

Colorado Department of Transportation Staff Bridge Bridge Detail Manual	Chapter: 12 Effective: June 30, 2024 Supersedes: September 14, 2020
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Pier Details

12.1 Purpose

These drawings are to present graphically all pertinent information necessary in the field construction of this segment of the structure.

12.2 Responsibility

The graphic presentation of information on these drawings shall be the responsibility of the individual preparing the drawings in addition to the designer.

12.3 Scales

Scales shall be used that are suitable to make the details legible when the drawing is reduced. Suggested scales for presenting the details of the piers are as follows:

- A) Plan and Elevations - 1"=10', 1"=20', 1"=30'.
- B) Sections - 1/8"=1'-0", 1/4" = 1'-0", 1/2"=1'-0", 3/4"=1'-0", etc.
- C) The Elevation of an opposite hand detail may be drawn to a smaller scale.

12.4 Orientation of Details

The PLAN of the pier shall be placed, if possible, at upper left of the drawing.

The ELEVATION of the pier shall be projected below the PLAN. When possible, the pier TYPICAL SECTION shall be placed to the right of the pier PLAN and ELEVATION. If space is limited, the sections or auxiliary views may be shown on another sheet.

Generally, sections should be taken from the PLAN and ELEVATION rather than from auxiliary views or other sections.

12.5 Opposite Hand Details

Piers are shown as ahead station and "opposite hand" details shall be avoided where possible. If needed, two preferred methods are as follows:

- A) Re-detail opposite hand pier.
- B) Detail the ELEVATION of the opposite hand pier to a smaller scale.

12.6 Horizontal Control Line

The horizontal control line shall be shown on the PLAN and labeled consistently with the plans. Example: "HCL", "Survey Line", "Project Line", etc.

12.7 Layout Line

For structures on tangent, the layout line shall coincide with the horizontal control line.

For structures located on a curve, the layout line shall be shown on the PLAN and labeled consistently with the plans. Example: "Tangent from TS Sta 31+48.00", "Chord from POC Sta 38+41.08 to PT Sta 39+78.00", "Tangent from POC Sta 382+10.00", etc.

12.8 Stationing

A station shall be placed at the intersection of the horizontal control line with the centerline of the pier.

All stations on the "Pier Details" shall be given to two decimal places.

The direction of stationing shall be indicated on the plan view as "Station Ahead".

12.9 Centerlines

Centerlines shall be identified and shown as discussed in the following subsections:

- A) Location - Centerlines shall be shown at the following locations, when applicable.
 - 1) Plan View
 - a) Centerline of pier
 - b) Centerline of all girders
 - c) Centerline of all bearings
 - d) Centerline of roadway
 - e) Centerline of columns and footings
 - f) Typical centerline of anchor bolts or bearing pads.
 - 2) Elevation View
 - a) Centerline of caissons
 - b) Centerline of columns and footings
 - 3) Section Through Pier
 - a) Centerline of bearings
 - b) Centerline of caissons
 - c) Centerline of columns and footings
- B) Identification - The centerlines shown on the pier details shall be identified in the following ways:
 - 1) Centerline of Girder - A circle containing the girder letter shall be placed at the end of each outside girder centerline, as shown in the PLAN views of the abutments in the graphic examples. If the bridge is a simple multi-span bridge, a circle containing the span number and girder letter is preferred, ie. 1A, 2D, 3C, etc. For continuous or single span bridges, a circle containing only the

girder letter shall be used. These girder number shall correspond to those shown on the "Construction Layout".

- 2) Other Centerlines - When it is applicable to identify some of the other centerlines, it should be done by using their particular names. Examples: Centerline Bearing, Centerline Anchor Bolts, Centerline Columns, Centerline Footings, etc.

12.10 Elevations

All elevations shown on the "Pier Details" shall be to two decimal places. Example: 80.25; except bottom of footings, which shall be to one decimal place. Example: Elev 5280.3.

The elevations given at the bottom of footings shall consist of all the significant figures preceding the decimal point. The other elevations on the drawing shall display only two digits preceding the decimal point. Example: Elev 80.28.

- A) Location - Elevations shall be shown on the ELEVATION view of the pier at the following locations, when applicable:
 - 1) Top of bearing seats.
 - 2) End of pier cap on the bottom face.
 - 3) Top of columns at the centerline of column.
 - 4) Bottom of footings or wall.
 - a) The basic footing elevation are provided on the design notes. The detailer shall make sure that the footing elevations correspond to the information described in the design notes. The top of the footing should be kept 2 feet minimum below ground line. The bottom of footings shall be held as close to 6 feet below the stream bed as possible. In order that pier columns may have the same height, it is permissible to vary the bottom footing elevations where possible, as long as these elevations do not differ by more than 1'-0".

12.11 Pier Cap Slopes

The top of the pier cap should be sloped, rather than stepped, between bearing seats to maintain, as nearly as possible, the 2-inch clearance to pier cap reinforcing steel.

12.12 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction of the pier.

The following list of common dimension, in feet and inches (to the nearest 1/8 inch), shall be shown on the details (except as noted).

A) Plan View of Pier

- 1) Outside of pier cap to outside of pier cap, along centerline of pier.
- 2) Layout line to outside of pier cap, along centerline of pier.
- 3) Typical girder spacing (given in decimals to a thousandth of a foot).
- 4) Layout line to nearest girder, along centerline of bearings (given in decimals to a thousandth of a foot).
- 5) Horizontal control line to layout line, along centerline of pier, for structures on a horizontal curve (given in decimals to hundredth of a foot).
- 6) Centerline of pier to centerline of bearing.
- 7) Outside of pier footing to outside of pier footing, along centerline of pier.
- 8) Outside of pier footing to layout line.
- 9) Bearing seats.

B) Typical Section Through Pier

- 1) Cap width, tie to centerline of pier.
- 2) Minimum cap height.
- 3) Wall or column width or diameter.
- 4) Wall or column height, if constant height.
- 5) Footing width and height, when applicable, tie to centerline pier.
- 6) Pile projection into footing
- 7) Top of footing to bottom layer of reinforcing

12.13 Angles

The following angles shall be shown in the PLAN view of the pier, when applicable.

- A) Skew angle (nearest second).
- B) Angles that the girders generate with the centerline of pier or centerline of bearings, if they are different than the skew angle.

