



INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 20-08

May 7, 2020

TO: All Design, Operations, and District Personnel, and Consultants

FROM: /s/ Stephanie J. Wagner
Stephanie J. Wagner
Director, Bridge Design Division
Engineering Department

SUBJECT: End Bent and Pier Diaphragm Details

REVISES: IDM Figures 406-16A, 406-16B, 406-16D thru 406-16I, 406-16K thru 406-16N, 409-2C, 409-2D, 409-3A, and 409-3B

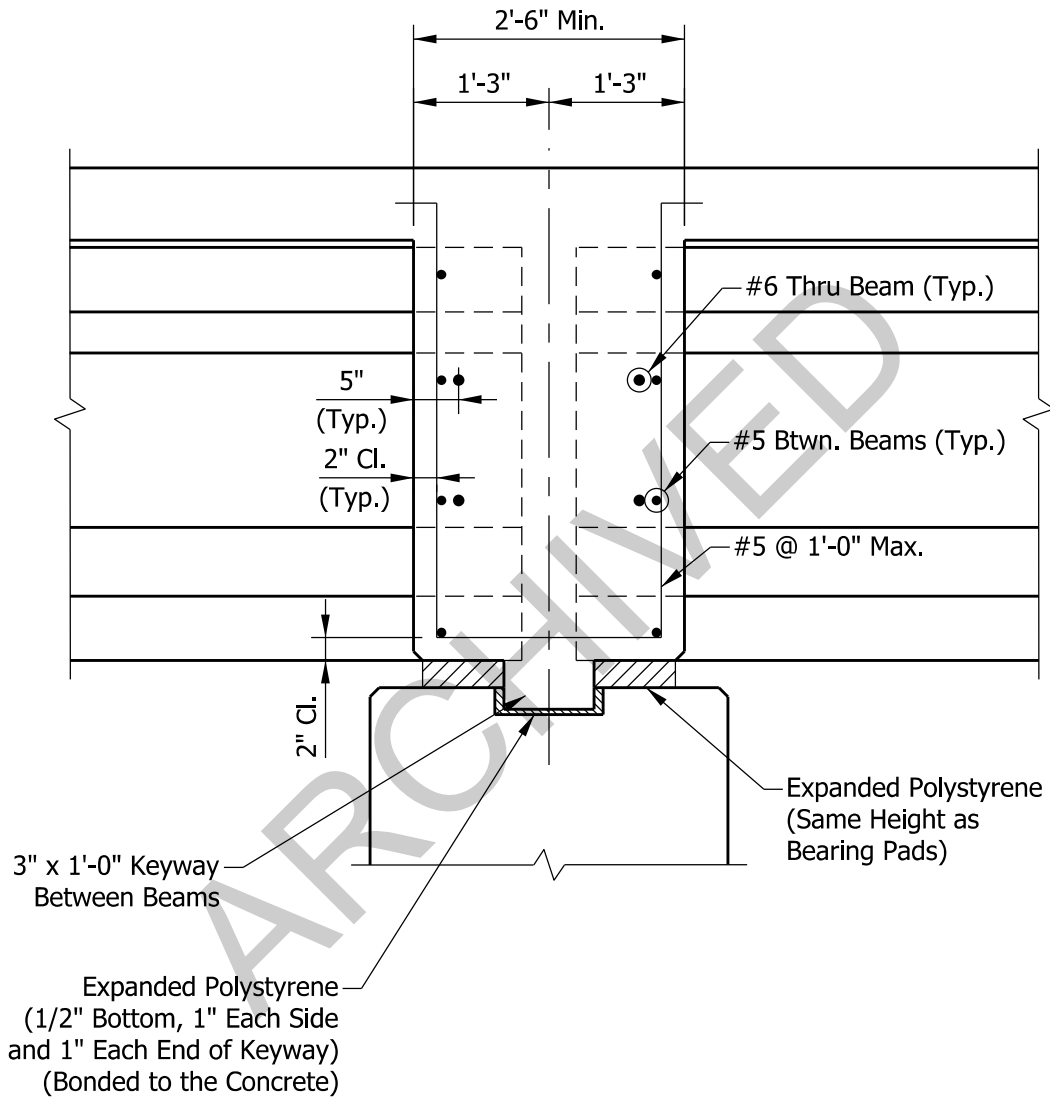
EFFECTIVE: Stage 3 submittal on or after June 1, 2020

The referenced *Indiana Design Manual* figures have been revised to address issues with minimum cover surrounding the prestressing strands in concrete beams. Revisions are summarized below. Figures are included for reference.

1. Removed reinforcing bar placed through the bottom flange for I-beam and Bulb-tee beams.
 - a. Updated pier diaphragm details (Chapter 406 figures)
 - b. Updated end bent details (Chapter 409 figures).
2. Updated formatting for pier cap sizing and bearing layout details (Chapter 406 figures)

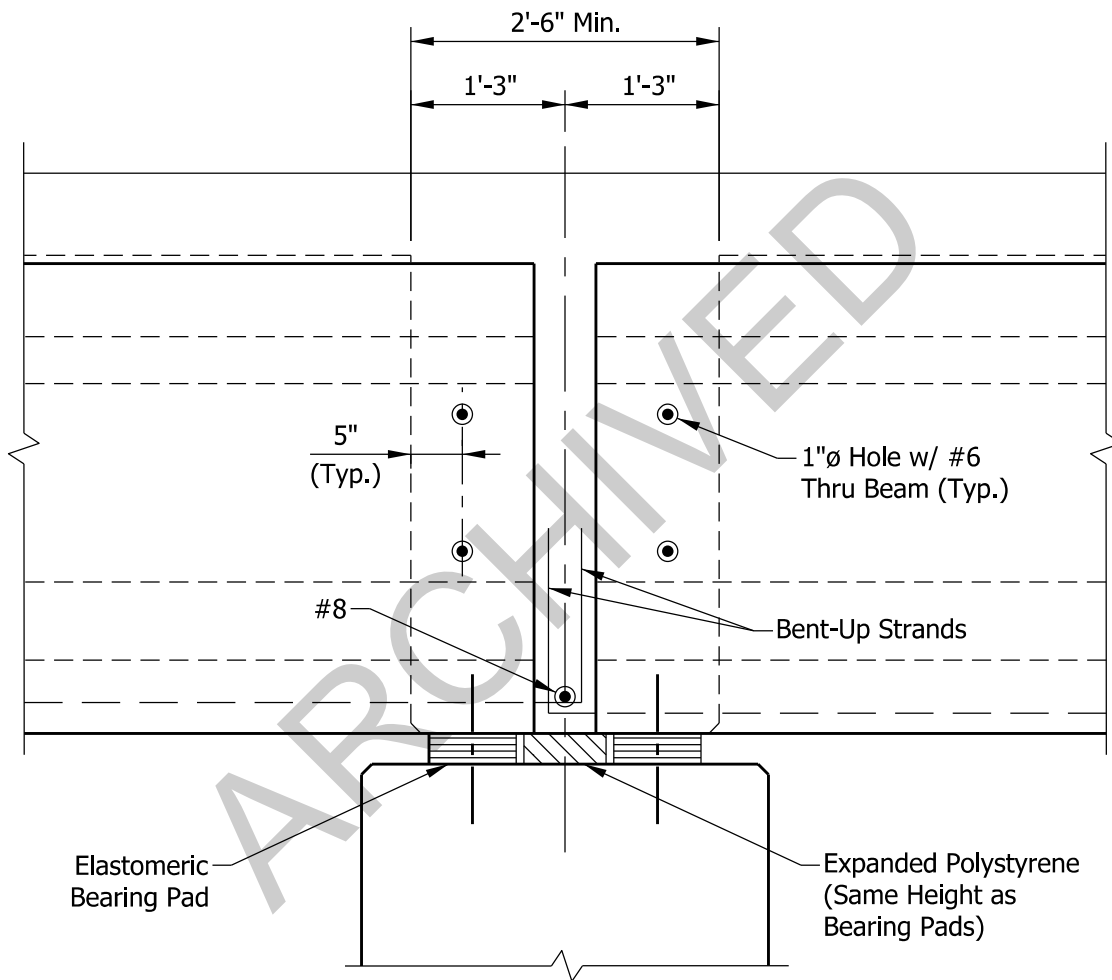
Details may be used immediately and should be incorporated in accordance with the effective date shown.

Questions regarding beam details should be directed to the INDOT Bridge Design Division at BridgeDesignOffice@indot.in.gov.



