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

January 20, 2017

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: 2017 First Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, July 2007. These revisions shall be implemented on all Department projects that begin Stage 2 plan development date after January 20, 2017. 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 July 2007 edition of the Bridge Design Manual may be downloaded at no cost using the following link:

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

Attached is a brief description of each revision.

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Summary of Revisions to the July 2007 ODOT BDM

BDM Section	Affected Pages	Revision Description
201.2.2	2-3	The latitude and longitude coordinates provided in the proposed structure block shall be measured to 0.01 seconds. The precision of measuring to the nearest second or the nearest hundredth of a second results in about 50-ft as opposed to about 1-ft.
204.6	2-26	The retaining wall justification study still exists, but the Preferred Alternative Verification Review does not. This section was revised to eliminate the stage review in which the submittal is made. That information is provided in other Department publications.
208.1	2-36 through 2-37	This revision corresponds with recent C&MS 501.05 revisions for the design of temporary excavation support. These revisions address when the contract plans will provide designs and pay items for temporary excavation support.
302.1.1	3-9	This revision corrects the concrete class for drilled shafts. Drilled shaft concrete was previously specified as Class QC2. However, C&MS 524.02 specifies concrete as Class QC4 or QC5.
302.1.4.3	3-13	The sacrificial graffiti coatings have been removed from the BDM. The sacrificial coatings have not performed well due to their short service life.
302.4.2	3-26	This section of the BDM listed the section properties for W36x16 rolled beams. This list was provided because in January 2006, Nucor implemented changes to the physical dimensions of the W36x16 group of shapes. Since then, Nucor has continued to tweak the section properties such that the sections provided in the BDM are no longer accurate. This list was eliminated.
303.1	3-48	The sacrificial graffiti coatings have been removed from the BDM. The sacrificial coatings have not performed well due to their short service life.
303.4.3	3-68 through 3-68.2	This revision was provided to clarify the concrete strength used for determining the structural capacity of a drilled shaft.
304.2	3-74	The table showing standard railing types still referenced BR-2-98 which was replaced with BR-2-15 in Jul 2015. This has been corrected.

BDM Section	Affected Pages	Revision Description
304.3.5	3-77	The section heading for 304.3.5 was revised from BR-2-98 to BR-2-15 to reflect the release of the new standard drawing.
306.1.2	3-82	This revision reflects the release of the new EXJ-6-17 drawing.
306.2.4	3-83	This revision reflects the release of the new EXJ-6-17 drawing.
306.3.4	3-86 through 3-87	The table in this section was revised to reflect the release of the new EXJ-6-17 drawing.
602.7	6-6	Note **[602.7-2]** specifying the use of sacrificial graffiti coatings has been retired.
702.6.2	7-5 through 7-6.2	Notes 702.6.2-1 & 702.6.2-3 previously referred to PSID-1-13 for the location of a construction joint for the top of the diaphragm. This location was accurate for prestressed I-beam superstructures, but for steel superstructures, the diaphragm construction joint shall be located at the approach slab seat elevation as shown in SICD-1-96. This revision corrects the notes for steel superstructures.
801	8-1	References to the Noise Wall Justification study which no longer exists have been removed.
ARN-14	Appendix - 8	Retired Note **[602.7-2]** was placed in the appendix.

E. In the existing structure block, provide a brief description of existing bridge. This should include type, length of spans and how measured (c/c of bearings, f/f of abutments), roadway width (t/t of barrier, t/t of curb, or f/f of railing), skew angle, original design loading or upgraded loading, type of deck and type of substructure, date when built, Structure File Number (SFN), approach slabs and wearing surface.

F. In the proposed structure block provide a brief description of proposed bridge. This should include type, length of spans and how measured (c/c of bearings), roadway width (t/t of barrier, t/t of curb, or f/f of railing), width of sidewalks, design loading, future wearing surface loading, skew angle, wearing surface, approach slabs, alignment, superelevation or crown and latitude and longitude bridge coordinates measured to the nearest 0.01 seconds.

G. A cross section of the proposed superstructure, including an elevation of the proposed pier type(s) if applicable.

H. The design and current average daily traffic (ADT) and the design average daily truck traffic (ADTT).

I. For each substructure unit where a bearing is to be used, the bearing condition (fixed or expansion) shall be designated in the profile view (FIX or EXP). Semi-integral substructures shall be designated as expansion (EXP) and integral shall be designated as integral (INT).

J. Horizontal and vertical clearances and their locations shall be provided for navigable waterway crossings.

K. A cross section sketch at the abutments shall be submitted to provide information to help verify bridge limits.

201.2.3 HYDROLOGY AND HYDRAULICS (H&H) REPORT

The Structure Type Study shall include a Hydrology and Hydraulics (H&H) Report. Refer to the ODOT Location and Design Manual, Volume 2, Section 1118.2 for more information.

aesthetically pleasing structure.

The spill-thru slope should intersect the face of abutment a minimum of one foot [300 mm], or as specified in a standard bridge drawing, below the bridge seat for stringer type bridges. For concrete slab and prestressed box beam bridges this distance should be 1'-6" [450 mm].

204.3 ABUTMENT TYPES

Preference should be given to the use of spill-thru type abutments. Generally for stub abutments on piling or drilled shafts the shortest distance from the surface of the embankment to the bottom of the toe of the footing should be at least 4'-0". For stub abutments on spread footing on soil, refer to BDM Section 202.2.3.1 for footing elevations. For any type of abutment, integral design shall be used where possible, see Section 205.8 for additional information.

Wall type abutments should be used only where site conditions dictate their use.

204.4 ABUTMENTS SUPPORTED ON MSE WALLS

When conditions are appropriate, the use of MSE walls to shorten bridge spans and eliminate embankment slopes is acceptable. MSE wall supported abutments shall be supported on piling regardless of the proximity of bedrock to the MSE wall foundation. The Department will not permit 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. The purpose for this provision is to reduce the potential for total pier failure in the event of an impact involving a large vehicle or its cargo. 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 an unsupported pile length of 20 feet [6 meters]. For unsupported pile lengths greater than 15 feet [4.5 meters], the designer should analyze the piles as columns above ground. Scour depths and the embedded depth to fixity of the driven piles shall be included in the determination of unsupported length.

B. Cap-and-column type piers.

C. Solid wall or T-type piers.

Note 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

Perform a wall justification in accordance with 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.

additional right-of-way, are exempt from Categorical Exclusion documentation, and require little or no public involvement. Minimal project types include: bridge painting, deck overlays, scupper installations, barrier facings, concrete sealing, partial depth concrete repairs, etc. Minimal projects do not require a preliminary design submission.

