INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 16-32
Technical Advisory

September 19, 2016

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

FROM: ***/s/ Jeremy C. Hunter***
Jeremy C. Hunter
Manager, Office of Bridge Design
Bridges Division

SUBJECT: **Integral End Bent Depth**

REVISES: ***Indiana Design Manual*** **Section 409-2.04(02), Figures 409-2C and 409-2D**

EFFECTIVE: **Immediately**

The *Indiana Design Manual* (IDM) provides the design requirements and assumptions for the use of integral end bents. The design assumptions and typical reinforcing details are appropriate for end bents of reasonable depth. Deeper end bents may be subject to frame action forces and not be representative of the design assumptions. Deeper end bents may also complicate superstructure replacement should the end bent not have the capacity to resist lateral earth pressure behind the bent without the superstructure functioning like a strut.

The Department is implementing a maximum allowable integral end bent depth of 6 feet as measured from the bottom of the beams to the bottom of the bent. Integral end bents deeper than 6 feet will be considered on a case by case basis, but will require coordination with, and approval from the Office of Bridge Design.

The referenced IDM section and figures have been revised to implement the above requirement. In addition, the previous terminology of "integral abutment" has been restored to "integral end bent".

joint is required for an integral structure of length greater than 500 ft, as shown in Figure 409-2F.

4. Wingwalls Configuration. Wingwalls shall extend parallel to the centerline of roadway. This configuration reduces the loads imposed upon the bridge structure due to passive earth pressure from the end-bent backfill. See Figure 409-5A for suggested wingwall dimensioning details. The minimum thickness of a wingwall used with an integral end bent shall be 1 ft. The wingwall length shall not be greater than 10 ft. A longer wingwall will require additional analysis.

5. Wingwall Connection. Force effects in the connection between the wingwall and cap, and in the wingwall itself, shall be investigated, and adequate reinforcing steel shall be provided.

6. Interior Diaphragms for Steel Structure. Where steel beams or girders are used, an interior diaphragm shall be placed within 10 ft of the end support to provide beam stability prior to and during the deck pour.

7. Intermediate Pier Details for Integral Structure Located in Seismic Area with Seismic Design Category Greater than A. Intermediate piers should include concrete restrainers as shown in Figure 409-2B.

409-2.04(02) Pile Connection and Plans Details [Rev. Oct. 2012, Sep. 2016]

An integral end bent may be constructed using either of the methods as follows

1. Method A. The superstructure beams are placed on and attached directly to the end bent piling. The entire end bent is then poured at the same time as the superstructure deck. This is the preferred method. See Figure 409-2D

2. Method B. The superstructure beams are set in place and anchored to the previously cast-in-place end bent cap. The concrete above the previously cast-in-place cap shall be poured at the same time as the superstructure deck. See Figure 409-2C

Optional construction joints may be placed in the end bent cap to facilitate construction. An optional joint below the bottom of the beam may be used regardless of bridge length. An optional construction joint may be placed at the pavement ledge elevation shown. However, since 2007 it has been the Department's practice to disallow pouring of the bridge approach continuously with the deck pour for structures with integral or semi-integral end bents.

Regardless of the method used, the end bent shall be in accordance with the following.

1. Width. The width shall not be less than 2.5 ft.

2. Depth. The depth from the bottom of the beam or girder to the bottom of the integral end bent should not exceed 6'- 0". Use of a deeper end bent must be approved by the Bridges Division Office of Bridge Design.

3. Cap Embedment. The embedment of the piles into the cap shall be 2 ft. The embedded portion of the pile should be confined with spiral reinforcement as shown in Figure 409-2E.

4. Beam Attachment. The beams shall be physically attached to the piling if using Method A, or to the cast-in-place cap if using Method B.

5. Beam Extension. The beams shall extend at least 1.75 ft into the bent, as measured along the centerline of the beam.

6. Concrete Cover. Concrete cover beyond the farthest-most edge of the beam at the rear face of the bent shall be at least 4 in. This minimum cover shall also apply to the pavement-ledge area. The top flanges of structural-steel or prestressed concrete I-beams may be coped to satisfy this requirement. Where the 4-in. minimum cover cannot be maintained within a 2.5-ft cap, the cap shall be widened.

7. Stiffener Plates. Structural-steel members shall have stiffener plates welded to both sides of their webs and to the flanges over the supports to anchor the beams into the concrete.

8. Reinforcement through the Webs of Beams. A minimum of three holes shall be provided through the webs of steel members near the front face of the bent for #6 bars to be inserted through. Two holes shall be provided through prestressed concrete I-beam webs near the front face of the bent, to allow #6 bars to be inserted to further anchor the beam to the cap. Box beams shall have two threaded inserts placed in each side face for anchorage of #7 threaded bars.

9. End-Bent Reinforcement. The minimum size of stirrups shall be #6 spaced at a maximum of 1'-0". Longitudinal cap reinforcement shall be at least #7 at 1'-0" maximum spacing along both faces of the bent. All reinforcing steel shall be epoxy coated.

