ACI DETAILING MANUAL-2004

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Including:

- Details and Detailing of Concrete Reinforcement (ACI 315-99)
- Manual of Structural and Placing Drawings for Reinforced Concrete Structures (ACI 315R-04)
- Supporting Reference Data

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The sample drawings in this manual are shown as a standard method of presenting information, not to establish standards for design. The drawings are intended to illustrate that it is the designer's function to tell the detailer specifically what he or she wants and needs. Locations of cutoff points and bends, amounts of steel, etc., are shown as examples of how the designer conveys the needed information, not as design recommendations for a specific structure.

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CONTENTS

Details and Detailing of Concrete Reinforcement (ACI 315-99)

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This document provides standards of practice for both the architect/engineer (A/E) and reinforcing steel detailer in showing reinforcing steel details. It is divided into three parts: one addressed to the A/E, one for the detailer, and a third providing reference tables and figures. It defines the responsibilities of both the A/E and detailer. It then establishes certain standards of practice for both the structural and placing drawings.

Keywords: beams (supports); bending (reinforcing steels); bridges (structures); buildings; columns (supports); concrete slabs; detailing; drafting (drawing); fabrication; floor systems; foundations; hooked reinforcing steels; microcomputers; placing drawings; reinforced concrete; reinforcing steels; splicing; stirrups; structural design; structural drawings; ties; tolerances (mechanics); walls; welded wire fabric.

CONTENTS

FOREWORD

Increased use of computers has led to sophisticated techniques of structural analysis and has increased manufacturing and fabrication capabilities. This added degree of

ACI 315-99 supersedes ACI 315-92 and became effective August 31, 1999.

sophistication has resulted in more complex structures being designed and built with structural members that have long spans, shallow depths, and contain a high percentage of reinforcing steel.

In the past, during the course of developing placing drawings, the detailer often suggested solutions in areas where the details were incomplete and where the reinforcing steel appeared to have constructibility problems. Usually these solutions were used only after their acceptance by the architect/engineer (A/E). Unfortunately, many problems do not surface during the detailing phase but rather occur during construction. The A/E and the contractor, working together, then solve the problem.

The A/E prepares the structural design to meet the requirements of the applicable building code and provides sufficient definition through the contract documents to convey all the requirements for detailing reinforcing steel. It is then the detailer's responsibility to develop all of the dimensions and quantities of the reinforcing steel to conform with the structural drawings and project specifications of the A/E.

As the complexity of design and construction increases, it is imperative that both the A/E and detailer understand their responsibilities clearly. The responsibilities of the A/E and the detailer, as they apply to the reinforced-concrete industry, are stated more clearly by the following separate sections.

This standard presents values in inch-pound and SI units. Hard metric values are usually not exact equivalents; therefore, each system is to be used independently of the other. Combining inch-pound and hard metric values can result in nonconformance with the standard. Soft metric values are exact equivalents, so combining inch-pound and soft metric values conforms to the standard.

PART A—RESPONSIBILITIES OF THE ARCHITECT/ENGINEER

CHAPTER 1—STRUCTURAL DRAWINGS

1.1—General

Structural drawings are those prepared by the A/E for the owner or purchaser of engineering services. The structural drawings and the project specifications form a part of the contract documents. Structural drawings must contain an adequate set of notes and all other essential information in a form that can be quickly and correctly interpreted. These drawings must convey definite instructions and show reinforcing bars and welded wire fabric. Structural and placing drawings may be combined.*

The responsibility of the A/E is to furnish a clear statement of design requirements to the detailer. The A/E's project specifications or structural drawings must not merely refer the detailer to an applicable building code for information to use in preparing the placing drawings. Instead, this information shall be interpreted by the A/E and shown in the form of specific design details or notes for the detailer to follow. Where omissions, ambiguities, or incompatibilities are discovered, additional information, clarifications, or corrections shall be requested by the detailer and provided by the A/E. The A/E should require in the specifications that placing drawings be submitted for approval.

Section 1.2.1 of ACI 318 (318M), Building Code Requirements for Structural Concrete, lists the information that shall be presented on the structural drawings or in the project specifications, which includes the following:

1. Anchorage length of reinforcing steel and location and length of lap splices; and
2. Type and location of mechanical and welded splices of reinforcing steel.

1.2—Drawing standards

1.2.1 *Materials*—The minimum standard media for production of structural drawings should be penciled on tracing paper. Other media providing improved reproducibility or durability, such as microfilm, electronic files, ink, tracing cloth, or polyester film, can also be used.

1.2.2 *Sizes*—Drawings should be made in standard sizes. All sheets in any one set of drawings should be the same size. There are two well-recognized sets of standard sizes.

Commercial standards:
18 x 24 in. (457 x 610 mm)
24 x 36 in. (610 x 914 mm)
27 x 36 in. (686 x 914 mm)
30 x 42 in. (762 x 1067 mm)

Federal agencies:
17 x 22 in. (432 x 559 mm)
22 x 34 in. (559 x 864 mm) + 2 in. (51 mm) binding (AASHTO)
28 x 40 in. (711 x 1016 mm) + 2 in. (51 mm) binding
30 x 42 in. (762 x 1067 mm)

All dimensions are to the cutting line outside the margin. Border lines are inside these dimensions. Requirements for placing drawings are in Part B, addressed to the detailer.

1.2.3 *Direction*—An arrow indicating the direction of North should be placed on every drawing that contains a plan view.

1.2.4 *Scales*—The scales used should be indicated on all structural drawings, preferably under the title of each view. Drawings that can be enlarged or reduced in reproduction should show a graphic scale, as well as a descriptive one, to aid the user.

1.2.5 *Lettering*—All lettering must be clear and legible. If reduced-scale photographic prints are made for field use, lettering must be correspondingly larger and meet microfilming standards in accordance with the Association for Information and Image Management (formerly the National Microfilm Association) publication "Modern Drafting Techniques for Quality Microreproductions."

1.3—Structural drawings—Buildings and other structures

1.3.1 *General*—Structural drawings and project specifications for elements such as beams, girders, columns, walls, and foundations shall show the type and grade of reinforcing steel, any special coatings, service live load, partition, ceil-

*Requirements for placing drawings are in Part B, addressed to the detailer.

ing and hanging loads, or any special dead loads other than the self-weight (mass) and concrete strength. Structural drawings and project specifications shall also show concrete dimensions, anchorage length of reinforcing steel and location and length of lap splices, type and location of mechanical and welded splices of reinforcing steel, concrete cover for the reinforcing steel, required joints, and any other information needed for the preparation of the placing drawings. Sleeve locations and any special reinforcing steel around sleeves or openings shall be indicated by the A/E. See Fig. 1, 2, 3, 4, 5, 6, and 7 (in Part C—Figures and Tables), for examples. In addition to these requirements, structural drawings of beams, girders, and columns must also show the information presented below.

1.3.2 *Beams and girders*—Schedules for beams and girders must contain the beam mark, size of member, number and size of straight and bent bars, special notes on bending, number, size, and spacing of stirrups or stirrup-ties, location of top bars, and any special information, such as the requirement of two layers of reinforcing steel. Show sections for beam-column joints, where necessary.

In continuous beams, the number and spacing of top bars to be placed in T-beam flanges (slabs) for crack control shall be shown, if so required by the design.

1.3.3 *Columns*—Column designs shall show the size of columns, number, locations, grade, and size of reinforcing steel, and all necessary details where column section or reinforcement changes. Method of splicing shall always be defined clearly, showing arrangement of splices, type (lap, mechanical or welded), length (if lap splice), and stagger. Orientation of reinforcing steel in two-way symmetrical columns shall be shown when reinforcing steel is not two-way symmetrical.

1.4—Structural drawings—Highway and transportation structures*

1.4.1 *Dimensions*—Because the structural drawings for highway structures usually are a combination of structural and placing drawings from which the structure will be built, all dimensions must be shown clearly. Drawings must show the dimensions of concrete protection for all reinforcing steel.† Where separate placing drawings are prepared, structural dimensions may be omitted, following the same practice as for buildings (see Section 3.5).

1.4.2 *Reinforcing steel*—Combination structural-placing drawings shall show the size, spacing, and location of the bars and welded wire fabric in the structure. The list of bars must show the number of pieces, size, length, mark of bars, and bending details of all bent bars. The list of welded wire fabric must show the mark, style, width, length, and number of pieces.

Reinforcing steel for larger structures is sometimes detailed, fabricated, and delivered by units, for example, footings, abutments, piers, and girders. The reinforcing steel list may be subdivided similarly. If the structure is sufficiently large, a separate drawing and reinforcing steel list is usually made for each unit.

Reinforcing steel for foundations, piers, abutments, wing walls, and slabs are usually shown on a plan, section, or elevation view on the drawings. Cross sections must be provided for clarification where necessary. The reinforcing steel list is a complete summary of materials required. All bars should appear at least once in a plan or elevation view and in a sectional view, or both.

For reference data on reinforcing bars and welded wire fabric from industry sources, refer to the Supporting Reference Data section of ACI SP-66. This section includes specific information on applicable ASTM specifications, coated reinforcing bars, common styles and design data for welded wire fabric, and reinforcing bar supports.

CHAPTER 2—STANDARDS OF PRACTICE

2.1—General

This chapter provides the A/E with minimum standards for application during the development of the design. Information presented here is a collection of notes derived from ACI 318 (318M); ACI 343R; AREMA *Manual for Railway Engineering*, Chapter 8, "Concrete Structures and Foundations;" and AASHTO "Standard Specifications for Highway Bridges," industry practice, practical considerations, and research results current at the time of this report. Reinforcing steel for structures designed under the provisions of ACI 349, ACI 359, and other similar documents can generally incorporate the direction given in this standard unless otherwise prohibited by the provisions of the respective related documents.

2.2—Tolerances

ACI 117 provides standard tolerances for concrete construction. Practical limitations of equipment and production efficiency have led to the establishment of certain fabrication tolerances that can be met with standard shop equipment. These standard tolerances are shown in Fig. 8 and 9 (in Part C) for both straight and bent bars. Where more restrictive tolerances are required than those shown in the referenced figures, they shall be indicated in the contract documents. The effects of tolerances on cover, strength, constructibility, and serviceability of the structure should be considered by the A/E.

2.3—Bar lengths

Placing drawings and bar lists must show all bar dimensions as out-to-out with bar lengths as the sum of all detailed dimensions, including hooks A and G (Table 1 in Part C).

2.4—Hooks and bends

Hooks and bends are specified to standardize the fabrication procedure and to limit the concrete stresses in the area of the hooks. See Table 1 and Fig. 10 in Part C.

2.5—Beams and girders

2.5.1 *Beam widths*—To permit satisfactory placing of concrete and to furnish adequate concrete protection, the A/E must provide for adequate clear distance between parallel bars and between bars and forms.

*The term "highway and transportation structures" used herein includes bridges, drainage, and related structures.

†Subject to requirements of ACI 318 (318M), Section 7.7, or the AASHTO bridge specifications, Articles 8.22 and 9.26.

The A/E must specify the required concrete protection for the reinforcing steel. The A/E must also specify the distance between bars for development and concrete placing. For buildings, the clear space is the larger of one bar diameter, 1-1/3 the maximum size of coarse aggregate to be used, and 1 in. (25 mm). For cast-in-place bridges, required clear space is the larger of 1.5 bar diameters, 1.5 maximum size aggregate, and 1.5 in. (40 mm).

Tables in the supporting reference data section give a wide range of beam widths and the maximum number of bars permitted in a single layer for 3/4 and 1 in. (20 and 25 mm) maximum aggregate size as provided by ACI 318 (318M).

Other tables in the supporting reference data section similarly give the same information for beams designed under the provisions of the AASHTO bridge specifications. These tables are provided for the use of the A/E; the detailer is not in a position to determine whether bars should be permitted to be placed in more than a single layer.

2.5.2 *Stirrup anchorage*—The A/E shall show or specify by notes the sizes, spacings, location, and types of all stirrups. These types include open stirrups and closed stirrups (or stirrup-ties) (Fig. 11 and 12 in Part C). Stirrups are most often fabricated from reinforcing bars, but may also be fabricated from welded wire fabric.

There are various permissible methods of anchorage, but the most common is to use one of the standard stirrup-tie types as shown in Fig. 10. Types S1 through S6, T1, T2, and T6 through T9 standard tie and stirrup hooks are shown in Table 1. Where stirrup support bars are required, they must be specified by the A/E. In designing the anchorage, allowance must be made to ensure that the ends of the stirrup hook are fully encased in concrete, as when hooks turn outward into shallow slabs.

Where the design requires closed stirrup-ties for shear, the closure may consist of overlapped, standard 90 degree end hooks of one- or two-piece stirrups, or properly spliced pairs of U-stirrups. Where the design requires closed ties for torsion, the closure may consist of overlapped, standard 135 degree hooks of one- or two-piece ties enclosing a longitudinal bar. At least one longitudinal bar shall be located inside each corner of the stirrups or ties, the diameter of this bar to be equal to at least the diameter of the stirrup (No. 4 [No. 13] minimum). Ties provided to resist radial forces resulting from bar or tendon curvature shall be anchored adequately.

2.5.3 *Spacings of bundled bars*—When bars are placed in contact with each other in groups of two, three, or four—known as bundled bars—the minimum clear space provided between bundles for buildings under ACI 318 (318M) shall be equal to the diameter of a single, round bar having an area equivalent to the area of the bundle. For bridge design, the AREMA design manual and the AASHTO bridge specifications require a minimum spacing equal to 1.5 times diameter of a single, equivalent area bar.

2.6—Columns

2.6.1 *Column verticals*—In selecting reinforcing steel for columns, consideration shall be given to the minimum spacing of bars or bundles required by ACI 7.6.3.* Tables in the supporting reference data section show the maximum number of bars for round columns and the maximum number of bars that can be placed in one face of a rectangular column. Splice arrangements shall be shown. For butt-spliced systems, an allowance must be included for an increase in diameter at mechanical splices and for access to welding. Special end preparation required for bars must be shown or specified. Where the reinforcing steel area required above is different from that in the column below, the structural drawings must clearly show the extension required (if any) of all reinforcing bars above and below the floor level (see also Section 2.7).

2.6.2 *Offset between column faces*—Where there is a change in size of a column, the structural drawings must show how the vertical bars are to be offset, or separate dowels must be shown (see Section 3.7.7.2). The slope of the inclined portion providing the offset shall not exceed one in six. See Fig. 4 for recommended splicing details.

Where column verticals are offset bent, additional ties are required and shall be placed not more than 6 in. (150 mm) from the point of the bend. For practical purposes, three closely spaced ties are usually used, one of which may be part of the regularly spaced ties, plus two extra ties. General arrangements of vertical bars and all tie requirements shall be established by the structural drawings.

In addition to showing size and regular spacing of column ties, the A/E shall also show any additional ties required for special conditions, such as splices and offset bends.

2.6.3 *Changing bar arrangement between floors*—When the bar arrangement is changed at a floor, the bars may extend through, terminate, or require separate dowels. Reinforcing steel at least equal in area to that in the column above must be extended from the column below to lap bars above by the required lap length or butt splices must be provided. Vertical bars from the column below, terminated for any reason, are cut off within 3 in. (75 mm) of the top of the finished floor unless otherwise indicated on the structural drawing. The A/E shall determine what, if any, additional extension of discontinued column verticals is required for adequate embedment, and show this information on the structural drawings.

2.6.4 *Spirals*—Pitch or spacing of spirals should be given to the nearest 1/4 in. (5 mm). According to ACI 318 (318M), the clear spacing between spiral turns shall not exceed 3 in. (80 mm) or be less than 1 in. (25 mm) or 1-1/3 times the maximum size of coarse aggregate used. Spirals shall be provided with 1-1/2 extra turns at both top and bottom. If necessary to splice a spiral, it shall be done by a lap splice of $48d_b$ or by welding.

Minimum diameters to which standard spirals can be formed and minimum diameters that are considered collapsible are shown below for various sizes of spiral bars. Plain or deformed bars or wire can be used to manufacture spirals.

Spirals are used primarily for columns, piers, and drilled caissons, but are also used in piles. Continuously wound, reinforcing steel in the form of a circular helix not meeting ACI 318 (318M) definition of a spiral may be used in these

*Reference to ACI 318 (318M) is given as "ACI" followed by the number of the section.

Spiral bar diameter, in. (mm)	Minimum outside diameter that can be formed, in. (mm)	Minimum outside diameter of collapsible spiral, in. (mm)
3/8 (10)	9 (225)	14 (350)
1/2 (13)	12 (300)	18 (450)
5/8 (16)	15 (375)	24 (600)
3/4 (19)	30 (750)	—

structures as tie reinforcement. Such reinforcing steel, sometimes referred to as continuous ties, is usually specified with a large pitch.

2.6.5 *Column ties*—The vertical bars in tied columns shall be tied together laterally. Standard arrangements of ties for various numbers of vertical bars are shown in Fig. 13 and 14 in Part C. The A/E may also specify welded wire fabric with an equivalent area of reinforcing steel for column ties. The arrangements of one-piece ties shown in Fig. 13 provide maximum rigidity for column cages preassembled on the site before erection. Preassembly is preferred only for the common designs employing one-story-length vertical bars all lap spliced at or near one point above the floor line. See Section 2.7.3 for lap splice restrictions.

With staggered butt splices on large vertical bars in two-story lengths, practical erection limitations usually require that column ties be assembled on free-standing vertical bars. Standard arrangements for two-piece column ties shown in Fig. 13 and 14 are recommended to facilitate field assembly. They are universally applicable to any splice arrangement required by the A/E. If access to the interior of a column or a pier is necessary, or if the A/E prefers, some other pattern of ties may be substituted, provided that the tie arrangement meets ACI 318 (318M) requirements.

The spacing of ties depends on the sizes of vertical bars, columns, and of ties. The maximum spacings permitted are shown in a table in the supporting reference data section.

In addition to showing size and regular spacing of column ties, the A/E shall also show any additional ties required for other special conditions such as at splices, and offset bends (see also Section 2.10 for seismic details).

If the design requires lateral reinforcement in the column between the top of the main spiral and the floor level above, it may be provided by a stub spiral (short section of spiral) or circular column ties to permit placing of the reinforcing steel in the floor system, and the arrangement shall be shown.

2.6.6 *Bundled bars*—Bundled bars can be used as column verticals. A bundle is defined as a group of parallel bars bundled in contact to act as a unit. Not more than four bars can be grouped into one bundle. Butt splices or separate splice bars should be used.

Bundled bars must be tied, wired, or otherwise fastened to ensure that they remain in position. All bundles of column verticals must be held by additional ties above and below the end-bearing mechanical splices and any short splice bars added for tension should be tied as part of the bundle within the limitation of the number of bars in a bundle. Bundled bars shall be enclosed within ties. Ties smaller than No. 4 (No. 13) for bundled bars shall not be used. Design and detail information on bundled bars as column verticals is provided in a table in the Supporting Reference Data Section in SP-66.

2.7—Development and splices of reinforcing steel

2.7.1 *General*—In ACI 318 (318M), development and lap splice lengths for deformed reinforcing bars can be calculated using one of two optional approaches. A previous calculation approach, from ACI 318-89 (318M-89) also remains acceptable. With multiple code-compliant approaches to calculation existing, choice, interpretation, and application are the A/E's responsibilities. Sufficient information shall be presented on the structural drawings and in the project specifications to allow detailing of bars at splices and embedment locations without referencing back to the code.

Tables in the supporting reference data section give values of tension development lengths and tension lap splice lengths of straight bars. Values of tension ℓ_d and tension lap splice lengths in the tables are based on the provisions in ACI 12.2.2. All tabulated data are for Grade 60 (420) reinforcing bars in normalweight concrete with the concrete compressive strength, f_c', ranging from 3000 to 8000 psi (21 to 56 MPa).

The tables use the terminology Cases 1 and 2. Cases 1 and 2, which depend on the type of structural element, concrete cover, and the center-to-center spacing of the bars, are also defined in the tables.

Separate tables are included for uncoated and epoxy-coated bars. There are no special development requirements in ACI 318 (318M) for zinc-coated (galvanized) bars and they should be treated as uncoated bars. For lightweight aggregate concrete, the values in the tables would have to be modified by the applicable factor (ACI 12.2.4).

ACI 1.2.1 requires that anchorage length of reinforcement and location and length of lap splices be shown on the structural drawings. This information can be shown by dimensioning cut-off locations and including tables of applicable lap splice lengths.

2.7.2 *Splices, general*—In beams or girders that require bars longer than can be carried in stock, splices shall be specified. The A/E shall show or specify by notes how the splicing is to be realized; namely, lap splices, mechanical splices, or welded splices.

The A/E shall also show, by details on structural drawings, the location and length of all splices. In beams or girders, splices should preferably be made where the stress in the bar is minimum, that is, at the point of inflection. Splices where the critical design stress is tensile should be avoided by the A/E wherever possible. Lapped bars may be either in contact or separated. The A/E shall show or note on the structural drawings whether splices are to be staggered or made at the same location. Bars to be spliced by noncontact lap splices in flexural members shall not be spaced transversely more than the smaller of one-fifth the length of lap and 6 in. (150 mm).

2.7.3 *Lap splices*—It is necessary for the A/E to show the location and length of lap splices because the strength of a lap splice varies with the bar diameter, concrete strength, bar spacing, concrete cover, position of the bar, distance from other bars, and the type of stress (compressive or tensile). Where bars of two sizes are lap spliced, the A/E must indicate the appropriate lap splice length. Lap splices are not permitted for No. 14 and 18 (No. 43 and 57) bars, except for transferring compression to smaller size dowels that are anchored into footings for buildings. Lap splices for bars larger than No. 11 (No. 36) are not permitted by the AREMA design manual or the AASHTO bridge specifications.

At column bar splice locations, sufficient bars (or dowels) from the lower columns must extend into the upper column to provide not less than the cross-sectional area of the required bars in the upper column. These bars must extend the minimum distance required for lap splices. The A/E should note that unless otherwise specified or shown on structural drawings, the detailer will detail the remaining bars in the lower column extending to within 3 in. (75 mm) of the top of the floor or other member transmitting the additional load to the column. Where the top ends of column bars are less than 6 ft (1800 mm) above the top of footings or pedestals, the bars should extend into the footings or pedestals. Normally, dowels will be used only if specifically noted on structural drawings.

Dowels for lap splices at column offsets should have a cross-sectional area at least equal to that of the bars above and they shall extend both above and below the splice locations, as specified by the A/E.

The A/E should also be aware that it is a standard practice in the industry when detailing column verticals to use the appropriate lap splice length for the bars in the column above. This applies regardless of differences in bar sizes.

For columns, the arrangement of bars at a lap splice is shown in Fig. 4. It should be noted that the amount of offset of the bars is greater for rectangular columns than for round columns. Column verticals to be lap spliced in square or rectangular columns, where column size does not change, are usually shop offset bent into the column above, unless otherwise shown by the A/E. The A/E shall indicate which vertical bars are to be offset bent for round columns in those cases where the column size doesn't change.

Where the depth of the footing, or footing and pedestal combined, is less than the minimum length of embedment required for dowels of a certain size, the size of dowel should be decreased and the number of dowels increased to give an equivalent area. This should also be shown on the structural drawings. Hooks at the ends of the bars can be desirable to resist tension, but the hook may not be considered in determining the embedment provided for compression.

Separate splice bars (dowels) are necessary for splicing column bars where the column section changes 3 in. (80 mm) or more, where the placing of parts of the structure is delayed, or between various units of structures. Except for special cases, separate splice bars (dowels) should be the same number, size, and grade as the bars joined and should be of proper length to splice with the main bars, and shall be specified by the A/E.

Lap splices for deformed welded wire fabric shall be shown by the A/E.* ACI 318 (318M) requires that, for deformed welded wire fabric, the splice shall be at least 1.3 times the development length (8 in. [200 mm] minimum). The A/E shall indicate the required splice dimension(s).

Lap splices for plain welded wire fabric shall also be shown by the A/E.* ACI 318 (318M) requires that the splice length, as measured between outermost cross wires of each fabric sheet, shall be not less than one spacing of cross wires plus 2 in. (50 mm) nor less than 1.5 ℓ_d (6 in. [150 mm] minimum) when A_s provided/A_s required < 2. When A_s provided/A_s required $\geq$ 2, only the requirement of 1.5 ℓ_d (2 in. [50 mm] minimum) will apply. Therefore, the A/E can either show the required splice dimension or indicate a typical detail showing the lap splice length equal to one spacing of cross wires plus 2 in. (50 mm), if that controls.

2.7.4 *Butt splices*—Mechanical splices or welded splices can be specified or, for compression only, end-bearing splices can be specified as butt splices for vertical column bars. For No. 14 and 18 (No. 43 and 57) bars, butt splices shall be used. Special preparation of the ends of the vertical bars is usually required for butt splices. Where a mechanical splice is used, both ends of the bar can be either square cut, flame cut, or standard shear cut, depending on the type of splice used. Because mechanical splices are usually staggered between alternate vertical bars and their location depends on the design requirements, the A/E must indicate the types of mechanical splices permissible, their location, and end preparation required. Where bars are welded, the most common practice is to provide a square-cut end at the top of the lower bar and a double-beveled end on the bottom of the upper bar. Field preparation of ends by flame cutting is satisfactory. All welding of reinforcing bars shall conform to AWS D1.4.

2.8—Joint details

2.8.1 *Rigid frame corners* —The A/E shall exercise care in designing the corner joint of a rigid frame. All main reinforcing steel that passes through the joint shall be free of any kinks or discontinuous bending. The center of radius of the bend must be kept within the joint. This point is important in splicing the top bars from the girder to the outside bars in the column. The A/E must provide complete information, showing the radius of any nonstandard bends and location and dimensions of lap splices. If a mechanical or welded splice is to be used, a physical description must be provided. Tension in the concrete surrounding the reinforcing steel where the steel changes direction must be considered.

2.8.2 *Wall intersections and corners*—All horizontal wall reinforcing steel in one, or sometimes both, faces of a wall shall be sufficiently extended past a corner or intersection to be fully developed (Fig. 15 in Part C). The A/E shall indicate which, if any, horizontal reinforcing steel must be extended, how far it must be extended, and how it must be anchored at intersections and corners of walls and footings. In areas where the applicable building code requires earthquake-resistant design, standard practice requires adequate anchorage of all horizontal bars.

Walls with loads that open corner intersections must be reinforced differently than walls with loads that close such intersections. Typical details are shown in Fig. 15 for

*Supplementary data on welded wire fabric appears in Chapter 2 ("Welded Wire Fabric") of the supporting reference data section.

resistance against loads from outside or inside, with the reinforcing steel from the appropriate face or faces anchored. Precautions to restrain radial tension are similar to those for rigid frame corners.

2.8.3 *Closed stirrups*—Where the structural drawings show closed stirrups, these stirrups may be closed by two-piece stirrups using overlapping standard 90 degree end hooks enclosing a longitudinal bar, or by properly spliced pairs of U-stirrups or a standard one-piece Type T1 or T2 stirrup tie. At least one longitudinal bar must be located at each corner of the section, the size of this bar to be at least equal to the diameter of the stirrup but not less than a No. 4 (No. 13). These details shall be shown by the A/E. (see Fig. 12). It should be noted that the use of 90 degree hooks and lap splices in closed stirrups is not considered effective in situations where the member is subjected to high torsional stress. Tests (Reference 1) have shown premature failure caused by spalling of the concrete covering and consequent loss of anchorage in the 90 degree hooks and lap splices in these situations (see Fig. 16 in Part C).

2.8.4 *Structural integrity*—Specific details for continuity of reinforcing steel to meet structural integrity requirements shall be incorporated in the design details by the A/E. Continuity is required in cast-in-place construction for joists, beams, and two-way slabs. Continuity of selected flexural reinforcement is achieved by making bars continuous or providing Class A tension lap splices and terminating bars with standard hooks at noncontinuous supports. Certain proportions of top and bottom flexural reinforcement in perimeter beams shall be made continuous around the structure and confined with closed stirrups. See ACI 7.13 and Fig. 2 and 3, for example details for structural integrity.

2.9—Reinforcing steel supports

The A/E is responsible for specifying acceptable materials, and corrosion protection required for reinforcing steel supports, or both, and if required, for side form spacers, as well as the particular structural elements or areas in which each is to be used. Specifications for the use of reinforcing steel supports usually are based on established industry practice.* For more details on bar supports and side form spacers, see Chapter 5.

2.10—Special details for seismic design of frames, joints, walls, diaphragms, and two-way slabs

2.10.1 *Introduction*—In designs for high seismic risk (such as NEHRP Seismic Performance Categories D and E)† reinforced-concrete members shall satisfy ACI 318 (318M), Chapters 1 through 17 and Sections 21.2 through 21.7 of Chapter 21 to provide a structural system with adequate details to permit nonlinear response without critical loss of strength.

In designs for moderate seismic risk (such as NEHRP Seismic Performance Category C),† reinforced-concrete frames and two-way slabs shall satisfy ACI 318 (318M), Chapters 1 through 18 and Section 21.8 of Chapter 21.

The provisions of Chapters 1 through 18 of ACI 318 (318M) apply to the design and detailing of reinforced concrete structures in regions of low or no seismic risk (such as NEHRP Seismic Performance Categories A and B).†

For seismic design, member sizes should be selected and reinforcing steel arranged to avoid congestion of the reinforcement. Careful selection of member size and reinforcing steel arrangement will help to avoid difficulties in the placement of the reinforcement and concrete.

The requirements of Chapter 21 of ACI 318 (318M) are used to illustrate what the A/E shall convey to the detailer (and to familiarize the detailer with the seismic reinforcing steel details). Much information can be shown by schematic diagrams as shown in Fig. 5, 6, 7, 17 and 18 (in Part C). These special seismic details are, in principle, applicable to flexural frame members and frame members subjected to both bending and axial load in regions of high seismic risk.

It is important for the A/E to examine the reinforcing steel layouts carefully in three dimensions and give the detailer the proper information. This examination will show congestion at beam-column joints of beam, column, and hoop reinforcement. Large scale drawings, models, or mock-ups of the joint details, such as those shown in Fig. 7, may be worthwhile to ensure that a design can be assembled and concrete can be placed.

When subjected to reversals of lateral overloads, joints in frames and boundary members of walls must be capable of developing plastic hinging and continuing to resist loads after yielding of the reinforcing steel without crushing or brittle failure of the concrete. To develop this ductility, concrete in these members, including the joints, shall be confined by transverse reinforcement consisting of rectangular or circular hoops (see Fig. 5, 6, 7, 17, and 18).

2.10.2 *Concrete*— ACI 318 (318M) requires that the specified concrete strength f'_c shall not be less than 3000 psi (20 MPa). For lightweight aggregate concrete, f'_c shall not exceed 4000 psi (30 MPa).

2.10.3 *Reinforcing steel*—Longitudinal reinforcement, resisting earthquake-induced flexural and axial forces in frame members and in wall boundary members, shall comply with ASTM A 706/A 706M. ASTM A 615/A 615M Grade 60 and Grade 40 (420 and 300) can be used, provided that actual yield strength does not exceed the specified yield strength by more than 18,000 psi (120 MPa), and tensile strength is at least 25% greater than the actual yield strength.

In regions of moderate seismic risk, standard ASTM A615/A615M Grade 60 and 40 (420 and 300) can be used.

Test results indicate that welded wire fabric hoops designed according to ACI 318 (318M) requirements are effective in confining the concrete in the joints (Reference 2).

*Established industry practices recommended for general use of bar supports issued by the Concrete Reinforcing Steel Institute are reprinted in the supporting reference data section.

†"NEHRP Recommended Provisions for the Development of Seismic Regulation for New Buildings" prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, issued in 1994, referred to as NEHRP. Seismic performance categories in ASCE 7 are similar to NEHRP. Regions of high earthquake risk correspond to Zones 3 and 4, regions of moderate earthquake risk to Zone 2, and low or no risk in Zone 1 in the Uniform Building Code.

2.10.4 *Beams—High seismic risk**—At least two bars, top and bottom, shall be provided as continuous longitudinal reinforcement for beams. For beams framing into two opposite sides of a column, these bars shall extend through the column core at least twice the beam depth without splices (see Fig. 5) and shall develop the bars beyond their theoretical cut-off points.

At joint faces, the positive moment strength of the beam shall be equal to or greater than one-half the negative moment strength. At other locations in the beam, the positive and negative moment strengths shall be equal to or greater than one-fourth the negative moment strength at the face of either joint. The A/E shall indicate quantities of reinforcing steel, cut-off points, and length and location of splices to satisfy these multiple code requirements.

Continuous top bars must be spliced near the center of a span in frames where moments are usually minimum and gravity load moments do not usually produce tensile stresses. Bottom bars shall not be spliced at the columns because of possible reversal of beam stresses.

At beam-column joints, the A/E shall indicate where and how the bars, straight or hooked, are to be terminated.

Where beams frame into only one side of a column, as at exterior columns, top and bottom beam reinforcing steel must have a 90 degree hook that extends to the far face of the confined region (core) and bends into the joint.† The development length of the hook for tension shall not be less than $8d_b$, 6 in. (150 mm), or $f_y d_b / (65 \sqrt{f'_c})$ $[f_y d_b / (5.4 \sqrt{f'_c})]$.

Hoops shall be provided in frame members over twice the member depth from the faces of the supports and toward midspan. If inelastic yielding can occur elsewhere, the A/E shall indicate location and hoop spacing requirements on both sides of the sections where the inelastic yielding can occur. Hoop spacing requirements are shown in Fig. 5.

Where hoops are not required by the A/E, stirrups shall be provided, spaced at not more than $d/2$ throughout the remaining length of the member and detailed as shown by the A/E.

2.10.5 *Beams—Moderate seismic risk**—ACI 318 (318M) requires that, at joint faces, the positive moment strength of the beam shall be equal to or greater than one-third the negative moment strength. At other locations in the beam, the positive and negative moment strengths shall be equal to or greater than one-fifth the negative moment strength at the face of either joint. The A/E shall indicate quantities of reinforcing steel required to satisfy ACI 318 (318M), cut-off points, and length and location of splices.

Stirrups shall be provided for a minimum length of twice the member depth from the support at an initial spacing of 2 in. (50 mm) and a remaining spacing not more than $d/4$, $8d_b$ of the smallest enclosed longitudinal bar, 24 diameters of the stirrup bar, or 12 in. (300 mm). For the remaining beam length, stirrups shall be spaced at not more than $d/2$.

*A frame member is defined as a beam if the factored compressive axial load is not greater than $(A_g f'_c) / 10$.

†Core. This term is indirectly defined in ACI 10.0 by the term "A_c" (area of core) = area within outside dimension of the confining reinforcement.

2.10.6 *Columns—High seismic risk*‡—Transverse reinforcement consisting of single or overlapping rectangular hoops for rectangular columns, and single, circular hoops or spirals for round columns are required (see Fig. 6). A rectangular hoop is closed by overlapping 135 degree hooks having tail extensions of six bar diameters (3 in. [75 mm] minimum) inside the core of the hoop.

Crossties of the same bar size and spacing of hoops may be used, but each end of the crosstie shall engage a peripheral vertical bar. See Fig. 6 and 17.

Hoops at a maximum spacing not exceeding one-quarter of the minimum column dimension and 4 in. (100 mm) shall be provided within the joint and above and below the joint for a distance not less than the column depth, one-sixth the column clear height, and 18 in. (450 mm). ACI 318 (318M) provisions regulate the size and spacing of the hoops. Outside this region, hoops shall be as required for nonseismic columns, including requirements for shear, and spacing shall not exceed six times the diameter of the longitudinal column bars or 6 in (150 mm).

Column verticals can be spliced by lap splices, mechanical splices, or welded splices. Lap splices are permitted only within the center half of the column length and shall be designed as tension splices. ACI 318 (318M) requires that mechanical splices or welded splices shall be staggered at least 24 in. (600 mm) and applied to alternate verticals. Offsets of longitudinal reinforcement is not recommended within the joint.

2.10.7 *Columns—Moderate seismic risk*‡—Tie spacing s_o over a length l_o from the face of the member shall not exceed the smaller of eight diameters of the smallest enclosed bar, 24 diameters of the tie bar, one-half the smallest cross-sectional column dimension, and 12 in. (300 mm). Length l_o shall not be less than one-sixth of the clear span (height) of the member, maximum cross-sectional dimension of the member, and 18 in. (450 mm). The first tie shall be spaced not more than $s_o/2$ from the joint face and the remaining ties shall be spaced not more than s_o.

2.10.8 *Walls and diaphragms—High and moderate seismic risk*—Walls and diaphragms, if designed as parts of the force-resisting system, are relatively stiff members compared with ductile beam-column frames. Because walls may or may not be designed as part of the primary lateral-load resisting system, it is most important that the A/E provide a complete description of the requirements for wall reinforcement. Usually this task can be accomplished by identifying structural walls and diaphragms and reference to typical details (see Fig. 18).

The vertical and horizontal reinforcement shall be placed in at least two curtains if the in-plane factored shear force exceeds $2A_{cv}\sqrt{f'_c}$ $[(1/6)A_{cv}\sqrt{f'_c}]$. The reinforcement ratio in each direction shall be equal to or greater than 0.0025 with a maximum bar spacing of 18 in. (450 mm).

When the compressive force in a boundary member exceeds $0.2 f'_c A_g$, the member shall be reinforced as a column

‡A frame member is defined as a beam if the factored compressive axial load is greater than $(A_g f'_c) / 10$.

in a high seismic risk area with closely spaced hoops extending until the compressive force is less than $0.15f'_c A_g$. Transverse reinforcement from wall and diaphragm members shall be fully developed within the confined cores of boundary members.

2.10.9 *Joints—High seismic risk frames*—Forces in longitudinal beam reinforcing steel at joint faces shall be based on a flexural tension stress of $1.25f_y$ and a corresponding increase in balancing compressive stresses and shear. Transverse hoop reinforcement, as for high-risk seismic columns, shall be provided in the joints. If the joint is confined by structural members meeting special requirements, lesser amounts of transverse reinforcement can be used. The A/E shall evaluate requirements for confinement and end anchorage of longitudinal beam reinforcement. These requirements can often be shown by typical details (see Fig. 5, 6, 7, and 17).

2.10.10 *Two-way slabs without beams—Moderate seismic risk* —Reinforcing steel for the fraction of M_u to be transferred by moment (Eq. (13-1), ACI 318 [318M]), but not less than half the total reinforcement required for the column strip, shall be placed in the width of slab between lines 1.5 times slab or drop panel thickness on opposite faces of the column. (This width equals $3h + c_2$ for edge and interior columns or $1.5h + c_2$ for corner columns.) The A/E shall show the reinforcing steel to be concentrated in this critical width. See Fig. 19(d) in Part C for typical detail used for locating other bars in nonseismic areas.*

A minimum of one-fourth of the column strip top reinforcing steel shall be continuous throughout the span.

Continuous column strip bottom reinforcing steel shall be not less than one-third of the total column strip top reinforcement at the support. A minimum of one-half of all bottom reinforcement at midspan shall be continuous and developed at the faces of the supports.

All top and bottom reinforcing steel shall be developed at discontinuous edges.

2.11—Corrosion-resistant coatings for reinforcing steel

2.11.1 *General*

2.11.1.1 *Specification*—Coated reinforcing steel provides a corrosion-protection system for reinforced-concrete structures. Structural drawings for structures or elements of structures that contain coated reinforcing steel shall include all of the essential information noted previously for uncoated reinforcement. The A/E must be cognizant that coated reinforcing steel undergoes further processing as compared with uncoated reinforcement. The coating process adds time to the normal delivery cycle. Replacement reinforcing steel or additional reinforcement to correct oversights may not be readily available. Therefore, it is important that the A/E convey specific complete instructions in the project specifications or on the structural drawings for the use of coated reinforcing steel.

*Even more necessary for moderate seismic risk, wind, or other lateral load.

2.11.1.2 *Provisions to be included in project specifications*—Provisions to be included are:

1. *Mechanical splices*—Specify requirements for repair of damaged coating after installation of mechanical splices.
2. *Welded splices*—Specify any desired or more stringent requirements for preparation or welding, such as removal of coating, beyond those contained in AWS D1.4; specify requirements for repair of damaged coating after completion of welding.
3. *Field bending of coated bars partially embedded in concrete*—If permitted by the A/E, specify requirements for repair of damaged coating after completion of bending operations.
4. *Cutting of coated bars in the field*—This practice is not recommended, but if required and permitted by the A/E, specify requirements for coating the ends of the bars.
5. *Limits on coating damage*—Specify limits on permissible coating damage caused by handling, shipment, and placing operations, and when required, the repair of damaged coating.

2.11.1.3 *Usage*—For overall economy, maximize the use of straight bars and use the fewest possible different bar sizes for a project. On projects where uncoated and coated bars are used, to avoid confusion, be precise in identifying those bars that are to be coated. It is seldom sufficient to call for coated reinforcing bars in an element with a general note. Reinforcing bars projecting into the element must be identified if they are to be coated.

2.11.2 *Epoxy-coated reinforcing bars*

2.11.2.1 *Material specification*—See "Standard Specification for Epoxy-Coated Reinforcing Steel Bars" (ASTM A 775/A 775M). To meet ACI 318 (318M), the reinforcing bars that are to be epoxy-coated shall conform to the requirements of ACI 3.5.3.1.

2.11.2.2 *Identification*—Epoxy-coated bars are identified with a suffix (E), or with an asterisk (*) and a note stating that all bars marked are to be epoxy-coated.

2.11.2.3 *Compatible tie wire and bar supports*—Coated tie wire or other acceptable materials must be specified for fastening epoxy-coated reinforcing bars. Suitable coatings are nylon, epoxy, or vinyl. Bar supports should be made of dielectric material or wire bar supports should be coated with dielectric material, such as epoxy or vinyl compatible with concrete, for a minimum distance of 2 in. (50 mm) from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars should be epoxy-coated.

2.11.3 *Zinc-coated (galvanized) reinforcing bars*

2.11.3.1 *Material specification*—See "Standard Specification for Zinc-Coated (Galvanized) Steel Bars For Concrete Reinforcement" (ASTM A 767/A 767M). To meet ACI 318 (318M) requirements, the reinforcing bars that are to be zinc-coated (galvanized) shall conform to ACI 3.5.3.1.

2.11.3.2 *Supplementary requirements*—There are three Supplementary Requirements in ASTM A 767/A 767M: Supplementary Requirement S1 requires sheared ends to be coated with a zinc-rich formulation; when bars are fabricated after galvanizing, S2 requires damaged coating to be repaired with a zinc-rich formulation; and if ASTM A 615/A 615M billet-steel bars are being supplied, S3 requires that a silicon analysis of each heat of steel be provided. S1 and S2 should be specified when fabrication after galvanization includes cutting and bending. S2 should be specified when fabrication after galvanization includes only bending.

2.11.3.3 *Coating weights (mass)*—Table 1 of ASTM A 767 has two classes of coating weights (mass). Class 1 (3.5 oz/ft^2 [1070 g/m^2]) is normally specified for general construction.

2.11.3.4 *Other embedded metals*—No uncoated reinforcing steel, nor any other embedded metal dissimilar to zinc, should be permitted in close proximity to galvanized reinforcing bars except as part of a cathodic protection system.

2.11.3.5 *Identification*—Bars are usually galvanized after fabrication. Bars that require special finished bend diameters (usually smaller bar sizes for stirrups and ties) should be identified. Maintenance of identification to the point of shipment during the galvanizing process is the responsibility of the galvanizer. Regular tags plus metal tags should be attached to each bar bundle. (The regular tag is often consumed in the galvanizing process, leaving the metal tag for permanent identification.) Zinc-coated (galvanized) bars are identified with a suffix (G) and a note stating that all bars marked as such are to be zinc-coated (galvanized).

2.11.3.6 *Compatible tie wire and bar supports*—No dissimilar metals nor uncoated bars should be permitted in the same reinforced-concrete element with galvanized bars. Galvanized bars must not be coupled to uncoated bars. Zinc-coated tie wire or nonmetallic coated tie wire should be used. Wire bar supports and support bars should be galvanized or coated with dielectric material, or bar supports should be made of dielectric material.

PART B—RESPONSIBILITIES OF THE DETAILER

CHAPTER 3—PLACING DRAWINGS

3.1—Definition

Placing drawings are working drawings that show the number, size, length, and location of the reinforcing steel necessary for the placement and fabrication of the material. Placing drawings can comprise plans, details, elevations, schedules, material lists, and bending details. They can be prepared manually or by computer.

3.2—Scope

Placing drawings are intended to convey the A/E's intent as covered in the contract documents. The contract documents plus any additions, such as addenda issued by the A/E (per terms agreed on in the contract if issued after the contract is made), constitute the sole authority for information in placing drawings. The placing drawings must include all information necessary for complete fabrication and placing of all reinforcing steel.

3.3—Procedure

Placing drawings are prepared by a detailer in accordance with the A/E's instructions contained in the contract documents. Any necessary, additional information must be supplied by the contractor concerning field conditions, field measurements, construction joints, and sequence of placing concrete. After approval by the A/E, including necessary revisions, the drawings may be used by the fabricator and placer.

3.4—Drawing standards

Placing drawings are prepared according to the same general standards as structural drawings.

3.4.1 *Layout*—Drawings usually show a plan, elevations, sections, and details of a structure, accompanied by schedules for footings, columns, beams, and slabs. The plan normally is drawn in the upper left corner of the sheet, with the elevations and details below and to the right of the plan. Schedules (and bending details) are normally placed in the upper right corner of the drawing. A figure in the supporting reference data section presents a recommended layout.

An arrow indicating the direction of North should be placed beside every plan view.

3.4.2 *Symbols and notation*—Common symbols and abbreviations for placing drawings are shown in the supporting reference data section.

Where unusual details or conditions require use of other (special) symbols or abbreviations, the drawings must provide explanations of the notation applied.

3.4.3 *Schedules*—The reinforcing steel of floors and many other parts of structures can best be shown in tabular form commonly referred to as a schedule. A schedule is a compact summary of all the bars complete with the number of pieces, shape and size, lengths, marks, grades, coating information, and bending details from which bar lists can be written easily and readily. Although these schedules usually include the bending details for bent bars, separate bending detail schedules can be used.

3.4.4 *Coated reinforcing bars*—When coated reinforcing bars are detailed along with uncoated reinforcing bars, the coated reinforcing bars must be identified in some manner, such as with a suffix (E) or (G) or with an asterisk (*), and a note stating that all reinforcing bars marked as such are to be epoxy-coated or galvanized. Epoxy-coated reinforcing bars listed with uncoated reinforcing bars in schedules or bills of materials must also be marked with (E) or (*). The designation (G) is appropriate for galvanized reinforcing bars.

3.5—Building drawings

Placing drawings, ordinarily prepared by the fabricator, show details for fabrication and for the placing of reinforcing steel. They are not for use in constructing formwork (except joist forms when these are supplied by the same fabricator), and consequently the only required dimensions are those necessary for the proper location of the reinforcing steel. Building dimensions are shown on the placing drawing only if necessary to locate reinforcing steel properly, as the detailer becomes responsible for accuracy of dimensions, when given. The placing drawings must be used with the structural drawings.

Bending details can be shown on a separate drawing instead of on the placing drawings.

3.5.1 *General requirements*—On receipt of the structural drawings, the fabricator takes the following steps:

1. Prepares placing drawings (including bending details);

2. Submits placing drawings, if required by the project specifications, to the specified authority for review and approval;

3. Prepares bar lists (bills of materials);

4. Fabricates reinforcing steel;

5. Provides coated bars if specified;

6. Provides bar supports per customer requirements; and

7. Tags, bundles, and delivers the fabricated reinforcing bars to the job site.

It should be noted that the general term fabricator, as used in this document, refers to a company that employs detailers, estimators, and shop personnel. In this regard, it is actually the detailer who performs steps 1, 2, and 3, whereas the shop personnel do steps 4, 5, 6, and 7.

Placing drawings must show the size, shape, grade, and location of coated and uncoated bars in the structure, including bar supports, if supplied by the fabricator. They also serve as the basis for preparing bar lists.

Where approval of placing drawings is required, the placing drawings should be submitted before reinforcing bar fabrication is begun.

For the convenience of both the contractor and fabricator, reinforcing steel is detailed, fabricated, and delivered by units, which generally consist of building components, such as footings, walls, columns, each floor, and roof. A separate placing drawing and bar list are usually made for each component. For small structures, all reinforcing steel can be handled as one unit. For large projects, the contractor may desire a unit, such as a single floor, to be divided to correspond with the construction schedule. Such arrangements, between the contractor and fabricator, with the A/E's approval, are made before the detailing is begun. All sections should be kept as large as practical because it is more economical to detail and fabricate for large units, especially where there is apt to be a duplication of bars.

3.5.2 *Marks* —Slabs, joists, beams, girders, and sometimes footings that are alike on structural drawings are given the same designation mark. Where possible, the same designations should be used on the placing drawings as on the structural drawings. When members alike on the structural drawings are slightly different on the placing drawings, a suffix letter is added to the designation to differentiate the numbers. If some of the beams marked 2B3 on the structural drawing actually differ from the others, the placing drawing would show some of the beams as 2B3 and the others as 2B3A. In reinforced-concrete joist floors, there can be so many variations from the basic joists shown on the structural drawings that it is necessary to change the basic designations (for example, from prefix J to prefix R, for rib).

Columns, and generally footings, are numbered consecutively or are designated by a system of coordinates on the structural drawings. The same designations should be used on placing drawings.

The described marking systems identify individual, reinforced-concrete members of a structure. Reinforcing bars must be individually identified on placing drawings. Only bent bars are given a mark to assist the placer in selecting the proper bars for each member. The straight bar size and length is its own identification.

3.5.3 *Schedules*—Reinforcing steel in elements of a structure can be drawn on placing drawings either on the plan, elevation, or section, or can be listed in a schedule. It is acceptable practice to detail footings, columns, beams, and slabs in schedules. There is no standard format for schedules. They take the place of a drawing, such as a beam elevation, and must clearly indicate to the placer exactly where and how all the material listed is to be placed.

3.5.4 *Responsibility of the detailer*—The responsibility of the detailer in preparing a placing drawing is to carry out all instructions on the contract documents.

The A/E must furnish a clear statement of the requirements. The detailer must carry out the requirements supplied by the A/E. The A/E, in either the project specifications or structural drawings, may not refer the detailer to an applicable building code for information to use in preparing placing drawings. This information must be interpreted by the A/E and must be shown in the form of specific design details or notes for the detailer to follow.

3.5.5 *Beams and joists* —For beams, joists, and girders, reinforcing steel is usually shown in schedules. Bending details may be separate or incorporated in the schedule. The detailer must show number, mark, and size of members; number, size, and length of straight bars; number, size, mark, and length of bent bars and stirrups; spacing of stirrups; offsets of bars; lap splices; bar supports; and any other special information necessary for the proper fabrication and placement of the reinforcing steel.

Among the special items that must be noted are:

1. Overall length of bar;

2. Height of hook where such dimensions are controlling;

3. Lap splice lengths;

4. Offset dimensions, if any; and

5. Location of bar with respect to supporting members where the bar is not dimensioned symmetrically on each side of the support.

3.5.6 *Slabs*—Reinforcing steel for slabs can be shown in plan views, in a schedule, and sometimes even in section. The schedule and bending details for slabs are similar to those for beams.

Panels that are exactly alike are given an identifying letter and reinforcing steel is shown for only one panel of each kind. In skewed panels, such as for the quadrant of a circle, the bars are fanned out so that they are placed at the required spacing at a specific location, usually at the midspan. Additional bars around openings, if required, must be shown.

3.5.7 *Columns* —Placing drawings for columns generally use a schedule form for detailing. The detailer must not only interpret the structural drawing, but clearly convey this interpretation to the placer. The detailer must show the quantity, size, and length or mark of all bars, including dowels, principal vertical bars, and ties. The detailer must also include plan sketches of typical bar arrangements for all but the simplest conditions. The detailer must clearly show length and location of lap splices, location of mechanical splices or welded splices, and position of offset bars.

3.5.8 *Dowels*—Dowels should be detailed, preferably, with the reinforcing steel in the element that is placed first. They must be ordered with the element to be available for placement at the proper time.

3.5.9 *Reinforcing steel supports*—Reinforcing steel supports specified in the contract documents, including quantities and description, can be shown on the placing drawings.

Bar support placing layouts for typical panels are required for two-way reinforcing steel and wherever needed to clarify placing sequence or quantities required. These layouts can be shown on the placing drawing or given by reference to the CRSI *Manual of Standard Practice*. Support bars, when required, must be shown clearly and identified on the placing drawings.

3.6—Highway drawings

Unlike the customary practice in the field of reinforced-concrete buildings, many state highway departments prepare a combination structural and placing drawing. The combination drawing includes a list of reinforcing steel materials from which the fabricator prepares bar lists. The placer uses the combination drawing to place the reinforcing bars. Highway departments that do not use combination drawings follow the procedures of Section 3.5.

3.6.1 *Marks*—Usually, each highway structure is identified by a bridge number, street name, or a station number (each station being 100 linear ft [30 m]) that designates its location on the project. This station identification or bridge number must be shown on all bundle tags and shipping papers to facilitate proper distribution of reinforcing bars on delivery.

For small, simple structures such as culverts, slab bridges, manholes, and catch basins, a station number in addition to the title description of the structure is sufficient identification without dividing the structure into smaller units by further marking.

Larger structures, such as reinforced-concrete deck girders, I-beam bridges, continuous-type bridges, and arches, consist of small units that together make up a complete structure. These units are referred to as end bents, intermediate bents, abutments, piers, retaining walls, end spans, intermediate spans, etc., and must be designated by markings. The construction units of unusually long culverts with more than one design of barrel, for varying load conditions or, where construction joints are required across the barrel, can be identified by section numbers. Schedules of reinforcing bars are used to divide a structure into parts enabling the fabricator to make it more convenient for the placer by delivering the bars in lots as required.

For highway structures, both straight and bent bars are given an individual mark. In highway structures, such as culverts and bridge spans, the arrangement of bars is the same, regardless of size or length. Standardized marks are sometimes used for bars occurring in the same relative position in culverts.

Any system of letters and numerals is acceptable. Some A/E's not only provide individual bar markings, but also indicate, by the mark, where the bar is placed in the structure.

3.6.2 *Schedules* —Highway structural drawings most often show details of the various elements directly on the plan or elevation. Schedules are sometimes used for piers, small structures, and even retaining walls. Highway structural drawings usually include, when detailed completely, a type of schedule that is really a bill of material, sometimes segregated by elements of a structure. These drawings are used by the fabricator to prepare shop bar lists.

3.6.3 *Dimensions*—When the drawings for highway structures are a combination of structural and placing drawings from which the structure will be built, all dimensions must be shown clearly. The contractor should not have to compute any needed dimensions. Drawings must show the dimensions of concrete protection for all reinforcing steel. For example, they must plainly show whether the cover dimension specified on a girder is the clear distance from the main reinforcing steel or the clear distance from the stirrups. Where separate placing drawings are prepared, structural dimensions may be omitted following the same practice as for buildings.

3.6.4 *Reinforcing steel* —Drawings must show the grade, size, spacing, splices, and location of the coated and uncoated bars in the structure. The bar schedule (combined drawing) must show the number of pieces, size, length, mark of bars, and bending details of all bent bars.

Reinforcing steel for larger structures is usually detailed, fabricated, and delivered by units for the convenience of both the contractor and fabricator; for example, footings, abutments, piers, and girders. The bar list is then similarly subdivided. If the structure is sufficiently large, a separate drawing and bar list is made for each unit.

Reinforcing bars for foundations, piers, abutments, wing walls, and slabs are usually shown on plan, section, or elevation views. Reinforcing steel can be shown in the simplest and clearest manner, however, the bar list must be a complete summary.

To be certain that all of the reinforcing steel is properly placed or positioned in a unit, a cross section is frequently required in addition to the plan and elevation of the unit where the bars are shown.

3.6.5 *Reinforcing steel supports*—Plain metal supports are used widely as a means of securely holding reinforcing steel in proper position while the concrete is being placed. Plastic coated or stainless legs can be specified to avoid possible rusting at points of exposure. Precast concrete blocks are used in some states, particularly in the western United States. Other types of proprietary supports are available and may be suitable. Support bars, when furnished, should be shown clearly and identified.

Where an exposed concrete surface is to receive special finishing treatments, such as sandblasting, bush-hammering, or any other removal of surface mortar, special consideration must be given to such things as selecting bottom bar supports and side form spacers that will not rust or otherwise impair the finished surface appearance.

Class of wire bar support, precast concrete blocks, or other proprietary supports, and locations where each is to be employed, should be specified or shown in the contract documents. The detailer should identify the specified types and show locations where each is to be used.

3.7—Detailing to fabricating standards

It is standard practice in the industry to show all bar dimensions as out-to-out and consider the bar lengths as the sum of all detailed dimensions, including Hooks A and G (see Table 1).

3.7.1 *Bending*—To avoid creating excessive stresses during bending, bars must not be bent too sharply. Controls are established by specifying the minimum inside radius or inside diameter of bend that can be made for each size of bar. The radius or diameter of the bend is usually expressed as a multiple of the nominal diameter of the bar d_b. The ratio of diameter of bend to diameter of bar is not a constant because it has been found by experience that this ratio must be larger as the bar size increases.

The minimum diameters of bend specified by ACI 318 (318M) for reinforcing bars, measured on the inside of the bar, are:

Bar sizes, No.	Other than ties/stirrups	Ties or stirrups
3, 4, 5 (10, 13, 16)	$6d_b$	$4d_b$
6, 7, 8 (19, 22, 25)	$6d_b$	$6d_b$
9, 10, 11 (29, 32, 36)	$8d_b$	—
14, 18 (43, 57)	$10d_b$	—

The inside diameter of bends of welded wire fabric (plain or deformed) for stirrups and ties, as specified by ACI 318 (318M), shall not be less than $4d_b$ for deformed wire larger than D6 (MD38.7) and $2d_b$ for all other wires. Bends with inside diameter of less than $8d_b$ shall not be less than $4d_b$ from the nearest welded intersection.

3.7.2 *Hooks*—ACI 318 (318M), Section 7.2 specifies minimum bend diameters for reinforcing bars. It also defines standard hook (Section 7.1) to mean the following:

a) A 180 degree bend plus an extension of at least $4d_b$, but not less than 2-1/2 in. (60 mm), at the free end of the bar; or

b) A 90 degree bend plus an extension of at least $12d_b$ at the free end of the bar; or

c) For stirrup and tie hooks only, either a 90 degree bend plus $6d_b$ extension for No. 3, 4, 5 (No. 10, 13, 16), and $12d_b$ extension for No. 6, 7, and 8 (No. 19, 22, and 25), or a 135 degree bend plus an extension of at least $6d_b$ at the free end of the bar. For closed ties, defined as hoops in Chapter 21 of ACI 318 (318M), a 135 degree bend plus an extension of at least $6d_b$ but not less than 3 in. (75 mm).

The minimum bend diameter of hooks shall meet the foregoing provisions. The standard hooks (Table 1) were developed such that the minimum requirements were met, but at the same time the need to allow for springback in fabrication and maintaining a policy of production fabrication pin size no smaller than the ASTM A615/A615M bend test pin size was recognized as well. In the Table, the extra length of bar allowed for the hook is designated as A or G and shown to the nearest 1 in. (25 mm) for end hooks and to the nearest 1/4 in. (5 mm) for stirrup and tie hooks.

Where the physical conditions of the job are such that either J, A, G, or H of the hook is a controlling dimension, it must be so noted on the drawings, schedules, and bar lists.

3.7.3 *Stirrup anchorage*

3.7.3.1 There are several permissible methods for stirrup anchorage. The most common is to use one of the hooks shown in Table 1. Types Sl to S6 in Fig. 10 illustrate not only the uses of the two types of hooks, but also the directions in which the hooks can be turned. In detailing the anchorage, care must be taken that the ends of stirrup hooks that are turned outward into shallow slabs have adequate cover. If not, the hooks should be turned inward and this change brought to the A/E's attention.

3.7.3.2 Where the free ends of stirrups cannot be tied to longitudinal bars, or where there are no longitudinal bars, stirrup support bars should be specified by the A/E.*

3.7.4 *Standard bar bends*

3.7.4.1 To list the various types of bent bars in a schedule, it is necessary to have diagrams of the bars with the lengths of the portions of the bars designated by letters. A chart of such standard bar bends is shown in Fig. 10.

3.7.4.2 Dimensions given for Hooks A and G are the additional length of bar allowed for the hook as shown in Table 1. For straight portions of the bar, the distance is measured to the theoretical intersection of the outside edge line extended to the outside edge line of the adjacent straight portion, or to the point of tangency to a curve, from which point the length of the latter is tabulated, as in Types 10 and 11 in Fig. 10. Truss bar dimensioning is special and is shown in large-scale detail in Fig. 10.

3.7.5 *Radius bending*—When reinforcing bars are used around curved surfaces, such as domes or tanks, and no special requirement is established in the contract documents, bars prefabricated to a radius equal or less than those in the following table are prefabricated by the reinforcing bar fabricator. In the smaller sizes, the bars are sprung to fit varying job conditions, such as location of splices, vertical bars, jack rods, window openings, and other blocked out areas in the forms. The larger size bars, which are more difficult to spring into desired position, are ordinarily employed in massive structures where placing tolerances are correspondingly larger.

Radially prefabricated bars of any size tend to relax the radius originally prefabricated as a result of time and normal handling. The last few feet involved in the lap splice area often appear as a tangent rather than a pure arc, due to limitations of standard bending equipment. For these reasons, final adjustments are a field placing problem to suit conditions and tolerance requirements of a particular job. See Fig. 8 and 9 for radial tolerances and Section 4.2(c)3. Bars requiring a larger radius

*These decisions should be shown on the structural drawings. If not, the detailer may suggest solutions, but only when subject to review and approval by the A/E. The final decision on these design problems is the A/E's responsibility.

When radial prefabrication is required

Bars are to be prefabricated when either radius or bar length is less than tabulated value		
Bar size, No.	Radius, ft (mm)	Bar length, ft (mm)
3 (10)	5 (1500)	10 (3000)
4 (13)	10 (3000)	10 (3000)
5 (16)	15 (4500)	10 (3000)
6 (19)	40 (12,000)	10 (3000)
7 (22)	40 (12,000)	10 (3000)
8 (25)	60 (18,000)	30 (9000)
9 (29)	90 (27,000)	30 (9000)
10 (32)	110 (33,000)	30 (9000)
11 (36)	110 (33,000)	60 (18,000)
14 (43)	180 (54,000)	60 (18,000)
18 (57)	300 (90,000)	60 (18,000)

or length than shown in the table are sprung in the field without prefabrication.

The presence of the tangent end does not create any problem on bar sizes No. 3 through 11 (No. 10 through 36) as they are generally lap spliced and tangent ends are acceptable. No. 14 and 18 (No. 43 and 57) bars cannot be lap spliced, however, and are usually spliced using a proprietary mechanical splice or a butt weld. It is a problem to place a radially bent bar when using a mechanical splice sleeve because of the tangent ends on bars bent to small radii. To avoid this problem, all No. 14 and 18 (No. 43 and 57) bars bent to a radius of 20 ft (6000 mm) or less should be furnished with an additional 18 in. (450 mm) added to each end. This 18 in. (450 mm) tangent end is to be removed in the field by flame cutting. Bars bent to radii greater than 20 ft (6000 mm) will be furnished to the detailed length with no consideration given to the tangent end. The ends of these bars generally are saw cut.

Shop removal of tangent ends can be made by special arrangement with the reinforcing bar supplier.

3.7.6 *Slants*—To determine the length of the straight bar necessary to form a truss bar, the length of the slant portion of the bar must be known. The standard angle is 45 degrees for truss bars, with any other angles being special. Slants and increments are calculated to the closest 1/2 in. (10 mm) so that for truss bars with two slants, the total increment will be in full inches (25 mm). This makes the computation easier and is within the tolerances permitted. It is important to note that when the height of the truss is too small, 45 degree bends become impossible. This condition requires bending at a lesser angle and lengthens the slant portion.

3.7.7 *Column verticals*

3.7.7.1 *General*—The A/E shall indicate the grade of reinforcing steel required on the structural drawings or in the project specifications. The detailer shall show special specification requirements for grade in listing column verticals for each story. In multistory columns, lower stories are sometimes designed for higher strength grades. Special requirements for bars to be butt-spliced can also be included.

A table in the supporting reference data section shows the number of bars that can be placed within spiral reinforcement in conformance with ACI 318 (318M). Three splice arrangements are shown: butt-splices, radially lapped splices with verticals or dowels from below inside of bars above, and circumferentially lapped splices with dowels from below the bars above. Spacing for the latter also applies to butt-spliced two-bar bundles.

Maximum number of bars for the two lap splice arrangements assumes all bars are spliced at the same cross section. For the butt-splice arrangement, no allowance was included for increase in diameter at couplers or end-bearing devices, or for access to butt weld.

3.7.7.2 *Offset between column faces*—Where a column is smaller than the one below, vertical bars from below must be offset to come within the column above, or separate dowels must be used. The slope of the inclined portion shall not exceed 1 to 6. In detailing offset column bars, a bar diameter plus clearance must be added to the desired offset. In the corners of columns, bars are usually offset on the diagonal, which requires that the offset be increased accordingly.

For any offset between column faces less than 3 in. (80 mm), the vertical bar should be offset bent. When the offset is 3 in. (80 mm) or more, the vertical bars in the column below should be terminated at the floor slab and separate straight dowels provided.

3.7.7.3 *Lap splices* —Typical arrangement of bars at a lap splice is shown in Fig. 4. Unless special details are provided on the structural drawings, all column verticals to be lap spliced in square or rectangular columns must be shop offset bent into the column above except as noted in Section 3.7.7.2. General practice is to use the offset for the corner bars that must be bent diagonally as the typical offset dimension for all the bars in the column. Column verticals in round columns where column sizes do not change must be offset bent only if a maximum number of lap spliced bars is desired in the column above (see table in the supporting reference data section).

3.7.8 *Column spirals*

3.7.8.1 *General*—Spirals shall be provided with 1-1/2 extra turns at both top and bottom. The height (or length) of a spiral is defined as the distance out-to-out of coils, including the finishing turns top and bottom, with a tolerance of plus or minus 1-1/2 in. (40 mm). Where a spiral cannot be furnished in one piece, it may be furnished in two or more sections to be field welded, or with additional length at each of the ends of each section to be lapped in the field, 48 diameters minimum, but not less than 12 in. (300 mm). The sections must be identified properly by mark numbers to ensure proper assembly.

Spacers are sometimes used for maintaining the proper pitch and alignment of the spiral and, when used, must conform to the minimum requirements of a table in the supporting reference data section. Maximum length of spacers is that of the spiral plus one pitch. One alternative method to using spacers is to ship the spiral as a compressed coil and tie it in place in the field. The project specifications or subcontract agreements should be written clearly to cover the supply of spacers or field tying of the spiral reinforcement.

The height of one-piece assembled spirals for fabrication and shipping is limited to 25 ft (7500 mm) unless special handling arrangements are made. For greater heights, spirals must be field spliced by lapping or welding. Spacers can be provided. Spirals are also used in piles, but these do not fall within ACI 318 (318M) definition of a spiral and are usually made of light wire and relatively large pitch.

3.7.8.2 *Spiral details*—Unless otherwise specifically provided, spirals should be detailed as extending from the floor level or top of footing or pedestal to the level of the lowest horizontal reinforcement in the slab, drop panel, or beam above. In a column with a capital, the spiral shall extend to the plane at which the diameter or width of the capital is twice that of the column. See Detail 2, Fig. 4. If the structural drawings require lateral reinforcement in the column between the top of the main spiral and the floor level above, it should be provided by a stub spiral (short section of spiral) or by circular column ties. Where stub spirals are used, they must be attached to the main spiral for shipment or fully identified by mark numbers.

3.7.9 *Dowels*—Dowels will be provided by the detailer as specified in the contract documents for the following:

1. Column footings to columns;
2. Wall footings to walls;
3. Wall intersections;
4. Stairs to walls;
5. Construction joints in footings, walls, and slabs;
6. Columns at floor levels where the vertical reinforcement cannot be offset bent and extended; and
7. Other places where it is not possible or desirable to extend the reinforcing steel continuously through a joint.

Dowels, preferably, should be detailed with that portion of the structure where concrete is placed first. They should always be ordered with that portion.

3.7.10 *Bar lists*—Bar lists used in cutting, bending, tagging, shipping, and invoicing are prepared from placing drawings. Bars are grouped separately on the bar list as follows:

1. Straight;
2. Bent, including stirrups and ties; and
3. Spirals.

The grade of reinforcing steel for all items must be shown.

Straight bars are usually grouped according to size, with the largest size first and those of the same size listed in the order of their length with the longest bar first.

Bent bars, stirrups, and ties are usually listed in a similar manner.

Spirals may be subdivided and listed in groups by the size of bar, diameter of spiral, pitch of spiral, and length. See the bar list example in the supporting reference data section.

CHAPTER 4—FABRICATING PRACTICE STANDARDS

4.1—Fabrication

A fabricated reinforcing bar is any deformed or plain steel bar for concrete reinforcing steel, conforming to ASTM specifications A 615/A 615M, A 616/A 616M, A 617/A 617M, or A 706/A 706M, which is cut to a specified length or cut and bent to a specified length and configuration. Welded-plain- and deformed-wire fabric meeting ASTM A 185 or A 497, respectively, and spirals formed from cold drawn wire conforming to ASTM A 82 or A 496, are also considered concrete reinforcement within this definition. Other materials used as concrete reinforcement and processes other than cutting and bending are not included in this definition.

4.2—Extras

Reinforcing bars are sold on the basis of their theoretical weights (mass) computed from the values given in the ASTM specifications, as calculated from the detailed placing drawings, lists, or purchase orders. In determining the weight (mass) of a bent bar, it is standard practice in the industry to show all bar dimensions as out-to-out and consider the bar lengths required for fabrication as the sum of all detailed dimensions, including Hooks A and G (see Fig. 10).

Charges for extras can be added to the base price per hundredweight. In this event, the principal extra charges are:

a) Size extras—vary as bar size changes;

b) Grade extras—are added to some grades of bars; and

c) Bending extras—are added for all shop bending.

Bending extra charges are separated into three classes as follows:

1. Light bending—All No. 3 (No. 10) bars, stirrups, hoops, supplementary ties, and ties, and all bars No. 4 through 18 (No. 13 through 57) that are bent at more than six points in one plane, or bars that are bent in more than one plane (unless special bending, see below), all one-plane radius bending with more than one radius in any bar (three maximum), or a combination of radius and other type bending in one plane (radius bending being defined as all bends having a radius of 12 in. [300 mm] or more to inside of bar);
2. Heavy bending—Bar sizes No. 4 through 18 (No. 13 through 57) that are bent at not more than six points in one plane (unless classified as light bending or special bending) and single radius bending; and
3. Special bending—All bending to special tolerances (tolerances closer than those shown in Fig. 8 and 9), all radius bending in more than one plane, all multiple plane bending containing one or more radius bends, and all bending for precast units.

d) Services and special fabrication—Extra charges for services and special fabrication may be computed individually to suit conditions for each product on items such as:

1. Detailing, listing, or both;
2. Owner's quality assurance/control requirements;
3. Transportation;
4. Epoxy coating and galvanizing;
5. Painting, dipping, or coating;
6. Spirals and continuous hoops;
7. Shearing to special tolerances;
8. Square (saw-cut) ends;
9. Beveled ends or ends not otherwise defined;
10. Bar threading;

11. Special bundling and tagging;
12. Overlength bars, and overwidth bars, or both; and
13. Welding.

4.3—Tolerances

There are established, standard industry fabricating tolerances that apply unless otherwise shown in the project specifications or structural drawings. Fig. 8 and 9 define these tolerances for the standard bar bends shown in Fig. 10. Note that tolerances more restrictive than these may be subject to an extra charge. For further tolerance information, see ACI 117.

CHAPTER 5—SUPPORTS FOR REINFORCING STEEL

5.1—General

The contract documents usually outline the need and requirements for reinforcing steel supports. The following requirements are applicable to supports for reinforcing bars, and may be applicable to supports for wire or welded wire fabric.

5.1.1 *General requirements*—When the contract documents specify merely that reinforcing steel "shall be accurately placed and adequately supported before the concrete is placed, and shall be secured against displacement within permitted tolerances," the contractor is free to select and purchase the type and class of wire bar supports, precast block, or other materials for each area.

5.1.2 *Specific requirements*—When the contract documents specify types or material for bar supports in different areas, the detailer for the supplier must indicate these materials and areas in which they are to be used, number, size, type, arrangement, and quantities required. These details must be outlined or referenced to a generally accepted document that shows such arrangements.*

5.2—Types of bar supports

5.2.1 *Wire bar supports*—Descriptions of wire bar supports and examples of their usage are available as industry recommendations in the CRSI *Manual of Standard Practice*, which is revised periodically to reflect the latest practice. *Caution*: When multiple layers of unusually heavy reinforcing bars are to be supported on wire bar supports, the number of wire bar supports may need to be increased to prevent penetration of support legs into the form material, especially where the surface is exposed to view or corrosion.

5.2.2 *Precast concrete bar supports*—Descriptions of commonly used types and sizes are available in the CRSI *Manual of Standard Practice*. Requirements for texture and color to suit job conditions should be added if necessary. *Caution*: If the finished surface will be subjected to sandblasting, bush-hammering, or chemical removal of external mortar, the different texture of the exposed precast blocks (unless part of a planned pattern) may be objectionable.

5.2.3 *Other types of bar supports*—CRSI's *Manual of Standard Practice* contains descriptions of one other type of bar supports, all-plastic bar supports. See the supporting reference data section for more information.

5.3—Side form spacers and beam bolsters

All reinforcing steel must be firmly held in place before and during casting of concrete by means of precast concrete blocks, metallic or plastic supports, spacer bars, wires, or other devices adequate to ensure against displacement during construction and to keep the reinforcing steel at the proper distance from the forms. Selection of the type of spacer traditionally has been the responsibility of the contractor. Detailing of side form spacers is not a standard requirement and is performed only when specifically required by the contract documents. The reinforcing bar placing drawings need only show, and the fabricator will only be responsible to supply, those side form spacers that are equal to the standard bar supports referred to in Section 5.2.

Beam bolsters are typically placed transversely to the beam. Beam bolsters placed longitudinally with the beam are supplied only upon special arrangements between the contractor and the supplier, if approved by the A/E.

5.4—Placing reinforcing steel supports

5.4.1 *General*—Reinforcing steel must be accurately located in the forms and firmly held in place before and during the placing of concrete. Adequate supports are necessary to prevent displacement during construction and to keep the reinforcing steel at a proper distance from the forms. Bar supports are sometimes specified to be "sufficient in number and strength to carry properly the reinforcing steel they support." The detailer should show bar supports as required.* Bar supports are detailed for shrinkage-temperature reinforcing steel in top slabs of reinforced concrete joist construction only if specifically required in the contract documents.

Bar supports are not intended to and should not be used to support runways for concrete buggies or similar loads.

5.4.2 *Supports for bars in reinforced concrete cast on ground*—Bar supports are detailed for the top bars only in slabs on grade, grade beams, footings, and foundation mats 4 ft (1200 mm) or less in thickness, in quantities not to exceed an average spacing of 4 ft (1200 mm) in each direction. Separate support bars are detailed only if so indicated by the A/E or on special arrangements with the contractor, as principal reinforcement is assumed to be used for support.

Bar supports will be furnished by the reinforcing-steel supplier for bottom bars in grade beams or slabs on ground and for the bars in singly reinforced slabs on ground only if specifically required in the contract documents. There are so many ways of supporting top bars in footings and foundation mats more than 4 ft (1200 mm) thick that suppliers furnish supports for such purposes only by special arrangement.

CHAPTER 6—COMPUTER-ASSISTED DETAILING

6.1—Use of computers in detailing

The computer system for detailing reinforcing bars has been devised to use digital computers and other data processing equipment to speed up the preparation of placing drawings, to facilitate neater and more compact drawings, and to

*Suggested sizes, styles, and placing of bar supports are shown in Chapter 3 (Bar Supports) of the supporting reference data section.

relieve the detailer of tedious and time-consuming computations that can be performed efficiently by a computer.

Computer-aided drafting, commonly called CAD, is also being used in the drawing and detailing of placing drawings. This system gives the detailer speed, accuracy, and an expeditious way of making changes when necessary.

6.2—Placing drawings

The detailer prepares the graphical part of the placing drawing in a conventional manner. All the listing of quantities and other descriptive printing, however, is performed by the computer's output device (that is, plotter, matrix printer, laser printer). While producing the placing drawings, the detailer may directly or indirectly input information into the computer for processing. When the input data have been processed, the drawing is completed by attaching to it the printed output from the computer. It contains all the necessary descriptive information pertaining to the reinforcing steel as well as the bending details. Computer output can be printed on transparent paper so that bar lists and bending details will be reproduced as part of the placing drawing.

The "label system" is often used to reference the bars on the drawing with its attached machine printout. Under this system, the detailer assigns a label number to each separate bar placing operation comprising either an individual bar or a group of bars. This label number, indicating the designated bars, is shown clearly on the drawing and is also written on the input sheet along with other pertinent data, such as bar size and spacing. The output from the computer prints the label number and then lists the descriptions of the various bars under each label. In this way, a quick reference can be made between the graphical section of the drawing and the machine printed bar descriptions.

6.3—Ordering procedures

When the placing drawings have been approved, preparation of shop orders is greatly simplified by using the data already generated for the label list or column or beam and slab schedule and bending details. All the detailer must indicate are the labels or the portions thereof that are to be ordered from a particular drawing, and the data processing equipment weighs and sorts and lists the material by grade, tag color, type of bending, and size and length in descending order on the bar list. The equipment can also produce the shipping tags and all manifest documents.

CHAPTER 7—RECOMMENDED PRACTICES FOR LOCATION OF BARS DESIGNATED ONLY BY SIZE/SPACING

Especially in slabs and walls designed for a given area of reinforcing steel per running foot, required reinforcement commonly is designated by size and spacing combinations to the nearest 1/2 in. (10 mm) for spacing. If the structural drawing specifically shows the positions of the first bar per panel, or for a given length shows the total number of bars, no problem is created—the detailer simply follows the specific requirements. Therefore, design notes, such as 20-No. 4 (20-No. 13) in a designated length, or No. 4 at 12 (No. 13 at 300 mm) with location of the starting bar shown, requires no further interpretation to complete a placing drawing or to calculate total number of bars required. When the structural drawing shows No. 4 at 12 (No. 13 at 300 mm) with no further instructions in the general notes or in the project specifications, the procedures shown in Fig. 19 (in Part C) are recommended.

CHAPTER 8—GLOSSARY

Architect/engineer—The architect, engineer, architectural firm, engineering firm, or architectural and engineering firm, issuing project drawings and specifications, or administering work under the contract documents.

Bar placing subcontractor—A contractor or subcontractor who handles and places reinforcement and bar supports, often colloquially referred to as a bar placer or placer.

Bar supports—Devices of formed wire, plastic or precast concrete to support, hold, and space reinforcing bars.

Butt-welded splice—Reinforcing bar splice made by welding the butted ends of the reinforcing bars.

Contract documents—Documents, including the project drawings and project specifications, covering the required work.

Contractor—Person, firm, or corporation with whom the owner enters into an agreement for construction of the work.

Coupler—Threaded device for joining reinforcing bars for the purpose of providing transfer of either axial compression or axial tension or both from one bar to the other.

Coupling sleeve—Nonthreaded device fitting over the ends of two reinforcing bars for the eventual purpose of providing transfer of either axial compression or axial tension or both from one bar to the other.

Detailer—Drafter who prepares reinforcing bar placing drawings and bar lists.

Fabricator—A bar company that is capable of preparing placing drawings, bar lists, and storing, shearing, bending, bundling, tagging, loading, and delivering reinforcing bars.

Mechanical splice—The complete assembly of an end-bearing sleeve, a coupler, or a coupling sleeve, and possibly additional materials or parts to accomplish the connection of reinforcing bars.

Owner—Corporation, association, partnership, individual, or public body or authority with whom the contractor enters into agreement, and for whom the work is provided.

Placing drawings—Detailed drawings or sketches that give the size, location, and spacing of the bars, and all other information required by the contractor to place the reinforcing steel.

Project drawings—The drawings which, along with project specifications, complete the descriptive information for constructing the work required or referred to in the contract documents.

Project specifications—The written documents that specify requirements for a project in accordance with the service parameters and other specific criteria established by the owner.

Schedule—Table on placing drawings to give the size, shape, and arrangement of similar items.

Sleeve—A tube that encloses such items as a bar, dowel, or anchor bolt.

Splice—Connection of one reinforcing bar to another by lapping, mechanical coupling or welding; the lap between sheets or rolls of welded wire fabric.

Structural drawings—Drawings that show all framing plans, sections, details, and elevations required to construct the work. For reinforced-concrete structures, they include the sizes and general arrangement of all the reinforcement from which the fabricator prepares the placing drawings.

Welded splice—A means of joining two reinforcing bars by electric arc welding. Reinforcing bar may be lapped, butted, or joined with splice plates or angles.

Work—The entire construction, or separately identifiable parts thereof, which are required to be furnished under the contract documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, as required by the contract documents.

CHAPTER 9—REFERENCES

9.1—Referenced standards

The documents of the various organizations referred to in this standard are listed below with their serial designation, including year of adoption or revision. The documents listed were the latest edition at the time this standard was revised. Because some of these documents are revised frequently, generally in minor detail only, the user of this standard should check directly with the sponsoring group if it is desired to refer to the latest revision.

American Association of State Highway and Transportation Officials

AASHTO Standard Specifications for Highway Bridges, 16th Edition 1996

American Concrete Institute

117-90	Standard Tolerances for Concrete Construction and Materials
318-95	Building Code Requirements for Structural Concrete
318M-95	Building Code Requirements for Structural Concrete (Metric)
343R-95	Analysis and Design of Reinforced Concrete Bridge Structures
349-97	Code Requirements for Nuclear Safety Related Concrete Structures
359-92	Code for Concrete Reactor Vessels and Containments

American Railway Engineering and Maintenance-of-Way Association

Manual for Railway Engineering, Chapter 8, Concrete Structures and Foundations, 1996

ASTM International

A 82-97a	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A 185-97	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 496-97a	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
A 497-97	Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
A 615/ A 615M-96a	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 616/ A 616M-96a	Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
A 617/ A 617M-96a	Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
A 706/ A 706M-96b	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A 767/ A 767M-97	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 775/ A 775M-97	Standard Specification for Epoxy-Coated Reinforcing Steel Bars

American Society of Civil Engineers

ASCE 7-95	Minimum Design Loads for Buildings and Other Structures

American Welding Society

D1.4-98	Structural Welding Code—Reinforcing Steel

Association for Information and Image Management

Modern Drafting Techniques for Quality Microreproductions

Building Seismic Safety Council

NEHRP-97	NEHRP Recommended Provisions for Seismic Regulations for New Buildings

Concrete Reinforcing Steel Institute

Manual of Standard Practice, 26th Edition, 2nd Printing, 1998
Reinforcement Anchorages and Splices, 4th Edition 1997

International Conference of Building Officials

Uniform Building Code, 1997

These publications can be obtained from the following organizations:

American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249
Washington, D.C. 20001

American Concrete Institute
P.O. Box 9094
Farmington Hills, Mich. 48333-9094

American Railway Engineering and Maintenance-of-Way Association
50 F Street, N.W.
Washington, D.C. 20001

ASTM International
100 Barr Harbor Drive
West Conshohocken, Pa. 19428

American Society of Civil Engineers
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Concrete Reinforcing Steel Institute
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Schaumburg, Ill. 60173

International Conference of Building Officials
5360 South Workman Mill Road
Whittier, Calif. 90601

9.2—Cited references

1. Collins, M. P., and Mitchell, D., "Detailing for Torsion," ACI JOURNAL, *Proceedings* V. 73, No. 9, Sept. 1976, pp. 506-511.

2. Guimaraes, G. N.; Kreger, M. E.; and Jirsa, J. O., "Reinforced Concrete Frame Connections Constructed Using High-Strength Materials," University of Texas at Austin, Aug. 1989 (PMFSEL *Report* No. 89-1).

CHAPTER 10—NOTATIONS

A_c = area of core of spirally reinforced compression member measured to outside diameter of spiral, in.^{2} (mm^2)

A_{cv} = net area of concrete section bounded by web thickness and length of section in the direction of shear force considered, in.^{2} (mm^2)

A_g = gross area of section, in.^{2} (mm^2)

A_s = area of nonprestressed tension reinforcement, in.^{2} (mm^2)

b_w = web width, in. (mm)

c_2 = size of rectangular or equivalent rectangular column, capital, or bracket measured transverse to the direction of the span for which moments are being determined, in. (mm)

d = distance from extreme compression fiber to centroid of tension reinforcement, in. (mm)

d_b = bar diameter, in. (mm)

f'_c = specified compressive strength of concrete, psi (MPa)

f_y = specified yield strength of nonprestressed reinforcement, psi (MPa)

h = overall thickness of member, in. (mm)

ℓ_d = development length, in. (mm)

ℓ_{dh} = development length for a bar with a standard hook, in. (mm)

ℓ_o = minimum length, measured from joint face along axis of structural member, over which transverse reinforcement must be provided, in. (mm)

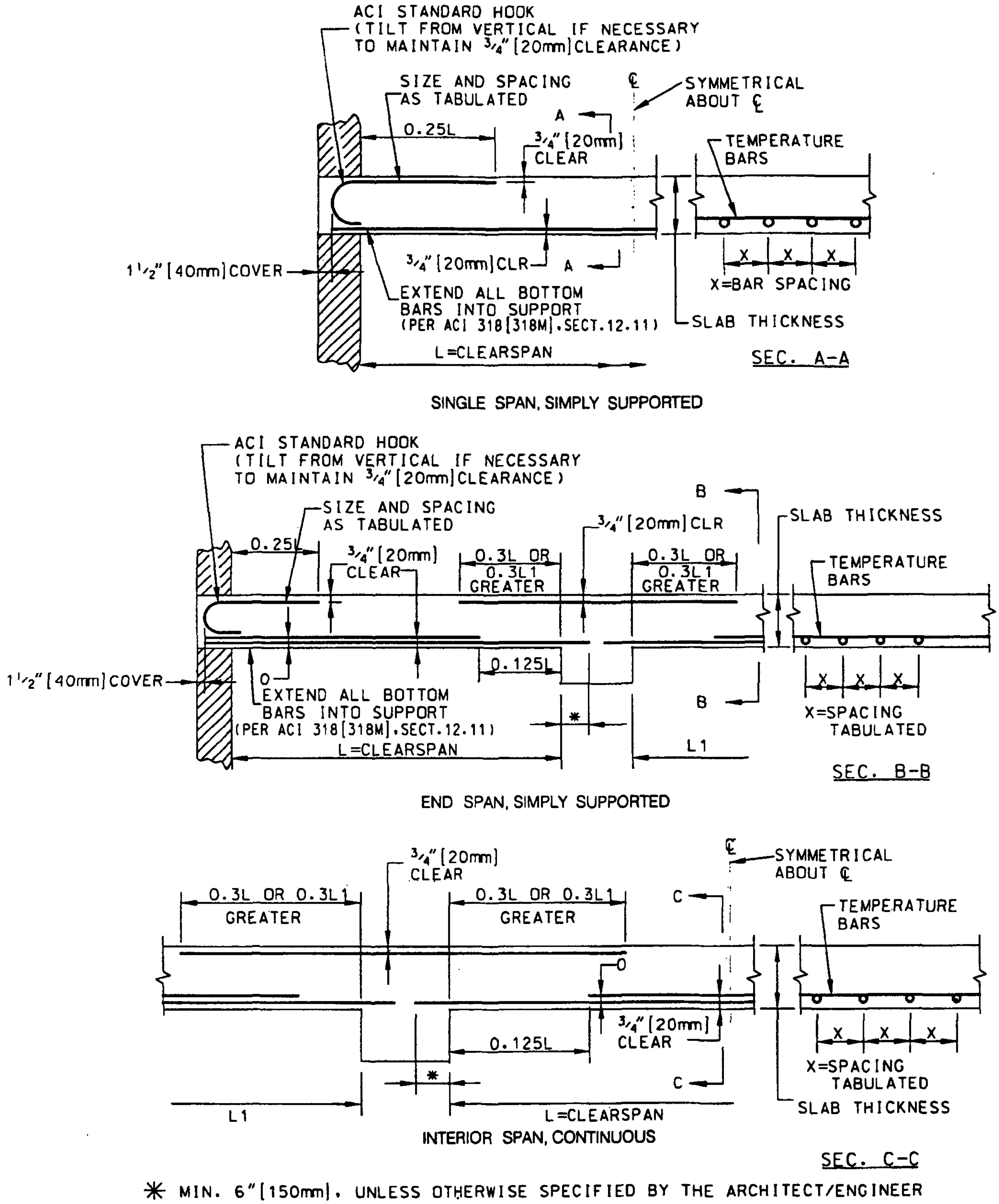
M_u = factored moment at section

s = spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in. (mm)

s_o = maximum spacing of transverse reinforcement, in. (mm)

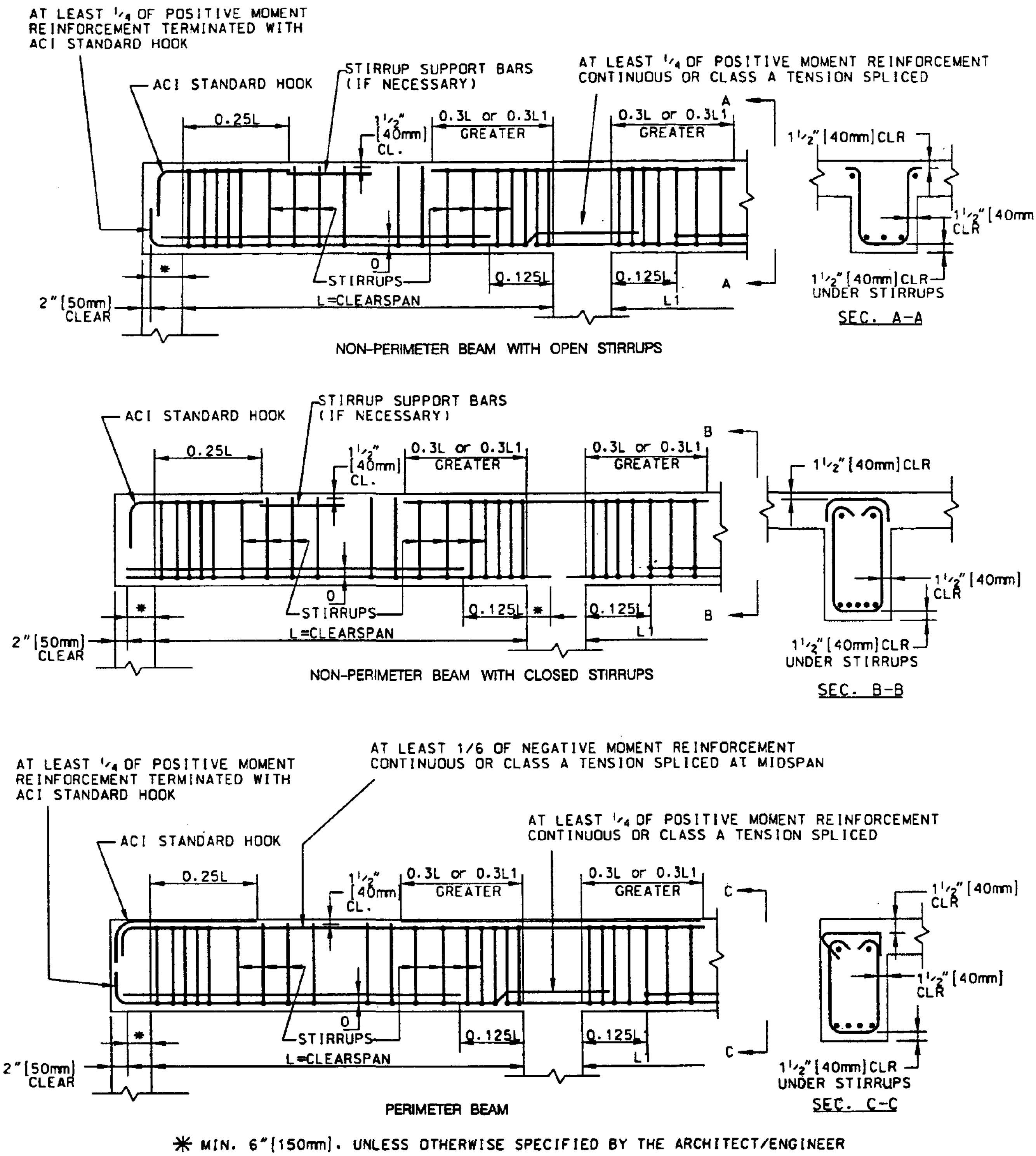
ρ = ratio of nonprestressed tension reinforcement

ρ_v = A_{sv}/A_{cv}; where A_{sv} is the projection on A_{cv} of area of distributed shear reinforcement crossing the plane of A_{cv}



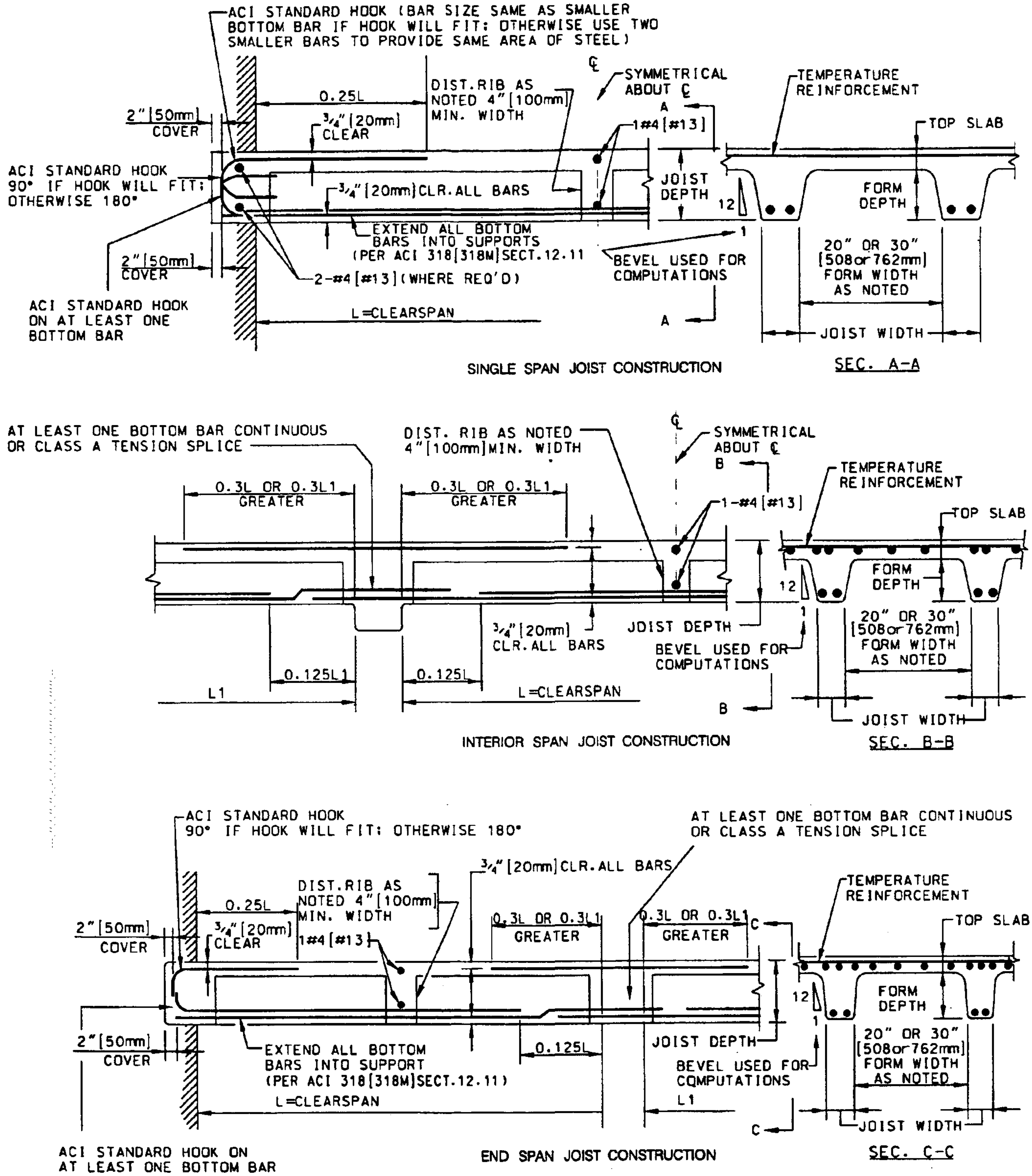
Note: Unless noted otherwise, tables and figures are based on ACI 318 (318M). Concrete cover shown is minimum and should be increased for more severe conditions. Except for single span slabs where top steel is unlikely to receive construction traffic, top bars lighter than No. 4 at 12 in. (No. 13 at 300 mm) are not recommended. For a discussion of bar support spacing, see Section 5.4 of this standard. See also Chapter 12 of ACI 318 (318M). Bar cutoff details must be verified to provide required development of reinforcement.

Fig. 1—Typical details for one-way solid slabs.



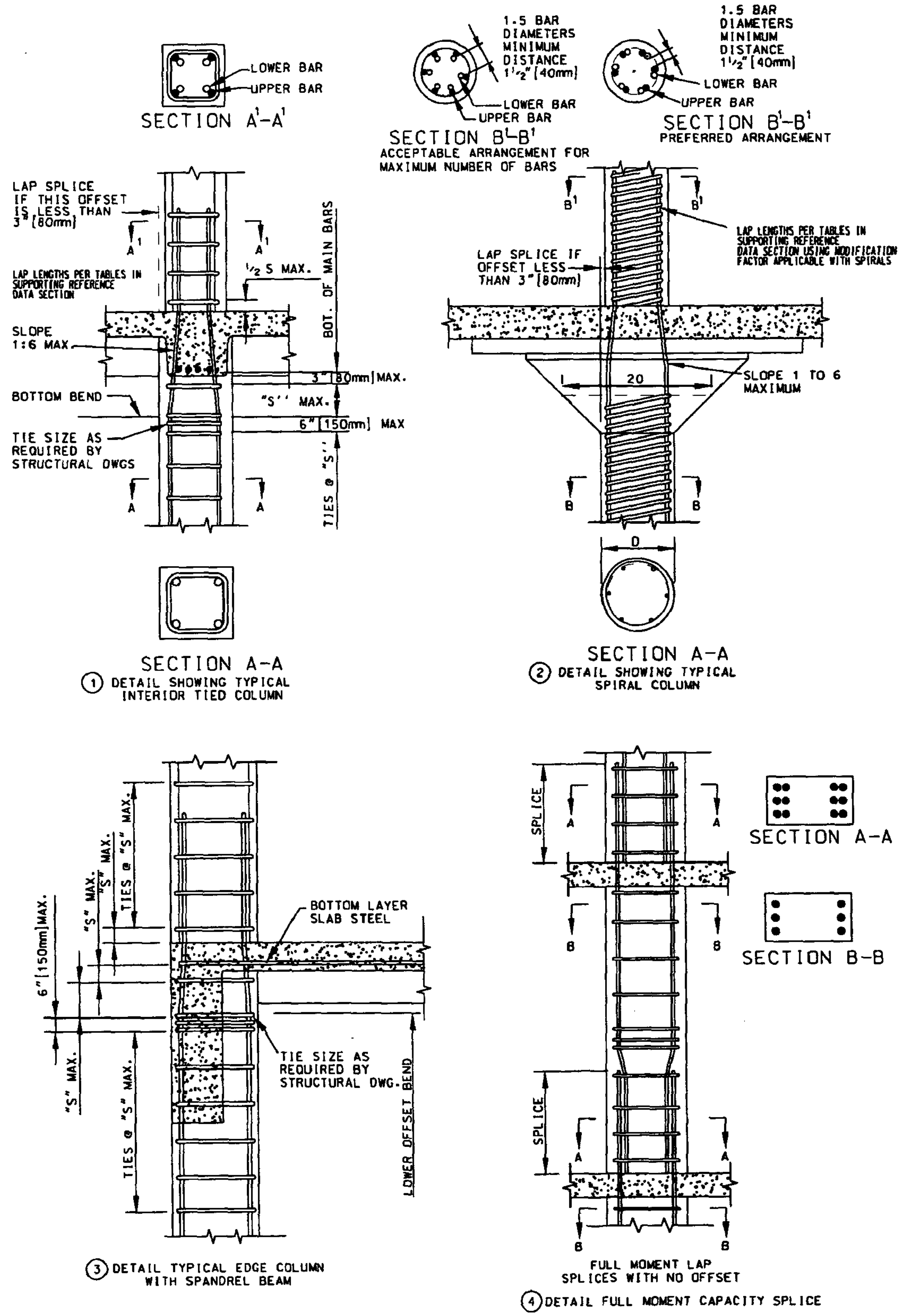
Note: Check available depth, top and bottom, for required cover on ACI standard hooks. At each end support, add top bar 0.25*L* in length to equal area of bars required. See also Chapter 12 and Chapter 21 of ACI 318 (318M). Bar cutoff details must be verified to provide required development of reinforcement.

Fig. 2—Typical details for beams.



Note: See also Chapter 12 and Section 7.13 of ACI 318 (318M). Bar cutoff details must be verified to provide required development of reinforcement.

Fig. 3—Typical details for one-way joist construction.



Note: Where column size above is unchanged from below, "upside down" offset bars are effective in maintaining full moment capacity at end of column. In U.S. practice, this unusual detail is rare, and should be fully illustrated on structural drawings to avoid misunderstandings, whenever its use is deemed necessary. For maximum tie spacing, see table in Supporting Reference Data section.

Fig. 4—Column splice details.

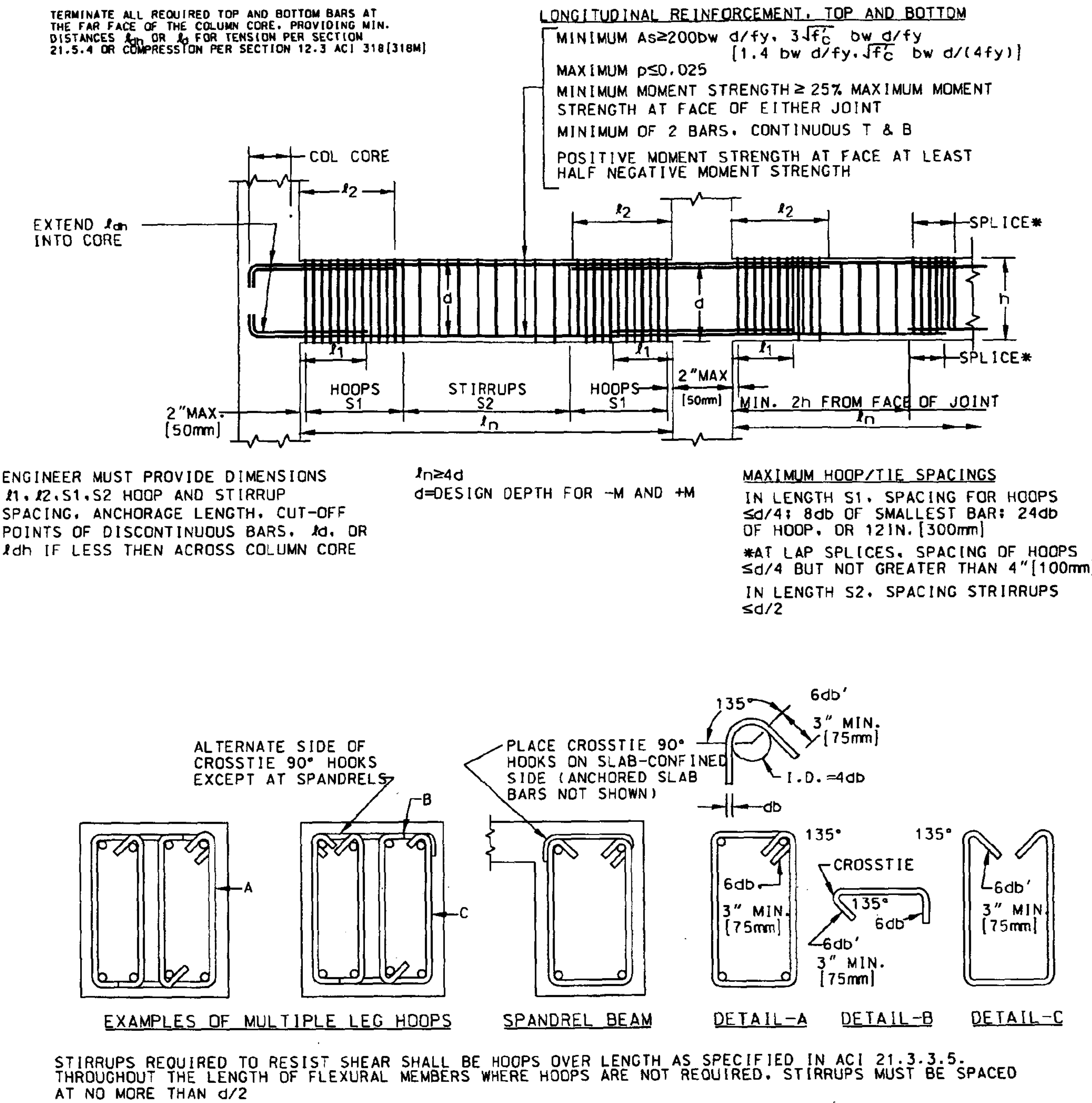


Fig. 5—Typical seismic-resistant details: flexural members.

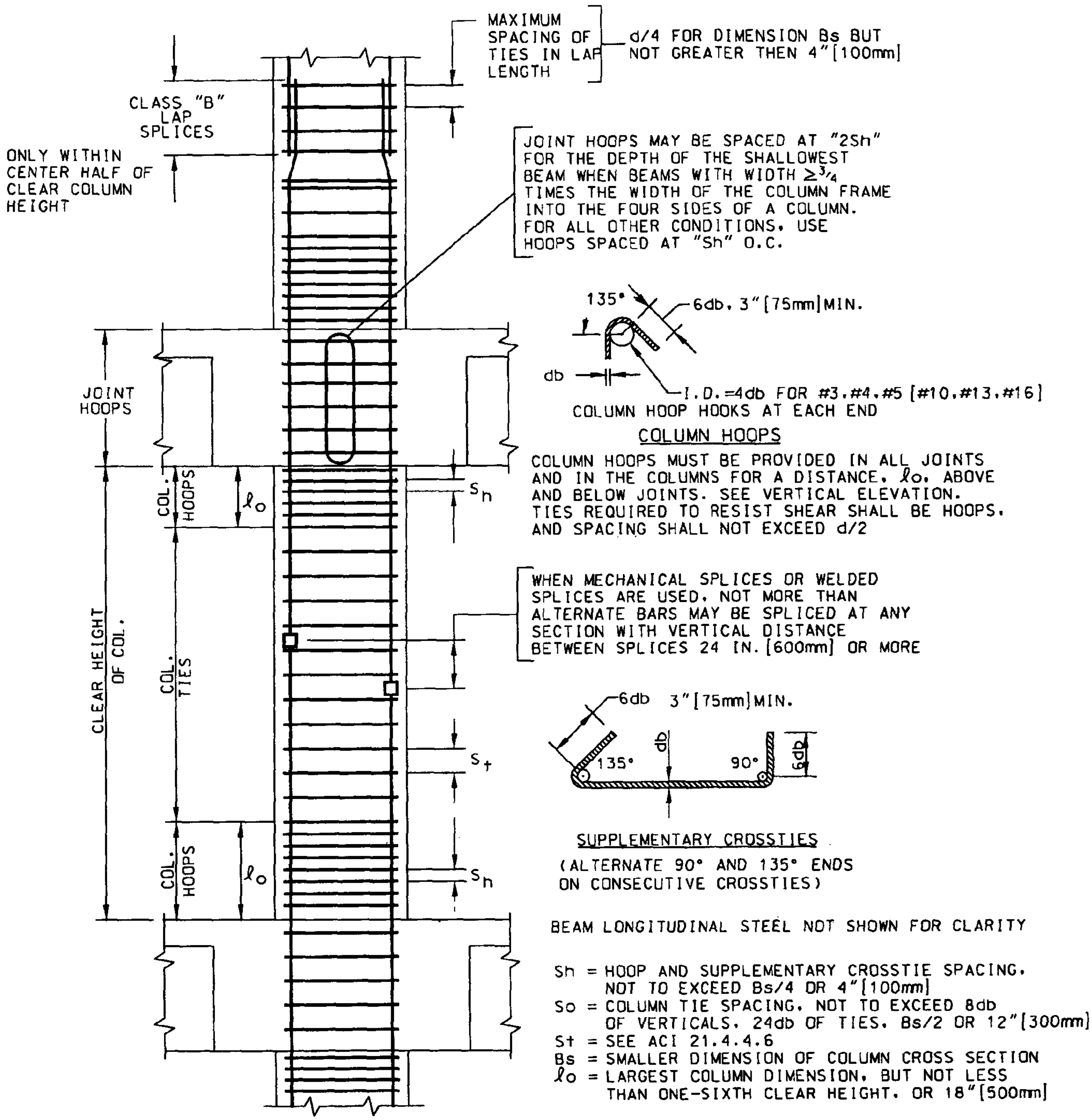
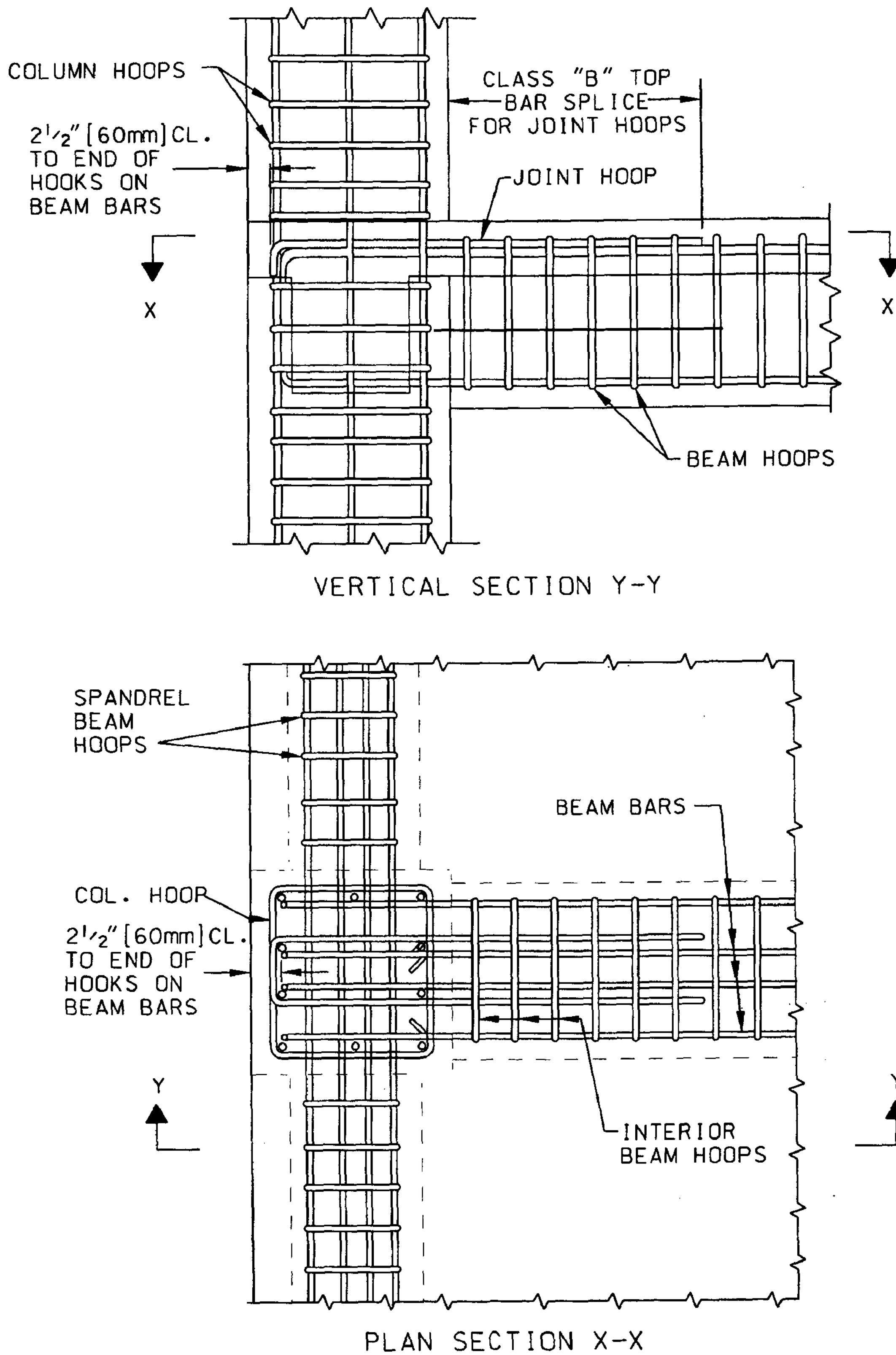


Fig. 6—Typical seismic-resistant details: columns.