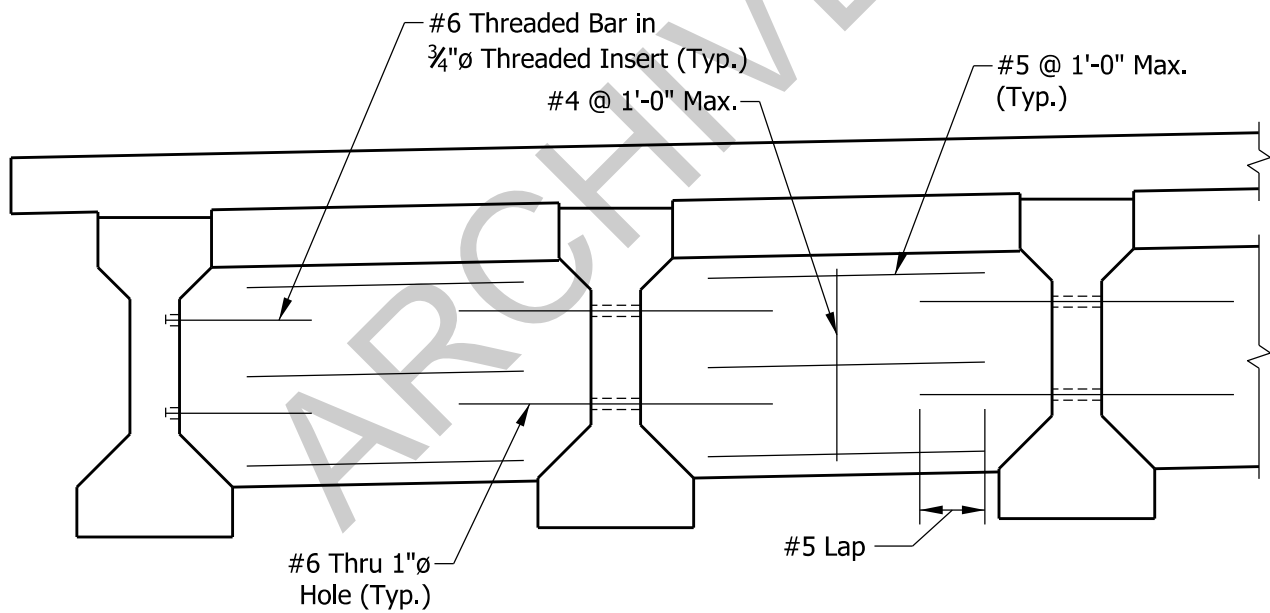
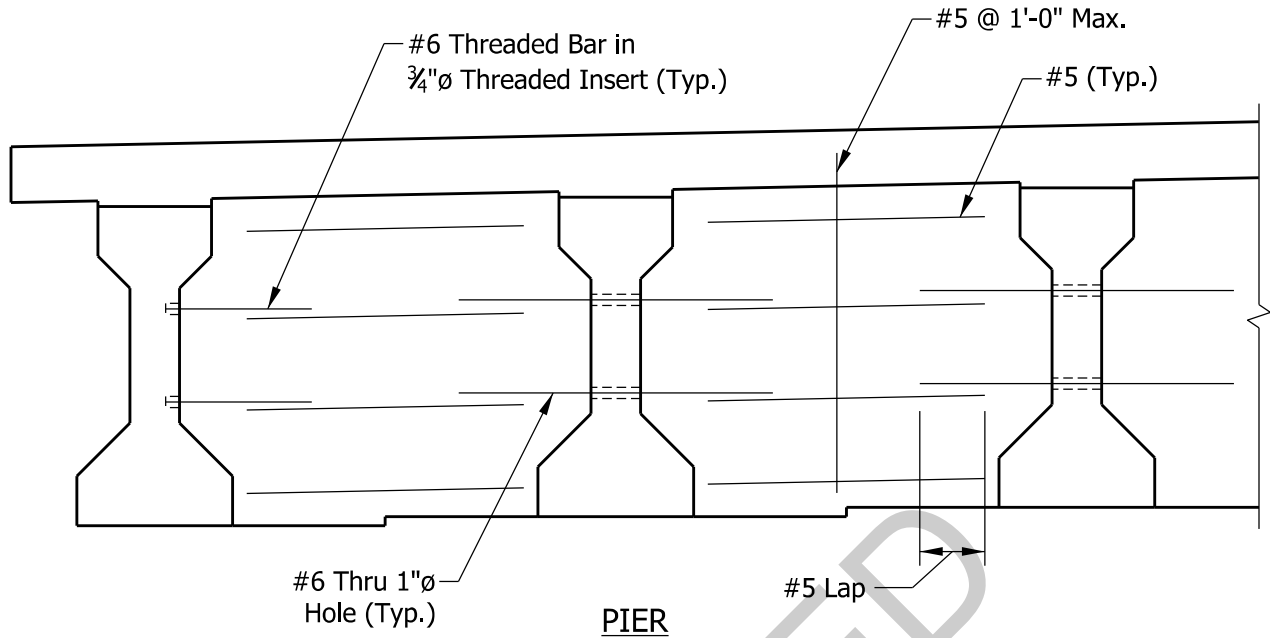
I-BEAM PIER DIAPHRAGM SECTION BETWEEN BEAMS

Figure 406-16A



I-BEAM PIER DIAPHRAGM SECTION AT BEAMS

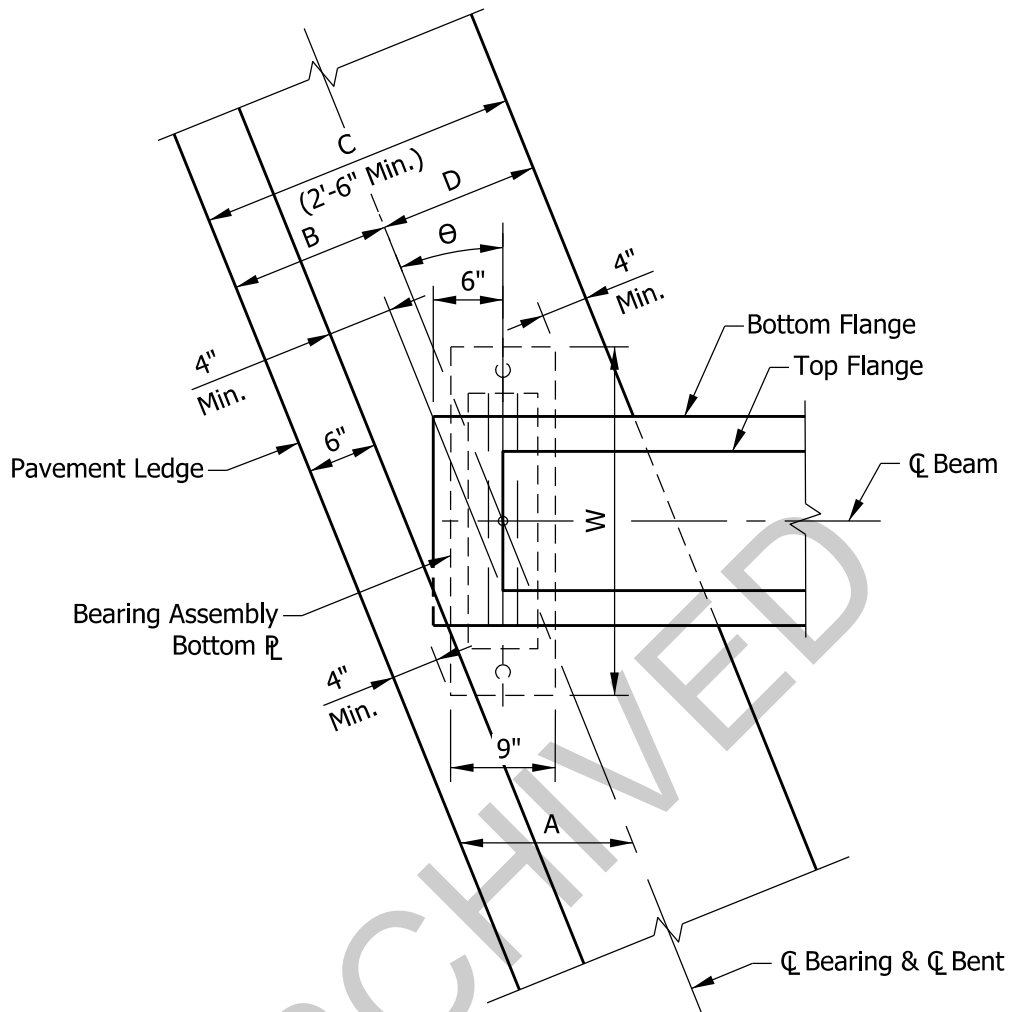
Figure 406-16B



NOTE: For steel intermediate diaphragms, see Standard Drawings.

