Bridge Design Details 7.1 October 2025

Bent

The BENT (PIER) LAYOUT and BENT (PIER) DETAIL sheets provide specific details for the bridge bents and piers. By definition, bridge supports can only be labeled as PIERS if a span crosses a waterway. By default, it is assumed that if any span of a bridge crosses a waterway, all supports except the abutments will be called piers.

Plan

1. Place at top, left side of sheet, oriented looking ahead on stationing or ahead on bent numbering; with the front side facing down and the centerline of bent horizontal.
2. The minimum scale is ¼" = 1'-0". Reinforcement may be shown in this view at this scale.
3. Show the same District layout line used on FOUNDATION PLAN. Do not repeat layout stations, bearings, skews, or dimensions shown elsewhere.
4. Show North arrow.
5. Show bearing pads, limits of level bearing area, expanded polystyrene, and expansion joint filler details.
6. Show reference lines (usually Centerline of Column or Centerline of Bridge) that are parallel to girders for bar cutoffs and placement.
7. Show a few stirrups at ends of bent caps on skews, including partial or split stirrups at round or octagonal columns and at corners of bent caps, see 7-11 Bent Cap Stirrup Reinforcement (Vertical Exterior Girders) and 7-12 Bent Cap Stirrup Reinforcement (Sloping Exterior Girders).
8. Show deck drains and details of reinforcement around drains.
9. Show centerline and outline of edges of utility and future utility openings, see Standard Plan: B6-10 Utility Openings T-Beam and Standard Plan: B7-10 Utility Openings Box Girder.
10. Avoid showing outline of girders and deck reinforcement.

Elevation

1. Place below PLAN view, projected from face of bent cap for skewed bents. Length of ELEVATION should match the length along the layout line at centerline of bent (NOTE: For skewed structures, the skewed length is longer than the width of the bridge normal to the bridge layout line).
2. Show finished grade and use solid lines for portions of structure below grade.

3. Use the same scale as PLAN view. Reinforcement may be shown in this view at this scale.
4. Show all footings and a few footing reinforcing bars to identify locations of column pins or bars in footing mats, see 7-2 Footing Reinforcement. Give footing elevations only if they are not shown on FOUNDATION PLAN.
5. Do not show all piles (NOTE: All piles not shown). Give pile cut-off elevations only if they are not shown on PILE DATA TABLE.
6. Show seal course, see 7-4 Structure Excavation (Type A) with Seal Course.
7. Show column geometries in ELEVATION or in a separate detail for "ARCHITECTURAL COLUMNS" or "COLUMN GEOMETRICS" detail.
8. Show deck overhang reinforcement and some column and flare reinforcement. Column and flare reinforcement include vertical bars and hoops.
9. Show cap stirrup spacing taken along centerline of bent with special stirrup details and spacing at columns or corners of skewed bents.
10. Show locations of all columns and bent cap SECTIONS.
11. Show new and future utilities; detail reinforcement around openings, see Standard Plan: B6-10 Utility Openings T-Beam and Standard Plan: B7-10 Utility Openings Box Girder.
12. Show locations deck drains, and pipes in bent cap and columns.
13. Show locations and details for bearing pads.
14. Do not show girders.

Footing Plan

1. Preferred scale ¼" = 1'-0". Reinforcement may be shown in this view at this scale.
2. Show all footings. Typically, one FOOTING PLAN provides pile layouts and another provides reinforcement details. Do not re-detail similar footings (NOTE: Details symmetric about centerline of footing. For details not shown, see "…").
3. Show complete pile layouts. Locate piles from centerline of column, which typically should equal centerline footing. Show centerline bent and footing.
4. Do not show layout information and dimensions that are shown on FOUNDATION PLAN from District layout line.

Sections and Details

1. For general requirements, see 1.1 General Detailing - Detail Layout, Sections, and Views.

2. SECTIONS and DETAILS showing reinforcement should not be less than ⅜” = 1’-0” scale; the preferred scale is ½” = 1’-0” minimum.
3. If main reinforcement cannot be shown in PLAN, show a PART PLAN of bent cap.
4. If non-standard concrete piles are used, include PILE DETAIL and SECTION that shows limits of payment and typical reinforcement. Otherwise, reference Standard Plans for details.

Bent Cap Section

1. Multiple sections may be needed for sections between and at columns.
2. Show main reinforcement, stirrups, and construction bars.
3. Show clearance to main cap reinforcing. Use outside deformation diameter to assure that deck clearance can be maintained, see 13 Reinforcement, for rebar dimensions.

Column Section

1. Use the same scale as BENT CAP SECTION.
2. Several sections may be needed for architectural columns, pinned column base, and variable bar patterns.

