INDIANA DEPARTMENT OF TRANSPORTATION
Driving Indiana's Economic Growth

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Mitchell E. Daniels, Jr., Governor
Michael B. Cline, Commissioner

AGENDA

June 21, 2012 Standards Committee Meeting

MEMORANDUM

June 06, 2012

TO: Standards Committee

FROM: Scott Trammell, Secretary

RE: Agenda for the June 21, 2012 Standards Committee Meeting

A Standards Committee meeting is scheduled for 09:00 a.m. on June 21, 2012 in the N955 Bay Window Conference Room. Please enter meeting through the double doors directly in front of the conference room.

The following agenda items are listed for consideration.

A. GENERAL BUSINESS ITEMS

OLD BUSINESS

(No items on this agenda)

NEW BUSINESS

(No items on this agenda)

B. CONCEPTUAL PROPOSAL ITEMS

OLD BUSINESS

(No items on this agenda)

NEW BUSINESS

1. Adoption of the 6th edition of AASHTO Bridge Design Specifications and incorporation of the necessary changes to the design manual. (Mr. Strain)

C. STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND STANDARD DRAWINGS PROPOSED ITEMS

OLD BUSINESS

Item No. 01A 04/19/12 (2012 SS)	Mr. Strain	pg 35
714.04(a)	Box Structure	
714.04(b)	Concrete Headwalls, Wingwalls, and Footings	
714.04(c)	Working Drawings	
714.06(a)	Headwall Reinforcement Placement Relative to Top of Structure	
714.06(c)	Sealing	

Item No. 01B 04/19/12 (2012 SS)	Mr. Strain	pg 38
723.03	General Requirements	
723.04	Design Requirements	
723.04(c)	Working Drawings	
723.13	Sealing	

NEW BUSINESS

Item No. 01 06/21/12 (2012 SS)	Mr. Strain	pg 42
Recurring Special Provision:		
724-B-XXX	*TOOTH EXPANSION JOINT FOR INTEGRAL STRUCTURES*	

Item No. 02 06/21/12 (2012 SS)	Mr. Walker	pg 45
Recurring Special Provision:		
728-B-XXX	*DRILLED SHAFT FOUNDATIONS*	

Item No. 03 06/21/12 (2012 SS)	Mr. Walker	pg 65
Recurring Special Provision:		
919-X-XXX	*SIGN SHEETING*	

cc: Committee Members (11)
FHWA (2)
ICA (1)

Mr. Strain
Date: 06/21/12

1. CONCEPTUAL PROPOSAL

REVISION TO INDIANA DESIGN MANUAL

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: AASHTO LRFD Bridge Design Specifications 5th edition has been superseded by the 6th edition. The incorporated changes to the 6th edition have been outlined on the attached document.

In addition, the research on the long term behavior of integral abutments and earthquake resistance have been completed and are ready for implementation.

PROPOSED SOLUTION: Adopt the 6th edition of AASHTO Bridge Design Specifications and incorporate the necessary changes to the design manual.

The revisions to the design manual to adopt the research to extend the limits of the integral abutment should be incorporated into the design manual.

APPLICABLE STANDARD SPECIFICATIONS: none

APPLICABLE STANDARD DRAWINGS: none

APPLICABLE DESIGN MANUAL SECTION: Revisions to the INDOT Design Manual:

403-3.05	Seismic requirement added for structures greater than 500 feet in length. Elastic dynamic analysis is required for structures with a length greater than 500 feet in a seismic category greater than A.
403-3.07	Train collision reference deleted.
403-4.02 #2	Wind Loading: The wind loading was stated incorrectly. The wind speed is now given as 70 mph and the reference on how to calculate the load is referenced.
Figure 403-4A	The reference note on the figure has also been corrected.
406-4.02	The reference to semi-lightweight concrete has been deleted. The air dry density for the lightweight concrete is given. The unit weight for the lightweight concrete is also given. The reference to alternate unit weights is deleted.
406-4.03 & 406-12.02(03)	References to semi-lightweight concrete are changed to lightweight. Paragraph related to ACI deleted.
408-2.01(04)	The eccentric loading factor on the footing is revised.
Figure 409-2A	Added new
Figure 409-2B	Added new
Figures 409-2C and -2D	Revised

1. CONCEPTUAL PROPOSAL

REVISION TO INDIANA DESIGN MANUAL

(CONTINUED)

Figures 409-2E, -2F, and –2G	Added new
409-5.01	Reference to railroad track and crashwall has been deleted.
409-6.03(02)	Collision -static force revised from 400 kips to 600 kips.
409-6.03(03)	Reference to pier and location of the railroad track have been deleted.
409-7.03(03)	Rotation equations for the elastomeric bearing design have been deleted.
410-6.04(05)	Items 4 and 5 are revised. Figure relocated and reaction force for overturn was increased to two thirds from one-half.

APPLICABLE SECTION OF GIFE: none

APPLICABLE RECURRING SPECIAL PROVISIONS: none

PAY ITEMS AFFECTED: none

Submitted By: Randy Strain

Title: Bridge Standards and Policy Engineer

Organization: INDOT

Phone Number: 317-232-3339

Date: 5-25-12

APPLICABLE SUB-COMMITTEE ENDORSEMENT: none

1. CONCEPTUAL PROPOSAL

NOTES RELATED TO THE CHANGES TO THE AASHTO LRFD BRIDGE DESIGN SPECIFICATION 2012 6TH EDITION

The item number is followed by a specification reference and a very brief subject note.

Item #	Spec Ref	Notes
1	3.3.2, 3.4.1 & 3.15, C4.7.6	These sections are revised to include blast loading.
2	Bridge Security Guidelines	Incorporates design and analysis recommendations from the 2011 Bridge Security Guidelines.
3	C14.6.3.2	Change in coefficient for equation C14.6.3.2-1 Coefficient 6 changed to 4.8
4	C14.7.5.3.3, C14.7.5.3.6 & 14.7.6.3.3	Strain equation changed to reflect coefficient change.
5	14.7.6.3.2	Allowable stress for FGP bearings increased. Plain reinforced bearing pads not often used.
6	Section 14	Rotation equations deleted from elastomeric bearing pad design. This will impact IDM Chapter 409 section 7.03
7	18.3.3.1 & 18.8.3.3	Construction
8-43	Seismic Guide Spec Revisions	To be adopted by INDOT in the near future
44	Bridge Construction Specs	
45	3.6.5.1 & 3.16	Change in static collision load from 400 to 600 kips, angle of impact from 0 to 15 degrees. Height above ground increased to 5 feet from 4 feet. Rail road offset of 50 feet deleted.
46	Section 4	Curvature or concrete box girders may be analyzed as straight segments when the central angle is 34 degrees or less. This methodology replaces the aspect ratio.
47	5.14.2.3.2 & 5.14.2.3.4	Segmental construction loads revised to include dynamic allowance.
48	New section 15	Design of sound barriers has been added to the specs.
49	C1.3.3	Defines “operating system” for movable bridges.
50	Bridge preservation	Addition to glossary
51	5.5.4.2.1	$\varphi = 0.80$ for lightweight concrete (was .70)
52	5.4.2.6 & 5.7.3.3.2	Revision to the calculation of the modulus of rupture.
53	Section 5	Revision for post tensioned curved girders.
54	Section 5	Removal of partial prestress
55	Research proposal	
56	Luminaires	

1. CONCEPTUAL PROPOSAL

NOTES RELATED TO THE CHANGES TO THE AASHTO LRFD BRIDGE DESIGN SPECIFICATION 2012 6TH EDITION

(CONTINUED)

57	12.6.6.3	Minimum cover to include base course.
58	Section 12 Culverts	General minor modifications.
59	Construction Specs	
60	Sections 3, 4 and 6	Revision to orthotropic decks
61	4.6.2.1.8	Revision to fatigue limit states.
62	Section 6	Seismic requirements for decks on steel girders.
63	6.6.1.2.3-1	Correction to loading condition of weld.
64	6.6.1.3.1 & 6.7.4.1	Intermediate diaphragm connection.
65	6.10.11.1.3	Revise sizing of transverse stiffeners.
66	6.11.8.2.2	Simplifies design of box flanges.
67	6.11.11.2	Revises moment of inertia for transverse flange stiffener.
68	9.5.3 & 9.8.2.3.3	Revision to partially and filled steel grid decks.
69		Guidelines for steel girder bridge analysis
70	10.6.3.3 & 11.6.3.3	Revision of eccentric loading of footings
71	10.8.3.6.3	Revision to shaft foundation bearing resistance.
72	Section 11	Seismic design of abutments when supported by wall.
73	Section 11	LRFD for MSE walls
74-79	Welding Code	
80-83	Manual for bridge evaluation	

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

403-3.05 EARTHQUAKE EFFECTS

403-3.05 Earthquake Effects

Earthquake Effects, *EQ*, should be determined in accordance with AASHTO *Guide Specifications for LRFD Seismic Bridge Design* and current interims. All structures with spans greater than 500 feet located in a seismic design category greater than category A will be analyzed using elastic dynamic analysis. *Standard Drawings*

delete

SECTION 403 TABLE OF CONTENTS

403-3.07 VEHICLE COLLISION WITH STRUCTURE

403-3.07 Vehicle ~~or Train~~ Collision with Structure

Unless the structure is protected as specified in *LRFD* 3.6.5.1, an abutment or pier located within 30 ft of the edge of a roadway, ~~or within 50 ft of the centerline of a railroad track~~, shall be designed for loads in accordance with *LRFD* 3.6.5.2.

A mechanically-stabilized-earth-wall bridge abutment placed adjacent to a roadway need not be checked for vehicle-collision forces as described in *LRFD* 3.6.5. However, if the wall must be placed inside the clear zone, roadway safety shall be addressed. ~~Such an abutment placed adjacent to a railroad track shall be checked as described in *LRFD* 3.6.5.~~

403-4.02 APPLICATION OF CONSTRUCTION LOADINGS

1. Construction Live Loads, CLL.
   a. CLL1, Construction Live Load = 20 psf extended the entire bridge width plus 2 ft outside of bridge coping over 30 ft longitudinal length centered on screed-machine load
   b. CLL2, Screed Machine = 4500 lb over 10 ft longitudinal length applied 6 in. outside the bridge coping
   c. CLL3, Vertical Railing and Walkway Load = 75 plf applied 6 in. outside the bridge coping over 30 ft longitudinal length centered on screed-machine load

2. Wind Load, WS. ~~WS, Wind on Structure = 50 psf in accordance with AASHTO *Guide Design Specifications (1995) for Bridge Temporary Works*, Fig. 2.1~~
   Wind on structure designed for 70 mph horizontal wind loading in accordance with AASHTO LRFD 3.8.1

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

FIGURE 403-4A

Wind Load: ~~Designed for 70 mph horizontal wind loading of 50 lb/ft² in accordance with AASHTO *Guide Design Specifications for Bridge Temporary Works* (1995), Figure 2.1.~~
Wind on structure designed for 70 mph horizontal wind loading in accordance with AASHTO LRFD 3.8.1

CONSTRUCTION-LOADINGS INFORMATION TO BE SHOWN ON GENERAL PLAN
Figure 403-4A

SECTION 406 TABLE OF CONTENTS

SECTION 406-4.02 NORMAL-WEIGHT AND LIGHTWEIGHT CONCRETE

406-4.02 Normal-Weight and Lightweight Concrete

The minimum f'_c for prestressed or post-tensioned concrete components shall be shown on the plans. Such a strength outside the range shown in Section 406-1.0 is not permitted without written approval of the Director of Bridges. For lightweight concrete, the air dry unit weight shall be shown on the plans as 119 lb/ft^3. The modulus of elasticity will calculated using the 119 lb/ft^3 value. The unit weight of the light weight concrete will be 124 lb/ft^3 The additional weight is to account for the mild reinforcing steel and the tensiong strands. See *LRFD* 5.4.2.2 for the coefficient of linear expansion.

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

SECTIONS 406-4.03 & 406-12.02(03)

The following will apply to concrete.

1. The design compressive strength of normal-weight and lightweight concrete at 28 days, f'_c, shall be in the range as follows:

   a. prestressed box beam: 5 to 7 ksi
   b. prestressed I-beam: 5 to 7 ksi
   c. prestressed bulb-tee beam: 6 to 8 ksi

   An exception to the range shown above will be allowed for a higher strength if the higher strength can be documented to be of significant benefit to the project, it can be effectively produced, and approval is obtained from the Director of Bridges.

2. At release of the prestressing strands, f'_c shall not be less than 4 ksi, and shall be determined during the beam design. The specified concrete compressive strength at release shall be rounded to the next higher 0.1 ksi.

406-4.02(01) Shrinkage and Creep

Losses due to shrinkage and creep, for other than than a segmentally-constructed bridge, that require a more-precise estimate including specific materials, structural dimensions, site conditions, construction methods, and age at various stages of erection, can be estimated by means of the methods specified in *LRFD* 5.4.2.3.2 and 5.4.2.3.3. Other acceptable methods are those described in the CEB-FIP 1978 / 1990 code. The annual average ambient relative humidity shall be taken as 70%.

406-4.02(02) Modulus of Elasticity, Poisson's Ratio, and Modulus of Rupture

The modulus of elasticity shall be calculated as specified in *LRFD* Eqn. 5.4.2.4-1. Poisson's ratio shall be taken as 0.2. See *LRFD* 5.4.2.6 for modulus-of-rupture values depending on whether the concrete is normal weight or lightweight, and whether the intended application is control of cracking, deflection, camber, or shear resistance.

semi was intended to be deleted

406-4.03 Semi-Lightweight Concrete

The use of ~~semi-~~lightweight concrete, with normal-weight sand mixed with lightweight coarse aggregate, is permitted with a specified equilibrium density between of 119 lb/ft^3. ~~Other unit weights may be used if approved by the Director of Bridges.~~ The use of ~~semi-~~lightweight

It is not advisable to use any other unit weight than 119 pcf

concrete shall be demonstrated to be necessary and cost effective during the structure-size-and-type study.

~~The structural performance of this concrete is equal to that of normal-weight concrete. However, the potential problems that shall be addressed are the control of the water content in the lightweight aggregate and the frost sensitivity of lightweight aggregate for a period of two weeks after casting. Consideration shall be given to using the mix design procedures for lightweight concrete described in ACI 211.2.~~

The modulus of elasticity will be less than that for normal-weight concrete. Creep, shrinkage, and deflection shall be appropriately evaluated and accounted for if lightweight concrete is to be used. The formula shown in *LRFD* 5.4.2.6 shall be used in lieu of physical test values for modulus of rupture. The formula for sand-lightweight concrete shall be used for lightweight concrete.

406-12.02(03) Indiana Bulb-Tee Beam

See Figures 406-14A through 406-14F, and 406-14M through 406-14R for details and section properties. For a long-span bridge, bulb-tee beams with a top-flange width of 60 in. shall be considered for improved stability during handling and transporting. Draped strands may be considered for use in a bulb-tee beam, but shall only be considered if tensile stresses in the top of the beam near its end are exceeded if using straight strands. The maximum allowable compressive strength, tensile strength, extent of strand debonding, and number of top strands shall be considered in evaluating the need for draped strands. If draped strands are used, the maximum allowable hold-down force per strand shall be 3.8 kip, with a maximum total hold-down force of 38 kip. For additional information on draped strands, see Section 406-12.03. lightweight concrete may be used for this type of beam if it is economically justified. See Section 406-4.03.

Prestressed-concrete bulb-tee members identified as wide bulb-tees have been approved for use. One of these sections shall be considered if it is deemed to be more economical or structurally adequate than an Indiana bulb-tee member. See Figures 406-14G through 406-14L, and 406-14S through 406-14X for details and section properties.

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

408-2.01(04) SLIDING STABILITY AND ECCENTRICITY

408-2.01(04) Sliding Stability and Eccentricity

The soil parameters shall be provided for calculating frictional sliding resistance and active and passive earth pressures as follows:

Soil Unit Weight, γ, for soil above footing base;
Soil Friction Angle, φ, for soil above footing base;
Active Earth Pressure Coefficient, K_a;
Passive Earth Pressure Coefficient, K_p; and
Coefficient of Sliding, tan δ.

The eccentricity of loading at the Strength Limit state, evaluated based on factored loads shall not exceed the following:

1. 1/3 ~~1/4~~ of the corresponding dimension B or L for a footing on soil; or

2. 0.45 ~~3/8~~ of the corresponding dimensions B or L for a footing on rock.