12.14 Anchor Bolts

When applicable, anchor bolts or bearing pads shall be shown in the PLAN of the pier or in a separate detail. The skew angle shall be shown to the nearest minute. See anchor bolt note.

12.15 Piling

When applicable, piling shall be shown but not dimensioned in the PLAN, ELEVATION, and SECTION THROUGH PIER.

12.16 Pier Nose Angle

The following statements pertain to pier nose angles, and are to be used when applicable:

- A) Nose angles shall be shown in the ELEVATION and SECTION.
- B) The size and length of the angle shall be shown in a separate detail, as described in the designer's notes.
- C) Angles are to be placed on the upstream side of the bridge only. See typical pier nose angle note.

12.17 Reinforced Concrete Details

The reinforced concrete details shall be made in accordance with the design notes and current standard practice. The statements listed below are to be followed when applicable.

- A) The footings shall be shown in the PLAN, ELEVATION, and SECTION views of the pier.
- B) All construction keys shall be raised.
- C) On parabolic T-girders, with a hinge action at the piers, the concrete key shall be placed up on the top or bottom of the column or wall and dimensioned.
- D) When detailing columns, the following notation shall be added to the column ties: "Rotate Splices".
- E) The clearance on intersecting planes of steel shall be checked. It is important to make sure that the vertical column bars that are projected into the pier cap will clear the horizontal bars in the bottom of the cap. It is also important to make sure all reinforcing called out fits within the designed area. Due to the problem of incorporating the necessary reinforcing in pier caps for continuous parabolic T-girder and concrete box girder bridges, special attention shall be given to the amount of reinforcing steel in the cap. This amount should be reviewed to ensure that there is ample clearance. Allowance should be made for the deformations (ridges) on the reinforcing steel. Do not show any of the superstructure on the pier detail drawings. The pier diaphragm and superstructure should be shown on the superstructure drawings. The expansion material may be shown on the pier details.
- F) A section view of the pier cap showing reinforcement placement accounting for the column reinforcing is required. Including a shaded depiction of the extended column reinforcing is preferred. Alternately, a plan view of the column reinforcing showing the longitudinal cap reinforcing threading through the bars would be acceptable.

- G) When cutting off bars in cantilever pier caps, the reinforcing steel shall extend into the cap to achieve the minimum development length required.
- H) Show only the first two vertical and horizontal lines of reinforcement to avoid the detail appearing cluttered.

Refer to the appropriate section of Chapter 4 for additional information concerning bar clearances, spacing, splicing, embedment, projections, etc.

12.18 Check Items

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required.

- A) Project number in proper location.
- B) Label Horizontal Control Line in the PLAN view.
- C) Layout Line, in the PLAN view.
- D) Stationing.
- E) Location and identification of centerlines.
- F) Elevations.
- G) All necessary dimensions.
- H) Skew angle of bridge and other pertinent angles.
- I) Anchor Bolts and note.
- J) Show footings in the PLAN view as well as in the SECTION and ELEVATION.
- K) Pier nose angle.
- L) Check all intersecting planes of reinforcing steel for the proper clearances.
- M) Check bearing plates to insure that they fit properly at the piers. See Figure 11-2
- N) Bearing pads (leveling pads may be shown on these pier details).
- O) Title PLAN, ELEVATION, and SECTION in accordance with their particular conditions.
- P) Check for typical notes.
- Q) Check title block for information.
- R) Limits of concrete coating/stain shown.
- S) Haunch dimensions, if applicable.
- T) Jacking details for future jacking when applicable.

12.19 Title Block

This drawing is entitled "PIER DETAILS" and shall be so indicated in the title block. The pier numbers may be included in the title, such as "PIER 2 AND 3 DETAILS".

If other details are combined on this drawing, they shall be indicated in the title.

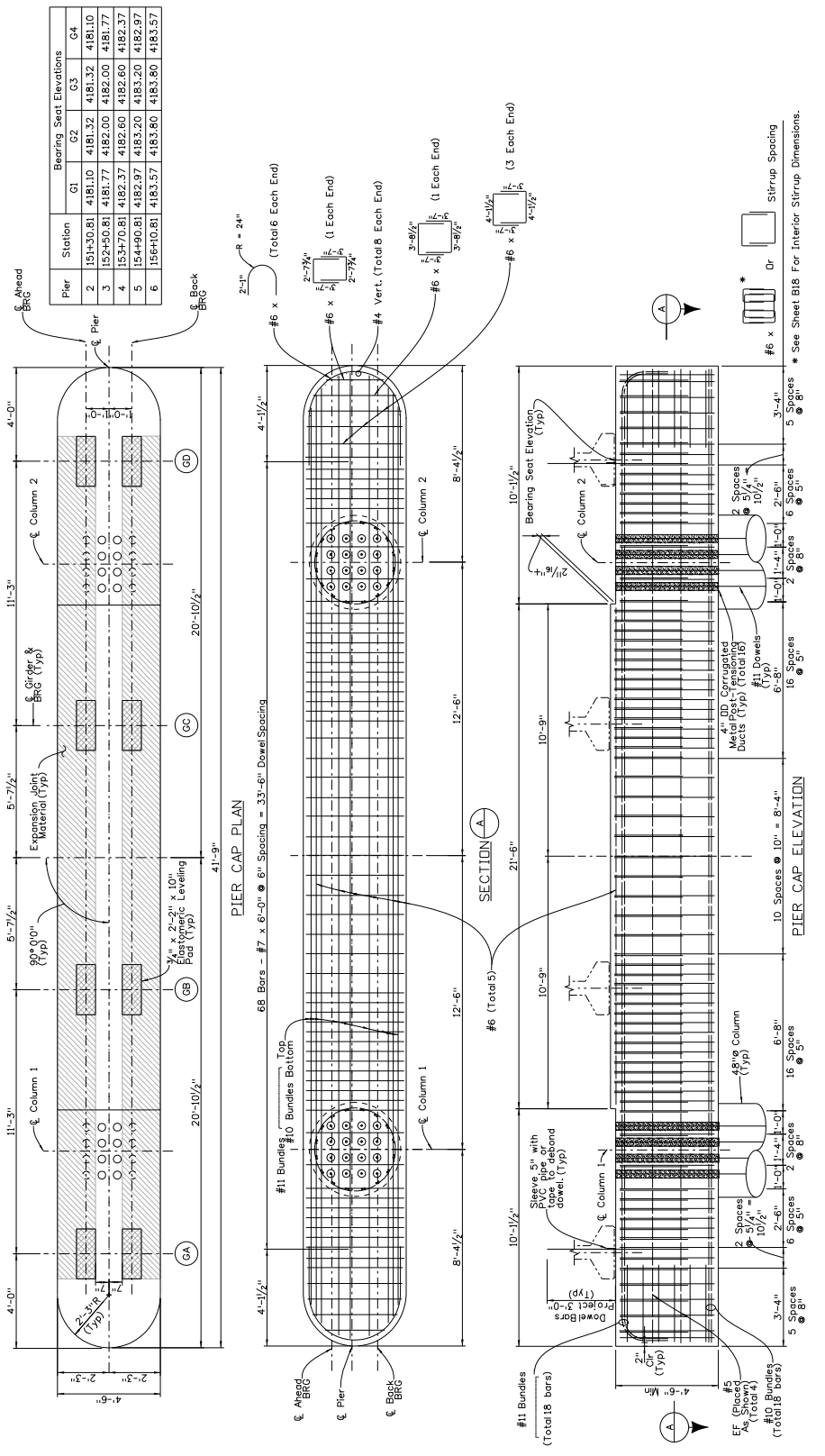
Example: If the “Abutment Details” are placed on this drawing with the “Pier Details”, the title shall be “ABUTMENT DETAILS - PIER DETAILS”.

