OHIO DEPARTMENT OF TRANSPORTATION

CENTRAL OFFICE, 1980 W. BROAD ST., COLUMBUS, OHIO 43216-0899

January 18, 2013

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Assistant Administrator, Office of Structural Engineering

Re: 2013 First Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, January 2004. These revisions shall be implemented on all Department projects begin Stage 2 plan development date after January 18, 2013. Implementation of some or all of these revisions for projects further along the development process should be considered on a project-by-project basis.

This package contains the revised pages. The revised pages have been designed to replace the corresponding pages in the book and are numbered accordingly. Revisions, additions, and deletions are marked in the revised pages by the use of one vertical line in the right margin. The header of the revised pages is dated accordingly.

To keep your Manual correct and up-to-date, please replace the appropriate pages in the book with the pages in this package.

To ensure proper printing, make sure your printer is set to print in the 2-sided mode.

The January 2004 edition of the Bridge Design Manual may be downloaded at no cost using the following link:

http://www.dot.state.oh.us/Divisions/HighwayOps/Structures/standard/Pages/default.aspx

Attached is a brief description of each revision.

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Summary of Revisions to the July 2004 ODOT BDM

BDM Section	Affected Pages	Revision Description
204.4	2-23	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
204.6.2.1	2-27 through 2-27.1	Information related to the use of spread footings on MSE walls was deleted because the Department discontinued the use of spread footing abutments on MSE walls in January 2012. Additional information regarding the use of spread footings on MSE walls is available in BDM Section 204.4.
205.4	2-29	Reference is made to BDM Section 205.5 for deviations from ODOT standard practice for prestressed beams.
205.5	2-30	Release of PSID-1-13 necessitates the revision to the preliminary engineering information related to prestressed I-beams.
209.7	2-41 through 2-41.2	Information related to the placing aesthetic logos or lettering on bridges and noise wall has been added.
301.7	3-8	Added restriction for attaching utilities directly to decks. Utilities attached directly to the bottom of the deck will be affected by future deck replacements.
302.1.1	3-9	The classes of concrete in this section were updated to reflect the changes to Items 499 & 511 in the 2013 C&MS.
302.1.2	3-9 through 3-10	The changes in this section reflect the changes to Items 499 & 511 in the 2013 C&MS.
302.1.4.1	3-11	The changes in this section reflect the changes to Items 499 & 511 in the 2013 C&MS.
302.5	3-37	The design model for multi-span composite prestressed beams has been modified. The positive moment connection created by extending strands into a pier diaphragm does not have sufficient capacity to resist creep caused by the prestressing force. Once the beams have deflected under creep, the loads applied to the structure act on a simple span until the creep deflection is overcome. Therefore, the new design model applies all loads to a simple span to design the beams. If there is any remaining load actually carried by a continuous structure the deck reinforcing steel does this work. Conservatively, this steel is designed for full continuity.

BDM Section	Affected Pages	Revision Description
302.5.1	3-37	This change reflects the modified design model specified in BDM Section 302.5.
302.5.1.2.a	3-39	The 0.6-inch strand has been removed as a standard practice for box beams. The use of this strand size shall be addressed with the industry as noted in BDM Section 205.4.
302.5.1.2.b	3-39	This change is consistent with the beam strand locations identified in PSBD-2-07.
302.5.1.3	3-41	This change reflects the modified design model specified in BDM Section 302.5.
302.5.1.7	3-43	The changes in this section reflect the changes to Items 499 & 511 in the 2013 C&MS.
302.5.2	3-43 through 3-44	These changes reflect the release of PSID-1-13 and the modified design model specified in BDM Section 302.5.
302.5.2.2	3-44	The preference for relieving excessive tensile stresses in the beam ends at release has been revised. Designers shall debond up to the LRFD 5.11.4.3 maximum limits before specifying draping. Research indicates that reduced draping forces helps reduce potential for web cracking.
302.5.2.2.a	3-44	PSID-1-13 utilizes only the 0.6-inch strand diameter. The use of the larger strand diameter increases efficiency of the I-beam shape and helps account for the loss of draped strand locations available in previous version of the I-beam standard.
302.5.2.2.c	3-45	This change reflects the use of the 0.6-inch strand diameter.
302.5.2.2.d	3-45	This change reflects the elimination of extending strands into the pier diaphragms in PSID-1-13 as well as the change in preferences mention in BDM Section 302.5.2.2 above.
302.5.2.4	3-48	This change in fixed pier anchorage reflects the modification of the pier diaphragm in PSID-1-13.
302.5.2.5	3-48	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
302.5.2.6	3-49	A revision to PSID-1-13 requires cast-in-place intermediate diaphragms for all beams less than 60” deep. PSID-1-13 also modified the location of the bottom of the end diaphragm.

BDM Section	Affected Pages	Revision Description
302.5.2.7	3-49	A reference to PSID-1-99 has been removed.
302.5.2.8	3-50	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
302.5.2.9	3-50	PSID-1-13 now utilizes uncoated reinforcing steel bars and welded wire fabric. Only the bars extending from the beams shall be epoxy coated.
Figure 330		Figure 330 has been deleted because the use of spread footing abutments on MSE walls was discontinued in January 2012.
Figure 331		The Geotextile fabric has been removed from the detail because this item was removed from SS840 in October 2012. Undercut dimension “X” has been added for illustration purposes with the removal of Figure 331.
Figure 333		The Geotextile fabric has been removed from the detail because this item was removed from SS840 in October 2012.
Figure 333A		The Geotextile fabric has been removed from the detail because this item was removed from SS840 in October 2012.
Figure 333B		The Geotextile fabric has been removed from the detail because this item was removed from SS840 in October 2012.
504	5-3	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
602.2	6-4 through 6-6.2	The first change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS. The second change in this section results from the use of WWR in prestressed I-beams according to PSID-1-13.
605.5	6-16	BDM Note [98] was retired. This note addressed the General Plan information associated with spread footing abutments supported on MSE walls which was discontinued in January 2012.
606.6	6-20	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
610.7	6-29	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.

BDM Section	Affected Pages	Revision Description
611.10.1	6-34	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
702.7.1	7-5	The change in this section reflects the changes to Items 499 & 511 in the 2013 C&MS.
ARN-37	Appendix 109.19	Archived note [98].

the use of spread footing supported abutments on MSE walls because of their susceptibility to loss of bearing caused by erosion during the service life of the structure. Piles require a minimum 15-foot embedment below the MSE wall. If rock exists within the minimum embedment depth, the piles shall be placed in pre-bored holes that extend a minimum of 5-ft into bedrock. The pre-bored holes shall be backfilled with Class QC Misc. concrete up to the top of the leveling pad elevation after pile installation.

Refer to Sections 201.2.6, 202.2.3 and 204.6.2 for the staged review requirements for MSE walls. Consult the Office of Structural Engineering for additional design recommendations.

204.5 PIER TYPES

For highway grade separations, the pier type should generally be cap-and-column piers supported on a minimum of 3 columns. (This requirement may be waived for temporary conditions that require caps supported on less than 3 columns.) Typically the pier cap ends should be cantilevered and have squared ends.

For bridges over railroads generally the pier type should be T-type, wall type or cap and column piers. Preference should be given to T-type piers. Where a cap and column pier is located within 25 feet [7.6 meters] from the centerline of tracks, crash walls will be required.

For waterway bridges the following pier type should be used:

A. Capped pile type piers; generally limited to a maximum height of 20 feet [6 meters]. For heights greater than 15 feet [4.5 meters], the designer should analyze the piles as columns above ground. Scour depths shall be considered.

B. Cap-and-column type piers.

C. Solid wall or T-type piers.

Note that the use of T-type piers, or other pier types with large overhangs, makes the removal of debris at the pier face difficult to perform from the bridge deck. For low stream crossings with debris flow problems and where access to the piers from the stream is limited, T-type piers, or other similar pier types, should not be used.

For unusual conditions, other types may be acceptable. In the design of piers which are readily visible to the public, appearance should be given consideration if it does not add appreciably to the cost of the pier.

204.6 RETAINING WALLS

In conformance with Section 1400 of the ODOT Location and Design Manual, Volume Three, a Retaining Wall Justification shall be included in the Preferred Alternative Verification Review Submission for a Major Project or in the Minor Project Preliminary Engineering Study Review Submission. A description of the Retaining Wall Justification is provided in Section 1404 of the ODOT Location and Design Manual, Volume Three. Generally, the justification compares the practicality, constructability and economics of the various types of retailing walls listed below:

A. Cast-in-place reinforced concrete
B. Precast concrete
C. Tied-back
D. Adjacent drilled shafts
E. Sheet piling
F. H-piling with lagging
G. Cellular (Block, Bin or Crib)
H. Soil nail
I. Mechanically Stabilized Earth (MSE)

Refer to SS840 for accredited MSE wall systems. Contact the Office of Structural Engineering for modular block wall systems. For wall systems that utilize geogrid reinforcements, the wall height shall be limited to 30 ft.

204.6.1 DESIGN CONSTRAINTS

Below are some design constraints to consider in the wall justification study to establish acceptable wall types:

A. Future use of the site (future excavations cannot be made in Mechanically Stabilized Embankments)

B. Deflection and/or differential settlements

C. Accessibility to the construction site

D. Aesthetics, including wall textures

E. Right-of-way (or other physical constraints)

F. Cost (approximate cost analysis)

G. Stage construction

H. Stability (long-term and during construction)

I. Railroad policies

204.6.2 STAGE 1 DETAIL DESIGN SUBMISSION FOR RETAINING WALLS

When a justification study has determined that a retaining wall is required, generally the wall will be a cast-in-place reinforced concrete wall or some type of proprietary wall system. The use of proprietary wall systems should be considered when the wall quantity for the project exceeds 5000 ft^2 [450 m^2].

F. The following factors of safety shall apply:

Factor of Safety	
Sliding	> 1.5
Overturning	> 2.0
Bearing Capacity	>2.5
Overall Stability	>1.5 (for walls supporting spread footing abutments)
	>1.30 (for all other walls)

G. Use the following soil parameters for design:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Select Granular Embankment Material	120 lb/ft^3 [18.9 kN/m^3]	34º	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lb/ft^3 [18.9 kN/m^3]	30º	0

Determine soil parameters for the foundation soils based on the soils encountered by the soil borings.

H. Compute the coefficient of lateral earth pressure, k_a, using the Coulomb equation.

I. MSE walls located within 25’-0” [7.6 m] of the centerline of tracks, or other distance as specified by an individual railroad, shall be protected by a crash wall as specified in Section 209.8 and the AREMA Manual for Railway Engineering. The MSE wall system does not meet the definition of a crash wall as defined by the AREMA Manual for Railway Engineering.

J. For MSE walls supporting abutments on piles, the minimum distance between the back face of the MSE wall panels and the toe of the bridge abutment footing shall be 1’-0” [305 mm] and the minimum distance between the back face of the MSE wall panels and the centerline of the closest row of piles shall be 3’-6” [1065 mm]. The distance between the centerlines of adjacent rows of piles shall be 3’-6” [1065 mm] to allow compaction of the fill between the pile sleeves.