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

SECTION 409

7. Intermediate Pier Details for Integral Structures Located in Seismic Areas Greater Than SDC A. Intermediate piers should include concrete restrainers as shown in figure 409-XX

409-2.04(02) Pile Connection and Plans Details

An integral end bent may be constructed using either of the methods as follows (See Figures 409-2B and 409-2C).

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.

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 should be poured at the same time as the superstructure deck.

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. The optional construction joint at the pavement-ledge elevation shown in Figures 409-2B and 409-2C allows the contractor to pour the reinforced-concrete bridge approach with the bridge deck.

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

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

2. Cap Embedment. The embedment of the piles into the cap should be 2 ft. The embedded portion ~~should not be wrapped with polystyrene~~ of the pile should be confined with spiral reinforcement as shown in figure 409-XX.

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

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

5. Concrete Cover. Concrete cover beyond the farthest-most edge of the beam at the rear face of the bent should be at least 4 in. This minimum cover should 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 should be widened.

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

The following requirements must be satisfied.

1. Backfill. Each integral end bent for a beam- or girder-type superstructure should be backfilled with aggregate for end-bent backfill. Each reinforced-concrete-slab bridge end bent should be backfilled with flowable-backfill material. The INDOT *Standard Drawings* provide backfill details for both concrete-slab and beam- or girder-type structures.

2. Bridge Approach. A reinforced-concrete bridge approach, anchored to the end bent with #5 bars, epoxy coated, and spaced at 1'-0" centers, should be used at each integral end bent regardless of the traffic volume. The bars should extend out of the pavement ledge as shown in Figures 409-2B and 409-2C. Two layers of polyethylene sheeting should be placed between the reinforced-concrete bridge approach and the subgrade. A rigid reinforced-concrete bridge approach is necessary to prevent compaction of the backfill behind the end bent.

3. ~~Bridge Approach Joint. A terminal joint of 2 ft width, as shown on the INDOT *Standard Drawings*, or a pavement relief joint, should be used at the roadway end of the reinforced concrete bridge approach if a portion of the adjacent pavement section is concrete. A joint is not required if the entire adjacent pavement section is asphalt.~~

   Bridge-Approach Joint. For structures less than 300 feet, a terminal joint 2 feet in width, as shown on the INDOT *Standard Drawings*, or a pavement relief joint should be placed at the end of the reinforce concrete bridge approach. An expansion joint should be considered for integral structures greater than 300 feet. An expansion joint is required for integral structures greater than 500 feet.

4. Wingwalls Configuration. Wingwalls should 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 should be 1 ft. The wingwall length should 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, should be investigated, and adequate reinforcing steel should be provided.

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

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

409-2.03(02) PASSIVE EARTH PRESSURE

409-2.03(02) Passive Earth Pressure

The restraining effect of passive earth pressure behind the end bents may be neglected in considering superstructure longitudinal force distribution to the interior piers. Alternatively, the effect of passive earth pressure behind the end bents may be considered by distributing the longitudinal forces between the interior supports, end bent supports, and the soil behind the end bents. ~~The resultant soil resistance should also be checked against the available passive earth pressure. The effect of passive earth pressure behind the end bent should be considered in evaluating thermal force effects and seismic forces.~~ (recommend delete)

409-2.01 GENERAL

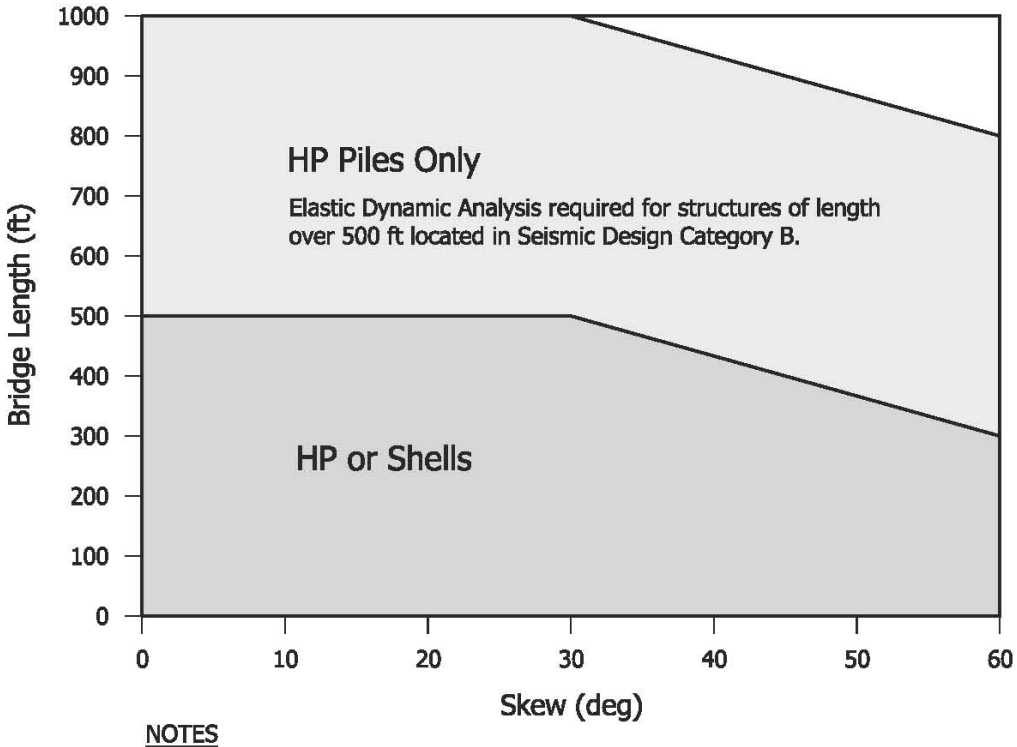
409-2.0 INTEGRAL END BENT

409-2.01 General

An integral end bent eliminates the expansion joint in the bridge deck, which reduces both the initial construction costs and subsequent maintenance costs.

Integral end bents should be used for a new structure in accordance with the geometric limitations provided in Figure 409-2A. Minimum support-length requirements need not to be investigated for an integral-end-bent bridge. Integral structures 500 feet in length or less will not require seismic analysis. Integral structures larger than 500 feet in length and located in a seismic design category B will be analyzed using elastic dynamic analysis.

~~For an existing bridge without integral end bents, the design criteria shown in Figure 409-2A should be used in evaluating the conversion to an integral end bent structure. For additional information, see Chapter 4~~12.



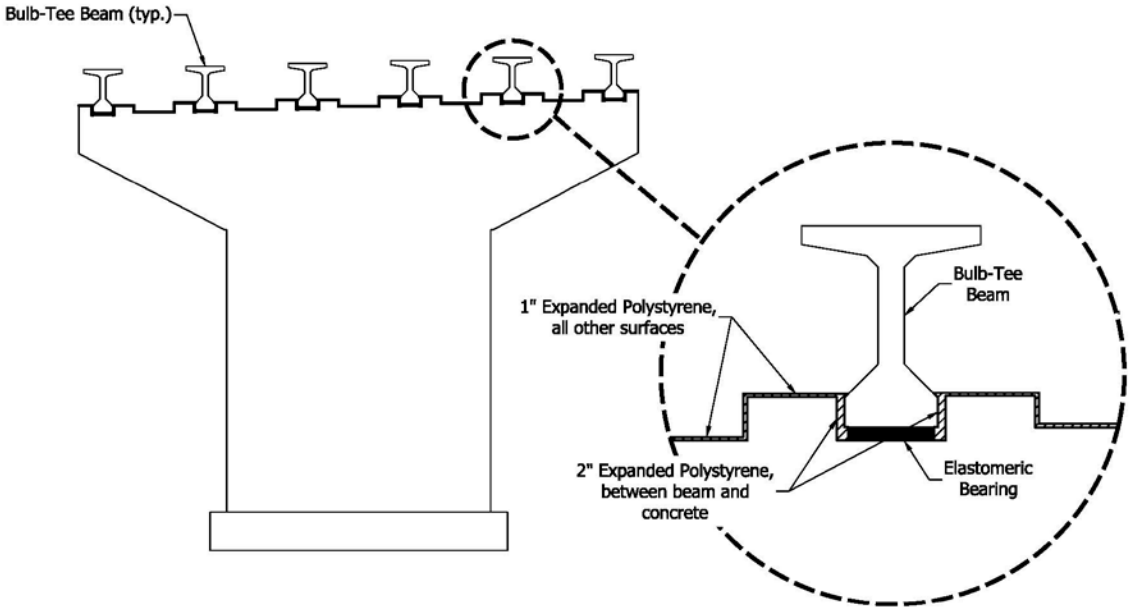
NOTES

1. Integral abutments may be used in a curved-alignment or curved-girder structure with length of 500 feet or less, with a subtended angle in plan not greater than 30°.

2. Pile confinement spiral reinforcement required on all integral abutments.

USE OF INTEGRAL ABUTMENT

Figure 409-2A

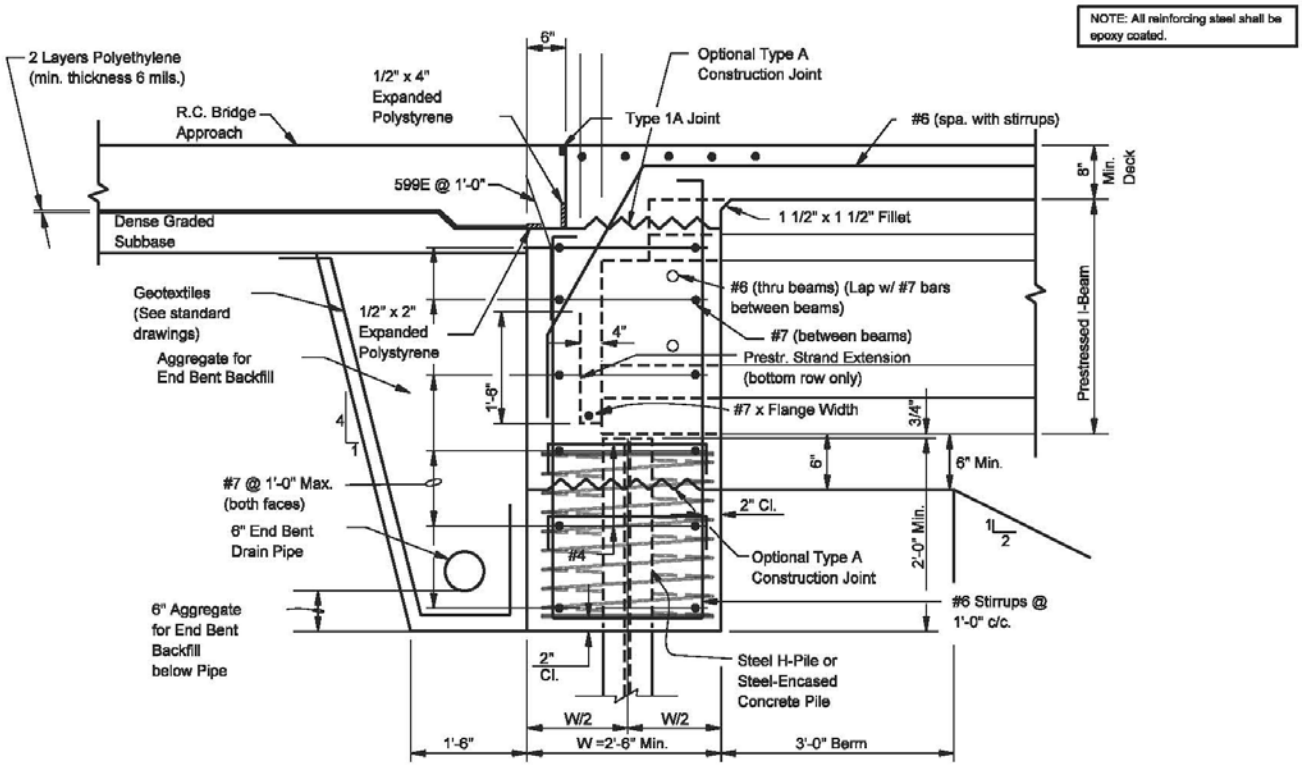


INTERMEDIATE PIER DETAIL FOR INTEGRAL STRUCTURES LOCATED IN SEISMIC AREAS GREATER THAN SDC A

Figure 409-2B

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



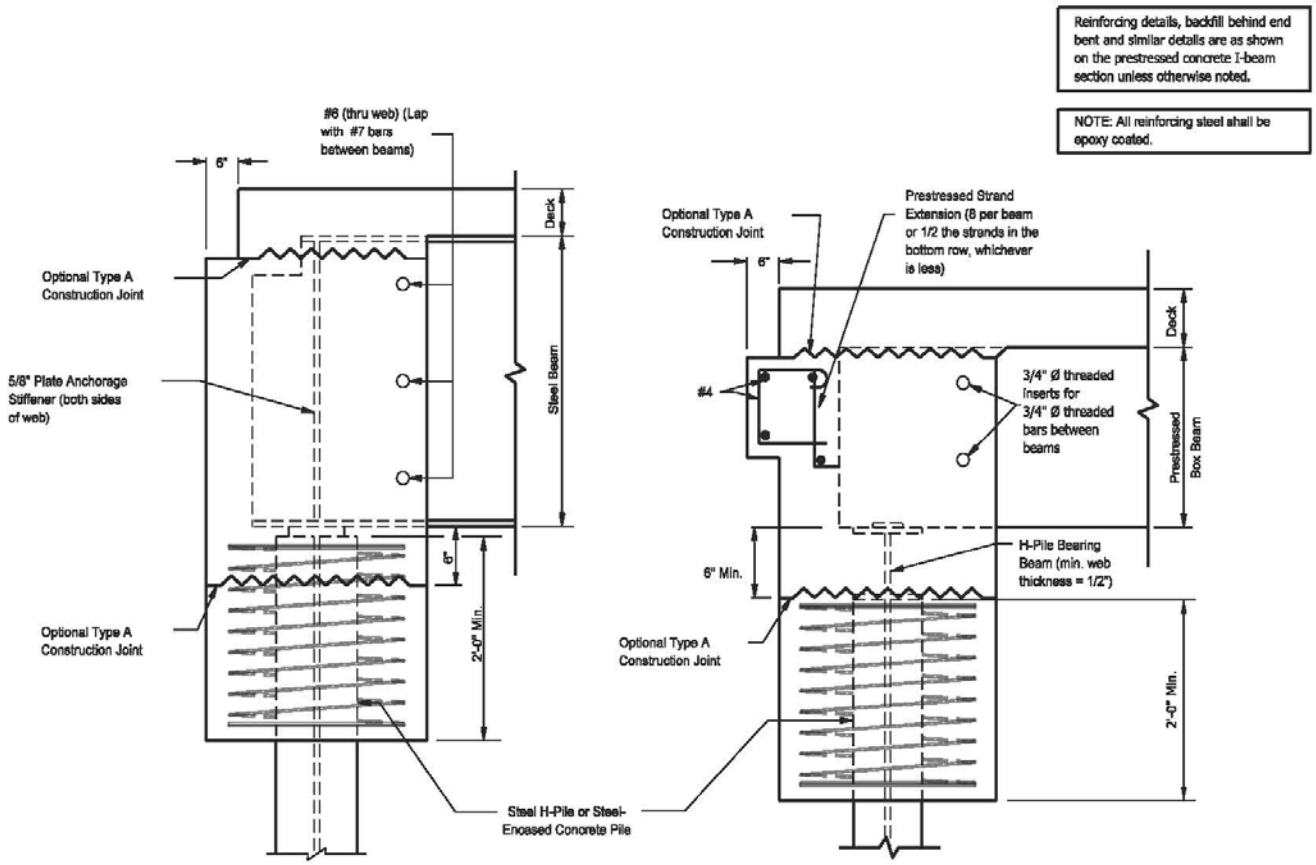
PRESTRESSED CONCRETE I-BEAM

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

Figure 409-2C
(Page 1 of 4)