Figure 7A.A.1 Detailing Example 1

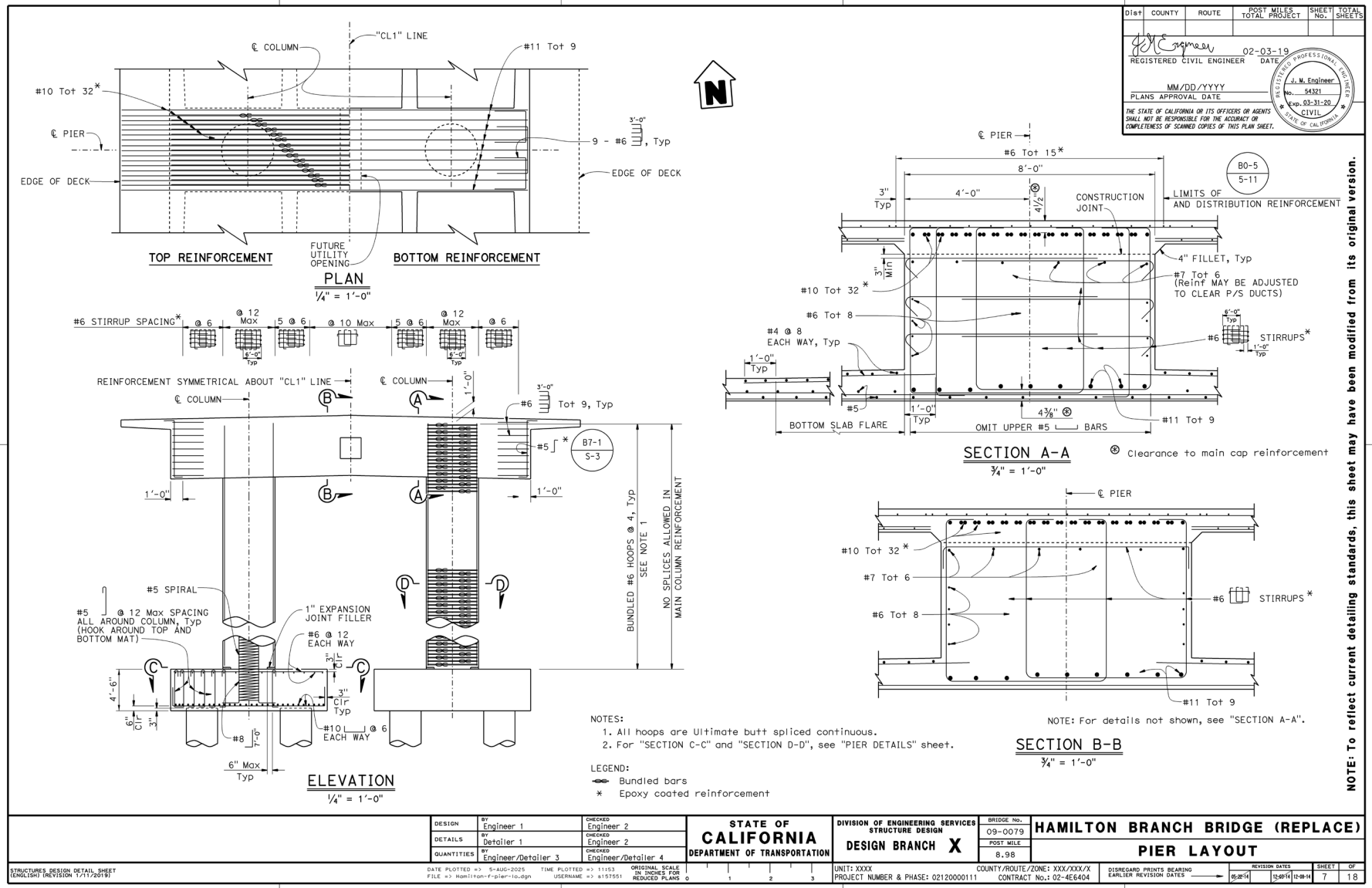


Figure 7A.A.2 Detailing Example 2

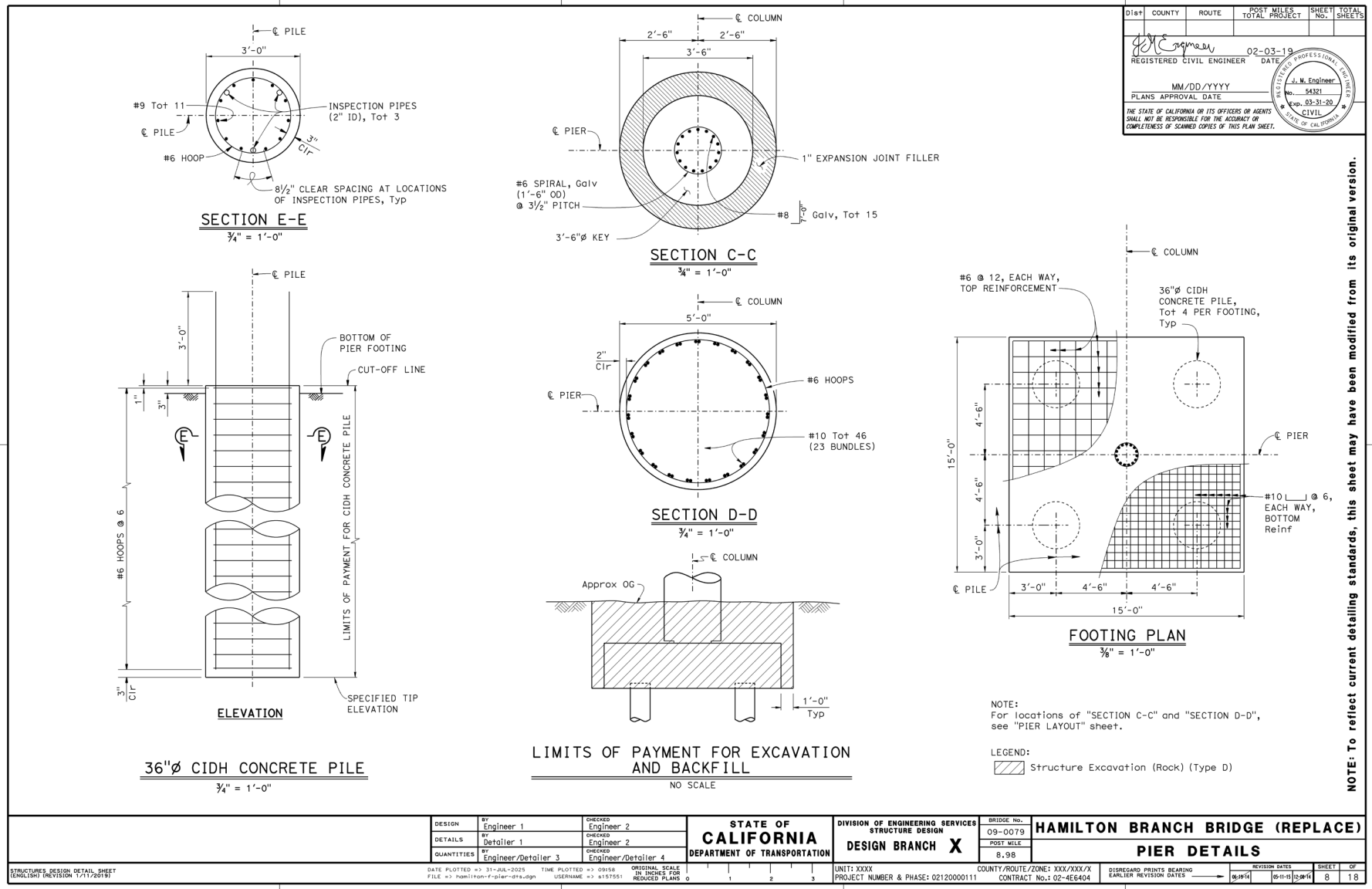


Figure 7A.A.3 Detailing Example 3

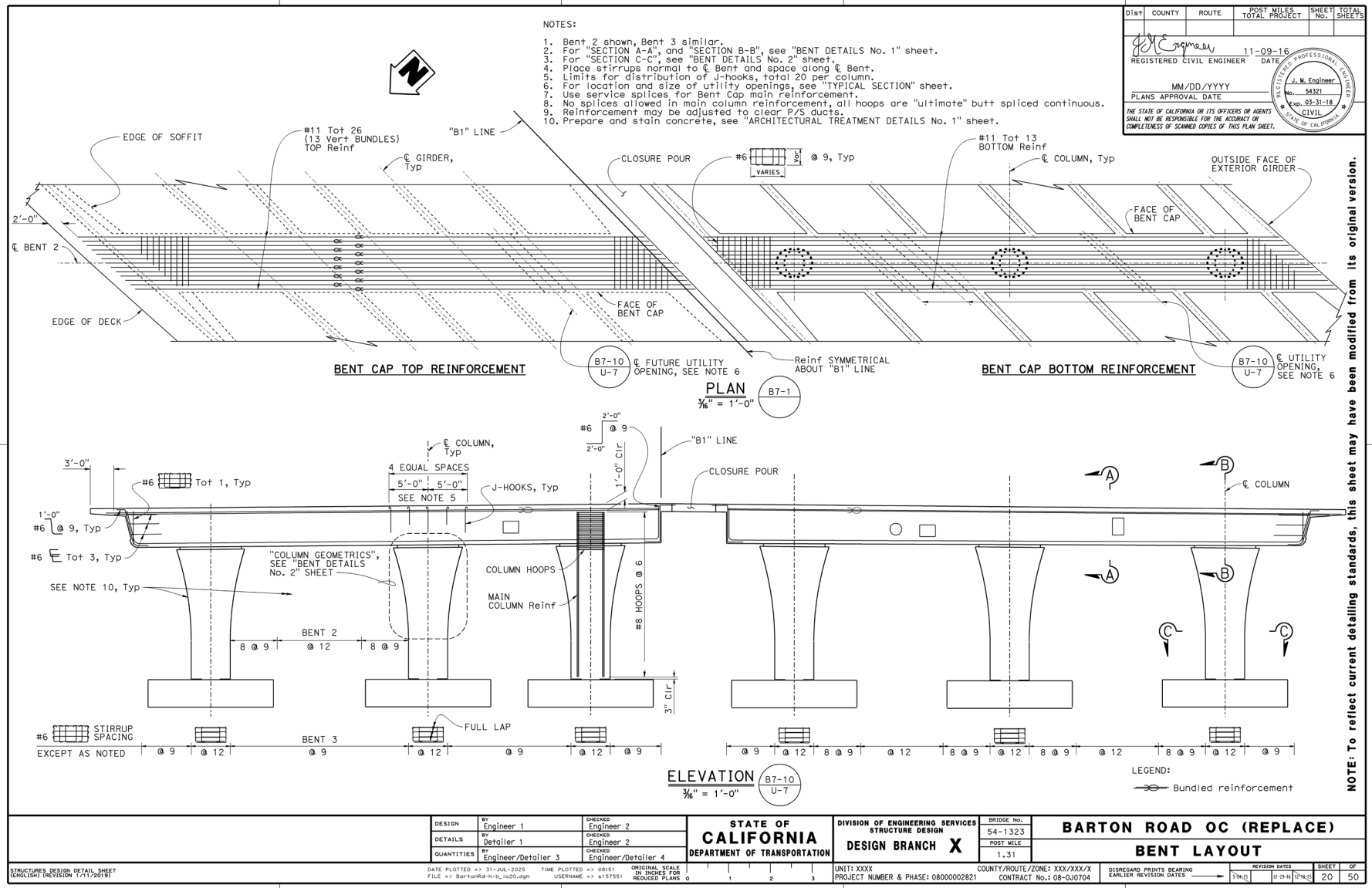


Figure 7A.A.4 Detailing Example 4

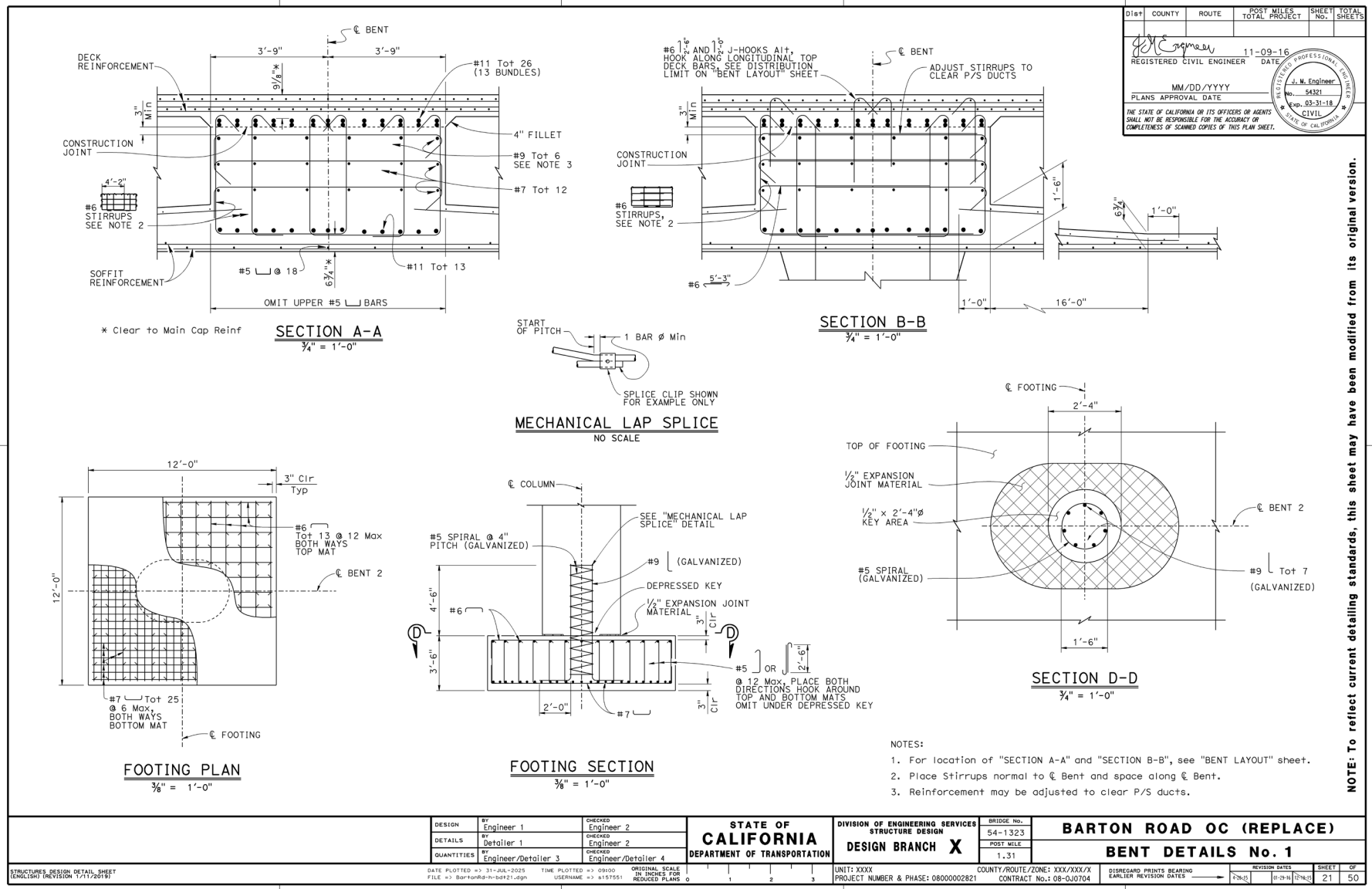


Figure 7A.A.5 Detailing Example 5

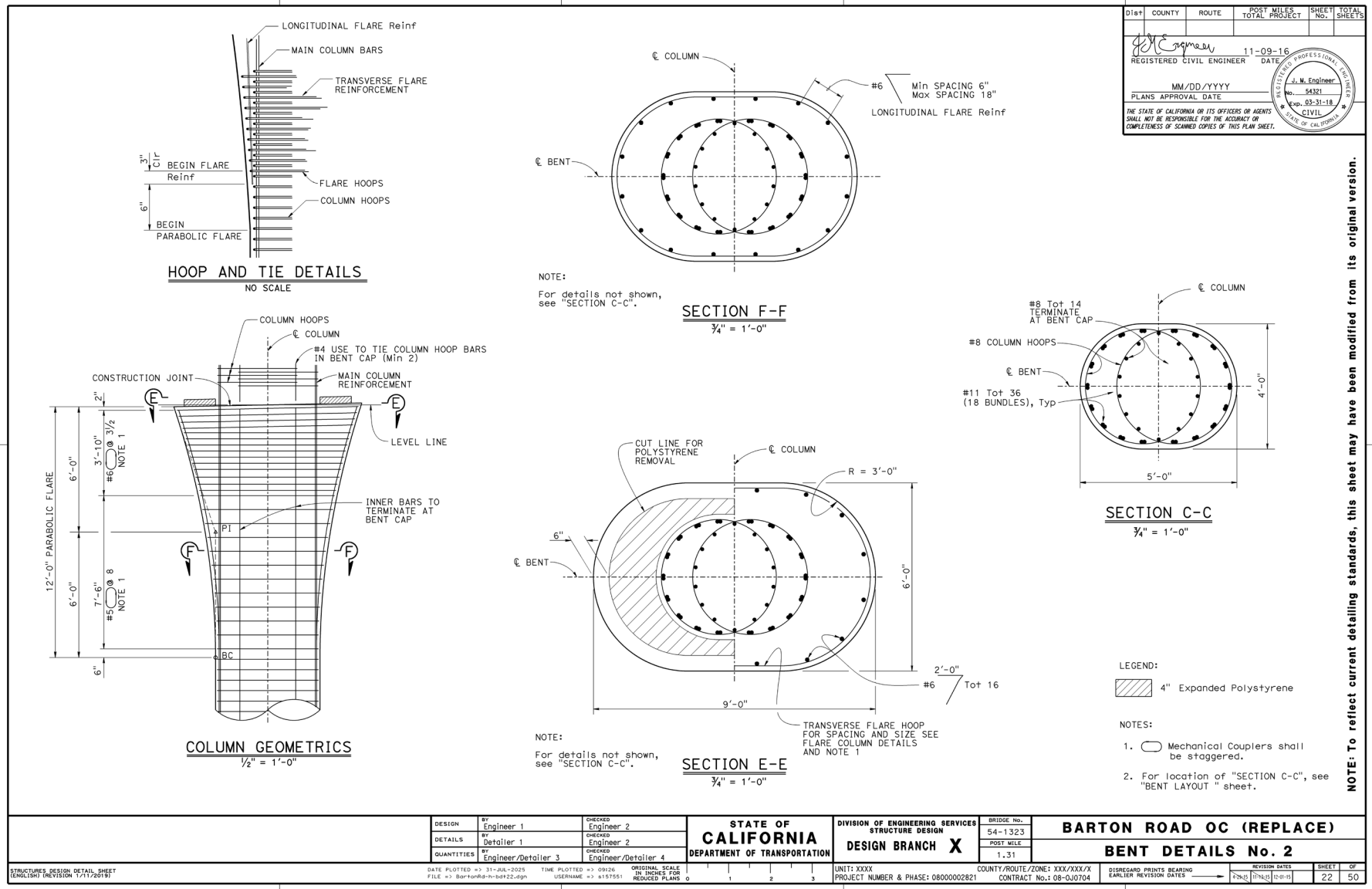


Figure 7A.A.6 Detailing Example 6

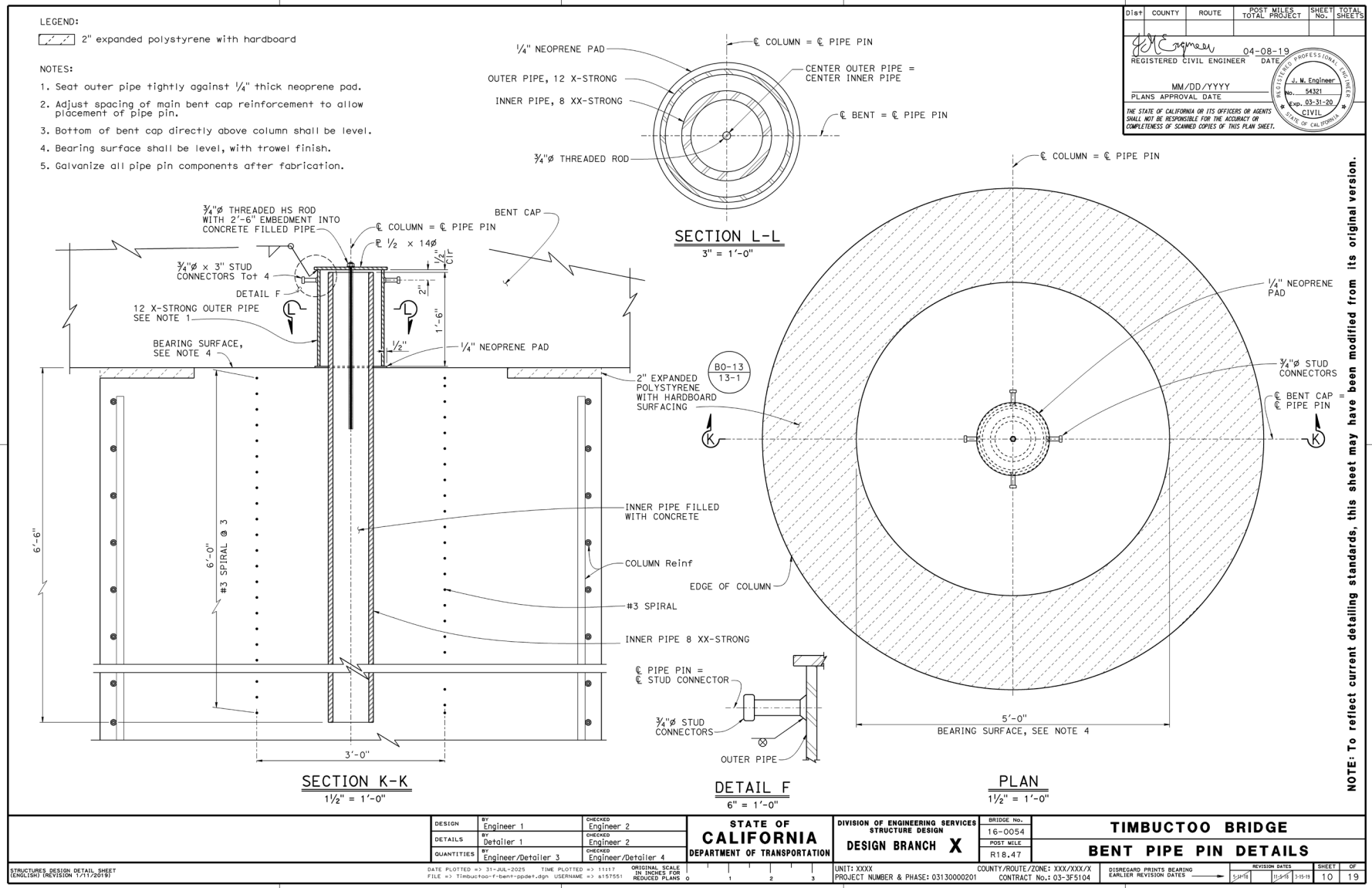


Figure 7A.A.7 Detailing Example 7

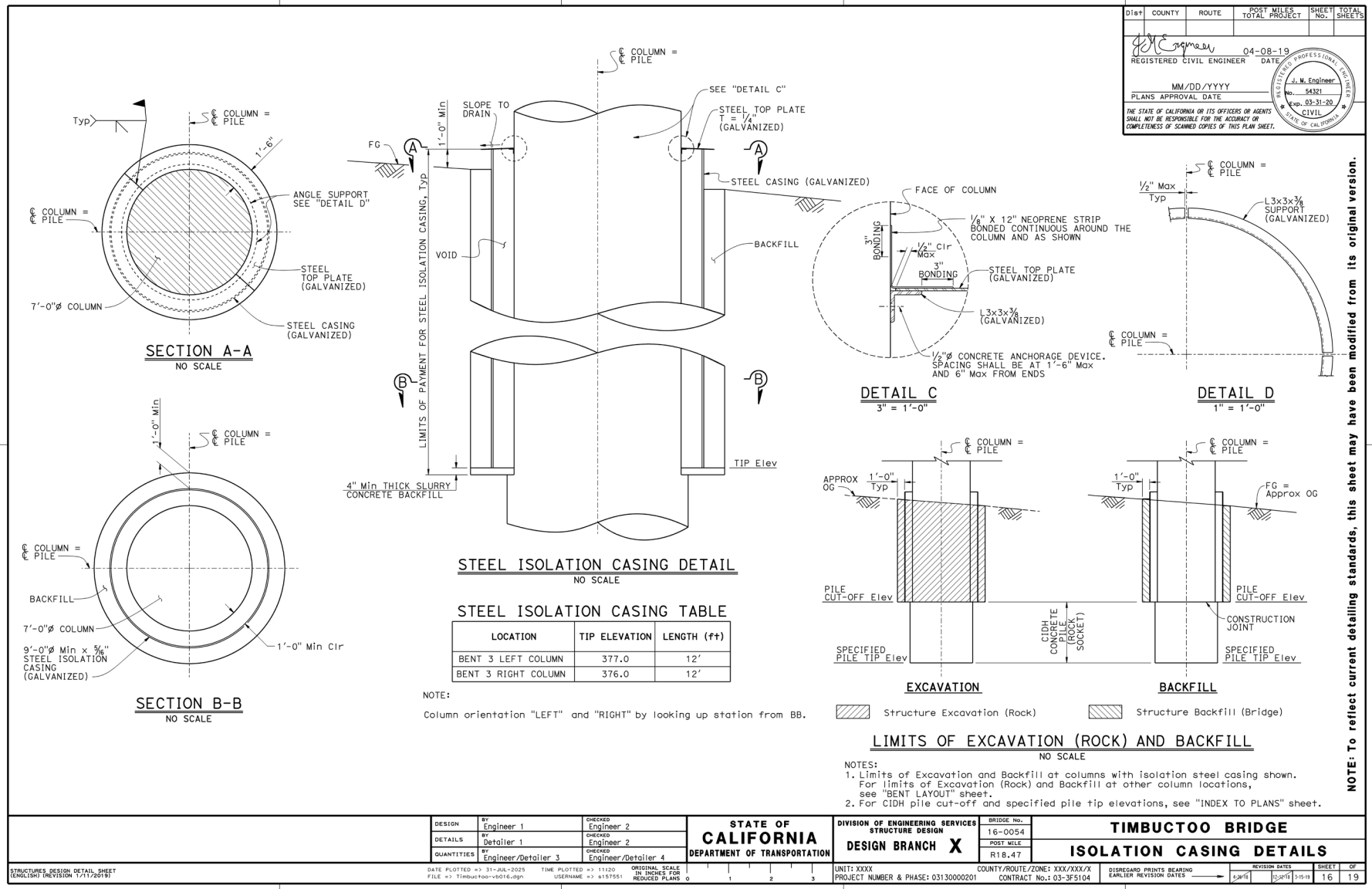


Figure 7A.A.8 Detailing Example 8

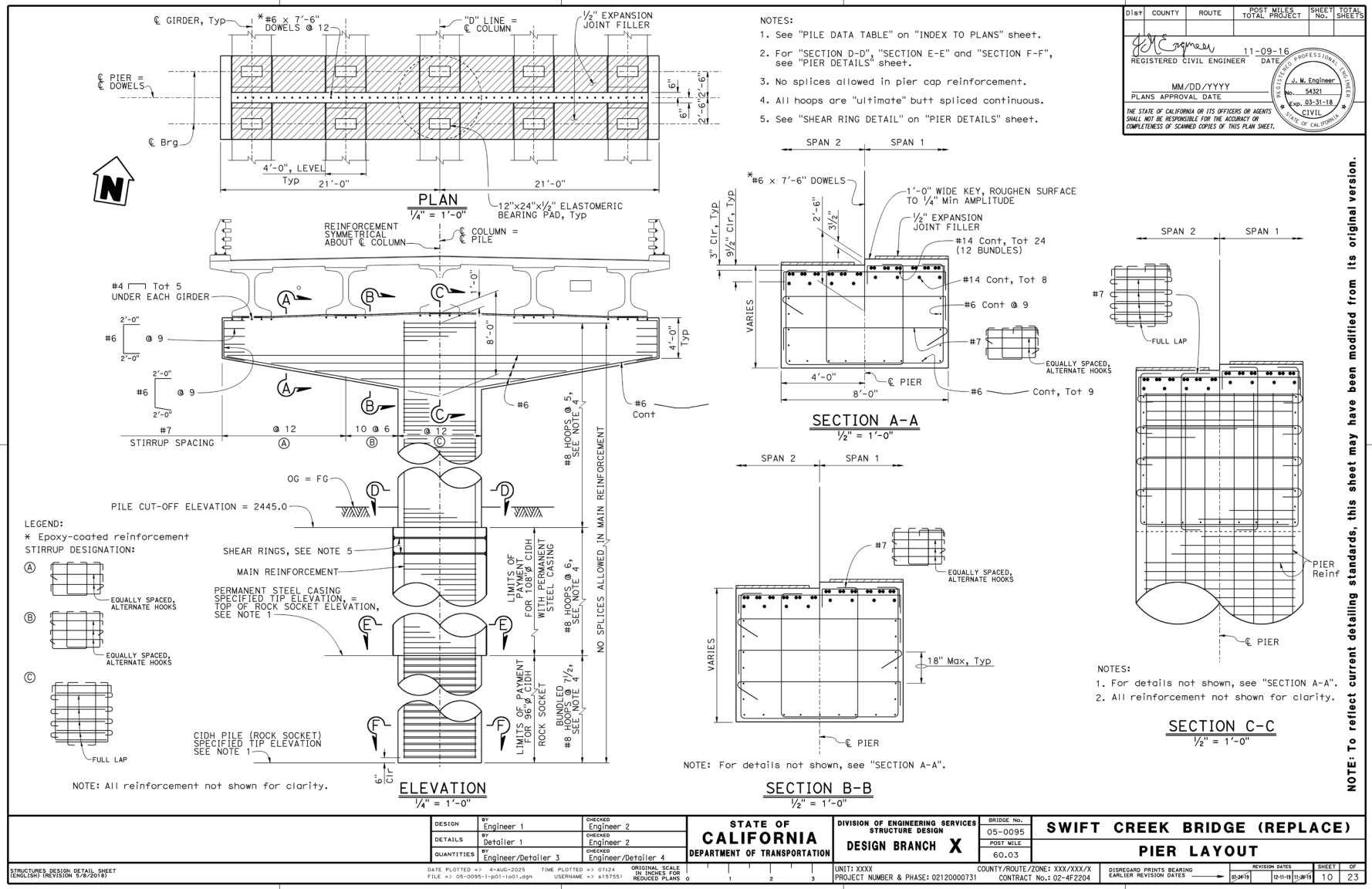


Figure 7A.A.9 Detailing Example 9

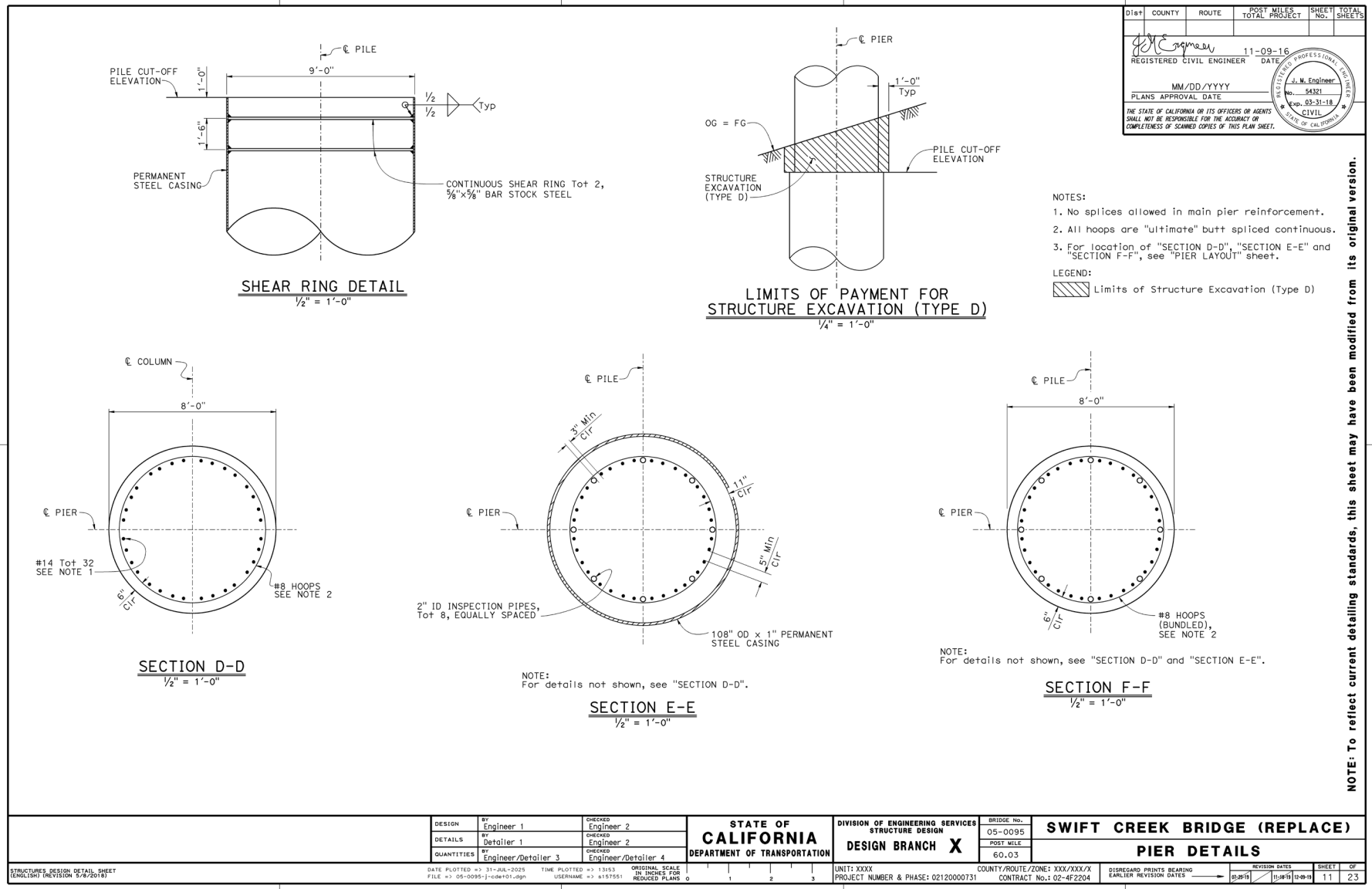


Figure 7A.A.10 Detailing Example 10

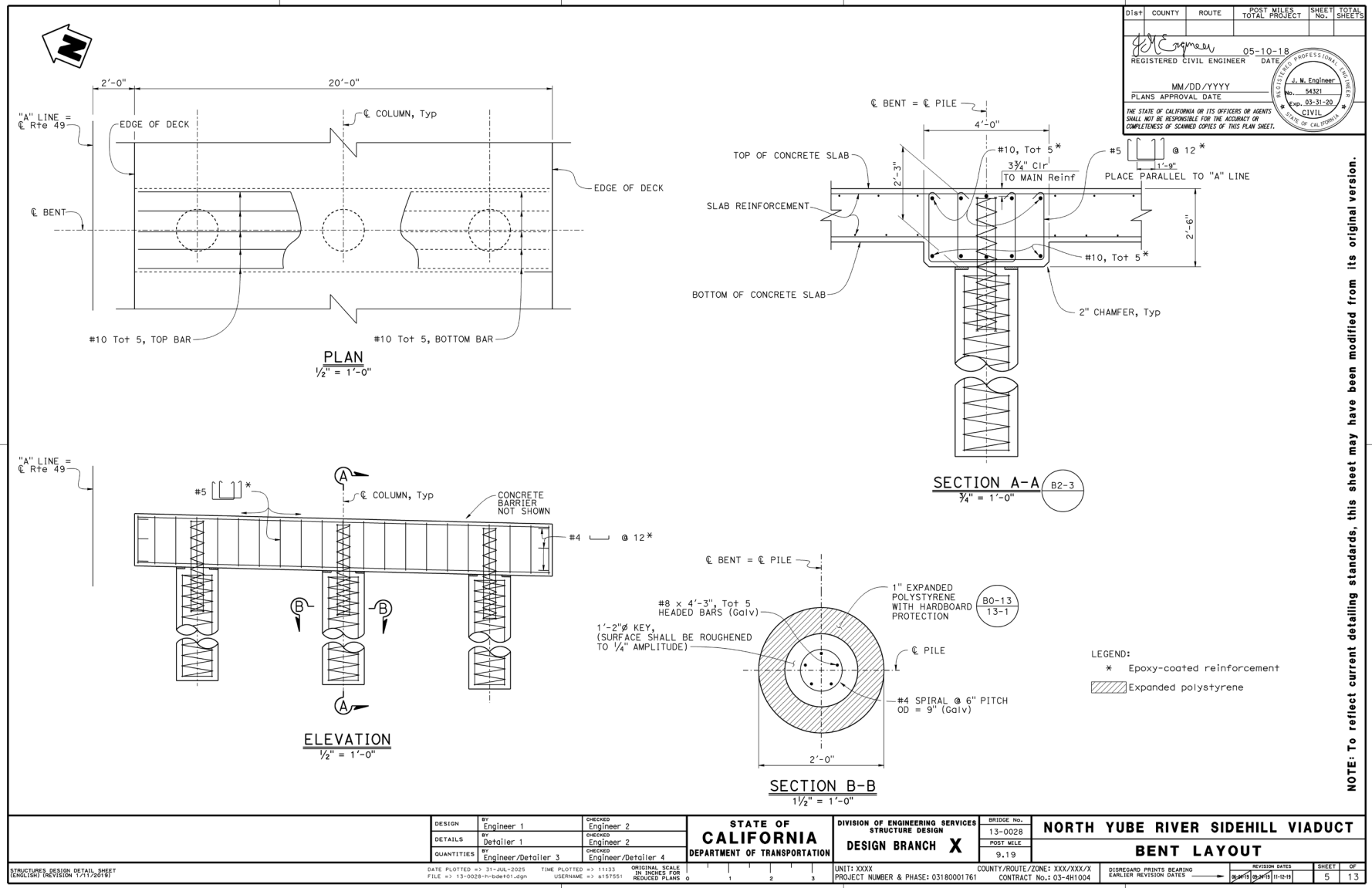


Figure 7A.A.11 Detailing Example11

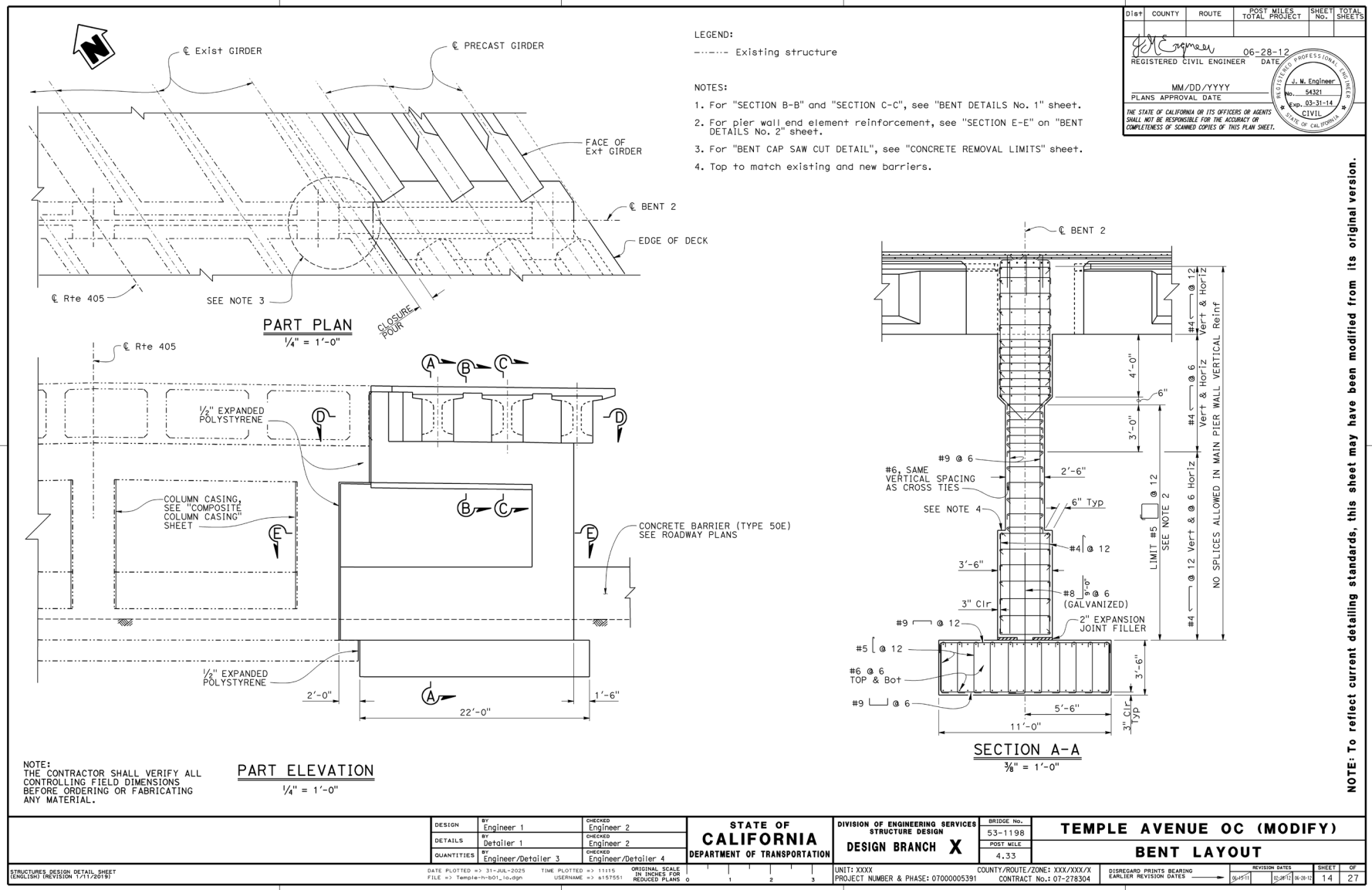


Figure 7A.A.12 Detailing Example 12

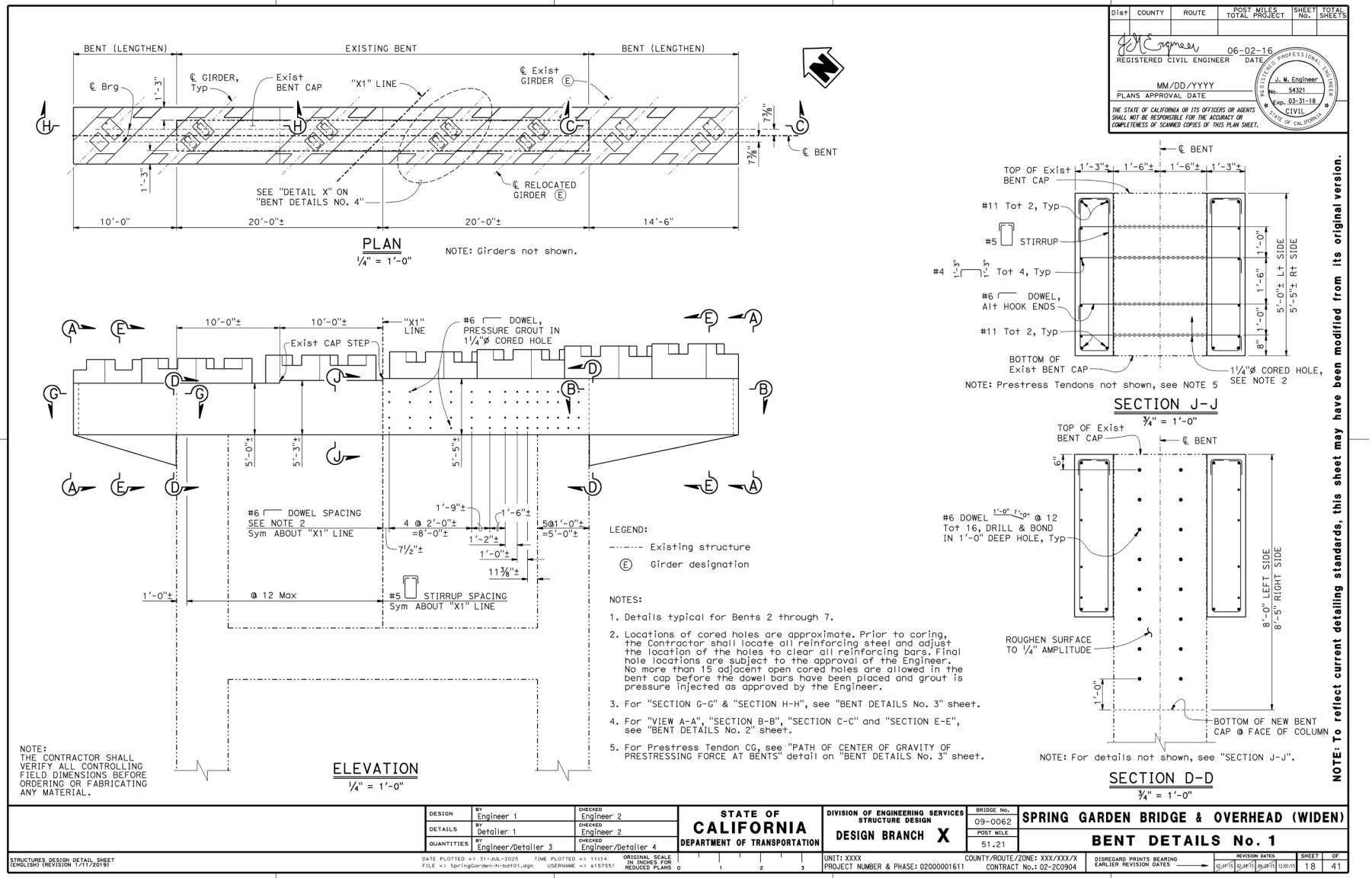


Figure 7A.A.13 Detailing Example 13

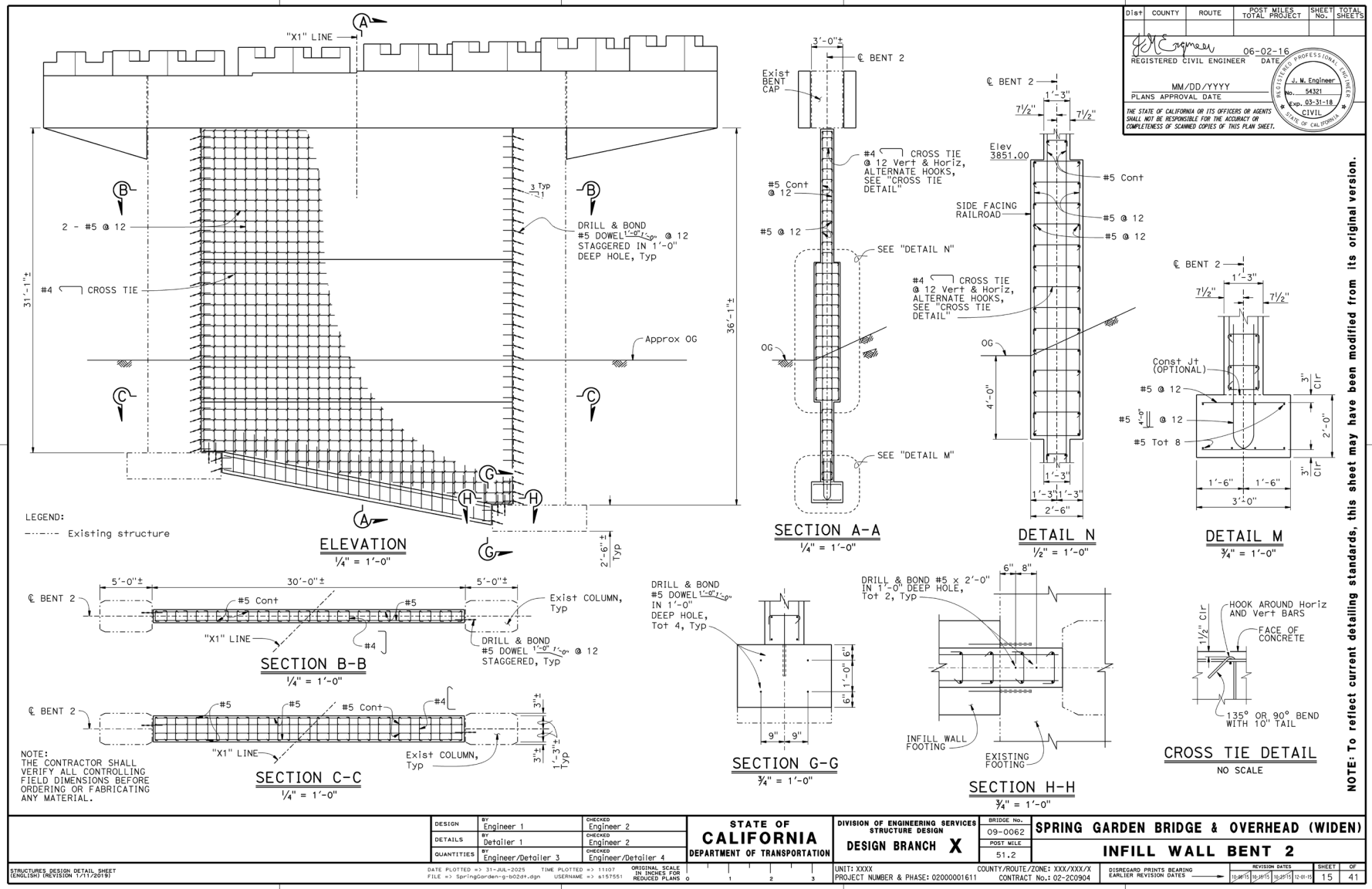
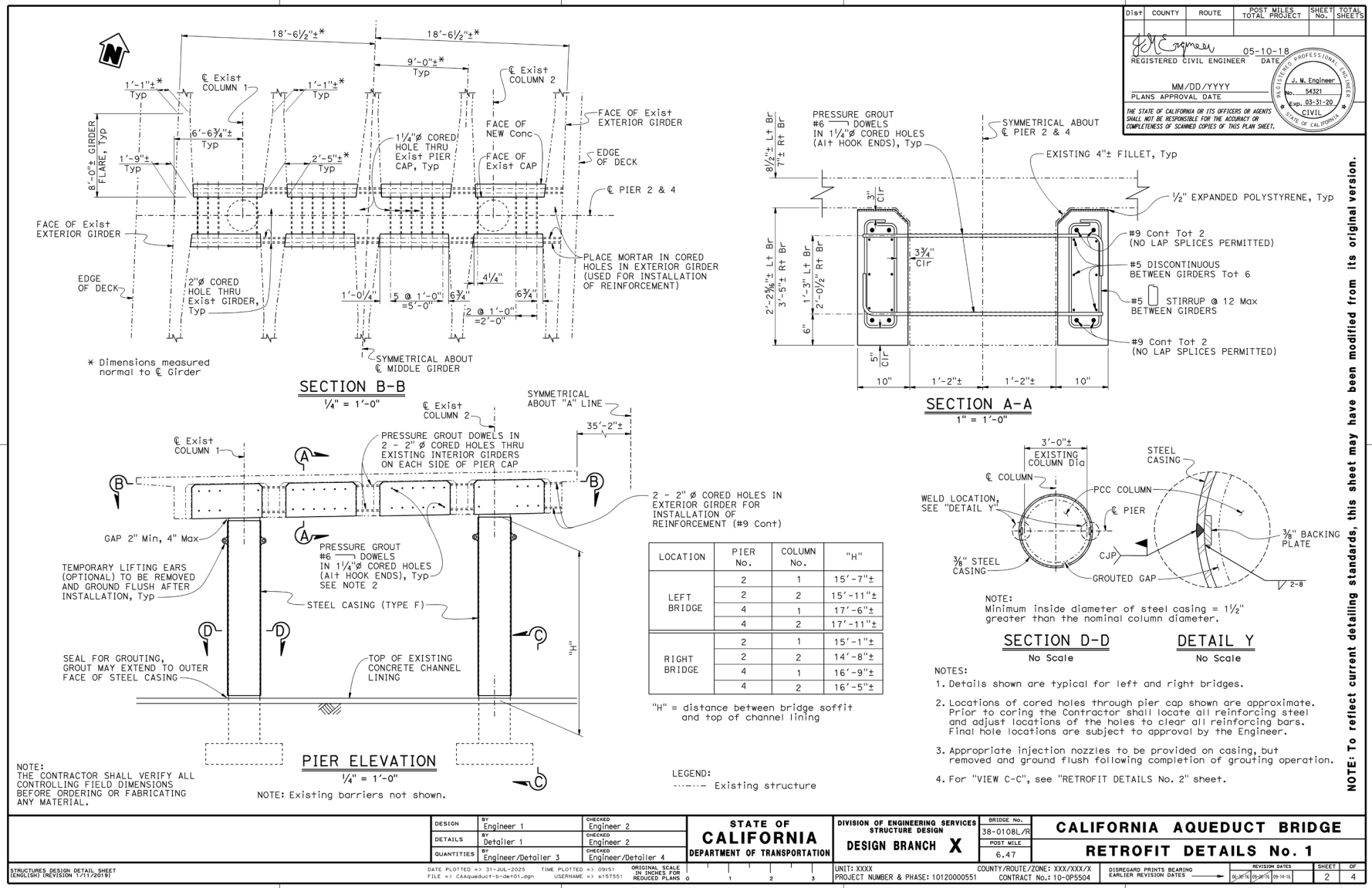


Figure 7A.A.14 Detailing Example 14



LOCATION	PIER No.	COLUMN No.	"H"
LEFT BRIDGE	2	1	15'-7"±
	2	2	15'-11"±
	4	1	17'-6"±
	4	2	17'-11"±
