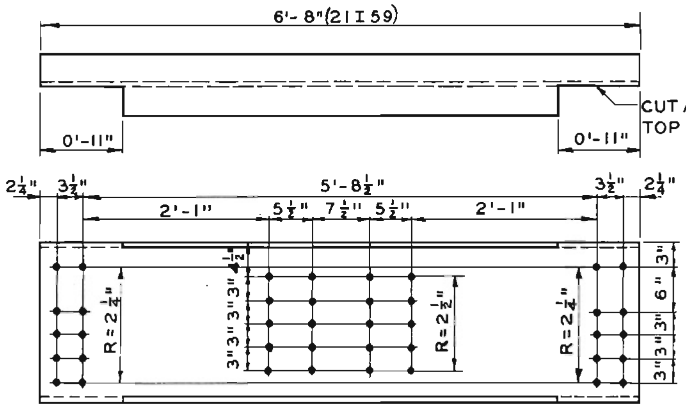
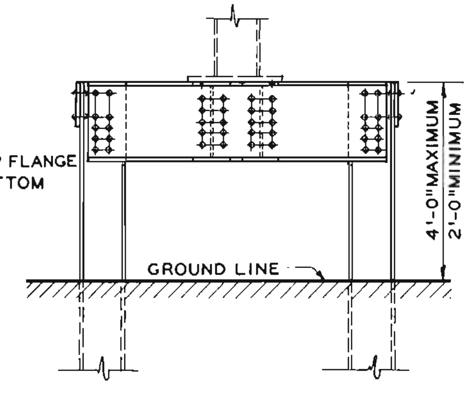
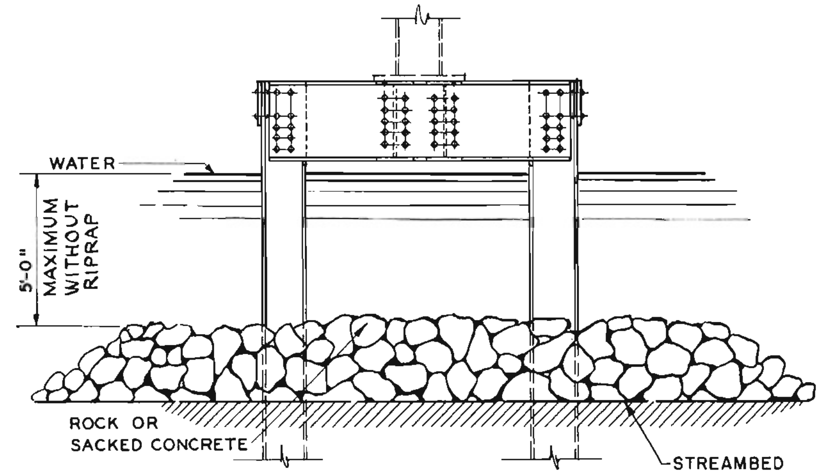
SYMBOLS	155
GENERAL NOTES	154
FRAMED STEEL TOWERS	184
FRAMED STEEL TOWERS	185



BEAM MK 9052



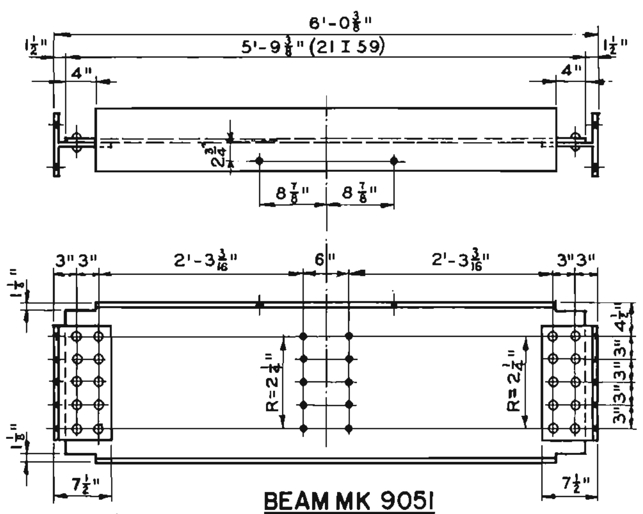
FOOTINGS IN SOIL



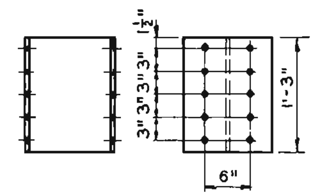
FOOTINGS IN WATER

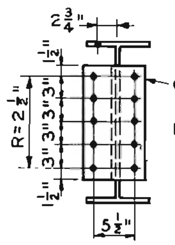
REQUIRED BEARING CAPACITY OF STEEL PILES, TONS PER PILE

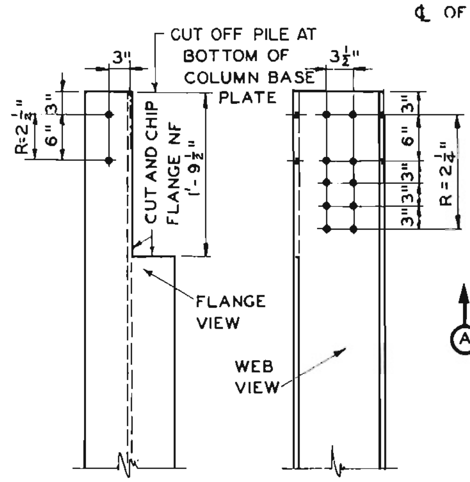
ADJACENT SPAN	HEIGHT OF TOWER 21' OR LOWER	23' TO 39'	41' TO 57'	59' TO 77'
25'	23	26	29	32
30'	25	29	32	36
35'	28	32	35	39
40'	30	35	39	43
45'	33	37	42	47
50'	35	40	45	50



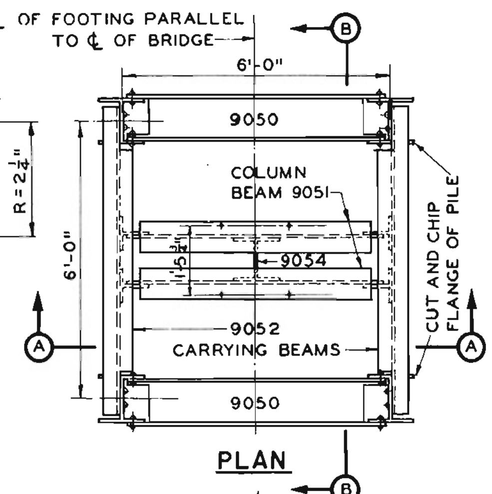
BEAM MK 9051


DIAPHRAGM MK 9054
12 X 12 I 53 X 1'-3"

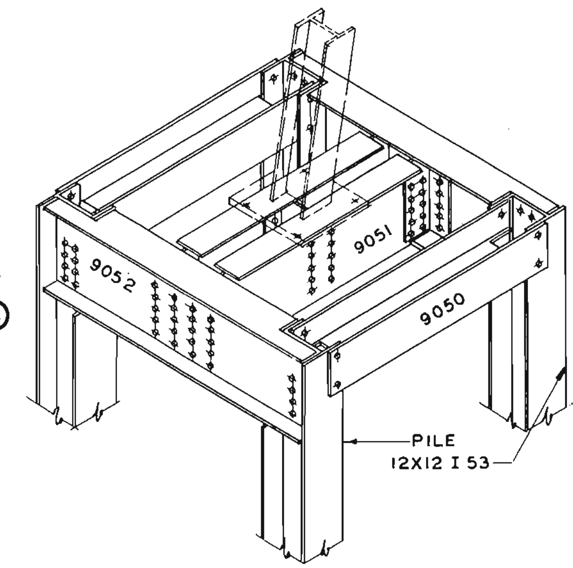




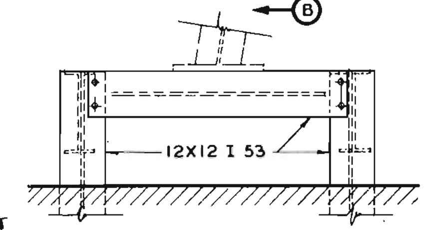
DETAIL AT TOP OF PILE



PLAN



ASSEMBLED VIEW

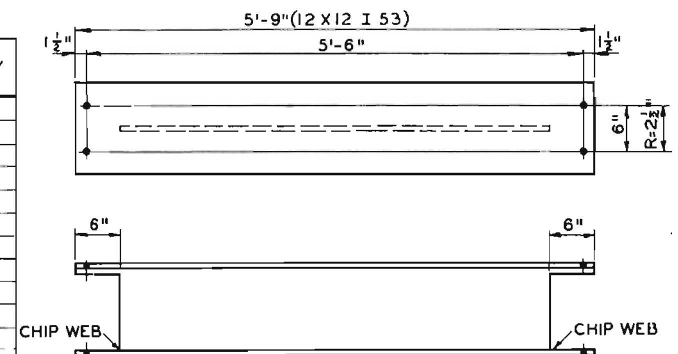


END VIEW

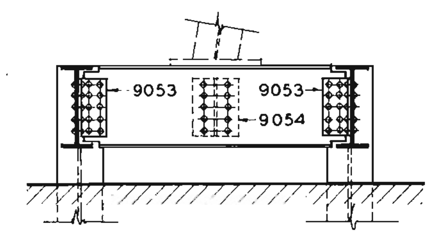
BILL OF MATERIALS FOR ONE FOOTING

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	QUANTITY
1	PILE	48-6020.120-053		12X12 I 53	—	—	4
2	BEAM	48-2900.21-059	9052	21 I 59	6'-8"	390	2
3	BEAM	48-2900.21-059	9051	21 I 59	5'-9½"	339	2
4	BEAM	48-6020.120-053	9050	12 X 12 I 53	5'-9"	305	2
5	CONNECTION	48-2900.21-059	9053	21 I 59	1'-3"	34	4
6	DIAPHRAGM	48-6020.120-053	9054	12 X 12 I 53	1'-3"	66	1
7	RIVET	43-6353.08-25		⅞	2½"	.62	40
8	RIVET	43-6353.08-23		⅞	2¼"	.57	116
9	RIVET BOLT WITH NUT		G8	⅞	3"	1.09	4
10	WASHER, STANDARD ROUND	43-9215.5-1		2½ X 5/32		.18	4

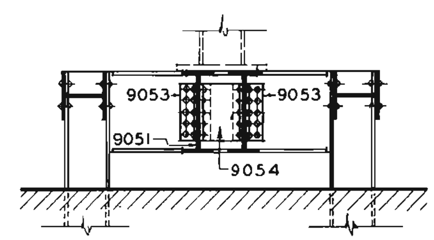
NOTE
LENGTH OF PILES DETERMINED BY CONDITIONS AT SITE AND BEARING CAPACITY REQUIRED.



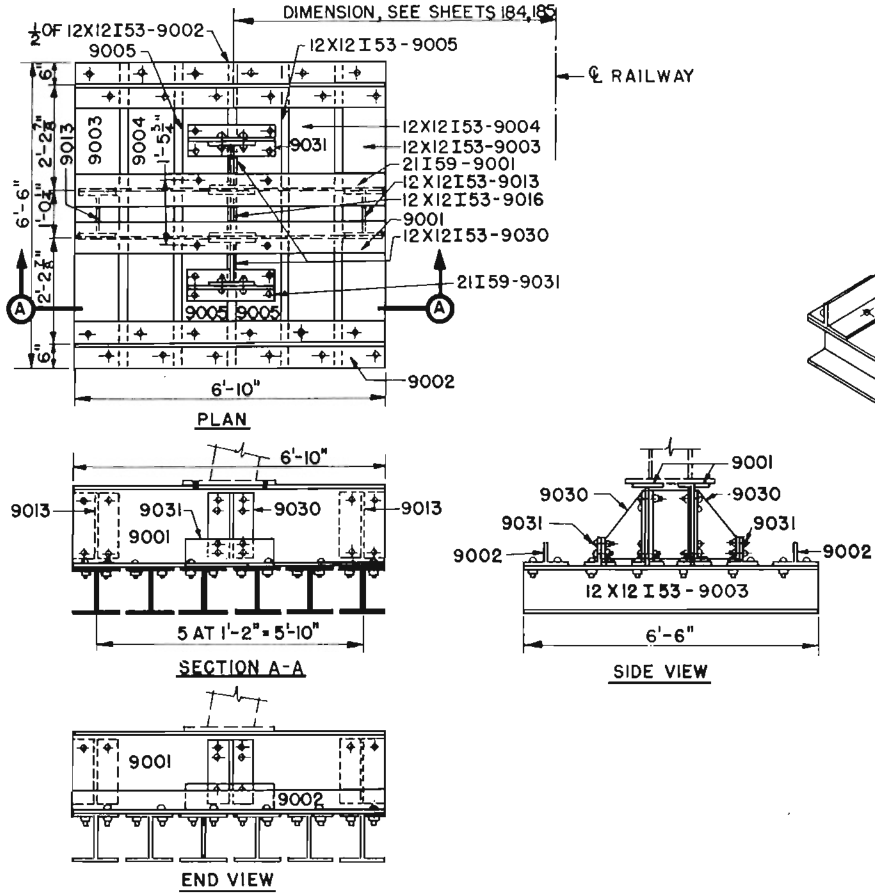
BEAM MK 9050



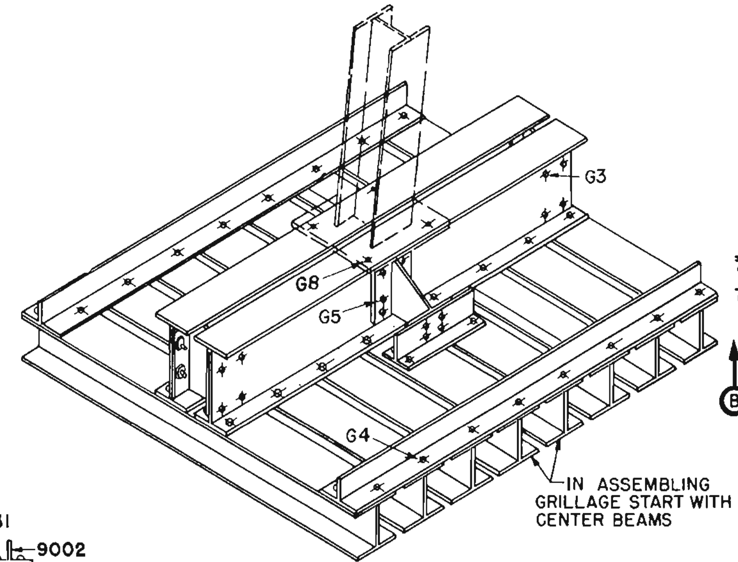
SECTION A-A



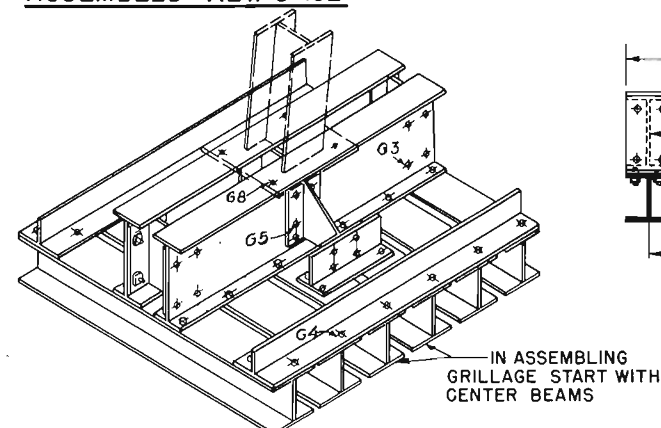
SECTION B-B



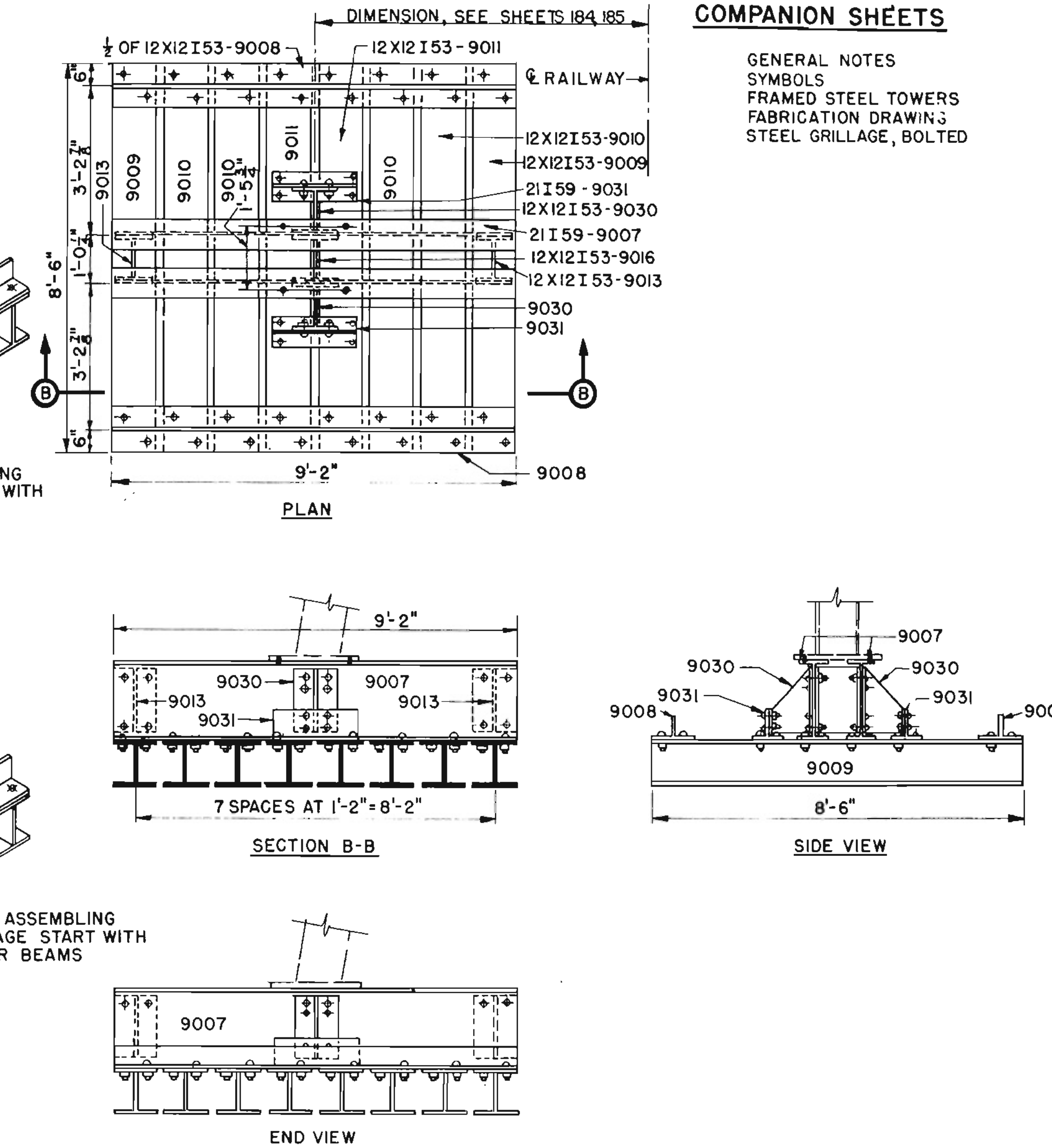
GRILLAGE FOOTING S-101



ASSEMBLED VIEW S-102



ASSEMBLED VIEW S-101



GRILLAGE FOOTING S-102

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	184,185
FABRICATION DRAWING	221
STEEL GRILLAGE, BOLTED	219

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING

LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE	LENGTH	WEIGHT EACH	S-101 QUANTITY	S-102 QUANTITY
1	TOP TIER BEAM	48-2900.21-059	9001	21 I 59	6'-10"	403	2	
2	TOP TIER HALF BEAM	48-6020.12-053	9002	12X12I53	6'-10"	180	2	
3	BOTTOM TIER BEAM		9003	12X12I53	6'-6"	345	2	
4	BOTTOM TIER BEAM		9004	12X12I53	6'-6"	345	2	
5	BOTTOM TIER BEAM		9005	12X12I53	6'-6"	345	2	
6	TOP TIER BEAM	48-2900.21-059	9007	21 I 59	9'-2"	541		2
7	TOP TIER HALF BEAM	48-6020.12-053	9008	12X12I53	9'-2"	243		2
8	BOTTOM TIER BEAM		9009	12X12I53	8'-6"	450		2
9	BOTTOM TIER BEAM		9010	12X12I53	8'-6"	450		4
10	BOTTOM TIER BEAM		9011	12X12I53	8'-6"	450		2
11	SEPARATOR		9013	12X12I53	1'-6"	80	2	2
12	SEPARATOR		9016	12X12I53	1'-6"	80	1	1
13	BRACE		9030	12X12I53	1'-6"	53	2	2
14	BRACE	48-2900.21-059	9031	21 I 59	1'-11"	50	2	2
						UNIT WEIGHT		
15	RIVET BOLT		G3	7/8	2 1/16"	.94	48	56
16	RIVET BOLT		G4	7/8	2 1/4"	.97	24	28
17	RIVET BOLT		G5	7/8	2 7/16"	1.00	16	16
18	RIVET BOLT AND WASHER		G8	7/8	3"	1.09	4	4

SCHEDULE FOR SELECTION OF GRILLAGE FOOTING FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

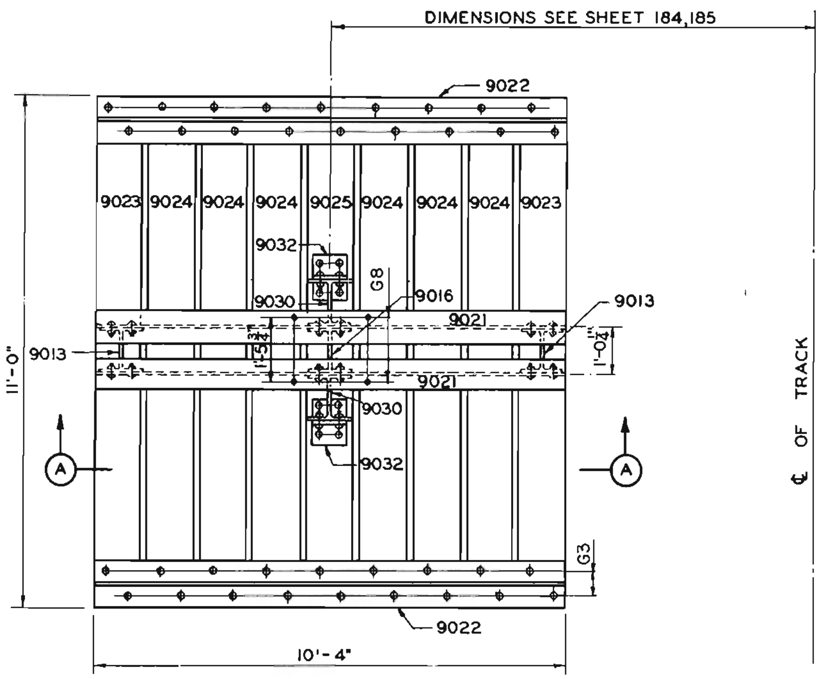
SPAN BETWEEN TOWERS	FOOTINGS ON SOIL				FOOTINGS ON ROCK			
	HEIGHT OF TOWER				HEIGHT OF TOWER			
	UP TO 21'	23' TO 39'	41' TO 50'	59' TO 77'	UP TO 21'	23' TO 39'	41' TO 59'	59' TO 77'
15' TO 25'	S-102	S-102	S-102	S-102	S-101	S-101	S-101	S-101
30'	S-102	S-102	S-102	S-103	S-101	S-101	S-101	S-102
35'	S-102	S-102	S-103	S-103	S-101	S-101	S-102	S-102
40'	S-102	S-103	S-103	S-103	S-101	S-102	S-102	S-102
45'	S-102	S-103	S-103	S-103	S-101	S-102	S-102	S-102
50'	S-103	S-103	S-103	S-103	S-102	S-102	S-102	S-102

TABLE FOR SELECTION OF GRILLAGE FOOTINGS FOR KNOWN SPAN LENGTH AND TOWER HEIGHT

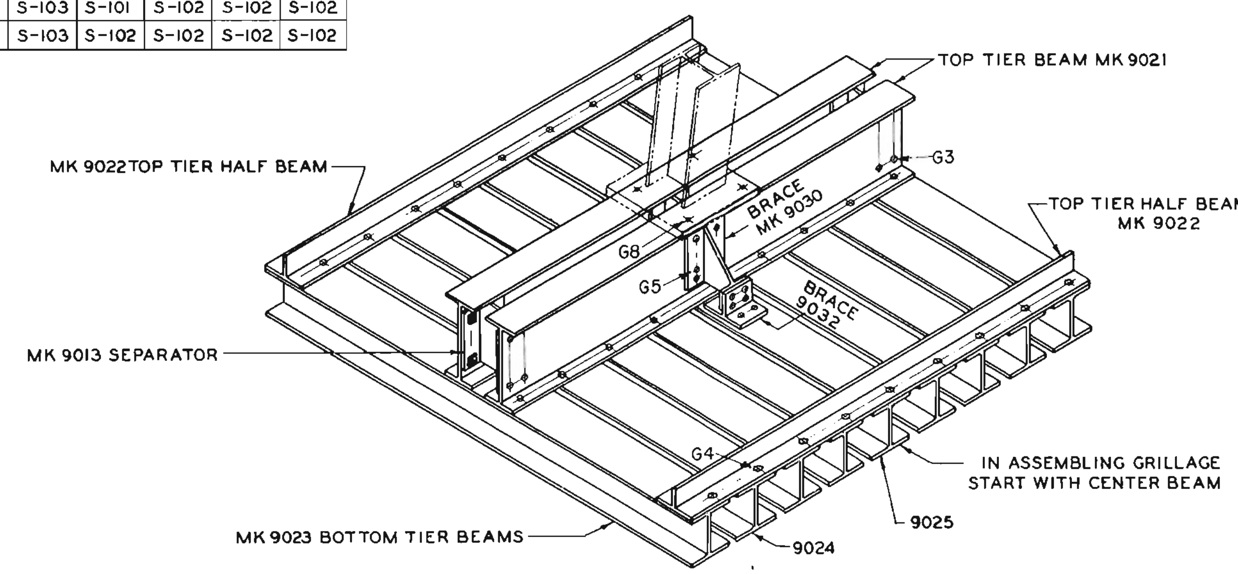
SPAN BETWEEN TOWERS	FOOTINGS ON SOIL — HEIGHT OF TOWER				FOOTINGS ON ROCK — HEIGHT OF TOWER			
	UP TO 21'	23' TO 39'	41' TO 50'	59' TO 77'	UP TO 21'	23' TO 39'	41' TO 59'	59' TO 77'
15' TO 25'	S-102	S-102	S-102	S-102	S-101	S-101	S-101	S-101
30'	S-102	S-102	S-102	S-103	S-101	S-101	S-101	S-102
35'	S-102	S-102	S-103	S-103	S-101	S-101	S-102	S-102
40'	S-102	S-103	S-103	S-103	S-101	S-102	S-102	S-102
45'	S-102	S-103	S-103	S-103	S-101	S-102	S-102	S-102
50'	S-103	S-103	S-103	S-103	S-102	S-102	S-102	S-102

COMPANION SHEETS

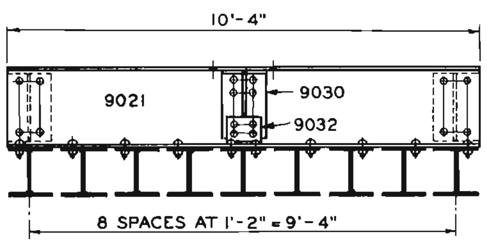
	SHEET
FRAMED STEEL TOWERS	184,185
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWING	221



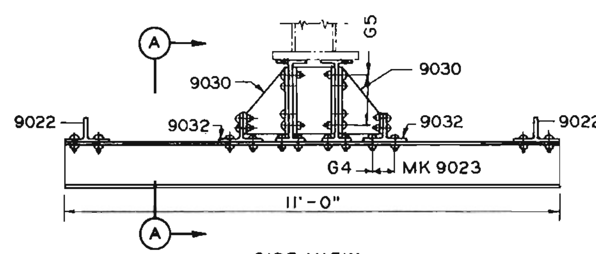
PLAN



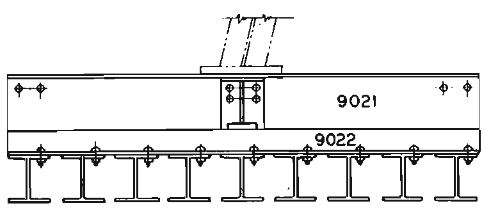
ASSEMBLED VIEW



SECTION A-A



SIDE VIEW



END VIEW

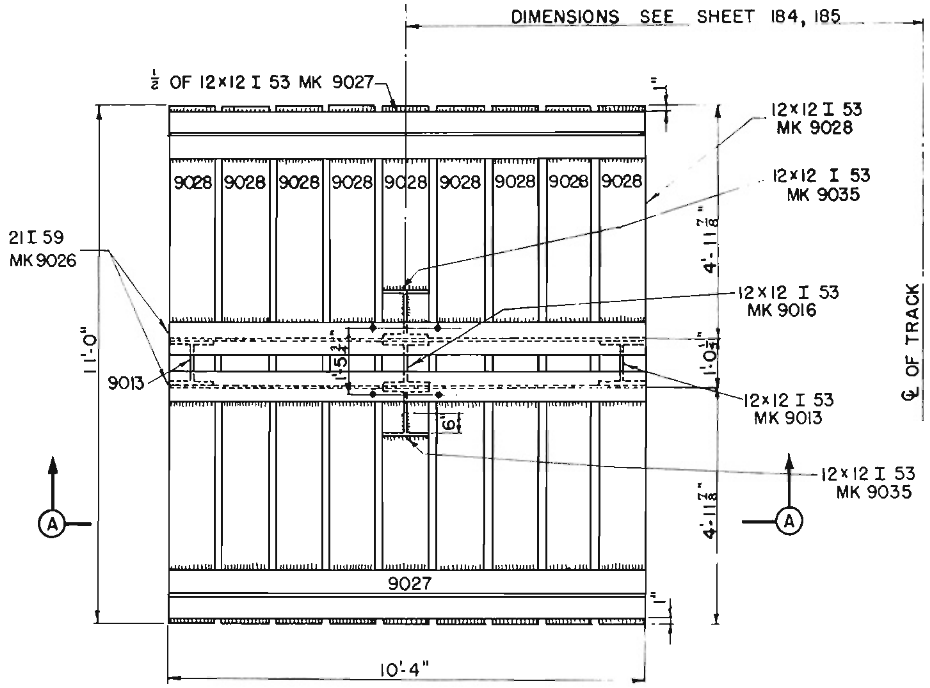
GRILLAGE FOOTING S-103

BILL OF MATERIALS FOR ONE GRILLAGE FOOTING S-103

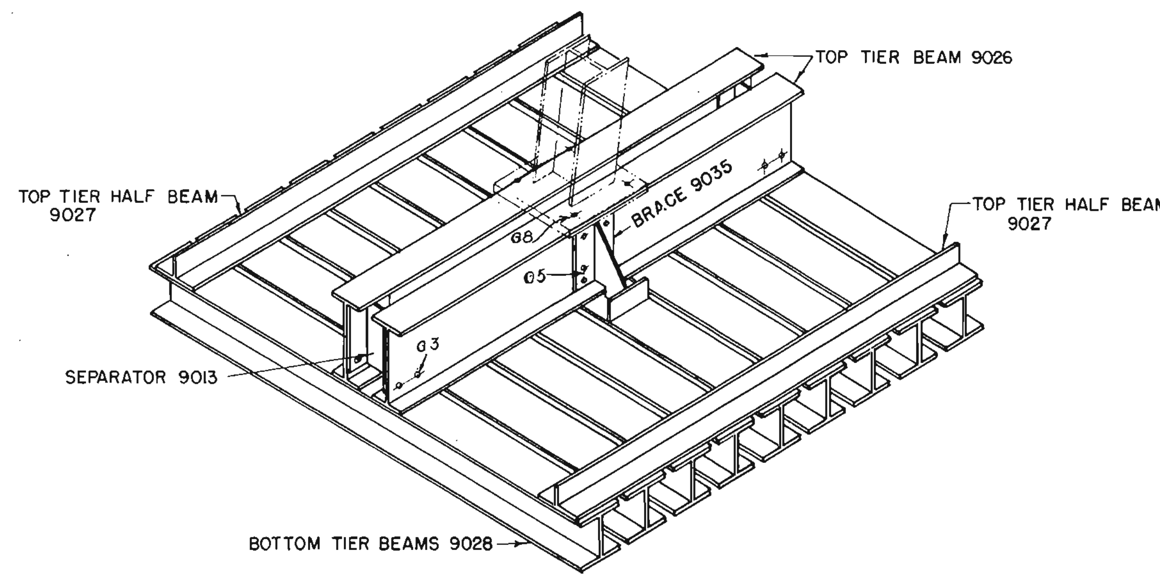
LINE	DESCRIPTION	STOCK NO	MARK	QUANTITY	SIZE	LENGTH	WEIGHT EACH
1	TOP TIER BEAM	48-2900.21-059	9021	2	21 I 59	10'-4"	610
2	TOP TIER HALF BEAM	48-6020.12-053	9022	2	$\frac{1}{2}$-12×12 I 53	10'-4"	274
3	BOTTOM TIER BEAM		9023	2	12×12 I 53	11'-0"	583
4	BOTTOM TIER BEAM		9024	6	12×12 I 53	11'-0"	583
5	BOTTOM TIER BEAM		9025	1	12×12 I 53	11'-0"	583
6	SEPARATOR		9013	2	12×12 I 53	1'-6"	80
7	SEPARATOR		9016	1	12×12 I 53	1'-6"	80
8	BRACE		9030	2	PC 12×12 I 53	1'-6"	53
9	BRACE	48-2900.21-059	9032	2	PC 21 I 59	0'-9"	22
10							
11							TOTAL WT LBS
12	RIVET BOLT		G3	60	$\frac{7}{8}$	$2\frac{1}{16}$"	56
13	RIVET BOLT		G4	32	$\frac{7}{8}$	$2\frac{1}{4}$"	31
14	RIVET BOLT		G5	16	$\frac{7}{8}$	$2\frac{7}{16}$"	16
15	RIVET BOLT AND WASHER		G8	4	$\frac{7}{8}$	3"	5