I-BEAM DIAPHRAGMS

Figure 406-16D



$$A = \frac{4''}{\cos \theta} + 4\frac{1}{2}'' + 0.5 W \tan \theta$$

$$B = A \cos \theta$$

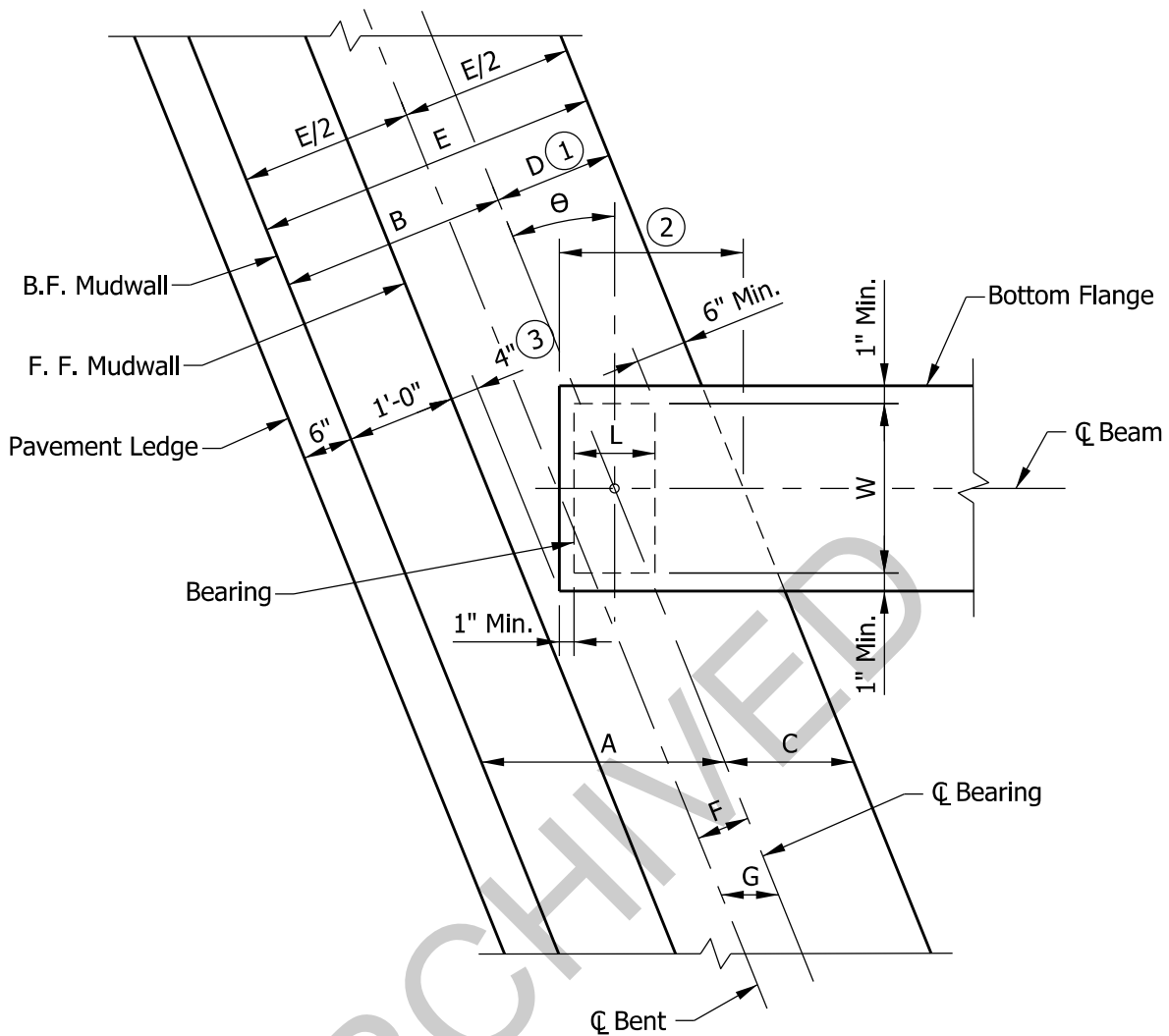
$$C = 2 B \text{ Round cap width up to an increment of 3''}$$

$$\text{Actual } B = 0.5 (\text{Cap Width})$$

$$D = \text{Actual } B$$

I-BEAM: END BENT CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16E
(Page 1 of 2)



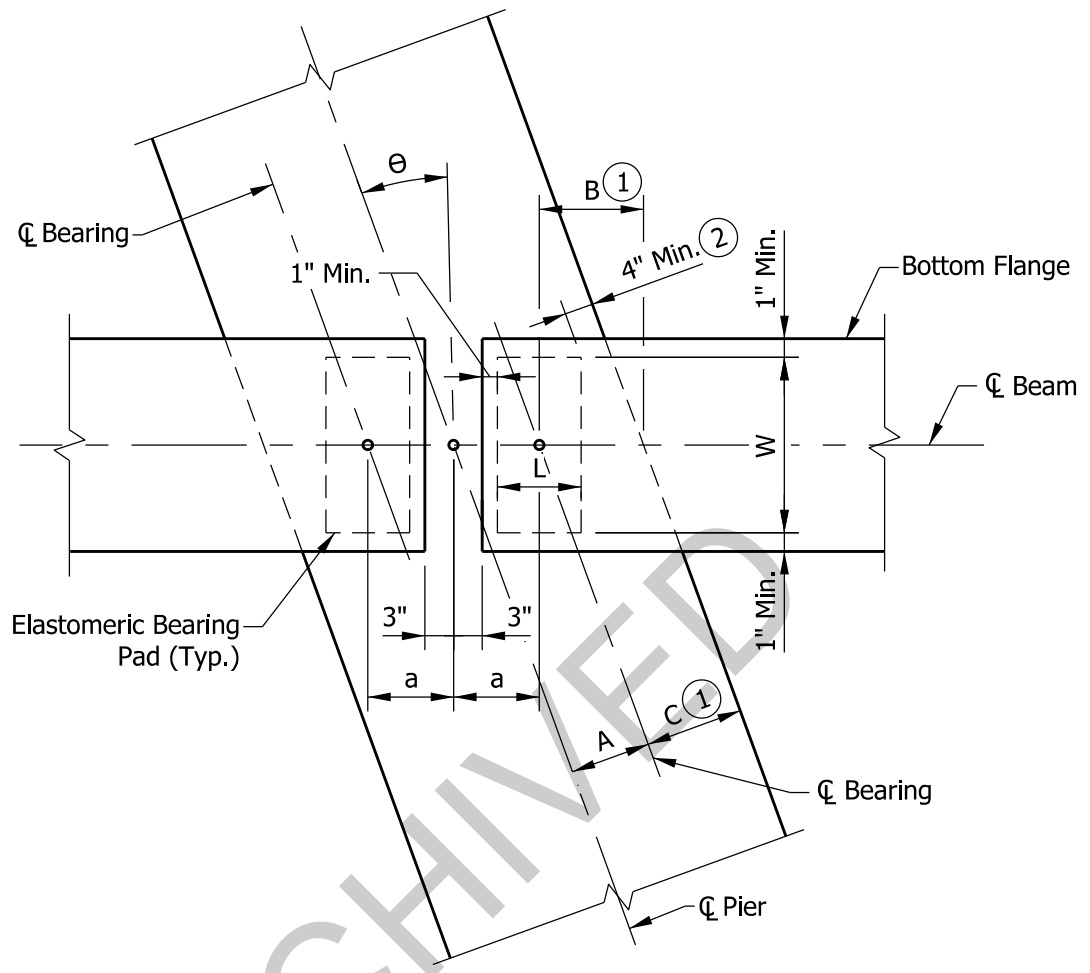
$$\begin{aligned}
 A &= \frac{16''}{\cos \theta} + 0.5 L + 1'' + (0.5 W + 1'') \tan \theta & E &= B + D \text{ Round up to an increment of 3''} \\
 B &= A \cos \theta & \text{Actual } D &= E - B \\
 C &= 0.5 (L + W \tan \theta) + \frac{6''}{\cos \theta} & F &= B - 0.5 E \\
 D &= C \cos \theta & G &= \frac{F}{\cos \theta}
 \end{aligned}$$

NOTES:

- ① Use for sizing cap only.
- ② Check seismic minimum support length for expansion bent.
- ③ This dimension should be increased for large expansion length.

I-BEAM: END BENT CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16E
(Page 2 of 2)



$$a = 0.5 L + 4''$$

$$A = a \cos \theta$$

$$B = 0.5 (L + W \tan \theta) + (4'') \frac{1}{\cos \theta}$$

$$C = B \cos \theta$$

Cap Width = $2 (A + C)$ Round cap width up to an increment of 3".

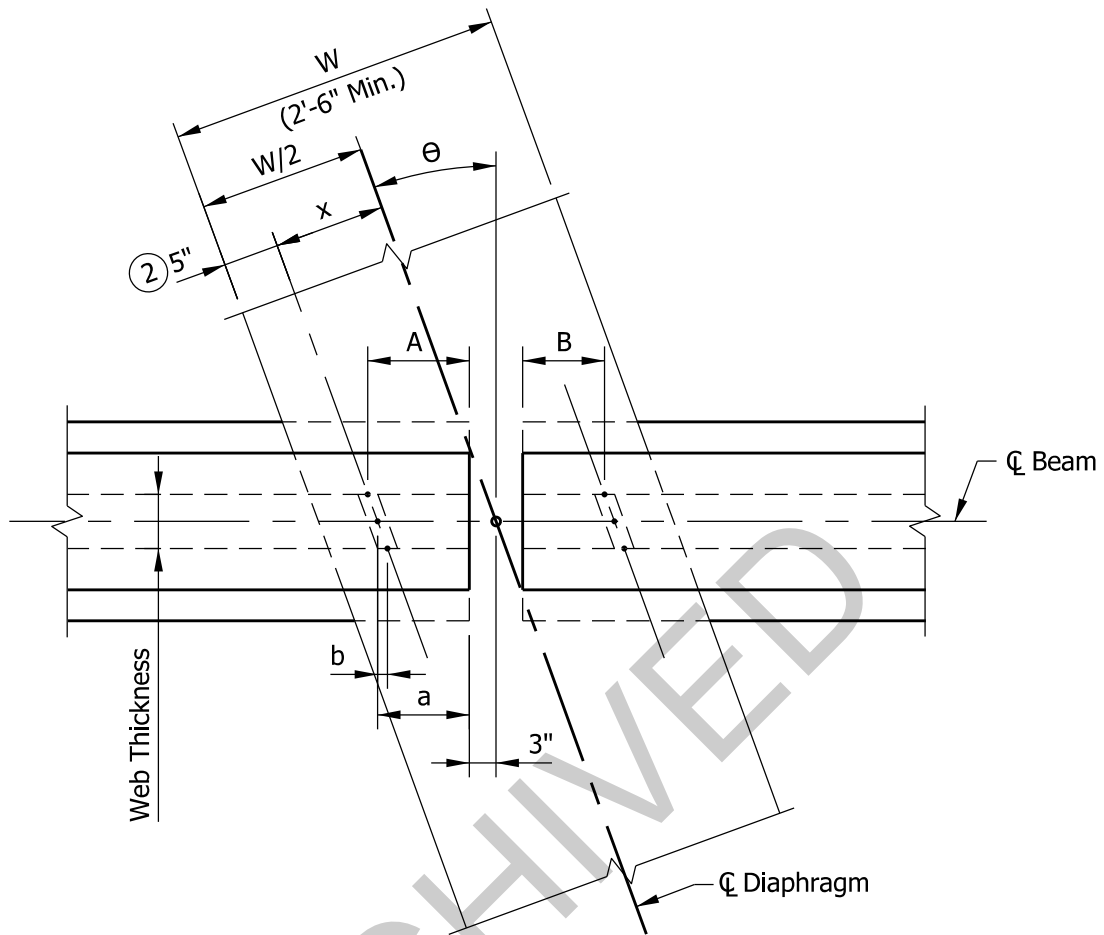
Actual C = $1/2$ Cap Width - A

NOTES:

- ① Use for sizing cap only.
- ② Use 6" for pier below expansion joint.