207 BRIDGE GEOMETRICS

207.1 VERTICAL CLEARANCE

The “Required Minimum” and “Actual Minimum” Vertical Clearances and their locations shall be shown on the Preliminary Structure Site Plan, Section 201.2.2. The “Actual Minimum” Vertical Clearance is the minimum overhead clearance provided by the design plans. For new grade separation structures, the “Required Minimum” Vertical Clearance shall not be less than the preferred clearance specified in ODOT’s Location and Design Manual, Figure 302-1 unless otherwise specified in the scope of services. A “Required Minimum” Vertical Clearance less than the L&D Manual minimum clearance will require a Design Exception in accordance with Section 105 of the L&D Manual.

207.2 BRIDGE SUPERSTRUCTURE

Bridge superstructure widths shall be established in accordance with ODOT's Location and Design Manual, Section 302, unless specified in the scope of services or other contract criteria.

207.3 LATERAL CLEARANCE

Divided highways having four or more lanes crossing under an intersecting highway shall be provided with a minimum lateral clearance of 30 feet [9000 mm] from the edge of traveled lane to the point where the 2:1 back slope intersects the radius at the toe of the 2:1 slope. Refer to ODOT's Location and Design Manual, Figure 307-2. To satisfy cost considerations or in order to maintain the typical roadway section (including roadway ditch) of the underpass through the structure, for four or more lane highways, wall abutments or the 2:1 slope of typical two-span grade separation structures may be located farther than 30 feet [9000 mm] from the near edge of traveled lane.

Lateral clearances for other roadway classifications shall be established in accordance with ODOT's Location and Design Manual, Section 302, unless specified in the scope of services or other contract criteria.

207.4 INTERFERENCE DUE TO EXISTING SUBSTRUCTURE

Where a new pier or abutment is placed at the location of an existing pier or abutment the usual

"Removal" note (and also the text of CMS 202.03) calls for sufficient removal of the old pier or abutment to permit construction of the new. However, a new pier or abutment preferably should not be located at an existing pier or abutment where the existing masonry may extend appreciably below the bottom of the proposed footing, or appreciably below the ground in case of capped-pile construction. This applies particularly where piles are to be driven. It is desirable to avoid the difficulty and expense of removing deep underground portions of the existing substructure and to avoid the resultant disturbance of the ground.

Where existing substructure units are shown on the Site Plan, the accuracy of the locations and extent should be carefully drawn. The existing substructure configuration should be shown based on existing plans or field verified dimensions, otherwise just a vertical line showing the approximate face of the abutment or pier widths should be shown. Misrepresentation of the location of the existing substructure units has resulted in expensive change orders during construction. Existing dimensions should be labeled as (+/-) plus or minus.

207.5 BRIDGE STRUCTURE, SKEW, CURVATURE AND SUPERELEVATION

During the Assessment of Feasible Alternatives, the location of the proposed structure should be studied to attempt to eliminate the presence of excessive skew, curves or extreme superelevation transitions within the actual bridge limits.

208 TEMPORARY SHORING

208.1 SUPPORT OF EXCAVATIONS

208.1.1 ESTIMATED QUANTITIES

Provide a pay item for Cofferdams and Excavation Bracing when either of the following conditions exist:

A. Excavation that extends below the ground water table or below an elevation defined as 3-ft above the Ordinary High Water Mark (see BDM Section 203.4 for more information).

B. Excavation of earth supporting:

    1. Structures/utilities when the structure/utility is located within a distance of 1½ times the depth of excavation. Designers shall consider the location of bridge substructures supported on shallow foundations but not substructures supported on deep foundations unless the excavation will expose the deep foundation members.

    2. Railroads when the excavation encroaches on foundation material defined by each railroad.

    3. Roadways used to maintain traffic when the edge line is located within a distance of one-half times the depth of excavation.

When a pay item for Cofferdams and Excavation Bracing is required for (B) above, show the approximate locations of the Excavation Bracing in the Plans.

208.1.2 EXCAVATION BRACING PLAN WARRANTS

Provide a complete design for Excavation Bracing in the Plans for each of the following conditions:

A. BDM Section 208.1.1.B.1

B. BDM Section 208.1.1.B.2

C. BDM Section 208.1.1.B.3 and the depth of any side of the excavation exceeds 8-ft

The designer shall consider the feasibility of this Excavation Bracing during the Structure Type Study.

208.1.3 DESIGN REQUIREMENTS

When warranted according to BDM Section 208.1.2, the design for Excavation Bracing shall be in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works and the latest edition of either the AASHTO LRFD Bridge Design Specifications or the AASHTO Standard Specifications for Highway Bridges. The design methodology may be in accordance with either Load and Resistance Factor Design or Allowable Stress Design.

As a minimum, provide the following information in the Plans:

A. Design methodology & governing specifications

B. Minimum section modulus (for sheet pile walls)

C. Top elevation and minimum bottom elevation

D. Limits of bracing

E. Sequence of installation and/or operations.

F. If bracing or tiebacks are required, provide all details, connections and member sizes

For projects involving railroads, the requirements will be different as each railroad company has their own specific requirements. The designer is responsible for contacting the responsible railroad and obtaining the specific requirements for design and construction.

208.1.4 DESIGN CONSIDERATIONS

Following are some conceptual ideas for the design of Excavation Bracing:

A. A cantilever sheet pile wall should generally be used for excavation up to approximately 12-ft in height.

B. For cuts greater than 12-ft in height, anchored or braced walls will generally be required.

C. Braced walls using waler and struts can sometimes be braced against another rigid element on the excavated side.

D. The use of steel “H” piles with lagging is also a practical solution for some sites. Please note that some railroad companies allow only interlocking steel sheet piling adjacent to their tracks.

E. Where sufficient embedment cannot be attained by driving sheet piling because of the location of shallow bedrock, predrilled holes into the bedrock with soldier “H” piles and lagging should be considered.

208.2 SUPPORT OF EXISTING STRUCTURE

Whenever temporary support is required for a portion of an existing structure used to maintain traffic, the Design Agency shall provide sufficient information in the plans to allow contractors to prepare bids and construct the project. The feasibility of temporary support of an existing structure should be considered and discussed during the Structure Type Study.

The design shown in the plans should include: permissible locations of temporary support; temporary support loads; construction sequences; construction limitations not otherwise provided in C&MS 501.05; and any remaining plan notes. As a minimum, the plan notes should address method of measurement and basis of payment for temporary support.