COMPANION SHEETS

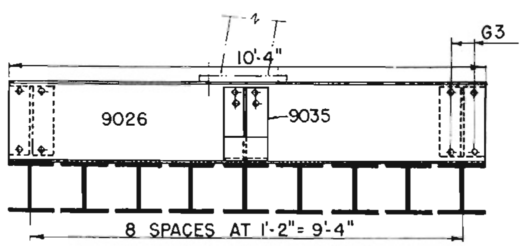
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FRAMED STEEL TOWERS	184
FRAMED STEEL TOWERS	185
FABRICATION DRAWING	221
STEEL GRILLAGE, BOLTED	219



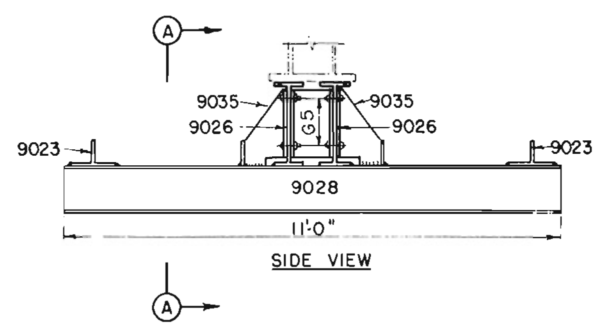
PLAN



ASSEMBLED VIEW

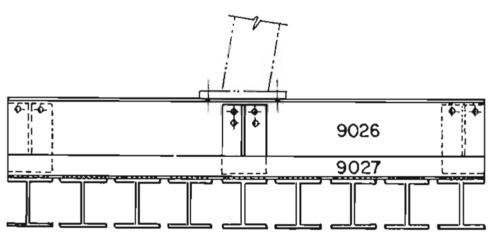


SECTION A-A



SIDE VIEW

ALL WELDS SHOWN ARE ¼" FILLET WELDS UNLESS OTHERWISE NOTED



END VIEW

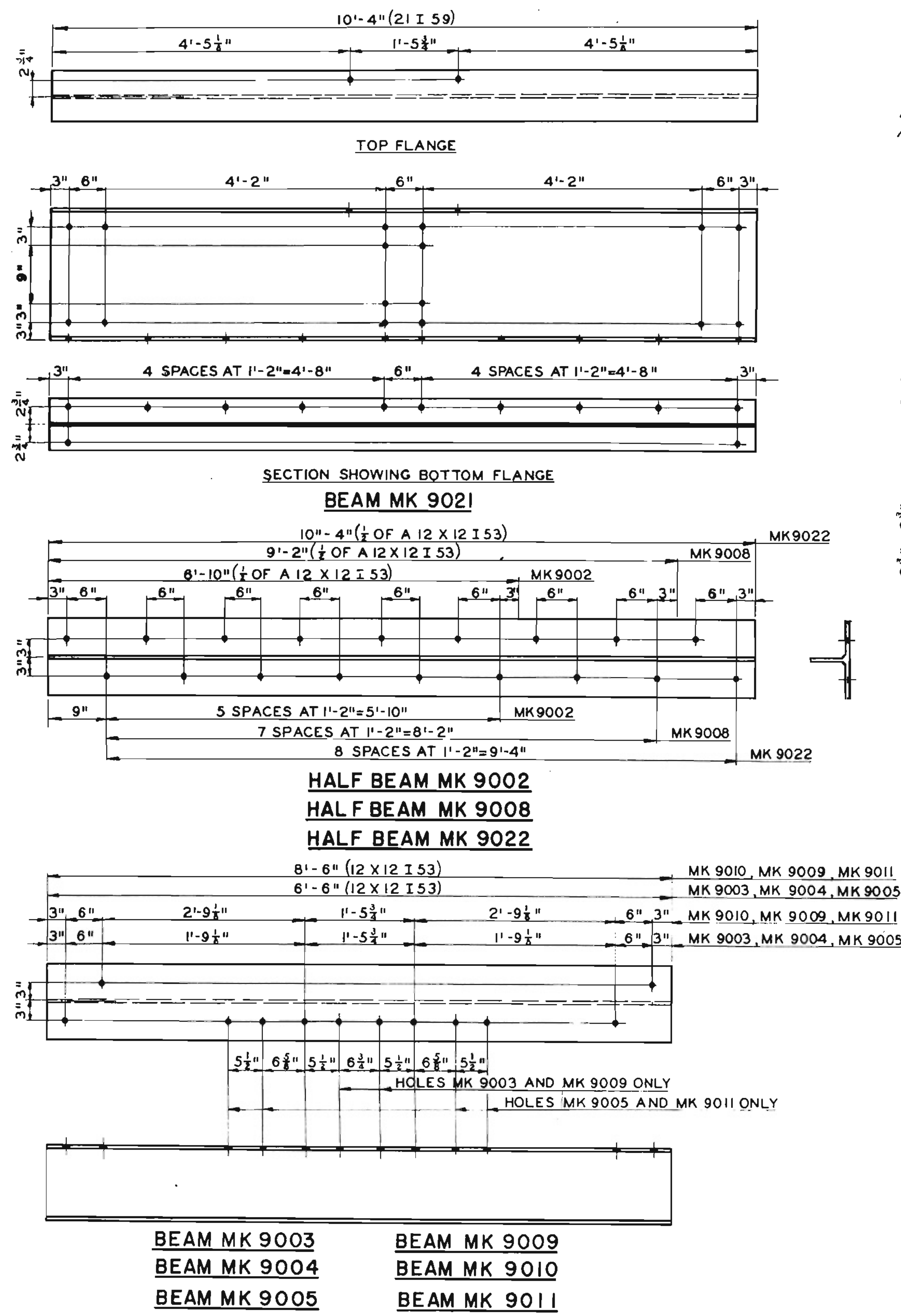
GRILLAGE FOOTING S103

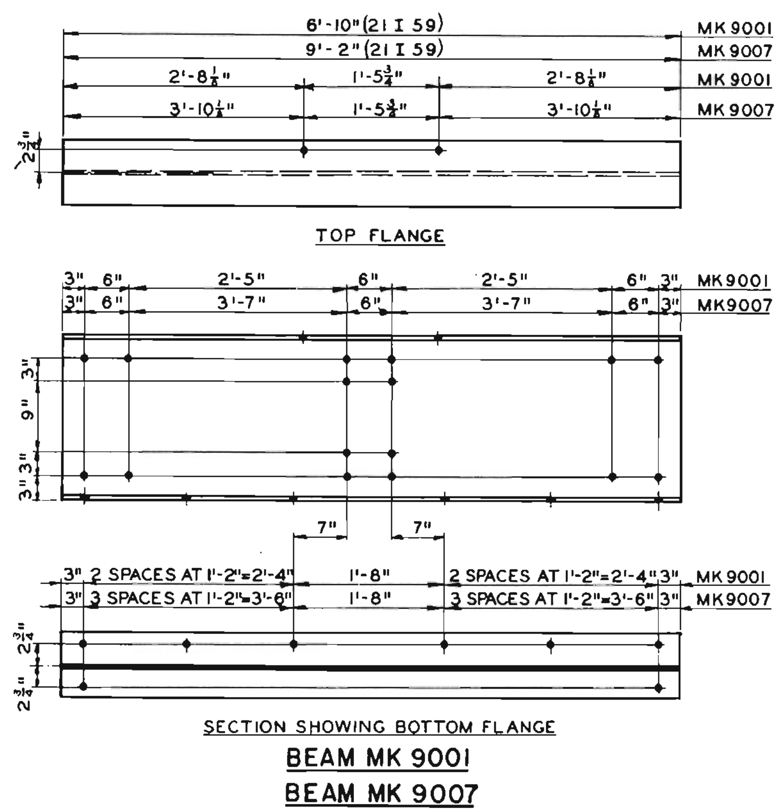
BILL OF MATERIALS FOR ONE GRILLAGE FOOTING S-103

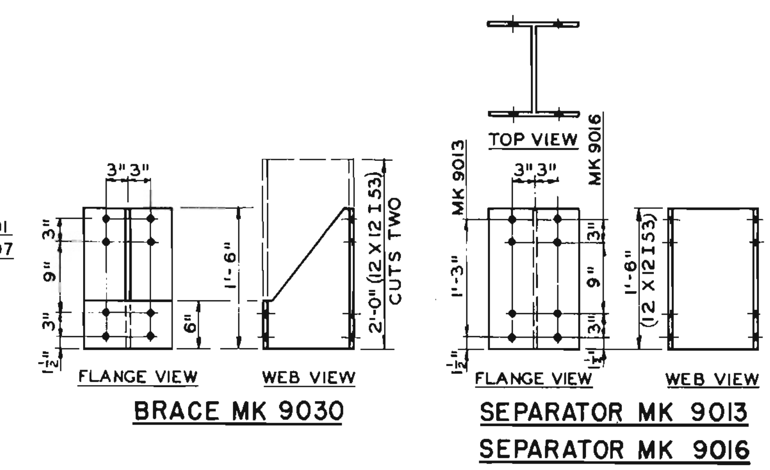
LINE	DESCRIPTION	STOCK NO	MARK	QUANTITY	SIZE	LENGTH	WEIGHT EACH
1	TOP TIER BEAM	48-2900.21-059	9026	2	21 I 59	10'-4"	610
2	TOP TIER HALF BEAM		9027	2	½-12×12 I 53	10'-4"	274
3	BOTTOM TIER BEAM		9028	9	12×12 I 53	11'-0"	583
4	SEPARATOR		9013	2	12×12 I 53	1'-6"	80
5	SEPARATOR		9016	1	12×12 I 53	1'-6"	80
6	BRACE		9035	2	12×12 I 53	1'-7½"	56
7							TOTAL WEIGHT
8							POUNDS
9	RIVET BOLT		G3	16	⅞	2 1/16"	15
10	RIVET BOLT		G5	16	⅞	2 1/16"	16
11	RIVET BOLT AND WASHER		G8	4	⅞	3"	5
12	WELDING ELECTRODE	46-3772.2-7			3/16		13

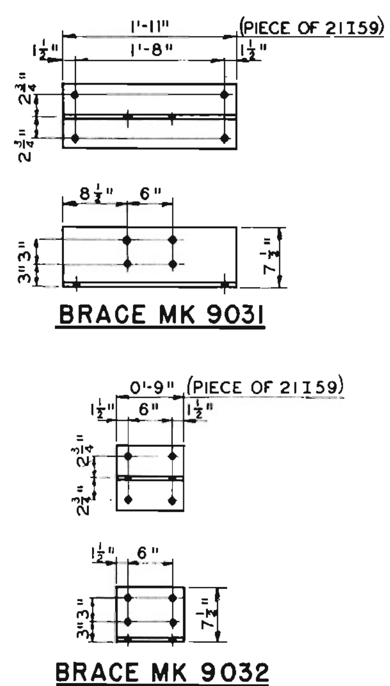
COMPANION SHEETS

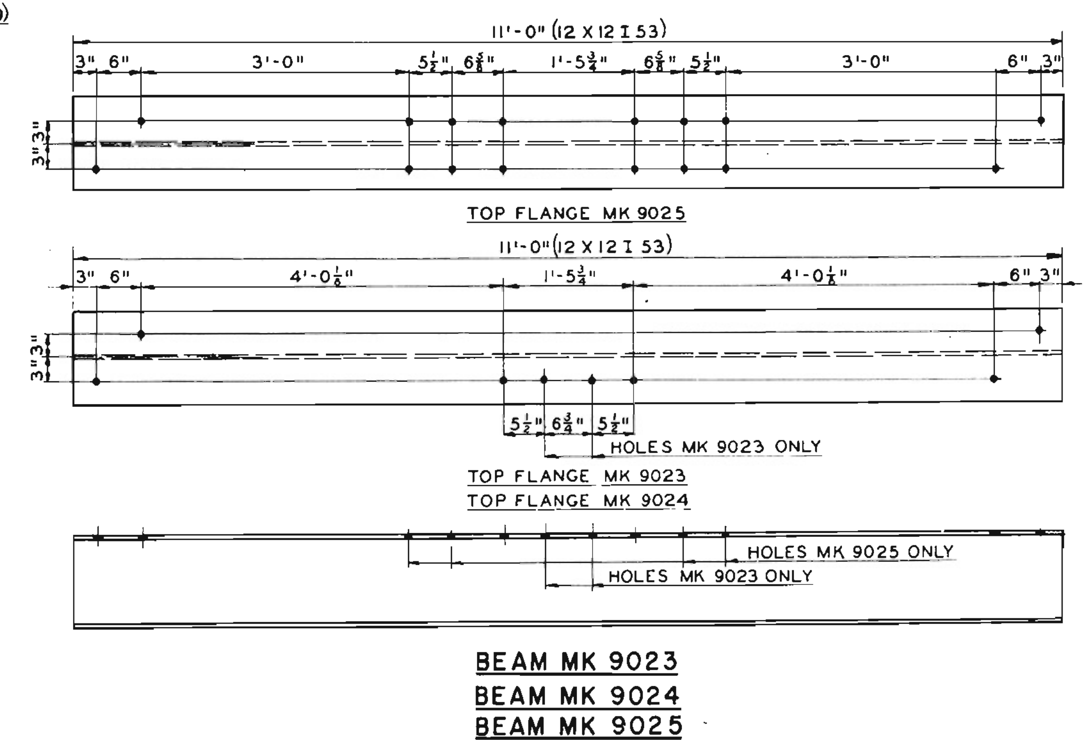
	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL GRILLAGE, BOLTED	219





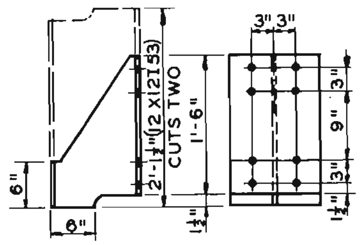




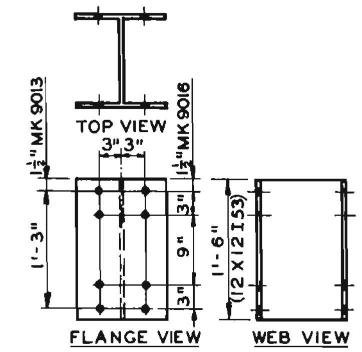


COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
STEEL GRILLAGES, WELDED	220

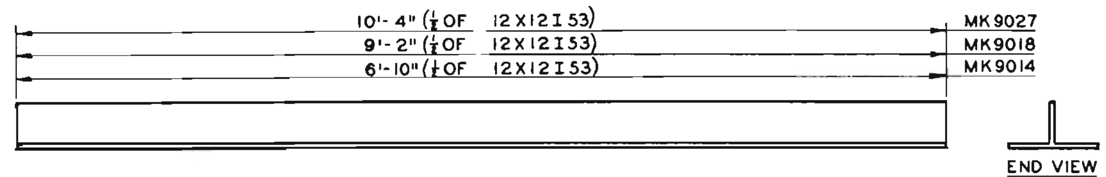


BRACE MK 9035



SEPARATOR MK 9013

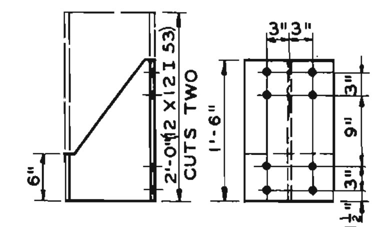
SEPARATOR MK 9016



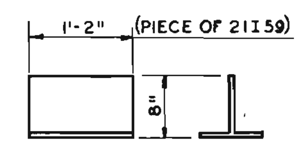
HALF BEAM MK 9014

HALF BEAM MK 9018

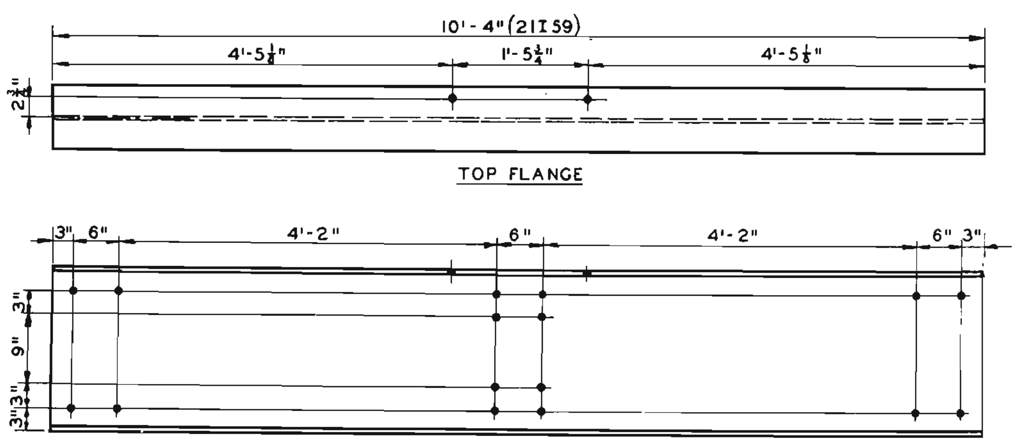
HALF BEAM MK 9027



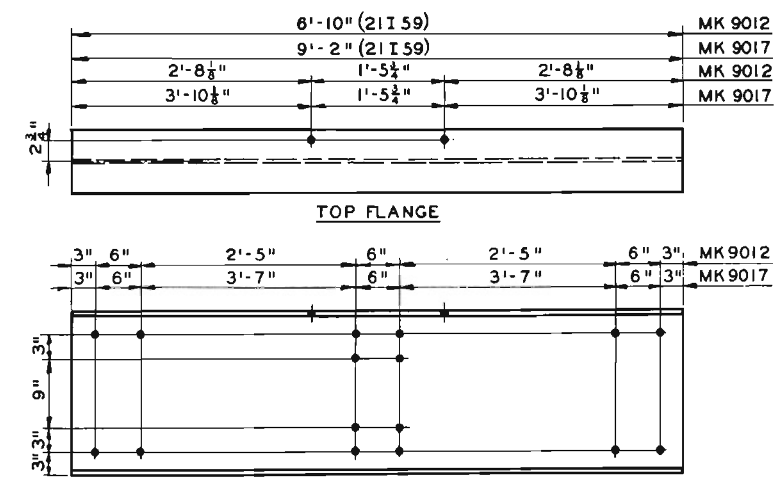
BRACE MK 9033



BRACE MK 9034



BEAM MK 9026

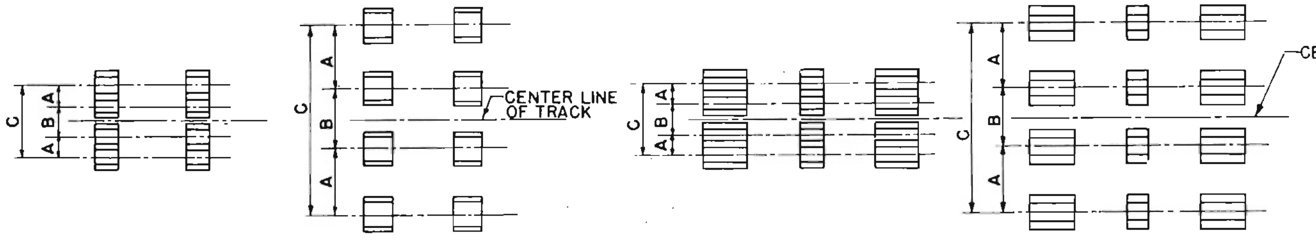


BEAM MK 9012

BEAM MK 9017

COMPANION SHEETS

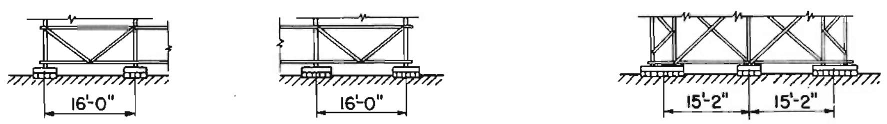
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIALS	224



TIMBER SPANS
FOR TOWER HEIGHTS UNDER 18' — FOR TOWERS 18' AND HIGHER

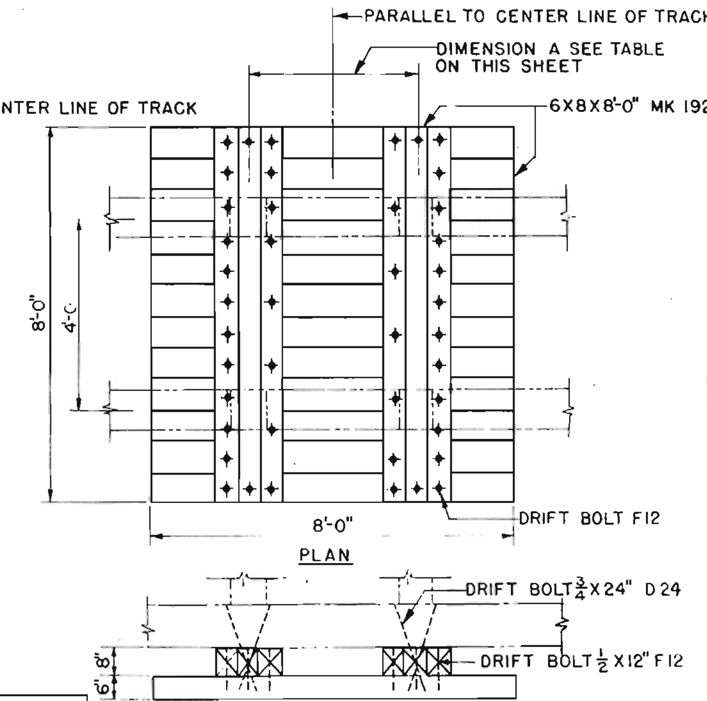
STEEL SPANS
FOR TOWER HEIGHTS UNDER 18' — FOR TOWERS 18' AND HIGHER

PLAN OF TIMBER GRILLAGE FOOTINGS

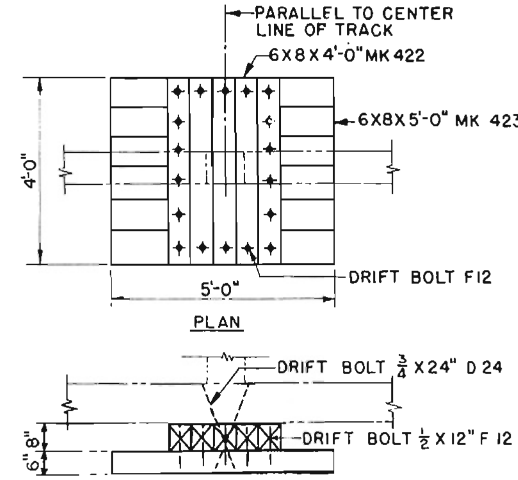


TIMBER SPANS — STEEL SPANS

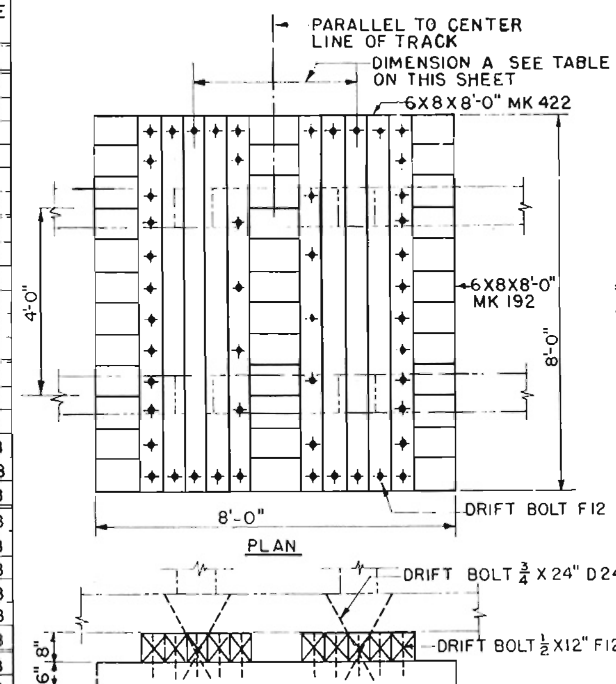
LONGITUDINAL ELEVATIONS



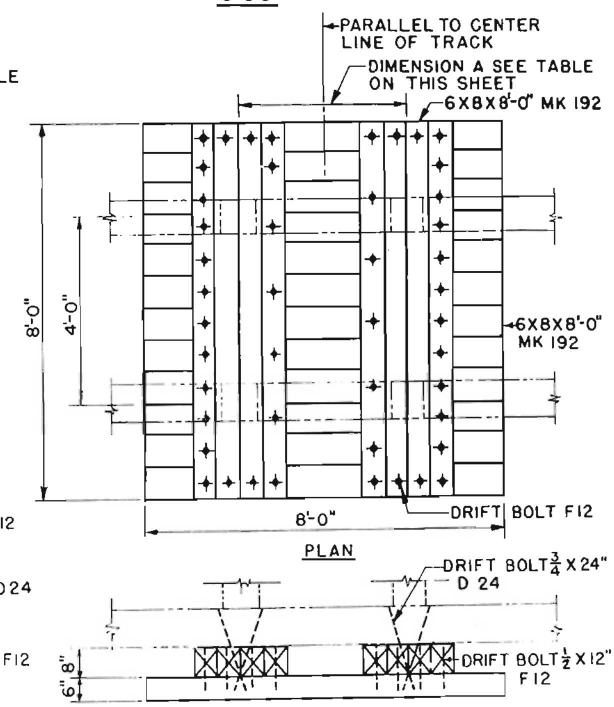
ELEVATION
G 96



ELEVATION
G 99



ELEVATION
G 98

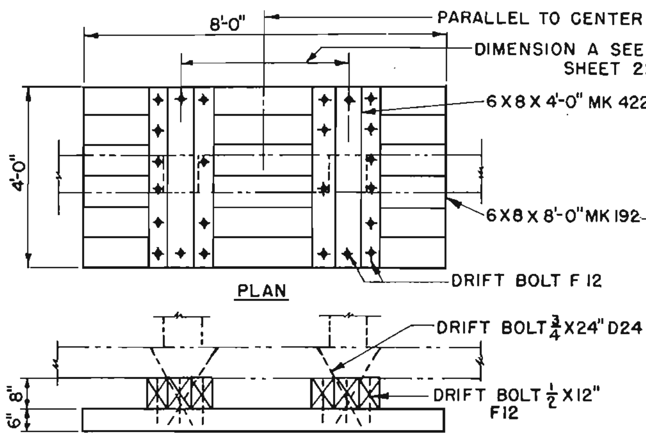


ELEVATION
G 97

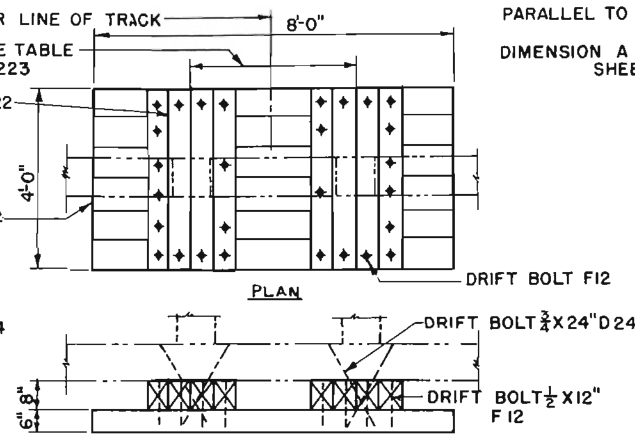
TIMBER GRILLAGE FOOTINGS

STORIES	TOWER HEIGHT	A	B	C	TIMBER SPANS	STEEL SPANS 50'		45'		40'		35'		30'		25'		20'	
					FOOTING MARK														
					ALL FOOTINGS	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT	DOUBLE BENT	SINGLE BENT
1	13'-4"	3'-5 1/2"	4'-11 3/4"	11'-10 3/4"	G-94	G-98	G-95	G-98	G-95	G-98	G-95	G-97	G-94	G-97	G-94	G-97	G-94	G-96	G-93
2	16'	3'-9 1/2"	5'-2"	12'-9"	G-94	G-98	G-95	G-98	G-95	G-98	G-95	G-97	G-94	G-97	G-94	G-97	G-94	G-96	G-93
	18'	4'-0 1/2"	5'-4"	13'-5"	G-110	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	20'	4'-3 1/2"	5'-6"	14'-1"	G-110	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	22'	4'-6 1/2"	5'-8"	14'-9"	G-110	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	24'	4'-9 1/2"	5'-10"	15'-5"	G-110	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	25'-10"	5'-0 1/4"	6'-0 1/4"	16'-0 3/4"	G-110	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
3	28'	5'-3 1/2"	6'-2"	16'-9"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	30'	5'-6 1/2"	6'-4"	17'-5"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	32'	5'-9 1/2"	6'-6"	18'-1"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	34'	6'-0 1/2"	6'-8"	18'-9"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	36'	6'-3 1/2"	6'-10"	19'-5"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	38'-4"	6'-7"	7'-0 3/4"	20'-2 3/4"	G-99	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
4	40'	6'-9 1/2"	7'-2"	20'-9"	G-102	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	42'	7'-0 1/2"	7'-4"	21'-5"	G-102	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	44'	7'-3 1/2"	7'-6"	22'-1"	G-102	G-107	G-108	G-107	G-108	G-109	G-110	G-109	G-110	G-109	G-110	G-111	G-112	G-111	G-112
	46'	7'-6 1/2"	7'-8"	22'-9"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	48'	7'-9 1/2"	7'-10"	23'-5"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	50'-10"	8'-1 3/4"	2'-7 1/4"	24'-4 3/4"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
5	53'	8'-5"	8'-3"	25'-1"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	55'	8'-8"	8'-5"	25'-9"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	57'	8'-11"	8'-7"	26'-5"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	59'	9'-2"	8'-9"	27'-1"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	61'	9'-5"	8'-11"	27'-9"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	63'-4"	9'-8 1/2"	9'-1 3/4"	28'-6 3/4"	G-102	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
6	65'	9'-11"	9'-3"	29'-1"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	67'	10'-2"	9'-5"	29'-9"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	69'	10'-5"	9'-7"	30'-5"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	71'	10'-8"	9'-9"	31'-1"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	73'	10'-11"	9'-11"	31'-9"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108
	75'-10"	11'-3 1/4"	10'-2 1/4"	32'-8 3/4"	G-101	G-103	G-104	G-103	G-104	G-103	G-104	G-105	G-106	G-105	G-106	G-107	G-108	G-107	G-108