NOTE: ROUND COLUMNS CAN HAVE EITHER HOOPS OR SPIRALS

Fig. 7(a)—Typical seismic-resistant joint details—Case 1: For regions of high seismic risk. Interior and spandrel beams narrower than column.

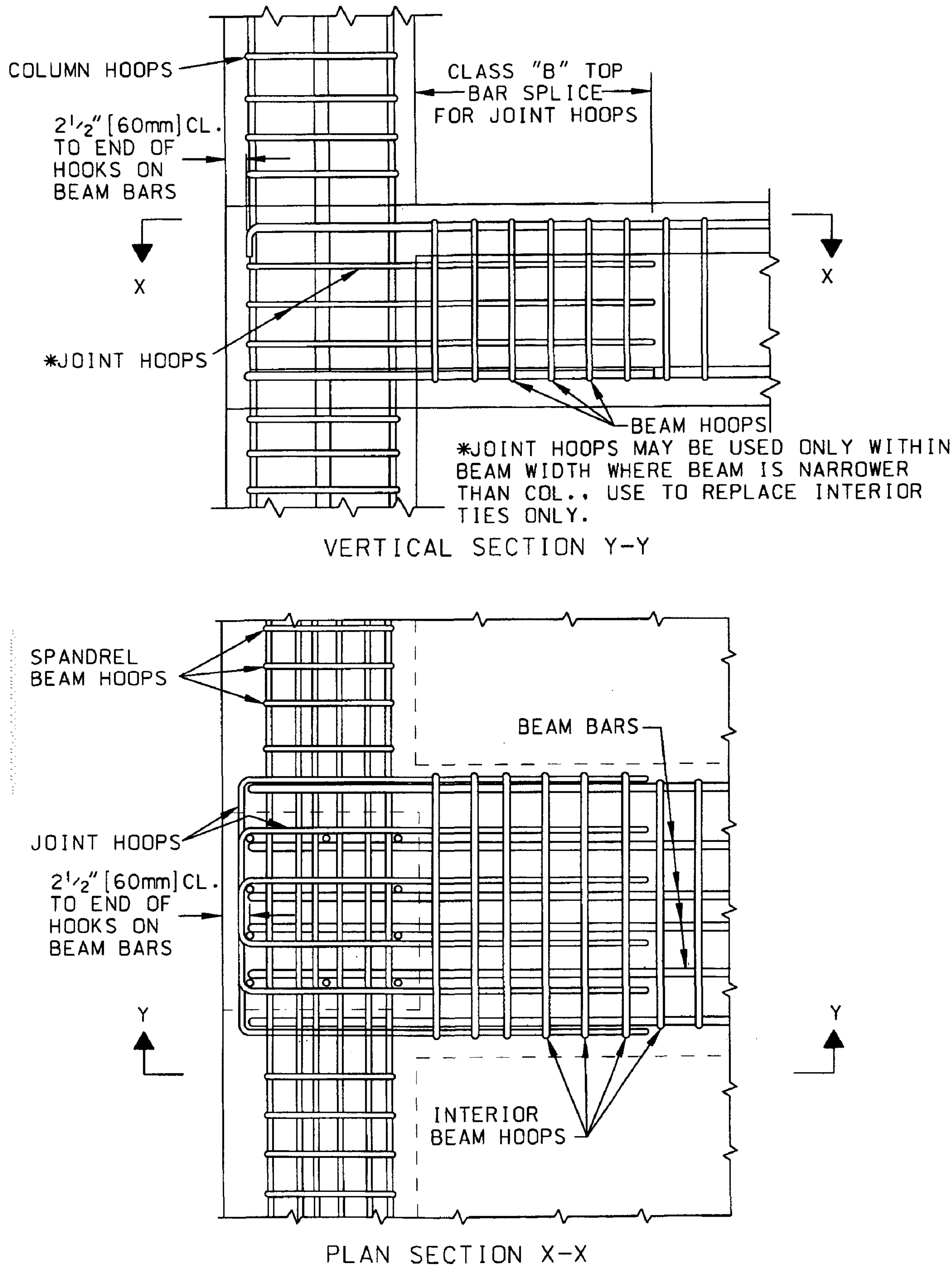


Fig. 7(b)—Typical seismic-resistant joint details—Case 2: For regions of moderate seismic risk. Interior beam wider than column; spandrel beams narrower than column.

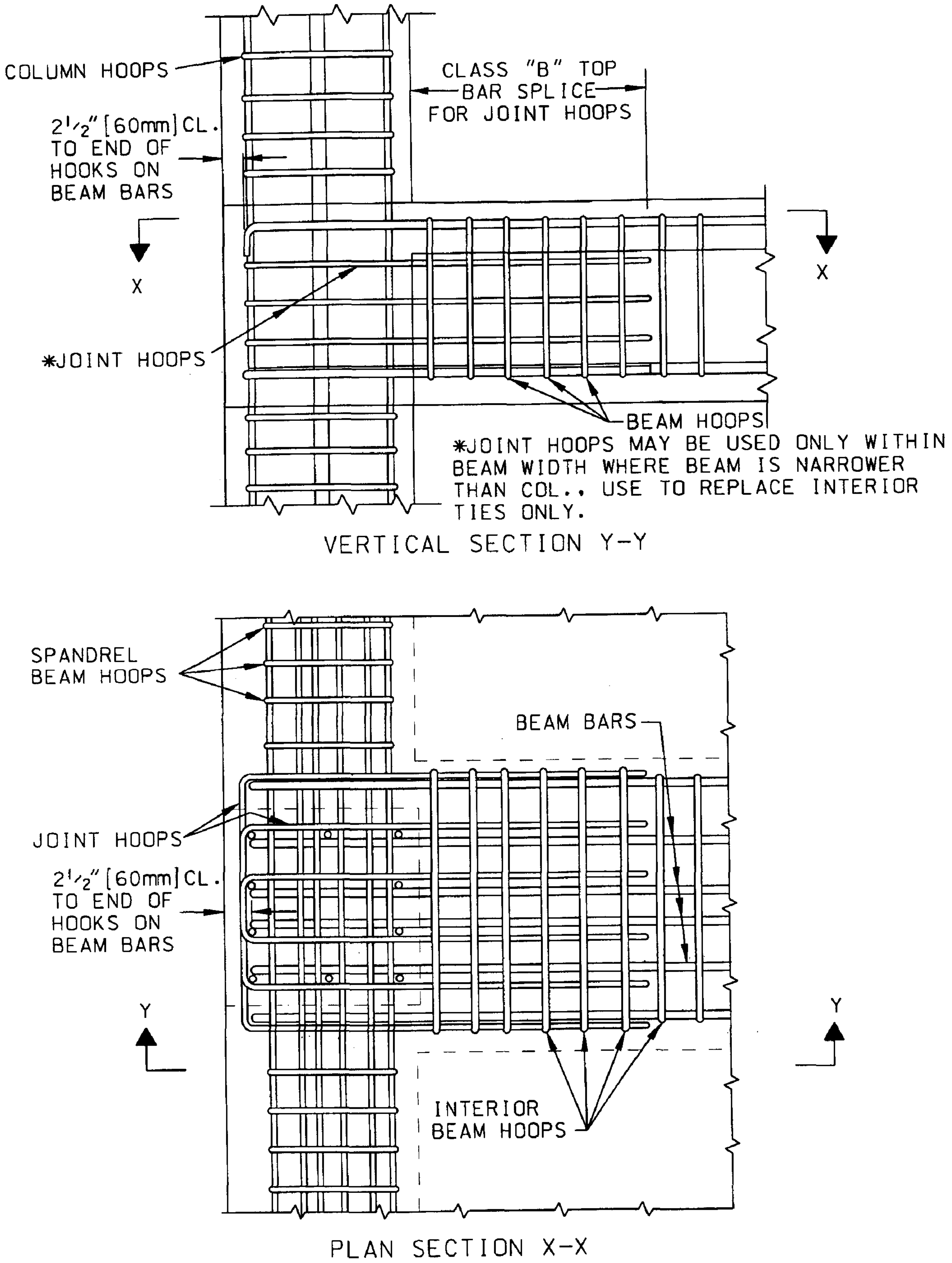
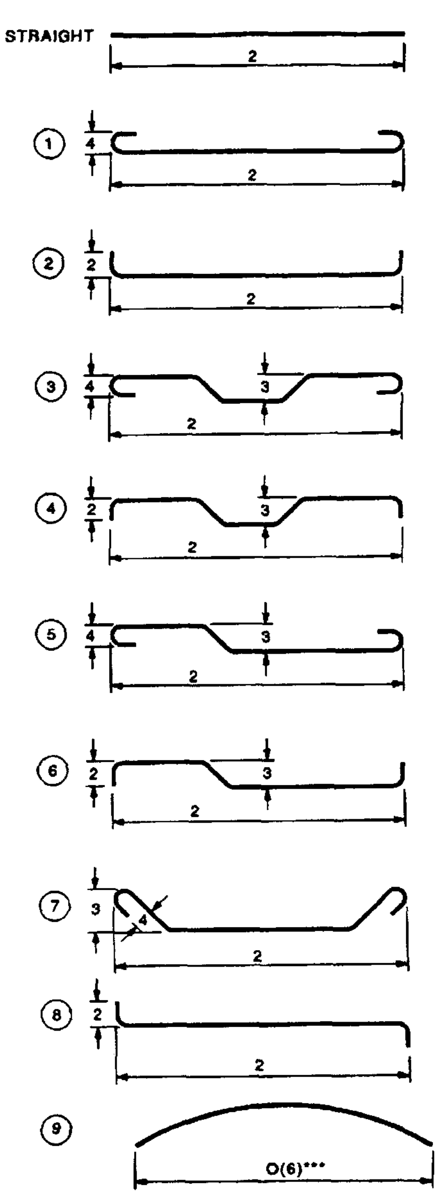
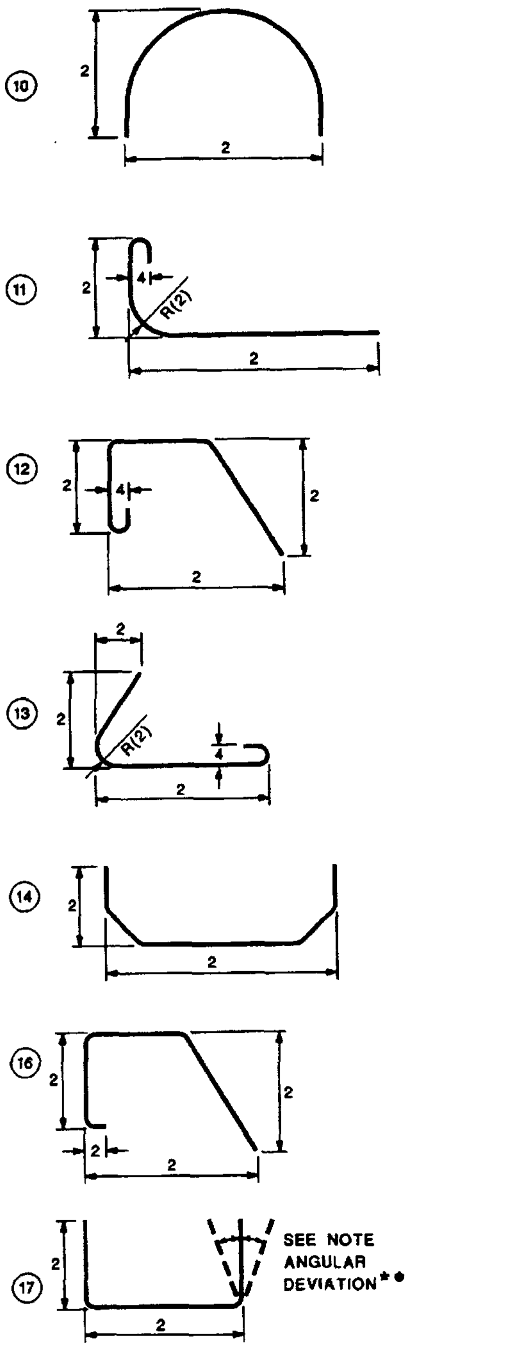


Fig. 7(c)—Typical seismic-resistant joint details—Case 3: For regions of moderate seismic risk. Interior beam wider than column; spandrel beam is same width as column.





TOLERANCE SYMBOLS

1	=	±1/2 in. (15 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length < 12 ft. 0 in. (3650 mm))
1	=	±1 in. (25 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length ≥ 12 ft. 0 in. (3650 mm))
1	=	±1 in. (25 mm) for bar size No. 6, 7, and 8 (No. 19, 22, and 25)
2	=	± 1 in. (25 mm)
3	=	+ 0, -1/2 in. (15 mm)
4	=	±1/2 in. (15 mm)
5	=	±1/2 in. (15 mm) for diameter ≤ 30 in. (760 mm)
5	=	±1 in. (25 mm) for diameter > 30 in. (760 mm)
6	=	± 1.5% × "O" dimension, ≥ ± 2 in. (50 mm) minimum

Note: All tolerances single plane and as shown.

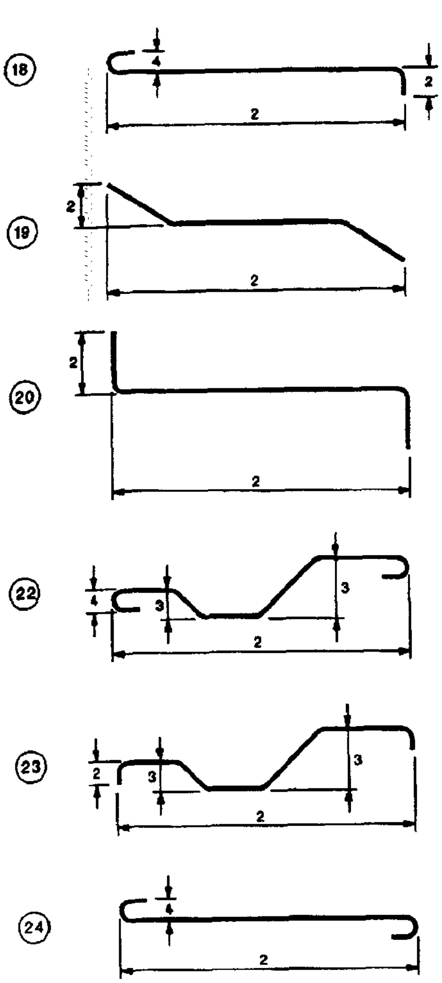
*Dimensions on this line are to be within tolerance shown but are not to differ from the opposite parallel dimension more than 1/2 in. (15 mm).

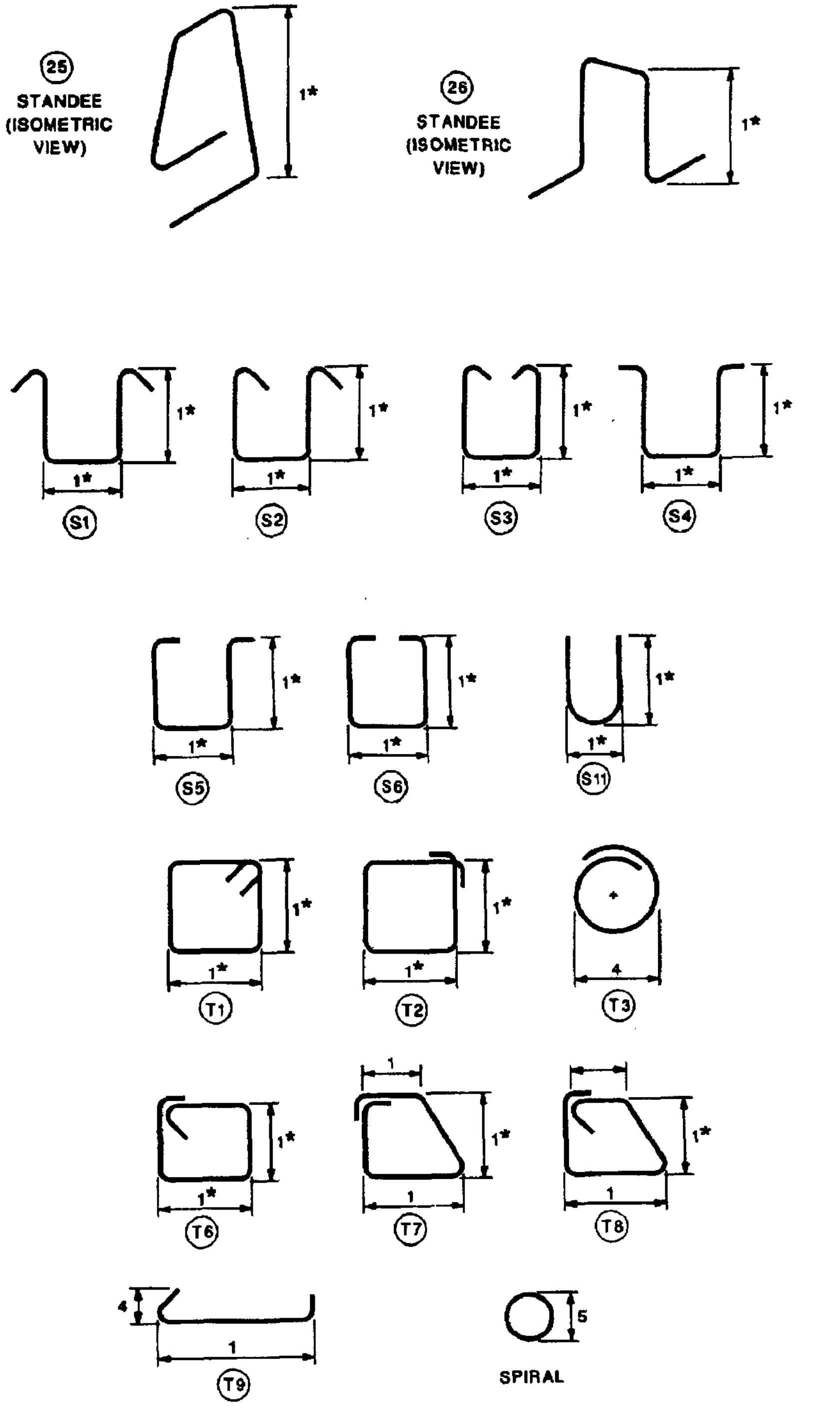
**Angular deviation—maximum ± 2-1/2 degrees or ± 1/2 in./ft (40 mm/m), but not less than 1/2 in. (15 mm) on all 90 degree hooks and bends.

***If application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.

Tolerances for Types S1-S6, S11, T1-T3, T6-T9 apply to bar size No. 3 through 8 (No. 10 through 25) inclusive only.

Fig. 8—Standard fabricating tolerances for bar sizes No. 3 through 11 (No. 10 through 36).



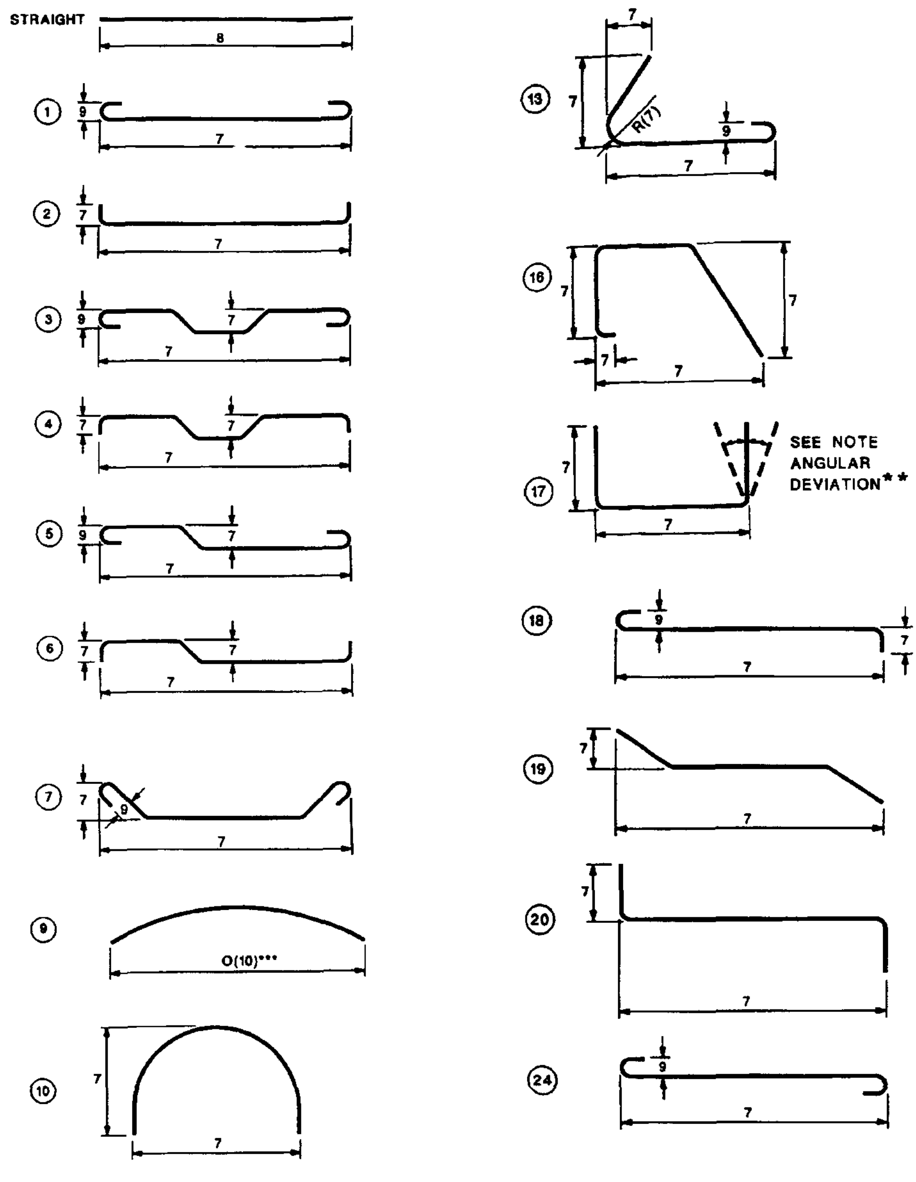


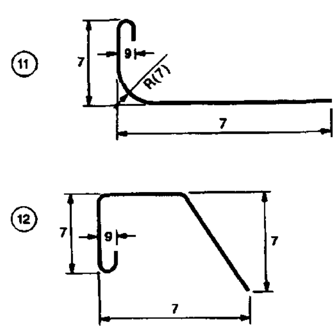
TOLERANCE SYMBOLS

1	=	±1/2 in. (15 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length < 12 ft. 0 in. (3650 mm))
1	=	±1 in. (25 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length ≥ 12 ft. 0 in. (3650 mm))
1	=	±1 in. (25 mm) for bar size No. 6, 7, and 8 (No. 19, 22, and 25)
2	=	± 1 in. (25 mm)
3	=	+ 0, -1/2 in. (15 mm)
4	=	±1/2 in. (15 mm)
5	=	±1/2 in. (15 mm) for diameter ≤ 30 in. (760 mm)
5	=	±1 in. (25 mm) for diameter > 30 in. (760 mm)
6	=	± 1.5% × "O" dimension, ≥ ± 2 in. (50 mm) minimum

Note: All tolerances single plane and as shown.
*Dimensions on this line are to be within tolerance shown but are not to differ from the opposite parallel dimension more than 1/2 in. (15 mm).
**Angular deviation—maximum ± 2-1/2 degrees or ± 1/2 in./ft (40 mm/m), but not less than 1/2 in. (15 mm) on all 90 degree hooks and bends.
***If application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.
Tolerances for Types S1-S6, S11, T1-T3, T6-T9 apply to bar size No. 3 through 8 (No. 10 through 25) inclusive only.

Fig. 8 (cont.)—Standard fabricating tolerances for bar sizes No. 3 through 11 (No. 10 through 36).



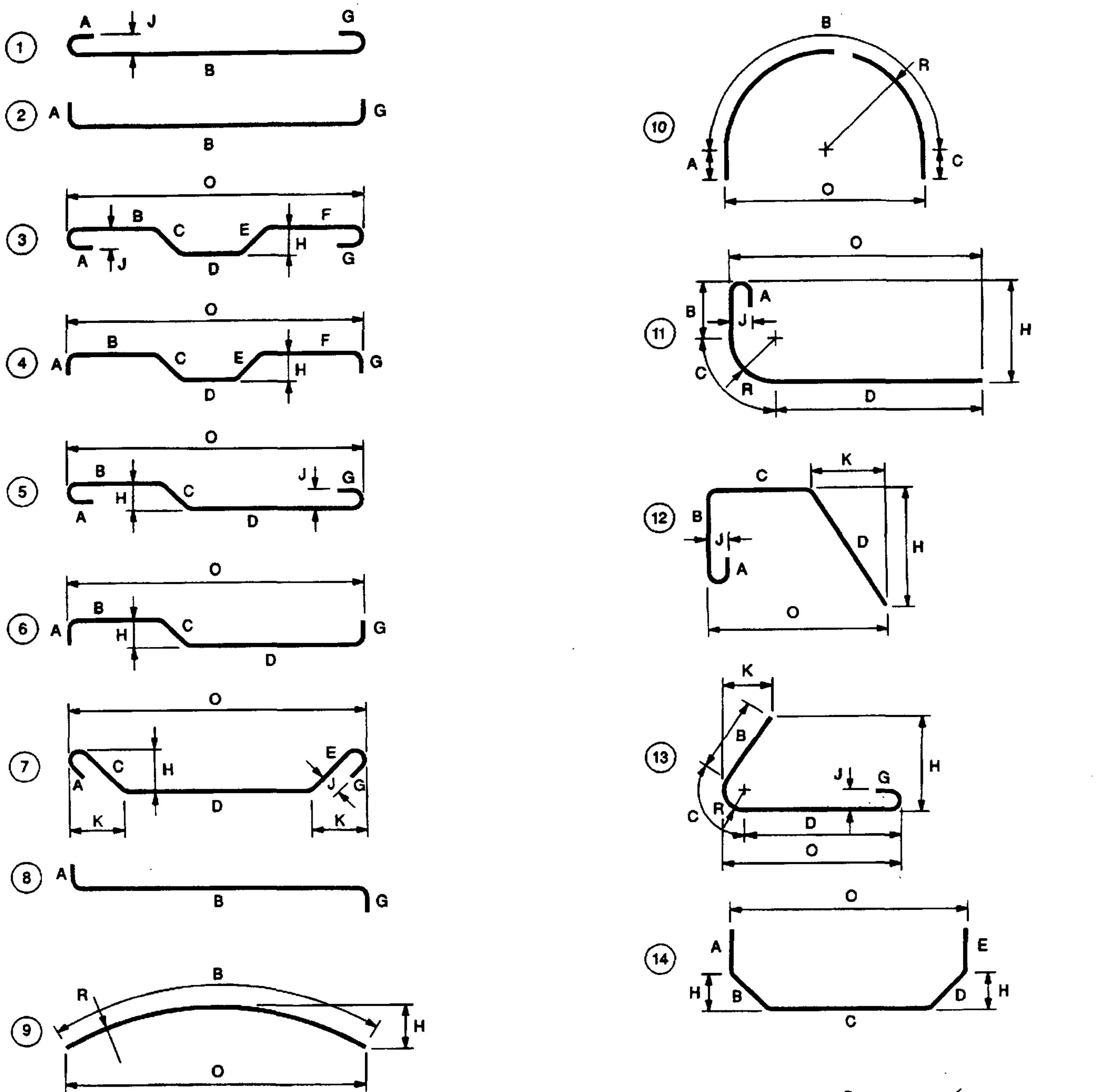


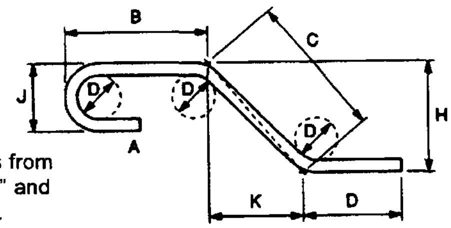
TOLERANCE SYMBOLS

Symbol	No. 14 (No. 43)	No. 18 (No. 57)
7	±2-1/2 in. (65 mm)	±3-1/2 in. (90 mm)
8	±2 in. (50 mm)	±2 in. (50 mm)
9	±1-1/2 in. (40 mm)	±2 in. (50 mm)
10 = 2% x "O" dimension, ≥	±2-1/2 in. (65 mm) min.	±3-1/2 in. (90 mm) min.

Note: All tolerances single plane as shown.
*Saw-cut both ends—Overall length ± 1/2 in. (15 mm).
**Angular deviation—Maximum ± 2 1/2 degrees or ± 1/2 in./ft (40 mm/m) on all 90 degree hooks and bends.
***If application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.

Fig. 9—Standard fabricating tolerances for bar sizes No. 14 and 18 (No. 43 and 57).





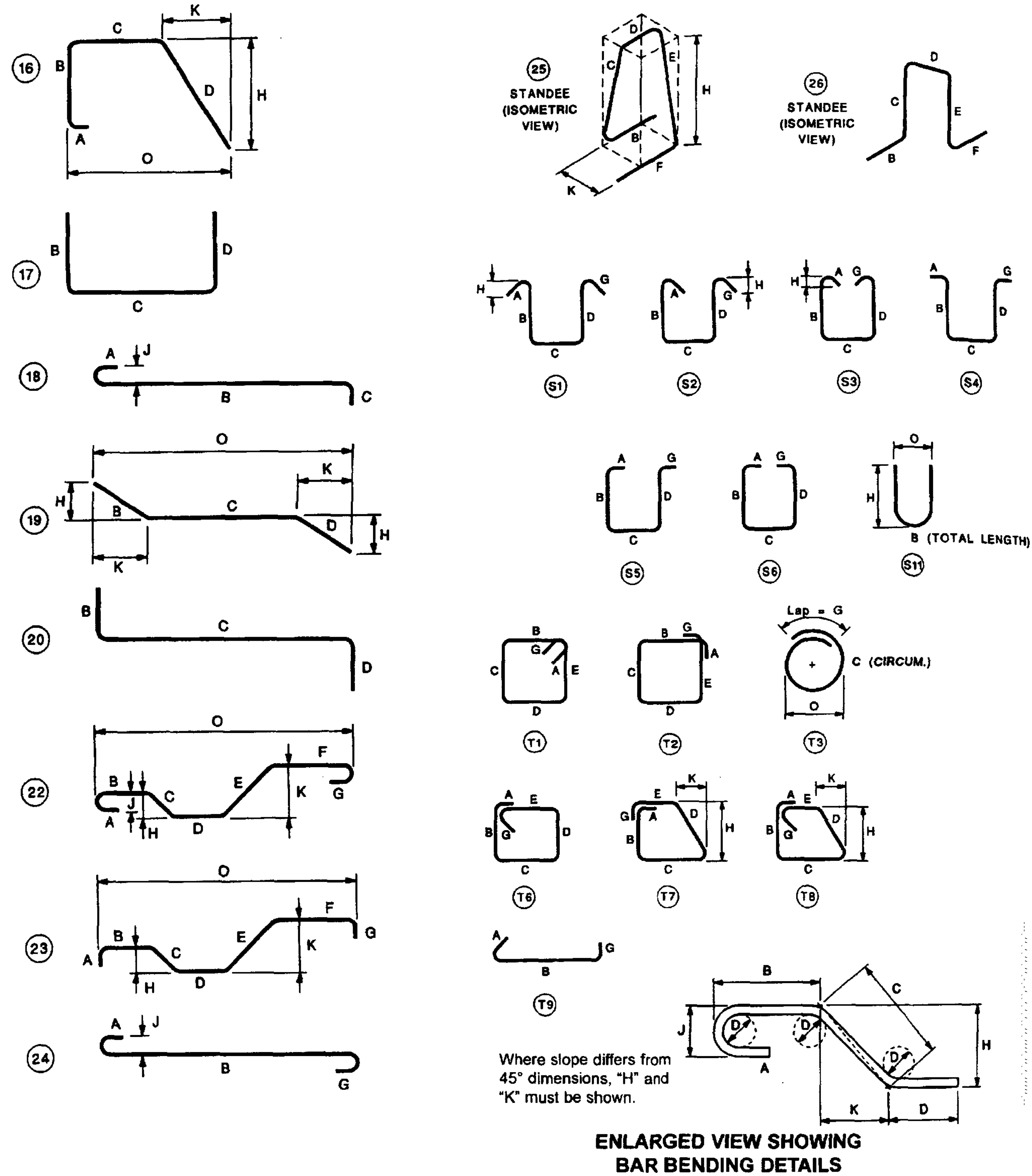
Where slope differs from 45° dimensions, "H" and "K" must be shown.

ENLARGED VIEW SHOWING BAR BENDING DETAILS

Notes:

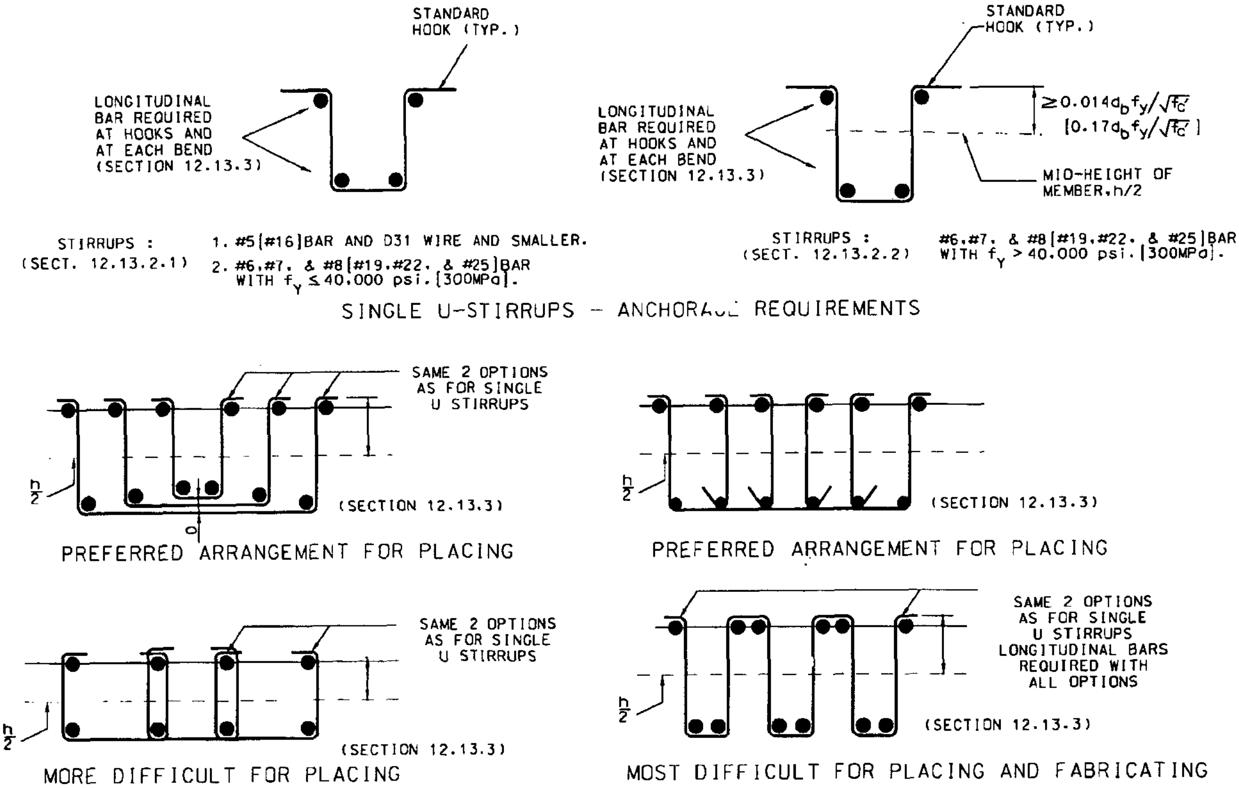
1. All dimensions are out-to-out of bar except "A" and "G" on standard 180 and 135 degree hooks.
2. "J" dimensions on 180 degree hooks to be shown only where necessary to restrict hook size, otherwise ACI standard hooks are to be used.
3. Where "J" is not shown, "J" will be kept equal or less than "H" on Types 3, 5, and 22. Where "J" can exceed "H," it should be shown.
4. "H" dimension stirrups to be shown where necessary to fit within concrete.
5. Where bars are to be bent more accurately than standard fabricating tolerances, bending dimensions that require closer fabrication should have limits indicated.
6. Figures in circles show types.
7. For recommended diameter "D" of bends and hooks, see Section 3.7.1; for recommended hook dimensions, see Table 1.
8. Unless otherwise noted, diameter "D" is the same for all bends and hooks on a bar (except for Types 11 and 13).

Fig. 10—Typical bar bends.



Notes:
1. All dimensions are out-to-out of bar except "A" and "G" on standard 180 and 135 degree hooks.
2. "J" *dimensions on 180 degree hooks to be shown only where necessary to* restrict hook size, otherwise ACI standard hooks are to be used.
3. Where "J" is not shown, "J" will be kept equal or less than "H" on Types 3, 5, and 22. Where "J" can exceed "H," it should be shown.
4. "H" dimension stirrups to be shown where necessary to fit within concrete.
5. Where bars are to be bent more accurately than standard fabricating tolerances, bending dimensions that require closer fabrication should have limits indicated.
6. Figures in circles show types.
7. *For recommended diameter* "D" *of bends and hooks, see Section 3.7.1; for* recommended hook dimensions, see Table 1.
8. Type S1 through S6, S11, T1 through T3, T6 through T9: apply to bar sizes No. 3 through 8 (No. 10 through 25).
9. Unless otherwise noted, diameter "D" is the same for all bends and hooks on a bar (except for Types 11 and 13).

Fig. 10 (cont.)—Typical bar bends.



NOTE: SECTION NUMBERS REFER TO ACI 318 [318M].

Fig. 11—ACI requirements for anchorage of open stirrups.

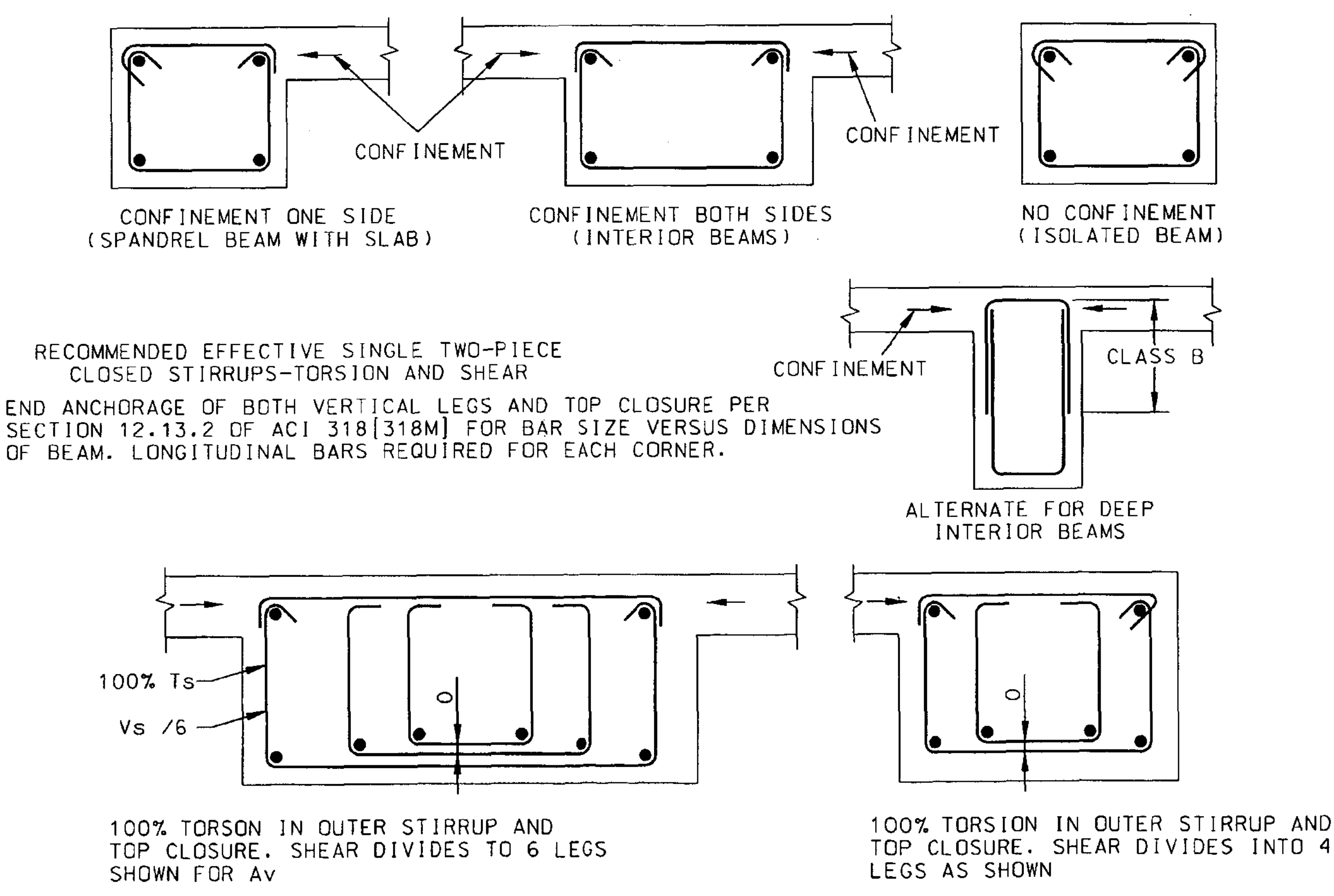
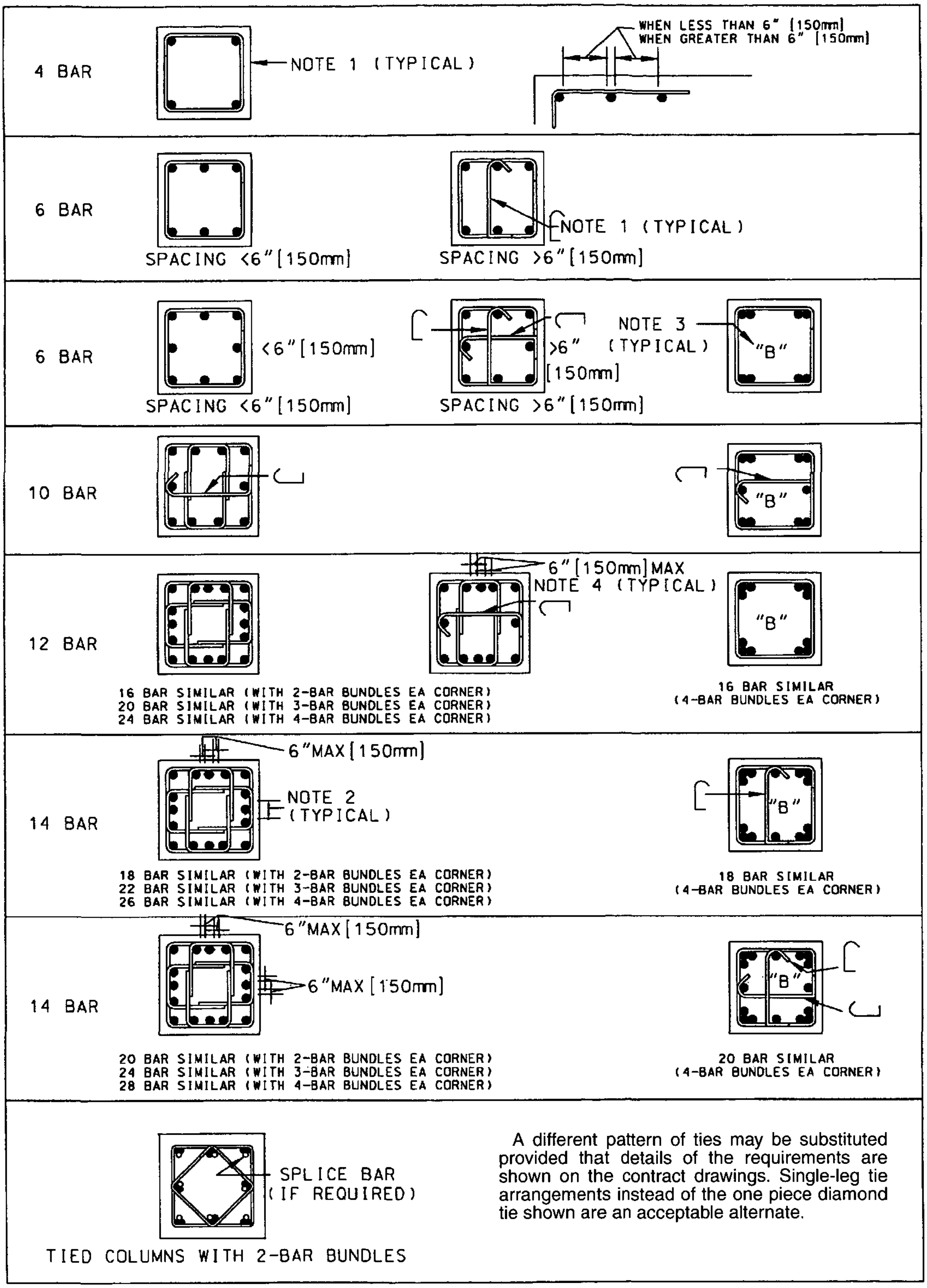


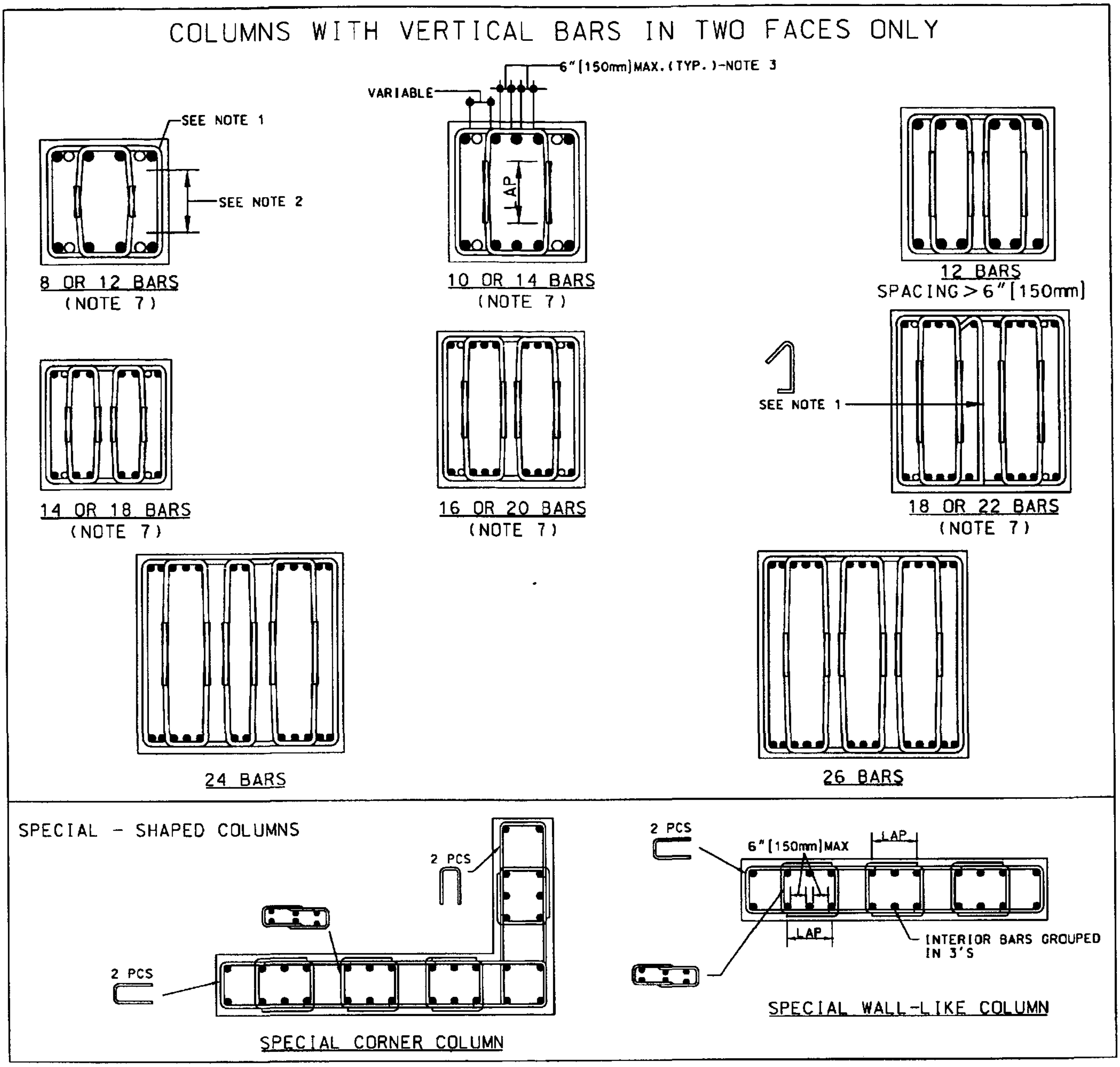
Fig. 12—Recommended two-piece closed single and multiple U-stirrups.



Notes:

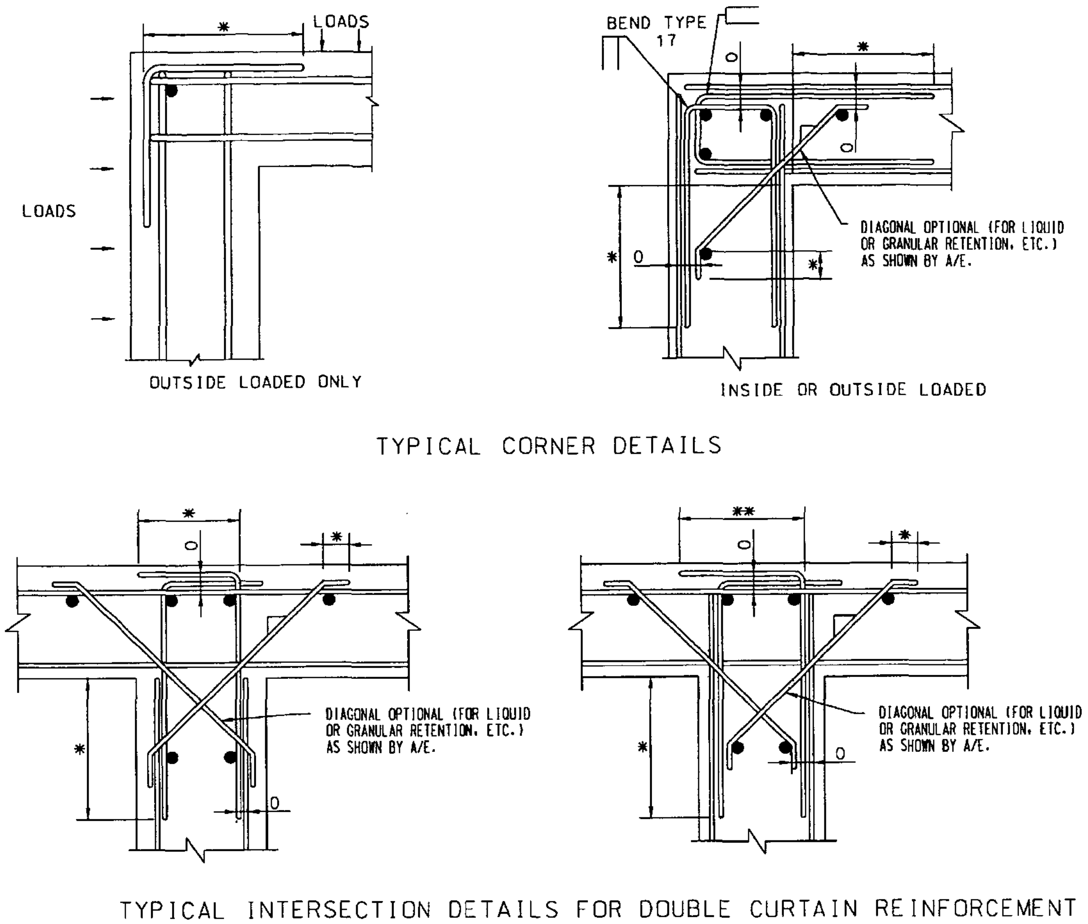
1. Alternate position of hooks in placing successive sets of ties.
2. Minimum lap shall be 12 in. (300 mm).
3. *B* indicates bundled bars. Bundles shall not exceed four bars.
4. Elimination of tie for center bar in groups of three limits clear spacing to be 6 in. (150 mm) maximum. Unless otherwise specified, bars should be so grouped.
5. Note to Architect/Engineer: Accepted practice requires that design drawings show all requirements for splicing column verticals, that is, type of splice, lap length if lapped, location in elevation, and layout in cross section.
6. Note to Detailer: Dowel erection details are required for any design employing special large vertical bars, bundled vertical bars, staggered splices, or specially grouped vertical bars as shown.
7. Bars must be securely supported to prevent displacement during concreting.
8. Tie patterns shown may accommodate additional single bars between tied groups provided clear spaces between bars do not exceed 6 in. (150 mm).
9. Minimum cover to ties, 11/2 in. (40 mm) for nonprestressed cast-in-place concrete.
10. Spaces between corner bars and interior groups of three and between interior groups may vary to accommodate average spacing > 6 in. (150 mm).
11. For average spacing < 6 in. (150 mm), one untied bar may be located between each tied group of three and between a tied group and a corner bar.

Fig. 13—Standard column ties applicable for either preassembled cages or field erection.



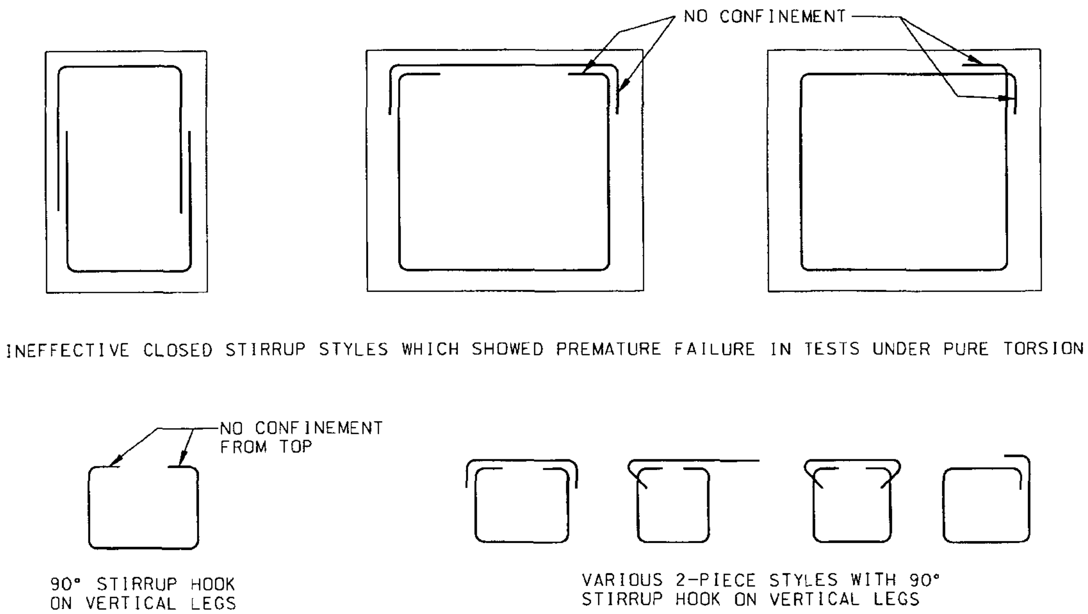
Notes:
1. Alternate position of hooks in placing successive sets of ties.
2. Minimum lap shall be 12 in. (300 mm).
3. Elimination of tie for center bar in groups of three limits clear spacing to be 6 in. (150 mm) maximum. Unless otherwise specified, bars should be so grouped.
4. Note to Architect/Engineer: Accepted practice requires that design drawings show all requirements for splicing column verticals, that is, type of splice, lap length if lapped, location in elevation, and layout in cross section.
5. Note to Detailer: Dowel erection details are required for any design employing special large vertical bars, bundled vertical bars, staggered splices, or specially grouped vertical bars as shown.
6. Bars must be securely supported to prevent displacement during concreting.
7. Bars shown as open circles may be accommodated provided clear spaces between bars do not exceed 6 in. (150 mm).
8. Tie patterns shown may accommodate additional single bars between tied groups provided clear spaces between bars do not exceed 6 in. (150 mm).
9. Minimum cover to ties, 1 1/2 in. (40 mm) for nonprestressed cast-in-place concrete.
10. Spaces between corner bars and interior groups of three and between interior groups may vary to accommodate average spacing > 6 in. (150 mm).
11. For average spacing < 6 in. (150 mm), one untied bar may be located between each tied group of three and between a tied group and a corner bar.

Fig. 14—Standard column ties applicable for either preassembled cages or field erection, special-shaped columns, and columns with bars in two faces only.



Notes: all 90 degree bends as shown unless otherwise indicated on structural drawings. Vertical bars shown at hooks only. Bends are shown as sharp angles for clarity.
*This dimension must be shown or specified by the Architect/Engineer.
**If other than a standard 90 degree end hook, this dimension must be shown by the Architect/Engineer.

Fig. 15—Typical wall details shown in horizontal cross section.



Notes: These styles are NOT RECOMMENDED for those members to be subjected to high torsional stress. Note lack of confinement when compared with similar members with confinement shown in Fig. 12.

Fig. 16—Not recommended; closed stirrup styles considered ineffective for members subjected to high torsion stress (based on tests by Collins and Mitchell).

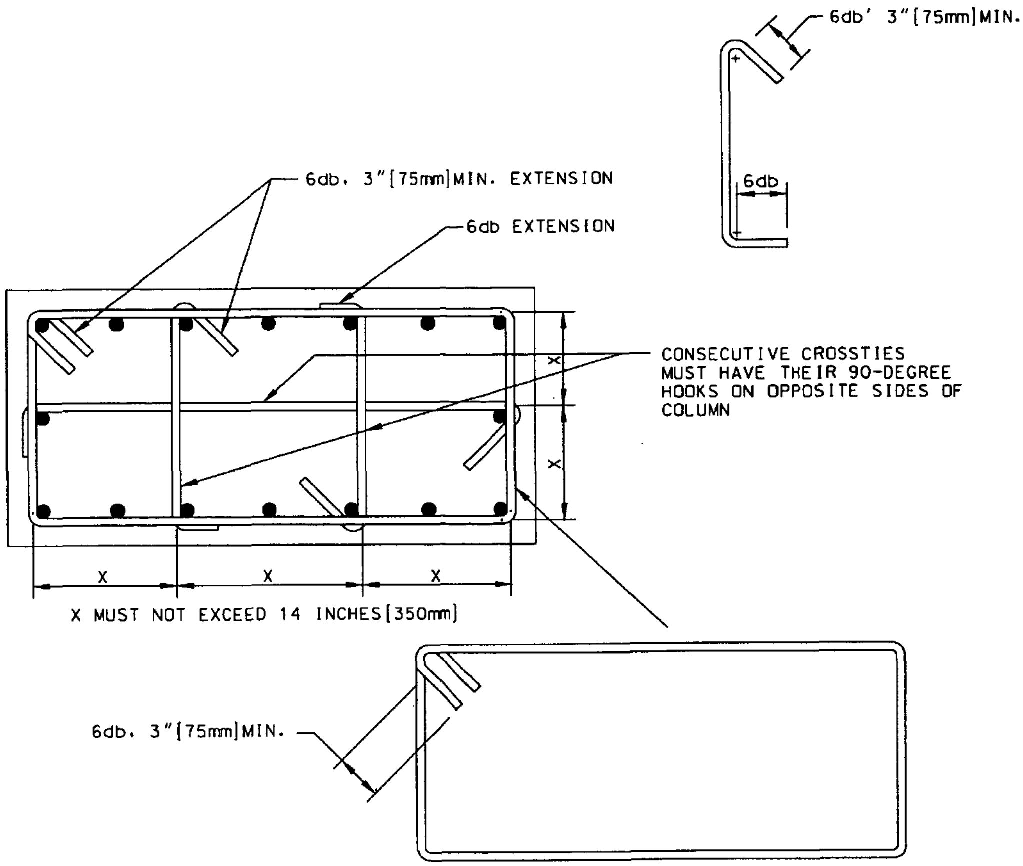


Fig. 17—Typical seismic resistant details: transverse reinforcement in columns.

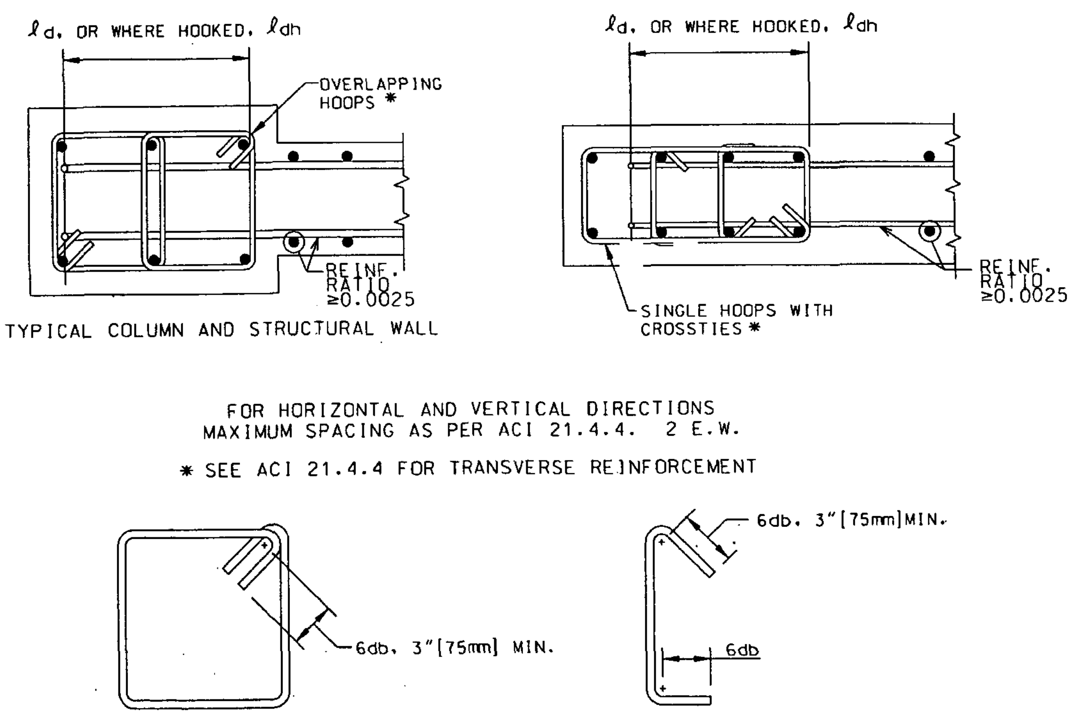


Fig. 18—Typical seismic-resistant details: boundary members.

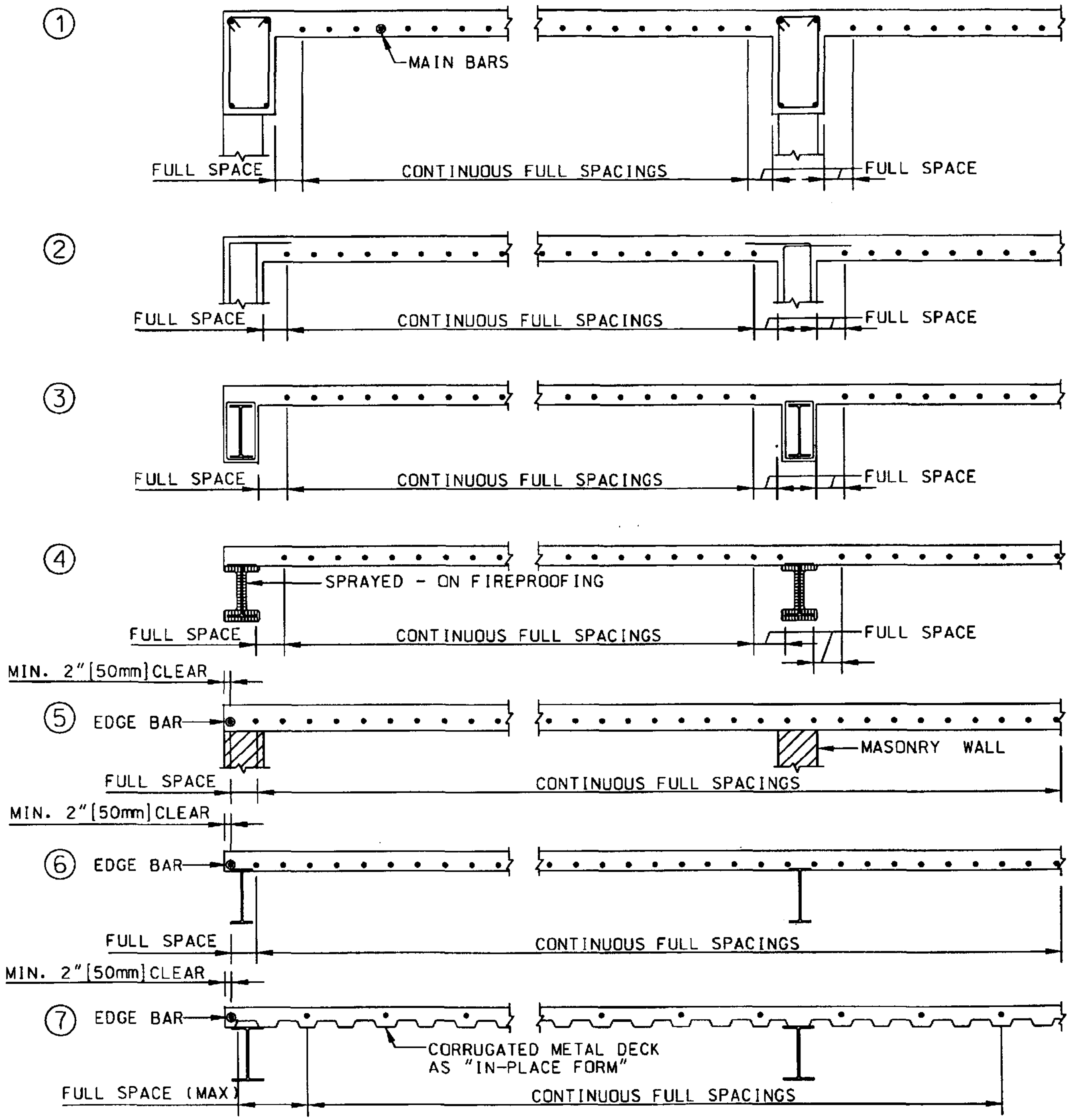


Fig. 19(a)—Location of first bar designated only by size and spacing, one-way slab main flexural reinforcing bars.

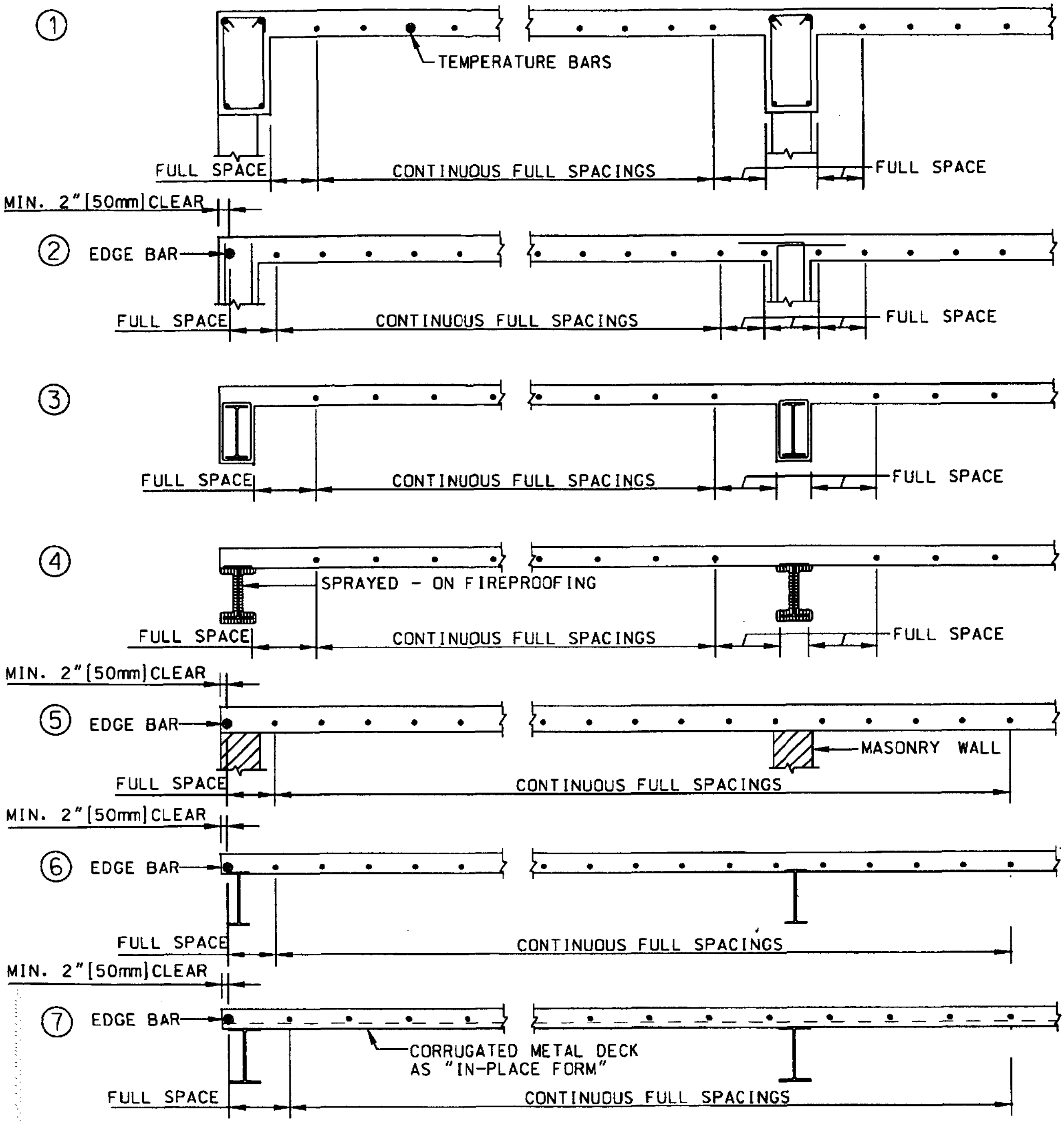


Fig. 19(b)—Location of first bar designated only by size and spacing, one-way slab shrinkage and temperature reinforcing bars.

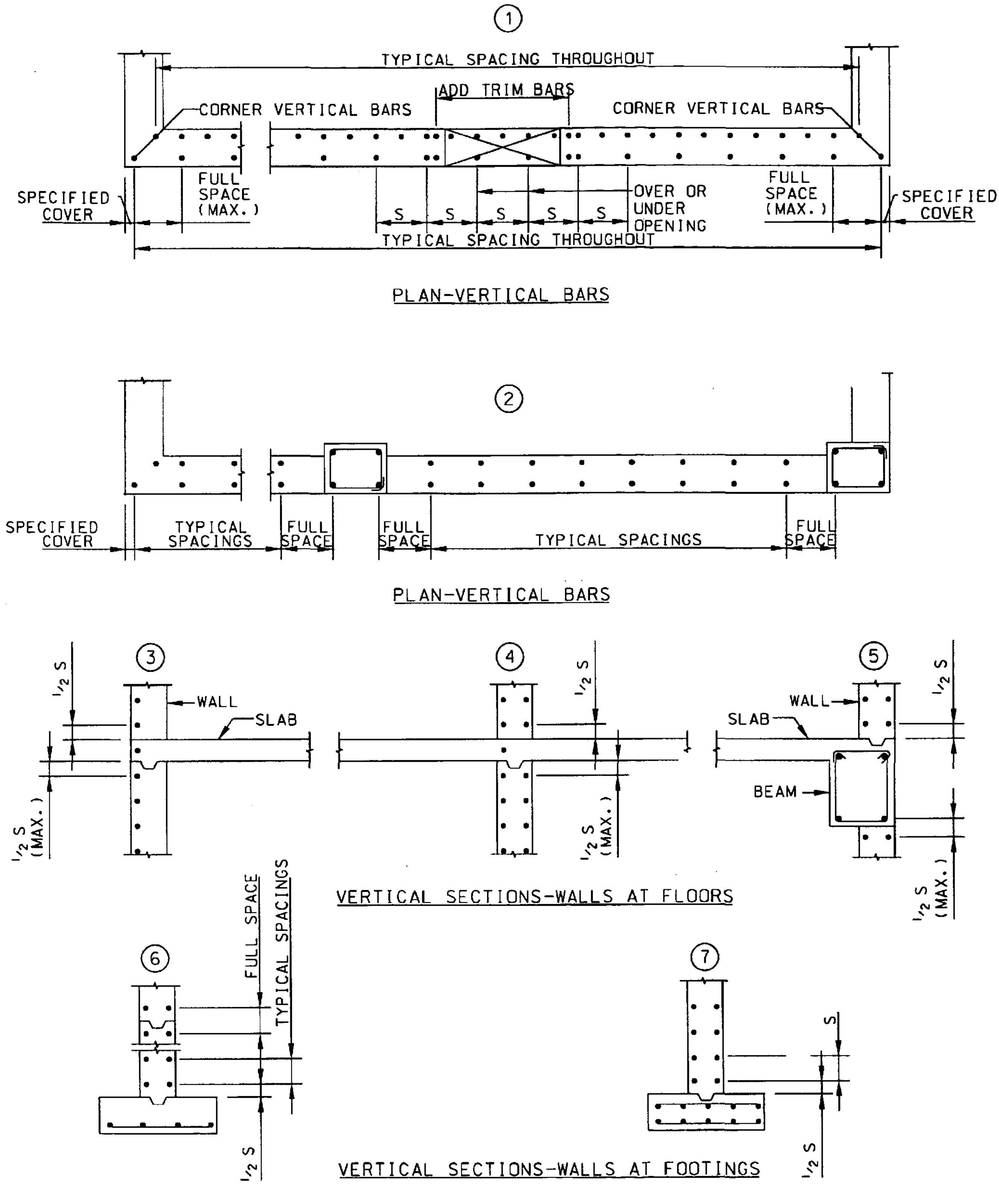
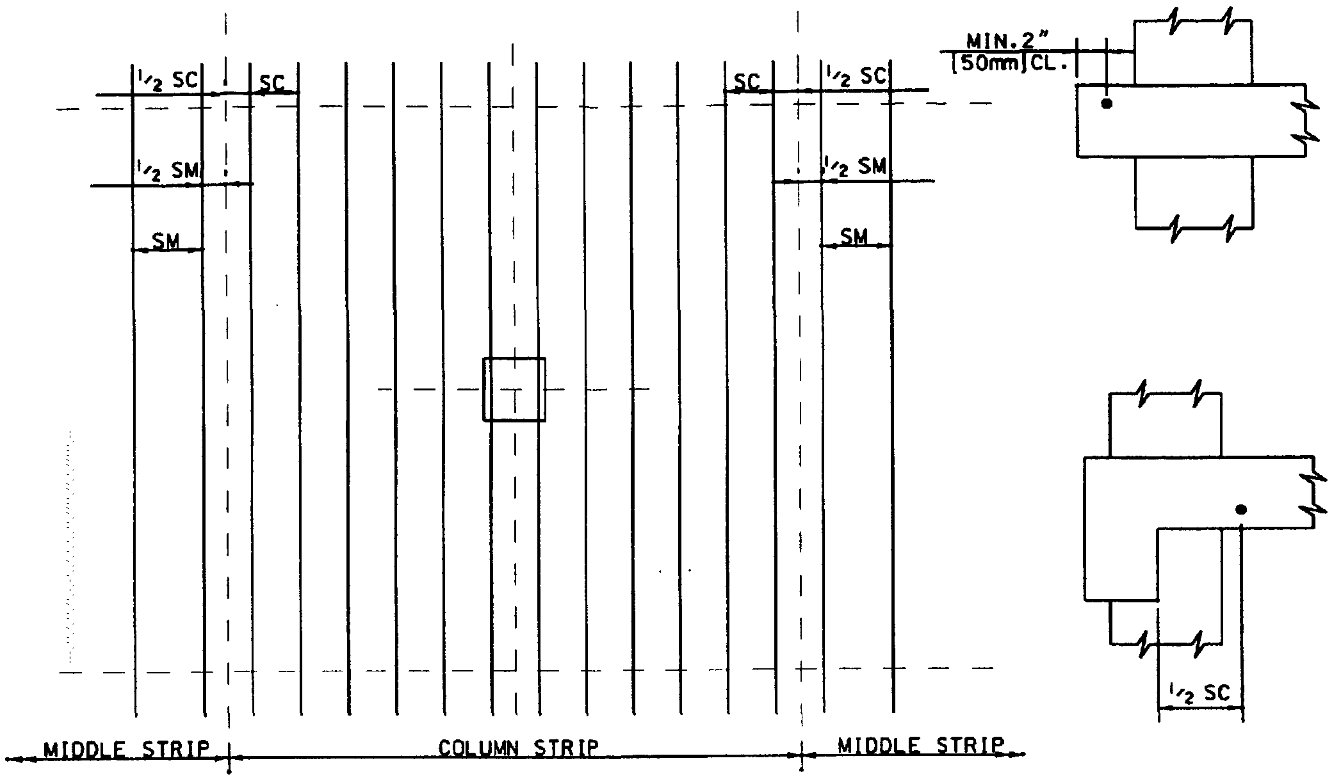


Fig. 19(c)—Location of first bar designated only by size and spacing, reinforcing bars in walls.

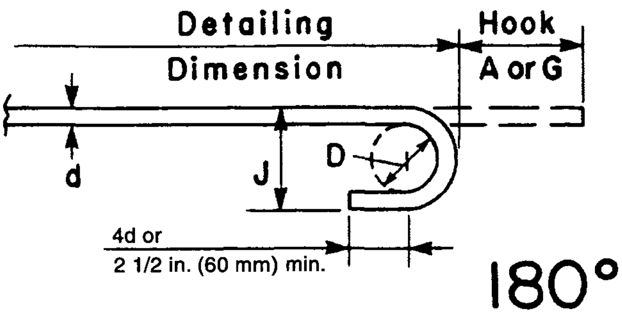


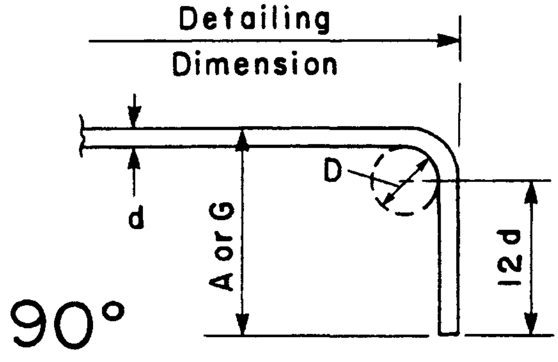
STANDARD SPACING UNLESS OTHERWISE DESIGNATED

EXCEPT FOR BARS PARALLEL TO SLAB EDGES, SPACE ALL REQUIRED BARS UNIFORMLY ACROSS COLUMN OR MIDDLE STRIPS STARTIMG AT ONE-HALF SPACING FROM EDGES OF COLUMN STRIPS, MIDDLE STRIPS, OR SPANDREL BEAMS. SPACE THE FIRST BARS PARALLEL TO SLAB EDGES WITH MINIMUM 2 IN. [50mm] CLEAR COVER. WHEN STRUCTURAL DRAWING DESIGNATES SEPARATELY A NUMBER OF BARS TO BE UNIFORMLY SPACED AND A NUMBER TO BE CONCENTRATED ABOUT THE COLUMN CENTERLINE, START THE UNIFORMLY SPACED BARS AT ONE-HALF SPACING FROM THE EDGES OF THE COLUMN STRIP

Fig. 19(d)—Location of first bar designated only by size and spacing, two-way slab reinforcing bars.

Table 1—Standard hooks: All specific sizes recommended meet minimum requirements of ACI 318



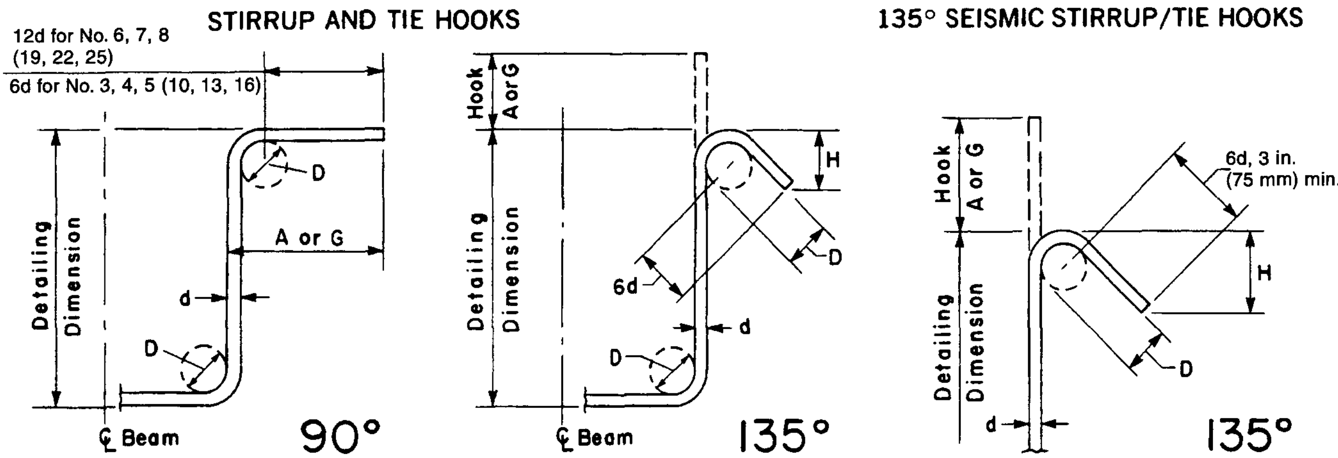


RECOMMENDED END HOOKS
All grades
D = Finished bend diameters

Bar size, No.	D,* in (mm)	180 degree hook		90 degree hook
		A or G, ft-in (mm)	J, ft-in. (mm)	A or G, ft-in. (mm)
3 (10)	2 1/4 (60)	5 (125)	3 (80)	6 (155)
4 (13)	3 (80)	6 (155)	4 (105)	8 (200)
5 (16)	3 3/4 (95)	7 (180)	5 (130)	10 (250)
6 (19)	4 1/2 (115)	8 (205)	6 (155)	1-0 (300)
7 (22)	5 1/4 (135)	10 (250)	7 (175)	1-2 (375)
8 (25)	6 (155)	11 (275)	8 (205)	1-4 (425)
9 (29)	9 1/2 (240)	1-3 (375)	11 3/4 (300)	1-7 (475)
10 (32)	10 3/4 (275)	1-5 (425)	1-1 1/4 (335)	1-10 (550)
11 (36)	12 (305)	1-7 (475)	1-2 3/4 (375)	2-0 (600)
14 (43)	18 1/4 (465)	2-3 (675)	1-9 3/4 (550)	2-7 (775)
18 (57)	24 (610)	3-0 (925)	2-4 1/2 (725)	3-5 (1050)

*Finished bend diameters include "spring back" effect when bars straighten out slightly after being bent and are slightly larger than minimum bend diameters in 3.7.2.

Table 1(cont.)—Standard hooks: All specific sizes recommended meet minimum requirements of ACI 318



STIRRUP
(TIES SIMILAR)
STIRRUP AND TIE HOOK DIMENSIONS
ALL GRADES

Bar size, No.	D,* in. (mm)	90 degree hook	135 degree hook	
		Hook A or G, ft-in. (mm)	Hook A or G, ft-in. (mm)	H approx., ft-in. (mm)
3 (10)	1 1/2 (40)	4 (105)	4 (105)	2 1/2 (65)
4 (13)	2 (50)	4 1/2 (115)	4 1/2 (115)	3 (80)
5 (16)	2 1/2 (65)	6 (155)	5 1/2 (140)	3 3/4 (95)
6 (19)	4 1/2 (115)	1-0 (305)	8 (205)	4 1/2 (115)
7 (22)	5 1/4 (135)	1-2 (355)	9 (230)	5 1/4 (135)
8 (25)	6 (155)	1-4 (410)	10 1/2 (270)	6 (155)

135 DEGREE SEISMIC STIRRUP/TIE
HOOK DIMENSIONS
ALL GRADES

Bar size, No.	D,*in. (mm)	135 degree hook	
		Hook A or G, ft-in. (mm)	H approx., ft-in. (mm)
3 (10)	1 1/2 (40)	4 1/4 (110)	3 (80)
4 (13)	2 (50)	4 1/2 (115)	3 (80)
5 (16)	2 1/2 (65)	5 1/2 (140)	3 3/4 (95)
6 (19)	4 1/2 (115)	8 (205)	4 1/2 (115)
7 (23)	5 1/4 (135)	9 (230)	5 1/4 (135)
8 (25)	6 (155)	10 1/2 (270)	6 (155)

*Finished bend diameters include "spring back" effect when bars straighten out slightly after being bent and are slightly larger than minimum bend diameters in 3.7.2.

MANUAL OF STRUCTURAL AND PLACING DRAWINGS FOR REINFORCED CONCRETE STRUCTURES (ACI 315R-04)

Reported by ACI Committee 315

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Donald E. Milks
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Committee 315 would like to acknowledge the contributions of the following individuals and companies in the preparation of the example drawings:

John J. Tekus (Akron Rebar Company); Dave F. Horton (Barker Steel Company, Inc.); Bruce Hirsch (Dalco Industries, Inc.); Dennis L. Hunter (Gerdau AmeriSteel); Charlie Davidson (Rockford Fabricators, Inc.); and Paul L. Nims (Structural Metals, Inc.).

Prepared in collaboration with the Federal Highway Administration, State of California Department of Transportation, and with the cooperation of the Engineering Practice Committee of the Concrete Reinforcing Steel Institute.

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These example drawings were prepared in collaboration with the Federal Highway Administration, State of California Department of Transportation, and with the cooperation of the Engineering Practice Committee of the Concrete Reinforcing Steel Institute.

Participation by federal agency representatives in the work of the American Concrete Institute and in the development of Institute standards does not constitute government endorsement of ACI or the standards which it develops.

CONTENTS

TYPICAL DRAWINGS FOR NONHIGHWAY STRUCTURES

The structural drawings used in this manual were primarily selected from design drawings of actual structures but were modified to conform with the requirements of "Building Code Requirements for Structural Concrete (ACI 318)" and to illustrate recommended methods of presenting the design information needed to make the placing drawings. The titles on the drawings are fictitious. In all cases, those who prepare the design drawings were responsible for the analysis and design.

ACI 318 requires that structural drawings, details, and project specifications show:

(a) Name and date of issue of code and supplement to which design conforms;

(b) Live load and other loads used in design;

(c) Specified strength of concrete at stated ages or stages of construction;

(d) Specified strength or grade of reinforcement;

(e) Size and location of all structural elements and reinforcement;

(f) Provision for dimensional changes resulting from creep, shrinkage, and temperature;

(g) Magnitude and location of prestressing forces;

(h) Anchorage length of reinforcement and location and length of lap splices; and

(i) Type and location of mechanical splices and welded splices of reinforcement.

Ratios used to indicate the bar extensions for longitudinal reinforcement as shown on some structural drawings are merely examples to show a design. These ratios are not standard because they vary with design conditions and different combinations of load and span. Under certain conditions, the ratios shown were close approximations and were used to facilitate the preparation of placing drawings.

For consistency, the locations of bar extensions have been based on clear spans. It is often desirable to use ratios of the span with reference to center lines of supports; in either case, the engineer should clearly specify all bar extensions.

The development and lap splice lengths shown are for illustrative purposes. The engineer should adjust these lengths in accordance with the latest code requirements for concrete strength, reinforcing steel yield strength, reinforcing steel confinement, and other factors.

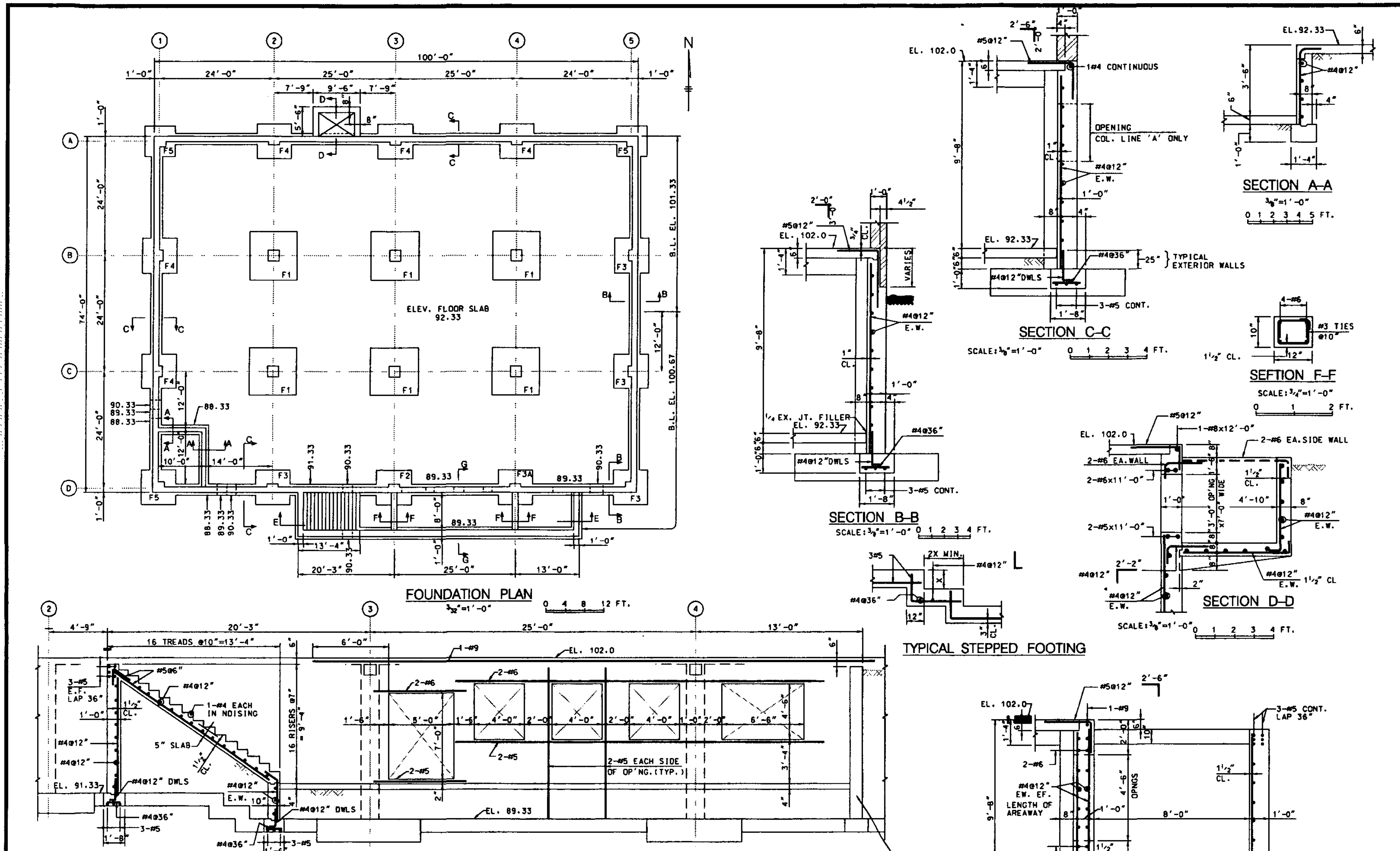
The following drawings, for the most part, reflect reinforcing bars in structural concrete applications. In many cases (such as walls; slabs, both supported and on ground; column ties; beam/joist stirrups; and shear reinforcing), welded wire fabric (WWF) can be an acceptable structural reinforcement. ACI 318 allows the use of WWF as steel reinforcement.

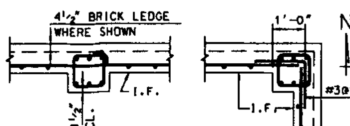
For those instances where reinforcing steel congestion is likely, larger-scale drawings should be used to determine tolerances and physical fit problems.

DRAWING S-1—FOUNDATIONS (STRUCTURAL DRAWING)

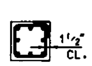
This drawing is for a small structure with reinforced concrete walls up to the first floor. There is a brick ledge along Column Line 5, and, for simplicity, all wall piers (pilasters) have been set back 4-1/2 in. so that the outside face reinforcement runs straight through. The framing above is structural steel, and all piers terminate as shown in the typical detail. The column footings and pier reinforcement are shown in schedules and all wall reinforcement is shown in section or elevation. The footing elevations are shown on the plan and in the notes.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

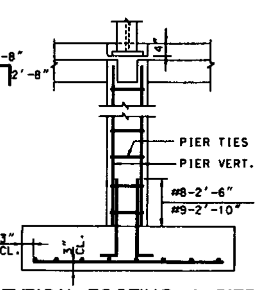




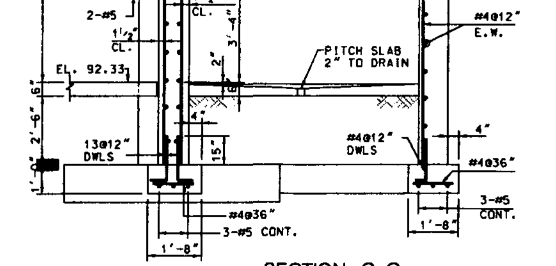
TYPICAL EXTERIOR PIERS



TYPICAL INTERIOR PIER



TYPICAL FOOTING & PIER



SECTION G-G

SCALE: 3/8"=1'-0"

FOOTING SCHEDULE

MARK	SIZE	REINF.
F1	9'-0"x9'-0"x1'-11"	10-#8 E.W.
F2	8'-0"x8'-0"x1'-10"	10-#7 E.W.
F3	7'-6"x7'-6"x1'-8"	9-#7 E.W.
F4	7'-0"x7'-0"x1'-7"	8-#7 E.W.
F5	6'-6"x6'-6"x1'-6"	9-#6 E.W.

PIER SCHEDULE

PIER	SIZE	VERTICAL	TIES
B2, B3, B4 C2, C3, C4	16"x16"	8-#9	#3@12"
D3, D4	16"x16"	8-#8	#3@12"
A1 THRU A5 B1, B5, C1, C5 D2, D5	16"x16"	6-#8	#3@12"
D1	16"x16"	6-#8	#3@12"

NOTES:

1. ALL CONCRETE WORK SHALL CONFORM TO ACI 318-99 BUILDING CODE.
2. REINFORCING STEEL SHALL CONFORM TO ASTM A615. GRADE 60.
3. fc'=4000 psi @ 28 DAYS FOR FOOTINGS & WALLS. fc'=5000 psi @ 28 DAYS FOR PIERS.
4. MAXIMUM SIZE OF AGGREGATE IS 3/4 IN.
5. ALL REINFORCING BAR SPLICES ARE TO BE CLASS B TENSION SPLICES PER LAP SPLICE SCHEDULE UNLESS OTHERWISE SHOWN. WALL HORIZONTALS ARE TO BE CONSIDERED "TOP BARS".
6. EXTEND #5 LONGITUDINAL BARS IN WALL FOOTINGS 1'-0" INTO COLUMN FOOTINGS.
7. E.W. = EACH WAY. E.F. = EACH FACE.
8. ALL ELEVATIONS SHOWN ON PLAN ARE TO TOP OF FOOTING.
9. UNLESS OTHERWISE NOTED TOP OF ALL FOOTINGS AT ELEV. 91.33.

LAP SPLICE SCHEDULE

BAR SIZE	TOP BARS	OTHER BARS
#3	24"	19"
#4	32"	25"
#5	40"	31"
#6	48"	37"
#7	70"	54"
#8	80"	62"
#9	91"	70"

REVISIONS

MARK	DESCRIPTION	DATE

OFFICE BUILDING FOUNDATION & PIERS

TRIANGLE ENGINEERING
101 N. MAIN STREET
SOMEWHERE, ALASKA 78711
TEL: 123-456-7890 FAX 123-456-7891

OFFICE BUILDING FOR BAILEY-JONES CO.
EASTON, PA

ARCHITECT: R.A. SMITH & ASSOCIATES ARCHITECTS

CONTRACTOR: HYPER-MEGA-GLOBAL CONSTRUCTION.COM LTD. INC.

DATE: 1/1/01 | DRAWN BY: A.B.C. | SHEET: S1
JOB NO.: 12-345 | CHECKED BY: X.Y.Z.

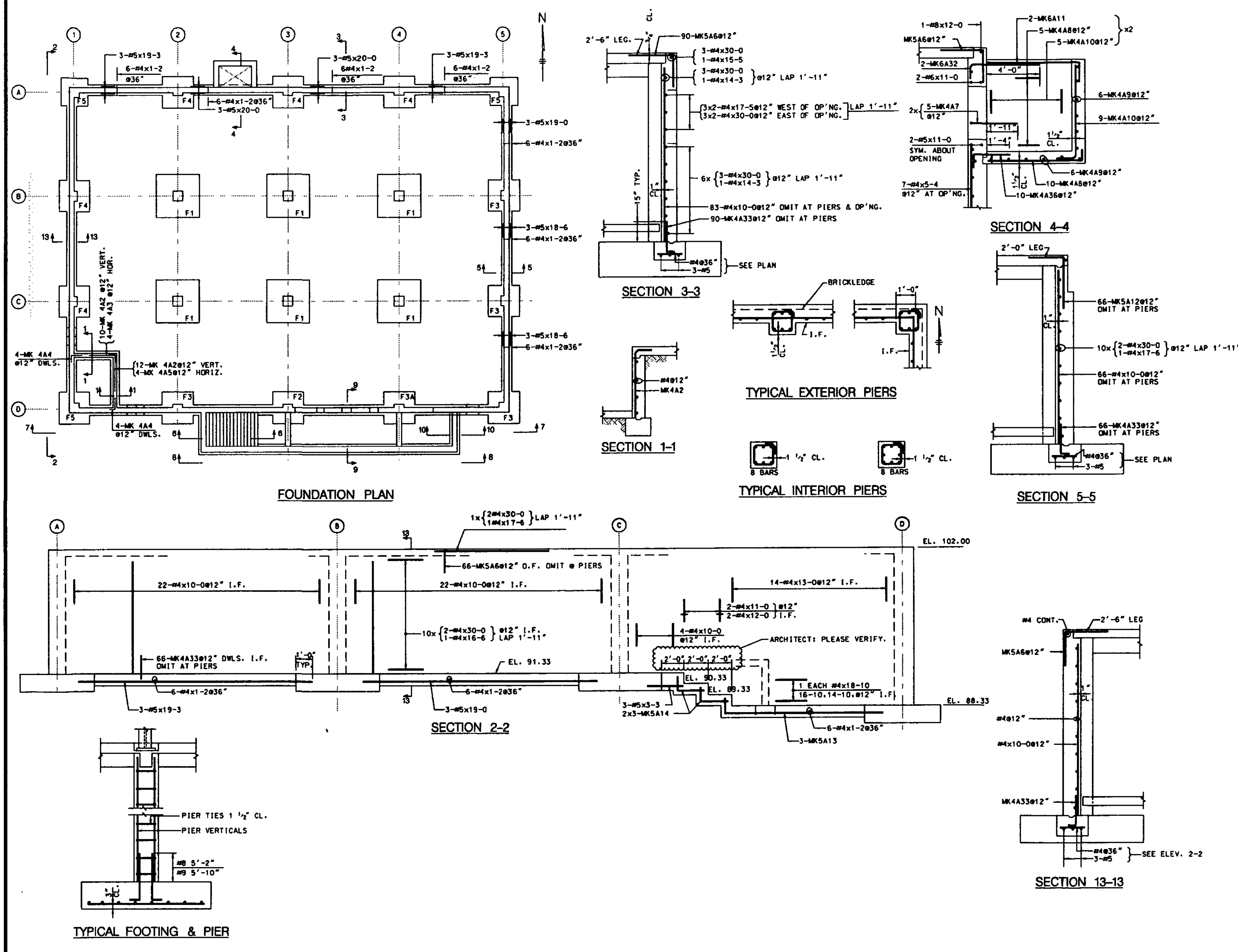
DRAWING P-1—
FOUNDATIONS (PLACING DRAWING)

The detailer has, because of the complexity of the construction, drawn complete wall elevations for both the West (Elevation 2-2) and South (Elevation 7-7) walls. The East (Section 5-5) and North (Section 3-3) walls are shown in cross section. The column footing and pier reinforcing bars are shown in schedules.

In drawing wall elevations where footing steps occur, the detailer refers to the "Typical Stepped Footing" detail on the structural drawing and footing elevations on the plan view. The exact horizontal location of these steps, however, is not given. In this case, the detailer makes an assumption, shows the dimensions on the elevations (see Elevation 2-2), circles same, and adds a note asking the engineer to verify.

Because fabricators stock bars in 60 ft lengths, horizontal runs of bars in excess of 30 ft have been detailed in multiples of 30 ft lengths plus the remainder length to complete the run. Vertical bars on the inside face are detailed between piers as the pier reinforcement makes it necessary to have wall bars in addition. Because wall dowels are provided for all vertical bars, some of the dowels project from the column footings.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



FOOTING SCHEDULE

MARK	QUAN.	SIZE	REINF. 1/2 E.W.	DOWELS
F1	6	9'-0"x9'-0"x1'-11"	20-#8x8-6	8-MK9A34
F2	1	8'-0"x8'-0"x1'-10"	20-#7x7-6	8-MK8A35
F3	4	7'-6"x7'-6"x1'-8"	18-#7x7-0	6-MK8A37
F4	1	7'-6"x7'-6"x1'-8"	18-#7x7-0	8-MK8A37
F5	5	7'-0"x7'-0"x1'-7"	16-#7x6-6	6-MK8A38
F6	3	6'-6"x6'-6"x1"-6"	18-#6x6-0	6-MK8A39

PIER SCHEDULE

PIER	QUAN.	SIZE	VERTICAL	TIES @12"
B2,B3,B4 C2,C3,C4	6	16"x16"	8-#9x10-2	10-MK3A1
A1 THRU A5 B1,B5,C1,C5 D2,D5	11	16"x16"	6-#8x10-2	10-MK3A1
D1	1	16"x16"	6-#8x13-2	13-MK3A1
D3,D4	2	16"x16"	8-#8x12-2	12-MK3A1

NOTE: SEE DWG. P1A FOR ADDITIONAL ELEVATIONS, SECTIONS AND BENDING DETAILS

LAP SPLICE SCHEDULE

BAR SIZE	TOP BARS	OTHER BARS
#3	24"	19"
#4	32"	25"
#5	40"	31"
#6	48"	37"
#7	70"	54"
#8	80"	62"
#9	91"	70"

REVISIONS

MARK	DESCRIPTION	DATE

OFFICE BUILDING FOUNDATION & PIERS

SQUARE FABRICATORS
1156 36TH. STREET
CONCENTRICVILLE, IL 61602
TEL: 987-654-3210 FAX: 987-654-3211

OFFICE BUILDING FOR BAILEY-JONES CO.
EASTON, PA

ARCHITECT: R.A. SMITH & ASSOCIATES ARCHITECTS

ENGINEER: TRIANGLE ENGINEERING

DATE: 1/29/01
JOB NO.: 5-678
DRAWN BY: C.R.W.
CHECKED BY: M.C.P.
SHEET: P1

DRAWING P-1A—
FOUNDATIONS (PLACING DRAWING)

The detailer has, because of the complexity of the construction, drawn complete wall elevations for both the West (Elevation 2-2) and South (Elevation 7-7) walls. The East (Section 5-5) and North (Section 3-3) walls are shown in cross section. The column footing and pier reinforcing bars are shown in schedules.

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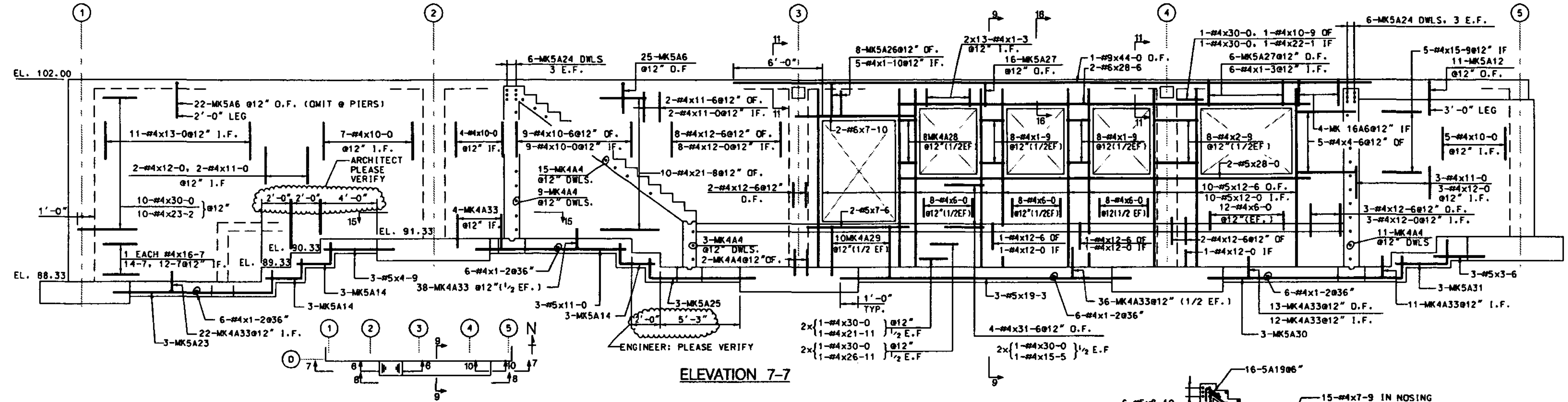
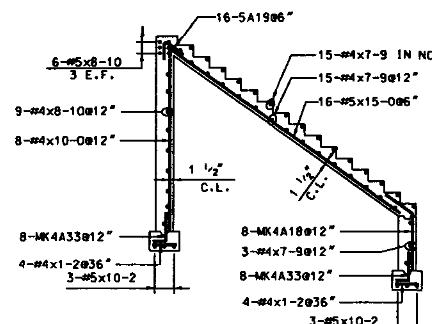
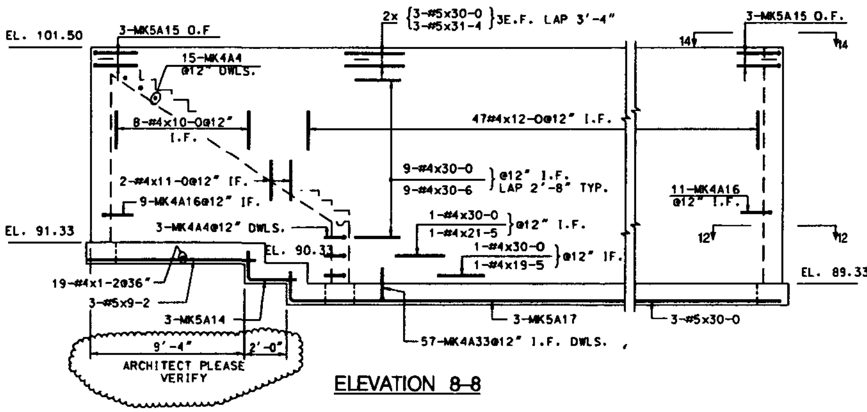


ELEVATION 7–7

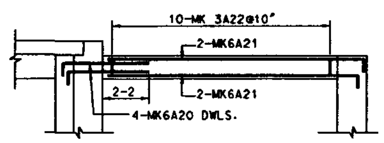
PARTIAL KEY PLAN



SECTION 6–6

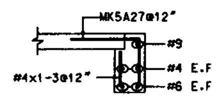


ELEVATION 8–8

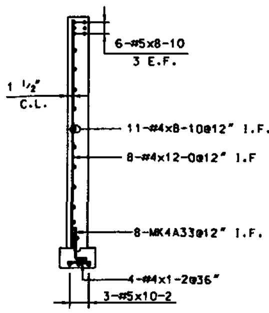


ELEVATION 11–11

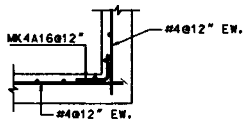
2 REQ'D THUS



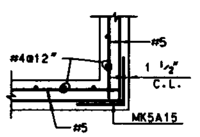
SECTION 16–16



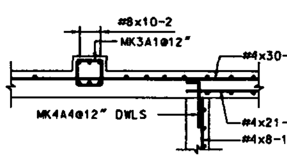
SECTION 10–10



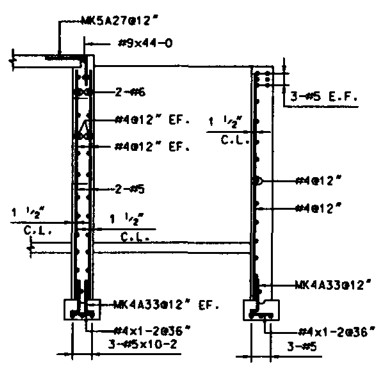
SECTION 12–12



SECTION 14–14



SECTION 15–15



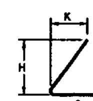
SECTION 9–9

BENDING DETAILS

SEE ACI DETAILING MANUAL "TYP. BAR BENDS''

MARK	SIZE	LENGTH	TYPE	A	B	C	D	E	G	H	J	K
3A1	3	5-0	T2	0-4	1-1	1-1	1-1	1-1	0-4			
4A2	4	4-6	2	0-8	3-10							
4A3	4	10-6	2	0-8	9-10							
4A4	4	4-0	2	0-8	3-4							
4A5	4	12-6	2	0-8	11-10							
5A6	5	4-6	17		2-0	2-6						
4A7	4	4-2	2	0-8	3-6							
4A8	4	6-4	17		1-0	5-4						
4A9	4	11-2	17		1-0	9-2	1-0					
4A3	4	6-2	2	0-8	5-6							
6A11	6	6-4	2	1-0	5-4							
5A12	5	5-0	17		2-0	3-0						
5A13	5	14-6	17		1-6	13-0						
5A14	5	4-0	17		1-6	2-6						
5A15	5	6-8	17		3-4	3-4						
4A16	4	5-4	17		2-8	2-8						
5A17	5	21-1	17		1-6	19-7						
4A18	4	5-3	3		2-8	2-7				2-0		1-7
5A19	5	5-2	H1		2-7	2-7				2-0		1-7
6A20	6	5-7	2	1-0	4-7							
6A21	6	9-9	2	1-0	8-9							
3A22	3	3-4	T2	0-4	0-9	0-7	0-9	0-7	0-4			
5A23	5	12-3	17		1-6	10-9						
5A24	5	4-8	2	0-10	3-10							
5A25	5	8-6	17		1-6	7-0						
5A26	5	5-0	17		2-6	2-6						
5A27	5	5-1	17		2-7	2-6						
4A28	4	2-7	2	0-8	1-3				0-8			
4A29	4	4-3	2	0-8	3-7							
5A30	5	14-9	17		1-6	13-3						
5A31	5	5-0	17		1-6	3-6						
6A32	6	5-10	2	1-0	4-10							
4A33	4	3-6	2	0-8	2-10							
9A34	9	6-0	2	1-7	4-5							
8A35	8	5-4	2	1-4	4-0							
4A36	4	3-7	2	0-8	2-11							
8A37	8	5-2	2	1-4	3-10							
8A38	8	5-1	2	1-4	3-9							
8A39	8	5-0	2	1-4	3-8							

NOTE: ALL REINFORCING BARS ASTM 615 GRADE 60
FOR PLAN SEE DWG. P1
I.F. = INSIDE FACE
O.F. = OUTSIDE FACE
E.F. = EACH FACE



TYPE H1

LAP SPLICE SCHEDULE

BAR SIZE	TOP BARS	OTHER BARS
#3	24"	19"
#4	32"	25"
#5	40"	31"
#6	48"	37"
#7	70"	54"
#8	80"	62"
#9	91"	70"

REVISIONS

MARK	DESCRIPTION	DATE

OFFICE BUILDING FOUNDATION & PIERS

SQUARE FABRICATORS
1156 35TH. STREET
CONCENTRICVILLE, IL 61802
TEL: 987-654-3210 FAX: 987-654-3211

OFFICE BUILDING FOR BAILEY-JONES CO.
EASTON, PA

ARCHITECT: R.A. SMITH & ASSOCIATES ARCHITECTS

ENGINEER: TRIANGLE ENGINEERING

DATE: 1/29/01
JOB NO.: 5–678
DRAWN BY: C.R.W.
CHECKED BY: M.C.P.
SHEET: P1A

DRAWING S-2—COLUMNS (STRUCTURAL DRAWING)

This drawing illustrates a variety of column details that ordinarily would not all occur in the same structure. The schedule format used is common for columns. Building A columns illustrate rectangular and round columns (which may change size from floor to floor, with lap splices). Column bars that do not continue are terminated just below the floor level.