The structure number and the first initial and last name of the designer and detailer shall be filled in on each sheet.

12.20 Typical Notes

The following notes shall appear on the drawing when applicable:

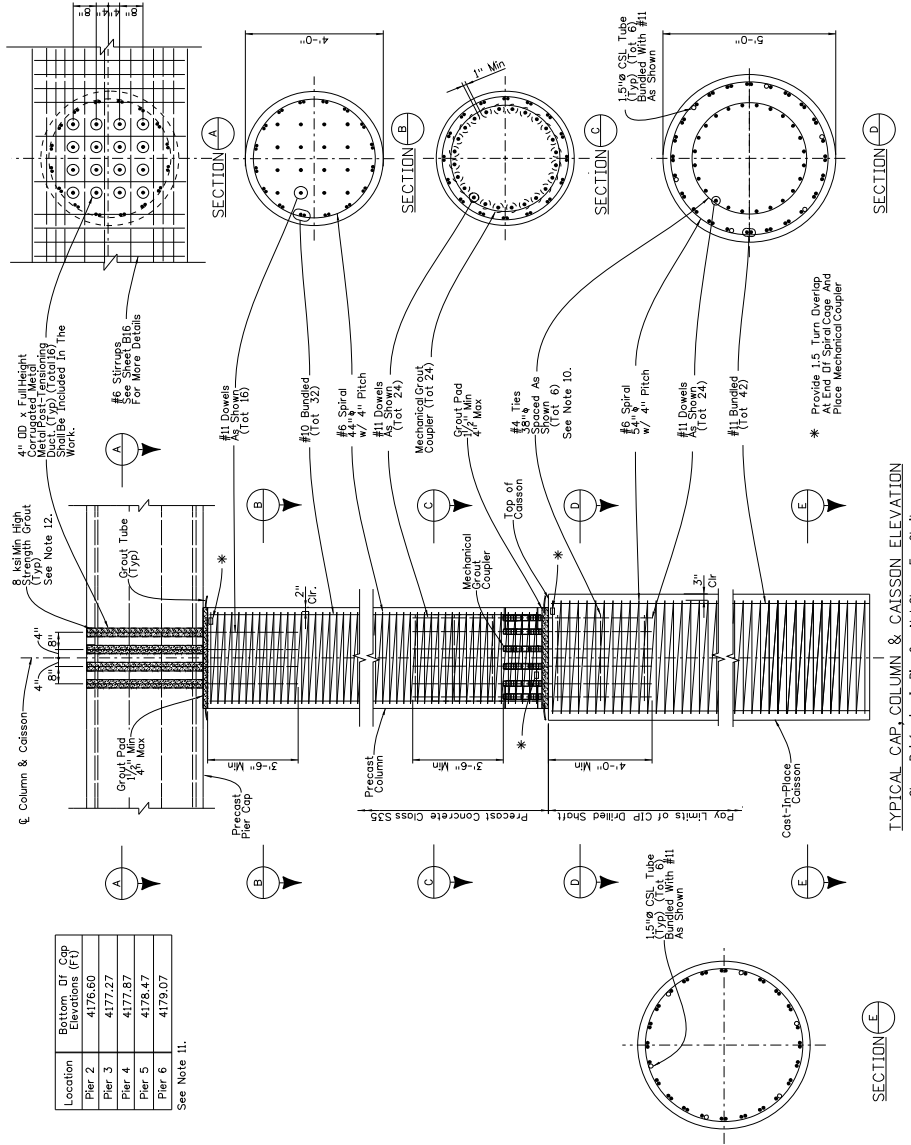
- A) Anchor Bolt Note - “Anchor Bolt _____” Φ X _____ Long.
- B) (Project _____)”
- C) Column Tie Bar Note - “Rotate Splices”
- D) Pier Nose Angle Note - “Pier nose angle on upstream end only.”
- E) Pour crash wall monolithically with pier wall.
- F) Column reinforcing projection Note – “Column reinforcing (_____ projection into cap)”



Example 12.1

* See Sheet B18 For Interior Stirrup Dimensions.

PIER PLAN AND ELEVATION



PIER DETAILS (1 OF 2)

TYPICAL CAP, COLUMN & CAISSON ELEVATION
Shear Reinforcing In Pier Cap Not Shown For Clarity.