RIGHT BRIDGE	2	1	15'-1"±
	2	2	14'-8"±
	4	1	16'-9"±
	4	2	16'-5"±

Bridge Design Details 7.2 August 2025

Footing Reinforcement

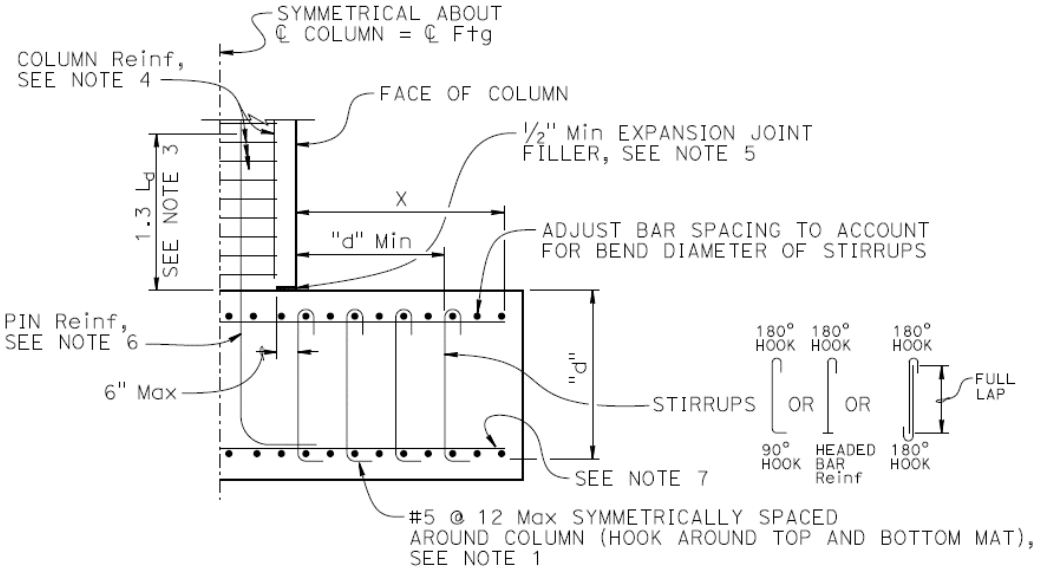


Figure 7.2.1 Footing Reinforcement Pinned Column (see also *Seismic Design Criteria* Figure C6.2.2.5-1)

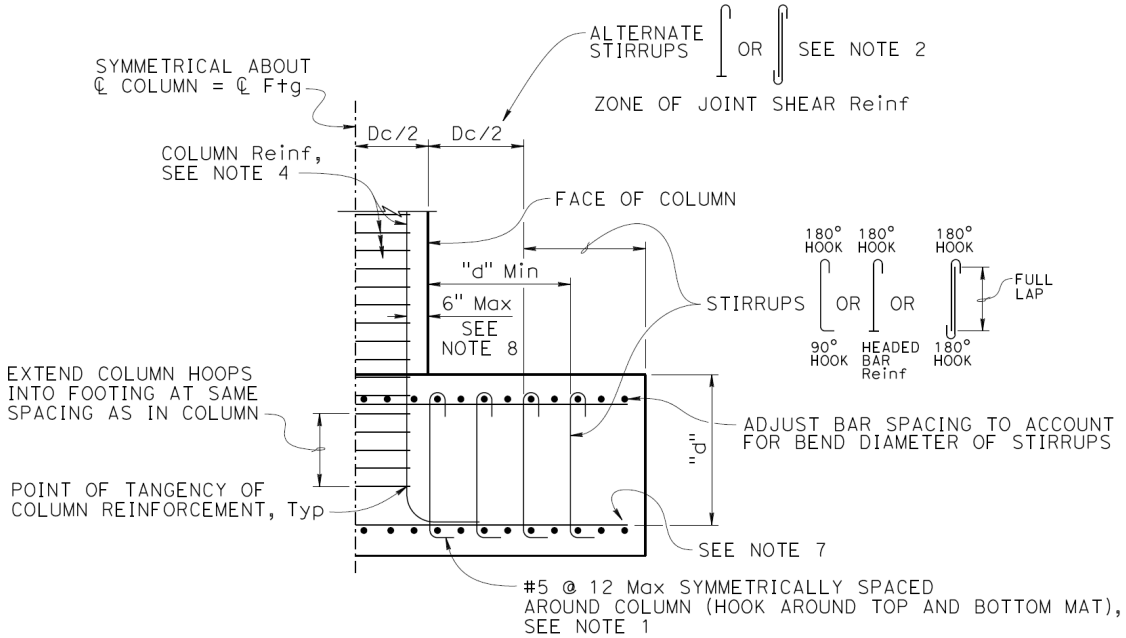


Figure 7.2.2 Footing Reinforcement Fixed Column (see also *Seismic Design Criteria* Figure C6.2.2.5-2)

Notes:

1. The minimum area of footing stirrups is shown, equivalent may be provided.
2. Alternate stirrups shall be used for Joint Shear if principal tension (P_t) > $3.50\sqrt{f'_c}$ (psi).
3. For minimum development length (L_d), see *AASHTO LRFD Bridge Design Specifications:* 5.10.8.2.1a Tension Development Length.
4. All column hoops shall be “ultimate” butt spliced continuous, see *Seismic Design Criteria 2.1*: 8.2.2 Reinforcement Splices in Seismic Critical Members.
5. The thickness of the expansion joint filler should allow for maximum column rotation and prevent crushing the edge of the column concrete against the footing. Minimum thickness should be ½".
