OHIO DEPARTMENT OF TRANSPORTATION

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

July 18, 2014

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: 2014 Third Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, July 2007. These revisions shall be implemented on all Department projects begin Stage 2 plan development date after July 18, 2014. 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	2-1	The hydraulic report of the Structure Type Study has been renamed Hydrology & Hydraulics (H&H) Report. Refer to the ODOT Location and Design Manual, Volume 2, Section 1118.2 for more information.
201.2.3	2-4 through 2-6	In January 2013, the ODOT Location and Design Manual, Volume 2 incorporated bridge hydraulics. To avoid redundant or conflicting information, the content of this section has been removed from the BDM.
201.2.6	2-6	Due to the relocation of bridge hydraulics noted above, reference to the scour evaluation has been updated.
202.2.3	2-10 through 2-11	This information was previously included in BDM Section 203.3 – Scour which was relocated as noted below.
202.2.3.1	2-11 through 2-11.2	This information was previously included in BDM Section 203.3 – Scour which was relocated as noted below.
203.1	2-20	This information was relocated to the ODOT Location and Design Manual, Volume 2, Section 1003.
203.2	2-21 through 2-22	This information was relocated to various sections of the ODOT Location and Design Manual, Volume 2.
203.3	2-22 through 2-23	Except as noted above in 202.2.3 and 202.2.3.1, this information was relocated to various sections of the ODOT Location and Design Manual, Volume 2.
203.5	2-24.1	The reference to the use of the USGS web based application StreamStats was updated to the L&D Vol. 2.
209.3	2-39	Erosion control at bridge ends has been relocated to the ODOT Location and Design Manual, Volume 2, Section 1113.1. Reference to new BDM Figure 209.3-1 for barrier placement for surface drainage at MSE wall supported abutments has been added.

BDM Section	Affected Pages	Revision Description
209.7.2	2-42 through 2-42.1	The policy of adding lettering and logos to ODOT bridges and noise walls has clarified which ODOT Divisions and Offices are responsible for Department approval. Additional guidelines have also been provided.
209.9	2-43	The pay item for asphalt has been updated to Item 441.
209.10	2-44	The pay item for asphalt has been updated to Item 441.
Figure 201.2.3-1		This Figure has been retired and the information was relocated to the ODOT Location and Design Manual, Volume 2, Section 1118.2.1.
Figure 203.2-1		This Figure has been relocated to the ODOT Location and Design Manual, Volume 2, Figure 1006-1.
Figure 209.3-1		This new Figure clarifies the provisions of BDM Section 209.3 regarding control of surface drainage at MSE walls.
302.1.3.1	3-10	The pay item for asphalt has been updated to Item 441. Reference to the ODOT Pavement Design Manual was also updated.
302.5.1.4	3-39	The pay item for asphalt has been updated to Item 441.
303.2.2.7	3-54 through 3-54.2	The “Bearing Retainer” details have been removed from SICD-1-96 due to poor performance. The replacement for the retainers is the “Diaphragm Guide” as specified in the new Standard Bridge Drawing, SICD-2-14. Information has been introduced in this section of the BDM to aid designers in specifying the new Diaphragm Guides.
502.1	5-1	This information was relocated to the ODOT Location and Design Manual, Volume 2, Section 1011.
606.1	6-11 through 6-14	Dynamic pile testing for piles to bedrock has been removed. Refusal on bedrock has been clarified to avoid over-driving.
702.10	7-10	The pay item for asphalt has been updated to Item 441.
1002 S*2.5.2.3*	10-4 through 10-5	A clarification has been added to this section that requires the jacking forces and locations to be shown for the high load multi-rotational bearing types.
1003 S*3.10.9.2*	10-8	The reference to “Bearing Retainers” has been revised to reflect the changes noted in BDM Section 303.2.2.7 above.

SECTION 200 - PRELIMINARY DESIGN

201 STRUCTURE TYPE STUDY

201.1 GENERAL

In conformance with Section 1400 of the ODOT Location and Design Manual, Volume Three, a Structure Type Study shall be included in the Preferred Alternative Verification Review Submission for a Major Project or in the Minor Project Preliminary Engineering Study Review Submission. The Structure Type Study is not required for projects classified as Minimal.

The project site should be studied in detail and evaluated to determine the best structure alternative. A site visit should be made. In many cases, it can be readily determined whether a particular bridge or culvert should be chosen for a particular site. If a bridge is the most appropriate structure for a particular site, then the Structure Type Study needs to be performed to determine the appropriate bridge type.

201.2 STRUCTURE TYPE STUDY SUBMISSION REQUIREMENTS

A Structure Type Study submission should include the following:

A. Profile for each bridge alternative..Section 201.2.1

B. Preliminary Structure Site Plan (for preferred bridge alternative)......................Section 201.2.2

C. Hydrology & Hydraulics (H&H) Report ....Section 201.2.3

D. Narrative of Bridge Alternatives...Section 201.2.4

E. Cost Analysis ....Section 201.2.5

F. Foundation Recommendation ....Section 201.2.6

G. Preliminary Maintenance of Traffic Plan ....Section 201.2.7

The Structure Type Study shall be included in the review submission made directly to the District Office. A concurrent review submission shall be made to the Office of Structural Engineering if the proposed structure type contains non-standard bridge railing types, non-redundant designs, or fracture critical designs. The Office of Structural Engineering will forward review comments for these items to the responsible District Office.