L. Integral abutment designs placed on MSE wall embankments are prohibited. Semi-integral abutment designs are allowed.

M. When detailing the pile layout and the design of the abutments and/or wingwalls, consider that 100% of the ground reinforcement shall be connect to the facing elements and the Department will not allow field cutting of reinforcement systems to avoid piles or other obstacles.

204.6.2.2 CAST-IN-PLACE WALLS

If a cast-in-place wall is justified, the design agency will be responsible for providing the complete wall design in the detail plans. The Stage 1 Detailed Design Submission shall include: footing elevations; allowable bearing pressures; a global stability analysis; settlement calculations, if necessary; and any construction constraints that may be required.

204.6.2.3 OTHER WALLS

The other wall types listed in Section 204.6 are for use with special project conditions such as top-down construction and other excavation methods. Contact the Office of Structural Engineering for recommendations when considering these other wall types. Typically only one wall type design shall be prepared for these methods.

205 SUPERSTRUCTURE INFORMATION

205.1 TYPE OF STRUCTURES

The types of superstructure generally used in Ohio consist of cast-in-place concrete slabs, prestressed concrete box or I-beams, and steel beams or welded plate girders. Normally shallow abutments and spill-thru slopes will be used. The type of superstructure used should be selected on the basis of economy as well as appearance. For special conditions where other types of super-structures may be considered, consult the Office of Structural Engineering for recommendations prior to initiating the design.

205.4 PRESTRESSED CONCRETE BOX BEAMS

The span limits for prestressed, side by side, concrete box beams generally range from 15 to 100 feet [5 to 30 meters]. These span limits are based on the current design data sheets with 0.167 in^2 [108 mm^2] low relaxation strands, a concrete 28-day compressive strength of 7000 psi [48.3 MPa], a release strength of 5000 psi [34.5 MPa] and an HS25 truck. Prestressed box beams of up to 120 foot spans [36 meters] have been designed using 10,000 psi [68.9 MPa] concrete and larger diameter strands. Concrete compressive strengths should be limited to 5000 psi [34.5 Mpa] at release and 7000 psi [48.3 Mpa] at 28-days. Refer to BDM Section 205.5 when considering a deviation from standard prestressed practice in Ohio.

The skew angle should be limited to a maximum of 30 degrees. Consult the Office of Structural Engineering for recommendations prior to designing a box beam structure with a higher degree of skew. For all four lane divided highways or where the design ADTT (one way) is greater than 2500, prestressed box beam superstructures shall not be used. Box beams may be used on curved alignment where the mid-ordinate is 6 inches [150 mm] or less, as long as the required bridge width is provided. The maximum asphalt wearing surface thickness for a non-composite designed box beam bridge shall be 8 inches [200 mm]. For multiple span bridges, individual span lengths may vary but the proposed box beam depth should be constant.

The Designer shall consider the site limitations for practical hauling. While weight of a precast bridge member is not typically a limiting factor, its length and ability to reach the jobsite may be a restriction. Maximum lengths are normally dictated by the smallest turning radius enroute to the project site. For beams 100 ft [30 m] long or more, the Designer should contact at least two approved fabricators of precast bridge members to obtain a written agreement stating that the member can be shipped to the project site. The agreements should be included in the Structure Type Study, Narrative of Bridge Alternatives.

Non-composite boxbeam designs should be used where over the side drainage is provided and where the combined deck grade is less than 4 percent. The combined deck grade, Cg, should be computed by the following equation:

$$Cg = [\text{transverse deck grade}^2 + \text{roadway grade}^2]^{1/2}$$

For a normal transverse deck grade horizontal to vertical of 3/16 inch per foot [1 to 64 (1.56 percent)], the maximum roadway grade would be 3.68 percent or less for non-composite design. Where the combined deck grade is greater than 4 percent or the deck drainage is confined to the bridge deck by a parapet, curb, etc., a composite design should be used.

205.5 PRESTRESSED CONCRETE I-BEAMS

The Bridge Design Manual and Standard Bridge Drawings represent standard practice for the prestressed industry in Ohio. When considering design deviations from these publications, contact the Ohio Prestressers Association and/or the PCI Central Region to request documentation that the deviation is acceptable and can be produced within the project timeframe by at least two independent producers prequalified under Supplement 1079. ODOT may request verification of this documentation during project reviews. These industry organizations are also valuable resources for preliminary pricing and practical hauling limitations to specific project locations. The transportation and weight issues listed for box beams also apply for I-beams

The standard bridge drawing allows 28-day concrete strengths up to 7.0 ksi and release strengths up to 5.0 ksi. Refer to BDM Section 300 for the preferred methods to relieve excessive tensile stresses.

Prestressed I-beam highway bridges should have a minimum of 4 stringer lines.

Prestressed I-beam bridges that meet the vertical clearance specified in Section 207 are acceptable over highway crossings.

205.6 STEEL BEAMS AND GIRDERS

For spans greater than 60 feet [18 meters], rolled beams, up to and including the 40 inch [1000 mm] depth, or welded plate girders should be considered. Continuous spans shall be used for multiple span bridges. The ratio of the length of the end spans to the intermediate spans usually should be 0.7 to 0.8. The latter ratio is preferred because it nearly equalizes the maximum positive moment of all spans. Integrally designed structures may have end span ratios of as low as 0.6 if prevention of uplift is considered. For multi-span, composite designed, rolled beams, the maximum intermediate span is generally around 115 feet [35 meters]. For single span, composite designed, rolled beams, the maximum span is generally around 100 feet [30 meters].

While constant depth plate girders can be used in the same range as rolled beams, they are generally not as cost effective as rolled beams for the same span lengths. Haunched girders over the intermediate substructure units should be considered for spans greater than 350’-0” [105 meters] or where economics warrant their use. Selections of any steel members should be based on an overall cost analysis of the structure.

Stringer type	Span length
Rolled beam	up to 115’ [35 m]
Constant Depth Girder	100’ - 350’ [30 - 105 m]
Haunched Girder	> 350’ [105 m]

Generally the minimum economical beam spacing for rolled beams is 8’-0” [2450 mm]. For plate girders a minimum spacing of 9’-0” [2750 mm] is generally recommended.

approach embankment slopes and where the pavement flow from the deck exceeds 0.75 ft^3/s [0.021 m^3/s], an integral curb shall be provided on the approach slab with a standard catch basin located off the approach slab in lieu of the flume. At the trailing end of bridge barriers, a bridge terminal assembly is required to protect this curb. The catch basin should be a Catch Basin No. 3A, as shown on Standard Construction Drawing CB-2.2. A properly sized conduit (Type F, 707.05 Type C) shall be used to provide an outlet down the embankment slope and the outlet shall be armored to prevent erosion.

Control of drainage is especially critical at abutments with MSE walls. On structures with MSE walls at the abutments, a barrier shall be provided on the approach slab with a standard catch basin to collect the drainage. Where possible, the catch basin shall be located at least 25 ft [7.6 m] beyond the limits of the MSE wall soil reinforcement. Continue the barrier 10 ft [3.0 m] past the catch basin. Use the same type of catch basin and conduit as described above.

For bridges that have deck joints consisting of finger joints or sliding plates with a trough collector system scuppers should be considered near the joint to minimize the amount of deck drainage flow across the joint.

For bridges that have over the side drainage a stainless steel drip strip should be provided to protect the deck edge and beam fascia from the deck surface run-off.

209.4 SLOPE PROTECTION

For structures of the spill-thru type where pedestrian traffic adjacent to the toe of the slope is anticipated or the structure is located in an urban area within an incorporated city limit, the slope under the structure shall be paved with Concrete slope protection, CMS 601.07. Consideration of slope protection should be given to all areas under freeway bridges over city streets not covered by pavement or sidewalk. Drainage discharge from the bridge should be checked to ensure that discharge is not crossing sidewalks, etc. so that ice, dirt and debris build-ups are prevented.

On spill-thru slopes under grade separation structures, areas that are not protected by concrete slope protection, shall be protected by crushed aggregate material as provided in CMS 601.06.

The slope protection, either concrete or rock, shall extend from the face of the abutment down to the toe of the slope and shall extend in width to 3 feet [1 meter] beyond the outer edges of the superstructure, except that at the acute corners of a skewed bridge the outside edge of the slope protection shall intersect the actual or projected face of the abutment 3 feet [1 meter] beyond the outer edge of the superstructure and shall extend down the slope, normal to the face of the abutment, to the toe of the slope. The base of the slope protection shall be toed in. Note that the natural vegetation on the slopes when shaded by a new structure will die out. For this case additional slope protection should be considered.

209.5 APPROACH SLABS

Approach slabs should be used for all ODOT bridges. Determine the length of the approach slab using the following formula:

$L = [1.5(H + h + 1.5)] \div \cos\theta \leq 30$ ft
$L = [1.5(H + h + 0.45)] \div \cos\theta \leq 9.15$ m

Where:
- L = Length of the approach slab measured along the centerline of the roadway rounded up to the nearest 5 ft [1.5 m]
- H = Height of the embankment measured from the bottom of the footing to the bottom of the approach slab (ft) [m]
- h = Width of the footing heel (ft) [m]
- θ = Skew angle

For four lane divided highways on new embankment, the minimum approach slab length shall be 25 ft [7.6 m] (measured along the roadway centerline). For structures with MSE walls at the abutments, the minimum approach slab length shall be 30 ft [9.1 m]. For all other structures the minimum length shall be 15 ft [4.6 m]. Refer to the approach slab standard bridge drawing for details.

Provide detail drawings for approach slabs which differ from the standard approach slabs. Examples include approach slabs that are a non-standard length, tapered, have a non-uniform width, or other such variation. When an approach slab falls within the limits of a vertical curve or superelevated section, the elevations at the edges of the approach slab shall be provided. Include these detail drawings in the structure plans for review during the detail design review stage. Approach slabs are paid for under Item 526.

On structure rehabilitation plans, when the existing approach slab is to be removed, the Designer shall include Item 202 - Approach Slab Removed in the structures estimated quantities.

209.6 PRESSURE RELIEF JOINTS

Type A pressure relief joints shall be specified when the approach roadway pavement is rigid concrete and shall be placed at the end of the approach slab.

The pressure relief joints are detailed on Standard Construction Drawing BP-2.3 (Revised 7/28/00), “Pressure Relief Joint Type A”.

209.7 AESTHETICS

209.7.1 GENERAL

Each structure should be evaluated for aesthetics. Normally it is not practical to provide cost premium aesthetic treatments without a specific demand, however careful attention to the details of the structure lines and forms will generally result in a pleasing structure appearance.

Some basic guidelines that should be considered are as follows:

A. Avoid mixing structural elements, for example concrete slab and steel beam superstructures or cap and column piers with wall type piers.

B. In general, continuous superstructures shall be provided for multiple span bridges. Where intermediate joints cannot be avoided, the depth of spans adjacent to the joints preferably should be the same. Avoid the use of very slender superstructures over massive piers.

C. Abrupt changes in beam depth should be avoided when possible. Whenever sudden changes in the depth of the beams in adjacent spans are required, care should be taken in the development of details at the pier.