209 MISCELLANEOUS

209.1 TRANSVERSE DECK SECTION WITH SUPERELEVATION

If the change in cross slope at the superelevation break point is less than or equal to 7 percent, then no rounding is required. For changes greater than 7 percent the bridge deck surface profile shall be as follows:

A. When the roadway break point is located between roadway lanes (not at the edge of pavement) the bridge cross slope is to extend to the toe of parapet. See “CASE a” in Figure 209.1-1.

B. When the roadway break point is located at the edge of pavement (adjacent shoulder width is less than four feet [1.2 meters]), the bridge cross slope is to be continued past the break point to the toe of deflector parapet. See “CASE b” in Figure 209.1-1.

C. When the roadway break point is located at the edge of pavement (adjacent shoulder width is equal to or greater than four feet [1.2 meters] and less than eight feet [2.4 meters]), a four foot [1.2 meter] rounding distance from the edge of pavement onto the shoulder is used to transition from the bridge cross slope to the 0.5 in. per ft. [0.04] shoulder cross slope. See “CASE c” in Figure 209.1-2.

D. When the roadway break point is located at the edge of pavement (adjacent shoulder width is equal to or greater than eight feet [2.4 meters]), a five foot [1.5 meter] rounding distance designed to transfer all loads.

302 SUPERSTRUCTURE

302.1 GENERAL CONCRETE REQUIREMENTS

302.1.1 CONCRETE DESIGN STRENGTHS

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

A. Substructure Concrete (Class QC1)..4.0 ksi

B. Superstructure Concrete (Class QC2)..4.5 ksi

C. Drilled Shaft Concrete (Class QC4 or QC5)..4.0 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 441 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 Manual, Section 400 for application rates.

C. 6 inches [155 mm] cast-in-place composite deck - defined as the minimum thickness of

Concrete surfaces that include patches should be sealed with an epoxy-urethane sealer so the concrete color will remain uniform.

The designer should include in the plans actual details showing the position, location and area required to be sealed. A plan note should not be used to describe the location as there can be both description and interpretation problems.

The designer has the option to select a specific type of sealer, epoxy-urethane or non-epoxy. The designer may also use a bid item for sealer, with no preference, and allow the contractor to choose based on cost.

Due to poor performance, epoxy-only sealers shall not be used.

In areas where concrete surfaces have a history of graffiti vandalism, the designer may add a permanent graffiti coating meeting the requirements of Supplement 1083 on top of the epoxy-urethane or non-epoxy sealer. A plan note is available in BDM Section 600. The designer should limit the concrete surfaces that are treated with permanent graffiti coatings to those reachable by easy climbing and visible to the traveling public.

302.2 REINFORCED CONCRETE DECK ON LONGITUDINAL MEMBERS

302.2.1 DECK THICKNESS

For reinforced concrete decks on steel or concrete longitudinal members, the deck thickness shall be computed by the following formula:

Tmin (inches) = $(S + 17)(12) \div 36 \geq 8½''$

Tmin (mm) = $(S + 5200) \div 36 \geq 215$ mm

> Where: S is the effective span length in feet [millimeters] determined according to *LRFD 9.7.3.2*. Tmin shall be rounded up to the nearest one-quarter inch [5 mm].

The one inch [25 mm] wearing thickness, Section 302.1.3.1, is included in the minimum concrete deck thickness but should be excluded in the calculations for structural design of the deck slab.

302.2.2 CONCRETE DECK DESIGN

The concrete deck design shall be in conformance with the approximate elastic methods of analysis specified in the *AASHTO LRFD Bridge Design Specifications*, latest edition, and the additional requirements specified in this Manual. Refined methods of analysis and the empirical design method, *LRFD 9.7.2*, are prohibited. The design live load shall be HL-93 and the design dead load shall include an allowance for a future wearing surface equal to 0.06 k/ft^2.

Shrinkage and temperature reinforcement conforming to *LRFD 5.10.8* shall be placed in the underside of deck overhang with the minimum clear cover measured to the transverse steel.

Deck designs for superstructures with effective span lengths ranging from 7.0 ft. to 14.0 ft. in 0.5 ft. increments are provided in Figures 302.2.2-1, 302.2.2-2 and 302.2.2-3. These designs apply for the full length of the bridge and preclude the need for additional transverse reinforcement at supported deck ends. The design of overhang reinforcement is valid for BR-1-13, SBR-1-13, BR-2-15 and TST-1-99 barrier systems. A complete list of design assumptions is

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allowed. 7/8 inch [22 mm] diameter studs are recommended as a standard diameter. The length of stud specified should be checked with manufacturers as to availability.

The Department's policy of using a 2 inch [50 mm] deep haunch over the top flange will have an effect on the length of shear studs.

Shear studs shall be field installed. In the case of galvanized structures, the design plans shall allow shop installation of studs prior to galvanizing or field installation after removing the coating by grinding at each stud location. If the studs are shop installed, the Contractor will be responsible for meeting all applicable OSHA requirements. A Detail note is available in Section 700.

302.4.2 ROLLED BEAMS

302.4.2.1 GALVANIZED BEAM STRUCTURES

If a galvanized bridge structure is the selected structure type, the following problems should be recognized and dealt with by the designer.

Galvanizing tanks are shallow and normally not longer than 45 feet [13.7 meters] in length. Therefore, beam lengths should not be longer than 60 feet [18.5 meters]. Before a design is

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 - 4500 psi 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.

303 SUBSTRUCTURE

303.1 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE

Specifications for the sealer are defined in CMS 512. Concrete surfaces shall be sealed with a concrete sealer as follows:

A. The front face of abutment backwalls, from top to bridge seat, the bridge seat and the breastwall down to the groundline shall be sealed with an epoxy-urethane or non-epoxy sealer. (Note: Sealing of the backwall shall not be required on prestressed box beam bridges because the beams are installed before the backwall is placed.)

B. The exposed surfaces of all wingwalls and retaining walls, exclusive of abutment type, that are within 30 feet [10 000 mm] of any pavement edge shall be sealed with an epoxy-urethane sealer.

C. Ends and sides of piers exposed to traffic-induced deicer spray, from any direction, shall be sealed with either an epoxy-urethane or non-epoxy sealer. Top of pier caps need only be sealed if there is an expansion joint or the tops are subject to exposure to deicer-laden water.

D. The total vertical surface of piers which are adjacent to traffic lanes shall be sealed with either an epoxy-urethane or non-epoxy sealer. Structures with A588[M] weathering steel superstructures shall also have their piers sealed as stated above with either an epoxy-urethane or non-epoxy sealer.