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

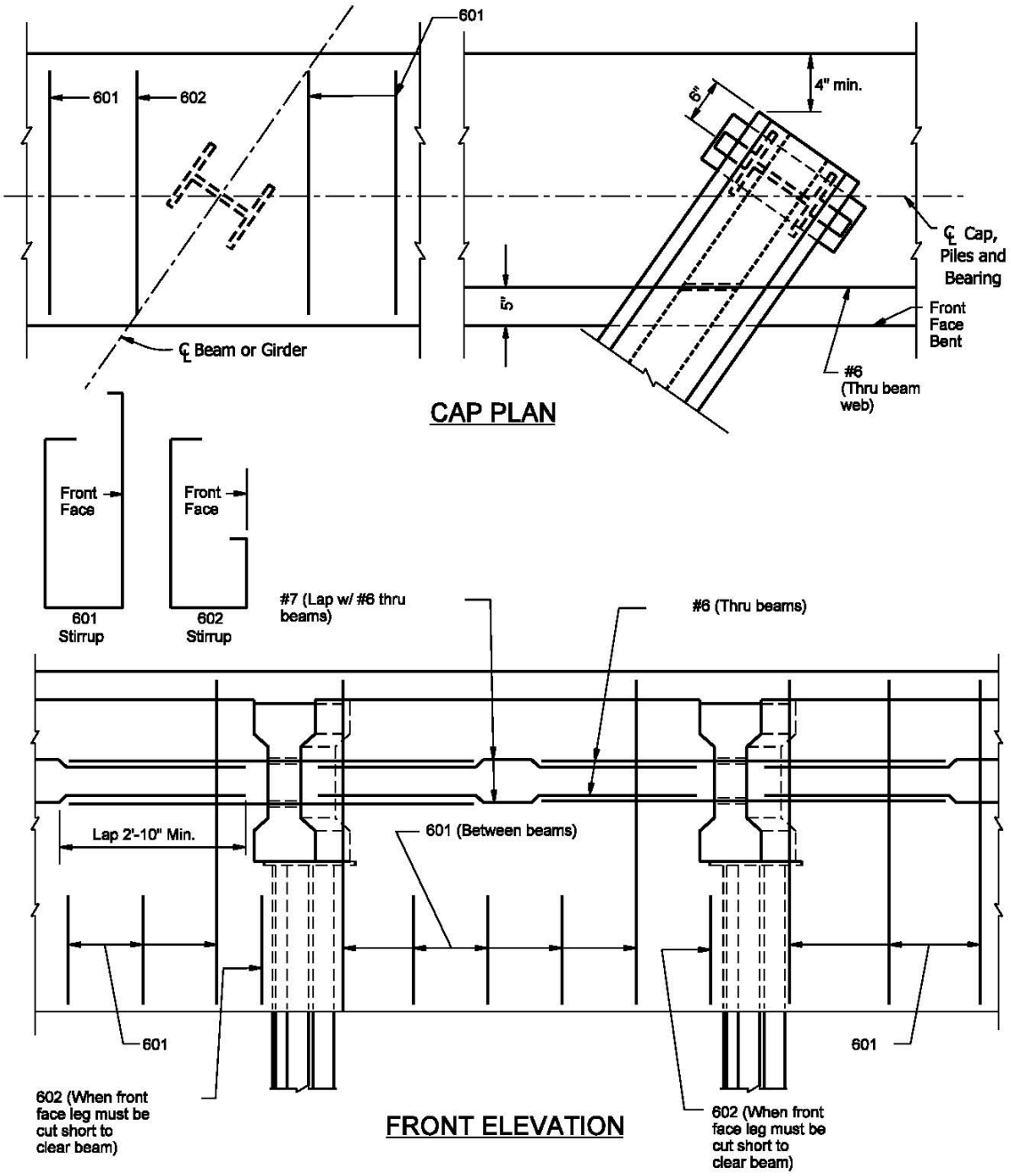


STEEL BEAM OR GIRDER

PRESTRESSED CONCRETE BOX BEAM

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

Figure 409-2C
(Page 2 of 4)

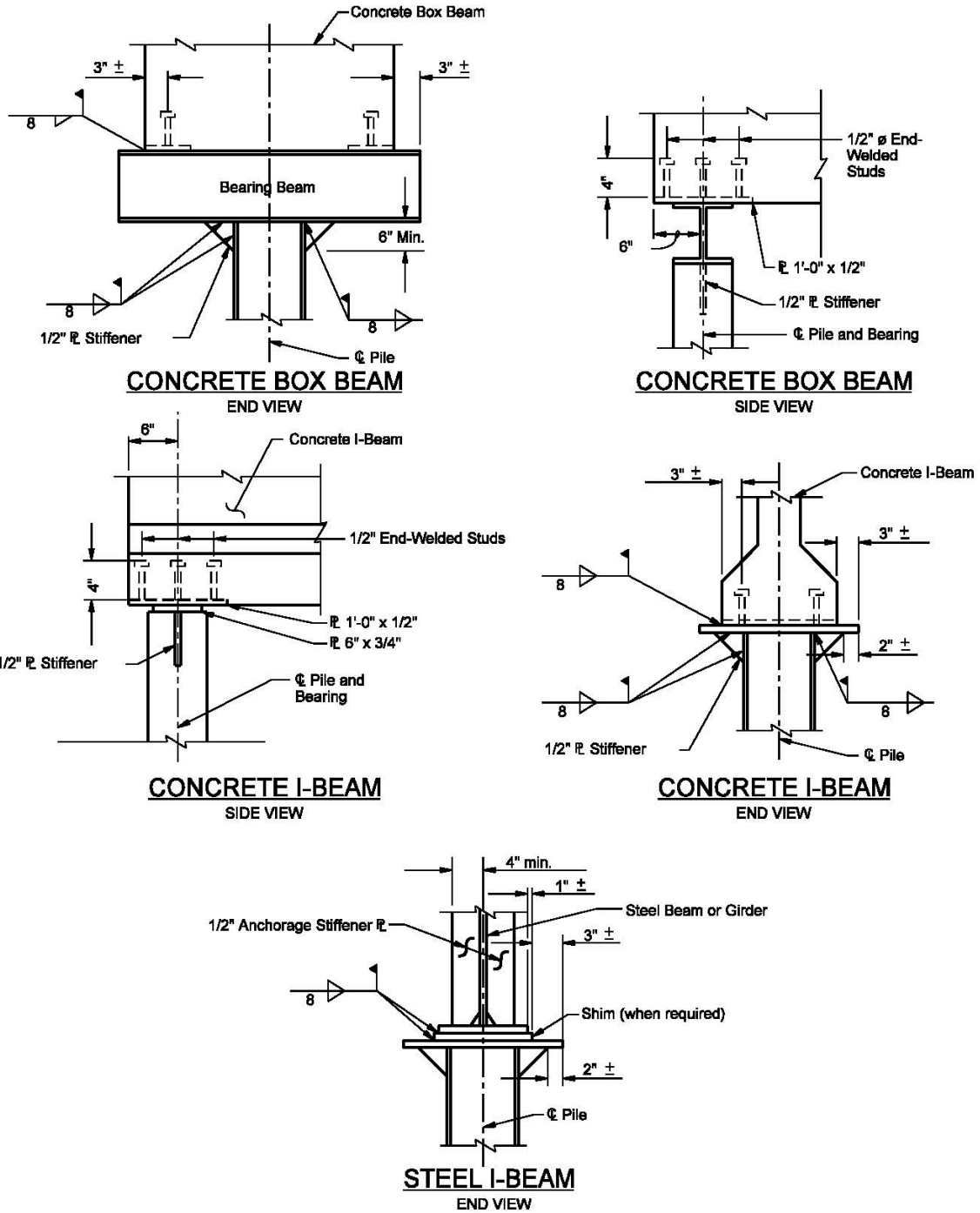


SUGGESTED INTEGRAL END BENT DETAILS
(Beams Attached Directly to Piling, Method A)

Figure 409-2C
(Page 3 of 4)

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

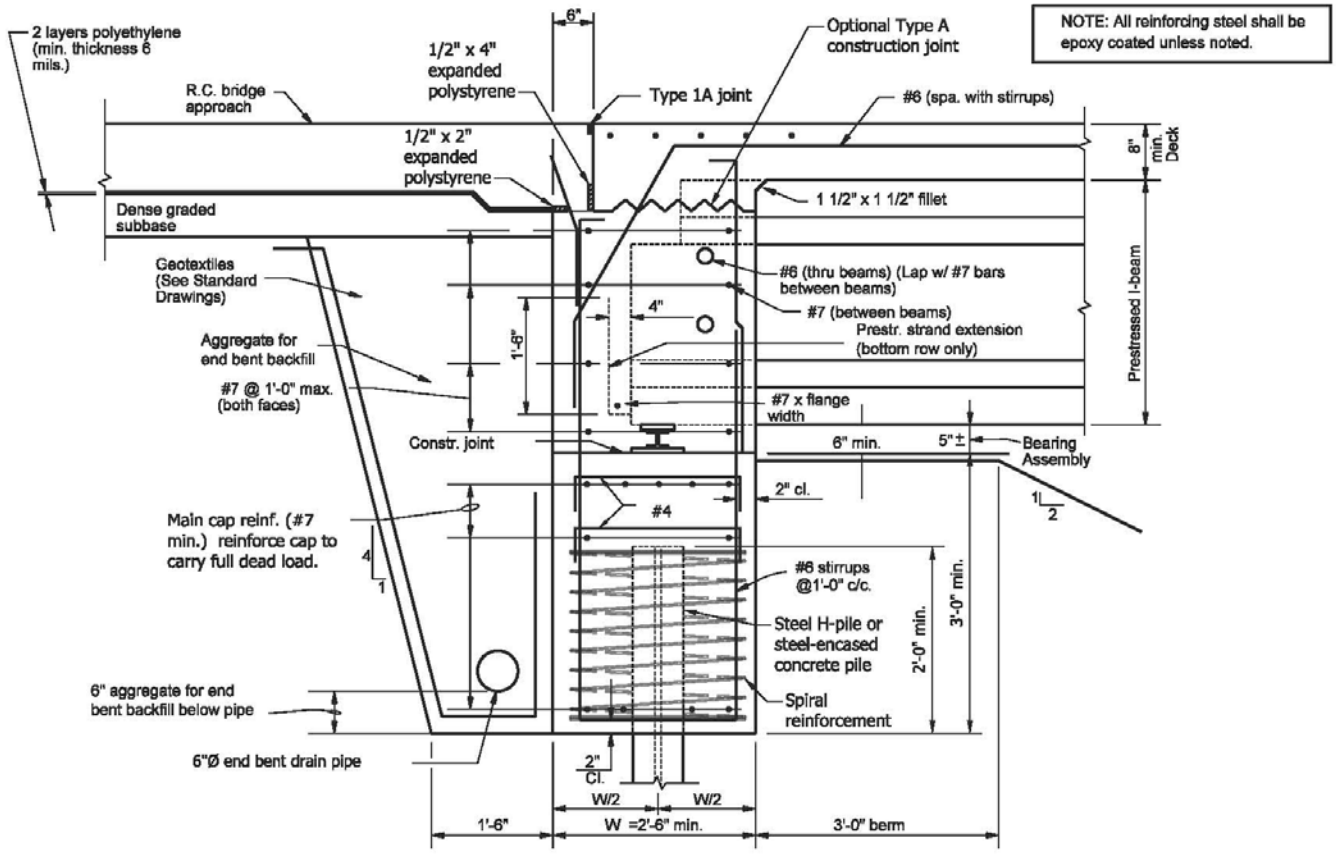


SUGGESTED INTEGRAL END BENT DETAILS
(Beams Attached Directly to Piling, Method A)

Figure 409-2C
(Page 4 of 4)

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



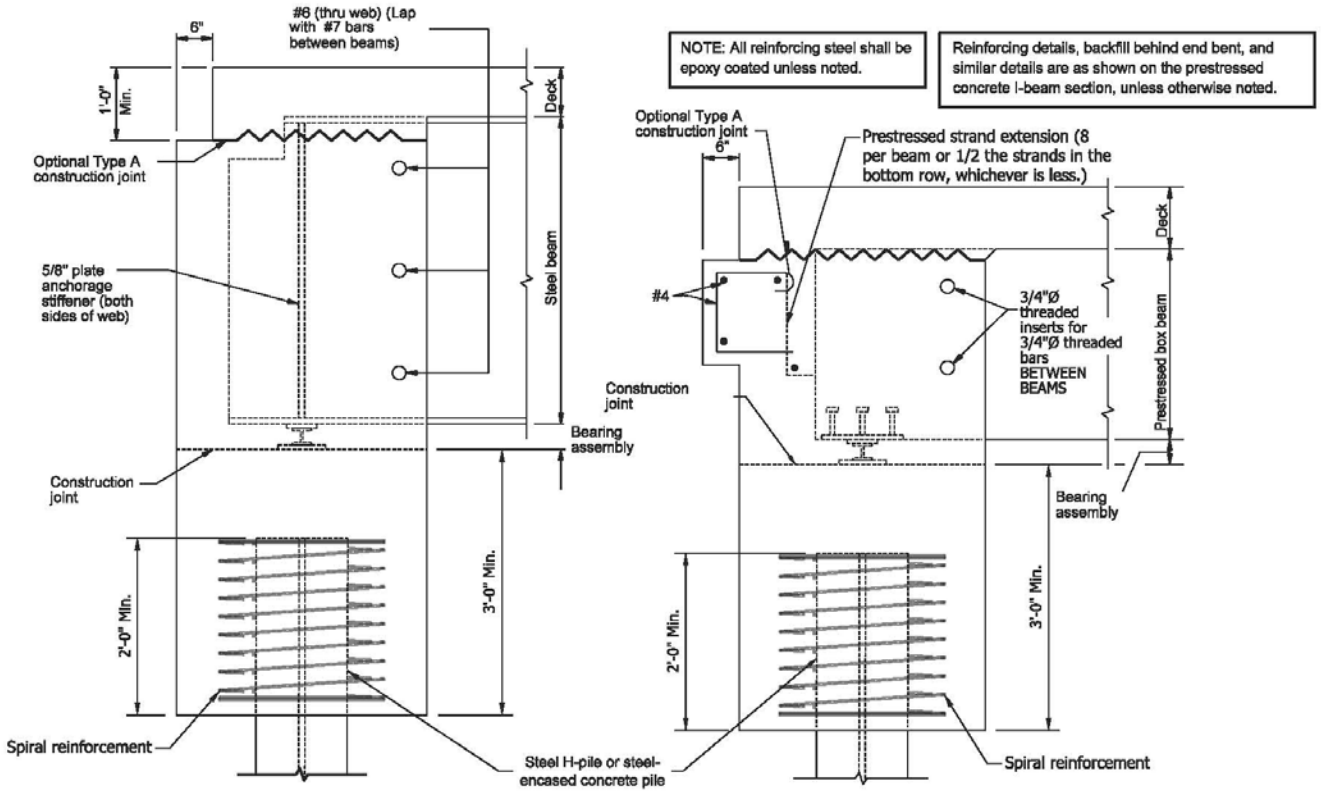
PRESTRESSED CONCRETE I-BEAM

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

Figure 409-2D
(Page 1 of 4)

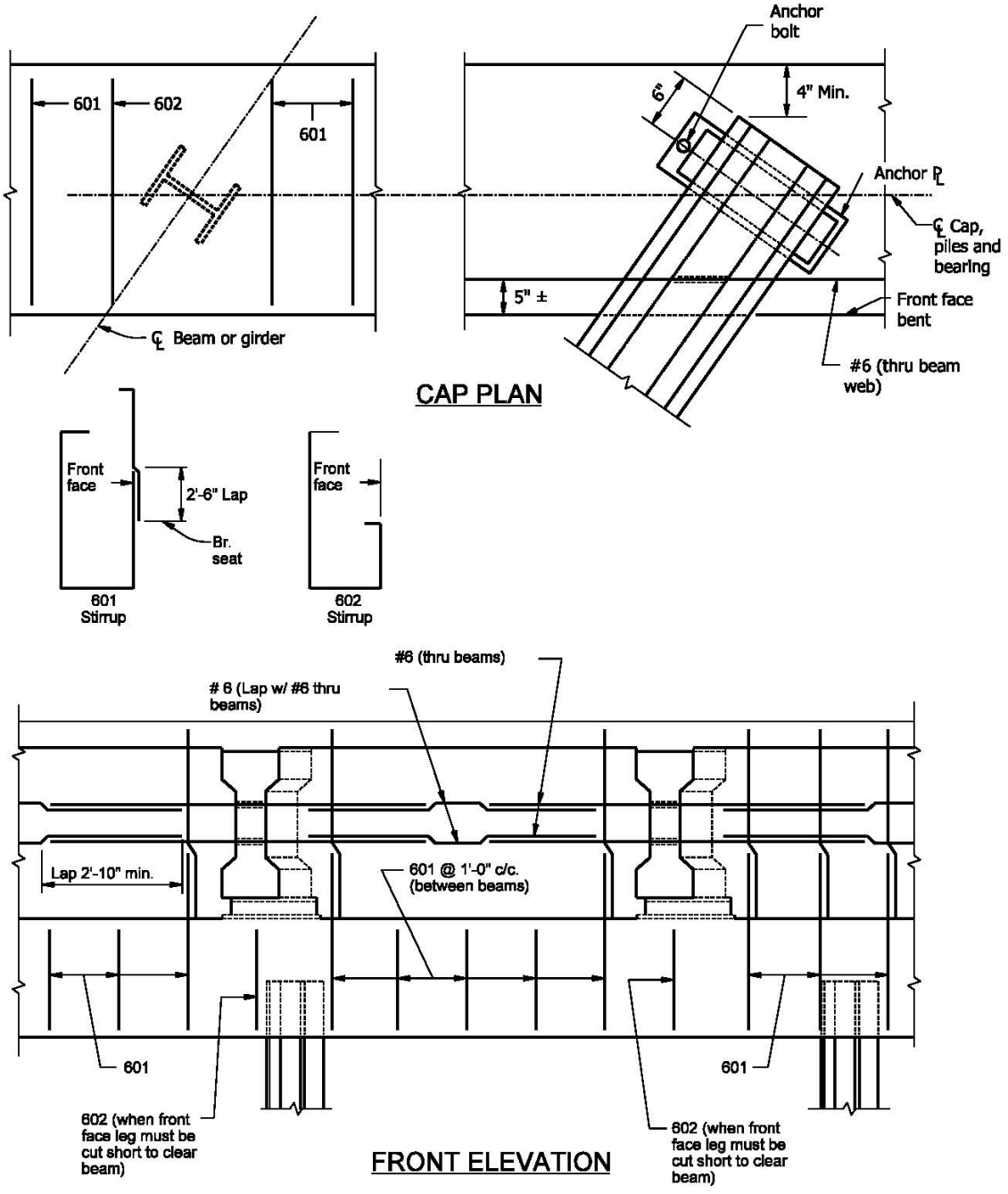
1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