10. Corner Bars. Corner bars shall extend from the rear face of the cap into the top of the deck at not more than 1'-0" spacing as shown in Figures 409-2B and 409-2C. The

figures show suggested details for an integral end bent with a structural-members bridge. Other reinforcement and connection details shall be used where they are structurally sound and afford an advantage if compared to that shown in the figures. See Figures 409-2B and 409-2C for drainage-pipes placement behind an end bent. See *LRFD* 11.4.1 and 11.6.6 for additional drainage information.

11. MSE Wall. If placed behind an MSE retaining wall, the end bent should be configured as shown in Figure 409-2G.

409-3.0 SEMI-INTEGRAL END BENT

409-3.01 General

Semi-integral end bents shall be considered if integral end bents are not practical or feasible. For a skew angle of greater than 30 deg or an expansion length of 250 ft or longer, twisting or racking of the bridge shall be investigated.

Minimum support-length requirements shall be investigated for semi-integral end bent Method 2.

409-3.02 Materials

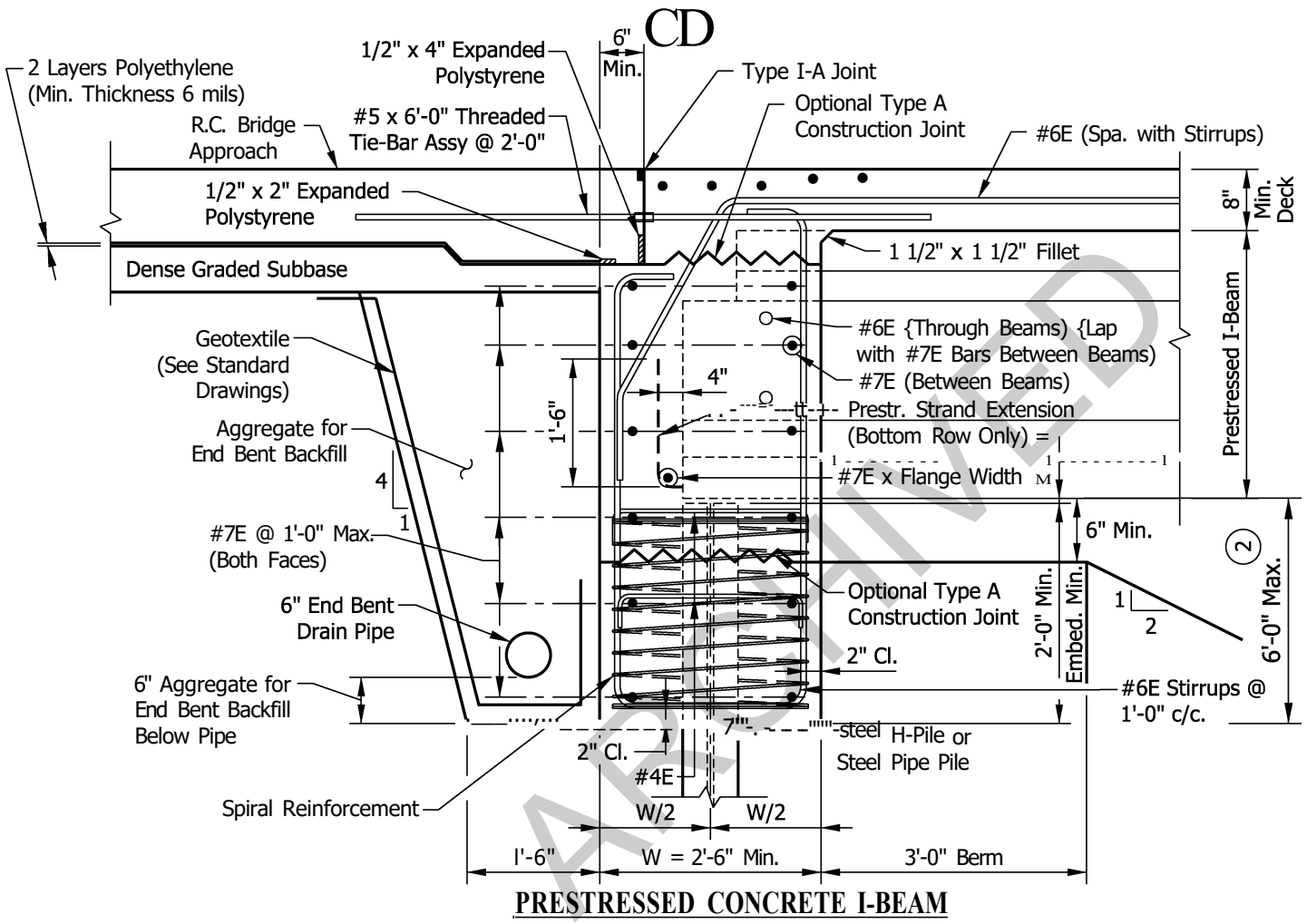
Semi-integral end bents and wingwalls will require the use of class C concrete and epoxy-coated reinforcing steel.