The Building B column schedule illustrates the location of staggered butt splices. The engineer has specified a compression splice for Columns K9 and K10, using square saw-cut ends in bearing with a sleeve to hold it in position. The engineer has provided two alternate tension butt-splice details for the remainder of Building B columns:

(1) an arc-welded splice; or

(2) a mechanical splice that will develop 125% of minimum yield strength of the reinforcing bar in tension.

The use of a particular alternate is the contractor's option.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 *or those of the AASHTO specifications or Caltrans requirements. The sample structural* drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

S-2

COLUMN SCHEDULE

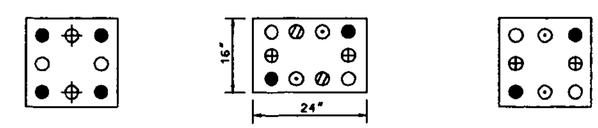
BUILDING A

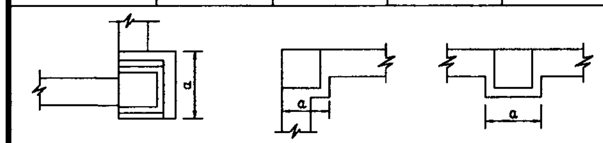
COL. MARK	1	2,26	3,4	5,6,9,10,11	7,8	12	13,14	15	16,17,18,19	20,21,23,24	22	25	27,28
No. OF COLUMNS	1	2	2	5	2	1	2	1	4	4	1	1	2
ROOF EL.134.50													
SIZE / VERTICAL / TIES OR SPIRALS — 3RD FL EL 123.50	17"x17" 4-#5 #3@12"	17"x17" 4-#8 #3@12"	17"x17" 4-#7 #3@12"	16"x16" 4-#6 #3@12"	14"x14" 4-#6 #3@12"	20"x20" 6-#6 #3@12"	20"Ø 8-#6 #3Ø @2¼"	20"Ø 8-#7 #3Ø @2¼"	20"Ø 8-#8 #3Ø @2¼"	17"x17" 6-#6 #3@12"	17"x17" 4-#7 #3@12"	16"x16" 6-#6 #3@12"	12"x12" 4-#6 #3@12"
SIZE / VERTICAL / TIES OR SPIRALS — 2ND FL EL 112.50	17"x17" 4-#8 #3@12"	22"x20" 6-#8 #3@12"	20"x20" 6-#7 #3@12"	16"x16" 6-#7 #3@12"	14"x14" 6-#6 #3@12"	20"x20" 8-#7 #3@12"	20"Ø 8-#8 #3Ø @2¼"	20"Ø 8-#9 #3Ø @2¼"	20"Ø 10-#8 #3Ø @2¼"	22"x20" 8-#7 #3@12"	17"x17" 4-#9 #3@12"	20"x16" 6-#8 #3@12"	16"x16" 6-#7 #3@12"
SIZE / VERTICAL / TIES OR SPIRALS — 1ST FL EL 100.0	20"x20" 6-#8 #3@12"	26"x20" 8-#7 #3@12"	26"x20" 8-#7 #3@12"	16"x20" 8-#8 #3@12"	18"x18" 6-#8 #3@12"	26"x20" 10-#8 #3@12"	22"Ø 8-#10 #3Ø @2"	22"Ø 10-#10 #3Ø @2"	22"Ø 12-#10 #3Ø @2"	26"x20" 10-#8 #3@12"	20"x20" 6-#9 #3@12"	24"x16" 8-#9 #3@12"	16"x16" 8-#8 #3@12"
SIZE / VERTICAL / TIES OR SPIRALS — BSMT FL EL 89.58	22"x22" 8-#8 #3@12"	28"x24" 8-#9 #3@12"	26"x22" 10-#9 #3@12"	24"x20" 10-#8 #3@12"	20"x20" 8-#8 #3@12"	28"x26" 12-#9 #3@12"	24"Ø 10-#11 #4Ø @3"	24"Ø 12-#11 #4Ø @3"	24"Ø 16-#11 #4Ø @3"	26"x22" 12-#10 #3@12"	22"x22" 8-#9 #3@12"	24"x20" 12-#8 #3@12"	18"x18" 8-#10 #3@12"
TOP OF FOUND. WALL, FTG. OR PILE CAP	6"	6"	6"	6"	2'-6"	2'-6"	4'-0"	6"	6"	6"	6"	6"	2'-6"

BUILDING B

COL. MARK	K9, K10	J9, J10	G9, G10
No. OF COLUMNS	2	2	2
ROOF EL.167.50			
SIZE / TIES — 6TH FL EL 156.50	20"x20" #4@18"	16"x24" #3@16" 2-#9 2-#9	20"x20" #3@18" 2-#10 2-#10
SIZE / TIES — 5TH FL EL 145.50	20"x20" #4@18" 2-#11 2-#11 1'-6" 4'-0"	16"x24" #3@16" 2-#10 2-#10	20"x20" #4@18" 2-#11 2-#11 1'-6" 4'-0"
SIZE / TIES — 4TH FL EL 134.50	20"x20" #4@18" 2-#14 1'-6"	16"x24" #4@16" 2-#11 2-#9 1'-6"	20"x20" #4@18" 2-#14 1'-6"
SIZE / TIES — 3RD FL EL 123.50	20"x20" #4@18" 2-#14 2-#11 1'-6"	16"x24" #4@16" 2-#11 2-#10 1-6	20"x20" #4@18" 2-#14 2-#11 4'-0" 1'-6"
SIZE / TIES — 2ND FL EL 112.50	20"x20" #4@18" 2-#11 2-#14 1'-6"	16"x24" #4@16" 2-#14 2-#11 2-#10 1'-6"	20"x20" #4@18" 2-#14 2-#11 4'-0" 1'-6"
SIZE / TIES — 1ST FL EL 100.00	20"x20" #4@18" 2-#18 2-#14 4'-0"	16"x24" #4@16" 2-#14 2-#11 2-#11 1'-6"	20"x20" #4@18" 2-#18 2-#18 2-#14 4'-0" 1'-6"
SIZE / TIES — BSMT FL 89.58	20"x20" #4@18" 4-#18 2-#18 2-#18 2-#18 1'-6" 4'-0"	16"x24" #4@16" 2-#18 2-#14 2-#18 2-#14 1'-0" 1'-6" 4'-0" 6'-6"	20"x20" #4@18" 2-#18 2-#18 2-#14 9'-0" 6'-6" 4'-0" 1'-6"
TOP OF FTG.			

COMPRESSION BUTT SPLICE REQ'D — TENSION BUTT SPLICE REQ'D EXCEPT WHERE LAPS ARE SHOWN

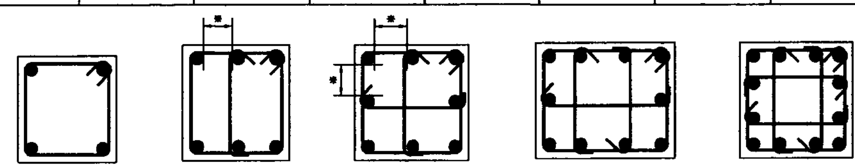




RE-ENTRANT CORNER EXTERIOR CORNER EXTERIOR

TYPICAL OFFSET OF COLUMNS FOR BLDG. A

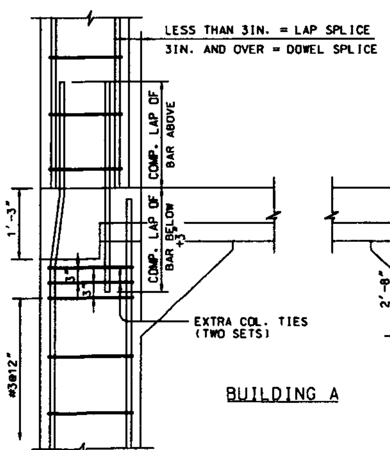
NOTE: "a" DIMENSION IS THE FIRST DIMENSION OF THE COLUMN SIZE AS INDICATED IN THE COLUMN SCHEDULE



4 BARS SINGLE TIES | 6 BARS 2 TIES PER SET | 8 BARS 3 TIES PER SET | 10 BARS 4 TIES PER SET | 12 BARS 5 TIES PER SET

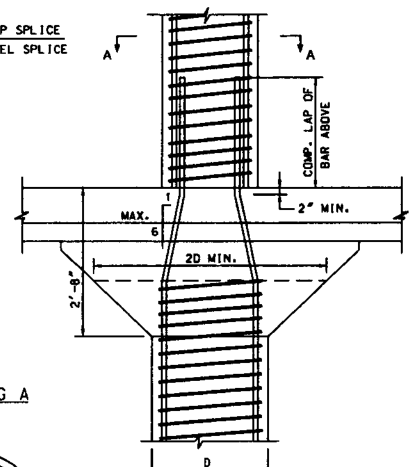
TYPICAL COLUMN TIE ARRANGEMENTS FOR SQUARE/RECTANGULAR COLUMNS

* WHEN 6" OR LESS OMIT INTERIOR TIE

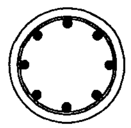


BUILDING A

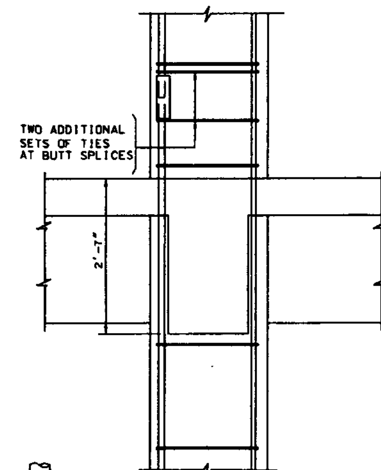
TYPICAL EXTERIOR COLUMN



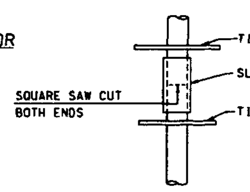
TYPICAL INTERIOR COLUMN



SECTION A-A



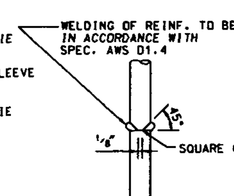
TYPICAL COLUMN BUILDING B



DETAIL END BEARING SPLICE

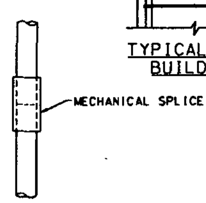
COMPRESSION SPLICE

2 ADDITIONAL SETS OF TYPICAL TIES ARE TO BE PROVIDED AT EACH BUTT SPLICE



DETAIL OF ARC WELDED BUTT SPLICE

TENSION SPLICE

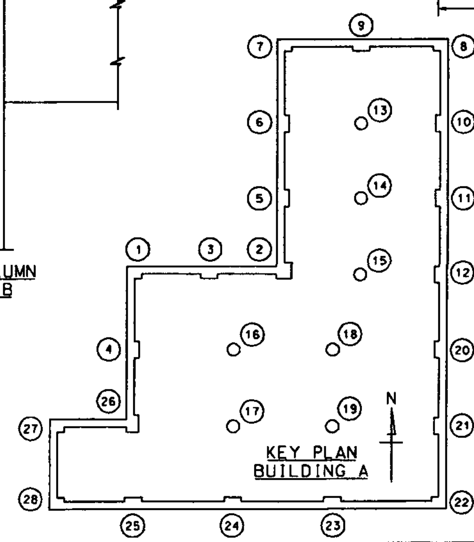


DETAIL OF MECHANICAL SPLICE

TENSION SPLICE

NOTE: MECHANICAL SPLICE MUST DEVELOP MIN. 125% OF MINIMUM YIELD STRENGTH IN TENSION NO SPECIAL END PREPARATION REQ'D

NOTE: CONTRACTOR'S OPTION ON TYPE OF TENSION SPLICE



KEY PLAN BUILDING A

NOTES:

1. fc' = --- PSI AT 28 DAYS. MAXIMUM SIZE AGGREGATE IS ¾ IN.
2. REINFORCING STEEL: ASTM A615 GRADE 60KSI SPIRALS-HOT ROLLED PLAIN ASTM A615 GRADE 60KSI
3. LAP VERTICAL BARS IN COLUMNS USING COMPRESSION LAP OF BAR ABOVE (EXCEPT WHERE BUTT SPLICED)
4. CONCRETE PROTECTION – 1½" MINIMUM COVER FOR TIES OR SPIRALS
5. BUTT SPLICED BARS OF DIFFERENT SIZES TO BE JOINED CONCENTRICALLY
6. ALL SPIRALS TO HAVE 1½ EXTRA TURNS TOP & BOTTOM
7. DETAIL IN ACCORDANCE WITH ACI DETAILING MANUAL.
8. BUILDING B ONLY – PROVIDE DOWELS AT ROOF EQUAL IN SIZE AND NUMBER TO COLUMN VERTICALS MAKE EACH LEG OF DOWEL 30 BAR DIA.

COMP. LAP SCHEDULE	
BAR SIZE	COMP. LAP
#4	15"
#5	19"
#6	23"
#7	27"
#8	30"
#9	34"
#10	38"
#11	43"
#14	N/A
#18	N/A

COLUMN SCHEDULE BUILDINGS A & B

TRIANGLE ENGINEERING
101 N. MAIN STREET
SOMEWHERE, ALASKA 78711
TEL: 123-456-7890 FAX: 123-456-7891

MANUFACTURING BLDG. FOR BROWN LEWIS CO.
CAMBRIDGE, MA

ARCHITECT: R.A. SMITH & ASSOCIATES ARCHITECTS

CONTRACTOR: HYPER-MEGA-GLOBAL CONSTRUCTION.COM LTD. INC.

DATE: 1/1/01	DRAWN BY: A.B.C.	SHEET: S2
JOB NO.: 34-567	CHECKED BY: X.Y.Z.	

DRAWING P-2—COLUMNS (PLACING DRAWING)

The detailer has used a schedule format similar to that of the structural drawing. Because of the complexity of bar placing arrangements in Building A, however, the detailer has included a sketch of the column at each story level. A key plan is included so that the placer will not have to refer to other drawings to locate the columns. Various typical sections and elevations that are helpful to the placer are shown. In this example, these details have been copied from the structural drawing. Reviewing the detailing of Column 12 will give an overall impression for the detailing approach. The first column lift (footing to first floor) is 28 x 26 in. and contains 12 #29 bars. The next story size and reinforcement are 20 x 26 in. and contain 10 #25 bars. The sketch for the lowest column lift shows that the column above is concentrically located bars with a 4 in. offset on each side. Offsets in excess of 3 in. require separate dowels. In Column 12, all four bars in each N-S face have been terminated, but only three dowels are required for each face to match up with the bars above.

In accordance with the engineer's "typical exterior column" detail, the vertical bars extend into the column above and splice with the bars above. When separate dowels are required, they should be the size of the bars in the column above. Two bars in each E-W face are extended upward and lapped with #25 bars above. The column ties are as shown in the typical 12-bar column detail with one circumferential tie (10T19), and one pair of interior single leg ties, in each direction (10T8 and 10T10).

The column size and reinforcement going to the next lift (first to second floor), the story above has a 20 x 20 in. column with 8 #22 vertical bars. This time the offset is all in one direction (see sketch,) and all the bars in the west face are terminated, with three dowels needed to match up with the bars above. Two bars in the east face are offset bent and extended upward, and two bars are terminated. Three of the bars are needed to match the bars above, and one dowel is provided. The other two straight bars extend upward from the N-S faces. It is not necessary to offset them as the center line of the bar above is 2 in. offset. Column ties are as shown for the typical 10-bar column and consist of one circumferential tie (10T12), a pair of single leg ties (10T8), and a single leg tie (10T13).

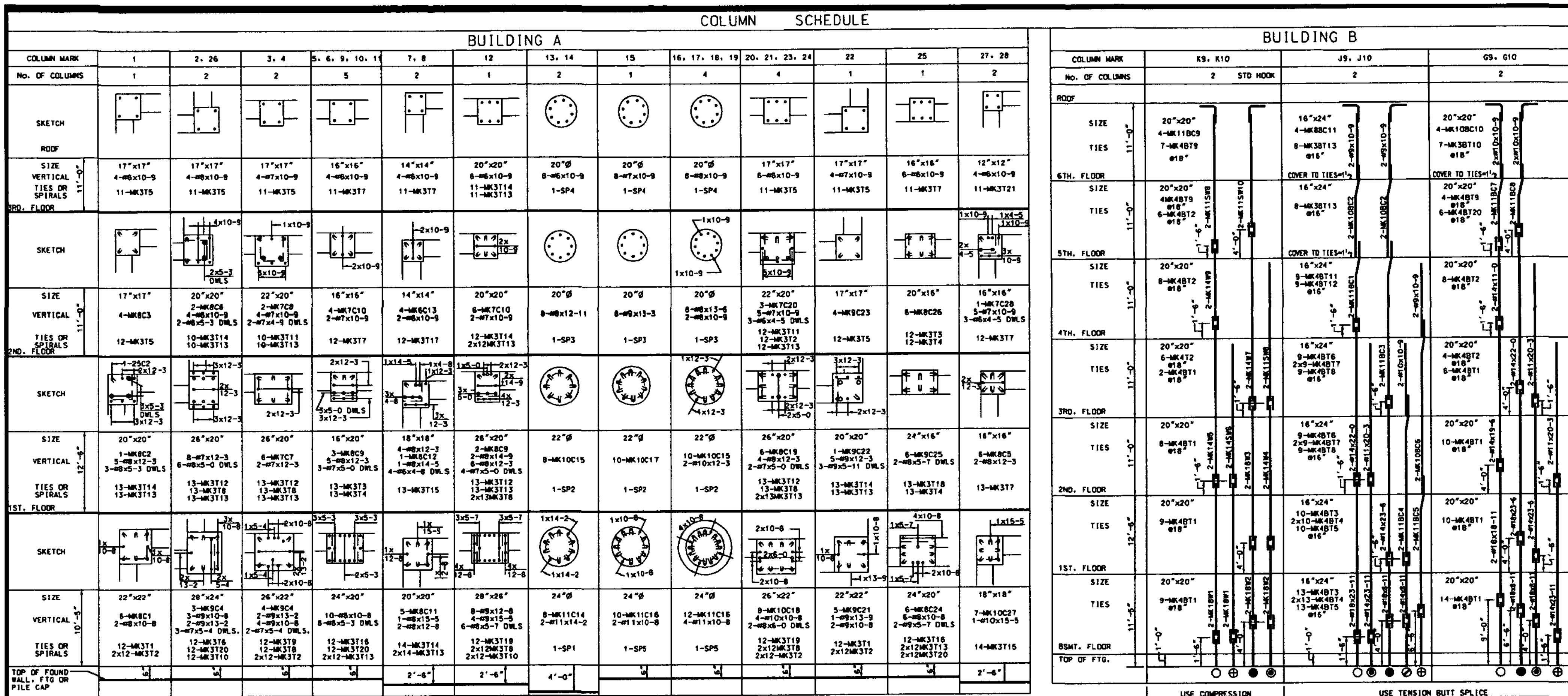
Proceeding to the next lift (second to third floor), the story above it is the same size (20 x 20 in.) with 6 #19 bars. The two bars in the N-S faces are not needed in the column above and are terminated. The remaining six bars in the E-W faces are in the same position as the bars above and all are offset bent to clear. Column ties are as shown for an eight-bar column and include an enclosing tie (10T14) plus a pair of single leg ties (10T13).

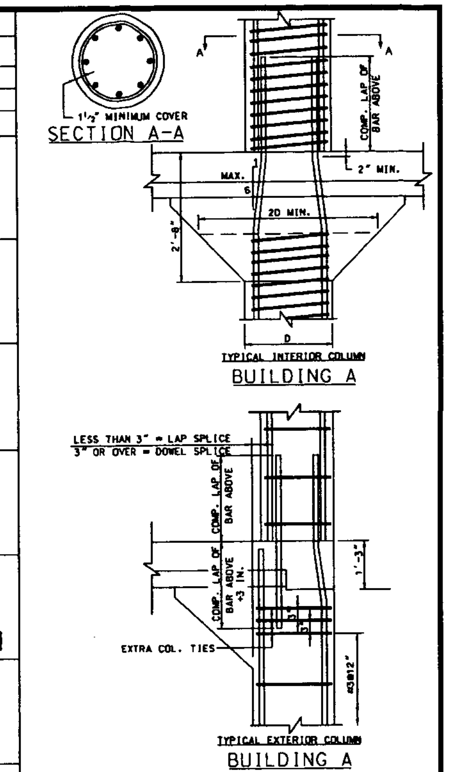
Finally, the upper lift needs only straight bar lengths. Column ties are as shown for a six-bar column and include an enclosing tie (10T14) and a single leg tie (10T13).

Butt-splices are commonly used in columns that do not change size significantly because it is necessary to keep the bars lined up. With staggered splices, the type of schedule used for Building B is almost mandatory—a graphical presentation of each column from footing to roof. A review of the schedule, carefully following the placing key for location of each bar in that column, makes the scheme self-explanatory. The schedule shows saw-cut ends on the butt-spliced bars for Columns K9 and K10, along with a positioning sleeve. The schedule shows a mechanical tension splice for all other butt splices. All butt-spliced bars are located concentrically and an allowance has been made for the reduced dimensions in detailing the ties above.

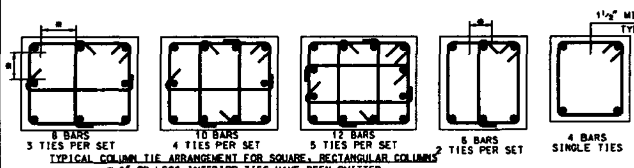
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

COLUMN SCHEDULE





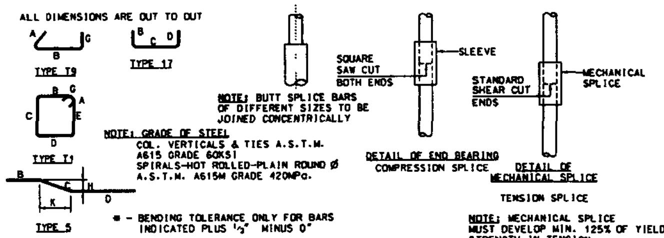
NOTE: FOR BUILDING "A" ALL COLUMN TIES ARE SPACED AT 12" EXCEPT AT BENDS IN COLUMN VERTICALS WHERE THEY SHALL BE 3"



TYPICAL COLUMN TIE ARRANGEMENT FOR SQUARE, RECTANGULAR COLUMNS
* 6" OR LESS INTERIOR TIES HAVE BEEN OMITTED

STRAIGHT SAW CUT BARS		
MARK	SIZE	LGTH.
18W1	18	23-11
18W2	18	11-5
18W3	18	21-0
14W4	14	21-0
14W5	14	22-0
14SW6	14	20-3
14W7	14	24-6
11SW8	11	20-3
14W9	14	11-0
11SW10	11	17-9

ALL DIMENSIONS ARE OUT TO OUT

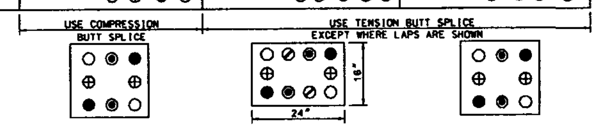


NOTE: BUTT SPLICE BARS OF DIFFERENT SIZES TO BE JOINED CONCENTRICALLY

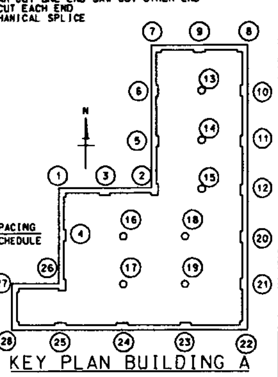
NOTE: GRADE OF STEEL
COL. VERTICALS & TIES A.S.T.M. A615 GRADE 60KSI
SPIRALS-HOT ROLLED-PLAIN ROUND Ø A.S.T.M. A615M GRADE 420MPa.

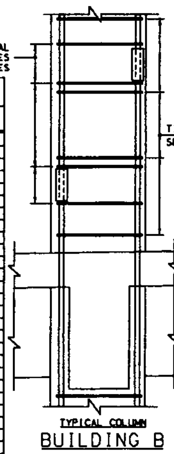
* - BENDING TOLERANCE ONLY FOR BARS INDICATED PLUS ½" MINUS 0"

NOTE: MECHANICAL SPLICE MUST DEVELOP MIN. 125% OF YIELD STRENGTH IN TENSION



SW DENOTES SHEAR CUT ONE END-SAW CUT OTHER END
# DENOTES SAW CUT EACH END
JJ DENOTES MECHANICAL SPLICE





BENDING DETAILS

MARK	SIZE	LGTH	TYPE	A	B	C	D	E	F	G	H	J	K
8C1	8	13-5	5		2-8	2-0	8-9				0-5		2-0
8C2	8	15-0	5		2-8	1-0	11-4				0-2½		1-0
8C3	8	12-11	5		2-1	1-0	9-10				0-2		1-0
9C4	9	13-2	5		2-5	1-8	9-1				0-4½		1-8
8C5	8	14-9	5		2-5	1-0	11-4				0-2		1-0
8C5	8	13-6	5		2-8	1-6	9-4				0-4		1-6
7C7	7	14-9	5		2-5	1-8	10-8				0-4½		1-8
7C8	7	13-3	5		2-5	2-0	8-10				0-5		2-0
8C9	8	14-9	5		2-5	1-0	11-4				0-2		1-0
7C10	7	12-11	5		2-1	1-0	9-10				0-2		1-0
8C11	8	15-5	5		2-8	2-0	10-9				0-5		2-0
8C12	8	14-5	5		2-1	1-0	11-4				0-2		1-0
6C13	6	12-11	5		2-1	1-0	9-10				0-2		1-0
11C14	11	17-8	5		3-5	1-3	13-0				0-4		1-3
10C15	10	15-0	5		2-8	1-3	11-1				0-3½		1-3
11C16	11	14-2	5		3-5	1-3	9-6				0-4		1-3
10C17	10	15-4	5		3-0	1-3	11-1				0-4		1-3
10C18	10	13-5	5		2-8	1-6	9-3				0-4½		1-6
8C19	8	14-9	5		3-5	1-9	10-7				0-4½		1-9
7C20	7	12-11	5		2-1	2-0	8-10				0-5		2-0
9C21	9	13-9	5		3-0	2-3	8-6				0-5½		2-3
9C22	9	15-4	5		3-0	1-0	11-4				0-2½		1-0
9C23	9	13-3	5		2-5	1-0	9-10				0-2½		1-0
8C24	8	13-9	5		3-0	1-0	9-9				0-3		1-0
9C25	9	15-0	5		2-8	1-8	10-8				0-4½		1-8
8C26	8	12-11	5		2-1	1-6	9-4				0-4		1-6
10C27	10	15-5	5		2-8	2-3	10-6				0-5½		2-3
7C28	7	12-11	5		2-1	1-0	9-10				0-2		1-0

MARK	SIZE	LGTH	TYPE	A	B	C	D	E	F	G	H	J	K
3T1	3	7-0	T1	0-4	1-7	1-7	1-7	1-7		0-4			
3T2	3	2-3	T9	0-4	1-7					0-4		0-3	
3T3	3	5-8	T1	0-4	1-1	1-5	1-1	1-5		0-4			
3T4	3	1-9	T9	0-4	1-1					0-4		0-3	
3T5	3	5-4	T1	0-4	1-2	1-2	1-2	1-2		0-4			
3T6	3	8-4	T1	0-4	2-1	1-9	2-1	1-9		0-4			
3T7	3	5-0	T1	0-4	1-1	1-1	1-1	1-1		0-4			
3T8	3	2-7	T9	0-4	1-11					0-4		0-3	
3T9	3	7-8	T1	0-4	1-11	1-7	1-11	1-7		0-4			
3T10	3	2-9	T9	0-4	2-1					0-4			
3T11	3	6-8	T1	0-4	1-7	1-5	1-7	1-5		0-4			
3T12	3	7-4	T1	0-4	1-5	1-11	1-5	1-11		0-4			
3T13	3	2-1	T9	0-4	1-5					0-4		0-3	
3T14	3	6-4	T1	0-4	1-5	1-5	1-5	1-5		0-4			
3T15	3	5-8	T1	0-4	1-3	1-3	1-3	1-3		0-4			
3T16	3	7-0	T1	0-4	1-9	1-5	1-9	1-5		0-4			
3T17	3	4-4	T1	0-4	0-11	0-11	0-11	0-11		0-4			
3T18	3	6-4	T1	0-4	1-9	1-1	1-9	1-1		0-4			
3T19	3	8-8	T1	0-4	2-1	1-11	2-1	1-11		0-4			
3T20	3	2-5	T9	0-4	1-9					0-4		0-3	
3T21	3	3-8	T1	0-4	0-9	0-9	0-9	0-9		0-4			

BENDING DETAILS

	MARK	SIZE	LGTH	TYPE	A	B	C	D	E	F	G	H	J	K
	11BC1	11	12-9	5		3-5	1-0	8-4				0-3		1-0
	10BC2	10	13-10	5		3-0	1-0	9-10				0-3		1-0
	11BC3	11	23-9	5		3-5	1-0	19-4				0-3		1-0
	11BC4	11	25-3	5		3-5	1-0	20-10				0-3		1-0
	11BC5	11	20-8	5		3-5	1-0	16-3				0-3		1-0
	10BC6	10	24-10	5		3-0	1-0	20-10				0-3		1-0
	11BC7	11	12-9	5		3-5	1-0	8-4				0-3		1-0
	11BC8	11	10-3	5		3-5	1-0	5-10				0-3		1-0
	11BC9	11	5-7	2	2-0	3-7								
	10BC10	10	5-0	2	1-10	3-2								
	9BC11	9	4-5	2	1-7	2-10								
*	4BT1	4	6-5	T1	0-4½	1-5	1-5	1-5	1-5		0-4½			
*	4BT2	4	6-3	T1	0-4½	1-4½	1-4½	1-4½	1-4½		0-4½			
*	4BT3	4	6-5	T1	0-4½	1-1	1-9	1-1	1-9		0-4½			
*	4BT4	4	1-10	T9	0-4½	1-1					0-4½		0-4	
*	4BT5	4	2-6	T9	0-4½	1-9					0-4½		0-4	
*	4BT6	4	6-3	T1	0-4½	1-0½	1-8½	1-0½	1-8½		0-4½			
*	4BT7	4	1-9	T9	0-4½	1-0½					0-4½		0-4	
*	4BT8	4	2-5	T9	0-4½	1-8½					0-4½		0-4	
*	4BT9	4	6-2	T1	0-4½	1-4¼	1-4¼	1-4¼	1-4¼		0-4½			
	3BT10	3	6-4	T1	0-4	1-5	1-5	1-5	1-5		0-4			
*	4BT11	4	6-2	T1	0-4½	1-0¼	1-8¼	1-0¼	1-8¼		0-4½			
*	4BT12	4	2-5	T9	0-4½	1-8¼					0-4½		0-4	
	3BT13	3	6-4	T1	0-4	1-1	1-9	1-1	1-9		0-4			

SPIRAL SCHEDULE

MARK	SIZE	PITCH	DIA.	HEIGHT
SP1	#4Ø	0-3	1-9	12-9
SP2	#3Ø	0-2	1-7	10-9
SP3	#3Ø	0-2¼	1-5	9-2
SP4	#3Ø	0-2¼	1-5	9-2
SP5	#4Ø	0-3	1-9	9-3

NOTE: ALL SPIRALS TO HAVE 1½ EXTRA TURNS TOP AND BOTTOM

COMP. LAP SCHEDULE	
BAR SIZE	COMP. LAP
#11	43"
#10	38"
#9	34"
#8	30"
#7	27"
#6	23"

ALL REINF. ASTM A615 GRADE 60KSI

REVISIONS		
MARK	DESCRIPTION	DATE

COLUMN SCHEDULE BUILDINGS A & B

SQUARE FABRICATORS
1156 35TH. STREET
CONCENTRICVILLE, IL 61602
TEL: 987-654-3210 FAX: 987-654-3211

MANUFACTURING BUILDING FOR BROWN-LEWIS CO.
CAMBRIDGE, MA

ARCHITECT: R.A. SMITH & ASSOCIATES ARCHITECTS

ENGINEER: TRIANGLE ENGINEERING

DATE: 1/29/01
JOB NO.: 9-876
DRAWN BY: C.R.W.
CHECKED BY: M.C.P.
SHEET: P2

DRAWING S-3—ONE-WAY CONCRETE JOIST FLOOR (STRUCTURAL DRAWING)

Beams are marked individually on the plan, for example, "1B1," with all beams that are essentially identical given the same mark. Joist ribs are indicated schematically on the plan by a mark, such as "1J1," with all essentially identical ribs given the same mark.

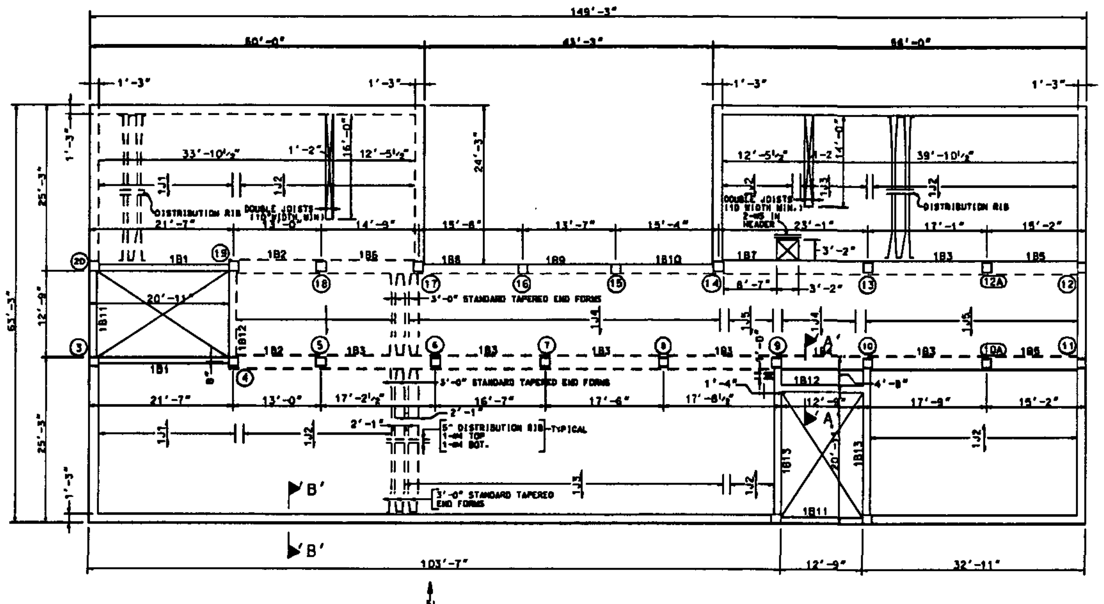
Detailed information on beams is given in the beam schedule where beam size and reinforcement are shown. The beam reinforcement location is shown graphically and related to the support center line.

Detailed joist information is presented using cross-sectional elevations of each of the five different joist marks, with an additional detail in the upper right-hand corner, showing that the pan forms are 8 in. deep and 20 in. wide. The floor framing plan indicates that these pans taper in for a distance of 3 ft 0 in. at each end. These dimensions are typical of standard size forms for concrete joists. Tapered ends are required only when the engineer determines that straight ends will not satisfy project requirements for shear.

The interior beams are the same depth as the joist (10-1/2 in.) so that a flush ceiling is maintained. This forming system in which separate beam forms are eliminated is often called the "joist-band" system.

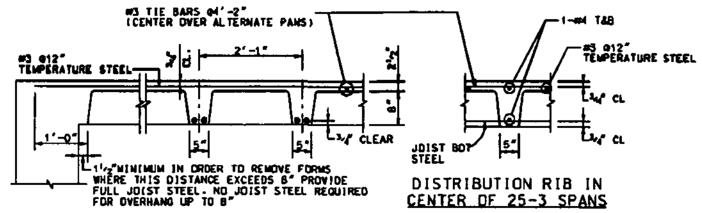
The stirrup hook bend requirements change between the interior (90 degree) and exterior (135 degree) beams.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



FIRST FLOOR FRAMING PLAN

SCALE: 3/32"=1'-0"

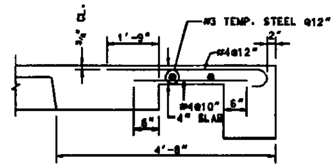


TYPICAL JOIST CONSTRUCTION

NO SCALE

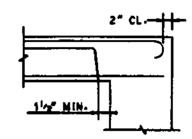
DISTRIBUTION RIB IN CENTER OF 25-3 SPANS

NO SCALE



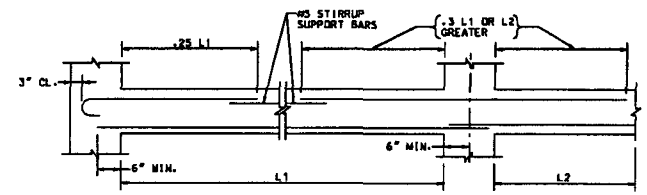
SECTION "A-A"

NO SCALE



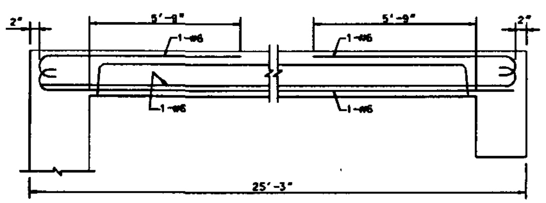
SECTION "B-B"

NO SCALE



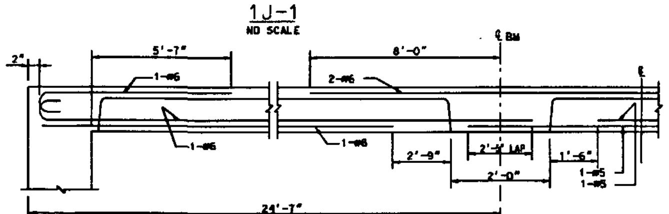
TYPICAL BEAM DIAGRAM

NO SCALE



1J-1

NO SCALE

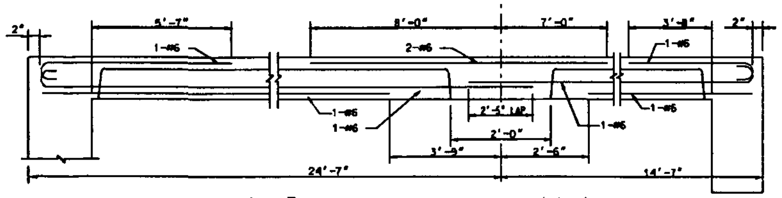


1J-2

NO SCALE

1J-5

NO SCALE

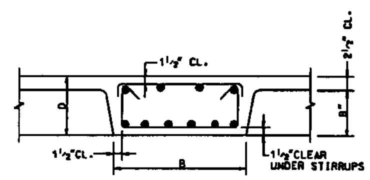


1J-3

NO SCALE

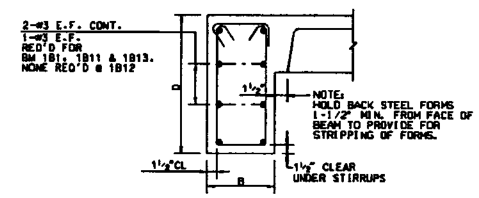
1J-4

NO SCALE



TYPICAL INTERIOR BEAM

NO SCALE



TYPICAL EXTERIOR BEAM

NO SCALE

BEAM SCHEDULE					
MARK	SIZE BxD	REINFORCING BOTTOM	REINFORCING TOP	LOCATION	STIRRUPS (ALL SIZE #3)
1B1	12x24	4-#6	2-#6 WEST		4@6" 3@10" COL. 3 OR 20 4@6" 3@8" 3@10" COL. 4 OR 19
1B2	24x10½	7-#7	4-#6 WEST 7-#7 EAST		3@4" 5@8" E.E.
1B3	24x10½	6-#7	8-#7		3@4" 3@6" 4@8" E.E.
1B4	24x10½	4-#8	8-#8		3@4" 2@8" E.E.
1B5	24x10½	4-#8	4-#6		3@4" 3@6 4@8" E.E.
1B6	24x10½	7-#8	4-#7		3@4" 5@8" 2@10" E.E.
1B7	24x10½	8-#9	4-#7 WEST 8-#8 EAST		4@6" 6@8" COL. 14 4@6" 8@8" 4@10" COL. 13
1B8	12x33	2-#6	2-#6 WEST 3-#6 EAST		2@6" 4@12" E.E.
1B9	12x33	2-#6	3-#6		2@6" 4@12" E.E.
1B10	12x33	2-#6	2-#5		2@6" 4@12" E.E.
1B11	12x20	4-#6	2-#6 CONT.		2@10" 2@12" E.E.
1B12	12x18	3-#6	2-#5 CONT.		2@8" 2@12" E.E.
1B13	12x24	4-#8	2-#7 CONT.		4@8" 4@10" E.E.

NOTES:

1. FC=4000 PSI AT 28 DAYS. MAXIMUM SIZE AGGREGATE ¾ IN.
2. REINFORCING STEEL SHALL CONFORM TO ASTM SPECIFICATION A615, GRADE 60.
3. ALL SLABS, JOISTS AND BEAMS SHALL HAVE NO HORIZONTAL JOINTS. ANY STOP IN CONCRETE WORK MUST BE MADE AT CENTER OF SPAN WITH VERTICAL BULKHEADS.
4. PROVIDE DETAILS IN ACCORDANCE WITH ACI 315 DETAILING MANUAL
5. ALL BAR SUPPORTS SHALL BE CLASS 1-PLASTIC PROTECTED.
6. DESIGN LIVE LOAD____PSF
7. LAP SPLICE ALL #3 AND #4 BARS 32 IN.

ISSUE RECORD

DATE

DRAWN

CHECKED

PROJECT NO.

HIGH SCHOOL
FOR VALLEY TOWNSHIP
PRINCETON, PA

CONSULTANT

RED WINGS

STAMP

ARCHITECTS

ONE SPARTANS BLVD.
EAST LANSING, MICHIGAN 2003

DRAWING TITLE

FIRST FLOOR FRAMING PLA

DRAWING NUMBER

S-3

SHEET NO. OF

DRAWING P-3—ONE-WAY CONCRETE JOIST FLOOR (PLACING DRAWING)

This example assumes the forming pans are being furnished by someone other than the reinforcing bar supplier. The pan supplier will provide a detailed pan layout. It is necessary for the detailer to show only the quantities of each marked joist and the extent of the area in which they are required. The rib outline on the placing drawing is shown as solid rather than dotted as on the structural drawing. The reason for this is that the drafting work is simplified by using solid lines for the joists.

The detailer has used a schedule for both beams and joists. The schedule shows the number of each beam or joist rib and all the reinforcement details. The detailer also used the same mark as on the structural drawing to make checking easier. Where the same marked beam or joist is not identical, it is necessary to add a suffix to one of the marks, as Beam 1B2A. Comparing 1B2 and 1B2A, note that the top bar at the right-hand support is longer for 1B2A. The reason is that the adjacent span is 17 ft 3-1/2 in., compared with 14 ft 9 in. for 1B2, and this bar extends to 0.3L of the greater span.

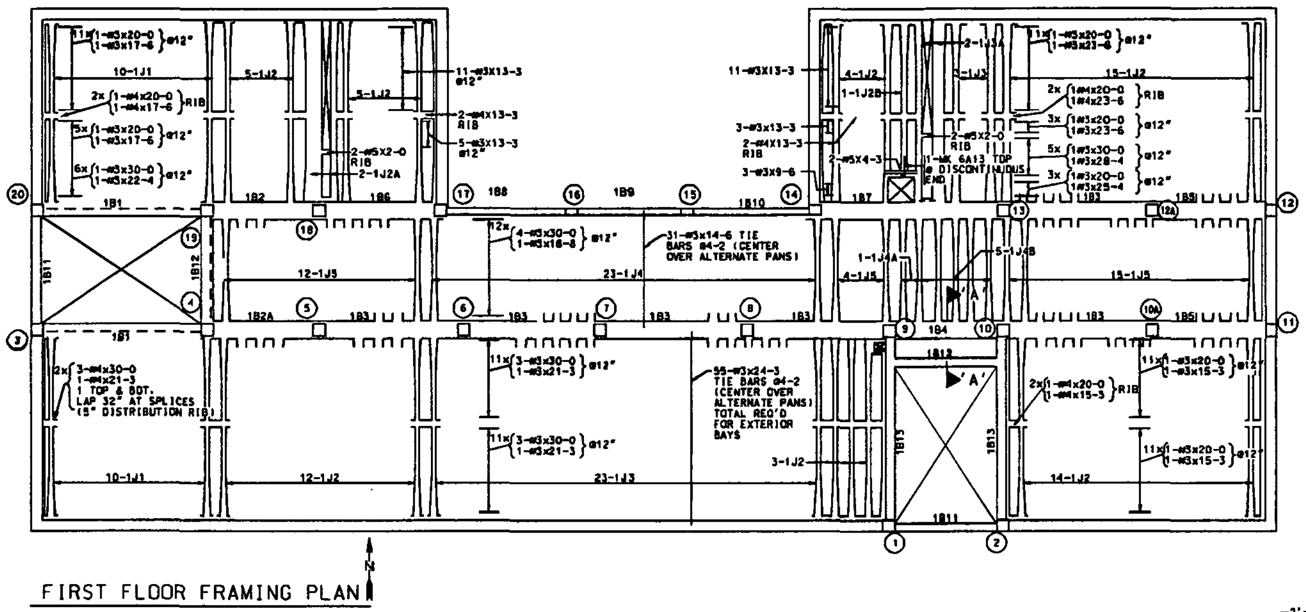
The various joist marks have suffixes such as 1J2, 1J2A, and 1J2B.

1J2 is a single joist of 5 in. width with two #19 bottom bars and one #19 top bar at the discontinuous end. 1J2A at each side of opening was specified to be a double joist (10 in. minimum width) on the structural drawing, but the pan layout determined that the joist on the left-hand side had to be 16 in. wide and that on the right 10 in. The reinforcement is not affected, however, and so two times the single joist reinforcement is added for each double joist. 1J2B is stopped short by an opening and therefore not continuous. The detailer had to make an assumption here and added one #19 top bar at each end of the joist.

Longitudinal temperature-shrinkage bars have been detailed as a multiple of 30 or 20 ft stock lengths plus one odd length to make up the run. This also applies to bars in the distribution ribs (bridging). Transverse tie bars over alternate ribs have been detailed extending 1 ft 0 in. into the supports, as shown on the structural drawing. Tie bars for all exterior bays are assumed identical in length and have been called out in one location only (adjacent to Column 8).

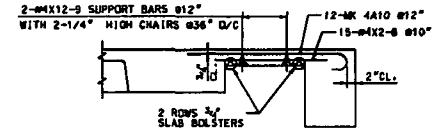
All wire bar support for supporting the reinforcing bars is shown in the schedules and sections; and, finally, the total quantities are listed. The reinforcing bar support items are detailed in the beam schedule (#10 support bars where there are no top bars) and #13 support bars in Section A-A. Support bars have replaced the #10 temperature bars shown in Section A-A on the structural drawing.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

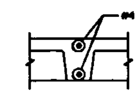


FIRST FLOOR FRAMING PLAN

ALL #3 TEMPERATURE REINF. SPACED @12
LAP SPLICE ALL #3 & #4 BARS 32"



SECTION "A-A"

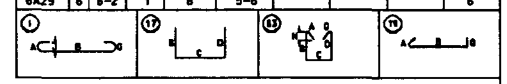


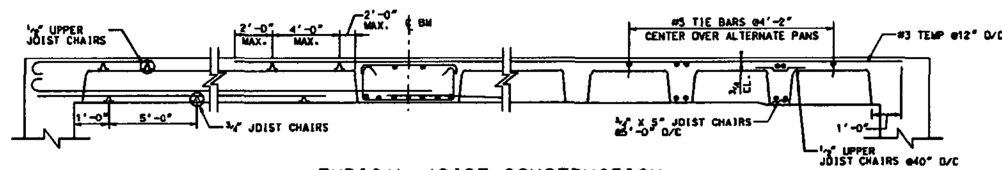
DISTRIBUTION RIB
IN CTR. OF 25'-3" SPANS

REFER TO FRAMING PLAN FOR QUANTITY AND LENGTHS OF #4 BARS

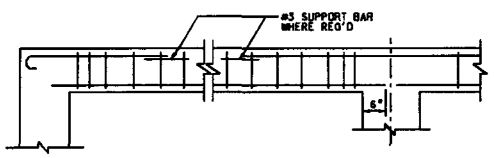
BENDING DETAILS

MARK	SIZE	LENGTH	TYPE	A	B	C	D	G	J
6A1	6	12-6	1	8	11-10				6
3A2	3	4-11	S3	4	1-9	9	1-9	4	2½
3A3	3	1-5	T9	4	9			4	
6A4	6	4-8	1	8	4-0				6
3A5	3	3-8	S3	4	7½	1-9	7½	4	
3A6	3	2-5	2	4	1-9			4	
6A7	6	5-1	1	8	4-5				6
7A8	7	5-3	1	10	4-5				7
7A9	7	7-4	1	10	6-6				7
4A10	4	4-9	1	6	4-3				4
3A11	3	6-5	S3	4	2-6	9	2-6	4	2½
6A12	6	5-6	1	8	4-10				6
6A13	6	7-6	1	8	6-10				6
3A14	3	4-3	S3	4	1-5	9	1-5	4	2½
5A15	5	15-7	1	7	14-5			7	5
3A16	3	3-11	S3	4	1-3	9	1-3	4	2½
7A17	7	25-9	1	10	24-11			10	7
6A18	6	4-6	1	8	3-10				6
6A19	6	6-9	1	8	6-1				6
6A20	6	18-0	1	8	17-4				6
6A21	6	17-8	1	8	17-0				6
6A22	6	25-7	1	8	24-11				6
6A23	6	26-4	1	8	25-8				6
6A24	6	20-9	1	8	20-1				6
6A25	6	5-2	1	8	4-6				6
6A26	6	16-4	1	8	15-8				6
6A27	6	16-10	1	8	16-2				6
6A28	6	9-6	1	8	8-10				6
6A29	6	6-2	1	8	5-6				6

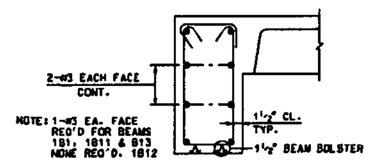




TYPICAL JOIST CONSTRUCTION



TYPICAL BEAM CONSTRUCTION



TYPICAL EXTERIOR BEAM

FOR PAN LAYOUT REFER TO ALPHA STEEL CO. DWG. NO. P-1

REINFORCING BARS: ASTM A615, GRADE 60

BEAM SCHEDULE

MARK	No.	SIZE B	SIZE D	BOTTOM No.	BOTTOM SIZE	BOTTOM LGTH.	TOP No.	TOP SIZE	TOP LENGTH OR MARK	LOCATION ℄ SUPPORT ℄ SUPPORT	#3 STIRRUPS (EXT., INT.) No.	MARK	SPACING	#5 STIRRUP SUPPORT BARS & #5 BARS EACH FACE No.	LGTH
1B1	2	12	24	4	6	20-7	2 2	6 6	MK 6A1 17-5	1-11, 4-0	17 17	MK 3A3 MK 3A2	4@6" 3@10" COL. 3 OR 20 4@6" 3@8" 3@10" COL. 4 OR 19	2 1-EA. FACE	21-7
1B2	1	24	10½	7	7	12-8	4 7	6 7	MK 6A4 9-4		16 16	MK 3A6 MK 3A5	3@4" 5@8" E.E.	2x2	2-0
1B2A	1	24	10½	7	7	12-8	4 7	6 7	MK 6A4 10-10		16 16	MK 3A6 MK 3A5	3@4" 5@8" E.E.	2x2	2-0
1B3	6	24	10½	6	7	17-2	8	7	11-1		20 20	MK 3A6 MK 3A5	3@4" 3@6" 4@8" E.E.	2x2	2-0
1B4	1	24	10½	4	8	13-9	8	8	11-1		10 10	MK 3A6 MK 3A5	3@4" 2@8" E.E.	-	-
1B5	2	24	10½	4	8	14-3	4	6	MK6A7		20 20	MK 3A6 MK 3A5	3@4" 3@6" 4@8" E.E.	2	7-0
1B6	1	24	10½	7	8	14-5	4	7	MK7A8		20 20	MK 3A6 MK 3A5	3@4" 5@8" 2@10" E.E.	2x2	3-0
1B7	1	24	10½	8	9	22-9	4 8	7 8	MK7A9 14-4		26 26	MK 3A6 MK 3A5	4@6" 6@8" COL. 14 4@6" 8@8" 4@10" COL. 13	2 2	2-0 5-0
1B8	1	12	33	2	6	MK 6A20	2 3	5 6	12-6 17-9	3-1, 3-1, 8-4	12 12	MK 3A3 MK 3A11	2@6" 4@12" E.E.	4 2 EA. FACE	17-0
1B9	1	12	33	2	6	16-1	3	6	17-7	3-1, 9-3	12 12	MK 3A3 MK 3A11	2@6" 4@12" E.E.	4 2 EA. FACE	16-3
1B10	1	12	33	2	6	MK 6A21	2	5	12-4	1-11, 3-1	12 12	MK 3A3 MK 3A11	2@6" 4@12" E.E.	4 2 EA. FACE	16-8
1B11	2	12	20	2 2	6 6	13-9 21-7	2	6	21-7	3-1, 3-1	8 8	MK 3A3 MK 3A14	2@10" 2@12" E.E.	2 1-EA. FACE	15-0
1B12	2	12	18	3	6	13-9	2	5	MK5A15		8 8	MK 3A3 MK 3A16	2@8" 2@12" E.E.	-	-
1B13	2	12	24	4	8	23-7	2	7	MK7A17		16 16	MK 3A3 MK 3A2	4@8" 4@10" E.E.	2 1-EA. FACE	24-7

NOTE: PLACE TOP BEAM BARS SYMMETRICALLY ABOUT COLUMN ℄ UNLESS OTHERWISE NOTED.

JOIST SCHEDULE

MARK	No.	SIZE B	SIZE D	BOTTOM No.	BOTTOM SIZE	BOTTOM LENGTH	TOP No.	TOP SIZE	TOP LENGTH	LOCATION ℄ SUPPORT ℄ SUPPORT
1J1	20	5"	8"+2½"	2	6	MK 6A22	2X1	6	MK 6A13	
1J2	58	5"	8"+2½"	1 1	6 6	20-8 MK 6A23	1	6	MK 6A13	
1J2A	2	VAR.	8"+2½"	2 2	6 6	20-8 MK 6A23	2	6	MK 6A13	
1J2B	1	5"	8"+2½"	2	6	MK 6A24	2X1	6	MK 6A13	1-MARK 6A13 TOP @ DISCONTINUOUS END
1J3	26	5"	8"+2½"	1 1	6 6	20-8 MK 6A23	1 2	6	MK 6A13 16-0	8-0, 8-0
1J3A	2	VAR.	8"+2½"	2 2	6 6	20-8 MK 6A23	2 4	6	MK 6A13 16-0	8-0, 8-0
1J4	23	5"	8"+2½"	1 1	6 6	11-11 MK 6A26	1	6	MK 6A25	
1J4A	1	5"	8"+2½"	1 1	6 6	12-5 MK 6A27	1 1	6 6	MK 6A28 MK 6A29	8-0
1J4B	5	5"	8"+2½"	1 1	6 6	12-5 MK 6A27	1	6	MK 6A29	
1J5	31	5"	8"+2½"	1 1	5 5	9-1 16-7	2	6	30-0	8-0, 8-0

@ TIE TO TEMP. STEEL

BAR SUPPORTS (CLASS 1)

30 LIN. FT. 3/4" SLAB BOLSTERS (SB)
330 LIN. FT. 1½" BEAM BOLSTERS (BB)
755 PCS. 3/4" X 5" JOIST CHAIRS (JC)
629 PCS. 1/2" UPPER JOIST CHAIRS (UJC)
10 PCS. 2¼" INDIVIDUAL HIGH CHAIRS (HC)

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS.

ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR.

LEGEND

O.F. – OUTSIDE FACE
I.F. – INSIDE FACE
E.F. – EACH FACE
HORIZ. – HORIZONTAL
VERT. – VERTICAL
DWLS. – DOWELS
FTG. – FOOTING
ELEV. – ELEVATION
E.W. – EACH WAY
T.O.F. – TOP OF FOOTING
B.O.F. – BOTTOM OF FOOTING
T.O.W. – TOP OF WALL
B.O.W. – BOTTOM OF WALL
GRD. BM. – GRADE BEAM
MK. – MARK
MAS. – MASONRY
DIAG. – DIAGONAL
COL. – COLUMN
PROJ. – PROJECTION
T & B – TOP & BOTTOM
N.F. – NEAR FACE
F.F. – FAR FACE
O/C – ON CENTER
@ – AT EACH

NO	DATE	ISSUED FOR
1		APPROVAL

MILE-HI REBAR
DENVER, COLORADO

JOB	VALLEY TOWNSHIP HIGH SCHOOL
LOCATION	PRINCETON, PA
DESCRIPTION	FIRST FLOOR FRAMING PLAN
CONTRACTOR	DUCKWORTH CONST. CO.
ENGINEER	YZERMAN, LIDSTROM & SHANAHAN

DRAWN:	CHECKED:	DATE:	REVISIONS	JOB NO.	DRAWING NO
RRB		3/15/01	9/3/03	2002	P-3

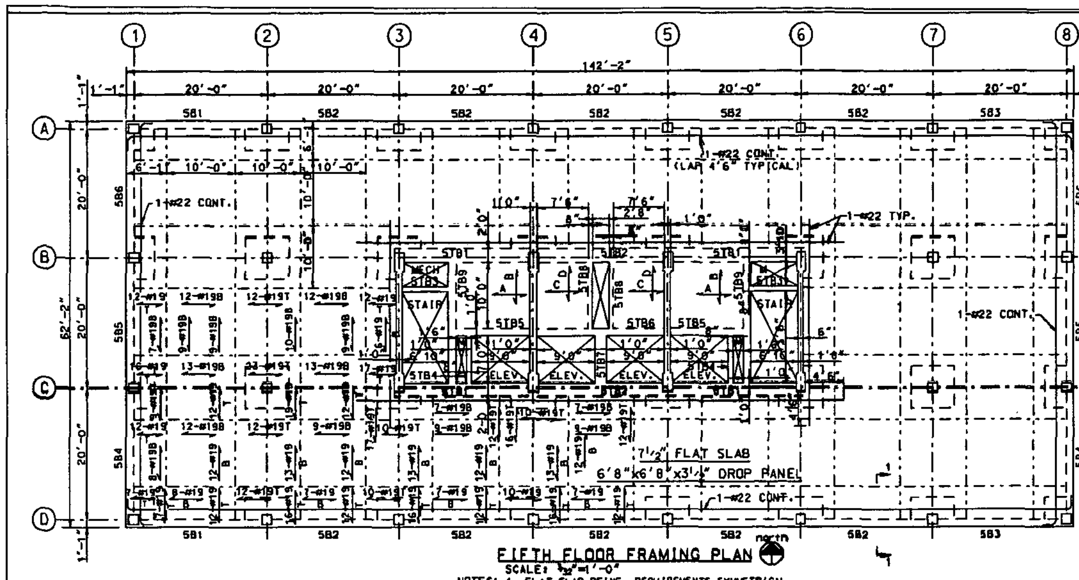
DRAWING S-4—FLAT SLAB FLOOR (STRUCTURAL DRAWING)

A flat slab floor consists of a thickened area around each column and can also include a column capital, which is a flared-out section at the top of the column. The slab itself is separated into column strips and middle strips, each approximately 1/2 span wide. These strips are dimensioned on the plan—keep in mind that the lines shown only represent the strip dimension. The slab reinforcement is indicated directly on the plan view and shown as bottom (B) or top (T) with the quantity and size indicated. The typical column and middle strip sections in the upper right-hand corner define the extent of the reinforcement.

The cross section detail labeled "typical detail one-way slab" is for the solid slabs in the core area. The reinforcement for these slabs is shown in the "slab schedule" just below the detail.

The beam reinforcement is shown in schedule format, including a sketch showing the location of the reinforcement. The perimeter beam stirrups are shown as two-piece to facilitate placing and the cap stirrups show a 135-degree hook at the exterior face for torsion.

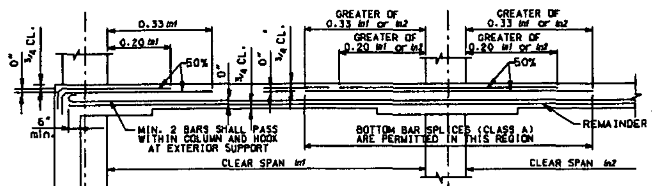
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



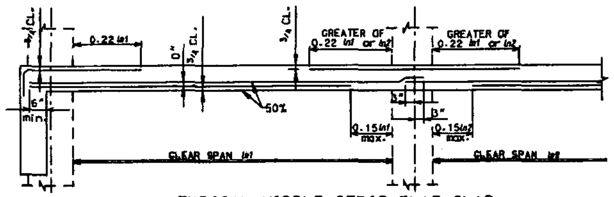
FIFTH FLOOR FRAMING PLAN

SCALE: 3/32"=1'-0"

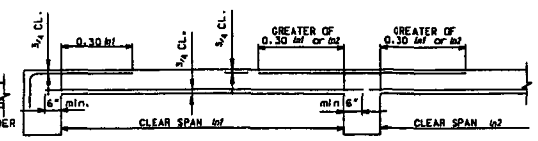
NOTES: 1. FLAT SLAB REINF. REQUIREMENTS SYMMETRICAL ABOUT N-S & E-W BUILDING CENTERLINES.
2. COLUMN SIZES: 20"x 20" TYPICAL EXCEPT AT B3 TO B6 & C3 TO C6 = 20"x 36"



TYPICAL COLUMN STRIP-FLAT SLAB



TYPICAL MIDDLE STRIP-FLAT SLAB



TYPICAL DETAIL - ONE WAY SLAB

SLAB SCHEDULE

MARK	DEPTH	REINFORCING	
		BOTTOM BARS	TOP BARS
A	7 1/2"	#19 @ 7 1/2"	#19 @ 7 1/2" @ NON CONT. END #19 @ 7 1/2" @ CONT. END
B	7 1/2"	#19 @ 7 1/2"	#19 @ 7 1/2" @ NON CONT. ENDS
C	7 1/2"	#16 @ 7 1/2"	#16 @ 7 1/2" @ NON CONT. END
D	7 1/2"	#13 @ 18" TEMP.	

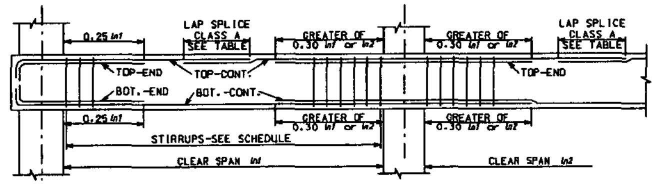
TENSION DEVELOPMENT & LAP SPLICE LENGTHS SCHEDULE - 4000 psi CONCRETE

TYPE	LAP CLASS	CASE No.	BAR SIZE (LENGTHS IN INCHES)								
			#10	#13	#16	#19	#22	#25	#29	#32	#36
TOP BARS	A	1	19	25	31	37	54	62	70	79	87
		2	28	37	47	56	81	93	105	118	131
	B	1	24	32	40	48	70	80	91	102	113
		2	36	48	60	72	106	121	136	153	170
OTHER BARS	A	1	15	19	24	29	42	48	54	61	67
		2	22	29	36	43	63	71	81	91	101
	B	1	19	25	31	37	54	62	70	79	87
		2	28	37	47	56	81	93	105	118	131

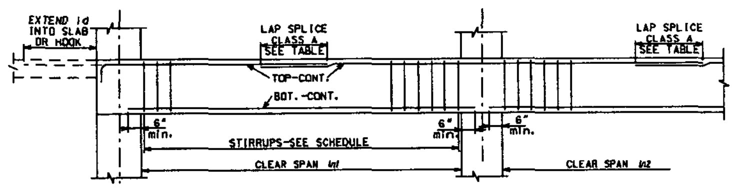
NOTES:
1. CASES 1 & 2 ARE DEFINED AS:
   BEAMS OR COLUMNS
   CASE 1: COVER AT LEAST $1.0d_b$ & C-C SPACING AT LEAST $2.0d_b$.
   CASE 2: COVER LESS THAN $1.0d_b$ OR C-C SPACING LESS THAN $2.0d_b$.
   ALL OTHER LOCATIONS
   CASE 1: COVER AT LEAST $1.0d_b$ & C-C SPACING AT LEAST $3.0d_b$.
   CASE 2: COVER LESS THAN $1.0d_b$ OR C-C SPACING LESS THAN $3.0d_b$.
2. LAP SPLICES ARE MULTIPLES OF TENSION DEVELOPMENT LENGTHS:
   CLASS A = $1.0l_d$, CLASS B = $1.3l_d$
3. TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE BELOW THE BAR

BEAM SCHEDULE

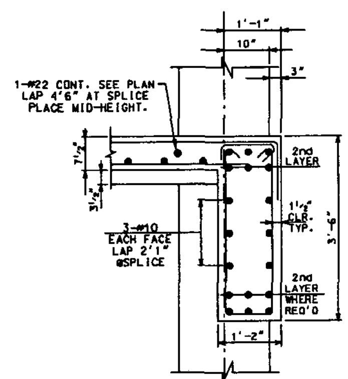
MARK	SIZE	BOTTOM BARS		TOP BARS			STIRRUPS			REMARKS
		NON CONT. END	CONT.	NON CONT. END	CONT.	CONT. END	SIZE	TYPE	SPACING E.E.	
5B1	14x42	3-#22	3-#22	3-#25	3-#25	3-#25	#13		1 @ 4" BAL @ 8"	TOP & BOTTOM STEEL IN TWO LAYERS
5B2	14x42		3-#22		3-#25	3-#25 EAST END	#13		1 @ 4" BAL @ 8"	TOP STEEL IN TWO LAYERS
5B3	14x42	3-#22	3-#22	3-#25	3-#25		#13		1 @ 4" BAL @ 8"	TOP & BOTTOM STEEL IN TWO LAYERS
5B4	14x42	2-#19	3-#22	3-#19	3-#22	3-#19	#13		1 @ 4" BAL @ 8"	TOP & BOTTOM STEEL IN TWO LAYERS
5B5	14x42		3-#22				#13		1 @ 4" BAL @ 8"	TOP FROM ADJACENT BEAMS
5B6	14x42	2-#19	3-#22	3-#19	3-#22	3-#19	#13		1 @ 4" BAL @ 8"	TOP & BOTTOM STEEL IN TWO LAYERS
5TB1	24x20		5-#25		6-#25		#10		1@3", 3@7" BAL @ 8"	
5TB2	24x20		5-#25				#10		1@3", 3@7" BAL @ 8"	
5TB3	8x14		2-#16		2-#16		#10		1 @ 2", BAL @ 5"	
5TB4	8x14		2-#16		2-#16		#10		1 @ 2", BAL @ 5"	
5TB5	12x20		3-#25		3-#25		#10		1@3", 3@6" BAL @ 8"	
5TB6	12x20		3-#25				#10		1@3", 3@6" BAL @ 8"	
5TB7	12x20		2-#29		2-#25		#10		1@2", 3@4" BAL @ 5"	
5TB8	8x14		2-#22		2-#22		#10		1 @ 2", BAL @ 5"	
5TB9	12x20		3-#29		3-#29		#10		1@2", 6@4" 4@5", BAL@8"	



TYPICAL SPANDREL BEAM



TYPICAL INTERIOR BEAM



SECTION 1-1

GENERAL NOTES:
1. f'_c = 4000 psi (FLOORS), f'_c = 5000 psi (COLUMNS) AT 28 DAY STRENGTH.
2. REINFORCING STEEL PER ASTM A615/615M, GRADE 420.
3. BEAM LONGITUDINAL REINFORCING 2" CLEAR. SLAB REINFORCING 3/4" CLEAR.
4. BAR SUPPORTS TO BE CLASS 1 (MAXIMUM PROTECTION PER CRSI MANUAL OF STANDARD PRACTICE-LATEST EDITION).
5. SLAB PLACING SEQUENCE:
   1st N-S BOTTOM BARS (BOTTOM MOST)-3/4" CLEAR
   2nd E-W BOTTOM BARS
   3rd E-W TOP BARS
   4th N-S TOP BARS (TOP MOST)-3/4" CLEAR
6. PROVIDE DETAILS IN ACCORDANCE WITH ACI DETAILING MANUAL.

ISSUE RECORD	DATE
CONSTRUCTION	3/20/01

DATE: 3/20/01
DRAWN: BHF
CHECKED:
JOB NO: 2001-1

KENDALL / AVERY ARCHITECTS
43 Mary Jane Way
Winter Park, Colorado

RILEY CONSULTING ENGINEERS
54 Mountain Trail
Steamboat Springs, Colorado

OFFICE BUILDING FOR ASHBY LABORATORIES
DENVER, COLORADO

DRAWING TITLE: FIFTH FLOOR FRAMING PLAN

SHEET NO. S-4

DRAWING P-4—FLAT SLAB FLOOR (PLACING DRAWING)

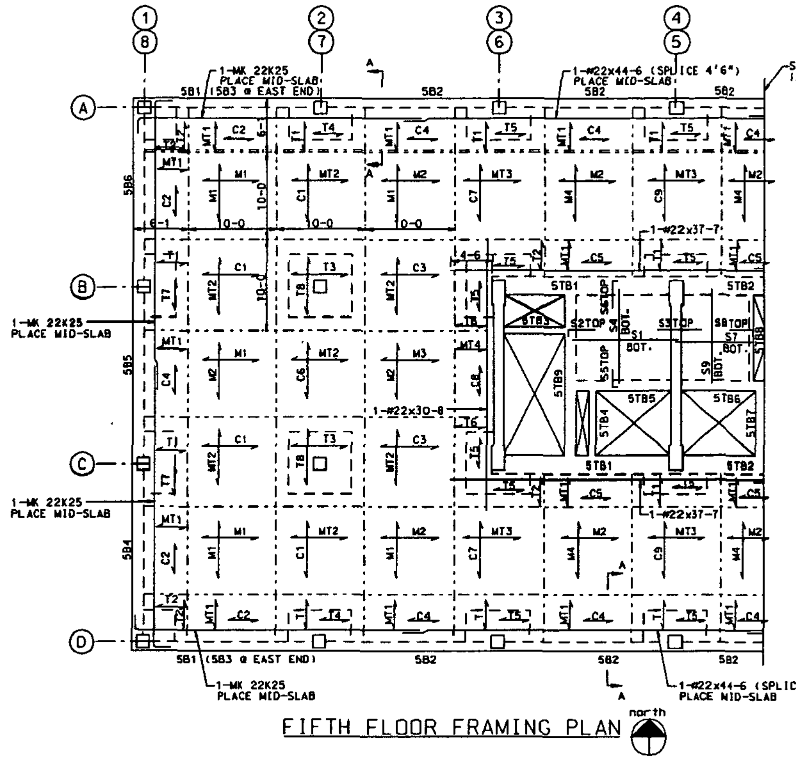
The detailer has shown only one-half plan as the building is symmetrical. Both the flat slab and two-way slab reinforcement are shown in schedule format. The detailer has separated the column strip and middle strip reinforcement into separate schedules. The column strip bottom bars have been identified with "C" and column strip top bars "T." Similarly, middle strip bottom bars with "M" and middle strip top bars "MT."

The two-way core slab reinforcement is in a separate schedule and identified with "S" for top and bottom bars.

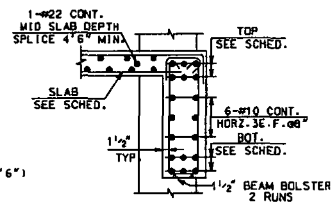
A bar support layout is shown for a typical panel in the lower right-hand corner with a placing sequence just below it.

The beam reinforcement is in a schedule very similar to the structural drawing design schedule. A sketch has been included for each beam to aid the placer. The dimensions have been included (as on Beam 5TB1) where the reinforcement is not symmetrical.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



FIFTH FLOOR FRAMING PLAN



SECTION A-A

TYPICAL SPANDREL BEAM

SLAB SCHEDULE

MARK	No. REQD.	REINF.
S1	2	16-#19x12-2 @ 7½
S2	2	16-MK 19K21 @ 7½
S3	2	16-#19x7-6 @ 7½
S4	2	18-#19x11-0 @ 7½
S5	2	18-MK 19K22 @ 7½
S6	2	18-MK 19K22 @ 7½
S7	2	16-#16x8-6 @ 7½
S8	2	16-MK 16K23 @ 7½
S9	2	6-#13x11-0 @ 15

COLUMN STRIP SCHEDULE

BOTTOM BARS

MARK	No. REQD.	REINF.	℄ W/S SKETCH ℄ E/N
C1	8	11-#19x21-9 *2-MK 19K29	
C2	8	8-#19x21-9	
C3	4	6-#19x22-5 *2-MK 19K5 5-#19x21-3	
C4	12	7-#19x22-5	
C5	6	7-#19x22-5	
C6	2	8-#19x22-5 *2-#19x22-6	
C7	4	6-#19x21-9 *2-MK 19K29 5-#19x20-9	
C8	2	6-#19x22-5	
C9	4	11-#19x20-9 *2-MK 19K29	

* PLACE WITHIN COLUMN CORE
HOOK AT EXT. SUPPORT

TOP BARS

MARK	No. REQD.	REINF.	℄ W/S SKETCH ℄ E/N
T1	20	8-MK 19K17 8-MK 19K18	
T2	12	4-MK 19K17 3-MK 19K18	
T3	4	12-#19x14-0 11-#19x9-2	
T4	4	6-#19x14-0 6-#19x9-2	
T5	20	5-#19x14-0 5-#19x9-2	
T6	4	3-MK 19K19 4-MK 19K20	
T7	4	5-#19x14-0 4-#19x9-2	
T8	4	10-#19x14-0 9-#19x9-2	

MIDDLE STRIP SCHEDULE

BOTTOM BARS

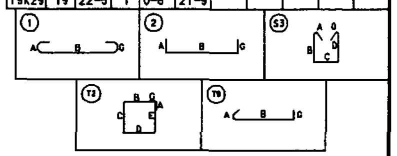
MARK	No. REQD.	REINF.	℄ W/S SKETCH ℄ E/N
M1	14	6-#19x20-8 6-#19x16-10	
M2	14	5-#19x20-6 4-#19x12-10	
M3	2	6-#19x20-3 6-#19x16-5	
M4	6	6-#19x20-8 6-#19x16-11	

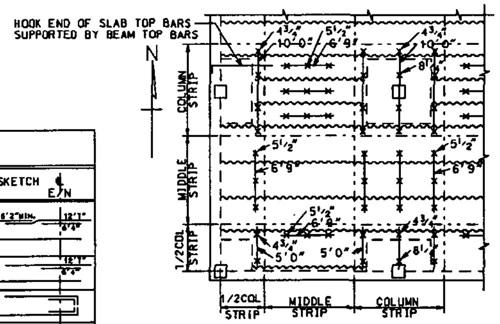
TOP BARS

MARK	No. REQD.	REINF.	℄ W/S SKETCH ℄ E/N
MT1	26	12-MK 19K26	
MT2	14	12-#19x10-0	
MT3	8	10-#19x10-0	
MT4	2	12-MK 19K27	

BENDING DETAILS

MARK	SIZE	LGTH.	TYPE	A	B	C	D	E	F	G
22K1	22	28-4	2	1-2	27-2					
22K2	22	7-5	2	1-2	6-3					
25K3	25	14-9	2	1-4	13-5					
25K4	25	7-7	2	1-4	6-3					
19K5	19	21-7	1	0-8	20-11					
13K6	13	8-2	S3	0-4½	3-3	0-11	3-3			0-4½
13K7	13	1-8	T9	0-4½	0-11					0-4½
19K8	19	7-3	2	1-0	6-3					
22K9	22	14-3	2	1-2	13-1					
10K10	10	6-6	T2	0-4	1-5	1-6	1-5	1-6		0-4
10K11	10	3-4	T2	0-4	0-5	0-11	0-5	0-11		0-4
25K12	25	26-5	2	1-4	25-1					
10K13	10	5-0	T2	0-4	1-5	0-9	1-5	0-9		0-4
25K14	25	16-4	2	1-4	15-0					
22K15	22	18-6	2	1-2	17-4					
19K17	19	8-11	2	1-0	7-11					
19K18	19	[illegible]	2	1-0	[illegible]					
19K19	19	6-1	2	1-0	5-1					
19K20	19	8-4	2	1-0	7-4					
19K21	19	5-2	2	1-0	4-2					
19K22	19	5-10	2	1-0	3-10					
16K23	16	3-7	2	0-10	2-9					
22K25	22	34-4	2	1-2	33-2					
19K26	19	6-11	2	1-0	5-11					
19K27	19	6-1	2	1-0	5-1					
19K29	19	22-5	1	0-8	21-9					





TYPICAL DETAIL FOR SLAB BAR SUPPORTS

—×—×— #13 SUPPORT BARS ON HIGH CHAIRS

〰〰 SLAB BOLSTERS

BAR PLACING ORDER

1. LAY NORTH-SOUTH BOTTOM BARS
2. LAY EAST-WEST BOTTOM BARS.
3. LAY EAST-WEST TOP BARS.
4. LAY NORTH-SOUTH TOP BARS.

SUPPORT BARS

20-#13 x 10-0
94-#13 x 6-9
60-#13 x 5-0

BAR SUPPORTS-CLASS 1

680 LIN. FT. 1½" BEAM BOLSTER (BB)
15 LIN. FT. 1" BEAM BOLSTER UPPER (BBU)
1720 LIN. FT. ¾" SLAB BOLSTER (SB)
282 PCS. 5½" INDIVIDUAL HIGH CHAIRS (HC)
200 PCS. 4¾" INDIVIDUAL HIGH CHAIRS (HC)
28 PCS. 8¼" INDIVIDUAL HIGH CHAIRS (HC)

NOTES:

1. ALL REINFORCING BARS TO CONFORM TO ASTM A615/A615M-GRADE 420.
2. *FOR TYPICAL BEAM AND SLAB DETAILS - SEE STRUCTURAL DRWG. S4.*
3. CONCRETE COVER: 1½" MIN. TO BEAM STIRRUPS.
   ¾" MIN. FOR TOP & BOTTOM SLAB BARS.
4. SEE ACI 315 FOR STANDARD BAR BENDS

BEAM SCHEDULE

MARK	NO. REQ'D	SIZE	BOTTOM	BOTTOM REMARKS	TOP	TOP REMARKS	HORZ.	HORZ. REMARKS	STIRRUPS	STIR. SPACING-E.E.	℄ W/S SKETCH ℄ E/N
5B1	2	14"x42"	3-MK 22K1 3-MK 22K2	CONT.HK@EXT.COL 2ndLAYER,HK@EXT.COL	3-MK 25K3 3-#25x25-2 3-MK 25K4 3-#25x12-8	CONT.HK@WEST COL CONT.@EAST COL 2ndLAYER,HK@WEST COL 2ndLAYER,CTR@EAST COL	6-#10x21-11	3 EACH FACE	28-MK 13K6 28-MK 13K7	1@4",BAL@8"	6'2" MIN. 12'7" 6'4"
5B2	10	14"x42"	3-#22x32-8	CONT.5'6"INTO BMS EACH END	3-#25x25-2 3-#25x12-8	CONT.@EAST COL 2ndLAYER,CTR@EAST COL	6-#10X22-1	3 EACH FACE SPLICE 2'1"@COL	28-MK 13K6 28-MK 13K7	1@4",BAL@8"	12'7" 6'4" 6'4"
5B3	2	14"x42"	3-MK 22K1 3-MK 22K2	CONT.HK@EXT.COL 2ndLAYER,HK@EXT.COL	3-MK 25K3 3-MK 25K4	CONT.HK@EAST COL 2ndLAYER,HK@EAST COL	6-#10x21-11	3 EACH FACE	28-MK 13K6 28-MK 13K7	1@4",BAL@8"	
5B4	2	14"x42"	3-MK 22K1 2-MK 19K8	CONT.HK@EXT.COL 2ndLAYER,HK@EXT.COL	3-MK 22K9 3-MK 19K8 3-#22x24-6 3-#19x12-8	CONT.HK@SOUTH COL 2ndLAYER,HK@SOUTH COL CONT.@NORTH COL 2ndLAYER,CTR@NO.COL	6-#10x21-11	3 EACH FACE	28MK 13K6 28MK 13K7	1@4",BAL@8"	4'6" MIN. 12'3" 6'4"
5B5	2	14"x42"	3-#22x32-8	CONT.5'6"INTO BMS EACH END	3-#22 3-#19	CONT.FROM ADJ.BMS 2ndLAYER FROM ADJ.BMS	6-#10x22-1	3 EACH FACE SPLICE 2'1"@COL	28-MK 13K6 28-MK 13K7	1@4",BAL@8"	4'8" MIN. 6'4"
5B6	2	14"x42"	3-MK 22K1 2-MK 19K8	CONT.HK@EXT.COL 2ndLAYER,HK@EXT.COL	3-MK 22K9 3-MK 19K8 3-#22x24-6 3-#19x12-8	CONT.HK@NORTH COL 2ndLAYER,HK@NORTH COL CONT.@SOUTH COL 2ndLAYER@SO.COL	6-#10x21-11	3 EACH FACE	28-MK 13K6 28-MK 13K7	1@4",BAL@8"	12'3" 4'6" MIN. 6'4"
5TB1	4	24"x20"	5-#25x19-4	FULL LENGTH 6"INTO BEAM	6-#25x18-7 6-#25x25-2	CONT.5'2"INTO SLAB CONT.@EAST COL	-		2x30-MK 10K10	1@3",3@7",BAL@8"	6'6" 5'2" MIN. 12'7"
5TB2	2	24"x20"	5-#25x19-4	FULL LENGTH 6"INTO BEAM	6-#25	CONT.FROM 5TB1 EA.END	-		2x30-MK 10K10	1@3",3@7",BAL@8"	5'2" MIN.
5TB3	2	8"x14"	2-#16x7-10	FULL LENGTH 6"INTO BEAM	2-#16x14-0	CONT.2'7"INTO SLAB EACH END	-		17-MK 10K11	1@2",BAL@5"	2'7"
5TB4	2	8"x14"	2-#16x8-0	FULL LENGTH 6"INTO BEAM	2-#16x15-2	CONT.2'7"INTO SLAB EACH END	-		17-MK 10K11	1@2"BAL@5"	2'7"
5TB5	2	12"x20"	3-#25x12-2	FULL LENGTH 6"INTO BEAM	3-MK 25K12	CONT.HK@5TB9	-		19-MK 10K13	1@3",3@6",BAL@8"	
5TB6	1	12"x20"	3-#25x20-0	FULL LENGTH 6"INTO BEAM	3-#25	CONT.FROM 5TB5 EA.END	-		31-MK 10K13	1@3",3@6",BAL@8"	5'2" MIN.
5TB7	1	12"x20"	2-#29x8-0	FULL LENGTH 6"INTO BEAM	2-MK 25K14	CONT.HK@5TB6	-		19-MK 10K13	1@2",3@4",BAL@5"	
5TB8	2	8"x14"	2-#22x11-0	FULL LENGTH 6"INTO BEAM	2-MK 22K15	CONT.HK@5TB6 CONT 4'6"INTO SLAB	-		24-MK 10K11	1@2",BAL@5"	
5TB9	2	12"x20"	3#29x19-0	FULL LENGTH 6"INTO BEAM	3#29x33-8	CONT.5'10"INTO SLAB EACH END	-		44-MK 10K13	1@2",6@4",4@5", BAL@8"	5'10"

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS.

ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR

NO	DATE	ISSUED FOR

MILE HIGH REBAR
Reinforcing Steel Fabrication
DENVER, COLORADO

JOB	ASHBY LABORATORIES OFFICE BLDG
LOCATION	DENVER, COLORADO
DESCRIPTION	FIFTH FLOOR FRAMING PLAN
CONTRACTOR	SHAVANO CONSTRUCTION
ENGINEER	RILEY CONSULTING ENGINEERS

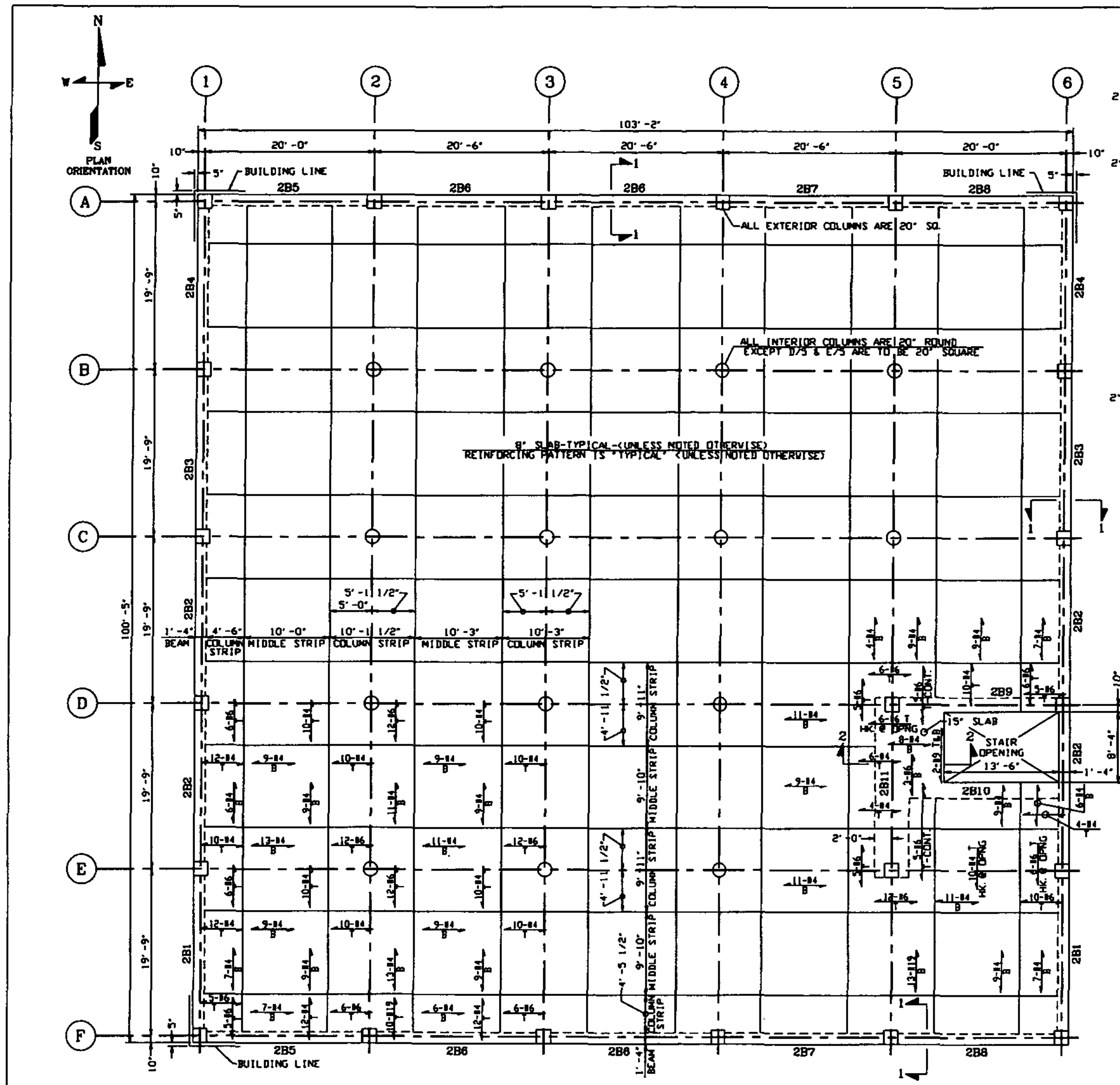
DRAWN:	CHECKED:	DATE:	REVISIONS	JOB NO.	DRAWING NO
SRV		3/20/01			P-4

DRAWING S-5—FLAT PLATE SLAB FLOOR (STRUCTURAL DRAWING)

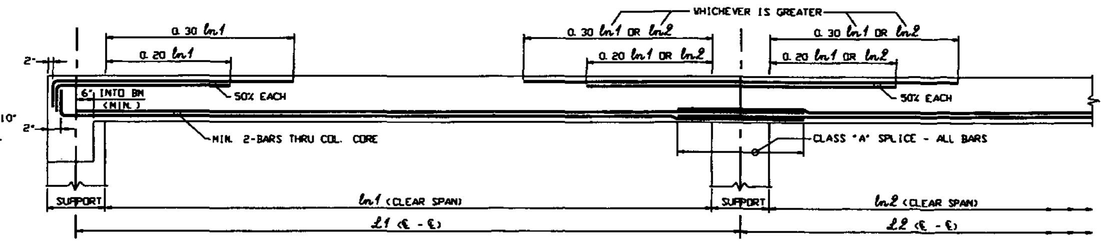
In this example, the floor system is a special type of flat slab with neither capitals nor drop panels at the column—a slab with a constant thickness throughout. The slab is detailed as column strips and middle strips, each approximately 1/2 span in width (see dimensions on the plan view). The column and middle strip lines only represent the strip dimensions. The engineer has not used a schedule for the slab reinforcement but rather has shown the reinforcing bar requirements on the plan view. The engineer has also shown sections through the column and middle strip that define the bar cut-offs. Following across on Column Line E, note that in the column strip the engineer requires 10 #19 Top at Column 1; 13 #13 Bottom between Columns 1 and 2; 12 #19 Top at Column 2; 11 #13 Bottom between Columns 2 and 3; and 12 #19 Top at Column 3. By only showing the reinforcement requirements in certain areas, the engineer implies a consistent reinforcement requirement.

The perimeter or "spandrel" beam reinforcement is shown in schedule format plus a typical sectional elevation showing the bar cutoffs. The three beams at the stair opening have been included in the beam schedule even though the elevation does not apply to them. The placing instruction for the location of the spandrel beam stirrup hooks appears in Section 1-1.

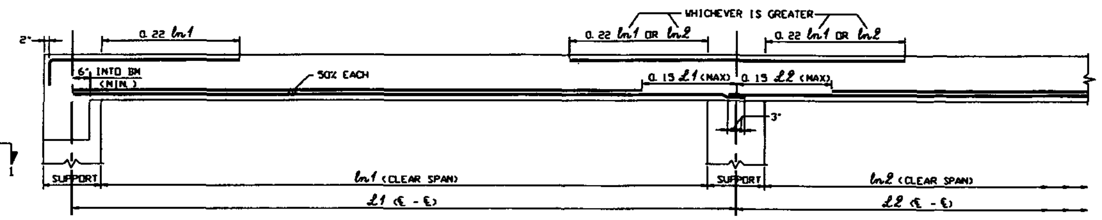
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



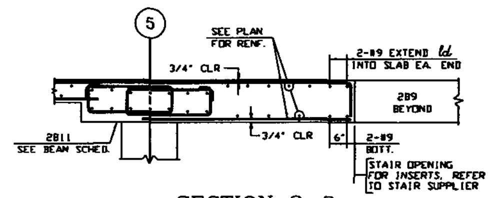
SECOND FLOOR FRAMING PLAN



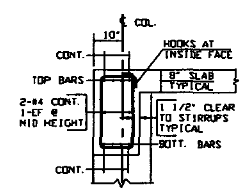
COLUMN STRIP



MIDDLE STRIP

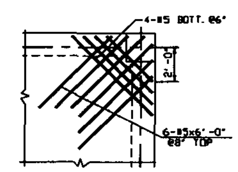


SECTION 2-2



SECTION 1-1

TYPICAL SPANDREL BEAM

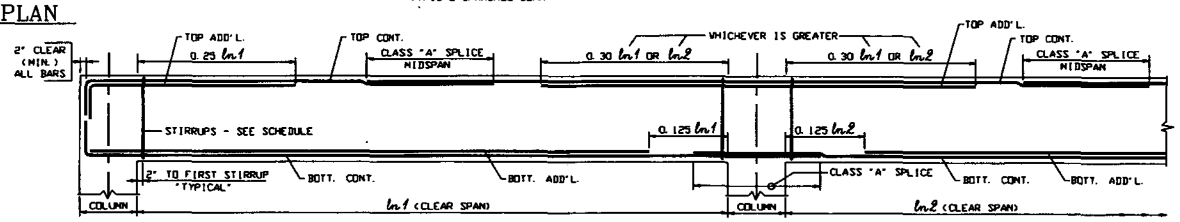


TYP. @ CORNERS

@ COLS. - A/1, A/6, D/6, F/1 & F/6

TENSION DEVELOPMENT-LAP SPLICE LENGTHS (INCHES) fc=4000 psi																	
BAR SIZE		#4		#5		#6		#7		#8		#9		#10		#11	
LAP CLASS		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
TOP BARS	CASE 1	25	32	31	40	37	48	54	70	62	80	70	91	79	102	87	113
	CASE 2	37	48	47	60	56	72	81	106	93	121	105	136	118	153	131	170
OTHER BARS	CASE 1	19	25	24	31	29	37	42	54	48	62	54	70	61	79	67	87
	CASE 2	29	37	36	47	43	56	63	81	71	93	81	105	91	118	101	131

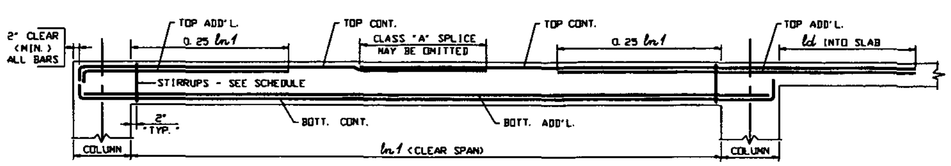
1. LAP SPLICE CASES DEFINED AS:
   BEAMS & COL'S. - CASE 1 : COVER = / > 1.0 db & c-c SPAC'G. = / > 2.0 db.
   CASE 2 : COVER = < 1.0 db OR c-c SPAC'G. = < 2.0 db.
   OTHER BARS - CASE 1 : COVER = / > 1.0 db & c-c SPAC'G. = / > 3.0 db.
   CASE 2 : COVER = < 1.0 db OR c-c SPAC'G. = < 3.0 db.
2. LAP CLASSES DEFINED AS:
   CLASS A = 1.0 ld
   CLASS B = 1.3 ld
3. TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE BELOW THE BARS.



TYPICAL - SPANDREL BEAM DETAIL

BEAM SCHEDULE

MARK	SIZE	BOTTOM CONT.	BOTTOM ADD'L.	TOP CONT.	TOP EXT. END	TOP INT. END	STIRRUPS SIZE	STIRRUPS SPACING, E.E., - U.N.O.
2B1	16x30	2-#8	2-#8	2-#9	2-#7	2-#8	#4	6@6", 3@12", BAL@18"
2B2	16x30	2-#8	2-#7	2-#9		2-#8	#4	5@6", 4@12", BAL@18"
2B3	16x30	2-#8	2-#7	2-#9		2-#8	#4	5@6", 4@12", BAL@18"
2B4	16x30	2-#8	2-#8	2-#9	2-#7	2-#8	#4	6@6", 3@12", BAL@18"
2B5	16x30	2-#8	2-#8	2-#9	2-#7	2-#8	#4	6@6", 3@12", BAL@18"
2B6	16x30	2-#8	2-#7	2-#9		2-#8	#4	5@6", 4@12", BAL@18"
2B7	16x30	2-#8	2-#7	2-#9		2-#8	#4	5@6", 4@12", BAL@18"
2B8	16x30	2-#8	2-#8	2-#9	2-#7	2-#8	#4	6@6", 3@12", BAL@18"
2B9	20x15	2-#8	2-#8	2-#7	2-#5	2-#7	#4	3@6", 3@12", BAL@18" (EAST END) 5@6", 4@12", BAL@18" (WEST END)
2B10	24x15	2-#7	3-#7	2-#7	2-#5	2-#7	#4	3@6", 3@12", BAL@18" (EAST END) 5@6", 4@12", BAL@18" (WEST END)
2B11	48x15	2-#9	5-#8	2-#7		5-#7	#4	3@6", 3@12", BAL@18" (NORTH END) 6@6", 6@12", BAL@18" (SOUTH END)



TYPICAL - INTERIOR BEAM DETAIL

NOTES:

1. REINFORCING BARS TO BE PER ASTM A615 - GRADE 60.
2. CONCRETE 28 DAY STRENGTH TO BE fc = 4000 psi.
3. PLACING DRAWINGS TO BE IN ACCORDANCE WITH ACI 315 DETAILING MANUAL.
4. EAST-WEST FLAT PLATE SLAB BARS TO BE IN OUTERMOST LAYERS - 3/4" CLEAR TOP AND BOTTOM.
5. BAR SUPPORTS TO BE CLASS 1 - MAX. PROTECTION - REFER TO CRSI MANUAL OF STANDARD PRACTICE, LATEST EDITION.

ACME LABORATORIES
OFFICE EXPANSION
924 MARCON BLVD. BARCLAY, NY

PATTON & LEWIS ENGINEERS
NEW YORK, NY

HEMPER & PEABODY ARCHITECTS
WATERTOWN, NY

REV. NO.	ISSUE	DATE
2	ISSUED FOR CONSTRUCTION <	09-03-2003
1	ISSUED FOR CONSTRUCTION	09/07/2001
---	ISSUED FOR BIDS	08/16/2001

FIRST ISSUE DATE: 08/16/2001
DRAWING SCALE: NONE
DRAWN BY: JJS
CHECKED BY: JMG

DRAWING TITLE: SECOND FLOOR FRAMING PLAN

DRAWING NO. S-5

SHEET 4 OF 15

DRAWING P-5—FLAT PLATE SLAB FLOOR (PLACING DRAWING)

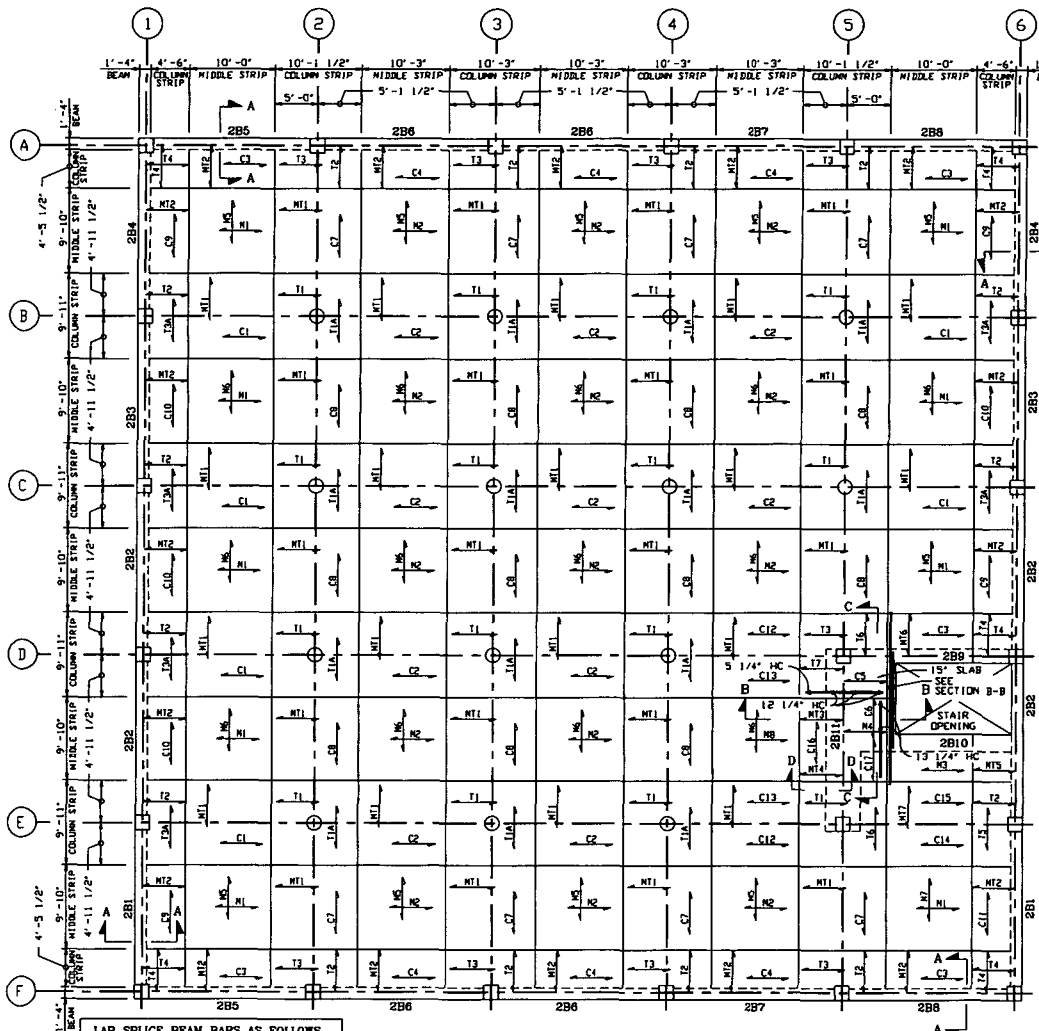
The detailer elected to use a schedule format, assigning a marking system as follows: "C" for column strip bottom bars; "T" for column strip top bars; "M" for middle strip bottom bars; and "MT" for middle strip top bars. This format is helpful for the placer in the field. The quantity of bars shown on this drawing was determined from the structural drawing plan view and the lengths from the structural drawing sections. The top bars in each column strip are of two different lengths.

The detailer has also shown a typical bar support layout and a sequence of placing the main bars and bar supports. This practice follows the structural drawing instructions.

The beam reinforcement schedule includes bar bend sketches.

It is important that any placing instruction shown on the structural drawing be included on the Placing Drawing, such as reference to stirrup hook location in spandrel beams (Section A-A).

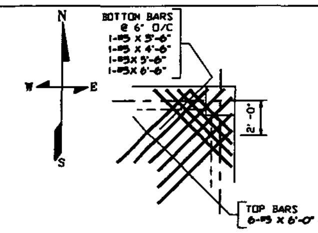
Structural and placing drawings presented *in this manual* are *examples of drafting style* and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize *how the engineer should clearly indicate design requirements and* convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



LAP SPLICE BEAM BARS AS FOLLOWS
TOP BARS:
#9 BAR ~ 70" (5'-10")
#8 BAR ~ 62" (5'-2")
#7 BAR ~ 54" (4'-6")
MID DEPTH BARS:
#4 BAR ~ 25" (2'-1")

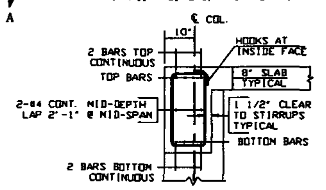
SECOND FLOOR FRAMING PLAN

8" SLAB TYPICAL EXCEPT WHERE NOTED



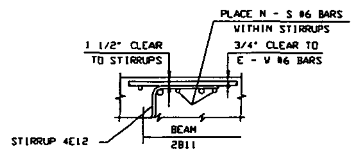
TYPICAL @ CORNERS

5 REQUIRED
@ A/1, A/6, D/6, F/1 AND F/6

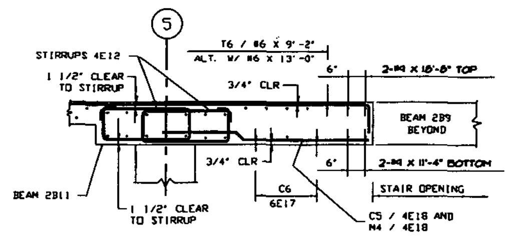


SECTION A - A

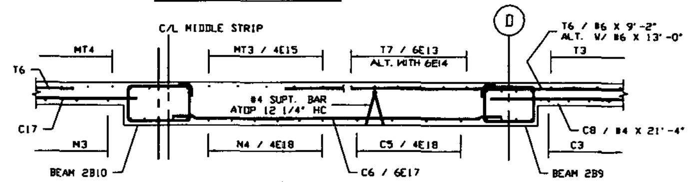
TYPICAL SPANDREL BEAM



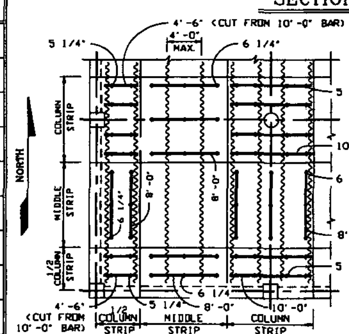
SECTION D - D



SECTION B - B



SECTION C - C



TYPICAL DETAIL FOR SLAB BAR SUPPORTS

** COLUMN STRIP SCHEDULE **

MIN. OF TWO (2) BT. COL. STRIP BARS "MUST" BE PLACED THRU THE COL. CORE

BOTTOM BARS		
MARK	NO.	REINFORCING
C1	6	11-#4 X 21'-5" 2-4E21
C2	10	11-#4 X 22'-1"
C3	5	5-#4 X 21'-5" 2-4E21
C4	6	6-#4 X 22'-1"
C5	ONE	4-4E18
C6	ONE	5-6E17
C7	8	11-#4 X 20'-6" 2-4E22
C8	11	11-#4 X 21'-4"
C9	4	5-#4 X 20'-6" 2-4E22
C10	4	6-#4 X 21'-4"
C11	ONE	5-#4 X 28'-4" 2-4E23
C12	2	4-#4 X 22'-1" 1-#4 X 19'-8" *
C13	2	6-#4 X 19'-8" *
C14	ONE	4-#4 X 18'-5" * 2-4E21
C15	ONE	7-#4 X 18'-5" *
C16	ONE	4-#4 X 21'-4"
C17	ONE	4-#4 X 10'-0"

TOP BARS		
MARK	NO.	REINFORCING
T1	15	6-#6 X 4'-2" 6-#6 X 15'-0"
T1A	14	6-#6 X 8'-10" 6-#6 X 12'-6"
T2	15	5-6E6 5-6E7
T3	9	5-#6 X 4'-2" 5-#6 X 15'-0"
T3A	6	5-#6 X 8'-10" 5-#6 X 12'-6"
T4	10	2-6E6 5-6E7
T5	ONE	2-6E8 5-6E9
T6	2	7-#6 X 4'-2" 8-#6 X 15'-0"
T7	ONE	5-6E13 5-6E14

* EXTEND ALL BARS 6" INTO BEAM

** MIDDLE STRIP SCHEDULE **

BOTTOM BARS		
MARK	NO.	REINFORCING
M1	9	4-#4 X 17'-0" 5-#4 X 20'-5" *
M2	14	4-#4 X 15'-10" 5-#4 X 21'-0"
M3	ONE	4-#4 X 18'-6" *
M4	ONE	6-4E18 EXT'D. TO OPEN'G.
M5	10	4-#4 X 16'-0" 5-#4 X 19'-6" *
M6	13	4-#4 X 15'-10" 5-#4 X 20'-5"
M7	ONE	9-#4 X 28'-0"
M8	ONE	4-#4 X 15'-11" 5-#4 X 19'-5"

TOP BARS		
MARK	NO.	REINFORCING
MT1	37	10-#4 X 10'-0"
MT2	19	12-4E19
MT3	ONE	5-4E15
MT4	ONE	5-#4 X 10'-0"
MT5	ONE	5-4E19
MT6	ONE	12-4E19
MT7	ONE	10-4E16

* EXTEND ALL BARS 6" INTO BEAM

BENDING DETAILS

SIZE	THEOR. LENGTH FT.	THEOR. LENGTH IN.	BAR MARK	VAR	BEND TYPE	A FT.	A IN.	A Q	B FT.	B IN.	B Q	C FT.	C IN.	C Q	D FT.	D IN.	D Q
8	23	9	8E1		2	1	4		22	5							
4	7	5	4E3		T2	0	4	2	1	1		2	3		1	1	
7	7	3	7E4		2	1	2		6	1							
4	5	7	4E5		T2	0	4	2	1	5		1	0		1	5	
6	6	2	6E6		2	1	0		5	2							
6	8	0	6E7		2	1	0		7	0							
6	15	10	6E8		1	0	8		15	2							
6	17	8	6E9		1	0	8		17	0							
7	22	10	7E10		1	1	0		21	2							
4	6	3	4E11		T2	0	4	2	1	9		1	0		1	9	
4	7	11	4E12		T2	0	4	2	2	7		1	0		2	7	
6	10	2	6E13		1	0	8		9	6							
6	12	2	6E14		1	0	8		11	6							
4	10	6	4E15		1	0	6		10	0							
4	15	6	4E16		1	0	6		15	0							
6	10	1	6E17		3				0	6	2	0	6	3	7	11	
4	6	0	4E18		3				2	0		0	4	2	3	7	2
4	6	4	4E19		2	0	8		5	8							
9	23	5	9E20		1	1	3		20	11							
4	22	0	4E21		1	0	6		21	6							
4	21	8	4E22		1	0	6		21	2							
4	30	0	4E23		1	0	6		29	6							
5	6	8	5E24		1	0	7		6	1							
7	13	9	7E25		1	0	10		12	11							
8	24	0	8E26		2	1	4		23	2							
8	23	0	8E27		1	0	11		21	2							
8	24	0	8E28		2	1	4		22	8							
9	15	2	9E29		2	1	7		13	7							

BAR MARK	E FT.	E IN.	E Q	F FT.	F IN.	F Q	G FT.	G IN.	G Q	H FT.	H IN.	H Q	J FT.	J IN.	J Q
8E1															
4E3	2	3					0	4	2						
7E4															
4E5	1	0					0	4	2						
6E6															
6E7															
6E8													0	6	
6E9													0	6	
7E10													0	7	
4E11	1	0					0	4	2						
4E12	1	0					0	4	2						
6E13													0	6	
6E14													0	6	
4E15													0	4	
4E16													0	4	
6E17	0	6	3	0	6	2				0	4	3			
4E18	0	6	3	0	6	2				0	3	1			
4E19															
9E20							1	3					0	11	3
4E21													0	4	
4E22													0	4	
4E23													0	4	
5E24													0	5	
7E25													0	7	
8E26															
8E27							0	11					0	11	
8E28															
9E29															

BAR MARK	K FT.	K IN.	K Q	O FT.	O IN.	O Q	R FT.	R IN.	R Q	BND DRV
8E1										
4E3										
7E4										
4E5										
6E6										
6E7										
6E8										
6E9										
7E10										
4E11										
4E12										
6E13										
6E14										
4E15										
4E16										
6E17	0	4	3	9	9	2				
4E18	0	3	1	5	10	3				
4E19										
9E20										
4E21										
4E22										
4E23										
5E24										
7E25										
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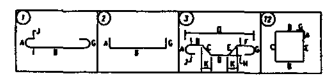
8E27										
8E28										
9E29										



BAR SUPPORTS

CLASS 1 - "PLASTIC" PROTECTED WIRE BAR SUPPORTS
660 LIN. FT. 1 1/2" BEAM BOLSTER (BB)
2935 LIN. FT. 3/4" SLAB BOLSTER (SB)
2 PCS - 13 1/4" INDIVIDUAL HIGH CHAIR (HC)
3 PCS - 12 1/4" INDIVIDUAL HIGH CHAIR (HC)
475 PCS - 6 1/4" INDIVIDUAL HIGH CHAIR (HC)
370 PCS - 5 1/4" INDIVIDUAL HIGH CHAIR (HC)

SUPPORT BARS

100 PCS - #4 X 10'-0"
157 PCS - #4 X 8'-0"

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL AND STRUCTURAL DRAWINGS.