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

Figure 409-2D
(Page 2 of 4)

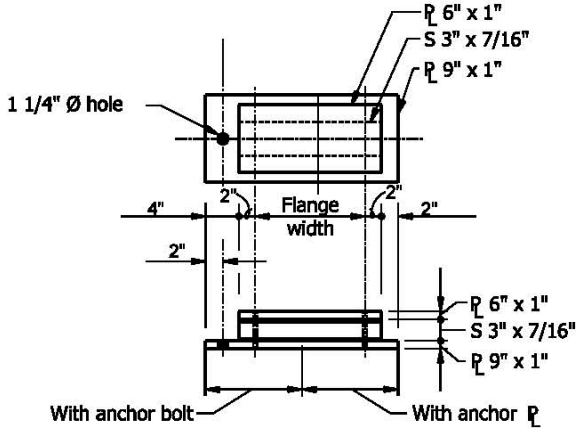


SUGGESTED INTEGRAL END BENT DETAILS
(Beams Attached to Concrete Cap, Method B)

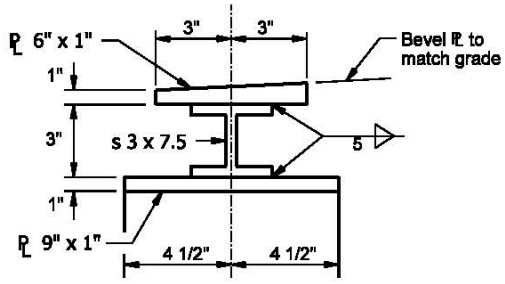
Figure 409-2D
(Page 3 of 4)

1. CONCEPTUAL PROPOSAL

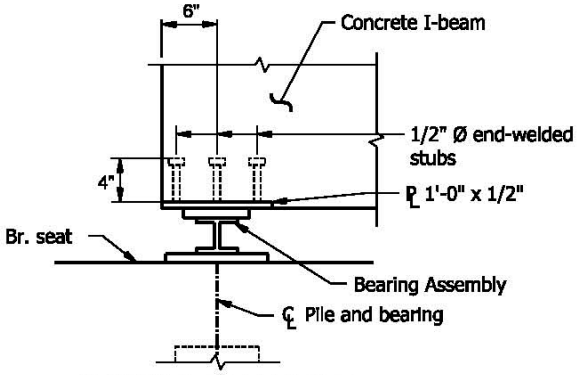
REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



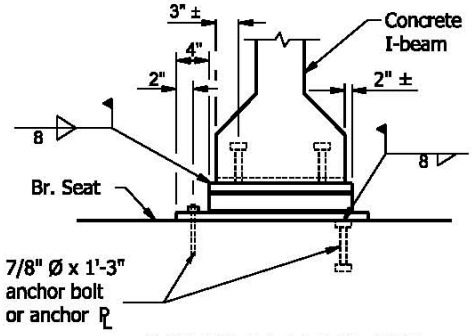
BEARING ASSEMBLY
TOP / SIDE VIEW



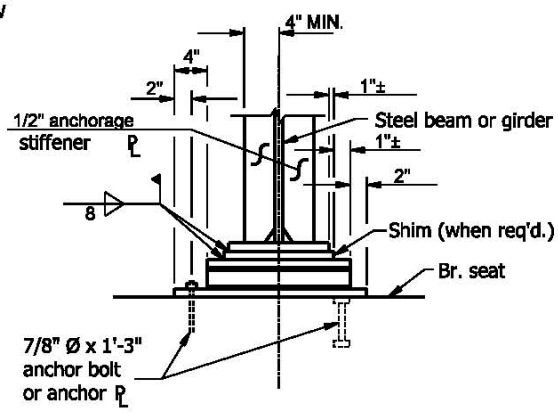
BEARING ASSEMBLY
END VIEW



CONCRETE I-BEAM
SIDE VIEW



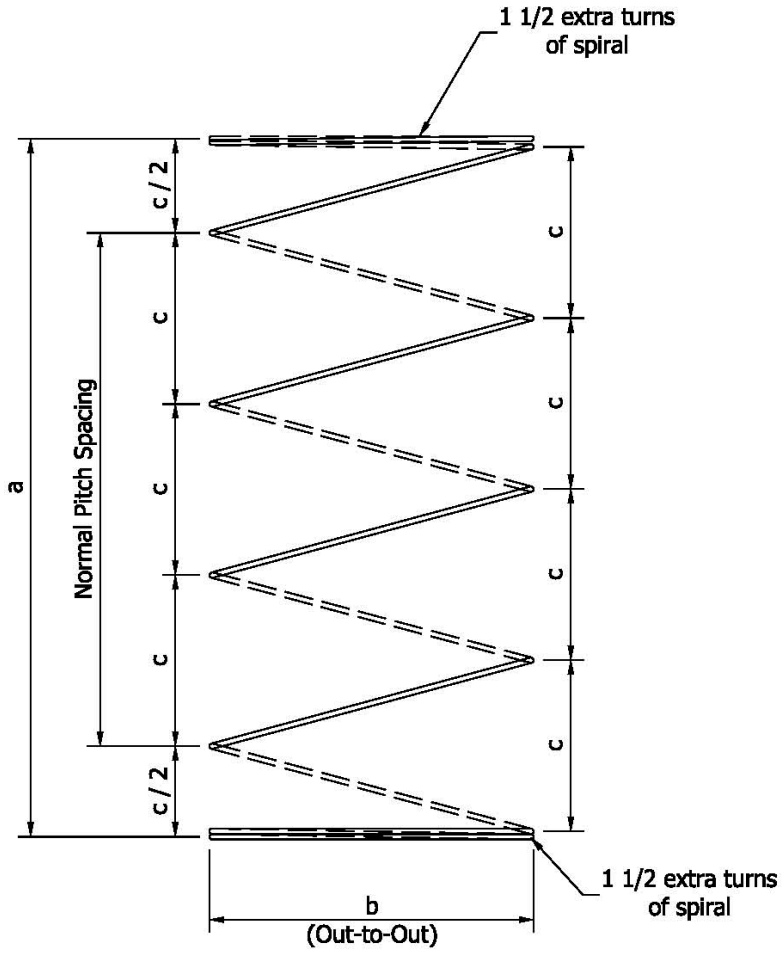
CONCRETE I-BEAM
END VIEW



STEEL I-BEAM
END VIEW

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

Figure 409-2D
(Page 4 of 4)



KEY:

a = Spiral Height
b = Outside Diameter
c = Pitch
d = Bar Diameter
L = Total Length of Spiral Reinforcement

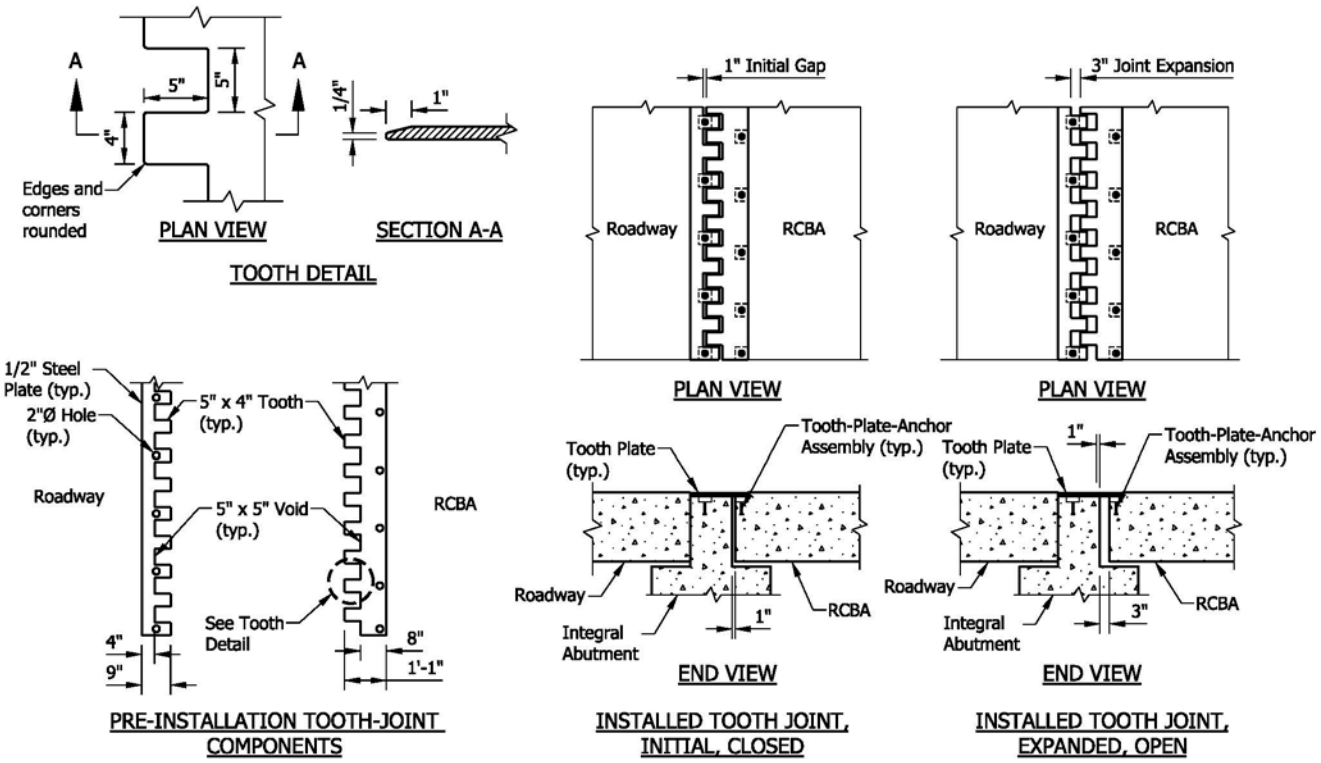
$L = [(a / c + 2(1\ 1/2\ turns)]\ \pi\ b$

SPIRAL REINFORCEMENT

Figure 409-2E

1. CONCEPTUAL PROPOSAL

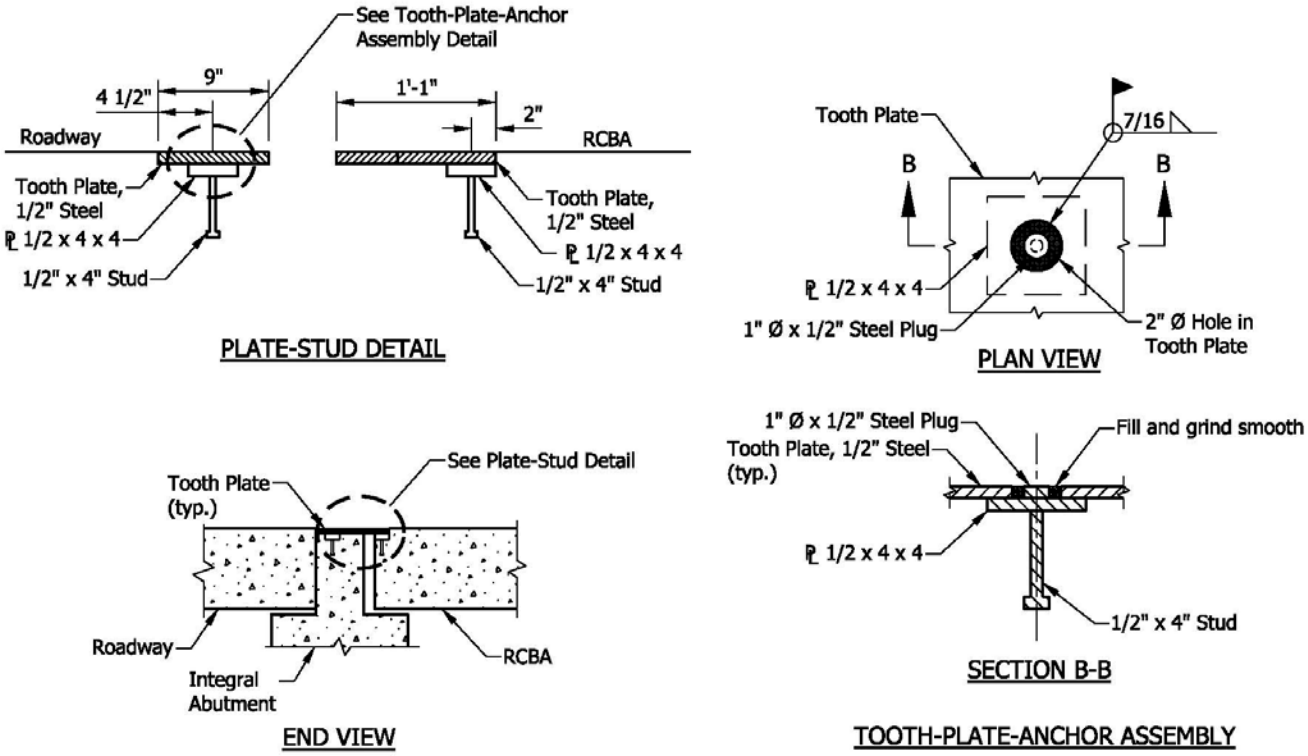
REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



TOOTH JOINT
Figure 409-2F
(Page 1 of 4)

1. CONCEPTUAL PROPOSAL

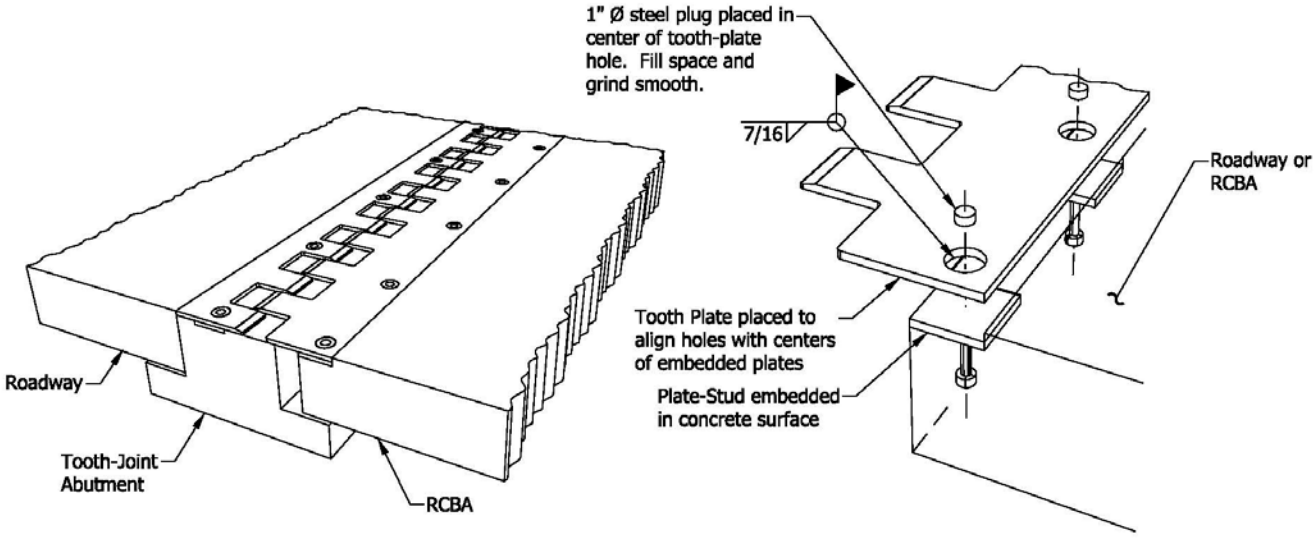
REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



TOOTH JOINT
Figure 409-2F
(Page 2 of 4)

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



ASSEMBLED TOOTH JOINT
EXPANDED POSITION

TOOTH-PLATE-ANCHOR ASSEMBLY
EXPLODED VIEW

TOOTH JOINT
Figure 409-2F
(Page 3 of 3)

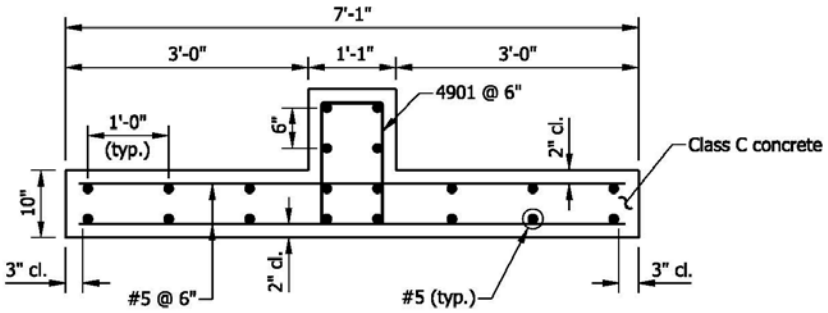
1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

QUANTITIES FOR ONE RUNNING FOOT OF ABUTMENT	
Concrete, class C	0.30 CFT
Reinforcing bars	32.9 LBS

NOTE:
All reinforcing steel shall be epoxy coated.