409-3.03 Details

Figure 409-3A shows details for Method 1. Figure 409-3B shows details for Method 2. Figure 409-3C shows details for the joint-protection sheeting. Figure 409-3D shows details pavement-ledge details for integral and semi-integral end bents. All applicable information shown in the figures shall be shown on the plans.

Wingwalls details are similar to those for an integral end bent except for the connection method. The wingwall is connected to the bent below the seat elevation. See Figure 409-5A for suggested wingwall-dimensioning details. The minimum wingwall thickness of a wingwall shall be 1 ft.

See *LRFD* 11.4.1 and 11.6.6 for additional drainage information.



PRESTRESSED CONCRETE I-BEAM

NOTES:

(D A pavement ledge greater than 6 in. may be considered for skewed structures or structures subject to significant truck traffic.

O A depth greater than 6 ft requires approval from the Office of Bridge Design.

3. All reinforcing steel shall be epoxy coated.

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

Figure 409-2C
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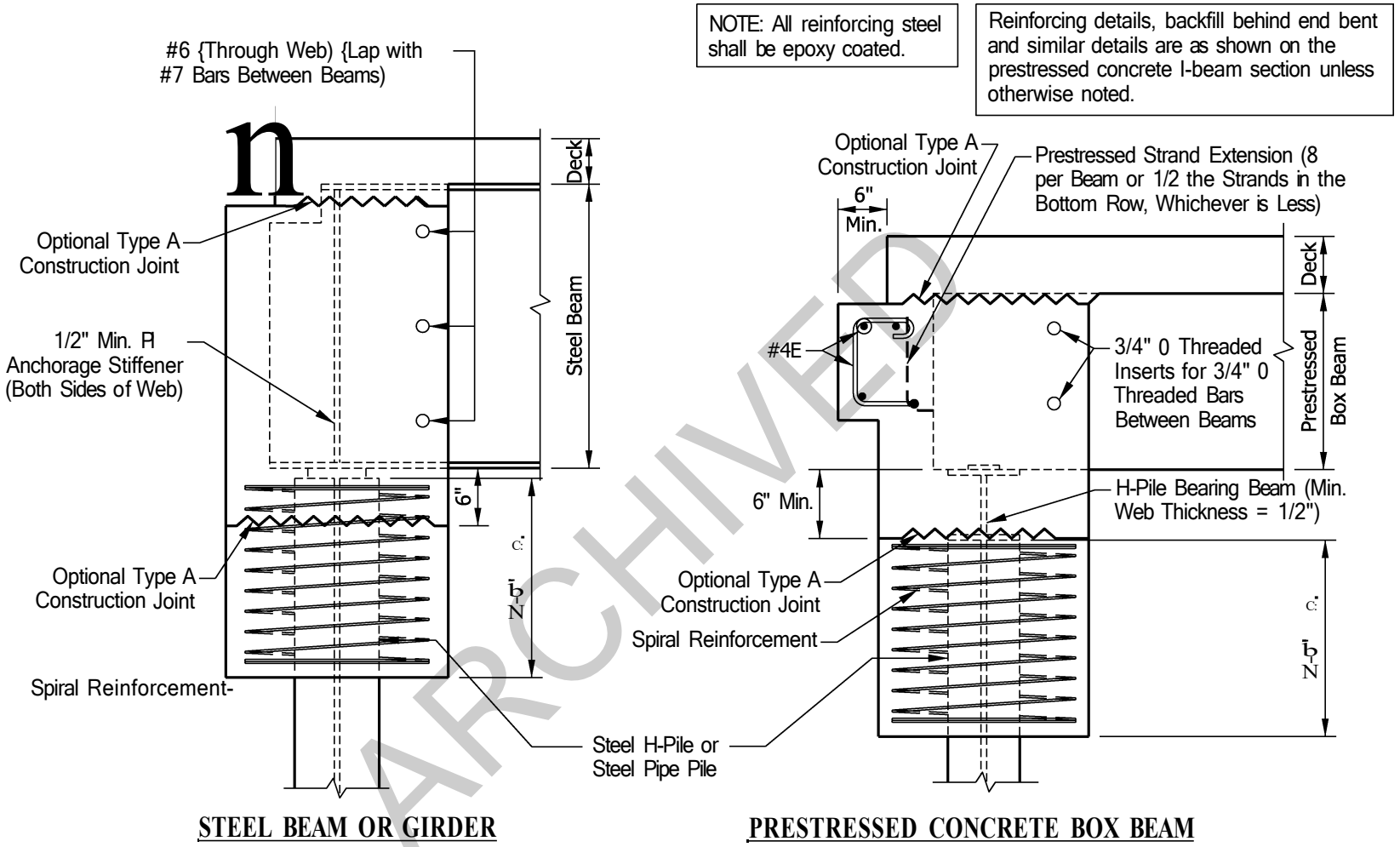
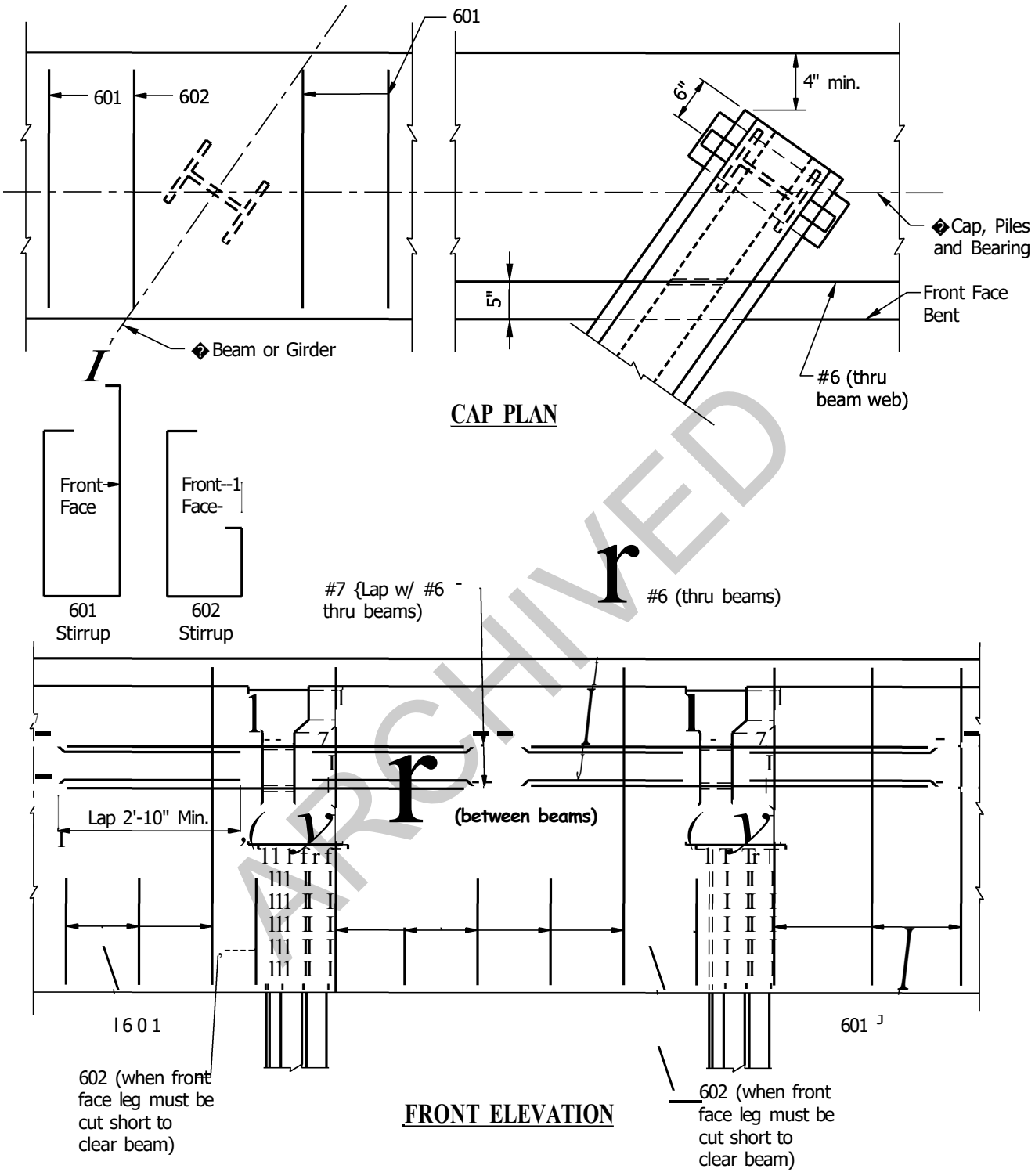