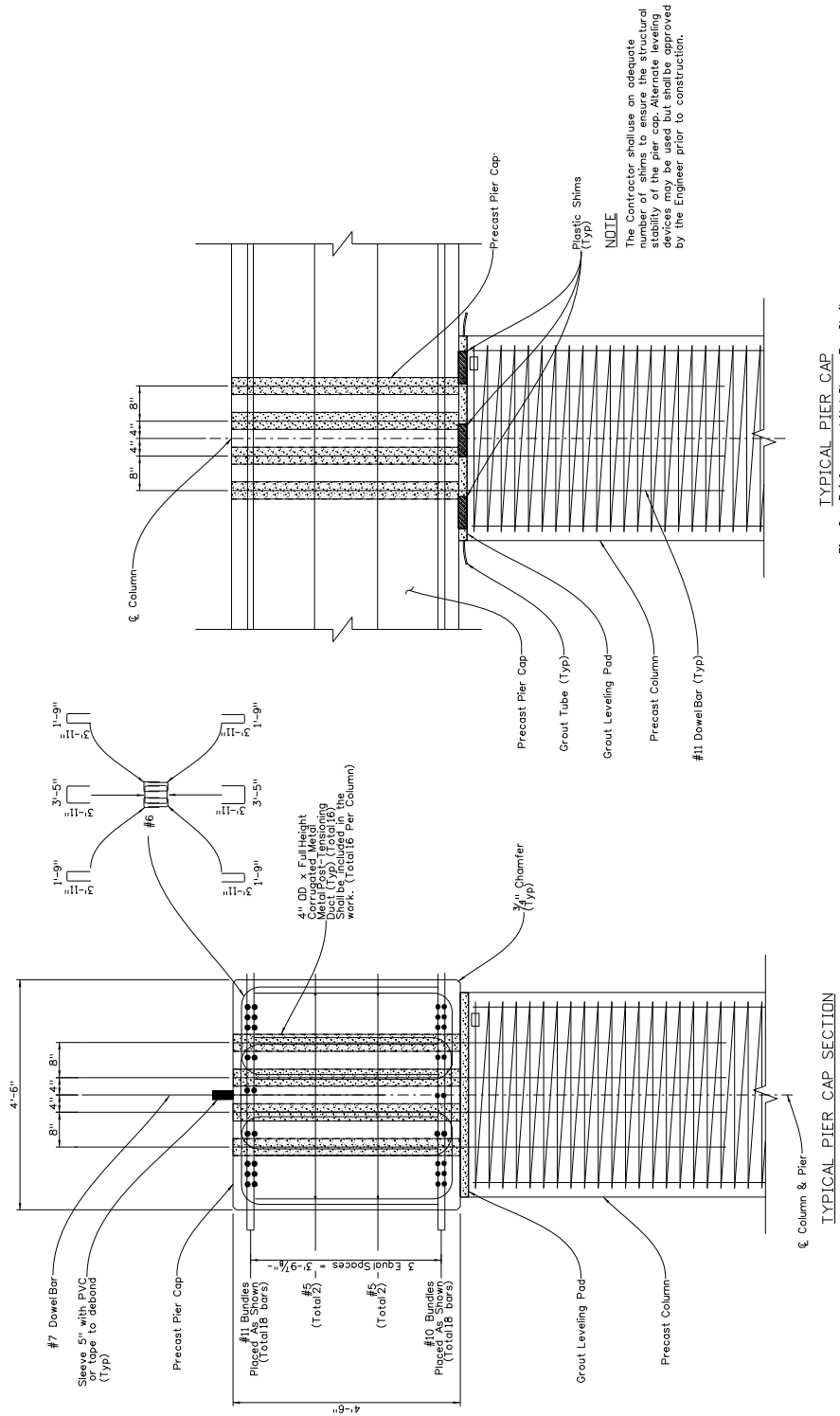
NOTES

- Provide 2'-0" Extra Length For Spiral Cage And Vertical Cut As Needed And Use Mechanical Splice To Secure The Ends Of The Spiral Cage As Shown In The Caisson Details. Continuous Spiral.
- Spiral Cage Shall Use Mechanical Splices To Form A Continuous Spiral.
- Steel Casing Shall Be Used. It Shall Be Included In Item 503-00060 Drilled Caisson.
- Caisson Design Is Based On Side Shear And End Bearing With An End Bearing Resistance Factor Of 0.5 And A Side Shear Resistance Factor Of 0.5.
- Proper Placement Of Precast Members Is Critical. The Use Of Jigs And Templates Are Encouraged. Excavation Backfills Are Necessary To Accommodate Jigs And Templates.
- The Contractor Shall Survey The Tops Of Each Precast Member After Placement. The Tops Of Member Elevations And Orientation Shall Be Verified At Each Phase Of Construction. Adjustments To Elevations Shall Be Made By Adjusting Grout Pad Thicknesses. The Use Of Shims Or Leveling Bolts Is Recommended.
- The Length Of Dowel Bars Protruding From The Top Of Precast Column Shall Be As Recommended In The Manufacturer's Recommendations For Embedment Into The Mechanical Grout Coupler. The Contractor Shall Determine This Length Prior To Pouring The Caisson.
- In Order To Maintain Min. Clearance Between The Coupler Diameter (D₁ To D₂) Should Be Limited To 3/4" Max.
- The Contractor shall submit a leveling plan for all precast units to be approved by the Engineer two weeks prior to construction.
- The six ties specified for the dowelcages in the caissons and columns are suggested only. The ties are suggested as an intent to provide integrity during cage placement.
- Final top of column elevations should include grout pad thicknesses. Precast column lengths should take into account allowances for 3/8" minimum grout pad thicknesses at the top and bottom of the columns.
- As a minimum, the dowelbars into the cap shall extend through the cap and then cut flush with the top of the cap. The use of ultra high performance concrete may be used for the cap. If this method is used, the contractor shall submit the shortened dowel length to the Engineer for approval prior to construction.