6. When pinned columns are used for oblong columns having overlapping hoops, pin reinforcement must be detailed to clear the hoops. For minimum design requirements for column pin and key, see *Seismic Design Criteria 2.1:* 7.6.4 Column Key Design. Pinned reinforcement should be galvanized and enclosed with spirals.
7. Provide 90-degree hooks or headed bar reinforcement at ends of top and bottom mat reinforcement, where L_d > X or as required. End hooks are not typical.
8. When precast construction is used, the 6-inch maximum distance to the first footing stirrup shall be measured to face of corrugated metal pipe.
9. For minimum clearances and pile embedment dimensions, see 6.4 Pile Footings.

Column Pin Reinforcement

Pin dowels and spirals shall be galvanized.

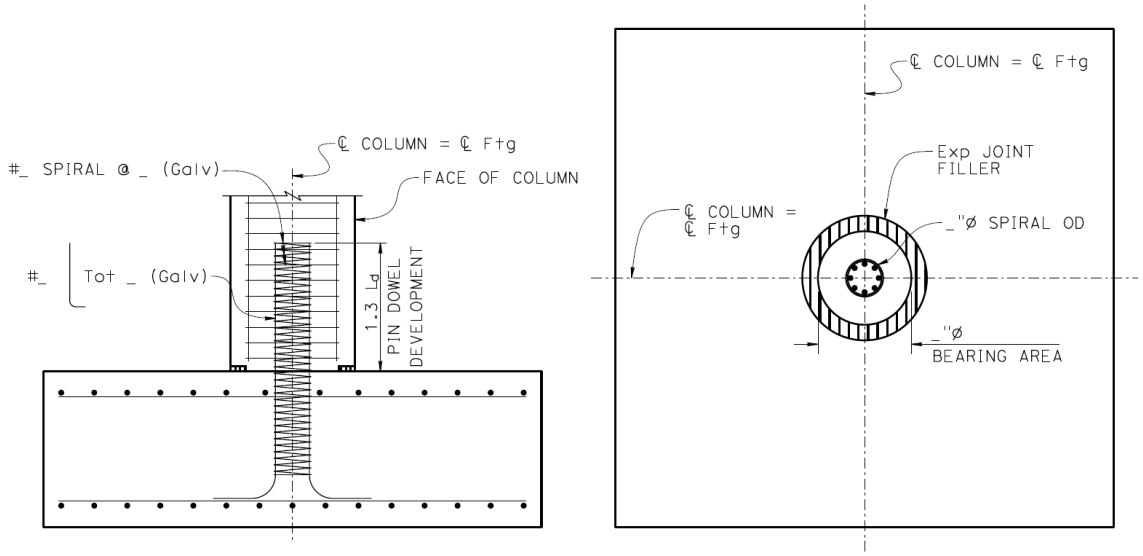


Figure 7.2.3 Column Pin Details

Bridge Design Details 7.3 August 2025

Column Earthwork

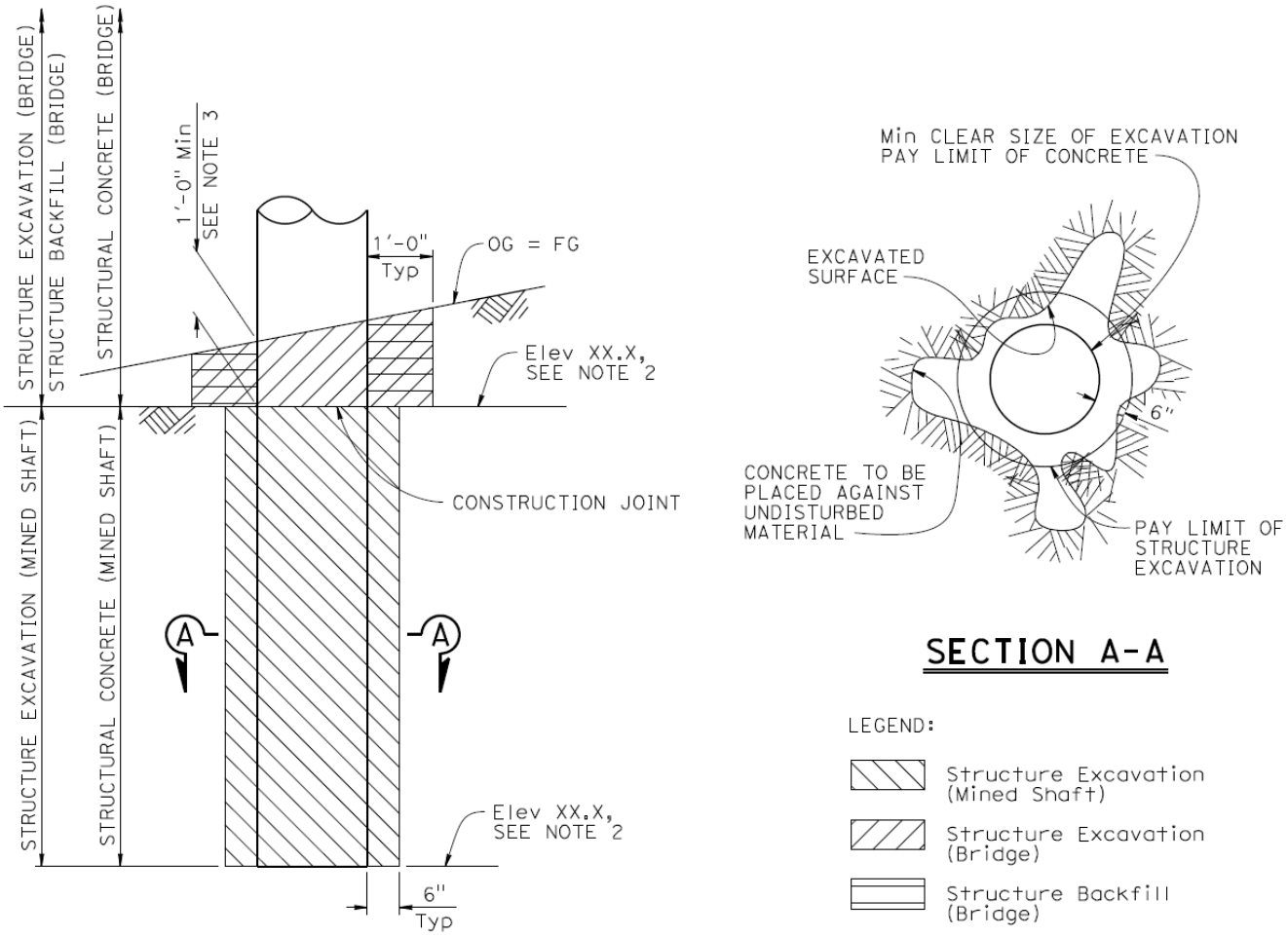


Figure 7.3.1 Hard Material Excavation

Notes:

1. Use STRUCTURE EXCAVATION (MINED SHAFT) item in hard material where excavation by blasting, mechanical, or chemical splitting of rock is needed.
2. Elevations provided are upper and lower limits of hard material excavation.
3. Optional construction joint is to be placed 1’-0” minimum below the Finish Grade.