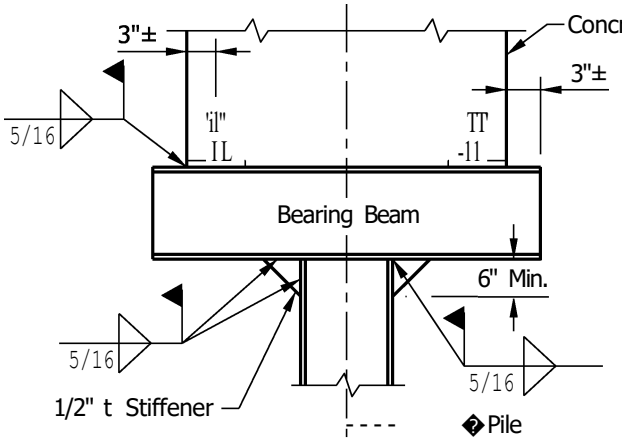
SUGGESTED INTEGRAL END BENT DETAILS
Method A, Beams Attached Directly to Piling

Figure 409-2C
(Page 2 of 4)

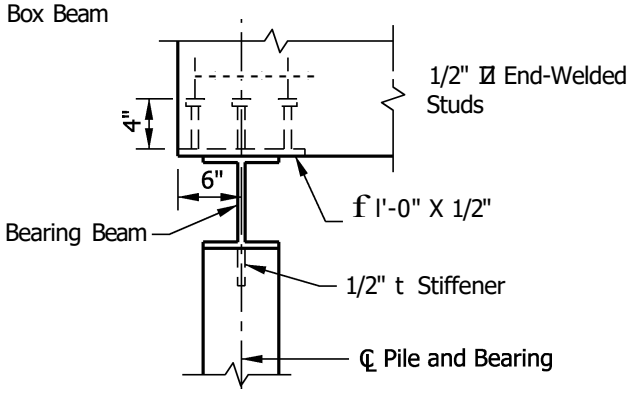


SUGGESTED INTEGRAL END BENT DETAILS
Method A, Beams Attached Directly to Piling

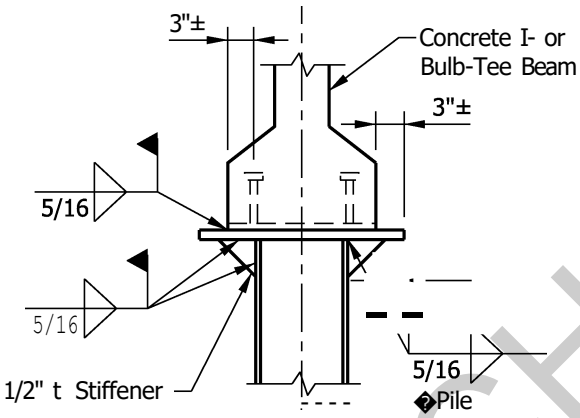
Figure 409-2C
(Page 3 of 4)