ELEVATIONS AND DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS "ONLY", AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR.

NOTES:

CONCRETE COVER
2" TO MAIN STEEL IN BEAMS
3/4" TO TOP AND BOTTOM SLAB STEEL

ALL REINFORCING BARS "ASTM A615, GRADE 60"

REFER TO ARCHITECT - ENGINEER DRAWING S-5, SHEET 4 OF 15

PLACE ALL INTERIOR TOP BEAM AND SLAB BARS SYMMETRICALLY ABOUT COLUMN C/L UNLESS OTHERWISE NOTED

PLACE ALL BOTTOM BARS SYMMETRICALLY UNLESS OTHERWISE NOTED

** BEAM SCHEDULE **

MARK	NO.	SIZE W X D	BOTTOM	TOP CONTINUOUS	TOP END EXTERIOR	TOP END INTERIOR	SKETCH (CLEAR SPAN)	STIRRUPS	SPACING EACH END	MID DEPTH
2B1	2	16 X 30	2-#8 X 17'-4" 2-8E1	2-4E29	2-7E4	2-#8 X 12'-6"		25-4E5	6 @ 6", 3 @ 12", BAL. @ 18"	2-#4 X 11'-7" 2-#4 X 21'-10"
2B2	4	16 X 30	2-#7 X 15'-5" 2-#8 X 25'-4"	2-#9 X 25'-7"	———	2-#8 X 12'-6"		20-4E5	5 @ 6", 4 @ 12", BAL. @ 18"	2-#4X 21'-10"
2B3	2	16 X 30	2-#7 X 15'-5" 2-#8 X 25'-4"	2-#9 X 25'-7"	———	2-#8 X 12'-6"		20-4E5	5 @ 6", 4 @ 12", BAL. @ 18"	2-#4 X 21'-10"
2B4	2	16 X 30	2-#8 X 17'-4" 2-8E1	2-4E29	2-7E4	———		25-4E5	6 @ 6", 3 @ 12", BAL. @ 18"	2-#4 X 11'-7"
2B5	2	16 X 30	2-#8 X 18'-0" 2-8E28	2-4E29	2-7E4	2-#8 X 15'-0"		25-4E5	6 @ 6", 3 @ 12", BAL. @ 18"	2-#4 X 11'-4" 2-#4 X 22'-4"
2B6	4	16 X 30	2-#7 X 14'-2" 2-#8 X 24'-6"	2-#9 X 26'-4"	———	2-#8 X 15'-0"		20-4E5	5 @ 6", 4 @ 12", BAL. @ 18"	2-#4 X 22'-7"
2B7	2	16 X 30	2-#7 X 14'-2" 2-#8 X 24'-6"	2-#9 X 26'-4"	———	2-#8 X 15'-0"		20-4E5	5 @ 6", 4 @ 12", BAL. @ 18"	2-#4 X 22'-7"
2B8	2	16 X 30	2-#8 X 18'-0" 2-8E28	2-4E29	2-7E4	———		25-4E5	6 @ 6", 3 @ 12", BAL. @ 18"	2-#4 X 11'-4"
2B9	ONE	20 X 15	2-#8 X 21'-2" 2-8E27	2-7E25 2-#7 X 17'-7"	2-5E24	2-#7 X 10'-4"		14-4E5	3@6", 3@12", BAL@18" E END 5@6", 4@12", BAL@18" W END	———
2B10	ONE	24 X 15	5-#7 X 21'-2" 2-7E10	2-7E25 2-#7 X 17'-7"	2-5E24	2-#7 X 10'-4"		14-4E11	3@6", 3@12", BAL@18" E END 5@6", 4@12", BAL@18" W END	———
2B11	ONE	48 X 15	5-#8 X 20'-11" 2-9E20	2-#8 X 31'-4"	———	2 X 5-#7 X 10'-8"		2 X 20-4E12	3@6", 3@12", BAL@18" N END 6@6", 6@12", BAL@18" S END	———

SEQUENCE FOR PLACING BAR SUPPORTS AND BARS

1. PLACE CONTINUOUS LINES OF SLAB BOLSTER IN NORTH-SOUTH DIRECTION AT 4'-0" MAXIMUM O/C BETWEEN COLUMNS. BEGIN SPACING 1'-0" FROM CENTER LINE OF COLUMN.
2. LAY EAST-WEST BOTTOM BARS IN COLUMN AND MIDDLE STRIPS.
3. LAY NORTH-SOUTH BOTTOM BARS IN COLUMN AND MIDDLE STRIPS.
4. LAY BOTTOM CORNER BARS.
5. PLACE 4 ROWS OF #4 SUPPORT BARS X 10'-0" AT 4'-0" MAXIMUM O/C ON HIGH CHAIRS AT 3'-0" MAXIMUM O/C IN EAST-WEST DIRECTION AT COLUMN HEAD.
6. LAY NORTH-SOUTH TOP BARS IN COLUMN STRIPS.
7. LAY EAST-WEST TOP BARS IN COLUMN STRIPS.
8. PLACE 3 ROWS OF #4 SUPPORT BARS X 8'-0" AT 4'-0" MAXIMUM O/C ON HIGH CHAIRS AT 3'-0" MAXIMUM O/C BETWEEN COLUMNS LENGTHWISE IN NORTH-SOUTH AND EAST-WEST COLUMN STRIPS. PLACE 2 ROWS AT ALL SLAB EDGES.
9. LAY NORTH-SOUTH MIDDLE STRIP TOP BARS BETWEEN ENDS OF EAST-WEST TOP BARS IN COLUMN STRIP.
10. LAY EAST-WEST MIDDLE STRIP TOP BARS.
11. LAY TOP CORNER BARS.

09-05-05	CHANGE TO IMPERIAL B.M.	09-05-05	APPROVAL
		10-2-01	APPROVAL
DATE	DESCRIPTION	DATE	SENT FOR

ABC BUILDING PRODUCTS

ACME LABORATORIES
OFFICE EXPANSION
BARCLAY, NY
KEMPER AND PEEBODY
PATTON AND LEWIS
MULLIN CONSTRUCTION CO.

JBM 10-02-01
JMS 10-02-01
842

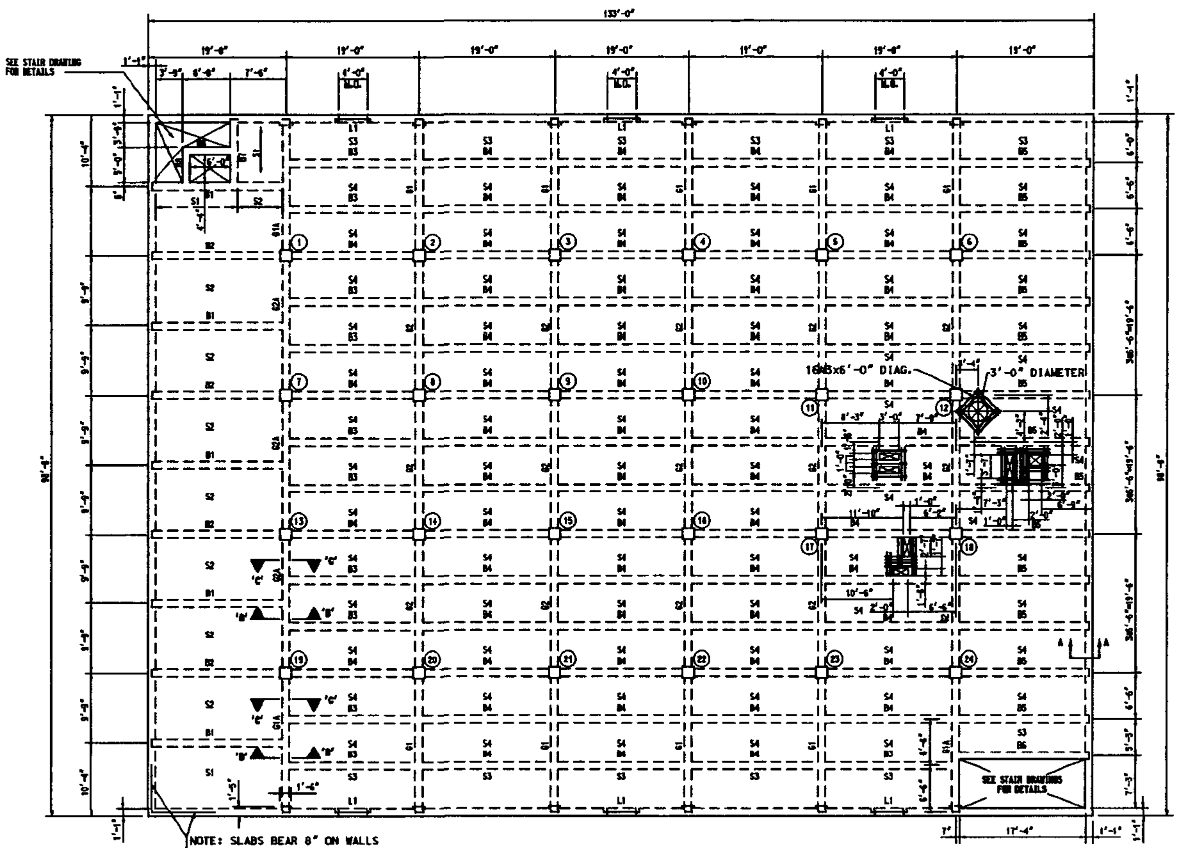
SECOND FLOOR FRAMING PLAN
P-5

DRAWING S-6—BEAM AND GIRDER FRAMING (STRUCTURAL DRAWING)

This example is a framing system using girders (G) between columns to support beams (B), which, in turn, support one-way slabs (S). In this example, the girders support the beams that do not frame directly into the columns. Each girder and beam is individually marked; those that are essentially the same are given the same mark. Slabs are marked as panels, with each panel spanning between pairs of beams. Panels can be of different lengths and still carry the same design mark.

The member size and reinforcement for girders, beams, and slabs are shown in schedules. These schedules are used with the typical details shown at the bottom of the structural drawing. The bottom bars in beams and girders (noted as "A" and "B") are two different lengths with the "B" bars in the second (upper) layer of bottom reinforcement, where noted in the schedule with an asterisk.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



FIRST FLOOR FRAMING PLAN

BEAM AND GIRDER SCHEDULE

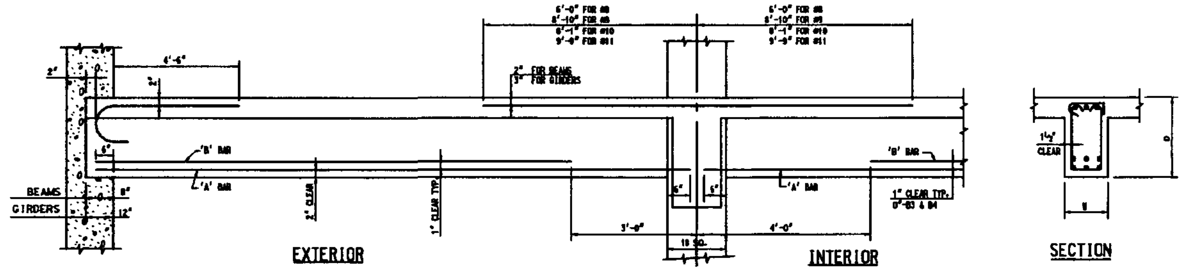
MARK	SIZE W	SIZE D	BOTTOM A BARS	BOTTOM B BARS	TOP	STIRRUPS NO.-SIZE	STIRRUPS SPACING FROM FACE OF SUPPORT
G1	14	32	3#9	3#8 *	3#9 @ NON-CONTINUOUS ENDS; 3#9 } @ COLS. 1 TO 6 & 3#8 } 19 TO 24 (2 LAYERS, #9 BARS IN TOP LAYER)	22#3	1@2, 3@6, 3@8, 2@10, 2@12
G1A	SAME AS G1, U.O.N. ADD 3#4 EF					25#4	1@2, 3@6, 3@8, BAL @10
G2	14	32	3#8	2#6 *	3 #11 @ COLS. 7 TO 18	16#3	1@2, 7@12
G2A	SAME AS G2, U.O.N. ADD 3#4 EF					22#4	1@2, 10@10
B1	12	22	3#9	3#7 *	2#8 NON-CONT. END 4#9 CONT. END	16#3	1@2, 2@5, 5@8
B2	12	22	3#7	2#8 *	2#8 NON-CONT. END 4#9 CONT. END	16#3	1@2, 2@5, 5@8
B3	10	22	2#7	2#6	2#10 EACH END	10#3	1@2, 4@8
B4	10	22	2#6	2#6	2#10 EACH END EXCEPT @END CONT. WITH B2,B3 B5,(SEE B2,B3,B5 FOR THIS REINF.)	10#3	1@2, 4@8
B5	10	22	2#7	2#7 *	2#11 CONT. END 2#8 NON-CONT. END	10#3	1@2, 4@8
B6	10	16	2#8	2#8	2#8 CONT.	10#3	1@2, 4@6
B7	10	18	2#5		2#5 CONT.	10#3	1@2, 4@7
B8	8	8	2#5			NONE	
L1	8	12	2#5			NONE	

* UPPER LEVEL

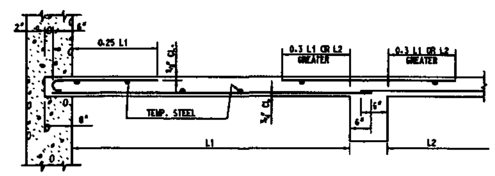
SLAB SCHEDULE

MARK	DEPTH	REINFORCING BOTTOM	REINFORCING TOP	REINFORCING TEMP.
S1	5"	#4@6½	#4 @12 NON-CONT. END #4 @7 CONT. END	#3@11
S2	5"	#4@9½	#4 @7 CONT. END	#3@11
S3	4"	#5@12	#3 @12 NON-CONT. END #4 @12 CONT. END	#3@14
S4	4"	#3@12	#4 @12 CONT. END	#3@14

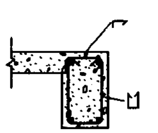
1. ALL CONCRETE WORK SHALL CONFORM TO ACI 318-99 BUILDING CODE
2. f_c' =4000 PSI @ 28 DAYS; MAX AGGREGATE SIZE = ¾"
3. REINFORCING STEEL SHALL CONFORM TO ASTM A615 GRADE 60
4. PLACE MAIN REINFORCING STEEL SO THAT BOTTOM OF STEEL IS 2" ABOVE FORMS IN BEAMS AND ¾" IN SLABS
5. WHERE BEAM OR GIRDER IS PARALLEL TO MAIN SLAB REINFORCING, PLACE #4x5-0 @12 IN. TOP OF SLAB, OVER AND AT RIGHT ANGLES TO SAID MEMBER
6. STIRRUPS TO HAVE 2-#3 SUPPORT BARS AS REQUIRED
7. LINTELS TO BEAR 8" ON EACH SIDE OF OPENING
8. PROVIDE 2-#3 BARS TOP & BOTTOM AT ALL OPENINGS AND EXTEND 1-9 BEYOND OPENING
9. PROVIDE #3 BARS AT RIGHT ANGLES TO MAIN REINFORCING STEEL AT OPENINGS IN SLAB AS SHOWN ON PLAN.
10. LAP ALL TEMPERATURE BARS 16"
11. PLACE E/W TOP GIRDER BARS AT COLUMNS FIRST BELOW N/S BEAM TOP BARS.
12. BAR SUPPORTS TO BE CLASS 3 (NO PROTECTION)
13. PROVIDE DETAILS IN ACCORDANCE WITH ACI-315 DETAILING MANUAL



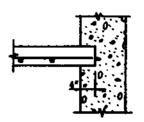
TYPICAL BEAM AND GIRDER DETAIL



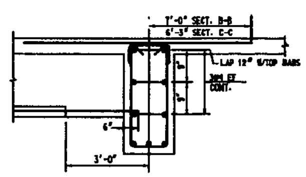
TYPICAL SLAB DETAIL



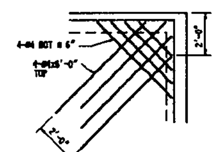
BM. STIRRUP DETAIL @ OPENINGS



SECTION A-A



SECTS. B-B & C-C



TYPICAL AT NW & SE CORNERS

PROJECT: FACTORY BUILDING FOR EXCEL MACHINE CO.
LOCATION: NEWTON, N.Y.
TITLE: FIRST FLOOR FRAMING PLAN
ENGINEER: LEWIS & PATTON, RICHLAND BUILDING, SUNVIEW, N.Y.

REVISIONS BY	DATE

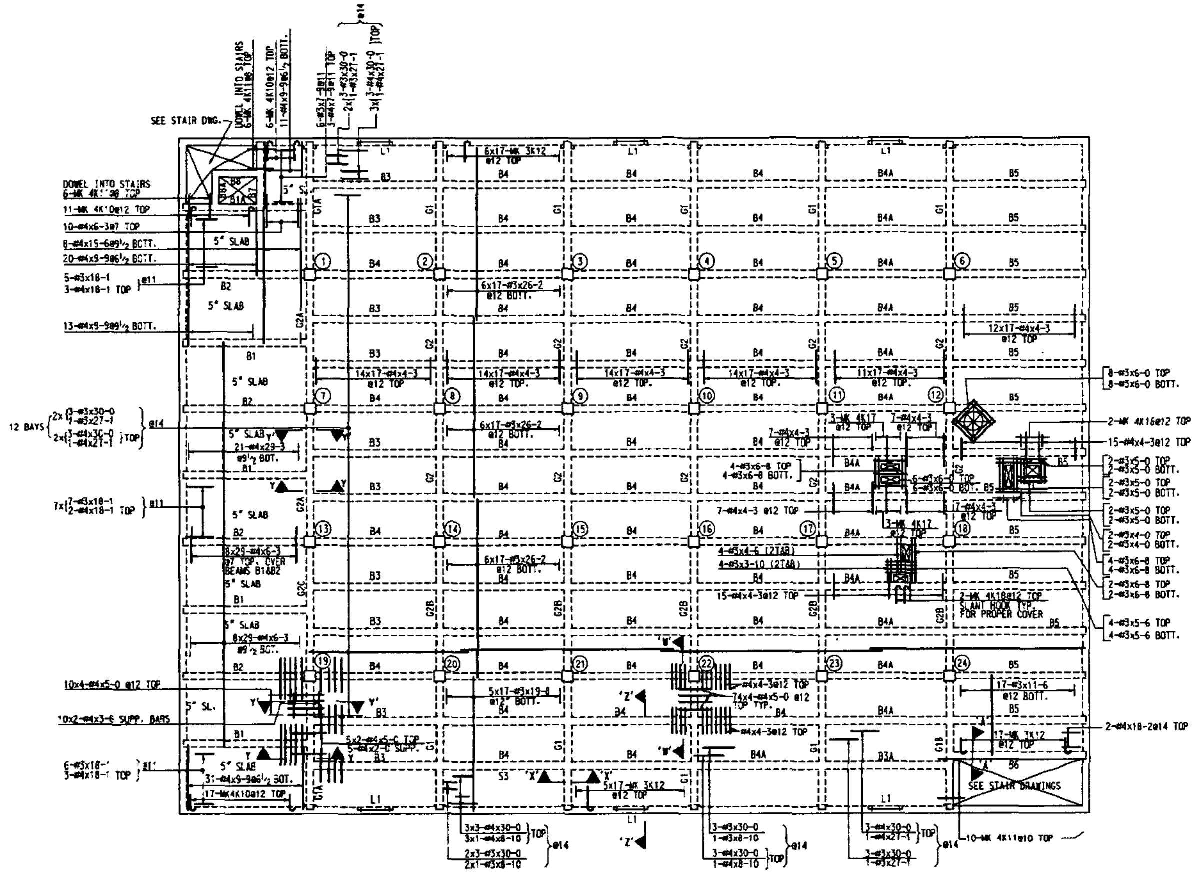
DWN. BY: RLW
DATE: 19-FEB-01
JOB NO.:
DWN. NO.: S-6

DRAWING P-6—BEAM AND GIRDER FRAMING (PLACING DRAWING)

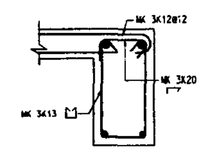
The detailer has retained the marking system shown on the structural drawing for the beams and girders with the exception that suffixes have been added as necessary where some marked members are not identical, such as GlA. The structural drawing slab marking system has been eliminated as the bars are detailed directly on the plan view. The reinforcement for beams and girders is shown in schedule format and closely follows the structural drawing. The detailer has identified those B bars that are placed in the upper layer of bottom bars—the top girder bars are placed first, that is, before the top beam bars, as shown on the structural drawings. Stirrup support bars are provided for stirrups that extend beyond the top bars.

The slab reinforcement is shown directly on the plan view so there is no need for schedules. Both the main and temperature-shrinkage reinforcement have been detailed without regard to small openings. The main bars have been located starting one full space from the face of the wall or beam. A typical row of main top steel has been shown over a beam, for instance, over Beam B3 just to the west of Columns 7 and 8. The notation of 14 x 17 - 13 x 4 - 3 slab is to be interpreted as 17 slab top bars over each beam and 14 beams in that vertical row. The detailer has substituted a #13 support bar (properly lapped) in the slabs for a #10 temperature-shrinkage bar to support the top steel over the beams. The support bar acts as a temperature-shrinkage bar in this case.

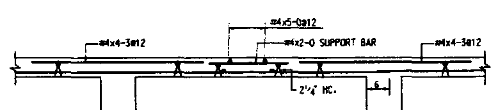
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



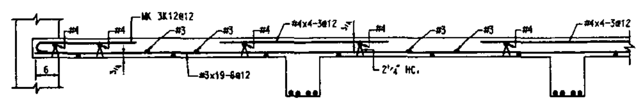
FIRST FLOOR FRAMING PLAN



SECTION A

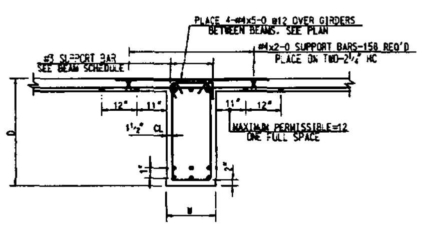


SECTION W-W

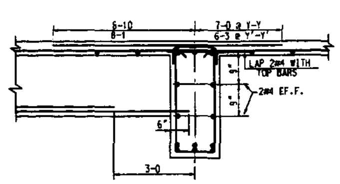


SECTION Z-Z

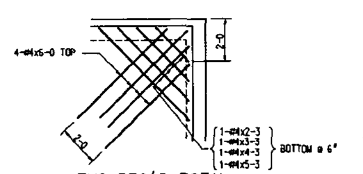
NOTE:
#4 BARS HAVE BEEN SUBSTITUTED FOR 3 RUNS OF #3 TEMPERATURE BARS IN EXTERIOR PANELS AND 2 RUNS IN INTERIOR PANELS TO SERVE AS SUPPORT BARS FOR TOP SLAB BARS
MIN. LAP =16" (#3 & #4)



SECTION X-X



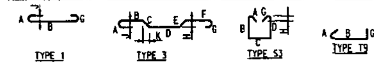
SECT. Y-Y & Y'-Y'



TWO REQ'D TOTAL
(TYPICAL DETAIL AT NW & SE CORNERS)

BENDING DETAILS

MARK	SIZE	LGTH	TYPE	A	B	C	D	E	F	G	J		H	K
9K1	9	6-7	1	1-3	5-4						11 3/4			
3K2	3	6-3	S3	4	2-4	11	2-4			4				
3K3	3	1-7	T9	4	11					4				
10K4	10	10-9	3		8-1	6-3							4-5	4-5
8K6	8	5-11	1	11	5-0						8			
3K8	3	4-5	S3	4	1-7	7	1-7			4				
5K9	5	13-6	1	7	12-11						5			
4K10	4	3-2	1	6	2-8						4			
4K11	4	4-0	3		2-0	2-0							1-5	1-5
3K12	3	2-4	1	3	1-11						3			
3K13	3	3-5	S3	4	1-1	7	1-1			4				
3K14	3	3-9	S3	4	1-3	7	1-3			4				
3K15	3	4-7	S3	4	1-7	9	1-7			4				
4K16	4	4-0	1	6	3-6						4			
4K17	4	4-5	1	6	3-11						4			
4K18	4	2-7	1	6	2-1						4			
8K19	8	22-5	1	11	21-6						8			
3K20	3	1-3	T9	4	7					4				
4K21	4	6-4	S3	4 1/2	2-4	11	2-4			4 1/2				
4K22	4	1-8	T9	4 1/2	11					4 1/2				
3K23	3	1-5	T9	4	9					4				



TYPE 1 TYPE 3 TYPE S3 TYPE T9

BAR SUPPORTS (CLASS 3)

490 PCS. 2" BEAM BOLSTERS x 5-0 (BB)
63 PCS. 1" BEAM BOLSTER UPPER x 5-0 (BBU)
402 PCS. 3/4" SLAB BOLSTERS x 10-0 (SB)
149 - 3 1/4" HC, SPACE @ 3-0 FOR 5" SLAB
1522 - 2 1/4 HC SPACE @ 3-0 FOR 4" SLAB

NOTES:
ALL SLABS ARE 4" THICK UNLESS OTHERWISE SPECIFIED.
MAIN SLAB BARS IN BOTTOM TO BE SUPPORTED IN EACH INTERIOR BAY BY TWO ROWS OF 3/4" SLAB BOLSTERS
MAIN SLAB BARS IN BOTTOM TO BE SUPPORTED IN EACH EXTERIOR BAY & 5" SLABS BY THREE ROWS OF 3/4" SLAB BOLSTERS
FOR BEAM & GIRDER DETAIL SEE ARCH'S DWG. 3 OF 12
SLAB BARS TO BE CUT IN FIELD AT OPENINGS
REINFORCING - ASTM A615 GRADE 60
SEE ACI-315 DETAILING MANUAL FOR TYPICAL BAR BENDS

BEAM AND GIRDER SCHEDULE

No.	MARK	SIZE W	SIZE D	REINFORCING BOTTOM "A" BARS	BOTTOM "B" BARS	TOP * NON-CONT.-END	TOP * CONT. END	STIRRUPS SPACE EA. END	STIRRUP SPACERS
9	G1	14	32	3-#9x19-0	3-#8x16-3 * EXTEND INTO EXTERIOR SUPP.	3-MK 9K1	3-#9x17-8 & 3-#8x12-0 COLS. 2 TO 6 & 20 TO 23 2 LAYERS, #9 BARS INTO TOP LAYER	22-MK 3K2 22-MK 3K3 (1@2", 3@6" 3@9", 2@10",2@12")	2-#3x7-10 LAP 12" WITH TOP BARS
2	G1A	14	32	3-#9x19-0	3-#8x16-3 * EXTEND INTO EXTERIOR SUPP.	3-MK 9K1	3-#9x17-8 & 3-#8x12-0 2 LAYERS, #9 BARS INTO TOP LAYER @ COL 1 & 19	25-MK 4K21 25-MK 4K22 (1@2", 3@6", 3@9" BAL @10")	2-#4x7-10 TOP LAP 12" 4-#4x19-0 2EF
1	G1B	14	32	3-#9x19-0	3-#8x16-3 EXTEND INTO EXTERIOR SUPP.	3-MK 9K1 SEE PLAN	3-#9x17-8, 3-#8x12-0 #9 IN TOP LAYER @ COL 24 FOR DOWELS TO STAIR	25-MK 4K21 25-MK 4K22 (1@2", 3@6", 3@9" BAL @10")	2-#4x7-10 TOP LAP 12" WITH TOP BARS 4-#4x19-0 2EF
10	G2	14	32	3-#8x19-0	2-#6x13-6 * PLACE SYM.		3-#11x19-6 @ COLS. COLS. 8-12, 14-18	16-MK 3K2 (1@2") 16-MK 3K3 (7@12")	
2	G2A	14	32	3-#8x19-0	2-#6x13-6 * PLACE SYM.		3-#11x19-6 @ COLS. 7 & 13	22-MK 4K21 22-MK 4K22 (1@2", 10@10")	2-#4x3-0 TOP 4-#4x19-0 2EF
5	G2B	14	32	3-#8x19-0	2-#6x13-6 PLACE SYM.		SEE G1, G1B & G2 FOR TOP STEEL	16-MK 3K2 16-MK 3K3 (1@2" 7@12")	
1	G2C	14	32	3-#8x19-0	2-#6x13-6 PLACE SYM.		SEE G1A & G2A FOR TOP STEEL	22-MK 4K21 22-MK 4K22 (1@2", 10@10")	2-#4x3-0 TOP 4-#4x19-0 2EF
5	B1	12	22	3-#8x18-0	3-#7x15-5 * EXTEND INTO EXT. SUPP.	2-MK 8K6	4-#9x15-0	16-MK 3K15 16-MK 3K23 (1@2",2@5",5@8")	
4	B2	12	22	3-#7x18-4	2-#8x15-5 * EXTEND INTO EXT. SUPP.	2-MK 8K6	4-#9x17-8	16-MK 3K15 16-MK 3K23 (1@2",2@5",5@6")	
10	B3	10	22	3-#7x18-10	2-#6x13-0 PLACE SYM.	2-#10x14-4	2-#10x16-2	10-MK 3K8 10-MK 3K20 (1@2", 4@8")	
1	B3A	10	22	2-#7x18-10	2-#6x15-10 EXT. INTO G1B	2-MK 10K4 @ STAIR	SEE B4	10-MK 3K8 10-MK 3K20 (1@2", 4@8")	
46	B4	10	22	2-#6x18-10	2-#6x13-0 PLACE SYM.		2-#10x16-2 SEE B2, B3 & B5	10-MK 3K8 10-MK 3K20 (1@2", 4@8")	
13	B4A	10	22	2-#6x18-10	2-#6x13-0 PLACE SYM.	SEE B3, B4 & B5 FOR TOP STEEL		10-MK 3K8 10-MK 3K20 (1@2", 4@8")	
13	B5	10	22	2-#7x18-4	2-#7x15-5 * EXTEND INTO EXT. SUPP.	2-MK 8K6	2-#11x19-6	10-MK 3K8 10-MK 3K20 (1@2", 4@8")	
1	B6	10	16	2-#8x18-4	2-#8x15-5 * EXTEND INTO EXT. SUPP.	2-MK 8K19 EXT. 3-8 PAST & G1B		10-MK 3K13 10-MK 3K20 (1@2", 4@6")	
1	B7	10	18	2-#5x9-9		2-MK 5K9 CONT. EXT. 2-8 @ B1		10-MK 3K14, 3K20 (1@2", 4@7")	
1	B8	8	8	2-#5x7-0					
1	B8A	8	8	2-#5x5-4					
6	L1	8	12	2-#5x5-0					

* NOTE- PLACE GIRDER TOP BARS FIRST UPPER LAYER

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS

ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, *AND ARE NOT TO BE USED FOR CONSTRUCTION* UNLESS VERIFIED BY THE CONTRACTOR.

REV. NO.	DATE	DESCRIPTION

ABC BUILDING PRODUCTS, INC.
123 EAST SMIN CHICAGO, ILL.
TEL. (803) 557-1234 FAX (803) 557-2222

DWG. COVERS: FIRST FLOOR FRAMING PLAN
JOB: FACTORY BLDG FOR EXCEL MACHINE CO.
LOCATION: NEWTON, N.Y.
ENGINEER: LEWIS & PATTON RICHLAND BLDG. SUNVIEW, N.Y.
CONTRACTOR: JAMES CONSTRUCTION COMPANY

DATE: 19-FEB-01	DWG. BY BW	FILE NO.
REV.	CHK. BY	DWG. NO. P-6

DRAWING SP-7A—SLIPFORM CONCRETE WALLS (COMBINED STRUCTURAL-PLACING DRAWING)

It is industry practice to prepare drawings of slipform concrete walls that are combined structural and placing drawings. These drawings are usually prepared by the slipform contractors or by a consulting engineer who has considerable experience in slipform construction.

The jacking systems that are used during the slipform operation place physical constraints on the placement of the reinforcing bars. Because slipform construction is a vertical extrusion process, all reinforcing bars are placed in the top or above the climbing form, continuously, and in a predetermined sequence. The space available to preplace horizontal bars is generally limited to 2 ft vertically. The placement of the vertical bars is only limited by the spacing of the jacking yokes and the bar length that can be supported above the forms and handled manually by the worker placing the bars. Additionally, no reinforcing bars can project beyond the face of the wall because they would interfere with the vertical movement of the forms. (For a general description of slipform operations and reinforcing bar placement, see *Placing Reinforcing Bars*, 7th Edition, 1997, Concrete Reinforcing Steel Institute, Shaumburg, Illinios.)

Usually, the slipform contractor's drawings will not show minor placing details, leaving it up to the general foreman to work out the most economical way of placing based on past experience. It is extremely important, however, that a bar placing sequence be shown for any walls that are subject to bending, tension, or both, so that lap splices do not occur in the same vertical or horizontal line in adjacent courses or rows of bars.

A bar cutting and bending schedule is prepared in the usual way; however, for quality-control purposes on larger structures, it is usually necessary to prepare a list that indicates how the bars are to be bundled in the fabricating shop and the sequence in which they should be received at the jobsite.

There are a number of notations peculiar to slipform work, which have come to be generally accepted in the industry. On wall sections or elevations the word "courses" or its abbreviation "CRS" is used to designate a quantity of bars at a particular height in the wall. Also, the term "story pole" or its abbreviation "S.P." is used to show the height above the foundation. A complete run of vertical bars is designated as a row.

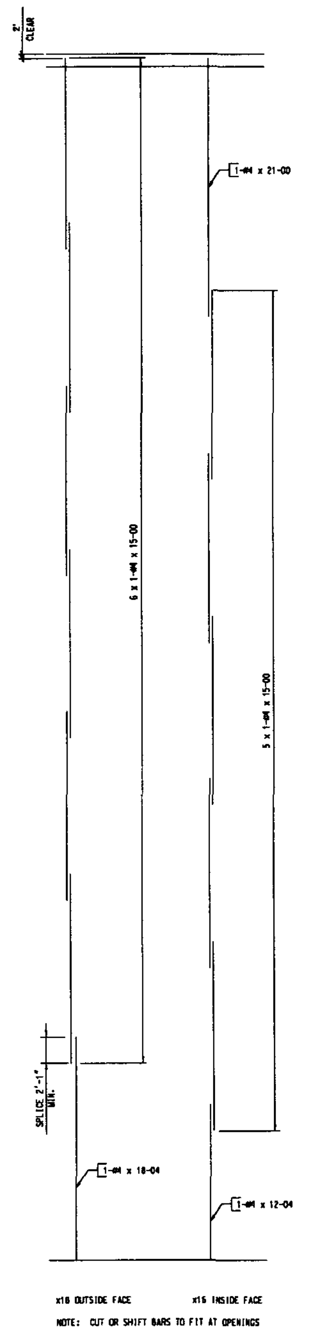
Probably the most difficult type of structure for which to prepare placing details is one consisting of interconnected circular walls (see Drawing SP-7B).

The usual practice is to show the main reinforcing bars both horizontally and vertically with a definite placing sequence. The engineer should carefully consider whether one or two layers of horizontal and vertical bars should be used. Additional drawings show reinforcing bars around or through openings, in keyways, pockets, and chases. In the case of a single circular structure such as a lowering tower or nuclear reactor shield wall, it is often simpler to show the wall as a revolved elevation and prepare supplemental drawings, if necessary, to show other details. In a circular wall, the horizontal radius-bent bars should be placed outside the jack rods when there is only one layer of horizontal bars.

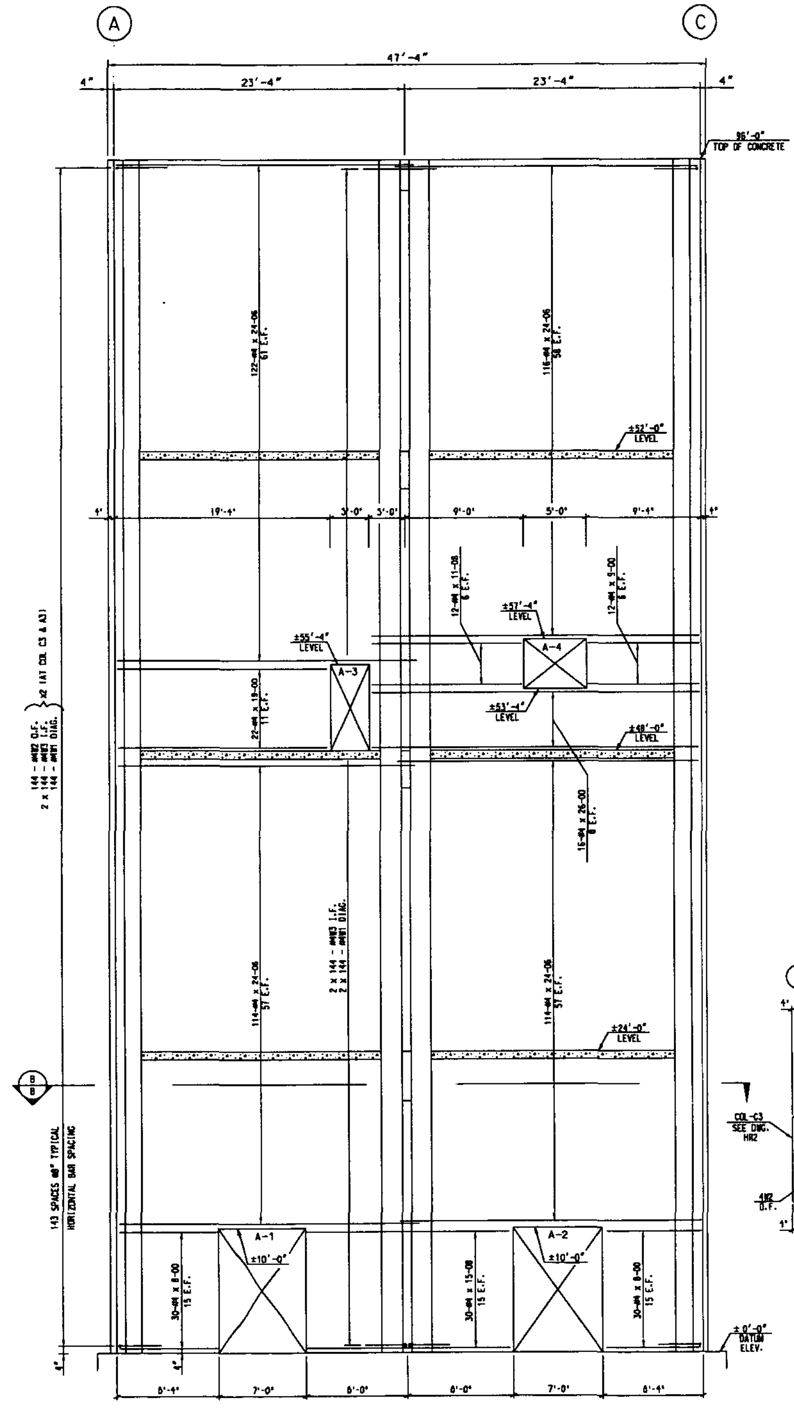
A square or rectangular structure with interior cross walls (see Drawing SP-7A) presents special problems in detailing the reinforcement because of numerous openings, inserts, box-outs, chases, and weld plates. The common practice is to prepare a set of wall elevation drawings to show exterior walls as sectional elevations with a small key plan on each drawing to locate the elevation in the structure. Before dimensions are placed on these drawings, a set of reproducible prints is made for use in preparing the reinforcing placement drawings.

The exterior wall elevations should be shown from the inside looking out because the work deck, where all the bar placement operations occur, only covers the interior of the structure. This perspective allows the placers to see the wall elevation drawn from the same side that the placement will occur. When detailing bar placement on interior walls, the terms near face (NF) and far face (FF) should be used to designate location of bars rather than inside and outside face. Column ties, unless the vertical bars and ties are preassembled in cages and lifted into place as units, should be detailed as two pieces with lap splices.

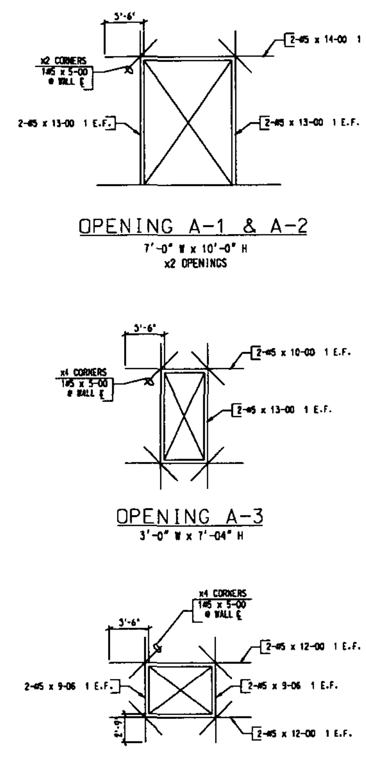
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



VERTICAL BAR SCHEMATIC
SCALE: 3/16"=1'-0"



SECT/ELEV A-A (LOOKING SOUTH)
SCALE: 3/16"=1'-0"



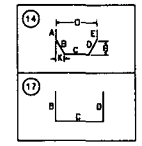
OPENING A-1 & A-2
7'-0" W x 10'-0" H
x2 OPENINGS

OPENING A-3
3'-0" W x 7'-04" H

OPENING A-4
5'-0" W x 4'-0" H

WALL OPENING ADD'L BARS
SCALE: 3/16"=1'-0"

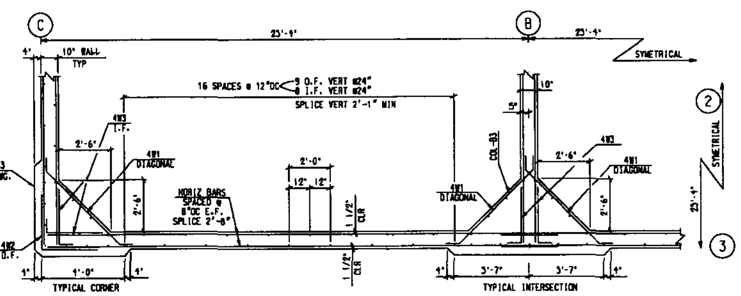
BENDING DETAILS											
MARK	No.	SIZE	LENGTH	TYPE	A	B	C	D	E	H	K
4W1	576	#4	7-05	14		1-00	5-05	1-00		0-08 1/2	0-08 1/2
4W2	288	#4	5-06	17		2-08	2-08				
4W3	576	#4	3-08	17		1-00	2-08				



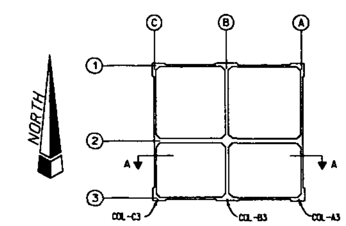
STRAIGHT BARS					
No.	SIZE	LENGTH	No.	SIZE	LENGTH
4	#5	14-00	16	#4	26-00
12	#5	13-00	466	#4	24-06
4	#5	12-00	16	#4	21-00
4	#5	10-00	22	#4	19-00
4	#5	9-06	18	#4	18-04
12	#5	5-00	30	#4	15-08
			188	#4	15-00
			16	#4	12-04
			12	#4	11-08
			12	#4	9-00
			60	#4	8-00

GENERAL NOTES:

1. ALL REINFORCING BARS SHALL BE PER ASTM A615/A615M, GRADE 60.
2. SPECIFIED CONCRETE STRENGTH f'_c AT 28 DAYS IS 4000 PSI.
3. JACK RODS FOR SLIPFORM NOT SHOWN. CO-ORDINATE WORK WITH SLIPFORM CONTRACTOR.
4. FOR COLUMN VERTICAL REINFORCING - SEE DWG HR-2.
5. SPLICE #4 VERTICAL BARS 2'-1" MIN. SPLICE #4 HORIZONTAL BARS 2'-8" MIN.



SECT/PLAN B-B SOUTH WALL
SCALE: 3/8"=1'-0"



KEY PLAN

ACME TERMINAL CO.

TITLE:	SOUTH WALL (RECTANGULAR SILO)		
DRAWN BY:	T. SHELTON		
CHECKED BY:	ALF		
APPROVED BY:	DLH		
SCALE:	AS SHOWN		
DRAWING NO:	SP-7A	DATE:	03/15/01

REV	REVISION DESCRIPTION	DATE

DRAWING SP-7B—SLIPFORM CONCRETE WALLS (COMBINED STRUCTURAL-PLACING DRAWING)

It is industry practice to prepare drawings of slipform concrete walls that are combined structural and placing drawings. These drawings are usually prepared by the slipform contractors or by a consulting engineer who has considerable experience in slipform construction.

The jacking systems that are used during the slipform operation place physical constraints on the placement of the reinforcing bars. Because slipform construction is a vertical extrusion process, all reinforcing bars are placed in the top or above the climbing form, continuously, and in a predetermined sequence. The space available to preplace horizontal bars is generally limited to 2 ft vertically. The placement of the vertical bars is only limited by the spacing of the jacking yokes and the bar length that can be supported above the forms and handled manually by the worker placing the bars. Additionally, no reinforcing bars can project beyond the face of the wall because they would interfere with the vertical movement of the forms. (For a general description of slipform operations and reinforcing bar placement, see *Placing Reinforcing Bars*, 7th Edition, 1997, Concrete Reinforcing Steel Institute, Shaumburg, Illinios.)

Usually, the slipform contractor's drawings will not show minor placing details, leaving it up to the general foreman to work out the most economical way of placing based on past experience. It is extremely important, however, that a bar placing sequence be shown for any walls that are subject to bending, tension, or both, so that lap splices do not occur in the same vertical or horizontal line in adjacent courses or rows of bars.

A bar cutting and bending schedule is prepared in the usual way; however, for quality-control purposes on larger structures, it is usually necessary to prepare a list that indicates how the bars are to be bundled in the fabricating shop and the sequence in which they should be received at the jobsite.

There are a number of notations peculiar to slipform work, which have come to be generally accepted in the industry. On wall sections or elevations the word "courses" or its abbreviation "CRS" is used to designate a quantity of bars at a particular height in the wall. Also, the term "story pole" or its abbreviation "S.P." is used to show the height above the foundation. A complete run of vertical bars is designated as a row.

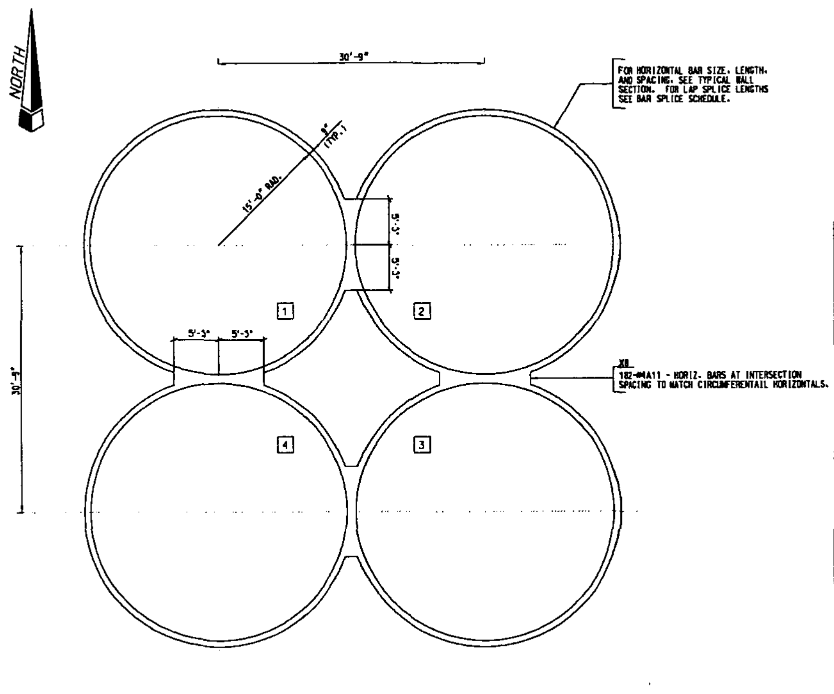
Probably the most difficult type of structure for which to prepare placing details is one consisting of interconnected circular walls (see Drawing SP-7B).

The usual practice is to show the main reinforcing bars both horizontally and vertically with a definite placing sequence. The engineer should carefully consider whether one or two layers of horizontal and vertical bars should be used. Additional drawings show reinforcing bars around or through openings, in keyways, pockets, and chases. In the case of a single circular structure such as a lowering tower or nuclear reactor shield wall, it is often simpler to show the wall as a revolved elevation and prepare supplemental drawings, if necessary, to show other details. In a circular wall, the horizontal radius-bent bars should be placed outside the jack rods when there is only one layer of horizontal bars.

A square or rectangular structure with interior cross walls (see Drawing SP-7A) presents special problems in detailing the reinforcement because of numerous openings, inserts, box-outs, chases, and weld plates. The common practice is to prepare a set of wall elevation drawings to show exterior walls as sectional elevations with a small key plan on each drawing to locate the elevation in the structure. Before dimensions are placed on these drawings, a set of reproducible prints is made for use in preparing the reinforcing placement drawings.

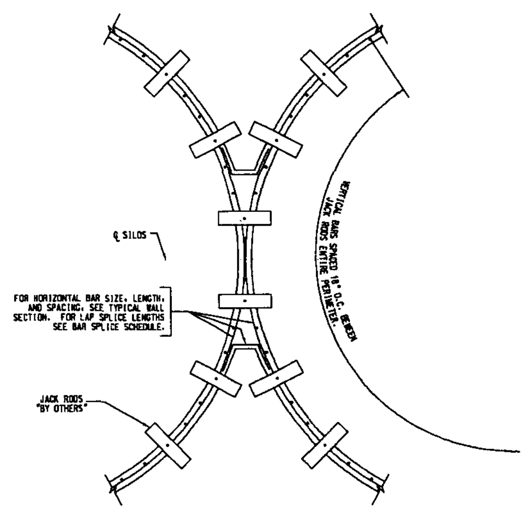
The exterior wall elevations should be shown from the inside looking out because the work deck, where all the bar placement operations occur, only covers the interior of the structure. This perspective allows the placers to see the wall elevation drawn from the same side that the placement will occur. When detailing bar placement on interior walls, the terms near face (NF) and far face (FF) should be used to designate location of bars rather than inside and outside face. Column ties, unless the vertical bars and ties are preassembled in cages and lifted into place as units, should be detailed as two pieces with lap splices.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



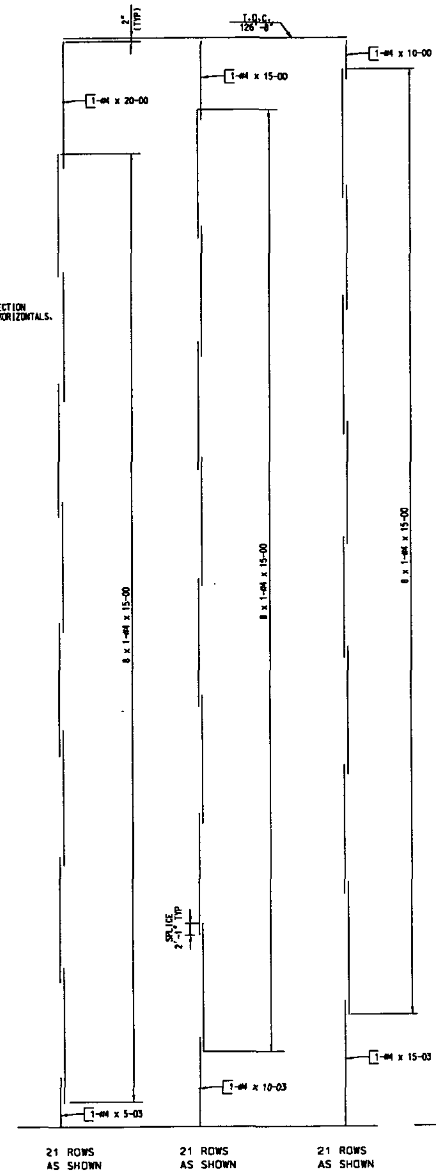
PLAN-HORIZONTAL BAR ARRANGEMENT

SCALE: 3/16"=1'-0"



WALL INTERSECTION DETAIL

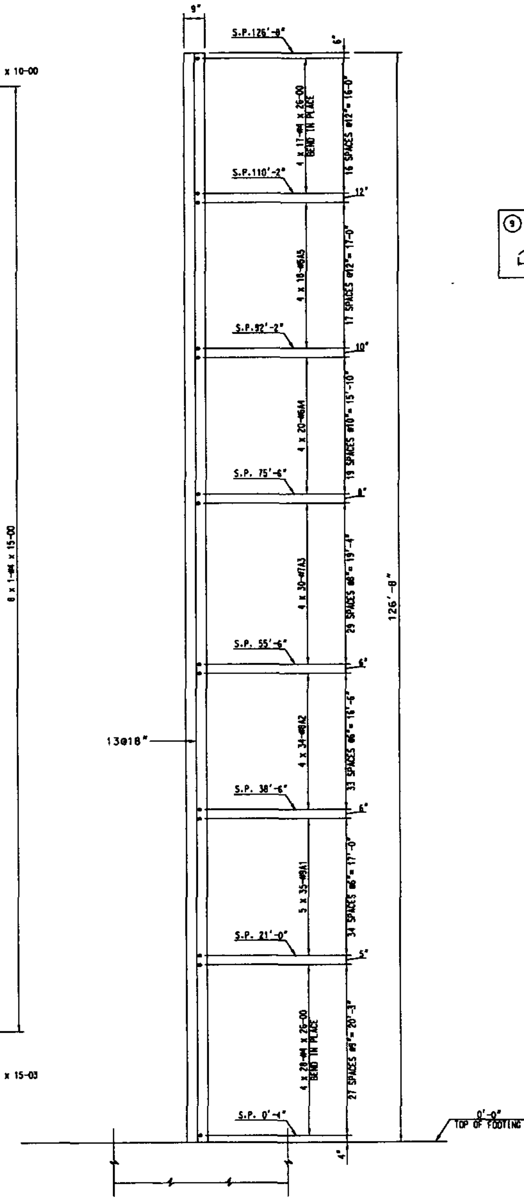
SCALE 1/4"=1'-0"



VERTICAL BAR ARRANGEMENT

x4 SILOS

SCALE: N.T.S.



HORIZONAL BARS

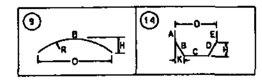
TYPICAL WALL SECTION

x4 SILOS

SCALE: HORIZ. 3/8"=1'-0" VERT. 8"=1'-0"

BENDING DETAILS

MARK	No.	SIZE	LENGTH	TYPE	A	B	C	D	E	H	K	O	R
9A1	700	#9	27-00	9		27-00				5-07		23-08	15-4½
8A2	544	#8	31-00	9		31-00				7-02		26-00	15-4½
7A3	480	#7	30-00	9		30-00				6-09		25-06	15-4½
6A4	320	#6	28-03	9		28-03				6-01		24-05	15-4½
5A5	288	#5	27-06	9		27-06				5-09		24-00	15-4½
4A11	1456	#4	5-10	14		2-01	1-08	2-01		1-11	0-09		



STRAIGHT BARS

No.	SIZE	LENGTH	No.	SIZE	LENGTH
720	#4	26-00			
84	#4	20-00			
84	#4	15-03			
2100	#4	15-00			
84	#4	10-03			
84	#4	10-00			
84	#4	5-03			

LAP SPLICE SCHEDULE

SIZE	HORIZONTAL	VERTICAL
#4	2'-08"	2'-1"
#5	3'-04"	———
#6	4'-00"	———
#7	5'-10"	———
#8	6'-08"	———
#9	7'-07"	———

GENERAL NOTES:

1. ALL REINFORCING BARS SHALL BE PER ASTM A615/A615M, GRADE 60.
2. SPECIFIED CONCRETE STRENGTH f'_c AT 28 DAYS IS 4000 PSI.
3. CONTINUOUS JACK RODS AT 6'-0" ± ON CENTER. CO-ORDINATE WORK WITH SLIPFORM CONTRACTOR.
4. ALL SPLICES TO BE STAGGERED. REFER TO SPLICE SCHEDULE FOR SPLICE LENGHTS.

REV	REVISION DESCRIPTION	DATE

ACME TERMINAL CO.

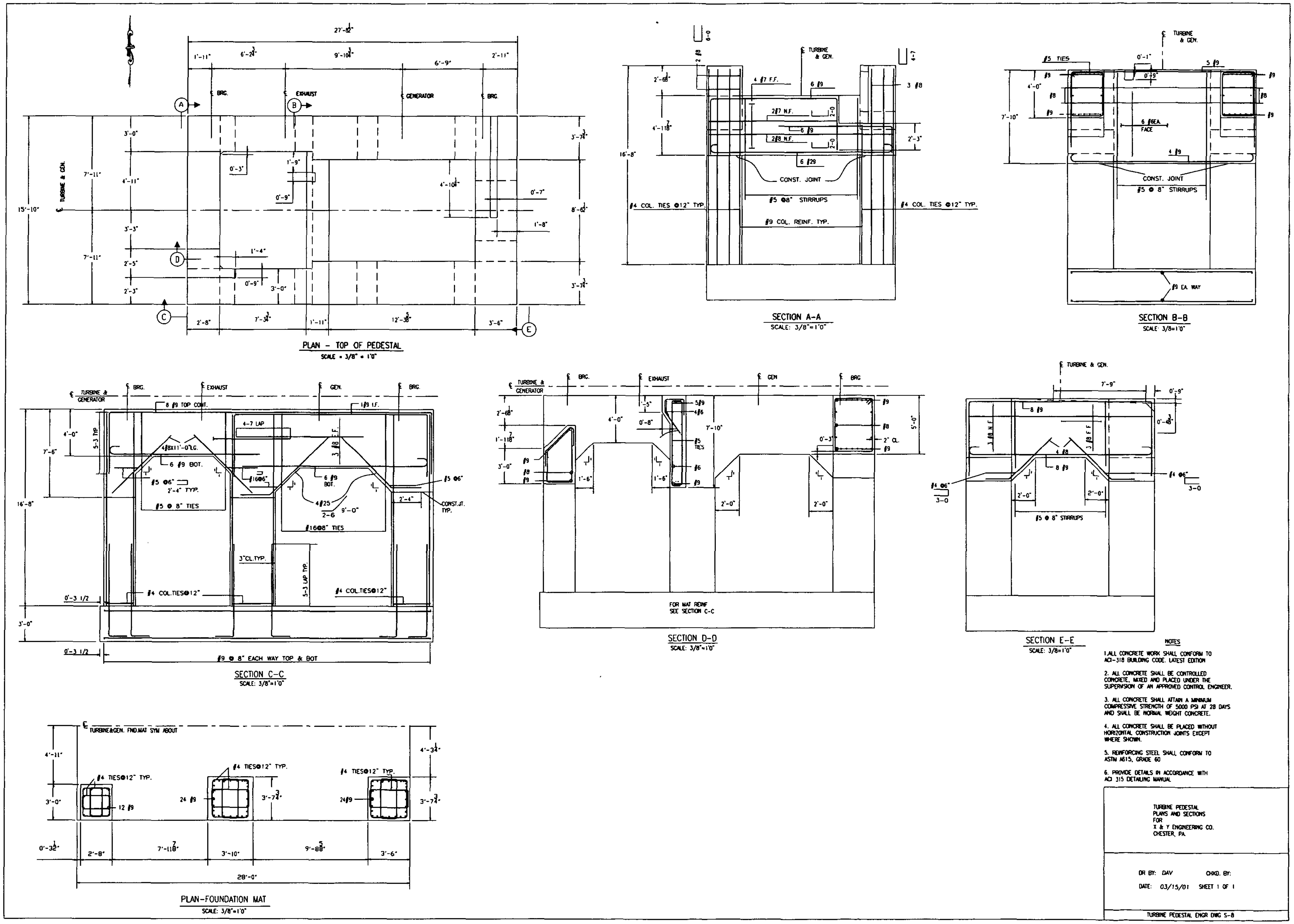
TITLE:	TYPICAL GRAIN SILO(ROUND)
DRAWN BY:	T.SHELTON
CHECKED BY:	ALF
APPROVED BY:	DLH
SCALE:	AS SHOWN
DRAWING NO: SP-7B	DATE: 03/15/01

DRAWING S-8—TURBINE PEDESTAL (STRUCTURAL DRAWING)

This drawing is for a small turbine-generator foundation in a non-seismic zone. The designer should pay close attention to all data shown on the manufacturer's outline drawing. Attention should also be given to the clearances required to prevent interference between turbine parts and the concrete foundation.

For clarity, anchor bars are not shown on this example but are required at times and can affect the location of the reinforcement.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



NOTES

1. ALL CONCRETE WORK SHALL CONFORM TO ACI-318 BUILDING CODE. LATEST EDITION

2. ALL CONCRETE SHALL BE CONTROLLED CONCRETE, MIXED AND PLACED UNDER THE SUPERVISION OF AN APPROVED CONTROL ENGINEER.

3. ALL CONCRETE SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 5000 PSI AT 28 DAYS AND SHALL BE NORMAL WEIGHT CONCRETE.

4. ALL CONCRETE SHALL BE PLACED WITHOUT HORIZONTAL CONSTRUCTION JOINTS EXCEPT WHERE SHOWN.

5. REINFORCING STEEL SHALL CONFORM TO ASTM A615, GRADE 60

6. PROVIDE DETAILS IN ACCORDANCE WITH ACI 315 DETAILING MANUAL

TURBINE PEDESTAL
PLANS AND SECTIONS
FOR
X & Y ENGINEERING CO.
CHESTER, PA

DR BY: DAV CHKD. BY:

DATE: 03/15/01 SHEET 1 OF 1

TURBINE PEDESTAL ENGR DWG S-8

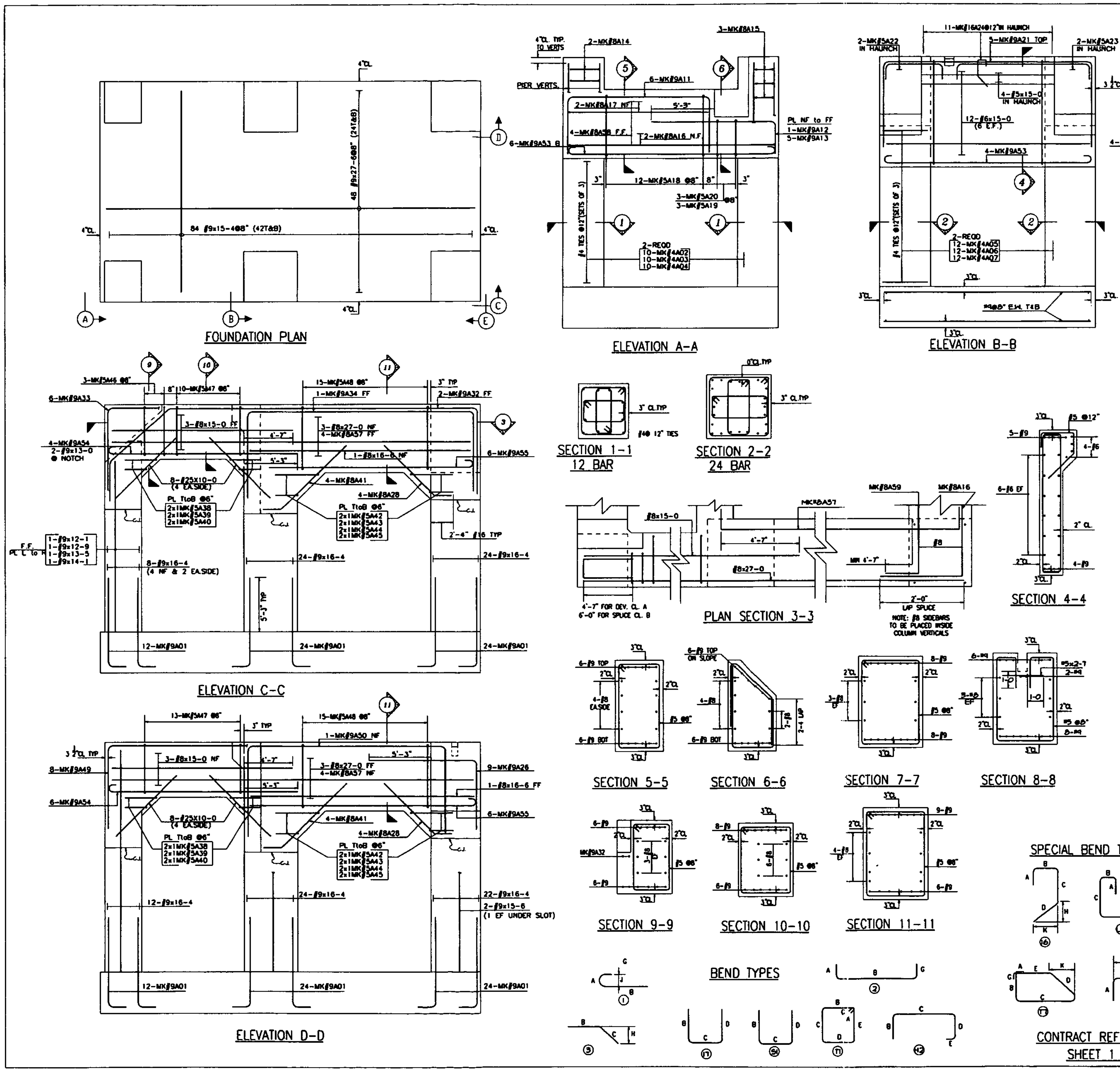
DRAWING P-8—TURBINE PEDESTAL (PLACING DRAWING)

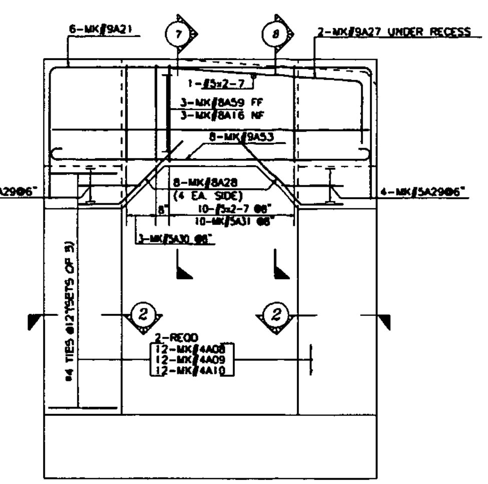
This drawing is an example of heavy construction. Due to the complexity of bar arrangement, the detailer drew complete elevations and cut sections through every member.

Where the beams change in size or are recessed or cut away, it is important to show the bar arrangement. For instance, the top of Elevation E-E shows a sloping trough that interrupts half the length of the beam. This required two of the top #29 bars to be bent below the trough and the beam stirrups to be arranged around the sloping recess.

Another unusual detail is shown in Elevation A-A. A portion of the beam has been cut away which, in turn, has caused a considerable rearrangement of beam bars and stirrups. See Sections 5-5 and 6-6.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.





ELEVATION E-E

MARK		SIZE	LGTH	TYPE	A	B	C	D	E	F	R	G	H	J	K	O
4A01		4	4-6	2	1-7	7-11										
4A02		4	10-1	T1	0-4-2	2-2	2-6	2-2	2-6			0-4-2				
4A03		4	7-5	T1	0-4-2	0-10-1	2-6	0-10-1	2-6			0-4-2				
4A04		4	6-11	T1	0-4-2	0-11-1	2-2	0-11-1	2-2			0-4-2				
4A05		4	13-8	T1	0-4-2	3-4	3-1-3	3-4	3-1-3			0-4-2				
4A06		4	9-6	T1	0-4-2	1-3	3-1-3	1-3	3-1-3			0-4-2				
4A07		4	9-9	T1	0-4-2	1-2-1	3-4	1-2-1	3-4			0-4-2				
4A08		4	13-0	T1	0-4-2	3-0	3-1-3	3-0	3-1-3			0-4-2				
4A09		4	9-4	T1	0-4-2	1-2	3-1-3	1-2	3-1-3			0-4-2				
4A10		4	9-1	T1	0-4-2	1-2-1	3-0	1-2-1	3-0			0-4-2				
9A11		9	21-3	H2		4-7	10-8	4-7								
9A12		9	12-3	17		2-6	9-9									
9A13		9	12-9	17		3-0	9-9									
8A14		8	14-2	17		6-0	2-2-2	6-0								
8A15		8	13-7	17		6-0	1-7-2	6-0								
8A16		8	27-0	17		6-0	15-0	6-0								
8A17		8	16-7	17		6-0	10-7									
5A18		5	13'2	T1	0-9	2-4	4-6	2-4	4-6			0-4				
5A19		5	9-6	S1		2-8	2-4	4-6								
5A20		5	7-11	T7			2-4	3-3-2	2-4						2-4	
9A21		9	25-4	17		5-3	15-3	5-3								
6A22		6	6-2	2	1-0	4-2						1-0				
6A23		6	11-4	2	1-0	9-9						1-0				
5A24		5	5-7	16	0-10	1-7	1-2	2-0					1-5		1-5	
9A26		9	13-9	17		5-3	6-6									
9A27		9	25-2	H1	5-3	5-7-2	9-0-2					5-3	0-5-3		9-0	14-7-2
8A28		8	9-6	3		7-0	2-6						2-1-2			
4A29		4	9-0	S1		3-0	3-0	3-0								
5A30		5	16-4	T1	0-5-2	3-2	4-6	3-2	4-6			0-5-2				
5A31		5	16-11	L2	1-3	0-11	4-6	3-2	4-6	1-4		1-3				
9A32		9	37-0	H1	5-3	22-9	6-2-2					2-10	4-4-2		4-4-2	27-1-2
9A33		9	37-7	17		5-3	27-1-2	5-3								
9A34		9	26-11	17		5-3	16-5-2	5-3								
5A38		5	9-2	S1		3-4	2-6	3-4								
5A39		5	8-2	S1		2-10	2-6	2-10								
5A40		5	7-2	S1		2-4	2-6	2-4								
8A41		8	9-6	5		7-0	2-6						1-9-1			
5A42		5	11-0	S1		3-11	3-1-3	3-11								
5A43		5	10-0	S1		3-5	3-1-3	3-5								
5A44		5	9-0	S1		2-10	3-1-3	2-10								
5A45		5	8-0	S1		2-5	3-1-3	2-5								
5A46		5	11-9	T1	0-5-2	1-11	3-6	1-11	3-6			0-5-2				
5A47		5	13-3	T1	0-5-2	2-8	3-6	2-8	3-6			0-5-2				
5A48		5	16-6	T1	0-5-2	3-3-3	4-6	3-3-3	4-6			0-5-2				
9A49		9	35-5	17		5-3	24-11	5-3								
9A50		9	24-9	17		5-3	14-3	5-3								
9A53		9	17-6	1	1-3	15-0						1-3				
9A54		9	17-0	1	1-3	15-9										
9A55		9	17-8	1	1-3	16-5										
8A57		8	18-11	2	1-4	16-3						1-4				
8A58		8	20-8	17		2-10	15-0	2-10								
8A59		8	17-8	2	1-4	15-0						1-4				

REINFORCING STEEL PLACING DRAWING
REINF.BARS-ASTM A615, GRADE-60
USE THIS DRAWING IN CONJUCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS.
ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR

SPECIAL BEND TYPES

CONTRACT REFERENCE DWG.
SHEET 1 of 1

		5-22-00	APPROVAL
DATE	DESCRIPTION	DATE	SENT FOR

ACE STEEL COMPANY

PROJECT	ABC NUCLEAR ENERGY PLANT
LOCATION	GARDNER MA.
ARCHITECT	J. M. SMITH
ENGINEER	X & Y ENGINEERING CO.
CUSTOMER	WOOD CONST. CO.
MADE BY HRM DATE 5-22-00	CONTRACT NO. 9-1234
TURBINE PEDESTAL PLACING DWG.	DRAWING NO. P-8

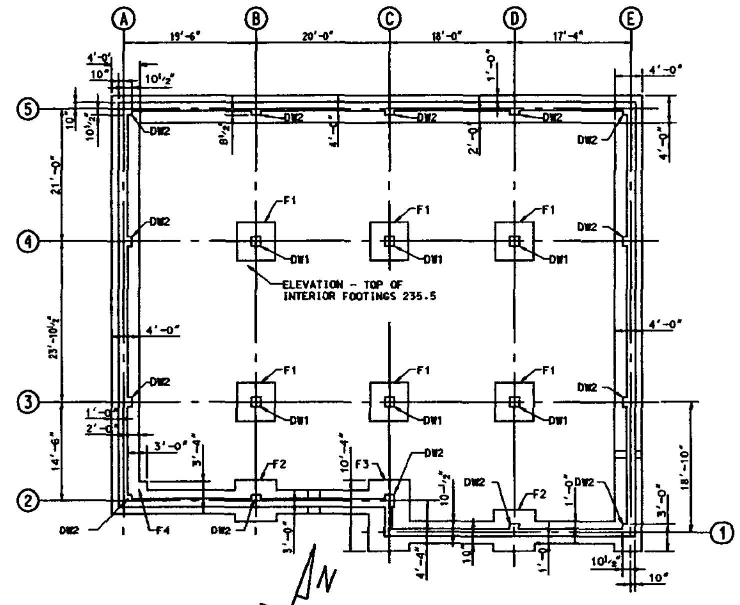
DRAWING S-9—FOUNDATIONS—CAD GENERATED (STRUCTURAL DRAWING)

This example represents a complete foundation of a small structure, drawn using a CAD program, which includes individual column footings; continuous wall footings; a retaining wall; a few piers which were added for illustrative purposes; and short columns. Piers that are part of a wall are set back to provide for a brick ledge; and for uniformity, this dimensioning applies to the south wall even though it does not have a brick ledge.

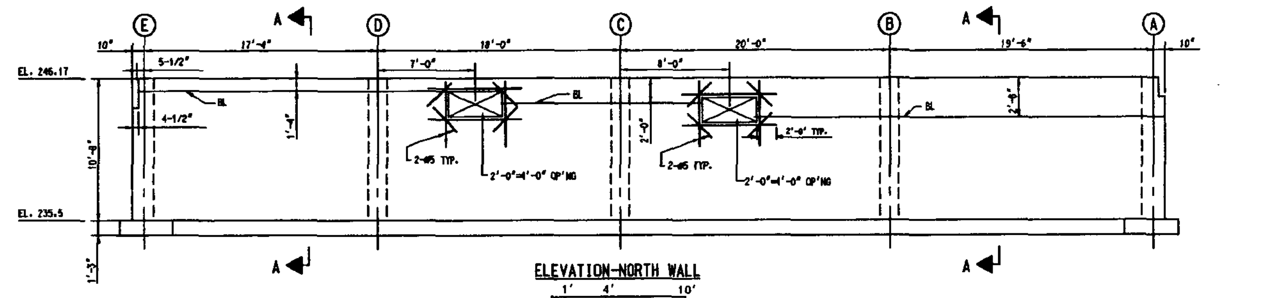
On an actual structural drawing there would be additional architectural information that has been omitted here for simplicity.

ACI 318 splice provisions require that the engineer be very definitive. In this example, the engineer has indicated the lap splice length for the vertical bars in the various sections and has covered the horizontal bars in Note 5. These splice lengths are more conservative than ACI 318 minimum requirements, but this is the engineer's prerogative. The engineer has similarly handled the development of the footing bars in Note 6.

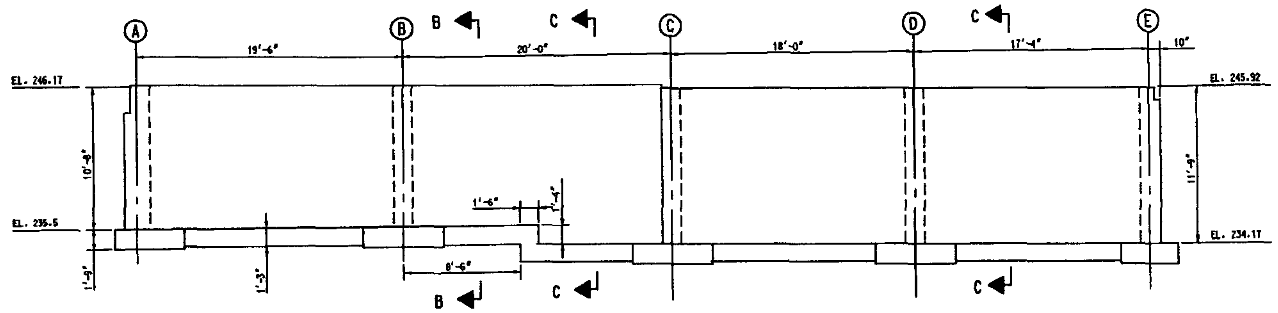
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



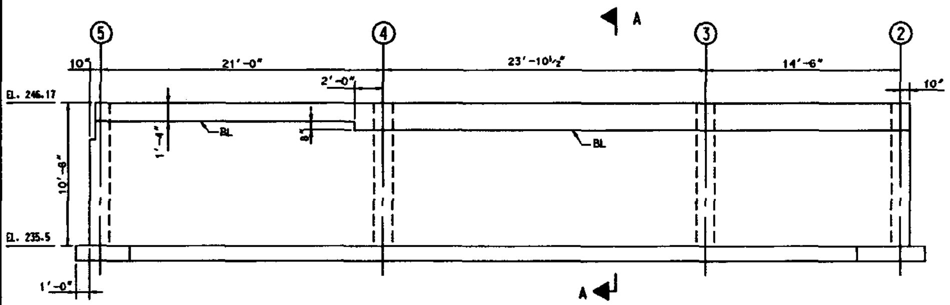
FOUNDATION PLAN



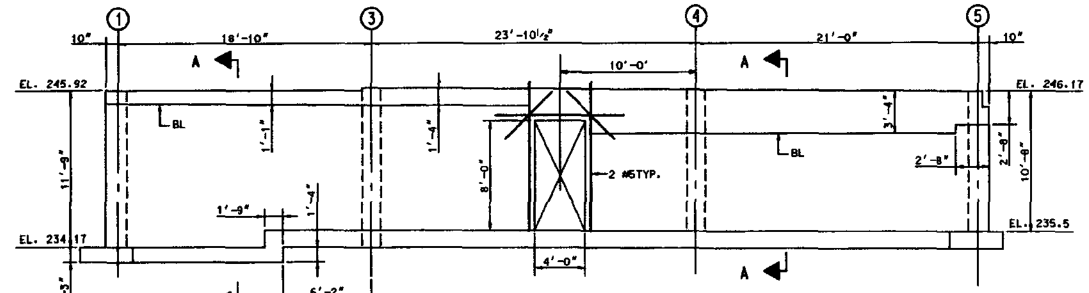
ELEVATION-NORTH WALL



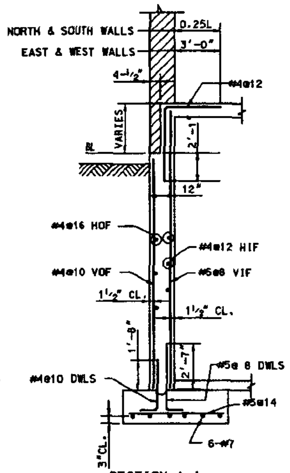
ELEVATION-SOUTH WALL



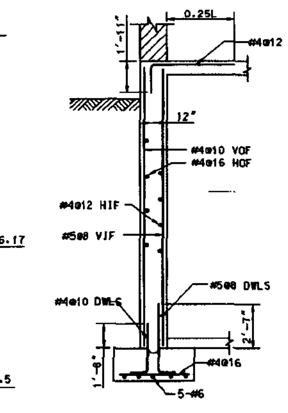
ELEVATION-WEST WALL



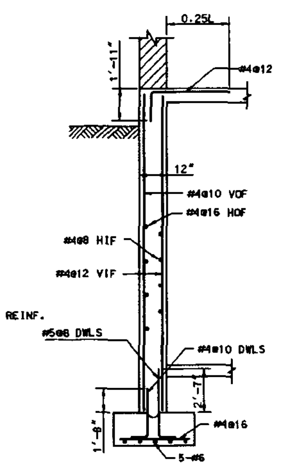
ELEVATION-EAST WALL



SECTION A-A



SECTION B-B



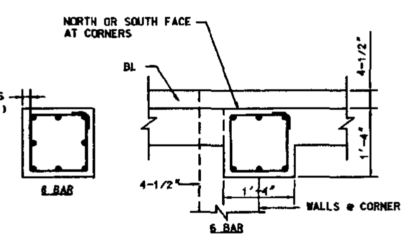
SECTION C-C

PIER DOWEL SCHEDULE			
MARK	SIZE	VERTICAL	TIES
DW1	16x16	8-#8	#3@12
DW2	16x16	6-#6	#3@12

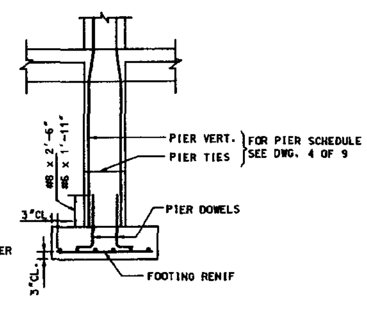
FOOTING SCHEDULE		
MARK	SIZE	REINF.
F1	5'-0" x 5'-0" x 1'-9"	16-#6 ½ EW
F2	6'-0" x 6'-0" x 1'-9"	18-#6 ½ EW
F3	6'-0" x 10'-4" x 1'-9"	10-#7 SW 11-#6 SW
F4	5'-0" x 5'-4" x 1'-9"	16-#5 ½ EW

NOTES

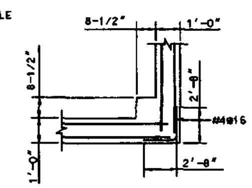
1. f'c 4000 psi AT 28 DAYS: MAXIMUM AGGREGATE SIZE = ¾"
2. REINFORCING STEEL TO BE ASTM A615 GRADE-60
3. PROVIDE DETAILS IN ACCORDANCE ACI-315 DETAILING MANUAL
4. DESIGN LIVE LOAD——PSF
5. LAP ALL HORIZONTAL BARS AS FOLLOWS
   FOOTINGS { #7=4'-6", #6=3'-1", #5=2'-5", #4=2'-1" }   WALLS { #7=5'-10", #6=4'-0", #5=3'-4", #4=2'-8" }
6. DEVELOP WALL FOOTING REINFORCEMENT INTO COLUMN FOOTINGS AS FOLLOWS:
   #7= 2'-9"
   #6= 2'-4"
   #5= 1'-11"
7. HIF= HORIZONTAL INSIDE FACE
   HOF= HORIZONTAL OUTSIDE FACE
   VIF= VERTICAL INSIDE FACE
   VOF= VERTICAL OUTSIDE FACE
   EW = EACH WAY
   SW = SHORT WAY
   LW = LONG WAY
   BL = BRICK LEDGE



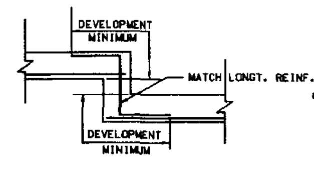
PIER TIE ARRANGEMENT



TYPICAL FOOTING & PIER



TYPICAL CORNER DETAIL



TYPICAL FOOTING STEP

PROJECT BARCLAY BUILDING FOR FOUNTAIN HILL ASSOCIATES
LOCATION GLENSIDE, NJ
CONTRACTOR
TITLE FOUNDATION
ARCHITECT ENGINEER E. ULSTER CLEVELAND, OHIO
REVISIONS BY DATE
DWN. BY DAG
DATE 12-MAR-01
JOB NO.
DWN. NO. S-9

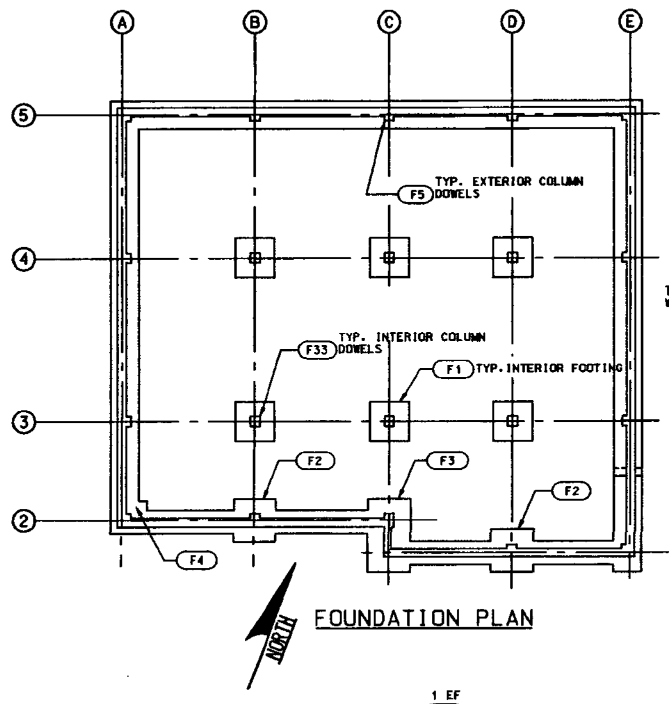
DRAWING P-9—FOUNDATIONS—CAD GENERATED (PLACING DRAWING)

This placing drawing differs from a manually prepared drawing in that each item is identified by use of a mark, or as it is called, a "label" (enclosed in an oval). The "label list," which is produced by CAD software, calls out the material within each label. This may be an individual item, such as for F17, or a whole series of items, such as with F8. The label list gives the quantity, size, and length or mark of the bars plus spacing when appropriate.

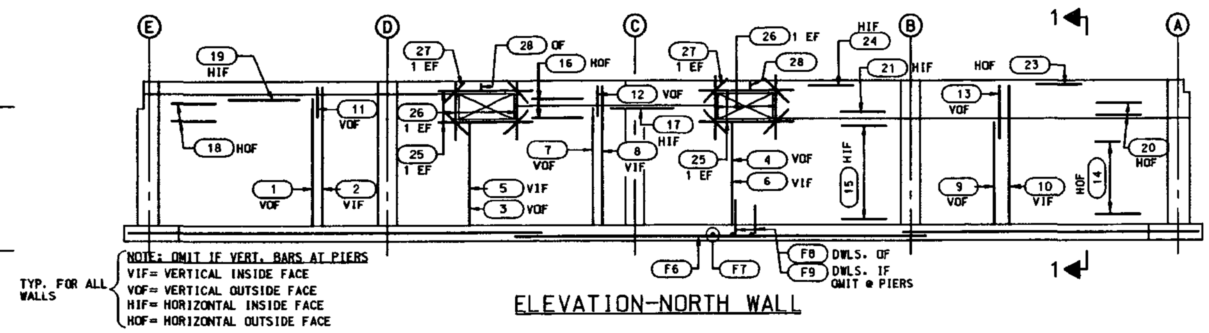
The CAD software calculates the quantity and length of bars and bending details, and assigns marks, printing the bending details schedule. The CAD software calculates long runs of bars such as in Labels 73 and 74. The detailer enters the concrete wall dimensions, size, spacing, and lap of the bars, and the software calculates the number of runs (11) and that there is one bar 30 ft 0 in. plus one bar 33 ft 5 in. in each run.

In this example, the detailer elected to show the column footings and column reinforcing bar details on the plan. On a larger, more complicated structure, a schedule would probably have been used.

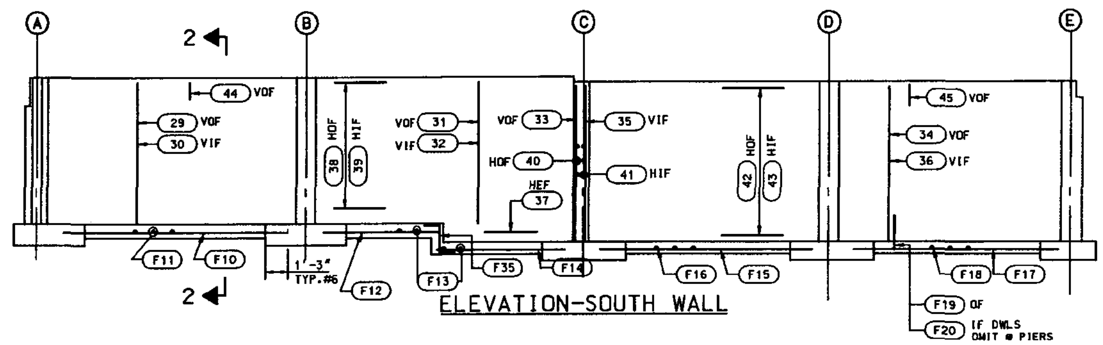
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



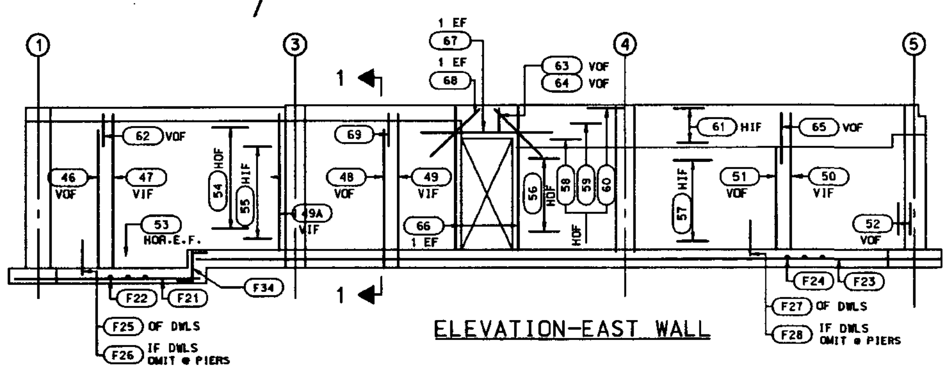
FOUNDATION PLAN



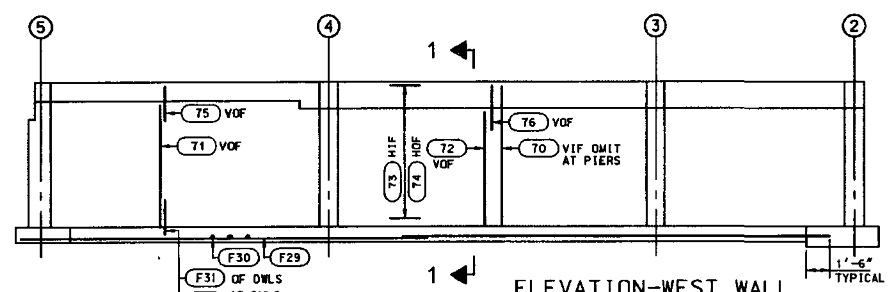
ELEVATION-NORTH WALL



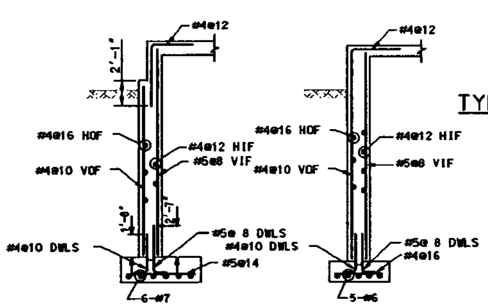
ELEVATION-SOUTH WALL



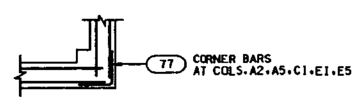
ELEVATION-EAST WALL



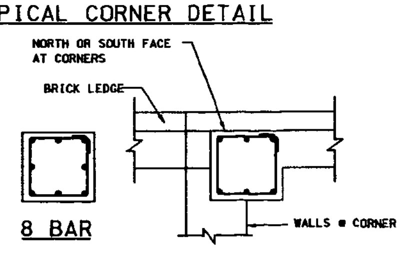
ELEVATION-WEST WALL



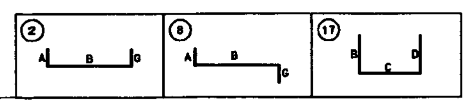
SECTION 1-1 SECTION 2-2



TYPICAL CORNER DETAIL



PIER TIE ARRANGEMENT



SZ	SW CI	BAR MARK	V	BND TYP	C D	A	B	C	D	E	E/R	G	H	J	K	O
#4		4A1		17			5-8	3-4								
#4		4A2		17			5-8	4-0								
#4		4A3		17			5-8	4-8								
#4		4A4		17			5-8	1-1								
#4		4A5		17			4-3½	1-11								
#4		4A6		17			5-4½	1-11								
#4		4A7		17			3-6	3-1								
#4		4A8		17			3-6	2-5								
#4		4A9		17			3-6	5-4								
#4		4A10		17			3-6	3-4								
#4		4A11		17			3-6	4-0								
#4		4A12		2			2-8	2-8								
#4		4A14		2		0-8	2-8									
#5		5A1		2		0-10	3-7									
#6		6A1		2		1-0	3-5									
#6		6A2		8		1-4	2-0¼					1-4				
#7		7A1		8		1-9	2-0¼					1-9				
#8		8A1		2		1-4	4-0									

NOTE:- FOR COLUMN SCHEDULE SEE ABC STEEL CO. DWG. P-11

SECT.- PIER/FTG 1 REQD.

	QTY.SZ. LNG/MRK	REMARKS
F1	6x 16 #6 x 4-6	8EW
F2	2x 18 #6 x 5-6	9EW
F3	10 #7 x 5-6	SW
F3	11 #6 x 9-10	LW
F4	8 #5 X 4-10	LW
F4	8 #5 X 4-6	SW
F5	6x 14 #6 6A1	
F6	2X 6 #7 x 30-0	6 RUNS
F6	6 #7 x 27-0	LAP 4-6
F7	61 #5 x 3-6	@14"
F8	91 #4 4A14	@10"
F9	106 #5 5A1	@8"
F10	5 #6 x 15-10	
F11	10 #4 x 2-6	@16"
F12	5 #6 x 8-0	
F13	12 #4 x 2-6	@16"
F14	5 #6 x 9-6	
F15	5 #6 x 14-6	
F16	9 #4 x 2-6	@16"
F17	5 #6 x 14-8	
F18	9 #4 x 2-6	@16"
F19	97 #4 4A14	@10"
F20	111 #5 5A1	@8"
F21	6 #7 x 14-8	
F22	13 #5 x 3-6	@14"
F23	6 #7 x 30-0	6 RUNS
F23	6 #7 x 28-11	LAP 4-6
F24	44 #5 x 3-6	@14"
F25	38 #4 4A14	@10"
F26	42 #5 5A1	@8"
F27	35 #4 4A14	@10"
F28	42 #5 5A1	@8"
F29	6 #7 x 30-0	6 RUNS
F29	6 #7 x 33-8	LAP 4-6
F30	46 #5 x 3-6	@14"
F31	72 #4 4A14	@10"
F32	83 #5 5A1	@8"
F33	8X 6 #8 8A1	
F34	6 #7 7A1	@ FOOTING STEP
F35	5 #6 6A2	@ FOOTING STEP

ELEV: NORTH WL. 1 REQD.

	QTY.SZ.LNG/MRK	REMARKS
1	27 #4 x 9-2	@10"
2	32 #5 x 10-6	@8"
3	5 #4 x 7-2	@10"
4	5 #4 x 7-2	@10"
5	6 #5 x 7-2	@8"
6	6 #5 x 7-2	@8"
7	18 #4 x 8-6	@10"
8	21 #5 x 10-6	@8"
9	36 #4 x 7-10	@10"
10	41 #5 x 10-6	@8"
11	21 #4 4A1	@12"
12	14 #4 4A2	@12"
13	28 #4 4A3	@12"
14	2x 5 #4 x 30-0	5 RUNS @16"
14	5 #4 x 21-6	LAP 2-8
15	2x 8 #4 x 30-0	8 RUNS @12
15	8 #4 x 21-6	LAP 2-8
16	2 #4 x 14-8	@16"
17	2 #4 x 14-8	@12"
18	2 #4 x 22-6	
19	2 #4 x 22-6	
20	2 #4 x 29-8	@16"
21	2 #4 x 29-8	@12"
22	1 #4 x 22-10	@16"
23	2x 1 #4 x 30-0	1 RUNS @16"
23	1 #4 x 20-9	LAP 2-8
24	1 #4 x 30-0	2 RUNS @12"
24	1 #4 x 20-9	LAP 2-8
25	2X 4 #5 x 8-0	2 TOP & BOT
26	2x 4 #5 x 5-2	2 VERT EA. SIDE
27	4x 4 #5 x 4-0	2 DIAG. EA CORNER
28	3x 2 #4 4A4	@12"

ELEV: SOUTH WL. 1 REQD.

	QTY.SZ.LNG/MRK	REMARKS
29	36 #4 x 10-6	@10"
30	41 #5 x 10-6	@8"
31	11 #4 x 11-10	@10"
32	14 #5 x 11-10	@8"
33	6 #4 x 11-7	@10"
34	44 #4 x 11-7	@10"
35	6 #5 x 11-7	@8"
36	50 #5 x 11-7	@8"
37	2 #4 x 9-10	
38	8 #4 x 30-0	8 RUNS 16"
38	8 #4 x 12-10	LAP 2-8
39	11 #4 x 30-0	11 RUNS @12"
39	11 #4 x 12-10	LAP 2-8
40	9 #4 x 5-0	@16"
41	12 #4 x 5-0	@12"
42	9 #4 x 30-0	9 RUNS @16"
42	9 #4 x 9-6	LAP 2-8
43	12 #4 x 30-0	12 RUNS @12"
43	12 #4 x 9-6	LAP 2-8
44	39 #4 4A5	@12"
45	34 #4 4A6	@12"

ELEV: EAST WL. 1 REQD.

	QTY.SZ.LNG/MRK	REMARKS
46	14 #4 x 10-6	@10"
47	15 #5 x 11-7	@8"
48	24 #4 x 9-2	@10"
49	16 #5 x 10-6	@8"
49A	11 #5 x 10-3	
50	42 #5 x 10-6	@8"
51	32 #4 x 7-2	@10"
52	2 #4 x 7-10	@10"
53	2 #4 x 11-5	
54	7 #4 x 31-2	@16"
55	8 #4 x 31-2	@12"
56	6 #4 x 29-6	@16"
57	8 #4 x 29-6	@12"
58	1 #4 x 26-10	@16"
59	1 #4 x 33-6	@16"
60	1 #4 x 30-0	1 RUNS @16"
60	1 #4 x 10-1	LAP 2-8
61	3 #4 x 30-0	3 RUNS @12"
61	3 #4 x 10-5	LAP 2-8
62	17 #4 4A7	@12"
63	4 #4 4A8	@12"
64	4 #4 x 2-5	@12"
65	28 #4 4A9	@12"
66	2X 2 #5 x 10-6	2 VERT EA. SIDE
67	2 #5 x 8-0	2 TOP & BOT
68	2X 2 #5 x 4-0	2 DIAG. EA CORNER
69	11 #4 4A10	@12"

ELEV: WEST WL. 1 REQD.

	QTY.SZ.LNG/MRK	REMARKS
70	83 #5 x 10-6	@8"
71	23 #4 x 9-2	@10"
72	49 #4 x 8-6	@10"
73	11 #4 x 30-0	11 RUNS @12"
73	11 #4 x 33-5	LAP 2-8
74	8 #4 x 30-0	8 RUNS @16"
74	8 #4 x 33-5	LAP 2-8
75	18 #4 4A10	@12"
76	37 #4 4A11	@12"
77	42 #4 4A12	@16"

ALL REINFORCING BARS TO BE A615 GRADE 60

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS

ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR.

REV. NO.	DATE	DESCRIPTION

ABC STEEL COMPANY

DWG. COVERS: FOOTINGS, FOUNDATION & WALLS
JOB: BARCLAY BUILDING
LOCATION: GLENSIDE, NJ
ENGINEER: E. ULSTER
CONTRACTOR: KINGSTON CONST. CO.

DATE: 15-MAR-01	DWG. BY BW	FILE NO.
REV.	CHK. BY	DWG. NO. P-9

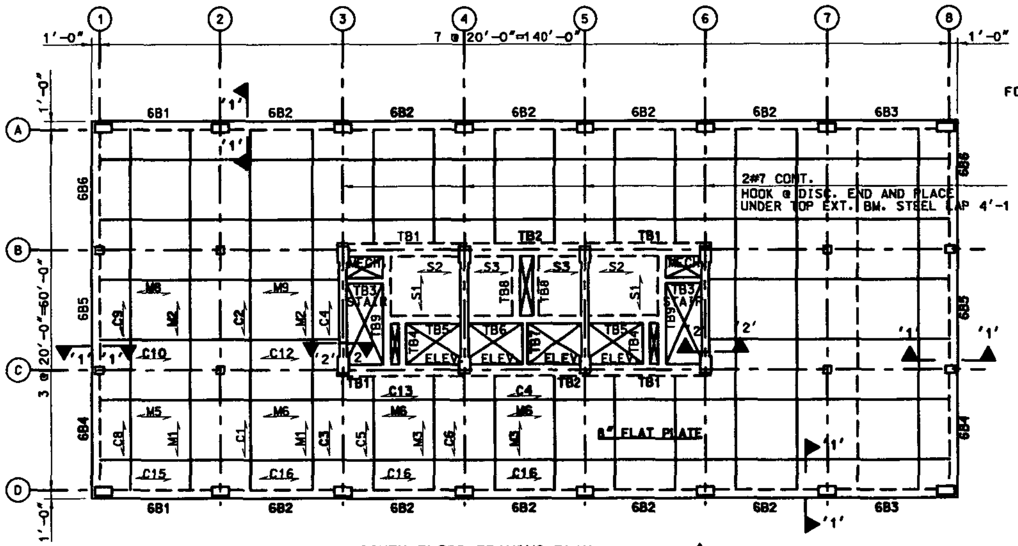
DRAWING S-10—SEISMIC FRAME BEAMS, FLAT PLATE FLOOR (STRUCTURAL DRAWING)

Seismic frame beams and columns require special design and detailing considerations. Special provisions for seismic detailing are defined by Chapter 21 of the ACI 318 Building Code Requirements and are illustrated by this drawing. The reinforcement for the seismic frame beams is shown in schedule format including a sketch that shows the bar extensions and embedments of the longitudinal reinforcing. The sketches in the schedule, Section 1-1, and the tie and hoop hook detail conform to Fig. 5 of the 315 Standard. Note 2 states that the longitudinal bars shall conform to ASTM A 706 to meet the ductility requirements of the code.

The column details shown by sectional plan and elevation also illustrate the requirements of the code and follow the typical seismic column details of Fig. 6 of the 315 Standard.

The interior beams, TB1 through TB8; the core slabs Sl, S2, and S3; and the 8 in. flat plate slab reinforcement are not shown by this structural drawing because the manner of presentation and scheduling are illustrated elsewhere in this manual.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



SIXTH FLOOR FRAMING PLAN
SCALE: 1/8"=1'-0"

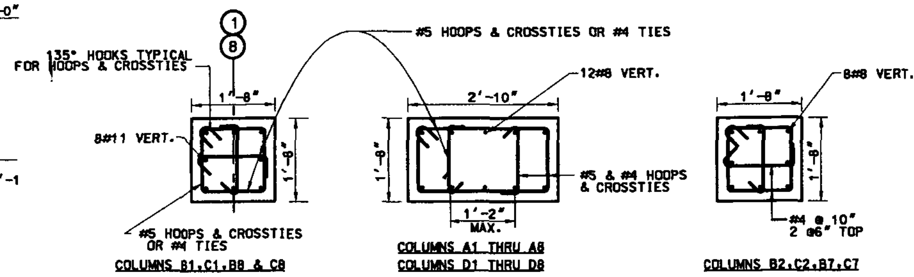
NOTE: SEE SHEET 12 OF 21 FOR COLUMN SCHEDULE, FLAT PLATE SCHEDULE, AND INTERIOR BEAM SCHEDULE.

SEISMIC FRAME-BEAM SCHEDULE (6TH FLOOR)

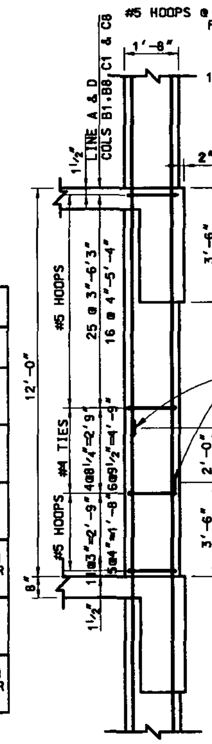
MARK	SIZE		BOTTOM BARS		TOP BARS		STIRRUP TIES			SKETCH	REMARKS
	WIDTH	DEPTH	NO. & SIZE	REMARKS	NO.& SIZE	REMARKS	NO.SIZE	TYPE	SPACING E.E.	COL. — COL.	
6B1	17	42	3#7 3#7	F.L. HK @ LINE '1' SHORT, HK @ LN.'1'	3#8 2#8	F.L. HK @ LINE '1' SHORT, HK @ LN.'1'	#4		2", 11 @7", BAL @15" o/c	7'-9" 7'-9" 5'-11" 5'-11"	
6B2	17	42	3#7	FULL LENGTH EXTEND PAST COLS. EA. END	3#8	FULL LENGTH EXTEND PAST COLS. EA. END	#4		2", 11 @ 7", BAL @15" o/c	7'-9" 7'-9" 5'-11" 5'-11"	
6B3	17	42	3#7 3#7	F.L. HK @ LINE '8' SHORT, HK @ LN.'8'	3#8 2#8	F.L. HK @ LINE '8' SHORT, HK @ LN.'8'	#4		2", 11 @7", BAL @15" o/c	7'-9" 7'-9" 5'-11" 5'-11"	
6B4	17	42	3#8	CONTINUOUS HK @ LN. 'D'	3#8	CONTINUOUS HK @ LN. 'D'	#4		2", 10 @8", BAL @15" o/c	12'-2" 4'-6"	TOP & BOTTOM BARS 3" CLEAR AT 'D'
6B5	17	42	3#8	CONTINUOUS	——	FROM ADJ. SPANS	#4		2".BAL @4" o/c	6'-0"	TOP BARS FROM ADJ. SPANS.
6B6	17	42	3#8	CONTINUOUS HK @ LN. 'A'	3#8	CONTINUOUS HK @ LN. 'A'	#4		2", 10 @8", BAL @15" o/c	12'-2" 4'-6"	TOP & BOTTOM BARS 3" CLEAR AT 'A'

NOTES:

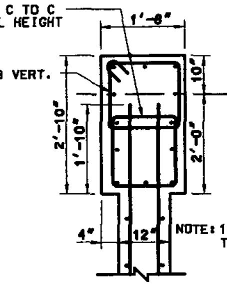
1. ALL CONCRETE TO BE f'c=5000 psi
2. REINF. BARS ASTM A706 SHALL BE USED FOR LONGITUDINAL BARS IN DUCTILE PERIMETER FRAMES AND COLUMN VERTICALS. ALL OTHER REINFORCING SHALL CONFORM TO ASTM A615-GRADE 60
3. UNFACTORED FLOOR LIVE LOAD 80 PSF.
4. THE SEISMIC FORCE RESISTING SYSTEM IN THE EAST-WEST DIRECTION CONSISTS OF THE DUCTILE PERIMETER FRAMES ON COLUMN LINES 'A' & 'D'.
5. THE SEISMIC FORCE RESISTING SYSTEM IN THE NORTH-SOUTH DIRECTION CONSISTS OF THE SPECIAL SHEAR WALLS ON COLUMN LINES 3, 4, 5 AND 6 AND THE DUCTILE PERIMETER FRAME ON COLUMN LINES 1 AND 8.
6. ALL DETAILING, FABRICATION AND PLACING OF REINFORCING BARS, SHALL CONFORM TO THE LATEST EDITION OF ACI 315.