D. The lines of the structure should be simple and without excessive curves and abrupt changes.

E. All structures should blend in with their surroundings.

One of the most significant design factors contributing to the aesthetic quality of the structure is unity, consistency, or continuity. These qualities will give the structure an appearance of a design process that was carefully thought out.

The aesthetics of the structure can generally be accomplished within the guidelines of design requiring only minimum special designs and minor project cost increase. As special situations arise preliminary concepts and details should be developed and coordinated with the Office of Structural Engineering.

If formliners are being considered, the depth of the projections should be as deep as possible in order to have the desired visual effect. Using shallow depths, such as ¼” to ½” [6 to 13 mm], provides very little, if any, visual effect (relief) when viewed from a distance. The depth of the formliner shall not be included in the measurement of the concrete clear cover.

The use of colored concrete, where the color is integral with the concrete mix, should generally not be used since the final visual appearance of the concrete is not uniform. The color varies greatly due to the aggregate, cement type, cement content and the curing of the concrete. None of these items are reasonably controlled in the field to a sufficient enough degree to insure a uniform final appearance. If color is required, a concrete coating should be used which will not only produce the required color but will also provide the necessary sealing of the concrete as required in Section 300 of this Manual.

The use of formliners and/or coloring of the concrete should be evaluated on a cost basis and submitted as part of the Structure Type Study, Cost Analysis.

For additional guidance, refer to the Department's document entitled "Aesthetic Design Guidelines" available at the Design Reference Resource Center on the Department's website.

209.7.2 LOGO AND LETTERING POLICY

The following criteria applies to logos and lettering proposed for use on Bridges and Noise Walls.

A. The Department will permit City logos and City names when the bridge or noise wall is located within the territorial jurisdiction of that City.

B. The Department will permit displaying the names of Public Streets or Paths on bridges carrying those same Public Streets or Paths. Private street names or private path names are not permissible.

C. A request for using logos and/or lettering shall be submitted during preliminary engineering to ODOT for approval. The request shall include:

   1. The logo or lettering size, location, color and style.

   2. A rendering of the proposal.

D. The Department may require the local agency requesting the logo or lettering to fund the costs exceeding those necessary for standard ODOT practice as defined in the Bridge Design Manual or Standard Bridge Drawings.

209.8 RAILWAY BRIDGES

For railway overpasses the specific requirements of the railway company involved need to be addressed. The design and operational requirements of the railway companies will vary from railway line to railway line and between companies. Some of the common railway concerns are as follows:

A. Horizontal and vertical clearances for both the proposed design and during construction,

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B. The constructability of the substructure units adjacent to their tracks,

C. Allowing adequate clearances for drainage ditches and access roads that are parallel to their tracks,

D. Location of railway utilities, and

E. Provisions for crash walls on piers.

Consideration for providing future tracks and the possibility of track abandonment should be investigated. All submissions are to be made in accordance with the Department's review process. Railway submissions shall be made as directed by the District planning administrator. The guidelines of the individual railway company may be requested thru the District's designated rail transportation coordinator.

Generally if a steel superstructure is proposed over the railway the type of steel should be ASTM A588[M]/A709[M] 50W steel. Bridges located in urban areas or which have sidewalks located on the bridge should include protective fencing. Preferably drainage from the bridge should be collected in drain pipes and drained away from the railway right of way. No drains shall be allowed to drain on the railroad tracks or roadbed.

Where piers are located within 25’-0” [7.6 meters] of the centerline of tracks or if required by an individual railroad, a crash wall shall be provided unless a T-type or wall type pier is used. Crash walls should have a minimum height of 10 feet [3.1 meters] above the top of rail, except where a pier is located within 12 feet [3.6 meters] of the centerline of tracks and in that instance the minimum height should be 12 feet [3.6 meters] above the top of rail. The crash wall shall be at least 2’-6” [760 mm] thick. For a cap and column pier the face of the wall shall extend 12 inches [300 mm] beyond the face of the columns on the track side. The designer should note that this requirement does not automatically require a crash wall thickness greater than the minimum. The crash wall should be anchored to the footings and columns.

When temporary shoring details are required for construction of substructure units adjacent to railway tracks, details shall be included in the plans. When considering excavation for substructure units, address whether sheet piling can be driven (avoid existing footing, clear any battered piles, elevation of bedrock, etc.) and whether the proper lengths can be provided to retain the railway tracks. The design should be such that no settlement of the tracks is allowed. Interlocking sheet piling of cantilever design is preferred. It may be appropriate to leave the temporary shoring in place after construction.

The minimum vertical clearance from the top of rail should be 23’-0” [7.0 meters]. The point of minimum vertical clearance should be measured (calculated) from a point six feet [1.8 meters], measured horizontally, from the centerline of tracks measured level with the top of the high rail. The horizontal clearances vary between railway companies and need to be addressed for each specific site. Minimum construction clearances shall at least be 14’-0” [4.25 meters] horizontal,

301.5.6 USE OF EPOXY COATED REINFORCING STEEL

All reinforcing steel shall be epoxy coated except as noted for prestressed box beams in Section 302.5.1.8.

All approach slabs shall have epoxy coated reinforcing steel.

301.5.7 MINIMUM CONCRETE COVER FOR REINFORCING

The clearances of reinforcing steel from the face of the cast-in-place concrete shall be as follows:

A. Top reinforcing steel in bridge decks and sidewalks (including a one inch [25 mm] monolithic wearing surface) .... 2½ inches [65 mm]

B. Bottom reinforcing steel in bridge decks... 1½ inches [40 mm]

C. Bottom steel in footings.. 3 inches [75 mm]

D. Column steel or spirals.. 3 inches [75 mm]

E. All other concrete .... 2 inches [50 mm]

Clearances not given in CMS 509.04 shall be shown in the detail plans.

301.5.8 MINIMUM REINFORCING STEEL

Minimum reinforcing steel requirements shall conform to AASHTO requirements for shrinkage and temperature reinforcement. Reinforcement for shrinkage and temperature stresses shall be provided near exposed surfaces of walls and slabs not otherwise reinforced.

The total area of reinforcing steel to be provided shall be 1/8 in^2 per foot [265 mm^2 per meter] in each direction.

The spacing of temperature and shrinkage reinforcement shall not exceed 3 times the wall or slab thickness, or 18 inches [450 mm].

301.6 REFERENCE LINE

For structures on a horizontal curve a reference line, usually a chord of the curve shall be provided. This reference line should be shown on the General Plan/Site Plan view with a brief description, including, for example, “Reference Line (centerline bearing to bearing),” and the stations of the points where the reference line intersects the curve. Skews, dimensions of substructure elements and superstructure elements should be given from this Reference Line, both on the General Plan /Site Plan and on the individual detail sheets. Dimensions from the curve generally should be avoided. The distance between the curve and reference line should be dimensioned at the substructure units. In this manner a check is available to the contractor.

The reference tangent can be used if appropriate.

301.7 UTILITIES

Utilities should not be supported on the fascia of bridge decks.

Utilities, other than gas and water, may be run through sidewalk sections or parapets of bridges but shall be encased in a protective conduit.

Placing utilities through or underneath MSE walls should be avoided when possible. When it is necessary to place a utility through or beneath an MSE wall, it shall be encased in a protective conduit or casing pipe that extends ten feet [3.0 m] beyond the limits of the select granular backfill for the MSE wall. Placing pipe culverts through MSE walls should be avoided. Water and sewer lines within ten feet [3.0 m] of an MSE wall shall also be encased in a protective conduit or casing pipe.

Utility conduits embedded in concrete should be shown and dimensioned so as to clear construction joints by a minimum of one inch [25 mm] and other conduits by a minimum of 2 inches [50 mm].

No utilities shall be embedded in the actual vehicular traffic carrying section of a concrete deck.

Utilities shall not be suspended below the bottom of the bridge superstructure nor attached directly to the deck.

For approval procedures for installation of utilities on bridges, please refer to ODOT's "Utilities Manual."

301.7.1 UTILITIES ATTACHED TO BEAMS AND GIRDERS

All utility lines placed between the stringers of grade separation structures should not be located in the floor panel behind the fascia stringer. This is to protect the lines from collisions.

Critical utility lines (gas, etc.) that could contribute to the severity of a collision should be located well above the bottom of the superstructure or be otherwise protected.

If the bridge design is a composite deck on prestressed box beams, the design may either eliminate an interior box beam or provide a space between two interior box beams to provide utility access in this space. This alternative will require a special design for both the boxbeams and the deck.

properly performed and are at locations of minimum stress. Construction joints shall be designed to transfer all loads.

302 SUPERSTRUCTURE

302.1 GENERAL CONCRETE REQUIREMENTS

302.1.1 CONCRETE DESIGN ALLOWABLES

The following concrete strengths (f'c) shall be assumed for design purposes:

A. Substructure Concrete (Class QC1)

1. Load Factor Design ....4.0 ksi
2. Service Load Design ....Unit stress = 0.33 x 4.0 ksi = 1.3 ksi

B. Superstructure Concrete (Class QC2)

1. Load Factor Design ....4.5 ksi
2. Service Load Design ....Unit stress = 0.33 x 4.5 ksi = 1.5 ksi

C. Drilled Shaft Concrete (Class QC2)

1. Load Factor Design ....4.0 ksi
2. Service Load Design ....Unit stress = 0.33 x 4.0 ksi = 1.3 ksi

302.1.2 SELECTION OF CONCRETE FOR BRIDGE STRUCTURES

The following concrete types may be specified for substructure concrete:

A. Class QC1 Concrete

B. Class QC1 Concrete with QC/QA

C. Class QC3 Special Concrete

D. Class QC4 Mass Concrete

The following concrete types may be specified for superstructure concrete:

A. Class QC2 Concrete

B. Class QC2 Concrete with QC/QA

C. Class QC3 Special Concrete

D. Class QC4 Mass Concrete

Concrete with QC/QA shall be specified for the class of concrete when the total concrete quantity for that class exceeds 150 yd^3.

Class QC3 Special Concrete shall be specified when concrete strengths and/or permeability other than the QC1 or QC2 are necessary.

Class QC4 Mass Concrete shall be specified when the minimum dimension for a concrete component is 5-ft or greater or the diameter of a drilled shaft is 7-ft or greater.

302.1.3 WEARING SURFACE

302.1.3.1 TYPES

A. 1 inch [25 mm] monolithic concrete - defined as the top one inch [25 mm] of a concrete deck slab. This one inch [25 mm] thickness shall not be considered in the structural design of the deck slab or as part of the composite section.

B. 3 inches [75 mm] asphalt concrete - defined as the minimum asphaltic concrete wearing surface to be used on only non-composite prestressed box beams. The asphalt concrete wearing surface shall be composed as follows:

1. Two separate 1½ inch [38 mm] minimum lifts of Item 448 Asphalt Concrete Surface Course, Type 1, PG70-22M. The first lift shall be variable thickness to accommodate beam camber. The second lift shall be a uniform 1½ inch [38 mm] thickness.