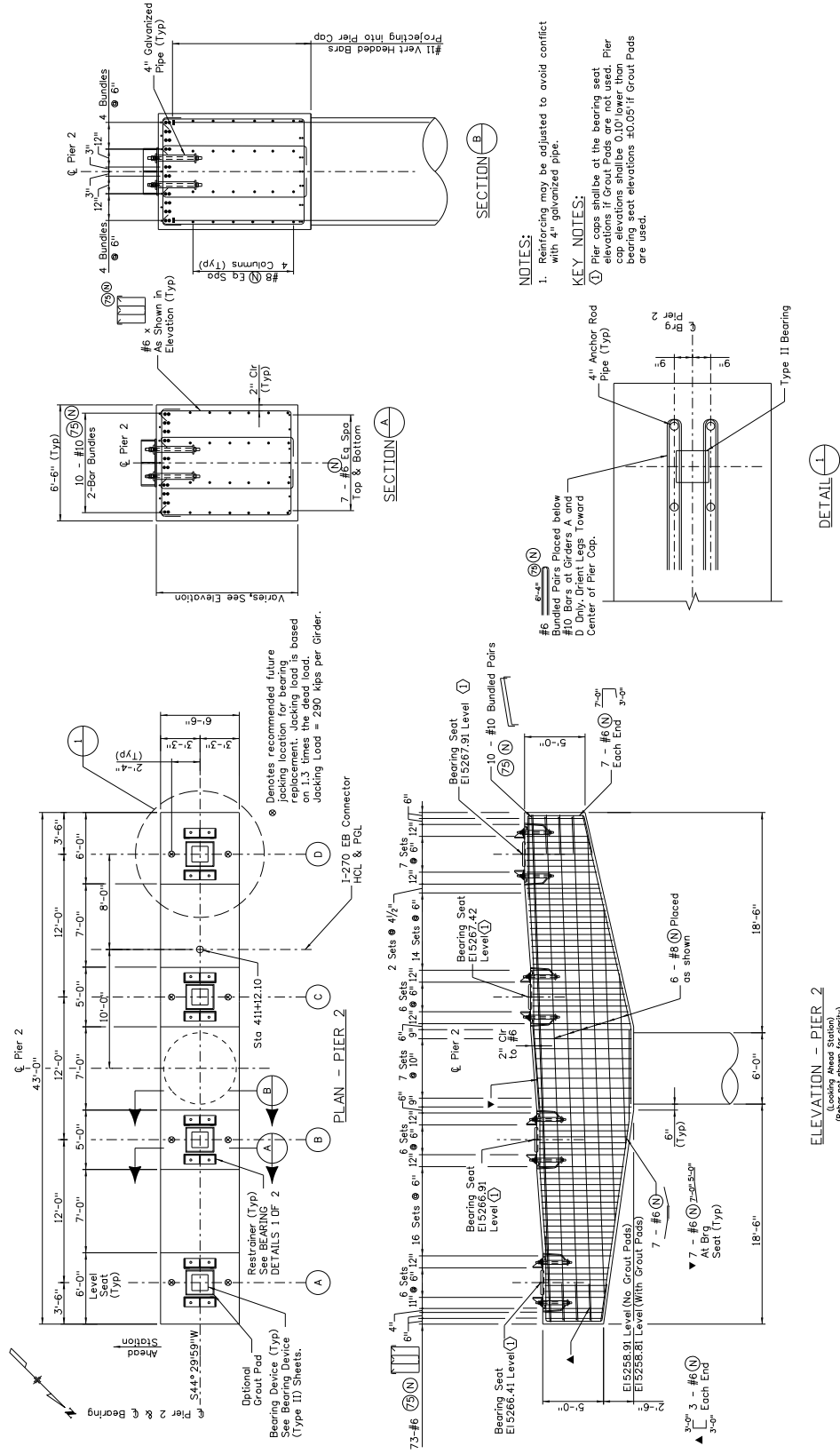
TOLERANCES

The Centerline Of The Caisson Dowel Cage Shall Be Within ± 1/2" In Any Direction From That Shown On The Plans.
A 1/2" column tolerance is the sum of the gaps at the top and bottom of the column. The #11 Dowel Bars And The Inside Face Of The Mechanical Grout Couplers. The Gap Between Top Column Is Between The Face Of The #11 Dowel Bars And The Inside Face Of The Cap. The Gap Between The Top Of The Column Is Based On The Section Of The Mechanical Grout Coupler. The Assumed Tolerance Due To The Mechanical Grout Coupler Is 1/4".