Use STRUCTURE EXCAVATION (BRIDGE) for all excavation and STRUCTURE BACKFILL (BRIDGE) for all backfill above PILE CUT-OFF or BOTTOM OF FOOTING elevation in typical earthwork situations.

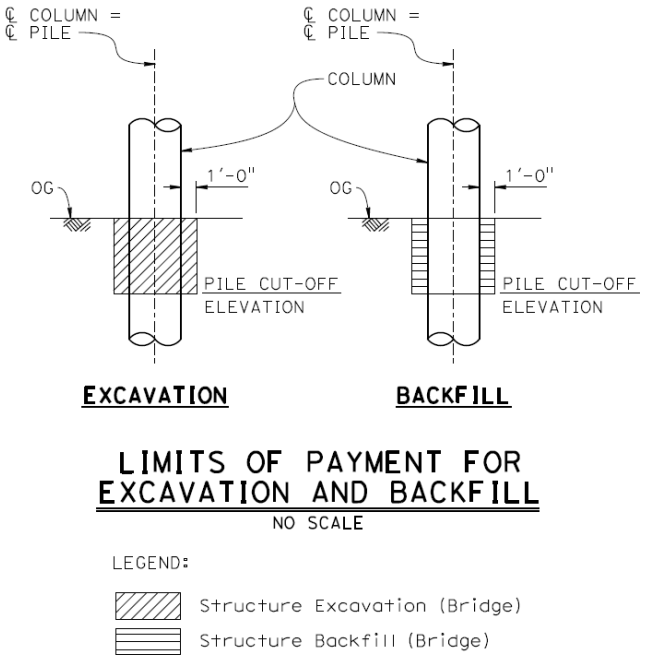


Figure 7.3.2 Pile Cut-Off Earthwork

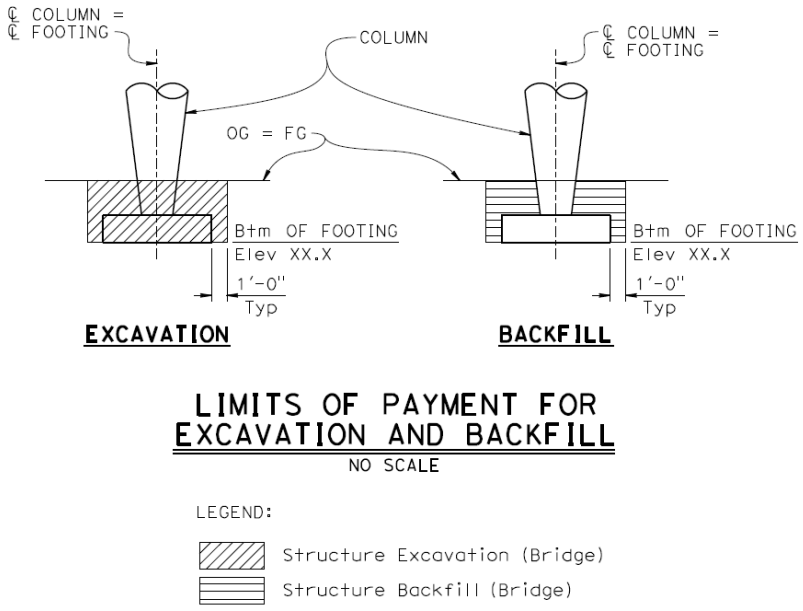


Figure 7.3.3 Bottom of Footing Earthwork

Bridge Design Details 7.4 August 2025

Structure Excavation (Type A) with Seal Course

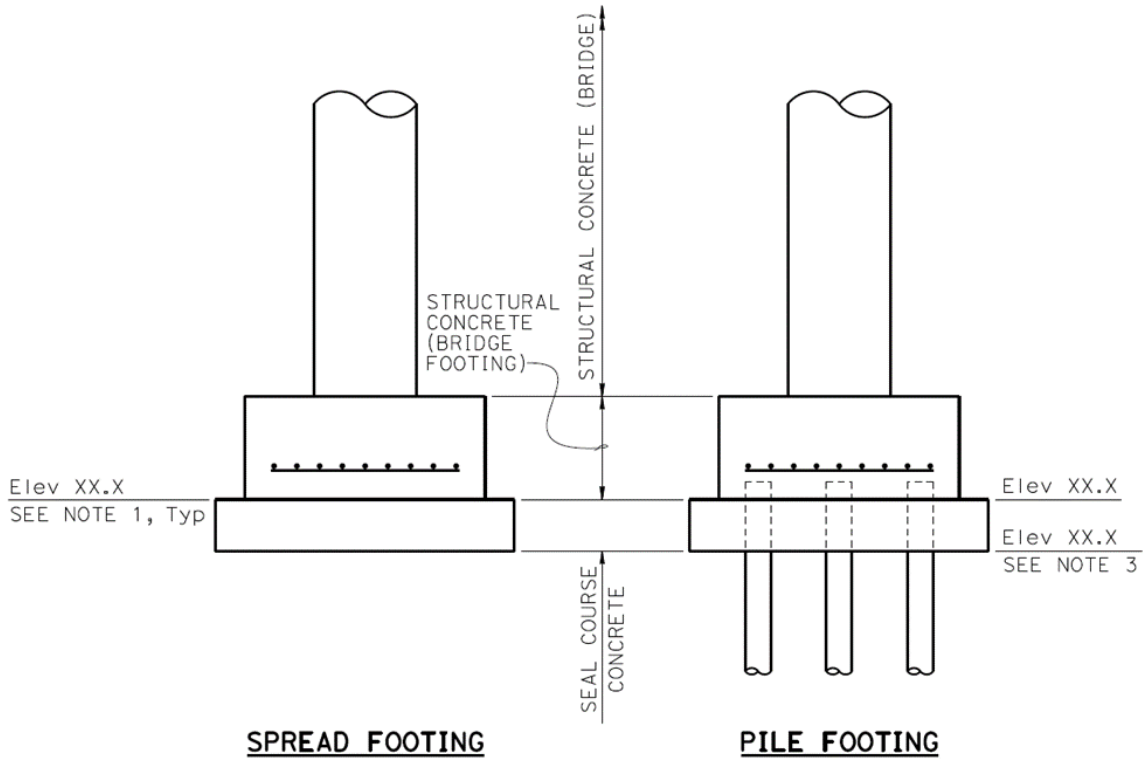


Figure 7.4.1 Footing with Seal Course

Notes:

1. When seal course is not used, the bottom of the footings shall be placed at the elevation shown on the FOUNDATION PLAN.
2. Seal course is placed only when ordered by the Engineer. Estimated quantities involved are based on the seal course thickness assumed during design and 1’-0” outside neat lines of footing. The thickness to be used will be determined in the field by the Engineer.
3. When pile footings are subject to critical scour, placing the elevation on the plans at the bottom of seal course is suggested.

Use STRUCTURE EXCAVATION (TYPE A) when seal course is required, and water is anticipated. Structure backfill is included in the cost for Type A excavation. Pay limits are defined in the Standard Specifications.

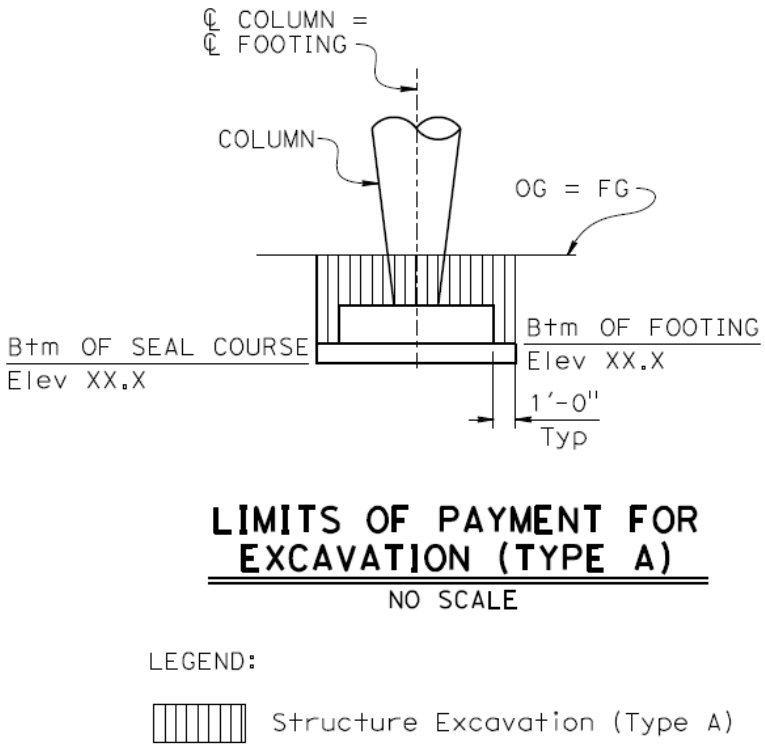


Figure 7.4.2 Structure Excavation (Type A)

Seal Course (CISS Piles)

If a Seal Course is required above soil plug inside a Cast-in-Steel-Shell (CISS) pile, it shall be shown in the pile details.

Example: The top of the soil plug elevation is at elevation 252.0 feet. A 5-foot seal course is required to counteract the hydrostatic forces of the groundwater and allow the concrete and pile reinforcement to be placed in dry conditions.

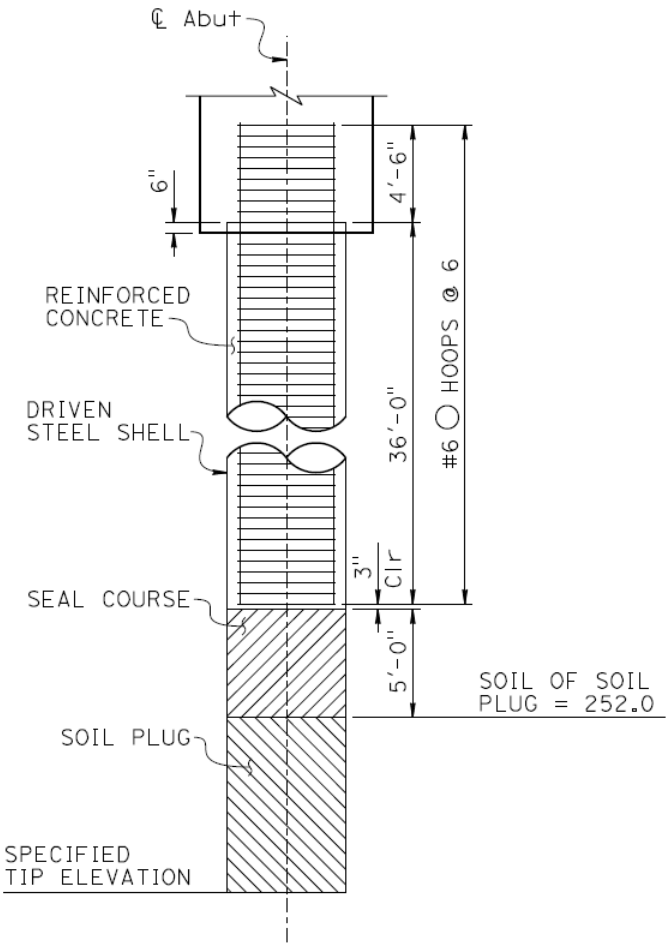


Figure 7.4.3 CISS Pile Seal Course

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Structure Excavation (Type D)

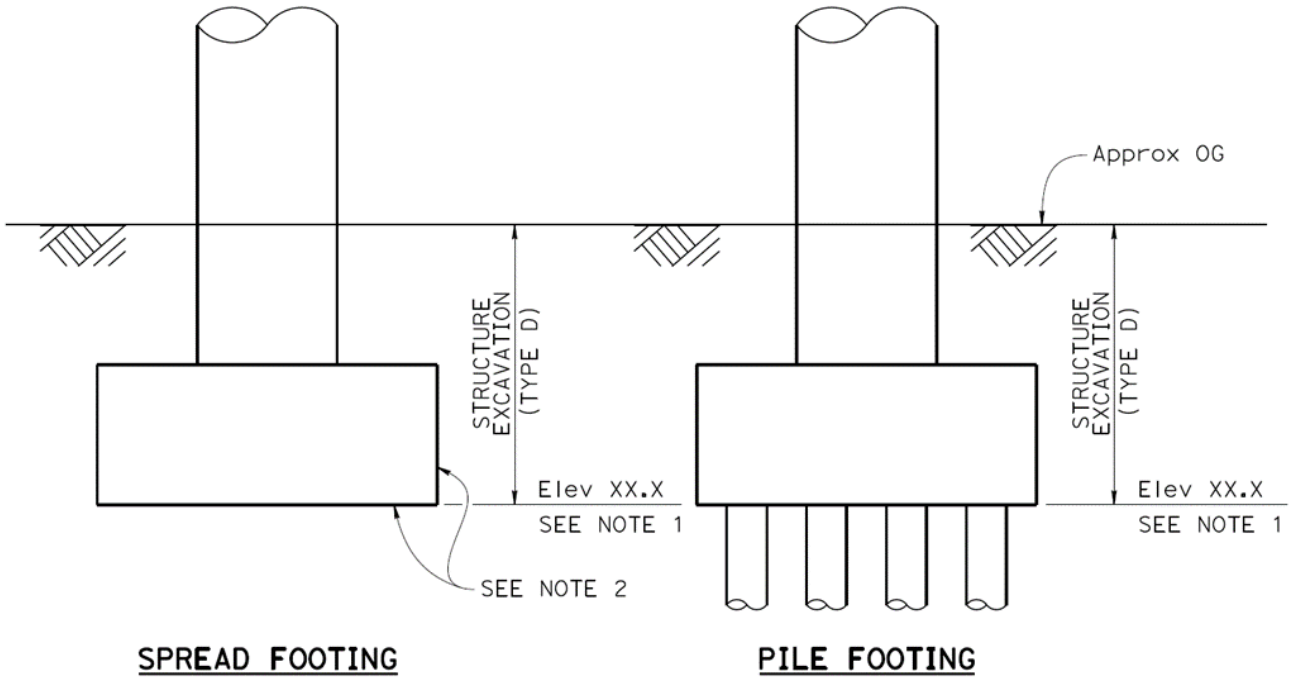

Figure 7.5.1 Footing without Seal Course

Notes:

1. Bottom of Footing Elevation should be shown on FOUNDATION PLAN.
2. Place footing concrete against undisturbed material. Pay limits are defined in the Standard Specifications.

Use STRUCTURE EXCAVATION (TYPE D) when wet conditions are possible, but no seal course is required or shown. Identify on the plans (e.g., NOTE: Structure Excavation (Type D) at Bent 3 only) or as delineated in Figure 7.5.1.

In cases where STRUCTURE EXCAVATION (TYPE D) is used at columns or piers, show excavation limits separately.

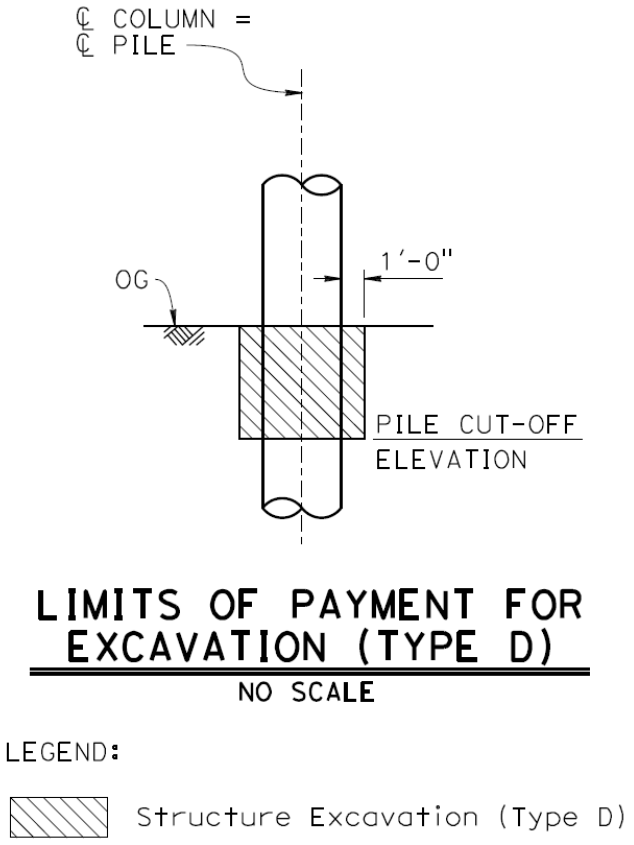

Figure 7.5.2 Structure Excavation (Type D)