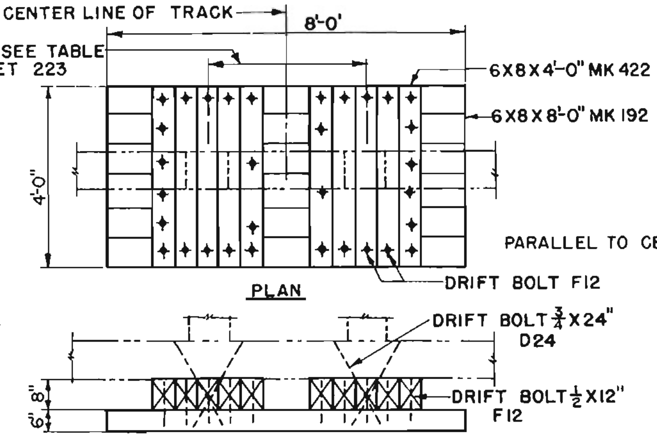
TIMBER GRILLAGE FOUNDATIONS, TIMBER TOWERS



G 93



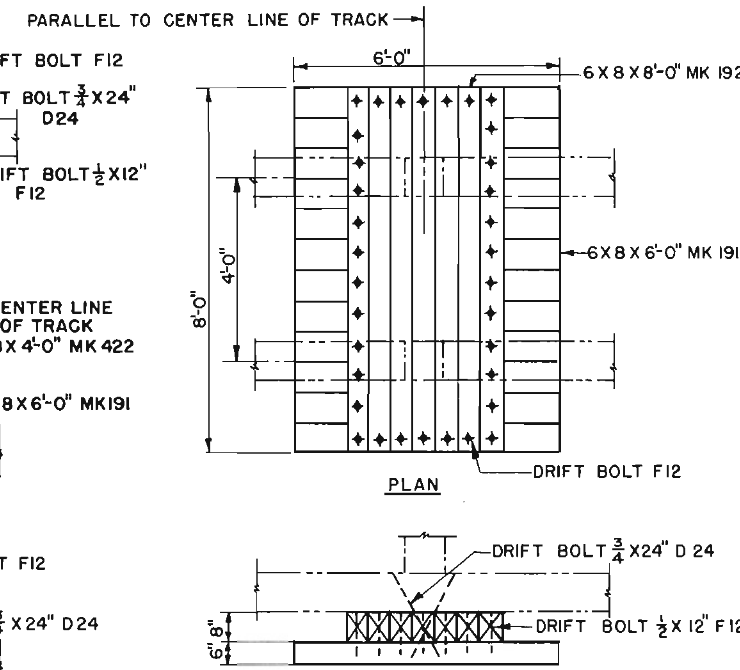
G 94



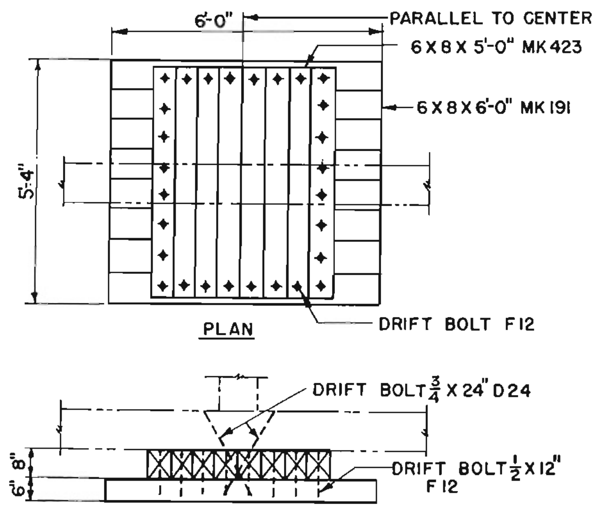
G 95

COMPANION SHEETS

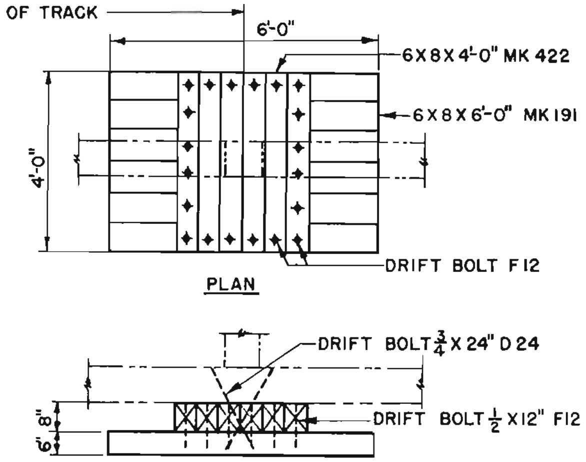
	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER GRILLAGE	223



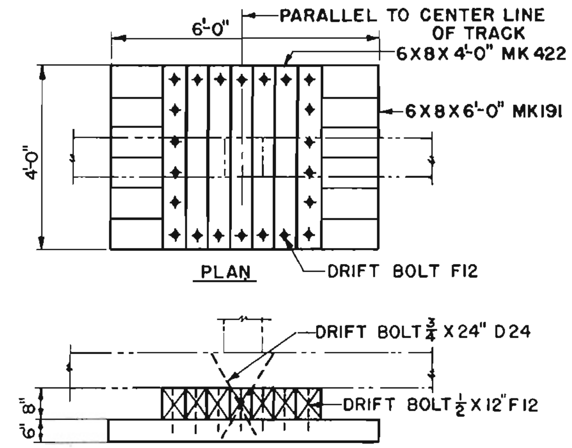
G 103



G 101



G 102



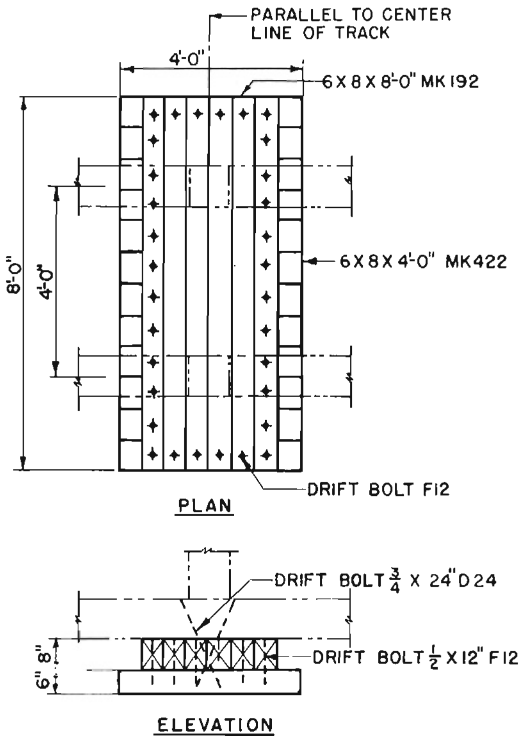
G 104

BILL OF MATERIALS FOR ONE TIMBER GRILLAGE

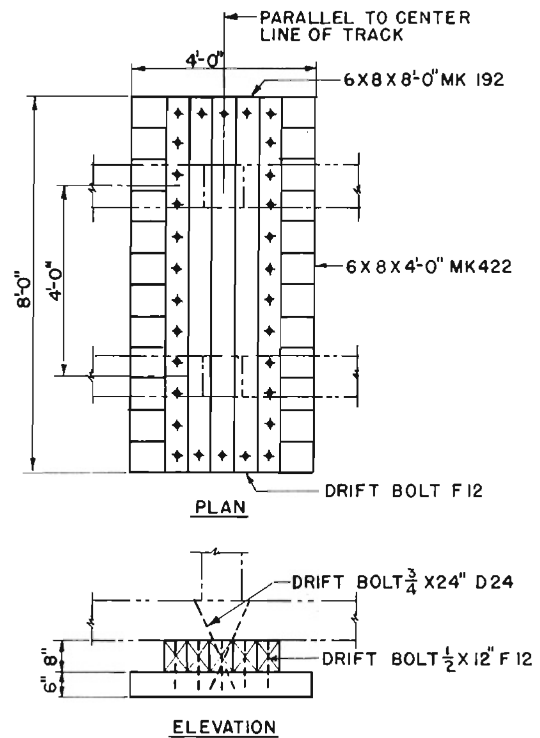
	GRILLAGE NUMBER						G93		G94		G95		G96		G97		G98		G99		G101		G102		G103		
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	QUANTITY	FBM	LINE
	LUMBER, SOFT WOOD																										
1	GRILLAGE	39-9352.68	192	6 X 8	8'-0"	120	6	192	6	192	6	192	18	576	20	640	22	704							7	222	1
2	DO	39-9352.68	191	6 X 8	6'-0"	90															8	192	6	144	12	288	2
3	DO	39-9352.68	423	6 X 8	5'-0"	75													6	120	8	160					3
4	DO	39-9352.58	422	5 X 8	4'-0"	60	6	96	8	128	10	160							5	80			6	96			4
	STEEL HARDWARE, BLACK																										
5	DRIFT BOLT	43-1636.07-24	D24	3/4	24"	3.15	4		4		4		8		8		8		2		2		2		4		5
6	DO	43-1636.05-12	F12	1/2	12"	1.65	24		28		32		42		46		50		18		28		20		34		6
	GRILLAGE NUMBER						G104		G105		G106		G107		G108		G109		G110		G111		G112				
	LUMBER, SOFT WOOD																										
7	GRILLAGE	39-9352.68	192	6 X 8	8'-0"	120			6	192			5	160			4	128			3	96					7
8	DO	39-9352.68	191	6 X 8	6'-0"	90	6	144																			8
9	DO	39-9352.68	422	6 X 8	4'-0"	60	7	112	12	192	12	192	12	192	11	176	12	192	10	160	12	192	9	144			9
	STEEL HARDWARE, BLACK																										
10	DRIFT BOLT	43-1636.07-24	D24	3/4	24"	3.15	2		4		2		4		2		4		2		4		2				10
11	DO	43-1636.05-12	F12	1/2	12"	1.65	22		32		20		30		18		28		16		26		14				11

COMPANION SHEETS

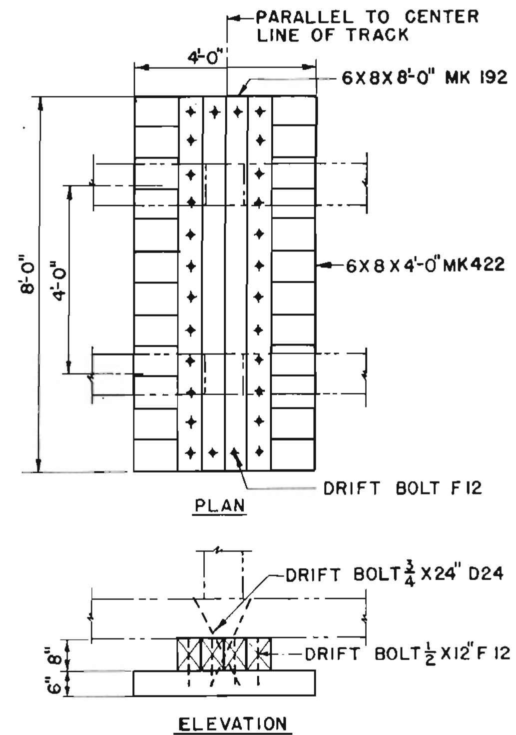
	SHEET
GENERAL NOTES	154
SYMBOLS	155
BILL OF MATERIAL	224
TIMBER GRILLAGE	223



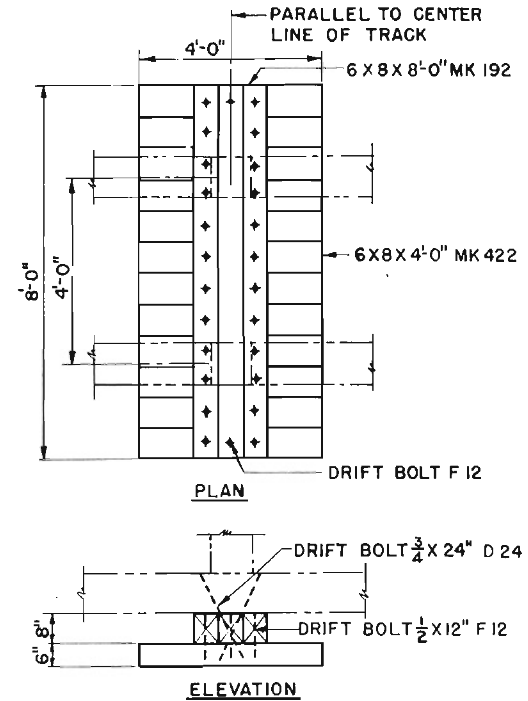
G 105



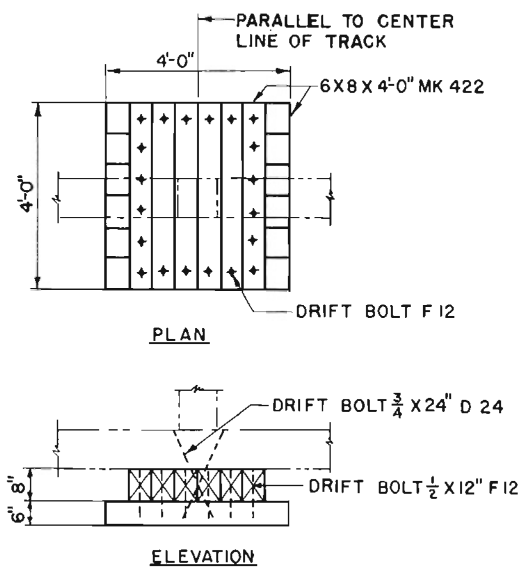
G 107



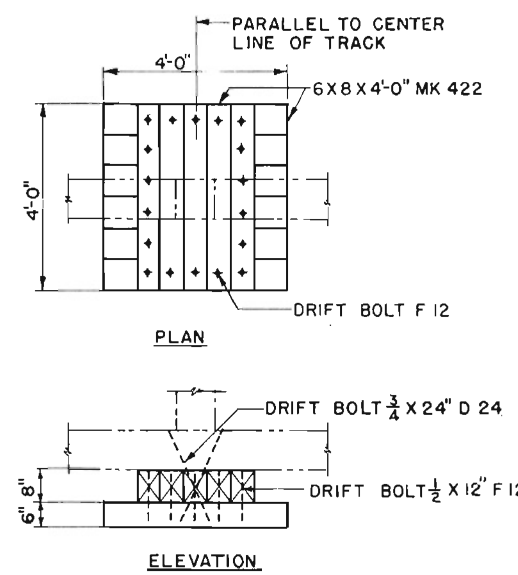
G 109



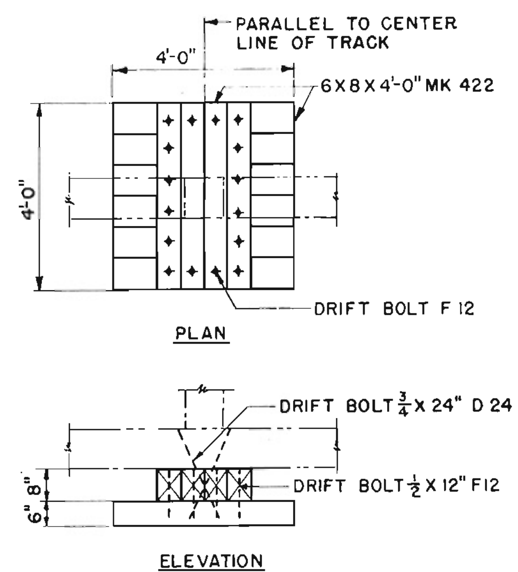
G 111



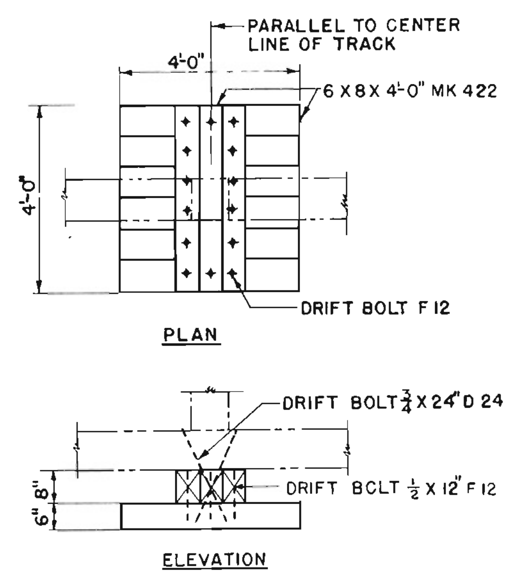
G 106



G 108



G 110

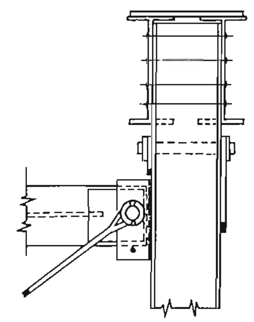


G 112

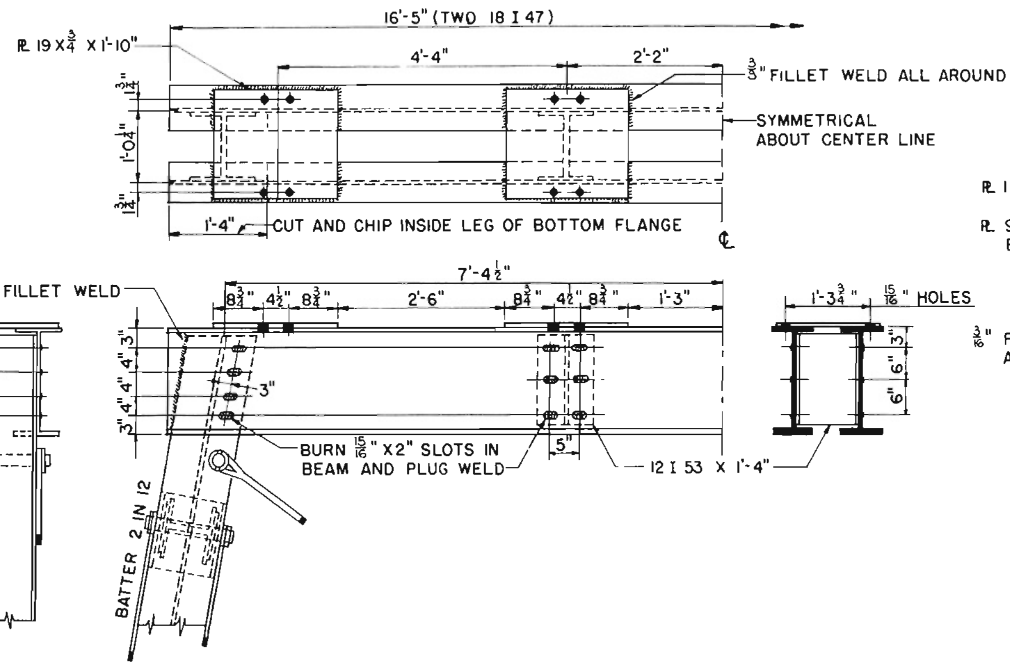
WELDED CONSTRUCTION WITH ROD BRACING, CAP BEAMS AND COLUMN SPLICE WELDED IN FABRICATION AND ERECTION

COMPANION SHEETS

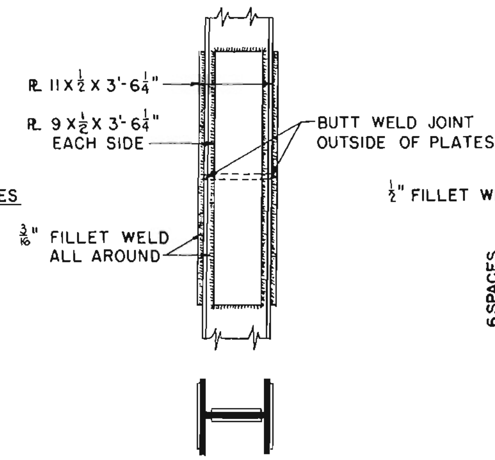
	SHEET
GENERAL NOTES	154
SYMBOLS	155



TYPICAL SIDE VIEW

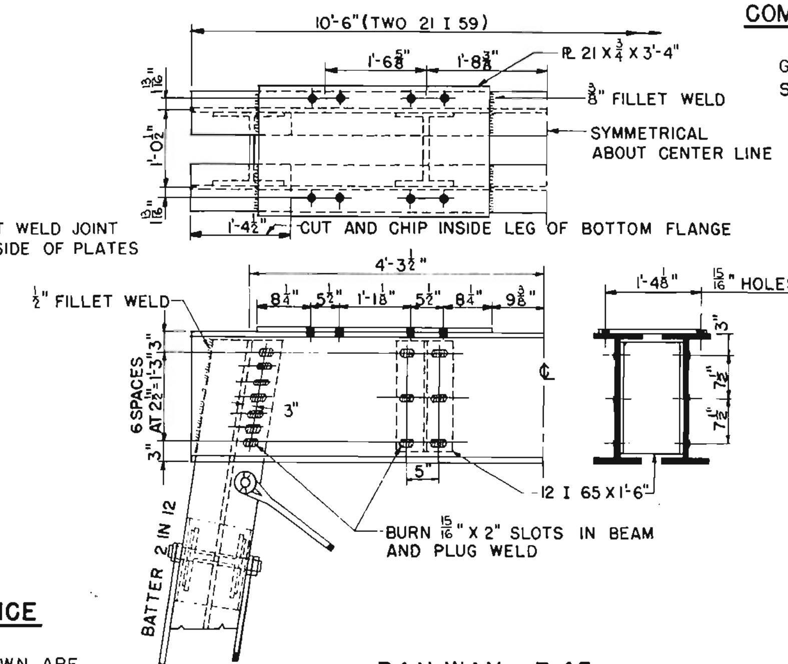


SINGLE-LANE HIGHWAY CLASS 50

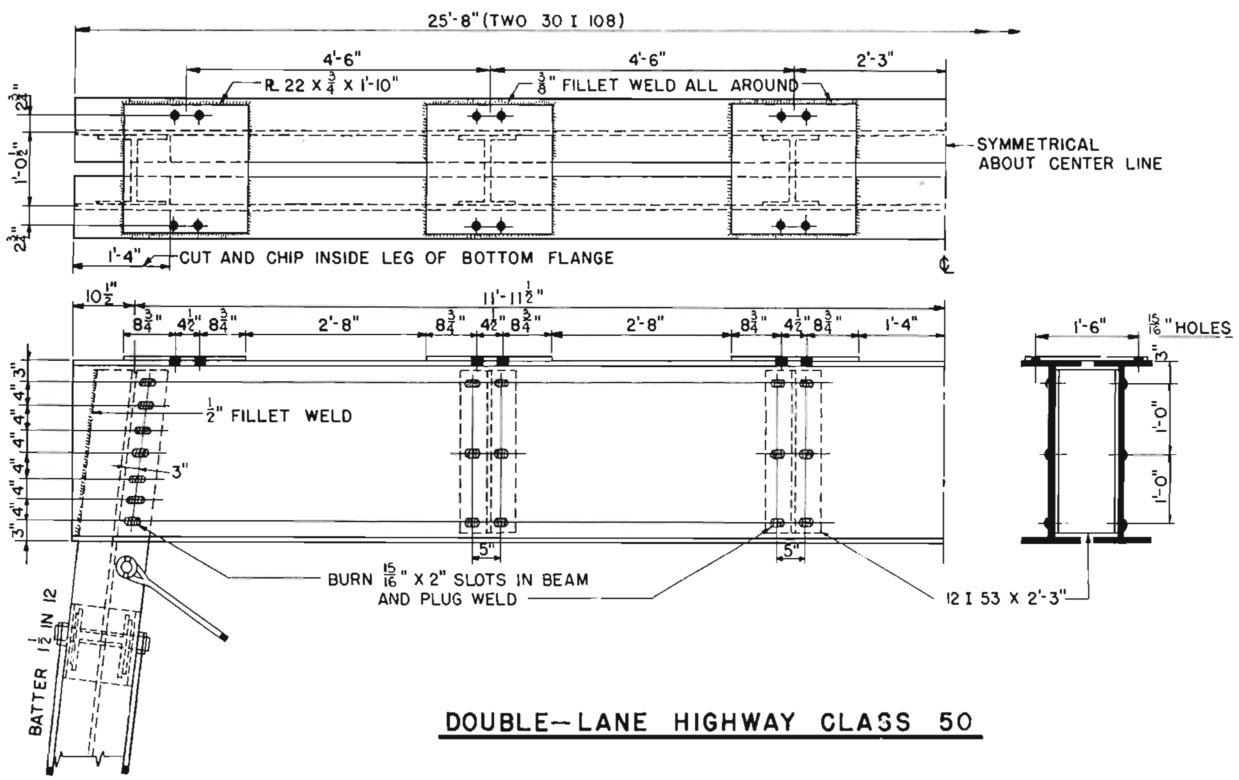


TYPICAL COLUMN SPLICE

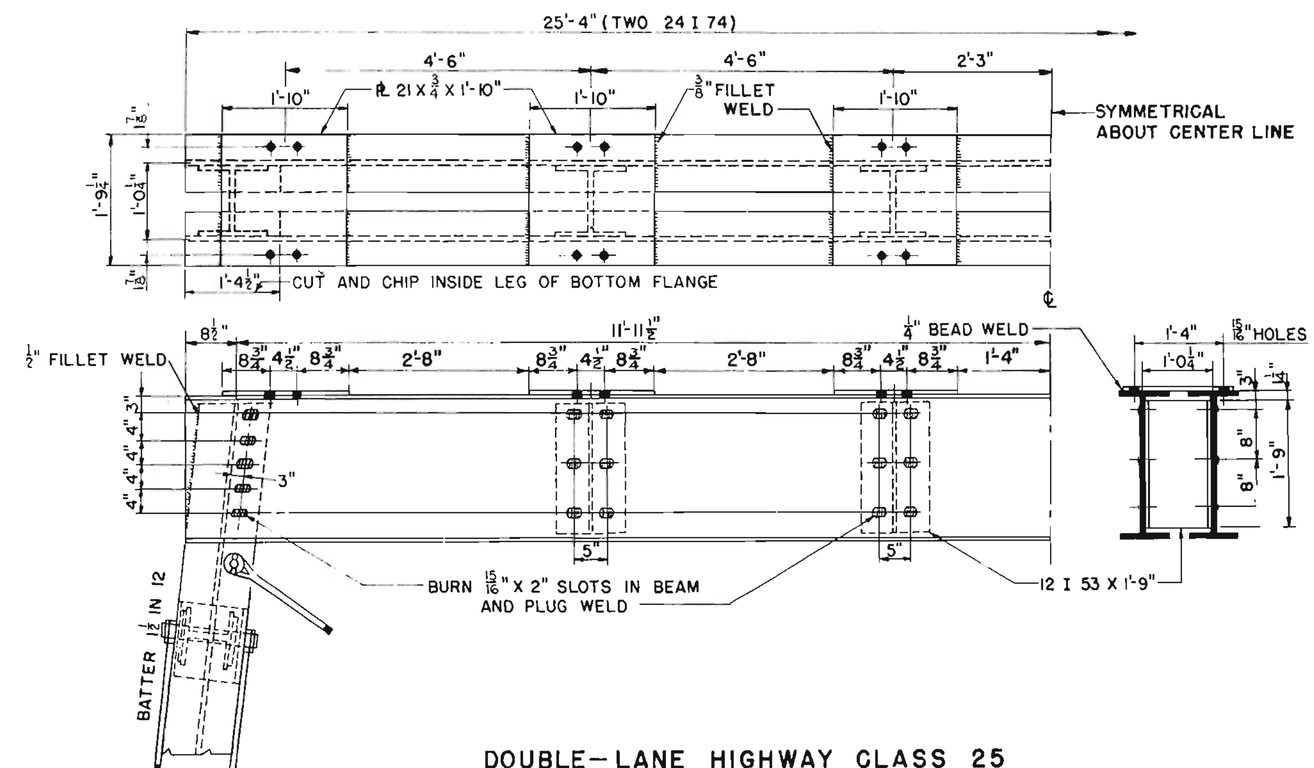
DETAIL OF COLUMNS NOT SHOWN ARE SAME AS COLUMNS FOR RIVETED DESIGN



RAILWAY E-45



DOUBLE-LANE HIGHWAY CLASS 50

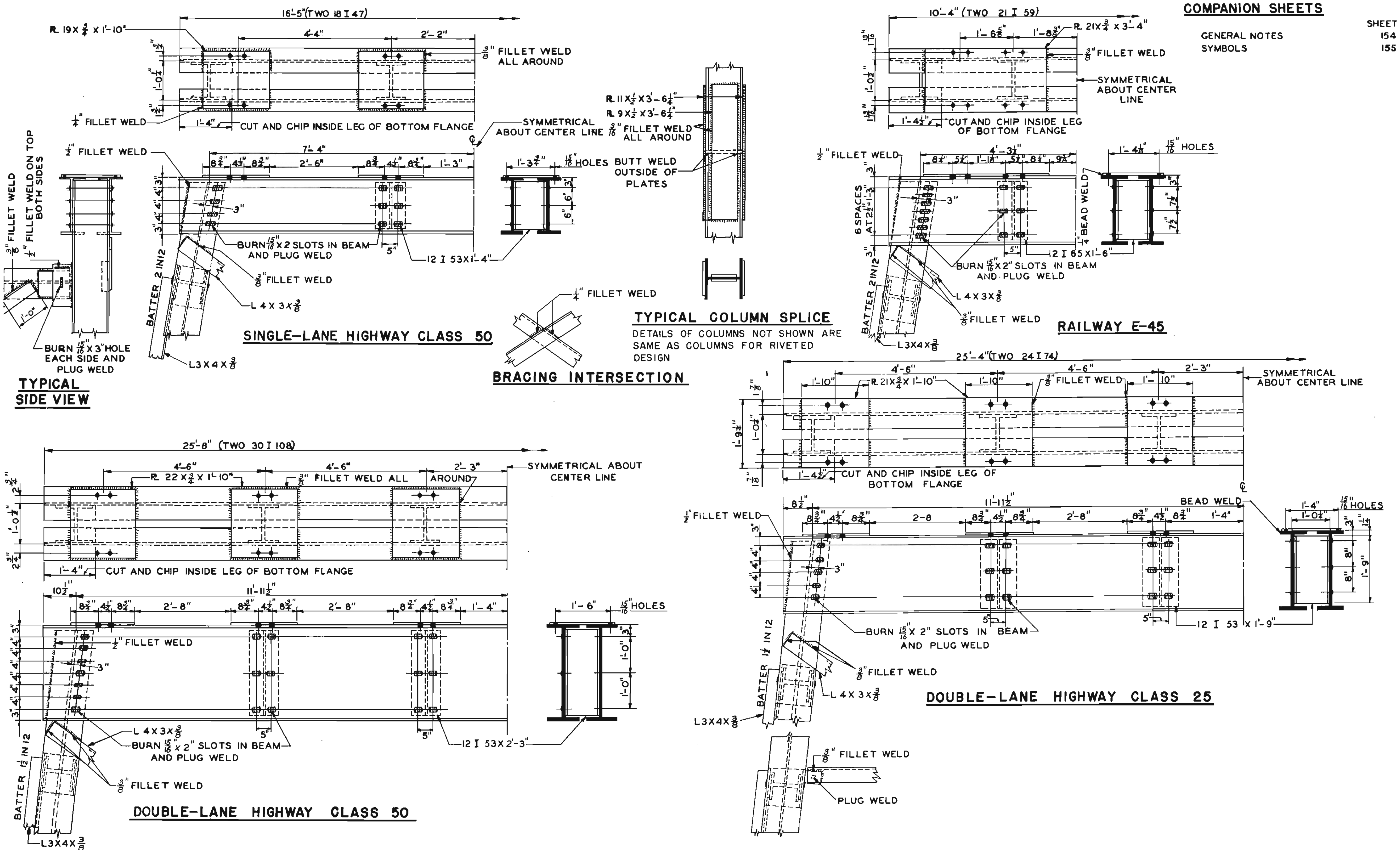


DOUBLE-LANE HIGHWAY CLASS 25

920303 O - 50 - 42

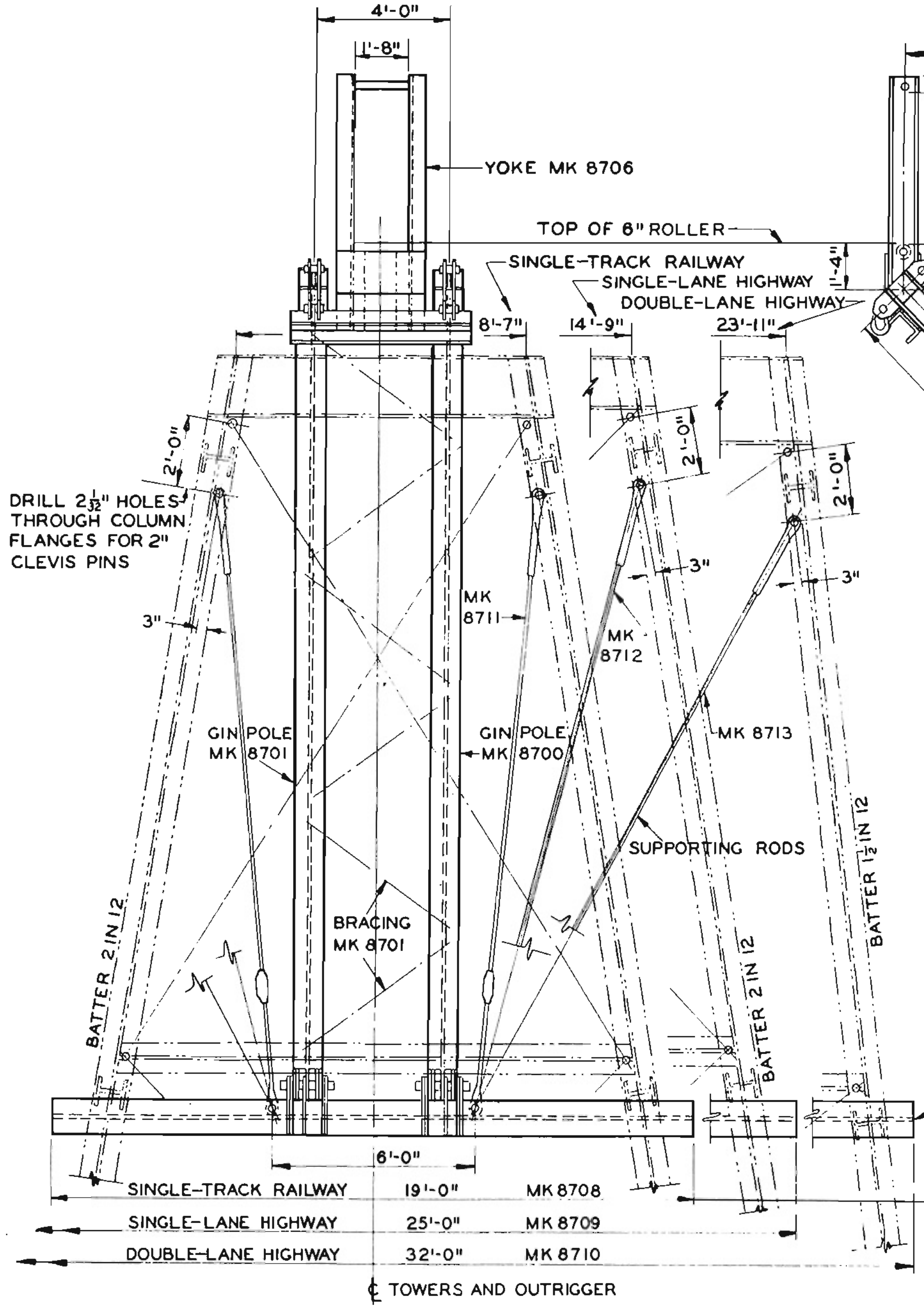
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155