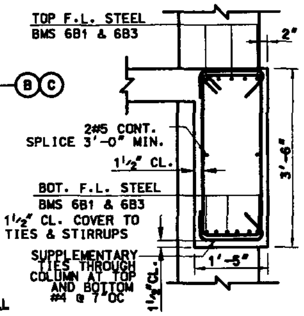
NOTE: 1½ IN. CLEAR COVER TO HOOPS AND TIES OF COLUMNS ALTERNATE LOCATION VERTICALLY OF CROSSTIE 90° HOOKS



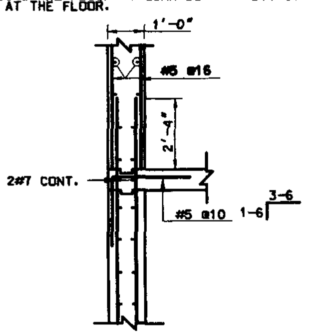
TYP. EXTERIOR COLUMN
SEISMIC DETAILS



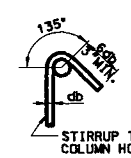
TYP. COL. & SHEAR WALL SEISMIC DETAILS ON LINES 3, 4, 5 & 6

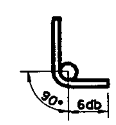


SECT. 1-1



SECT. 2-2
WALL- LINE 3 & 4





TYP. TIE & STIRRUP HOOK DETAILS
AT SUPPLIMENTARY TIES

REV. NO.	DATE
DESCRIPTION	

MULLIN & JAMES-ENGINEERS
MAIN STREET, USA

JOB	OFFICE BUILDING FOR TRITON INDUSTRIES
LOCATION	YOURTOWN, USA
TITLE	6TH FLOOR FRAMING PLAN
DRAWN BY	K.W.
DATE	03/14/01
CHECKED BY	J.T.
JOB NO.	03142001
SHEET	S-10

DRAWING P-10—SEISMIC FRAME BEAMS, FLAT PLATE FLOOR (PLACING DRAWING)

The detailer has elected to follow the scheduling format used by the engineer and has redrawn the plan view so the placer can locate the scheduled beams. The schedule has been expanded to include the beam horizontal bars shown by Section 1-1 and also the bar supports required for proper clearance of the reinforcement. The notes, in conjunction with the sketch, clearly inform the placer where to place the bars.

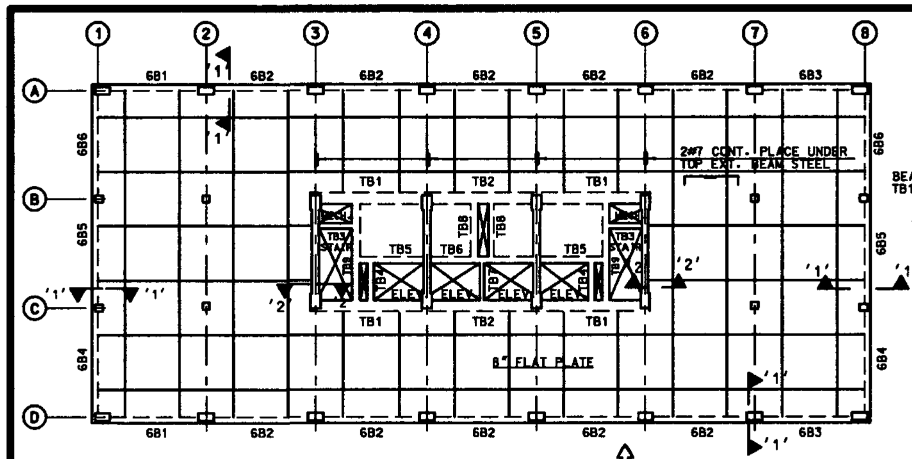
The building code requirements for stirrup spacing are illustrated in the beam schedule. The engineer has eliminated all lap splices in the longitudinal main reinforcement in frame beams 6B1, 6B2, and 6B3—referring to Fig. 5 of the 315 Standard, elimination of the lap splices eliminates the necessity of conforming to the maximum hoop spacing requirements of $d/4$ or greater than 4 in. This requirement could not be avoided in the north-south frame beams 6B4, 6B5, and 6B6, where the #25 top bars were lap spliced at the midpoint of 6B5 and the #25 bottom bar splices were placed at the column face, thus necessitating a hoop spacing of 4 in. on center throughout the beam span.

The column reinforcement is shown on this drawing by a series of elevations to illustrate the care needed to properly detail the reinforcement for a seismic frame column. Generally, the verticals, hoops, and ties of a seismic frame column can be scheduled similar to that shown for Building B on Drawing P-2, except that the hoop and tie spacing would be segregated into three zones: "A," "B," and "C."

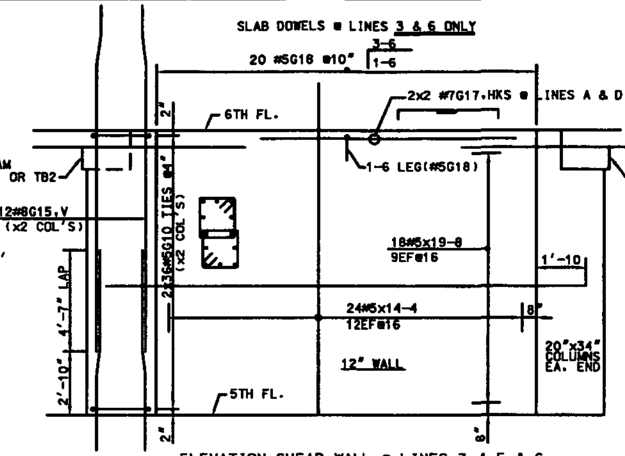
The elevations also illustrate the details necessary to ensure that the splice location is placed within the center half of the clear column height. The splice location for the columns at each end of the shearwall are at a different point from the exterior column splice point because the interior beams are not as deep as the exterior spandrel beams.

No details for the interior beams, core slabs, or flat plate slabs are illustrated by this drawing. Refer to other drawings in this manual for those detailing requirements.

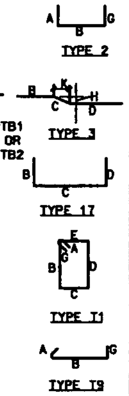
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



SIXTH FLOOR FRAMING PLAN



ELEVATION-SHEAR WALL @ LINES 3,4,5 & 6
4 REQ'D EXCEPT AS NOTED.

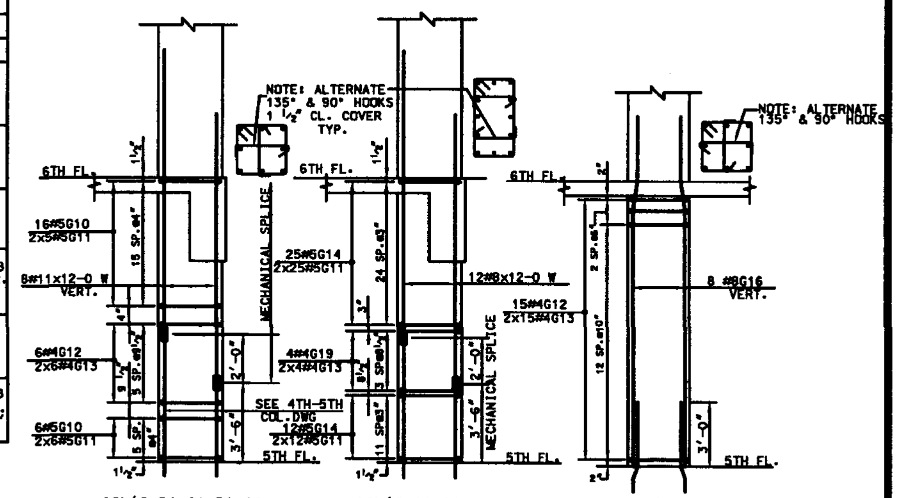


BENDING DETAILS
STANDARD ACI BENDING TYPES

MARK	SIZE	LENGTH	TYPE	A	B	C	D	E	F/R	G	H	J	K	O
7G1	#7	29-4	2	1-2	28-2					—				
7G2	#7	9-9	2	1-2	8-7					—				
8G4	#8	31-4	2	1-4	30-0					—				
8G5	#8	11-11	2	1-4	10-7					—				
4G6	#4	9-7	T1	0-4½	1-2	3-3	1-2	3-3		0-4½				
4G7	#4	1-11	T9	0-4½	1-2					0-4½				
8G8	#8	27-6	2	1-4	26-2					—				
8G9	#8	35-2	2	1-4	33-10					—				
5G10	#5	6-7	T1	0-5½	1-5	1-5	1-5	1-5		0-5½				
5G11	#5	2-5	T9	0-5½	1-5					0-6				
4G12	#4	6-5	T1	0-4½	1-5	1-5	1-5	1-5		0-4½				
4G13	#4	2-3	T9	0-4½	1-5					0-4½				
5G14	#5	8-11	T1	0-5½	1-5	2-7	1-5	2-7		0-5½				
8G15	#8	16-7	3		4-7	1-0	11-0				0-3		1-0	
8G16	#8	15-9	3		3-0	1-0	11-0				0-3		1-0	
7G17	#7	34-1	2	1-2	32-11					—				
5G18	#5	5-0	17		1-6	3-6	—							
4G19	#4	8-9	T1	0-4½	1-5	2-7	1-5	2-7		0-4½				
5G20	#5	6-0	17		3-0	3-0	—							

SEISMIC FRAME-BEAM SCHEDULE

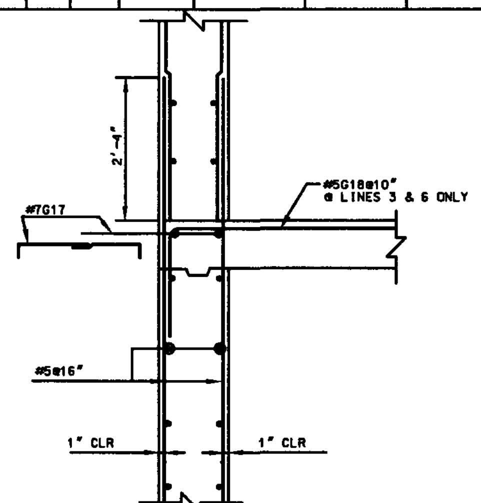
BEAM MARK	NO. REQ'D	SIZE WxD	REINFORCING: BOTTOM	REMARKS	HORIZ. 1 EF MID. HEIGHT	REMARKS	TOP	REMARKS	STIRRUPS	TYPE	SPACING & LOCATION	SKETCH (COL. COL.)	REMARKS
6B1	2	17"x42"	3#7G1 3#7G2	HK @ LINE '1' FULL LENGTH HK @ LINE '1'	2#5x12-4 2#5x23-0 1#5G20	START @ LN '1' CTR. @ LINE '2' (SPLICE 3'-0") O.F. COR BAR	3#8G4 2#8G5	HK @ LINE '1' FULL LENGTH HK @ LINE '1'	27#4G6 2x5#4G7 2x5#4G7		1@2", 11@7", BAL@15"EE. 135° HKS @ O.F. TYP. 7" o/c T&B@COL. LN. '1' 7" o/c T&B@COL. LN. '2'		
6B2	10	17"x42"	3#7x34-8	FULL LENGTH 5'-11"PAST COL EACH END	2#5x23-0	CTR. ON COL EAST END (SPLICE 3'-0")	3#8x38-4	FULL LENGTH 7'-9"PAST COL EACH END	27#4G6 2x5#4G7		1@2", 11@7", BAL@15"EE. 7" o/c T&B @ EAST COL		
6B3	2	17"x42"	3#7G1 3#7G2	HK @ LINE '8' FULL LENGTH HK @ LINE '8'	2#5x12-4 1#5G20	START @ LN '8' O.F. COR BAR	3#8G4 2#8G5	HK @ LINE '8' FULL LENGTH HK @ LINE '8'	27#4G6 2x5#4G7		1@2", 11@7", BAL1@15"EE. 7" o/c T&B@COL. LN. '8'		
6B4	2	17"x42"	3#8G8	HK @ LINE 'D'	2#5x12-4 2#5x23-0	START @ LN 'D' CTR. @ LINE 'C' (SPLICE 3'-0")	3#8G9	HK @ LINE 'D'	25#4G6 2x3#4G7 2x3#4G7		1@2", 10@8", BAL@15 E.E. 7" o/c T&B@COL. LN. 'D' 7" o/c T&B@COL. LN. 'C'		PLACE T & B BARS 3" CLR. @ LINE 'D'
6B5	2	17"x42"	3#8x18-4	——	2#5x23-0	CTR. @ LINE 'B' (SPLICE 3'-0")	FROM 6B4, 6B5	TOP BARS SPLICE AT ℄ OF SPAN	55 #4G6 2x3#4G7		1@2", BAL @ 4" EE. 7" o/c T&B@COL. LN. 'B'		
6B6	2	17"x42"	3#8G8	HK @ LINE 'A'	2#5x12-4	START @ LN 'A'	3#8G9	HK @ LINE 'A'	25 #4G6 2x3#4G7		1@2", 10@8", EE. BAL@15 7" o/c T&B@COL. LN. 'A'		PLACE T & B BARS 3" CLR. @ LINE 'A'



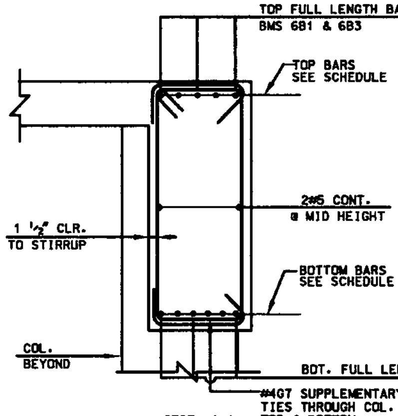
COL'S B1, C1, B8, C8
W= END PREPARATION PER SPLICE SUPPLIER
4 REQ'D
20"x20"

COL'S A1 TO A8, D1 TO D8
16 REQ'D
20"x34"

COL'S B2, C2, B7, C7
4 REQ'D
20"x20"



SECT. 2-2



SECT. 1-1

NOTES:

1. LONGITUDINAL REINFORCING IN FRAME BEAMS 6B1 THRU 6B6, AND ALL COLUMN VERTICALS SHALL CONFORM TO ASTM A706. ALL OTHER REINF. WILL CONFORM TO ASTM A615, GRADE 60
2. FOR REINFORCING DETAILS OF INTERIOR BEAMS, CORE SLABS, AND FLAT PLATE SLABS, REFER TO DRAWING NO.__

REINFORCING STEEL PLACING DRAWING

USE THIS DRAWING IN CONJUNCTION WITH THE ARCHITECTURAL & STRUCTURAL DRAWINGS.

ELEVATIONS & DIMENSIONS SHOWN ON THIS DRAWING ARE FOR PURPOSES OF PLACING REINFORCING BARS ONLY, AND ARE NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFIED BY THE CONTRACTOR.

REV. NO.	DATE	REVISIONS

ABC BUILDING PRODUCTS

DWG. COVERS	6TH FLOOR SEISMIC BEAMS SHEARWALLS & COLS. SUPPORTING 6TH FLOOR
JOB	OFFICE BUILDING FOR TRITON INDUSTRIES
LOCATION	ELM ST. YOURTOWN, USA
ENGINEER	MULLIN & JAMES-ENGINEERS
CONTRACTOR	WE BUILD BETTER CONST. CO.

DATE 11/29/01	DWG BY KEW	FILE NO.	BR7F010
REV	CHECKED BY JT	DWG. NO.	P-10

TYPICAL DRAWINGS FOR HIGHWAY STRUCTURES

Drawings H-1 through H-6F are the latest standard designs issued by the Federal Highway Administration (FHWA) for some common applications of reinforced concrete in highway structures. Each example illustrates some simplified details to facilitate estimating, detailing, fabrication, and placing of reinforcement to minimize overall cost while satisfying design requirements. Bending details, splices, concrete cover, and other information defined shown in these drawings conform to many, if not all, Department of Transportation standards, which can differ from the ACI Standards used elsewhere in this manual.

In studying these examples, the "General Notes" are as suggested by the FHWA. Appendixes referred to in "General Notes" or elsewhere are published by the U.S. Department of Transportation.* The detailer is cautioned that consultants will usually modify them to suit conditions at the site and local practice.

Drawings HS-7 and HP-7 are not part of the FHWA standards. They were included to show an example of a highway structure where the detailing was performed by the bar fabricator. Placing drawing HP-7 is also an example of computer-assisted detailing.

Drawings H-8, H-8A, H-8B, H-8C, and H-8D are issued by the State of California Department of Transportation (Caltrans) for cantilevered retaining walls. Other drawings or notes referred to in these drawings are published by Caltrans.†

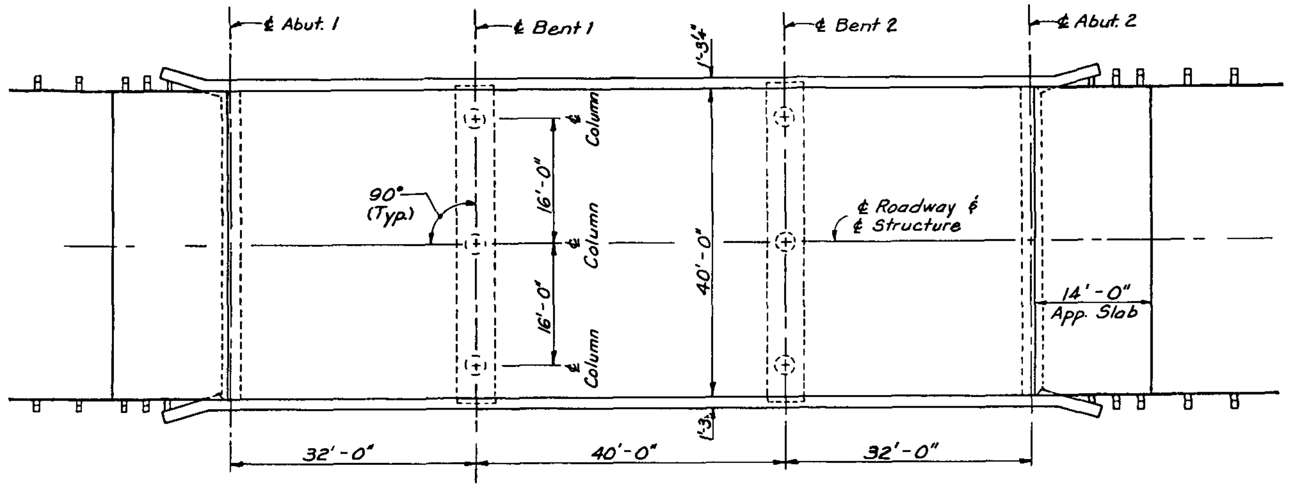
*See Standard Plans for Highway Bridges, V. 1, Jan. 1990, and V. IVA, Ap. 1984, Federal Highway Administration, DOT, Washington D.C.

†See Standard Plans 1999, State of California Department of Transportation, Sacramento, California, July.

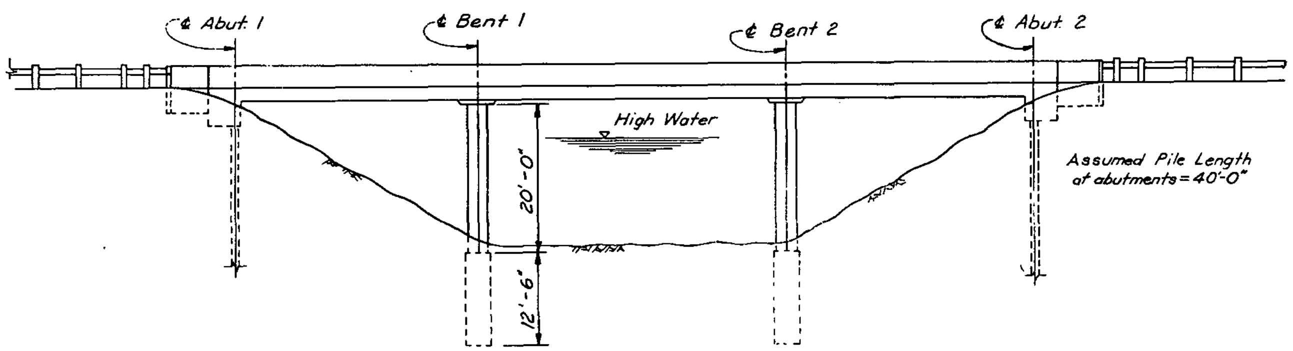
DRAWING H-1—SLAB BRIDGE—GENERAL

This example is shown in detail on Sheets H-1 through H-1C. The superstructure is a three-span solid continuous slab. The piers consist of three circular columns. The slab is continuous with pile supported abutments at each end that provide simple supports. The lateral distribution of loads to the interior columns is accomplished by a cap that is 4 in. thicker than the deck. Deck and barrier rail reinforcement is shown on Sheet H-1 together with "General Notes" and a "Summary of Quantities." The general notes require protection of the reinforcement from corrosion where deicing salts or saltwater may be expected.

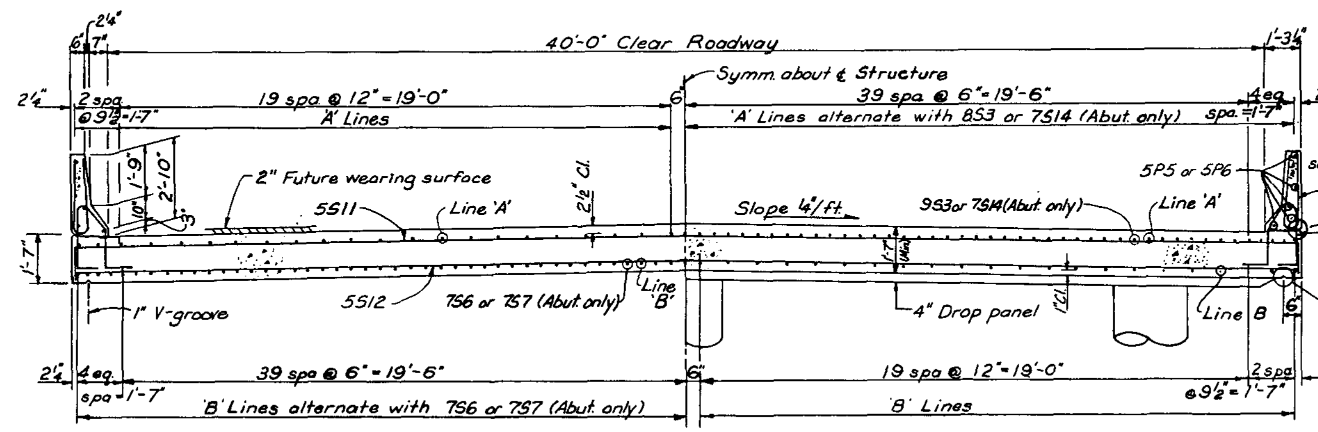
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



PLAN



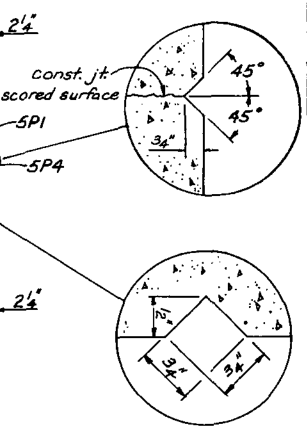
ELEVATION



HALF SECTION NEAR MID SPAN

HALF SECTION NEAR BENT

TYPICAL CROSS SECTION



GENERAL NOTES

Design Specifications: Standard Specifications for Highway Bridges, AASHTO, 1977 and Interim Specifications, 1978 thru 1982, using Load Factor Design (LFD) except for foundation design.

Design Loadings:
Dead Load: Includes 25 pounds per square foot for future wearing surface.
Live Load: AASHTO HS20-44.

Concrete: All concrete shall be class A(AE) with 28 day compressive strength of F'_c as given below:

Slab: F'_c = 4,500 psi
Approach slab and Bent: F'_c = 4,000 psi
All other: F'_c = 3,000 psi

The air entraining agents shall meet with the approval of the engineer. All exposed edges shall be chamfered ¾ inch, except as noted.

Reinforcing Steel: Deformed reinforcing steel shall conform to ASTM A615 (AASHTO M31), grade 60. Spiral reinforcing steel shall conform to ASTM A82 (AASHTO M32). Spacing of reinforcing steel is shown from center to center of bars. Splices shall be lapped 30 diameters unless otherwise shown. Cover for reinforcement shall be 2 inches clear except as noted.

Bridge Slab Protective System: Where bridge slabs are likely to be subjected to potential damaging applications of deicing salts or where a salt water environment presents the potential for corrosion of reinforcing steel, a protective system is required that will effectively prevent chloride induced deterioration.

Drilled Shaft: All loose material existing in drilled shaft after drilling operation has been completed shall be removed before placing concrete.

Piles: Steel H piles shall be driven to a minimum bearing capacity shown below:
Abutments – 40 tons.
Bents – 50 tons.

Quantities: Concrete and reinforcing steel in columns above the top of the drilled shafts are included in the bent quantities.

Drainage: No provisions for deck drainage have been made in these plans. If required, see Appendix A for suggested details.

Alternate Rail: See Appendix A for alternate rail details.

SUMMARY OF QUANTITIES

Item	Units	Super-Structure	Approach Slab	Abutments	Bents	Total
Structure Excavation	C.Y.	To meet conditions of site and specifications				
Concrete, Class A(AE)	C.Y.	286.0	52.9	39.8	64.6*	443.3
Reinforcing Steel	LBS.	63,690	10,600	4,380	8,770*	87,440
42"Ø Drilled Shaft	L.F.	—	—	—	75	75
Steel H-Piles	L.F.	—	—	560	960	1,500

*Does not include drilled shaft

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

THREE SPAN SLAB BRIDGE
SPANS 32-40-32 = 104 FT.
GENERAL PLAN AND CROSS SECTION

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.H.	CHECKED BY F.L.	APRIL, 1984
DRAWN BY F.H. & M.L.	RECOMMENDED	SHEET NO. 101

DRAWING H-1

DRAWING H-1A—SLAB BRIDGE ABUTMENT DETAILS

Reinforcing steel detail dimensions and quantities for the approach slab, abutment, and wing walls are shown in plan and sections.

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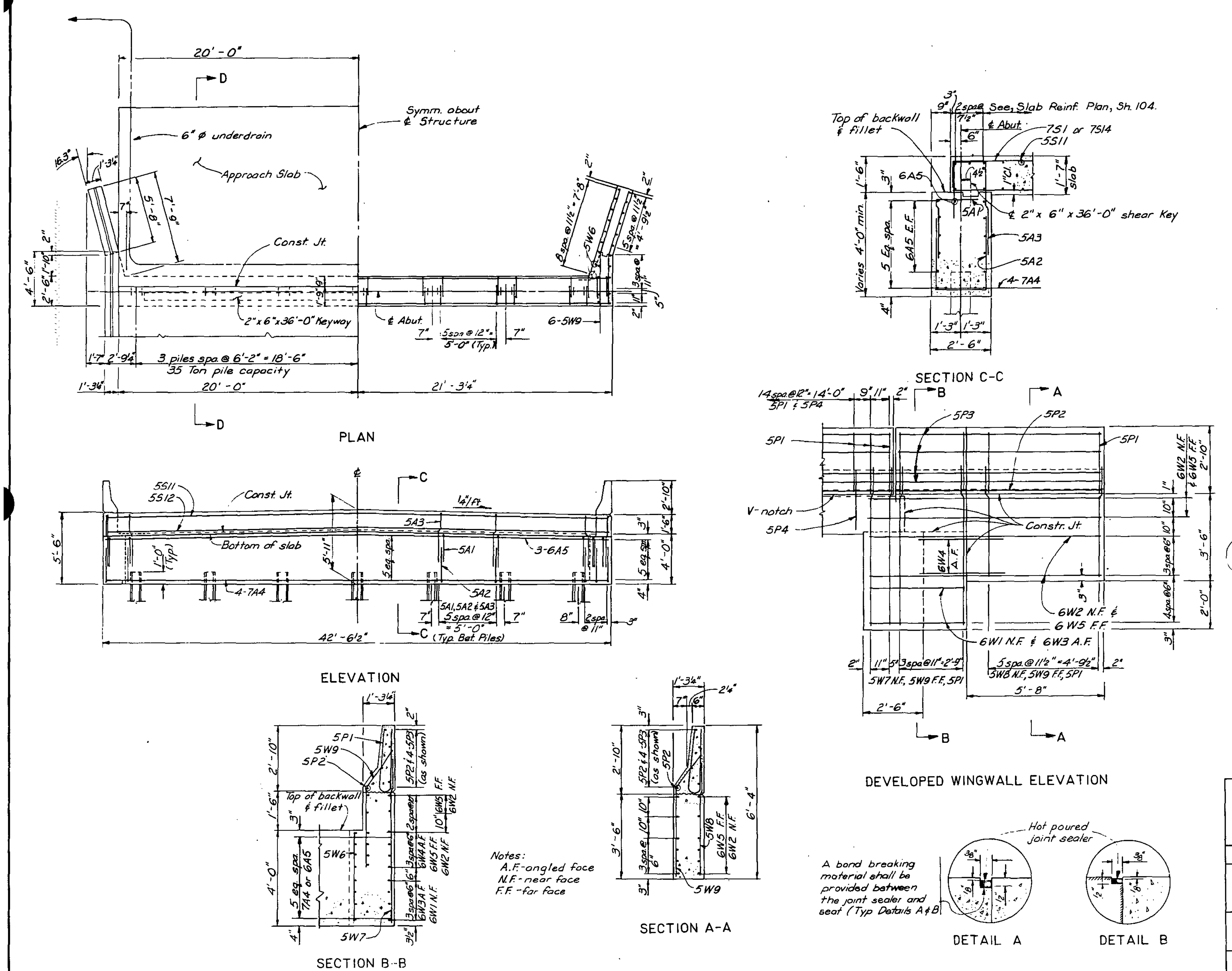
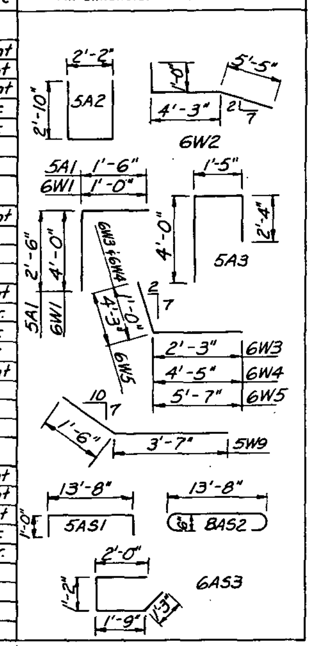


REINFORCING STEEL SCHEDULE

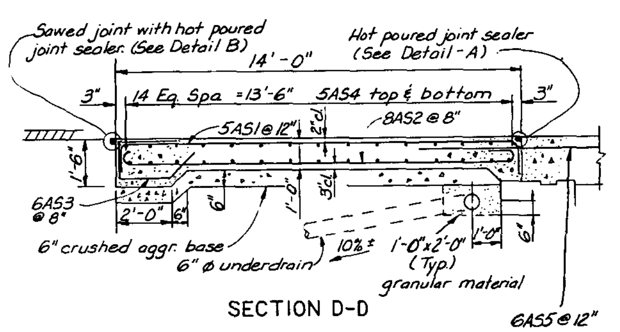
REINFORCING STEEL			
*Mark	No.	Length	Type
ABUTMENT			
5A1	84	4'-0"	Bent
5A2	84	7'-10"	Bent
5A3	84	7'-9"	Bent
7A4	8	42'-2"	Str.
6A5	22	42'-2"	Str.
WINGWALL			
6W1	16	5'-0"	Bent
6W2	24	10'-8"	↕
6W3	16	3'-3"	↕
6W4	16	5'-5"	↕
6W5	24	9'-10"	Bent
5W6	8	3'-7"	Str.
5W7	24	6'-7"	Str.
5W8	24	4'-7"	Str.
5W9	48	5'-1"	Bent
APPROACH SLAB			
5AS1	80	15'-8"	Bent
8AS2	120	15'-0"	Bent
6AS3	120	6'-2"	Bent
5AS4	60	39'-8"	Str.
6AS5	82	7'-0"	Str.

BENDING DIAGRAMS

All dimensions out to out



*Digit preceding letter denotes bar size.



U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

THREE SPAN SLAB BRIDGE
SPANS 32-40-32=104 FT.
ABUTMENT DETAILS

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.H.	CHECKED BY F.L.	APRIL 1984
DRAWN BY F.H. & M.L.	RECOMMENDED Vasant C. Mistry	SHEET NO. 102

DRAWING H-1A

DRAWING H-1B—SLAB BRIDGEBENT DETAILS

Alternate details for connection of columns to pilecap and drilled shaft are shown. Column and cap reinforcement details are also shown.

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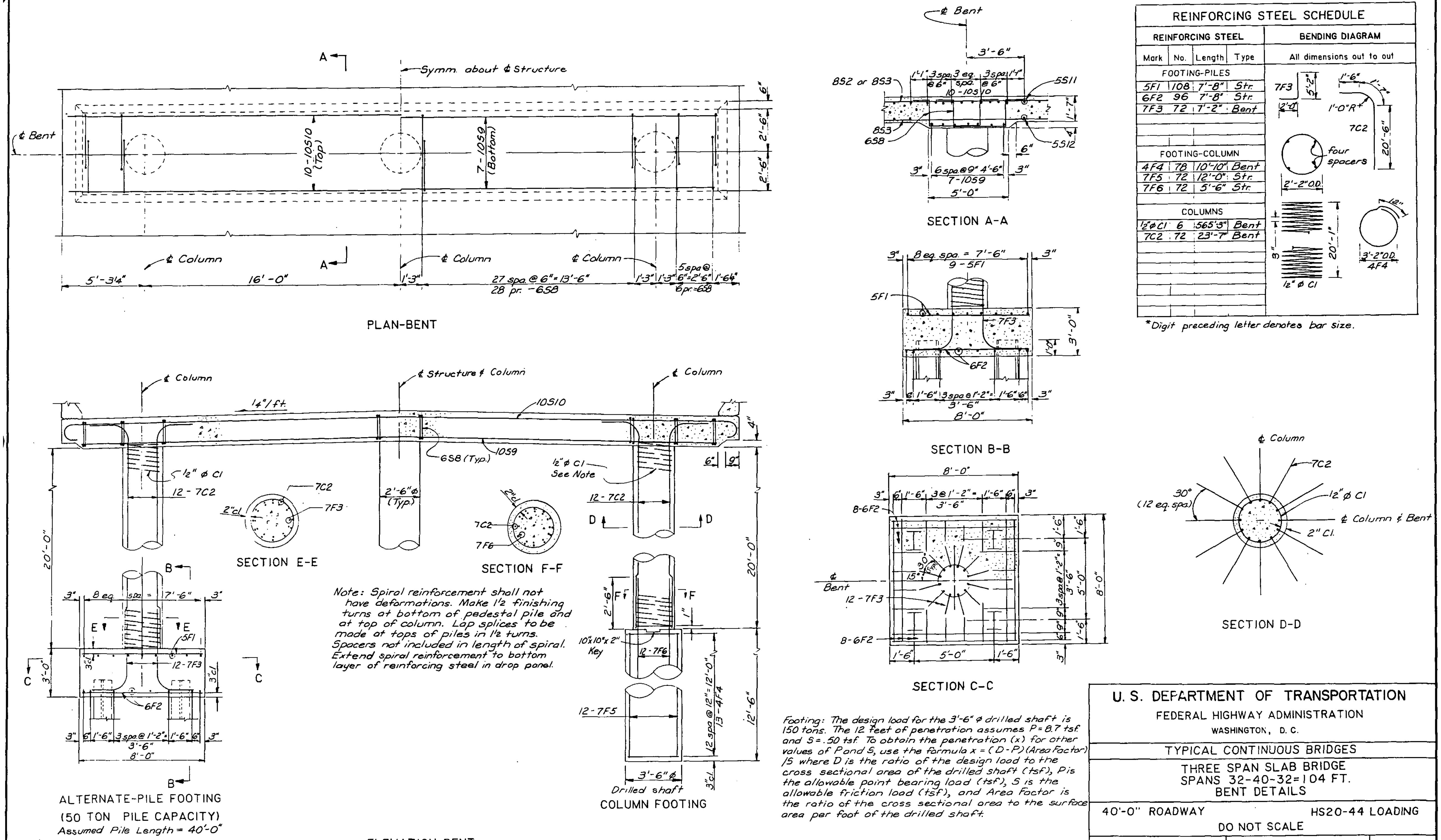

Note: Spiral reinforcement shall not have deformations. Make 1½ finishing turns at bottom of pedestal pile and at top of column. Lap splices to be made at tops of piles in 1½ turns. Spacers not included in length of spiral. Extend spiral reinforcement to bottom layer of reinforcing steel in drop panel.

REINFORCING STEEL SCHEDULE

Mark	No.	Length	Type
FOOTING-PILES			
5F1	108	7'-8"	Str.
6F2	96	7'-8"	Str.
7F3	72	7'-2"	Bent
FOOTING-COLUMN			
4F4	78	10'-10"	Bent
7F5	72	12'-0"	Str.
7F6	72	5'-6"	Str.
COLUMNS			
½"ϕ Cl	6	565'-3"	Bent
7C2	72	23'-7"	Bent

BENDING DIAGRAM — All dimensions out to out

*Digit preceding letter denotes bar size.

Footing: The design load for the 3'-6" ϕ drilled shaft is 150 tons. The 12 feet of penetration assumes P = 8.7 tsf and S = .50 tsf. To obtain the penetration (x) for other values of P and S, use the formula x = (D - P)(Area Factor)/S where D is the ratio of the design load to the cross sectional area of the drilled shaft (tsf), P is the allowable point bearing load (tsf), S is the allowable friction load (tsf), and Area Factor is the ratio of the cross sectional area to the surface area per foot of the drilled shaft.

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

THREE SPAN SLAB BRIDGE
SPANS 32-40-32=104 FT.
BENT DETAILS

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.H. — CHECKED BY F.L. — APRIL 1984
DRAWN BY F.H. & M.L. — RECOMMENDED [signature] — SHEET NO. 103

DRAWING H-1B

DRAWING H-1C—SLAB BRIDGE DECK SLAB AND PARAPET DETAILS

Plan of slab reinforcement and bending details are shown. Several details not included in "Typical Bar Details" for building applications are used in this bridge.

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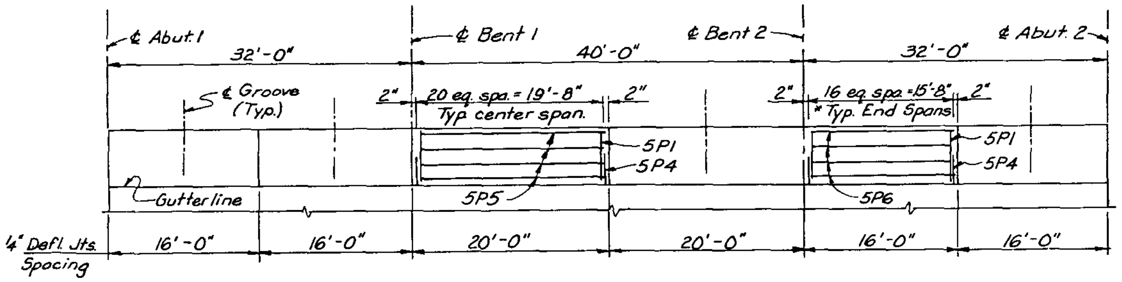
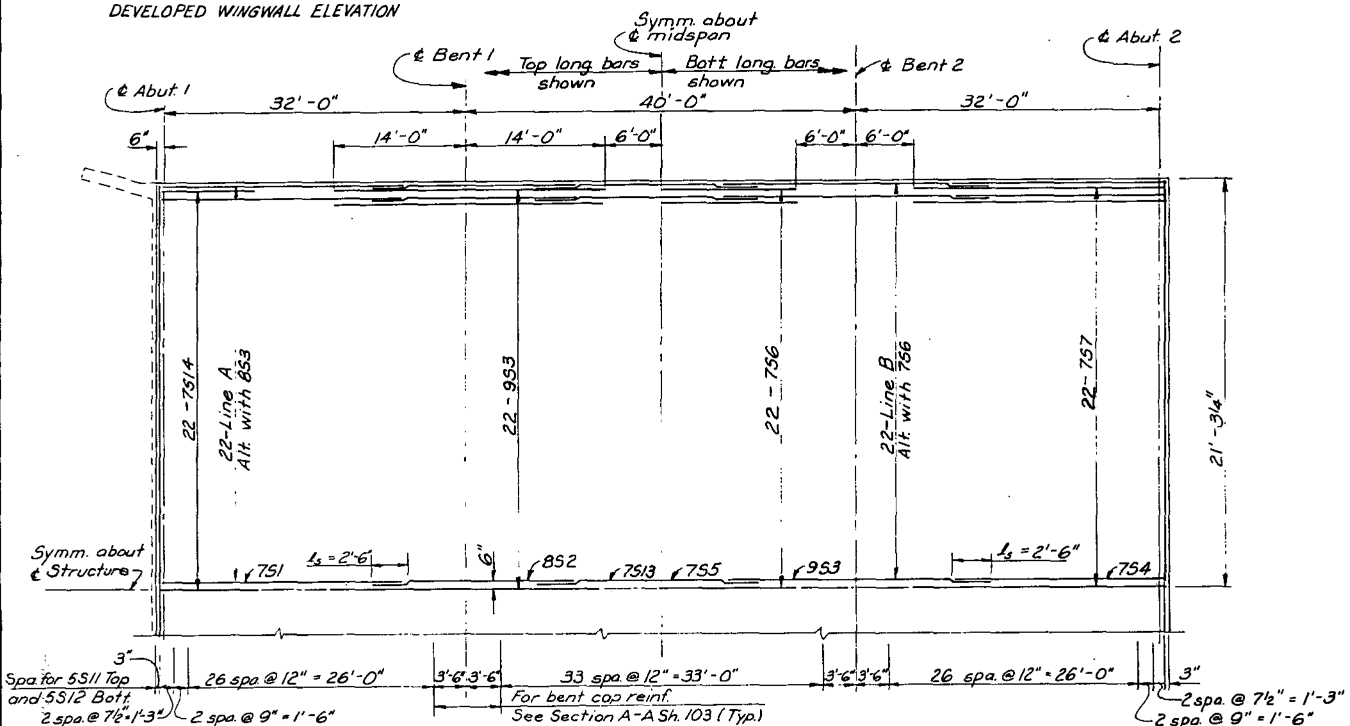


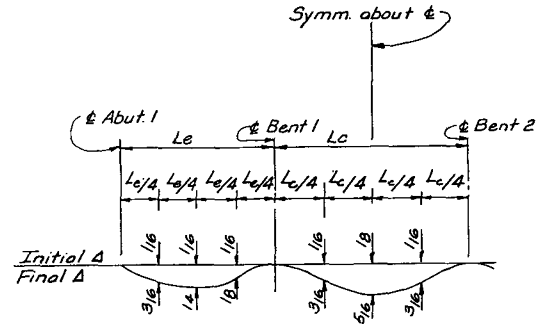
*At Abutments use 5W7 for first two 5P4. See DEVELOPED WINGWALL ELEVATION

PARAPET REINFORCING AND JOINT LAYOUT

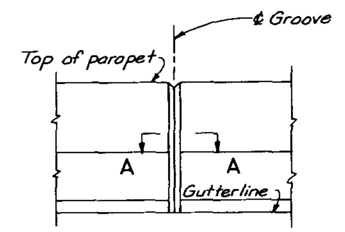


SLAB REINFORCEMENT PLAN

Line A: 7S1-8S2-7S13-8S2-7S1
Line B: 7S4-9S3-7S5-9S3-7S4

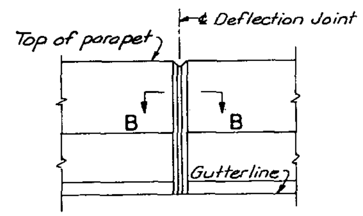


D.L. DEFLECTION DIAGRAM

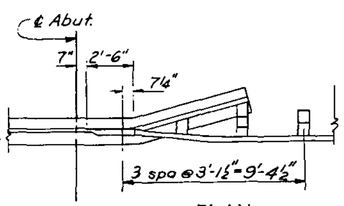


PARAPET GROOVE

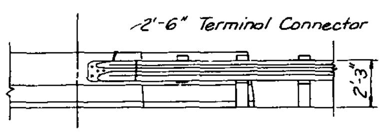
Place at midpoint between deflection joints.



DEFLECTION JOINT THRU PARAPET

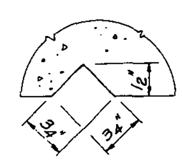


PLAN



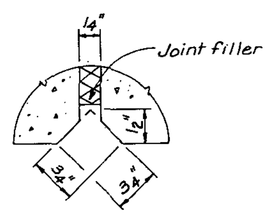
ELEVATION

GUARDRAIL CONNECTION DETAIL



SECTION A-A

Groove detail for both sides of parapet.



SECTION B-B

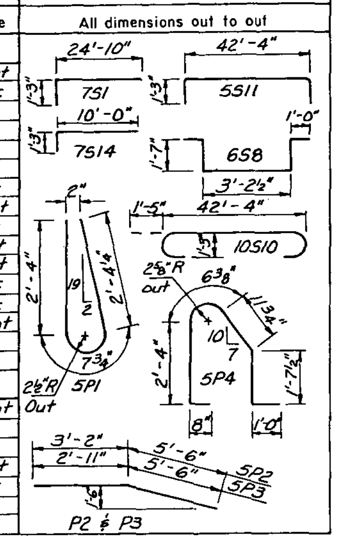
Deflection joint detail for both sides of parapet.

REINFORCING STEEL SCHEDULE

Mark	No.	Length	Type
SLAB			
7S1	88	26'-1"	Bent
8S2	88	20'-0"	Str.
9S3	174	28'-0"	↕
7S4	88	20'-10"	↕
7S5	44	17'-0"	↕
7S6	43	28'-0"	↕
7S7	86	26'-4"	Str.
6S8	136	8'-5"	Bent
10S9	14	39'-10"	Str.
10S10	20	45'-2"	Bent
5S11	96	44'-10"	Bent
5S12	96	42'-4"	Str.
7S13	44	25'-0"	Str.
7S14	86	11'-3"	Bent
PARAPET			
5P1	264	5'-4"	Bent
5P2	4	8'-8"	↕
5P3	16	8'-5"	↕
5P4	216	7'-2"	Bent
5P5	20	19'-8"	Str.
5P6	40	15'-8"	Str.

BENDING DIAGRAM

All dimensions out to out



Note: Digit(s) preceding letter denote(s) bar size.

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

THREE SPAN SLAB BRIDGE
SPANS 32-40-32=104 FT.
DECK SLAB AND PARAPET DETAILS

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

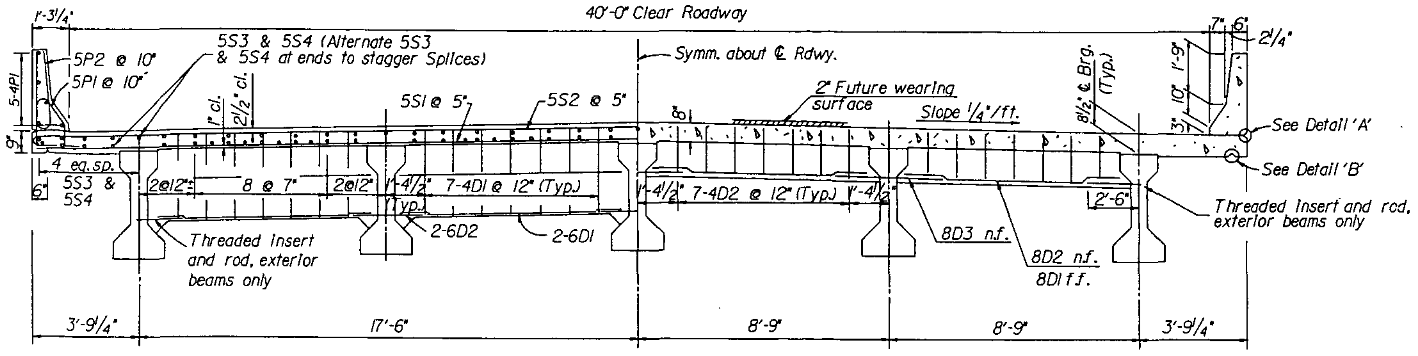
DESIGNED BY F.H.	CHECKED BY F.L.	APRIL 1984
DRAWN BY F.H. & M.L.	RECOMMENDED Vasant C. Mistry	SHEET NO. 104

DRAWING H-1C

DRAWING H-2—PRECAST AASHTO I-BEAM SECTIONS—GENERAL

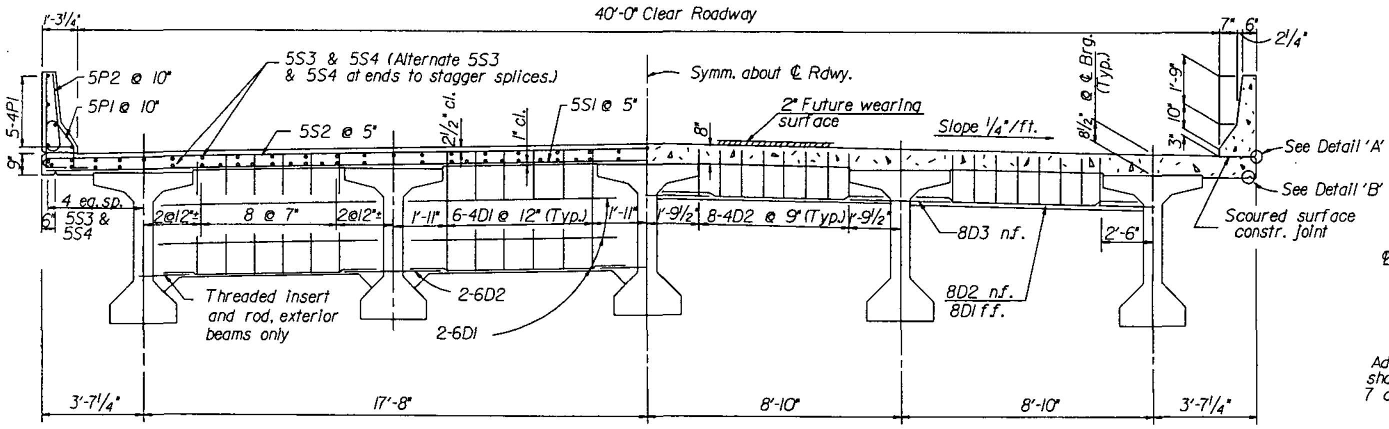
This drawing shows cross sections, general notes, and details for 28 and 40 ft roadway width bridges using standard AASHTO I-beams. Elevation views show beam spacing, deck slab thickness, and reinforcement at both bearing and intermediate diaphragm. The deck slabs are one-way designs spanning from beam to beam. All reinforcement has been identified with a unique mark (for example, 6A1, 5S2) where the first digit is the bar size. A total of six drawings are provided for this project.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



AT INTERMEDIATE DIAPHRAGM AT BEARING

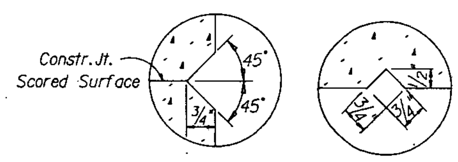
AASHTO BEAMS - TYPE II, III & IV



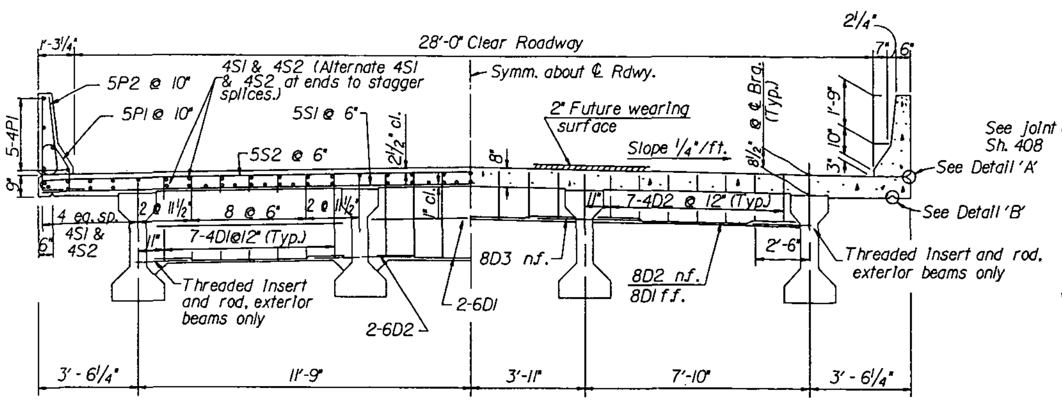
AT INTERMEDIATE DIAPHRAGM AT BEARING

AASHTO BEAMS - TYPE V & VI

TYPICAL CROSS SECTIONS 40 FOOT ROADWAY



DETAIL 'A' DETAIL 'B'



AT INTERMEDIATE DIAPHRAGM AT BEARING

AASHTO BEAMS - TYPE II, III & IV

TYPICAL CROSS SECTION 28 FOOT ROADWAY

GENERAL NOTES

Design Specifications: AASHTO Standard Specifications for Highway Bridges, 1989, 14th Edition.

Design Loadings:
Dead Load: Includes 25 pounds per square foot for future wearing surface.
Live Load: AASHTO HS20-44

Precast Prestressed Concrete: Concrete in prestressed beams shall be class P with minimum compressive strength of f_c' and f_{ci}' as shown on the plans for various designs.

Cast-in-Place Concrete: Cast-in-place concrete shall be class A(AE) with a minimum 28 day compressive strength of f_c' = 4000 psi. Extreme fiber stress in compression f_c equals 1400 psi for the roadway slab. The air entraining agent shall meet with the approval of the Engineer. All exposed edges shall be chamfered 3/4" except as noted.

Pretensioning Steel: Pretensioning steel shall be 7-wire, 1/2-inch diameter stress relieved strands conforming to AASHTO M203 (ASTM A416), grade 270. The initial tensile force applied to each strand shall be 28,900 lbs.

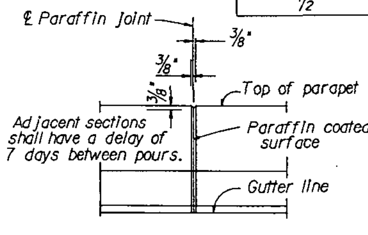
Reinforcing Steel: Reinforcing steel shall conform to ASTM A615, A616, or A617, grade 60. Dimensions relating to spacing of reinforcing steel are to centers of bars. Splices shall be lapped 30 diameters unless otherwise shown. Reinforcing steel covering shall be 2" clear, except as noted.

Drainage: No provision for drainage has been made in these plans. For suggested details see sheet 102 and FHWA's "Bridge Deck Drainage Guidelines," Report No. FHWA/RD-87/014.

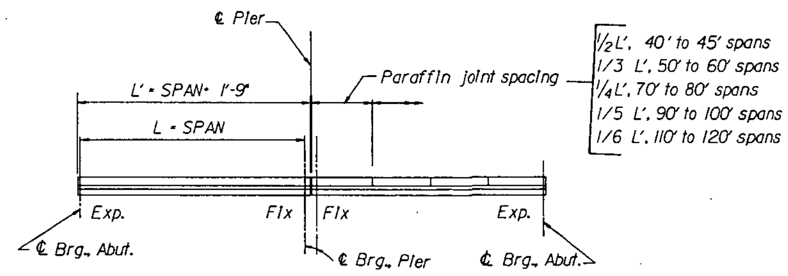
Bridge Slab Protective System: Where bridge slabs are likely to be subjected to potential damaging applications of deicing salts or where a salt water environment presents the potential for corrosion of reinforcing steel, a protective system is required that will effectively prevent chloride induced deterioration.

Alternate Rail: See Appendix A for alternate rail details.

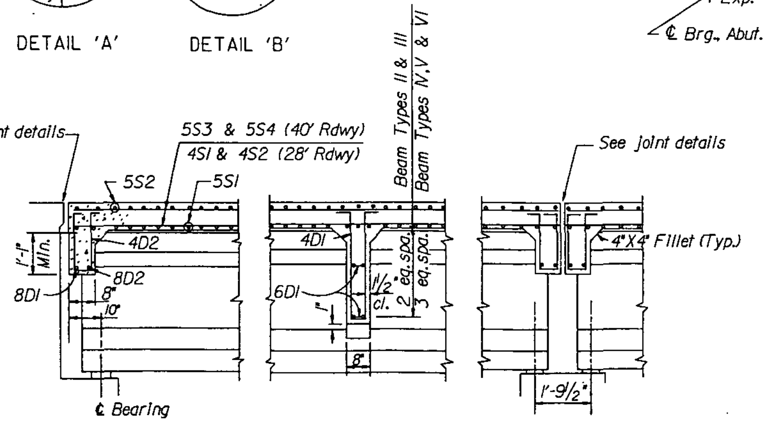
Nominal Diameter of Strand (Inches)	Nominal Area of Strand (square inches)	Nominal Weight of Strand (lb. per 1000 ft.)	Minimum Breaking Strength of Strand (lb.)	Yield Strength Requirements	
				Initial Load (lb.)	Minimum Load at 1% Extension (lb.)
1/2	0.153	520	41,300	4,130	37,170



PARAFFIN JOINT THROUGH PARAPET



KEY



AT ABUTMENT AT INTERMEDIATE DIAPHRAGM AT PIER (Fixed Bearing)

LONGITUDINAL SECTION

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
PRETENSIONED AND POST-TENSIONED SPANS 40' TO 120'
CROSS SECTIONS, GENERAL NOTES, AND DETAILS

28'&40' ROADWAYS HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.H.	DESIGN CHECKED BY F.L.	SEPT 1989
DRAWN BY M.L.	DRAWING CHECKED BY F.H.	SHEET NO. 401

DRAWING H-2

DRAWING H-2A—PRECAST AASHTO I-BEAM SECTIONS—REINFORCING STEEL

This drawing shows, in schedule form, the reinforcement required for the slab, parapets, and diaphragms for each roadway width and span. Shown for each reinforcing bar mark are the total bar length and count. Also shown in the drawing are design information (beam reactions and dead load deflections) and illustrations of the different bend types.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

REINFORCING STEEL SCHEDULE

SLAB

Roadway	Span in Feet	Beam Type	4S1 Straight Length	4S1 No.	4S2 Straight Length	4S2 No.	5S1 Straight Length	5S1 No.	5S2 Bent Length	5S2 No.	5S3 Straight Length	5S3 No.	5S4 Straight Length	5S4 No.
28' ROADWAY	40	II	41'-4"	74			30'-3"	84	31'-5"	84				
	45	II	40'-0"	74	7'-4"	74	•	94	•	94				
	50	III	•	74	12'-4"	74	•	104	•	104				
	55	III	•	74	17'-4"	74	•	114	•	114				
	60	III	•	74	22'-4"	74	•	124	•	124				
	65	III	•	74	27'-4"	74	•	134	•	134				
	70	IV	40'-0"	74	32'-4"	74	•	144	•	144				
	80	IV	30'-0"	148	23'-4"	74	30'-3"	164	31'-5"	164				
40' ROADWAY	40	II					42'-3"	101	43'-5"	101	41'-4"	93		
	45	II					•	113	•	113	40'-0"	93	7'-4"	93
	50	III					•	125	•	125	•	93	12'-4"	93
	55	III					•	137	•	137	•	93	17'-4"	93
	60	III					•	149	•	149	•	93	22'-4"	93
	65	III					•	161	•	161	•	93	27'-4"	93
	70	IV					•	173	•	173	•	93	32'-4"	93
	70	Mod IV					•	173	•	173	•	93	•	93
	70	BT-54					•	173	•	173	40'-0"	93	32'-4"	93
	80	IV					•	197	•	197	30'-0"	186	23'-4"	93
	80	Mod IV					•	197	•	197	30'-0"	186	•	93
	80	BT-54					•	197	•	197	30'-0"	186	23'-4"	93
	90	V					•	221	•	221	40'-0"	186	13'-4"	93
	90	Mod V					•	221	•	221	•	186	•	93
	90	BT-63					•	221	•	221	•	186	13'-4"	93
	100	V					•	245	•	245	•	186	23'-4"	93
	100	Mod V					•	245	•	245	•	186	•	93
	100	BT-63					•	245	•	245	•	186	23'-4"	93
	110	VI					•	269	•	269	•	186	33'-4"	93
	110	Mod VI					•	269	•	269	•	186	•	93
	110	BT-72					•	269	•	269	40'-0"	186	33'-4"	93
	120	VI					•	293	•	293	35'-0"	279	19'-4"	93
	120	Mod VI					•	293	•	293	35'-0"	279	•	93
	120	BT-72					42'-3"	293	43'-5"	293	35'-0"	279	19'-4"	93

PARAPETS AND DIAPHRAGMS

Roadway	Span in Feet	Beam Type	4P1 Straight Length	4P1 No.	5P1 Bent Length	5P1 No.	5P2 Bent Length	5P2 No.	4D1 Bent Length	4D1 No.	4D2 Bent Length	4D2 No.	6D1 Straight Length	6D1 No.	6D2 Straight Length	6D2 No.	8D1 Straight Length	8D1 No.	8D2 Straight Length	8D2 No.	8D3 Straight Length	8D3 No.
28' ROADWAY	40	II	20'-7"	20	5'-5 1/4"	104	5'-7"	104	5'-7 1/2"	21	4'-1 1/2"	42	7'-0"	12	3'-6"	4	24'-2"	2	7'-0"	6	5'-10"	4
	45	II	23'-1"	20	•	116	•	116	5'-7 1/2"	21	4'-1 1/2"	42	•	12	•	4	•	2	•	6	•	4
	50	III	17'-0"	30	•	132	•	132	6'-8 1/2"	21	4'-3 1/2"	42	•	12	•	4	•	2	•	6	•	4
	55	III	18'-8"	30	•	144	•	144	•	21	•	42	•	12	•	4	•	2	•	6	•	4
	60	III	20'-4"	30	•	156	•	156	•	21	•	42	•	12	•	4	•	2	•	6	•	4
	65	III	16'-5"	40	•	168	•	168	6'-8 1/2"	21	4'-3 1/2"	42	•	12	•	4	•	2	•	6	•	4
	70	IV	17'-8"	40	•	184	•	184	7'-9 1/2"	21	4'-8 1/2"	42	•	12	•	4	•	2	•	6	•	4
	80	IV	20'-2"	40	•	208	•	208	7'-9 1/2"	21	4'-8 1/2"	42	7'-0"	12	•	4	24'-2"	2	7'-0"	6	•	4
40' ROADWAY	40	II	20'-7"	20	•	104	•	104	5'-7 1/2"	28	4'-1 1/2"	56	7'-11"	16	•	6	35'-4"	2	7'-11"	8	•	6
	45	II	23'-1"	20	•	116	•	116	5'-7 1/2"	28	4'-1 1/2"	56	•	16	•	6	•	2	•	8	•	6
	50	III	17'-0"	30	•	132	•	132	6'-8 1/2"	28	4'-3 1/2"	56	•	16	•	6	•	2	•	8	•	6
	55	III	18'-8"	30	•	144	•	144	•	28	•	56	•	16	•	6	•	2	•	8	•	6
	60	III	20'-4"	30	•	156	•	156	•	28	•	56	•	16	•	6	•	2	•	8	•	6
	65	III	16'-5"	40	•	168	•	168	6'-8 1/2"	28	4'-3 1/2"	56	•	16	•	6	•	2	•	8	•	6
	70	IV	17'-8"	40	•	184	•	184	7'-9 1/2"	28	4'-8 1/2"	56	•	24	•	6	•	2	•	8	•	6
	70	Mod IV	•	40	•	184	•	184	7'-9 1/2"	28	4'-8 1/2"	56	•	24	•	6	35'-4"	2	7'-11"	8	•	6
	70	BT-54	17'-8"	40	•	184	•	184	8'-10 1/2"	28	4'-1 1/2"	64	•	24	•	6	35'-8"	2	8'-0"	8	•	6
	80	IV	20'-2"	40	•	208	•	208	7'-9 1/2"	28	4'-8 1/2"	56	•	24	•	6	35'-4"	2	7'-11"	8	•	6
	80	Mod IV	•	40	•	208	•	208	7'-9 1/2"	28	4'-8 1/2"	56	•	24	•	6	35'-4"	2	7'-11"	8	•	6
	80	BT-54	20'-2"	40	•	208	•	208	8'-10 1/2"	28	4'-1 1/2"	64	•	24	•	6	35'-8"	2	8'-0"	8	•	6
	90	V	18'-1"	50	•	230	•	230	9'-1 1/2"	48	4'-4 1/2"	64	•	24	•	12	35'-8"	2	8'-0"	8	•	6
	90	Mod V	•	50	•	230	•	230	9'-1 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	90	BT-63	18'-1"	50	•	230	•	230	10'-4 1/2"	48	4'-1 1/2"	64	•	24	•	12	•	2	•	8	•	6
	100	V	20'-1"	50	•	260	•	260	9'-1 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	100	Mod V	•	50	•	260	•	260	9'-1 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	100	BT-63	20'-1"	50	•	260	•	260	10'-4 1/2"	48	4'-1 1/2"	64	•	24	•	12	•	2	•	8	•	6
	110	VI	18'-4"	60	•	288	•	288	10'-7 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	110	Mod VI	•	60	•	288	•	288	10'-7 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	110	BT-72	18'-4"	60	•	288	•	288	11'-10 1/2"	48	4'-1 1/2"	64	•	24	•	12	•	2	•	8	•	6
	120	VI	20'-0"	60	•	312	•	312	10'-7 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	120	Mod VI	•	60	•	312	•	312	10'-7 1/2"	48	4'-4 1/2"	64	•	24	•	12	•	2	•	8	•	6
	120	BT-72	20'-0"	60	5'-5 1/4"	312	5'-7"	312	11'-10 1/2"	48	4'-1 1/2"	64	7'-11"	24	3'-6"	12	35'-8"	2	8'-0"	8	5'-10"	6

Note: The first digit of the bar mark indicates the size of the bar.

SUMMARY OF QUANTITIES

Roadway	Span in Feet	Beam Type	Reinforcing Steel (lbs.) Slab Parapet Diaphragm	Reinforcing Steel (lbs.) One Beam Pre Tensioned	Reinforcing Steel (lbs.) One Beam Post Tensioned	Concrete (cu.yds.) Slab Parapet Diaphragm	Concrete (cu.yds.) One Beam Pre Tensioned	Concrete (cu.yds.) One Beam Post Tensioned
28' ROADWAY	40	II	9510	300		41.4	3.9	
	45	II	10,680	330		46.1	4.4	
	50	III	11,800	400		51.2	7.3	
	55	III	12,870	440		55.8	8.1	
	60	III	13,930	500		60.5	8.8	
	65	III	14,990	530		65.2	9.5	
	70	IV	16,120	650		70.4	14.4	
	80	IV	18,300	720		79.8	16.4	
40' ROADWAY	40	II	15,440	320		55.2	3.9	
	45	II	17,270	350		61.4	4.4	
	50	III	19,070	450		68.1	7.3	
	55	III	20,800	480		74.2	8.1	
	60	III	22,530	500	730	80.4	8.8	7.6
	65	III	24,260	530		86.6	9.5	
	70	IV	26,160	650	1030	93.6	14.4	15.3
	70	Mod IV	26,160	650		93.6	12.6	
	70	BT-54	26,190	810		97.1	12.2	
	80	IV	29,720	720	1120	106.0	16.4	17.4
	80	Mod IV	29,720	710		106.0	14.3	
	80	BT-54	29,740	920		109.5	13.9	
	90	V	33,340	1310	1890	122.4	23.7	25.8
	90	Mod V	33,340	1240		122.4	20.9	
	90	BT-63	33,370	1100		123.1	16.8	
	100	V	36,870	1420	2060	134.8	26.3	28.4
	100	Mod V	36,870	1380		134.7	23.2	
	100	BT-63	36,900	1210		135.6	18.7	
	110	VI	40,420	1620	2460	148.4	31.0	34.0
	110	Mod VI	40,420	1570		148.3	27.0	
	110	BT-72	40,450	1390		149.2	22.0	
	120	VI	43,970	1730	2610	160.8	33.8	36.8
	120	Mod VI	43,970	1680		160.8	29.5	
	120	BT-72	44,000	1510		161.6	24.0	

MAXIMUM BEAM REACTIONS IN KIPS

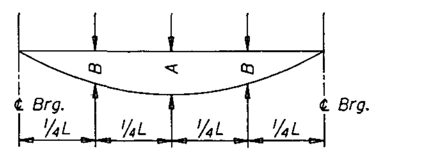
Roadway	Loading	II 40' Ext.	II 40' Int.	II 45' Ext.	II 45' Int.	II 50' Ext.	II 50' Int.	III 50' Ext.	III 50' Int.	III 55' Ext.	III 55' Int.	III 60' Ext.	III 60' Int.	III 65' Ext.	III 65' Int.	IV 70' Ext.	IV 70' Int.	IV 80' Ext.	IV 80' Int.	IV 90' Ext.	IV 90' Int.
28' Roadway	Dead Load	30.0	31.1	33.7	34.9			42.5	44.0	46.7	48.3	50.9	52.6	55.0	56.9	67.8	70.0	77.4	79.8		
	Live Load	36.3	39.3	37.4	40.6			38.4	41.7	39.3	42.6	39.9	43.3	40.5	43.9	41.0	44.4	41.8	45.3		
	Impact	10.9	11.8	10.9	11.8			11.1	12.1	11.0	11.9	10.8	11.7	10.5	11.4	10.7	11.6	10.0	10.9		
	Total	77.2	82.2	82.0	87.3			92.0	97.8	97.0	102.8	101.6	107.6	106.0	112.2	119.5	126.0	129.2	136.0		
	Total One Abut.	265.7		284.3				323.9		343.1		361.4		379.3		432.8		472.1			
40' Roadway	Dead Load	31.1	32.8	35.0	36.8			43.9	46.1	48.3	50.6	52.6	55.1	56.9	59.6	69.8	72.9	79.7	83.1		
	Live Load	39.0	43.9	40.3	45.3			41.4	46.5	42.3	47.5	43.0	48.3	43.6	49.1	44.1	49.6	45.0	50.6		
	Impact	11.7	13.2	11.7	13.1			12.0	13.5	11.8	13.3	11.6	13.1	11.3	12.8	11.5	12.9	10.8	12.1		
	Total	81.8	89.9	87.0	95.2			97.3	106.1	102.4	111.4	107.2	116.5	111.8	121.5	125.4	135.4	135.5	145.8		
	Total One Abut.	354.4		378.9				429.9		455.1		479.0		502.5		570.6		621.6			

Roadway	Loading	V 90' Ext.	V 90' Int.	V 100' Ext.	V 100' Int.	VI 110' Ext.	VI 110' Int.	VI 120' Ext.	VI 120' Int.	MOD IV 70' Ext.	MOD IV 70' Int.	MOD IV 80' Ext.	MOD IV 80' Int.	MOD V 90' Ext.	MOD V 90' Int.	MOD V 100' Ext.	MOD V 100' Int.	MOD VI 110' Ext.	MOD VI 110' Int.	MOD VI 120' Ext.	MOD VI 120' Int.
28' Roadway	Dead Load																				
	Live Load																				
	Impact																				
	Total																				
	Total One Abut.																				
40' Roadway	Dead Load	100.1	106.4	111.0	117.9	126.4	134.1	137.4	145.3	67.0	70.4	76.3	80.3	95.8	100.2	106.4	111.3	120.0	124.3	130.8	136.7
	Live Load	45.9	51.8	46.4	52.4	46.9	52.9	47.2	53.3	44.0	49.6	44.5	50.2	45.2	50.9	45.5	51.3	45.8	51.6	46.1	51.9
	Impact	10.5	11.9	10.2	11.5	9.8	11.1	9.4	10.7	11.3	12.7	10.8	12.2	10.5	11.9	10.1	11.4	9.8	11.0	9.4	10.6
	Total	156.5	170.1	167.6	181.8	183.1	198.1	194.0	209.3	122.3	132.7	131.6	142.7	151.5	163.0	162.0	174.0	175.6	186.9	186.3	199.2
	Total One Abut.	733.6		790.8		870.4		925.8		557.5		606.4		706.4		761.8		828.2		886.8	

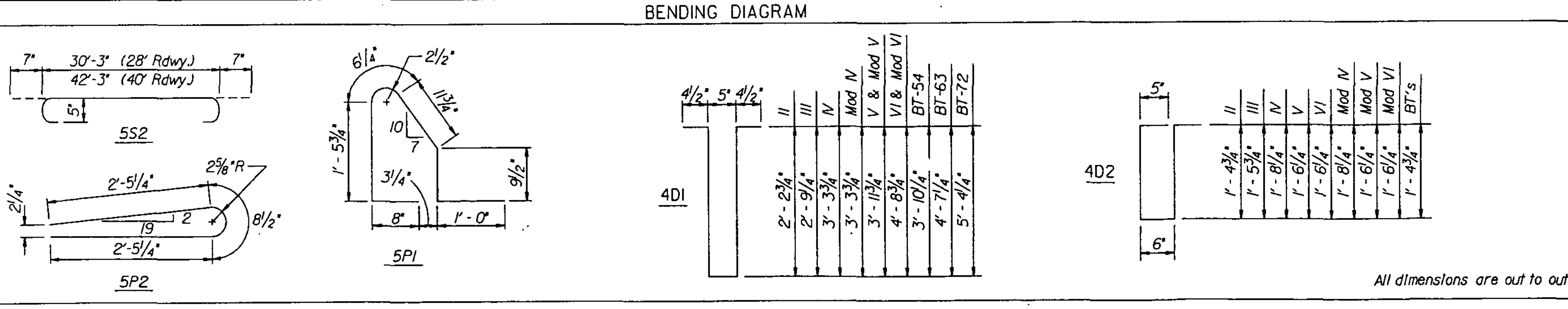
Roadway	Loading	BT-54 70' Ext.	BT-54 70' Int.	BT-54 80' Ext.	BT-54 80' Int.	BT-63 90' Ext.	BT-63 90' Int.	BT-63 100' Ext.	BT-63 100' Int.	BT-72 110' Ext.	BT-72 110' Int.	BT-72 120' Ext.	BT-72 120' Int.
28' Roadway	Dead Load												
	Live Load												
	Impact												
	Total												
	Total One Abut.												
40' Roadway	Dead Load	66.3	69.8	75.6	79.5	87.5	92.0	97.1	102.0	109.9	115.3	119.9	125.7
	Live Load	44.0	49.6	44.5	50.2	45.2	50.9	45.5	51.3	45.8	51.6	46.1	51.9
	Impact	11.3	12.7	10.8	12.2	10.5	11.9	10.1	11.4	9.8	11.0	9.4	10.6
	Total	121.6	132.1	130.9	141.9	143.2	154.8	152.7	164.7	165.5	177.9	175.4	188.2
	Total One Abut.	554.3		602.6		665.2		715.3		781.0		832.0	

DEAD LOAD DEFLECTION
(For cast in place concrete)

Roadway	Deflection @	II 40'	II 45'	II 50'	III 50'	III 55'	III 60'	III 65'	IV 70'	IV 80'	IV 90'	V 90'	V 100'	VI 110'	VI 120'	MOD IV 70'	MOD IV 80'	MOD V 90'	MOD V 100'	MOD VI 110'	MOD VI 120'	BT-54 70'	BT-54 80'	BT-63 90'	BT-63 100'	BT-72 110'	BT-72 120'
28' Rdwy.	A	1/4	3/8		1/4	5/16	7/16	5/8	7/16	11/16																	
	B	3/16	1/4		3/16	1/4	5/16	7/16	1/4	1/2																	
40' Rdwy.	A	1/4	3/8		1/4	3/8	1/2	11/16	7/16	3/4		5/8	1	1	1 3/8	1/2	7/8	3/4	1 1/16	1 1/8	1 1/2	7/16	3/4	7/8	1 1/8	1 1/4	1 3/4
	B	3/16	1/4		3/16	1/4	3/8	1/2	5/16	1/2		7/16	11/16	3/4	1	3/8	5/8	1/2	3/4	13/16	1 1/16	5/16	1/2	5/8	3/4	7/8	1 1/4



BENDING DIAGRAM



All dimensions are out to out.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST I-BEAM SECTIONS
PRETENSIONED AND POST-TENSIONED, SPANS 40' TO 120'
REINFORCING STEEL, QUANTITIES AND SECTIONS

28' & 40' ROADWAYS — HS20-44 LOADING
DO NOT SCALE

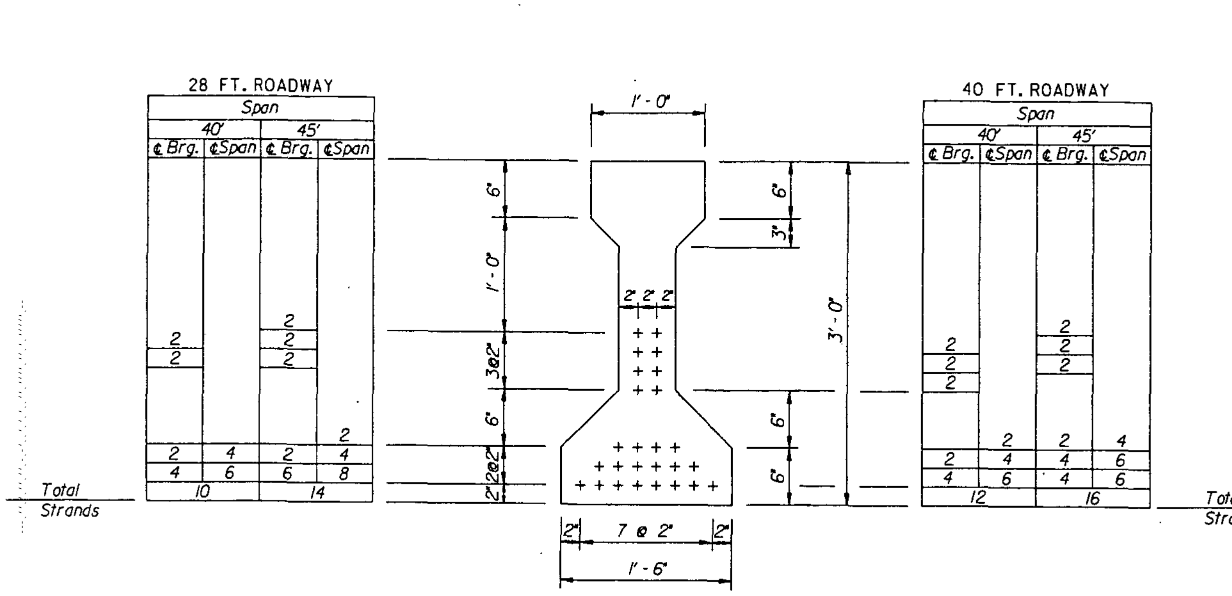
DESIGNED BY F.H.	DESIGN CHECKED BY F.L.	SEPT 1989	
DRAWN BY B.T.	DRAWING CHECKED BY F.H.	SHEET NO. 402	

DRAWING H-2A

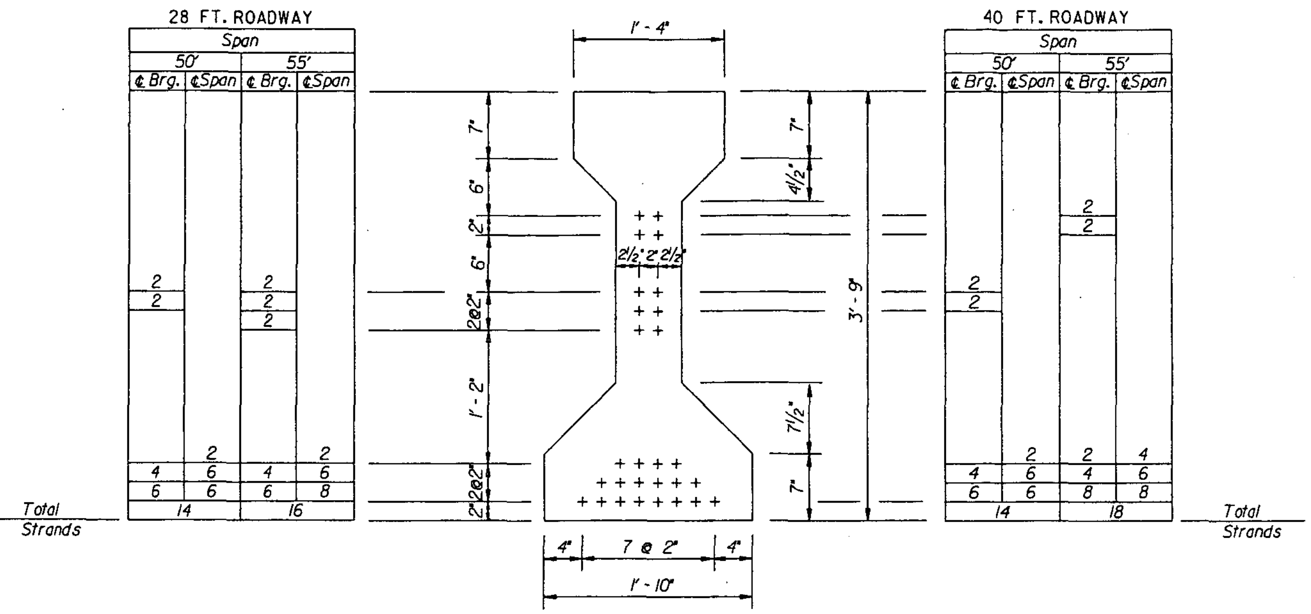
DRAWING H-2B—PRECAST AASHTO I-BEAM SECTIONS—PRETENSIONED STRANDS (40 to 55 FT SPANS)

This drawing shows the beam sections and elevations for 40 to 55 ft spans. Included in this drawing are the reinforcing bar required at both the support and midspan and the profile of the pretensioning strands. Quantities of reinforcing steel and concrete appear in a schedule.

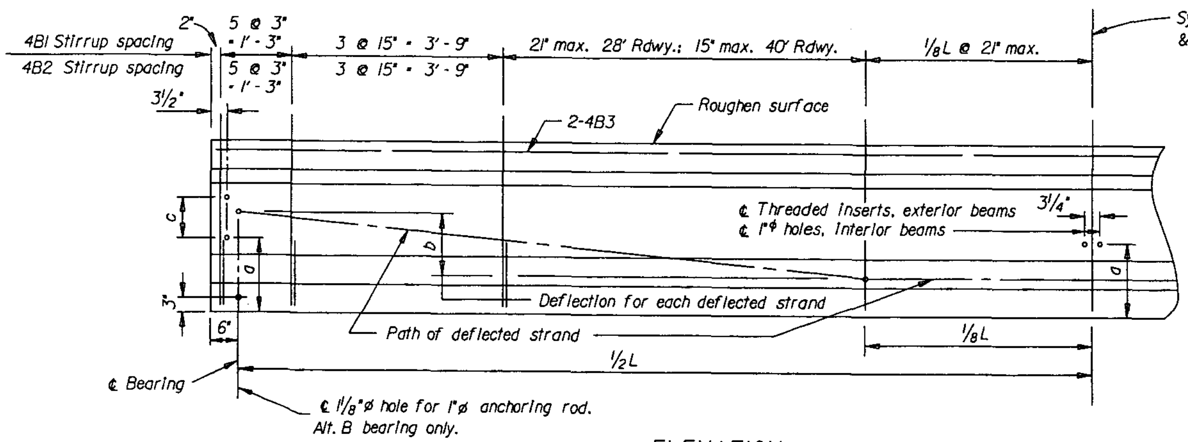
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



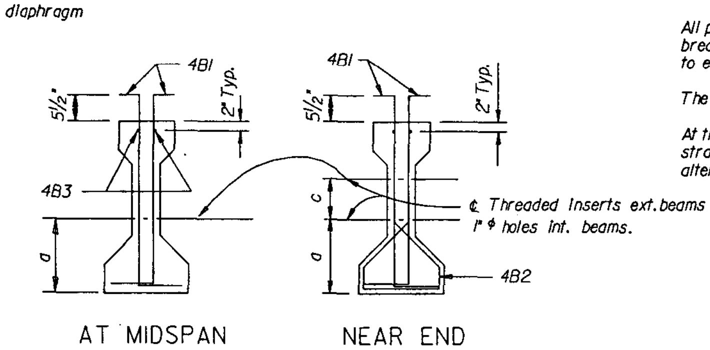
AASHTO TYPE II BEAM



AASHTO TYPE III BEAM



ELEVATION



SECTIONS

NOTES

All pretensioning strands are 1/2 inch in diameter and shall have a minimum breaking strength of 41,300 lb. per strand. The initial tensile force applied to each strand shall be 28,900 lbs.

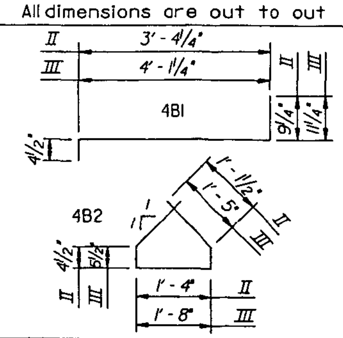
The required strength of concrete at transfer of prestress shall be 4000 psi

At transfer of prestress the sequence of release shall be: (a) the deflected strands, (b) the hold-down devices, and (c) the straight strands. Any alternate procedures shall meet with the approval of the engineer.

SPAN IN FEET		AASHTO BEAM TYPE	DIMENSION				REINFORCING STEEL SCHEDULE						SUMMARY OF QUANTITIES FOR ONE BEAM		
							4B1 Bent		4B2 Bent		4B3 Str.		REINFORCING	CONCRETE	
			a	b	c		Length	No.	Length	No.	Length	No.	Total Wt.-Lbs.	Volume-Cu.Yd.	Beam Wt.-Lbs.
28' RDWY	40'	II	1'-3 1/2"	1'-0"	0'-8 1/2"		4'-6"	70	4'-4"	18	21'-4"	4	300	3.9	15,800
	45'	II	1'-3 1/2"	1'-0"	0'-8 1/2"		4'-6"	78	4'-4"	18	23'-10"	4	330	4.4	17,700
	50'	III	1'-6"	1'-6"	1'-2 1/2"		5'-5"	82	5'-5"	18	26'-4"	4	400	7.3	29,800
	55'	III	1'-6"	1'-6"	1'-2 1/2"		5'-5"	90	5'-5"	18	28'-10"	4	440	8.1	32,700
40' RDWY	40'	II	1'-3 1/2"	0'-10"	0'-8 1/2"		4'-6"	78	4'-4"	18	21'-4"	4	320	3.9	15,800
	45'	II	1'-3 1/2"	1'-0"	0'-8 1/2"		4'-6"	86	4'-4"	18	23'-10"	4	350	4.4	17,700
	50'	III	1'-6"	1'-6"	1'-2 1/2"		5'-5"	94	5'-5"	18	26'-4"	4	450	7.3	29,800
	55'	III	1'-6"	2'-2"	1'-2 1/2"		5'-5"	102	5'-5"	18	28'-10"	4	480	8.1	32,700

BENDING DIAGRAM

All dimensions are out to out



Note: The first digit of the bar mark indicates the size of the bar.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
PRETENSIONED DEFLECTED STRANDS, SPANS 40' TO 55'
BEAM SECTIONS AND ELEVATIONS

28' & 40' ROADWAYS — HS20-44 LOADING

DO NOT SCALE

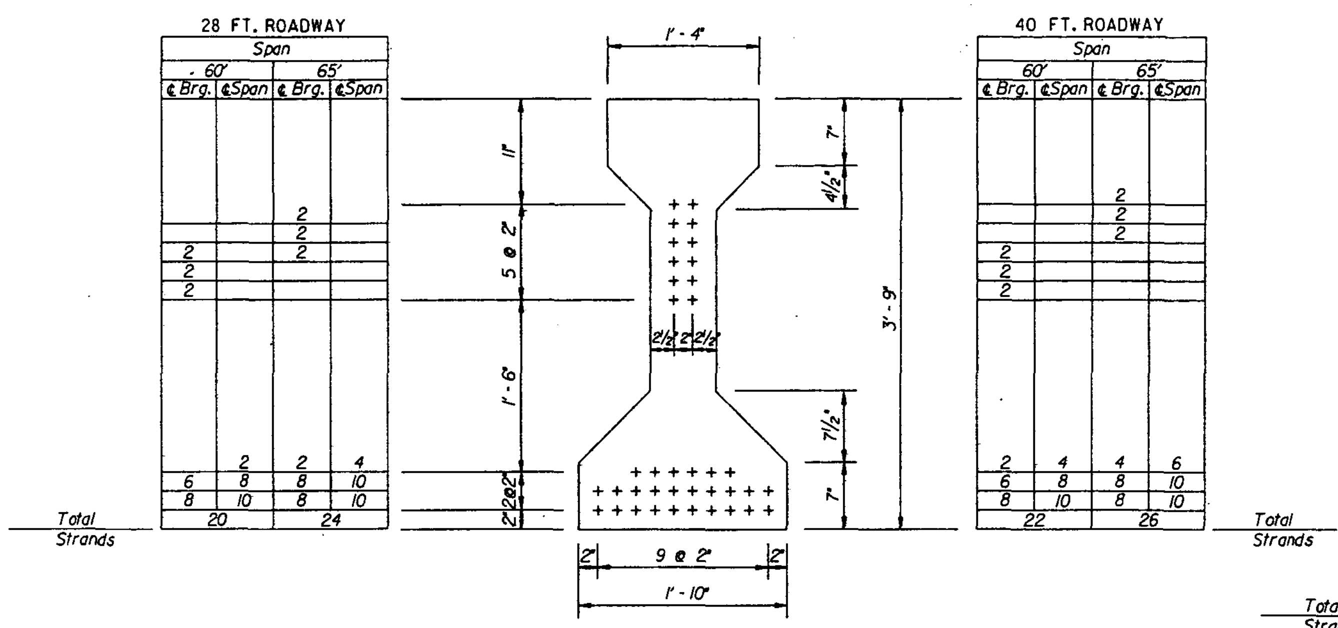
DESIGNED BY	F.H.	DESIGN CHECKED BY	F.L.	SEPT 1989
DRAWN BY	B.T.	DRAWING CHECKED BY	F.H.	SHEET NO. 403

DRAWING H-2B

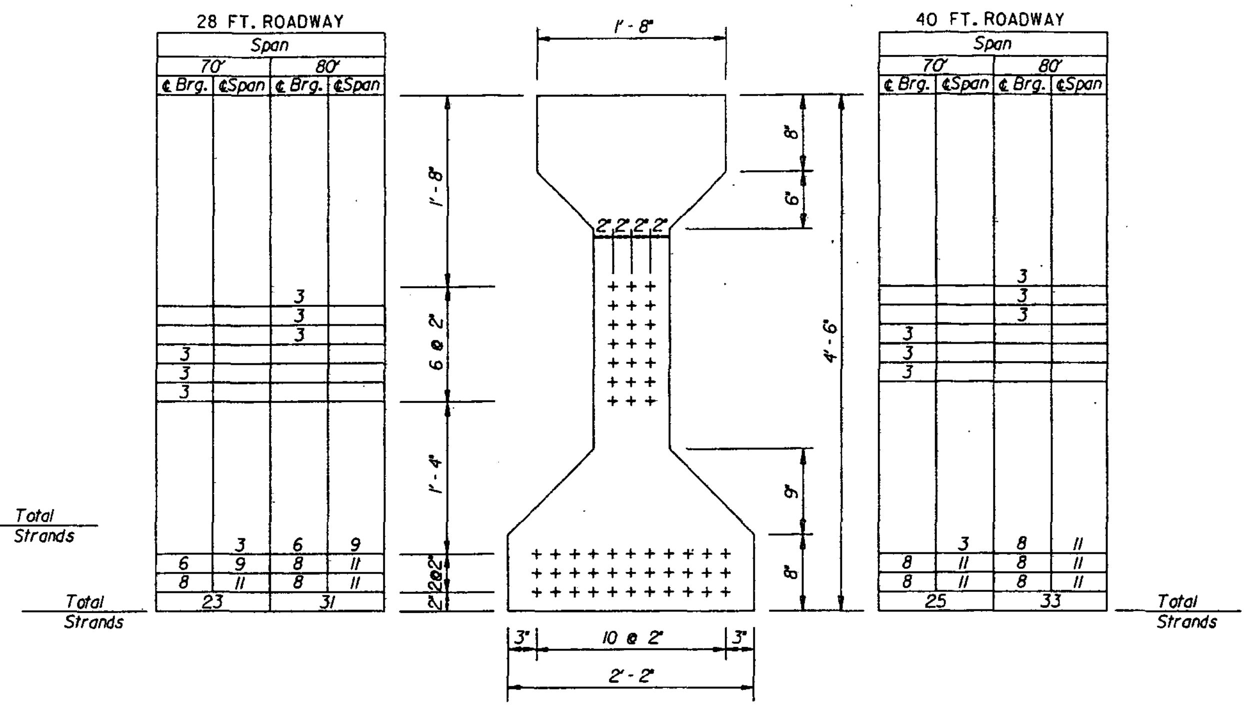
DRAWING H-2C—PRECAST AASHTO I-BEAM SECTIONS—PRETENSIONED STRANDS (60 TO 80 FT SPANS)

This drawing is similar to H-2B, except that this drawing covers 60 to 80 ft spans.

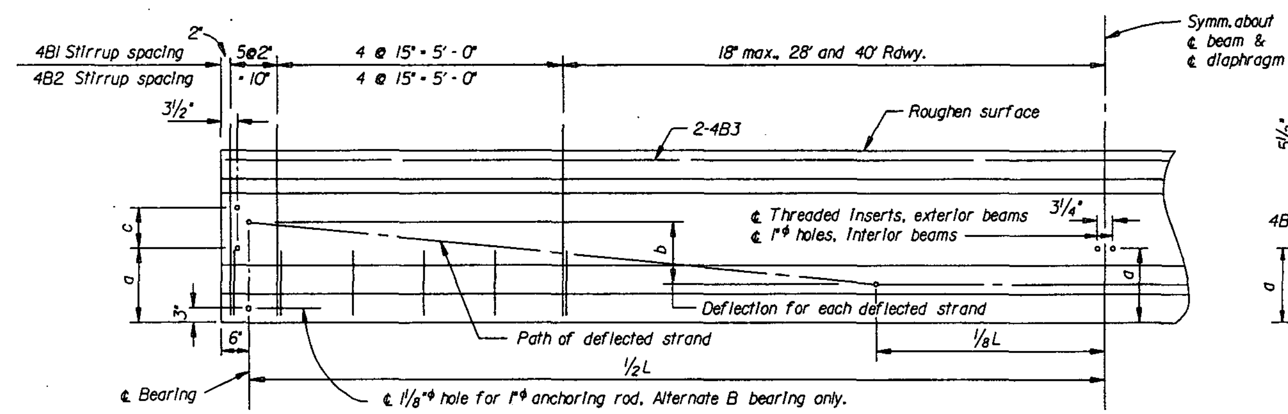
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



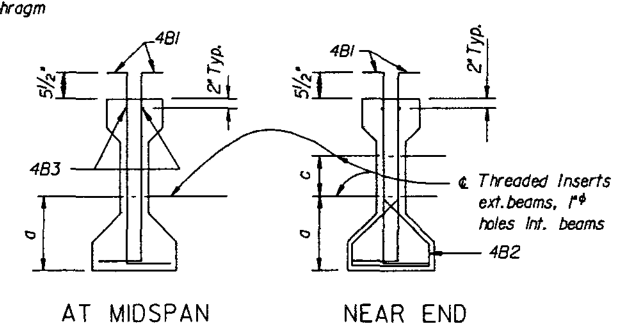
AASHTO TYPE III BEAM



AASHTO TYPE IV BEAM



ELEVATION



SECTIONS

NOTES

All pretensioning strands are 1/2 inch in diameter and shall have a minimum breaking strength of 41,300 lb. per strand. The initial tensile force applied to each strand shall be 28,900 lbs.

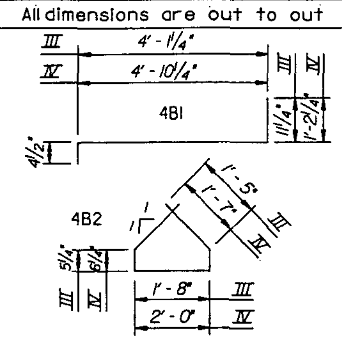
The required strength of concrete at transfer of prestress shall be 4000 psi.

At transfer of prestress the sequence of release shall be: (a) the deflected strands, (b) the hold-down devices, and (c) the straight strands. Any alternate procedures shall meet with the approval of the engineer.

	SPAN IN FEET	AASHTO BEAM TYPE	DIMENSION a	DIMENSION b	DIMENSION c		4B1 Bent Length	4B1 Bent No.	4B2 Bent Length	4B2 Bent No.	4B3 Str. Length	4B3 Str. No.	SUMMARY: REINFORCING Total Wt.-Lbs.	CONCRETE Volume-Cu.Yd.	CONCRETE Beam Wt.-Lbs.
28′ RDWY	60	III	1′ - 6″	1′ - 10″	1′ - 2 1/2″		5′ - 5″	106	5′ - 4″	20	31′ - 4″	4	500	8.8	36,100
28′ RDWY	65	III	1′ - 6″	2′ - 2″	1′ - 2 1/2″		5′ - 5″	110	5′ - 4″	20	33′ - 10″	4	530	9.5	39,000
28′ RDWY	70	IV	1′ - 8 1/2″	1′ - 8″	2@9 1/4″		6′ - 5″	118	6′-2″	20	36′ - 4″	4	650	14.4	59,000
28′ RDWY	80	IV	1′ - 8 1/2″	2′ - 2″	2@9 1/4″		6′ - 5″	130	6′-2″	20	41′ - 4″	4	720	16.4	67,300
40′ RDWY	60	III	1′ - 6″	1′ - 10″	1′ - 2 1/2″		5′ - 5″	106	5′ - 4″	20	31′ - 4″	4	500	8.8	36,100
40′ RDWY	65	III	1′ - 6″	2′ - 4″	1′ - 2 1/2″		5′ - 5″	110	5′ - 4″	20	33′ - 10″	4	530	9.5	39,000
40′ RDWY	70	IV	1′ - 8 1/2″	1′ - 10″	2@9 1/4″		6′ - 5″	118	6′-2″	20	36′ - 4″	4	650	14.4	59,000
40′ RDWY	80	IV	1′ - 8 1/2″	2′ - 4″	2@9 1/4″		6′ - 5″	130	6′-2″	20	41′ - 4″	4	720	16.4	67,300

BENDING DIAGRAM

All dimensions are out to out



Note: The first digit of the bar mark indicates the size of the bar.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
PRETENSIONED DEFLECTED STRANDS, SPANS 60′ TO 80′
BEAM SECTIONS AND ELEVATIONS

28′&40′ ROADWAYS HS20-44 LOADING
DO NOT SCALE

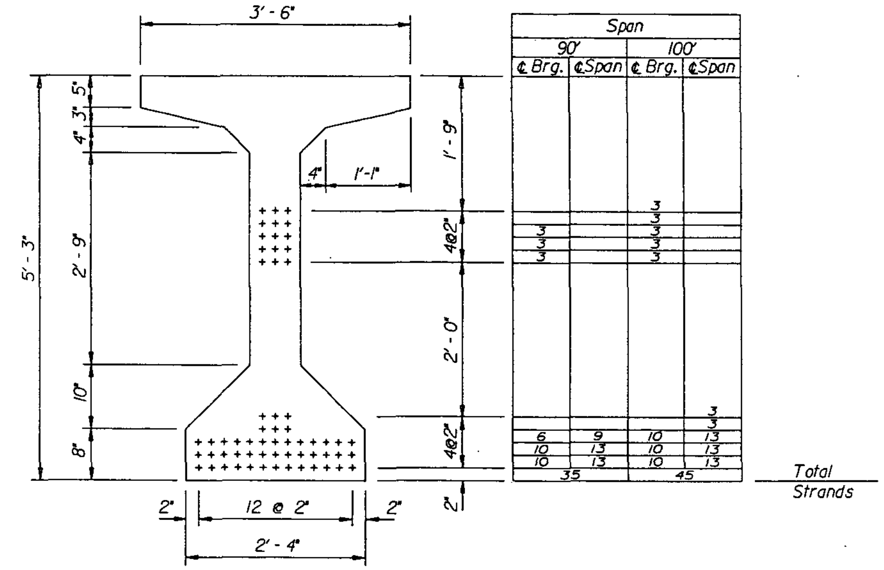
DESIGNED BY F.H. DESIGN CHECKED BY F.L. SEPT 1989
DRAWN BY B.T. DRAWING CHECKED BY F.H. SHEET NO. 404

DRAWING H-2C

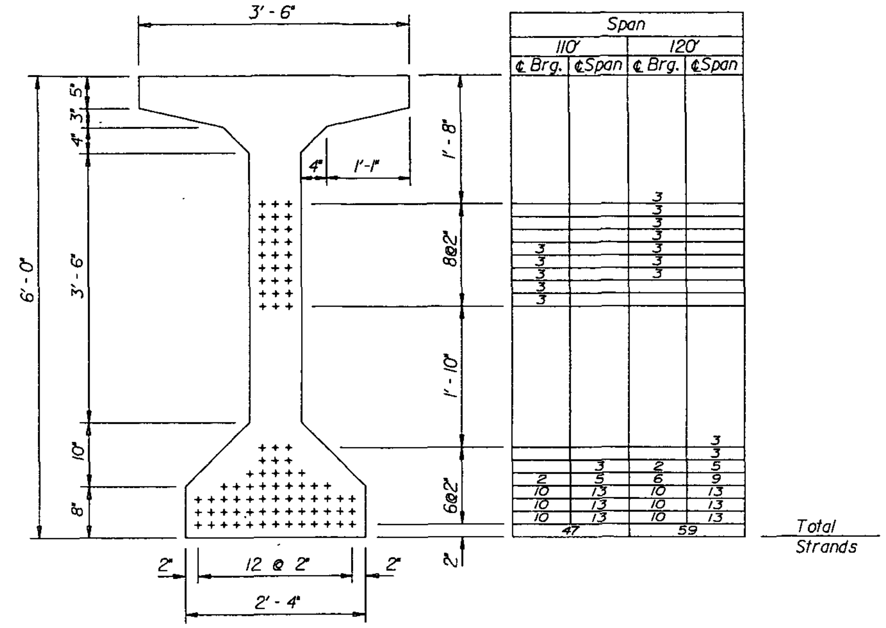
DRAWING H-2D—PRECAST AASHTO I-BEAM SECTIONS—PRETENSIONED STRANDS (90 TO 120 FT SPANS)

This drawing is similar to H-2B, except that this drawing covers 90 to 120 ft spans.

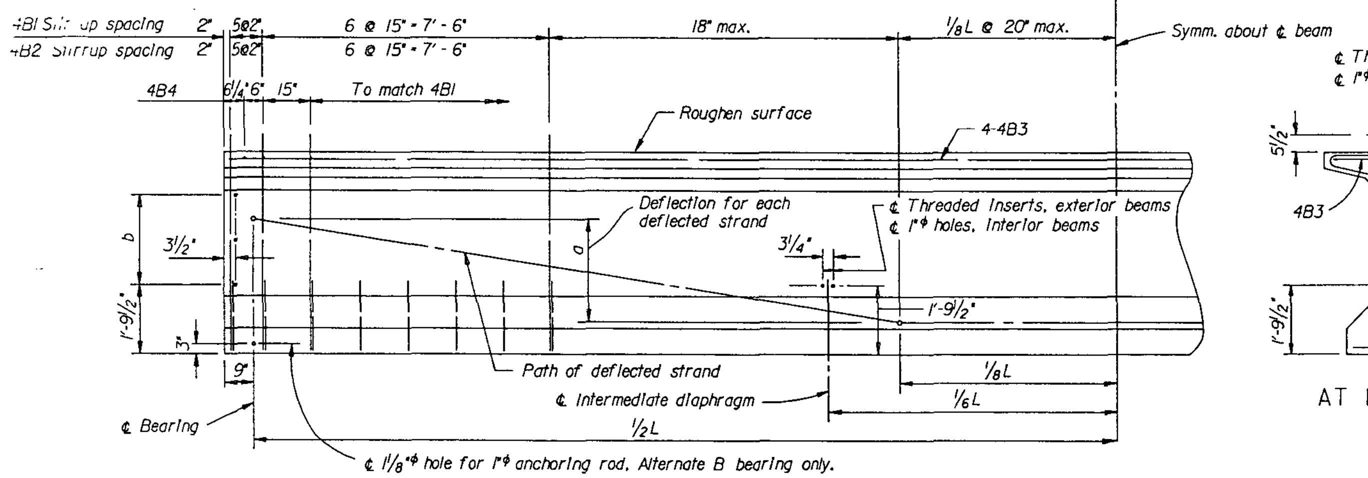
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural *drawings emphasize how the engineer should clearly indicate design requirements* and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



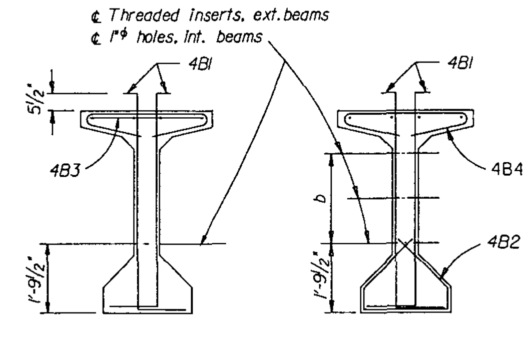
AASHTO TYPE V BEAM



AASHTO TYPE VI BEAM



ELEVATION



SECTIONS

NOTES

All pretensioning strands are 1/2 inch in diameter and shall have a minimum breaking strength of 41,300 lb. per strand. The initial tensile force applied to each strand shall be 28,900 lbs.

The required strength of concrete at transfer of prestress shall be 4000 psi. for 90' to 110' spans, and 4500 psi for 120' span.

At transfer of prestress the sequence of release shall be: (a) the deflected strands, (b) the hold-down devices, and (c) the straight strands. Any alternate procedures shall meet with the approval of the engineer.

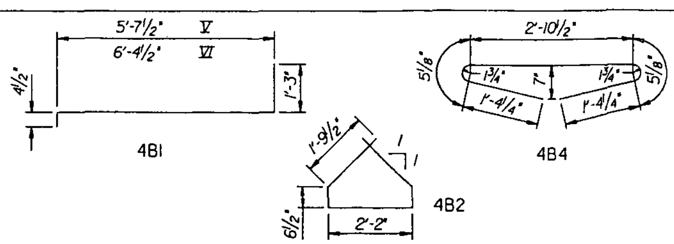
SPAN IN FEET	AASHTO BEAM TYPE	DIMENSION a	DIMENSION b	4B1 Bent Length	4B1 No.	4B2 Bent Length	4B2 No.	4B3 Str. Length	4B3 No.	4B4 Bent Length	4B4 No.	Reinforcing Total Wt. Lbs.	Concrete Volume Cu. Yds.	Concrete Beam Wt. Lbs.
90	V	2'-8"	2 @ 1'-2"	7'-3"	146	6'-10"	24	31'-6"	12	6'-5"	65	1310	23.7	97,300
100	V	2'-8"	2 @ 1'-2"	7'-3"	158	6'-10"	24	34'-10"	12	6'-5"	71	1420	26.3	108,000
110	VI	2'-10"	2 @ 1'-5"	8'-0"	170	6'-10"	24	38'-2"	12	6'-5"	77	1620	31.0	127,100
120	VI	3'-2"	2 @ 1'-5"	8'-0"	182	6'-10"	24	41'-6"	12	6'-5"	83	1730	33.8	138,500

(REINFORCING STEEL SCHEDULE; SUMMARY OF QUANTITIES FOR ONE BEAM)

Note: The first digit of the bar mark indicates the size of the bar.

BENDING DIAGRAM

All dimensions are out to out



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
PRETENSIONED DEFLECTED STRANDS, SPANS 90' TO 120'
BEAM SECTIONS AND ELEVATIONS

40'-0" ROADWAY HS20-44 LOADING
DO NOT SCALE

DESIGNED BY F.H.	DESIGN CHECKED BY F.L.	SEPT 1989
DRAWN BY B.T.	DRAWING CHECKED BY F.H.	SHEET NO. 405

DRAWING H-2D

DRAWING H-2E—PRECAST AASHTO I-BEAM SECTIONS—POST-TENSIONED STRANDS (60 TO 90 FT SPANS)

This drawing shows the beam sections and elevations for 60 to 90 ft spans. Included in this drawing are the reinforcing bar required at both the support and midspan and the profile of the post-tensioning strands. Quantities of reinforcing steel and concrete appear in a schedule.

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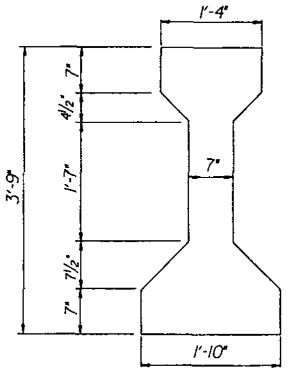
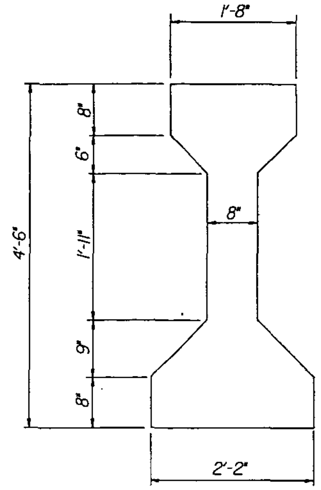


AASHTO TYPE III BEAM



AASHTO TYPE IV BEAM

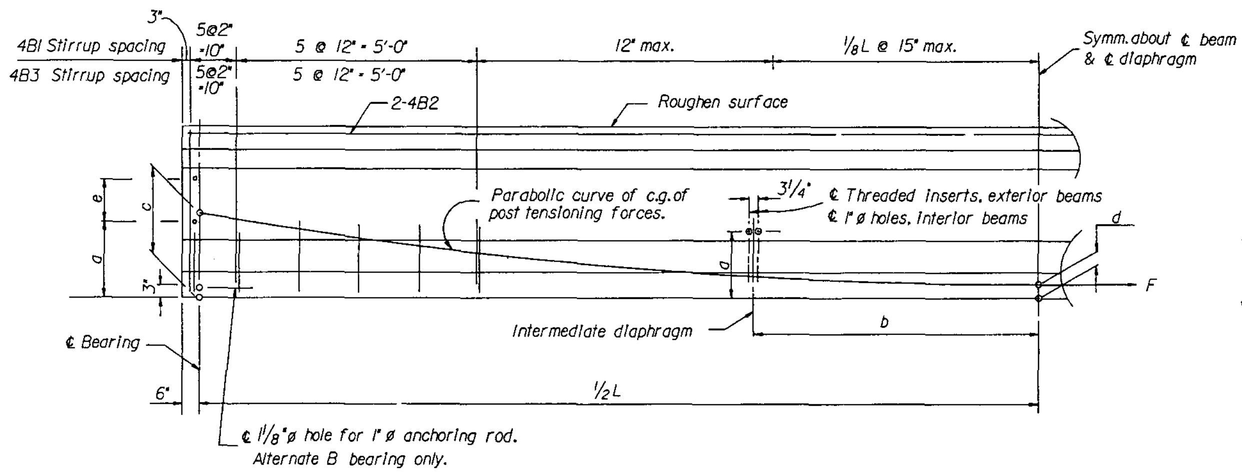
Total post-tensioning force 'F' in lbs., at ℄ span after losses			
60'	70'	80'	90'
520,000	620,000	770,000	920,000

NOTES

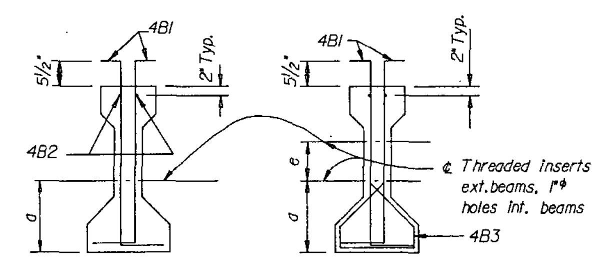
The required strength of concrete at transfer of prestress shall be 4,000 psi for 60' to 80' spans, and 5,000 psi for 90' spans.