2. Two applications of Item 407 Tack Coat - one prior to placement of the first lift of surface course and one prior to placement of the second lift of surface course. Refer to the ODOT Pavement Design & Rehabilitation Manual, Section 404.11 for application rates.

C. 6 inches [155 mm] cast-in-place composite deck - defined as the minimum thickness of concrete slab for composite prestressed box beams. The top 1 inch [25 mm] shall be considered monolithic as defined above. Also see Section 302.5.1.3.

302.1.3.2 FUTURE WEARING SURFACE

All bridges shall be designed for a future wearing surface (FWS) of 60 psf [2.87 kPa].

The future wearing surface is considered non-structural and shall not be used in design to increase the strength of the superstructure. The presence of a future wearing surface does not exclude the use of the 1 inch [25 mm] monolithic wearing surface as defined above.

302.1.4 CONCRETE DECK PROTECTION

302.1.4.1 TYPES

A. Epoxy Coated Reinforcing Steel - CMS 709.00

B. Minimum concrete cover of 2½ inches [65 mm]

C. Class QC2 Concrete

D. Drip Strips

E. CMS 512, Type D, Waterproofing or CMS 512 Type 3 Waterproofing

F. Asphaltic concrete wearing surface

302.1.4.2 WHEN TO USE

All reinforcing steel shall be epoxy coated.

The Designer shall supply basic erection data on the contract plans. As a minimum, include the following information:

A. If temporary supports are required, provide the location of the assumed temporary support points, reactions and deflections for each construction stage and loading condition.
B. Instructions to the Contractor as to when and how to fasten connections for cross frames or diaphragms to assure stability during all temporary conditions.

Further design information for curved structures is contained in the “Guide Specifications for Horizontally Curved Highway Bridges”, published by the American Association of State Highway and Transportation Officials.

302.5 PRESTRESSED CONCRETE BEAMS

Model multi-span, non-composite members as simple-span for all loading conditions. The live load and future wearing surface shall be as defined in Section 301.4.

Model multi-span, composite members using the two loading conditions that follow:

A. The beams shall be designed as simple-span for all loading conditions. The live load and future wearing surface shall be as defined in Section 301.4.

B. The deck reinforcing shall be designed for beams acting as simple-span for non-composite dead loads and as continuous span for live load and composite dead loads. The live load and future wearing surface shall be as defined in Section 301.4.

302.5.1 BOX BEAMS

Physical dimensions and section properties of box beam cross sections shall be as shown on the Prestressed Concrete Box Beam Bridge Details, Standard Bridge Drawing.

Box beams should be limited to a maximum skew of 30 degrees.

Multiple span box beam bridges shall be joined over the piers with a T-joint as shown in the Standard Bridge Drawing. Structurally, beams shall be designed as simple spans. The decks of composite beams shall be designed as continuous for live loads and composite dead loads.

Expansion at the piers shall be accommodated by elastomeric expansion bearings or by flexibility of the piers for integral designs.

The length of abutment seats of prestressed concrete box beam bridges should be long enough to accommodate the total width out-to-out of all beams including a fit-up allowance of ½ inch [12 mm] per joint between beams.

In order to keep the beam seat from extending beyond the fascia of any pier of a box beam bridge, the length of the pier seat should only include a fit-up allowance for the joints between the beams of 1/4 inch [6 mm] per joint.

For box beam bridges that have skew combined with grade or which have variable superelevation, beam seats shall be designed and dimensioned to provide support for the full width of the box beams.

If a bridge structure's geometry causes a bridge deck in an individual span to have a different cross slope at one bearing than at the other bearing, the difference should be evenly divided so that the box beam seat cross slopes at both bearings are made to be the same. This adjustment gives the box beam full support at the seat without creating any twist or torsion on the box beam. Any elevation differences created by this beam seat adjustment should be adjusted for in the overlay, whether asphaltic or concrete.

Prestressed box beam members shall be supported by two bearings at each support.

Abutment wingwalls above the bridge seat and backwalls should not be cast until after box beams have been erected. The cast in place wingwall and box beam should normally be separated by one inch [25 mm] joint filler, CMS 705.03. The designer should show both requirements in the plans. Casting the backwall and wingwalls after the box beams are erected eliminates installation problems associated with the actual physical dimensions of the box beam and the joint filler. Cracking and spalling of backwall and wingwall concrete due to movements of the elastomeric bearings is also alleviated.

For box beam bridges with steel railing, the post spacing and position of post anchorage shall be detailed on the plans. The dimensioning for the post spacing shall be referenced to each prestressed beam end. The designer shall check that the post anchor spacing does not interfere with tierod locations or the "T" joint over the pier. The designer should confirm that post anchors at the ends of skewed box beams have both adequate concrete cover and do not interfere with the tierods. If the designer finds that no post spacing option can comply with the above requirements, the option of relocating the tie rods may be chosen. See standard drawings for maximum allowable spacing of tie rods.

When the box beam ends are not completely encased in concrete, the Standard Bridge Drawing requires Type B waterproofing on the ends. When required, Designers shall include a pay item for Item 512, Type B Waterproofing, in the estimated quantities.

302.5.1.1 DESIGN REQUIREMENTS

For box beam members, the live load distribution factors of AASHTO Section 3.23.4.3 shall be used.

302.5.1.2 STRANDS

Debonding of strands, by an approved plastic sheath, shall be done to control stresses at the ends of the beams. Refer to Section 302.5.2.2.d for debonding limits.

Deflecting of strands in box beams to limit stresses shall not be allowed.

The designer shall show on the plans the number, spacing and length of debonding. The box beam fabricator may have the option to change the position of debonding as long as the change is still symmetrical.

All strands extended from a beam to develop positive moment resistance shall not be debonded strands.

302.5.1.2.a TYPE, SIZE OF STRANDS

A. Low-relaxation ½ inch diameter (A_S = 0.153 in^2) seven wire uncoated strands, ASTM A416, Grade 270.

B. Low-relaxation ½ inch diameter (A_S = 0.167 in^2) seven wire uncoated strands, ASTM A416, Grade 270.

302.5.1.2.b SPACING

Strands shall be spaced at increments or multiples of 2 inches [50 mm].

The location of the centerline of the first row of strands shall be 2 inches [50 mm] from the bottom of the beam. All strands shall be completely enclosed by the #4 stirrup bars. Strands near the top flange shall be placed below all transverse and longitudinal reinforcing steel and to the left and right of the void.

302.5.1.2.c STRESSES

Initial prestressing loads for low-relaxation strand shall be according to AASHTO requirements and shall be detailed on the plans.

Initial stress .... 0.75 f'_s = 202,500 psi [1400 MPa]
Initial tension load .... 30,982 lb/strand (A_S = 0.153 in^2)
33,818 lb/strand (A_S = 0.167 in^2)

Initial stress	0.75 f'_s = 1400 Mpa
Initial tension load	138 600 N/strand (A_S = 99 mm^2)

151 200 N/strand (A_S = 108 mm^2)

The estimated stress in the prestressing tendon immediately after transfer shall be 0.69 f's = 186,300 psi [1285 Mpa] for loss calculation purposes.

Total losses shall be calculated with 70% relative humidity (RH) and a modulus of elasticity of prestensioning reinforcement (E_S) equal to 28,500 ksi [196 500 Mpa]. Total losses may be expressed by:

$F_S = SH + ES + CR_C + CR_S$

$F_S = 11{,}175 + [25{,}650/E_{ci} + 11.4]f_{cir} - 6.65\ f_{cds}$

$F_S = 77.0 + [176\ 850/E_{ci} + 11.4]f_{cir} - 6.65\ f_{cds}$

302.5.1.3 COMPOSITE

Composite reinforced deck slabs on prestressed box beams shall be a minimum of 6 inches [155 mm] thick and shall be reinforced with #6 [#19M] bars. The longitudinal bars shall be spaced at 18" [450 mm] and the transverse bars spaced at 9" [225 mm]. For ease of placement on skewed structures, the transverse bars may be placed parallel to the substructure units with spacing measured parallel to the longitudinal axis of the structure.

On multiple span composite box beam bridges additional longitudinal reinforcing steel over the piers is required. The additional bars shall be alternately spaced with the standard longitudinal reinforcement and the pier bar's length shall be equal to the larger of: 40 percent of the length of the longer adjacent stringer span or a length that meets the requirements of AASHTO 8.24.3.3. The pier bars should be placed longitudinally and approximately centered on the pier but with a 3 foot [1000 mm] stagger.

When designing the deck reinforcement for a multiple span structure, unless a more precise method of analysis is performed, the composite structure shall be conservatively modeled as a continuous beam on a single support centered on the pier.

Composite box beam structures with concrete parapets or sidewalks should not incorporate fit-up tolerances in the finished roadway width. To compensate for fit-up tolerances the composite deck and barrier and/or sidewalk should be designed to cantilever or overhang the boxbeam units by 2" [50 mm] to 8" [200 mm] each side with the fit-up being absorbed in the overhang. A mixture of 48" [1220 mm] and 36" [915 mm] boxbeam units may be necessary to meet this requirement.

See Figure 320 for a sketch of the cross-section of the composite deck superstructure.

302.5.1.4 NON-COMPOSITE WEARING SURFACE

Non-composite box beam bridges with asphalt overlays shall have either Type D Waterproofing or Type 3 Waterproofing as specified in CMS 512 placed on the boxes before the 1½ inch [38 mm] minimum layers of CMS type 448 asphaltic concrete is applied. See section 302.1.3.1. The Type 3 Waterproofing is preferred.

Non-composite box beam bridges with asphalt overlays shall be limited to a 4 percent combined grade. Combined grades greater than 4 percent require a composite deck design. Combined grade includes both the longitudinal and transverse structure grades calculated as follows:

Combined Grade (Cg) = $([\text{deck slope}]^2 + [\text{transverse grade}]^2)^{½}$

302.5.1.5 CAMBER

In establishing bridge seat elevations and assuring a minimum design slab or overlay thickness, allowance shall be made for camber due to prestressing according to the following:

A = Minimum topping thickness

B = Anticipated total mid-span camber due to the design prestressing force at time of release

C = Mid-span deflection due to the self weight of the beam (including diaphragms)

D = Mid-span deflection due to dead load of the topping and other non-composite loads

E = Mid-span deflection due to dead load of railing, sidewalk and other composite dead loads not including future wearing surface

F = Adjustment for vertical curve (Positive for crest vertical curves)

G = Total topping thickness at beam bearings = A + 1.8B - 1.85C - D - E - F. If F > 1.8B - 1.85C - (D + E) then G = A.

H = Total topping thickness at mid-span = A. If F > 1.8B - 1.85C - (D + E) then H = A - (1.8B - 1.85C) + D + E + F.

Use the gross moment of inertia for the non-composite beam to calculate the camber and deflection values B, C, and D. For E, use the moment of inertia for the composite section when designing a composite box beam otherwise use the non-composite section. Note that with the exception of when F > 1.8B - 1.85C - (D + E), the dead load deflection adjustment (D + E) is made by adjusting the beam seat elevations upward.