I-BEAM: PIER CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16F



$$x = 1/2 W - 5''$$

$$a = (x) \frac{1}{\cos \theta} - 3''$$

$$b = (1/2 \text{ Web Thickness}) (\tan \theta)$$

$$A = a + b$$

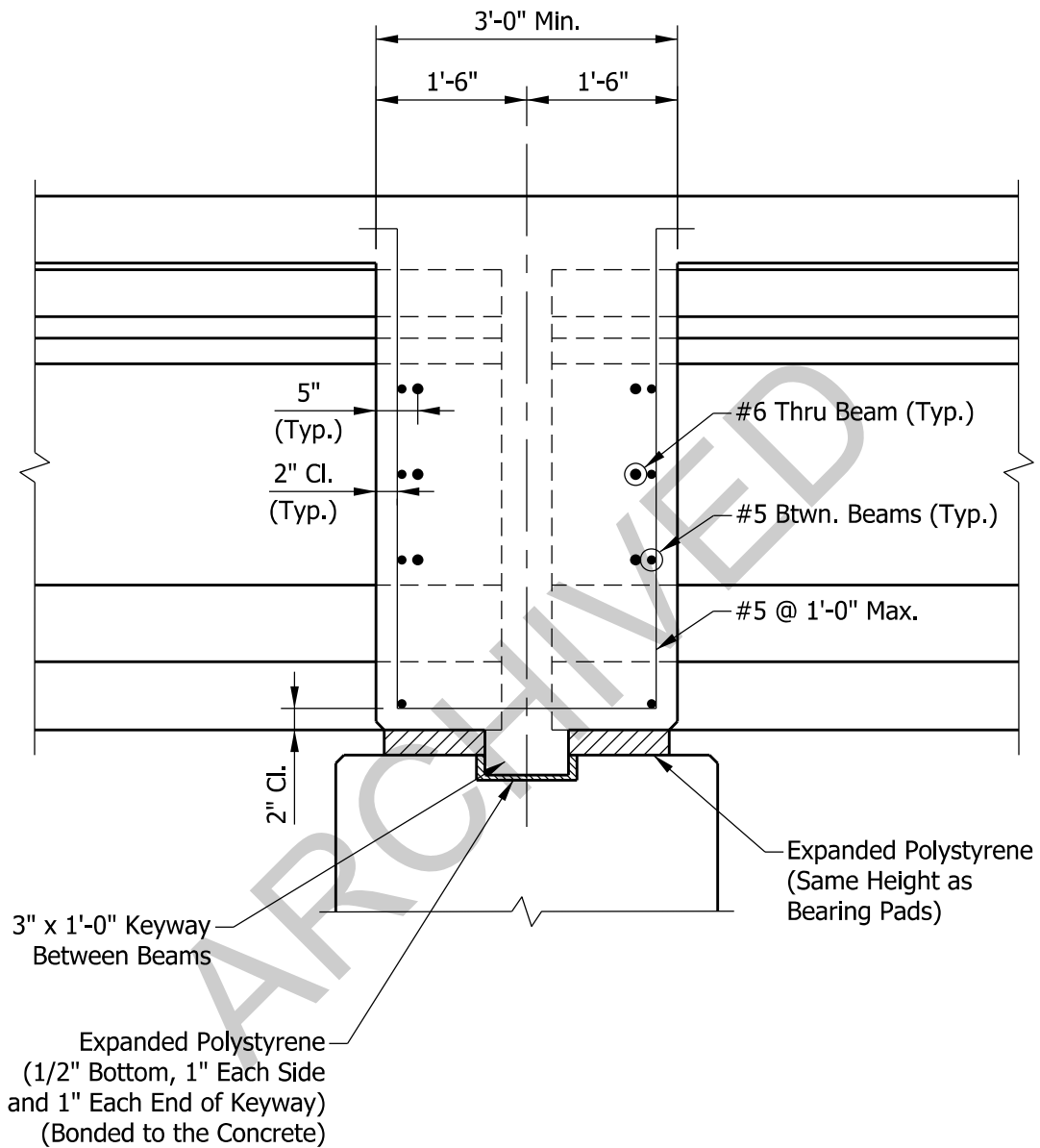
$$B = a - b$$

NOTES:

1. If $B < 2''$ use larger diaphragm.
- ② This dimension will increase or decrease slightly if ends of beams are not vertical. See Section 406-12.0 for additional information.

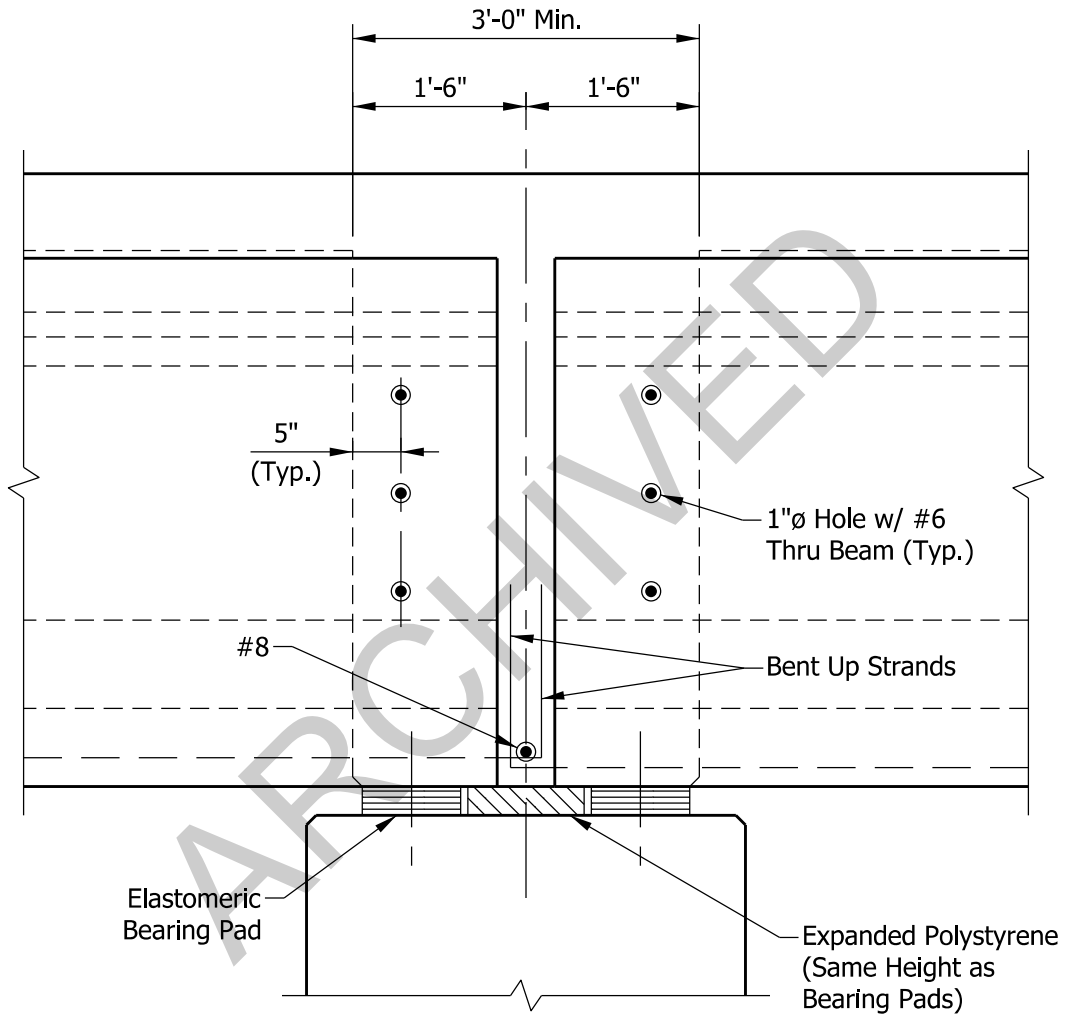
**I-BEAM:
HOLES AT PIER DIAPHRAGM**

Figure 406-16G



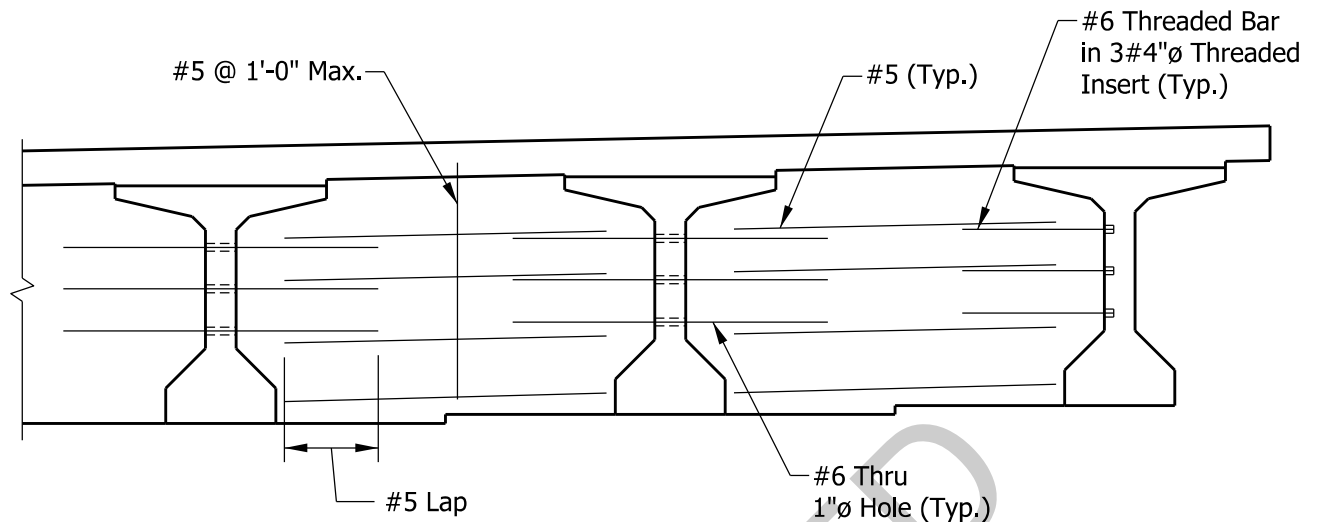
BULB-TEE PIER DIAPHRAGM SECTION BETWEEN BEAMS