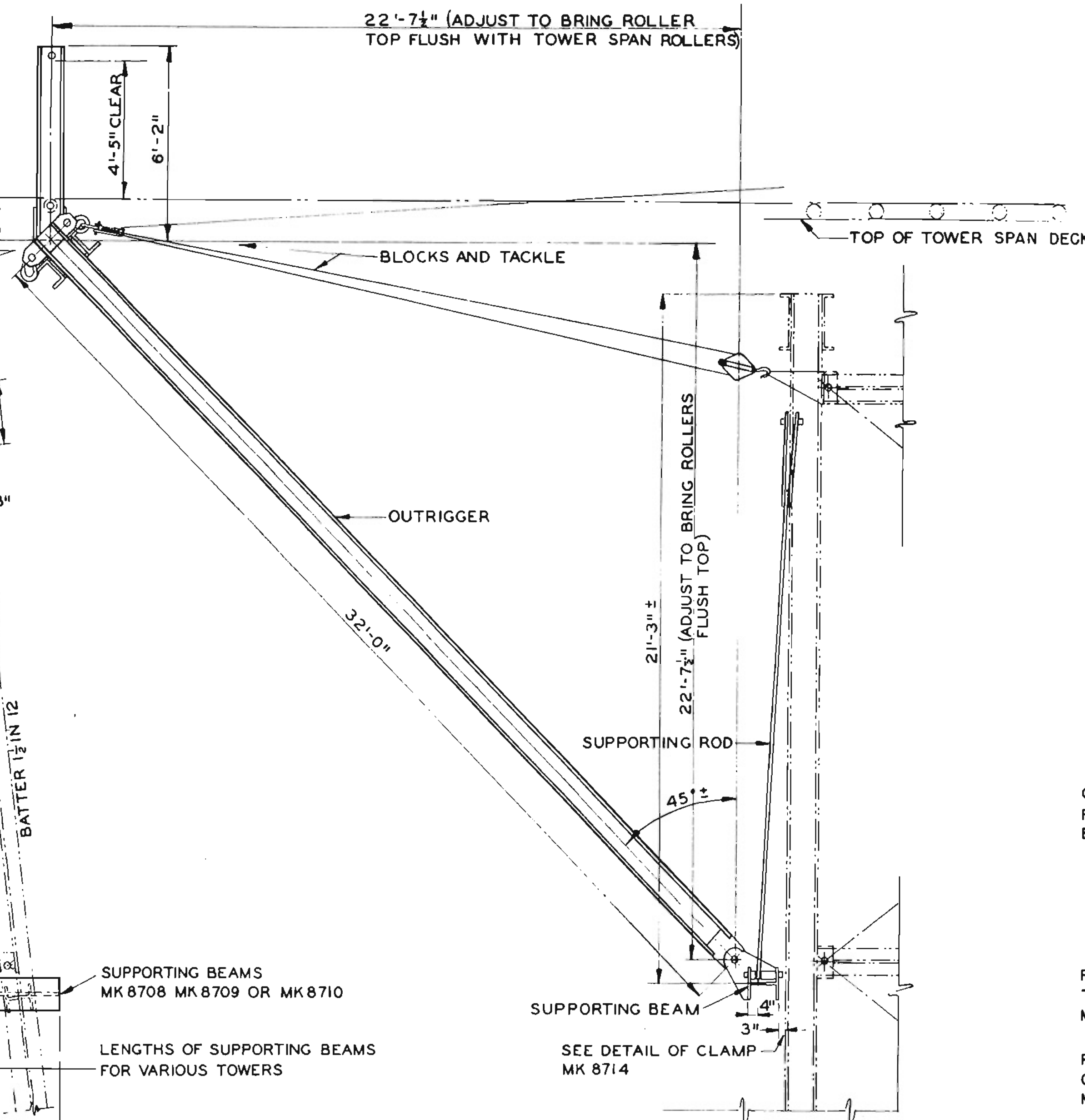


COMPANION SHEETS

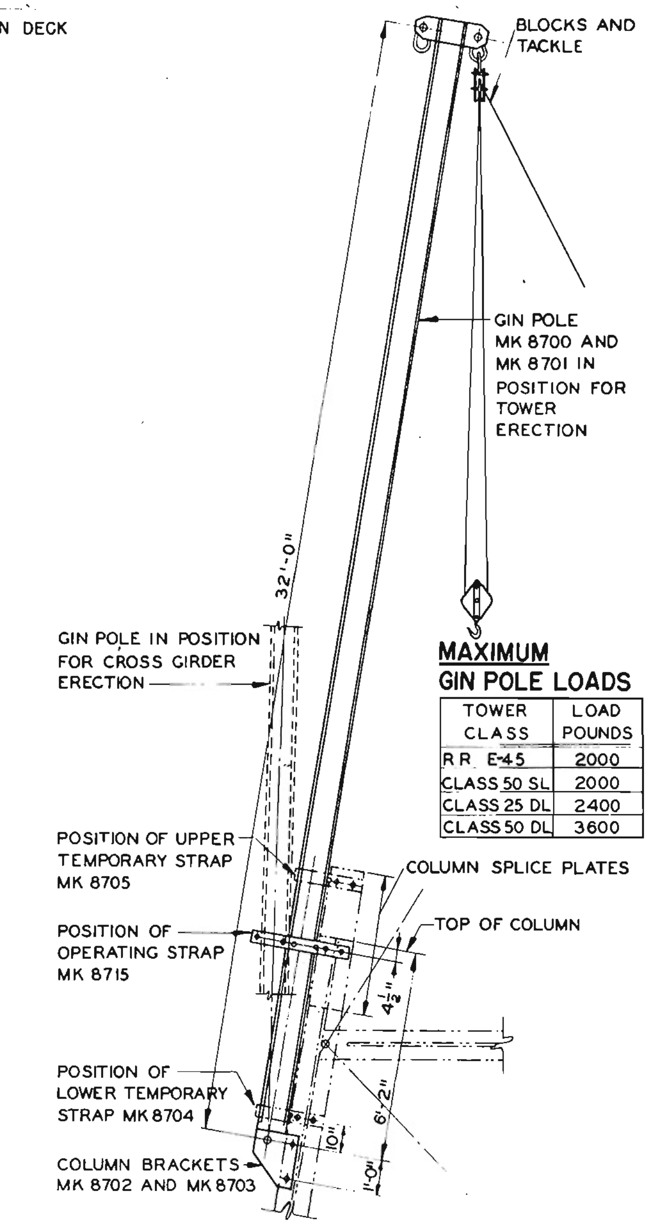
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWINGS	229,230
BILL OF MATERIALS	231



OUTRIGGER FRONT ELEVATION



OUTRIGGER SIDE ELEVATION



GIN POLE SIDE ELEVATION

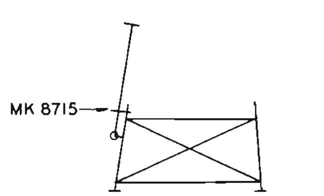
MAXIMUM GIN POLE LOADS

TOWER CLASS	LOAD POUNDS
R.R. E-45	2000
CLASS 50 SL	2000
CLASS 25 DL	2400
CLASS 50 DL	3600

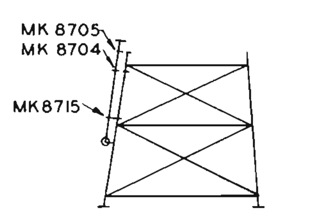
MAXIMUM OUTRIGGER LOAD LINE PULL, POUNDS

STRINGER	SPAN LENGTH					
	[1]45'	[1]50'	60'	70'	80'	90'
R.R. E-45	8000	6400				
CLASS 50-S.L.		5300	3300	4600	6800	10,300
CLASS 25-D.L.		4900	3100	4400	6400	9,600
CLASS 50-D.L.		6000	3500	5200	8100	13,100

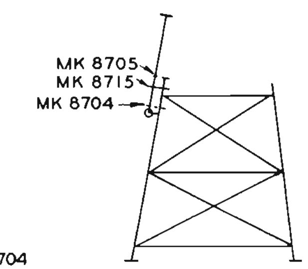
[1] USING OUTRIGGER AT ONLY ONE TOWER



GIN POLE IN POSITION TO ERECT SECOND STORY



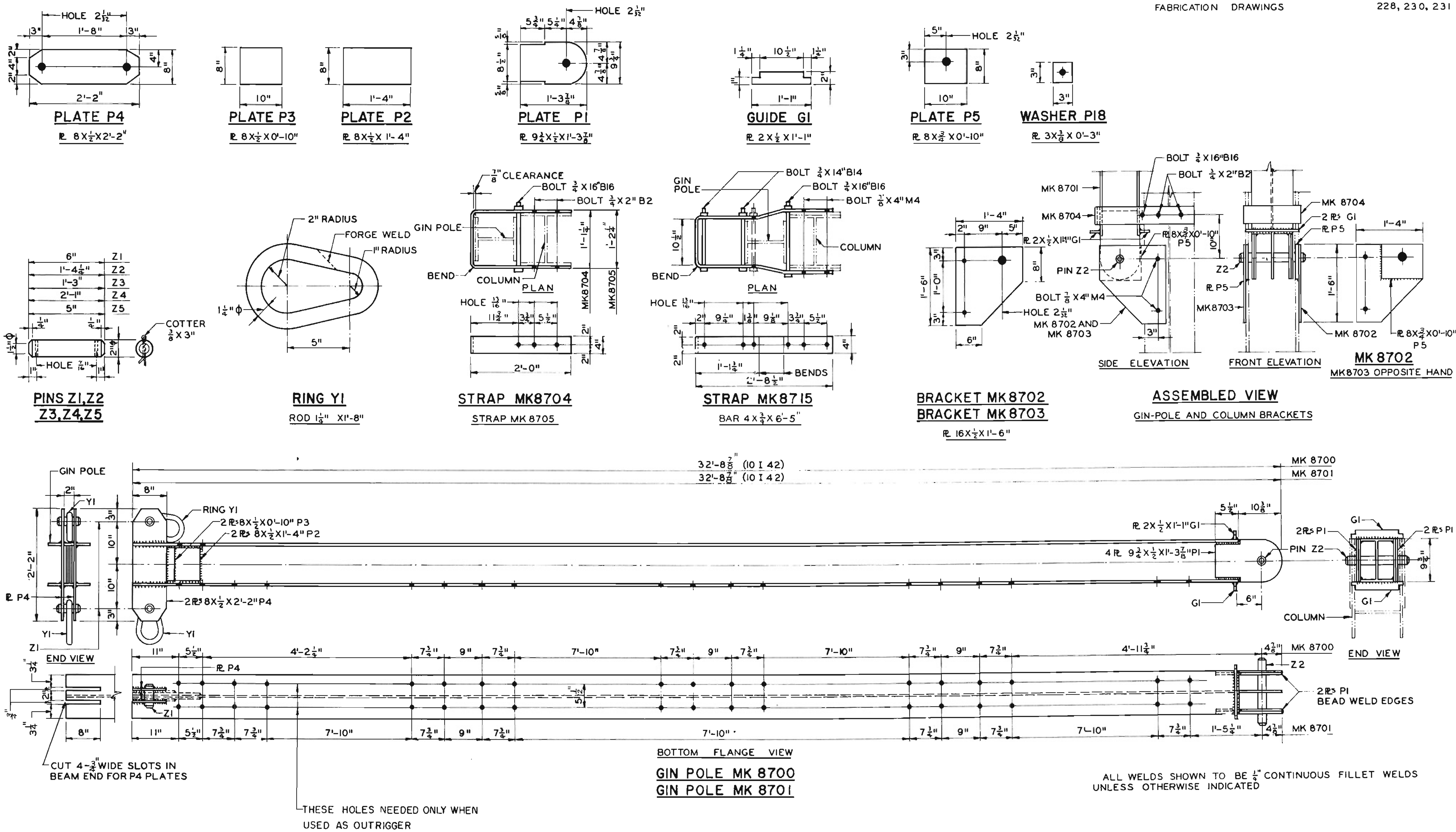
TEMPORARY STRAPS MK 8704 AND MK 8705 IN POSITION FOR RAISING GIN POLE



GIN POLE IN POSITION TO ERECT THIRD STORY

COMPANION SHEETS

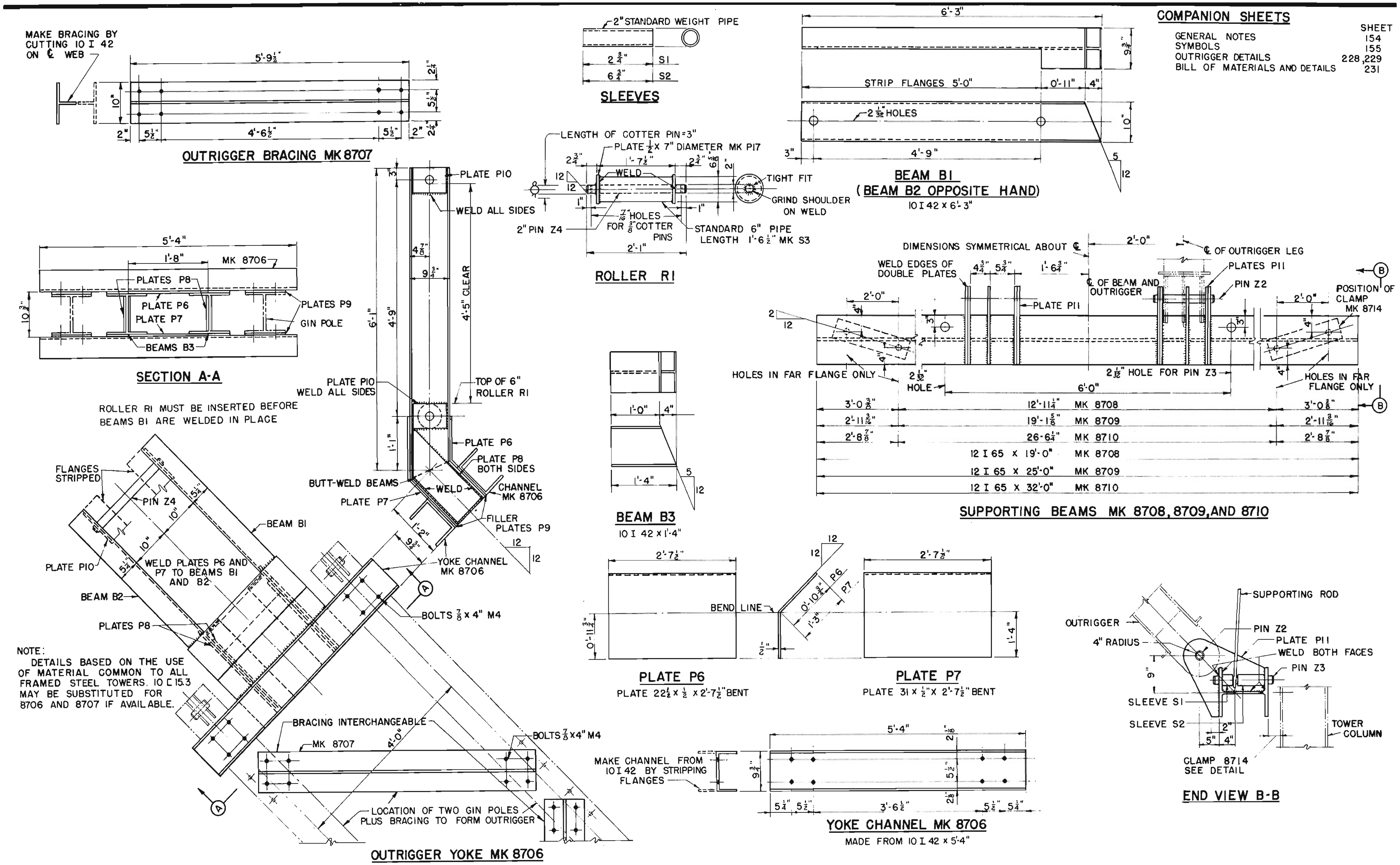
	SHEET
GENERAL NOTES	154
SYMBOLS	155
FABRICATION DRAWINGS	228, 230, 231



ALL WELDS SHOWN TO BE ¼" CONTINUOUS FILLET WELDS UNLESS OTHERWISE INDICATED

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
OUTRIGGER DETAILS	228, 229
BILL OF MATERIALS AND DETAILS	231



COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
OUTRIGGER DETAILS	228 TO 230

BILL OF MATERIALS FOR ONE OUTRIGGER CONSISTING OF 2 GIN POLES, 1 YOKE, 6 OUTRIGGER BRACES, 1 SUPPORTING BEAM, 2 SUPPORTING RODS, 4 TEMPORARY STRAPS, 2 OPERATING STRAPS, 4 COLUMN BRACKETS AND 2 CLAMPS

MATERIAL COMMON TO ERECTION OF ANY STEEL TOWER OR STEEL STRINGER

LINE	ITEM	DESCRIPTION	STOCK NO	MARK	QUANTITY	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	LINE
1	GIN POLE	BEAM		8700	1	10 I 42	32'-8 7/8"	1375	1
2		DO		8701	1	10 I 42	32'-8 7/8"	1375	2
3		RING	46-6375.5-13	Y1	4	1 1/4	1'-8"	7	3
4		[2] PIN		Z1	4	2	0'-6"	5	4
5		DO		Z2	2	2	1'-4 1/4"	15	5
6		GUIDE	47-7844.05	G1	4	2 X 1/2	1'-1"	4	6
7		PLATE	47-7844.05	P1	8	9 3/4 X 1/2	1'-3 7/8"	22	7
8		DO	47-7844.05	P2	4	8 X 1/2	1'-4"	18	8
9		DO	47-7844.05	P3	4	8 X 1/2	0'-10"	11	9
10		DO	47-7844.05	P4	4	8 X 1/2	2'-2"	30	10
11	COLUMN BRACKET	DO	47-7844.05	8702	2	16 X 1/2	1'-6"	41	11
12		DO	47-7844.07	P5	2	8 X 3/4	0'-10"	17	12
13		BOLT AND ONE NUT	43-2219.08-04	M4	2	7/8	4"	[1] 5	13
14	COLUMN BRACKET	PLATE	47-7844.05	8703	2	16 X 1/2	1'-6"	41	14
15		DO	47-7844.07	P5	2	8 X 3/4	0'-10"	17	15
16		BOLT AND ONE NUT	43-2219.08-04	M4	2	7/8	4"	[1] 5	16
17	TEMPORARY STRAP	BAR	47-7844.05	8704	2	4 X 1/2	5'-0"	34	17
18		DO	47-7844.05	8705	2	4 X 1/2	5'-0"	34	18
19		BOLT AND ONE NUT	43-2325.07-02	B2	16	3/4	2"	[1] 14	19
20		DO	43-2325.07-16	B16	4	3/4	16"	[1] 10	20
21	OPERATING STRAP	BAR	47-7844.07	8715	2	3/4	6'-5"	66	21
22		BOLT AND ONE NUT	43-2219.08-04	M4	8	7/8	4"	[1] 14	22
23		DO	43-2325.07-16	B16	2	3/4	16"	[1] 5	23
24		DO	43-2325.07-144	B14	4	3/4	14"	[1] 9	24
25	YOKE	CHANNEL (CUT I BEAM)		8706	2	10 I 42	5'-4"	112	25
26		BEAM		B1	1	10 I 42	5'-3"	168	26
27		DO		B2	1	10 I 42	5'-3"	168	27
28		DO		B3	2	10 I 42	1'-4"	49	28
29		[2] PIN		Z4	1	2"	2'-1"	22	29
30	ROLLER	STANDARD PIPE	44-6246.3-06	S3	1	6"	1'-6 1/2"	29	30
31		PLATE	47-7844.05	P17	2	7" DIA X 1/2			31
32		DO	47-7844.05	P6	1	22 1/2 X 1/2	2'-7 1/2"	100	32
33		DO	47-7844.05	P7	1	31 X 1/2	2'-7 1/2"	138	33
34		DO	47-7844.05	P8	4	8 X 1/2	1'-11"	25	34
35		DO	47-7844.05	P9	4	9 3/4 X 1/2	0'-9 3/4"	13	35
36		DO	47-7844.05	P10	4	6 X 1/2	0'-8"	7	36
37		[2] PIN		Z4	1	2"	2'-1"	22	37
38		BOLT AND ONE NUT	43-2219.08-04	M4	16	7/8	4"	[1] 33	38
39	BRACING	TEE (SPLIT I-BEAM)		8707	6	10 I 42	5'-9 1/2"	168	39
40		BOLT AND ONE NUT	43-2219.08-04	M4	24	7/8	4"	[1] 55	40
41	SUPPORTING BEAM	PLATE	47-7844.05	P11	10	18 X 1/2	1'-6 1/2"	47	41
42		[2] PIN		Z3	2	2"	1'-3"	13	42
43		SLEEVE STANDARD PIPE	44-6246.7-02	S1	2	2"	0'-2 3/4"	1	43
44		DO	44-6246.7-02	S2	2	2"	0'-6 3/4"	2	44
45	SUPPORTING ROD	CLEVIS PLATE	47-7844.05	C1	4	4 1/2 X 1/2	2'-6"	19	45
46		SQUARE ROD		L1	2	3/4 □	5'-6'	11	46
47		TURNBUCKLE, STANDARD		T1	2	1 1/8"	0'-9 1/8"	3	47
48		[2] PIN		Z5	2	2"	0'-5"	5	48
49	CLAMP	PLATE	47-7844.05	8714	2	5 X 1/2	2'-6"	21	49
50		DO	47-7844.05	P12	2	2 1/2 X 1/2	0'-3 1/2"	1	50
51		DO	47-7844.05	P13	2	2 7/8 X 1/2	0'-3 1/2"	2	51
52		DO	47-7844.05	P14	4	2 1/2 X 1/2	0'-8 1/2"	3	52
53		DO	47-7844.05	P15	8	2 1/2 X 1/2	0'-2 7/8"	1	53
54		DO	47-7844.05	P16	2	4 X 1/2	0'-6 3/4"	4	54
55		BOLT AND ONE NUT	43-2219.08-04	M4	2	7/8	4"	[1] 5	55
56		DO	43-2219.08-07	M7	4	7/8	7"	[1] 8	56
57	MISCELLANEOUS	WASHER	47-7844.04	P18	154	3 X 3/8		1	57
58		ELECTRODE WELDING	45-3646.2-7			3/16		[1] 40	58
59		COTTER KEY (FOR PINS)			24	3/8	3"		59

ADDITIONAL MATERIAL REQUIRED FOR ERECTION OF SINGLE TRACK RAILWAY STEEL TOWER AND STEEL STRINGER

1	SUPPORTING ROD	SQUARE ROD		8711	2	3/4 □	10'-5"	20	1
2	SUPPORTING BEAM	BEAM	48-2900.12-065	8708	1	12 I 65	19'-0"	1236	2

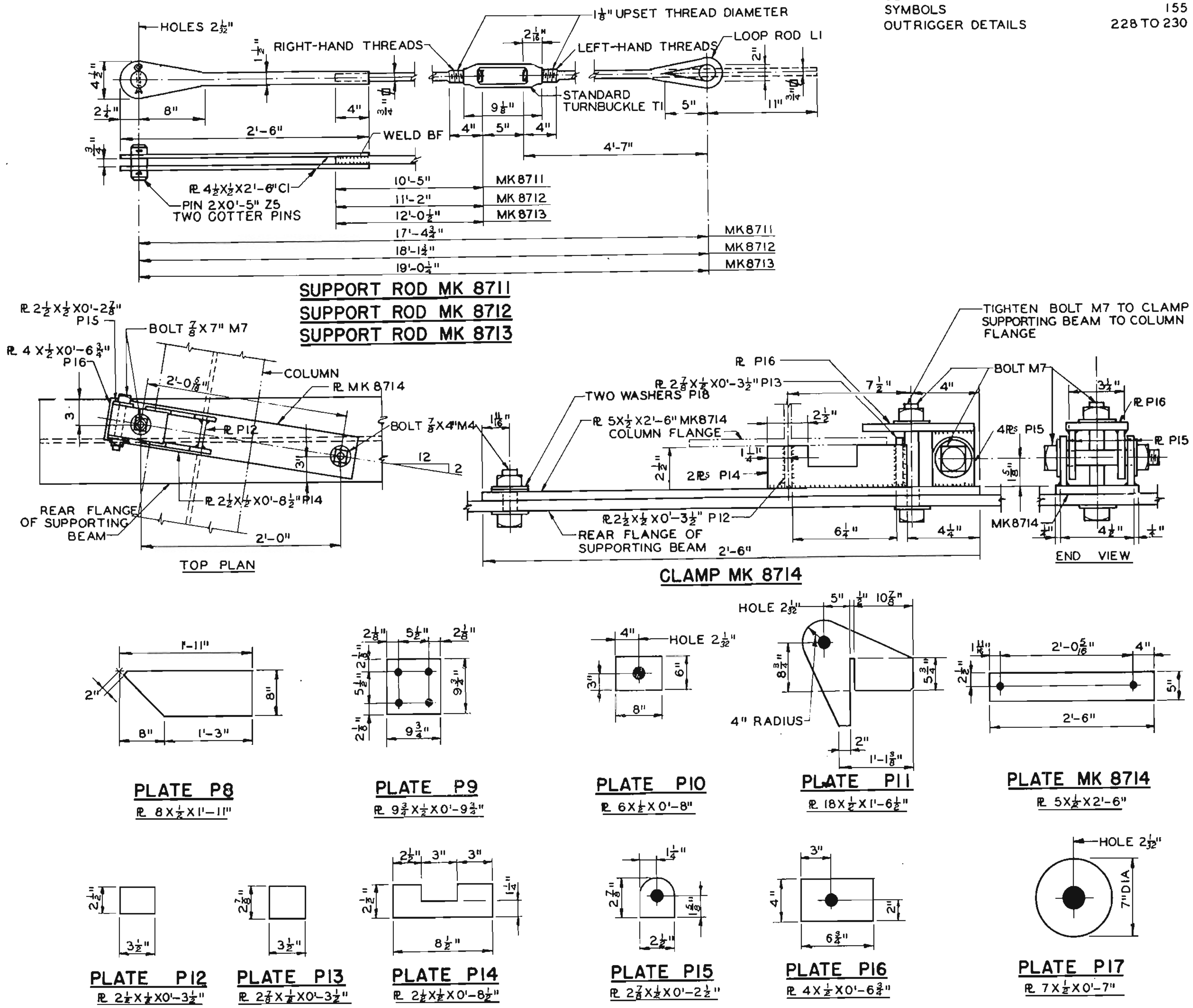
ADDITIONAL MATERIAL REQUIRED FOR ERECTION OF SINGLE LANE HIGHWAY STEEL TOWER AND STEEL STRINGER

1	SUPPORTING ROD	SQUARE ROD		8712	2	3/4 □	11'-2"	21	1
2	SUPPORTING BEAM	BEAM	48-2900.12-065	8709	1	12 I 65	25'-0"	1625	2

ADDITIONAL MATERIAL REQUIRED FOR ERECTION OF DOUBLE LANE HIGHWAY STEEL TOWER AND STEEL STRINGER

1	SUPPORTING ROD	SQUARE ROD		8713	2	3/4 □	12'-0 1/2"	23	1
2	SUPPORTING BEAM	BEAM	48-2900.12-065	8710	1	12 I 65	32'-0"	2075	2

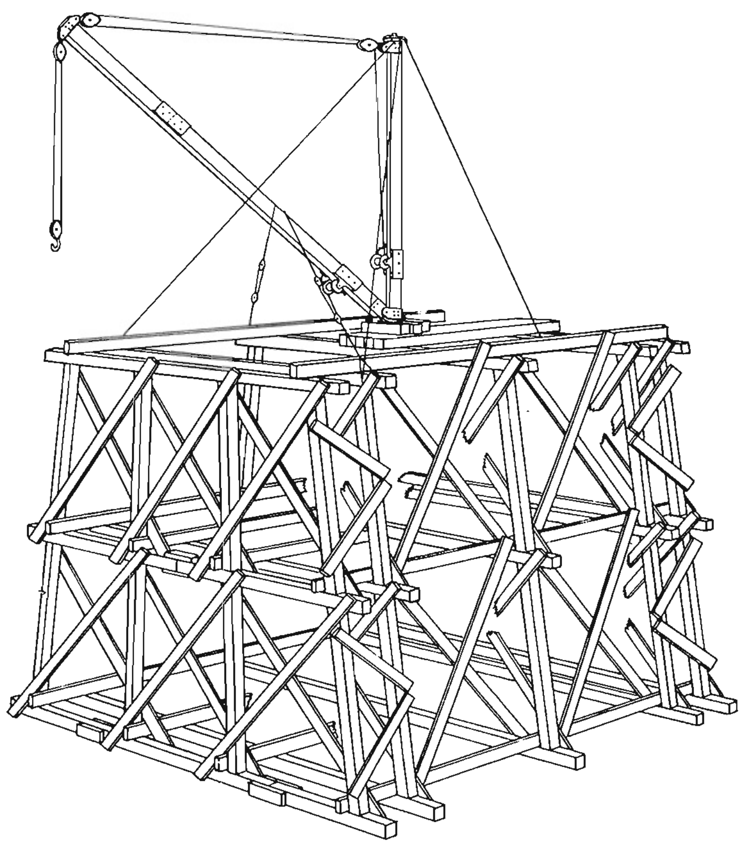
[1] TOTAL WEIGHT
[2] EACH PIN TO HAVE TWO COTTER KEYS (BILLED IN LINE 59)