Example 12.2

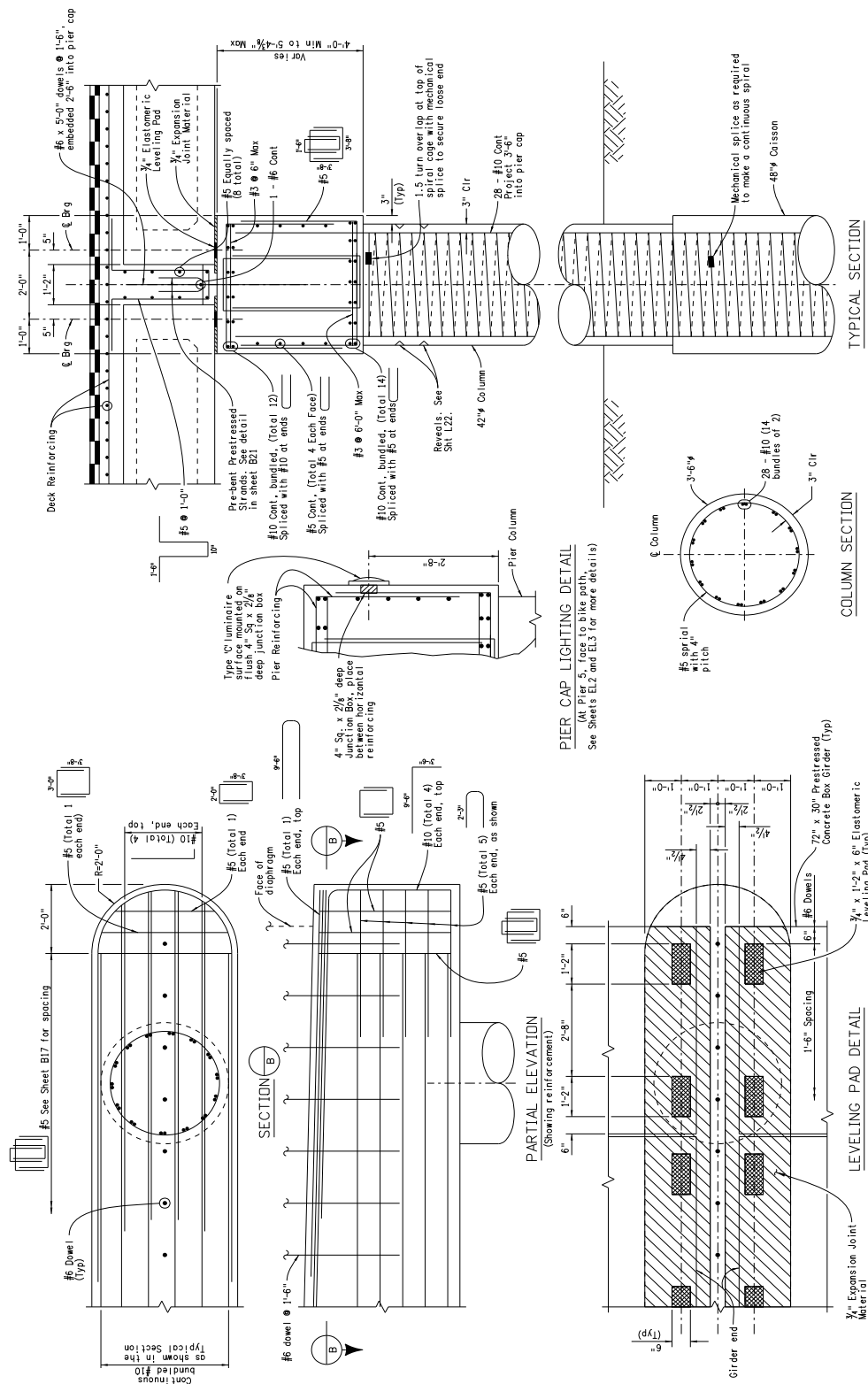


Example 12.3



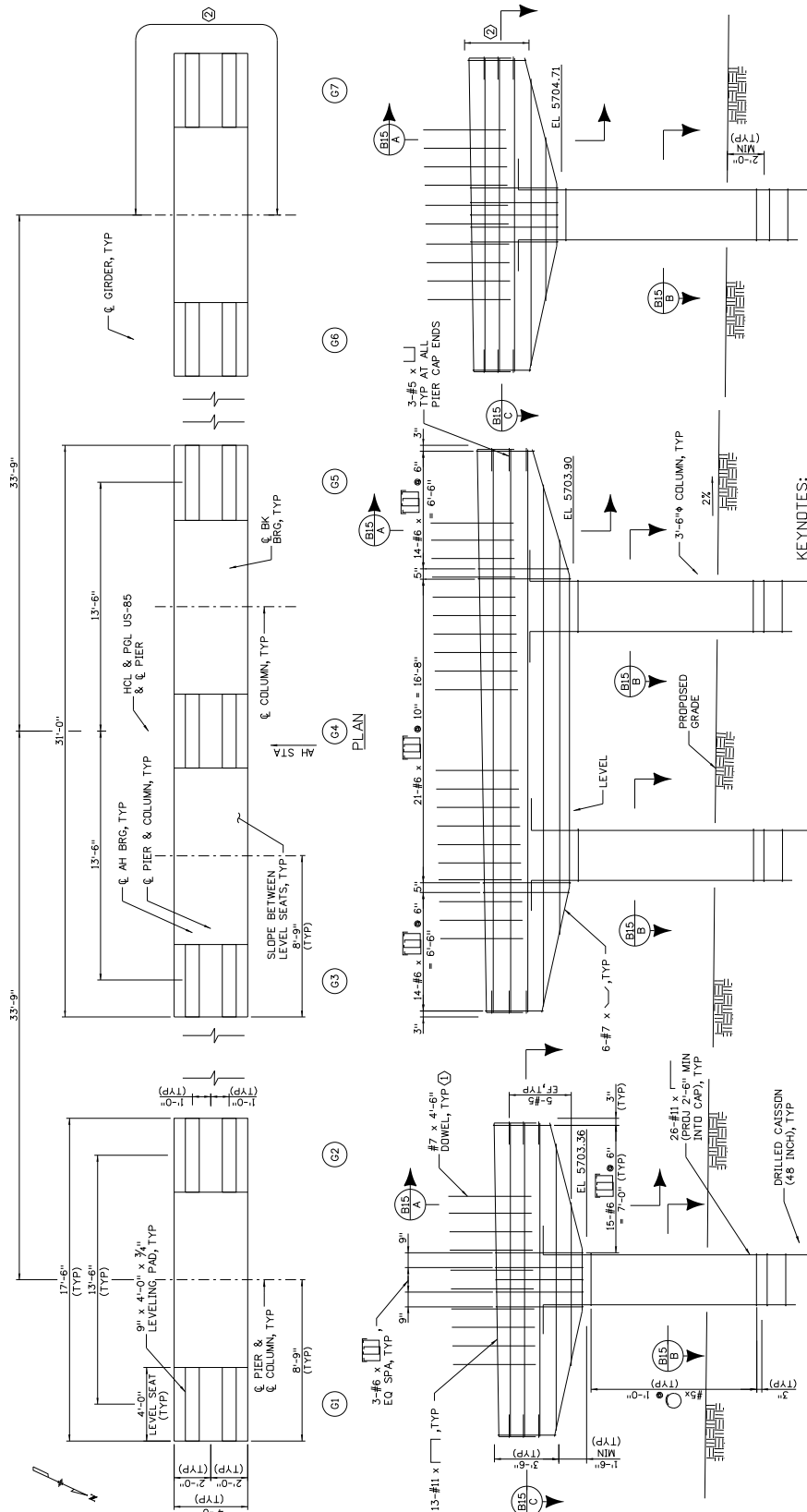
EXAMPLE 12.4

CENTRAL 70
 I-270 EB OVER I-70
 PIER 2 CAP DETAILS



PIER SECTIONS & DETAILS

EXAMPLE 12.5



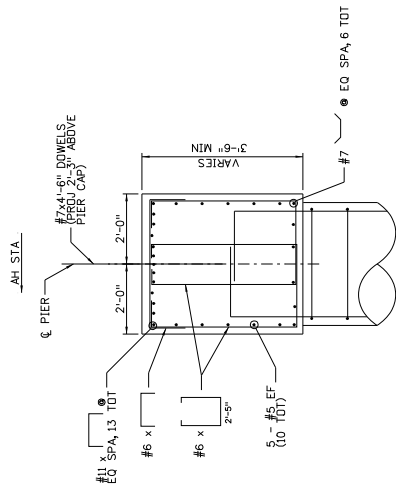
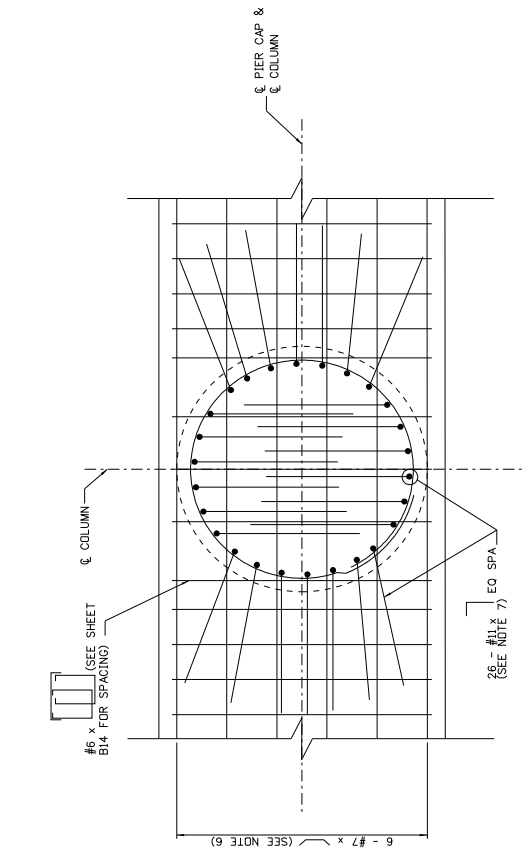
KEYNOTES:

- ① SEE SHEET B16 FOR SPACING.
- ② LIMITS OF SPRAY ON WATERPROOFING MEMBRANE (30 MIL THICK) TO BE APPLIED UNDER EXTERIOR GIRDERS ONLY. (BRIDGE); APPLY UNDER EXTERIOR GIRDERS ONLY.

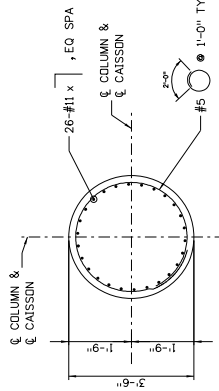
ELEVATION
(LOOKING AHEAD STATION)
(RIPRAP NOT SHOWN)

US-85 OVER SAND CREEK
PIER 2 (SHEET 1 OF 2)

EXAMPLE 12.6



SECTION (B14)
SCALE: 3/8"=1'-0"



SECTION (B14)
SCALE: 3/8"=1'-0"

SECTION (B14)
SCALE: 3/8"=1'-0"
(EXTERIOR COLUMN SHOWN, OTHER COLUMNS SIMILAR)