Figure 406-16H

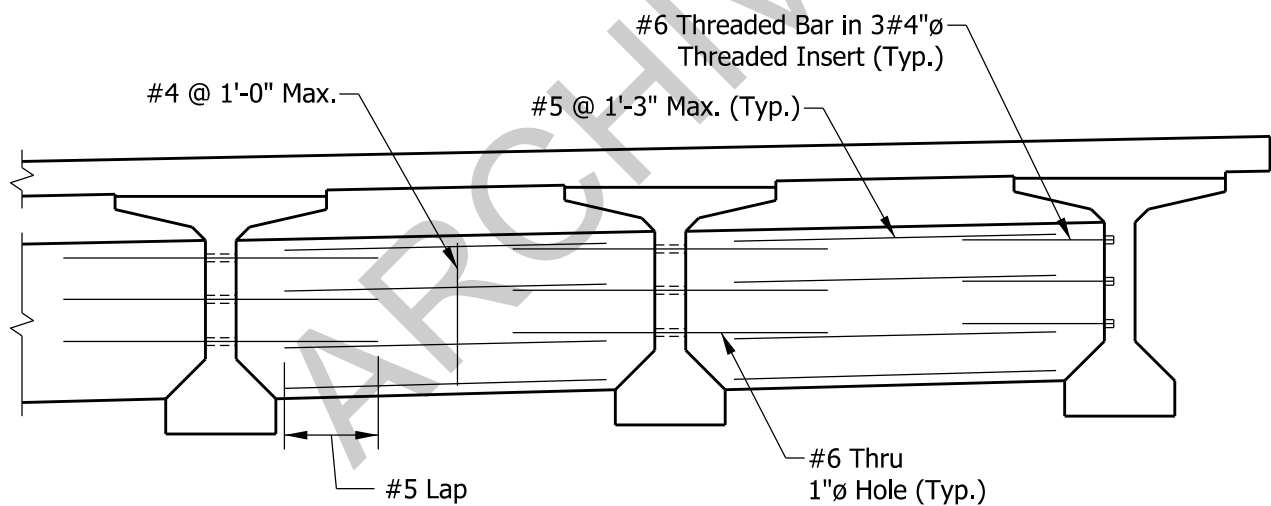


BULB-TEE PIER DIAPHRAGM SECTION AT BEAMS

Figure 406-16 I



PIER

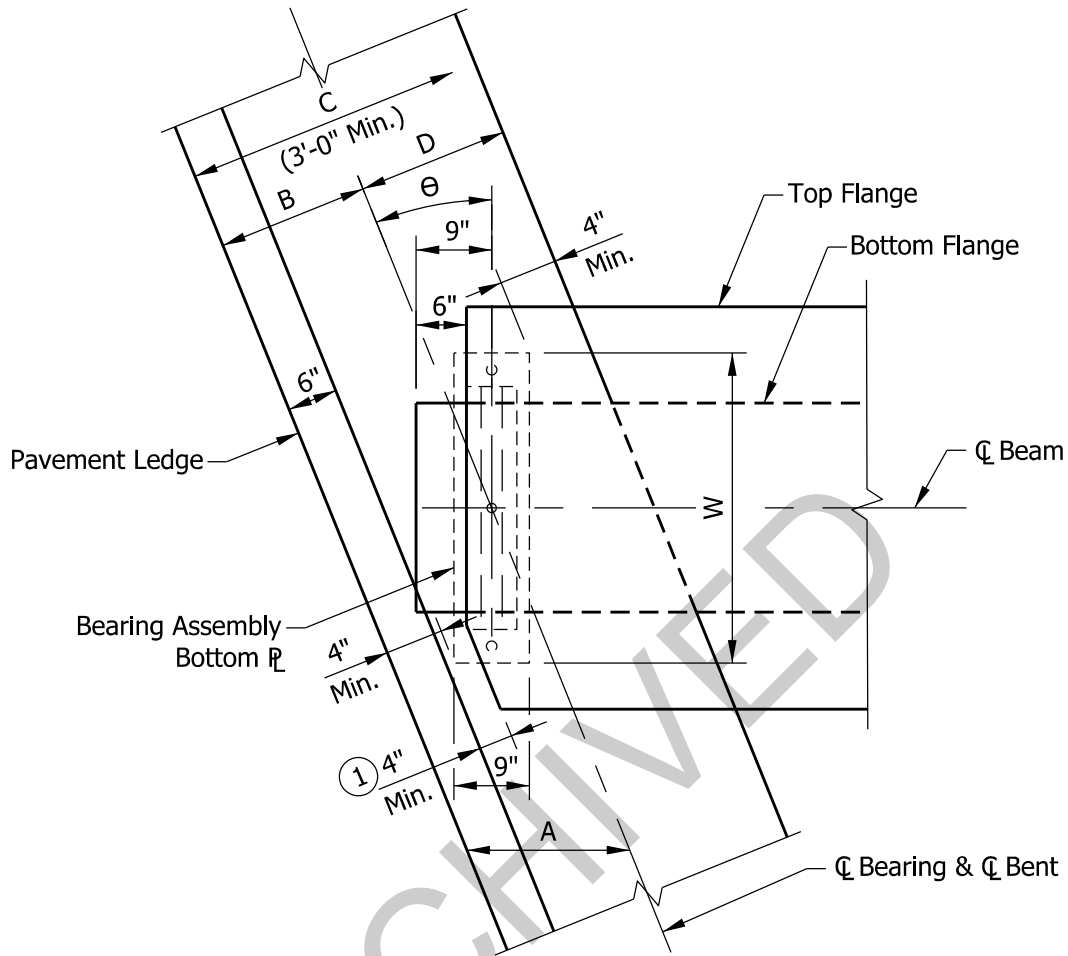


INTERMEDIATE
(Alternate Concrete Diaphragm)

NOTE: For steel intermediate diaphragms, see Standard Drawings.