The designer should include in the plans actual details showing the position, location and area required to be sealed. A plan note to describe the position should not be used as there can be both description and interpretation problems.

The designer has the option to select a specific type of sealer, epoxy-urethane or non-epoxy. The designer also has the alternative to just use a bid item for sealer, with no preference, and allows the contractor to choose based on cost.

See Figures 303.1-1, 303.1-2 & 303.1-3.

In areas where concrete surfaces have a history of graffiti vandalism, the designer may add a permanent graffiti coating meeting the requirements of Supplement 1083 on top of the epoxy-urethane or non-epoxy sealer. A plan note is available in BDM Section 600. The designer should limit the concrete surfaces that are treated with permanent graffiti coatings to those reachable by easy climbing and visible to the traveling public.

303.2 ABUTMENTS

303.2.1 GENERAL

Abutments should be provided with backwalls to protect the superstructure from contact with the approach fill and to assist in preventing water from reaching the bridge seat.

For members designed to retain earth embankments and restrained from deflecting freely at their tops, the computed backfill pressure shall be determined by using at-rest pressure. Examples include: rigid frame bridges, abutment walls keyed to the superstructure, and some types of U-abutments.

For abutment walls of structures designed without provision for expansion between superstructure and substructure and where an appreciable amount of superstructure expansion is anticipated, passive earth pressure should be considered in the design.

To allow for slight tilting of wall type abutments after the backfill has been placed, batter the

Pier 5 ~

52 - 14" C.I.P. Reinforced Concrete Piles

36 piles installed vertical & 16 piles battered

Ultimate Bearing Value = 270 kip

Estimated Length = 85 ft

Order Length = 90 ft (Total Length = 4680 ft)

The difference in Ultimate Bearing Value between piers 1, 2, 3 & 4 and pier 5 requires 1 dynamic testing item.

Forward Abutment ~

30 - 12" C.I.P. Reinforced Concrete Piles

20 piles installed vertical & 10 piles battered

Ultimate Bearing Value = 152 kip

Estimated Length = 75 ft

Order Length = 80 ft (Total Length = 2400 ft)

No additional dynamic load testing items are required.

For this example, the Designer should include notes **[606.2-1]**, **[606.2-4]** and **[606.2-5]** from Section 606.2 in the General Notes. Note **[606.2-1]** should be modified as follows:

PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value is 152 kip per pile for the rear and forward abutment piles. The Ultimate Bearing Value is 250 kip per pile for Pier 1, 2, 3, and 4 piles and 270 kip per pile for Pier 5 piles.

Abutment Piles:

30 piles 70 ft long, order length (Rear)

30 piles 80 ft long, order length (Forward)

1 dynamic load testing item

Pier 1, 2, 3, and 4 Piles:

320 piles 75 ft long, order length

1 static load test item

1 subsequent static load test item

4 dynamic load-testing items

4 restrike items

Pier 5 Piles:

52 piles 90 ft long, order length

1 dynamic load testing item

The Designer should provide the following items in the Estimated Quantities:

Item	**Extension**	**Total**	**Unit**	**Description**
506	11100	Lump	Sum	Static Load Test
506	12200	1	Each	Subsequent Static Load Test
507	00500	4200	ft	12" Cast-In-Place Reinforced Concrete Piles, Driven
507	00550	4500	ft	12" Cast-In-Place Reinforced Concrete Piles, Furnished
507	00600	26,820	ft	14" Cast-In-Place Reinforced Concrete Piles, Driven
507	00650	28,680	ft	14" Cast-In-Place Reinforced Concrete Piles, Furnished
523	20000	6	Each	Dynamic Load Testing
523	20500	4	Each	Restrike

303.4.3 DRILLED SHAFTS

When determining the structural capacity of drilled shafts, multiply the compressive strength provided by the concrete mix design by a factor of 0.9 [e.g. f'_c = 0.9 (4.5 ksi) = 4.0 ksi for Class QC5] for all limit states.

To allow for the misalignment of drilled shafts that support single pier columns, the shaft diameter shall be 6 in. [150 mm] larger than the column diameter. To allow for misalignment of shafts into footings, footing widths shall be at least 1’-0” [305 mm] larger than the shaft diameter.

The diameter of bedrock sockets for drilled shafts are generally 6 in. [150 mm] less than the diameter of the shaft above the bedrock elevation. This downsize provides sufficient room is the shaft for the rock core barrel. Reinforcing steel cages should be based on the bedrock socket diameter.

For un-cased or temporarily cased drilled shafts, the spiral reinforcement should be a #4 [#13M] bar with a 4½ in. [115 mm] pitch. (Note: the above requirement shall be met even if the 4½ in. [115 mm] pitch may not meet the spiral requirements of *LRFD 5.7.4.6*) For shaft diameters 4.0 ft. and less, the out-to-out spiral diameter shall be 6 in. [150 mm] less than the rock socket diameter. For shaft diameters greater than 4.0 ft., the out-to-out spiral diameter shall be 12 in. [300 mm] less than the rock socket diameter. When steel casing is left in place, the spiral reinforcing pitch shall be 12 in. [300 mm].

The minimum clear distance between longitudinal and lateral reinforcement shall not be less than 5 times the maximum aggregate size. Where heavy reinforcement is required, consideration may be given to an inner and outer reinforcing cage.

For record and project use, each drilled shaft for a structure shall be individually identified by a unique number. The designer may choose to number the drilled shafts on the individual

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Bridge Railing Testing Criteria	Acceptance Equivalencies					
NCHRP 350	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
NCHRP 230		MSL-1 MSL-2		MSL-3		
AASHTO Guide Specification		PL-1		PL-2	PL-3	

The AASHTO Guide Specification provides a Performance Level Selection Criteria for bridge railings that is considered an acceptable alternative to NCHRP Report 350 and may be used for railing designs on any project.

Section 304.2 of this Manual lists standard ODOT bridge railing types available along with the corresponding NCHRP 350 level of acceptability. For non-standard railing designs, a review submission, concurrent with the Structure Type Study, shall be made to the Office of Structural Engineering as stated in Section 201 of this Manual. The design of all non-standard railing systems shall be based on the NCHRP 350 or MASH level of acceptability. Designers may be required to submit actual crash test report data to verify the level of acceptability of a proposed design.