- NOTES:
1. PIER SHALL BE CONCRETE CLASS D (BRIDGE).
 2. BEAM SEAT ELEVATIONS ARE AT TOP OF CONCRETE BELOW LEVELING PAD AT ϵ PIER.
 3. ELEVATIONS SHOWN SHALL BE VERIFIED AT TIME OF CONSTRUCTION BY THE ENGINEER.
 4. FOR CAISSON LAYOUT, SEE SHEET B09.
 5. FOR LEVELING PAD DETAILS, SEE SHEET B16.
 6. #7 BARS MAY BE SHIFTED ONLY AS NECESSARY TO AVOID INTERFERENCE WITH #11 COLUMN BARS.
 7. TOP HORIZONTAL LEG OF #11 COLUMN BARS SHALL BE TURNED TOWARD CENTER OF COLUMN WHERE 2" CLEAR COVER TO PIER CAP CANNOT BE PROVIDED.

TOP OF CONCRETE ELEVATIONS TABLE

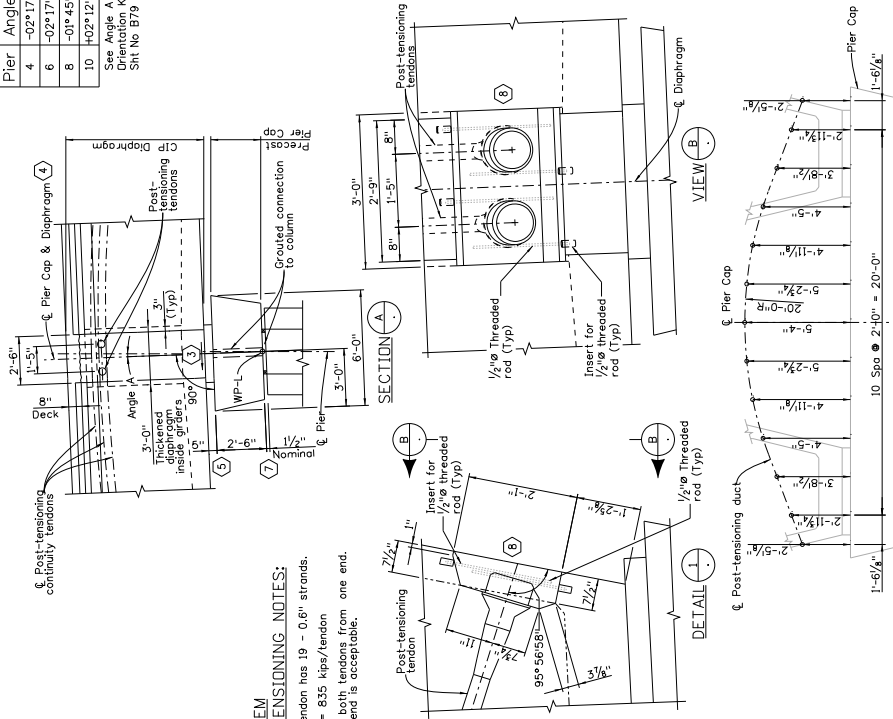
STRUCTURE	G1	G2	G3	G4	G5	G6	G7
PIER 2	5708.31	5708.58	5709.12	5709.39	5709.66	5709.93	

US-85 OVER SAND CREEK
PIER 2 (SHEET 2 OF 2)

EXAMPLE 12.7

Pier	Angle A
4	-02°17'26"
6	-02°17'26"
8	-01°45'30"
10	+02°12'38"