A grid consisting of #3 bars at 3 inch centers in both directions shall be placed near each anchorage of the post-tensioning system.

Friction Coefficients are K=0.0002 and u=0.25 with an anchorage deformation of 1/8".



ELEVATION



AT MIDSPAN NEAR END

SECTIONS

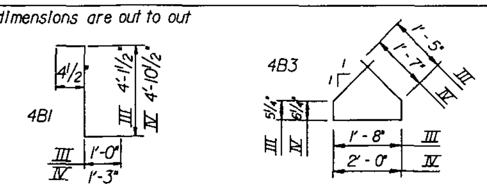
SUMMARY OF QUANTITIES FOR ONE BEAM

	SPAN IN FEET	AASHTO BEAM TYPE	REINFORCING STEEL Total Wt. Lbs.	CONCRETE Volume Cu. Yds.	CONCRETE Beam Wt. Lbs.
40' Roadway	60	III	670	8.8	36,200
	70	IV	870	14.4	59,200
	80	IV	980	16.4	67,600
	90	IV	1040	18.5	75,800

SPAN IN FEET		AASHTO BEAM TYPE	DIMENSION					REINFORCING STEEL SCHEDULE					
								4B1 Bent		4B2 Str.		4B3 Bent	
			a	b	c	d	e	Length	No.	Length	No.	Length	No.
40' Roadway	60	III	1'-6"	0	1'-8¼"	5"	1'-2½"	5'-6"	134	31'-0"	4	5'-4"	22
	70	IV	1'-8½"	0	1'-6¾"	5"	2 @ 9¼"	6'-6"	154	36'-0"	4	6'-2"	22
	80	IV	1'-8½"	0	1'-6¾"	5"	2 @ 9¼"	6'-6"	174	27'-9"	6	6'-2"	22
	90	IV	1'-8½"	15'-0"	1'-4¾"	4"	2 @ 9¼"	6'-6"	194	31'-1"	6	6'-2"	22

BENDING DIAGRAM

All dimensions are out to out



Note: The first digit of the bar mark indicates the size of the bar.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
POST-TENSIONED, SPANS 60' TO 90'
BEAM SECTIONS AND ELEVATIONS

40'-0" ROADWAY HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.H.	DESIGN CHECKED BY F.L.	SEPT 1989
DRAWN BY M.L.	DRAWING CHECKED BY F.H.	SHEET NO. 406

DRAWING H-2E

DRAWING H-2F—PRECAST AASHTO I-BEAM SECTIONS—POST-TENSIONED STRANDS (90 TO 120 FT SPANS)

This drawing is similar to H-2E except that this drawing covers 90 to 120 ft spans.

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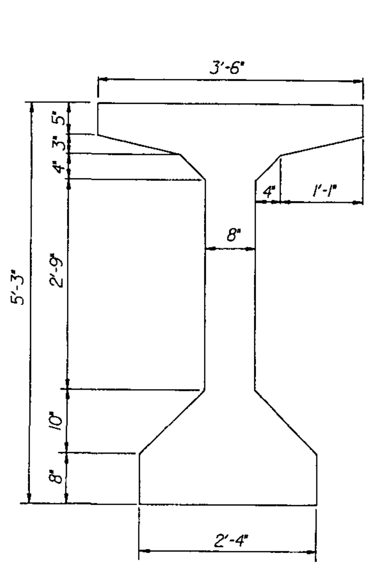
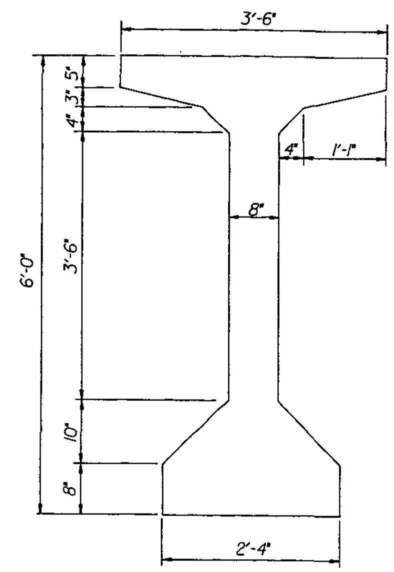


AASHTO TYPE V BEAM



AASHTO TYPE VI BEAM

NOTES

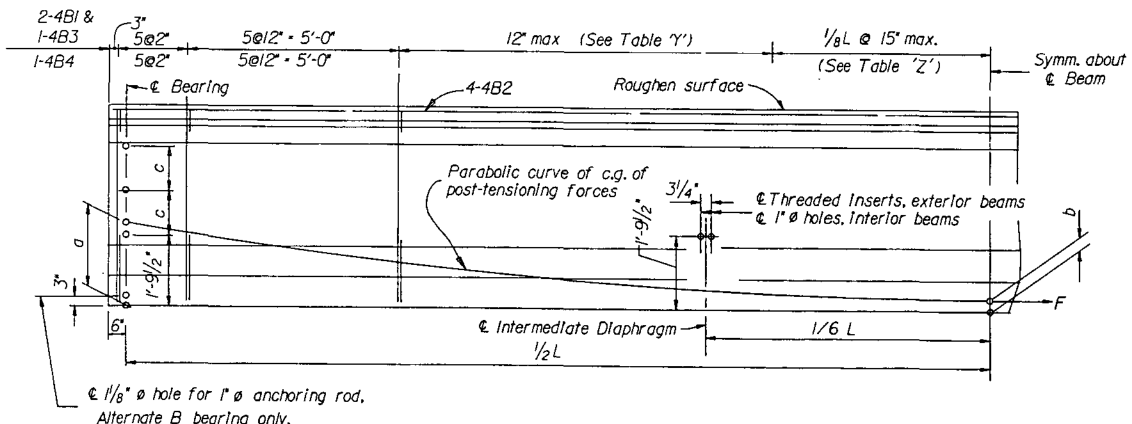
The required strength of concrete at transfer of prestress shall be 4000 psi for 90' spans. 4200 psi for 100' to 110' spans, and 5000 psi for 120' spans.

A grid consisting of #3 bars at 3 inch centers in both directions shall be placed near each anchorage of the post-tensioning system.

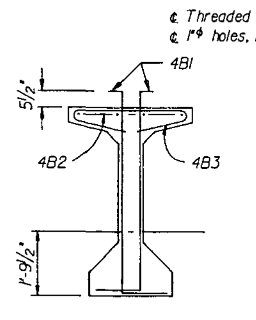
Friction Coefficients are K=0.0002 and u=0.25 with an anchorage deformation of 1/8".

SPAN IN FEET	4B1 & 4B3 SPACING	
	Y	Z
90	29 @ 1'-0" = 28'-2"	9 @ 1'-3" = 11'-3"
100	32 @ 1'-0" = 31'-11"	10 @ 1'-3" = 12'-6"
110	36 @ 1'-0" = 35'-8"	11 @ 1'-3" = 13'-9"
120	40 @ 1'-0" = 39'-5"	12 @ 1'-3" = 15'-0"

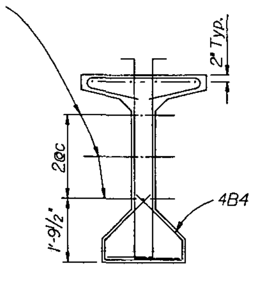
Total post-tensioning force, 'F' in lbs., at ℄ span after losses			
90'	100'	110'	120'
870,000	1,020,000	1,100,000	1,250,000



ELEVATION



AT MIDSPAN



NEAR END

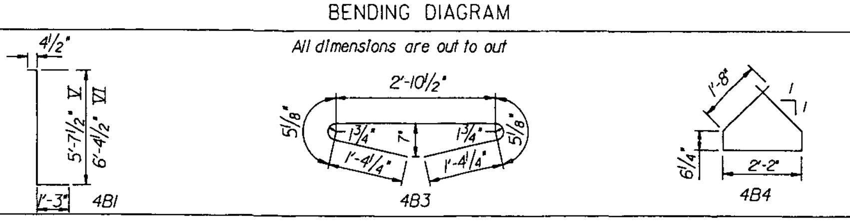
SUMMARY OF QUANTITIES FOR ONE BEAM				
SPAN IN FEET	AASHTO BEAM TYPE	REINFORCING STEEL Total Wt. Lbs.	CONCRETE Volume Cu. Yds.	CONCRETE Beam Wt. Lbs.
90	V	1890	25.9	106,700
100	V	2060	28.5	117,400
110	VI	2460	34.2	140,800
120	VI	2610	36.9	152,200

SPAN IN FEET	AASHTO BEAM TYPE	DIMENSION			REINFORCING STEEL SCHEDULE							
					4B1 Bent		4B2 Str.		4B3 Bent		4B4 Bent	
		a	b	c	Length	No.	Length	No.	Length	No.	Length	No.
90	V	1'-11"	5"	1'-2"	7'-3"	194	31'-2"	12	6'-5"	97	6'-6 1/2"	22
100	V	1'-11 5/8"	5 3/8"	1'-2"	7'-3"	210	34'-6"	12	6'-5"	105	6'-6 1/2"	22
110	VI	1'-10"	5"	1'-4 1/4"	8'-0"	230	37'-10"	12	6'-5"	115	6'-6 1/2"	22
120	VI	2'-2"	5"	1'-4 1/4"	8'-0"	250	41'-2"	12	6'-5"	125	6'-6 1/2"	22

Note: The first digit of the bar mark indicates the size of the bar.

BENDING DIAGRAM

All dimensions are out to out



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST AASHTO I-BEAM SECTIONS
POST-TENSIONED, SPANS 90' TO 120'
BEAM SECTIONS AND ELEVATIONS

40'-0" ROADWAY HS20-44 LOADING
DO NOT SCALE

DESIGNED BY F.H. DESIGN CHECKED BY F.L. SEPT 1989
DRAWN BY M.L. DRAWING CHECKED BY F.H. SHEET NO. 407

DRAWING H-2F

DRAWING H-3—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—GENERAL

This drawing includes the general plan and typical cross section for a four-span bridge. It consists of precast/prestressed I-beams composite with a cast-in-place deck. End and intermediate diaphragms are cast-in-place. "General Notes" and "Summary of Quantities" are provided. Corrosion protection is required where exposure to deicing salts or saltwater may occur. Precast/prestressed piles and steel H-piles are used for support. A total of six drawings are provided for this project.

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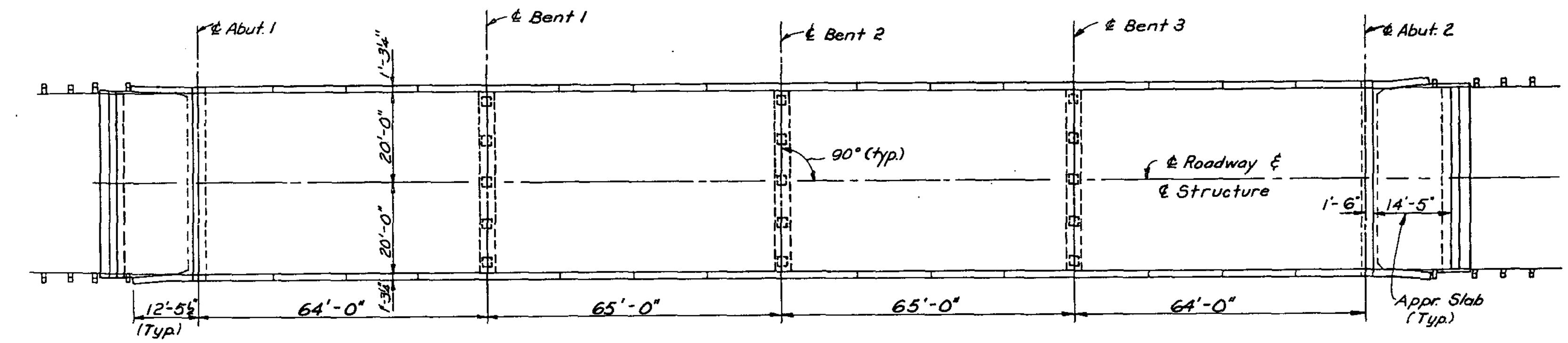
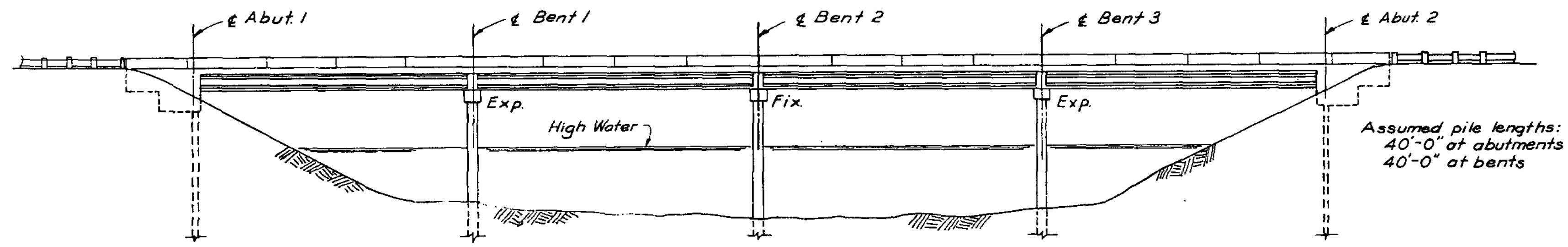
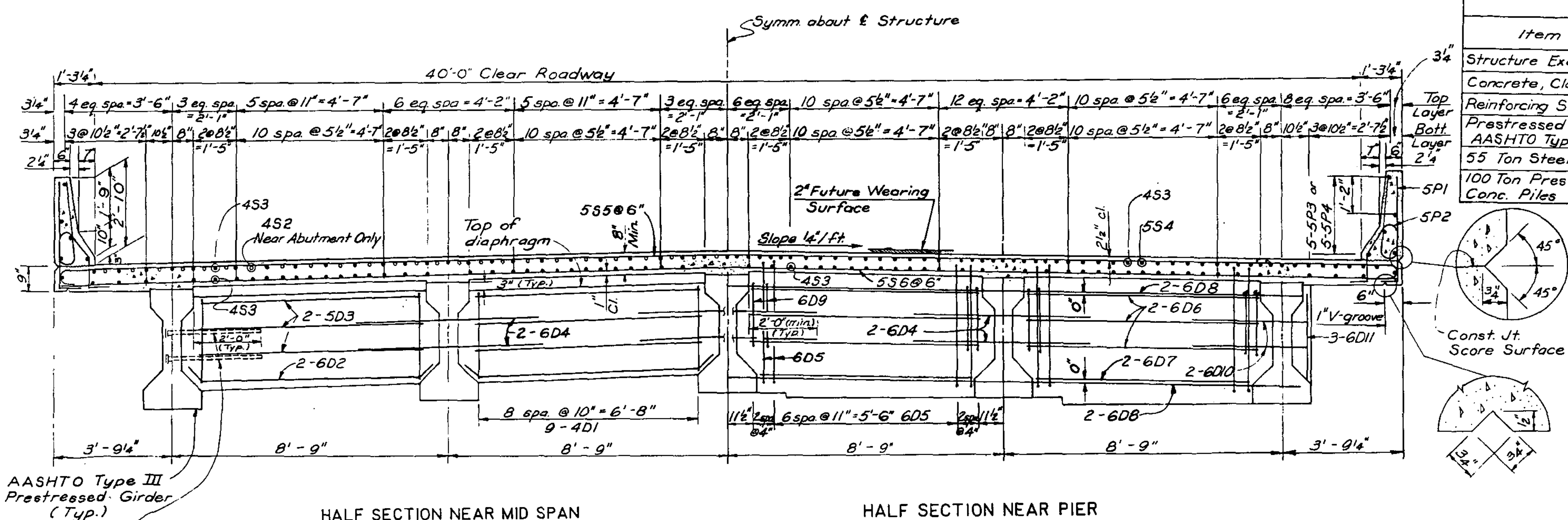


PLAN



ELEVATION



Threaded insert and 1"Ø high tensile strength lag studs or equivalent. (exterior beam only)

TYPICAL CROSS SECTION

GENERAL NOTES

Design Specifications: Standard Specifications for Highway Bridges, AASHTO 1977 and Interim Specifications, 1978 thru 1982, using Load Factor Design (LFD) except for foundation design.

Design Loadings:
Dead Load: Includes 25 pounds per square foot for future w.s.
Live Load: AASHTO HS20-44

Precast Prestressed Concrete: Concrete in prestressed beams shall be class P with minimum compressive strength of f'_c as given below.
f'_c = 5,000 psi, at 28 days
f'_c = 4,000 psi, at the time of transfer of prestressing

Cast-In-Place Concrete: All cast-in-place concrete shall be class A(AE) with 28 day compressive strength of f'_c as given below:
Deck slab: f'_c = 4,500 psi.
Approach slab and Bents: f'_c = 4,000 psi.
All other: f'_c = 3,000 psi.
The air entraining agents shall meet with the approval of the engineer. All exposed edges shall be chamfered ¾ inch, except as noted.

Bridge Slab Protective System: Where bridge slabs are likely to be subjected potential damaging applications of deicing salts or where a salt water environment presents the potential for corrosion of reinforcing steel, a protective system is required that will effectively prevent chloride induced deterioration.

Reinforcing Steel: Deformed reinforcing steel shall conform to ASTM A615 (AASHTO M31), grade 60. Spiral reinforcing steel shall conform to ASTM A82 (AASHTO M32). Spacing of reinforcing steel is shown from center to center of bars. Splices shall be lapped 30 diameters unless otherwise shown. Cover for reinforcement shall be 2 inches clear except as noted.

Prestressing Steel: Prestressing steel shall conform to ASTM A416 (AASHTO M203), grade 270.

Piles: Piles shall be driven to a minimum bearing capacity shown below:
Abutments: 55 tons
Bents: 100 tons

Drainage: No provisions for deck drainage have been made in these plans. If required, see Appendix A for suggested details.

Alternate Rail: See Appendix A for alternate rail details.

SUMMARY OF QUANTITIES

Item	Unit	Super-Structure	Approach Slab	Abutments	Bents	Total
Structure Excavation	C.Y.	To meet conditions of site and specifications				
Concrete, Class A(AE)	C.Y.	341.4	65.8	89.5	81.8	578.5
Reinforcing Steel	LBS.	85,290	12,190	8,440	16,330	122,250
Prestressed Conc. Beam AASHTO Type III	Ea.	20	—	—	—	20
55 Ton Steel H-Piles	L.F.	—	—	640	—	640
100 Ton Prestressed Conc. Piles	L.F.	—	—	—	600	600

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
GENERAL PLAN AND CROSS SECTION

40'-0" ROADWAY HS20-44 LOADING
DO NOT SCALE

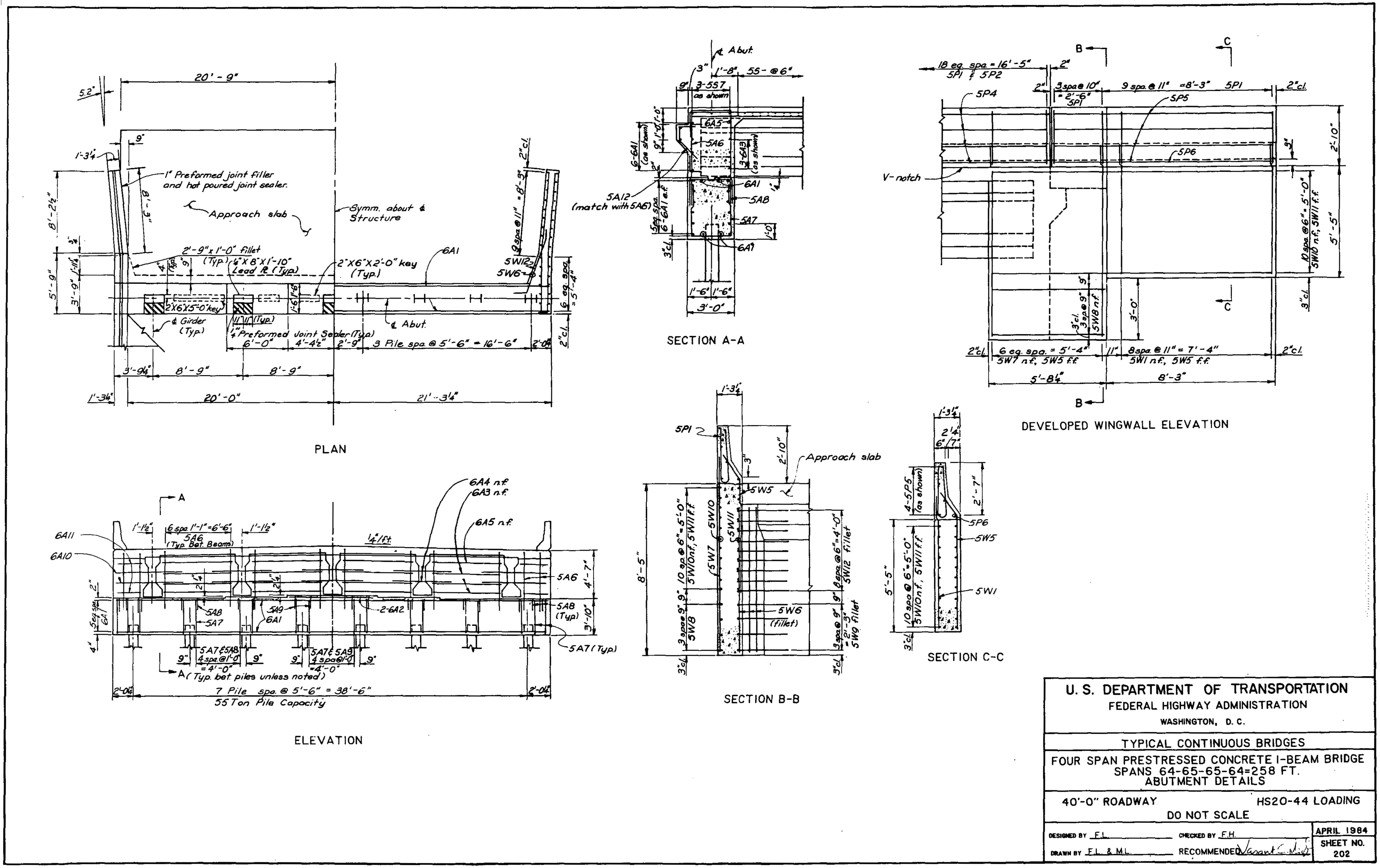
DESIGNED BY F.L.	CHECKED BY F.H.	APRIL 1984
DRAWN BY F.L. & M.L.	RECOMMENDED [signature]	SHEET NO 201

DRAWING H-3

DRAWING H-3A—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—ABUTMENT DETAILS

This drawing provides abutment and wing wall details.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.


PLAN
ELEVATION
SECTION A-A
SECTION B-B
SECTION C-C
DEVELOPED WINGWALL ELEVATION
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.
TYPICAL CONTINUOUS BRIDGES
FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
ABUTMENT DETAILS
40'-0" ROADWAY
HS20-44 LOADING
DO NOT SCALE
DESIGNED BY F.L.
CHECKED BY F.H.
DRAWN BY F.L. & M.L.
RECOMMENDED
APRIL 1984
SHEET NO. 202

DRAWING H-3A

DRAWING H-3B—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—BENT DETAILS

Fixed and expansion bent details are shown. Precast/prestressed pile details are also shown.

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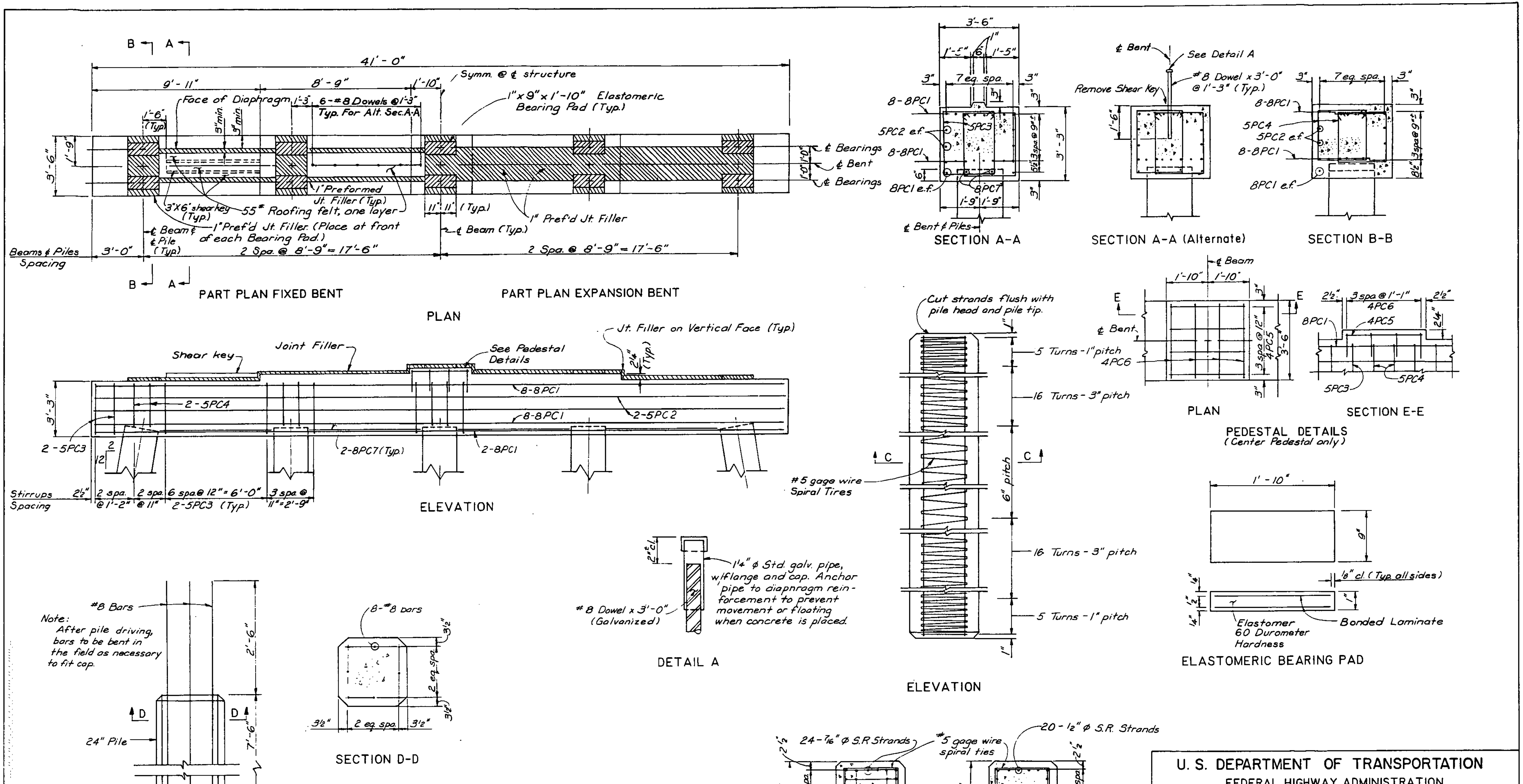

PILE DATA-TYPE - SS

Pile Size	No. and Size of S.R. Strand		Total Pretensioning Force - pounds		Unit Prestress-psi (after losses)		Section Modulus in.³
	Regular	Alternate	Regular	Alternate	Regular	Alternate	
24"	24-7/16"⌀	20-1/2"⌀	520,800	578,200	723	803	2304

Notes:

1. Strands shall be 7/16"⌀ or 1/2"⌀ 7-wire S.R. strands conforming to ASTM A416 (AASHTO M203), grade 270.
2. Concrete in the precast prestressed piles shall have a minimum compressive strength (f'_c) of 5,000 psi at 28 days.
3. The required strength of concrete at transfer of prestress shall be 4,000 psi.

PRESTRESSED CONCRFTE PILE DETAILS

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
BENT DETAILS

40'-0" ROADWAY HS20-44 LOADING
DO NOT SCALE

DESIGNED BY F.L. CHECKED BY F.H. APRIL 1984
DRAWN BY F.L. & M.L. RECOMMENDED Vasant C. Mistry SHEET NO. 203

DRAWING H-3B

DRAWING H-3C—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—FRAMING PLAN AND DECK SLAB DETAILS

A framing plan showing precast I-beams, bent, and interior and end diaphragm details is given. Slab reinforcement is shown in plan view.

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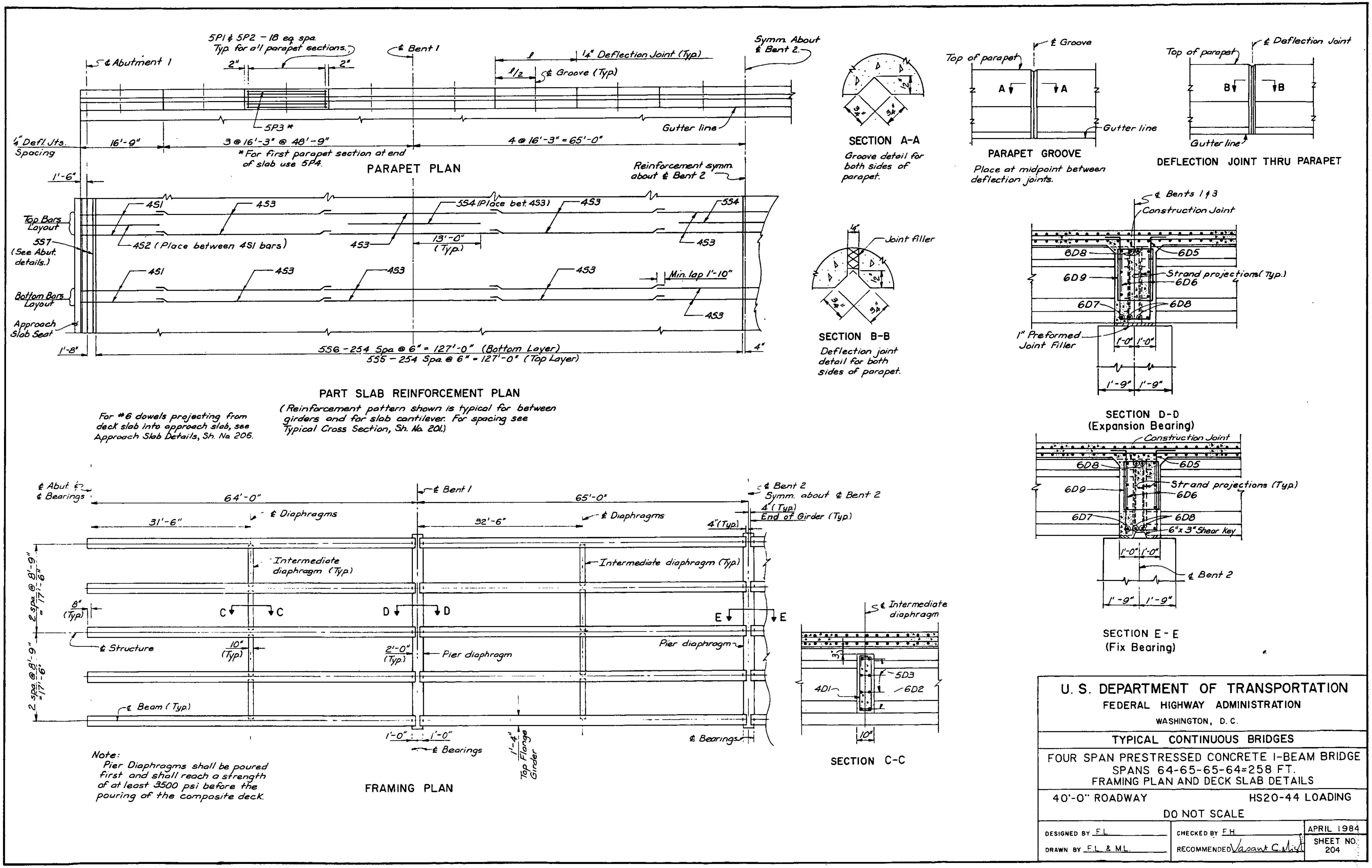
5P1 & 5P2 – 18 eq. spa. Typ. for all parapet sections.
℄ Abutment 1
℄ Bent 1
1/4" Deflection Joint (Typ.)
Symm. About ℄ Bent 2.
℄ Groove (Typ.)
5P3 *
Gutter line
1/4" Defl. Jts. Spacing
16'-9"
3 @ 16'-3" = 48'-9"
4 @ 16'-3" = 65'-0"
* For first parapet section at end of slab use 5P4.
PARAPET PLAN
Reinforcement symm. about ℄ Bent 2
1'-6"
Top Bars Layout
5S7 (See Abut. details.)
Bottom Bars Layout
Approach Slab Seat
4S1
4S3
5S4 (Place bet. 4S3)
4S2 (Place between 4S1 bars)
13'-0" (Typ.)
Min. lap 1'-10"
1'-8"
5S6 - 254 Spa. @ 6" = 127'-0" (Bottom Layer)
5S5 - 254 Spa. @ 6" = 127'-0" (Top Layer)
4"
PART SLAB REINFORCEMENT PLAN
(Reinforcement pattern shown is typical for between girders and for slab cantilever. For spacing see Typical Cross Section, Sh. No. 201.)
For #6 dowels projecting from deck slab into approach slab, see Approach Slab Details, Sh. No. 206.
SECTION A-A
Groove detail for both sides of parapet.
℄ Groove
Top of parapet
Gutter line
PARAPET GROOVE
Place at midpoint between deflection joints.
℄ Deflection Joint
DEFLECTION JOINT THRU PARAPET
Joint filler
SECTION B-B
Deflection joint detail for both sides of parapet.
℄ Bents 1 & 3
Construction Joint
6D8
6D5
6D9
Strand projections (Typ.)
6D6
6D7
1" Preformed Joint Filler
1'-0"
1'-9"
SECTION D-D
(Expansion Bearing)
6" x 3" Shear Key
℄ Bent 2
SECTION E-E
(Fix Bearing)
℄ Abut. & ℄ Bearings
64'-0"
65'-0"
31'-6"
32'-6"
℄ Diaphragms
℄ Bent 2
Symm. about ℄ Bent 2
4" (Typ.)
End of Girder (Typ.)
Intermediate diaphragm (Typ.)
2 spa. @ 8'-9" = 17'-6"
8" (Typ.)
℄ Structure
10" (Typ.)
2'-0" (Typ.)
Pier diaphragm
℄ Beam (Typ.)
1'-0"
℄ Bearings
1'-4" Top Flange Girder
Note:
Pier Diaphragms shall be poured first and shall reach a strength of at least 3500 psi before the pouring of the composite deck.
FRAMING PLAN
℄ Intermediate diaphragm
5D3
4D1
6D2
10"
SECTION C-C
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.
TYPICAL CONTINUOUS BRIDGES
FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
FRAMING PLAN AND DECK SLAB DETAILS
40'-0" ROADWAY
HS20-44 LOADING
DO NOT SCALE
DESIGNED BY F.L.
CHECKED BY F.H.
APRIL 1984
DRAWN BY F.L. & M.L.
RECOMMENDED Vasant C. Mistry
SHEET NO. 204

DRAWING H-3C

DRAWING H-3D—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—BEAM DETAILS

Precast/prestressed I-beam construction details are shown. Prestressing strands and reinforcing steel design requirements and details are shown. The list under "Notes" specifies general material requirements, casting, and handling procedures for the precast/prestressed beams.

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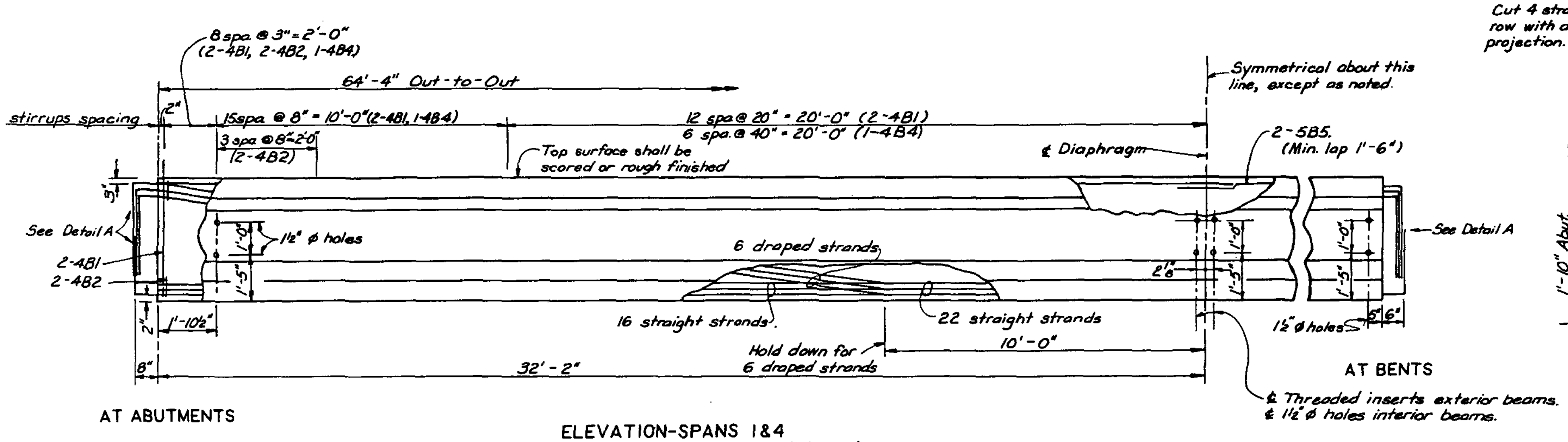
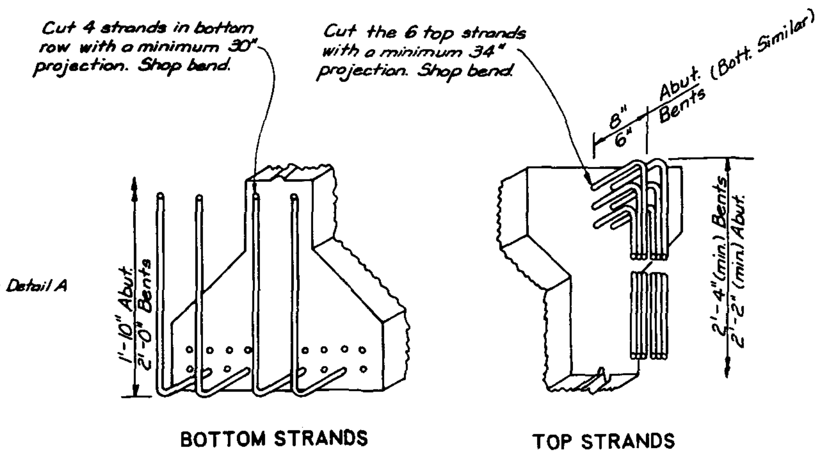
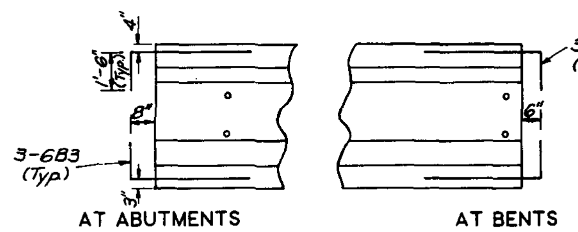


ELEVATION-SPANS 1&4

(SPANS 2 & 3 are similar except end details.)

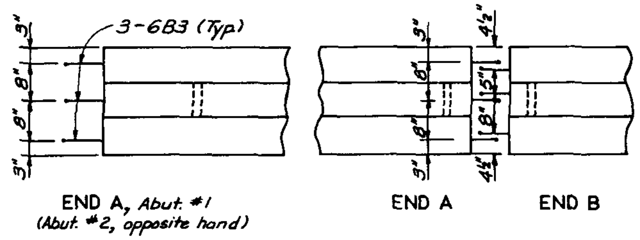


DETAIL A

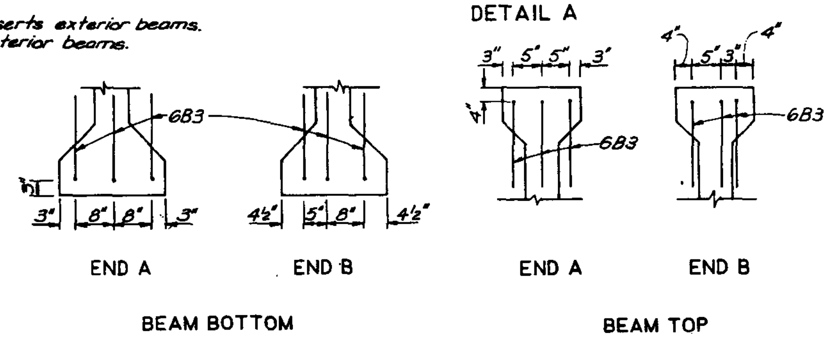


ALTERNATE DETAIL AT BEAM ENDS

(Alternate to Detail 'A')



PART PLAN



PART SECTIONS

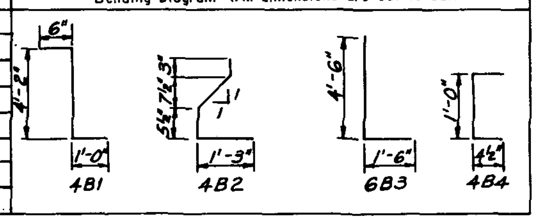
NOTES:

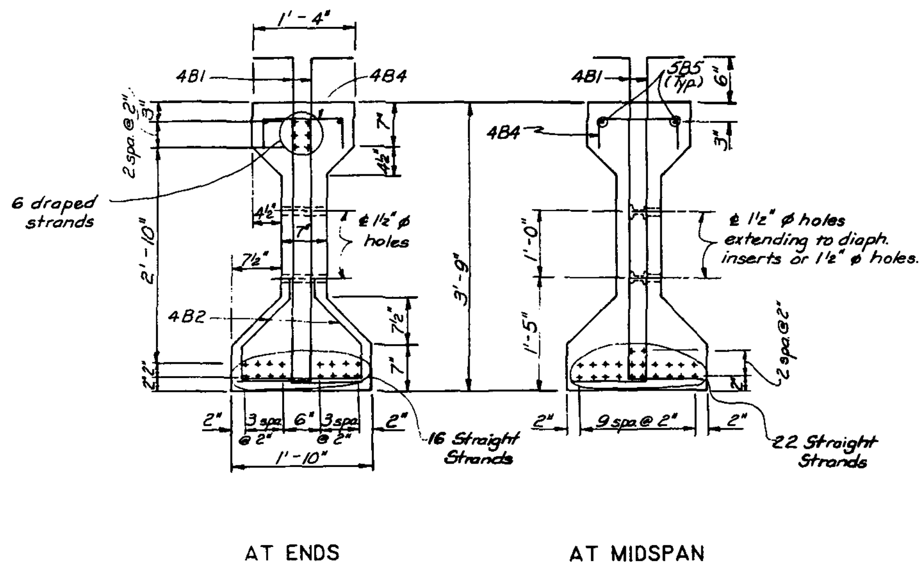
1. All beams shall be AASHTO Type III.
2. Strands shall be ½" ø 7-wire S.R. strands conforming to ASTM A416, grade 270, and shall be pretensioned to an initial force of 28,900 lbs.
3. The required strength of concrete at transfer of prestress shall be 4,000 psi.
4. The sequence used for release of pretensioning force on the strands shall be such that stresses are kept as near as possible symmetrical about the centroid of the beam.
5. Beams shall be picked up or blocked at points within 4 feet of the ends. The type of lifting device used shall be subject to approval by the Engineer.
6. Diaphragm inserts may be Richmond Structural concrete inserts, type EC-2, EC-2F or equivalent.

REINFORCING STEEL SCHEDULE PER BEAM

Mark	Type	Length	No.
4B1	Bent	5'-8"	142
4B2	"	2'-10"	48
6B3	"	6'-0"	12
4B4	"	1'-9"	61
5B5	Str.	32'-10"	4

Bending Diagram (All dimensions are out to out)





TYPICAL SECTIONS

SUMMARY OF QUANTITIES PER BEAM

ITEM	UNIT	QUANTITY
Class P Concrete	Cu. Yd.	93
Reinforcing steel	Lbs.	950
½" ø 7-wire strand	LF	1,471
Total weight	Lbs.	39,250

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
BEAM DETAILS

40'-0" ROADWAY HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.L. CHECKED BY F.H. APRIL 1984

DRAWN BY F.L. & M.L. RECOMMENDED [signature] SHEET NO. 205

DRAWING H-3D

DRAWING H-3E—PRECAST/PRESTRESSED CONCRETE I-BEAM BRIDGE—APPROACH SLAB AND REINFORCING STEEL SCHEDULE

The reinforcing steel schedule is presented here. Special bends are not shown in the ACI 315 Standard. Wing wall, approach slab, and guardrail connection details are shown.

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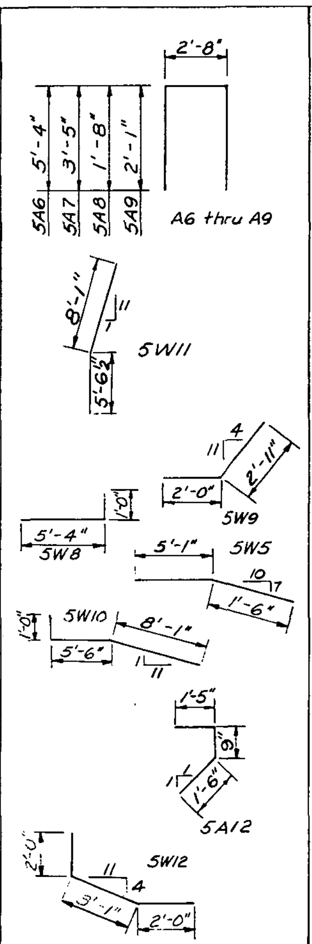
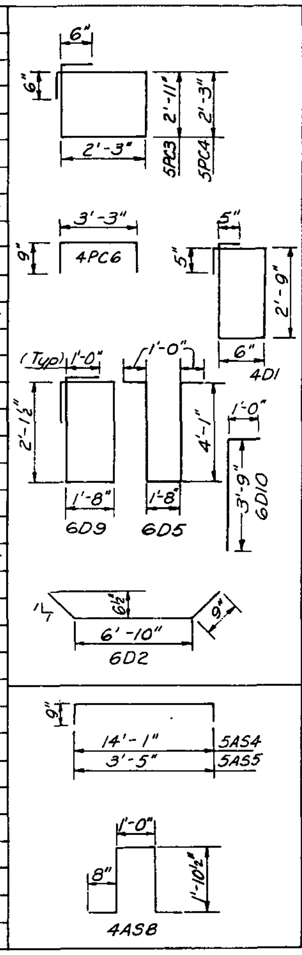
REINFORCING STEEL SCHEDULE

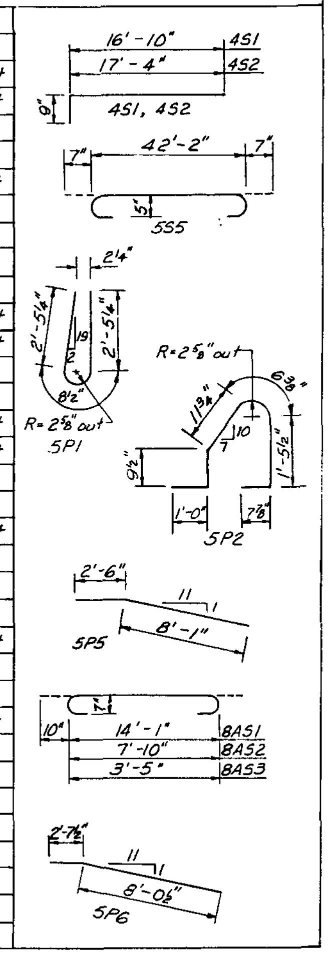
Mark	No.	Length	Type
ABUTMENTS			
6A1	44	42'-2"	Str.
6A2	4	8'-6"	↕
6A3	24	6'-8"	↕
6A4	12	6'-1"	↕
6A5	8	7'-2"	Str.
5A6	64	13'-4"	Bent
5A7	78	9'-6"	↕
5A8	64	6'-0"	↕
5A9	14	6'-10"	Bent
6A10	8	6'-8"	Str.
6A11	8	2'-10"	Str.
5A12	64	3'-8"	Bent
WINGWALLS			
5W1	36	6'-5"	Str.
5W2	Not	Used	—
5W3	Not	Used	—
5W4	Not	Used	—
5W5	64	6'-7"	Bent
5W6	12	6'-11"	Str.
5W7	28	9'-5"	Str.
5W8	16	6'-4"	Bent
5W9	16	4'-11"	↕
5W10	44	14'-7"	↕
5W11	44	13'-7½"	↕
5W12	36	7'-1"	Bent



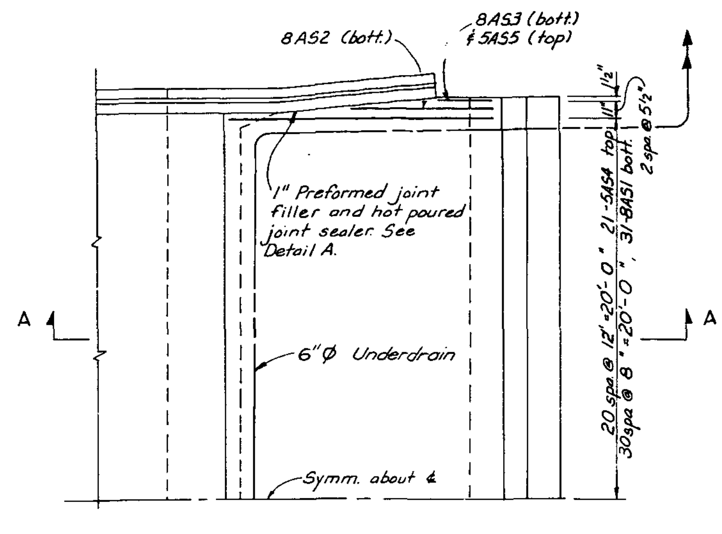
Mark	No.	Length	Type
PIER CAPS			
8PC1	54	40'-8"	Str.
5PC2	12	40'-8"	Str.
5PC3	192	11'-4"	Bent
5PC4	60	10'-0"	Bent
4PC5	12	3'-5"	Str.
4PC6	12	4'-9"	Bent
8PC7	24	6'-6"	Str.
DIAPHRAGMS			
4D1	144	7'-4"	Bent
6D2	32	8'-4"	Bent
5D3	96	7'-1"	Str.
6D4	84	5'-8"	Str.
6D5	108	11'-10"	Bent
6D6	72	7'-1"	Str.
6D7	24	6'-9"	Str.
6D8	12	36'-6"	Str.
6D9	48	9'-7"	Bent
6D10	24	4'-9"	Bent
6D11	18	2'-6"	Str.



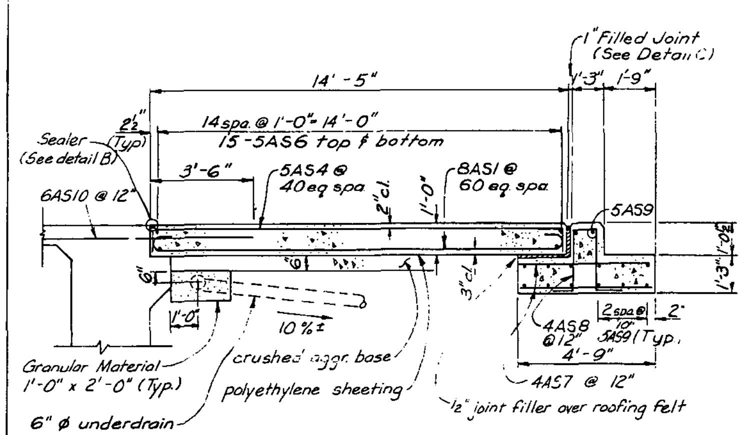
Mark	No.	Length	Type
SLAB			
4S1	238	17'-7"	Bent
4S2	104	18'-1"	Bent
4S3	833	34'-7"	Str.
5S4	156	26'-0"	Str.
5S5	510	43'-4"	Bent
5S6	510	42'-0"	Str.
5S7	6	38'-0"	Str.
PARAPET			
5P1	660	5'-7"	Bent
5P2	608	5'-5"	Bent
5P3	140	16'-0"	Str.
5P4	20	16'-6"	Str.
5P5	16	10'-7"	Bent
5P6	4	10'-8"	Bent
APPROACH SLAB			
8AS1	122	15'-9"	Bent
8AS2	4	9'-6"	↕
8AS3	4	5'-1"	↕
5AS4	82	15'-7"	↕
5AS5	4	4'-11"	Bent
5AS6	120	21'-3"	Str.
4AS7	168	4'-5"	Str.
4AS8	84	6'-1"	Bent
5AS9	28	41'-3"	Str.
6AS10	82	7'-0"	Str.



Note: Digit preceding letter denotes bar size.

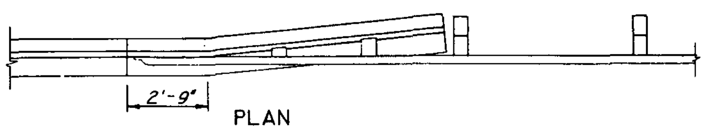


PLAN

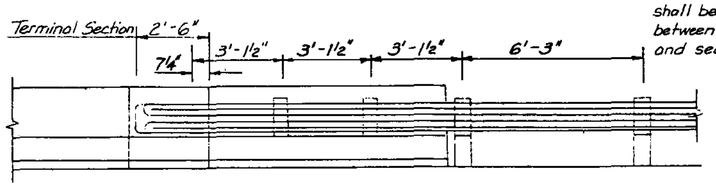


SECTION A-A

APPROACH SLAB

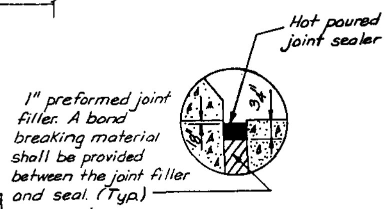


PLAN

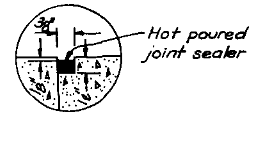


ELEVATION

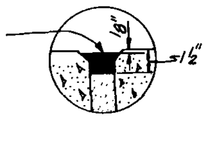
GUARDRAIL CONNECTION DETAILS



DETAIL A



DETAIL B



DETAIL C

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN PRESTRESSED CONCRETE I-BEAM BRIDGE
SPANS 64-65-65-64=258 FT.
APPROACH SLAB AND REINFORCING SCHEDULE

40'-0" ROADWAY HS20-44 LOADING
DO NOT SCALE

DESIGNED BY F.L. CHECKED BY F.H. APRIL 1984
DRAWN BY F.L. & M.L. RECOMMENDED Vasant C. Mistry SHEET NO. 206

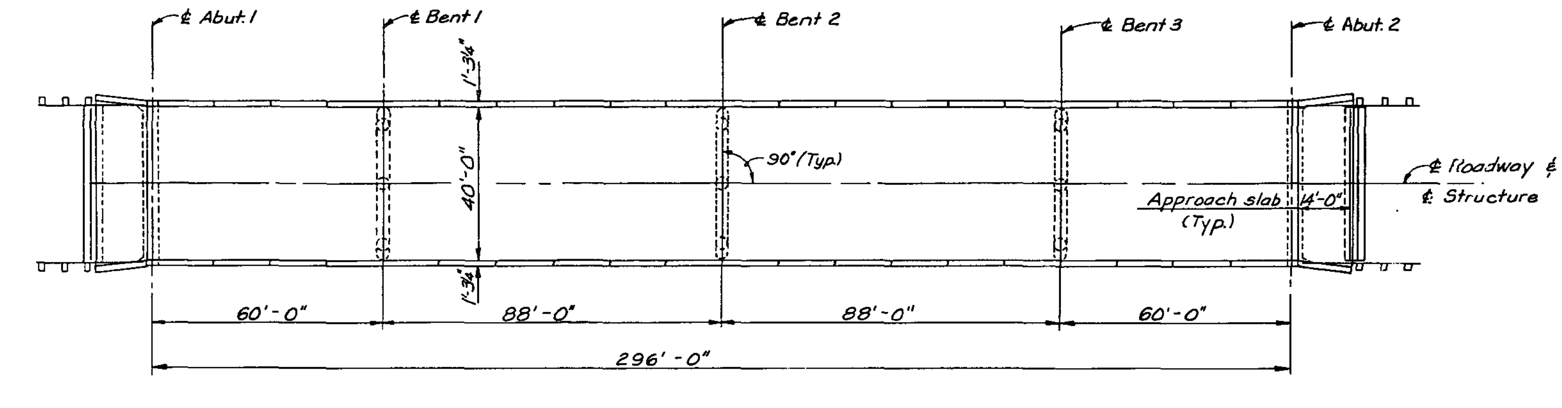
DRAWING H-3E

DRAWING H-4—ROLLED BEAM BRIDGE—GENERAL

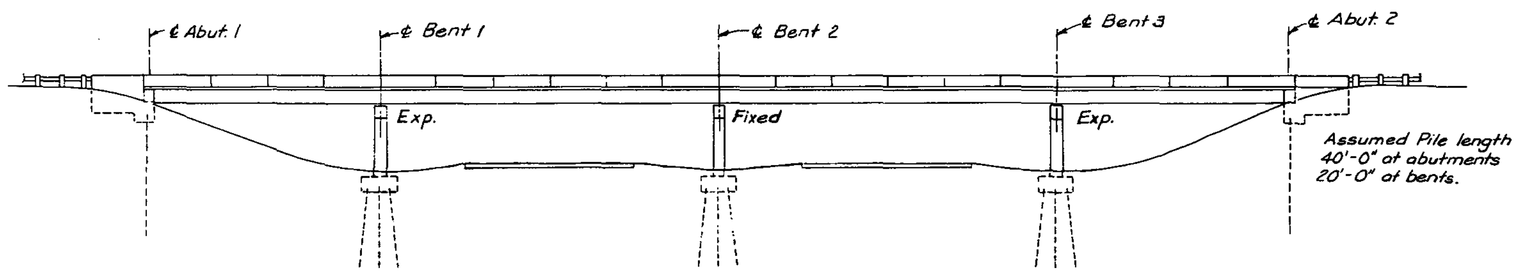
This is a four-span bridge, containing five longitudinal rows of rolled steel stringers supported by reinforced concrete bents and abutments. There is a reinforced concrete deck slab supported by the stringers. The deck slab extends beyond the outside girders and supports a reinforced concrete barrier rail at the edge.

This drawing shows the general layout of the bridge, plus "General Notes." There is also a typical transverse cross section, left-side cut near midspan and right side near pier. Deck reinforcement details are shown in the typical cross sections. A total of four drawings are provided for this project.

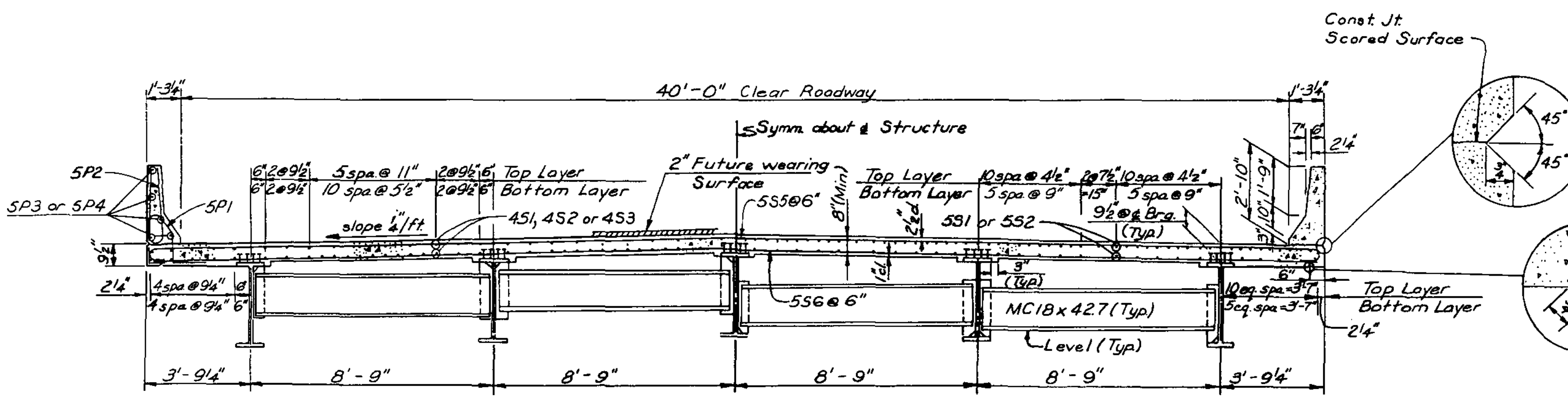
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



PLAN



ELEVATION



HALF SECTION NEAR MID SPAN

HALF SECTION NEAR PIER

TYPICAL CROSS SECTION

GENERAL NOTES

Design Specifications: Standard Specifications for Highway Bridges, AASHTO 1977 and Interim Specifications, 1978 thru 1982, using Load Factor Design (LFD) except for foundation design.

Design Loadings:
Dead Load: Includes 25 pounds per square foot for future wearing surface.
Live Load: AASHTO HS20-44. Live load deflection not to exceed $\frac{1}{800}$ of the span length.

Concrete: All concrete shall be class A(AE) with 28 day compressive strength of F'_c as given below.
Slab: F'_c = 4,500 psi.
All Other: F'_c = 4,000 psi.
The air entraining agents shall meet with the approval of the engineer. All exposed edges shall be chamfered ¾ inch, except as noted.

Reinforcing Steel: Deformed reinforcing steel shall conform to ASTM A615 (AASHTO M31), grade 60. Spiral reinforcing steel shall conform to ASTM A82 (AASHTO M32). Spacing of reinforcing steel is shown from center to center of bars. Splices shall be lapped 30 diameters unless otherwise shown. Cover for reinforcement shall be 2 inches clear except as noted.

Bridge Slab Protective System: Where bridge slabs are likely to be subjected to potential damaging applications of deicing salts or where a salt water environment presents the potential for corrosion of reinforcing steel, a protective system is required that will effectively prevent chloride induced deterioration.

Structural Steel: Structural steel for rolled beams and splice plates shall conform to ASTM A572, Grade 50 (AASHTO M223). All other structural steel shall conform to ASTM A-36 (AASHTO M183).

Camber: Rolled beams shall be cambered for the Dead Load deflections plus the allowed camber tolerance and, when required, for additional permanent camber.

Welding: Welding shall be done in accordance with the best modern practice and the applicable requirements of AWS D1.1-80 except as modified by AASHTO "Standard Specifications for Welding of Structural Steel Highway Bridges, 1981."

Bolted Connections: All bolted connections shall be made with ⅞" ϕ high strength bolts conforming to ASTM A325 (AASHTO M164). All field splices are friction type connections with class A contact surfaces.

Paint: All structural steel shall be given three or more coats of paint. Surfaces to be in contact with steel or concrete shall not be painted. The paint system and workmanship shall conform to AASHTO Standard Specifications for Highway Bridges.

Piles: Piles shall be driven to a minimum bearing capacity shown below:
Abutments: 70 tons
Bents: 55 tons; alternate pile footing ~ 28 tons.

Foundation Pressure: The alternate spread footing at the bent is designed for an allowable soil bearing pressure of 4 tons per square foot.

Drainage: No provisions for drainage have been made in these plans. If required, see Appendix A for suggested details.

Alternate Rail: See Appendix A for alternate rail details.

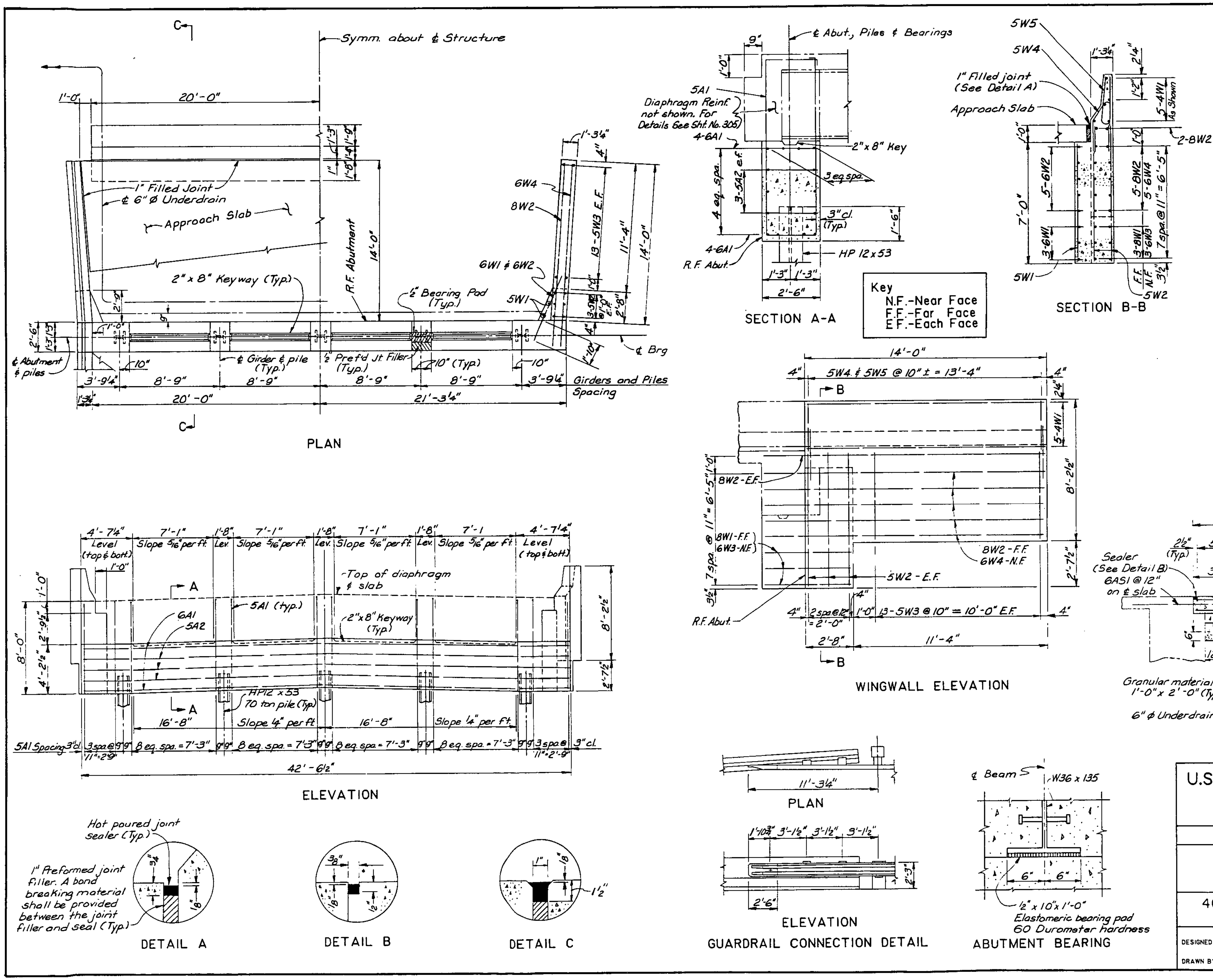
U. S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION WASHINGTON, D. C.		
TYPICAL CONTINUOUS BRIDGES		
FOUR SPAN ROLLED BEAM BRIDGE SPANS 60-88-88-60=296 FT. GENERAL PLAN AND CROSS SECTION		
40'-0" ROADWAY	HS20-44 LOADING	
DO NOT SCALE		
DESIGNED BY B.T.	CHECKED BY F.H.	APRIL 1984
DRAWN BY B.T. & M.L.	RECOMMENDED Vasant C. Mistry	SHEET NO. 301

DRAWING H-4

DRAWING H-4A—ROLLED BEAM BRIDGE—ABUTMENT DETAILS

This drawing shows details for the reinforced concrete abutments, wing walls, and approach slabs. The reinforcing steel schedule for these elements is shown here. Some special bending is required as shown in the schedules. See the note on diaphragm reinforcement referring to Sheet 305 (H-4C).

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

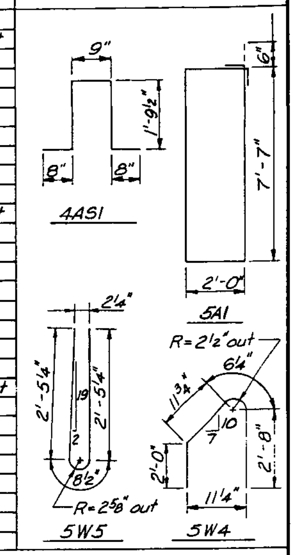


REINFORCING STEEL SCHEDULE

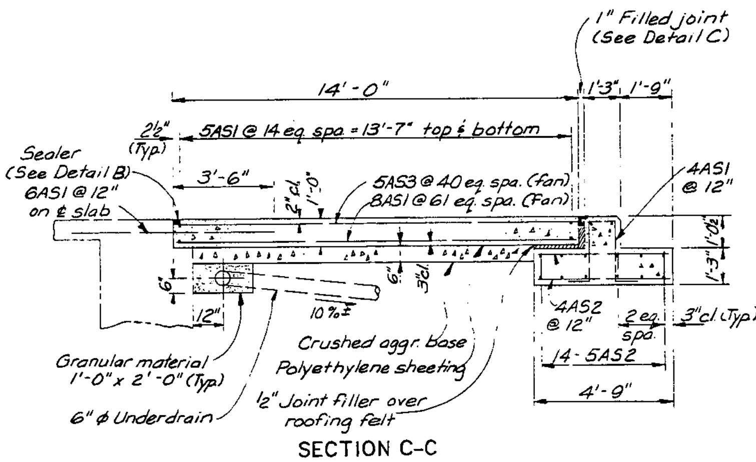
Mark	No.	Length	Type
Abutment			
5A1	88	20'-2"	Bent
5A2	12	42'-0½"	Str.
6A1	16	42'-0½"	Str.
Wingwall			
4W1	20	13'-8"	Str.
5W1	8	6'-7"	"
5W2	24	7'-7"	"
5W3	104	5'-0"	"
5W4	68	6'-2"	Bent
5W5	68	5'-7"	"
6W1	12	4'-8"	Str.
6W2	20	6'-3"	"
6W3	12	4'-10"	"
6W4	20	16'-2"	"
8W1	12	4'-10"	"
8W2	28	16'-2"	"
Approach Slab			
4AS1	80	5'-8"	Bent
4AS2	160	4'-3"	Str.
5AS1	60	39'-8" (2)	"
5AS2	28	39'-6"	"
5AS3	82	13'-8"	"
8AS1	124	13'-8"	"

BENDING DIAGRAM

All dimensions are out to out



(1) Digit preceding letter denotes bar size.
(2) Dimension given is for first bar at abutment backwall. Increase the length of remaining bars by 1½ in. increments for 5AS1.



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN ROLLED BEAM BRIDGE
SPANS 60-88-88-60=296 FT.
ABUTMENT DETAILS

40'-0" ROADWAY HS20-44 LOADING

DO NOT SCALE

DESIGNED BY B.T.	CHECKED BY F.H.	APRIL 1984
DRAWN BY B.T. & M.L.	RECOMMENDED Vasant C. Mistry	SHEET NO. 302

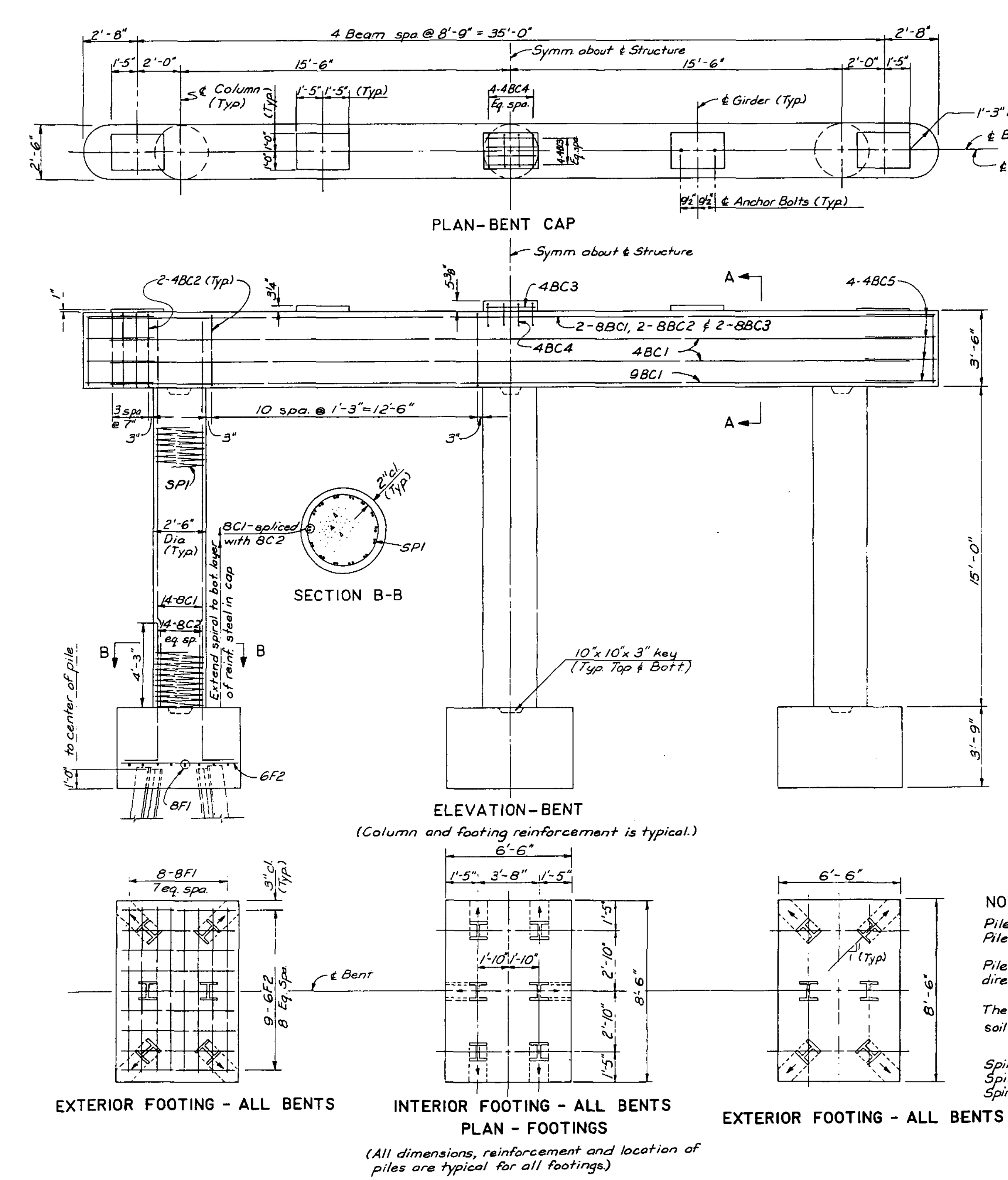
DRAWING H-4A

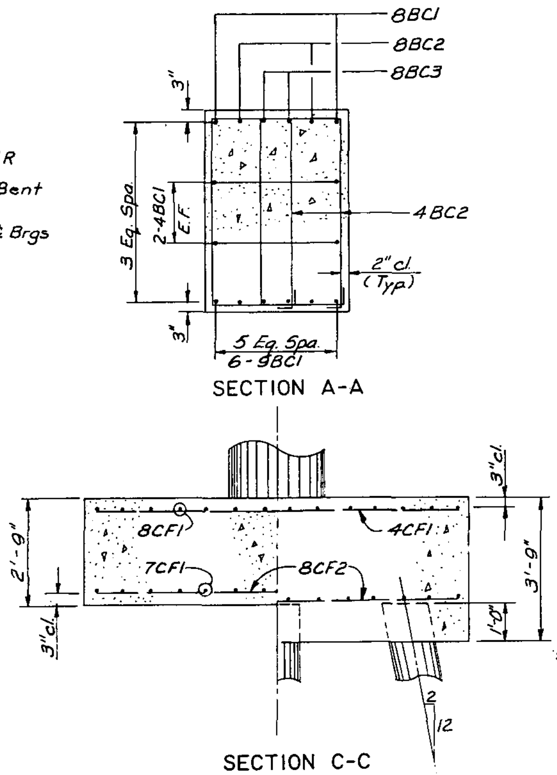
DRAWING H-4B—ROLLED BEAM BRIDGE—BENT DETAILS

This drawing shows bent and alternate footing details including concrete dimensions and reinforcement details.

Details for separate footings are provided under each column and the reinforcement for them is shown in the schedule. An alternate combined footing design is shown, which provides for either a combined spread footing or one supported on piles, but the concrete plan dimensions and the reinforcement are the same in either case. This reinforcement is listed in the schedule under the title "alternate combined footings."

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel..



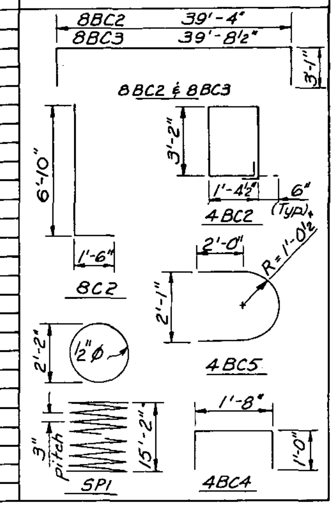


REINFORCING STEEL SCHEDULE

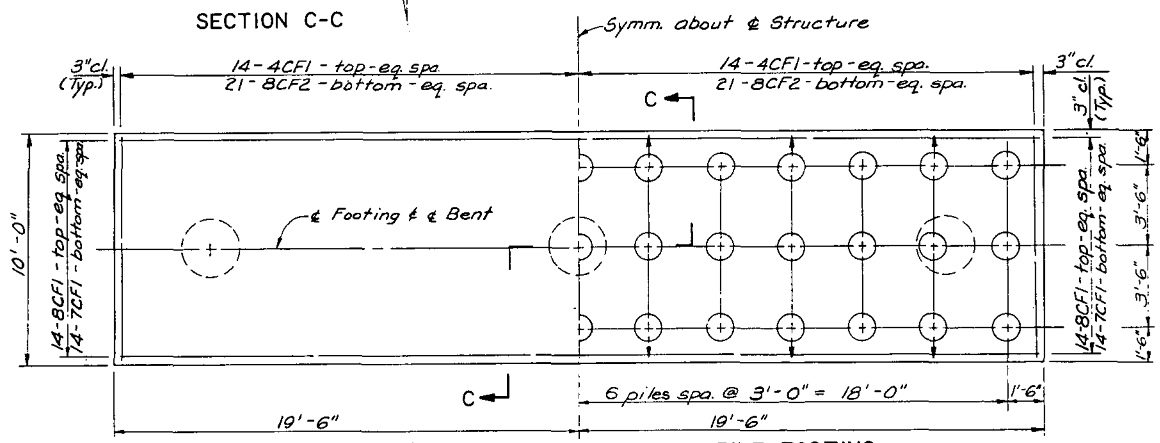
Mark	No.	Length	Type
Bent Cap			
4BC1	12	37'-8"	Str.
4BC2	180	10'-1"	Bent
4BC3	12	2'-6"	Str.
4BC4	12	3'-8"	Bent
4BC5	24	7'-3"	Bent
8BC1	6	37'-10"	Str.
8BC2	6	45'-6"	Bent
8BC3	6	45'-10½"	Bent
9BC1	18	37'-10"	Str.
Columns			
8C1	126	18'-0"	Str.
½"ø SP1	9	433'-8"	Bent
8C2	126	8'-4"	Bent
Footings			
8F1	72	8'-0"	Str.
6F2	81	6'-0"	Str.
Alternate Combined Footings			
4CF1	81	9'-6"	Str.
7CF1	42	38'-6"	Str.
8CF1	42	38'-6"	Str.
8CF2	123	9'-6"	Str.

BENDING DIAGRAM

All dimensions are out to out



* Digit preceding letter denotes bar size.



ALTERNATE COMBINED FOOTINGS - ALL BENTS

NOTES:

Piles for isolated footings shall have 55 ton capacity.
Piles for the alternate footing shall have 28 ton capacity.

Piles indicated thus ↟ shall be battered 2:12 in direction of the arrow.

The alternate spread footing is designed for an allowable soil pressure of 4 tons per square foot.

Spiral reinforcement shall not have deformations.
Spirals shall have 1½ extra turns at each end.
Spiral splices if used shall have a 2'-0" lap.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN ROLLED BEAM BRIDGE
SPANS 60-88-88-60=296 FT.
BENT DETAILS

40'-0" ROADWAY	HS20-44 LOADING	
DO NOT SCALE		
DESIGNED BY B.T.	CHECKED BY F.H.	APRIL 1984
DRAWN BY B.T. & M.L.	RECOMMENDED Vasant C. Mistry	SHEET NO. 303

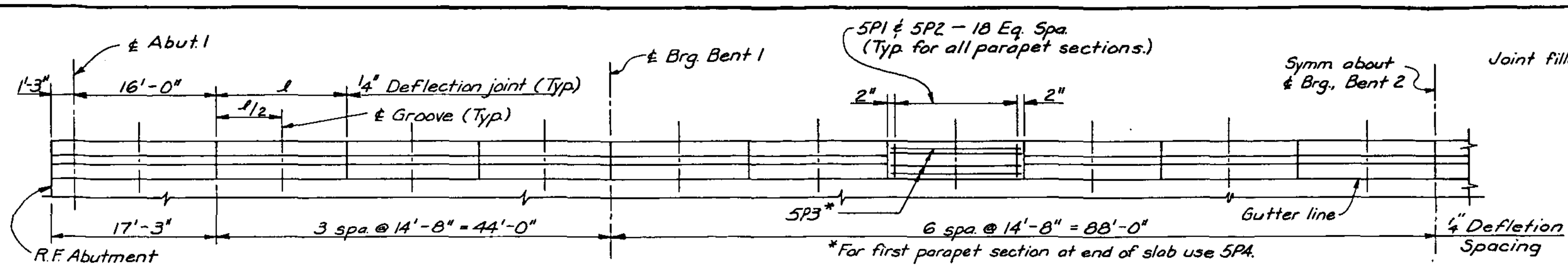
DRAWING H-4B

DRAWING H-4C—ROLLED BEAM BRIDGE
DECK—SLAB DETAILS

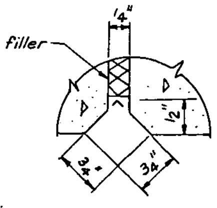
This drawing shows the reinforcement details for the deck slab. The transverse reinforcement is continuous across the slab and consists of #5 (#16) bars with hooks (5S5) in the top and #5 (#16) straight bars (5S6) in the bottom, both at 6 in. on center, as shown on the slab reinforcement plan. For longitudinal reinforcement, the detailer should refer to the "typical cross section" (Sheet H-4) and the slab reinforcement plan view on this sheet. Note the typical lap splice for the #5 (#16) bars is 20 in. Diaphragm reinforcement requirements are shown here also. See "superstructure reinforcing steel schedule" for quantities.

This drawing also shows the concrete placing sequence to help the detailer provide reinforcing steel to fit the conditions at the ends of each placement.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

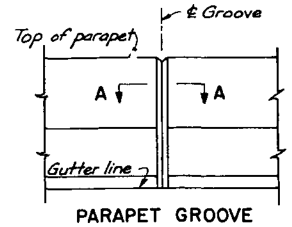


PARAPET PLAN



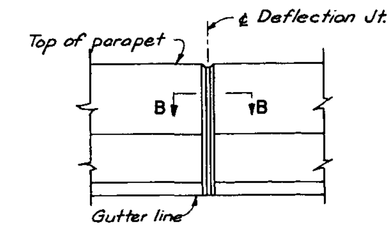
SECTION B-B

Deflection joint detail for both sides of parapet.

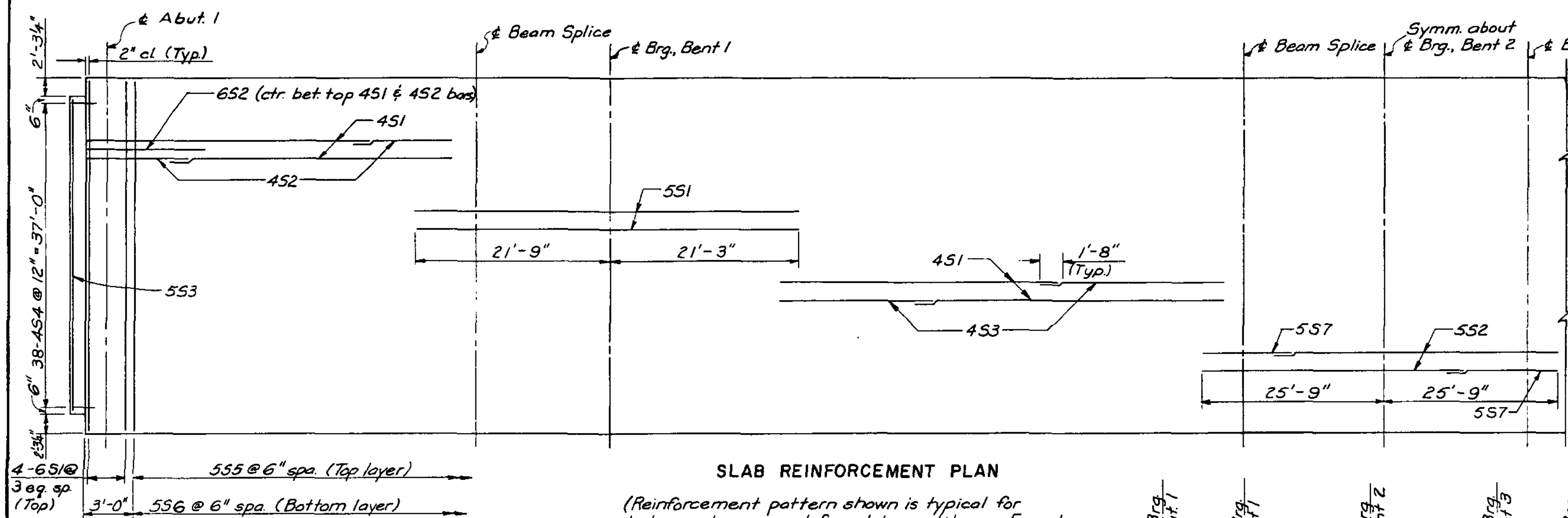


PARAPET GROOVE

Place at midpoint between deflection joints.



DEFLECTION JOINT THRU PARAPET



SLAB REINFORCEMENT PLAN

(Reinforcement pattern shown is typical for between beams and for slab cantilever. Except as noted, pattern is also typical for both top and bottom reinforcement layers. For spacing see Typical Cross Section, sh. no. 301.)

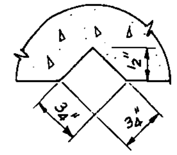
SUMMARY OF QUANTITIES

Item	Unit	Super-Structure	Approach Slab	Abutments	Bents	Total
Structure Excavation	C.Y.	To meet conditions of site and specifications				
Concrete Class A(AE)	C.Y.	369.4	64.0	90.1	122.8	646.3
Reinforcing Steel	LBS.	102,180	10,150	7,400	19,020	138,750
Structural Steel A-36	LBS.	26,320	—	—	—	26,320
Structural Steel A-572	LBS.	237,720	—	—	—	237,720
Fabricated Structural Metal	LBS.	5,490*	—	—	—	5,490
55 Ton Steel H-Piles	L.F.	—	—	—	1,080	1,080
70 Ton Steel H-Piles	L.F.	—	—	—	400	400

*Bearings only

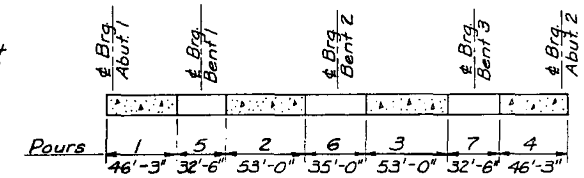
NOTES:

- First digit of mark indicates bar size.
- Longitudinal slab bars shall have a minimum splice lap of 20 inches for No. 5 bars and 16 inches for No. 4.
- For 6AS1 projecting from deck slab and end diaphragm into approach slab, see Approach Slab Details, Sheet 302 and End Diaphragm Details this sheet.



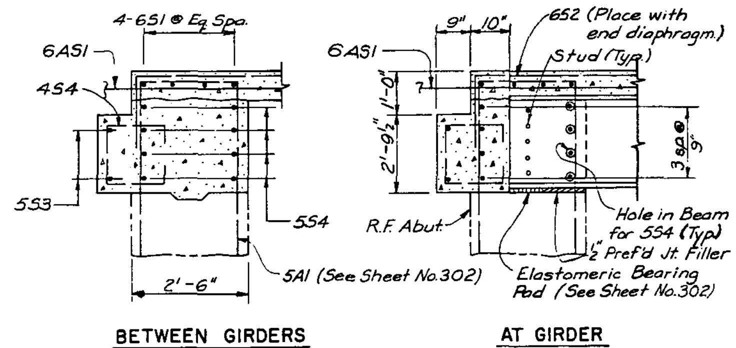
SECTION A-A

Groove detail for both sides of parapet.



DECK CONCRETE POURING SEQUENCE

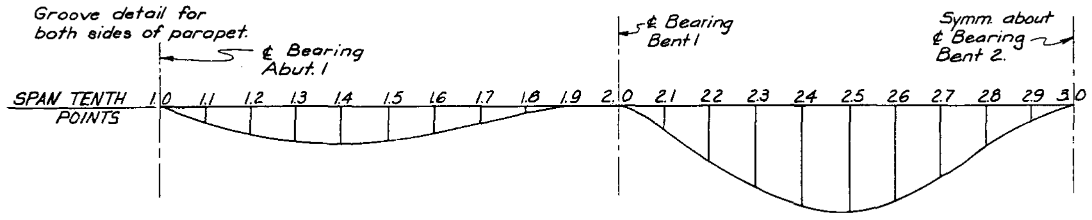
NOTES: Pours 1, 2, 3 ¢ 4 should be made consecutively.
Pours 5, 6 ¢ 7 may be made consecutively.
Retarders may be used if approved by the engineer.



BETWEEN GIRDERS

AT GIRDER

SECTIONS THRU END DIAPHRAGM



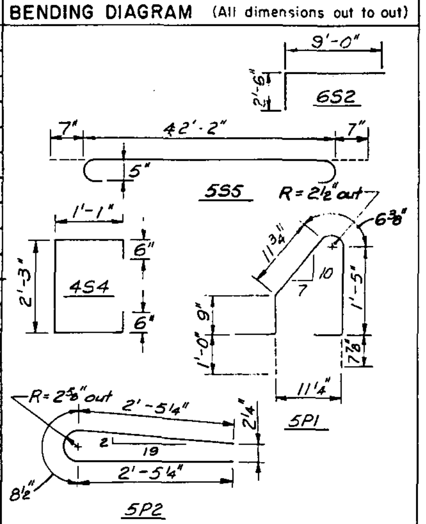
DEAD LOAD DEFLECTION DIAGRAM

SUPERSTRUCTURE REINFORCING STEEL SCHEDULE

REINFORCING STEEL

Mark	Type	Length	No.
4S1	Str.	35'-0"	480
4S2	"	8'-6"	240
4S3	"	13'-0"	240
4S4	Bent	5'-5"	76
5S1	Str.	43'-0"	318
5S2	"	40'-0"	159
5S3	"	37'-8"	4
5S4	"	42'-2"	16
5S5	Bent	43'-4"	586
5S6	Str.	42'-2"	586
5S7	Str.	12'-10"	159
5P1	Bent	5'-4"	760
5P2	"	5'-7"	760
5P3	Str.	14'-4"	180
5P4	"	16'-11"	20
6S1	"	42'-2"	8
6S2	Bent	11'-6"	98
6AS1	Str.	7'-0"	80

BENDING DIAGRAM (All dimensions out to out)



DEAD LOAD DEFLECTIONS (IN.)

POINT	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
STRUCT. STEEL	0	0	1/16	1/16	1/16	1/16	1/16	0	0	0	0	1/16	1/16	1/8	3/16	3/16	3/16	1/8	1/16	0	0
CONCRETE SLAB	0	1/8	1/4	5/16	3/8	5/16	1/4	3/16	1/16	0	0	3/16	7/16	11/16	7/8	15/16	13/16	5/8	3/8	1/8	0
PARAPET & W.S.	0	1/16	1/16	1/16	1/16	1/16	1/16	1/16	0	0	0	1/16	1/8	3/16	1/4	1/4	3/16	3/16	1/8	1/16	0
TOTAL	0	3/16	3/8	7/16	1/2	7/16	3/8	1/4	1/16	0	0	5/16	5/8	1	1 5/16	1 3/8	1 3/16	15/16	9/16	3/16	0

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D. C.

TYPICAL CONTINUOUS BRIDGES

FOUR SPAN ROLLED BEAM BRIDGE
SPANS 60-88-88-60=296 FT.
DECK SLAB DETAILS

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

DESIGNED BY B.T. — CHECKED BY F.H. — APRIL 1984
DRAWN BY B.T. & M.L. — RECOMMENDED Vasant C. Mistry — SHEET NO. 305

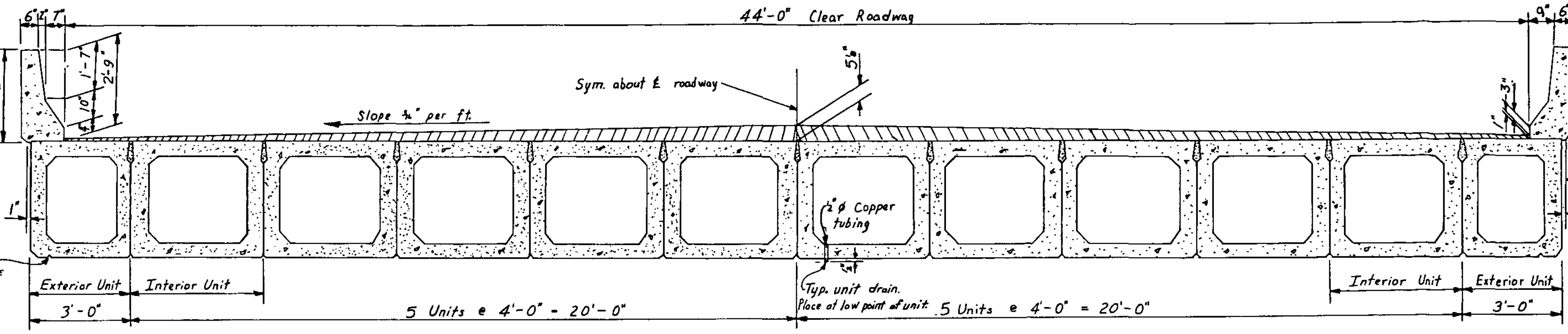
DRAWING H-4C

DRAWING H-5—PRECAST PRETENSIONED BOX SECTIONS—GENERAL

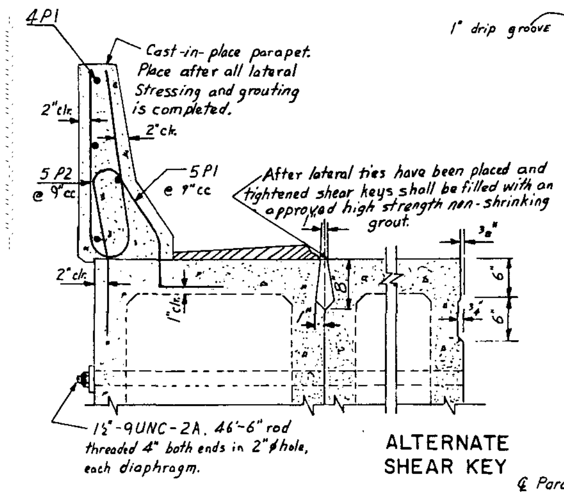
This superstructure consists of precast pretensioned box sections joined together with grouted connections and transverse ties. Details are shown for 50, 60, 70, and 80 ft spans.

The reinforcing steel is identified by mark number and listed in the schedule of material. "General Notes" citing specifications and construction requirements are provided. The "General Notes" indicate that reinforcing steel Grade 60 (420) is required. A total of two drawings are provided for this project.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

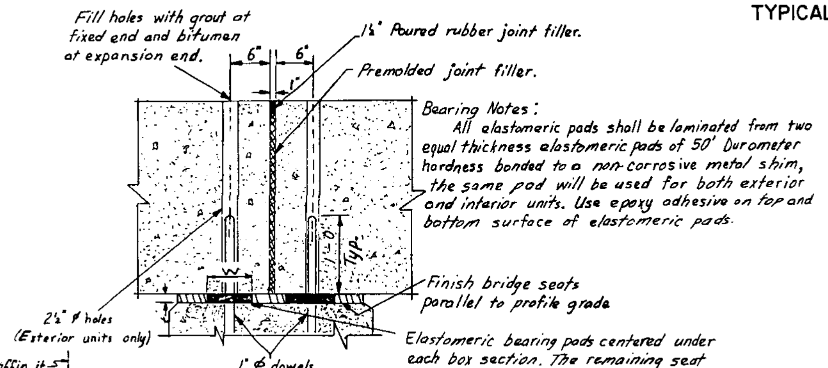


TYPICAL CROSS SECTION

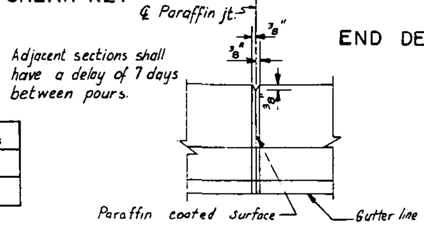


PART END ELEVATION

ALTERNATE SHEAR KEY



END DETAIL (PIER)



Span	No. of Joints
50 & 60	2
70 & 80	3

PARAFFIN JOINT THROUGH PARAPET

ELASTOMERIC BEARING PAD DIMENSIONS			
Span	Length	w	t
50'	24"	4"	5/8"
60'	24"	4"	3/4"
70'	24"	5"	7/8"
80'	24"	6"	1"

GENERAL NOTES

Design Specifications: AASHTO Standard Specifications for Highway Bridges, 1973 with 1974 & 1975 Interim Specifications.

Design Live Load: HS20-44.

Precast Prestressed Concrete: The minimum compressive strength of prestressed concrete at the age of 28 days shall be 5000 psi. Minimum compressive strength at transfer of stressing force shall be 4000 psi. The designmix shall be approved by the engineer.

Cast-in-Place Concrete: Cast-in-place concrete shall be class A(AE) with a minimum 28 day compressive strength of f'_c=4000 psi. The air entraining agent shall meet with the approval of the engineer. All exposed edges shall be chamfered 3/4" except as noted.

Pretensioning Steel: Pretensioning steel shall consist of high tensile strength 7-wire strands with a nominal diameter of 1/2" and conform to AASHTO M203, 270 Grade. The initial tensile force applied to each strand shall be 28,900 lbs.

Reinforcing Steel: Reinforcing steel shall conform to ASTM A615, A616 or A617, grade 40, 50 or 60. Dimensions relating to spacing of reinforcing steel are to centers of bars. Design details assume that grade 40 reinforcing steel will be furnished. Reinforcing steel covering shall be 2" clear except as noted.

Lateral Ties: Structural steel used for lateral tie rods shall conform to AASHTO M-183. Threads on the rods shall be cut to the Coarse Series Class 2A. If desired, equivalent rods with rolled threads or high strength tendons may be substituted. The rods shall be furnished with one heavy semifinished hexagon nut and one bearing plate at each end. The rods shall be shop painted with two coats of red lead-iron oxide paint. The field paint for the exposed parts at the ends of the rod assemblies shall consist of one coat of tinted red lead-iron oxide followed by a final coat of paint, the color of which shall be specified by the engineer.

Lateral Tensioning: Lateral ties shall be provided through the diaphrams in the positions indicated. Each tie shall be equivalent to a 1 1/2" AASHTO M183 steel bar tensioned to 30,000 lbs. or an equal force applied by lateral tensioning of high strength tendons.

Handling Prestressed Units: In handling, the units must be maintained in an upright position at all times and must be picked up only by means of the lifting devices provided or suitable alternates approved by the engineer.

Finish: When the bituminous wearing surface is placed directly on the top of the unit, that surface shall be given a broom finish normal to the ℄ of roadway.

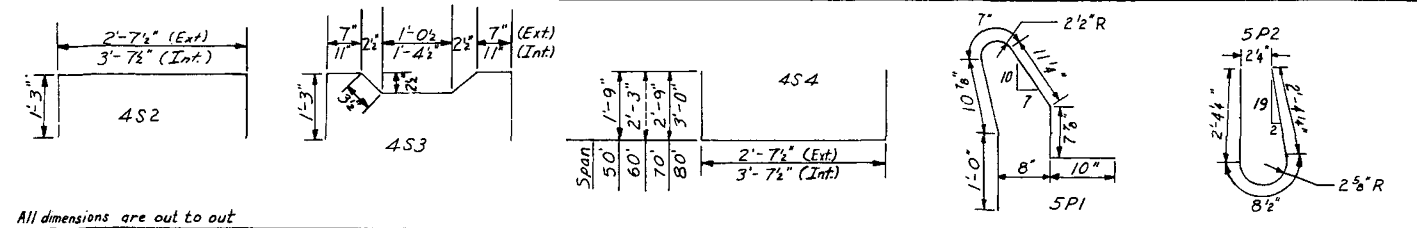
Drainage: No provision for drainage has been made in these plans. If required, see sheet no. 102 for suggested details.

Deicing Chemicals: Where de-icing chemicals are used, these plans must be modified to protect against corrosion. Moisture barriers and coated reinforcing are two of several bridge deck protective systems.

Construction Tolerances: Dimensional tolerances shall not exceed those recommended in the AASHTO Interim Manual for inspection of prestressed concrete bridge members.

SCHEDULE OF MATERIALS · PER SPAN

Span	Concrete Cu. Yds.			Reinforcing Steel																													Prestress
	12 Box Units	2 Parapets	Total	4S1				4S2				4S3				4S4				4S5		5S1	4P1		5P1		5P2		6S1		Total Wt. (Lbs.)	No. 1/2" ϕ Strands
				Exterior		Interior		Exterior		Interior		Exterior		Interior		Exterior		Interior														
				No.	L	No.	L	No.	L	No.	L	No.	L	No.	L	No.	L	No.	L	No.	L	No.	No.	L	No.	L	No.	L	No.	L		
50'	113.0	8.1	121.1	116	2'-8"	580	3'-8"	128	5'-1 1/2"	640	6'-1 1/2"	114	5'-3 1/2"	570	6'-3 1/2"	90	6'-1 1/2"	450	7'-1 1/2"	92	25'-9"	68	30	16'-8"	138	4'-11"	138	5'-5"	48	6'-0"	15,720	152
60'	147.9	9.7	157.6	140	"	700	"	152	"	760	"	138	"	690	"	108	7'-1 1/2"	540	8'-1 1/2"	"	30'-9"	"	"	20'-0"	168	"	168	"	"	"	19,220	164
70'	186.4	11.3	197.7	164	"	820	"	176	"	880	"	162	"	810	"	124	8'-1 1/2"	620	9'-1 1/2"	"	35'-9"	"	40	17'-5"	192	"	192	"	"	"	22,720	186
80'	222.1	12.8	234.9	188	"	940	"	200	"	1000	"	186	"	930	"	140	8'-7 1/2"	700	9'-7 1/2"	"	40'-9"	"	"	19'-11"	224	"	224	"	"	"	26,160	224



All dimensions are out to out

Note: Digit(s) preceding letter of the bar mark denote(s) size.

Span	Max. Reactions (Kips)		Handling Wt. (Tons)	
	Abut.	Pier	Exterior Unit	Interior Unit
50'	443.9	782.9	15.8	19.7
60'	531.9	950.3	21.0	25.8
70'	625.5	1131.0	26.8	32.4
80'	704.5	1283.9	32.0	38.6

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

STANDARD CONCRETE BRIDGES

PRECAST PRETENSIONED BOX SECTIONS
SPANS 50' TO 80'
QUANTITIES AND SECTION

44'-0" ROADWAY   HS20-44 LOADING

DO NOT SCALE

RECOMMENDED: Chief, Design Branch
RECOMMENDED: Director, Office of Engineering
RECOMMENDED: Chief, Bridge Division
APPROVED: H A Lindberg, Assoc. Admr. for E. & T.O.

JANUARY 1976

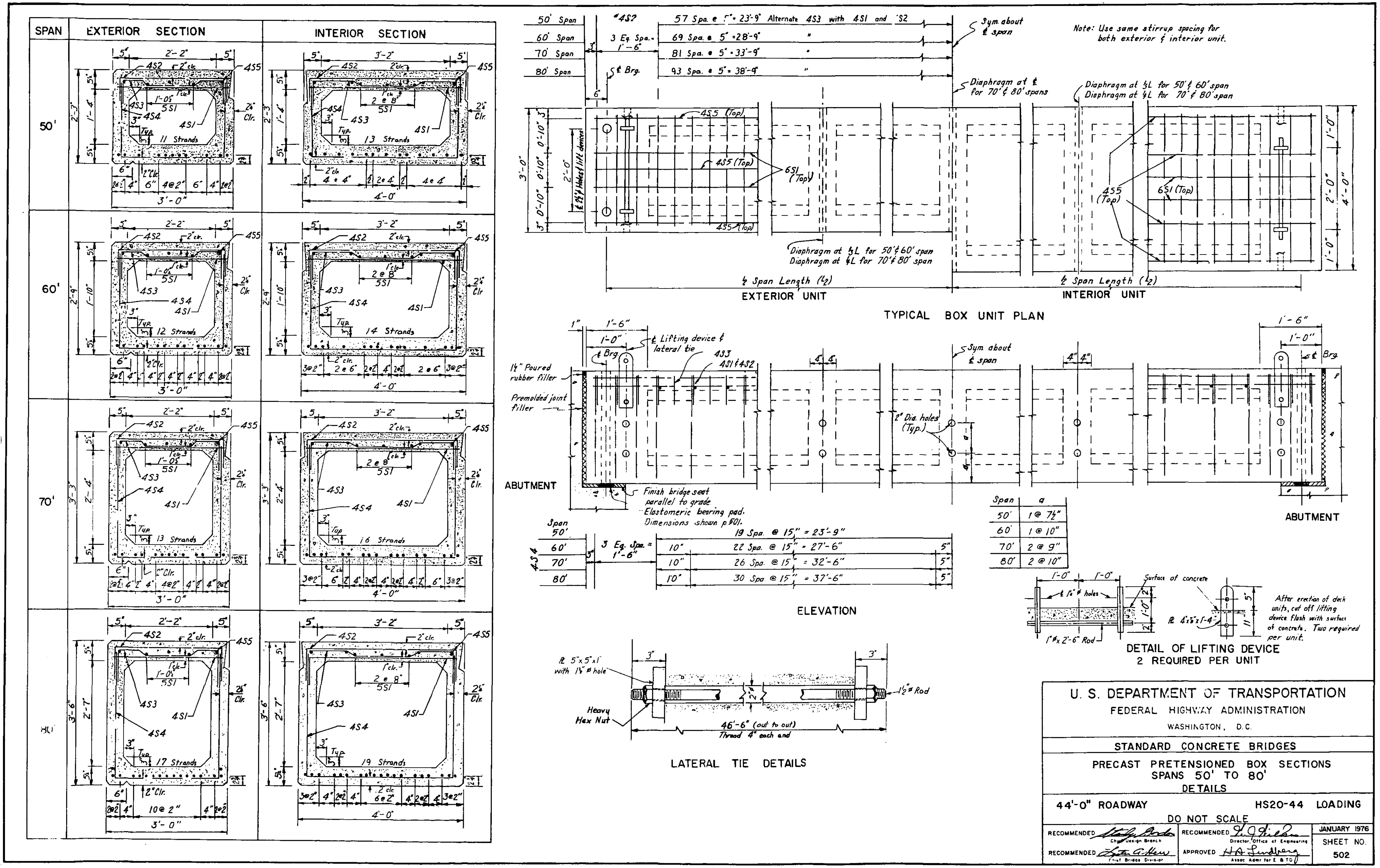
SHEET NO. 501

DRAWING H-5

DRAWING H-5A—PRECAST PRETENSIONED BOX SECTIONS—DETAILS

Reinforcing steel details for the box sections are shown. Details for both reinforcing bars and prestressing tendons should be coordinated with the precasting sequence. Where more than one supplier is involved, responsibility for furnishing bar supports, tendon supports and, if needed, side-form spacers should be established in advance.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



SPAN
EXTERIOR SECTION
INTERIOR SECTION
50'
60'
70'
11 Strands
13 Strands
12 Strands
14 Strands
13 Strands
16 Strands
17 Strands
19 Strands
Note: Use same stirrup spacing for both exterior & interior unit.
½ Span Length (L/2)
EXTERIOR UNIT
INTERIOR UNIT
TYPICAL BOX UNIT PLAN
ABUTMENT
ELEVATION
LATERAL TIE DETAILS
DETAIL OF LIFTING DEVICE
2 REQUIRED PER UNIT
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.
STANDARD CONCRETE BRIDGES
PRECAST PRETENSIONED BOX SECTIONS
SPANS 50' TO 80'
DETAILS
44'-0" ROADWAY
HS20-44 LOADING
DO NOT SCALE
JANUARY 1976
SHEET NO.
502

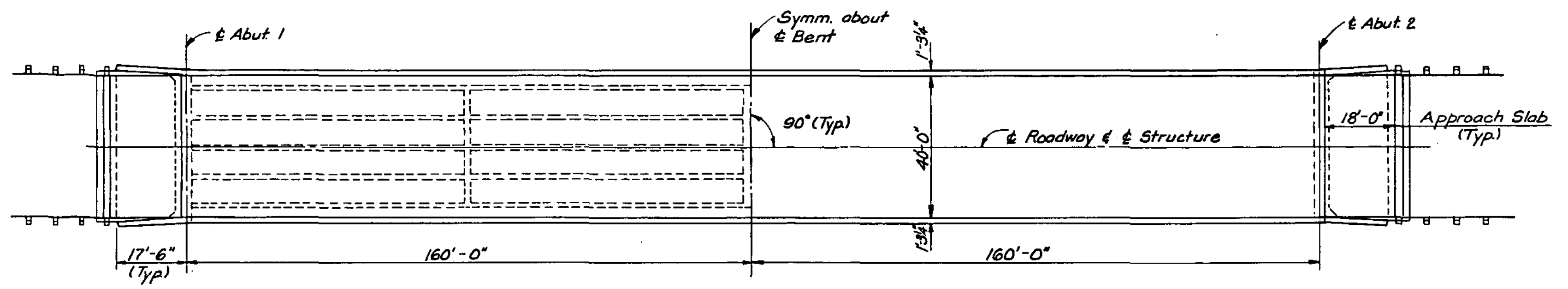
DRAWING H-5A

137

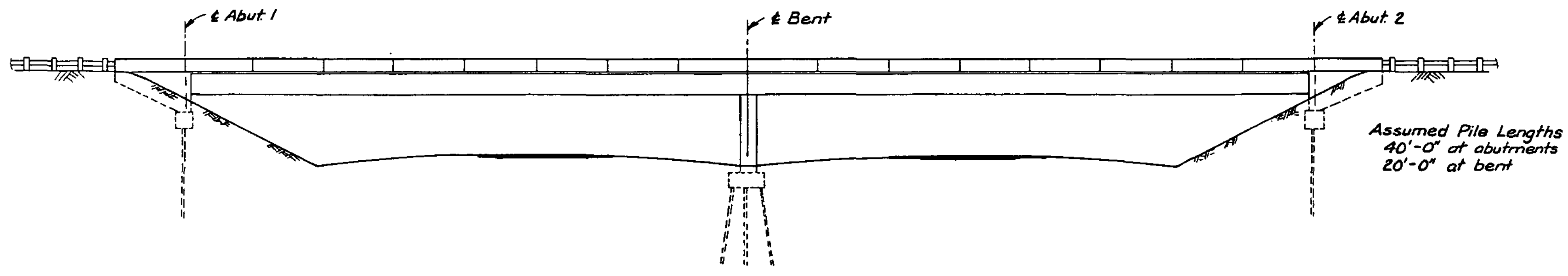
DRAWING H-6—POST-TENSIONED CONCRETE BOX GIRDER BRIDGE—GENERAL

General plan and typical cross sections are shown for a bridge with two 160 ft continuous spans. The end wall (diaphragm) abutments are pile supported. The center support is a three-column bent bearing upon pile supports, including battered piles. "General Notes" are listed on this sheet. The typical cross section shows reinforcing steel in the box girder. A total of seven drawings are provided for this project. The reinforcing steel layout for slab reinforcement between girder webs and slab cantilevers is shown.