Bridge Design Details 7.6 August 2025

Column Reinforcement

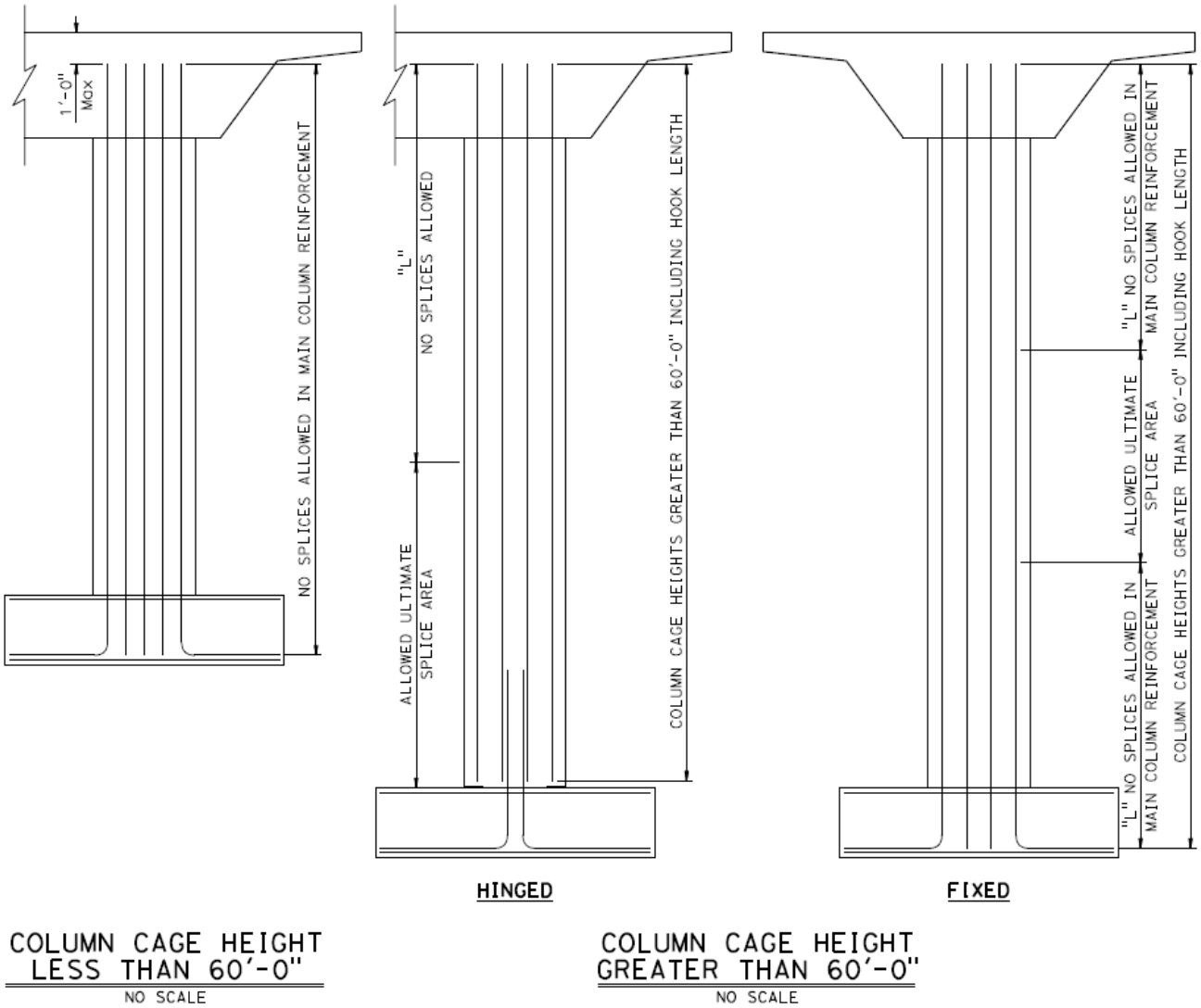

Figure 7.6.1 Column Cage Details

Notes:

1. “L” is to be determined by Engineer.
2. All hoops to have an “ultimate splice”. Hoops shall extend full length of column cage.
3. Vertical reinforcement shall be developed fully into bent cap, avoid using hooks at the top of column. Headed reinforcement may be used as an alternative.
4. Total length of unspliced column reinforcement shall not exceed 60 feet.

Hooks on Column Reinforcement

When necessary, column longitudinal reinforcement may be hooked into a bent cap or footing; sufficient space should be provided so that hooks do not interfere with other reinforcement or prestressing tendons. For basic hook development length (L_{dh}), see *AASHTO LRFD Bridge Design Specifications:* 5.10.8.2.4a Basic Hook Development Length. Reinforcement must also satisfy the development requirements and Joint Shear that is detailed in the current *Seismic Design Criteria 2.1*.

If reinforcement is not hooked and the development length (L_d) is not available, T-headed bar reinforcement should be used. For T-headed bar details, see *Memo to Designers:* 20-21 Seismic Requirements for Headed Bar Reinforcement.

Bridge Design Details 7.7 August 2025

Bent Cap Section Details (0º to 20º Skew)

Details of bent cap reinforcement for concrete Box Girders and T-Beams where deck reinforcement is placed **parallel** to skew.

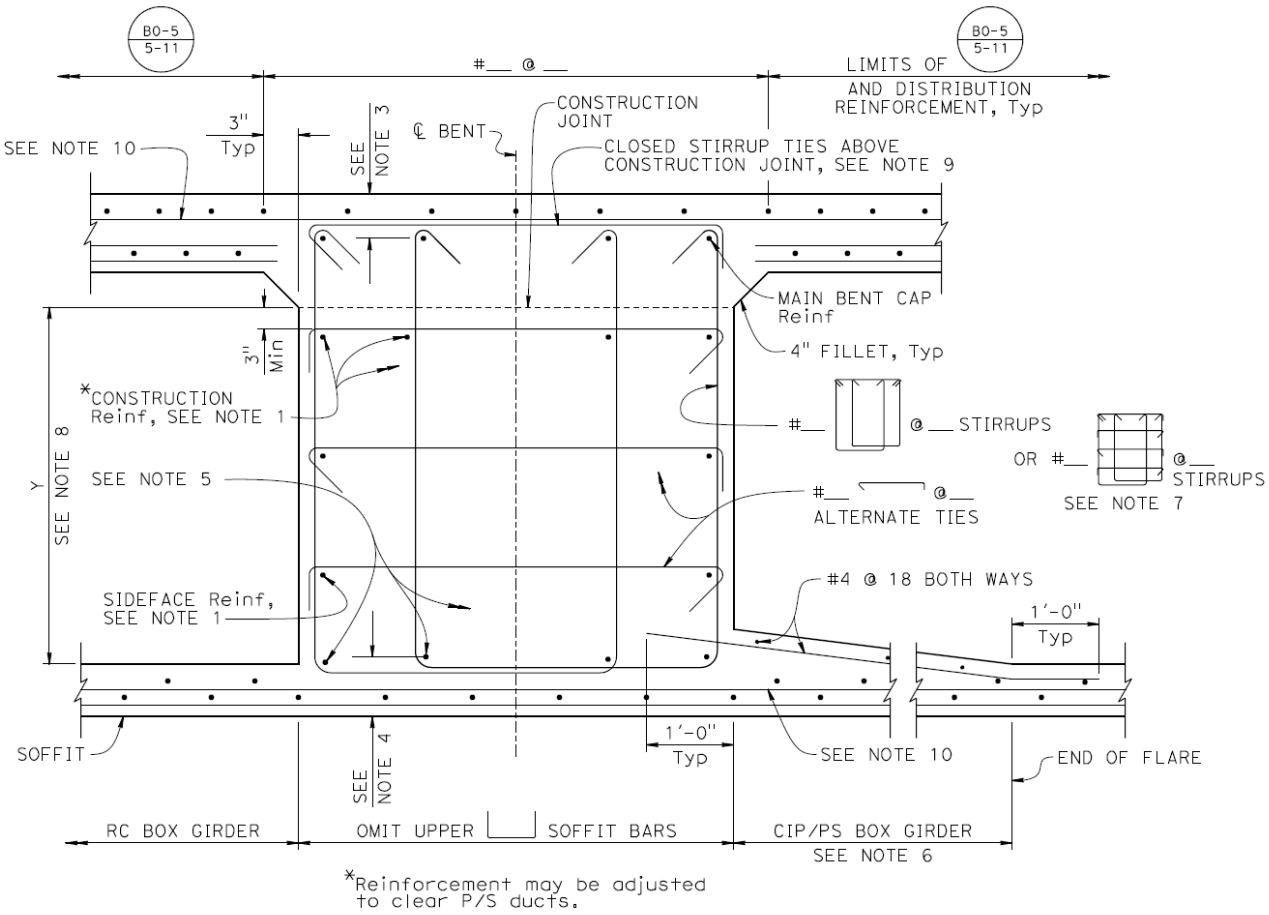

Figure 7.7.1 Typical Bent Cap Section

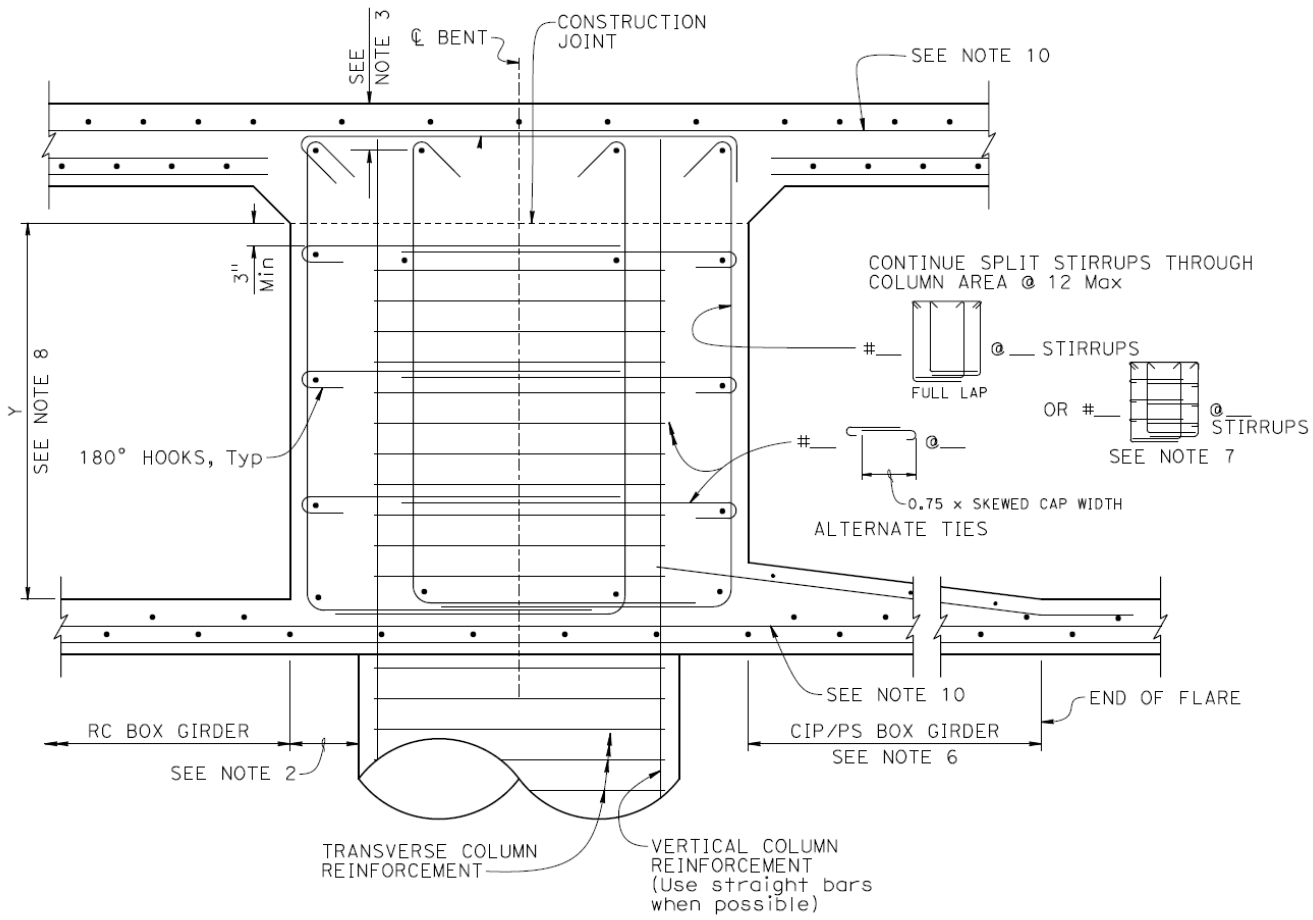

Figure 7.7.2 Bent Cap Section at Columns (For details not shown, see Figure 7.7.1)

Notes:

1. Adequate bent cap, overhang, construction, and side face reinforcement must be detailed. Different sizes and spacings may be required by designer, and large bars may not have adequate clearance when extended into overhang.
2. Bent caps should be at least 1'-0" wider than columns on each side; additional width may be required by the designer.
3. Dimension clearance to top main cap reinforcement so that longitudinal deck reinforcement will be above reinforcement provided in bent cap.
4. Dimension clearance to bottom main cap reinforcement so that longitudinal soffit reinforcement will be below reinforcement provided in bent cap.
5. Special consideration should be given in layout and spacing of bottom reinforcement in bent cap and vertical reinforcement in round columns to avoid conflicts. Place reinforcement as symmetrically as possible. Use minimum of 4 - #11 bars on top and bottom.

6. Soffit flares are typically required for CIP/PS Box Girders. Soffit flare dimensions should be shown on GIRDER LAYOUT sheet.
7. If multiple stirrup legs are required, they should be equally spaced. If equal spaces are not possible, stirrup width should be dimensioned on plans. Stirrups should be placed parallel to girders. Limits and spacing of stirrups and horizontal cross ties may be shown together or separated.
8. When Y > 3'-0", add stirrup tie at 3'-0" max vertical spacing. Hook ties around side face reinforcement and match horizontal spacing of stirrups.
9. Alternate 135° hooks on ties. Use completely closed (135° hooks only) at outrigger bents beyond the box section.
10. Reinforcement shall satisfy Seismic Design Criteria articles. Layout of reinforcement shall be shown in PLAN on BENT LAYOUT and/or GIRDER REINFORCEMENT sheets.
11. The 180° hooks shown on side face reinforcement through column section may be substituted for 135° hooks detailed in the current *Seismic Design Criteria* and 7.1 Bent Detailing Examples. The 135° hooks are constructability compromise that is satisfied with lap shown through column hoops. Hook length will vary based on degree of hooks shown on plans.

Bridge Design Details 7.8 August 2025

Bent Cap Section Details (Over 20º Skew)

Details of bent cap reinforcement for concrete Box Girders and T-Beams where deck reinforcement is placed **normal** to skew.