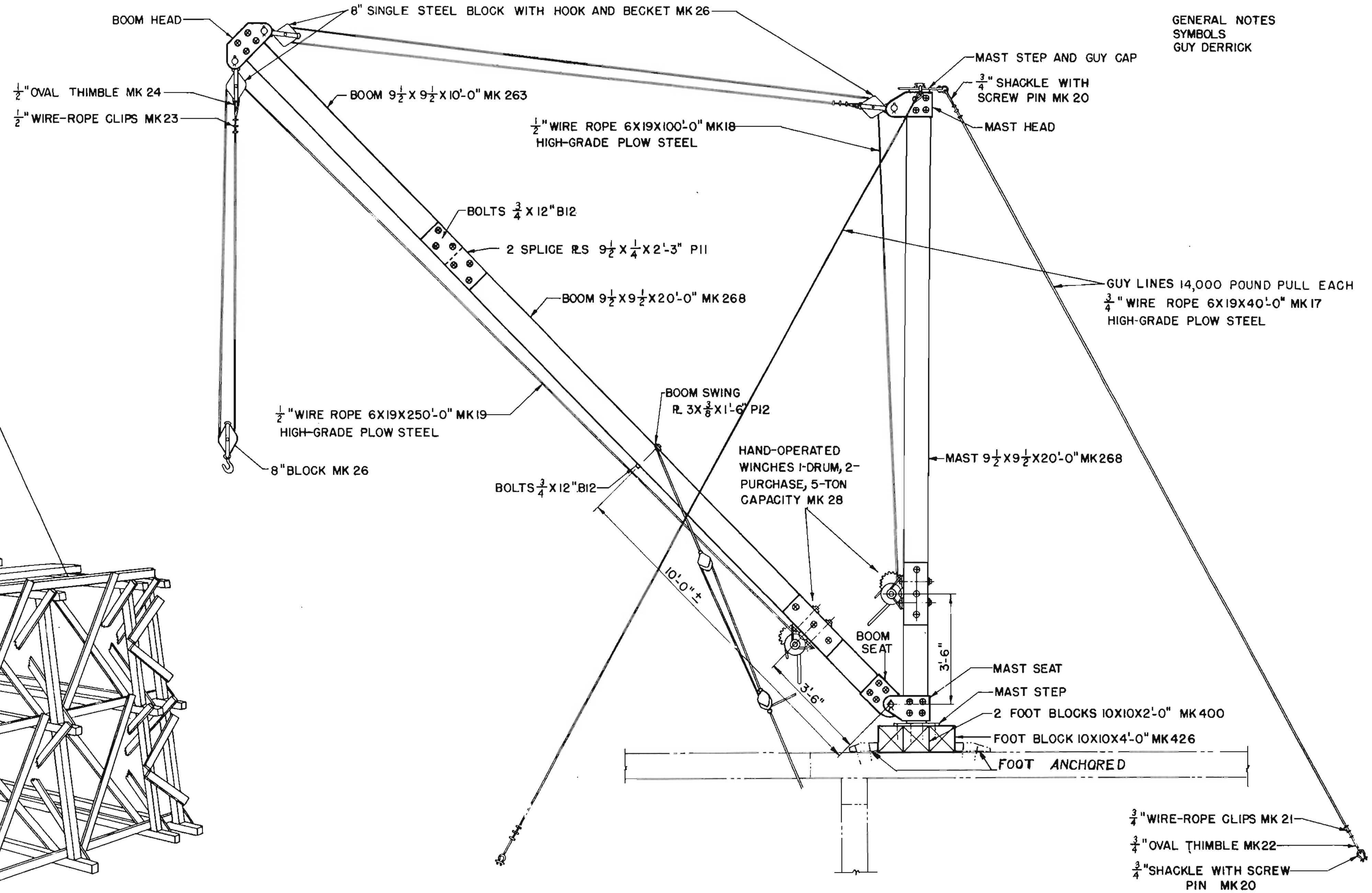
ALL WELDS SHOWN TO BE 1/4" CONTINUOUS WELDS UNLESS OTHERWISE NOTED

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
GUY DERRICK	233,234



ASSEMBLED VIEW IN ERECTION



SIDE ELEVATION OF DERRICK

6,000-POUND PICKUP CAPACITY

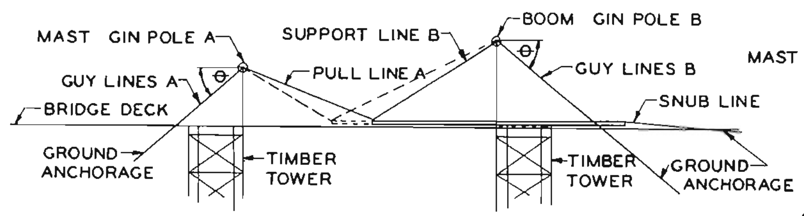
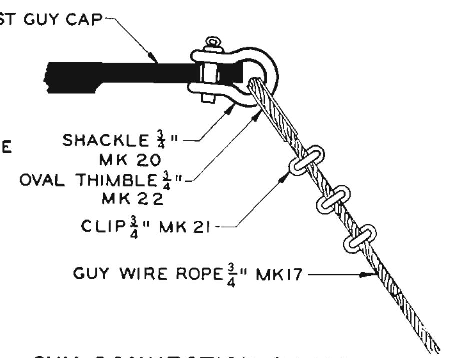


TABLE OF STRESSES

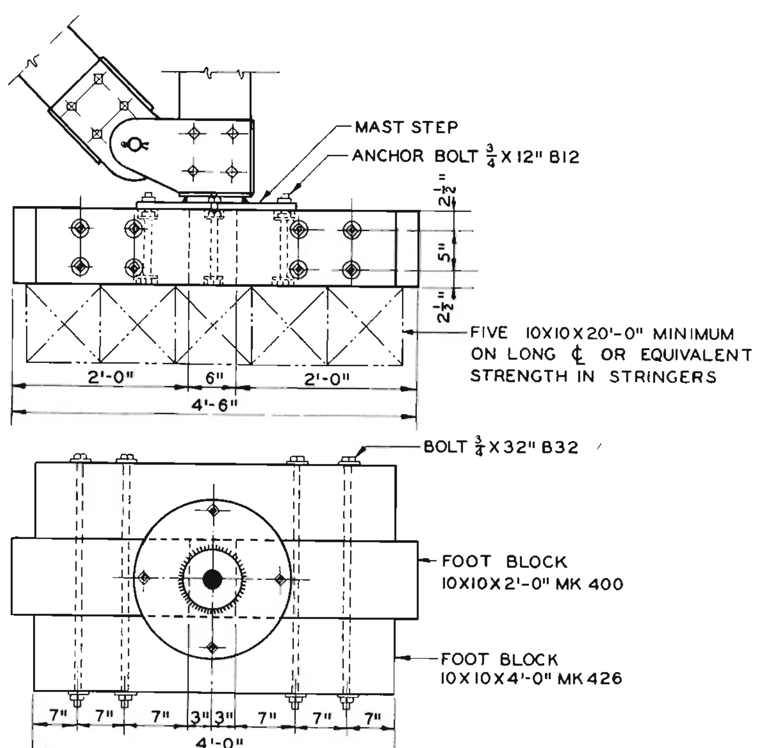
SPAN	MAX STRESS PULL LINE A	MAX STRESS SUPPORT LINE B	MAX TOTAL GUY LINE STRESSES - θ=45° GUY LINES A	GUY LINES B	MAX SNUB LINE PULL HORIZONTAL
CLASS 50 - SINGLE LANE AND DOUBLE LANE					
UP TO 60'	5980	1500	4720	1810	3475
70'	8775	2440	6790	3040	4610
80'	11400	3850	10240	4870	6460
90'	17840	5920	16270	7600	9160
CLASS 25 - DOUBLE LANE					
UP TO 60'	4120	1030	3250	1250	2390
70'	6320	1760	4890	2190	3320
80'	7830	2640	7030	3350	4440
90'	10240	3400	9340	4360	5260
RAILROAD - E45					
UP TO 40'	5380	3140	3400	3140	3330
45'	7820	5120	5330	5320	4740
50'	6740	1410	4170	1510	3440

SPANS UP TO 30' CAN BE ERECTED BY DERRICK

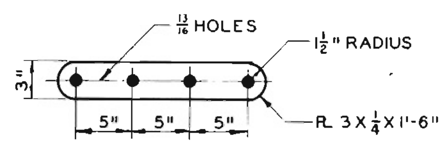
TIMBER GUY DERRICK MAST AND BOOM USED AS GIN POLES FOR LAUNCHING STEEL STRINGERS



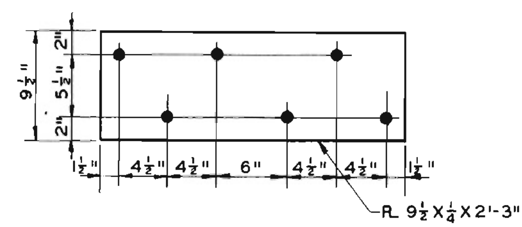
GUY CONNECTION AT MAST HEAD



FOOT BLOCK AND OUTRIGGER



BOOM SWING PLATE MK P12



BOOM SPLICE PLATE MK P11

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER DERRICK	232,233

BILL OF MATERIALS FOR ONE DERRICK

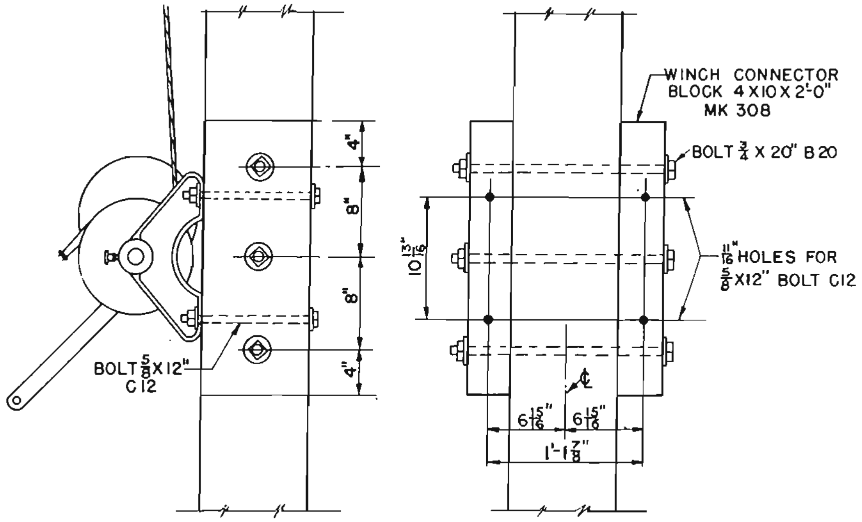
LINE	DESCRIPTION	STOCK NO	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM
1	MAST STEP AND GUY CAP	47-7844.07	P1	3/4 X 1'-9" DIA		72	2	
2	DO	47-7344.05	P2	1/2 X 0'-8" DIA		6	2	
3	MAST HEAD AND SEAT END PLATE	47-7844.07	P3	9 1/2 X 3/4	0'-9 1/2"	18	2	
4	MAST HEAD AND SEAT SIDE PLATE	47-7344.03	P4	9 1/2 X 1/4	1'-5 1/4"	12	4	
5	BOOM-HEAD SIDE PLATE	47-7844.03	P5	9 1/2 X 1/4	1'-10"	19	2	
6	BOOM-SEAT SIDE PLATE	47-7944.03	P6	9 1/2 X 1/4	1'-4"	10	2	
7	MAST WASHER	47-7844.03	P7	1/4 X 0'-4" DIA		1	2	
8	MAST HEAD AND SEAT SIDE PLATE AND BOOM-HEAD SIDE AND END PLATE	47-7844.03	P8	9 1/2 X 1/4	0'-9 1/2"	6	7	
9	BOOM-SEAT SIDE AND END PLATE	47-7344.03	P9	9 X 1/4	0'-9 1/2"	6	3	
10	MAST SEAT AND HEAD BRACE PLATE	47-7844.03	P10	3 X 1/4	0'-9 1/2"	2	2	
11	BOOM SPLICE PLATE	47-7844.03	P11	9 1/2 X 1/4	2'-3"	18	2	
12	BOOM SWING PLATE	47-7844.04	P12	3 X 3/8	1'-6"	6	1	
13	PIN, COLD ROLLED STEEL	45-6375.5-15	13	1 1/2" DIA	1'-1"	11	4	
14	MAST PIVOT PIN, COLD ROLLED STEEL	46-6375.5-15	14	1 1/2" DIA	0'-4"	4	2	
15	PIPE SPREADER, BOOM-SEAT	44-6246.7-02	15	2" STANDARD	0'-9"	3	1	
16	PIPE-SLEEVE HEAD PINS	44-6246.7-02	29	2" STANDARD	0'-4"	1	6	
17	COTTER PIN		16	3/8 Ø	3"	[1] 1	10	
18	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-124	B12	3/4	12"	[1] 59	28	
19	DO	43-2325.07-2	B20	3/4	20"	[1] 18	6	
20	DO	43-2325.07-32	B32	3/4	32"	[1] 36	8	
21	DO	43-2325.06-12	C12	5/8	12"	[1] 10	8	
22	SHACKLE	12-4372.5-07	20	3/4		[1] 18	8	
23	BLOCK, SINGLE, STEEL, WITH HOOK AND BECKET	19-3755.05-08	26	8			4	
24	DO	19-3267.05-04	25	4			4	
25	WIRE-ROPE GUY	22-4321.4-07	17	3/4	40'-0"	36	4	
26	WIRE-ROPE BOOM LINE	22-4321.4-05	18	1/2	100'-0"	40	1	
27	WIRE-ROPE LOAD LINE	22-4321.4-05	19	1/2	250'-0"	100	1	
28	MANILLA-ROPE BOOM SWING LINE	21-7555.3-05	27	1/2	30'-0"	2	2	
29	HAND WINCH, SINGLE DRUM	66-9450.05	28	5 TON		110	2	
30	THIMBLE OVAL, GALVANIZED	12-6587.5-07	22	3/4		[1] 3	8	
31	DO	12-6587.5-05	24	1/2			2	
32	CLIP, WIRE-ROPE, GALVANIZED	42-3544.5-08	21	7/8		[1] 42	24	
33	DO	42-3544.5-05	23	1/2		[1] 3	6	
34	ELECTRODE WELDING	46-3772.2-7		3/16		[1] 7		
35	BOOM	39-6620.1-1	263	9 1/2 X 9 1/2	10'-0"	313	1	83
36	DO	39-6620.1-2	268	9 1/2 X 9 1/2	20'-0"	625	1	167
37	MAST	39-6620.1-2	268	9 1/2 X 9 1/2	20'-0"	625	1	167
38	BLOCK WINCH CONNECTOR	39-3340.1	310	4 X 10	2'-0"	25	4	27
39	FOOT BLOCK	39-6620.1	400	10 X 10	2'-0"	62	2	33
40	DO	39-6620.1	426	10 X 10	4'-0"	124	2	67

[1] TOTAL WEIGHT

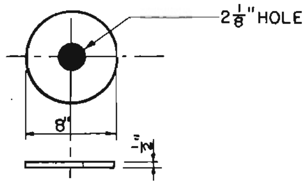
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER DERRICK	232,233

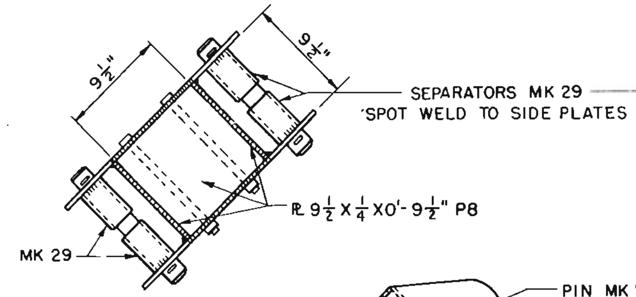
ALL WELDS SHOWN ARE 1/4" FILLET UNLESS OTHERWISE NOTED



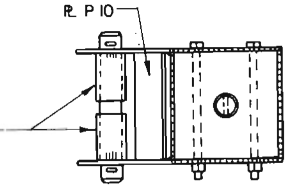
WINCH ATTACHMENT DETAIL



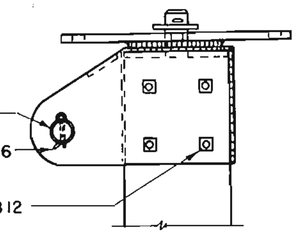
MAST STEP AND GUY CAP P2
PL 1/2 X 0'-8" DIA



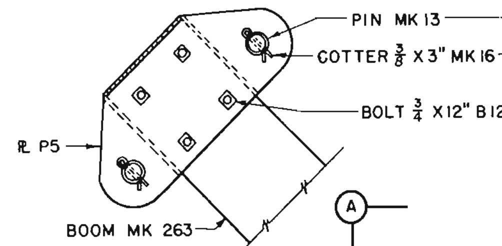
END VIEW



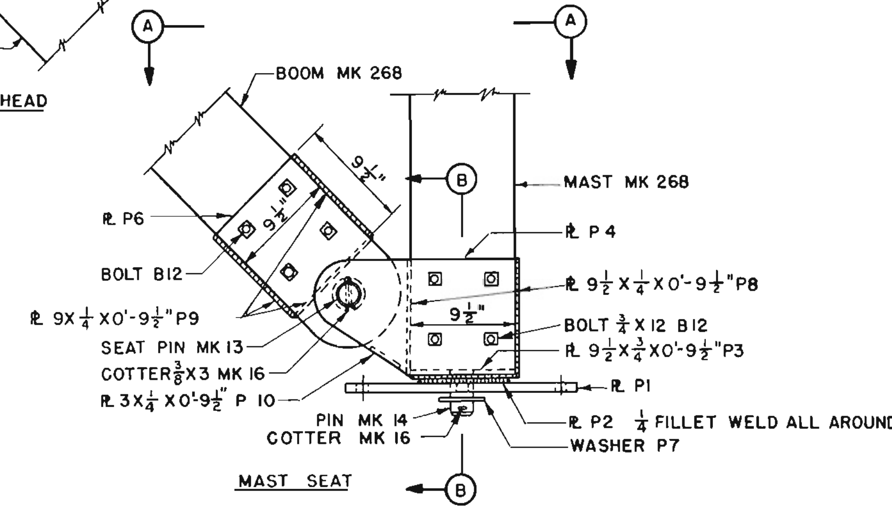
TOP VIEW WITHOUT GUY CAP



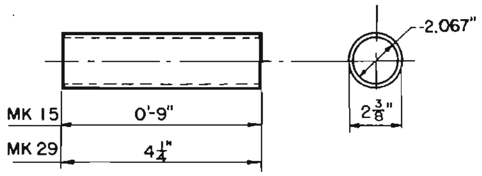
MAST HEAD



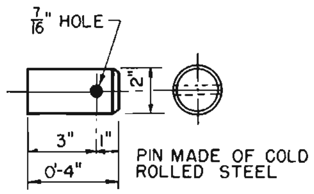
BOOM HEAD



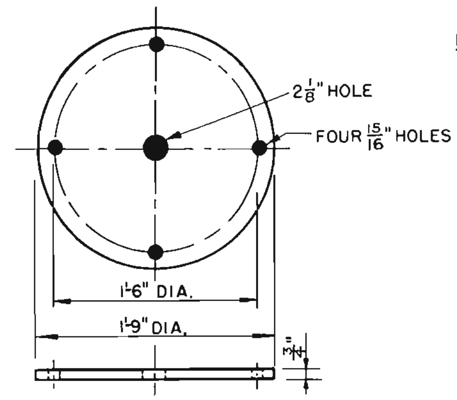
MAST SEAT



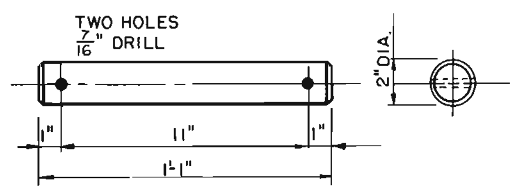
SEPARATORS
2" DIA STANDARD STEEL PIPE



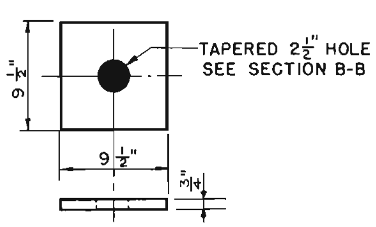
MAST PIVOT PIN MK 14
2" DIA X 0'-4"



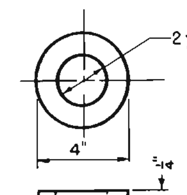
MAST STEP AND GUY CAP P1
PL 3/4 X 1'-9" DIA



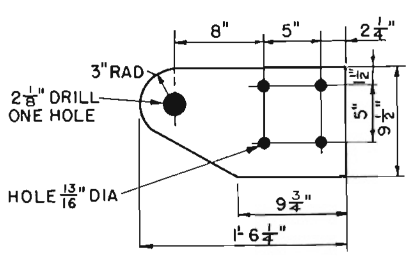
SEAT PIN MK 13
2" DIA X 1'-1"



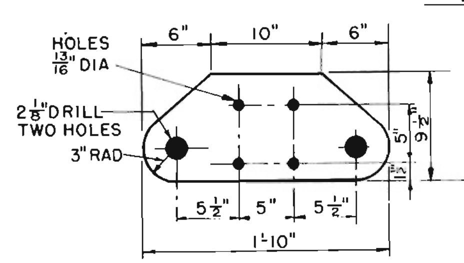
MAST END PLATE P3
PL 9 1/2 X 3/4 X 0'-9 1/2"



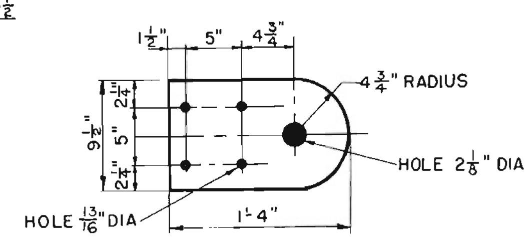
MAST WASHER P7
PL 1/4 X 0'-4" DIA



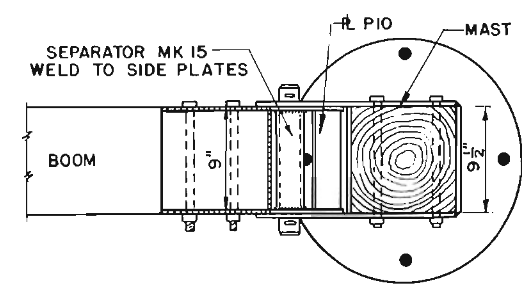
MAST-HEAD AND SEAT SIDE PLATE P4
PL 9 1/2 X 1/4 X 1'-6 1/4"



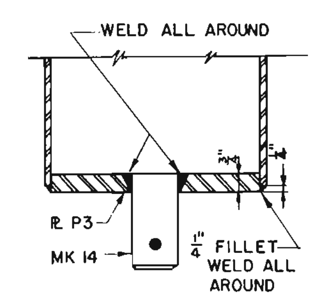
BOOM-HEAD SIDE PLATE P5
PL 9 1/2 X 1/4 X 1'-10"



BOOM-SEAT SIDE PLATE P6
PL 9 1/2 X 1/4 X 1'-4"



SECTION A-A



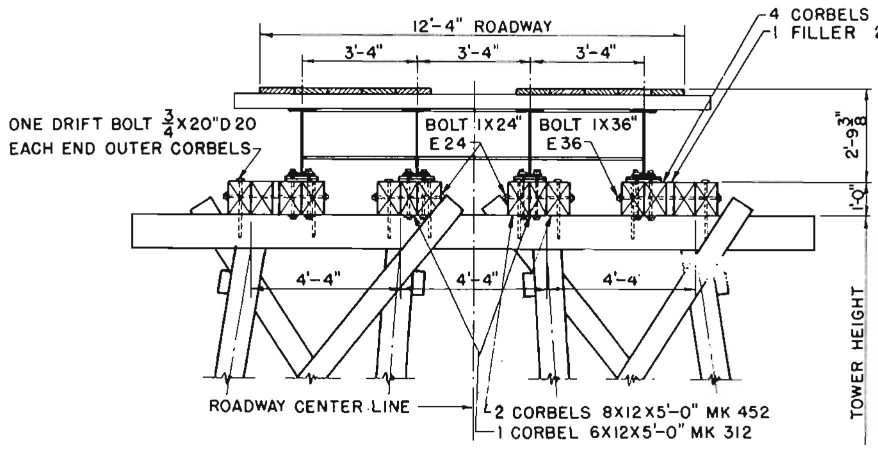
SECTION B-B

MAST AND BOOM ELEVATION

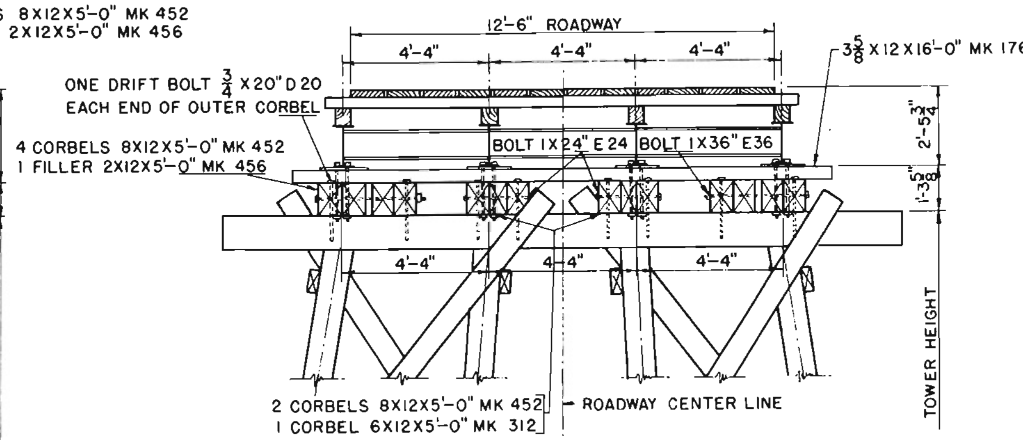
BLOCKING ON CLASS 50 SINGLE-LANE TOWER FOR 30-FOOT I-BEAM SPAN (1943 DESIGN, TM 5-285)

COMPANION SHEETS

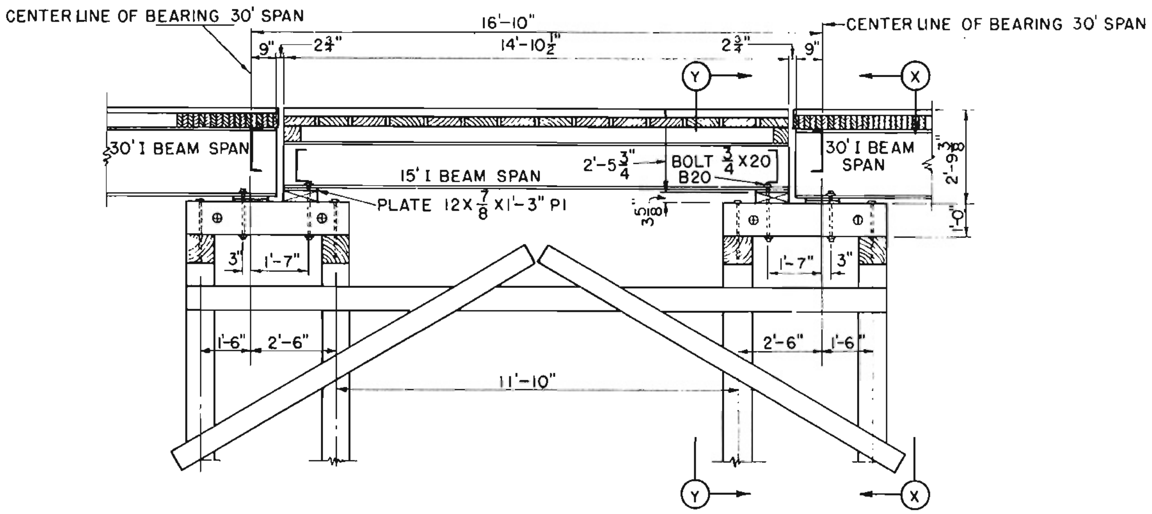
	SHEET
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	236
ADAPTATIONS	237
TIMBER TOWERS	10
TIMBER TOWERS BILL OF MATERIALS	11
STEEL SPANS	4
STEEL SPANS BILL OF MATERIALS	5
STEEL SPANS	6
SHIMS	178