The designer shall provide the camber at the time of release (B–C), the camber at the time of erection (1.8B – 1.85C), long term camber (2.45B – 2.40C), and a longitudinal superstructure cross section in the plans. For non-composite beams, show the thickness of the Item 448 Intermediate course and the Item 448 surface course at each centerline of bearing and at mid-span points. For composite beams, show the total topping thickness at each centerline of bearing and at mid-span points and provide a screed elevation table.

302.5.1.6 ANCHORAGE

In a box beam design, all beams shall be anchored at abutments and piers. The anchor shall be in the center of the cross section of the box beam and shall conform to details presented in the Standard Bridge Drawing.

Fixed end anchor dowels shall be installed with a non-shrinking grout (mortar). Expansion end anchor dowel holes shall be filled with joint sealer, CMS 705.04.

Preformed expansion joint filler, 705.03, the same thickness as the elastomeric bearing, shall be installed under the box beam, around the anchor dowel, to halt the grout or sealer from leaking through to the beam seat.

302.5.1.7 CONCRETE MATERIALS FOR BOX BEAMS

The designer has a choice of 28-day compressive strengths ranging form 5500 psi [38 Mpa] to 7000 psi [48 Mpa]. The 28-day compressive strength chosen for design shall be listed in the contract plan General Notes.

The designer has a choice of compressive strength at the time of release ranging from 4000 psi [27.5 Mpa] to 5000 psi [34.5 Mpa]. The release strength chosen for design shall be listed in the contract plan General Notes.

Cast-in-place concrete for composite decks, pier “T” sections, etc., shall be superstructure concrete – 4.5 ksi [31.0 MPa] at 28 days.

For concrete in composite decks see Section 301.1.1.

302.5.1.8 REINFORCING

Epoxy coated reinforcing steel shall be used in composite deck slabs and shall be Grade 60 [420], F_y = 60 ksi [420 MPa].

Reinforcing steel used in the standard design box beams is Grade 60 [420], F_y = 60 ksi [420 MPa].

The fabricator, by specification, is required to use a corrosion-inhibiting admixture in the concrete. Reinforcing bars projecting from the prestressed members shall be epoxy coated.

302.5.1.9 TIE RODS

Tie rods shall be provided and installed according to the Prestressed Concrete Box Beam Bridge standard bridge drawing.

Diaphragms and transverse tie rods for prestressed concrete box beam spans shall be provided at mid-span for spans up to 50 feet [15 000 mm], at third points for spans from 50 feet [15 000 mm] to 75 feet [23 000 mm] and at quarter points for spans greater than 75 feet [23 000 mm].

302.5.2 I-BEAMS

AASHTO standard prestressed I-beam shapes, type II through type IV; modified type IV and WF36-49 through WF72-49 as shown in the standard bridge drawing, shall be used.

In designing prestressed I-beams, the non-composite section shall be used for computing stresses due to the beam and deck slab. The composite section shall be used for computing stresses due to the superimposed dead, railing and live loads. When designing the deck reinforcement for a multiple span structure, unless a more precise method of analysis is performed, the composite structure shall be conservatively modeled as a continuous beam on a single support centered on the pier.

Aside from access for shipping strands and clipped flanges as shown in the standard drawing, abrupt changes or discontinuities in the beam cross-section shall be avoided. If not, a refined analysis that accounts for section loss, resulting stress concentrations, and time dependent loading is required. Examples include providing breaks in the top flange to locate a utility or scupper for deck drainage.

302.5.2.1 DESIGN REQUIREMENTS

In order to prevent fabrication mistakes for beam length, the effect that the longitudinal grade has on dimensions measured along a beam's length should be addressed in the plans. When the beam length measured along the grade differs from the beam length measured horizontally by more than 3/8" [10 mm], all affected dimensions measured along the length of the beam should be clearly labeled so that the fabricator can make the necessary allowances in the shop drawings. A Typical Detail note is available in Section 700.

When detailing beam elevations, dimension the locations of all inserts, hold-downs, etc. to the ends of the beam rather than the centerlines of bearing.

302.5.2.2 STRANDS

The preferred strand pattern is straight, parallel strands with no debonding. However, excessive tensile stresses may develop in the beam ends during the release of the prestressing force. To relieve these excessive stresses, the following strand patterns are allowed: (listed in order of preference)

A. Partially debonded bottom flange strands up to the limits specified in *LRFD 5.11.4.3*.

B. Combination of the maximum partially debonded bottom flange strands permitted by *LRFD 5.11.4.3* and draped strands.

Transforming strand area in order to increase section properties is not allowed.

302.5.2.2.a TYPE, SIZE

Use low-relaxation, 0.6-inch diameter (A_S = 0.217 in^2) seven wire uncoated strands, ASTM A416, Grade 270. The prestressing strand type and size shall be listed in the contract plan General Notes.

302.5.2.2.b SPACING

Strands shall be spaced at increments of 2 inches [50 mm].

A minimum 2 inch [50 mm] dimension from bottom of beam to centerline of the first row of strands and any exterior beam surface shall also be maintained.

302.5.2.2.c STRESSES

Initial prestressing loads for low-relaxation strand shall be as per AASHTO requirements and shall be detailed on the plans.

Initial stress .... 0.75 f'_s = 202,500 psi
Initial tension load..43,943 lb/strand (A_S = 0.217 in^2)

The estimated stress in the prestressing tendon immediately after transfer shall be 0.69 f's = 186,300 psi [1285 Mpa] for loss calculation purposes.

Total losses shall be calculated with 70% relative humidity (RH) and a modulus of elasticity of prestensioning reinforcement (E_S) equal to 28,500 ksi [196 500 Mpa]. Total losses may be expressed by:

$$F_S = SH + ES + CR_C + CR_S$$

$$F_S = 11{,}175 + [25{,}650/E_{ci} + 11.4]f_{cir} - 6.65\ f_{cds}$$

$$F_S = 77.0 + [176\ 850/E_{ci} + 11.4]f_{cir} - 6.65\ f_{cds}$$

302.5.2.2.d DEBONDING

Debonding or shielding of the strands, with an approved plastic sheath, may be done at the beam ends to relieve excessive stresses. The following guidelines shall be followed for debonded strand designs:

A. The maximum debonded length at each end shall not be greater than 0.16L - 40" [0.16L - 1000]. Where L equals the span length in inches [millimeters].

B. A minimum of one-half the number of debonded strands shall have a debonded length equal to one-half times the maximum debonded length.

C. No more than 25% of the total number of strands in the I-beam shall be debonded.

D. No more than 40% of the strands in any row shall be debonded.

E. Debonded strands shall be symmetrical about the centerline of the beam.

The designer shall show on the detail plans the number, spacing and the length of required debonding per strand.

302.5.2.2.e DRAPING

Draping or harping of the strands may be done to relieve excessive stresses at the beam ends.

The hold down point shall be located at least 5'-0" [1.5 m] on each side of the midspan of the beam using increments of 6" [150 mm]. The Designer shall calculate the vertical uplift force, P_U, at each hold-down location to ensure the following limits are not exceeded:

No. of Draped Strands per Row	P_U/Strand (lb) [kN]	P_U/Unit (lb) [kN]
1	6000 [26.6]	48,000 [213.5]
2	4000 [17.7]	48,000 [213.5]
3	4000 [17.7]	48,000 [213.5]

Where:

$P_U/\text{Strand} = (1.05)0.75\ f'_S\ A_{PS}\ \text{Tan}\ \psi$

$P_U/\text{Strand} = (1.05)0.00075\ f'_S\ A_{PS}\ \text{Tan}\ \psi$

$$P_U/\text{Unit} = \sum_{i=1}^{n}\left(P_U / \text{Strand}\right)_i$$

and, f'_S = 270,000 psi [1860 MPa]
A_{PS} = Area of single strand (in^2) [mm^2]
n = no. of strands
ψ = Angle of strand inclination measured from horizontal

To minimize the uplift force, locate the hold down point as close as allowed to the midspan and limit the height of the draped strands at the beam ends to only the height required to control stresses. It is not necessary for the angle of inclination for each row of draped strands to be the same. The height of draped strands at beam ends and at midspan shall be multiples of 2" [50 mm]. Do not place straight strands above draped strands in the same vertical column.

302.5.2.3 CAMBER

A variable depth haunch shall be required to account for the effects of camber due to the design prestressing. This haunch depth shall include an additional 2 inches [50 mm] that may be sacrificed to account for differences between actual and design camber. This sacrificial depth shall not be included when determining the composite section properties; however, its weight shall be included in the dead load of the slab. Haunch concrete shall be included in the total volume of superstructure concrete for payment.

In establishing bridge seat elevations and assuring a minimum design slab thickness, allowance shall be made for camber due to prestressing as per the following:

A = Design slab thickness

B = Anticipated total mid-span camber due to the design prestressing force at time of release.

C = Mid-span deflection due to the self-weight of the beam.

D = Mid-span deflection due to dead load of the slab, diaphragms and other non-composite loads.

E = Mid-span deflection due to dead load of railing, sidewalk and other composite dead loads not including future wearing surface.

F = Adjustment for vertical curve. Positive for crest vertical curves.

G = Sacrificial haunch depth (2" [50 mm]).

H = Total topping thickness at beam bearings = A + 1.8B - 1.85C - D - E - F + G. If F > 1.8B - 1.85C - (D + E) then H = A + G

I = Total topping thickness at mid-span = A + G. If F > 1.8B - 1.85C - (D + E) then I = A - (1.8B - 1.85C) + D + E + F + G.

The gross moment of inertia for the non-composite beam shall be used to calculate the camber and deflection values for B, C and D. The moment of inertia for the composite section should be used to calculate value E.

The designer shall show a longitudinal superstructure cross section in the plans detailing the total topping thickness, including the design slab thickness and the haunch thickness at the centerline of spans and bearings. Provide the camber at the time of release (B-C), camber at the time of erection (1.8B – 1.85C), long term camber (2.45B – 2.40C), and a screed elevation table according to Section 302.2.3.

302.5.2.4 ANCHORAGE

One inch diameter anchors shall be provided at each fixed pier as shown on the standard bridge drawing.

The number of anchors required shall be determined by analysis. These anchors shall be designed to transfer superstructure loads to the substructure at the Strength Limit States and resist seismic loads at the Extreme Event Limit State.

The anchors shall be a minimum of 2'-0" long. Anchors shall be embedded a minimum of 1'-0" into the pier cap. The anchors should be drilled in place at the centerline of the pier. The designer should confirm the pier cap has reinforcing steel clearance to accept these anchors.

302.5.2.5 DECK SUPERSTRUCTURE AND PRECAST DECK PANEL

Only cast-in-place concrete decks shall be designed and used.

The precast panel alternative, previously used, has shown cracking problems at the joints between the panels and there are questions on the transfer of stresses in the finished deck sections.

302.5.2.6 DIAPHRAGMS

Maximum spacing of intermediate diaphragms shall be 40'-0" [12 000 mm].