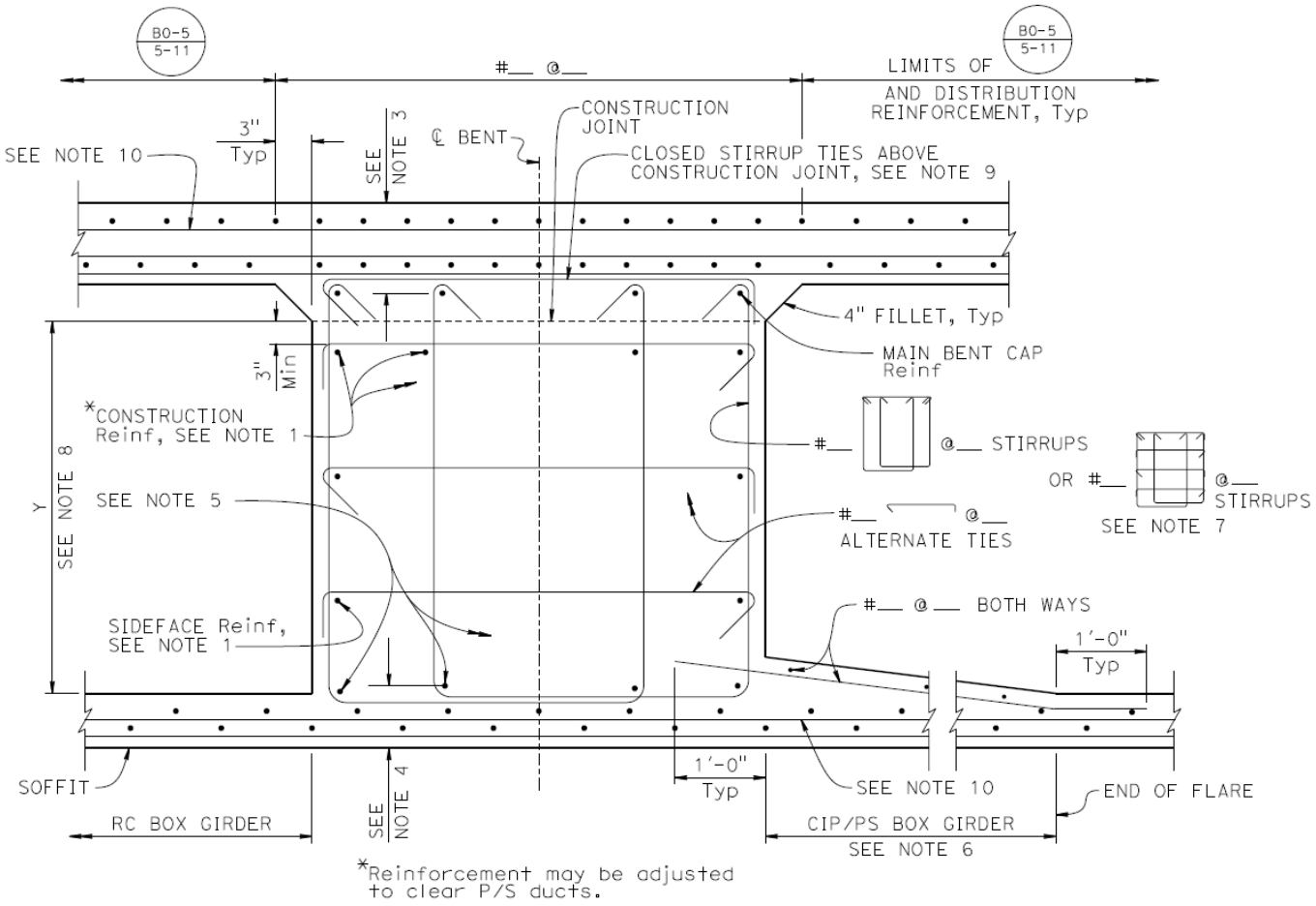

Figure 7.8.1 Typical Bent Cap Section

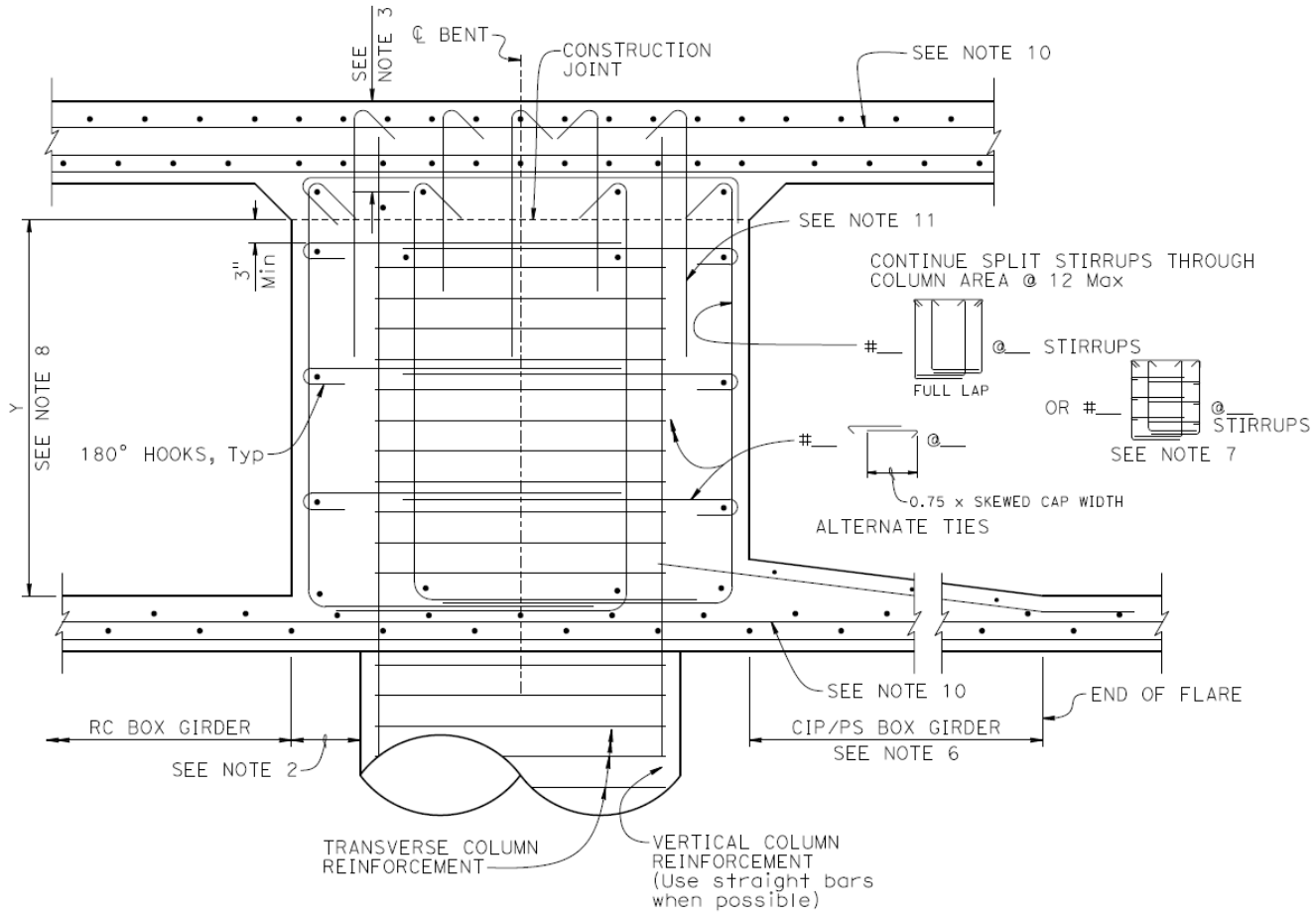

Figure 7.8.2 Bent Cap Section at Columns (For details not shown, see Figure 7.8.1)

Notes:

1. Adequate bent cap, overhang, construction, and side face reinforcement must be detailed. Different sizes and spacings may be required by designer, and large bars may not have adequate clearance when extended into overhang.
2. Bent caps should be at least 1’-0” wider than columns; additional width may be required by the designer.
3. Dimension clearance to top main cap reinforcement so that longitudinal deck reinforcement will be above reinforcement provided in bent cap.
4. Dimension clearance to bottom main cap reinforcement so that longitudinal soffit reinforcement will be below reinforcement provided in bent cap.
5. Special consideration should be given in layout and spacing of bottom reinforcement in bent cap and vertical reinforcement in round columns to avoid conflicts. Place reinforcement as symmetrically as possible. Use minimum of 4 - #11 bars on top and bottom.

6. Soffit flares are typically required for CIP/PS Box Girders. Soffit flare dimensions should be shown on GIRDER LAYOUT sheet.
7. If multiple stirrup legs are required, they should be equally spaced. If equal spaces are not possible, stirrup width should be dimensioned on plans. Stirrups should be placed perpendicular to ℄ Bent. Limits and spacing of stirrups and horizontal cross ties may be shown together or separated. Consider placing stirrups parallel to girders near utility openings when required.
8. When Y > 3’-0”, add stirrup tie at 3’-0” max vertical spacing. Hook ties around side face reinforcement and match size and horizontal spacing of stirrups.
9. Alternate 135° hooks on ties. Use completely closed (135° hooks only) at outrigger bents beyond the box section.
10. Reinforcement shall satisfy Seismic Design Criteria articles. Layout of reinforcement shall be shown in PLAN on BENT LAYOUT and/or GIRDER REINFORCEMENT sheets.
11. J-dowels hooked around longitudinal top deck reinforcement and extended alternatively 2’-0” and 2’-6” into bent cap.
12. The 180° hooks shown on side face reinforcement through column section may be substituted for 135° hooks detailed in the current *Seismic Design Criteria* and 7.1 Bent Detailing Examples. The 135° hooks are constructability compromise that is satisfied with lap shown through column hoops. Hook length will vary based on degree of hooks shown on plans.

Bridge Design Details 7.9 August 2025

Main Bent Cap Top Reinforcement (Wide)

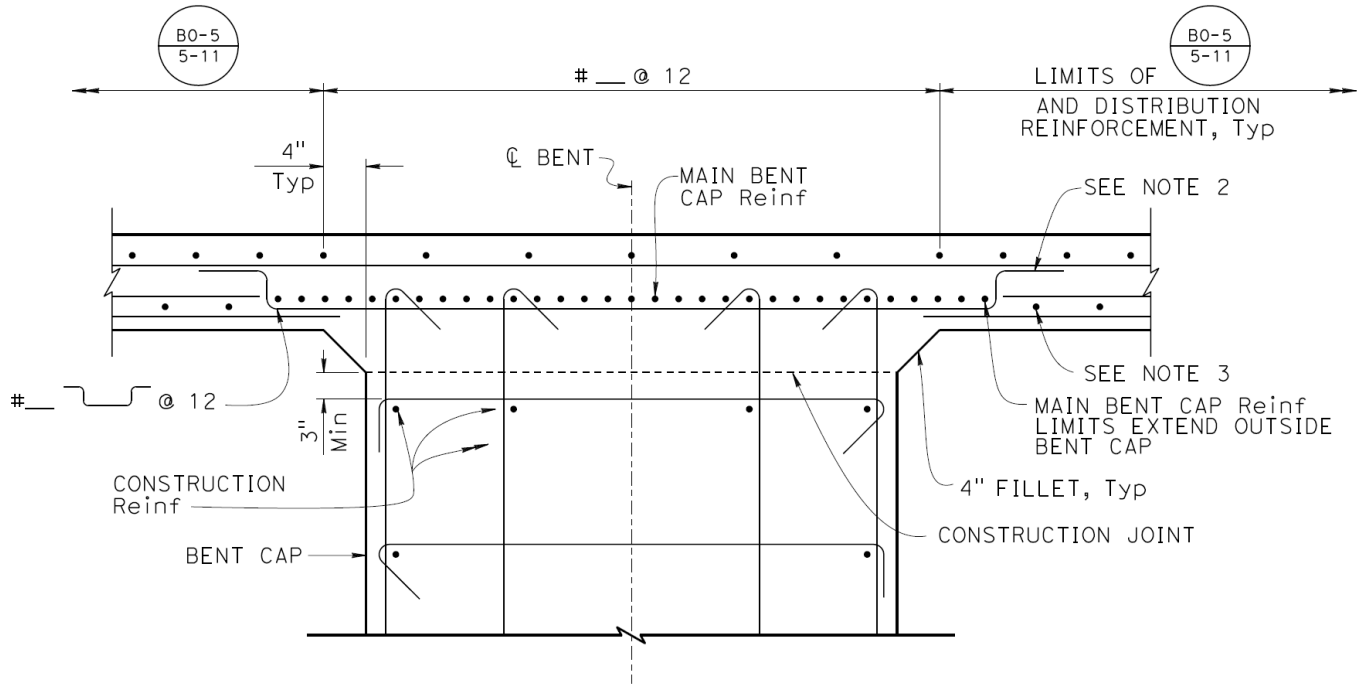

Figure 7.9.1 Bent Cap Reinforcement (0° to 20° Skew)

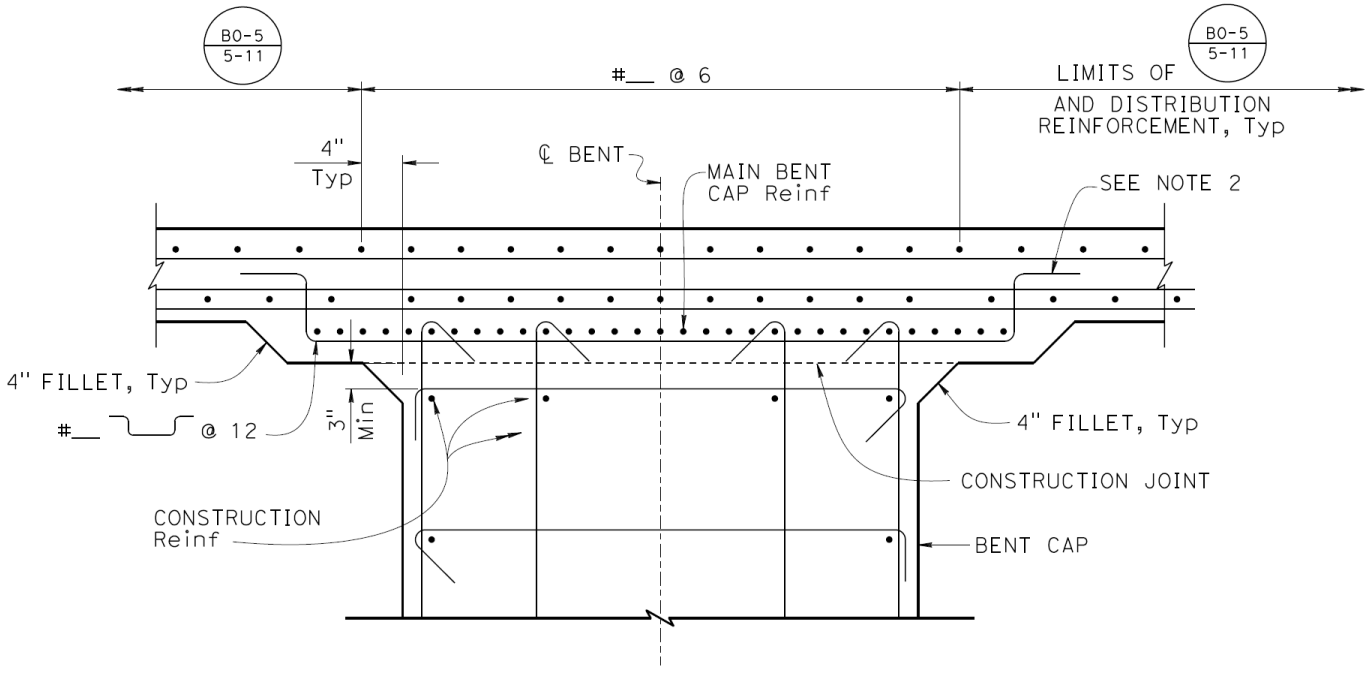

Figure 7.9.2 Bent Cap Reinforcement (Over 20° Skew)

Notes:

1. Main bent cap top reinforcement may be bundled vertically or horizontally wider than bent cap section. Vertical bundles should be avoided in post-tensioned/prestressed girder bridges.
2. Hooks should be tied to top deck longitudinal reinforcement (0° to 20° Skew); hooks to be located between top and bottom deck longitudinal reinforcement (Over 20° Skew).
3. Distribution and transverse bars in deck may need to be terminated beyond the typical 3” minimum from face of bent cap to allow placement of additional top bent cap reinforcement.
4. A “dropped” deck section may be required if main bent cap bars are bundled vertically or if skew is greater than 20°.

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Bent Cap Stirrup Reinforcement (Vertical Exterior Girders)

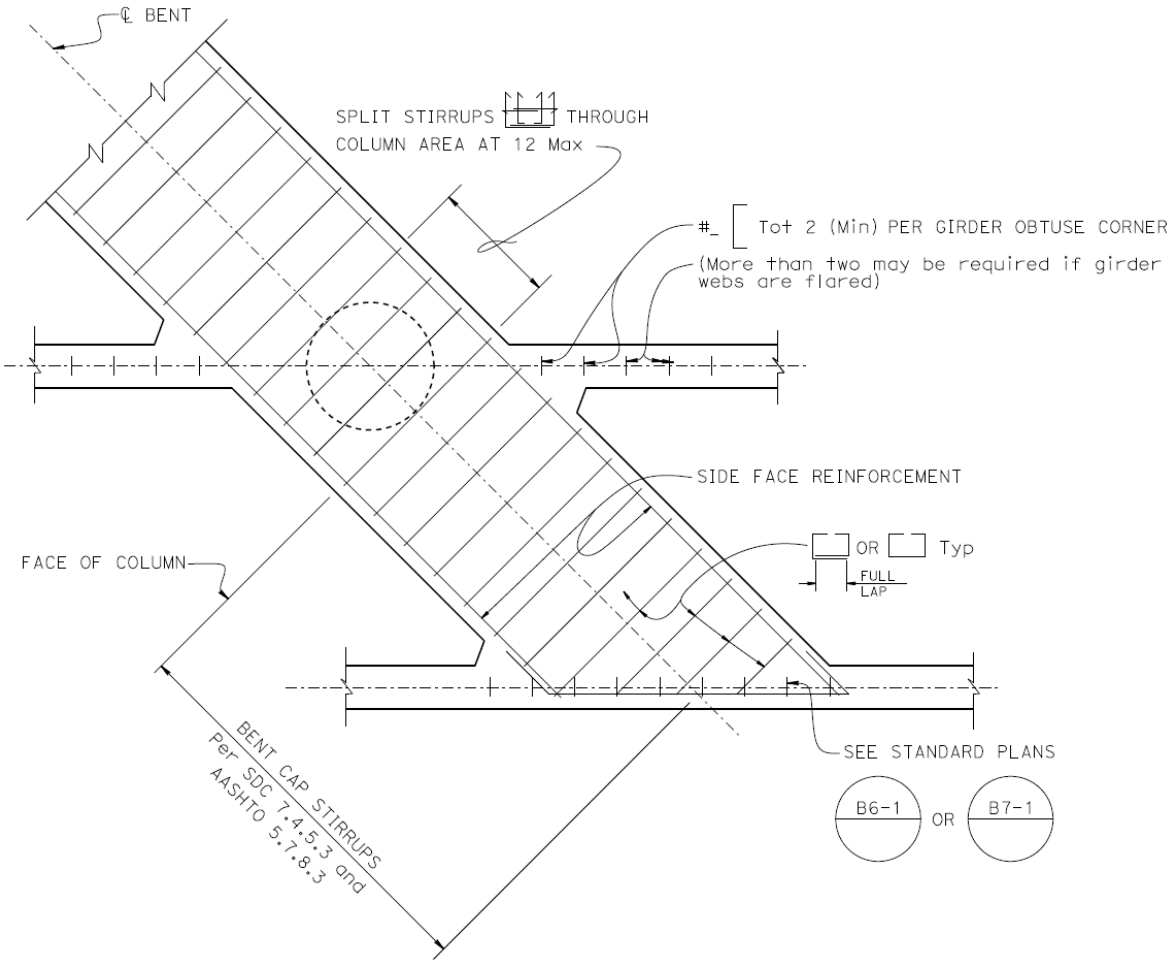

Figure 7.10.1 Stirrup Reinforcement at Skewed Bent Caps (Greater than 20° Skew)

Notes:

1. On sharply skewed structures, a PART PLAN is provided as shown here, to assure adequate reinforcement is provided at bent cap and hinge ends.
2. For skews 0º to 20º, place bent cap and diaphragm stirrups parallel to girders; for skews over 20º, place bent cap and diaphragm stirrups normal to ℄ Bent but may be placed parallel to girders if required for utility openings. Careful consideration should be given to the size and placement of utility openings on sharply skewed structures.