4901 x 3'-9"

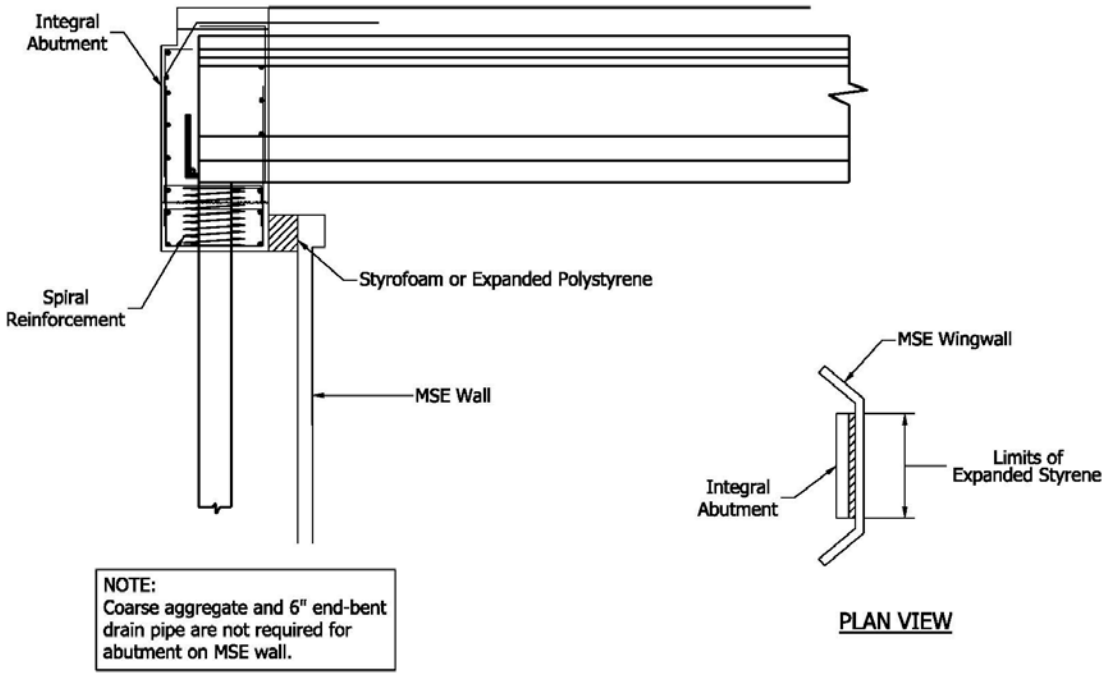


SECTION A-A

TOOTH-JOINT ABUTMENT
Figure 409-2F
(Page 4 of 4)

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL



INTEGRAL ABUTMENT PLACED BEHIND MSE WALL

Figure 409-2G

SECTION 409

409-4.03 Details

409-4.03(01) Construction Joint

The following applies to a construction joint at a spill-through end bent.

1. Type. Construction joint type A shall be used for each horizontal construction joint. See the INDOT *Standard Drawings*.

2. Integral. See Figures 409-2B and 409-2C for construction-joint use at an integral end bent.

409-4.03(02) Longitudinal Open Joint

If the bridge deck includes a longitudinal open joint, an expansion joint shall also be placed in the end bent. Also, flashing shall be placed behind the joint in the end bent. See the INDOT *Standard Drawings*.

409-5.0 CANTILEVER ABUTMENT AND WINGWALLS

409-5.01 General

See Chapter 402 and *LRFD* 11.6 for more information on the selection and design of abutments.

An abutment functions as both an earth-retaining and vertical-load-carrying structure. A parapet abutment is designed to accommodate thermal movements with strip-seal expansion devices between the concrete deck and abutment end block. An integral abutment shall be designed to accommodate movements at the roadway end of the approach panel.

A mechanically-stabilized-earth-wall bridge abutment placed adjacent to a roadway need not to be checked for vehicle-collision forces as described in *LRFD* 3.6.5. However, if the wall must be placed inside the clear zone, roadside safety shall be addressed. ~~Such an abutment placed adjacent to a railroad track shall be checked as described in *LRFD* 3.6.5.~~

~~A mechanically-stabilized-earth-wall bridge abutment placed within 50 ft of the centerline of a railroad track shall be shielded with a crashwall. The crashwall size shall be as specified in the AREMA *Manual for Railway Engineering*. The crashwall shall be designed for a static collision load of 400 kip.~~

409-6.03(02) Roadway-Grade Separation

A new-bridge pier located within 30 ft of the edge of roadway shall be designed for a vehicular collision-static force of ~~400~~ 600 kip, as indicated in *LRFD* ~~3.6.5.2.~~ 3.6.5.1

409-6.03(03) Railroad-Grade Separation

The design shall be in accordance with the AREMA *Manual for Railway Engineering* if the pier is within 25 ft of a present-track or a future-track centerline. ~~If the pier is located within 50 ft of a present-track centerline, it shall be designed for a vehicular collision-static force of 400 kip, if applicable, as described in *LRFD* 3.6.5.2.~~

409-7.03(03) Determining Standard Bearing-Device Type

The procedure for determining the applicable standard elastomeric bearing device is the same for each structural-member type.

~~1.~~ ~~Step 1.~~ Determine the Required Bearing-Device Type. Determine the dead-load plus live-load reaction, and calculate the maximum expansion length for the bridge at the support for which the device is located. Then enter Figure 409-7B, 409-7C, 409-7D, or 409-7E, Elastomeric Bearing Pad or Assembly Types, Properties, and Allowable Values, for the appropriate structural-member type, with the reaction and maximum expansion length. The required bearing-device size is that which corresponds to the reaction and expansion-length values shown in the figure which are less than or equal to those determined. If the reaction or expansion length is greater than the figure's value, use the next larger device size. If the reaction or expansion length is greater than the maximum value shown on the figure, the pad must be properly resized and designed.

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

2. Step 2: Check Compressive Stress due to Total Load Associated with Rotational Deflection. The rotational deflection, θ_S, is the sum of the total service-load rotation due to imposed loads about the transverse axis, θ_X, or about the longitudinal axis, θ_Z, initial lack of parallelism due to grade, θ_G, and the rotation due to uncertainties, θ_U.

The rotation of the beam due to imposed loads, θ_X or θ_Z, shall be the value, in radians, determined in the dead-load-plus-live-load analysis from the beam design about the transverse x-axis or about the longitudinal z-axis.

The total service-load rotation due to lack of parallelism, θ_G, in radians, shall be determined from Equation 409-7.1 as follows:

$$\theta_G = \left|\tan^{-1}\left(\frac{El.1 - El.2}{L_e}\right)\right|\left(\frac{\pi}{180}\right) \qquad \text{[Equation 409-7.1]}$$

Where: $El.1$ = Bridge seat elevation of one support, ft
$El.2$ = Bridge seat elevation of adjacent support, ft
L_e = Span length between the two centerlines of bearings along the bridge seat, ft

The rotation due to uncertainties, θ_U, shall be taken as 0.005 rad (*LRFD* 14.4.2.1) in the longitudinal direction unless an approved quality control plan justifies a smaller value. For a bearing of 36 in. width, the rotation in the transverse direction due to uncertainties, θ_U, shall be neglected.

The values of $\theta_{S,X}$ or $\theta_{S,Z}$ can be obtained from the equations as follows:

$$\theta_{S,X} = \theta_X + \theta_G + \theta_U \qquad \text{[Equation 409-8.2]}$$

$$\theta_{S,Z} = \theta_Z + \theta_G + \theta_U \qquad \text{[Equation 409-8.3]}$$

The value of $\theta_{S,X}$ or $\theta_{S,Z}$ shall be incorporated into the appropriate equation below.

Rectangular pads shall satisfy the following:

$$\sigma_S \geq 0.5GSi\left(\frac{L}{h_{ri}}\right)^2\left(\frac{\theta_{S,X}}{n}\right) \qquad \text{[LRFD Equation 14.7.6.3.5d-1]}$$

1. CONCEPTUAL PROPOSAL

REVISIONS TO VARIOUS SECTIONS OF THE INDIANA DESIGN MANUAL

~~$$\sigma_S \geq 0.5GSi\left(\frac{W}{h_{ri}}\right)^2\left(\frac{\theta_{S,Z}}{n}\right)$$ [*LRFD* Equation 14.7.6.3.5d-2]~~

~~where *W*, *L*, *S*, and *n* are as indicated in Figure 409-7B, 409-7C, 409-7D, or 409-7E, for the appropriate structural member type. The values of h_{ri} and *n* shall be taken as shown on the INDOT *Standard Drawings*. *G* shall be taken as 0.139 ksi.~~

~~If the above conditions are not satisfied for standard bearings, the pad dimensions shall be changed, or a beveled stainless steel plate shall be provided between the beam and bearing pad at the supports. For details, see Figure 409-7F.~~

The maximum service limit state rotation due to total load, ~~Θ_S~~, shall be calculated in accordance with 14.4.2.1

The requirement of a tapered plate shall be determined in accordance with 14.8.2

SECTION 410

410-6.04(05) Limiting Eccentricity Due to Overturning

Resistance to limiting eccentricity due to overturning is provided by the infill within the module. In performing a sliding analysis, the following shall be considered.

1. Eccentricity shall be evaluated at the Strength Limit state.
2. The requirements of *LRFD* 10.6.3 and 11.11.4.4 will apply.
3. Calculation methods are similar to those for a cast-in-place concrete wall.
4. Load factors shall be as shown in *LRFD* Figure ~~C11.5.5-2.~~ C11.5.6-2
5. The location of the resultant of the reaction forces shall be within the middle ~~one-half~~ two thirds of the base with.
6. Passive resistance on front of the wall due to wall embedment is most-often neglected.
7. Unless a structural bottom is provided to retain the soil within the module, a maximum of 80% of the soil fill for a precast-concrete modular binwall, or a metal binwall within the modules, is effective in resisting overturning moments.

Mr. Strain
Date: 06/21/12

SPECIFICATION, SPECIAL PROVISIONS AND DRAWINGS (OLD BUSINESS ITEM)
REVISION TO STANDARD SPECIFICATIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: The Standard Specifications in section 714 do not adequately call out the design requirements for precast box culverts.

PROPOSED SOLUTION: The Standard Specification sections 714 can be amended to call out the proper design sections from AASHTO bridge specifications for three-sided structures and box structures larger than 12 feet and ASTM C 1577 for sizing and loading where that specification is appropriate.

APPLICABLE STANDARD SPECIFICATIONS: 714

APPLICABLE STANDARD DRAWINGS: N.A,.

APPLICABLE DESIGN MANUAL SECTION: Culvert Chapter is presently under development

APPLICABLE SECTION OF GIFE: N.A.

APPLICABLE RECURRING SPECIAL PROVISIONS: N.A.

PAY ITEMS AFFECTED: None

Submitted By: Randy Strain

Title: Bridge Standards and Policy Engineer

Organization: INDOT

Phone Number: 317-232-3339

Date: 03/23/2012

APPLICABLE SUB-COMMITTEE ENDORSEMENT: This submission has been endorsed by the members of the committee to write the culvert chapter for the design manual.

REVISION TO STANDARD SPECIFICATIONS (OLD BUSINESS ITEM)

SECTION 714 – REINFORCED CONCRETE BOX STRUCTURES
714.04(a) BOX STRUCTURE
714.04(b) CONCRETE HEADWALLS, WINGWALLS, AND FOOTINGS
714.04(c) WORKING DRAWINGS
714.06(a) HEADWALL REINFORCEMENT PLACEMENT RELATIVE TO TOP OF STRUCTURE
714.06(c) SEALING

The Standard Specifications are revised as follows:

SECTION 714, BEGIN LINE 98, DELETE AND INSERT AS FOLLOWS:

(a) Box Structure

A box structure ~~shall~~*may* be designed in accordance with ~~the methodology presented in~~ ASTM C 1577 *if the box section is listed therein. A box structure section not listed therein shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications* with the following exceptions.

SECTION 714, BEGIN LILNE 126, DELETE AND INSERT AS FOLLOWS:

A headwall with ~~bridge railing~~ *guardrail* mounted on top ~~and~~, the anchorage of the headwall to the box structure section, *or a moment slab with bridge railing* shall be designed for the bridge railing test level shown on the plans.

SECTION 714, BEGIN LINE 140, DELETE AS FOLLOWS:

(c) Working Drawings

Working drawings shall be submitted in accordance with 105.02 for fabrication of a precast reinforced concrete box structure greater than 12 ft ~~(3.6 m)~~ span, a box structure of a size not described in ASTM C 1577, headwalls, wingwalls, and footings. Design calculations ~~which show the effects of hydrostatic pressure on the structure~~ shall ~~also~~ be submitted with the working drawings. Detailed plans for falsework and centering will not be required. Working drawings shall include all details, dimensions, and quantities necessary to construct the structure, headwalls, wingwalls, or footings and shall include, but not be limited to, the following information.

SECTION 714, BEGIN LINE 206, INSERT AS FOLLOWS:

(a) Headwall Reinforcement Placement Relative to Top of Structure

The headwall shall be a single precast piece which spans from sidewall to sidewall of a span. The vertical headwall reinforcement shall be attached to the top of the structure by either drilling holes or precasting holes. A chemical anchoring material, if used, shall be from the Department's List of Approved Chemical Anchoring Materials.

SECTION 714, BEGIN LINE 256, DELETE AS FOLLOWS:

~~**(c) Sealing**~~

~~Sealer shall be applied in accordance with 709 on the top surfaces of the structure section, headwalls and wingwalls. It shall extend 5 ft (1.5 m) vertically down the exterior of each section or 5 ft (1.5 m) vertically down both faces of each headwall or wingwall or to the bottom of each, whichever is less. Sealer material shall not be placed in keyway joints, if present. The sealer shall be provided for the full length of the structure. Surface preparation and application procedures shall be as recommended by the sealer manufacturer~~.

COMMENTS AND ACTION (OLD BUSINESS ITEM)

SECTION 714 – REINFORCED CONCRETE BOX STRUCTURES
714.04(a) BOX STRUCTURE
714.04(b) CONCRETE HEADWALLS, WINGWALLS, AND FOOTINGS
714.04(c) WORKING DRAWINGS
714.06(a) HEADWALL REINFORCEMENT PLACEMENT RELATIVE TO TOP OF STRUCTURE
714.06(c) SEALING

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: 714.03 pg 589, 590; 714.06 pg 592, 593. Recurring Special Provision affected: NONE Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book _____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ _____ Revise RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ Standard Drawing Effective _____ _____ Create RPD (No. _____) Effective _____ Letting _____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y___N___ By _____ Addition or _____ Revision Received FHWA Approval? _____

SPECIFICATION, SPECIAL PROVISIONS AND DRAWINGS (OLD BUSINESS ITEM)
REVISION TO STANDARD SPECIFICATIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: Some of our three-sided structures appear to have been damaged during the erection process. The legs of the three-sided structures need to be shimmed before the weight of the structure is released. The analysis of the structure to be able to handle the un-braced self-weight condition may not have been considered by the designer.