Modifications to the ODOT standard railing types or other NCHRP 350 or MASH approved railing system should be avoided. Additional structural steel tubing added to satisfy pedestrian concerns does not require additional crash testing provided these elements do not protrude nearer to the roadway than the rail elements on the tested design and they do not present any type of snagging potential to an impacting vehicle. If an accepted crash tested railing system is modified, the face geometry (i.e. offset, rail height, spacing, etc.) shall match the tested design and the static strength and deflections shall remain at least equal to the tested design. Include with the preliminary design submission to the Office of Structural Engineering, strength and deflection calculations to support these modifications. The calculations shall follow the procedure defined in the *AASHTO LRFD Bridge Design Specifications, Sections A13.1-3*. The intent of any modification shall be to maintain the original NCHRP 350 or MASH acceptability level.

All railing elements fabricated with ASTM A500 steel tubing shall specify a drop-weight tear test per CMS 707.10. Provisions shall be made at tube splices for expansion and contraction. Steel railing systems shall also allow for structural movement at expansion joints without adversely affecting the system's level of acceptability.

Aesthetically pleasing railing systems have been successfully crash tested but are for use only where TL-2 acceptability requirements are allowed. These systems include the Texas Classic Traffic Railing, Type T411 with open windows, a smooth stone masonry barrier with reinforced concrete core wall and an artificial stone precast concrete barrier. Detailed information regarding the latter two systems may be found in FHWA Report No. FHWA-RD-90-087 "Guardrail Testing Program: Final Report", June 1990 and FHWA Report No. FHWA-SA-91-051 "Summary Report on Selected Aesthetic Bridge Rails and Guardrails", June 1992.

The recommended railing design for bridges with combination vehicular and pedestrian traffic is detailed in Standard Bridge Drawing BR-2-15. Other designs are allowed as previously mentioned above, provided the following requirements are met:

A. The curb height shall be 8".

B. The sidewalk width shall be 5'-0" or greater.

A pedestrian railing may be used in lieu of a crash tested barrier at the deck edge provided a crash tested barrier system meeting the minimum requirements for the specific location is used to separate the vehicular and pedestrian traffic. Pedestrian railing shall be designed in accordance with AASHTO.

304.2 STANDARD RAILING TYPES

Drawing No.	Description	NCHRP Level
BR-1-13	36" New Jersey Shape Concrete Bridge Railing	TL-4
	42" New Jersey Shape Concrete Bridge Railing	TL-5
BR-2-15	Bridge Sidewalk Railing with Concrete Parapet	TL-4
DBR-2-73	Deep Beam Bridge Guardrail	TL-2
DBR-3-11	Deep Beam Bridge Retrofit Railing	TL-3
PCB-91	Portable Concrete Barrier (Fully Anchored)	TL-4
	Portable Concrete Barrier (Unanchored)	TL-3
SBR-1-13	42" Single Slope Concrete Bridge Railing	TL-5
SBR-2-13	57” Single Slope Concrete Median	TL-5
TST-1-99	Twin Steel Tube Bridge Railing	TL-4

304.3 WHEN TO USE

304.3.1 PARAPET TYPE (BR-1-13, SBR-1-13 & SBR-2-13)

The Department currently has three (3) standard concrete parapet type bridge railing systems for

On projects where maintaining minimum lane widths during a construction phase is not possible due to limited bridge width, the use of a top mounted steel post and tubular steel rail system, similar to the Twin Steel Tube bridge guardrail, may be justified. The railing, post and anchorage designs of these systems are to be in accordance with the *AASHTO LRFD Bridge Design Specifications, Sections A13.1-3*.

304.3.5 BRIDGE SIDEWALK RAILING WITH CONCRETE PARAPETS (BR-2-15)

This railing system is for use on bridges with sidewalks at least 5'-0" wide and a curb height of 8 inches. Although this system is essentially a combination railing system, it may also be used without a sidewalk in applications where pedestrian traffic is not a concern.

Where Vandal Protection Fencing is required, the fencing shall be installed behind the steel tubing as shown in Figure 305.3-2. However, the steel tubing may be omitted if the concrete parapet height is 32" or greater. See Figure 305.3-1. If the tubing is omitted, the fencing should extend the full length of the concrete parapet and the additional 18" parapet height at each end, as detailed in the standard, is not required.

The concrete parapet shall be designed and detailed as follows:

A. All horizontal reinforcing steel shall be detailed as continuous for the total length of the structure.

B. Crack control joints shall be sawed into the concrete parapets. The distance between the saw-cut joints on the structure shall be between 6'-0" and 10'-0". The detailed locations of the crack control joints and vertical reinforcing bars shall be shown in the contract plans.

C. The saw-cut crack control joint shall be detailed as 1 ¼ inch deep and shall be filled with a polyurethane or polymeric material conforming to ASTM C920, Type S. The bottom one-half inch of both the inside and outside face shall be left unsealed to allow any water that enters the joint to escape. This requirement is established in the Standard Bridge Drawing; however, a plan note is required for special designs. See Section 600.

305 FENCING

305.1 GENERAL

The primary purposes of protective fencing are to provide for the security of pedestrians and to discourage the throwing or dropping of objects from bridges onto traffic below.

The Vandal Protection Fencing Standard Bridge Drawing provides standard details for fencing attached to bridges. The designer may need to enhance this standard to deal with requirements for the specific structure.

305.2 WHEN TO USE

Fencing shall be installed on all bridges over vehicular traffic except as noted herein. Fencing shall be installed on bridges over rail traffic if required in an agreement with the affected railroad. Bridges that carry vehicular traffic over county/township routes shall be exempt from fencing. For existing bridges, fencing shall be provided when new concrete or refaced concrete barriers are installed. At locations where fencing will adversely affect public safety (e.g. reduced sight distance), submit a written request for exemption to the Deputy Director Engineering. The request for exemption shall include supporting documentation.

Under Bridge Feature	**Fence Required**
Interstate	Yes
US Route	Yes
State Route	Yes
County/Township Route	No *
City Route	Yes
Railroad	Yes/No (Based on RR agreement)
Waterway	No
* – Bridges carrying only pedestrian/bicycle traffic shall have vandal protective fencing.	

305.3 FENCING CONFIGURATIONS

For structures without sidewalks, the top of fence shall be a minimum height of 8-ft above the pavement surface. For structures with sidewalks, the top of fence shall be a minimum height of 8-ft above the sidewalk. For a greater degree of protection against objects being thrown from the bridge, the fence may be curved to overhang the sidewalk. For curved fence the posts shall be vertical for at least 8-ft above the sidewalk before curving inward over the sidewalk. The overhang shall be at least 1-ft less than the width of the sidewalk. See Figures 305.3-1 & 305.3-2.