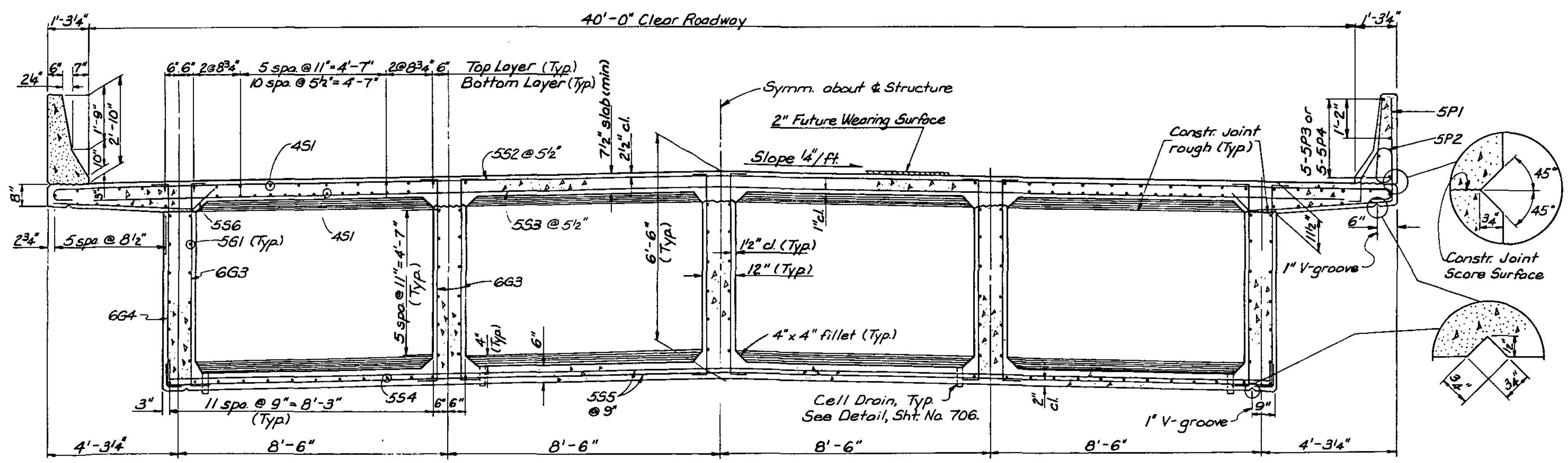
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



PLAN



ELEVATION



TYPICAL CROSS SECTION

GENERAL NOTES:

Design Specifications: Standard Specifications for Highway Bridges AASHTO 1983 and Interim Specifications, 1984 and 1985 using Working Stress Design (WSD).

Design Loadings:
Dead Load: Includes 25 pounds per square foot for future wearing surface.
Live Load: AASHTO HS20-44

Concrete: All concrete shall be class A(AE) with compressive strength of f'_c as given below:
Box Girder: f'_c = 5,000 psi at 28 days
f'_{ci} = 4,000 psi at time of prestressing
All other: f'_c = 4,000 psi at 28 days
Extreme fiber in compression f_c equals 1500 psi for deck slab. The air entraining agents shall meet with the approval of the engineer. All exposed edges shall be chamfered 3/4 inch, except as noted.

Bridge Slab Protective System: Where bridge slabs are likely to be subjected to potential damaging applications of deicing salts or where a salt water environment presents the potential for corrosion of reinforcing steel, a protective system is required that will effectively prevent chloride induced deterioration.

Reinforcing Steel: Deformed reinforcing steel shall conform to ASTM A615 (AASHTO M31), grade 60. Spiral reinforcing steel shall conform to ASTM A82 (AASHTO M32). Spacing of reinforcing steel is shown from center to center of bars. Splices shall be lapped 30 diameters unless otherwise shown. Cover for reinforcement shall be 2 inches clear except as noted.

Prestressing Steel: Strands for post-tensioning tendons shall be 7-wire, stress-relieved strand conforming to ASTM A416 (AASHTO M203), grade 270.

Piles: Piles shall be driven to a minimum bearing capacity shown below.
Abutments: 80 Tons
Bent : 65 Tons

Drainage: No provisions for deck drainage have been made in these plans. If required, see Appendix A for suggested details.

Alternate Rail: See Appendix A for alternate rail details.

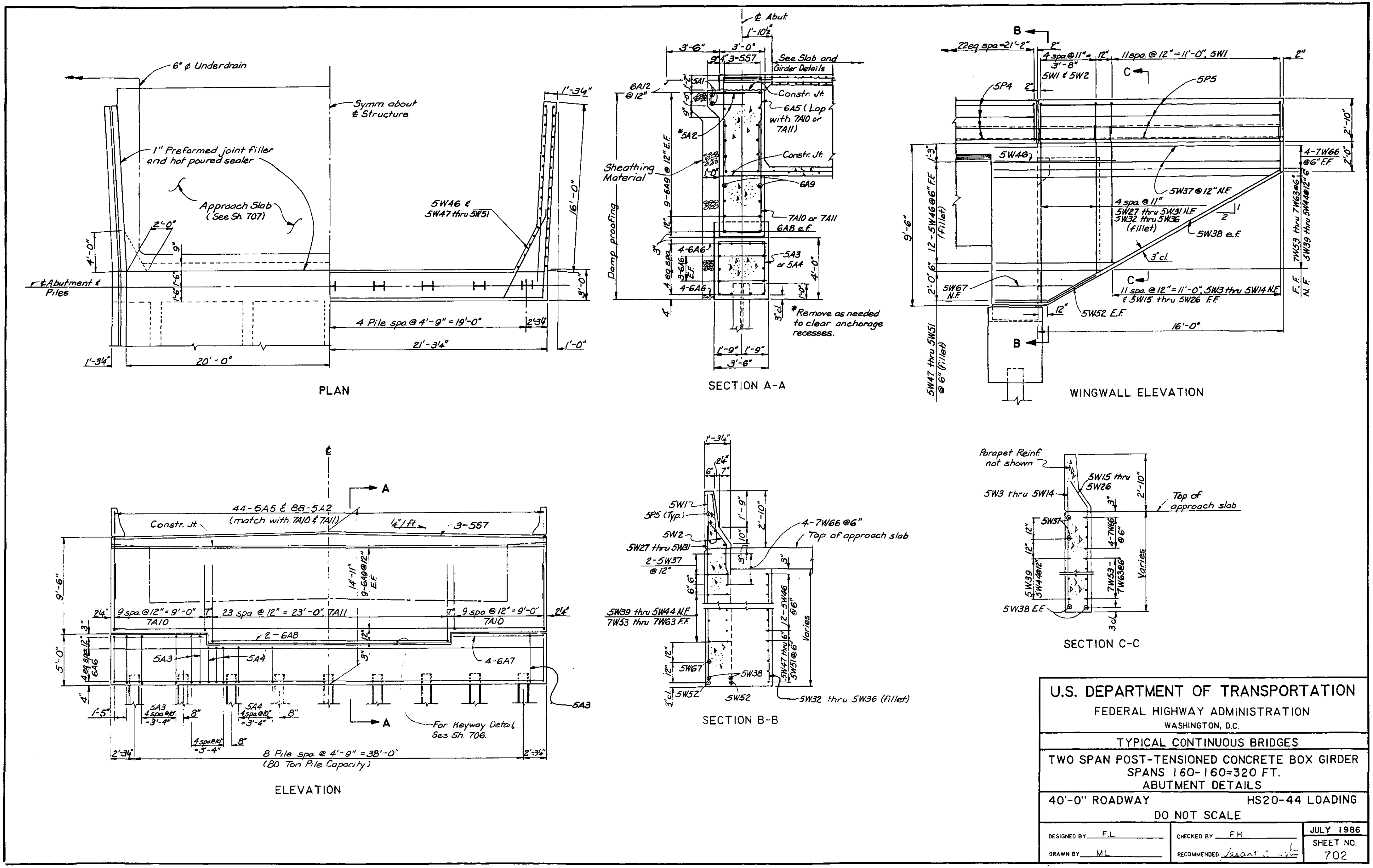
U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION WASHINGTON, D.C.	
TYPICAL CONTINUOUS BRIDGES	
TWO SPAN POST-TENSIONED CONCRETE BOX GIRDER SPANS 160-160=320 FT. GENERAL PLAN AND CROSS SECTION	
40'-0" ROADWAY	HS20-44 LOADING
DO NOT SCALE	
DESIGNED BY F.L. / CHECKED BY F.H.	JULY 1986
DRAWN BY M.L. / RECOMMENDED Vasant C. Mistry	SHEET NO. 701

DRAWING H-6

DRAWING H-6A—POST-TENSIONED CONCRETE BOX GIRDER BRIDGE—ABUTMENT DETAILS

Abutment, parapet (barrier rail), and wing wall details are shown.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION WASHINGTON, D.C.
TYPICAL CONTINUOUS BRIDGES
TWO SPAN POST-TENSIONED CONCRETE BOX GIRDER SPANS 160-160=320 FT. ABUTMENT DETAILS
40'-0" ROADWAY HS20-44 LOADING DO NOT SCALE
DESIGNED BY F.L. · CHECKED BY F.H. · JULY 1986
DRAWN BY M.L. · RECOMMENDED [illegible] · SHEET NO. 702

DRAWING H-6A

DRAWING H-6B—POST-TENSIONED CONCRETE BOX GIRDER—BRIDGEBENT DETAILS

Bent details including end diaphragms, supporting columns, and pile cap are shown. A reinforcing steel schedule for these elements is provided.

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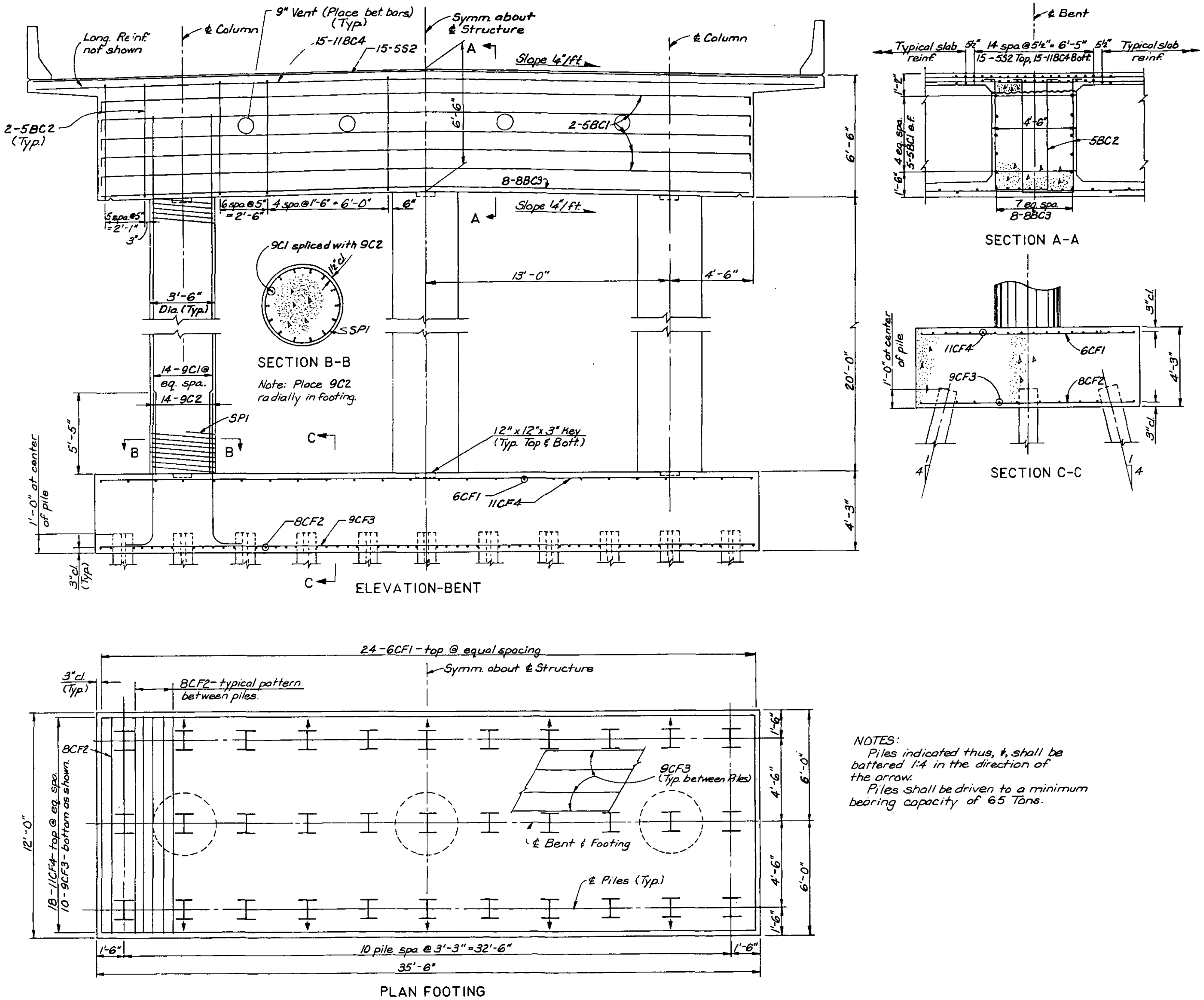


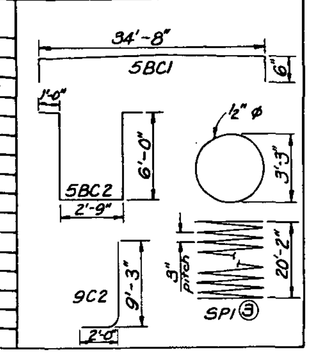
NOTES:
Piles indicated thus, ↕, shall be battered 1:4 in the direction of the arrow.
Piles shall be driven to a minimum bearing capacity of 65 Tons.

REINFORCING STEEL SCHEDULE

REINFORCING STEEL

Mark (1)	No.	Length	Type
Bent Cap			
5BC1	10	35'-8"	Bent
5BC2	68	16'-9"	Bent
8BC3	8	34'-8"	Str.
11BC4	15	42'-2"	Str.
Columns			
½"φSP1	3	854'-3"	Bent
9C1	42	24'-6"	Str.
9C2	42	11'-3"	Bent
Combined Footing			
6CF1	24	11'-6"	Str.
8CF2	54	11'-6"	Str.
9CF3	10	35'-0"	Str.
11CF4	18	35'-0"	Str.

BENDING DIAGRAM (2)



(1) First digit(s) of mark indicate(s) bar sizes.
(2) All dimensions are out to out.
(3) Spirals shall have 1½ additional turns at both ends. Splices for spirals shall have a lap of 2'-0". Spiral reinforcement shall not have deformations.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

TWO SPAN POST-TENSIONED CONCRETE BOX GIRDER
SPANS 160-160=320 FT.
BENT DETAILS

40'-0" ROADWAY | HS20-44 LOADING
DO NOT SCALE

DESIGNED BY F.L. | CHECKED BY F.H. | JULY 1986
DRAWN BY M.L. | RECOMMENDED [signature] | SHEET NO. 703

DRAWING H-6B

DRAWING H-6D—POST-TENSIONED CONCRETE BOX GIRDER BRIDGE—SLAB AND GIRDER REINFORCEMENT

Barrier rail parapet plan view, top slab plan view, and longitudinal cross section are shown with typical reinforcing steel requirements.

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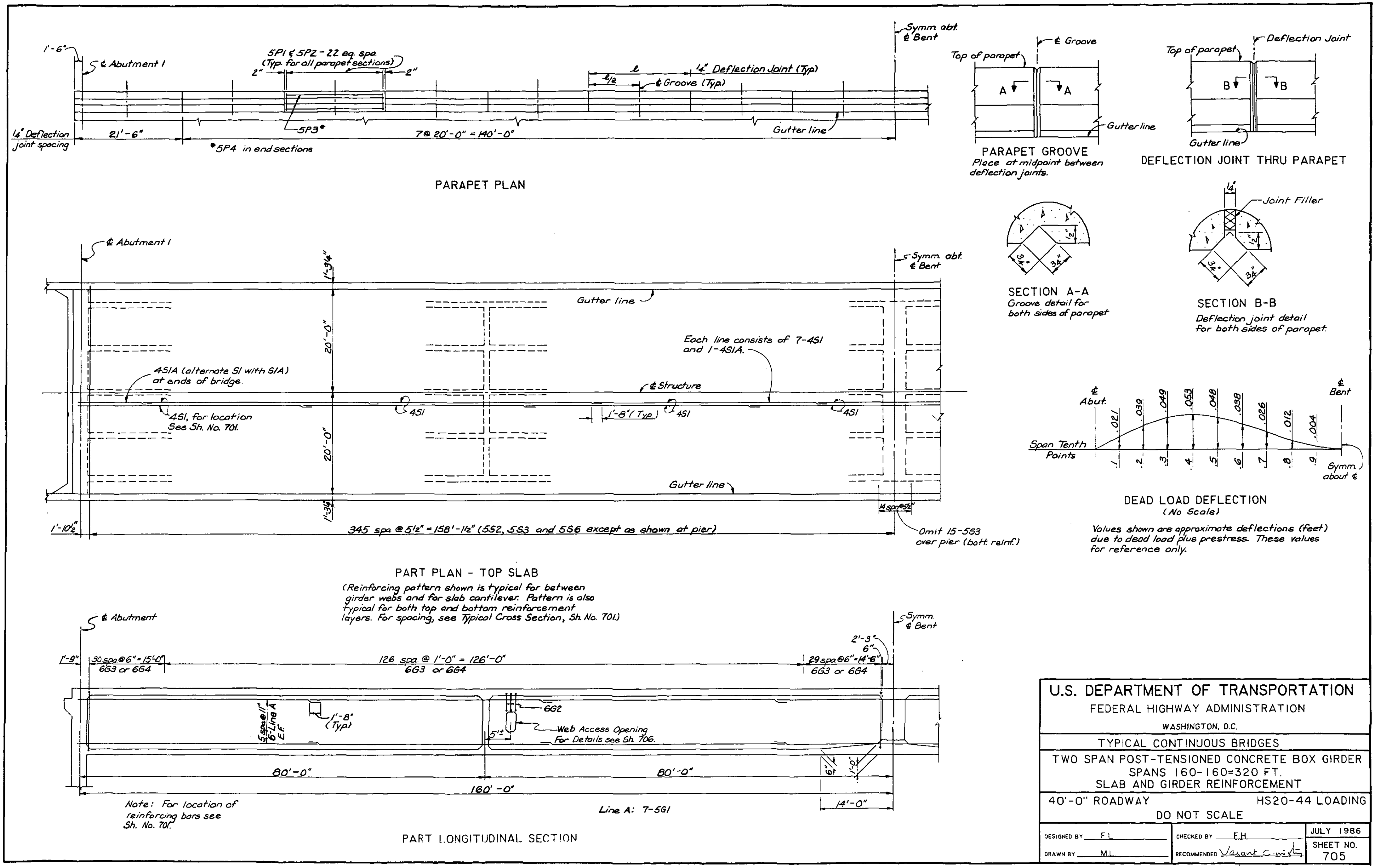
PARAPET PLAN
5P1 & 5P2 - 22 eq. spa. (Typ. for all parapet sections)
¢ Abutment 1
1'-6"
2"
2"
ℓ
ℓ/2
1/4" Deflection Joint (Typ)
¢ Groove (Typ)
Symm. abt. ¢ Bent
5P3*
Gutter line
1/4" Deflection joint spacing
21'-6"
7 @ 20'-0" = 140'-0"
*5P4 in end sections
PARAPET GROOVE
Place at midpoint between deflection joints.
Top of parapet
¢ Groove
Gutter line
DEFLECTION JOINT THRU PARAPET
Deflection Joint
SECTION A-A
Groove detail for both sides of parapet
SECTION B-B
Deflection joint detail for both sides of parapet.
Joint Filler
PART PLAN - TOP SLAB
(Reinforcing pattern shown is typical for between girder webs and for slab cantilever. Pattern is also typical for both top and bottom reinforcement layers. For spacing, see Typical Cross Section, Sh. No. 701.)
4S1A (alternate S1 with S1A) at ends of bridge.
4S1, for location See Sh. No. 701.
Each line consists of 7-4S1 and 1-4S1A.
¢ Structure
1'-8" (Typ)
Gutter line
1'-3 1/4"
20'-0"
20'-0"
1'-10 1/2"
345 spa @ 5 1/2" = 158'-1 1/2" (5S2, 5S3 and 5S6 except as shown at pier)
14 spa @ 5 1/2"
Omit 15-5S3 over pier (bott. reinf.)
DEAD LOAD DEFLECTION
(No Scale)
¢ Abut.
¢ Bent
Span Tenth Points
.021 .039 .049 .053 .048 .038 .026 .012 .004
.1 .2 .3 .4 .5 .6 .7 .8 .9
Symm. about ¢
Values shown are approximate deflections (feet) due to dead load plus prestress. These values for reference only.
PART LONGITUDINAL SECTION
¢ Abutment
1'-9"
30 spa @ 6" = 15'-0"
6G3 or 6G4
126 spa. @ 1'-0" = 126'-0"
6G3 or 6G4
29 spa @ 6" = 14'-6"
6G3 or 6G4
2'-3"
6"
6G2
5 spa @ 11" 6'-Line A E.F.
1'-8" (Typ)
Web Access Opening For Details see Sh. 706.
80'-0"
80'-0"
160'-0"
14'-0"
Note: For location of reinforcing bars see Sh. No. 701.
Line A: 7-5G1
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.
TYPICAL CONTINUOUS BRIDGES
TWO SPAN POST-TENSIONED CONCRETE BOX GIRDER
SPANS 160-160=320 FT.
SLAB AND GIRDER REINFORCEMENT
40'-0" ROADWAY
HS20-44 LOADING
DO NOT SCALE
DESIGNED BY F.L.
CHECKED BY F.H.
JULY 1986
DRAWN BY M.L.
RECOMMENDED Vasant C. Mistry
SHEET NO. 705

DRAWING H-6D

DRAWING H-6F—POST-TENSIONED CONCRETE BOX GIRDER BRIDGE—APPROACH SLAB

The main reinforcing steel schedule is shown here. Details for the (two) approach slabs are also shown on this drawing in both plan view and section.

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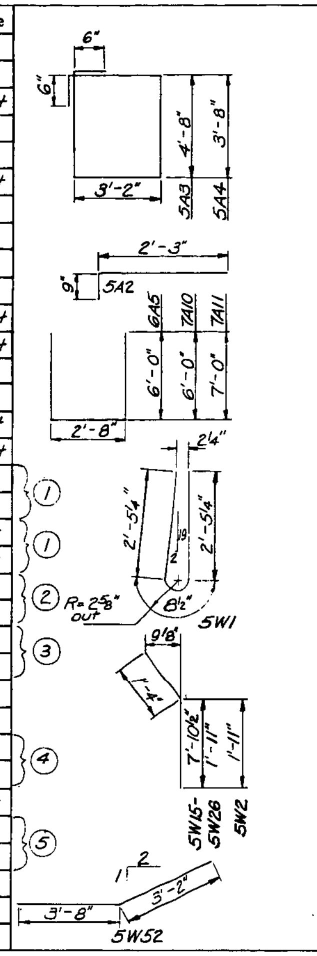
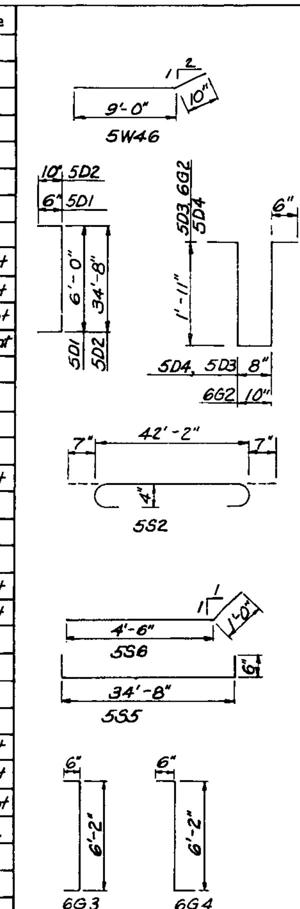
REINFORCING STEEL SCHEDULE

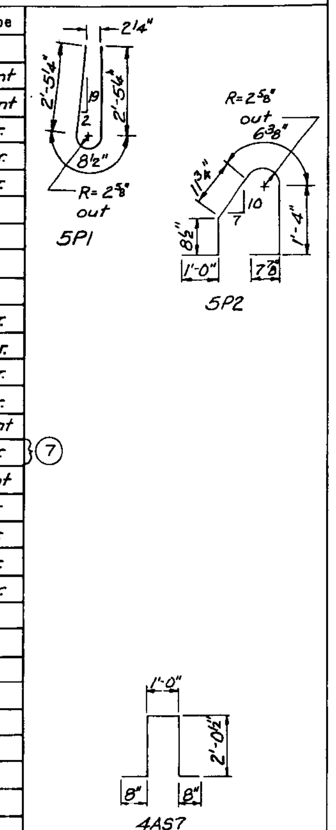
Mark	No.	Length	Type	
ABUTMENTS				
5A1	4	42'-2"	Str.	
5A2	176	3'-0"	Bent	
5A3	36	16'-8"	↕	
5A4	52	14'-8"	↕	
6A5	88	14'-8"	Bent	
6A6	28	42'-2"	Str.	
6A7	16	8'-9"	↕	
6A8	4	23'-6"	↕	
6A9	36	42'-2"	Str.	
7A10	40	14'-8"	Bent	
7A11	48	16'-8"	Bent	
6A12	82	7'-0"	Str.	
WINGWALLS				
5W1	68	5'-7"	Bent	
5W2	20	3'-4"	Bent	
5W3	4	8'-4"	Str.	(1)
5W14	↕	2'-11"	Str.	(1)
5W15	↕	8'-10"	Bent	(1)
5W26	↕	3'-4"	Bent	(1)
5W27	↕	10'-8"	Str.	(2)
5W31	↕	9'-5"	Str.	(2)
5W32	↕	8'-0"	Str.	(3)
5W36	4	6'-6"	Str.	(3)
5W37	8	18'-8"	Str.	
5W38	8	16'-8"	Str.	
5W39	4	7'-9"	Str.	(4)
5W44	4	17'-9"	Str.	(4)
5W46	48	9'-10"	Bent	
5W47	4	4'-3"	Str.	(5)
5W51	4	8'-10"	Str.	(5)
5W52	8	6'-11"	Bent	
7W53	4	5'-9"	Str.	(6)
7W63	4	15-9"	Str.	(6)



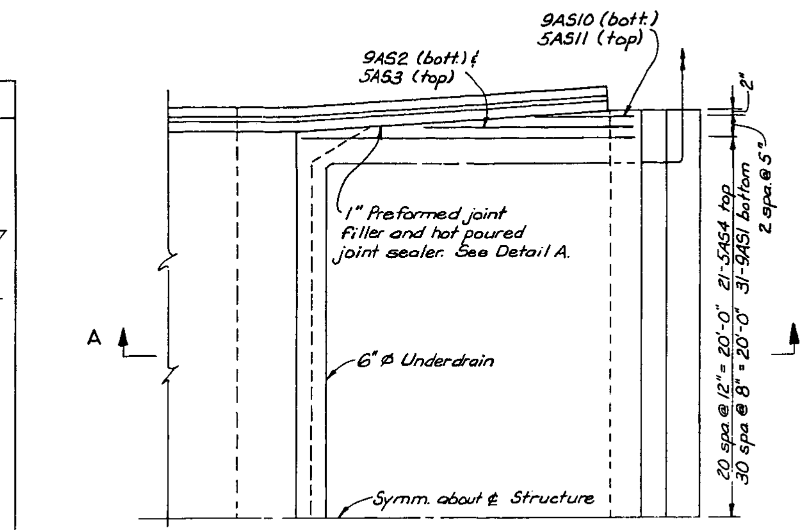
Mark	No.	Length	Type
WINGWALLS (CONT.)			
7W66	16	18'-8"	Str.
5W67	4	5'-9"	Str.
DIAPHRAGM			
5D1	96	7'-4"	Bent
5D2	20	36'-4"	Bent
5D3	16	5'-1"	Bent
5D4	16	5'-5"	Bent
SLAB			
4S1	798	45'-0"	Str.
4S1A	114	17'-1"	Str.
5S2	691	43'-4"	Bent
5S3	676	38'-0"	Str.
5S4	322	45'-0"	Str.
5S4A	46	18'-9"	Str.
5S5	416	35'-8"	Bent
5S6	1382	5'-6"	Bent
5S7	6	42'-2"	Str.
BOX GIRDER			
5G1	420	47'-9"	Str.
6G2	18	5'-8"	Bent
6G3	2976	7'-2"	Bent
6G4	74	7'-2"	Bent
6G5	24	6'-0"	Str.



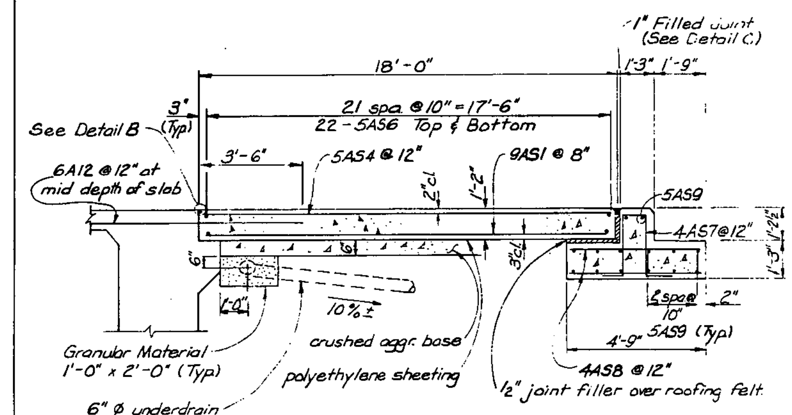
Mark	No.	Length	Type	
PARAPET				
5P1	736	5'-7"	Bent	
5P2	736	5'-3"	Bent	
5P3	140	19'-9"	Str.	
5P4	20	21'-3"	Str.	
5P5	20	15'-8"	Str.	
APPROACH SLAB				
9AS1	122	17'-7"	Str.	
9AS2	4	7'-11"	Str.	
6AS3	4	8'-0"	Str.	
5AS4	82	17'-8"	Str.	
5AS5	NOT	USED	Bent	
5AS6	88	39'-8"	Str.	(7)
4AS7	86	6'-5"	Bent	
4AS8	172	4'-5"	Str.	
5AS9	28	41'-9"	Str.	
9AS10	4	2'-0"	Str.	
6AS11	4	2'-1"	Str.	



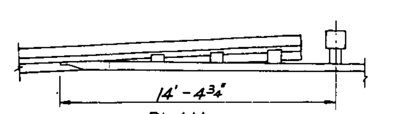
(1) increment of 6"
(2) increment of 5½"
(3) increment of 4½"
(4) increment of 2'-0"
(5) increment of 1'-1¾"
(6) increment of 1'-0"
(7) Dimension given is for first bar at abutment backwall. Increase the length of remaining bars by 1¼ in. increments.



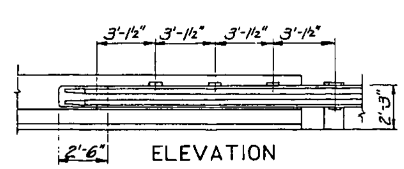
PLAN



SECTION A-A
APPROACH SLAB

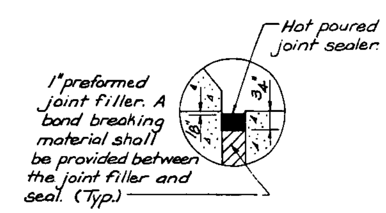


PLAN

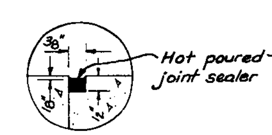


ELEVATION

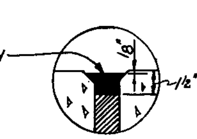
GUARDRAIL CONNECTION DETAIL



DETAIL A



DETAIL B



DETAIL C

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

TYPICAL CONTINUOUS BRIDGES

TWO SPAN POST-TENSIONED CONCRETE BOX GIRDER
SPANS 160-160=320 FT.
APPROACH SLAB AND REINFORCING SCHEDULE

40'-0" ROADWAY — HS20-44 LOADING

DO NOT SCALE

DESIGNED BY F.L. — CHECKED BY F.H. — JULY 1986
DRAWN BY V.L. — RECOMMENDED Vincent Christy — SHEET NO. 707

DRAWING H-6F

DRAWING H-8A—CANTILEVERED RETAINING WALL—TYPE 1 (9700 TO 10,900 MM HEIGHTS)

This drawing is similar to H-8, except it shows Type 1 walls from 9700 to 10,900 mm in height.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

Caltrans Metric

October 26,2000
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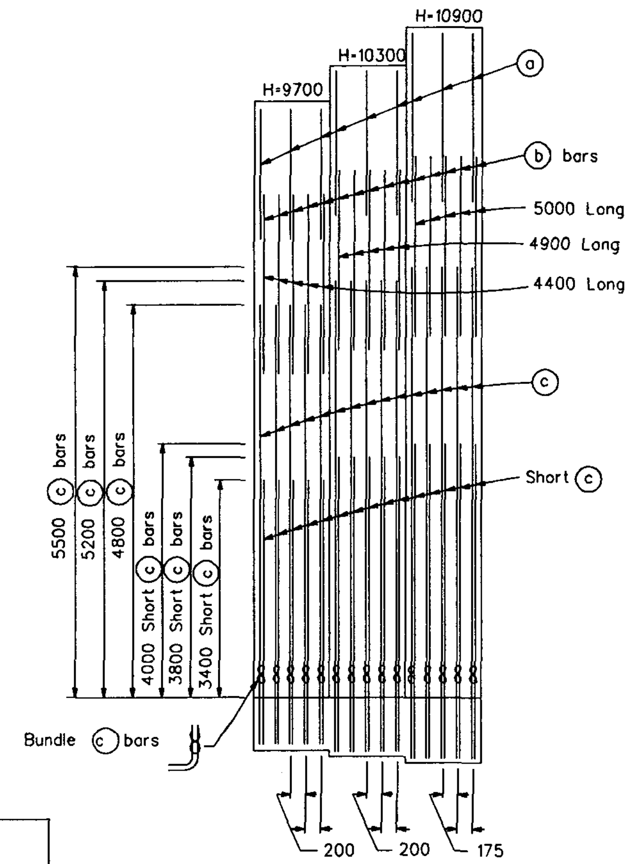
To accompany plans dated ______



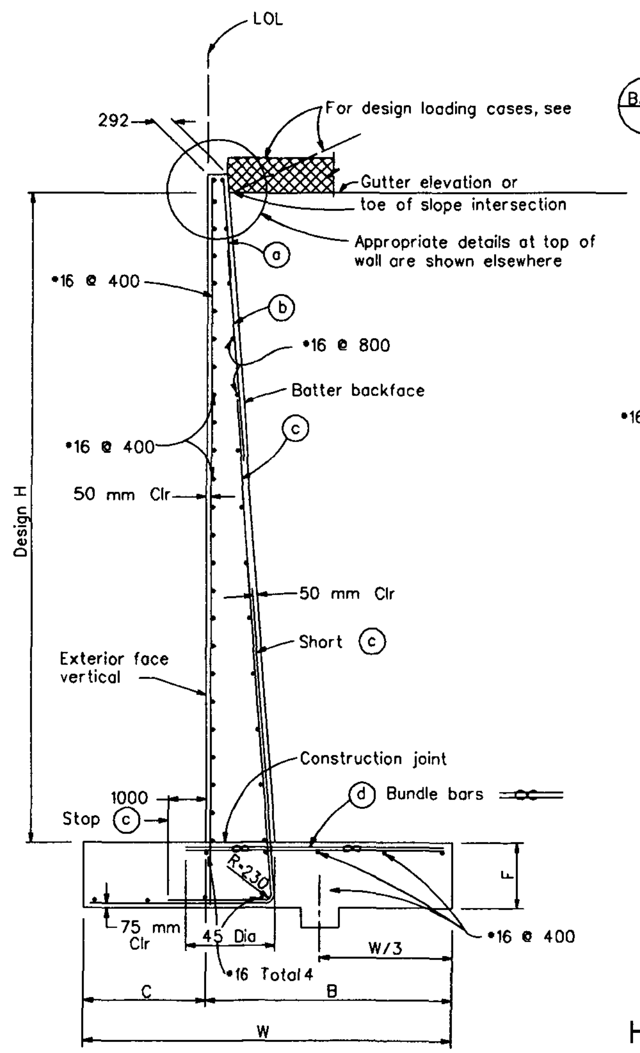
ELEVATION

TABLE OF REINFORCING STEEL, DIMENSIONS AND DATA				
Design H		9700	10300	10900
W		5600	5900	6200
C		1800	1900	2000
B		3800	4000	4200
F Spread Footing		1000	1 100	1200
Batter		100:8	100:8	100:8
ⓐ bars		•19@400	•19@400	•19@350
ⓑ bars		•29@200	•29@200	•29@175
ⓒ bars		•36@200∞	•36@200∞	•36@175∞
ⓓ bars		•29@200 ∞	•29@200∞	•29@175∞
Total ⓔ bars		6-•19	6-•19	6-•19
Total ⓕ bars		4-•16	4-•16	4-•16
Loading Case I	H Comp kN	1 10	125	140
	V Comp kN	265	300	330
	Toe Pr. kPa	300	325	350
Loading Case II	H Comp kN	165	185	210
	V Comp kN	365	410	455
	Toe Pr. kPa	370	400	435
Loading Case III	H Comp kN	130	145	160
	V Comp kN	295	330	370
	Toe Pr. kPa	380	400	425

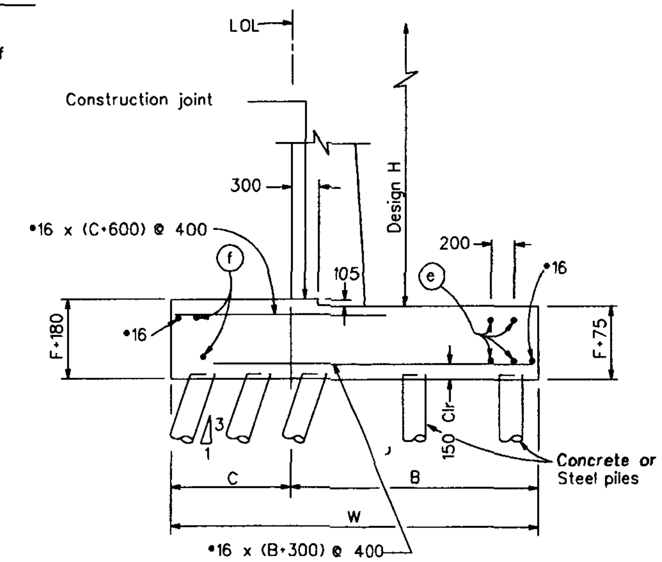
∞ Denotes a bundle of 2 bars.

NOTES

1. For details not shown and drainage notes see (B3-8)
2. For wall stem joint details, see (B0-3 / 3-3) and (B0-3 / 3-4)
3. At ⓒ and Short ⓒ bars:
   H ≤ 1800 mm, no splices are allowed within 500 mm above the top of footing.
   H > 1800 mm, no splices are allowed within H/4 above the top of footing.



SPREAD FOOTING SECTION



400 kN PILE FOOTING SECTION

Reinforcement detailed is to be placed in addition to that shown for spread footing. See Pile Layout on other sheets.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL TYPE 1 H=9700 THROUGH 10 900 mm

NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

RSP B3-2 DATED OCTOBER 26,2000 SUPERSEDES STANDARD PLAN B3-2 DATED JULY 1,1999-PAGE 183 OF THE STANDARD PLANS BOOK DATED JULY 1999.

REVISED STANDARD PLAN RSP B3-2 Drawing H-8A

DRAWING H-8B—CANTILEVERED RETAINING WALL—TYPE 1A (1200 TO 3600 MM HEIGHTS)

This drawing is similar to H-8, except it shows Type 1A walls from 1200 to 3600 mm in height. Type 1A walls differ from Type 1 in that Type 1A walls are short with a uniform thickness.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.

October 26,2000
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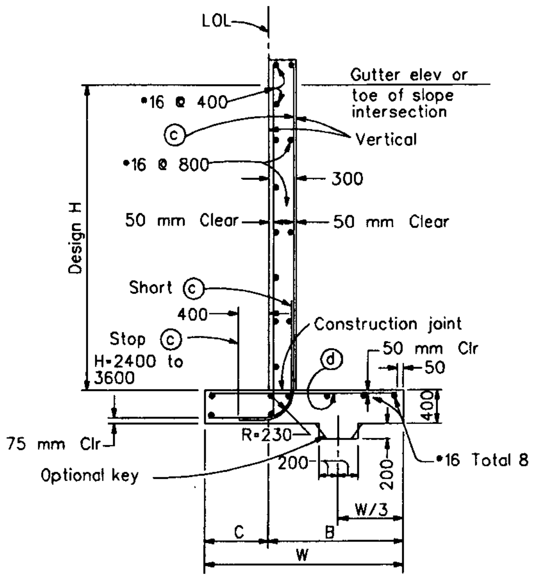
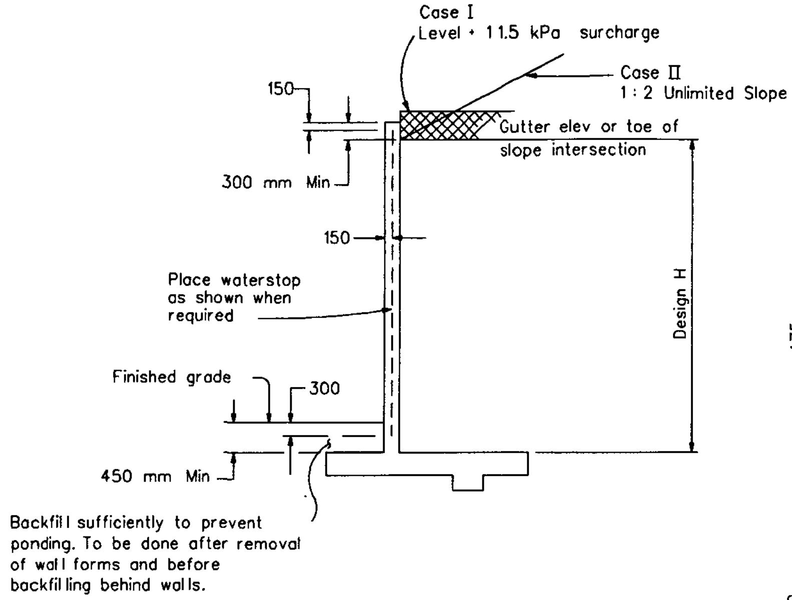
To accompany plans dated ________________

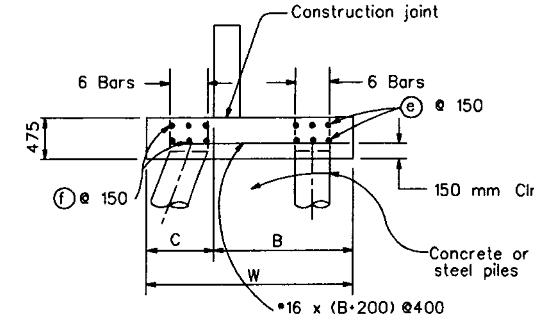


SPREAD FOOTING SECTION

Place concrete in toe, against undisturbed material, except as permitted by the Engineer.



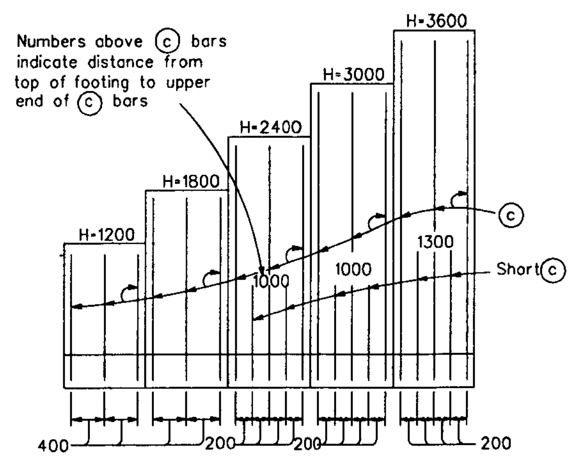
DESIGN



400 kN PILE FOOTING SECTION

Reinforcement detailed is to be placed in addition to that shown for spread footing. All piles not shown, see Pile Layout on other sheets. For pile footing for Design H=1200 use same footing dimensions as for Design H=1800.

TABLE OF REINFORCING STEEL, DIMENSIONS AND DATA					
Design H	1200	1800	2400	3000	3600
W	1000	1300	1600	1900	2200
C	300	400	500	600	700
B	700	900	1 100	1300	1500
(c) bars	•16@400	•16@400	•16@200	•19@200	•25@200
(d) bars	•16@400	•16@400	•16@400	•16@200	•19@200
Total (e) bars	6-•19	6-•19	6-•19	6-•25	6-•25
Total (f) bars	—	—	—	6-•19	6-•19
Case I-Toe Press. kPa	75	95	1 10	125	135
Case II-Toe Press. kPa	50	70	90	1 10	130



ELEVATION

NOTES

1. Retaining Wall Type 1A designed for Design Loading Cases I and II only.
2. For design notes, drainage notes and other details, See (B3-8)
3. For wall stem joint details, see (B0-3 / 3-3) and (B0-3 / 3-4)
4. At (c) and Short (c) bars:
   H ≤ 1800 mm, no splices are allowed within 500 mm above the top of footing.
   H > 1800 mm, no splices are allowed within H/4 above the top of footing.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL
TYPE 1A

NO SCALE

ALL DIMENSIONS ARE IN *MILLIMETERS UNLESS OTHERWISE SHOWN*

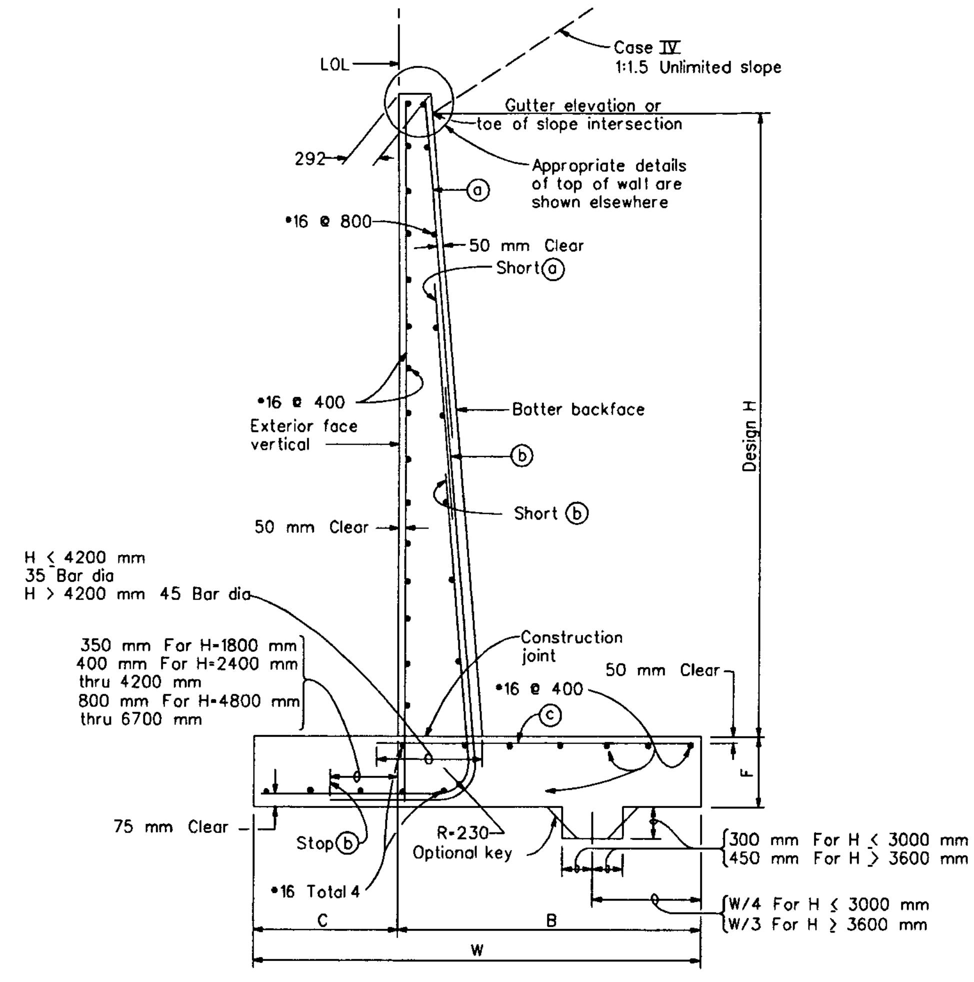
RSP B3-3 DATED OCTOBER 26,2000 SUPERSEDES STANDARD PLAN B3-3 DATED JULY 1,1999-PAGE 184 OF THE STANDARD PLANS BOOK DATED JULY 1999.

REVISED STANDARD PLAN RSP B3-3 | Drawing H-8B

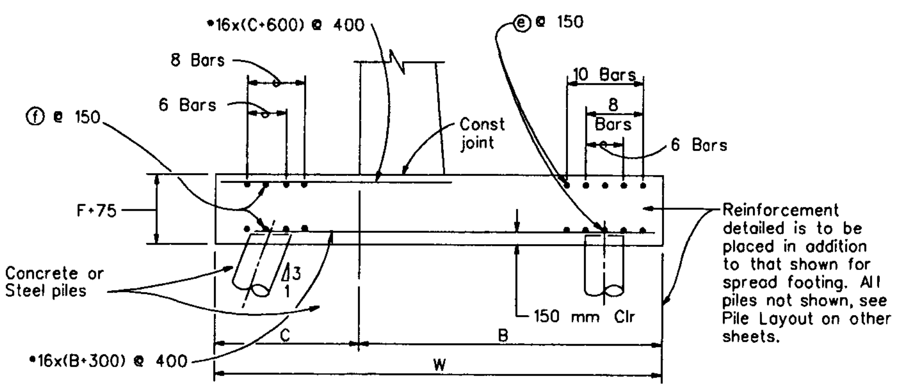
DRAWING H-8C—CANTILEVERED RETAINING WALL—TYPE 2 (1800 TO 6700 MM HEIGHTS)

This drawing is similar to H-8, except it covers Type 2 walls from 1800 to 6700 mm in height. Type 2 walls, compared with Type 1 walls, are of medium height with a set surcharge slope of 1 to 1-1/2.

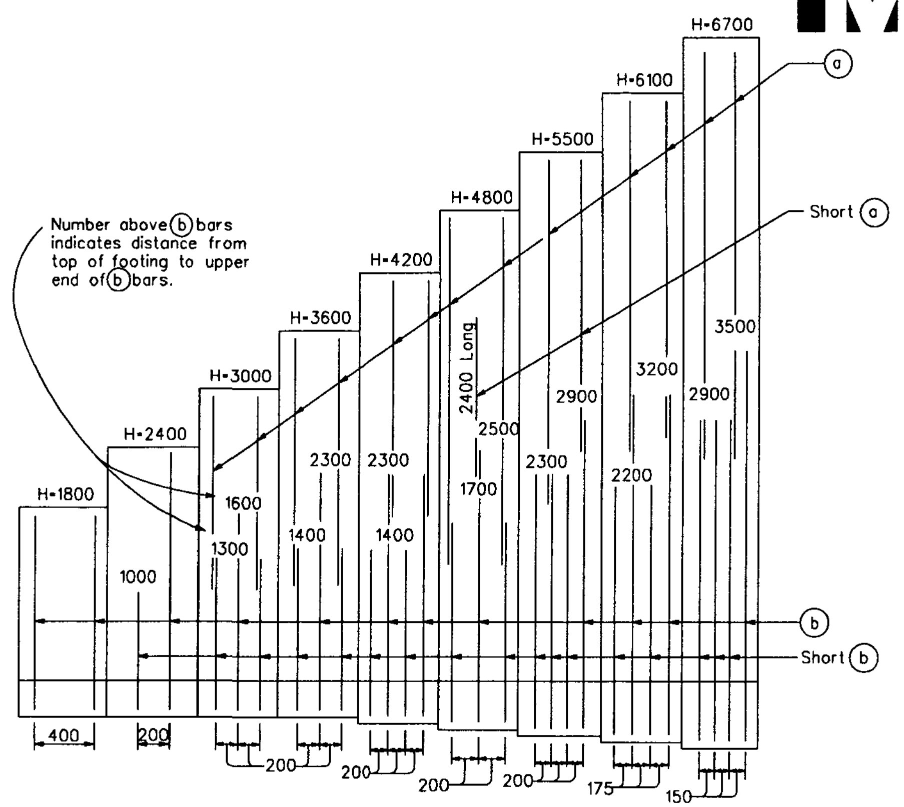
Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.



SPREAD FOOTING SECTION



400 kN PILE FOOTING SECTION



ELEVATION

TABLE OF REINFORCING STEEL, DIMENSIONS AND DATA									
Design H	1800	2400	3000	3600	4200	4800	5500	6100	6700
W	1200	1600	2000	2500	3000	3500	4000	4600	5400
C	400	500	550	650	750	850	950	1 150	1350
B	800	1 1 00	1450	1850	2250	2650	3050	3450	4050
F	400	400	400	400	450	550	650	750	850
Batter	100:4	100:4	100:4	100:4	100:4	100:4	100:5	100:6	100:7
ⓐ bars			•16@400	•16@400	•19@400	•19@200	•25@400	•25@350	•25@300
ⓑ bars	•16@400	•16@200	•19@200	•25@200	•29@200	•36@200	•36@200	•36@175	•36@150
ⓒ bars	•16@400	•16@400	•19@400	•19@200	•19@200	•25@200	•25@200	•25@175	•25@150
Total ⓔ bars	6-•19	6-•19	8-•25	8-•25	8-•25	8-•25	10-•19	10-•19	10-•19
Total ⓕ bars			8-•19	8-•19	8-•19	8-•19	6-•19	6-•19	6-•19
Toe Press KPa	125	155	185	215	240	275	315	335	335

NOTES

1. For design notes, drainage notes and other details, See (B3-8)
2. For wall stem joint details, see (B0-3 / 3-3) and (B0-3 / 3-4)
3. At ⓑ and Short ⓑ bars:
   H ≤ 1800 mm, no splices are allowed within 500 mm above the top of footing.
   H > 1800 mm, no splices are allowed within H/4 above the top of footing.

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To accompany plans dated ____________

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL TYPE 2

NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

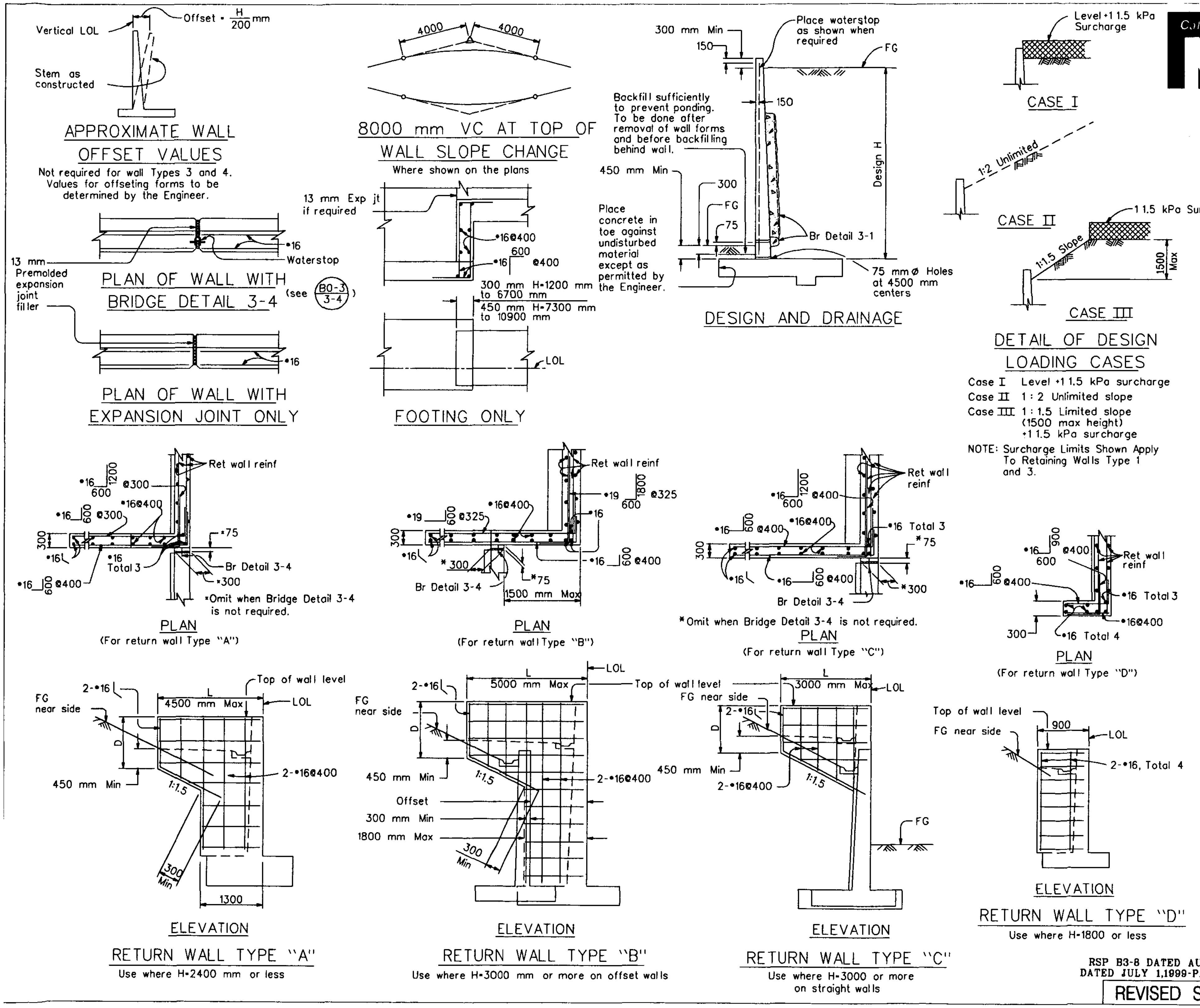
RSP B3-4 DATED OCTOBER 26,2000 SUPERSEDES STANDARD PLAN B3-4 DATED JULY 1,1999-PAGE 185 OF THE STANDARD PLANS BOOK DATED JULY 1999.

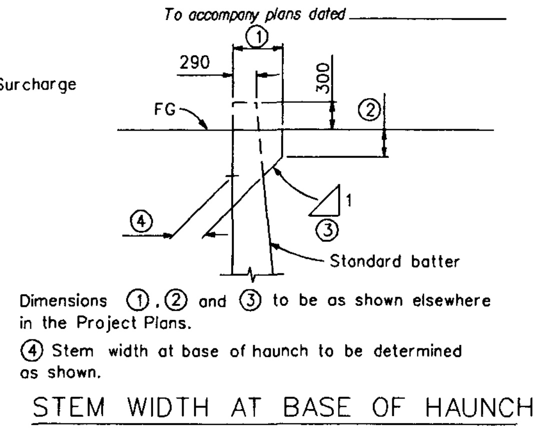
REVISED STANDARD PLAN RSP B3-4   Drawing H-8C

DRAWING H-8D—CANTILEVERED RETAINING WALL—DETAILS

This drawing shows miscellaneous design data and details.

Structural and placing drawings presented in this manual are examples of drafting style and graphic arrangement. These drawings are demonstrative examples of how structural and placing drawings are configured from a drafting perspective only. They are in no way to be used as structural designs, although, in general, they meet the requirements of ACI 318 or those of the AASHTO specifications or Caltrans requirements. The sample structural drawings emphasize how the engineer should clearly indicate design requirements and convey necessary information to the detailer, including specific locations of cutoff points and amount of steel.





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October 26,2000

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NOTES

Design Conditions:

Design H may be exceeded by 150 millimeters before going to the next size. Special footing design is required where foundation material is incapable of supporting toe pressure listed in table.

Return wall not required unless shown elsewhere.

Design Data:

f_c = 10 MPa f'_c = 25 MPa f_s = 168 MPa

n = 10 earth = 19 kN/m^3

1 1.5 kPa surcharge:

Equivalent fluid pressure =

5.6 kPa/m maximum for determination of toe pressure.

4.2 kPa/m minimum for determination of heel pressure.

Earth pressures for 1:2 unlimited slope, 1:1.5 slope, and 1:1.5 unlimited slope, determined from Rankine's formula with Ø=33°-42'.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

RETAINING WALL DETAILS NO. 1

NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

RSP B3-8 DATED AUGUST OCTOBER 26,2000 SUPERSEDES STANDARD PLAN B3-8 DATED JULY 1,1999-PAGE 189 OF THE STANDARD PLANS BOOK DATED JULY 1999.

REVISED STANDARD PLAN RSP B3-8 Drawing H-8D

SUPPORTING REFERENCE DATA

In addition to the standard, "Details and Detailing of Concrete Reinforcement (ACI 315)," and the report, "Manual of Structural and Placing Drawings for Reinforced Concrete Structures (ACI 315R)," several sections of supporting reference data appear in this third part of the manual. Some of this material has been reprinted from industry sources, particularly for the benefit of those outside the United States who do not have ready access to U.S. trade association literature.

CONTENTS

CHAPTER 1—REINFORCING BARS

1.1—Bar specifications

The specifications for reinforcing bars published by the American Society for Testing and Materials (ASTM) are accepted for construction in the United States. ACI 318 (318M) requires deformed reinforcing bars to conform to one of the following ASTM specifications:

a) "Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement" (ASTM A 615/A 615M);

b) "Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement" (ASTM A 706/A 706M); or

c) "Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement" (ASTM A 996/A 996M).

Bar mats for concrete reinforcement are required to conform to "Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement" (ASTM A 184/A 184M).

Table 1 gives reinforcing bar nominal dimensions and weights for U.S. sizes (inch-pound). Table 2 summarizes the mechanical requirements for steel reinforcing bars. It also indicates the grades and bar sizes.

1.2—Welding of bars

The weldability of steel, which is established by its chemical composition, sets the minimum preheat and interpass temperatures and limits the applicable welding procedures. Chemical compositions are not ordinarily meaningful for rail- and axle-steel bars. ASTM A 615/A 615M states, "Welding of the material in this specification should be approached with caution since no specific provisions have been included to enhance its weldability," and ASTM A 996/A 996M states, "The weldability of the steel is not a requirement of this specification." For these reasons, reinforcing bars conforming to ASTM A 706/A 706M should be used to enhance weldability.

Before specifying ASTM A 706/A 706M reinforcing bars, local availability should be investigated. Most producers can make ASTM A 706/A 706M bars but not in quantities less than one heat of steel for each bar size. (A heat of steel varies in different mills but can be approximately 50 to 200 tons [45 to 181 metric tons].) Thus, A 706/A 706M in lesser quantities of single bar sizes may not be immediately available from any single producer.*

"The ASTM A 706/A 706M specification includes provisions for making and marking reinforcing bars that also meet the ASTM A 615/A 615M specification. The purpose of these provisions is to increase the availability of low-alloy steel bars in smaller diameters.

1.3—Overall bar diameter

Bar diameters are nominal with the overall diameter measured to the outside of deformations being somewhat greater (refer to Table 3 and Fig. 1). The outside diameter can be important when punching holes in structural steel members to accommodate bars or when allowing for the out-to-out width of a group of beam bars crossing and in contact with column longitudinal bars. Diameters tabulated are approximate sizes to the outside of the deformations, so clearance should be added.

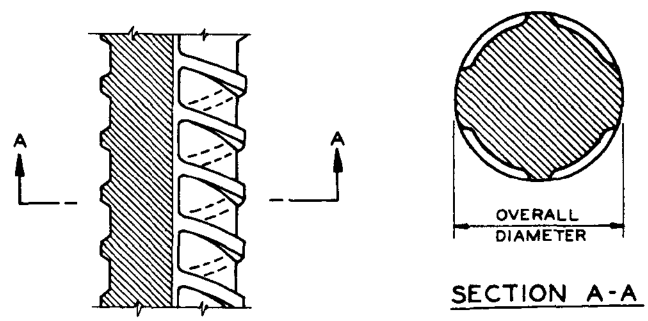


Fig. 1—Overall diameter of reinforcing bars.

*Gustafson, D. P., and Felder, A. L., 1991, "Questions and Answers on ASTM A 706 Reinforcing Bars," *Concrete International*, V. 13, No. 7, July, pp. 54-57.

Table 1—Designations, weights, dimensions, and deformation requirements of standard ASTM reinforcing bars

		Nominal dimensions†			Deformation requirements, in. (mm)		
Bar size,* inch-pound (metric)	Nominal weight, lb/ft (nominal mass, kg/m)	Diameter, in. (mm)	Cross-sectional area, in.^{2} (mm^2)	Perimeter, in. (mm)	Maximum average spacing	Minimum average height	Maximum gap (chord of 12.5% of nominal perimeter)
3 (10)	0.376 (0.560)	0.375 (9.5)	0.11 (71)	1.178 (29.9)	0.262 (6.7)	0.015 (0.38)	0.143 (3.6)
4 (13)	0.668 (0.994)	0.500 (12.7)	0.20 (129)	1.571 (39.9)	0.350 (8.9)	0.020 (0.51)	0.191 (4.9)
5 (16)	1.043 (1.552)	0.625 (15.9)	0.31 (199)	1.963 (49.9)	0.437 (11.1)	0.028 (0.71)	0.239 (6.1)
6 (19)	1.502 (2.235)	0.750 (19.1)	0.44 (284)	2.356 (59.8)	0.525 (13.3)	0.038 (0.97)	0.286 (7.3)
7 (22)	2.044 (3.042)	0.875 (22.2)	0.60 (387)	2.749 (69.8)	0.612 (15.5)	0.044 (1.12)	0.334 (8.5)
8 (25)	2.670 (3.973)	1.000 (25.4)	0.79 (510)	3.142 (79.8)	0.700 (17.8)	0.050 (1.27)	0.383 (9.7)
9 (29)	3.400 (5.060)	1.128 (28.7)	1.00 (645)	3.544 (90.0)	0.790 (20.1)	0.056 (1.42)	0.431 (10.9)
10 (32)	4.303 (6.404)	1.270 (32.3)	1.27 (819)	3.990 (101.3)	0.889 (22.6)	0.064 (1.63)	0.487 (12.4)
11 (36)	5.313 (7.907)	1.410 (35.8)	1.56 (1006)	4.430 (112.5)	0.987 (25.1)	0.071 (1.80)	0.540 (13.7)
14 (43)	7.65 (11.38)	1.693 (43.0)	2.25 (1452)	5.32 (135.1)	1.185 (30.1)	0.085 (2.16)	0.648 (16.5)
18 (57)	13.60 (20.24)	2.257 (57.3)	4.00 (2581)	7.09 (180.1)	1.58 (40.1)	0.102 (2.59)	0.864 (21.9)

*Bar sizes are based on number of eighths of an inch included in nominal diameter of the bar. (Bar numbers approximate number of millimeters of nominal diameter of bar.)
†Nominal dimensions of deformed bar are equivalent to those of a plain round bar having the same weight (mass) per foot (meter) as the deformed bar.

Table 2—ASTM specifications—bar sizes, grades, and requirements for strength in tension, elongation, and bending

Type of steel and ASTM specification	Bar sizes, in.-lb (metric)	Grade, in.-lb (metric)	Minimum yield strength, psi (MPa)	Minimum tensile strength, psi (MPa)	Minimum percentage elongation in 8 in. (203.2 mm)	Cold bend test pin diameter (*d* = nominal diameter of specimen)
Billet-steel A 615/ A 615M	3 to 6 (10 to 19)	40 (300)	40,000 (300)	70,000 (500)	#3 (#10)................11	#3, #4, #5 (#10, #13, #16)................3-1/2*d*
					#4, #5, #6 (#13, #16, #19).......................12	#6 (#19)................5*d*
	3 to 18 (10 to 57)	60 (420)	60,000 (420)	90,000 (620)	#3, #4, #5, #6 (#10, #13, #16, #19)...........9	#3, #4, #5 (#10, #13, #16)................3-1/2*d*
					#7, #8 (#22, #25).....8	#6, #7, #8 (#19, #22, #25).......................5*d*
					#9, #10, #11, #14, #18 (#29, #32, #36, #43, #57)................7	#9, #10, #11 (#29, #32, #36)...............7*d*
						#14, #18 (90) (#43, #57 (90))................9*d*
	6 to 18 (19 to 57)	75 (520)	75,000 (520)	100,000 (690)	#6, #7, #8 (#19, #22, #25)........................7	#6, #7, #8 (#19, #22, #25).......................5*d*
					#9, #10, #11, #14, #18 (#29, #32, #36, #43, #57)...............6	#9, #10, #11 (#29, #32, #36)...............7*d*
						#14, #18 (90) (#43, #57, (90))..............9*d*
Low-alloy steel A706/A706m	3 to 18 (10 to 57)	60 (420)	60,000 (420)	80,000 (550)	#3, #4, #5, #6 (#10, #13, #16, #19).......14	#3, #4, #5 (#10, #13, #16).......................3*d*
					#7, #8, #9, #10, #11 (#22, #25, #29, #32, #36).......................12	#6, #7, #8 (#19, #22, #25).......................4*d*
					#14, #18 (#43, #57).......................10	#9, #10, #11 (#29, #32, #36)...............6*d*
						#14, #18 (#43, #57).......................8*d*

Notes: For low-alloy steel reinforcing bars, ASTM A 706/A 706M prescribes a maximum yield strength of 78,000 psi (540 MPa) and the tensile strength shall not be less than 1.25 times the actual yield strength; and bend tests are 180 degrees, except that ASTM A 615/A 615M permits 90 degrees for bar sizes #14 and #18 (#43 and #57).

Table 3—Overall diameter of reinforcing bars

Bar size, inch-pound (metric)	Approximate diameter to outside of deformations, in. (mm)
#3 (#10)	7/16 (11)
#4 (#13)	9/16 (14)
#5 (#16)	11/16 (17)
#6 (#19)	7/8 (22)
#7 (#22)	1 (25)
#8 (#25)	1-1/8 (29)
#9 (#29)	1-1/4 (32)
#10 (#32)	1-7/16 (37)
#11 (#36)	1-5/8 (41)
#14 (#43)	1-7/8 (48)
#18 (#57)	2-1/2 (64)

Table 4—Maximum gap and end deviation (refer to Fig. 2)*

Bar size, inch-pound (metric)	Approximate maximum gap, in. (mm)	Approximate maximum end deviation, in. (mm)
#8 (#25)	3/64 (1.2)	1/32 (0.8)
#9 (#29)	1/16 (1.6)	1/32 (0.8)
#10 (#32)	1/16 (1.6)	1/32 (0.8)
#11 (#36)	5/64 (2.0)	1/32 (0.8)
#14 (#43)	3/32 (2.4)	3/64 (1.2)
#18 (#57)	1/8 (3.2)	1/16 (1.6)

*Based on nominal bar diameters.

1.4—ACI standard fabricating tolerances for nominally square saw-cut bar ends

For adequate structural performance, the total angular deviation of the gap should not exceed 3 degrees for end-bearing compression connections, as shown in Fig. 2(a) and listed in Table 4.

To achieve a proper fit in the field, the ends of the bars should be saw-cut or otherwise cut in such a manner as to provide a reasonably flat surface. It is recommended that deviation of the gap between the ends of bars in contact should not exceed 1-1/2 degrees for a compression connection, when measured from a right angle to the end 12 in. (300 mm) of the bar, as shown in Fig. 2(b) and listed in Table 4. Relative rotation or other field adjustment of the bars may be necessary during erection to secure a fit that falls within the recommended gap limits.

It is not intended that bars saw-cut for tension mechanical splices meet the ACI 318 (318M) mandated maximum deviation and gap tolerances for end-bearing (compression) splices.

1.5—Coated reinforcing bars

There are various types of corrosion-protection systems for reinforced concrete structures. One approach is to coat the bars with a suitable protective coating. The protective coating can be a nonmetallic material, such as epoxy, or a metallic material, such as zinc (galvanizing). Because this manual is primarily concerned with steel reinforcing materials,

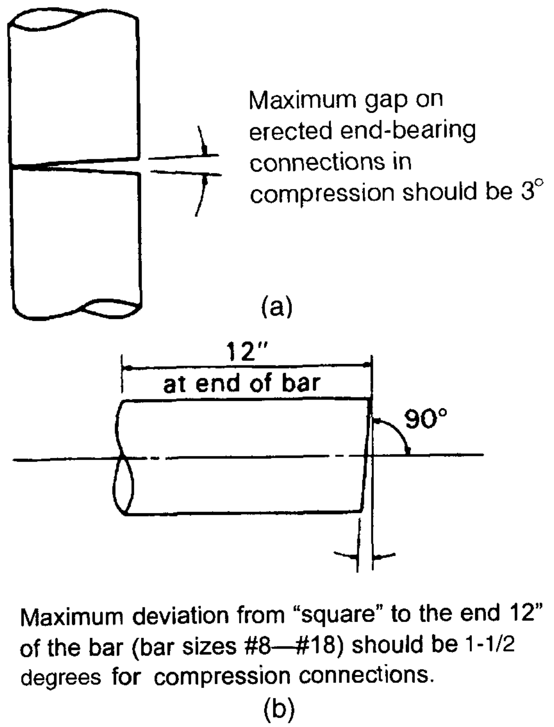


Fig. 2—Maximum gap and end deviation: (a) maximum gap; and (b) end deviation.

only the use of epoxy-coated or zinc-coated (galvanized) bars as a corrosion-protection system is discussed.

1.6—ASTM specifications for coated bars

Zinc-coated (galvanized) reinforcing bars should conform to ASTM A 767/A 767M. The bars that are to be epoxy-coated or zinc-coated (galvanized) should meet the ACI 318 (318M) requirements for uncoated bars as described in Section 1.1.

The ASTM A 775/A 775M specification for epoxy-coated reinforcing bars includes requirements for the epoxy-coating material, surface preparation of the bars before application of the coating, the method of application of the coating material, limits on coating thickness, and acceptance tests to ensure that the coating was properly applied. Epoxy-coated bars conforming to the ASTM A 775/A 775M specification are usually fabricated after application of the epoxy coating. Damage to the coating might occur during handling and fabrication of the coated bars. Damaged areas of coating should be repaired (touched-up) with the appropriate patching material.

In 1995, ASTM issued a second specification for epoxy-coated bars, designated as ASTM A 934/A 934M. The other ASTM specification prescribes requirements for bars that are prefabricated before application of the epoxy coating. Requirements for the epoxy-coating material, surface preparation of the bars before coating, method of coating application, limits on coating thickness, and acceptance tests are included in the ASTM A 934/A 934M specification.

The ASTM A 767/A 767M specification for zinc-coated (galvanized) reinforcing bars includes requirements for the zinc coating material, the galvanizing process, the class or weight of coating per unit surface area of bar, finish and adherence of the coating, and fabrication. Reinforcing bars are usually galvanized after fabrication. ASTM A 767/A 767M prescribes minimum finished bend diameters for bars that are fabricated before galvanizing. Smaller finished bend diameters are permitted if the bars are stress-relieved. Thus, when bars are fabricated before galvanizing, the architect/engineer should specify which bars require special finished bend diameters, usually the smaller bar sizes for stirrups and ties. The ASTM A 767/A 767M specification has two classes of zinc coating weights. Class I (3.5 oz./ft^2 [1070 g/m^2]) is normally specified for general construction.

The ASTM A 767/A 767M, A 775/A 775M, and A 934/A 934M specifications are product standards. Their provisions cover the coated bars to the point of shipment from the manufacturer's facility. The architect/engineer should consider including provisions in the project specifications for the following (refer to ACI 301 for the requirements):

1. Compatible bar supports, support bars, and spreader bars in walls;
2. Compatible tie wire;
3. Field bending of coated bars partially embedded in concrete—specify requirements for the repair of damaged coating after completion of field bending operations. Field bending of bars that are epoxy-coated in accordance with the ASTM A 934/A 934M specification is not recommended;
4. Mechanical splices—specify requirements for the repair of damaged coating after installation of mechanical splices and specify requirements for coating all parts of mechanical splices, including steel splice sleeves, bolts, and nuts;
5. Welded splices—specify any desired or more stringent requirements for preparation or for welding than those contained in the *Structural Welding Code—Reinforcing Steel*, ANSI/AWS D1.4; specify requirements for the repair of damaged coating after completion of welding, and specify requirements for coating all welds and all steel splice members that are used to splice the bars;
6. Cutting of coated bars in the field—specify requirements for coating the ends of the bars;
7. Handling epoxy-coated bars—require handling equipment to have padded contact areas; require multiple pick-up points for lifting bundles to prevent bar-to-bar abrasion from sags in the bundles, and prohibit dropping or dragging coated bars;
8. Storage of epoxy-coated bars at the jobsite, including provisions for longer-term storage; and
9. Repair of all damaged coating due to shipment, handling, and placing operations—specify a limit on the maximum amount of repaired damaged areas.

1.7—Design data for reinforcing bars

Table 5 to 10 contain general design data for reinforcing bars, including development and lap splice lengths.

1.8—Detailing data for reinforcing bars

Table 11 and 12 and Fig. 3 contain additional data useful for the reinforcing bar detailer: shipping limit tables and an example bar list.

Table 5—Areas (in.^{2}/ft) for various bar sizes and spacings

Spacing, in.	#3	#4	#5	#6	#7	#8	#9	#10	#11	#14	#18	Spacing, in.
3.0	0.44	0.80	1.24	1.76	2.40	3.16	4.00	5.08	—	—	—	3.0
3.5	0.38	0.69	1.06	1.51	2.06	2.71	3.43	4.35	—	—	—	3.5
4.0	0.33	0.60	0.93	1.32	1.80	2.37	3.00	3.81	4.68	6.75	—	4.0
4.5	0.29	0.53	0.83	1.17	1.60	2.11	2.67	3.39	4.16	6.00	10.67	4.5
5.0	0.26	0.48	0.74	1.06	1.44	1.90	2.40	3.05	3.74	5.40	9.60	5.0
5.5	0.24	0.44	0.68	0.96	1.31	1.72	2.18	2.77	3.40	4.91	8.73	5.5
6.0	0.22	0.40	0.62	0.88	1.20	1.58	2.00	2.54	3.12	4.50	8.00	6.0
6.5	0.20	0.37	0.57	0.81	1.11	1.46	1.85	2.34	2.88	4.15	7.38	6.5
7.0	0.19	0.34	0.53	0.75	1.03	1.35	1.71	2.18	2.67	3.86	6.86	7.0
7.5	0.18	0.32	0.50	0.70	0.96	1.26	1.60	2.03	2.50	3.60	6.40	7.5
8.0	0.17	0.30	0.47	0.66	0.90	1.19	1.50	1.91	2.34	3.38	6.00	8.0
8.5	0.16	0.28	0.44	0.62	0.85	1.12	1.41	1.79	2.20	3.18	5.65	8.5
9.0	0.15	0.27	0.41	0.59	0.80	1.05	1.33	1.69	2.08	3.00	5.33	9.0
9.5	0.14	0.25	0.39	0.56	0.76	1.00	1.26	1.60	1.97	2.84	5.05	9.5
10.0	0.13	0.24	0.37	0.53	0.72	0.95	1.20	1.52	1.87	2.70	4.80	10.0
10.5	0.13	0.23	0.35	0.50	0.69	0.90	1.14	1.45	1.78	2.57	4.57	10.5
11.0	0.12	0.22	0.34	0.48	0.65	0.86	1.09	1.39	1.70	2.45	4.36	11.0
11.5	0.11	0.21	0.32	0.46	0.63	0.82	1.04	1.33	1.63	2.35	4.17	11.5
12.0	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27	1.56	2.25	4.00	12.0
12.5	0.11	0.19	0.30	0.42	0.58	0.76	0.96	1.22	1.50	2.16	3.84	12.5
13.0	0.10	0.18	0.29	0.41	0.55	0.73	0.92	1.17	1.44	2.08	3.69	13.0
13.5	0.10	0.18	0.28	0.39	0.53	0.70	0.89	1.13	1.39	2.00	3.56	13.5
14.0	0.09	0.17	0.27	0.38	0.51	0.68	0.86	1.09	1.34	1.93	3.43	14.0
14.5	0.09	0.17	0.26	0.36	0.50	0.65	0.83	1.05	1.29	1.86	3.31	14.5
15.0	0.09	0.16	0.25	0.35	0.48	0.63	0.80	1.02	1.25	1.80	3.20	15.0
15.5	0.09	0.15	0.24	0.34	0.46	0.61	0.77	0.98	1.21	1.74	3.10	15.5
16.0	0.08	0.15	0.23	0.33	0.45	0.59	0.75	0.95	1.17	1.69	3.00	16.0
16.5	0.08	0.15	0.23	0.32	0.44	0.57	0.73	0.92	1.13	1.64	2.91	16.5
17.0	0.08	0.14	0.22	0.31	0.42	0.56	0.71	0.90	1.10	1.59	2.82	17.0
17.5	0.08	0.14	0.21	0.30	0.41	0.54	0.69	0.87	1.07	1.54	2.74	17.5
18.0	0.07	0.13	0.21	0.29	0.40	0.53	0.67	0.85	1.04	1.50	2.67	18.0

Note: 1 in.^{2}/ft = 2116.7 mm^2/m.

Table 6—Bundled bars for longitudinal column reinforcement*

Bundle†	Effective number of bars	Bar size, inch-pound (metric)	Total area, in.^{2} (mm^2)	Equivalent diameter, in. (mm)	Minimum clear distance, in. (mm)	
					Between bundles	Bundle to edge‡
2-bar	2	#8 (#25)	1.58 (1020)	1.42 (36.1)	2-1/8 (55)	1-1/2 (40)
		#9 (#29)	2.00 (1290)	1.60 (40.6)	2-1/2 (65)	1-3/4 (45)
		#10 (#32)	2.54 (1640)	1.80 (45.7)	2-3/4 (70)	2 (50)
		#11 (#36)	3.12 (2010)	2.00 (50.8)	3 (75)	2 (50)
3-bar	3	#8 (#25)	2.37 (1530)	1.74 (44.2)	2-1/4 (55)	1-3/4 (45)
		#9 (#29)	3.00 (1940)	1.95 (49.5)	3 (75)	2 (50)
		#10 (#32)	3.81 (2460)	2.20 (55.9)	3-1/2 (90)	2-1/4 (55)
		#11 (#36)	4.68 (3020)	2.44 (62.0)	3-3/4 (95)	2-1/2 (65)
4-bar	4	#8 (#25)	3.16 (2040)	2.01 (51.1)	3-1/4 (85)	2-1/4 (55)
		#9 (#29)	4.00 (2580)	2.26 (57.4)	3-1/2 (90)	2-1/2 (65)
		#10 (#32)	5.08 (3280)	2.55 (64.8)	4 (100)	2-3/4 (70)
		#11 (#36)	6.24 (4030)	2.82 (71.6)	4-1/4 (100)	3 (75)

*Bars in a bundle should terminate with at least 40 bar diameters stagger except where the bundle terminates.

†Splice bars, welding, or positive connection should be provided for splices required to carry full tension or tension in excess of the capacity of the unspliced portion of the bundle. Compression can be transmitted by end bearing of square-cut ends.

‡These minimum distances apply to bundles only. Where ties or spirals are present, the 1-1/2 in. (40 mm) minimum cover to them will control in some cases. A 3 in. (75 mm) cover is required where columns are cast against and permanently exposed to earth.

Table 7(a)—Tension development and lap-splice lengths for uncoated reinforcing bars

Bar size, inch-pound (metric)	Lap class	Lengths (in.) per concrete strength											
		3000 psi (21 MPa)				4000 psi (28 MPa)				5000 (35 MPa)			
		Top bars		Other bars		Top bars		Other bars		Top bars		Other bars	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 (#10)	A	22	32	17	25	19	28	15	22	17	25	13	19
	B	28	42	22	32	24	36	19	28	22	33	17	25
#4 (#13)	A	29	43	22	33	25	37	19	29	22	33	17	26
	B	37	56	29	43	32	48	25	37	29	43	22	33
#5 (#16)	A	36	54	28	41	31	47	24	36	28	42	22	32
	B	47	70	36	54	40	60	31	47	36	54	28	42
#6 (#19)	A	43	64	33	50	37	56	29	43	33	50	26	38
	B	56	84	43	64	48	72	37	56	43	65	33	50
#7 (#22)	A	63	94	48	72	54	81	42	63	49	73	37	56
	B	81	122	63	94	70	106	54	81	63	94	49	73
#8 (#25)	A	72	107	55	82	62	93	48	71	55	83	43	64
	B	93	139	72	107	80	121	62	93	72	108	55	83
#9 (#29)	A	81	121	62	93	70	105	54	81	63	94	48	72
	B	105	157	81	121	91	136	70	105	81	122	63	94
#10 (#32)	A	91	136	70	105	79	118	61	91	70	105	54	81
	B	118	177	91	136	102	153	79	118	91	137	70	105
#11 (#36)	A	101	151	78	116	87	131	67	101	78	117	60	90
	B	131	196	101	151	113	170	87	131	101	152	78	117
#14 (#43)	N/A	121	181	93	139	105	157	81	121	94	140	72	108
#18 (#57)	N/A	161	241	124	186	139	209	107	161	125	187	96	144

Note: 1 in. = 25.4 mm.

Table 7(b)—Tension development and lap-splice lengths for uncoated reinforcing bars

Bar size, inch-pound (metric)	Lap class	Lengths (in.) per concrete strength											
		6000 psi (42 MPa)				7000 psi (49 MPa)				8000 (56 MPa)			
		Top bars		Other bars		Top bars		Other bars		Top bars		Other bars	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 (#10)	A	15	23	12	18	14	21	12	16	13	20	12	15
	B	20	30	16	23	18	28	16	21	17	26	16	20
#4 (#13)	A	20	31	16	24	19	28	15	22	18	26	14	20
	B	26	40	20	31	25	37	19	28	23	34	18	26
#5 (#16)	A	25	38	20	29	24	35	18	27	22	33	17	25
	B	33	49	25	38	31	46	24	35	29	43	22	33
#6 (#19)	A	31	46	24	35	28	42	22	33	26	40	20	30
	B	40	59	31	46	37	55	28	42	34	51	26	40
#7 (#22)	A	44	66	34	51	41	61	32	47	38	58	30	44
	B	58	86	44	66	53	80	41	61	50	75	38	58
#8 (#25)	A	51	76	39	58	47	70	36	54	44	66	34	51
	B	66	98	51	76	61	91	47	70	57	85	44	66
#9 (#29)	A	57	85	44	66	53	79	41	61	49	74	38	57
	B	74	111	57	85	69	103	53	79	64	96	49	74
#10 (#32)	A	64	96	49	74	59	89	46	69	56	83	43	64
	B	83	125	64	96	77	116	59	89	72	108	56	83
#11 (#36)	A	71	107	55	82	66	99	51	76	62	93	48	71
	B	93	139	71	107	86	128	66	99	80	120	62	93
#14 (#43)	N/A	86	128	66	99	79	119	61	91	74	111	57	85
#18 (#57)	N/A	114	171	88	131	106	158	81	122	99	148	76	114

Notes: 1 in. = 25.4 mm.

1. Tabulated values are based on Grade 60 (420) reinforcing bars and normalweight concrete. Lengths are in inches; **2.** Tension development lengths and tension lap-splice lengths are calculated per ACI 318 (318M), Sections 12.2.2 and 12.15, respectively. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum code requirements; **3.** Cases 1 and 2, which depend on the type of structural element, concrete cover, and center-to-center spacing of the bars, are defined as: Beams or Columns: Case 1—Cover at least $1.0d_b$ and center-to-center spacing at least $2.0d_b$ and Case 2—Cover less than $1.0\ d_b$ or center-to-center spacing less than $2.0d_b$. All: Case 1—Cover at least $1.0d_b$ and center-to-center spacing at least $3.0d_b$. Others: Case 2—Cover less than $1.0d_b$ or center-to-center spacing less than $3.0\ d_b$; **4.** Lap splice lengths are multiples of tension development lengths; Class A = $1.0\ell_d$ and Class B = $1.3\ell_d$ (ACI 318 [318M], Section 12.15.1); **5.** ACI 318 (318M) does not allow tension lap splices of #14 (#43) or #18 (#57) bars. The tabulated values for those bar sizes are the tension development lengths; **6.** Top bars are horizontal bars with more than 12 in. (300 mm) of concrete cast below the bars; and **7.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3.

Table 8(a)—Tension development and lap-splice lengths for epoxy-coated reinforcing bars

Bar size, inch-pound (metric)	Lap class	Lengths (in.) per concrete strength											
		3000 psi (21 MPa)				4000 psi (28 MPa)				5000 (35 MPa)			
		Top bars		Other bars		Top bars		Other bars		Top bars		Other bars	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 (#10)	A	28	42	25	37	24	37	22	32	22	33	19	29
	B	37	55	32	48	32	47	28	42	28	42	25	38
#4 (#13)	A	38	56	33	50	33	49	29	43	29	44	26	38
	B	49	73	43	64	42	63	37	56	38	57	33	50
#5 (#16)	A	47	70	41	62	41	61	36	54	36	54	32	48
	B	61	91	54	80	53	79	47	70	47	71	42	62
#6 (#19)	A	56	84	50	74	49	73	43	64	44	65	38	58
	B	73	109	64	96	63	95	56	84	57	85	50	75
#7 (#22)	A	82	123	72	108	71	106	63	94	63	95	56	84
	B	106	159	94	140	92	138	81	122	82	123	73	109
#8 (#25)	A	93	140	82	124	81	121	71	107	72	108	64	96
	B	121	182	107	161	105	158	93	139	94	141	83	124
#9 (#29)	A	105	158	93	139	91	137	81	121	82	122	72	108
	B	137	205	121	181	119	178	105	157	106	159	94	140
#10 (#32)	A	119	178	105	157	103	154	91	136	92	138	81	122
	B	154	231	136	204	133	200	118	177	119	179	105	158
#11 (#36)	A	132	197	116	174	114	171	101	151	102	153	90	135
	B	171	256	151	226	148	222	131	196	133	199	117	175
#14 (#43)	N/A	158	237	139	209	137	205	121	181	122	183	108	162
#18 (#57)	N/A	210	316	186	278	182	273	161	241	163	244	144	216

Note: 1 in. = 25.4 mm.

Table 8(b)—Tension development and lap-splice lengths for epoxy-coated reinforcing bars

Bar size, inch-pound (metric)	Lap class	Lengths (in.) per concrete strength											
		6000 psi (42 MPa)				7000 psi (49 MPa)				8000 (56 MPa)			
		Top bars		Other bars		Top bars		Other bars		Top bars		Other bars	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 (#10)	A	20	30	18	26	19	28	16	25	17	26	15	23
	B	26	39	23	34	24	36	21	32	23	34	20	30
#4 (#13)	A	27	40	24	35	25	37	22	33	23	35	20	30
	B	35	52	31	46	32	48	28	42	30	45	26	40
#5 (#16)	A	33	50	29	44	31	46	27	41	29	43	25	38
	B	43	64	38	57	40	60	35	53	37	56	33	49
#6 (#19)	A	40	60	35	53	37	55	33	49	35	52	30	46
	B	52	77	46	68	48	72	42	63	45	67	40	59
#7 (#22)	A	58	87	51	77	54	80	47	71	50	75	44	66
	B	75	113	66	99	70	104	61	92	65	98	58	86
#8 (#25)	A	66	99	58	87	61	92	54	81	57	86	51	76
	B	86	129	76	114	80	119	70	105	74	111	66	98
#9 (#29)	A	75	112	66	99	69	103	61	91	65	97	57	85
	B	97	145	85	128	90	134	79	119	84	126	74	111
#10 (#32)	A	84	126	74	111	78	116	69	103	73	109	64	96
	B	109	163	96	144	101	151	89	133	94	142	83	125
#11 (#36)	A	93	140	82	123	86	129	76	114	81	121	71	107
	B	121	181	107	160	112	168	99	148	105	157	93	139
#14 (#43)	N/A	112	168	99	148	103	155	91	137	97	145	85	128
#18 (#57)	N/A	149	223	131	197	138	207	122	182	129	193	114	171

Notes: 1 in. = 25.4 mm.
1. Tabulated values are based on Grade 60 (420) reinforcing bars and normalweight concrete. Lengths are in inches; **2.** Tension development lengths and tension lap-splice lengths are calculated per ACI 318 (318M), Sections 12.2.2 and 12.15, respectively. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum code requirements; **3.** Cases 1 and 2, which depend on the type of structural element, concrete cover, and center-to-center spacing of the bars, are defined as: Beams or Columns: Case 1—Cover at least $1.0d_b$ and center-to-center spacing at least $2.0d_b$ and Case 2—Cover less than $1.0\ d_b$ or center-to-center spacing less than $2.0d_b$. All: Case 1—Cover at least $1.0d_b$ and center-to-center spacing at least $3.0d_b$. Others: Case 2—Cover less than $1.0d_b$ or center-to-center spacing less than $3.0\ d_b$; **4.** Lap splice lengths are multiples of tension development lengths; Class A = $1.0\ell_d$ and Class B = $1.3\ell_d$ (ACI 318 (318M), Section 12.15.1); **5.** ACI 318 (318M) does not allow tension lap splices of #14 (#43) or #18 (#57) bars. The tabulated values for those bar sizes are the tension development lengths; **6.** Top bars are horizontal bars with more than 12 in. (300 mm) of concrete cast below the bars; **7.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3; and **8.** A factor of 1.5 was used for epoxy-coated bars, if the bar center-to-center spacing is at least $7.0d_b$ and the concrete cover is at least $3.0d_b$, then Case 1 lengths can be multiplied by 0.918 (for top bars) or 0.8 (for other bars).

Table 9—Tension embedment lengths for standard end hooks

Bar size, inch-pound (metric)	Length (in.) per concrete strength						
	3000 psi (21 MPa)	3500 psi (24 MPa)	4000 psi (28 MPa)	5000 psi (35 MPa)	6000 psi (42 MPa)	7000 psi (49 MPa)	8000 psi (56 MPa)
#3 (#10)	9	8	7	7	6	6	6
#4 (#13)	11	10	10	9	8	7	7
#5 (#16)	14	13	12	11	10	9	9
#6 (#19)	17	16	15	13	12	11	10
#7 (#22)	19	18	17	15	14	13	12
#8 (#25)	22	21	19	17	16	15	14
#9 (#29)	25	23	22	19	18	16	15
#10 (#32)	28	26	24	22	20	19	17
#11 (#36)	31	29	27	24	22	21	19
#14 (#43)	37	35	32	29	27	25	23
#18 (#57)	50	46	43	39	35	33	31

Notes: 1 in. = 25.4 mm.

1. Tabulated values are based on Grade 60 (420) reinforcing bars and normalweight concrete. Lengths are in inches; **2.** Tension development lengths of standard hooks are calculated per ACI 318 (318M), Section 12.5; **3.** For bar sizes #3 through #11 (#10 through #36) only: a. If concrete cover conforms to ACI 318 (318M) Section 12.5.3.3, then a modification factor of 0.7 may be applied but the length should not be less than $8d_b$ nor 6 in. (150 mm); and b. If hook is enclosed in ties or stirrups per ACI 318 (318M) Section 12.5.3.3, then a modification factor of 0.8 can be applied, but the length should not be less than $8.0d_b$ nor 6 in. (150 mm); and **4.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3.

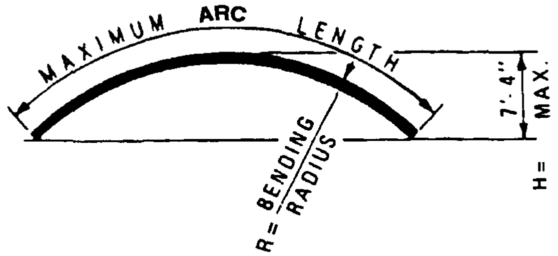
Table 10—Compression embedment and lap-splice lengths for reinforcing bars

Bar size, inch-pound (metric)	Compression length (in.) per concrete strength							Lap splice
	3000 psi (21 MPa)	3500 psi (24 MPa)	4000 psi (28 MPa)	5000 psi (35 MPa)	6000 psi (42 MPa)	7000 psi (49 MPa)	8000 psi (56 MPa)	
#3 (#10)	9	8	8	8	8	8	8	12
#4 (#13)	11	10	10	9	9	9	9	15
#5 (#16)	14	13	12	12	12	12	12	19
#6 (#19)	17	16	15	14	14	14	14	23
#7 (#22)	19	18	17	16	16	16	16	27
#8 (#25)	22	21	19	18	18	18	18	30
#9 (#29)	25	23	22	21	21	21	21	34
#10 (#32)	28	26	24	23	23	23	23	38
#11 (#36)	31	29	27	26	26	26	26	43
#14 (#43)	37	35	32	31	31	31	31	N/A
#18 (#57)	50	46	43	41	41	41	41	N/A

Notes: 1 in. = 25.4 mm.

1. Tabulated values are based on Grade 60 (420) reinforcing bars and normalweight concrete. Lengths are in inches; **2.** Compression development lengths are calculated per ACI 318 (318M), Section 12.3. Compression lap splice lengths are calculated per ACI 318 (318M), Section 12.16; **3.** For compression development lengths, if bars are enclosed in spirals or ties per ACI 318 (318M), Section 12.3.3.2, then a modification factor of 0.75 can be applied but the length should not be less than 8 in. (200 mm); **4.** For lap splice lengths in compression members: a. In a tied compression member, if the bars are enclosed by ties per ACI 318 (318M), Section 12.17.2.4, then a modification factor of 0.83 can be applied, but the length should not be less than 12 in. (300 mm); and b. If bars are enclosed in a spirally reinforced compression member per ACI 318 (318M), Section 12.17.2.5, then a modification factor of 0.75 can be applied, but the length should not be less than 12 in. (300 mm); and **5.** ACI 318 (318M) does not allow compression lap splices of #14 and #18 (#43 and #57) bars, except to # 11 (# 36) and smaller bars.

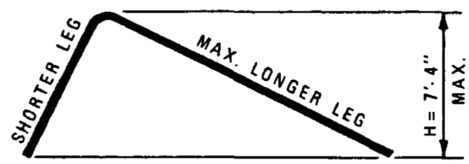
Table 11—Maximum arc length for shipping reinforcing bars



Radius	Maximum length	Radius	Maximum length	Radius	Maximum length	Radius	Maximum length	Radius	Maximum length	Radius	Maximum length
4'-0"	20'-5"	13'-6"	29'-7"	23'-0"	37'-9"	32'-6"	44'-6"	42'-0"	50'-5"	51'-6"	55'-8"
4'-6"	20'-3"	14'-0"	30'-1"	23'-6"	38'-2"	33'-0"	44'-10"	42'-6"	50'-8"	52'-0"	55'-11"
5'-0"	20'-7"	14'-6"	30'-7"	24'-0"	38'-7"	33'-6"	45'-2"	43'-0"	51'-0"	52'-6"	56'-2"
5'-6"	21'-0"	15'-0"	31'-0"	24'-6"	38'-11"	34'-0"	45'-6"	43'-6"	51'-3"	53'-0"	56'-5"
6'-0"	21'-6"	15'-6"	31'-6"	25'-0"	39'-4"	34'-6"	45'-10"	44'-0"	51'-6"	53'-6"	56'-8"
6'-6"	22'-1"	16'-0"	31'-11"	25'-6"	39'-8"	35'-0"	46'-2"	44'-6"	51'-10"	54'-0"	56'-11"
7'-0"	22'-8"	16'-6"	32'-5"	26'-0"	40'-0"	35'-6"	46'-6"	45'-0"	52'-1"	54'-6"	57'-2"
7'-6"	23'-3"	17'-0"	32'-10"	26'-6"	40'-5"	36'-0"	46'-9"	45'-6"	52'-5"	55'-0"	57'-5"
8'-0"	23'-10"	17'-6"	33'-3"	27'-0"	40'-9"	36'-6"	47'-1"	46'-0"	52'-8"	55'-6"	57'-9"
8'-6"	24'-4"	18'-0"	33'-9"	27'-6"	41'-1"	37'-0"	47'-5"	46'-6"	52'-11"	56'-0"	58'-0"
9'-0"	24'-11"	18'-6"	34'-2"	28'-0"	41'-6"	37'-6"	47'-8"	47'-0"	53'-3"	56'-6"	58'-3"
9'-6"	25'-6"	19'-0"	34'-7"	28'-6"	41'-10"	38'-0"	48'-0"	47'-6"	53'-6"	57'-0"	58'-6"
10'-0"	26'-0"	19'-6"	35'-0"	29'-0"	42'-2"	38'-6"	48'-4"	48'-0"	53'-9"	57'-6"	58'-9"
10'-6"	26'-7"	20'-0"	35'-5"	29'-6"	42'-6"	39'-0"	48'-7"	48'-6"	54'-0"	58'-0"	59'-0"
11'-0"	27'-1"	20'-6"	35'-10"	30'-0"	42'-10"	39'-6"	48'-11"	49'-0"	54'-4"	58'-6"	59'-3"
11'-6"	27'-7"	21'-0"	36'-3"	30'-6"	43'-2"	40'-0"	49'-3"	49'-6"	54'-7"	59'-0"	59'-6"
12'-0"	28'-1"	21'-6"	36'-7"	31'-0"	43'-6"	40'-6"	49'-6"	50'-0"	54'-10"	59'-6"	59'-8"
12'-6"	28'-7"	22'-0"	37'-0"	31'-6"	43'-10"	41'-0"	49'-10"	50'-6"	55'-1"	—	—
13'-0"	29'-1"	22'-6"	37'-5"	32'-0"	44'-2"	41'-6"	50'-1"	51'-0"	55'-5"	—	—

Given radius (R) and height (H): **1.** ϕ = one-half of subtended arc = $\cos^{-1}(1 - H/R)$; **2.** L = maximum length of arc = $2\,\phi\,R$.
Notes: 1 in. = 25.4 mm. 1. H should not exceed $2R$; and 2. L should not exceed reinforcing bar stock length.

Table 12—Maximum right angle leg for shipping reinforcing bars



Shorter leg	Maximum longer leg	Shorter leg	Maximum longer leg	Shorter leg	Maximum longer leg
7'-5"	49'-0"	8'-5"	14'-11"	9'-5"	11'-8"
7'-6"	34'-11"	8'-6"	14'-6"	9'-6"	11'-6"
7'-7"	28'-9"	8'-7"	14'-1"	9'-7"	11'-4"
7'-8"	25'-1"	8'-8"	13'-9"	9'-8"	11'-3"
7'-9"	22'-8"	8'-9"	13'-5"	9'-9"	11'-1"
7'-10"	20'-10"	8'-10"	13'-1"	9'-10"	11'-0"
7'-11"	19'-5"	8'-11"	12'-10"	9'-11"	10'-10"
8'-0"	18'-4"	9'-0"	12'-7"	10'-0"	10'-9"
8'-1"	17'-5"	9'-1"	12'-5"	10'-1"	10'-8"
8'-2"	16'-7"	9'-2"	12'-2"	10'-2"	10'-7"
8'-3"	16'-0"	9'-3"	12'-0"	10'-3"	10'-5"
8'-4"	15'-5"	9'-4"	11'-10"	10'-4"	10'-4"

Notes: 1 in. = 25.4 mm. Given short leg (S) and height (H): L = maximum longer leg = $SH/\sqrt{S^2 - H^2}$. **1.** $(S + L)$ should not exceed stock length; **2.** H should not exceed S; and **3.** By definition, L is greater than S. The maximum limit for S is therefore $H\sqrt{2}$.

X Y Z PRODUCTS COMPANY
CHICAGO, ILLINOIS

PROJECT NO. 27693
CUSTOMER: JONES BROS. CONST. CO. DRAWING NO. Figs.18-5a,18-6a
PROJECT: FIELDCREST APT. BLDG. SHEET 1 of 2
LOCATION: SMITHVILLE, N.C. DATE 9/15/97 REVISED 9/19/97
MATERIAL FOR: PARTIAL BASEMENT COLUMNS DRAWN BY H.N.H.

ITEM	NO. PCS.	SZ	LENGTH	BAR MARK	TYPE	A	B	C	D	E	F	G	H	J	K	O	R
1	STRAIGHT																
2	4	57	23-11														
3	4	57	18-11														
4	12	57	8-11														
5																	
6	8	43	23-11														
7	4	43	8-11														
8																	
9	12	29	12-8														
10	6	29	10-8														
11	6	29	4-1														
12																	
13	STRAIGHT (SAW CUT BOTH ENDS)																
14	8	57	23-11	57W1													
15	8	57	11-5	57W2													
16																	
17	HEAVY BENDING																
18	4	36	20-0	36BC5	3		16-0	1-0	3-0				0-3	1-0			
19	64	36	13-6	36C16	3		3-0	1-3	9-3				0-4	1-3			
20																	
21	18	29	12-8	29C4	3		1-11	1-8	9-1				0-4 1/2	1-8			
22																	
23	LIGHT BENDING																
24	22	10	8-4	10T6	T2	0-4	2-1	1-9	2-1	1-9		0-4					
25	22	10	7-8	10T9	T2	0-4	1-11	1-7	1-11	1-7		0-4					
26	50	10	6-3	10BT1	T2	0-4	1-4 3/4	1-4 3/4	1-4 3/4	1-4 3/4		0-4					
27	26	10	6-3	10BT3	T2	0-4	1-0 3/4	1-8 3/4	1-0 3/4	1-8 3/4		0-4					
28	44	10	3-4	10T10	S10		1-3 1/2	0-9	1-3 1/2								
29	22	10	2-10	10T23	T5	0-5	2-1	0-4									
30	52	10	2-10	10BT4	S10		1-0 1/4	0-9 1/4	1-0 1/4								
31	22	10	2-8	10T8	T5	0-5	1-11	0-4									
32	22	10	2-6	10T20	T5	0-5	1-9	0-4									
33																	
34			SPIRALS														
35			Height		Dia.	Pitch	Turns	Spcrs									
36	4	13	8-9	SP5	21"	3"	38	3									

ALL DIMENSIONS ARE OUT TO OUT
ALL BARS ASTM A615M GRADE 420

FOR STANDARD BEND TYPES REFER TO
CRSI MANUAL OF STANDARD PRACTICE

Fig. 3—Typical bar list for building.

CHAPTER 2—WIRES AND WELDED WIRE FABRIC

2.1—Introduction

Welded wire fabric consists of wires arranged in a square or rectangular grid. Each wire intersection is welded using automatic electric-resistance welding machines. Table 13 lists the applicable ASTM specifications for wire and welded wire fabric, and Table 14 lists the minimum strength requirements of steel wires in welded wire fabric. Plain wires, deformed wires, or a combination of both can be used in welded wire fabric.

The Wire Reinforcement Institute should be contacted directly for any information on metric wire or welded wire fabric.

2.2—Designation of wire size

Individual wire (plain and deformed) size designations are based on the cross-sectional area of a given wire. The prefixes W and D are used in combination with a number. The letter W designates a plain wire, and the letter D denotes a deformed wire. The number following the letter gives the cross-sectional area in hundredths of a square inch. For example, wire designation W4 would indicate a plain wire with a cross-sectional area of 0.04 in.^{2}; a D10 wire would indicate a deformed wire with a cross-sectional area of 0.10 in.^{2} The size of wires in welded wire fabric is designated in the same manner. This system has many advantages.

Nominal cross-sectional area of a wire is determined from the weight (mass) per foot (meter) of wire rather than the diameter.

Table 13—Specifications for wire and welded wire fabric

ASTM designation	Title
A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
A 185	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 496	Specification for Steel Wire, Deformed, for Concrete Reinforcement
A 497	Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
A 884/A 884M	Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement

Note: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.

Table 14—Minimum requirements of wire in welded wire fabric

Welded plain wire fabric, ASTM A 185			
Wire size	Minimum tensile strength, psi	Minimum yield strength, psi	Minimum weld shear strength, psi
W1.2 and over	75,000	65,000	35,000
Under W1.2	70,000	56,000	—
Welded deformed wire fabric, ASTM A 497			
Wire size	Minimum tensile strength, psi	Minimum yield strength, psi	Minimum weld shear strength, psi
D4 to D31	80,000	70,000	35,000
Under D4	80,000	70,000	—

Note: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.

2.3—Styles of welded wire fabric

Spacings and sizes of wires in welded wire fabric are identified by the style designation. A typical style designation is: 6 x 12-W12 x W5.

This denotes welded wire fabric in which:

- Spacing of longitudinal wire = 6 in.;
- Spacing of transverse wires = 12 in.;
- Size of longitudinal wires = W12 (0.12 in.^{2}); and
- Size of transverse wires = W5 (0.05 in.^{2}).

A welded deformed wire fabric style would be noted in the same manner by substituting the prefix D for the W. Note that style designation gives spacings and sizes of wires only and does not provide any other information, such as width and length of sheet.