PROPOSED SOLUTION: In order to remedy this situation a couple of revisions are recommended to the Standard Specifications. The first revision would direct the manufacturer to provide technical instruction and on-site assistance to the contractor during the erection of the members. The second revision would instruct the designer to consider this loading condition and include the calculations in the working drawings.

The addition of a moment slab for a bridge rail is added and the use of a concrete sealer is removed.

APPLICABLE STANDARD SPECIFICATIONS: 723

APPLICABLE STANDARD DRAWINGS: N.A.

APPLICABLE DESIGN MANUAL SECTION: Culvert Chapter under development.

APPLICABLE SECTION OF GIFE: N.A.

APPLICABLE RECURRING SPECIAL PROVISIONS: N.A.

PAY ITEMS AFFECTED: None

Submitted By: Randy Strain

Title: Bridge Standard and Policy Engineer

Organization: INDOT

Phone Number: 317-232.3339

Date: April 24 2012

APPLICABLE SUB-COMMITTEE ENDORSEMENT: None

REVISION TO STANDARD SPECIFICATIONS (OLD BUSINESS ITEM)

SECTION 723 – REINFORCED CONCRETE THREE-SIDED STRUCTURES
723.03 GENERAL REQUIREMENTS
723.04 DESIGN REQUIREMENTS
723.04(c) WORKING DRAWINGS
723.13 SEALING

The Standard Specifications are revised as follows:

SECTION 723, BEGIN LINE 94, INSERT AS FOLLOWS:

723.03 General Requirements

Excavation and disposal shall be in accordance with the applicable requirements of 206. The areas designated for waterproofing shall be waterproofed in accordance with 702.23. All underground drains encountered during excavation for the structure shall be perpetuated as dictated by field conditions. Drainage openings through masonry shall be in accordance with 702.16. Handling of three-sided structures shall be in accordance with 907.05. Handling of wingwalls and spandrel walls shall be in accordance with 907.06.

For precast three-sided structures, the manufacturer's representative shall provide technical instruction and on-site technical assistance to the Contractor during the erection of the members.

SECTION 723, BEGIN LINE 119, DELETE AND INSERT AS FOLLOWS:

A headwall with ~~bridge railing~~ *guardrail* mounted on top, ~~and~~ the anchorage of the headwall or spandrel wall to the structure section, *or a moment slab with bridge railing,* shall be designed for the bridge railing test level shown on the plans.

SECTION 723, BEGIN LINE 163, INSERT AS FOLLOWS:

(c) Working Drawings

Working drawings shall be submitted in accordance with 105.02 for fabrication of a precast or cast-in-place reinforced concrete three-sided structure, precast or cast-in-place reinforced concrete three-sided structure extension, precast or cast-in-place headwalls, precast or cast-in-place wingwalls, and precast or cast-in-place spandrel walls. The working drawings shall include all details, dimensions, and quantities necessary to construct the structure, headwalls, wingwalls, or spandrel walls and shall include, but not be limited to, the following information.

1. Structure span and rise.

2. Structure section details showing all concrete dimensions and reinforcement requirements. *An analysis of the precast segment modeled as a simple span and designed in accordance with AASHTO LRFD Bridge Design Specifications Section 5.7.3. This analysis will demonstrate that the precast segment is designed to withstand the forces of erection.*

REVISION TO STANDARD SPECIFICATIONS (OLD BUSINESS ITEM)

SECTION 723 – REINFORCED CONCRETE THREE-SIDED STRUCTURES
723.03 GENERAL REQUIREMENTS
723.04 DESIGN REQUIREMENTS
723.04(c) WORKING DRAWINGS
723.13 SEALING

SECTION 723, BEGIN LINE 378, DELETE AS FOLLOWS:

723.13 ~~Sealing~~*Blank*

~~Sealer shall be applied in accordance with 709 on the top surface of the structure section, headwalls, and wingwalls. It shall extend 5 ft (1.5 m) vertically down the exterior of each vertical leg or 5 ft (1.5 m) vertically down both faces of each headwall or wingwall or to the bottom of each, whichever is less. Sealer material shall not be placed in keyway joints, if present. The sealer shall be provided for the full length of the structure. Surface preparation and application procedures shall be as recommended by the sealer manufacturer.~~

COMMENTS AND ACTION (OLD BUSINESS ITEM)

SECTION 723 – REINFORCED CONCRETE THREE-SIDED STRUCTURES
723.03 GENERAL REQUIREMENTS
723.04 DESIGN REQUIREMENTS
723.04(c) WORKING DRAWINGS
723.13 SEALING

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: 723.03 pg 651, 652; 723.13 pg 657. Recurring Special Provision affected: NONE Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book _____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ _____ Revise RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ Standard Drawing Effective _____ _____ Create RPD (No. _____) Effective _____ Letting _____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y___N___ By _____ Addition or _____ Revision Received FHWA Approval? _____

SPECIFICATION, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO SPECIAL PROVISIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: With the extension of the integral abutment a problem of proloned shrinkage and larger thermal movements, a joint is needed at the end of the approach. The joint needs to accommodate the shrinkage of the longer integral structure as well as the larger thermal movements. Commercial joints have been used for this purpose in the past but have not performed well.

PROPOSED SOLUTION: A new type of joint has been designed that can accommodate the shrinkage as well as the thermal movement. This joint is based on the steel tooth joint but in this design the movement of the joint takes place on top of the tooth joint abutment. By locating the movement over the tooth joint abutment, the risk of debris filling the void and causing damage to the approach is eliminated. The design is a simple interlocking tooth joint which is designed to self clean and provides a smooth transition to the roadway.

A recurring provision is proposed to support the plan details for this joint. It is proposed that the joint and the joint abutment be paid for per linear foot.

The proposed pay item, sliding plate, is an existing pay item for a very similar joint. This proposed type of joint will only be used for integral structures over 500 feet.

APPLICABLE STANDARD SPECIFICATIONS: 724

APPLICABLE STANDARD DRAWINGS:

APPLICABLE DESIGN MANUAL SECTION: 409-2.04(02) item 3, and figure 409-2F

APPLICABLE SECTION OF GIFE:

APPLICABLE RECURRING SPECIAL PROVISIONS:

PAY ITEMS AFFECTED: 724-03855

Submitted By: Randy Strain

Title: Bridge Standard and Policy Engineer

Organization: INDOT

Phone Number: 317-232-3339

Date: 6-1-2012

APPLICABLE SUB-COMMITTEE ENDORSEMENT: Details reviewed by ASCE Structural Committee

REVISION TO SPECIAL PROVISIONS

PROPOSED NEW 724-B-XXX TOOTH EXPANSION JOINT FOR INTEGRAL STRUCTURES

724-B-XXX TOOTH EXPANSION JOINT FOR INTEGRAL STRUCTURES

(Adopted 06-21-12)

Description

This work shall consist of furnishing materials, and placing a tooth expansion joint, including the tooth joint abutment, in accordance with 105.03.

Materials

Materials shall be in accordance with the following:

Concrete, Class C.....702
Epoxy Coated Reinforcing Bars.....910.01
Structural Steel.....910.02

The Contractor shall prepare and submit working drawings in accordance with 105.02. The working drawings shall include details of the assembly.

Construction Requirements

Dimensions for the tooth joint shall be as shown on the plans.

All welding shall be in accordance 711.32. All splice welds shall develop full strength.

Method of Measurement

Tooth expansion joints will be measured by the linear foot along and parallel to the plane of the finished joint surface.

Basis of Payment

Tooth expansion joint will be paid for at the contract unit price per linear foot, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Expansion Joint, Sliding Plate	LFT

The cost of the tooth joint abutment shall be included in the cost of the pay item.

COMMENTS AND ACTION

RSP 724-B-XXX TOOTH EXPANSION JOINT FOR INTEGRAL STRUCTURES

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: SECTION 724 Recurring Special Provision affected: NONE Standard Sheets affected: NONE Design Manual Sections affected: 409-2.04(02) ITEM 3, AND FIGURE 409-2F GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book _____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ _____ Revise RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ Standard Drawing Effective _____ _____ Create RPD (No. _____) Effective _____ Letting _____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y___N___ By _____ Addition or _____ Revision Received FHWA Approval? _____

Mr. Walker
Date: 06/21/12

SPECIFICATION, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO SPECIAL PROVISIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: INDOT currently allows the use of drilled shaft foundations through unique special provision. The problem occurs when design consultants obtain the unique special provision and make changes. These changes effect the production, testing, and quality of the drilled shaft foundation.

Additionally, the unique special provisions that currently exist are not written in accordance with INDOT standard format or structure and are somewhat confusing.

PROPOSED SOLUTION: Create a recurring special provision to be placed on the menu of Recurring Special Provisions to be selected by design consultants when drilled shaft foundations are to be used in an INDOT contracts.

The recurring special provision shall be written in accordance with INDOT's standard formatting and structure.

APPLICABLE STANDARD SPECIFICATIONS: None

APPLICABLE STANDARD DRAWINGS: None

APPLICABLE DESIGN MANUAL SECTION: None

APPLICABLE SECTION OF GIFE: None

APPLICABLE RECURRING SPECIAL PROVISIONS: create new 728 provision

PAY ITEMS AFFECTED: Create or modify existing pay items to have drilled shafts designated by diameter. Also the item for exploratory core needs to be created or maintained.

Submitted By: Ron Walker

Title: Manager, Office of Materials Management

Organization: INDOT

Phone Number: 610-7251

Date: June 5, 2012

APPLICABLE SUB-COMMITTEE ENDORSEMENT: ad hoc committee consisting of: Youlanda Belew, Ron Heustis, Jim Reilman, Tom Struewing, & Mir Zaheer

REVISION TO SPECIAL PROVISIONS

PROPOSED NEW 728-B-XXX DRILLED SHAFT FOUNDATIONS

728-B-XXX DRILLED SHAFT FOUNDATIONS

(Adopted X-XX-12)

The Standard Specifications are revised as follows:

SECTION 728, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 728 - ~~BLANK~~*DRILLED SHAFT FOUNDATIONS*

728.01 Description

This work shall consist of the construction of reinforced concrete drilled shaft foundations in accordance with 105.03.

MATERIALS

728.02 Materials

Materials shall be in accordance with the following:

Admixtures for Use in Concrete.....912.03
Cement Grout.....707.09
Reinforcing Bars.....910.01
Structural Concrete.....702*
**Except as modified herein*

If indicated on the plans, casings shall be in accordance with either ASTM A 252, grade 2 or ASTM A 36. Otherwise, casings shall be steel, smooth, clean, watertight, and of adequate strength to resist construction stresses. The inside diameter of permanent casing and the outside diameter of temporary casing shall not be less than the specified diameter of the drilled shaft. Casing diameters shall be within the American Pipe Institute's tolerances for regular steel pipe. The Contractor may request to provide a casing larger in diameter than that specified.

Slurry shall be either a polymer or mineral slurry, using sodium bentonite or attapulgite. Slurry shall have a grain size that will remain in suspension with sufficient viscosity and gel characteristics to transport excavated material. The slurry shall be capable of maintaining the stability of the drilled shaft excavation to allow proper concrete placement.

Concrete shall be either class C or class A, as shown on the plans, except that the concrete shall maintain a slump of between 6 in. and 9 in. for two hours and have a maximum water cementitious ratio of 0.443. Type F or G chemical admixture shall be used to achieve and maintain the required slump. A rheology-modifying admixture may be used if approved by the Engineer and admixture manufacturer. The rheology-modify admixture shall meet the requirements of a type S chemical admixture in accordance with ASTM C 494.

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728.03 Concrete Mix Design

A concrete mix design, CMD, shall be as specified herein and shall be verified by a trial batch. The CMD shall be submitted to the Engineer for verification at least 7 days prior to the trial batch demonstration. The format shall be acceptable to the Engineer and include the following:

(a) a list of all ingredients
(b) the source of all materials
(c) the gradation of the aggregates
(d) the absorption of the aggregates
(e) the SSD bulk specific gravity of the aggregates
(f) the specific gravity of pozzolan
(g) the batch weights
(h) the names of all admixtures
(i) the range of admixture dosage rates as recommended by the manufacturer.

728.04 Trial Batch

An American Concrete Institute certified concrete field testing technician, grade 1, hereinafter referred to as the Contractor's certified technician, shall be on site to direct and perform all sampling and testing.

A trial batch shall be produced and tested by the Contractor's certified technician and the Department's qualified technician to verify that the CMD meets the concrete mix criteria. Sufficient concrete shall be batched to accurately represent the CMD and provide the volume of concrete required to perform all tests from the same batch. The concrete shall be batched and mixed in accordance with 702.06 and 702.07. The Engineer will test the trial batch and provide the Contractor with the results. Trial batch concrete shall not be used for more than one test, except the concrete used for the unit weight may be used to conduct the air content test. After mixing, the concrete shall be agitated for a time period to simulate delivery, not to exceed 45 minutes.

The Contractor shall cast four 6 in. by 12 in. cylinders for compressive strength determination. Two of the cylinders shall be tested at an age of 7 days and two cylinders tested at an age of 28 days. Compressive strength shall be reported as the average of the two cylinders tested at the appropriate age.

The Department will cast four 6 in. by 12 in. cylinders. Two of the cylinders will be tested at an age of 7 days and two cylinders tested at an age of 28 days. Compressive strength will be reported as the average of the two cylinders tested at the appropriate age. Additional cylinders may be cast and tested at another age. Average compressive strength test results by the Department, which achieve the minimum compressive strength requirement at an earlier age, will be considered as validating the compressive strength requirement for the CMD; however, compressive strengths at 28 days are still required. The 28-day compressive strength shall meet or exceed the requirements of ASTM C 94, Appendix X1., unless otherwise approved by the Engineer.

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The Department's test results will be used to validate CMD compliance with the required concrete properties.

All molds, facilities, and materials necessary to prepare and initially cure cylinders shall be provided.

Gradations will be determined to validate the fine and coarse aggregates used.

The Department's qualified technician will measure the concrete properties and verify compliance to the Contractor's results within the following tolerances.

CONCRETE PROPERTIES AND ALLOWABLE TOLERANCES BETWEEN RESULTS

Concrete Property	*Tolerance between results*
Aggregate Correction Factor	*±0.1% point*
Air Content	*±0.5% point*
Slump	*±1.0 in.*
28-day Compressive Strength	*±8.5%*
Unit Weight	*±1.9 lb/cu ft*
Water/Cementitious ratio	*±0.015*

All test results not within the tolerance are to be investigated by the Department and the Contractor as to the cause and determine corrective actions required to resolve the discrepancy. The relative yield shall be determined by both the Department and Contractor and compared to the theoretical value for relative yield in the following table based on the measured air content. A relative yield that is more than ±0.005 from the theoretical is not cause for rejection, but will be investigated for cause and possible corrective action.