For pedestrian bridges, use bent pipe frames with pipe bend radii of 24" at the upper corners and the start of the radii about 8-ft above the sidewalk surface. The fabric shall start at the deck line, top of curb or parapet and may stop at the upper end of the bent portion of the frame. Fabric on the top horizontal area of the frame is not required to prevent an individual from walking on the top of the enclosure. See Figure 0-3 for an illustration of this configuration. Alternatively, the frame may be designed to form a peak at the center of the structure, similar to a house roofline.

The maximum gap at the bottom of the fence shall be 1-in. A detail to close the bottom of a fencing section is included on the standard bridge drawing.

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306.1.1 PAY ITEM

Expansion devices, except as specifically listed in this section, shall be paid for as Item 516.

For sealed expansion devices the elastomeric seal, either strip or compression, shall be included in the pay Item 516.

The plans shall clearly show what components are included with the expansion devices, Item 516. As an example, cross frames, which are field welded to both the superstructure girders and the expansion devices, are part of the 513 structural steel item. The seal is considered part of the expansion device and should be included in the 516 pay item.

306.1.2 EXPANSION DEVICES WITH SIDEWALKS

On structures with sidewalks, the expansion devices shall be the same type as furnished for main bridge deck expansion joint.

Sidewalk details for standard expansion devices (strip seals) are shown on the standards. For non-standard devices, a curb plate and sidewalk cover plate will be required. The Curb and sidewalk plates should be separated at the interface of the sidewalk and curb. See details on Standard Bride Drawings: EXJ-2-81, EXJ-3-82, EXJ-4-87, EXJ-5-93 and EXJ-6-17 for sidewalk plates.

306.1.3 EXPANSION DEVICES WITH STAGE CONSTRUCTION

On projects involving stage construction, joints in the seal armor must be located and shown in the plans. At the stage construction lines, expansion devices should require complete penetration welded butt joints. If butt welds will be in contact with a sealing gland the butt-welded joint shall be ground flush at the contact area.

306.2 EXPANSION DEVICE TYPES

306.2.1 ABUTMENT JOINTS IN BITUMINOUS CONCRETE, BOX BEAM BRIDGES

This poured joint seal system is capable of small expansion movements, up to 3/16". Refer to AS-1-15 Sheet 2, Detail A. This joint system requires including the following bid item in the structure estimated quantities: Item 409 - Sawing and Sealing Bituminous Concrete Joints.

306.2.2 ABUTMENT JOINTS AS PER AS-1-15

A group of no or small movement joints used for sealing and rotational purposes are detailed on Standard Bridge Drawing, AS-1-15.

306.2.3 EXPANSION JOINTS USING POLYMER MODIFIED ASPHALT BINDER

This device is for use on structures with concrete or asphalt overlays and where total expected movement is 0 to 1½". The Department has a Supplemental Specification for the Polymer Modified Asphalt Expansion Joint System.

Thickness of the polymer-modified joint shall be between 2" and 5”. The design plans shall show a plan view and cross-section of each polymer modified asphalt expansion joint location on the bridge. The plan view shall provide the station of the joint centerline at the centerline of construction, skew angle and dimension its length as measured along the centerline of the joint. The cross-section shall dimension the width and thickness of the joint, width of the expansion gap and other significant joint details.

306.2.4 STRIP SEAL EXPANSION DEVICES

The seal size is limited to a 5" [125 mm] maximum. Unpainted A588[M] weathering steel should not be used in the manufacture of this type expansion device as A588[M] does not perform well in the atmospheric conditions an expansion device is subjected to. Standard Bridge Drawings, EXJ-4-87, EXJ-5-93 and EXJ-6-17, are available. The designer must ensure that all details are covered in the plans because the standard drawing is not inclusive for all structure types.

The strip seal shall be of one piece across the total width of the structure. No splices will be acceptable.

306.2.5 COMPRESSION SEAL EXPANSION DEVICES

Maximum allowable seal size is 4" [100 mm]. A 5" [125 mm] wide seal shall not be used since installation problems have been encountered. Compression seal expansion devices are limited to structures with a maximum skew of 15 degrees. Movement should be limited so that the seal is not compressed greater than 60 percent or less than 20 percent.

The compression seal shall be of one piece across the total width of the structure. No splices will be acceptable. Standard Bridge Drawings EXJ-2-81 & EXJ-3-82 give generally used details.

306.2.6 STEEL SLIDING PLATE ENDDAMS, RETIRED STANDARD DRAWING SD-1-69

In general steel sliding plate enddams are not recommended for new structures. This expansion device is limited to total movement of 4" [100 mm], including movement in both directions.

Expansion Length (ft)	Expansion Length (m)	Joint Required	Approach Slab Joint
0 - 40	0 - 12	None	AS-1-15 detail B or C
40 - 225	12 - 65	PM (1) or EXJ-6-17	AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-6-17	AS-1-15 detail B or C
500 +	150 +	TTED or MED	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

TTED = Tooth Type expansion device

MED = Modular Expansion Device

(1) = Stringer bridges with sidewalks should not use polymer modified expansion joint systems

306.3.5 NON-COMPOSITE PRESTRESSED BOX BEAM BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required (2)	Approach Slab Joint
0 - 40	0 - 12		AS-1-15 detail A
40 - 225	12 - 65	PM (1) or EXJ-5-93	AS-1-15 detail E AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-5-93	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

(1) = Bridges with sidewalks should not use polymer modified expansion joint systems

(2) = Joint requirements are for rigid or fixed abutments. For flexible abutments requiring no expansion movement a PM joint is recommended except for (1).

306.3.6 COMPOSITE PRESTRESSED CONCRETE BOX BEAM BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required (2)	Approach Slab Joint
0 - 40	0 - 12	PM	AS-1-15 detail D or F
40 - 225	12 - 65	PM (1) or EXJ-5-93	AS-1-15 detail D or F AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-5-93	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

(1) = Bridges with sidewalks should not use polymer modified expansion joint systems

(2) = Joint requirements are for rigid or fixed abutments. For flexible abutments requiring no expansion movement a PM joint is recommended except for (1).

306.3.7 ALL TIMBER STRUCTURES

No allowance for temperature need be made.

307 BEARINGS

307.1 GENERAL

The Department's policy is, whenever possible, use laminated elastomeric bearings.

Justification, including design calculations showing elastomeric bearings will not be adequate for the structure, must be available.

When specialized bearings, such as pot, disc or spherical, are required, detail notes shall be included in the contract plans. A plan note for pot bearings is provided in the appendix and may require modification by the designer based on the specific structure. If a cost evaluation shows that either spherical or disc bearings could be competitive against pot bearings, those bearings should be included in the plans and special notes developed.