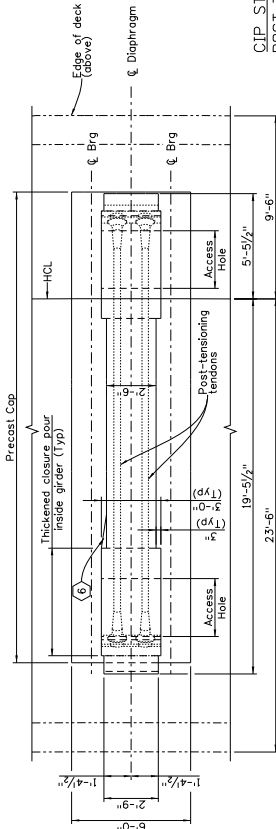
See Angle A
Orientation Key,
SH No. B79



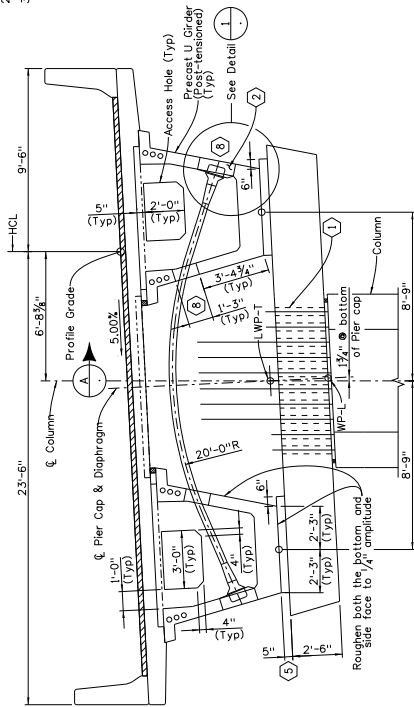
CIP STEM POST-TENSIONING NOTES:

1. Each tendon has 19 - 0.61" strands.
2. Peak = 835 Kips/tendon
3. Stress both tendons from one end.

US85/C470 INTERCHANGE IMPROVEMENTS
SOUTHBOUND TO EASTBOUND FLYOVER
PIER 4, 6, 8, 10 DETAILS (1 of 3)



PLAN - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)

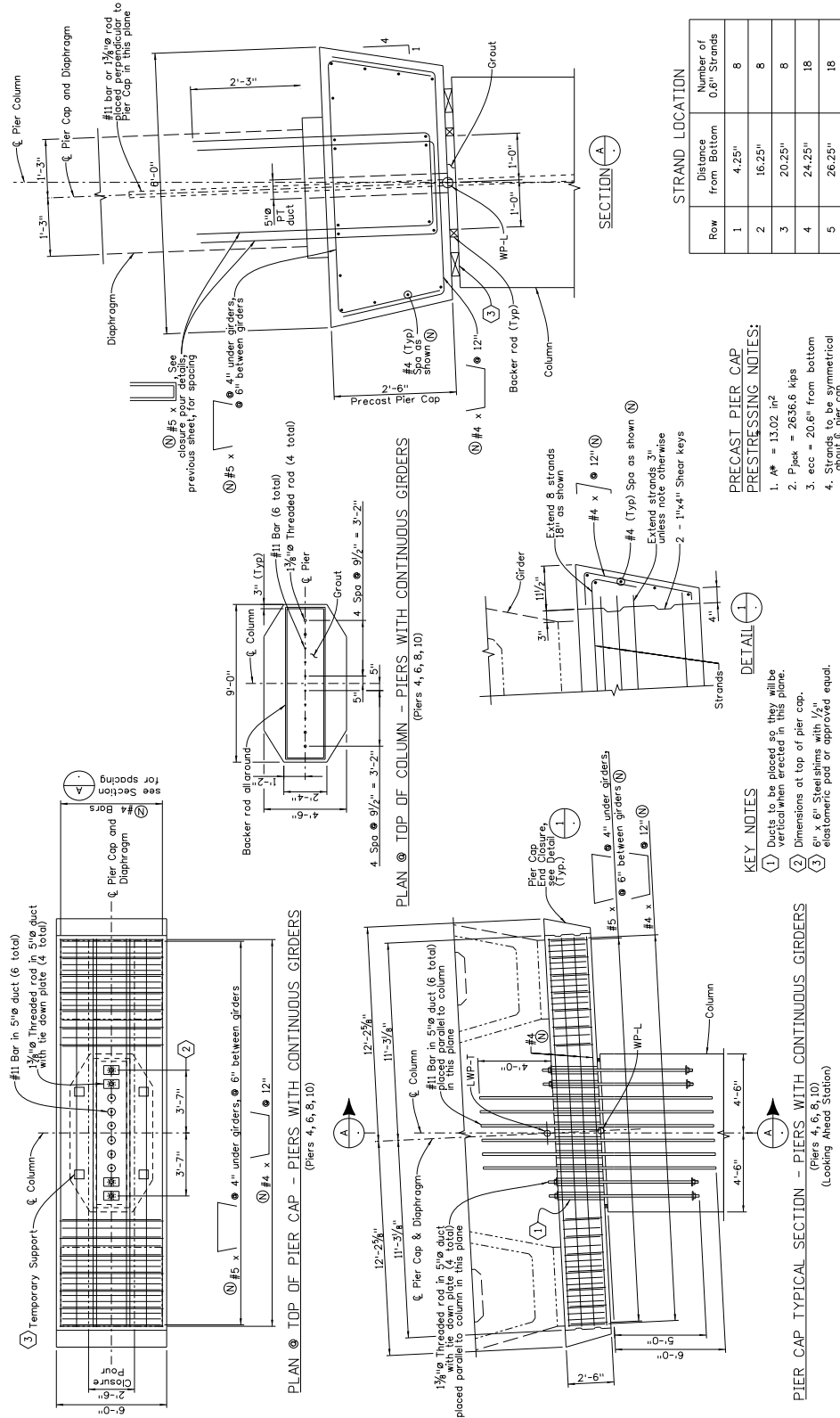


TYPICAL SECTION - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)
(Looking Ahead Station)

KEY NOTES

- 1 Dowels from column to pass through corrugated post-tensioning ducts.
- 2 Post-tensioning access pocket to be filled with Class D Concrete after grouting ducts.
- 3 Match longitudinal grade.
- 4 Diaphragm to be placed perpendicular to the pier cap.
- 5 Concrete shells to be placed under the girders and achieve $f_{ci} = 3,000$ psi prior to placing diaphragm concrete. Self-consolidating concrete or grout acceptable alternatives.
- 6 Place dry pack grout to prevent potential for water ponding.
- 7 Grout thickness set at 1/2" nominally. Allowable thickness is 1/2" to 3".
- 8 See Fixed Pier Type 2 Grider Details sheet for location and dimensions of voids, blockouts, ducts and sleeves through girder.

EXAMPLE 12.8



EXAMPLE 12.9