THEORETICAL EFFECT OF AIR CONTENT ON RELATIVE YIELD
(@ 6.5% Target Air Content)

Air Content	*Theoretical Relative Yield*	*Air Content*	*Theoretical Relative Yield*	*Air Content*	*Theoretical Relative Yield*
3.0 (fail)	*0.965*	*5.7*	*0.992*	*8.4 (fail)*	*1.019*
3.1 (fail)	*0.966*	*5.8*	*0.993*	*8.5 (fail)*	*1.020*
3.2 (fail)	*0.967*	*5.9*	*0.994*	*8.6 (fail)*	*1.021*
3.3 (fail)	*0.968*	*6.0*	*0.995*	*8.7 (fail)*	*1.022*
3.4 (fail)	*0.969*	*6.1*	*0.996*	*8.8 (fail)*	*1.023*
3.5 (fail)	*0.970*	*6.2*	*0.997*	*8.9 (fail)*	*1.024*

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3.6 (fail)	*0.971*	*6.3*	*0.998*	*9.0 (fail)*	*1.025*
3.7 (fail)	*0.972*	*6.4*	*0.999*	*9.1 (fail)*	*1.026*
3.8 (fail)	*0.973*	*6.5*	*1.000*	*9.2 (fail)*	*1.027*
3.9 (fail)	*0.974*	*6.6*	*1.001*	*9.3 (fail)*	*1.028*
4.0 (fail)	*0.975*	*6.7*	*1.002*	*9.4 (fail)*	*1.029*
4.1 (fail)	*0.976*	*6.8*	*1.003*	*9.5 (fail)*	*1.030*
4.2 (fail)	*0.977*	*6.9*	*1.004*	*9.6 (fail)*	*1.031*
4.3 (fail)	*0.978*	*7.0*	*1.005*	*9.7 (fail)*	*1.032*
4.4 (fail)	*0.979*	*7.1*	*1.006*	*9.8 (fail)*	*1.033*
4.5 (fail)	*0.980*	*7.2*	*1.007*	*9.9 (fail)*	*1.034*
4.6 (fail)	*0.981*	*7.3*	*1.008*	*10.0 (fail)*	*1.035*
4.7 (fail)	*0.982*	*7.4*	*1.009*	*10.1 (fail)*	*1.036*
4.8 (fail)	*0.983*	*7.5*	*1.010*	*10.2 (fail)*	*1.037*
4.9 (fail)	*0.984*	*7.6*	*1.011*	*10.3 (fail)*	*1.038*
5.0	*0.985*	*7.7*	*1.012*	*10.4 (fail)*	*1.039*
5.1	*0.986*	*7.8*	*1.013*	*10.5 (fail)*	*1.040*
5.2	*0.987*	*7.9*	*1.014*	*10.6 (fail)*	*1.041*
5.3	*0.988*	*8.0*	*1.015*	*10.7 (fail)*	*1.042*
5.4	*0.989*	*8.1 (fail)*	*1.016*	*10.8 (fail)*	*1.043*
5.5	*0.990*	*8.2 (fail)*	*1.017*	*10.9 (fail)*	*1.044*
5.6	*0.991*	*8.3 (fail)*	*1.018*	*11.0 (fail)*	*1.045*

CMD's, which have had a successful trial batch demonstration for another drilled shaft contract may be submitted for the Engineer's approval. The results from Department and Contractor testing of the concrete properties listed above from the trial batch concrete shall be included in the submittal.

If the Engineer approves the use of the submitted CMD which has had a successful trial batch demonstration from another drilled shaft contract, verification of the tolerances shall be made during the first day of production by tests conducted by the Contractor and the Engineer. The results of the tests from the first day of concrete production shall be within the concrete property tolerances listed above.

Except for adjustments to compensate for routine aggregate moisture fluctuations, changes in target aggregate SSD batch weights shall be documented and submitted to the Engineer for approval, prior to implementing. A maximum adjustment of ±3 percentage

points of fine to total aggregate ratio by volume will be permitted. Changes to the dosage amounts of admixtures will be permitted.

A new CMD shall be prepared and successfully demonstrated by trial batch for any change in material, cementitious content or target water/cementitious ratio.

CONSTRUCTION REQUIREMENTS

728.05 Contractor Qualifications

A contractor performing drilled shaft construction shall be prequalified with the Department for drilled shaft work and shall be from the List of Approved Drilled Shaft Contractors published by the Department.

728.06 Quality Control Testing

The Contractor shall perform all quality control testing including, but not limited to, slurry testing and plastic and hardened concrete testing. The Contractor shall provide copies of all quality control test reports to the Engineer no later than 5 business days after the tests are completed. If the Contractor fails to submit test reports within the timeframe allowed, the Engineer may withhold progress estimates until the reports are provided.

728.07 Submittals

A minimum of 45 days prior to the start of drilled shaft construction, the Contractor shall submit a QCP in accordance with ITM 803 detailing the plan for construction of the drilled shafts. The QCP shall at a minimum include the following:

- *(a) The name of the contractor that will perform the drilled shaft construction.*
- *(b) A list of equipment to be used including, but not limited to cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, core sampling equipment, tremies, concrete pumps, and temporary casings.*
- *(c) A list of proposed materials and suppliers including, but not limited to concrete, reinforcement bars, permanent casings and slurry.*
- *(d) A detailed description of the proposed sequence of construction through the project, at each structure and at each bent and pier of each structure.*
- *(e) A detailed explanation of methods and procedures for construction including, but not limited to the following:*
  1. *The method of construction proposed for each drilled shaft.*
  2. *The procedures for ensuring correct horizontal and vertical alignment of each drilled shaft.*
  3. *The procedures for removing or excavating through subsurface obstructions, whether natural or man-made.*
  4. *The procedures for advancing casing, as applicable.*

5. *The details regarding the lengths, sizes and locations of the temporary casings and details regarding the methods to install and extract the temporary casing as applicable.*
6. *The methods of mixing, circulating and de-sanding slurry. A copy of the slurry manufacturer's recommendations shall be included.*
7. *The names and qualifications of technicians that will perform slurry testing.*
8. *The names and qualifications of the certified technicians.*
9. *The procedures for dewatering and cleaning drilled shaft excavations.*
10. *The methods for placing and supporting reinforcement bars in the correct locations.*
11. *The materials and methods for installing, protecting and grouting crosshole sonic logging testing access tubes.*
12. *The procedures for concrete placement.*
13. *The procedures and materials for pressure grouting voids when using permanent casing.*
14. *Detailed procedures for how construction problems will be addressed.*

Drilled shaft construction shall not begin until the QCP is approved in writing by the Engineer.

728.08 Preconstruction Meeting

The Contractor shall hold a pre-construction meeting with the Engineer after approval of the QCP and a minimum of 14 days prior to construction. The preconstruction meeting shall include at a minimum representatives of the Contractor, the subcontractor performing the drilled shaft construction, the Engineer, the design consultant, the geotechnical consultant drilled shaft inspector, and the Office of Geotechnical Services.

728.09 Equipment

Drilling and excavation equipment shall be capable of producing a drilled shaft that is a minimum of 20% of the planned drilled shaft length below the tip elevations shown in the plans. Blasting will not be permitted for drilled shaft excavation unless approved in writing by the Engineer.

Drop chutes for concrete placement shall consist of a smooth tube of one piece construction with an attached hopper.

Tremies shall consist of a watertight tube of sufficient length, diameter, and wall thickness to discharge concrete at the base of the drilled shaft excavation without bending, crimping or impeding the flow of concrete. The inside diameter of the tremie shall be a minimum of 10 in. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The inside and outside surfaces of the tremie shall be clean and smooth.

Concrete pumps shall be capable of maintaining a continuous flow of concrete from beginning to completion of a drilled shaft pour. Pump lines shall have a minimum 4 in. diameter and shall be constructed with watertight joints.

728.10 Construction Methods

The Contractor shall use the construction methods specified in the contract for each drilled shaft. If more than one method is specified or no method is specified for a drilled shaft, the Contractor may choose the method suitable for the drilled shaft. Construction methods shall be one of the following:

(a) Dry Construction Method

The dry construction method shall consist of drilling the excavation, removing accumulated water and loose material from the excavation, and placing concrete and reinforcement in a relatively dry excavation.

The dry construction method shall only be used in locations where conditions are such that the rate of groundwater infiltration into the excavation does not exceed 12 in. per hour. The maximum depth of water shall not exceed 2 in. prior to concrete pour. The sides and bottom of the excavation shall remain stable without any caving, sloughing, or swelling, and the full depth of the excavation may be visually inspected prior to placing concrete.

(b) Wet Construction Method

The wet construction method shall consist of drilling the excavation, cleaning the excavation by muck bucket and air lifting, and placing concrete in a manner to displace water and slurry up and out of the excavation as concrete is placed.

The wet construction method shall be used where conditions are not suitable for the dry construction method. To prevent caving, sloughing, or swelling of the excavation during drilling, slurry shall be added to the excavation prior to encountering groundwater.

(c) Casing Construction Method

The casing construction method shall consist of placing either a temporary or permanent casing in accordance with the following:

1. Temporary Casing Method

The temporary casing method shall consist of drilling the shaft excavation in accordance with the dry or wet construction method, placing a casing to maintain the excavation, and then withdrawing the casing during placement of the concrete.

2. Permanent Casing Method

The permanent casing method shall consist of driving, vibrating, or drilling a casing to a specified depth prior to excavation of the drilled shaft. Material inside the

casing is then excavated and concrete placed in accordance with the dry or wet construction method.

728.11 Construction

The Contractor shall maintain a construction log for each drilled shaft. The log shall include the following as a minimum:

(a) The drilled shaft number.
(b) The method of construction.
(c) A description and approximate top and bottom elevation of each soil or rock material encountered during excavation.
(d) The rate of groundwater infiltration.
(e) The depth of water in the excavation just prior to concrete placement.
(f) The type of slurry, as applicable.
(g) The results of all slurry testing, as applicable.
(h) The methods used to clean and check the excavation prior to concrete placement.
(i) The method of concrete placement.
(j) The results of all plastic concrete testing.
(k) The number of concrete cylinders made for compressive strength testing.
(l) Time of completion of excavation cleaning
(m) Time of installation of reinforcing steel
(n) Time that concrete placement begins and ends
(o) The rate of concrete placement and the total time required to place concrete.
(p) The method of temporary casing removal, as applicable.
(q) A record of the head of concrete before and during removal of temporary casing, as applicable.
(r) The total volume of concrete placed versus theoretical volume of concrete required.
(s) A description of all equipment and materials used.
(t) A record of any problems encountered including possible soil and water inclusion, possible voids, and possible drilled shaft or casing collapse.

A drilled shaft excavation shall not be left unfilled overnight unless cased to full depth.

(a) Exploratory Cores and Proof Testing

The Contractor shall obtain exploratory cores within the footprint of each drilled shaft prior to the start of production drilling. Cores shall be NX-size and shall extend a minimum of 15 ft below the planned tip elevation of the drilled shaft. The Engineer will observe exploratory coring and will inspect cores to determine if the material is suitable for the planned depth and size of drilled shaft. Additional exploratory cores shall be obtained as directed by the Engineer.

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The Contractor shall take soil samples and rock cores to determine the character of the material throughout the entire drilled shaft length and to a depth directly below the complete shaft excavation. The soil samples shall be extracted with a split spoon sampler or undisturbed sample excavation. The test borings and rock cores shall be obtained by an INDOT- Approved Geotechnical Consultant and complete boring logs shall be prepared and submitted by the geotechnical consultant.

The Contractor shall take rock cores, approximately 2 in. in diameter, to a minimum of 15 ft. below the tip of the drilled shaft rock sockets or three times the diameter of the rock socket, whichever is greater, or as directed by the Engineer. The core hole shall be properly grouted before the concrete pour for the shaft. The rock cores shall be extracted with a core barrel. Rock cores shall be measured, visually identified, and described on the Contractor's field log within twenty-four hours after the exploration is completed. The Engineer will inspect the cores and determine the final depth of required excavation based on evaluation of the material's suitability.

The bedrock beneath the drilled shaft excavations shall be proof-tested to verify the integrity of the rock. Proof-testing of the rock shall consist of drilling an exploratory hole, approximately 2 in. in diameter and 15 ft. deep and observing such indicators as speed of drilling under given drill pressure, dropping or clogging of the drill bit and loss of drill water, if used.

(b) Casing

If the dry construction method is used and casing is not placed during excavation, the Contractor shall take appropriate measures to prevent deterioration of the excavation. If the excavation has deteriorated, the Contractor shall over-ream the excavation prior to placement of concrete and reinforcement. Over-reaming shall be by methods approved by the Engineer.

If the temporary casing method is used, the casing shall be advanced with the drilling until a nearly impervious ground formation is reached. The casing shall be seated in the formation and excavation shall continue until the required tip elevation is reached. Dependent on the rate of groundwater infiltration, construction shall proceed in accordance with either the dry or wet construction method. The temporary casing shall be withdrawn during placement of the concrete and while the concrete is still in a plastic state. The casing shall be withdrawn at a slow, uniform rate in a direction parallel to the axis of the drilled shaft. The casing shall not be rotated, reinserted, driven or vibrated during withdrawal. The rate of concrete placement and rate of casing withdrawal shall be such that the concrete displaces all loose materials, water and slurry up and out of the excavation without mixing with or displacing the concrete. At a minimum, a 5 ft head of concrete shall be maintained above either the highest hydrostatic water level or slurry, whichever is higher, as the casing is withdrawn.

If the permanent casing method is used, the casing shall be driven, vibrated or advanced by drilling to the specified tip elevation. If the casing cannot be driven to the

full depth of the excavation, the Contractor may either excavate material within the embedded portion of the casing or drill a pilot hole ahead of the casing until the casing reaches the specified depth. If a pilot hole is drilled, it shall be centered in the drilled shaft and shall be no larger than one-half the diameter of the drilled shaft. The Contractor shall not over-ream the excavation to the outside diameter of the casing. Permanent casing shall be continuous between the elevations shown on the plans. Any length of permanent casing installed below the shaft cutoff elevation, shall remain in place. Temporary casing shall not be used instead of, or in addition to, permanent casing. After the permanent casing is placed, all loose materials and water shall be removed. Reinforcement shall be placed and the casing shall be filled with concrete. All voids between the casing and the soil surrounding the casing shall be pressured grouted with cement grout.

All subsurface casing shall be considered temporary unless specified as permanent casing in the contract.

If the Contractor elects to remove a casing and substitute a longer or larger diameter casing through caving soils, the excavation shall be stabilized either with slurry or by backfilling before the new casing is installed.

Temporary casing which becomes bound and cannot be practically removed will constitute a defect in the drilled shaft. The Contractor shall submit a proposed method to remediate the defect to the Engineer for approval. The submittal shall include design drawings and calculations stamped by a professional engineer.

When temporary casing is used and the drilled shaft extends above ground or through a body of water, the portion of the drilled shaft above the existing ground or above the bottom of the body of water may be formed with a removable casing. Removable casings may be removed when the following conditions are met:

1. *The concrete has cured for a minimum of 72 hours.*

2. *The concrete attains a compressive strength of at least 2500 psi, as determined from 6 in. x 12 in. concrete cylinder breaks.*

3. *The drilled shaft concrete is not exposed to moving water for 7 days.*

(c) Slurry

The Contractor shall insure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft.

The level of slurry in a drilled shaft excavation shall be maintained at a level sufficient to prevent caving of the hole, but not less than 4 ft above the highest expected piezometric pressure head along the depth of the shaft. In the event of a sudden significant loss of slurry in the excavation, the construction of that drilled shaft shall be

stopped until either a method to stop slurry loss or an alternate construction procedure has been approved by the Engineer.

728.12 Excavation Inspection

The Contractor shall provide all necessary equipment for checking the dimensions, alignment, and cleanliness of the drilled shaft excavation. The dimensions and alignment shall be determined by the Contractor under the direction of the Engineer. Final drilled shaft depths shall be measured with a suitable weighted tape or other approved method after final cleaning.

The bottom of the drilled shaft excavation shall be clean such that a minimum of 50% of the base surface of each drilled shaft has less than 1/2 in. of loose material at the time of concrete placement. The maximum depth of loose material at any location on the base surface of the drilled shaft excavation shall not exceed 1.5 in. The contractor shall remove any loose material adhering to the vertical sides of the bedrock socket. Acceptability of the excavation for cleanliness will be determined by the Engineer by means of visual inspection and sounding for dry excavations and by measuring and sounding with a weighted tape or by other methods deemed appropriate by the Engineer for wet excavations. For dry excavations, the maximum depth of water shall not exceed 2 in. at the time of concrete placement and the rate of groundwater flow into the excavation shall not exceed 12 in. per hour.

728.13 Construction Tolerances

Drilled shafts shall meet the following construction tolerances:

(a) Drilled shafts shall be within 3 in. horizontally of the location shown in the plans.
(b) The top of drilled shafts shall be within plus 1 in. and minus 3 in. of the elevation shown in the plans.
(c) The alignment of vertical drilled shafts shall not vary from plumb by more than 1/4 in. per ft of depth.
(d) The alignment of battered drilled shafts shall not vary by more than 1/2 in. per ft of depth from the specified batter rate.
(e) After placement of concrete, the top of reinforcement bars shall be within plus 6 in. and minus 3 in. of the location shown in the plans.
(f) Excavation equipment and methods shall be such that the completed drilled shaft will have a planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the drilled shaft within a tolerance of 3/8 in. per ft of diameter.

728.14 Reinforcing Steel Cage Construction and Placement

Reinforcement shall be fastened and placed in accordance with 703. Approved non-corrosive spacing devices shall be installed to hold the reinforcement at least 3 in. from the sides of the drilled shaft excavation along its entire height and concentrically centered within the drilled shaft. At a minimum, spacers shall be placed within 1 ft of the

bottom of the drilled shafts and at intervals not exceeding 10 ft along the height of the drilled shaft. Approved bottom supports shall be installed to hold reinforcement the required dimension above the bottom of the drilled shaft. Concrete shall be placed immediately after placing reinforcement in the drilled shaft excavation. If concrete is not placed immediately after placing reinforcement, the Contractor shall remove the reinforcement to allow the Engineer to verify the integrity of the drilled shaft excavation and to ensure loose material has been removed.