For specialized bearings, the designer's detail plan notes shall require the contractor to coordinate the required substructure bearing seat elevations or dimensions with the selected bearing manufacturer. A note is available in Section 700.

307.2 BEARING TYPES

307.2.1 ELASTOMERIC BEARINGS

Refer to S*14.7.5* for additional design requirements.

[602.3-2] DESIGN DATA:

Concrete for prestressed beams:

Compressive Strength (final) - __(1)__ ksi

Compressive Strength (release) - __(2)__ ksi

Welded Wire Fabric:

Yield Strength – 70 ksi (4)

Prestressing strand:

Area = __(3)__ in^2

Ultimate Strength = 270 ksi

Initial stress = 202.5 ksi (Low relaxation strands)

NOTE TO DESIGNER:

(1) Specify 28-day compressive strength from the following range: 5.5 – 7.0 ksi

(2) Specify compressive strength at release from the following range: 4.0 – 5.0 ksi

(3) Specify prestressing strand area from the following: 0.153 in^2, 0.167 in^2, or 0.217 in^2

(4) Reference to Welded Wire Fabric applies to I-beams only.

602.4 FOR RAILWAY PROJECTS

For structures carrying railroad traffic, provide notes **[602.3-1]; [602.3-2]** (if necessary); and the following notes on the project plans:

[602.4-1] 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. *

NOTE TO DESIGNER: Note **[601.3-2]** may be required if special criteria or distributions have been used for the design of this rail structure. See **[601.3-2]** and determine if a modified note is required for inclusion. Fill-in items above marked "*" with current edition and latest interims.

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

[602.4-2] DESIGN LOADING: Cooper E-80 with diesel impact

602.5 DECK PROTECTION METHOD

If any of the following deck protection methods have been specified in the plans, include the following note, modified as necessary for the specific structure, in the Design Data section of the Structure General Notes:

[602.5-1] DECK PROTECTION METHOD:

Epoxy coated reinforcing steel

2½” concrete cover

Superplasticized dense, Micro-silica, Epoxy, or Latex modified concrete overlay

Waterproofing and asphalt concrete overlay

Steel drip strip

Other (Specify)

602.6 MONOLITHIC WEARING SURFACE

Furnish the following note for concrete bridge decks.

[602.6-1] MONOLITHIC WEARING SURFACE is assumed, for design purposes, to be 1 inch thick.

602.7 SEALING OF CONCRETE SURFACES

Use the following notes when permanent anti-graffiti coatings are required:

[602.7-1] ITEM 512 SEALING OF CONCRETE SURFACES, AS PER PLAN, (PERMANENT GRAFFITI PROTECTION):
Apply a permanent graffiti coating qualified according to Supplement 1083 that is compatible with the concrete sealer over which it is applied. Apply the graffiti coating in accordance with the manufacturer’s printed instructions.

Description of Superstructure	Note
No phased construction, and Steel superstructures with skew < 30º, or I-beam superstructure with skew < 10º	702.6.2-1
No phased construction, and Steel superstructures with skew ≥ 30º, or I-beam superstructure with skew ≥ 10º	702.6.2-2
Phased construction with closure pour, and Steel superstructures with skew < 30º, or I-beam superstructure with skew < 10º	702.6.2-3
Phased construction with closure pour, and Steel superstructures with skew ≥ 30º, or I-beam superstructure with skew ≥ 10º	702.6.2-4
Phased construction without closure pour, and Steel superstructures with skew < 30º, or I-beam superstructure with skew < 10º	702.6.2-5
Phased construction without closure pour, and Steel superstructures with skew ≥ 30º, or I-beam superstructure with skew ≥ 10º	702.6.2-6

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.

Use the following notes as prescribed in the table above:

[702.6.2-1] 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 a horizontal construction joint in the diaphragm as shown on PSID-1-13, sheet 7 of 10 for prestressed I-beam superstructures or as shown on SICD-1-96 for steel superstructures and place remaining diaphragm concrete with the deck.

[702.6.2-2] 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.

NOTE TO DESIGNER: (Applies only to [702.6.2-2])

Locate the deck construction joint parallel to the centerline of the abutment offset 1-ft from the face of the diaphragm toward the span.

[702.6.2-3] 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 a horizontal construction joint in the diaphragm as shown on PSID-1-13, sheet 7 of 10 for prestressed I-beam superstructures or as shown on SICD-1-96 for steel superstructures and place remaining diaphragm concrete with the deck. Place closure pour concrete in the diaphragm and deck concurrently.

NOTE TO DESIGNER: (Applies only to [702.6.2-3])

If a closure pour is required in the deck per BDM Section 302.2.9, provide a closure pour in the diaphragm as well. Locate the closure pour in the diaphragm, as near as practical, to mid-bay and orient the vertical construction joints parallel to the centerline of the adjacent beam/girders. Provide 3-in chamfers at the acute corners.

[702.6.2-4] ABUTMENT DIAPHRAGM CONCRETE, PHASED CONSTRUCTION: Place the diaphragm concrete encasing the structural member ends of an individual phase 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. Place closure pour concrete in the diaphragm and deck concurrently.

NOTE TO DESIGNER: (Applies only to [702.6.2-4])

If a closure pour is required in the deck per BDM Section 302.2.9, provide a closure pour in the diaphragm as well. Locate the closure pour in the diaphragm, as near as practical, to mid-bay and orient the vertical construction joints parallel to the centerline of the adjacent beam/girders. Locate the deck construction joint parallel to the centerline of the abutment offset 1-ft from the face of the diaphragm toward the span. Provide 3-in chamfers at the acute corners.

[702.6.2-5] ABUTMENT DIAPHRAGM CONCRETE, PHASED CONSTRUCTION: Place the diaphragm concrete encasing the structural member ends of an individual phase with the deck concrete.

NOTE TO DESIGNER: (Applies only to [702.6.2-5])

Do not use this note where a deck closure pour is required per BDM Section 302.2.9.

[702.6.2-6] ABUTMENT DIAPHRAGM CONCRETE, PHASED CONSTRUCTION: Place the diaphragm concrete encasing the structural member ends of an individual phase 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.

NOTE TO DESIGNER: (Applies only to [702.6.2-6])

Do not use this note where a deck closure pour is required per BDM Section 302.2.9. Locate the deck construction joint parallel to the centerline of the abutment offset 1-ft from the face of the diaphragm toward the span.