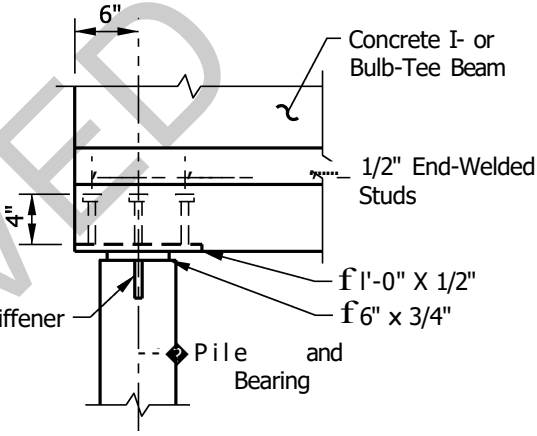
CONCRETE BOX BEAM
END VIEW



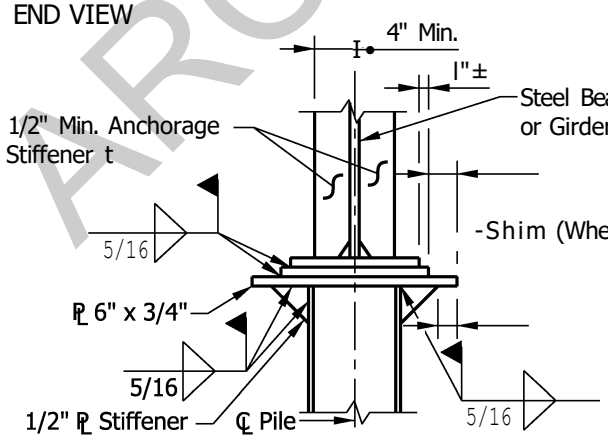
CONCRETE BOX BEAM
SIDE VIEW



CONCRETE I- OR BULB-TEE BEAM
END VIEW



CONCRETE I- OR BULB-TEE BEAM
SIDE VIEW



STEEL BEAM
END VIEW

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

Figure 409-2C