Prior to placement of concrete, the Contractor shall determine and record the elevation of the bottom of the drilled shaft excavation and provide a copy of the record to the Engineer.

728.15 Concrete Placement

Concrete placement shall be in accordance with the applicable portions of 702, except as modified herein.

Concrete shall not be placed in a drilled shaft excavation without approval from the Engineer. Concrete placement shall be made by one continuous pour from the bottom to the top of the drilled shaft. The elapsed time from batching of the first load of concrete to the completion of concrete placement shall not exceed two hours unless otherwise approved by the Engineer based on results of slump loss testing from a trial batch.

Concrete shall be placed by means of a chute, tremie or a concrete pump. Placement of concrete by a chute shall only be for the dry construction method in excavations where the maximum depth of water does not exceed 2 in.

Concrete placed by chute shall fall directly to the base of the drilled shaft without contacting either the reinforcement or sides of the drilled shaft excavation. The drop chute shall be supported so that the free fall of the concrete measured from the bottom of the chute is no more than 25 ft. If concrete placement causes the drilled shaft excavation to cave or slough, or if the concrete strikes the rebar cage or sidewall, the Contractor shall reduce the height of free fall or reduce the rate of concrete flow into the excavation. If concrete placement cannot be satisfactorily accomplished by chute in the opinion of the Engineer, the Contractor shall use either a tremie or concrete pump to accomplish the pour.

Placement of concrete under water or slurry by tremie shall not begin until the tremie is in place at the base of the drilled shaft. Valves, bottom plates or plugs shall be used only if concrete discharge can begin within a distance of 1/2 times the diameter of the tremie from the base. Plugs shall either be removed from the drilled shaft excavation or be of a material approved by the Engineer which will not cause a defect in the drilled shaft if left in place. The tremie discharge end shall remain at least 10 ft below the head of the plastic concrete at all times after the first 10 ft of concrete is placed. The flow of concrete shall be continuous and the concrete in the tremie shall be maintained at a

positive pressure differential at all times to prevent water or slurry intrusion into the drilled shaft concrete.

Placement of concrete under water or slurry by concrete pump shall not begin until the pump discharge opening is in place at the base of the drilled shaft. A plug or similar device shall be used to separate the concrete from the fluid in the drilled shaft excavation until pumping begins. The plug shall either be removed from the drilled shaft excavation or be of a material approved by the Engineer which will not cause a defect in the drilled shaft if left in place.

The Contractor shall pump an adequate quantity of grout, mortar, or concrete without coarse aggregate through the pump system and lines ahead of the drilled shaft concrete to lubricate the pumping system. Material used for lubrication shall not be allowed to remain in the drilled shaft, but shall be discharged ahead of the drilled shaft concrete up and out of the drilled shaft excavation. The lubrication process shall not be repeated during the remainder of the pour. The pump shall be operated so that a continuous stream of concrete without air pockets is delivered into the excavation. The discharge opening shall remain at least 10 ft below the head of the plastic concrete at all times after the first 10 ft of concrete is placed. When lifting the pump line during concrete placement, the Contractor may temporarily reduce the line pressure until the opening has been repositioned at a higher level in the excavation. The rate of concrete placement shall be controlled to prevent displacement of the reinforcement. When the concrete reaches the top of the drilled shaft excavation, all laitance shall be removed.

If at any time during the concrete pour, the tremie or pump discharge opening is removed from the plastic concrete column and discharges concrete above the rising concrete head, the shaft shall be considered defective. In such case, the Contractor shall remove the reinforcement and concrete, clean the excavation and complete any other remedial actions as directed by the Engineer.

Concrete in the drilled shaft shall not be vibrated.

Concrete placement shall continue after the drilled shaft excavation is full and good quality concrete is evident at the top of the shaft. Any laitance or contaminated concrete shall be displaced or removed.

The Contractor shall maintain a concrete volume versus depth chart for all concrete placed under slurry. Minimum depth measurements shall be taken after every load of concrete placed by tremie and after every 3 ft if pumped.

728.16 Acceptance

(a) Concrete

Acceptance of concrete will be determined on the basis of tests performed by the Department. Concrete and any necessary labor for sampling shall be furnished as

required by the Department. During concrete placement at each drilled shaft, testing for slump, unit weight, relative yield, and air content will be conducted on the first load of the day and once every 30 cubic yards. Slump, slump retention, and air content shall be in accordance with 728.02. The relative yield should not exceed 0.010 more than the theoretical value shown in the THEORETICAL EFFECT OF AIR CONTENT ON RELATIVE YIELD table in 728.04, based on the measured air content. Should this occur, the process and material are to be reviewed through an increase in testing frequency to check results, establish trends and validate impact of corrective actions.

During the concrete placement at each drilled shaft, two cylinders will be cast for compressive strength at a frequency of once every 60 cubic yards. If plastic concrete properties of high air content, high slump, or high relative yield indicate a cause for concern, additional pairs of cylinders will be cast for compressive strength. Initial curing of cylinders shall be completed by submerging the cylinders in water saturated with calcium hydroxide at a temperature range of between 60 to 80 °F for no less than 16 hours or no more than 48 hours. Each cylinder will be tested for 28 day compressive strength and the paired values averaged to determine the sample result. Concrete placed in the drilled shafts shall have a 28 day compressive strength that meets or exceeds the compressive strength shown in the plans.

If at any time a construction method fails, in the opinion of the Engineer, to produce the desired final results, the Contractor shall stop construction of drilled shafts and submit a proposed remedy and alternate method for approval by the Engineer.

(b) Slurry

When slurry is used during drilled shaft excavation, the Contractor shall perform testing to determine the density, viscosity, and pH of the slurry. A minimum of four sets of tests shall be made during the first 8 hours of slurry use. If the first four sets of tests indicate consistent, acceptable results, the testing frequency may be decreased to one set of tests for every 4 hours of slurry use. Tests shall be performed when the slurry temperature is above 40° F. Test results shall be within the ranges shown below:

SLURRY PROPERTIES

Property	*Test Method*	*Required Range*
Density, pcf	*Density Balance*	*64.3-69.1*
Viscosity, seconds/quart	*Marsh Cone*	*28-45*
pH	*pH paper or meter*	*8-11*

The Contractor shall perform sand content testing in accordance with the American Petroleum Institute. The sand content shall not exceed 4% by volume at any point in the excavation when slurry is used.

Prior to placing concrete in a drilled shaft excavation with slurry, the Contractor shall obtain slurry samples from the base of the excavation and at intervals of 10 ft along

the length of the excavation. The samples shall be tested and two consecutive samples shall have acceptable results for density, viscosity, pH, and sand content before concrete is placed in the drilled shaft excavation. If test results are not acceptable, the Contractor shall take corrective action to bring the slurry in to compliance with the requirements.

The Contractor shall provide copies of all slurry test reports, signed by the testing technician, to the Engineer prior to placement of concrete in the drilled shaft.

(c) Drilled Shaft

Completed drilled shafts will be tested for acceptance by the Engineer, using crosshole sonic logging, CSL, and impulse response spectrum, IRS, test methods. The Contractor shall provide all equipment, labor and material required by the Engineer to perform CSL and IRS testing. CSL and IRS testing will be performed no sooner than five business days after placement of concrete in the drilled shaft.

The Contractor shall provide access for the Engineer to the top of each drilled shaft for CSL and IRS testing. Access shall include a stable work platform for the test operators and equipment close to the head of each shaft and be large enough to accommodate two operators with a standard surveyor's tripod and a small bench or table.

1. CSL Testing

Unless otherwise specified, the Contractor shall provide and install access tubes for CSL testing in all drilled shafts. The Contractor shall at a minimum provide the following for CSL testing:

a. Schedule 40, 1.5 in. I.D. mild steel tubes for each drilled shaft. The bottom of each tube shall be sealed watertight with a threaded end-cap. Any coupling of tubing required to make up the required lengths shall be made using threaded sleeve couplers, sealed watertight. The tubing shall be round and regular in section, with a clean interior surface, free of defects or obstructions that would prevent the passage of a 1 1/4 in. diameter probe through the tube. The exterior surfaces shall be free of dirt, oil, grease, heavy rust scale, or other contaminants which may inhibit formation of a good mechanical bond with the drilled shaft concrete. The use of used or recycled tubing or slightly rusted tubing is acceptable provided that it meets the requirements herein.

b. Clean, potable water sufficient to fill the access tubes completely.
c. Cement grout sufficient to fill the access tubes on completion of testing.
d. Grout mixing equipment and operator.
e. Grout pumping equipment and operator. The pump shall have a 1.0 in. tremie pipe capable of reaching the bottom of the access tubes.

f. Hosepipe, pump, or other means of placing clean water in the access tubes prior to testing, and for topping off the tubes during testing.

The Contractor shall install access tubes for CSL testing as follows:

(1) A minimum of four tubes or one tube per foot of drilled shaft diameter, whichever is greater, shall be installed at approximately equidistant points around the interior of the reinforcement. Tubes shall be installed parallel to each other and securely attached to the reinforcement to prevent excessive movement during handling, installation and placement of concrete.

(2) The bottoms of each tube shall be set 3 in. above the bottom of the reinforcement. Tubes shall not be placed in contact with the bottom of the drilled shaft excavation. The top of each tube shall extend 3 ft to 6 ft above the planned top of the drilled shaft. If the top of the drilled shaft will be below grade or water, tubes shall extend 3 ft to 6 ft above grade or water level, or other reasonable access level if cofferdams or casings are used.

(3) Reinforcement shall be handled and installed to prevent kinking or permanent bending of the access tubes or displacement of the tubes from the required position. Access tubes shall be parallel, undamaged, and securely fixed at the time of concrete placement.

(4) Prior to placing concrete, the Contractor shall determine and record the bottom elevation of at least one of the access tubes and provide the record to the Engineer.

(5) Prior to placing concrete, access tubes shall be completely filled with potable water and the top of the tubes sealed with watertight fittings. Anti-freeze shall be added to the water in cold weather to prevent freezing.

(6) Upon acceptance of the drilled shaft by the Engineer, the Contractor shall remove the water from the CSL access tubes and completely fill the tubes with cement grout.

2. IRS Testing

The Contractor shall prepare a minimum of two areas on the top of each completed drilled shaft for IRS testing. The areas shall be prepared using chipping hammers or other hand tools not weighing more than 15 lb. Each prepared area shall be a minimum of 3 in. in diameter, shall be within ± 1 in. of the level of surrounding

concrete, shall be acceptably clean, sound, level, and free of standing water and all foreign or loose materials. Chipping hammers shall not be heavier than 15 lb. At least one area shall be in the center of the drilled shaft and at least one area shall be a minimum of 18 in. from the center of the drilled shaft, but shall not be outside of the reinforcement of the drilled shaft.

The Engineer will make a preliminary interpretation of the IRS test results on site. If anomalous responses are recorded, or the data indicates a low modulus or contaminated concrete near the top of the drilled shaft, the Contractor shall prepare a new test area near the perimeter of the shaft, at a minimum of 60 degrees rotation from the first test location.

The Engineer will provide copies of all CSL and IRS test results to the Contractor.

The Engineer will evaluate the results of CSL and IRS testing and notify the Contractor in writing if the drilled shaft is accepted or rejected.

If a drilled shaft is rejected, the Engineer may require excavation or coring in order to allow for further assessment of the drilled shaft. If coring is required, the Contractor shall obtain full depth cores from the drilled shaft at locations determined by the Engineer. An accurate log of the coring shall be kept. The cores and coring log shall be submitted to the Engineer for testing and inspection. The Contractor may provide calculations or other test results to the Engineer to support the acceptability of the drilled shaft.

The Engineer will evaluate cores and any additional information provided and will notify the Contractor in writing of the final determination of whether the drilled shaft is accepted or rejected. If a drilled shaft is rejected, the Contractor shall submit a plan to the Engineer for approval to either repair or replace the defective drilled shaft. The Contractor shall not continue construction on a drilled shaft until authorized in writing by the Engineer.

728.17 Method of Measurement

Drilled shafts will be measured by the linear foot for the diameter of drilled shaft specified. The length of drilled shaft will be the difference between the top of drilled shaft elevation and the actual tip elevation of the drilled shaft.

Exploratory cores for drilled shafts will be measured by the linear foot of core.

Permanent casing will be measured by the linear foot for the diameter of casing placed.

728.18 Basis of Payment

REVISION TO SPECIAL PROVISIONS

PROPOSED NEW 728-B-XXX DRILLED SHAFT FOUNDATIONS

Drilled shafts will be paid for at the contract unit price per linear foot of the diameter of drilled shaft specified.

Exploratory cores for drilled shafts will be paid for at the contract unit price per linear foot.

Permanent casing for drilled shafts will be paid for at the contract unit price for the diameter placed.

Payment will be made under:

Pay Item	***Pay Unit Symbol***
Drilled Shaft,_____ diameter	*LFT*
Drilled Shaft, Exploratory Core	*LFT*
Drilled Shaft, Permanent Casing	*LFT*

All costs required for the construction of drilled shafts, including, but not limited to labor, equipment, and materials, excavation, cleaning and dewatering, temporary casing, reinforcement, all required reports, quality control plans and logs, and all other incidentals shall be included in the cost of the drilled shaft.

All equipment, labor, materials, and costs for the testing of the drilled shaft and quality control testing and reports shall be included in the cost of the drilled shaft.

Rejected drilled shafts shall be repaired or replaced, as approved by the Engineer, with no additional payment.

COMMENTS AND ACTION

RSP 728-B-XXX DRILLED SHAFT FOUNDATIONS

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: SECTION 728 Recurring Special Provision affected: NONE Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book _____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ _____ Revise RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ Standard Drawing Effective _____ _____ Create RPD (No. _____) Effective _____ Letting _____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y___N___ By _____ Addition or _____ Revision Received FHWA Approval? _____

Mr. Walker
Date: 06/21/12

SPECIFICATION, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO SPECIAL PROVISIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: AASHTO M 268-10 for retroreflective and non-reflective sheeting is being revised extensively and the categories in this specification are not exactly the same as required by the Standard Specifications. AASHTO M 268-10 applies to flat vertical signing and does not include work zone sheeting. ASTM 4956 and AASHTO M 268 had been identical prior to this revision.

PROPOSED SOLUTION: Revise 919.01(b) to reference ASTM 4956 for reflective sheeting and non-reflective sheeting

APPLICABLE STANDARD SPECIFICATIONS: 919.01(b)

APPLICABLE STANDARD DRAWINGS: None

APPLICABLE DESIGN MANUAL SECTION: None

APPLICABLE SECTION OF GIFE: None

APPLICABLE RECURRING SPECIAL PROVISIONS: RSP 919-X-XXX

Submitted By: Ron Walker

Title: Manager, Office of Materials Management

Organization: INDOT

Phone Number: 317-610-7251 x 204

Date: 6-6-12

APPLICABLE SUB-COMMITTEE ENDORSEMENT? None

REVISION TO SPECIAL PROVISIONS

PROPOSED NEW 919-X-XXX SIGN SHEETING

919-X-XXX SIGN SHEETING

(Adopted XX-XX-12)

The Standard Specifications are revised as follows:

SECTION 919, BEGIN LINE 88, DELETE AND INSERT AS FOLLOWS:

1. Reflective Sheeting

Reflective sheeting used for signs, channelizing and delineation devices shall be in accordance with ~~AASHTO M 268~~ *ASTM 4956*. Type V reflective sheeting may be used on delineators. Reboundable reflective sheeting shall be used on plastic drums, flexible delineator posts, and other flexible channelizers.

The reflective sheeting shall include an adhesive backing Class 1 or Class 2 in accordance with ~~AASHTO M 268~~ *ASTM 4956*.

2. Non-reflective Sheeting

Non-reflective sheeting shall be in accordance with ~~AASHTO M 268~~ *ASTM 4956* except that the sheeting shall not incorporate optical elements. The color shall be black in accordance with Federal Standard 595, Color No. 17038.

COMMENTS AND ACTION

RSP 919-X-XXX SIGN SHEETING

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: 919.01(b)1 and 919.01(b)2 pg 961. Recurring Special Provision (possible change in 627.03) 627-R-546 CABLE BARRIER SYSTEM Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book _____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ _____ Revise RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ Standard Drawing Effective _____ _____ Create RPD (No. _____) Effective _____ Letting _____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y___N___ By _____ Addition or _____ Revision Received FHWA Approval? _____