BULB-TEE DIAPHRAGM

Figure 406-16K



$$A = \frac{4''}{\cos \theta} + 4\frac{1}{2}'' + 0.5 W \tan \theta$$

$$B = A \cos \theta$$

$$C = 2 B \text{ Round cap width up to an increment of } 3''.$$

$$\text{Actual } B = 0.5 (\text{Cap Width})$$

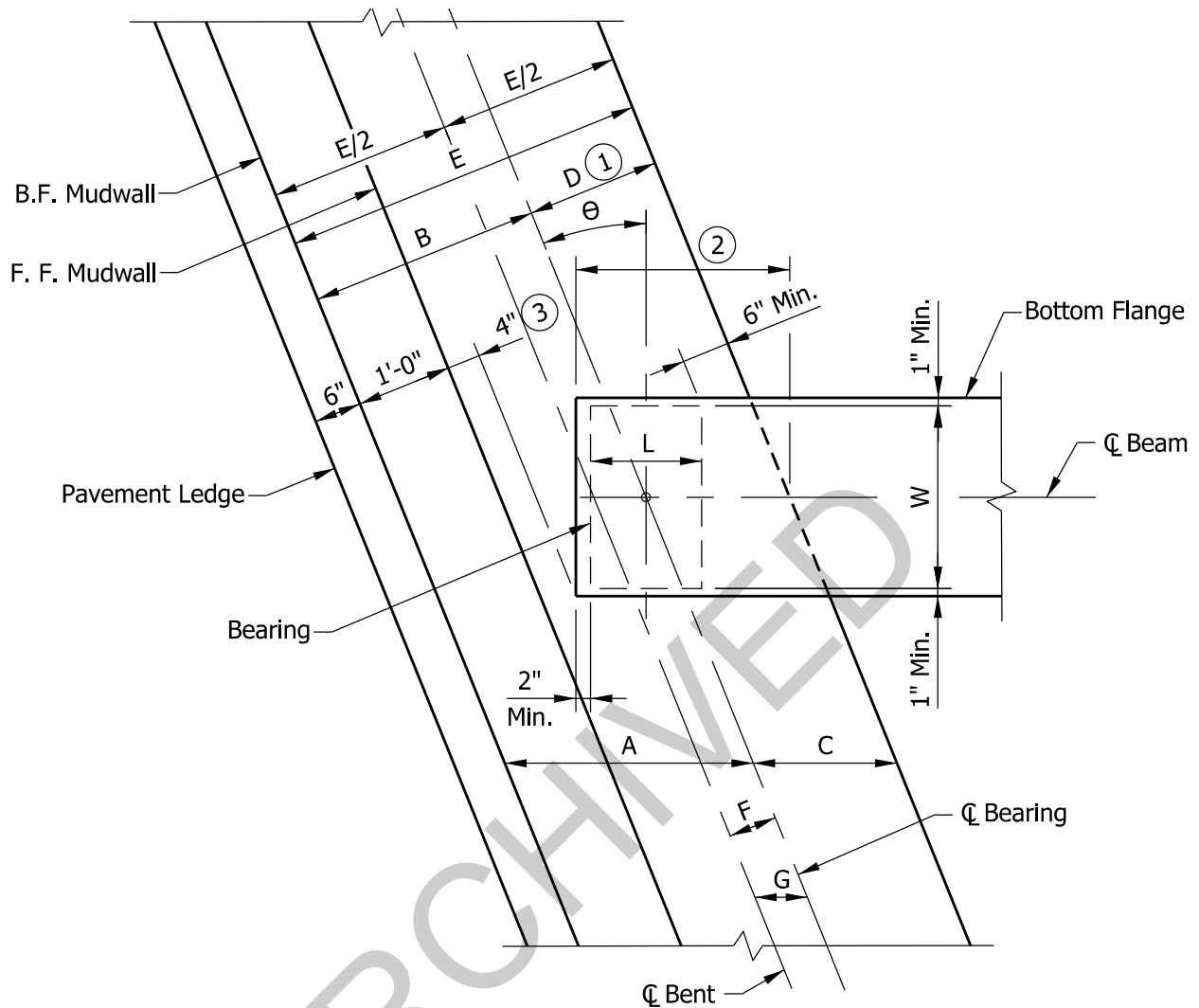
$$D = \text{Actual } B$$

NOTE:

- ① Clip top flange as needed.

BULB-TEE: END BENT CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16L
(Page 1 of 2)



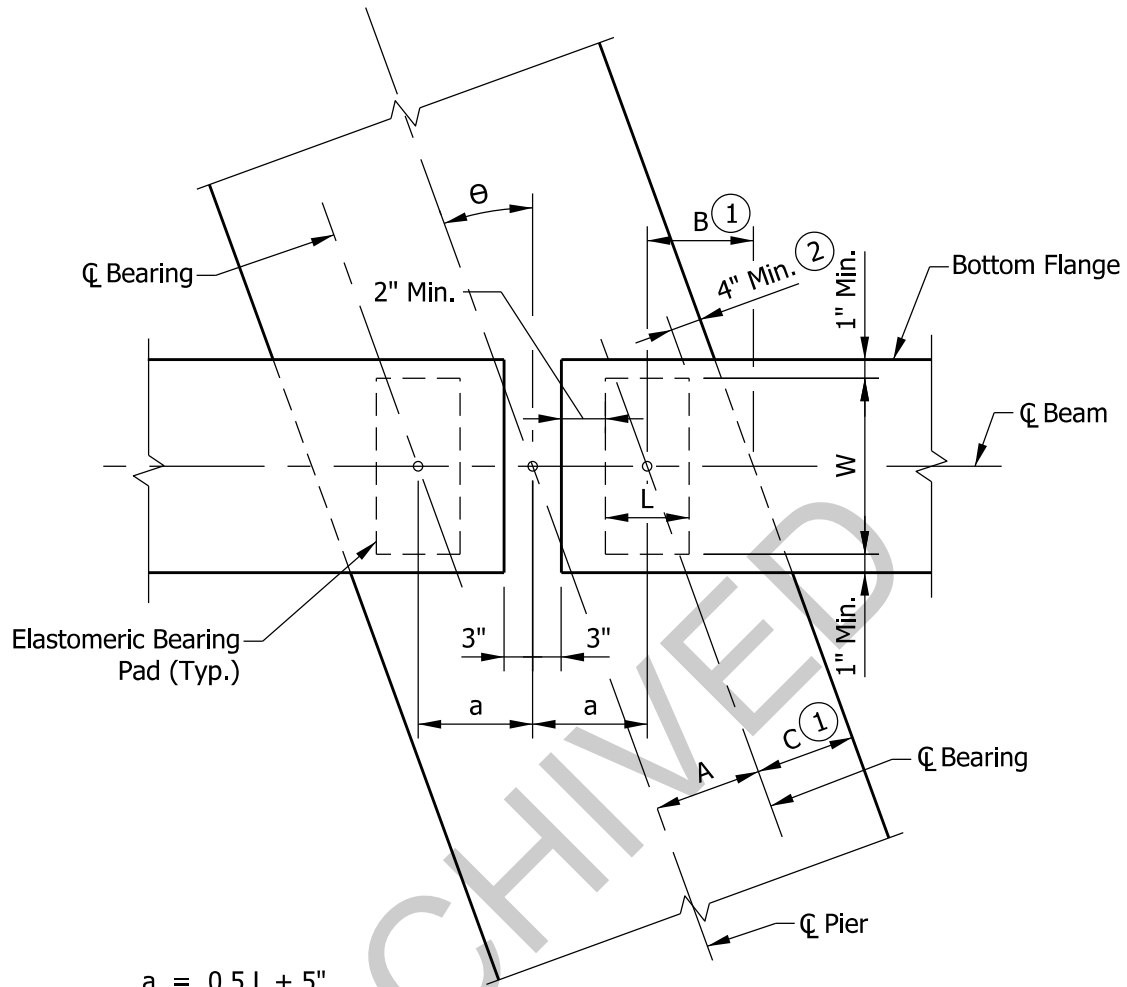
$$\begin{aligned}
 A &= \frac{16''}{\cos \theta} + 0.5 L + 2'' + (0.5 W + 1'') \tan \theta & E &= B + D \text{ Round up to an increment of 3''} \\
 B &= A \cos \theta & \text{Actual } D &= E - B \\
 C &= 0.5 (L + W \tan \theta) + \frac{6''}{\cos \theta} & F &= B - 0.5 E \\
 D &= C \cos \theta & G &= \frac{F}{\cos \theta}
 \end{aligned}$$

NOTES:

- ① Use for sizing cap only.
- ② Check seismic minimum support length for expansion bent.
- ③ This dimension should be increased for large expansion length.

BULB-TEE: END BENT CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16L
(Page 2 of 2)



$$a = 0.5 L + 5"$$

$$A = a \cos \theta$$

$$B = 0.5 (L + W \tan \theta) + (4") \frac{1}{\cos \theta}$$

$$C = B \cos \theta$$

Cap Width = $2 (A + C)$ Round cap width up to an increment of 3".

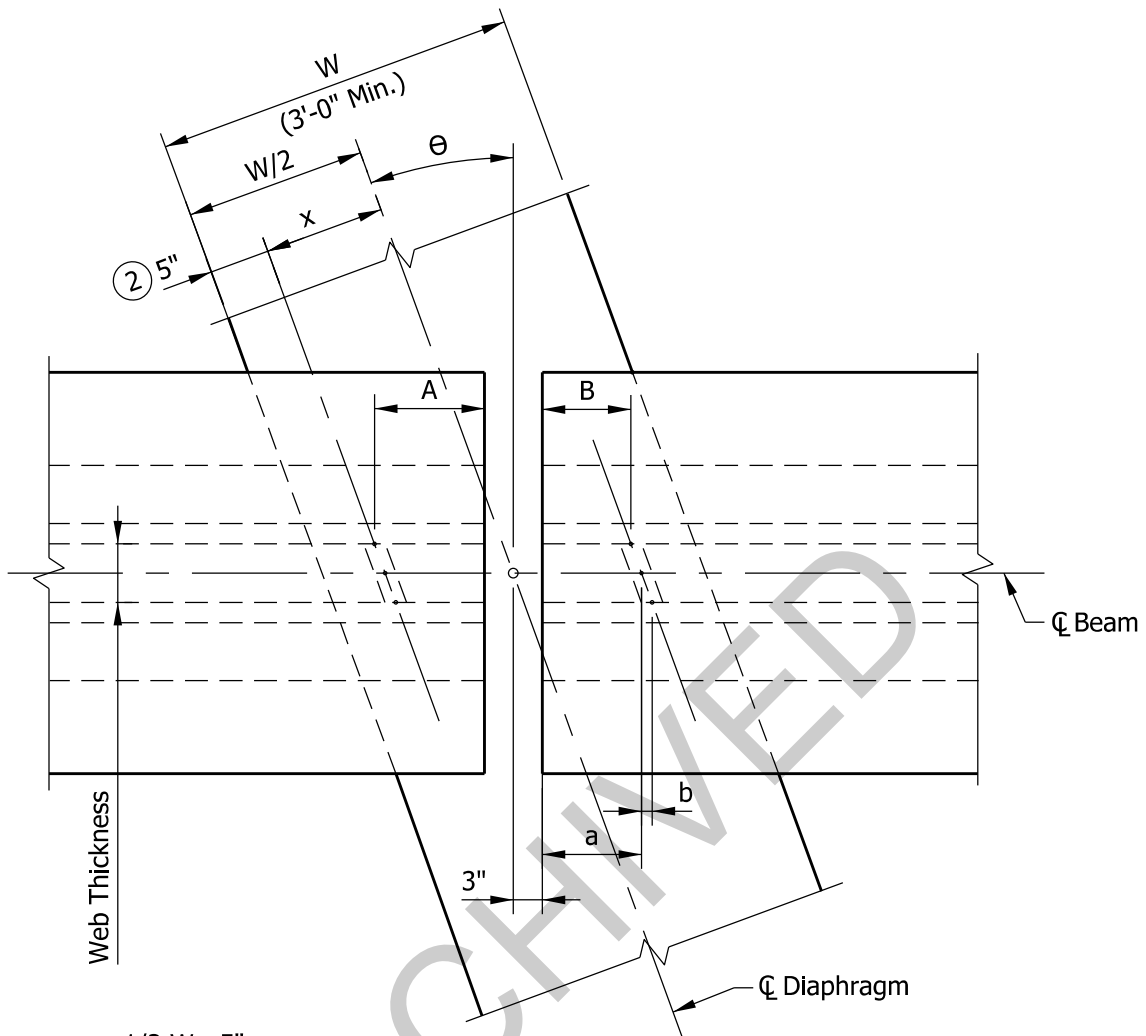
Actual C = $1/2$ Cap Width - A

NOTES:

- ① Use for sizing cap only.
- ② Use 6" for pier below expansion joint.