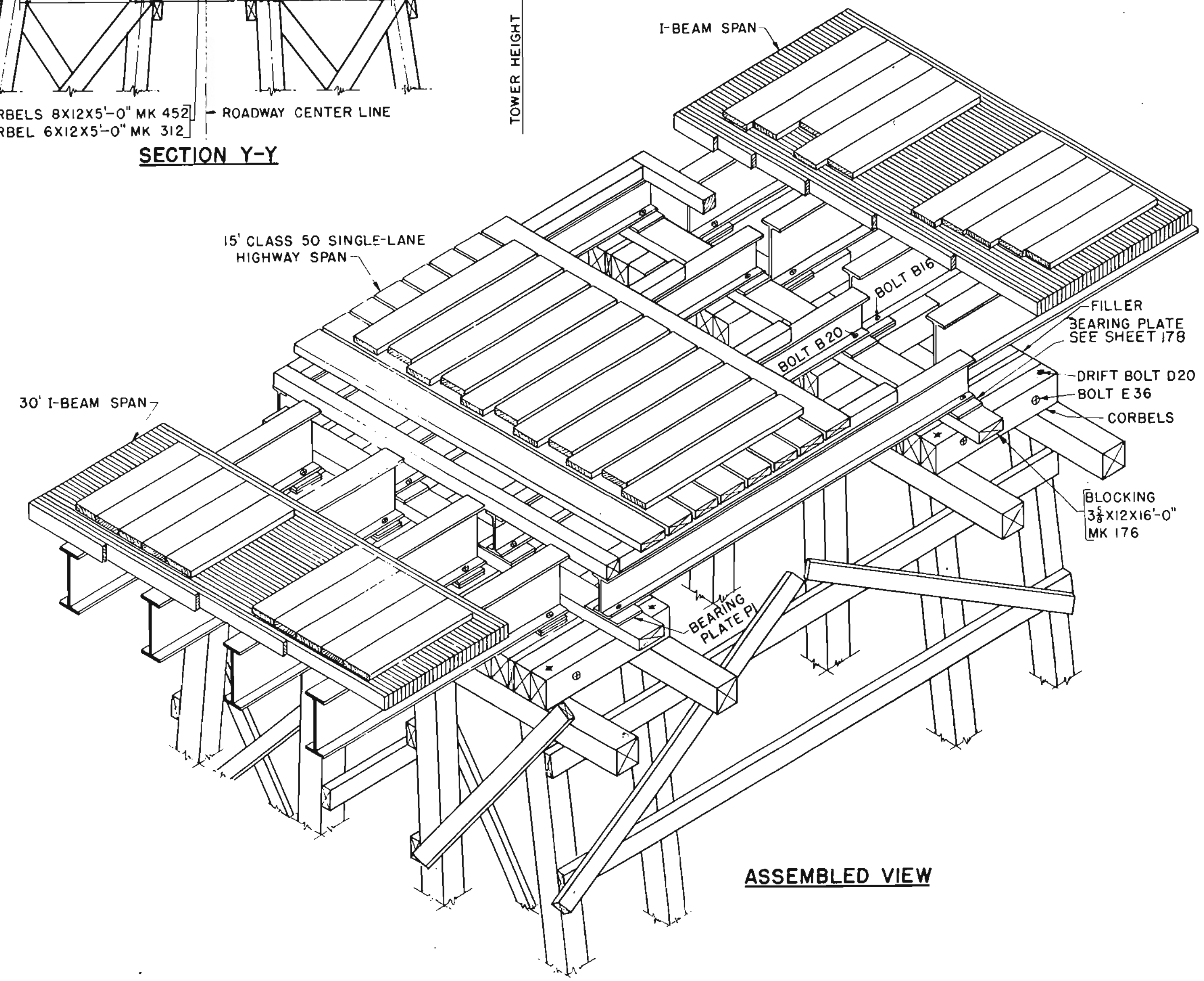
SECTION X-X



SECTION Y-Y



LONGITUDINAL SECTION THROUGH TOWER



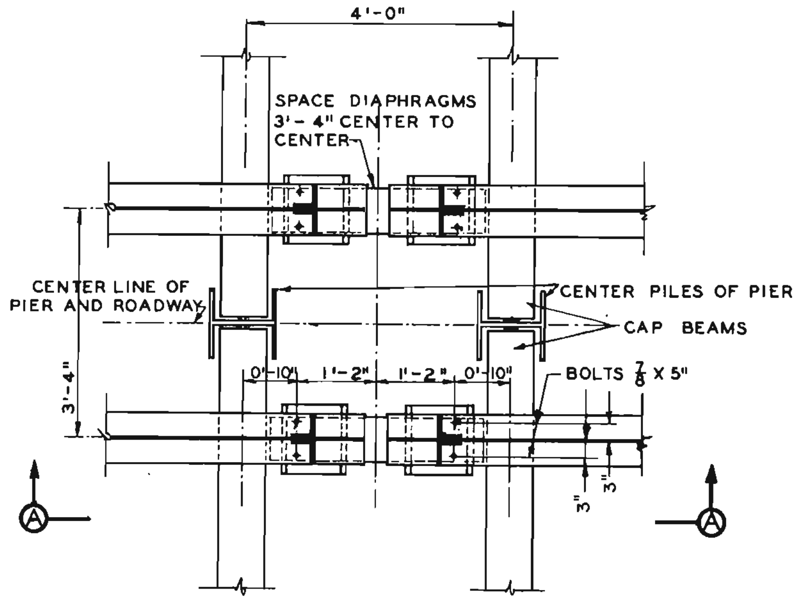
ASSEMBLED VIEW

BILL OF MATERIAL FOR EXTRA HARDWARE AND LUMBER AT ONE TOWER

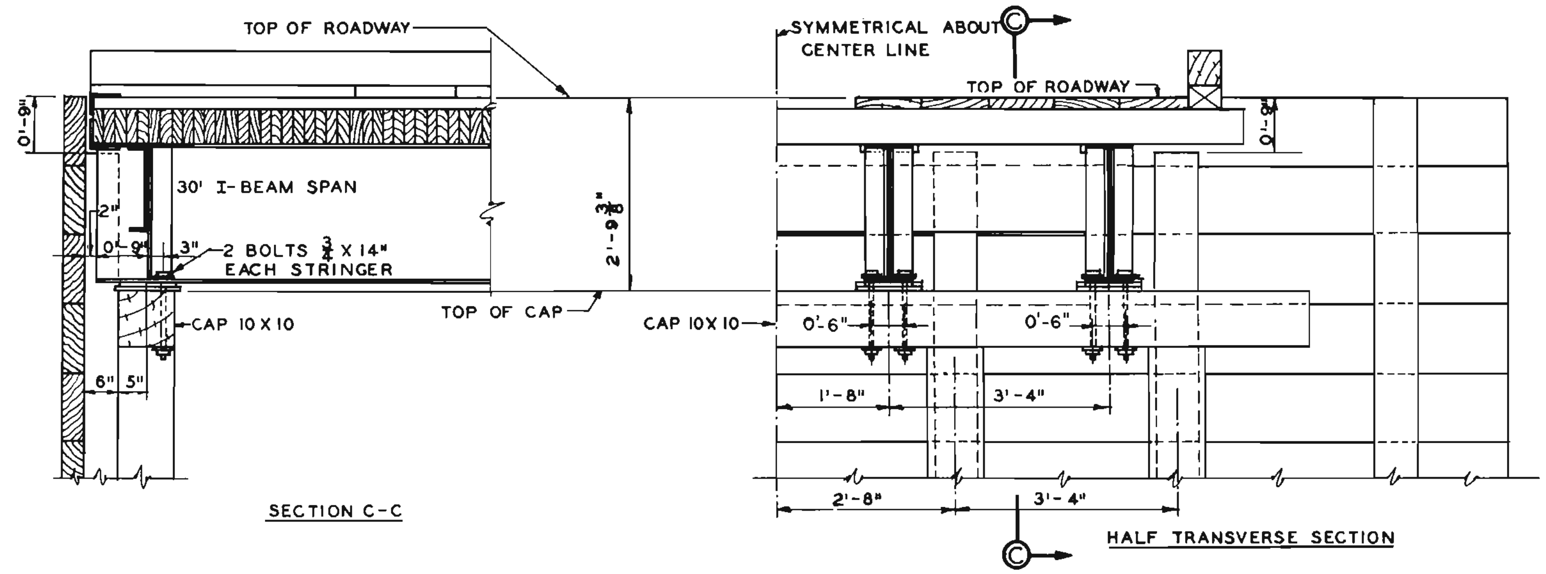
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM
1	CORBEL	39-6616.12	452	8X12	5'-0"	150	24	960
2	DO	39-3360.12	312	6X12	5'-0"	110	4	120
3	FILLER	39-3228.12	456	2X12	5'-0"	40	4	40
4	BLOCKING	39-3340.12	176	3 5/8X12	16'-0"	240	2	128
5	BEARING PLATE	47-7844.08	P1	12X 7/8	1'-3"	45	8	
6	DRIFT BOLT	43-1636.07-2	D20	3/4	20"	1)85	32	
7	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.07-16	B16	3/4	16"	1)41	16	
8	DO	43-2325.07-2	B20	3/4	20"	1)50	16	
9	DO	43-2325.1-24	E24	1	24"	1)52	8	
10	DO	43-2325.1-36	E36	1	36"	1)73	8	

1) TOTAL WEIGHT

COMPANION SHEETS	SHEET
TIMBER GRILLAGE ABUTMENT	24
TIMBER PILE PIER	30
STEEL PILE PIER	32
GENERAL NOTES	154
ADAPTATIONS	235,237
SYMBOLS	155

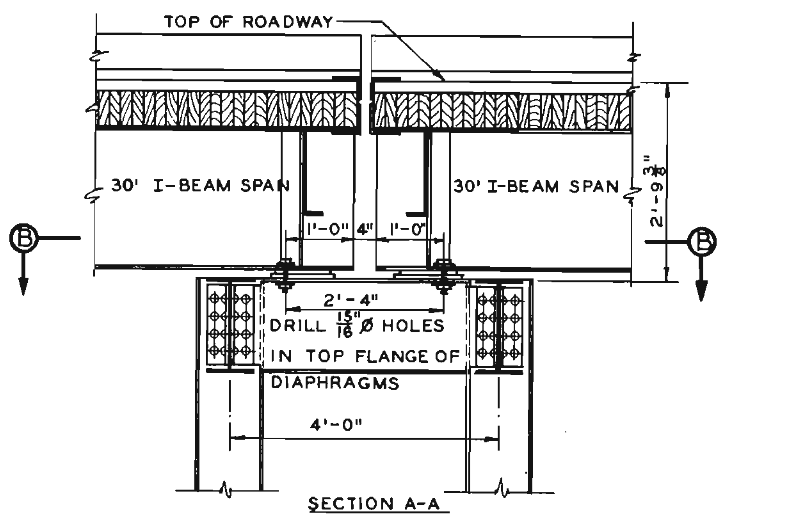


SECTION B-B



FOR DETAILS AND DIMENSIONS NOT SHOWN, SEE CLASS 50 SINGLE-LANE ABUTMENT SHEET 23

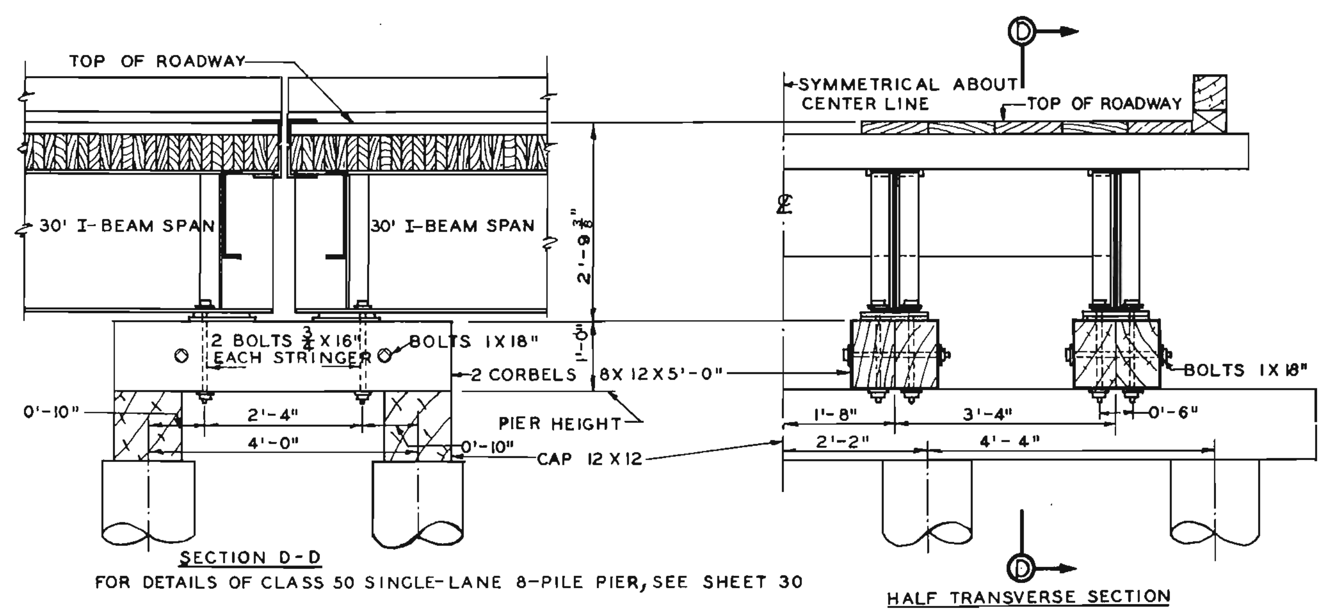
TIMBER GRILLAGE ABUTMENT



SECTION A-A

FOR DETAILS OF CLASS 50 SINGLE-LANE SIX-PILE PIER, SEE SHEET 32

STEEL PILE PIER

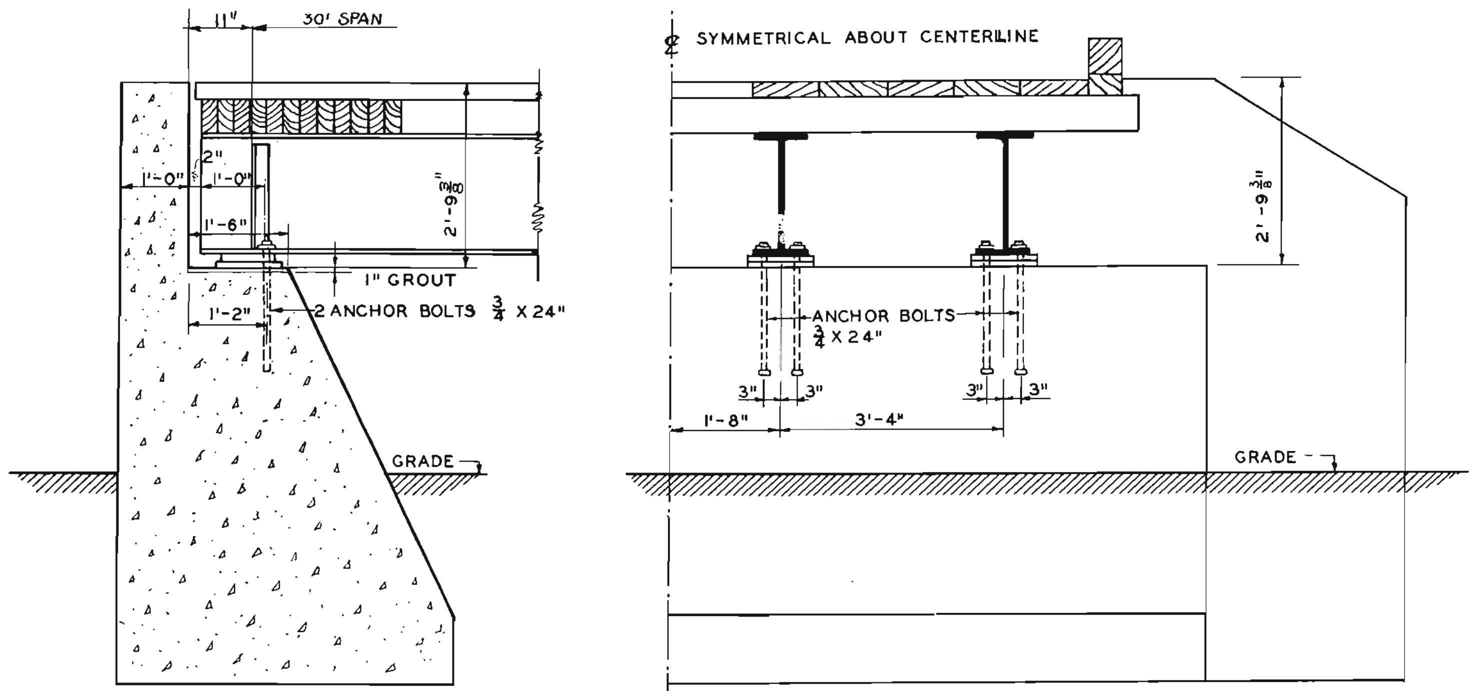


FOR DETAILS OF CLASS 50 SINGLE-LANE 8-PILE PIER, SEE SHEET 30

TIMBER PILE PIER

COMPANION SHEETS

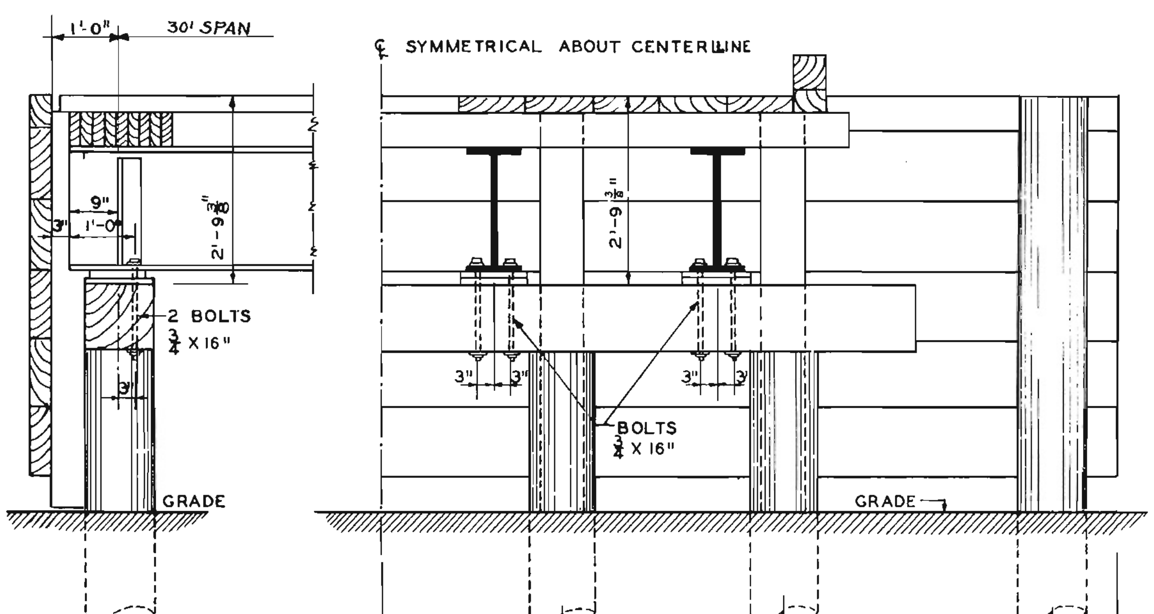
	SHEET
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	235,236
CONCRETE ABUTMENT	27
TIMBER PILE ABUTMENT	23,24
STEEL PILE ABUTMENT	25,26



SECTION ON CENTERLINE

FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 27

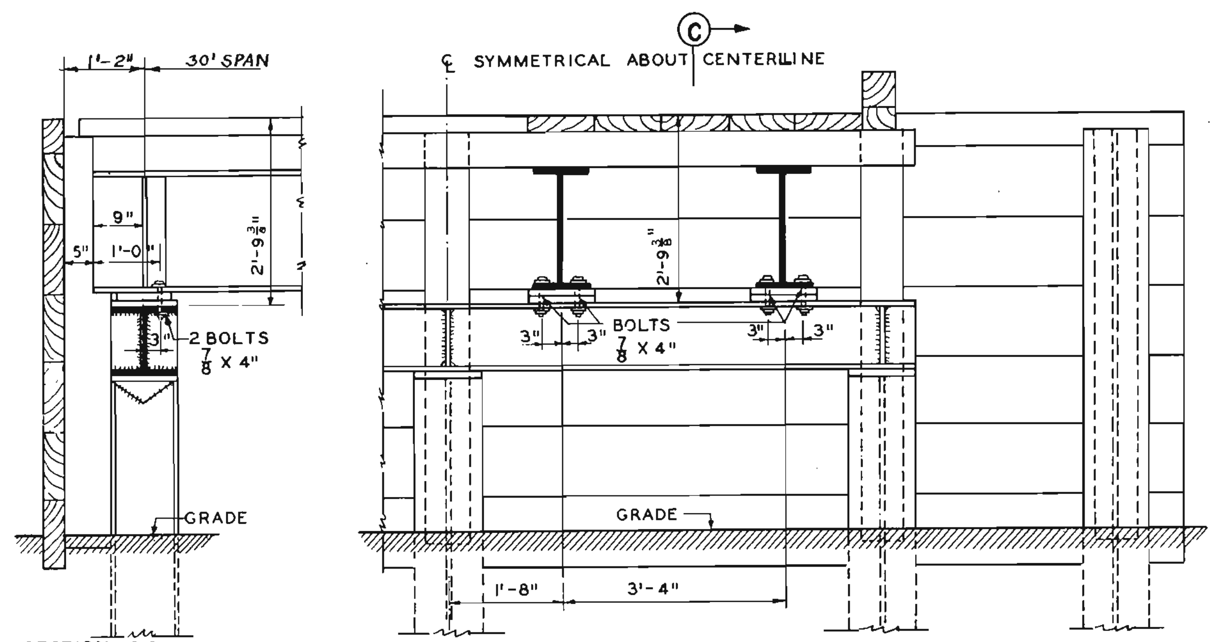
CONCRETE ABUTMENT



SECTION ON CENTERLINE

FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 23 AND 24

TIMBER PILE ABUTMENT

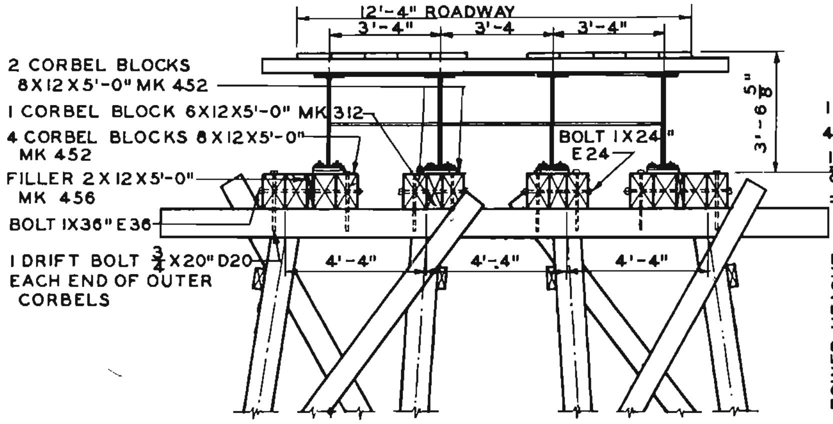


SECTION C-C

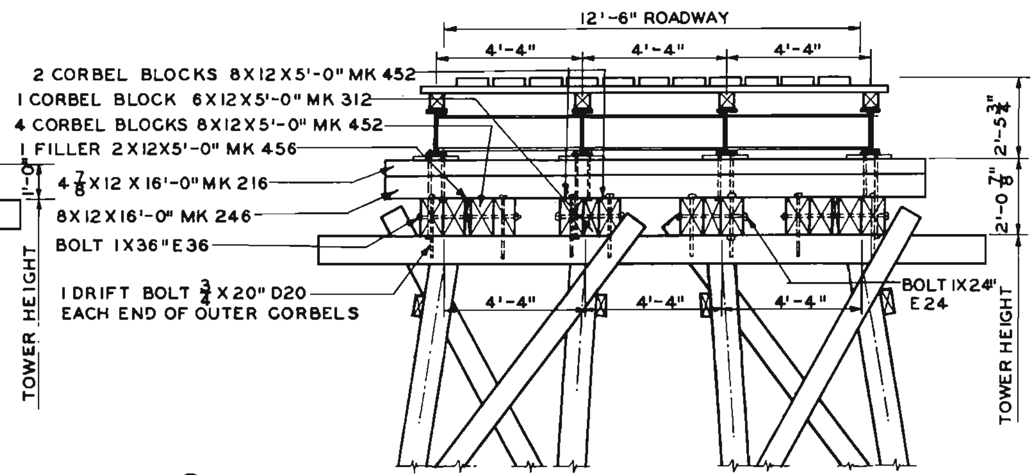
FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 25 AND 26

STEEL PILE ABUTMENT

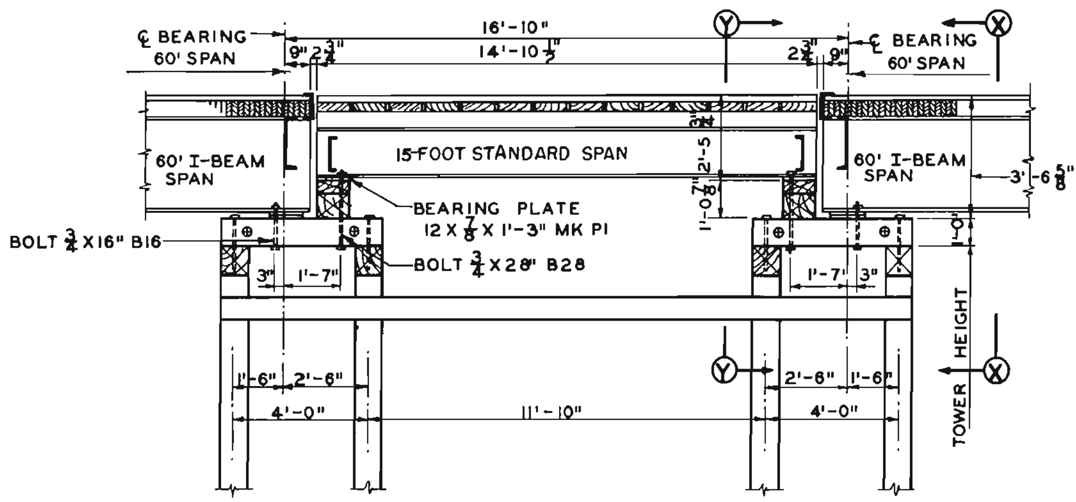
BLOCKING ON CLASS 50 SINGLE-LANE TOWER FOR 60-FOOT I-BEAM SPAN (1943 DESIGN, TM 5-285)



SECTION X-X



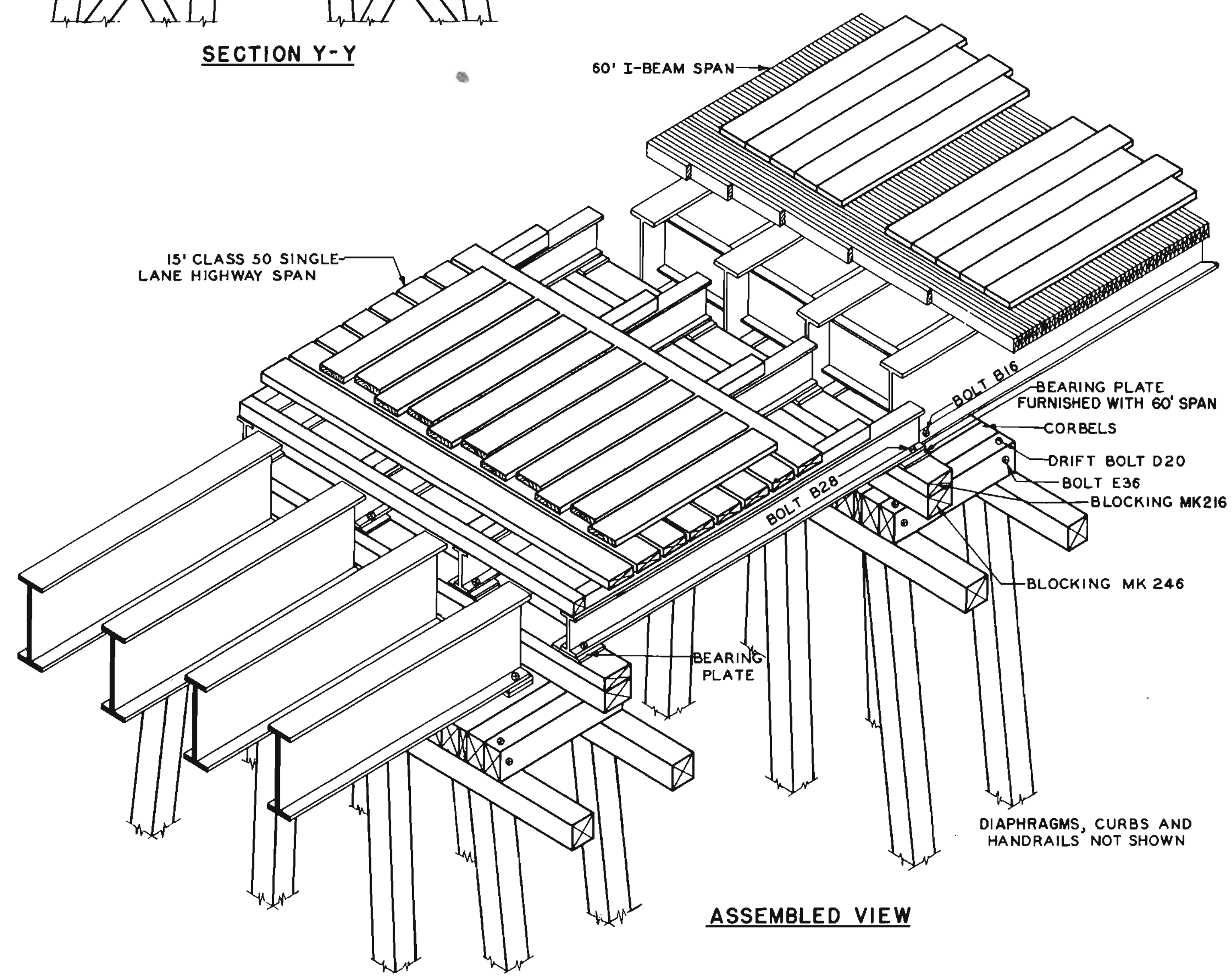
SECTION Y-Y



LONGITUDINAL SECTION THROUGH TOWER

COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	239
ADAPTATIONS	240
TIMBER TOWERS	10
TIMBER TOWERS, BILL OF MATERIALS	11
STEEL SPANS	4
STEEL SPANS, BILL OF MATERIALS	5
STEEL SPANS	6



ASSEMBLED VIEW

BILL OF MATERIALS FOR EXTRA HARDWARE AND LUMBER AT ONE TOWER

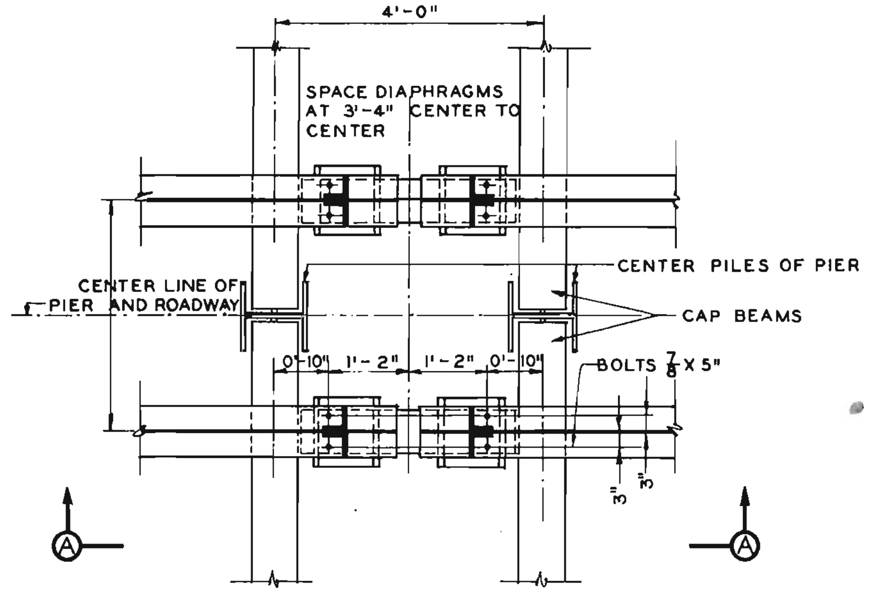
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE INCHES	LENGTH	UNIT WEIGHT POUNDS	QUANTITY	FBM
1	CORBEL	39-6616.120-	452	8 X 12	5'-0"	150	24	960
2	DO	39-3360.120-	312	6 X 12	5'-0"	110	4	120
3	FILLER	39-3228.120-	456	2 X 12	5'-0"	40	4	40
4	BLOCKING	39-6616.120-	246	8 X 12	16'-0"	480	2	256
5	DO	39-3360.120-160	216	1/ 4 7/8 X 12	16'-0"	360	2	192
6	BEARING PLATE	47-7844.080.700	P1	12 X 7/8	1'-3"	45	8	
7	DRIFT BOLT	43-1636.070-200	D20	3/4	20"	2/ 85	32	
8	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.070-160	B16	3/4	16"	2/ 41	16	
9	DO	43-2325.070-160	B28	3/4	28"	2/ 64	16	
10	DO	43-2325.070-160	E24	1	24"	2/ 52	8	
11	DO	43-2325.070-160	E36	1	36"	2/ 73	8	

1/ TO BE CUT FROM 6 X 12 X 16'-0"

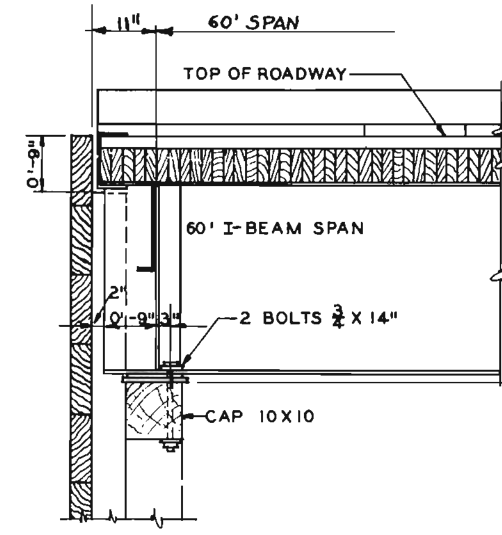
2/ TOTAL WEIGHT

COMPANION SHEETS

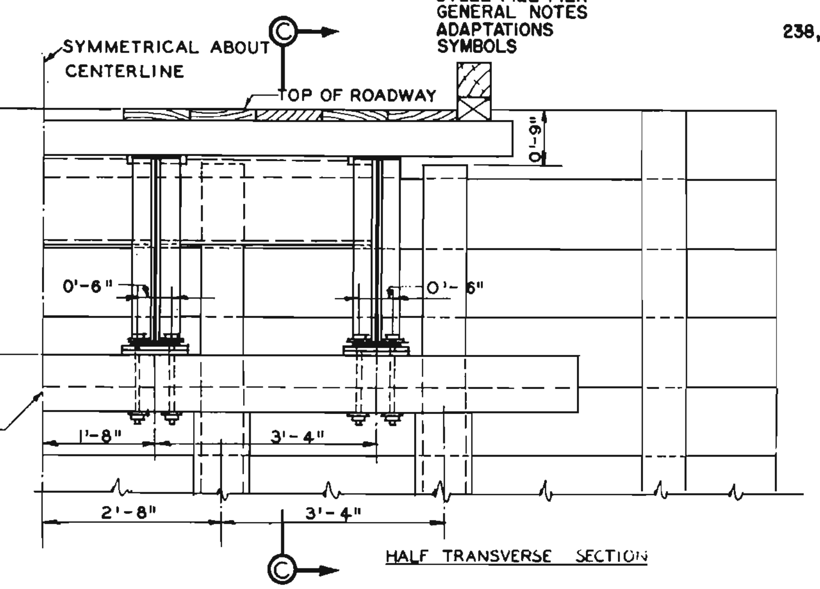
	SHEET
TIMBER GRILLAGE ABUTMENT	24
TIMBER PILE PIER	30
STEEL PILE PIER	32
GENERAL NOTES	154
ADAPTATIONS	238,240
SYMBOLS	155