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Bent Cap Stirrup Reinforcement (Sloped Exterior Girders)

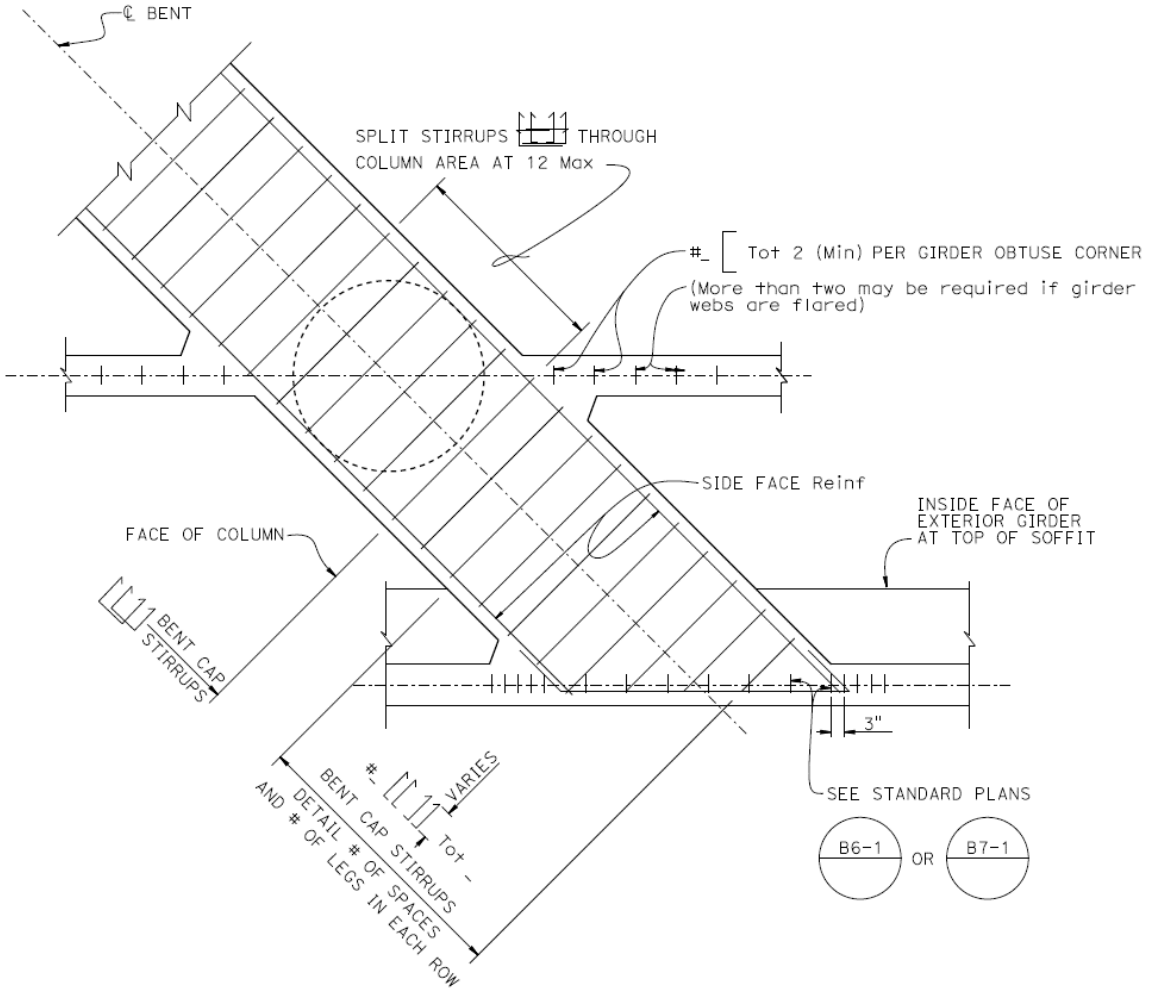


Figure 7.11.1 Stirrup Reinforcement at Skewed Bent Caps (Greater than 20° Skew)

Notes:

1. On sharply skewed structures, a PART PLAN is provided as shown here, to assure adequate reinforcement is provided at bent cap and hinge ends.
2. For skews 0º to 20º, place bent cap and diaphragm stirrups parallel to girders; for skews over 20º, place bent cap and diaphragm stirrups normal to ℄ Bent but may be placed parallel to girders if required for utility openings. Careful consideration should be given to the size and placement of utility openings on sharply skewed structures.

Bridge Design Details 7.12 August 2025

Bent Cap End Reinforcement

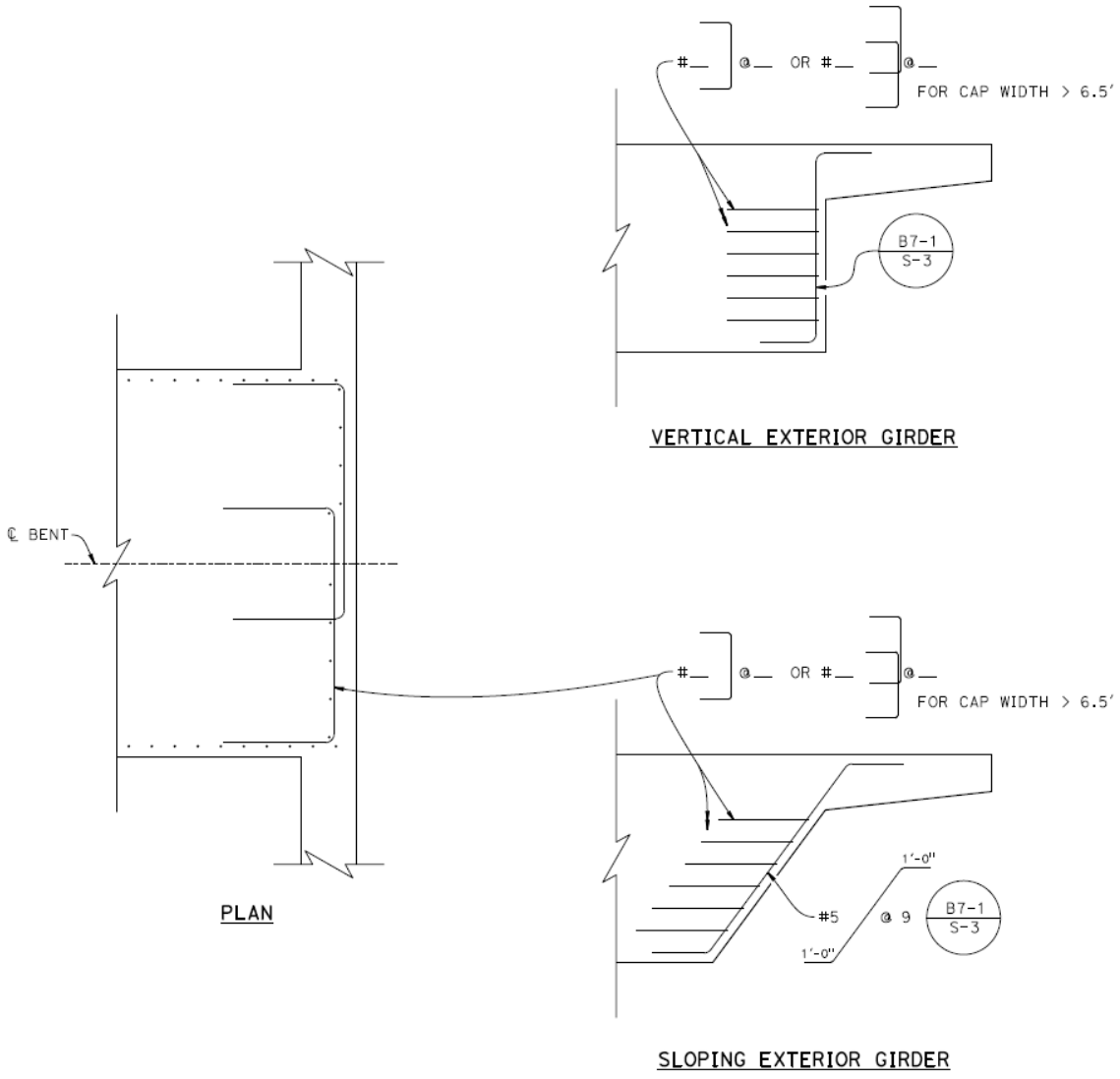


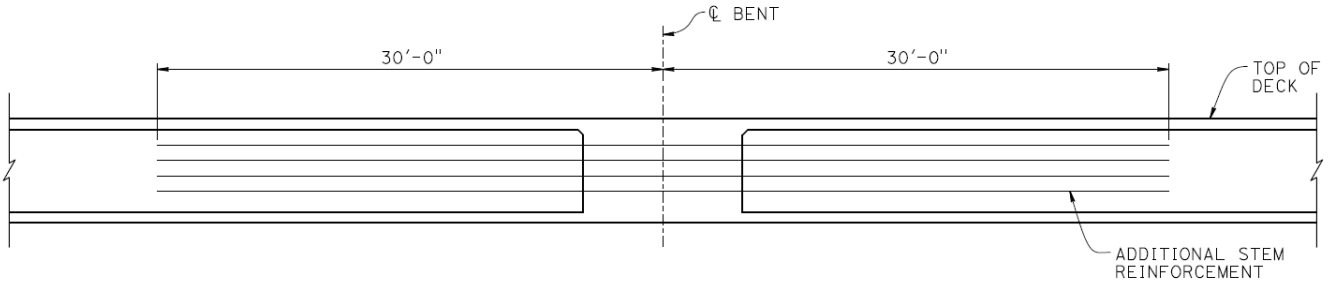
Figure 7.12.1 Box Girder or T-Beam Reinforcement

Notes:

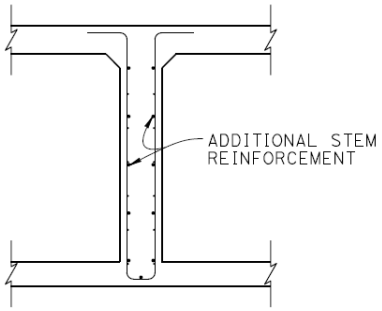
1. “U” Bar size and embedment shall be designed considering shear friction for all loads.

Bridge Design Details 7.13 August 2025

Additional Stem Reinforcement



STEM REINFORCEMENT ELEVATION



STEM REINFORCEMENT SECTION

Figure 7.13.1 Stem Reinforcement Details

Notes:

1. Details shown are similar for Box Girders and T-Beams.
2. Refer to *Seismic Design Criteria* for amount of additional girder stem reinforcement required for vertical acceleration.

Bridge Design Details 7.14 August 2025

Bent Cap Pipe Pin Details

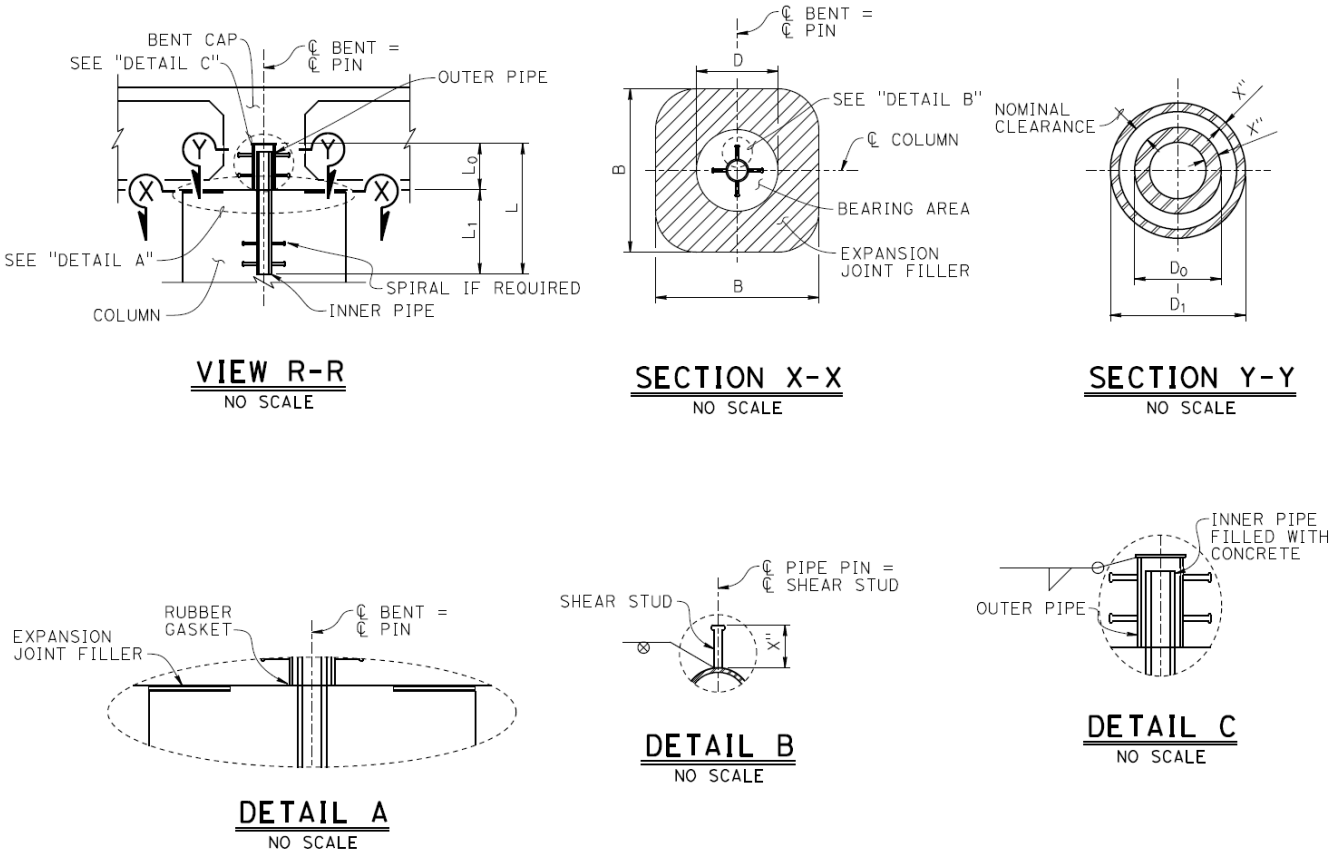


Figure 7.14.1 Pipe Pin Details

Notes:

1. Outer Pipe to seat tightly against ¼" thick rubber gasket placed on concrete around pipe pin.
2. Adjust spacing of main bent cap, column vertical, and column hoop reinforcement to allow placement of pipe pin, as approved by Engineer.
3. Pipe pin details not to be used where uplift capacity is required.

Bridge Design Details 7.15 August 2025

Drop Cap Details (Precast Girders)

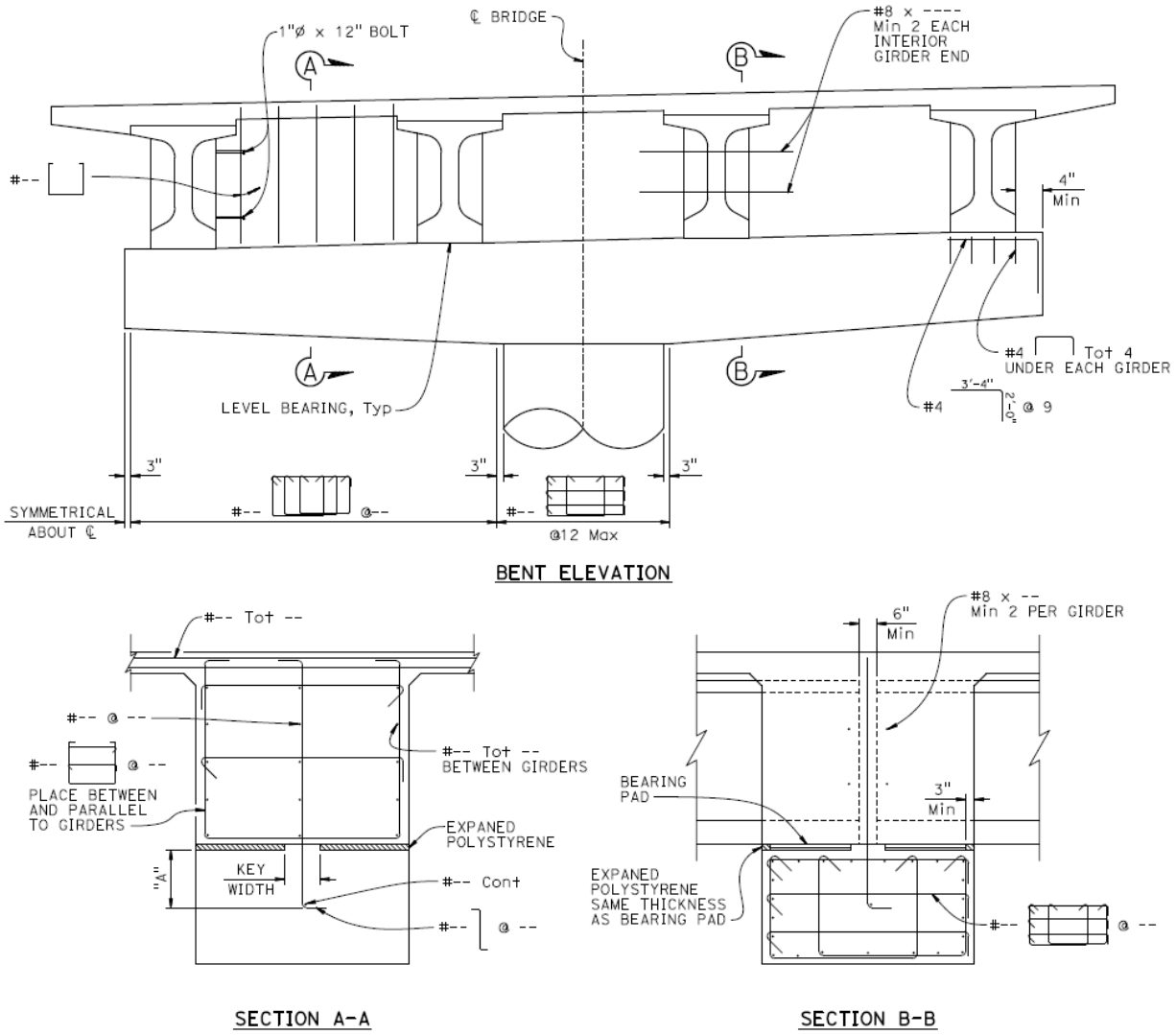


Figure 7.15.1 Drop Cap Details

Notes:

1. Bulb-Tee Precast Girder details shown; other precast girder details are similar.
2. Pipe shear and/or internal shear keys may be used in lieu or in combination with dowels.
3. Area shown for key shall be intentionally roughened.