Intermediate diaphragms for 60” and deeper beams may be either cast-in-place concrete or galvanized steel. The contractor shall choose the type. Intermediate diaphragms for less than 60” deep beams shall be cast-in-place concrete. Details for each type are provided in the standard bridge drawing. The design plans shall show the centerline location of each intermediate diaphragm. Payment for the intermediate diaphragms shall be made at the contract price for item 515, each, Intermediate Diaphragms.

Cast-in-place intermediate diaphragms should not make contact with the underside of the deck because they could act as a support to the deck, causing cracking and possible over stressing of the deck. The top of the cast-in-place intermediate diaphragm should start at the bottom vertical edge of the top flange and end at the top of the vertical edge of the bottom flange.

If the Standard Bridge Drawing for I-beams is not referenced by the contract plans, the designer shall add a note to the plans for prestressed I-beam designs requiring cast-in-place intermediate diaphragms to be placed and cured at least 48 hours before deck placement.

Threaded inserts shall be used to connect the cast-in-place diaphragm reinforcing steel to the I-beam. Use of the inserts will ease installation of the diaphragms, allow transfer of load to the beam and help protect the diaphragms against cracking. The threaded inserts and the threaded rods shall be galvanized according to CMS 711.02.

End diaphragms shall be provided. Diaphragms shall be cast-in- place. The top of the end diaphragm shall make complete contact with the deck. The bottom of the end diaphragm shall end at the top of the elastomeric bearing. Refer to the standard bridge drawing for typical diaphragm details.

302.5.2.7 DECK POURING SEQUENCE

A deck pour sequence is required for all multiple span prestressed I-beam designs made continuous at pier locations. The standard drawing establishes one sequence that allows the beams to deflect without stressing pre-placed diaphragms. The designer shall either accept the standard drawing sequence or detail an alternative.

302.5.2.8 CONCRETE MATERIALS FOR I-BEAMS

The designer has a choice of 28-day compressive strengths ranging from 5500 psi [38 Mpa] to 7000 psi [48 Mpa]. The 28-day compressive strength chosen for design shall be listed in the contract plan General Notes.

The designer has a choice of compressive strength at the time of release ranging from 4000 psi [27.5 Mpa] to 5000 psi [34.5 Mpa]. The release strength chosen for design shall be listed in the contract plan General Notes.

Cast-in-place concrete, (composite decks, pier diaphragms, intermediate diaphragms, etc.) shall be superstructure concrete – 4.5 ksi at 28 days.

Consult the Office of Structural Engineering for recommendations prior to designing a structure with concrete strengths higher than those shown above.

302.5.2.9 REINFORCING

The fabricator, by specification, is required to use a corrosion-inhibiting admixture to the concrete.

Reinforcing bars projecting from the prestressed members shall be epoxy coated. All other beam reinforcement shall be uncoated. Reinforcing steel shall be Grade 60, F_y = 60 ksi. Welded wire fabric shall be Grade 70, F_y = 70 ksi.

302.5.2.10 TRANSPORTATION & HANDLING CONSIDERATIONS

In order to prevent damaging the beams during transit and erection, fabricators may require additional strands to be placed in the top flange. These shipping strands keep the top flange in compression until the beams are set into final position. Once set, the shipping strands are cut to release their prestressing force and allow the beams to reach their design ultimate capacity.

I. The road surface on the temporary structure shall have antiskid characteristics, crown, drainage and superelevation in accordance with all ODOT and AASHTO publications.

504 GENERAL NOTES

The designer should provide plan note(s) with the Temporary Structure plans similar to the following:

A. The Contractor may substitute used or alternate members for the members shown on the Temporary Structure Plans, provided that the strength of the substitute or alternate member is equal to or greater than the original member. Maintain waterway opening size and required clearances. Submit calculations for the substitute or alternate member according to 502. Use only new bolts.

B. Structural steel need not be painted.

The following instructions are provided to assist in developing the necessary general notes.

When 513 Structural Steel is specified in the plans, only the following CMS descriptions shall apply:

A. Straightening 513.11

B. Holes for High Strength and Bearing Bolts 513.19

C. High Strength Steel Bolts, Nuts and Washers 513.20

D. Welding 513.21

E. Nondestructive Testing 513.25

F. Shipping, Storage and Erection 513.26

When Item 511 is specified in the plans, the C&MS 511 surface finish requirements shall be waived.

The following notes shall be included in the Structure General Notes. In the roadway plans the pay item description “614 Maintenance of Traffic” shall include an “as per Plan.” Coordination with the roadway plans for this item is required.

A. MAINTENANCE: Maintain all portions of the temporary structure in good condition with regard to strength, safety and ridability. The Department will consider this maintenance to be incidental to Item 614, Maintaining Traffic. Maintain the waterway opening shown on the plans at all times. If debris accumulates within the waterway opening or on any part of the structure promptly remove the debris. The Department will compensate for debris removal according to 109.05.

B. CLOSING OF THE TEMPORARY STRUCTURE: If for any reason or at any time the temporary structure's ability to safely carry traffic is in question, immediately take the actions necessary to protect traffic, repair and reopen the temporary structure. When closing a temporary structure for this purpose, immediately notify the Engineer and the appropriate law enforcement agency. Water elevations exceeding the design (5) year highwater elevation or an excessive accumulation of debris within the waterway opening shall be sufficient reasons to close the temporary structure. Mark the design (5) year highwater elevation with fluorescent paint on the temporary structure, at a visible location. The Department will consider the costs associated with closing the temporary structure to be incidental to Item 614, Maintaining Traffic.

[3] DESIGN LOADING: HS25 (#), Case________(I or II)** and the Alternate Military Loading.

Future Wearing Surface (FWS) of __60 *__ Lbs/ft^2.

[3M] DESIGN LOADING: MS-22.5 (#), Case______(I or II)** and the Alternate Military Loading.

Future Wearing Surface (FWS) of __2.87 *__ kPa.

* Designer to modify load if appropriate.
** The statement "Case (I or II)" applies only to steel bridges.

\# Replace vehicle type with HS-20, or metric equal, if the design is for a rehabilitation of an existing structure

For bikeway/pedestrian bridges that will not accommodate vehicular traffic the design loading shall be:

[4] DESIGN LOADING **:** __*__ Lb/ft^2

[4M] DESIGN LOADING **:** __*__ kN/m^2

* As defined for the specific structure in accordance with the AASHTO Guide Specifications for Design of Pedestrian Bridges

For bikeway/pedestrian bridges subject to vehicular traffic the design loading shall be:

[5] DESIGN LOADING **:** __*__ Lb/ft^2 and H15-44 vehicle

[5M] DESIGN LOADING **:** __*__ kN/m^2 and M13.5 vehicle

* As defined for the specific structure in accordance with the AASHTO Guide Specifications for Design of Pedestrian Bridges

602.2 DESIGN STRESSES

A. General Design Data For Load Factor design:

[6] DESIGN DATA :

Concrete __*__ - compressive strength 4500 psi (superstructure)

Concrete __*__ - compressive strength 4000 psi (substructure)

Concrete QC2 - compressive strength 4000 psi (drilled shaft)

* Class QC2 Concrete for superstructure
  Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

Reinforcing steel - ASTM A615 or A996Grade 60 minimum yield strength 60,000 psi
Spiral reinforcement may be plain bars, ASTM A82 or A615

If spiral reinforcing bars are not used, omit the portion of the note beginning with "spiral".

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 50,000 psi
A709 Grade 36 - yield strength 36,000 psi

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

[6M] DESIGN DATA :

Concrete __*__ - compressive strength 31.0 MPa (superstructure)

Concrete __*__ - compressive strength 27.5 MPa (substructure)

Concrete QC2 - compressive strength 27.5 MPa (drilled shaft)

* Class QC2 Concrete for superstructure
  Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

Reinforcing steel - A615M or A996M
Grade 420 minimum yield strength = 420 MPa
Spiral reinforcement may be plain bars, ASTM A82 or A615M

If spiral reinforcing bars are not used, omit the portion of the note beginning with "spiral".

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 350 MPa
A709 Grade 36 - yield strength 250 MPa

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

B. General Design Data For Service Load Design (Working Stress Design):

[7] DESIGN DATA **:**

Concrete __*__ - unit stress 1500 psi (superstructure)

Concrete __*__ - unit stress 1300 psi (substructure)

Concrete QC2 - unit stress 1300 psi (drilled shaft)

* Class QC2 Concrete for superstructure
Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

Reinforcing Steel - ASTM A615 or A996
Grade 60 - unit stress 24,000 psi
Spiral reinforcement may be plain bars, ASTM A82 or A615

If spiral reinforcing bars are not used, omit the portion of the note beginning with "spiral".

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 27,000 psi
A709 Grade 36 - yield strength 20,000 psi

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

[7M] DESIGN DATA **:**

Concrete __*__ - unit stress 10.3 MPa (superstructure)

Concrete __*__ - unit stress 9.2 MPa (substructure)

Concrete QC2 - unit stress 9.2 MPa (drilled shaft)

* Class QC2 Concrete for superstructure
Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

Reinforcing Steel - ASTM A615M or A996M
Grade 420 - unit stress 165 MPa
Spiral reinforcement may be plain bars, ASTM A82 or A615M

If spiral reinforcing bars are not used, omit the portion of the note beginning with "spiral".

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 186 MPa
A709 Grade 36 - yield strength 138 MPa

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

C. Additional Design Data for Prestressed Concrete Members:

Provide the following note in addition to either note **[6]** or **[7]**.

[8] DESIGN DATA:

Concrete for prestressed beams:
Compressive Strength (final) - 5500 psi **
Compressive Strength (release) - 4000 psi **

Welded Wire Fabric:
Yield Strength – 70 ksi***

Prestressing strand:
Area = 0.153 in^2 **
Ultimate Strength = 270 ksi
Initial stress = 202.5 ksi (Low relaxation strands)

** Revise the prestressed concrete strength values for final strength and strength at release if a design strength is different than the values listed above. Also, modify the diameter and area of the strands as required.
*** Reference to Welded Wire Fabric applies to I-beam only.

[8M] DESIGN DATA:

Concrete for prestressed beams:
Compressive Strength (final) - 38 Mpa **
Compressive Strength (release) - 27.5 Mpa **

Welded Wire Fabric:
Yield Strength – 480 MPa***

Prestressing strand:
Area = 99 mm^2 **

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Ultimate Strength = 1860 MPa
Initial stress = 1395 MPa (Low relaxation strands)

** Revise the prestressed concrete strength values for final strength and strength at release if a design strength is different than the values listed above. Also, modify the diameter and area of the strands as required.

602.3 FOR RAILWAY PROJECTS

For structures carrying railroad traffic, provide the following notes on the project plans:

[9] DESIGN SPECIFICATIONS: This structure conforms to the requirements of the "Manual for Railway Engineering" by the American Railway Engineering and Maintenance-of -way Association, XXXX * Edition.

CONSTRUCTION AND MATERIAL SPECIFICATIONS: State of Ohio, Department of Transportation, dated January 1, XXXX. *

* Designer should fill-in current edition and latest interims.

NOTE TO DESIGNER: Note **[2A]** may be required if special criteria or distributions have been used for the design of this rail structure. See **[2A]** and determine if a modified note is required for inclusion.