BULB TEE: PIER CAP SIZING AND BEARING LAYOUT DETAILS

Figure 406-16M



$$x = 1/2 W - 5''$$

$$a = (x) \frac{1}{\cos \Theta} - 3''$$

$$b = (1/2 \text{ Web Thickness}) (\tan \Theta)$$

$$A = a + b$$

$$B = a - b$$

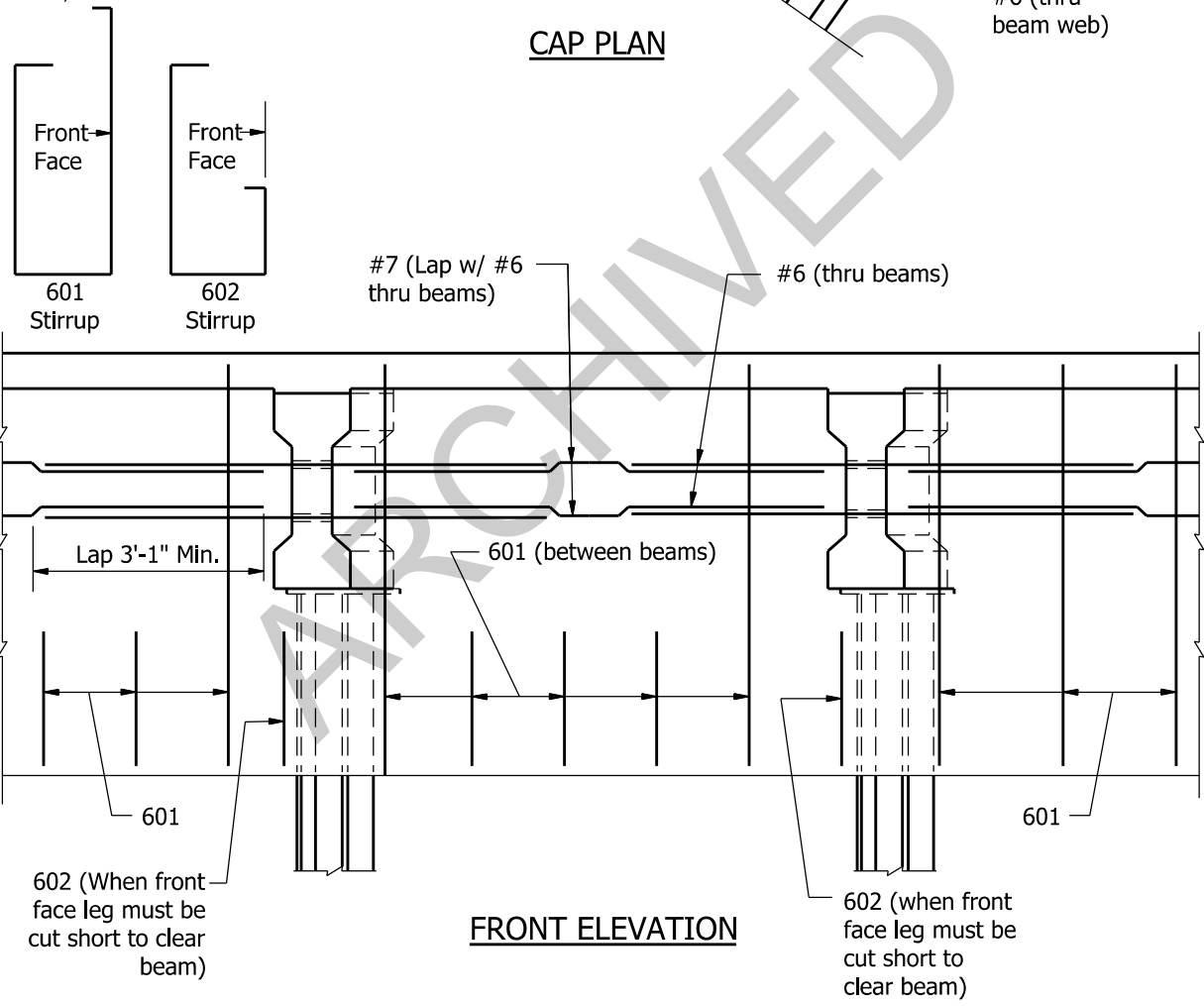
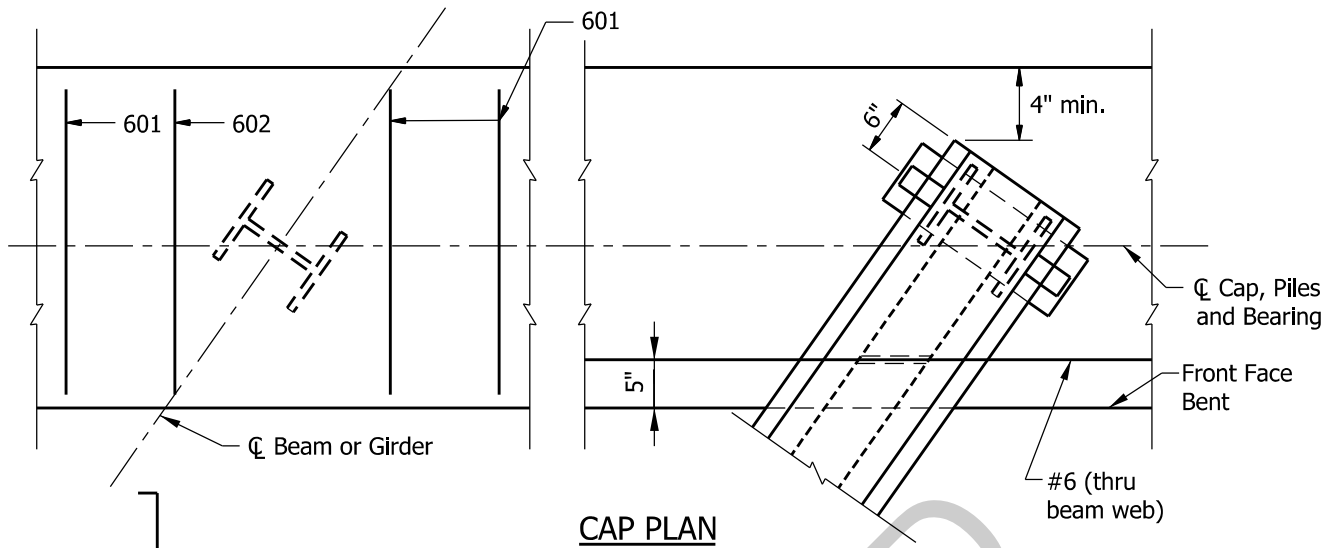
NOTES:

1. If $B < 2''$ use larger diaphragm.

② This dimension will increase or decrease slightly if ends of beams are not vertical. See Section 406-12.0 for additional information.