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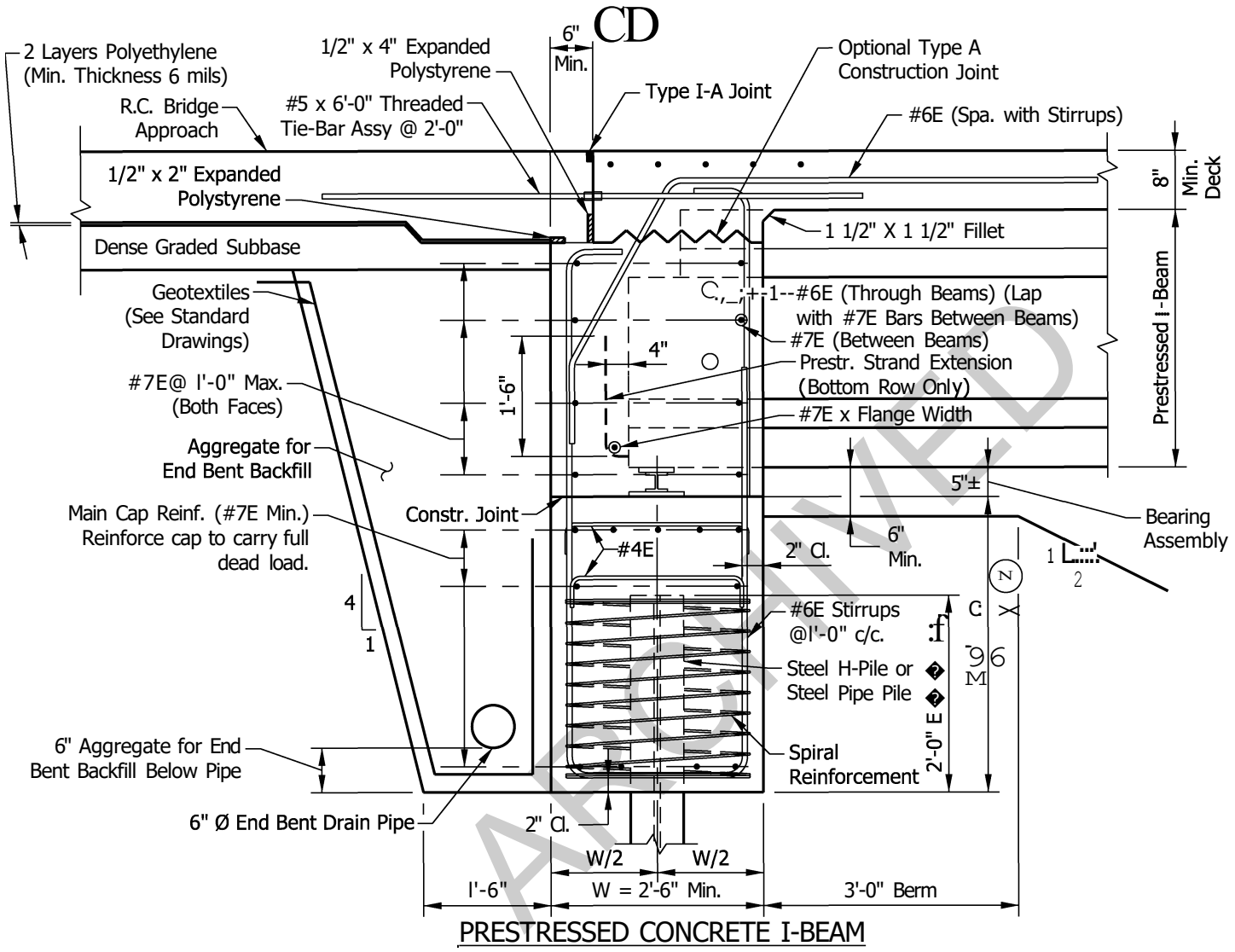


PRESTRESSED CONCRETE I-BEAM

NOTES:

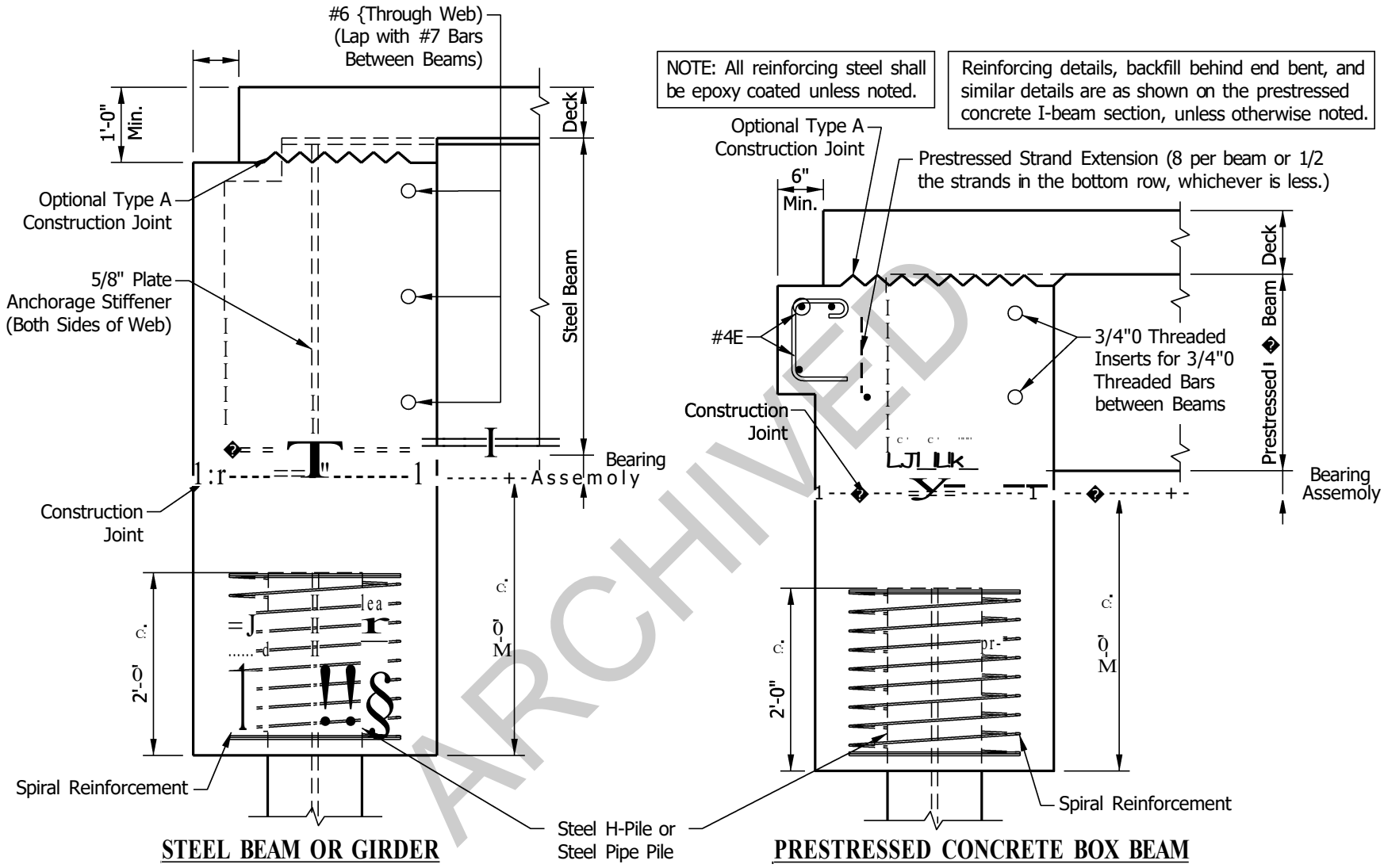
(D A pavement ledge greater than 6 in. may be considered for skewed structures or structures subject to significant truck traffic.