Use the following note, modified as necessary to meet AREMA and/or a specific railroad criterion, with all railroad structures.

[10] DESIGN DATA :

Design Loading - Cooper E-80 with diesel impact (or specific railroad criteria)

Concrete __*__ - unit stress 1500 psi (superstructure)
Concrete __*__ - unit stress 1333 psi (substructure)

Concrete QC2 - unit stress 1300 psi (drilled shaft)

* Class QC2 Concrete for superstructure
Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 27,000 psi
A709 Grade 36 - yield strength 20,000 psi

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

Reinforcing steel - ASTM A615-unit stress 24,000 psi

[10M] DESIGN DATA :

Design Loading - Cooper E-80 with diesel impact (or specific railroad criteria)

Concrete __*__ - unit stress 10.3 MPa (superstructure)
Concrete __*__ - unit stress 9.2 MPa (substructure)

Concrete QC2 - unit stress 1300 psi (drilled shaft)

* Class QC2 Concrete for superstructure
Class QC1 Concrete for substructure

Only included if drilled shafts are being constructed

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 186 MPa
A709 Grade 36 - yield strength 138 MPa

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

Reinforcing steel - ASTM A615M-unit stress 167 Mpa

602.4 DECK PROTECTION METHOD

If any of the following deck protection method(s) have been specified in the plans, include the following note in the Design Data section of the Structure General Notes (modify as necessary for the specific structure):

[11] DECK PROTECTION METHOD:

Epoxy coated reinforcing steel

For wall type abutments on spread footings with no new embankment provide note **[26]** or **[27]** and the following note:

[25] CONSTRUCTION CONSTRAINTS: Fill the void created by excavating for the abutment footings with Type B granular material, 703.16.C. After the footing and the breastwall have been constructed, fill the void behind each abutment up to the beam seat elevation and from the beam seat up on a 1:1 slope to the subgrade elevation prior to constructing the backwall and setting the beams on the abutment.

605.3 EMBANKMENT CONSTRUCTION NOTE

In an attempt to reduce settlements of the roadway approaches, specify the placement of embankment materials in 6 inch [150 mm] lifts. Include one of the following plan notes in the Project General Notes and make reference to the work defined below at the appropriate locations within the plans.

<u>Note that Item 203 is a roadway quantity and coordination with the roadway plans is necessary.</u>

To define the limits of measured pay quantities for bridges with wall-type abutments, provide excavation, backfill, and embankment diagrams (or a composite diagram, where suitable), using schematic abutment cross-sections, showing the boundaries between structure and roadway excavation, and between structure backfill and roadway embankment.

[26] ITEM 203 EMBANKMENT, AS PER PLAN: Place and compact embankment material in 6 inch [150 mm] lifts for the construction of the approach embankment between stations _**_ to _**_.

** The approximate limits should be 100 feet behind each abutment

[27] ITEM 203 EMBANKMENT, AS PER PLAN: Place and compact embankment material in 6 inch [150 mm] lifts for the construction of the approach embankment.

605.4 UNCLASSIFIED EXCAVATION

Compute and use pay items for Item 503 as follows:

When an excavation includes 10 yd^3 [m^3] or more of rock (or shale), itemize the quantity of rock excavation separately under:

Item 503 - Rock (or Shale) Excavation

When the rock (or shale) excavation is under 10 yd^3 [m^3], do not itemize the rock (or shale) excavation separately. Provide the following pay item:

Item 503 - Unclassified excavation, including rock (and/or shale)

When excavation includes no rock (or shale), provide the following pay item:

Item 503 - Unclassified excavation

In computing the quantity of Item 503 excavation, the designer should confirm that all removals under items 201, 202 or 203 have been excluded, according to CMS 503.01. Generally, the basis of payment for Item 503 should be yd^3 [m^3]. Lump sum quantities may be used if authorized by the District and with the understanding that cost may be higher than when specific quantities are used.

605.5 PROPRIETARY RETAINING WALLS

[98] Note Retired – See Appendix

For projects with proprietary retaining wall systems supporting bridge abutments on pile foundations, provide the following note:

[99] PROPRIETARY RETAINING WALL DATA:
The proprietary wall supplier shall design the internal stability of a mechanically stabilized earth (MSE) wall in accordance with the SS840 to support the

for the remaining piling represented by the testing. Submit all test results to the Office of Structural Engineering.

For subsequent static load tests, upon completion of a 10,000 ft [3000 m] increment of driven length, repeat the above procedure for the initial static load test. If necessary, the Engineer will revise the driving criteria for the remaining piling accordingly.

When performing the restrike, if the pile has not reached the blow count determined for the plan specified Ultimate Bearing Value, continue driving the pile until this capacity is achieved.

Provide the following note when battered piles are specified.

[30d] Note retired – see appendix

606.3 STEEL PILE POINTS

[31] Note retired - see appendix

606.4 PILE SPLICES

Provide the following note when H-piles are specified.

[100] PILE SPLICES: In lieu of using the full penetration butt welds specified in CMS 507.09 to splice steel H-piles, the Contractor may use a manufactured H-pile splicer. Furnish splicers from the following manufacturer:

Associated Pile and Fitting Corporation

8 Wood Hollow Rd. Plaza 1

Parsippany, New Jersey 07054

Install and weld the splicer to the pile sections in accordance with the manufacturer's written assembly procedure supplied to the Engineer before the welding is performed.

606.5 MINIMUM HAMMER SIZE

[33] Note retired - see appendix

606.6 PILE ENCASEMENT

The following note shall be used where capped pile piers and steel "H" piles are being used for a bridge structure crossing a waterway. The exposed steel piling corrodes at the waterline, or near there. The note should not be used if the capped pile pier standard drawing is being used as standard drawing already specifies pile encasement methods.

[34] ITEM SPECIAL - PILE ENCASEMENT

Encase all steel H-piles for the capped pile piers in Class QC1 concrete. Provide a concrete slump between 6 to 8 inches with the use of a superplasticizer. Place the concrete within a form that consists of polyethylene pipe (707.33), or PVC pipe (707.42). The encasement shall extend from 3 feet [1 meter] below the finished ground surface up to the concrete pier cap. Position pipe so that at least 3 inches [75 mm] of concrete cover is provided around the exterior of the pile.

In lieu of encasing the pile in concrete, galvanize the piles according to 711.02. The galvanizing shall be continuous from a minimum of 3 feet below the finish ground surface up to the concrete pier cap. The galvanized coating thickness shall be a minimum of 4 mils [100 μm]. Repair all gouges, scrapes, scratches or other surface imperfections caused by the handling or the driving of the pile to the satisfaction of the Engineer.

The Department will measure pile encasement by the number of feet. The Department will determine the sum as the length measured along the axis of each pile from the bottom of the encasement to the bottom of the pier cap. The Department will not pay for galvanizing provided beyond the project requirements. The Department will pay for accepted quantities at the contract price for Item – Special, Pile Encasement.

606.7 FOUNDATION BEARING PRESSURE

Provide the following note, with the blanks filled in as appropriate for each individual project, if there are abutments or piers which are supported by spread footings. Show the actual calculated maximum bearing pressure under the footing.

[35] FOUNDATION BEARING PRESSURE: **_______** footings, as designed, produce a maximum bearing pressure of **______** tons per square foot [Mpa]. The allowable bearing

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610.7 RAILING

Use the following note where the existing parapet is to be refaced. Modify the note accordingly for each specific project.

[48] ITEM 517 - RAILING FACED, AS PER PLAN

DESCRIPTION: This work consists of facing curb style parapets, using cast in place concrete, to obtain the deflector shape as shown in the plans.

REMOVAL: Carefully remove the existing aluminum railing, posts, curb plates, existing concrete curb and bulb angle gutter. Remove all loose or unsound concrete. Remove sound concrete, as necessary, to obtain a minimum 4 inch [100 mm] thickness of new concrete.

NOTE TO DESIGNER: Modify the list of items in the above removal portion of this note as necessary to fit the actual conditions of your particular project.

DOWEL HOLES AND REINFORCING STEEL: Drill dowel holes where shown in the plans. Install reinforcing steel according to Item 510 using epoxy grout, 705.20. Prior to drilling dowel holes, locate all existing reinforcing steel bars in the area of the hole with the aid of a reinforcing steel bar locator (pachometer). If an existing bar is encountered at the same location as a proposed dowel hole, move the dowel hole to either side of the existing bar. The Department will pay for all reinforcing steel, dowel holes and grouting with Item 517.

SURFACE PREPARATION: Thoroughly clean the parapet surface in contact with the refacing with detergent to remove surface contaminants. After detergent cleaning and within 24 hours of placing concrete, blast clean and air broom or power sweep all surfaces in contact with the refacing to remove all spalls, laitance, curing compounds, concrete sealers and other contaminants detrimental to the achievement of an adequate bond. Acceptable blast cleaning methods are high-pressure water blasting with or without abrasives in water, abrasive blasting with containment or vacuum abrasive blasting. Use hand tools as necessary to remove scale from any exposed reinforcing steel. Materials: Concrete shall be Class QC2 with a compressive strength of 4500 psi [31 MPa]. Furnish reinforcing steel according to 709.00, grade 60 [420], with a minimum yield strength of 60,000 psi [420 MPa].

CONTROL JOINTS: Sawcut 1 1/4 inch [32 mm] deep control joints along the perimeter of the parapet as soon as the saw can be operated without damaging the concrete. Place the joint saw cuts at the same location as the existing deflection joints. Use an edge guide, fence or jig to ensure that the cut joint is straight, true and aligned on all faces of the parapet. The joint width shall be the width of the saw blade, a nominal width of 1/4 inch [6 mm]. Seal the perimeter of the control joint to a minimum depth of one inch [25 mm] with a polyurethane or polymeric material conforming to ASTM C920, Type S. Leave the bottom one-half inch [12 mm] of both the inside and outside faces of the parapet unsealed to allow any water which may enter the joint to escape.

METHOD OF MEASUREMENT: The Department will measure this item in feet by the actual length of railing faced between the ends of the existing concrete parapet.

BASIS OF PAYMENT: Payment for this item includes all costs of removal, dowel holes, reinforcing steel, concrete, shrinkage control joints, epoxy injection and inspection platforms. The Department will pay for accepted quantities at the contract price for Item 517, Railing Faced, As Per Plan.

NOTE TO DESIGNER: Include the reinforcing steel in the bar list with appropriate bending diagrams, as necessary, even though the reinforcing steel is included with item 517 for payment. Modify the method of measurement and items of work included in this pay item as necessary to fit your specific project.

611 MISCELLANEOUS GENERAL NOTES

611.1 DOWEL HOLES

[49] Note Retired - See appendix

611.2 APPROACH SLABS

[50] Note Retired - See Appendix

[50A] Note Retired - See appendix

[93A] Note Retired - See appendix

[93B] Note Retired - See appendix

proper bearing. Furnish two shims per beam. The Department will measure this item by the total number supplied. The Department will pay for accepted quantities at the contract price for Item 516 - 1/8" [3 mm] Preformed Bearing Pads. Any unused shims will become the property of the State.