SECTION B-B



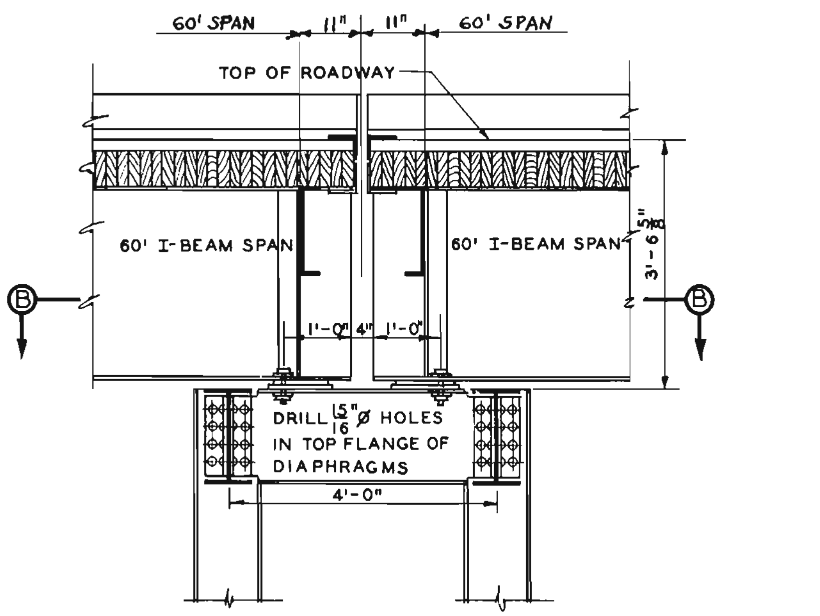
SECTION C-C



HALF TRANSVERSE SECTION

FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 24

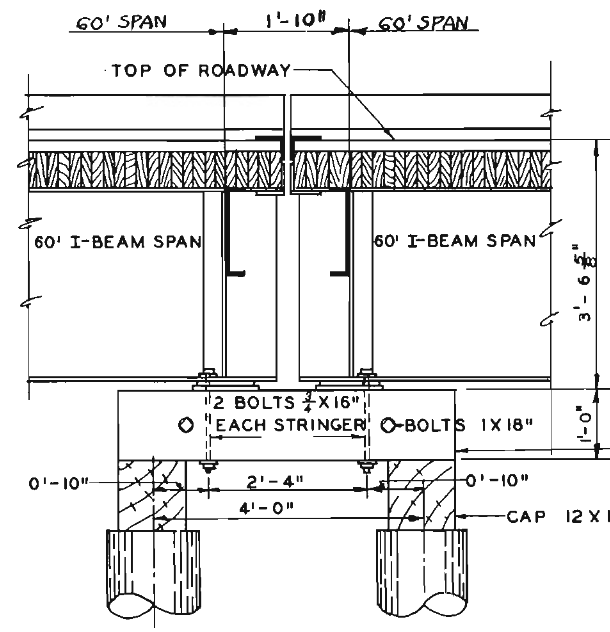
TIMBER GRILLAGE ABUTMENT



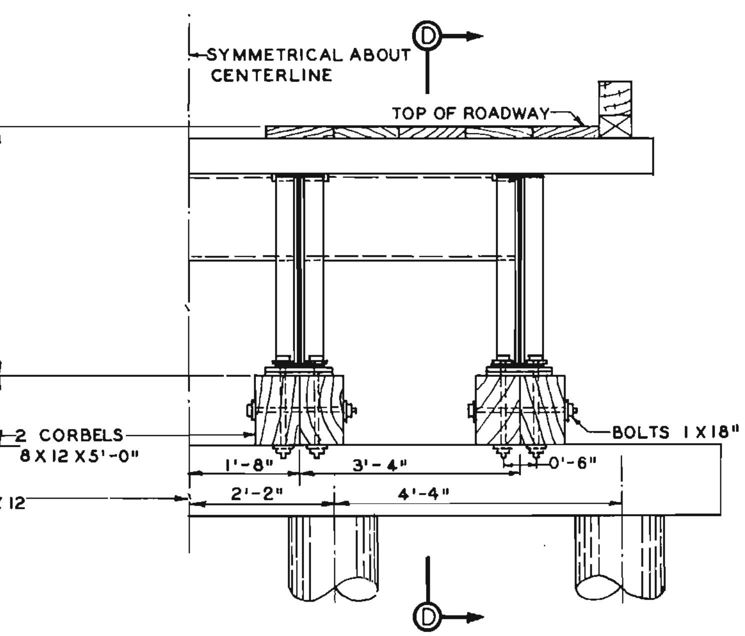
SECTION A-A

FOR DETAILS OF CLASS 50 SINGLE-LANE SIX-PILE PIER, SEE SHEET 32

STEEL PILE PIER



SECTION D-D



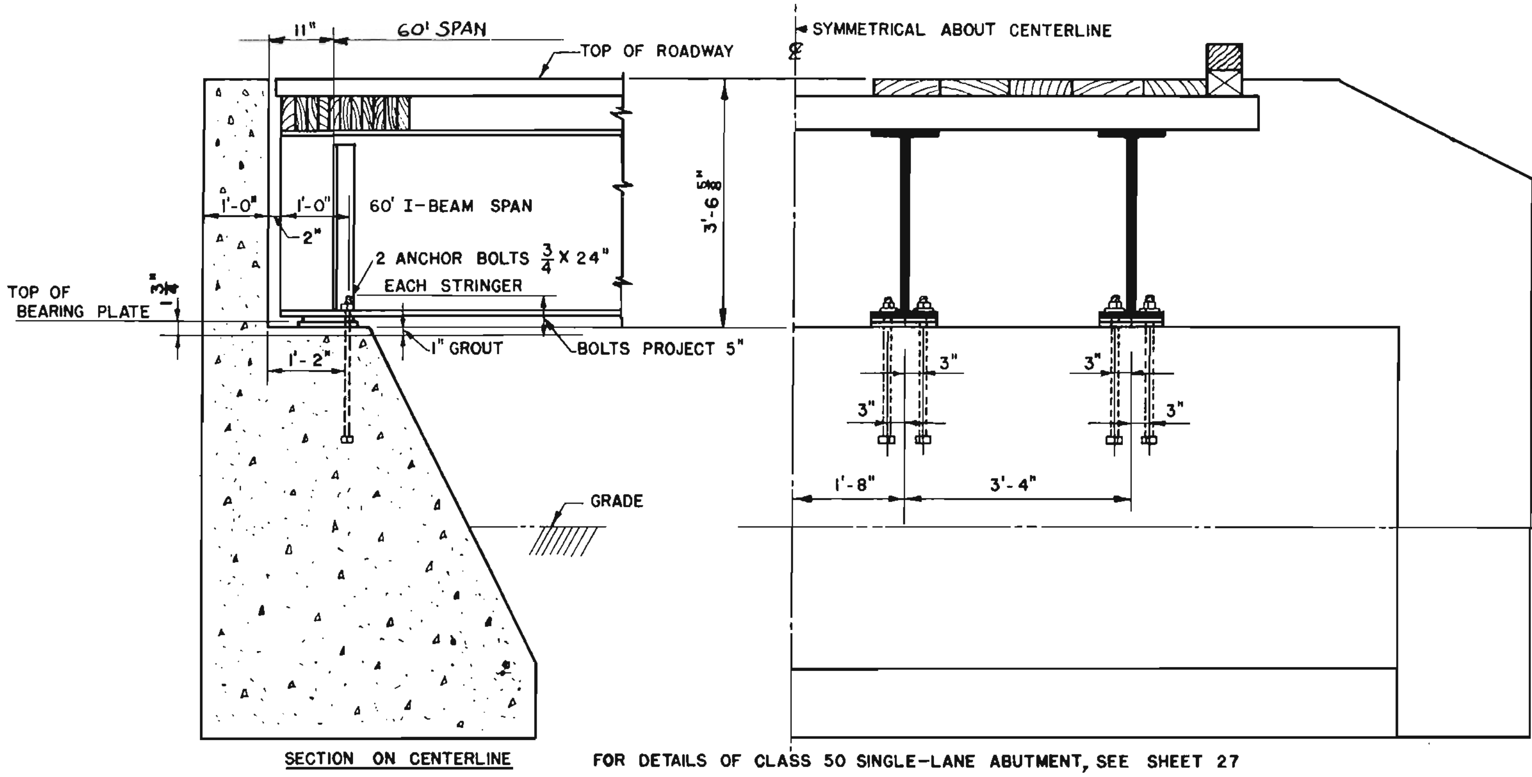
HALF TRANSVERSE SECTION

FOR DETAILS OF CLASS 50 SINGLE-LANE 8-PILE PIER, SEE SHEET 30

TIMBER PILE PIER

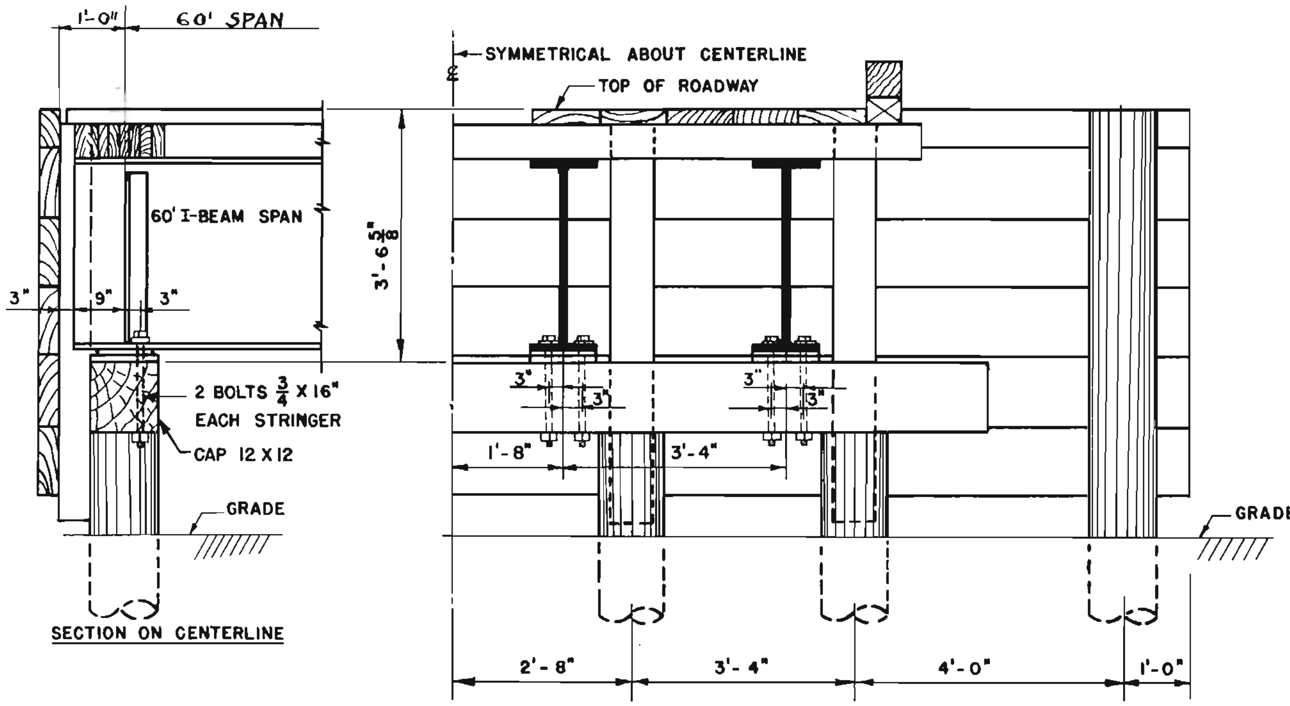
COMPANION SHEETS

	SHEET
TIMBER ABUTMENTS FOR STEEL SPANS	23,24
STEEL PILE ABUTMENTS FOR STEEL SPANS	25,26
CONCRETE ABUTMENTS FOR STEEL SPANS	27
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	238, 239



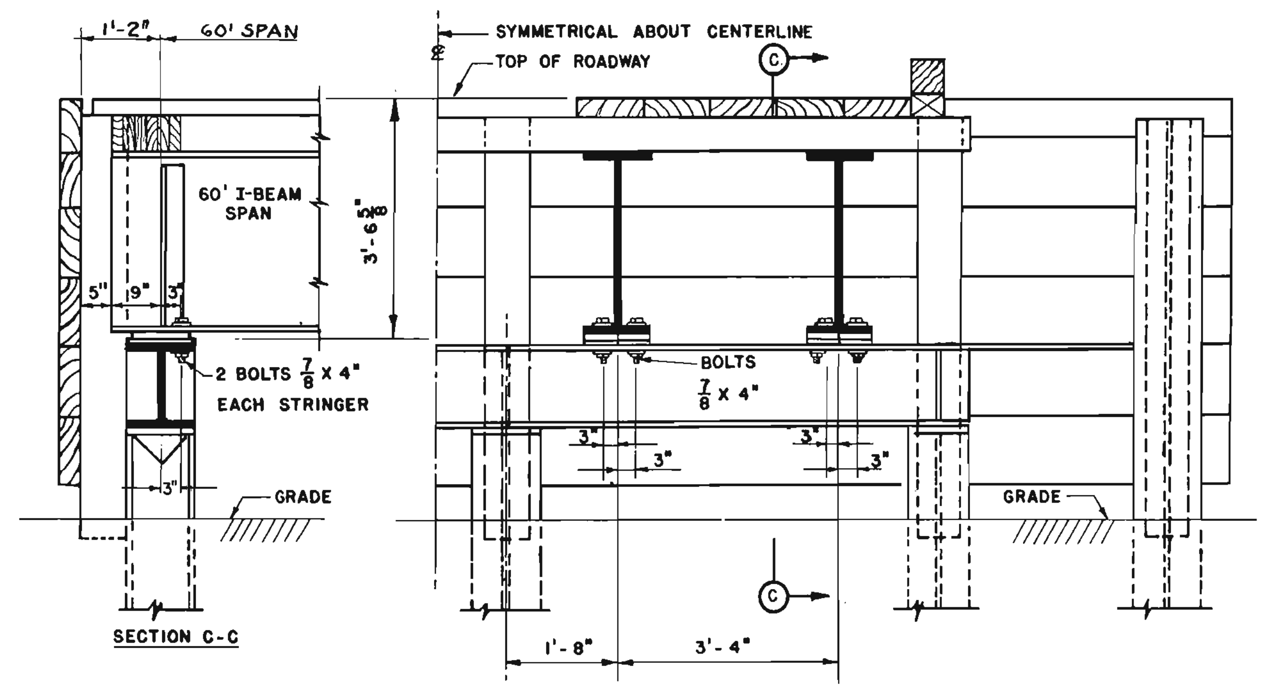
FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 27

CONCRETE ABUTMENT



FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 23 AND 24

TIMBER PILE ABUTMENT

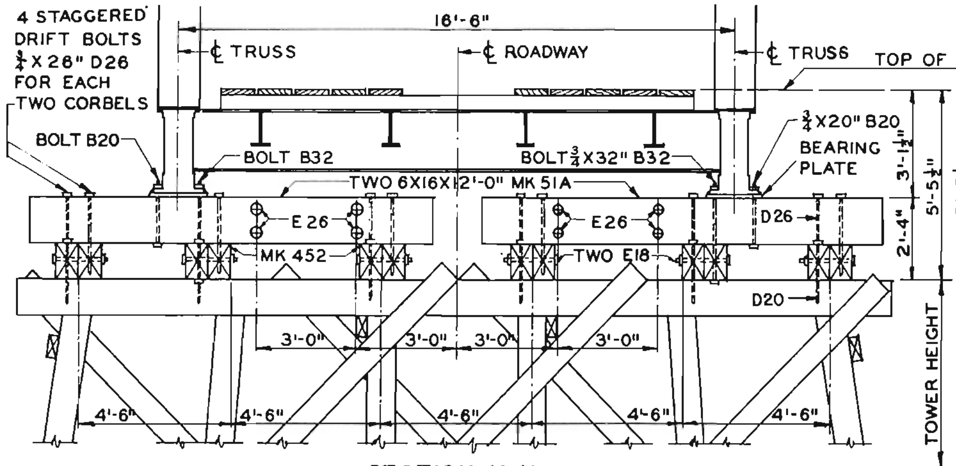


FOR DETAILS OF CLASS 50 SINGLE-LANE ABUTMENT, SEE SHEET 25 AND 26

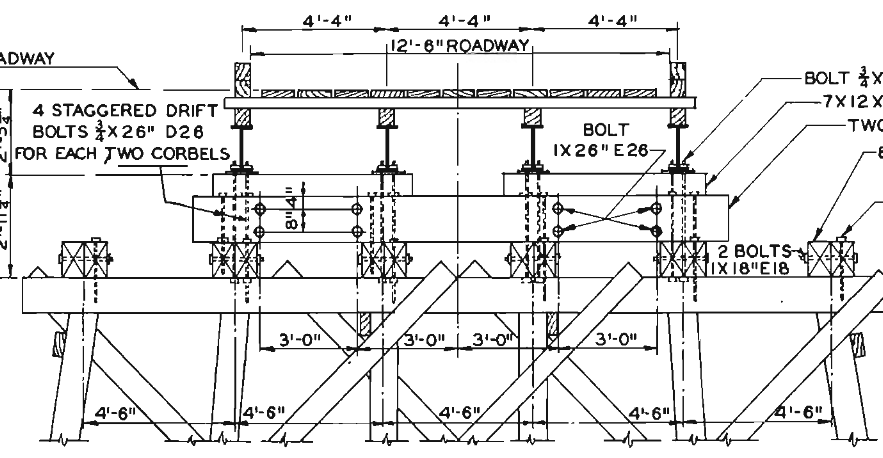
STEEL PILE ABUTMENT

COMPANION SHEETS

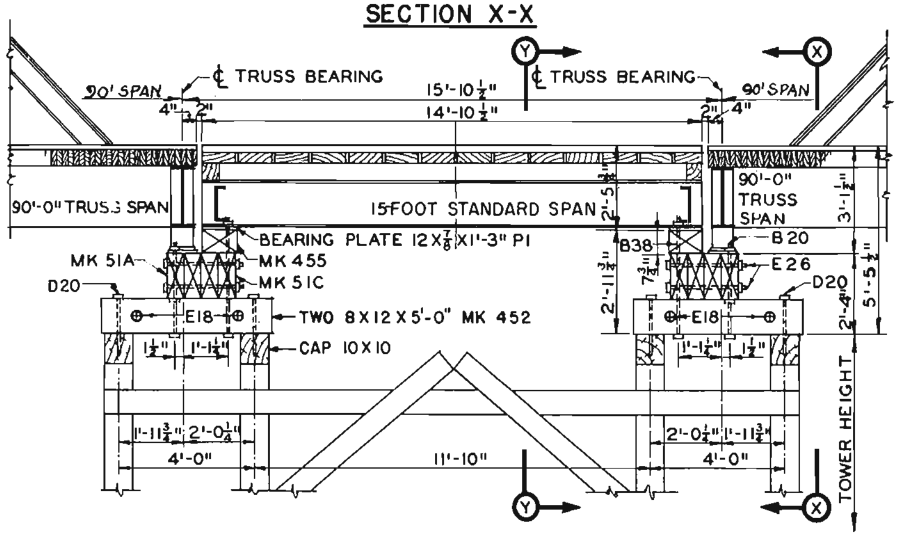
	SHEET
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	242
ADAPTATIONS	243
FRAMED TIMBER TOWERS	53
STEEL SPANS, 15-FOOT	4



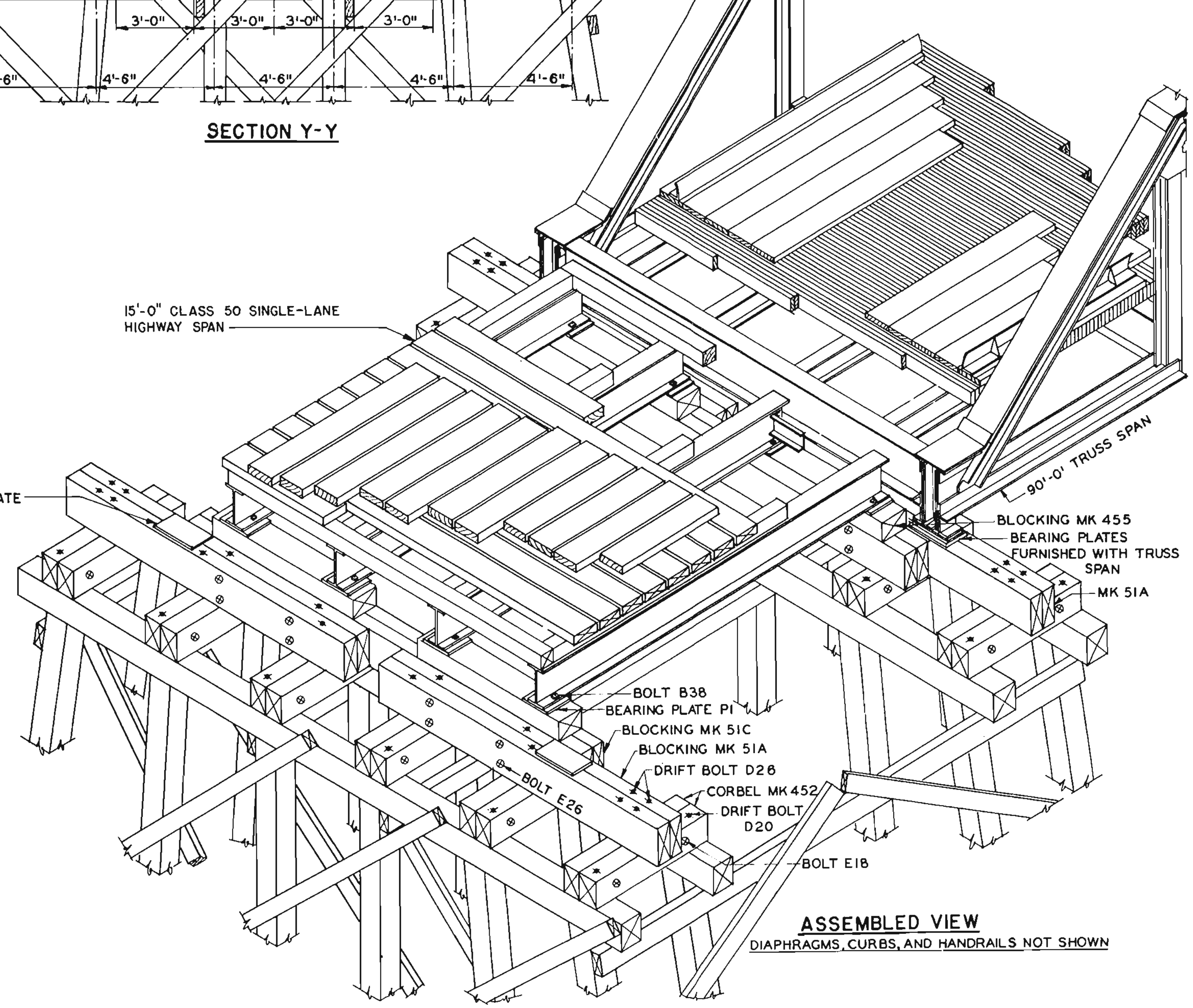
SECTION X-X



SECTION Y-Y



LONGITUDINAL SECTION THROUGH TOWER



ASSEMBLED VIEW

DIAPHRAGMS, CURBS, AND HANDRAILS NOT SHOWN

BILL OF MATERIAL FOR EXTRA HARDWARE AND LUMBER AT ONE TOWER

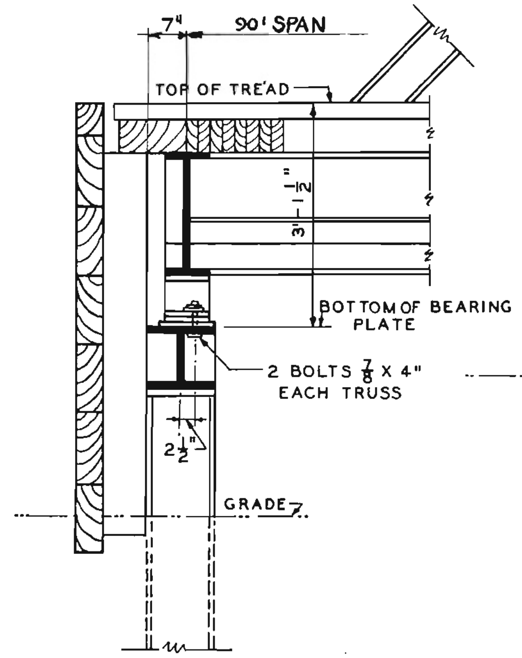
LINE	DESCRIPTION	STOCK NUMBER	MARK	SIZE (INCHES)	LENGTH	UNIT WEIGHT (POUNDS)	QUANTITY	FBM
1	CORBEL	39-6616.120-	452	8 X 12	5'-0"	150	24	960
2	BLOCKING		51C	6 X 16	16'-0"	480	4	512
3	DO		51A	6 X 16	12'-0"	360	8	768
4	DO	39-6616.120-	455	7¾ X 12	6'-0"	180	4	168
5	BEARING PLATE	47-7844.080-700	P1	12 X ⅞	1'-3"	45	8	
6	DRIFT BOLT	43-1636.070-200	D20	¾	20"	64 1/	24	
7	DO	43-1636.070-260	D26	¾	26"	180 1/	48	
8	MACHINE BOLT WITH SQUARE NUT AND TWO WASHERS	43-2325.070-200	B20	¾	20"	12 1/	4	
9	DO	43-2325.070-320	B32	¾	32"	18 1/	4	
10	DO	43-2325.070-380	B38	¾	38"	84 1/	16	
11	DO	43-2325.100-180	E18	1	18"	125 1/	24	
12	DO	43-2325.100-260	E26	1	26"	110 1/	16	

1/ TOTAL WEIGHT

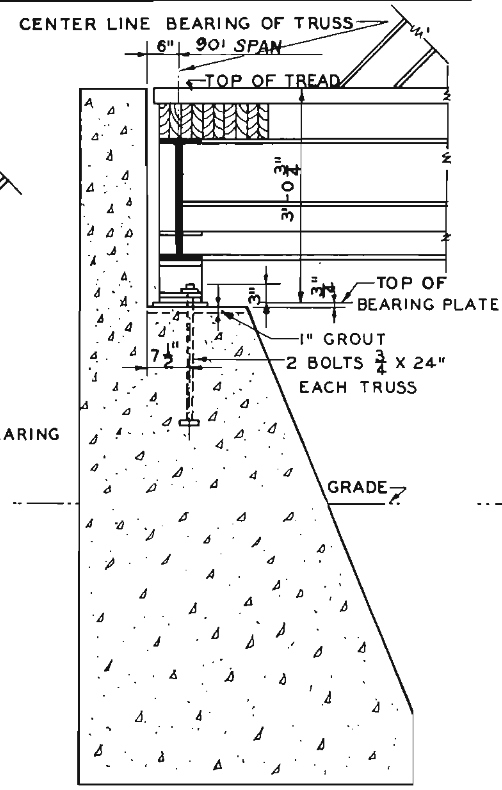
DIMENSIONS ON DOUBLE-LANE CLASS 25 STEEL PILE, CONCRETE AND CLASS 50 TIMBER PILE ABUTMENTS FOR 90-FOOT TRUSS SPAN (1943 DESIGN, TM 5-285)

COMPANION SHEETS

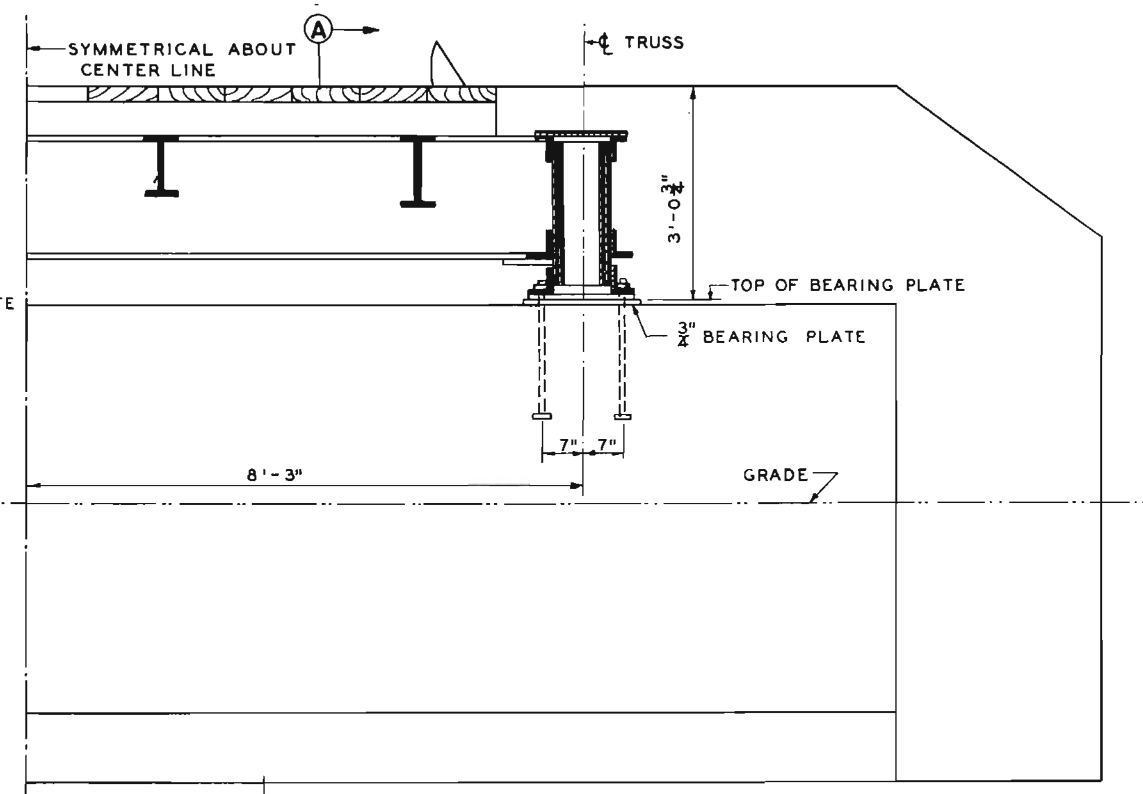
	SHEET
GENERAL NOTES	154
SYMBOLS	155
ADAPTATIONS	241,243
CONCRETE ABUTMENT	111
STEEL PILE ABUTMENT	109,110
TIMBER PILE ABUTMENT	64