O A depth greater than 6 ft requires approval from the Office of Bridge Design.

3. All reinforcing steel shall be epoxy coated.

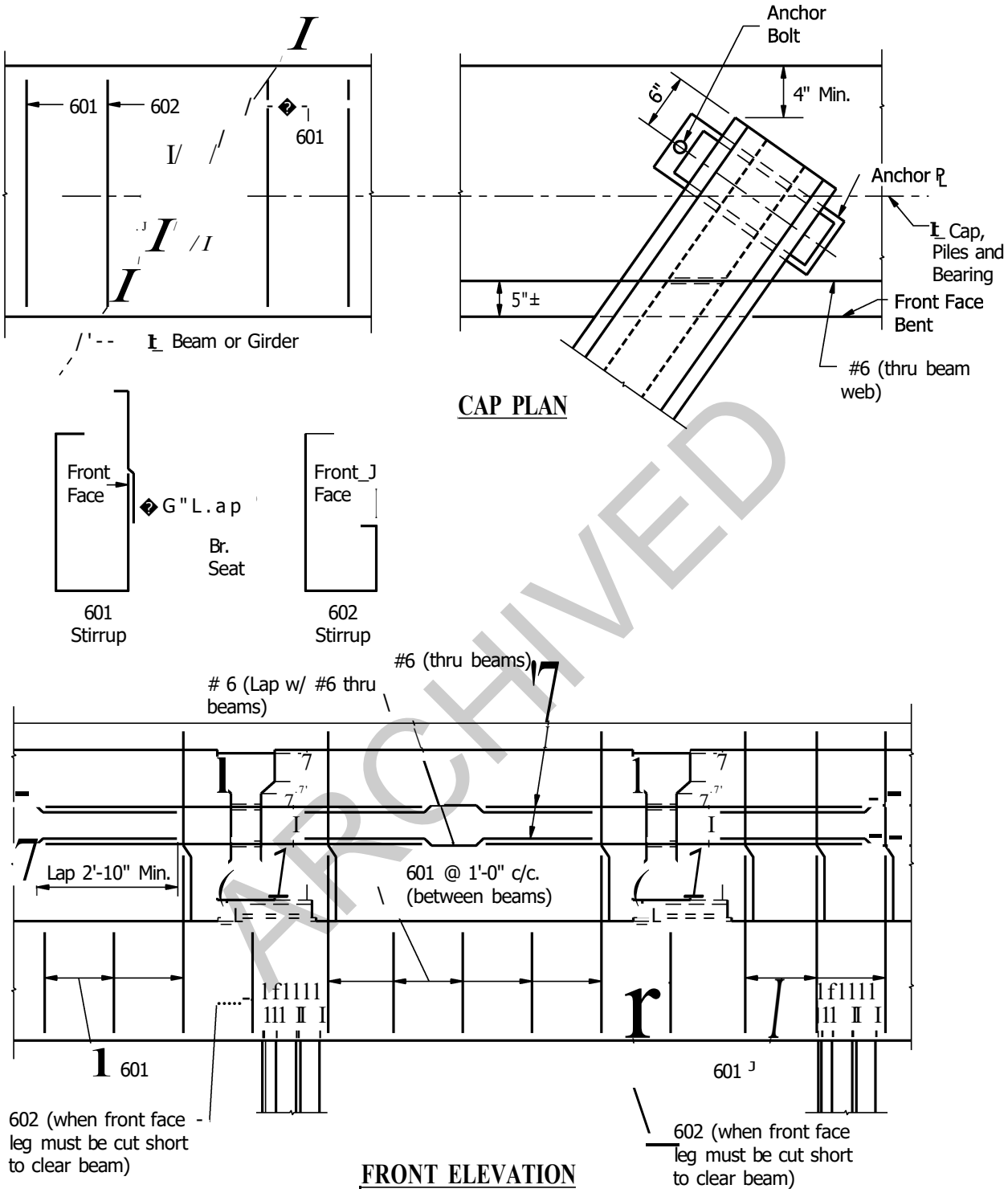
SUGGESTED INTEGRAL END BENT DETAILS
Method B, Beams Attached to Concrete Cap