Welded wire fabric with nonuniform wire spacings is available. In this case, special information is added to the style designation to describe the welded wire fabric.

It is important to note that the terms longitudinal and transverse are related to the manufacturing process and do not refer to the relative position of the wires in a structural concrete member or system. Transverse wires are individually welded at right angles as the welded wire fabric advances through the welding machine. In some fabric machines, the transverse wire is fed from a continuous coil; in others, they are precut to length and hopper fed to the welding position.

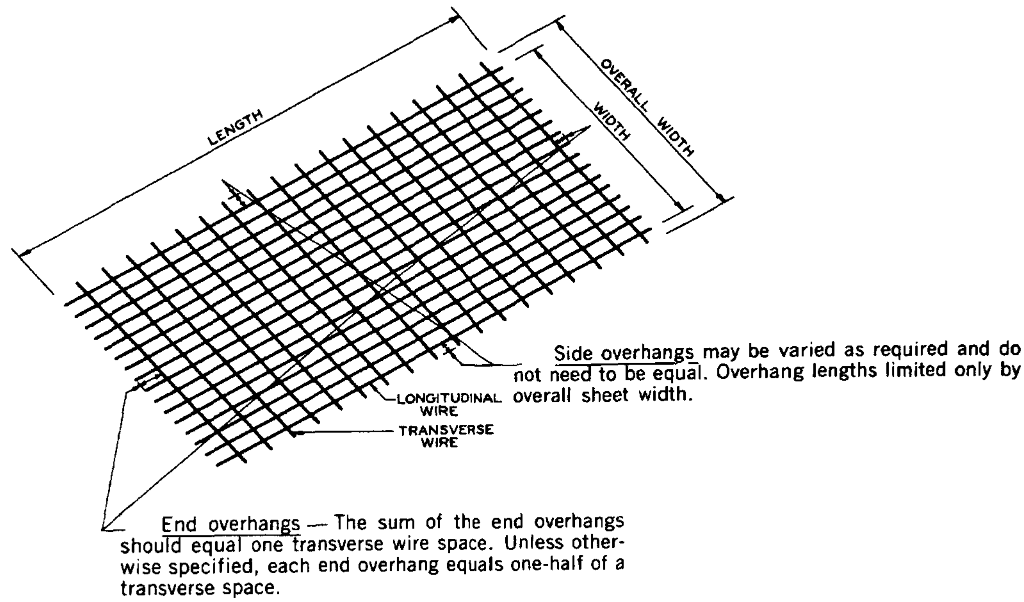
Common styles of welded wire fabric are shown in Table 15.

Table 15—Common styles of welded wire fabric

Style designation (W = plain, D = deformed)	Steel area, in.^{2}/ft		Approximate weight, lb/100 ft^2
	Longitudinal	Transverse	
4 x 4 - W1.4 x W1.4*	0.042	0.042	31
4 x 4 - W2.0 x W2.0*	0.060	0.060	43
4 x 4 - W2.9 x W2.9*	0.087	0.087	62
4 x 4 - W/D4 x W/D4	0.120	0.120	86
6 x 6 - W1.4 x W1.4*	0.028	0.028	21
6 x 6 - W2.0 x W2.0*	0.040	0.040	29
6 x 6 - W2.9 x W2.9*	0.058	0.058	42
6 x 6 - W/D4 x W/D4	0.080	0.080	58
6 x 6 - W/D4.7 x W/D4.7	0.094	0.094	68
6 x 6 - W/D7.4 x W/D7.4	0.148	0.148	107
6 x 6 - W/D7.5 x W/D7.5	0.150	0.150	109
6 x 6 - W/D7.8 x W/D7.8	0.156	0.156	113
6 x 6 - W/D8 x W/D8	0.160	0.160	116
6 x 6 - W/D8.1 x W/D8.1	0.162	0.162	118
6 x 6 - W/D8.3 x W/D8.3	0.166	0.166	120
12 x 12 - W/D8.3 x W/D8.3	0.083	0.083	63
12 x 12 - W/D8.8 x W/D8.8	0.088	0.088	67
12 x 12 - W/D9.1 x W/D9.1	0.091	0.091	69
12 x 12 - W/D9.4 x W/D9.4	0.094	0.094	71
12 x 12 - W/D16 x W/D16	0.160	0.160	121
12 x 12 - W/D16.6 x W/D16.6	0.166	0.166	126

Note: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.

*Styles can be obtained in rolls.



Industry Method of Designating Style:
Example — WWF 6x12—W16xW8

Longitudinal wire spacing . . . . 6"	Longitudinal wire size W16
Transverse wire spacing . . . . 12"	Transverse wire size W8

Fig. 4—Nomenclature of welded wire fabric.

2.4—Epoxy-coated wires and welded wire fabric

Epoxy-coated wire and welded wire fabric are used in reinforced concrete construction as a corrosion-protection system.

The ASTM specification A 884/A 884M covers the epoxy coating of plain and deformed steel wire, and plain and deformed steel welded wire fabric. The specification includes requirements for the epoxy-coating material; surface preparation of the steel before application of the coating; the method of application of the coating; limits on coating thickness; and acceptance tests to ensure that the coating was properly applied.

2.5—Dimensions of welded wire fabric

Description of width, length, and overhang dimensions of welded wire fabric sheets are as follows (refer also to Fig. 4):

Width—center-to-center distance between the outside longitudinal wires. This dimension does not include side overhangs;

Side overhang—extension of transverse wires beyond centerline of outside longitudinal wires. If no side overhang is specified, welded wire fabric will be furnished with side overhangs on each side, of no greater than 1 in. Wires can be cut flush (no overhangs) specified as (+0 in., +0 in.). When specific side overhangs are required, they are noted as (+1 in., +3 in.) or (+6 in., +6 in.);

Overall width—width including side overhangs—the tip-to-tip dimension of transverse wires;

Length—tip-to-tip dimension of longitudinal wires. Whenever possible this dimension should be an even multiple of the transverse wire spacing. (The length dimension always includes end overhangs.);

End overhang—extension of longitudinal wires beyond the centerline of outside transverse wires. Unless otherwise noted, standard end overhangs of 1/2 the transverse spacing are assumed to be required and end overhangs need not be specified. Nonstandard end overhangs can be specified for special situations; preferably, the sum of the two end overhangs should equal the transverse wire spacing.

2.6—Design data for welded wire fabric

Cross-sectional areas of welded wire fabric listed in Table 16 are provided by many wire sizes and various common spacings. Typical development and lap splice lengths are given in Table 17, 18, 19, and 20 for both plain and deformed welded wire fabric and deformed wire, based on requirements of ACI 318 (318M), Sections 12.7, 12.8, 12.18, and 12.19. Tabulated values are basic lengths, which can be subjected to applicable modification factors of ACI 318_(318M), Sections 12.2.3, 12.2.4, and 12.2.5.

Note that the development or lap splice length for plain welded wire fabric is affected by the spacing of both the longitudinal and transverse wires, while these lengths for deformed welded wire fabric are affected by only the longitudinal wire spacing.

Table 16—Sectional areas of welded wire fabric

Wire size number		Nominal diameter, in.	Nominal weight, lb/ft	Area per width (in.^{2}/ft) for various spacings, in.						
Plain	Deformed			2	3	4	6	8	12	16
W45	D45	0.757	1.53	2.70	1.80	1.35	0.90	0.68	0.45	0.34
W31	D31	0.628	1.05	1.86	1.24	0.93	0.62	0.47	0.31	0.23
W20	D20	0.505	0.680	1.20	0.80	0.60	0.40	0.30	0.20	0.15
W18	D18	0.479	0.612	1.08	0.72	0.54	0.36	0.27	0.18	0.14
W16	D16	0.451	0.544	0.96	0.64	0.48	0.32	0.24	0.16	0.12
W14	D14	0.422	0.476	0.84	0.56	0.42	0.28	0.21	0.14	0.11
W12	D12	0.391	0.408	0.72	0.48	0.36	0.24	0.18	0.12	0.090
W11	D11	0.374	0.374	0.66	0.44	0.33	0.22	0.17	0.11	0.083
W10.5		0.366	0.357	0.63	0.42	0.32	0.21	0.16	0.11	0.079
W10	D10	0.357	0.340	0.60	0.40	0.30	0.20	0.15	0.10	0.075
W9.5		0.348	0.323	0.57	0.38	0.29	0.19	0.14	0.095	0.071
W9	D9	0.338	0.306	0.54	0.36	0.27	0.18	0.14	0.090	0.068
W8.5		0.329	0.289	0.51	0.34	0.26	0.17	0.13	0.085	0.064
W8	D8	0.319	0.272	0.48	0.32	0.24	0.16	0.12	0.080	0.060
W7.5		0.309	0.255	0.45	0.30	0.23	0.15	0.11	0.075	0.056
W7	D7	0.299	0.238	0.42	0.28	0.21	0.14	0.11	0.070	0.053
W6.5		0.288	0.221	0.39	0.26	0.20	0.13	0.098	0.065	0.049
W6	D6	0.276	0.204	0.36	0.24	0.18	0.12	0.090	0.060	0.045
W5.5		0.265	0.187	0.33	0.22	0.17	0.11	0.083	0.055	0.041
W5	D5	0.252	0.170	0.30	0.20	0.15	0.10	0.075	0.050	0.038
W4.5		0.239	0.153	0.27	0.18	0.14	0.090	0.068	0.045	0.034
W4	D4	0.226	0.136	0.24	0.16	0.12	0.080	0.060	0.040	0.030
W3.5		0.211	0.119	0.21	0.14	0.11	0.070	0.053	0.035	0.026
W3		0.195	0.102	0.18	0.12	0.090	0.060	0.045	0.030	0.023
W2.9		0.192	0.099	0.17	0.12	0.087	0.058	0.044	0.029	0.022
W2.5		0.178	0.085	0.15	0.10	0.075	0.050	0.038	0.025	0.019
W2.1		0.162	0.070	0.13	0.084	0.063	0.042	0.032	0.021	0.016
W2	D2	0.160	0.068	0.12	0.080	0.060	0.040	0.030	0.020	0.015
W1.5		0.138	0.051	0.090	0.060	0.045	0.030	0.023	0.015	0.011
W1.4		0.134	0.048	0.084	0.056	0.042	0.028	0.021	0.014	0.011

Notes: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.
1. The above listing of plain and deformed wire sizes represents wires normally selected to manufacture welded wire fabric to specific areas of reinforcement. Wire sizes other than those listed above, including larger sizes, may be available if the quantity required is sufficient to justify manufacture; and **2.** The nominal diameter of a deformed wire is equivalent to the diameter of a plain wire having the same weight per foot as the deformed wire.

Table 17—Tension development and lap-splice lengths for plain welded wire fabric

Wire	Wire spacing, in.	Development length, in., per cross-wire spacing, in.				Development length for different cross-wire spacing, in.			
		4	6	8	12	4	6	8	12
W0.5 to W5.5	4	6	6	6	6	6	8	10	14
	6	6	6	6	6	6	8	10	14
	12	6	6	6	6	6	8	10	14
W6	4	6	6	6	6	6	8	10	14
	6	6	6	6	6	6	8	10	14
	12	6	6	6	6	6	8	10	14
W8	4	6	6	6	6	8	8	10	14
	6	6	6	6	6	6	8	10	14
	12	6	6	6	6	6	8	10	14
W10	4	7	7	7	7	10	10	10	14
	6	6	6	6	6	7	8	10	14
	12	6	6	6	6	6	8	10	14
W12	4	8	8	8	8	12	12	12	14
	6	6	6	6	6	8	8	10	14
	12	6	6	6	6	6	8	10	14
W14	4	10	10	10	10	15	15	15	15
	6	6	6	6	6	10	10	10	14
	12	6	6	6	6	6	8	10	14
W16	4	11	11	11	11	17	17	17	17
	6	7	7	7	7	11	11	11	14
	12	6	6	6	6	6	8	10	14
W18	4	12	12	12	12	19	19	19	19
	6	8	8	8	8	12	12	12	14
	12	6	6	6	6	6	8	10	14
W20	4	14	14	14	14	21	21	21	21
	6	9	9	9	9	14	14	14	14
	12	6	6	6	6	7	8	10	14
W22	4	15	15	15	15	23	23	23	23
	6	10	10	10	10	15	15	15	15
	12	6	6	6	6	8	8	10	14
W24	4	17	17	17	17	25	25	25	25
	6	11	11	11	11	17	17	17	17
	12	6	6	6	6	8	8	10	14
W26	4	18	18	18	18	27	27	27	27
	6	12	12	12	12	18	18	18	18
	12	6	6	6	6	9	9	10	14
W28	4	19	19	19	19	29	29	29	29
	6	13	13	13	13	19	19	19	19
	12	6	6	6	6	10	10	10	14
W30	4	21	21	21	21	31	31	31	31
	6	14	14	14	14	21	21	21	21
	12	7	7	7	7	10	10	10	14
W31	4	22	22	22	22	32	32	32	32
	6	14	14	14	14	22	22	22	22
	12	7	7	7	7	11	11	11	14
W45	4	31	31	31	31	47	47	47	47
	6	21	21	21	21	31	31	31	31
	12	10	10	10	10	16	16	16	16

Notes: Contact the Wire Reinforcement Institute for any information on metric wire or welded wire fabric.
1. Tabulated values are based on a minimum yield strength of 56,000 psi (smaller than size W1.2) or 65,000 psi (size W1.2 or larger) and 4000 psi normalweight concrete. Lengths are in inches; **2.** Tension development lengths and tension lap splice lengths are calculated per ACI 318 (318M), Sections 12.8 and 12.19, respectively; and **3.** For the lap splice lengths, area of steel provided was assumed to be less than twice the area of steel required (ACI 318 (318M), Section 12.19.1).

Table 18—Tension development lengths for deformed welded wire fabric

Wire size	For top welded wire fabric for different cross-wire spacing, in.				For other welded wire fabric for different cross-wire spacing, in.			
	4	6	8	12	4	6	8	12
D1	4	4	4	4	4	4	4	4
D2	5	5	5	5	4	4	4	4
D3	6	6	6	6	4	4	4	4
D4	6	6	6	6	5	5	5	5
D5	7	7	7	7	6	6	6	6
D6	8	8	8	8	6	6	6	6
D7	9	9	9	9	7	7	7	7
D8	9	9	9	9	7	7	7	7
D9	10	10	10	10	7	7	7	7
D10	10	10	10	10	8	8	8	8
D11	11	11	11	11	8	8	8	8
D12	11	11	11	11	9	9	9	9
D13	12	12	12	12	9	9	9	9
D14	13	12	12	12	10	9	9	9
D15	14	13	13	13	11	10	10	10
D16	15	13	13	13	11	10	10	10
D17	16	13	13	13	12	10	10	10
D18	16	14	14	14	13	11	11	11
D19	17	14	14	14	13	11	11	11
D20	18	15	15	15	14	11	11	11
D21	19	15	15	15	15	11	11	11
D22	20	15	15	15	16	12	12	12
D23	21	16	16	16	16	12	12	12
D24	22	16	16	16	17	12	12	12
D25	23	16	16	16	18	12	12	12
D26	24	17	17	17	18	13	13	13
D27	25	17	17	17	19	13	13	13
D28	26	17	17	17	20	13	13	13
D29	27	18	17	17	20	14	13	13
D30	27	18	18	18	21	14	14	14
D31	28	19	18	18	22	15	14	14
D45	41	27	22	22	32	21	17	17

Notes: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.
1. Tabulated values are based on a minimum yield strength of 70,000 psi and 4000 psi normalweight concrete. Lengths are in inches; **2.** Tension development lengths are calculated per ACI 318 (318M), Section 12.7; **3.** Top welded wire fabric is horizontal welded wire fabric with more than 12 in. of concrete cast below the welded wire fabric; and **4.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3.

Table 19—Lap-splice lengths for deformed welded wire fabric

Wire size	For top welded wire fabric for different cross-wire spacing, in.				For other welded wire fabric for different cross-wire spacing, in.			
	4	6	8	12	4	6	8	12
D1	8	8	8	8	8	8	8	8
D2	8	8	8	8	8	8	8	8
D3	8	8	8	8	8	8	8	8
D4	8	8	8	8	8	8	8	8
D5	9	9	9	9	8	8	8	8
D6	10	10	10	10	8	8	8	8
D7	11	11	11	11	9	9	9	9
D8	12	12	12	12	9	9	9	9
D9	13	13	13	13	10	10	10	10
D10	13	13	13	13	10	10	10	10
D11	14	14	14	14	11	11	11	11
D12	15	15	15	15	11	11	11	11
D13	15	15	15	15	12	12	12	12
D14	17	16	16	16	13	12	12	12
D15	18	16	16	16	14	13	13	13
D16	19	17	17	17	15	13	13	13
D17	20	17	17	17	16	13	13	13
D18	21	18	18	18	16	14	14	14
D19	23	18	18	18	17	14	14	14
D20	24	19	19	19	18	15	15	15
D21	25	19	19	19	19	15	15	15
D22	26	20	20	20	20	15	15	15
D23	27	20	20	20	21	16	16	16
D24	29	21	21	21	22	16	16	16
D25	30	21	21	21	23	16	16	16
D26	31	22	22	22	24	17	17	17
D27	32	22	22	22	25	17	17	17
D28	33	22	22	22	26	17	17	17
D29	35	23	23	23	27	18	17	17
D30	36	24	23	23	27	18	18	18
D31	37	25	24	24	28	19	18	18
D45	54	36	28	28	41	27	22	22

Notes: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.
1. Tabulated values are based on a minimum yield strength of 70,000 psi and 4000 psi normalweight concrete. Lengths are in inches; **2.** Tension development lengths are calculated per ACI 318 (318M), Section 12.18; **3.** Top welded wire fabric is horizontal welded wire fabric with more than 12 in. of concrete cast below the welded wire fabric; and **4.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3.

Table 20—Tension development and lap-splice lengths for deformed wire

Wire size	Development length, in.		Lap splice length, in.	
	Top	Other	Top	Other
D1	12	12	16	16
D2	12	12	16	16
D3	12	12	16	16
D4	14	12	18	16
D5	16	12	20	16
D6	17	13	22	17
D7	18	14	24	18
D8	20	15	26	20
D9	21	16	27	21
D10	22	17	29	22
D11	23	18	30	23
D12	24	19	31	24
D13	25	19	33	25
D14	26	20	34	26
D15	27	21	35	27
D16	28	21	36	28
D17	29	22	37	29
D18	30	23	38	30
D19	30	23	39	30
D20	31	24	40	31
D21	32	25	41	32
D22	33	25	42	33
D23	33	26	43	33
D24	34	26	44	34
D25	35	27	45	35
D26	35	27	46	35
D27	36	28	47	36
D28	37	28	48	37
D29	37	29	49	37
D30	38	29	50	38
D31	39	30	50	39
D45	47	36	61	47

Notes: Contact the Wire Reinforcement Institute for information on metric wire or welded wire fabric.

1. Tabulated values are based on a minimum yield strength of 75,000 psi and 4000 psi normalweight concrete. Lengths are in inches; **2.** Tension development lengths and tension lap-splice lengths are calculated per ACI 318 (318M), Sections 12.2.2 and 12.15, respectively; **3.** Lap-splice lengths are multiples of tension development lengths: Class A = $1.0\ell_d$ and Class B = $1.3\ell_d$ (ACI 318 [318M], Section 12.15.1). Lap Class B was assumed for the tables; **4.** Top wires are horizontal wires with more than 12 in. of concrete cast below the wires; and **5.** For lightweight-aggregate concrete, multiply the tabulated values by 1.3.

CHAPTER 3—BAR SUPPORTS

3.1—General

If types and arrangements of bar supports are not specifically indicated in the contract documents, they will generally be supplied in accordance with usual industry practices as outlined in the Concrete Reinforcing Steel Institute's recommendations for bar supports reprinted in this chapter. Unless otherwise mutually agreed between the buyer and seller of the reinforcing steel, bar supports are customarily supplied only for the support of reinforcing bars. Supports are furnished only on formed soffits or for top bars in doubly reinforced slabs on ground that are 4 ft (1200 mm) or less in total thickness. In certain regions of the United States, none are supplied for bottom bars nor for bars in footings or singly reinforced slabs on ground, unless special provisions are made for them in the contract documents.

3.2—Side-form-spacers

The furnishing of side-form-spacers against vertical or sloping forms to maintain prescribed side cover and cross position of reinforcing bars has traditionally been a construction option. In situations where side-form-spacers are needed, various devices have been used, including double-headed nails, form ties, slab or beam bolsters, precast blocks, and proprietary all-plastic shapes. The greatest need for side-form-spacers is on finished faces that are exposed to weather and salt spray. The type and number of side-form-spacers is determined by the proportions of the form, the arrangement and placing of reinforcement, and the form material and forming system used. Estimating or detailing side-form-spacers with the reinforcement is not a normal industry practice. If any special devices are required, such as side-form-spacers, they are usually considered formwork accessories, furnished (and detailed if need be) by the contractor or subcontractor providing the formwork.

3.3—Nonstandard bar supports

In addition to the standard bar supports described in the Concrete Reinforcing Steel Institute (CRSI) recommendations, other materials, such as fabricated galvanized steel, are sometimes used as bar supports and side-form-spacers. Galvanized bar supports can be specified when galvanized reinforcing bars are used to avoid the possibility of galvanic (electrolytic) action leading to corrosion of steel. Epoxy- or plastic-coated bar supports should be used to support epoxy-coated reinforcing bars. The purpose of this particular bar support is to minimize damage to the coating on the bars so as not to introduce a potential source of corrosion at or in close proximity to the point of contact with the coated bar and the support.

3.4—CRSI bar-support *recommendations*

The following CRSI bar support recommendations appear in Chapter 3 of its *Manual of Standard Practice* and are reprinted here by permission of the Concrete Reinforcing Steel Institute. Because recommendations like these are subject to periodic revision, it is advisable to check with the CRSI if it is desired to use the latest revision.

1. Introduction

Bar supports may consist of metal, precast concrete, plastic or other materials. Most widely used are factory-made wire bar supports, which are made of plain wire or stainless steel wire. The lower portions may be provided with special rust protection by a plastic covering, or by being made in whole or part of stainless wire. Precast concrete blocks, plain or provided with tie wires, are used to support bars in footings, slabs-on-grade, on horizontal work and as side form spacers. Dowel blocks are commonly used to support bars in footings and slabs on grade. All-plastic supports are generally used as side form spacers and on horizontal work.

In this chapter, industry practices for all types of bar supports and their placing are presented. In general, maximum spacing for various conditions of usage for placing wire bar supports are recommended to be followed when using supports made of other materials. These recommendations for usage of bar supports complement those for placing reinforcing bars in Chapter 8.

CRSI neither implies nor expresses approval or certification of any proprietary products. Neither does CRSI establish or promulgate product manufacturing standards. Any products pictured or described herein are listed for general informational purposes only and are intended only to depict market-available materials presently known to CRSI. The recommendations in this chapter concerning the construction, and the selection and use of bar supports SHOULD NOT BE SUBSTITUTED FOR THE JUDGMENT OF AN EXPERIENCED ARCHITECT/ENGINEER as to the best way of achieving specific design requirements in the field.

2. Wire Bar Supports

2.1 Scope

The industry practices presented herein are intended to serve as a guide for the selection and utilization of steel wire bar supports used to position reinforcing bars in reinforced concrete.

2.2 Typical Types and Sizes

The types and sizes of supports that are usually available are shown in Table 1.

Based upon long-term experience and field observations, bar supports made in accordance with the wire sizes and geometrical dimensions shown in Table 2 have performed satisfactorily. Bar supports fabricated from larger wire sizes than shown in Table 2, but made in accordance with the geometrical dimensions shown in Table 2, should also perform satisfactorily and the larger wire sizes should not be cause for rejection.

2.3 Rust Prevention

Wire bar supports are classified in terms of methods employed to minimize rust spots, or similar blemishes on the surface of the concrete directly caused by the bar supports. The four classes and their intended degree of protection are described in Sections 2.5, 2.6, 2.7 and 2.8.

2.4 Identification

Project specifications, project drawings, details, and purchase orders generally identify wire bar supports by nominal height, symbol of type of support, and class of protection (Example: 3½-CHC-1 identifies a 3½ in. height, continuous high chair, Class 1-Plastic Protected.)

2.5 Class 1—Maximum Protection

PLASTIC-PROTECTED WIRE BAR SUPPORTS-which are intended for use in situations of moderate to severe exposure and/or situations requiring light grinding (1/16 in. maximum) or sandblasting of the concrete surface.

Plastic-protected wire bar supports generally are fabricated from cold-drawn steel wire in accordance with the AS&W wire sizes and the geometrical dimensions shown in Table 2. Class 1 bar supports are usually available in Types SB, BB, JC, HC, BC, and CHC, which are furnished with radius bearing legs in the form of a hook or spherical foot at the lower end of the legs. The hook generally consists of elevating the cut end of the support at least ⅛ in. above the supporting base. The spherical foot generally has an outside diameter of not less than 1½ times the specified wire diameter and is not less than ⅛ in. above the supporting base.

Following current industry practice, the plastic protection may be applied either by a dipping operation or by the addition of premolded plastic tips to the legs of the support. In both of these methods of protection application, it should be adequately demonstrated that the plastic on the bar support will not chip, crack, deform or peel under ordinary job conditions.

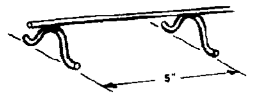
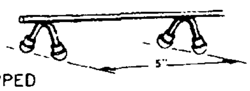
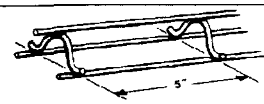
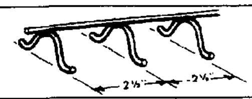
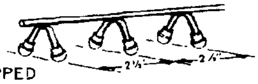
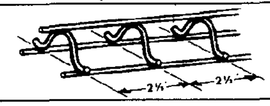
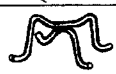
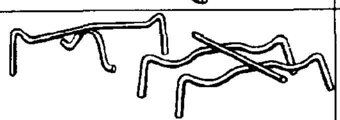
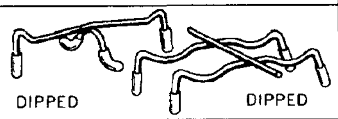
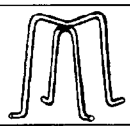
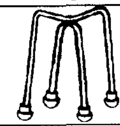
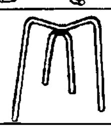
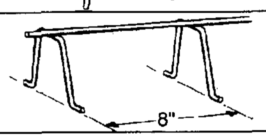
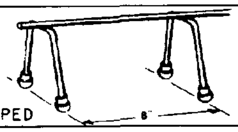
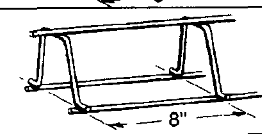
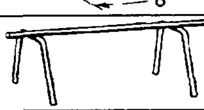
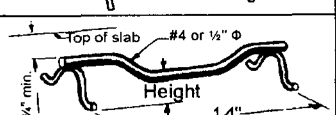
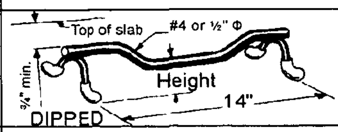
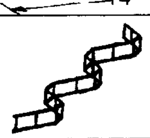
Based upon experience and field observations of satisfactory performance of Class 1—Plastic-Protected Wire Bar Supports, the plastic should have a thickness of 3/32 in. or greater, at points of contact with the formwork. The plastic should extend upward on the wire to a point at least ½ in. above the formwork.

2.6 Class 1A—Maximum Protection (for Use with Epoxy-Coated Reinforcing Bars)

EPOXY-, VINYL-, OR PLASTIC-COATED BRIGHT BASIC WIRE BAR SUPPORTS—which are intended for use in situations of moderate to maximum exposure where no grinding or sandblasting of the concrete surface is required. They are generally used when epoxy-coated reinforcing bars are required.

BAR SUPPORTS

TABLE 1—TYPICAL TYPES AND SIZES OF WIRE BAR SUPPORTS

SYMBOL	BAR SUPPORT ILLUSTRATION	BAR SUPPORT ILLUSTRATION PLASTIC CAPPED OR DIPPED	TYPE OF SUPPORT	TYPICAL SIZES
SB		 CAPPED	Slab Bolster	¾, 1, 1½, and 2 in. heights in 5 ft. and 10 ft. lengths
SBU*			Slab Bolster Upper	Same as SB
BB		 CAPPED	Beam Bolster	1, 1½, 2 to 5 in. heights in increments of ¼ in. in lengths of 5 ft.
BBU*			Beam Bolster Upper	Same as BB
BC		DIPPED 	Individual Bar Chair	¾, 1, 1½, and 1¾ in. heights
JC			Joist Chair	4, 5, and 6 in. widths and ¾, 1 and 1½ in. heights
HC		CAPPED 	Individual High Chair	2 to 15 in. heights in increments of ¼ in.
HCM*			High Chair for Metal Deck	2 to 15 in. heights in increments of ¼ in.
CHC		 CAPPED	Continuous High Chair	Same as HC in 5 ft. and 10 ft. lengths
CHCU*			Continuous High Chair Upper	Same as CHC
CHCM*			Continuous High Chair for Metal Deck	Up to 5 in. heights in increments of ¼ in.
JCU**			Joist Chair Upper	14 in. span; heights —1 thru +3½ in.vary in ¼ in. increments
CS			Continuous Support	1½ to 12 in. in increments of ¼ in. in lengths of 6'-8"

*Usually available in Class 3 only, except on special order.
**Usually available in Class 3 only, with upturned or end bearing legs.

TABLE 2—TYPICAL WIRE SIZES[1] AND GEOMETRY

SYMBOL	NOMINAL HEIGHTS[2]	TYPICAL WIRE SIZES				USUAL GEOMETRY
		CARBON STEEL			STAINLESS STEEL[4]	
		TOP[3]	LEGS	RUNNER	LEGS	
SB	All	4 ga.	6 ga.	N/A	8 ga.	Legs spaced 5 in. on center.
SBU	All	4 ga.	6 ga.	7 ga.	—	Same as SB
BB	Up to 1½ in. incl Over 1½ in. to 2 in. incl Over 2 in. to 3½ in. incl Over 3½ in.	7 ga. 7 ga. 4 ga. 4 ga.	7 ga. 7 ga. 4 ga. 4 ga.	N/A N/A N/A N/A	9 ga. 8 ga. 7 ga. —	Legs spaced 2½ in. on center.
BBU	Up to 2 in. incl Over 2 in.	7 ga. 4 ga.	7 ga. 4 ga.	7 ga. 4 ga.	— —	Same as BB.
BC	All	N/A	7 ga.	N/A	9 ga.	—
JC	All	N/A	6 ga.	N/A	9 ga.	—
HC	2 in. to 3½ in. incl Over 3½ in. to 5 in. incl Over 5 in. to 9 in. incl Over 9 in. to 15 in. incl	N/A N/A N/A N/A	4 ga. 4 ga. 2 ga. 0 ga.	N/A N/A N/A N/A	7 ga. — — —	Legs at 20 deg or less with vertical. When height exceeds 12 in., legs are reinforced with welded cross wires or encircling wires.
HCM	2 in. to 5 in. incl Over 5 in. to 9 in. incl Over 9 in. to 15 in. incl	N/A N/A N/A	4 ga. 2 ga. 0 ga.	N/A N/A N/A	— — —	Same as HC. The longest leg will govern the size of wire to be used.
CHC	2 in. to 3½ in. incl Over 3½ in. to 5 in. incl Over 5 in. to 9 in. incl Over 9 in. to 15 in. incl	2 ga. 2 ga. 2 ga. 2 ga.	4 ga. 4 ga. 2 ga. 0 ga.	N/A N/A N/A N/A	7 ga. — — —	Legs at 20 deg or less with vertical. All legs 8¼ in. on center maximum, with leg within 4 in. of end of chair, and spread between legs not less than 50% of nominal height.
CHCU	2 in. to 5 in. incl Over 5 in. to 9 in. incl Over 9 in. to 15 in. incl	2 ga. 2 ga. 2 ga.	4 ga. 2 ga. 0 ga.	4 ga. 4 ga. 4 ga.	— — —	Same as CHC
CHCM	Up to 2 in. incl Up to 2 in. incl Over 2 in. to 5 in. incl	4 ga. 2 ga. 2 ga.	6 ga. 4 ga. 4 ga.	N/A N/A N/A	— — —	With 4 ga. top wire, maximum leg spacing is 5 in. on center. With 2 ga. top wire, maximum spacing is 10 in. on center.
JCU	–1 in. to +3½ in. incl (Measured from form to top of middle portion of saddle bar) in ¼ in. increments.	#4 bar or ½ in. dia	2 ga.	N/A	—	Legs spaced 14 in. on center. Maximum height of JCU at support legs should be slab thickness minus ¾ in.
CS	1½ in. to 7 in. incl 5 in. to 12 in. incl 7½ in. to 12 in. incl	8 ga. 6 ga. 4 ga.	8 ga. 6 ga. 4 ga.	8 ga. 6 ga. 4 ga.	— — —	Legs spaced 6 in. on center, 4 in. on center at bend point. Middle runner used for heights over 7 in.

1Wire sizes are American Steel & Wire gauges.
2The nominal height of the bar support is taken as the distance from the bottom of the leg, sandplate or runner wire to the bottom of the reinforcement. Variations of ±⅛ in. from the stated nominal height are generally permitted by usual construction specifications for tolerances.
3Top wire on continuous supports may be straight or corrugated, at the option of the Manufacturer.
4When no wire size is shown for a stainless steel leg, use plain carbon steel legs and attach stainless steel tips to them as noted in Section 2.7 on page 3-4.

Epoxy-, vinyl-, or plastic-coated wire bar supports generally are fabricated from cold-drawn steel wire in accordance with the AS&W wire sizes and geometrical dimensions shown in Table 2. Class 1A bar supports are usually available in Types SB, BB, HC, JC, BC and CHC, which are furnished with radius bearing legs in the form of a hook at the lower end of the legs. The hook generally consists of elevating the cut end of the leg at least 1/8 in. above the supporting formwork. Also available are Types SBU, BBU and CHCU.

Following current industry recommendations, a minimum 5-mil thickness of coating, or thickness as specified, may be applied by the electrostatic spray method or fluidized bed method.

Prior to application of the coating, the wire should be cleaned to ensure proper adhesion and bond of the dielectric material. After curing, the coating should be free of holes, voids, cracks and deficient areas. Hanger marks are permissible and not cause for rejection.

If any of these deficiencies occur during the coating application process, they should be repaired in accordance with the patching material manufacturer's recommendations. It is also common practice in the field to repair small areas damaged during shipment.

2.7 Class 2—Moderate Protection

STAINLESS STEEL PROTECTED WIRE BAR SUPPORTS—which are intended for use in situations of moderate exposure and/or situations requiring light grinding (1/16 in. maximum) or sandblasting of the concrete surface. Class 2 protection may be obtained by use of either Type A or B Stainless Steel Protected Wire Bar Supports. The difference between them is the length of the stainless steel tip attached at the bottom of each leg to the bright basic wire.

Caution is advised when using Class 2 bar supports subjected to severe conditions of exposure to sea water, or an atmosphere containing highly corrosive chemicals. Tests indicate, however, that the product should withstand deterioration with equal ability to the concrete surrounding it. Any grinding done to concrete surfaces should be done with an iron free wheel, such as an aluminum oxide wheel, to avoid entrapment of particles that produce rust.

Type A stainless steel protected wire bar supports are usually Types SB, BB, BC, JC, HC and CHC, and are generally fabricated from cold-drawn steel wire in accordance with the AS&W wire gauges and in the typical geometrical dimensions shown in Table 2. A tip of stainless steel is attached to the bottom of each leg such that no portion of the non-stainless steel wire lies closer than 1/4 in. from the form surface.

The stainless steel tip generally is of a size and shape to provide a bearing surface equivalent to the radius bearing described under Class 1 bar supports. Straight end bearing legs are sometimes furnished for special applications. The stainless steel is generally specified to conform to ASTM Specification A493, AISI Type 430.

Following current industry practice, the legs of the support may be fabricated wholly from stainless steel wire conforming to the foregoing recommendation without the addition of stainless steel tips, and the bar supports meet all other requirements for Type A supports.

Type B stainless steel protected wire bar supports are generally fabricated from cold-drawn steel wire so that no non-stainless steel wire of the bar support lies closer than 3/4 in. from the form surface. If required by design, protection exceeding 3/4 in. is available by special order.

The stainless steel tip generally is of a size and shape to provide a bearing surface equivalent to the radius bearing described under Class 1 bar supports. Straight end bearing legs are sometimes furnished for special applications. The stainless steel is generally specified to conform to ASTM Specification A493, AISI Type 430.

Following current industry practice, the legs of the support may be manufactured from stainless steel wire or the legs may be fabricated from cold-drawn carbon steel wire with stainless steel wire leg extensions attached to the bottom of each leg. The minimum gauges and the geometrical dimensions generally conform to the requirements of Table 2. The leg extensions generally are at least of the same gauge as the wire to which they are welded. The leg extensions are usually so designed that no portion of the carbon steel wire is closer than 3/4 in. from the form surface. The legs, or leg extensions, generally provide radius bearing equivalent to that required of Class 1 bar supports. The stainless steel wire is generally specified to conform to the foregoing recommendation.

2.8 Class 3—No Protection

BRIGHT BASIC WIRE BAR SUPPORTS—which have no protection against rusting and which are intended for use in situations where surface blemishes can be tolerated, or where supports do not come in contact with the exposed concrete surface.

Bright basic wire bar supports are generally fabricated from cold-drawn steel wire in accordance with the AS&W wire sizes and geometry shown in Table 2.

Types SB, BB, BC, JC, HC, and CHC are generally furnished with radius bearing legs as described under Class 1 bar supports. Straight end bearing legs are sometimes furnished for special applications.

Types CHC, SB, BB and HC may be provided with earth-bearing bases (sand plates) of sheet metal having sufficient gauge and bearing area. Such supports are designated by the suffice "P"; i.e., CHCP, SBP, BBP, or HCP. Earth-bearing bases are usually confined to Class 3 supports only.

Types SB, BB, and CHC may be provided with horizontal runner wires, allowing the bar support to rest on a lower mat of bars. Such supports are designated by the suffix "U"; i.e., SBU, BBU, or CHCU. Supports with horizontal runner wires are usually confined to Class 3 supports only.

3. Precast Concrete Bar Supports

Precast concrete bar supports are normally supplied in three styles: (1) plain, (2) with wires, and (3) doweled. Plain precast concrete bar supports are used to support bars off the ground. Precast concrete bar supports with wires are used in applications such as a side form spacer to maintain concrete cover against the vertical form, to align a rebar cage in a drilled shaft or in situations where it is necessary to maintain position of the support by tying to the bars. Precast concrete bar supports with wires are commonly supplied with two 16 gauge tie wires cast in the center. Precast concrete side form spacers for caisson alignment are generally furnished with multiple sets of wires to minimize support movement when positioned. Doweled precast concrete bar supports are cast with a hole in the center, approximately 2¼ in. deep, and large enough to insert a #4 bar with a 90° bend at the top used to support top bars above the precast concrete bar support. At the same time the precast concrete bar support can be used to support bottom bars off the ground by placing them on either side of the dowel bar. Precast concrete bar supports can also be used to support vertical reinforcement as in a drilled shaft, by placing the supports under the vertical members of the rebar cage. Properly spaced, precast concrete bar supports sufficiently support the bars within the tolerances established for the placement of bars.

The types and sizes of precast concrete bar supports that are usually available are shown in Table 3.

It is recommended that the Supplier review the project specifications for the required concrete color and compressive strength. Precast concrete bar supports can also be furnished in any other sizes needed for unusual job conditions, by special arrangement with the Supplier. These bar supports provide maximum rust protection.

4. All-Plastic Bar Supports and Side Form Spacers

The industry practices presented herein are intended to serve as a guide for the selection and utilization of all-plastic bar supports used to position reinforcing bars in reinforced concrete.

All-plastic bar supports may be used for horizontal and vertical reinforcing steel. They may have a snap-on action or other method of attachment. All-plastic supports are lightweight, non-porous and chemically inert in concrete. Properly designed all-plastic bar supports should have rounded seatings so as not to punch holes in the formwork and should not deform under load when subjected to normal temperatures encountered in use nor should they shatter or severely crack under impact loading when used in cold weather.

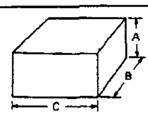
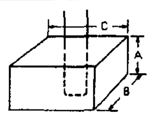
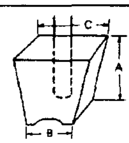
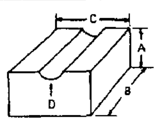
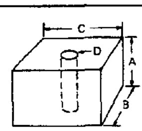
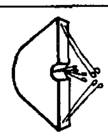
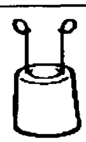
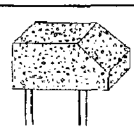
According to one report, since all-plastic bar supports and spacers are subject to temperature effects, they should have at least 25% of their gross plane area perforated to compensate for the difference in the coefficient of thermal expansion between the plastic and concrete.* Also according to this same report, all-plastic supports should not be placed closer than 12 in. apart along a bar.

All-plastic bar supports will not rust, therefore eliminating blemishes on the surface of the concrete. These supports are particularly suitable in situations of moderate to severe exposure or when grinding of the concrete is necessary. All-plastic supports may be used to support epoxy-coated reinforcing bars (see Section 5). These bar supports provide maximum rust protection.

The types and sizes of all-plastic bar supports that are generally available are shown in Table 4.

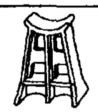
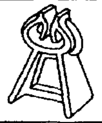
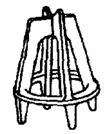
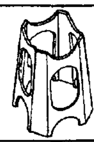
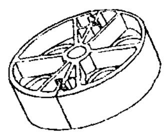
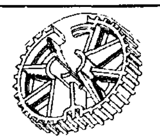
*"Selection of Bar Spacers for Reinforced Concrete" by M. Levitt and M.R. Herbert, *Concrete*, November 1968, Cement and Concrete Association, London, England

TABLE 3—TYPICAL TYPES AND SIZES OF PRECAST CONCRETE BAR SUPPORTS

SYMBOL	BAR SUPPORT ILLUSTRATION	TYPE OF SUPPORT	TYPICAL SIZES	DESCRIPTION
PB		Plain Block	A—¾" to 6" B—2" to 6" C—2" to 48"	Used when placing rebar off grade and formwork. When "C" dimension exceeds 16" a piece of rebar should be cast inside block.
WB		Wired Block	A—¾" to 4" B—2" to 3" C—2" to 3"	Generally 16 ga. tie wire is cast in block, commonly used against vertical forms or in positions necessary to secure the block by tying to the rebar.
TWB		Tapered Wired Block	A—¾" to 3" B—¾" to 2½" C—1¼" to 3"	Generally 16 ga. tie wire is cast in block, commonly used where minimal form contact is desired.
CB		Combination Block	A—2" to 4" B—2" to 4" C—2" to 4" D—fits #3 to #5 bar	Commonly used on horizontal work.
DB		Dowel Block	A—3" B—3" to 5" C—3" to 5" D—hole to accommodate a #4 bar	Used to support top mat from dowel placed in hole. Block can also be used to support bottom mat.
DSSS		Side Spacer - Wired	Concrete cover, 2" to 6"	Used to align the rebar cage in a drilled shaft.* Commonly 16 ga. tie wires are cast in spacer. Items for 5" to 6" cover have 9 ga. tie wires at top and bottom of spacer.
DSBB		Bottom Bolster - Wired	Concrete cover, 3" to 6"	Used to keep the rebar cage off of the floor of the drilled shaft.* Item for 6" cover is actually 8" in height with a 2" shaft cast in the top of the bolster to hold the vertical bar.
DSWS		Side spacer for drilled shaft applications	Concrete cover, 3" to 6"	Generally used to align rebar in a drilled shaft. Commonly manufactured with two sets of 12 ga. annealed wires, assuring proper clearance from the shaft wall surface.

*Also known as a pier, caisson or cast-in-drilled hole.

TABLE 4—TYPICAL TYPES AND SIZES OF ALL-PLASTIC BAR SUPPORTS

SYMBOL	BAR SUPPORT ILLUSTRATION	TYPE OF SUPPORT	TYPICAL SIZES	DESCRIPTION
BS		Bottom Spacer	Heights, ¾" to 6"	Generally for horizontal work. Not recommended for ground or exposed aggregrate finish.
BS-CL		Bottom Spacer	Heights, ¾" to 2"	Generally for horizontal work, provides bar clamping action. Not recommended for ground or exposed aggregate finish.
HC		High Chair	Heights, ¾" to 5"	For use on slabs or panels.
HC-V		High Chair, Variable	Heights 2½" to 6¼"	For horizontal and vertical work. Provides for different heights.
WS		Wheel Spacer	Concrete Cover ⅜" to 3"	Generally for vertical work. Bar clamping action and minimum contact with forms. Applicable for column reinforcing steel.
DSWS		Side Spacer for drilled shaft applications	Concrete Cover 2½" to 6"	Generally used to align rebar in a drilled shaft.* Two piece wheel that closes and locks on to the stirrup or spiral assuring proper clearance from the shaft wall surface.
VLWS		Locking Wheel Spacer for all vertical applications	Concrete Cover ¾" to 6"	Generally used in both drilled shaft and vertical applications where excessive loading occurs. Surface spines provide minimal contact while maintaining required tolerance.

*Also known as a pier, caisson or cast-in-drilled hole.

5. Bar Supports for Epoxy-Coated Reinforcing Bars

Epoxy-coated reinforcing bars have become a widely used corrosion-protection system for reinforced concrete structures. Compatible types of bar supports should be used to support epoxy-coated reinforcing bars. The purpose of the compatible types of bar supports is to minimize damage to the coating on the bars during field placing of the coated bars, and not to introduce a potential source of corrosion at, and in close proximity to the point of contact of the bar supports with the coated bars. CRSI recommends:

1. Wire bar supports should be coated entirely with dielectric material such as epoxy or plastic, compatible with concrete, for a distance of at least 2 in. from the point of contact with the epoxy-coated reinforcing bars, or;
2. Bar supports should be made of dielectric material; if precast concrete blocks with embedded tie wires or precast concrete doweled blocks are used, the wires or dowels should be epoxy-coated or plastic-coated; or;
3. Reinforcing bars that are used as support bars should be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars where specified by the Architect/Engineer, should be epoxy-coated. Proprietary combination bar clips and spreaders that are used in walls with epoxy-coated reinforcing bars should be made of corrosion-resistant material or coated with dielectric material.

For epoxy-coated and plastic-coated wire bar supports, CRSI recommends:

1. Repair of damaged coating—the repair of damaged coating, when required, should be made with patching material and done in accordance with the material Manufacturer's recommendations; the patching material should be compatible with the epoxy-coating material or plastic-coated material, and be inert in concrete. It should not be expected that epoxy-coated or plastic-coated wire bar supports will be completely free of damage. Hanger marks on the coated bar supports, resulting from the coating application process, are acceptable and should not be considered as damaged coating.
2. Inspection—all tests and inspections are normally made at the Manufacturer's facility prior to shipment, unless otherwise specified.

6. Placing Bar Supports

6.1 Application and Use of Bar Supports*

Bar supports are generally estimated and furnished for all formed beams, girders, joists and slabs as shown in the following recommended details, unless otherwise specified in the project drawings or project specifications.

When wire bar support units are placed in continuous lines, they are usually placed so that the ends of the supporting wires can be lapped to lock the last legs on adjoining units. Bars are not normally placed more than 2 in. beyond the last leg at the end of a run of any continuous support.

Bar supports are generally furnished for the top bars only in slabs on ground**, 4'-0" or less in thickness in quantities not to exceed average spacings at 4'-0" in each direction. For some available types, see Section 13. Support bars are not normally furnished, as principal reinforcement is used for support.

In certain regions, bar supports are not generally furnished by the reinforcing steel supplier for bottom bars in grade beams, slabs on ground, bars in singly reinforced*** slabs on ground or for column or wall footings. Bar supports are not normally furnished for top bars in foundation mats more than 4'-0" in thickness. There are so many ways of supporting such bars that Suppliers generally furnish supports for such purposes only by special arrangement.

Similarly, bar supports are not normally furnished by the reinforcing steel Supplier for supporting welded wire fabric except by special arrangement or unless otherwise specified in the project drawings or project specifications.

Historically, it has not been industry practice in certain regions to furnish bar supports to space or support reinforcing bars in walls, columns, sides of beams, or for any other special conditions not covered in the following recommended details. However, examination of exposed concrete surfaces without side form spacers often reveals spalling of the concrete and mislocated reinforcement. If the concrete cover on the reinforcement is less than that specified, early deterioration and spalling of such exposed surfaces can be expected to occur. Maintaining the proper cover on the reinforcement, as is done for slabs, can be accomplished for vertical surfaces by use of side form spacers. If the General Contractor desires to use side form spacers, special arrangements should be made with the Supplier of the reinforcing steel (see Section 16 in Chapter 5).

It is usually not industry practice to furnish bar supports for temperature-shrinkage reinforcement in top slabs of concrete joist construction unless shown on the project drawings or project specifications, or otherwise mutually agreed between Buyer and Seller of reinforcing steel.

Bar supports are intended to support the steel reinforcement and normal construction loads. BAR SUPPORTS ARE NOT INTENDED TO SUPPORT HOSES FOR CONCRETE PUMPS, OR RUNWAYS FOR CONCRETE BUGGIES OR SIMILAR LOADS.

6.2 Recommended Details and Placing Sequences

Bar supports will generally be furnished in accordance with the following recommended details and placing sequences.

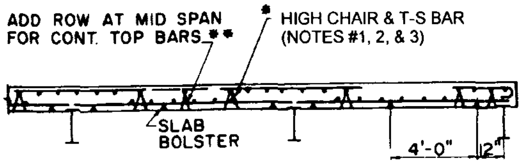
DEPENDING ON REGIONAL PLACING PRACTICES, VARIOUS TYPES OF WIRE, PRECAST CONCRETE, AND ALL-PLASTIC BAR SUPPORTS ARE CONSIDERED APPROPRIATE METHODS OF SUPPORTING REINFORCEMENT IN SLABS, JOISTS, BEAMS, AND GIRDERS. THESE BAR SUPPORT TYPES ARE ACCEPTABLE PROVIDED THEY MAINTAIN THE REQUIRED CONCRETE COVER AND DO NOT DEFLECT UNDER NORMAL CONSTRUCTION LOADS.

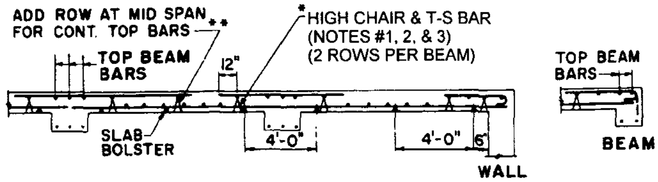
*Complete information on placing bars and bar supports can be found in the publication *Placing Reinforcing Bars* available from the Concrete Reinforcing Steel Institute.

**"Slabs on ground" include slabs cast either directly upon the ground or upon unreinforced concrete fill used as a leveling course (mud mat).

***Singly reinforced slabs on ground contain reinforcement, usually for shrinkage and temperature, at one level, in one or both directions.

7. One-Way Solid Slabs





SLAB SECTION **SLAB SECTION**

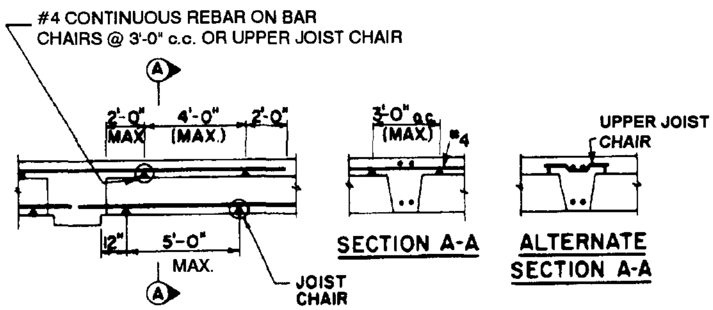
*Continuous high chairs may be used in lieu of support bars and high chairs.

**Exceptions: Not required if adjacent rows are spaced 4'-0" or less apart. With #3 continuous top bars provide rows of support @ 2'-0" c.-c.

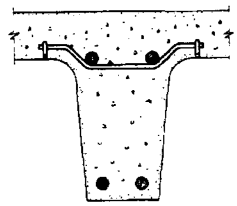
Note: Placing practices in certain regions may prefer to substitute individual bar supports in lieu of slab bolsters.

Notes:
1. A line of properly lapped support bars can replace an equal amount of temperature-shrinkage (T-S) steel. T-S bars to be used for supports—Use Class A tension lap splice.
2. For #5 T-S bars use high chairs @ 4'-0" c.-c.
   For #4 T-S bars use high chairs @ 3'-0" c.-c.
3. Do not use #3 T-S bar for support bar, substitute one #4 bar (properly lapped) with high chairs @ 3'-0" c.-c.

8. Joists



JOIST ELEVATION



UPPER JOIST CHAIR
Upper joist chair is available on special order only.

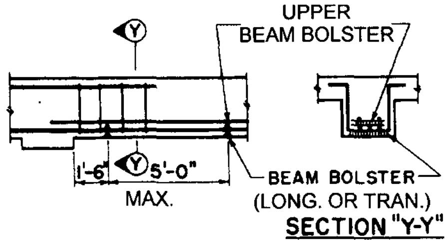
Bar supports are generally not provided for temperature-shrinkage welded wire fabric or bars in concrete joist slabs. It is recommended that temperature-shrinkage bars be tied, and spaced with #3 bars centered on alternate rows of forms, i.e., about 4'-2" to 6'-0" centers at right angles to temperature-shrinkage bars.

Top bars are normally supported either by bars on individual chairs or by upper joist chairs.

For two-way joist construction (waffle slabs), the bar supports in the ribs in one direction can usually be made the same as for one-way concrete joist construction. Bar supports can be omitted in ribs at right angles as these bars are supported on the bottom bars running in the first direction, except top bars in the middle strips.

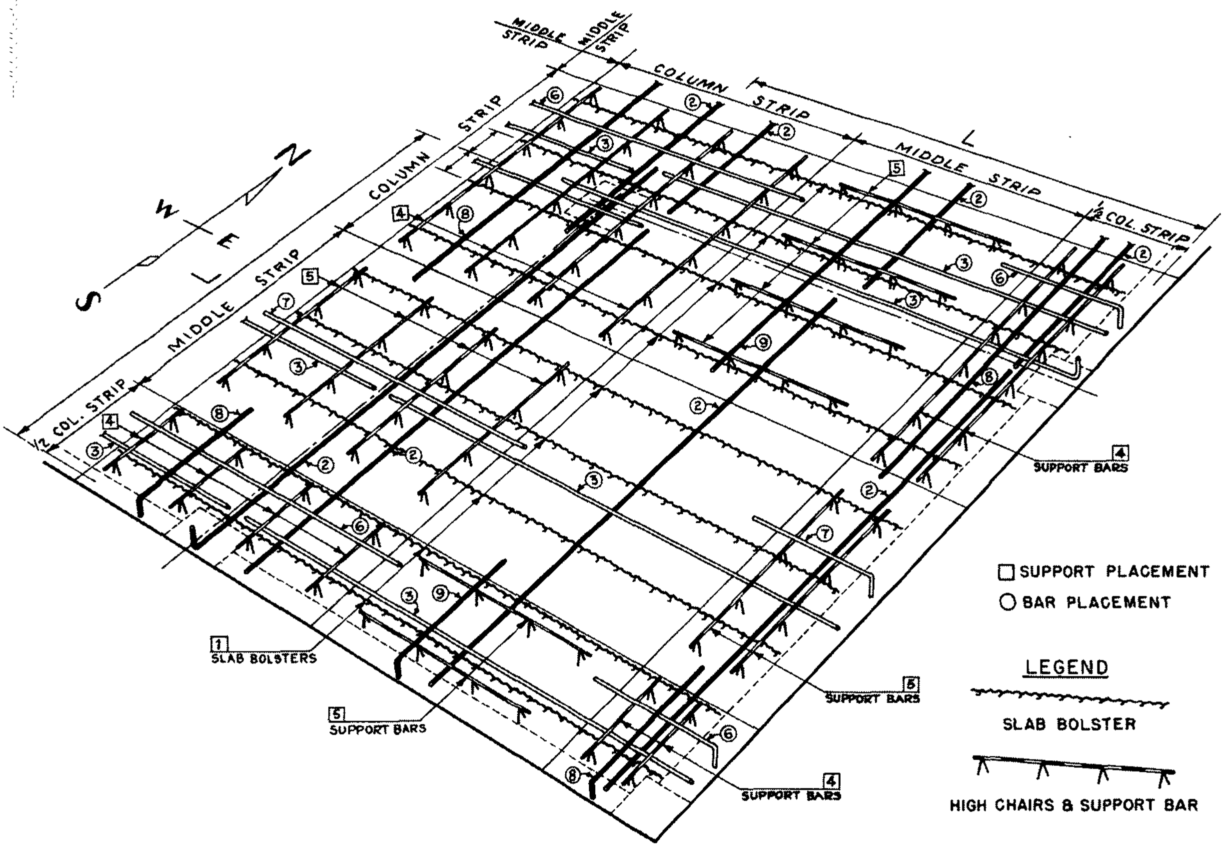
9. Beams and Girders

Transverse beam bolsters spaced at a maximum of 5'-0" on centers, and, for bars in two layers, upper beam bolsters at the same spacing, are regional field placing practices. Longitudinal beam bolsters are supplied only upon special arrangements between Contractor and Supplier.



BEAM ELEVATION

10. Sequence of Placing Bar Supports and Bars in Two-Way Flat Plate



□ 1. Place continuous lines of slab bolsters in E-W direction at 4'-0" maximum o.c. between columns.

○ 2. Set N-S bottom bars in column and middle strips.*

○ 3. Set E-W bottom bars in column and middle strips.*

□ 4. Place 3 or more rows of #4 support bars (length 0.5L) at 4'-0" maximum o.c. on high chairs at 3'-0" maximum o.c. in N-S direction at each column head.

□ 5. Place 3 or more rows of #4 support bars (length approx. 0.4L) at 4'-0" maximum o.c. on high chairs at 3'-0" maximum o.c. between columns lengthwise in N-S and E-W column strips.

○ 6. Set E-W top column strip bars at column heads.

○ 7. Set E-W top middle strip bars.

○ 8. Set N-S top column strip bars at column heads.

○ 9 Set N-S top middle strip bars.

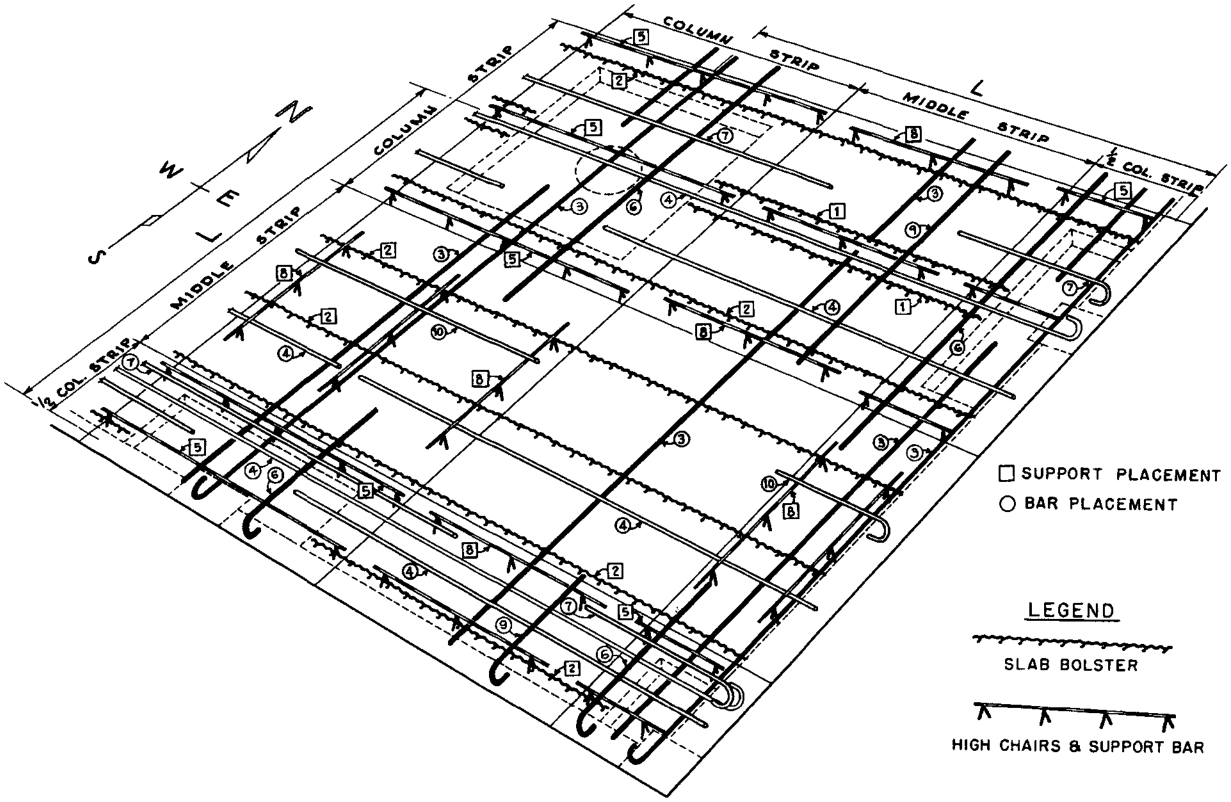
Note 1: This sequence is used when the Architect/Engineer specifies the outmost layer direction. In this case the N-S bars are closest to the bottom and top of slab.

Note 2: Placing practices in certain regions may prefer to substitute individual bar supports in lieu of slab bolsters.

Note 3: Refer to Section 6.2 for use of various types and materials of bar supports.

*For structural integrity, the ACI 318 Building Code requires that all column strip bottom bars must be made continuous with adjacent spans. If bars must be spliced, use a Class A tension splice located at the support. Two of these rebars must pass through the column core and be placed within the column reinforcement. Note that, in the illustration above, these bars have been hooked at the exterior support and that the slab bolsters were extended.

11. Sequence of Placing Bar Supports and Bars in Two-Way Flat Slab



☐ 1. Place a single line of slab bolsters in E-W direction on each side adjacent to column centerline between drop panels.

☐ 2. Place continuous lines of slab bolsters in E-W direction at 4'-0" maximum o.c. between drop panels. Begin spacing 3" outside drop panels. Add one E-W slab bolster at slab edges between drop panels.

○ 3. Set N-S bottom bars, column and middle strips.*

○ 4. Set E-W bottom bars, column and middle strips.*

☐ 5. Place 3 rows of #4 support bars (length 0.5L) on high chairs at 3'-0" maximum o.c. in E-W direction at each column head. Tie middle support bar to column verticals.

○ 6. Set N-S column strip top bars.

○ 7. Set E-W column strip top bars.

☐ 8. Place 3 or more rows of #4 support bars (length 0.32L) at 4'-0" maximum o.c. in N-S and E-W column strips, parallel to the strips. Place 2 rows at all slab edges.

○ 9. Set N-S top bars in middle strips.

○ 10. Set E-W top bars in middle strip.

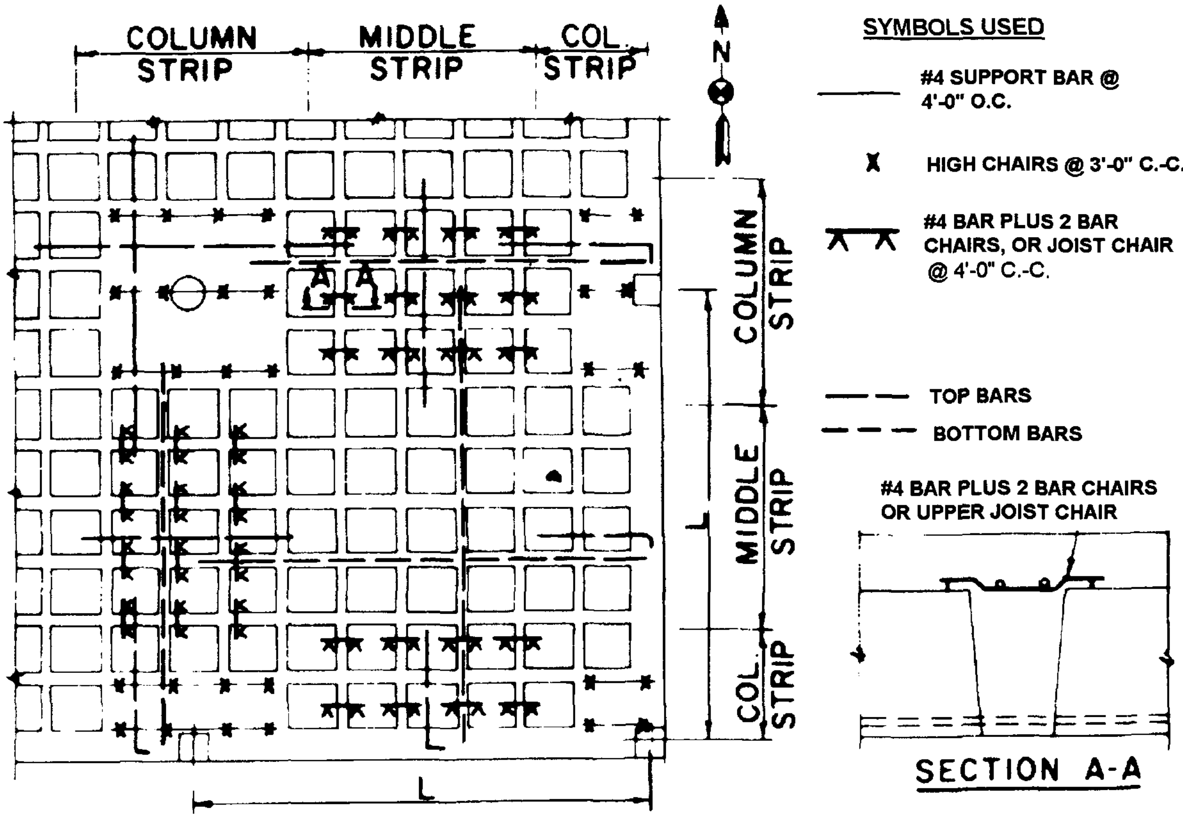
Note 1: This sequence is used when the Architect/Engineer does not specify the outermost bar layer direction, usually when spans in each direction are equal. In this case the bottom layer is N-S, the topmost layer is E-W.

Note 2: Placing practices in certain regions may prefer to substitute individual bar supports in lieu of slab bolsters.

Note 3: Refer to Section 6.2 for use of various types and materials of bar supports.

*For structural integrity, the ACI 318 Building Code requires that all column strip bottom bars must be made continuous with adjacent spans. If bars must be spliced, use a Class A tension splice located at the support. Two of these rebars must pass through the column core and be placed within the column reinforcement. Note that, in the illustration above, these bars have been hooked at the exterior support and that the slab bolsters were extended.

12. Sequence of Placing Bar Supports and Bars in Two-Way Waffle Flat Slab



1. Place standard joist chairs in joist rib bottom @ 5'-0" c.c. in N-S column strip and N-S middle strip (full length).
2. Set N-S column and middle strip bottom bars.*
3. Set E-W column and middle strip bottom bars.*
4. At column heads, place 3 (or more) rows of #4 support bars (length full width of column head) on high chairs @ 3'-0" c.c. in E-W direction.
5. Set N-S column strip bars.
6. Place #4 bar plus two bar chairs (or upper joist chair) @ 4'-0" c.c. in N-S and E-W middle strip. If top bars are spaced over the entire middle strip, use #4 support bars at 4'-0" c.c. with bar chairs @ 3'-0" c.c.
7. Set N-S and E-W middle strip top bars.
8. Set E-W column strip top bars; tie column strip N-S bars to support bars; tie column strip E-W bars to N-S bars.

Note 1: Placing practices in certain regions may prefer to substitute individual bar supports in lieu of joist chairs.

Note 2: Refer to Section 6.2 for use of various types and materials of bar supports.

*For structural integrity, the ACI 318 Building Code requires that all column strip bottom bars must be made continuous with adjacent spans. If bars must be spliced, use a Class A tension splice located at the support. Two of these rebars must pass through the column core and be placed within the column reinforcement. Note that, in the illustration above, these bars have been hooked at the exterior support.

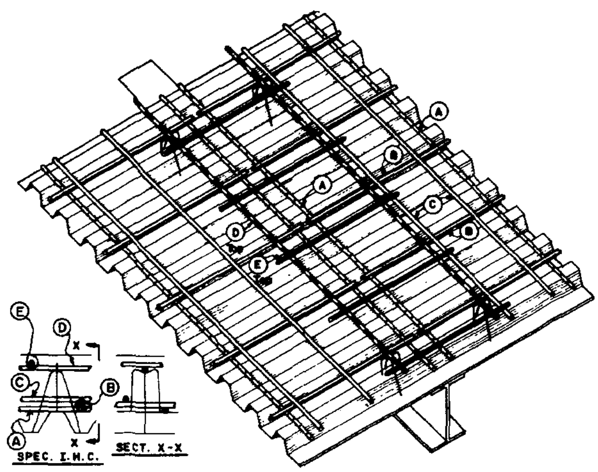
13. Bar Supports For Special Conditions

13.1 One- Way Slabs on Corrugated Steel Forms—Placing Sequence

1. Place corrugated steel forms and fasten to supporting members.
2. Set #3 support bars (A) @ 5'-0" on steel form.
3. Set main bar (B) (positive reinforcement) over valleys. Tie to support bars. NOTE: Main bar spacing should be a multiple of steel form pitch.
4. Set temperature-shrinkage bars (C). Tie to main bars.
5. Place special individual high chairs @ 3'-0" o.c.* NOTE: For continuous top bars place extra row of highs chairs at midspan.
6. Place #4 support bars (D) on chairs. (A line of properly lapped support bars can replace an equal amount of temperature-shrinkage steel.)
7. Set top bars (E) (negative reinforcement). Tie to support bars.

*Special continuous high chairs may be used in lieu of support bars and high chairs.

NOTE: Refer to Section 6.2 for use of various types and materials of bar supports.



ONE-WAY SLABS ON CORRUGATED STEEL FORMS

13.2 *Foundation Mats and Slabs on Ground or On Mud-Mat*

Plain Concrete Block—Heights to 6".

All-Plastic Chair with Base Plate—Heights to 5".

HCP—An individual high chair with sand plate for soil bearing. Heights to 15".

CHCU—Continuous high chair upper. Continuous runner wires provide for support off lower mat of bars. Heights up to 15".

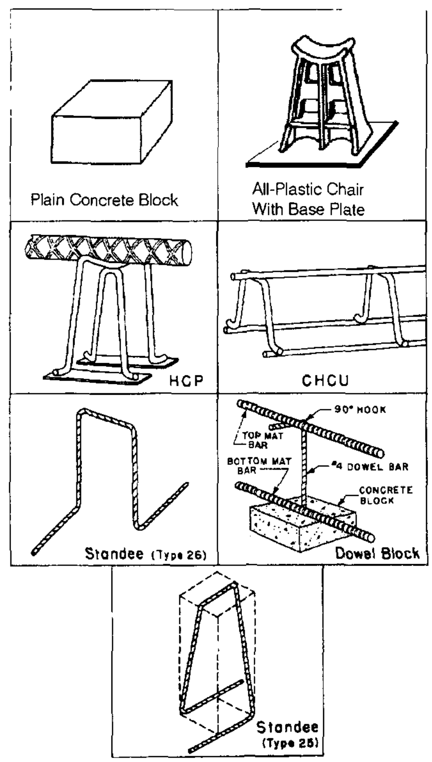
Standee—A reinforcing bar fabricated to order with bent legs resting on lower mat of bars.

Dowel Block—A precast block with hole for #4 dowel bar. Suitable for support of both top and bottom mats of bars. Heights to 2'-0".

Recommended Practice for Usage

For slabs of total thickness:

1. 2'-0" or less—HCP, Plain Concrete Block, All-Plastic Chair with Base Plate, CHCU, Standees using #4 bars, or dowel blocks (Western States only).
2. More than 2 '-0" and up to 4'-0"—Standees using #5 bars.
3. More than 4'-0"—Bar supports are generally not furnished except by special arrangement.

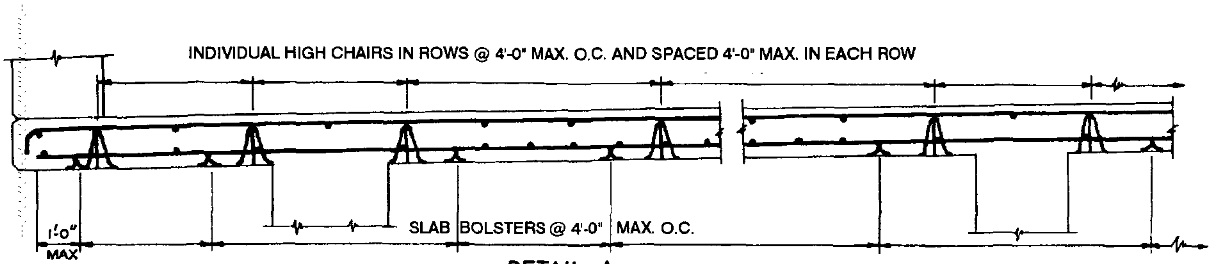


Spacing of bar supports for slabs on ground or on mud-mat follows the recommendations on Sections 6 through 14, adjusted for the particular conditions of weight and rigidity of the reinforcing steel specified.

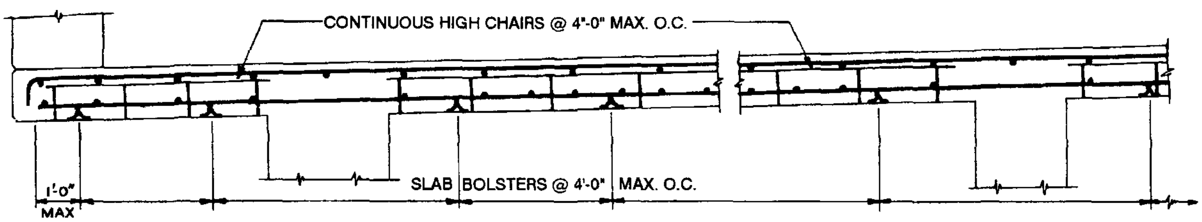
Bar supports conforming to any applicable choice indicated are generally estimated and furnished for slabs up to 4'-0" thick unless otherwise specified.

14. Bar Supports For Highway Bridge Slab Reinforcement

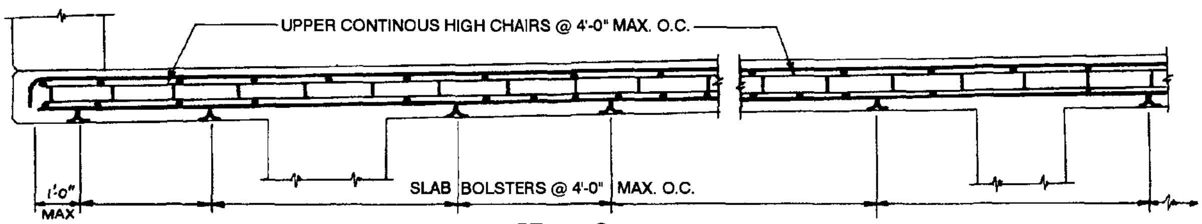
14.1 Slabs on Flat Formwork



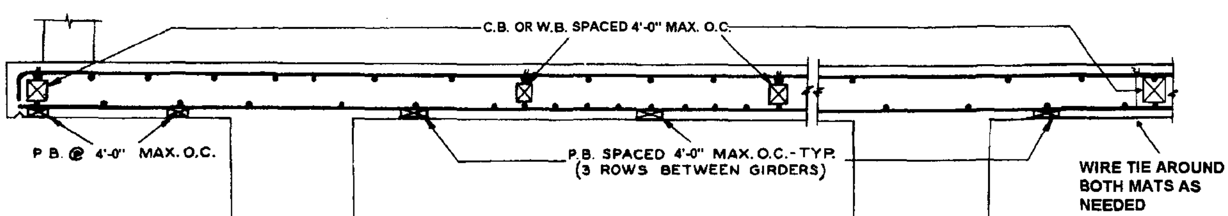
DETAIL A
SHOWING INDIVIDUAL HIGH CHAIRS



DETAIL B
SHOWING CONTINUOUS HIGH CHAIRS



DETAIL C
SHOWING UPPER CONTINUOUS HIGH CHAIRS



P.B.: PLAIN PRECAST CONCRETE BAR SUPPORT
W.B.: PRECAST CONCRETE BAR SUPPORT WITH WIRES
C.B.: COMBINATION BLOCK

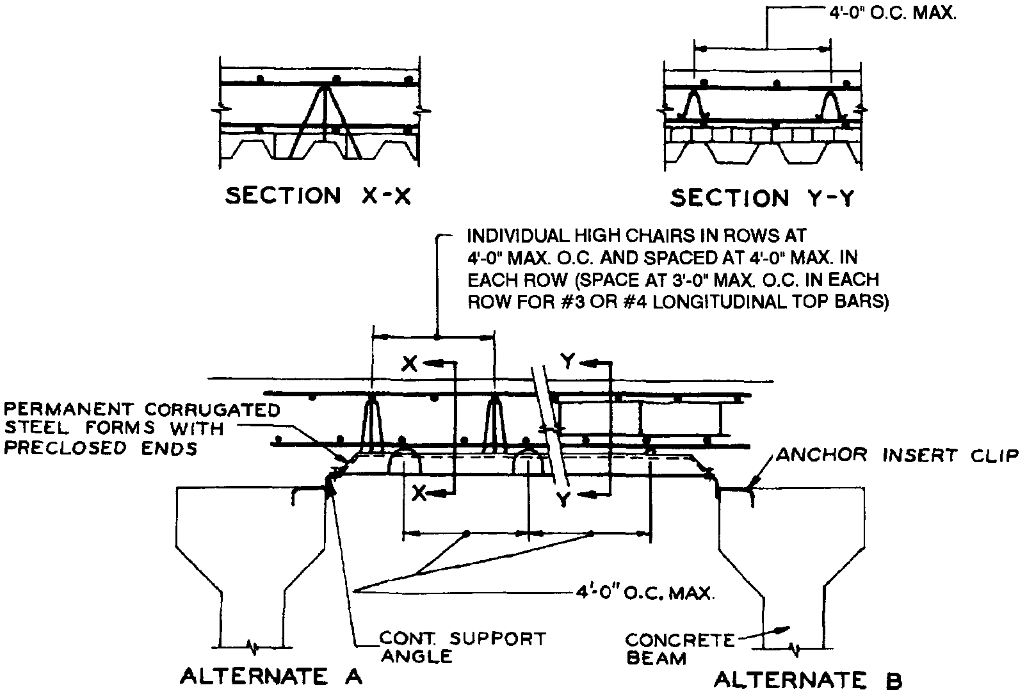
DETAIL D
SHOWING PRECAST CONCRETE BAR SUPPORTS

GIRDER STIRRUPS AND THEIR TOP BARS THAT EXTEND SUFFICIENTLY INTO THE BRIDGE DECK CAN BE USED TO SUPPORT THE TOP SLAB REINFORCEMENT, THEREBY ELIMINATING THE NEED FOR TOP AND BOTTOM LONGITUDINAL SLAB BARS WITHIN THE GIRDERS AND ANY TOP BAR SUPPORTS ADJACENT TO THE GIRDERS.

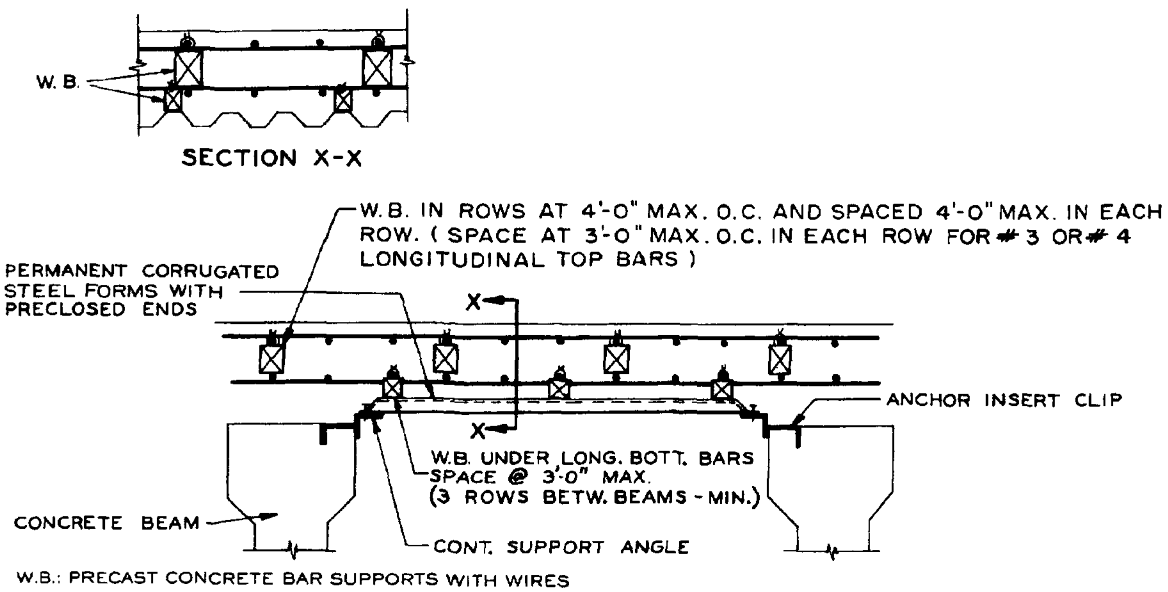
Notes:

1. Placing practices in certain regions may prefer to substitute individual bar supports in lieu of slab bolsters.
2. Refer to Section 6.2 for use of various types and materials of bar supports.

14.2 Slabs on Permanent Corrugated Steel Forms



WIRE BAR SUPPORTS ON PERMANENT STEEL FORMS



PRECAST CONCRETE BAR SUPPORTS ON PERMANENT STEEL FORMS

Note: Refer to Section 6.2 for use of various types and materials of bar supports.

CHAPTER 4—SPIRALS

4.1—Purpose

This chapter presents CRSI's recommendations to establish a standard of practice for steel spirals used for concrete column reinforcement in the building industry. This recommendation establishes three standard sizes of steel bars and wire used for spirals and includes a table listing the recommended pitches in multiples of 1/4 in. (5 mm) for spirals with column diameters from 12 to 52 in. (300 to 1300 mm) inclusive in even 2 in. (50 mm) increments. Definitions of terms applicable to steel spirals are also included.

4.2—Definitions

Spirals—a concrete column reinforcement consisting of a continuous, helical coil of constant diameter made of steel bars or wire held firmly in place and true to line by steel spacers or other positive methods.

Pitch—the center-to-center distance between two adjacent loops of a spiral.

Length (height) of spiral—the distance from end-to-end of a spiral coil, including the finishing turns top and bottom, with a tolerance of ±1-1/2 in. (40 mm).

Spiral-reinforcement ratio—the ratio of the volume of spiral reinforcement to the total volume of the core (out-to-out of spirals) of a spirally reinforced concrete column.

Spacers—A steel channel or angle punched to form hooks that are bent over the spiral loops to maintain the specified pitch (Fig. 5).

4.3—Reinforcement recommendations

Steel bars for spirals should conform to ASTM A 615/A 615M or to ASTM A 706/A 706M. Steel wire for spirals should conform to ASTM A 82 or to ASTM A 496.

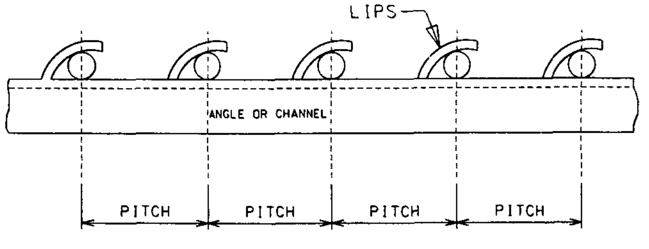


Fig. 5—Typical spacer.

4.4—Size and pitch recommendations

Spiral wire or bar size and pitch for a range of concrete compressive strengths and circular column sizes from 12 to 52 in. (300 to 1300 mm) are given in Table 21.

4.5—Spacer recommendations

ACI 318 (318M) requires that spiral reinforcement be held firmly in place and true to line. When spacers are used, ACI 318R (318MR) suggests they be furnished in accordance with Table 22.

4.6—Weight (mass) of spirals

Spiral weight (mass) for a range of circular column sizes from 12 through 52 in. (300 to 1300 mm) and spiral size and pitch are given in Table 23(a) to (c).

Table 21—Recommended spirals for circular columns

Specified concrete compressive strength f_c', psi (MPa)	Column size, in.	Spiral size and pitch, in.
3000 (21)	12	3/8 diameter at 2-1/2
	14 to 24	3/8 diameter at 2-3/4
	26 to 52	3/8 diameter at 3
4000 (28)	12 to 24	3/8 diameter at 2
	26 to 52	3/8 diameter at 2-1/4
5000 (35)	12 to 14	3/8 diameter at 1-1/2
	16 to 24	1/2 diameter at 3
	26 to 52	1/2 diameter at 3-1/4
6000 (42)	16 to 28	1/2 diameter at 2-1/2
	30 to 52	1/2 diameter at 2-3/4
8000 (56)	16	1/2 diameter at 1-3/4
	18 to 38	5/8 diameter at 3
	40 to 52	5/8 diameter at 3-1/4

Notes: 1 in. = 25.4 mm.
1. f_y = 60,000 psi (420 MPa); 2. Plain round bar or wire shown. Deformed bars of same size can also be used; 3. Based on 1-1/2 in. (40 mm) concrete cover and core diameter 3 in. (80 mm) less than column size; 4. Column size (diameter) in even 2 in. (50 mm) increments; and 5. Based on minimum costs.

Table 22—Suggested guidelines for spiral spacers

Spiral wire or bar size	Spiral core diameter, in.	Minimum number of spacers
3/8 in. diameter or #3 (10 mm diameter or #10)	Less than 20	2
	20 to 30	3
1/2 in. diameter or #4 (13 mm diameter or #13)	More than 30	4
5/8 in. diameter or #5 (16 mm diameter or #16)	No greater than 24	3
	More than 24	4

Note: 1 in. = 25.4 mm.

Table 23(a)—Weight (mass) of #3 (#10) spirals

Column diameter, in.	Pitch of #3 (#10) spiral, in. 1.5	1.75	2	2.25	2.5	2.75	3	3.25	A, lb
12	6.80	5.83	5.11	4.54	4.09	3.72	3.42	3.16	2.55
14	8.38	7.18	6.29	5.59	5.03	4.58	4.20	3.88	3.14
16	9.95	8.53	7.47	6.64	5.98	5.44	4.99	4.60	3.73
18	11.52	9.88	8.65	7.69	6.92	6.29	5.77	5.33	4.32
20	13.10	11.23	9.83	8.74	7.86	7.15	6.56	6.05	4.91
22	14.67	12.58	11.01	9.79	8.81	8.01	7.34	6.78	5.50
24	16.25	13.93	12.19	10.83	9.75	8.87	8.13	7.51	6.09
26	17.82	15.28	13.37	11.88	10.70	9.73	8.92	8.23	6.68
28	19.40	16.63	14.55	12.93	11.64	10.58	9.70	8.96	7.27
30	20.97	17.98	15.73	13.98	12.59	11.44	10.49	9.68	7.86
32	22.55	19.33	16.91	15.03	13.53	12.30	11.28	10.41	8.45
34	24.12	20.68	18.09	16.08	14.48	13.16	12.06	11.14	9.04
36	25.69	22.02	19.27	17.13	15.42	14.02	12.85	11.86	9.63
38	27.27	23.37	20.45	18.18	16.36	14.88	13.64	12.59	10.23
40	28.84	24.72	21.63	19.23	17.31	15.74	14.43	13.32	10.82
42	30.42	26.07	22.82	20.28	18.25	16.60	15.21	14.04	11.41
44	31.99	27.42	24.00	21.33	19.20	17.45	16.00	14.77	12.00
46	33.57	28.77	25.18	22.38	20.14	18.31	16.79	15.50	12.59
48	35.14	30.12	26.36	23.43	21.09	19.17	17.57	16.22	13.18
50	36.72	31.47	27.54	24.48	22.03	20.03	18.36	16.95	13.77
52	38.29	32.82	28.72	25.53	22.98	20.98	19.15	17.68	14.36

Notes: 1 in. = 25.4 mm; 1 lb/ft = 1.488 kg/m; and 1 lb = 0.4536 kg.
1. Concrete cover is 1-1/2 in. (40 mm) (column core diameter = column diameter minus 3 in. [80 mm]); **2.** Weight (mass) is in lb/ft (kg/m) of height, exclusive of spacers (if used); **3.** *A* is weight (mass) in lb (kg) of anchorage provided by 1-1/2 extra turns at each end; **4.** Total weight (mass) of spiral in lb (kg) is column height in ft (m) times spiral weight in lb/ft (kg/m), plus *A*; **5.** The table considered ACI 318 (318M) Section 7.10.4.3 requirement that clear spacing between spirals not exceed 3 in. (80 mm), nor be less than 1 in. (25 mm); and **6.** The table also considered the following shop fabrication minimum core diameters for #3 (#10) bars of 9 in. (225 mm).

Table 23(b)—Weight (mass) of #4 (#13) spirals

Column diameter, in.	Pitch of #4 (#13) spiral, in. 1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	A, lb
16	17.50	15.00	13.13	11.68	10.51	9.56	8.77	8.10	7.52	6.56
18	20.30	17.40	15.23	13.54	12.19	11.09	10.17	9.39	8.72	7.61
20	23.09	19.80	17.33	15.40	13.87	12.61	11.56	10.68	9.92	8.66
22	25.89	22.20	19.42	17.27	15.54	14.13	12.96	11.96	11.11	9.71
24	28.69	24.59	21.52	19.13	17.22	15.66	14.36	13.25	12.31	10.76
26	31.49	26.99	23.62	21.00	18.90	17.18	15.75	14.54	13.51	11.80
28	34.28	29.39	25.72	22.86	20.58	18.71	17.15	15.83	14.71	12.85
30	37.08	31.79	27.81	24.73	22.26	20.23	18.55	17.12	15.90	13.90
32	39.88	34.18	29.91	26.59	23.93	21.76	19.95	18.42	17.10	14.95
34	42.68	36.58	32.01	28.46	25.61	23.28	21.35	19.71	18.30	16.00
36	45.47	38.98	34.11	30.32	27.29	24.81	22.74	21.00	19.50	17.05
38	48.27	41.38	36.21	32.19	28.97	26.34	24.14	22.29	20.70	18.10
40	51.07	43.78	38.30	34.05	30.65	27.86	25.54	23.58	21.90	19.15
42	53.87	46.17	40.40	35.92	32.33	29.39	26.94	24.87	23.09	20.20
44	56.67	48.57	42.50	37.78	34.00	30.91	28.34	26.16	24.29	21.25
46	59.46	50.97	44.60	39.65	35.68	32.44	29.74	27.45	25.49	22.30
48	62.26	53.37	46.70	41.51	37.36	33.97	31.14	28.74	26.69	23.35
50	65.06	55.77	48.80	43.38	39.04	35.49	32.53	30.03	27.89	24.40
52	67.86	58.16	50.90	45.24	40.72	37.02	33.93	31.32	29.09	25.45

Notes: 1 in. = 25.4 mm; 1 lb/ft = 1.488 kg/m; and1 lb = 0.4536 kg.
1. Concrete cover is 1-1/2 in. (40 mm) (column core diameter = column diameter minus 3 in. [80 mm]); **2.** Weight (mass) is in lb/ft (kg/m) of height, exclusive of spacers (if used); **3.** *A* is weight (mass) in lb (kg) of anchorage provided by 1-1/2 extra turns at each end; **4.** Total weight (mass) of spiral in lb (kg) is column height in ft (m) times spiral weight in lb/ft (kg/m), plus *A*; **5.** The table considered ACI 318 (318M) Section 7.10.4.3 requirement that clear spacing between spirals not exceed 3 in. (80 mm), nor be less than 1 in. (25 mm); and **6.** The table also considered the following shop fabrication minimum core diameters for #4 (#13) bars of 12 in. (300 mm).

Table 23(c)—Weight (mass) of #5 (#16) spirals

Column diameter, in.	Pitch of #5 (#16) spiral, in.								A, lb
	1.75	2	2.25	2.5	2.75	3	3.25	3.5	
18	26.94	23.57	20.96	18.87	17.16	15.74	14.53	13.50	11.78
20	30.68	26.85	23.87	21.49	19.54	17.92	16.54	15.37	13.41
22	34.42	30.12	26.78	24.11	21.92	20.10	18.56	17.23	15.05
24	38.16	33.40	29.69	26.73	24.30	22.28	20.57	19.10	16.69
26	41.91	36.67	32.60	29.34	26.68	24.46	22.58	20.97	18.33
28	45.65	39.95	35.51	31.96	29.06	26.64	24.60	22.84	19.97
30	49.40	43.22	38.42	34.58	31.44	28.83	26.61	24.71	21.61
32	53.14	46.50	41.34	37.20	33.83	31.01	28.63	26.58	23.24
34	56.88	49.78	44.25	39.83	36.21	33.19	30.64	28.46	24.88
36	60.63	53.05	47.16	42.45	38.59	35.38	32.66	30.33	26.52
38	64.37	56.33	50.07	45.07	40.97	37.56	34.67	32.20	28.16
40	68.12	59.60	52.98	47.69	43.35	39.74	36.69	34.07	29.80
42	71.86	62.88	55.90	50.31	45.74	41.93	38.70	35.94	31.44
44	75.60	66.16	58.81	52.93	48.12	44.11	40.72	37.81	33.07
46	79.35	69.43	61.72	55.55	50.50	46.29	42.74	39.68	34.71
48	83.09	72.71	64.63	58.17	52.88	48.48	44.75	41.56	36.35
50	86.84	75.99	67.54	60.79	55.27	50.66	46.77	43.43	37.99
52	90.58	79.26	70.46	63.41	57.65	52.85	48.78	45.30	39.63

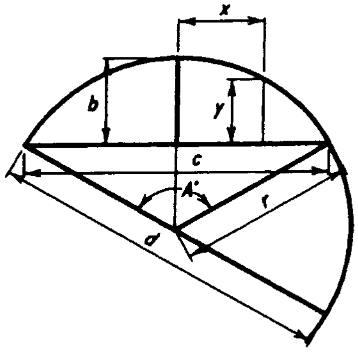
Notes: 1 in. = 25.4 mm; 1 lb/ft = 1.488 kg/m; and1 lb = 0.4536 kg.
1. Concrete cover is 1-1/2 in. (40 mm) (column core diameter = column diameter minus 3 in. [80 mm]); **2.** Weight (mass) is in lb/ft (kg/m) of height, exclusive of spacers (if used); **3.** *A* is weight (mass) in lb (kg) of anchorage provided by 1-1/2 extra turns at each end; **4.** Total weight (mass) of spiral in lb (kg) is column height in ft (m) times spiral weight in lb/ft (kg/m), plus *A*; **5.** The table considered ACI 318 (318M) Section 7.10.4.3 requirement that clear spacing between spirals not exceed 3 in. (80 mm), nor be less than 1 in. (25 mm); and **6.** The table able also considered the following shop fabrication minimum core diameters for #5 (#16) bars of 15 in. (375 mm).

CHAPTER 5—MATHEMATICAL TABLES AND FORMULAS

The circular properties and trigonometric formulas that follow are included here for the benefit of the reader when it is necessary to make these calculations.

5.1—Properties of the circle

PROPERTIES OF THE CIRCLE



Circumference = 6.28318 r = 3.14159 d

Diameter = 0.31831 circumference

Area = $3.14159r^2$

Arc $a = \frac{\pi r A^\circ}{180^\circ} = 0.017453\, rA^\circ$

Angle $A^\circ = \frac{180^\circ a}{\pi r} = 57.29578\, \frac{a}{r}$

Radius $r = \frac{4b^2 + c^2}{8b}$

Chord $c = 2\sqrt{2br - b^2} = 2r \sin\frac{A}{2}$

Rise $b = r - \frac{1}{2}\sqrt{4r^2 - c^2} = \frac{c}{2}\tan\frac{A}{4}$

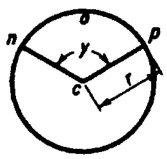
$= 2r\sin^2\frac{A}{4} = r + y - \sqrt{r^2 - x^2}$

$y = b - r + \sqrt{r^2 - x^2}$

$x = \sqrt{r^2 - (r + y - b)^2}$

Diameter of circle of equal periphery as square	= 1.27324 side of square
Side of square of equal periphery as circle	= 0.78540 diameter of circle
Diametér of circle circumscribed about square	= 1.41421 side of square
Side of square inscribed in circle	= 0.70711 diameter of circle

CIRCULAR SECTOR



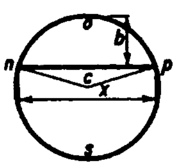
r = radius of circle y = angle *ncp* in degrees

Area of Sector *ncpo* = ½ (length of arc *nop* x r)

= Area of Circle × $\frac{y}{360}$

= $0.0087266 \times r^2 \times y$

CIRCULAR SEGMENT



r = radius of circle x = chord b = rise

Area of Segment *nop* = Area of Sector *ncpo* – Area of triangle *ncp*

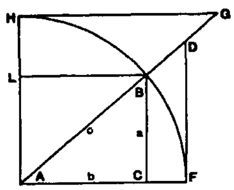
$= \frac{(\text{Length of arc } nop \times r) - x(r - b)}{2}$

Area of Segment *nsp* = Area of Circle – Area of Segment *nop*

5.2—Trigonometric formulas

TRIGONOMETRIC FORMULAS

TRIGONOMETRIC FUNCTIONS



Radius AF $= 1$
$= \sin^2 A + \cos^2 A = \sin A \operatorname{cosec} A$
$= \cos A \sec A = \tan A \cot A$

Sine A $= \dfrac{\cos A}{\cot A} = \dfrac{1}{\operatorname{cosec} A} = \cos A \tan A = \sqrt{1 - \cos^2 A} = BC$

Cosine A $= \dfrac{\sin A}{\tan A} = \dfrac{1}{\sec A} = \sin A \cot A = \sqrt{1 - \sin^2 A} = AC$

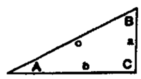
Tangent A $= \dfrac{\sin A}{\cos A} = \dfrac{1}{\cot A} = \sin A \sec A = FD$

Cotangent A $= \dfrac{\cos A}{\sin A} = \dfrac{1}{\tan A} = \cos A \operatorname{cosec} A = HG$

Secant A $= \dfrac{\tan A}{\sin A} = \dfrac{1}{\cos A} = AD$

Cosecant A $= \dfrac{\cot A}{\cos A} = \dfrac{1}{\sin A} = AG$

RIGHT ANGLED TRIANGLES



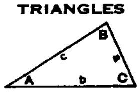
$a^2 = c^2 - b^2$

$b^2 = c^2 - a^2$

$c^2 = a^2 + b^2$

Known	Required					
	A	B	a	b	c	Area
a, b	$\tan A = \frac{a}{b}$	$\tan B = \frac{b}{a}$			$\sqrt{a^2 + b^2}$	$\frac{ab}{2}$
a, c	$\sin A = \frac{a}{c}$	$\cos B = \frac{a}{c}$		$\sqrt{c^2 - a^2}$		$\frac{a\sqrt{c^2 - a^2}}{2}$
A, a		$90° - A$		$a \cot A$	$\frac{a}{\sin A}$	$\frac{a^2 \cot A}{2}$
A, b		$90° - A$	$b \tan A$		$\frac{b}{\cos A}$	$\frac{b^2 \tan A}{2}$
A, c		$90° - A$	$c \sin A$	$c \cos A$		$\frac{c^2 \sin 2A}{4}$

OBLIQUE ANGLED TRIANGLES



$s = \dfrac{a + b + c}{2}$

$K = \sqrt{\dfrac{(s - a)(s - b)(s - c)}{s}}$

$a^2 = b^2 + c^2 - 2bc \cos A$

$b^2 = a^2 + c^2 - 2ac \cos B$

$c^2 = a^2 + b^2 - 2ab \cos C$

Known	Required					
	A	B	C	b	c	Area
a, b, c	$\tan \frac{1}{2} A = \frac{K}{s - a}$	$\tan \frac{1}{2} B = \frac{K}{s - b}$	$\tan \frac{1}{2} C = \frac{K}{s - c}$			$\sqrt{s(s-a)(s-b)(s-c)}$
a, A, B			$180° - (A + B)$	$\frac{a \sin B}{\sin A}$	$\frac{a \sin C}{\sin A}$	
a, b, A		$\sin B = \frac{b \sin A}{a}$			$\frac{b \sin C}{\sin B}$	
a, b, C	$\tan A = \frac{a \sin C}{b - a \cos C}$				$\sqrt{a^2 + b^2 - 2ab \cos C}$	$\frac{ab \sin C}{2}$

CHAPTER 6—COMMON SYMBOLS AND ABBREVIATIONS

6.1—Organizations

AASHTO American Association of State Highway and Transportation Officials
ACI American Concrete Institute
AIA American Institute of Architects
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute
ANSI American National Standards Institute
ASTM ASTM International
AWS American Welding Society
CRSI Concrete Reinforcing Steel Institute
CSI Construction Specifications Institute
FHWA Federal Highway Administration
ICC International Code Council
NCMA National Concrete Masonry Association
PCA Portland Cement Association
PTI Post-Tensioning Institute
WRI Wire Reinforcement Institute

6.2—Stress and force designations

f'_c specified compressive strength of concrete, psi (MPa)
f_y minimum specified yield strength of reinforcing steel, psi (MPa)
psf pounds per square foot used for loads on building or reactions as from soil on footings
psi pounds per square inch—used for stress or strength of concrete and reinforcing bars
kip 1000 pounds
ksi kips per square inch

6.3—Structural steel designations

C American Standard Channels
HP Bearing pile shapes
HSS Hollow structural sections
L Angles
M Miscellaneous shapes
MC Miscellaneous channels
MT Structural tees from M-shapes
S American Standard Beams
ST Structural tees from S-shapes
TS Structural tubing
W Wide-flange shapes
WT Structural tees from W-shapes

For information of structural steel shapes and dimensions, see AISC's *Steel Construction Manual*. For information on steel joists, see SJI's *Standard Specifications and Load Tables*.

6.4—Bar supports

BB Beam bolster
BBU Beam bolster upper
BC Individual bar chair
CHC Continuous high chair
CHCM Continuous high chair for metal deck
CHCU Continuous high chair upper
CS Continuous support
HC Individual high chair
HCM High chair for metal deck
HCP Individual high chair with plate
JC Joist chair
JCU Joist chair upper
SB Slab bolster
SBU Slab bolster upper

6.5—Parts of a structure (used in marks for structural members)

B Beams
C Columns
F Footings
G Girders
J Joists
L Lintels
P Piers, caissons, drilled shafts
R Roof
S Slabs
SW Shearwall(s)
W Walls

6.6—Common abbreviations

ABT About
ABUT Abutment
ADDL Additional
ADJ Adjacents
ALT Alternate
APPROX Approximate

B, BOT Bottom
BAL Balance
BDL Bundle
BETW Between
BLDG Building
BM Beam
BNT Bent
BOF Bottom of footing
BP Bearing plate
BSMT Basement

CANT Cantilever
CB Catch basin, corner bar
CC Center-to-center
CF Counterfort
CHK Check
CIP Cast-in-place
CJ Construction joint
CL, CLR Clear
CMU Concrete masonry unit
COL(S) Column(s)
CONC Concrete
CONST Construction
CONT Continuous
CONTR Contractor
CONTR JT Contraction joint
COR Corner
CTRD Centered
CY Cubic yard

D10 Deformed wire, 0.10 in.^{2} area
DBL Double
DET Detail
DETLR Detailer
DIA Diameter
DIAF Diaphragm
DIAG Diagonal
DIR Direction
DIST Distance, distribution
DWG Drawing
DWL Dowel

E East
E, EC, EPOX Epoxy-coated
EA Each
EE Each end
EF Each face

EJ, EXP JT	Expansion joint
EL, ELEV	Elevation, elevator
EQ	Equal, equation
EQUIV	Equivalent
EST	Estimate
EW	Each way
EXIST	Existing
EXP	Expansion
EXT	Extend, exterior
FDN, FNDN	Foundation
FF	Far face
FIG	Figure
FIN	Finish
FL	Floor
FS	Far side
FT	Feet, foot
FTG	Footing
GA	Gage
GALV	Galvanized
GC	General contractor
GR	Grade
HK	Hook
H, HOR, HORIZ, HZ	Horizontal
HP	High point
HT	Height
ID	Inside diameter
IF	Inside face
IN	Inch, inches
INCL	Include
INS	Inside
INT	Interior
JST	Joist
JT	Joint
KIP	Thousand pounds
LB	Pound
LF	Linear feet
LGTH	Length
LIN	Linear
LOC	Location
LONGIT	Longitudinal
LP	Low point
LT	Left
LW	Long way
MAX	Maximum
MH	Manhole
MID	Middle
MIN	Minimum
MK	Mark
MP	Midpoint
N	North
NF	Near face
NIC	Not in contract
NO	Number
NOM	Nominal
NS	Near side
NTS	Not to scale
OC	On center
OD	Outside diameter
OF	Outside face
OPNG	Opening
OPP	Opposite
PC	Precast
PCP	Precast-concrete panels
PCS	Pieces
PI	Point of inflection, point of intersection
PIP	Poured-in-place
PL	Plain bar, plate
PR	Pair
PROJ	Project
PT	Point
PVMT	Pavement
QTY	Quantity
R	Radius
RC	Reinforced concrete
RD	Round
REBAR	Deformed reinforcing bar
REG	Register
REINF	Reinforcement
REQ	Require
RESTEEL	Plain bars used for reinforcement, reinforcing bar, wire, welded wire fabric
RET WALL, REV	Revision
RM	Room
RT	Right
RW	Retaining wall
S	South
SCHED	Schedule
SD	Storm drain
SECT	Section
SOG	Slab on ground
SP	Spiral
SPA	Space
SPCG	Spacing
SPCR	Spacer
SQ	Square
ST	Stair, step, stirrup, street
STA	Station
STD	Standard
STIR	Stirrup
STR	Straight
STRUCT	Structural, structures
SUPP	Support
SW	Short way
SYM	Symmetric
T	Top
TBL	Table
TC, TOC	Top of concrete, top of curb
TEMP	Temperature
TF, TOF	Top of footing
TOM	Top of masonry
TOS	Top of slab, top of steel
TOW, TW	Top of wall
TRANSV	Transverse
TYP	Typical
UNO, UON	Unless otherwise noted
UOS, USO	Unless otherwise shown
V, VERT, VT	Vertical
W 10	Plain wire, 0.10 in.^{2} area
W	West
WT	Weight
WWF	Welded wire fabric
X-SECT	Cross-section

CHAPTER 7—REFERENCES

7.1—Referenced standards and reports

The standards and reports listed below were the latest editions at the time this document was prepared. Because these documents are revised frequently, the reader is advised to contact the proper sponsoring group if it is desired to refer to the latest version.

American Association of State Highway and Transportation Officials

Standard Specifications for Highway Bridges

American Concrete Institute

117	Standard Specifications for Tolerances for Concrete Construction and Materials
201.2R	Guide to Durable Concrete
301	Specifications for Structural Concrete
315	Details and Detailing of Concrete Reinforcement
315R	Manual of Structural and Placing Drawings for Reinforced Concrete
318	Building Code Requirements for Structural Concrete
318M	Building Code Requirements for Structural Concrete (Metric)
343R	Analysis and Design of Reinforced Concrete Bridge Structures
345R	Guide for Concrete Highway Bridge Deck Construction
349	Code Requirements for Nuclear Safety Related Concrete Structures
359	Code for Concrete Reactor Vessels and Containments
408.1R	Suggested Development, Splice and Standard Hook Provisions for Deformed Bars in Tension

American Institute of Steel Construction

Manual of Steel Construction

American Society of Civil Engineers

ASCE 7 Minimum Design Loads for Buildings and Other Structures

American Welding Society

ANSI/AWS D1.4 Structural Welding Code—Reinforcing Steel

Association for Information and Image Management

Modern Drafting Techniques for Quality Microreproductions

ASTM International

A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
A 184/A 184M	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A 185	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 496	Specification for Steel Wire, Deformed, for Concrete Reinforcement
A 497	Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
A 615/ A 615M	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 706/ A 706M	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
A 767/ A 767M	Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 775/ A 775M	Specification for Epoxy-Coated Reinforcing Steel Bars
A 884/ A 884M	Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
A 934/ A 934M	Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
A 996/ A 996M	Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

Building Seismic Safety Council

NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings

Concrete Reinforcing Steel Institute

Manual of Standard Practice
Placing Reinforcing Bars
Reinforcement Anchorages and Splices

International Conference of Building Officials

Uniform Building Code

Steel Joist Institute

Standard Specifications and Load Tables

Wire Reinforcement Institute

Manual of Standard Practice—Structural Welded Wire Reinforcement

These documents may be obtained from the following organizations:

American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249
Washington, D.C. 20001
Tel: (202) 624-5800
Fax: (202) 624-5806
www.aashto.org

American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333
Tel: (248) 848-3700
Fax: (248) 848-3701
www.concrete.org

American Institute of Steel Construction
One E. Wacker Dr., Ste 3100
Chicago, IL 60601
Tel: (312) 670-2400
Fax: (312) 670-5403
www.aisc.org

American Railway Engineering and Maintenance-Of-Way Association
8201 Corporate Drive, Suite 1125
Landover, MD 20785
Tel: (301) 459-3200
Fax: (301) 459-8077
www.arema.net

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191
Tel: (703) 295-6000
Fax: (703) 295-6222
www.asce.org

American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126
Tel: (305) 443-9353
Fax: (305) 443-7559
www.aws.org

Association for Information and Image Management
1100 Wayne Avenue, Suite 1100
Silver Springs, MD 20910
Tel: (301) 587-8202
Fax: (301) 587-2711
www.aiim.org

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428
Tel: (610) 832-9500
Fax: (610) 832-9555
www.astm.org

Building Seismic Safety Council
1090 Vermont Avenue
Washington, D.C. 20005
Tel: (202) 289-7800
Fax: (202) 289-1092
www.nibs.org/bsschome.htm

Concrete Reinforcing Steel Institute
933 North Plum Grove Road
Schaumburg, IL 60173
Tel: (847) 517-1200
Fax: (847) 517-1206
www.crsi.org

International Conference of Building Officials
5360 South Workman Mill Road
Whittier, CA 90601
Tel: (562) 699-0541
Fax: (562) 699-8031
www.icbo.org

Steel Joist Institute
3127 10th Ave. N
Myrtle Beach, SC 29577
Tel: (843) 626-1995
Fax: (843) 626-5565
www.steeljoist.org

Wire Reinforcement Institute
301 East Sandusky Street
Findlay, OH 45840
Tel: (419) 425-9473
Fax: (419) 425-5741
www.bright.net/~wwri

INDEX