SECTION B-B

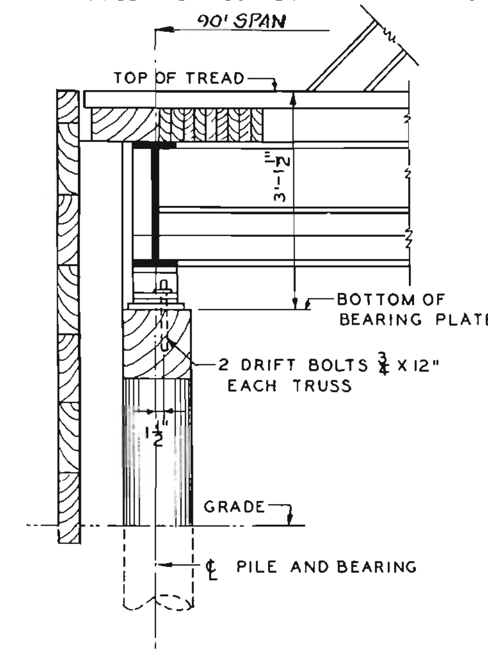


SECTION A-A



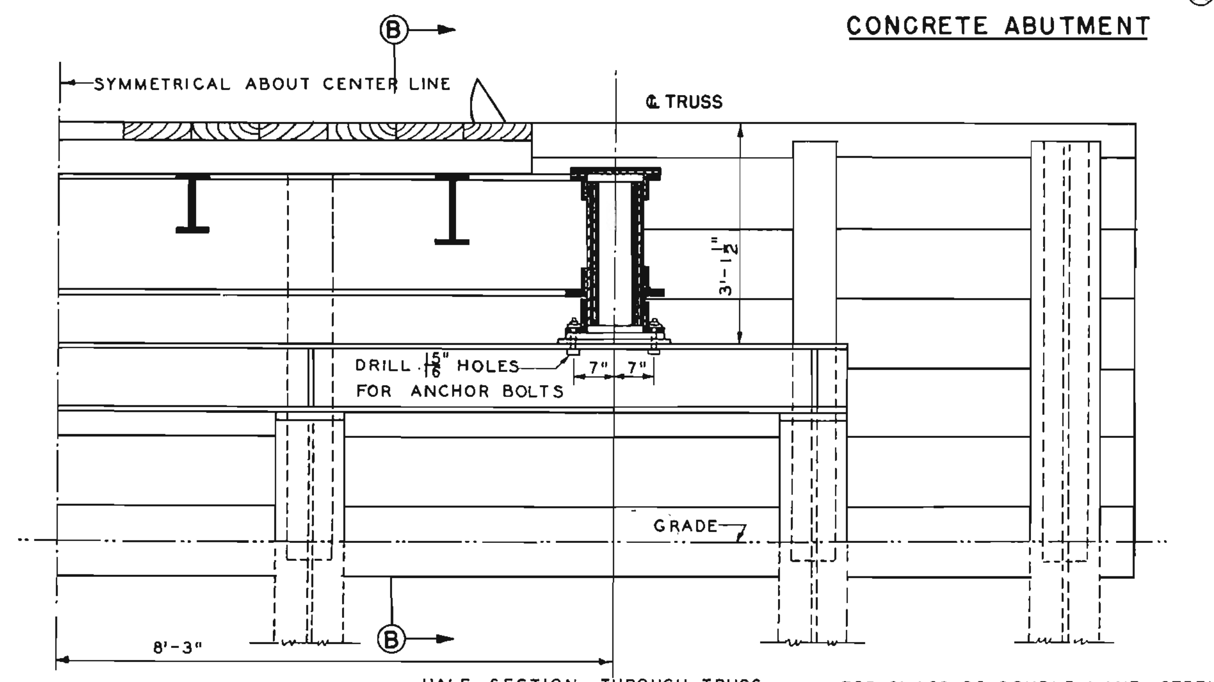
FOR CLASS 25 DOUBLE-LANE CONCRETE ABUTMENT, SEE SHEET 111

HALF SECTION THROUGH TRUSS



SECTION C-C

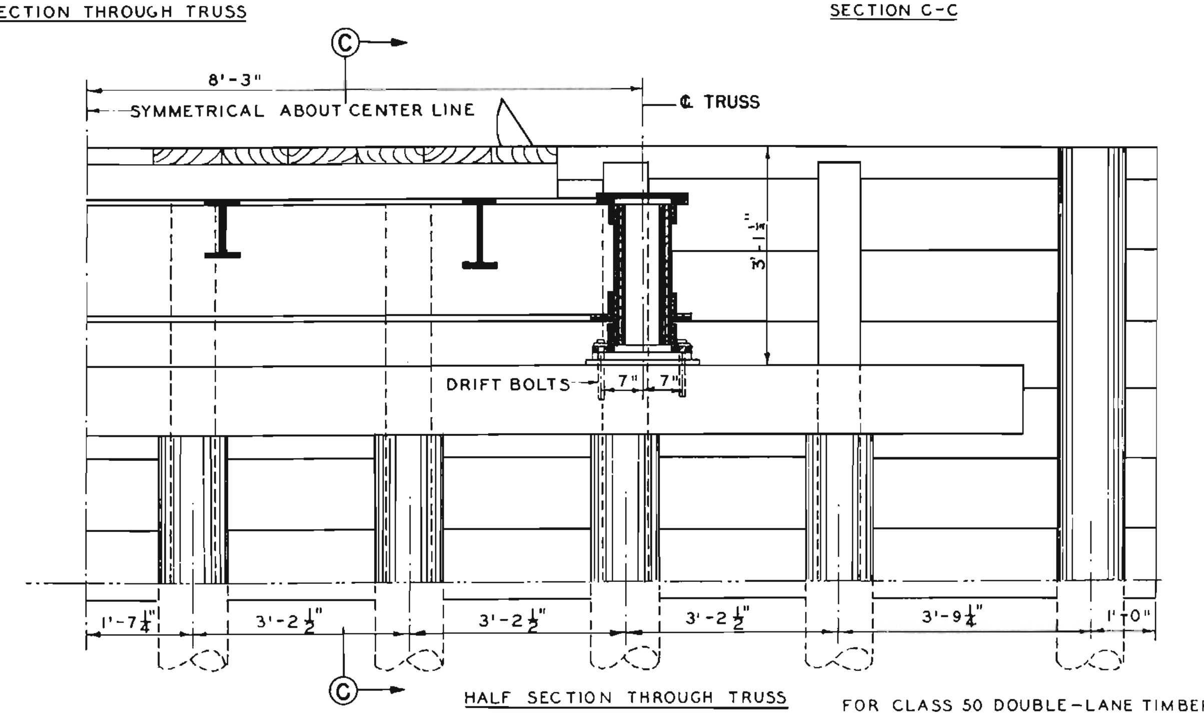
CONCRETE ABUTMENT



HALF SECTION THROUGH TRUSS

FOR CLASS 25 DOUBLE-LANE STEEL PILE ABUTMENT, SEE SHEET 110

STEEL PILE ABUTMENT



HALF SECTION THROUGH TRUSS

FOR CLASS 50 DOUBLE-LANE TIMBER PILE ABUTMENT, SEE SHEET 64

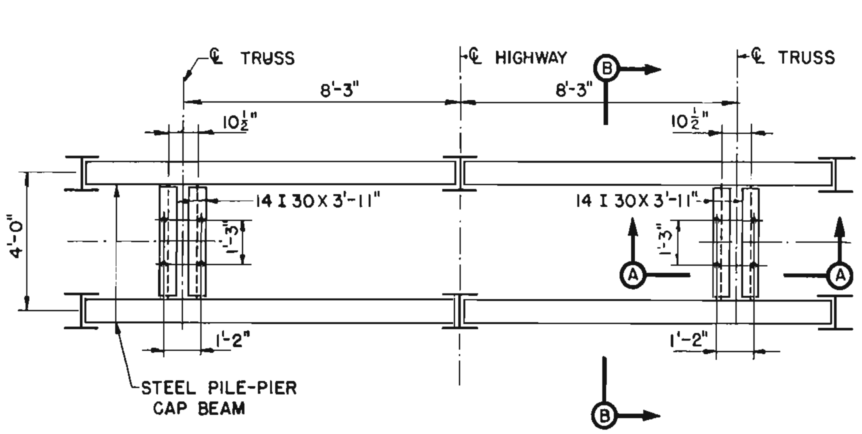
TIMBER PILE ABUTMENT

920303 O - 50 - 44

DIMENSIONS ON CLASS 50 DOUBLE-LANE PILE PIERS AND GRILLAGE ABUTMENTS FOR 90-FOOT TRUSS SPAN (1943 DESIGN, TM 5-285)

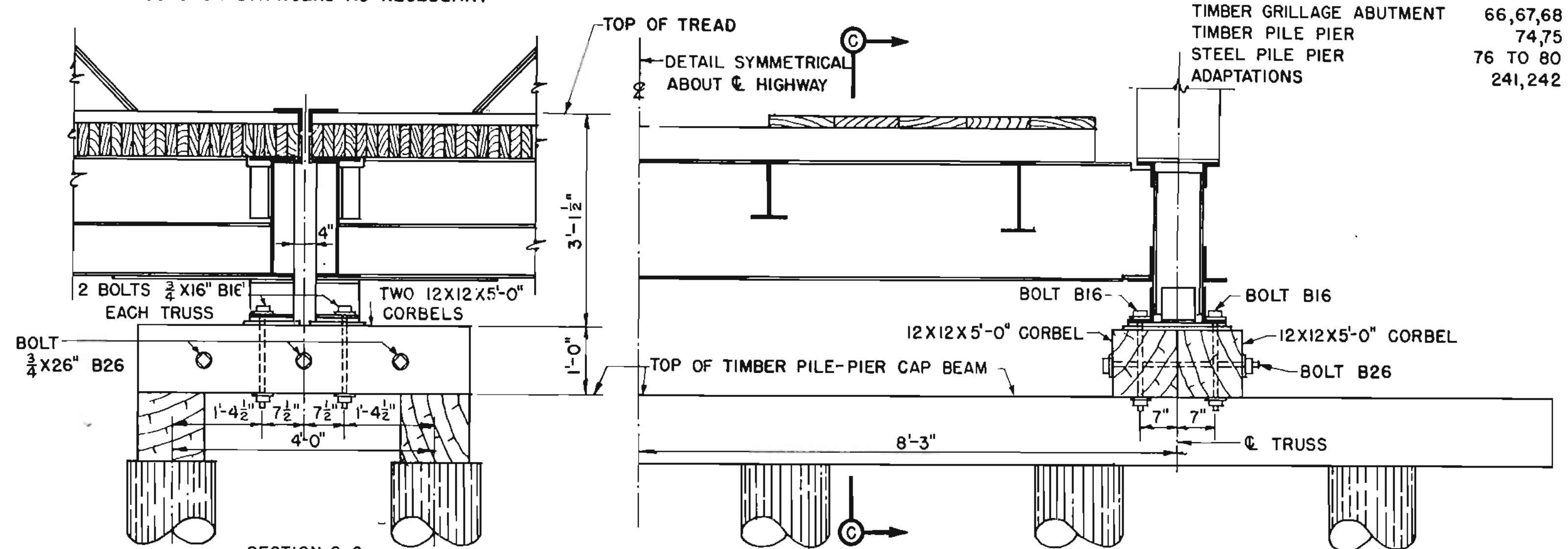
COMPANION SHEETS

	SHEET
GENERAL NOTES	154
SYMBOLS	155
TIMBER GRILLAGE ABUTMENT	66,67,68
TIMBER PILE PIER	74,75
STEEL PILE PIER	76 TO 80
ADAPTATIONS	241,242



TOP PLAN

TO USE ONE 90' TRUSS WITH OTHER SPANS, SUPPORT OTHER STRINGERS ON TWO CORBELS 8X12X5'-0" AND BLOCK UNDER TRUSSES OR STRINGERS AS NECESSARY

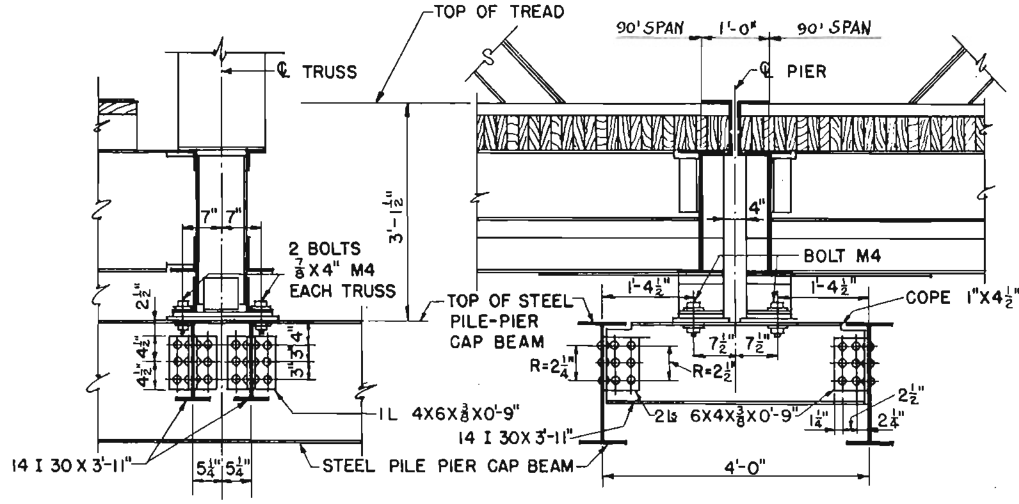


SECTION C-C

TRANSVERSE SECTION THROUGH TRUSS

MODIFIED TIMBER PILE PIER

(SEE SHEET 75 FOR DIMENSIONS OF CLASS 50 DOUBLE-LANE HIGHWAY TIMBER PILE PIER NOT SHOWN THIS DETAIL)

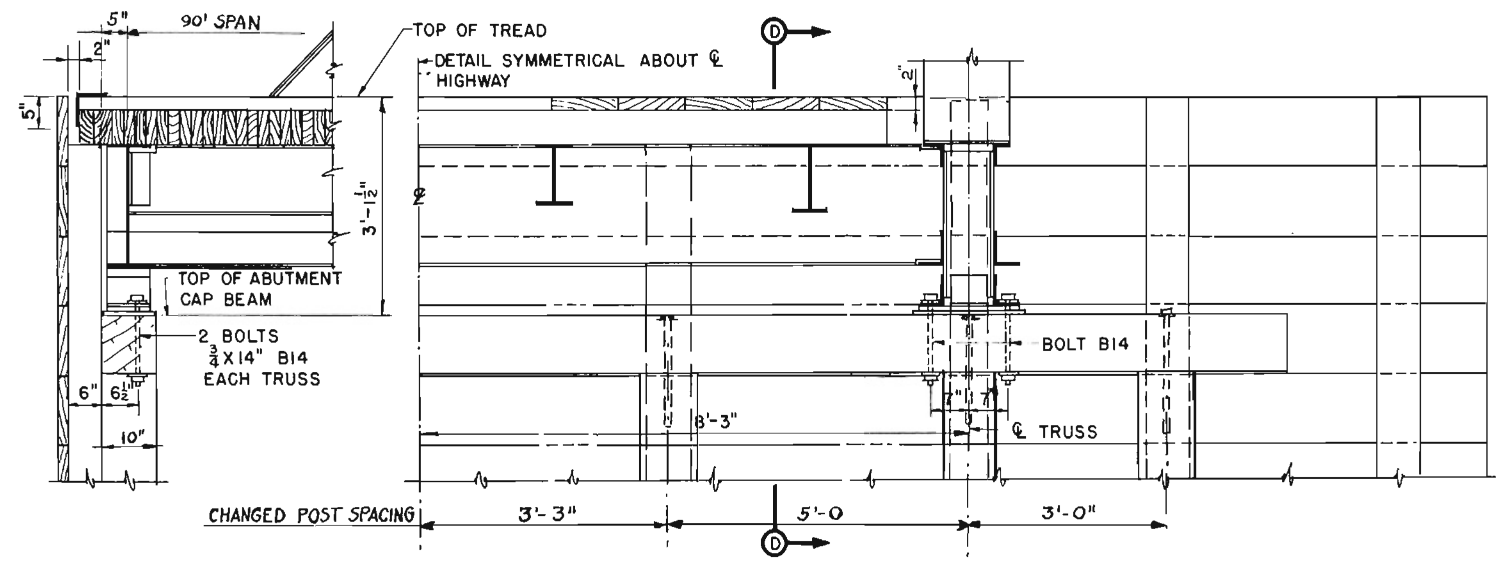


SECTION A-A

SECTION B-B

MODIFIED STEEL PILE PIER

(SEE SHEETS 76 TO 80 FOR DIMENSIONS OF CLASS 50 DOUBLE-LANE HIGHWAY STEEL PILE PIER NOT SHOWN THIS DETAIL)



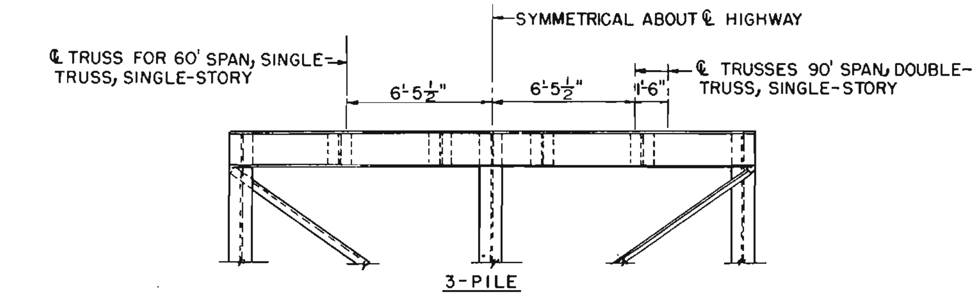
SECTION D-D

TRANSVERSE SECTION THROUGH TRUSS

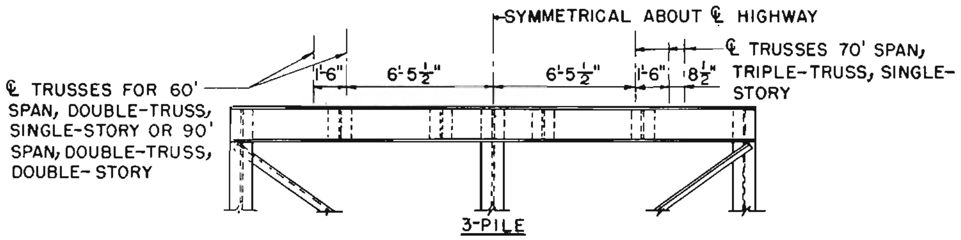
MODIFIED TIMBER GRILLAGE ABUTMENT

(SEE SHEET 67 FOR DIMENSIONS OF CLASS 50 DOUBLE-LANE HIGHWAY TIMBER GRILLAGE ABUTMENT NOT SHOWN THIS DETAIL).

STEEL AND TIMBER PILE BENT AND ABUTMENT, AND TIMBER PILE PIER FOR UP TO 90-FOOT BAILEY-BRIDGE SPANS (TM 5-277)

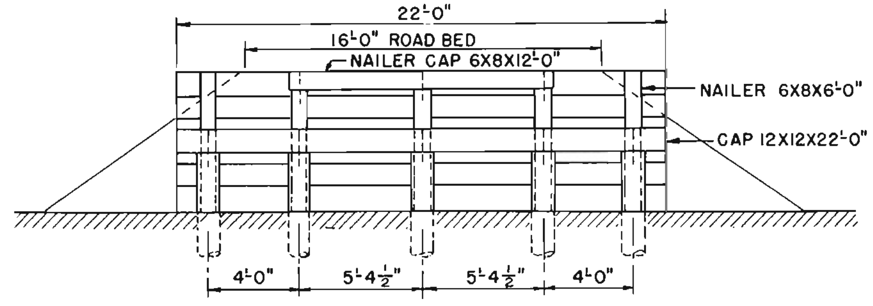


STEEL PILE BENT



STEEL PILE BENT

FOR DETAILS OF STEEL PILE BENT, SEE SHEET 116



ELEVATION, TIMBER PILE ABUTMENT

DETAILS NOT SHOWN ARE SAME AS SHEET 21

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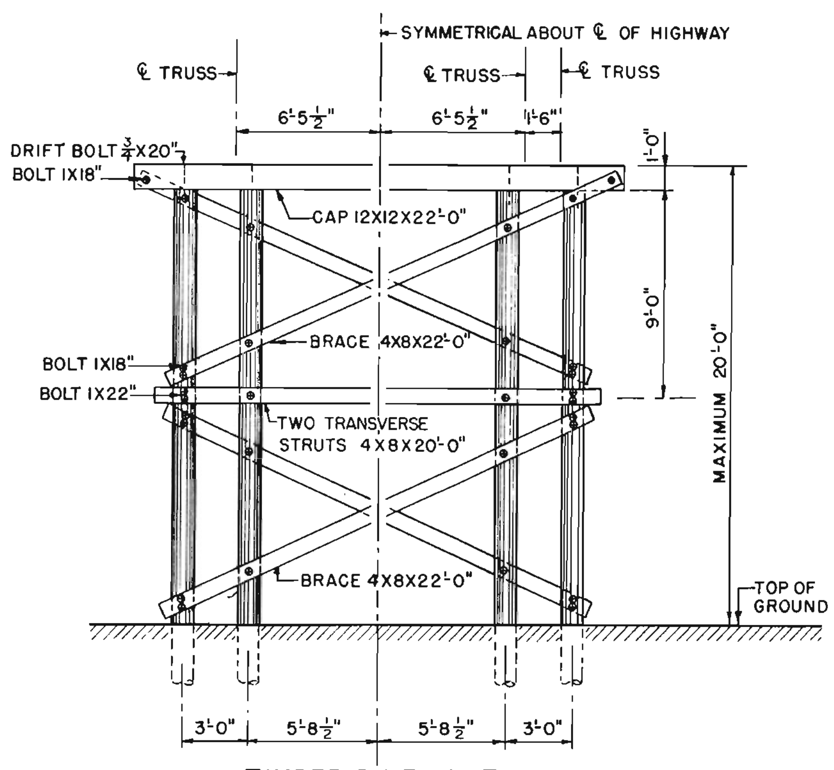
CONCRETE ABUTMENT SEE SHEET 111
STEEL PILE ABUTMENT SEE SHEET 69

REQUIRED PILE BEARING CAPACITIES (TONS)

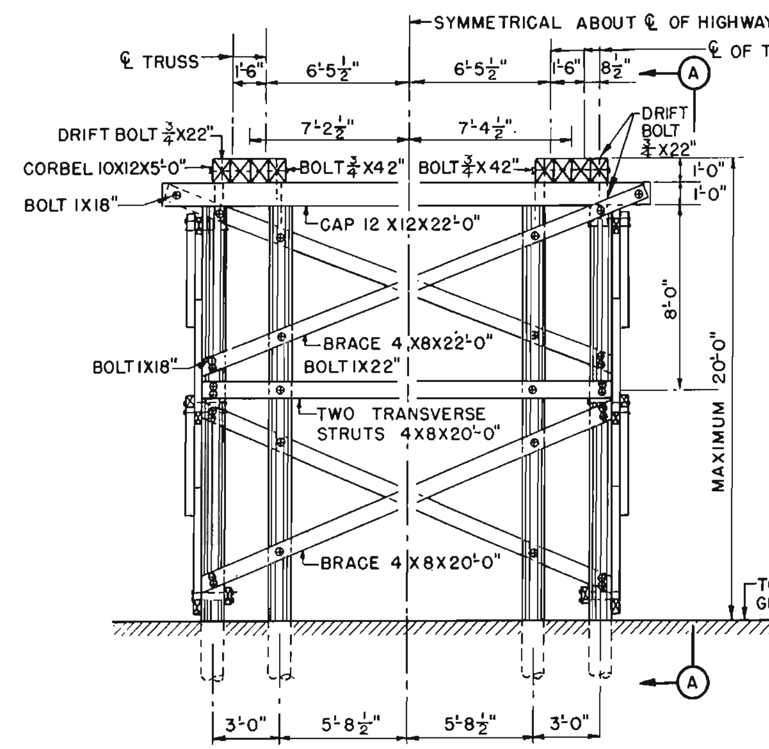
TYPE OF SPAN	STEEL PILE BENT	STEEL PILE ABUTMENT	TIMBER PILE ABUTMENT
60' SPAN, SINGLE-TRUSS, SINGLE STORY	25 TONS	16 TONS	16 TONS
90' SPAN, DOUBLE-TRUSS, DO	29 DO	16 DO	14 DO
60' SPAN, DOUBLE-TRUSS, DO	37 DO	24 DO	20 DO
70' SPAN, TRIPLE-TRUSS, DO	42 DO	25 DO	20 DO
90' SPAN, DOUBLE-TRUSS, DOUBLE-STORY	50 DO	31 DO	20 DO

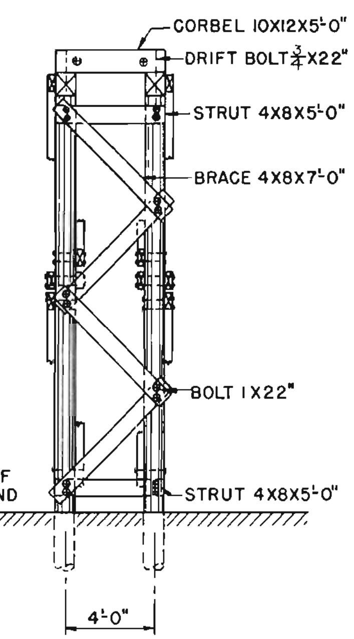


TIMBER PILE BENT

HALF ELEVATION
60' SPAN, SINGLE-TRUSS, SINGLE-STORY;
REQUIRED PILE BEARING CAPACITY 18 TONS

HALF ELEVATION
90' SPAN, DOUBLE-TRUSS, SINGLE-STORY;
REQUIRED PILE BEARING CAPACITY 16 TONS



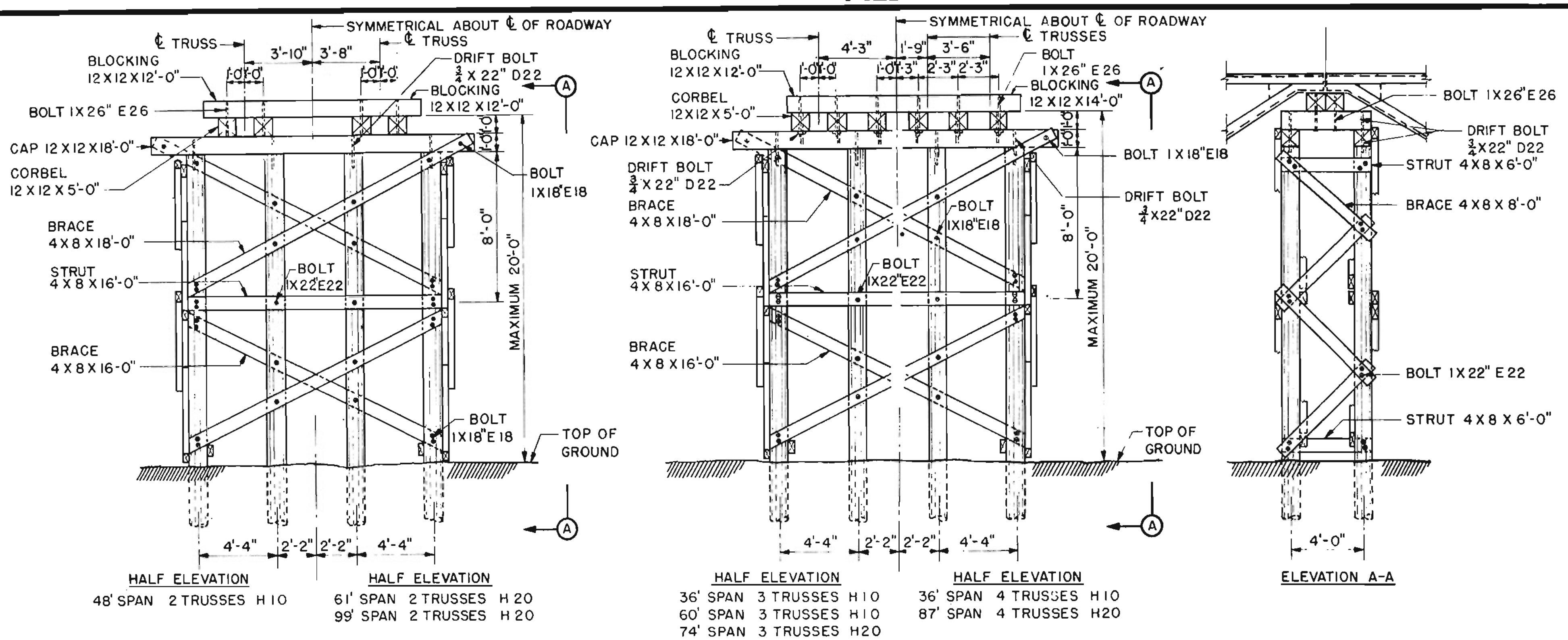


TIMBER PILE PIER

ELEVATION A-A

HALF ELEVATION
60' SPAN, DOUBLE-TRUSS, SINGLE-STORY;
REQUIRED PILE BEARING CAPACITY 11 TONS
OR
90' SPAN, DOUBLE-TRUSS, DOUBLE-STORY;
REQUIRED PILE BEARING CAPACITY 15 TONS

HALF ELEVATION
70' SPAN, TRIPLE-TRUSS SINGLE-STORY;
REQUIRED PILE BEARING CAPACITY 13 TONS



TIMBER PILE PIERS

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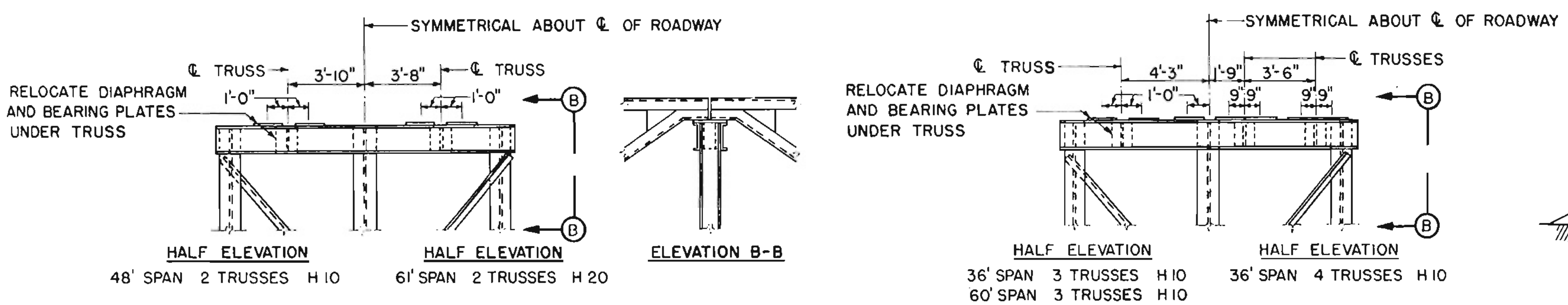
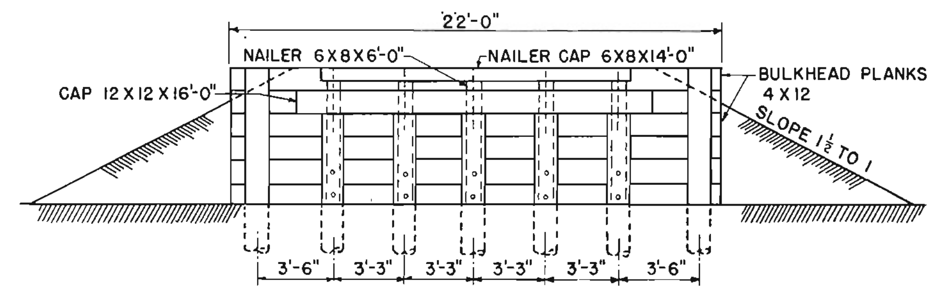
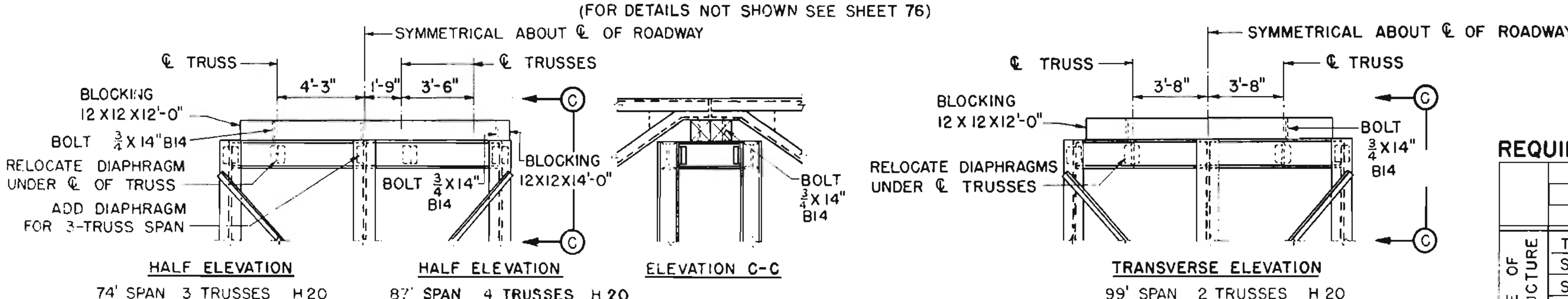
   99' SPAN 2 TRUSSES H 20
   36' SPAN 3 TRUSSES H 10
   36' SPAN 4 TRUSSES H 10
   48' SPAN 2 TRUSSES H 10
   60' SPAN 2 TRUSSES H 10



STEEL-PILE BENTS
(FOR DETAILS NOT SHOWN SEE SHEET 76)



TIMBER PILE ABUTMENT B
74' SPAN 3 TRUSSES H 20
87' SPAN 4 TRUSSES H 20
(FOR DETAILS NOT SHOWN SEE SHEET 21)



STEEL-PILE PIERS
(FOR DETAILS NOT SHOWN SEE SHEET 32)

REQUIRED BEARING CAPACITY OF PILES (TONS PER PILE)

SPAN	36'	36'	48'	60'	61'	74'	87'	99'
NUMBER OF TRUSSES	3	4	2	3	2	3	4	2
TYPE OF TRUSS	H 10	H 10	H 10	H 10	H 20	H 20	H 20	H 20
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