702.7 CONCRETE DECK SLAB DEPTH AND PAY QUANTITIES

For all steel beam and girder bridges with a concrete deck, provide the following note that

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SECTION 800 – NOISE BARRIERS

801 INTRODUCTION

When noise barriers are necessary, the Office of Environmental Services will furnish the required noise barrier height, length and location(s). The detail design for noise barriers shall be included in the Stage 2 Detailed Design Review Submission.

Design specifications for ground mounted precast concrete noise barrier walls are provided in Standard Bridge Drawing NBS-1-09. Associated designer notes are provided in Design Data Sheet NBSDD-1-09. The Department occasionally permits the use of noise barrier walls consisting of material types other than precast concrete. These wall types are pre-approved according to the requirements of the Department's Standard Procedure 27-005(SP) for new products and this Manual. Alternate noise barrier material types currently approved include: metal; fiberglass; brick or masonry; and acrylic. A complete listing of approved noise barrier suppliers for material types other than precast concrete are provided in Figures 801-1 and 801-2.

802 DESIGN CONSIDERATIONS

802.1 NOISE BARRIER FOUNDATIONS

802.1.1 GENERAL

The Design Agency shall perform a subsurface investigation at all noise barrier locations. The subsurface work shall be in accordance with the most current revision of the ODOT Specifications for Geotechnical Explorations. The noise barrier borings shall be included in the plans with the soil profile/foundation investigation sheets.

The standard foundation for noise barrier walls is a 30-inch diameter drilled shaft with a maximum length of 30-ft. Consult the Office of Structural Engineering when specifying longer or larger diameter drilled shafts.

In regions of poor soils or where obstructions (e.g. underground utilities, drainage facilities, mse wall components, etc.) preclude the use of 30-inch diameter drilled shafts as the appropriate foundation type, consult the Office of Structural Engineering for the use of an alternate foundation type (e.g. larger diameter drilled shafts, spread footings, etc.). If bedrock is anticipated within the drilled shaft length required by BDM Section 802.1.2 and the bedrock has an unconfined compressive strength of 7500 psi or better, provide the required shaft length or a reduced length with a 3-ft minimum length rock socket. For weaker bedrock, provide the required shaft length or a reduced length with a 5-ft minimum length rock socket.

802.1.2 DRILLED SHAFT DESIGN

The following foundation design procedure applies to only 30-inch diameter drilled shafts. For shafts of other diameter or for design parameters that exceed those herein, the foundation shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications, Section 10.

A. At each noise barrier boring location determine the SPT "N" blow counts from 2.5-ft to 25-ft in 2.5-ft increments. The SPT "N"-value is the total number of blows required to drive the sampler from 6" to 12" and from 12" to 18".

B. Correct the N-values for hammer efficiency and depth. Use the following depth correction factors:

Depth (ft.)	Correction Factor	Depth (ft.)	Correction Factor
2.5	1.6	15.0	1.0
5.0	1.4	17.5	0.96
7.5	1.2	20.0	0.91
10.0	1.1	22.5	0.88
12.5	1.1	25.0	0.84

C. The final design "N"-value used to establish the required minimum shaft length should be based on either average or lowest corrected "N"-values as follows. When the corrected "N"-values are consistent with depth or when the corrected values increase with depth, the final design "N"-value shall be the average of the corrected values along the length of drilled shaft. Otherwise, the final design "N"-value shall be the lowest corrected value along the length of the drilled shaft. The following examples assumes a drilled shaft with a design length of 15-ft.

Depth (ft.)	Corrected "N"-value	
5	8	
10	15	
15	16	Design "N" = (8+15+16)/3=13
20	25	
25	30	

Depth (ft.)	Corrected "N"-value	
5	16	
10	8	
15	15	Design "N" = 8
20	25	
25	30	

D. Establish the soil type as granular or cohesive at each boring. Soil should be considered granular when the plasticity index is less than 7.

E. Select the Granular Soil Foundation Depth Table (Figure 802.1.2-1) or the Cohesive Soil Foundation Depth Table (Figure 802.1.2-2) to determine the required drilled shaft length for the assumed post spacing and wall height at each boring location. Refer to the Design Data

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

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 **[606.2-5]** was retired when the information was added to C&MS 507.05.

ARN-12 RETIRED NOTE 605.5-1

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

[605.5-1] PROPRIETARY RETAINING WALL DATA:

The proprietary wall supplier shall design the internal stability of a mechanically stabilized earth (MSE) wall in accordance with SS840 to support loads from the abutment provided in the table below. All loads in the table are nominal (i.e. unfactored) applied to the reinforced soil mass at the base of the concrete footing. The loads in the table do not include earth pressure loads from the abutment backfill. However, the proprietary wall supplier shall include earth pressure loads from the abutment backfill in the design calculations. Refer to AASHTO LRFD Bridge Design Specifications, Section 3, for load definitions.

Wall Location	DC (k/ft)	DW (k/ft)	LL (k/ft)	PL (k/ft)	FR (k/ft)
#1					
#2					
#3					

HISTORY: Note **[605.5-1]** was retired because spread footings were no longer permitted to be used for MSE wall supported abutments.

ARN-13 RETIRED NOTE 610.3-1

Include the following note in the Structural General Notes when a concrete parapet or railing is used and standard drawings do not cover the below requirements.

[610.3-1] CONCRETE PARAPETS: As soon as a concrete saw can be operated without damaging the freshly placed concrete, sawcut 1 1/4" deep control joints into the perimeter of the concrete parapet starting and ending at the elevation of the concrete deck. Place the sawcuts at a minimum of 6 feet and a maximum of 10 feet centers. 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. Seal the perimeter of the deflection control joint to a minimum depth of 1 inch with a polyurethane or polymeric material conforming to ASTM C920, Type S. Leave the bottom ½ inch of the inside and outside face unsealed to allow water to escape.

HISTORY: Note **[610.3-1]** was retired with the release of BR-1-13, SBR-1-13 and SBR-2-13.

ARN-14 RETIRED NOTE 602.7-2

Use the following notes when sacrificial anti-graffiti coatings are required:

[602.7-2] ITEM 512 SEALING OF CONCRETE SURFACES, AS PER PLAN, (SACRIFICIAL GRAFFITI PROTECTION):
Apply a permanent graffiti coating qualified according to Supplement 1083 that is compatible with the concrete sealer over which it is applied. Apply the graffiti coating in accordance with the manufacturer's printed instructions.

HISTORY: Note **[602.7-2]** was retired due to the poor performance of the sacrificial graffiti coatings**.**