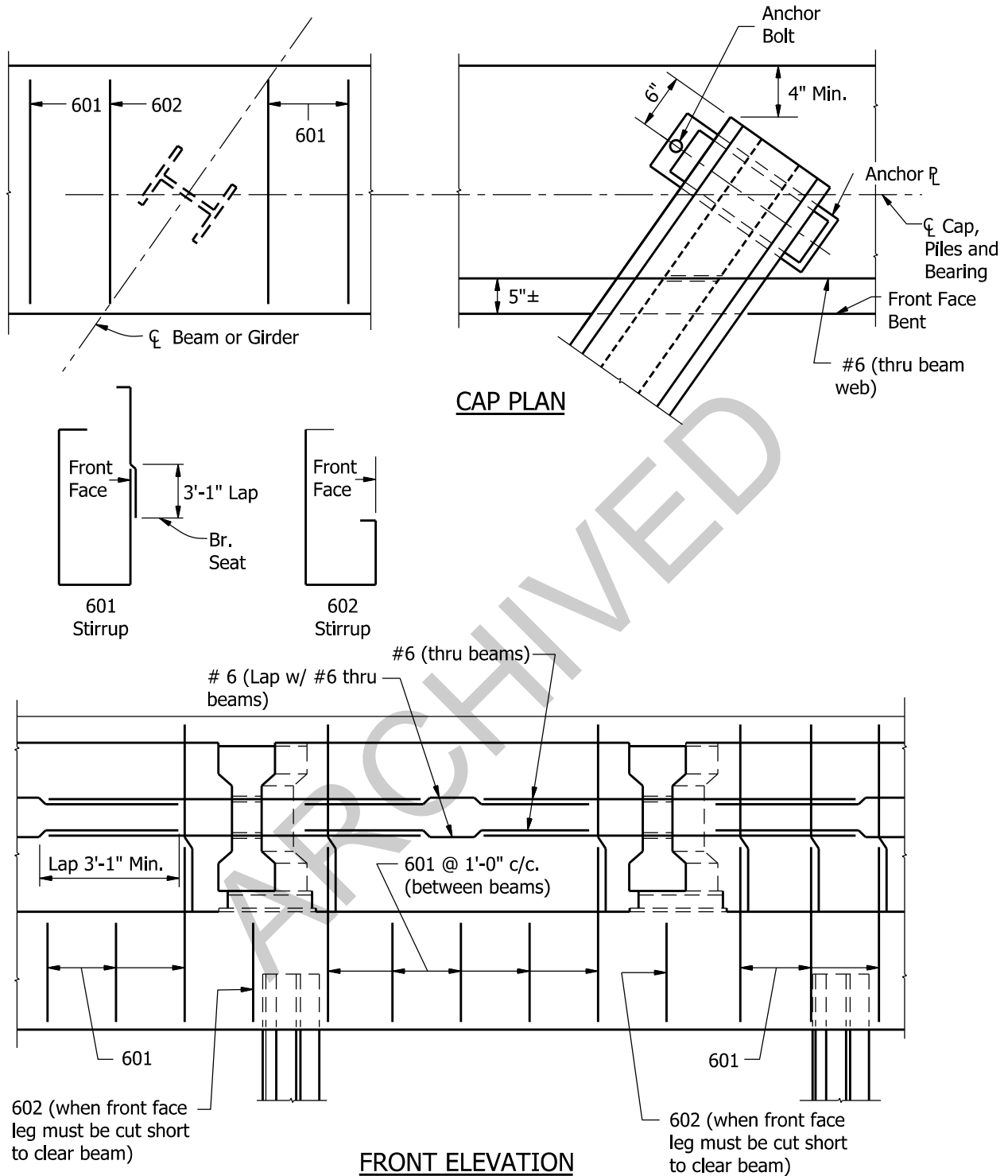
BULB-TEE HOLES AT PIER DIAPHRAGM

Figure 406-16N



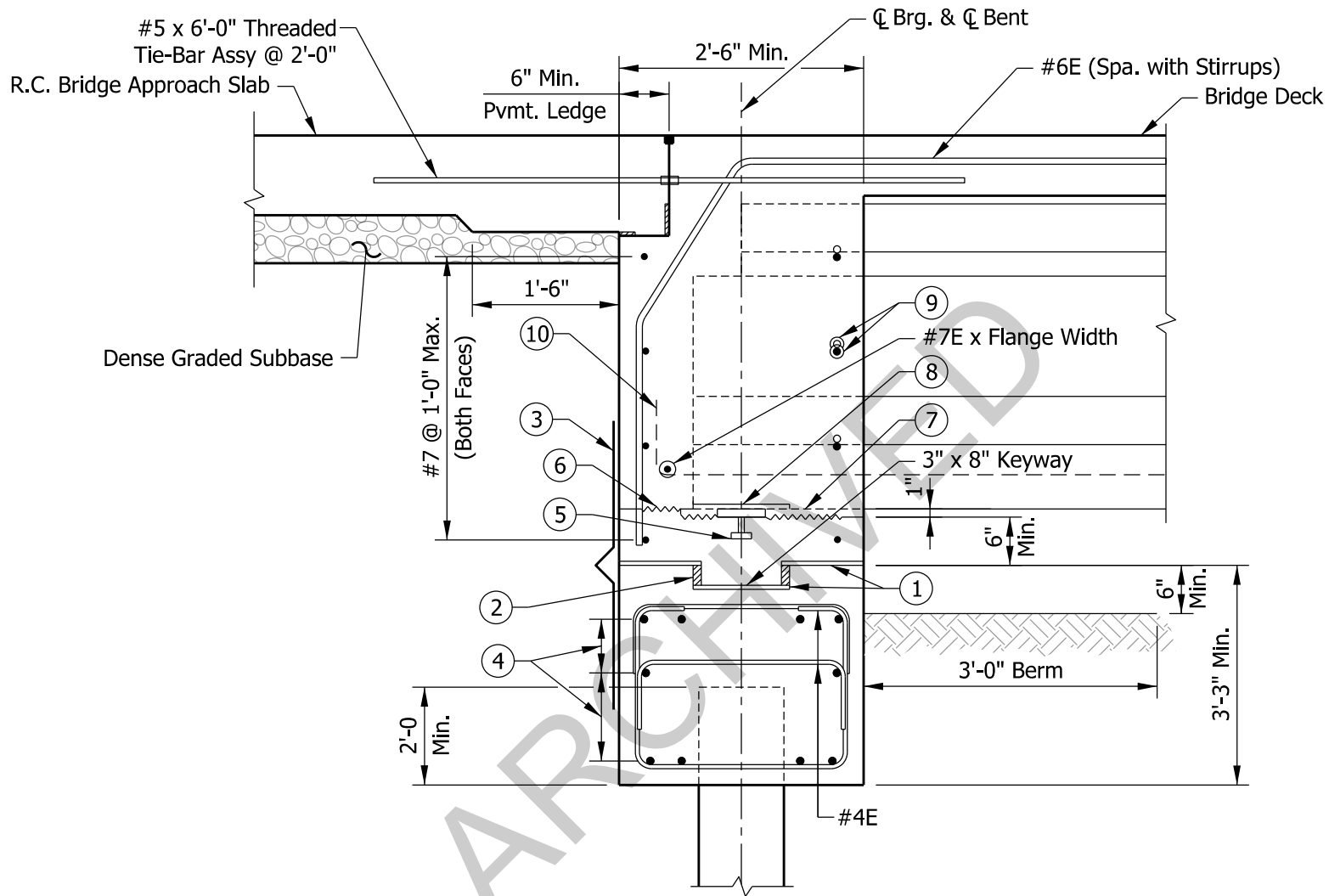
**SUGGESTED INTEGRAL END BENT DETAILS
Method A, Beams Attached Directly to Piling**

**Figure 409-2C
(Page 3 of 4)**



SUGGESTED INTEGRAL END BENT DETAILS
Method B, Beams Attached to Concrete Cap

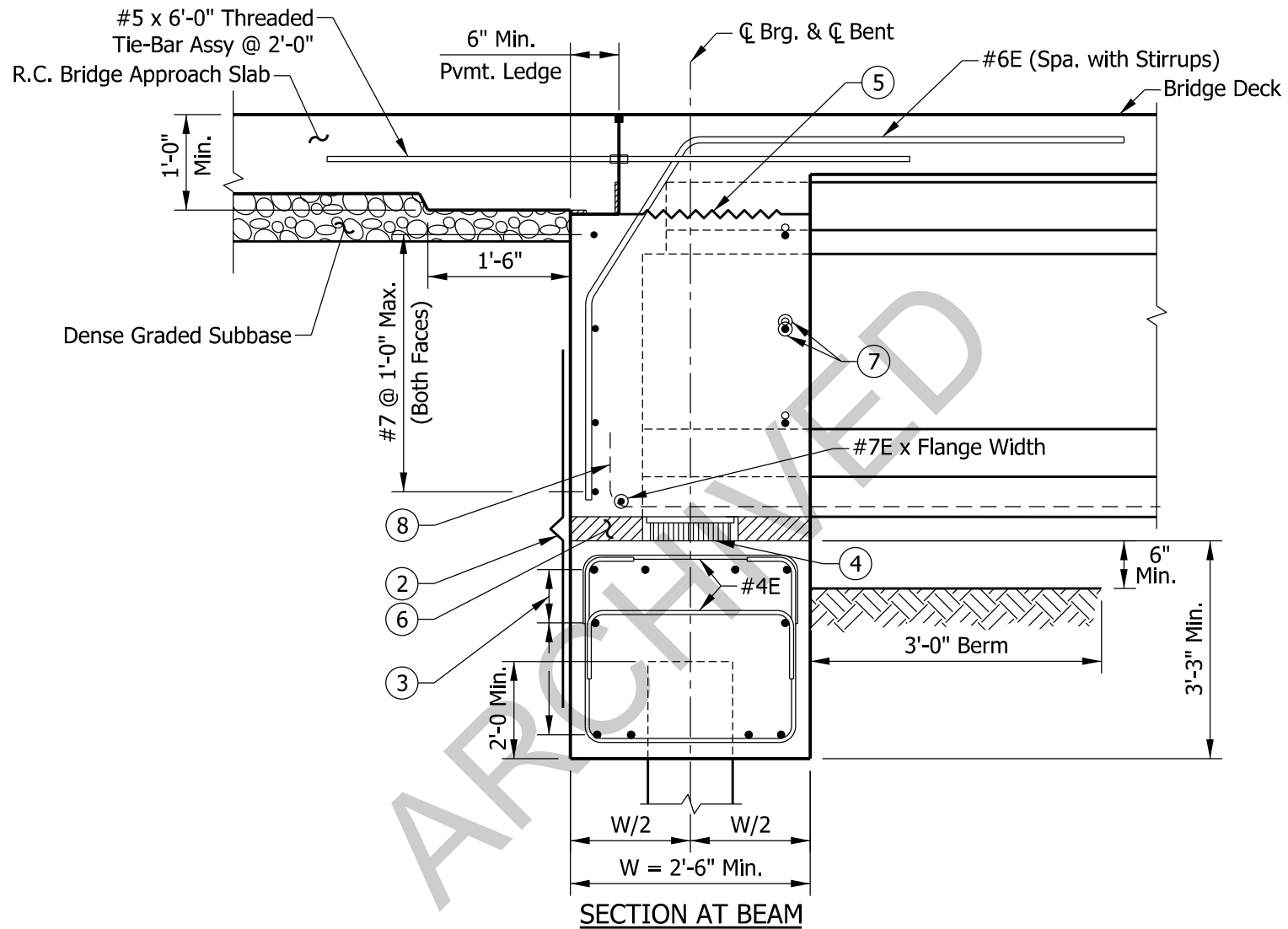
Figure 409-2D
(Page 3 of 4)



SECTION AT BEAM

**SUGGESTED SEMI-INTEGRAL END BENT DETAILS
(Method 1)**

**Figure 409-3A
(Page 1 of 4)**



**SUGGESTED SEMI-INTEGRAL END BENT DETAILS
(Method 2)**

**Figure 409-3B
(Page 1 of 3)**