Figure 409-2D
(Page 1 of 4)



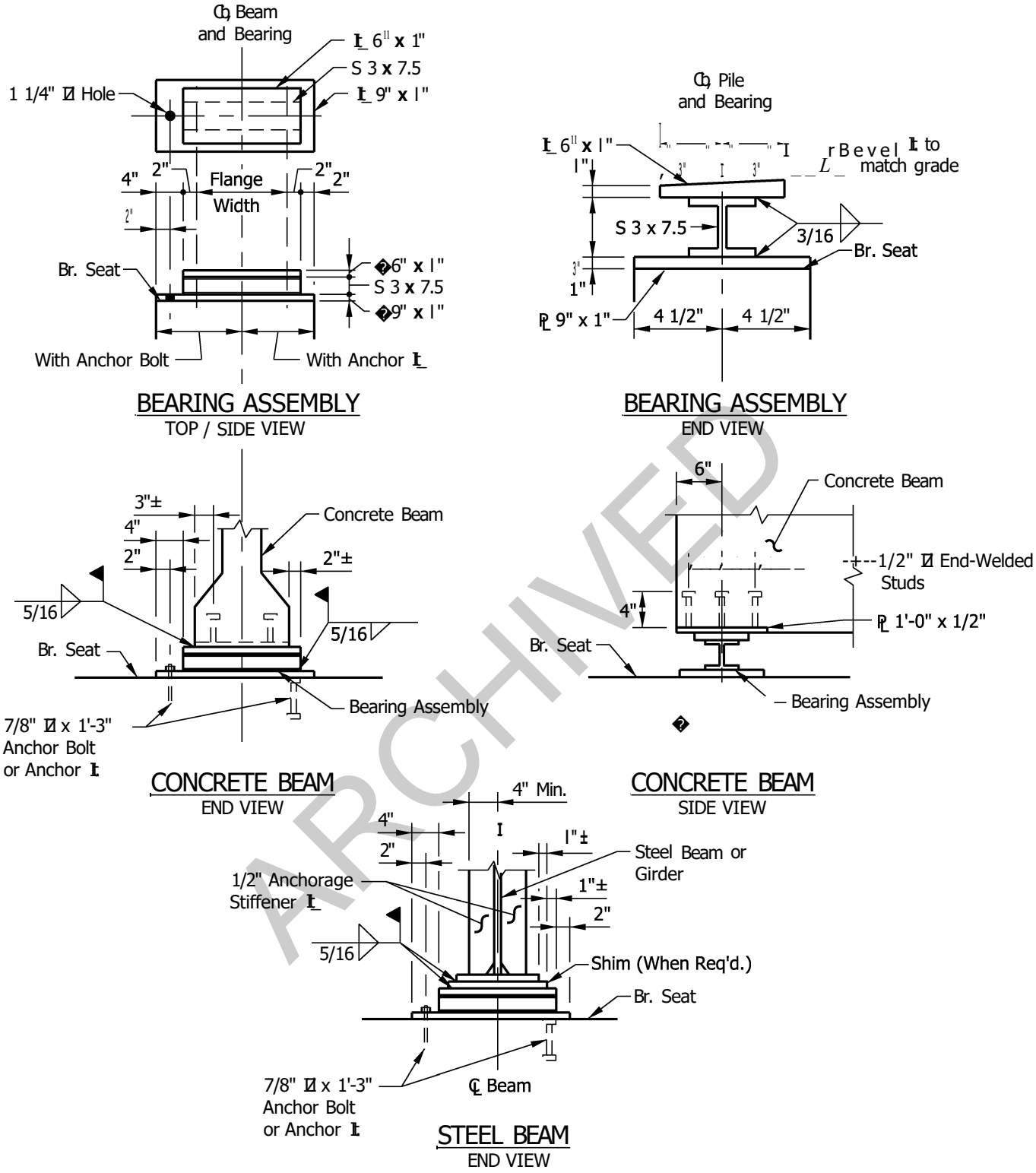
SUGGESTED INTEGRAL END BENT DETAILS
Method B, Beams Attached to Concrete Cap

Figure 409-2D
(Page 2 of 4)



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

Figure 409-2D
(Page 3 of 4)



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

Figure 409-2D
(Page 4 of 4)