NOTE TO DESIGNER: The plan area of the shim pad shall be the same as the elastomeric bearing.

611.7 CLEANING STEEL IN PATCHES

Use this note with all concrete patching bid items that refer to the cleaning requirements specified in 519.04

[55a] ITEM 519 - PATCHING CONCRETE STRUCTURES, AS PER PLAN: Prior to the surface cleaning specified in 519.04 and within 24 hours of placing patching material, blast clean all surfaces to be patched including the exposed reinforcing steel. Acceptable methods include high-pressure water blasting with or without abrasives in the water, abrasive blasting with containment, or vacuum abrasive blasting.

611.8 CONVERSION OF STANDARD BRIDGE DRAWINGS

The Department's Standard Bridge Drawings are available in English units only. If the project scope has established that Contract Documents will be prepared in metric units, the Designer has two options:

A. Convert the English drawings to metric units. This means removing the standard title blocks and using the converted drawings as plan insert sheets directly in the project plans. In doing so, the Designer assumes responsibility for the accuracy to the converted drawings. CADD files may be downloaded from the ODOT, Office of Structural Engineering web site.

B. Specify the English Standard Bridge Drawings in the Plans and use the following note:

[55b] CONVERSION OF STANDARD BRIDGE DRAWINGS: The Standard Bridge Drawings referenced in this plan are in English units. Any conversion of dimensions required to construct the items shown on the standards is the responsibility of the Contractor. Refer to 109.02 for a listing of Conversion Factors. Conversions shall be appropriately precise and shall reflect standard industry metric values where suitable.

611.9 COFFERDAMS AND EXCAVATION BRACING

Use this note when the plans include detail designs for temporary shoring.

[101] ITEM 503, COFFERDAMS AND EXCAVATION BRACING, AS PER PLAN:
The design shown on the plans for temporary support of excavation is one representative design that may be used to construct the project. The Contractor may construct the design shown on the plans or prepare an alternate design to support the sides of excavations. If constructing an alternate design for temporary support of excavation, prepare and provide plans in accordance with C&MS 501.05. The Department will pay for the temporary support of excavation at the contract lump sum price for Cofferdams and Excavation Bracing. No additional payment will be made for providing an alternate design.

611.10 DECK PLACEMENT NOTES

611.10.1 FALSEWORK AND FORMS

Use the following note when web depths greater than 84 in. are specified.

[102] ITEM 511, CLASS QC2 CONCRETE, SUPERSTRUCTURE, AS PER PLAN *

Locate the lower contact point of the overhang falsework at least _**_ inches ± 2 in. above the top of the girder's bottom flange. The bracket contact point location requirements of C&MS 508 do not apply.

NOTE TO DESIGNER:

* Modify the pay item description to fit the specific project requirements.

** The minimum dimension for the location for the lower point of contact should be 76 in. below the bottom of the top flange. Designers should verify the acceptability of the design within the range of tolerance specified.

611.10.2 DECK PLACEMENT DESIGN ASSUMPTIONS

Use the following note on all projects requiring mechanized finishing machines to place deck concrete.

[103] DECK PLACEMENT DESIGN ASSUMPTIONS:
The following assumptions of construction means and methods were made for the analysis and design of the superstructure. The Contractor is responsible for the design of the falsework support system within these parameters and will assume responsibility for superstructure analysis for deviation from these design assumptions.

An eight wheel finishing machine with a maximum wheel load of _____ kips for a total machine load of _____ kips.

A minimum out-to-out wheel spacing at each end of the machine of 103".

A maximum spacing of overhang falsework brackets of 48 in.

[71] INTERMEDIATE DIAPHRAGMS: Do not place the deck concrete until all intermediate diaphragms have been properly installed. If concrete diaphragms are used, complete the installation of the intermediate diaphragms at least 48 hours before deck placement begins. Concrete shall conform to C&MS 511 with a design strength of 4.5 ksi.

702.7.2 SEMI-INTEGRAL OR INTEGRAL ABUTMENT CONCRETE PLACEMENT FOR DIAPHRAGMS

Hardened concrete end diaphragms restrain the movement and rotation of beam/girder ends that occur during deck placement. This restraint will increase stress in both the beam/girder and diaphragm. Factors that can contribute to detrimental stress increases include large structure skew and phased construction. When these factors exist, hardened diaphragms should be avoided during the deck placement. The following table provides guidelines for concrete diaphragm placement options.

Diaphragm Placement (3)		Skew < 30° (Steel) or <10° (I-beam) No Closure Pour	Skew < 30° (Steel) or <10° (I-beam) Closure Pour (2)	Skew ≥ 30° (Steel) or ≥10° (I-beam) No Closure Pour	Skew ≥ 30° or ≥10° (I-beam) Closure Pour (2)
Phase 1	Placed 48 hrs before deck placement	✓	✓		
	Placed with deck placement	✓	✓	✓(1)	✓(1)
	Placed after deck placement	✓	✓	✓	✓
Successive Phases	Placed 48 hrs before deck placement	✓	✓		
	Placed with deck placement	✓	✓	✓(1)	✓(1)
	Placed after deck placement	✓	✓	✓	✓

Notes:
✓= Diaphragm concrete placement option is acceptable
1. Requires submittal and Engineer approval
2. Place closure pour concrete in the diaphragm with or after deck placement.
3. For bridges built without phased construction, follow guidance for Phase 1 with No Closure Pour.

Designers should consider the absence of restraint at the diaphragm location and when calculating the unbraced length of beam/girder flanges. If necessary, temporary bracing details should be included in the plans. Temporary end bracing should be oriented perpendicular to beam/girder webs.

The following notes may be needed depending on whether the bridge superstructure is steel or prestressed concrete; requires phased construction; or is skewed a specific amount.
Use the following note for either steel superstructures skewed less than 30 degrees or I-beam superstructures skewed less than 10 degrees without phased construction.

[71a] ABUTMENT DIAPHRAGM CONCRETE: Place the diaphragm concrete encasing the structural member ends with the deck concrete or at least 48 hours before placement of the deck concrete. If placed separately, locate the horizontal construction joint between the diaphragm and deck concrete at the approach slab seat.

Use the following note for either steel superstructures skewed 30 degrees or more or I-beam superstructures skewed 10 degrees or more without phased construction.

[71b] ABUTMENT DIAPHRAGM CONCRETE: Place the diaphragm concrete encasing the structural member ends after the deck placement in the adjacent span is complete. Procedures that place the abutment diaphragm with the deck concrete may be approved by the Engineer if the placement submittal can assure that the deck concrete in the adjacent span will be placed before concrete in the diaphragm has reached its initial set.

Use the following note for either steel superstructures skewed less than 30 degrees or I-beam superstructures skewed less than 10 degrees with phased construction and closure pours required per BDM Section 302.2.9.

[71c] ABUTMENT DIAPHRAGM CONCRETE, PHASED CONSTRUCTION: Place the diaphragm concrete encasing the structural member ends of an individual phase with the deck concrete or at least 48 hours before placement of the deck concrete. If placed separately, locate the horizontal construction joint between the diaphragm and deck concrete at the approach slab seat. Place closure pour concrete in the diaphragm and deck concurrently.

NOTE TO DESIGNER:
For bridges with phased construction that do not require closure pours according to BDM Section 302.2.9, omit the last sentence of note **[71c]**

Use the following note for either steel superstructures skewed 30 degrees or more or I-beam superstructures skewed 10 degrees or more with phased construction and closure pours required per BDM Section 302.2.9.

[71d] ABUTMENT DIAPHRAGM CONCRETE, PHASED CONSTRUCTION: Place the diaphragm concrete encasing the structural member ends of an individual phase after the satisfaction of the Engineer prior to setting the bearings. The Department will not pay for this removal.

HISTORY: Note **[92]** was retired when the information was added to C&MS 516.07.

ARN-33 RETIRED NOTE 69

Where the load plate of an elastomeric bearing is to be connected to the structure by welding, provide the following note with the pertinent bearing details:

[69] WELDING: Control welding so that the plate temperature at the elastomer bonded surface does not exceed 300º F [150º C] as determined by use of pyrometric sticks or other temperature monitoring devices.

HISTORY: Note **[69]** was retired when the information was added to C&MS 516.07.

ARN-34 RETIRED NOTE 70

Where elastomeric bearing repositioning is required for a steel beam or girder superstructure, provide the following plan note.

[70] BEARING REPOSITIONING: If the steel is erected at an ambient temperature higher than 80ºF [26º C] or lower than 40º F [4º C] and the bearing shear deflection exceeds 1/6 of the bearing height at 60º F (+/-) 10º F [15º C +/- 5º], raise the beams or girders to allow the bearings to return to their undeformed shape at 60º F (+/-) 10º F [15º C +/- 5º].

HISTORY: Note **[70]** was retired when the information was added to C&MS 516.07.

ARN-35 RETIRED NOTE 91

For galvanized structures with welded shear connectors, place the following note on the same plan sheet as the shear connector spacing.

[91] WELDED SHEAR CONNECTORS: Install shear connectors after the decking or other walking/working surface, has been installed. Remove the galvanic coating by grinding at each connector location prior to welding.

HISTORY: Note **[91]** was retired when the information was added to C&MS 513.22.

ARN-36 RETIRED NOTE 30d

Provide the following note when battered piles are specified.

[30d] BATTERED PILES: The blow count for battered piles shall be the blow count determined for vertical piles of the same Ultimate Bearing Value divided an efficiency factor (D). Compute the efficiency factor (D) as follows:

$$D = \frac{1 - UG}{\sqrt{(1 + G^2)}}$$

U = Coefficient of friction, which is estimated at 0.05 for double-acting air operated or diesel hammers; 0.1 for single-acting air operated or diesel hammers; and 0.2 for drop hammers.

G = Rate of batter (1/3, 1/4, etc.)

HISTORY: Note **[30d]** was retired when the information was added to C&MS 507.05.

ARN-37 RETIRED NOTE 98

For projects with proprietary retaining wall systems supporting bridge abutments on spread footings, provide the following note and table:

[98] PROPRIETARY RETAINING WALL DATA:
The proprietary wall supplier shall design the internal stability of a mechanically stabilized earth (MSE) wall in accordance with the SS840 to support the abutment loads provided in the table below. All loads in the table represent unfactored service loads applied to the reinforced soil mass at the base of the concrete footing. DL represents a vertical spread footing strip load that includes the dead load of the approach slab; the dead load of the abutment; and the dead load from the superstructure. LL represents a vertical spread footing strip load that includes only the live load from the superstructure. H represents a horizontal strip load from the superstructure applied perpendicular to the face of wall. Ecc. represents the distance between the geometrical center of the strip footing and the resultant of all loads applied to the footing.

Wall Location	DL (k/ft)	LL (k/ft)	H (k/ft)	Ecc. (ft)	Bearing Pressure (k/ft^2)
#1					
#2					
#3					

For projects with proprietary retaining wall systems supporting bridge abutments on pile foundations, provide the following note:

HISTORY: Note **[98]** was retired because spread footings were no longer permitted to be used for MSE wall supported abutments.