Additional structural related items that are required at this stage of the review process include:

A. Retaining Wall Justification (L&D Section 1404.2)

B. Noise Wall Justification (ODOT Policy #21-001 and Procedure #417-001)

C. Pedestrian Overpass Justification (L&D Section 1404.4)

201.2.1 PROFILE FOR EACH BRIDGE ALTERNATIVE

The profile for each bridge alternative considered shall generally be drawn to a scale of 1”=20’ [1 to 200] and shall generally be taken along the proposed centerline of survey for the full length of the bridge. The profiles shall include: the existing and proposed profile grade lines; existing ground line; the cross-section of channel; an outline of the structure; highest known high water mark; normal water elevation; Ordinary High Water Mark (OHWM); flow line elevation (thalweg); design and 100 year highwater elevations including backwater; overtopping flood elevation and frequency; existing and proposed profile grade elevations at 25 ft [10 m] increments; and minimum and required vertical and horizontal clearances. Note: normal water elevation is the water elevation in the stream which has not been affected by a recent heavy rain runoff and could be found in the stream most of the year. Refer to BDM Section 203.4 for OHWM definition.

201.2.2 PRELIMINARY STRUCTURE SITE PLAN

The Site Plan scale generally should be 1” = 20’ [1 to 200]. For some cases to get the entire bridge on one sheet a smaller scale may be provided, if all details can be clearly shown. For bridges where the 1” = 20’ [1 to 200] scale is too small to clearly show the Site Plan details, a 1” = 10’ [1 to 100] scale may be considered. The following general information should be shown on the Preliminary Structure Site Plan:

A. The plan view should show the existing structures (use dashed lines); contours at 2 foot [0.5 meter] intervals showing the existing surface of the ground (for steep slopes contours at 5 foot [2.0 meter] or greater intervals may be used); existing utility lines and their disposition; proposed structure; proposed temporary bridge; proposed channel improvements; a north arrow; and other pertinent features concerning the existing topography and proposed work in an assembled form.

   In case of a highway grade separation or a highway-railway grade separation, the required minimum and actual minimum horizontal and vertical clearances and their locations shall be shown in the plan and profile views.

   For a bridge over a railway, the vertical clearance shall be measured from a point level with the top of the highest rail and 6 feet [2 meters] from the centerline of those tracks, or greater if specified by the individual railroad. Reference shall be made to Chapter 15, Section 1.2.6(a), AREMA Specifications for increased lateral clearances required when tracks are on a horizontal curve.

B. A profile as described in Section 201.2.1. The profile scale shall be the same as the plan view.

C. Horizontal and vertical curve data.

D. Size of drainage area. The elevation, discharge and stream velocity through the structure and the backwater elevation for the 100-year frequency base flood, the design year flood and if necessary the overtopping flood. The clearance from the lowest elevation of the bottom of the superstructure to the design year water surface elevation (freeboard) should be provided.

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.

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.

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201.2.4 NARRATIVE OF BRIDGE ALTERNATIVES

The Structure Type Study shall include a brief narrative identifying the structure alternatives and their costs. The narrative should provide insight into why the particular proposed structure was chosen. Factors that need to be considered in selecting a structure for a particular site include geometry, economics, maintainability, constructability, right-of-way constraints, disruption to the traveling public, waterway crossing requirements or grade separations requirements, clearances for railway and highway crossings, foundation considerations, historical and environmental concerns, debris and ice flow problems and appearance.

201.2.5 COST ANALYSIS

The Structure Type Study shall include a cost analysis comparing alternative structures shall be performed, unless the site conditions discourage the use of all but one type of structure. The cost analysis should include the initial construction cost and all major future rehabilitation and maintenance costs, converted to present dollars. Sufficient preliminary design must be performed for an accurate cost estimate. Cost data information may be obtained from "Summary of Contracts Awarded". This publication is available from the Office of Contracts.

201.2.6 FOUNDATION RECOMMENDATION

The Structure Type Study shall include a Foundation Recommendation that consists of:

A. General foundation type (i.e. Drilled Shafts, Friction Piles, Bearing Piles or Spread Footings)

B. Preliminary estimates of nominal and factored resistances

C. Boring plan and boring logs

The boring plan and boring logs should be prepared in accordance with the Specifications for Geotechnical Explorations.

For the scour evaluation, performed in accordance with the L&D Vol. 2, provide D_{50} values from the particle size analysis.

vertical clearance; treatment of slopes around the ends and under the bridge; channel changes; soil boring locations; centerline of temporary structure and temporary approach pavement; stationing of bridge limits (i.e. the bridge ends of approach slabs); limits of channel excavation shown by crosshatching with a description provided in a legend; the location and description of bench marks; the following earthwork note: "EARTHWORK limits shown are approximate. Actual slopes shall conform to plan cross sections."; and guardrail stationing.

When providing guardrail stationing: for bridges with twin steel tube bridge railing, station the first top mounted post on the bridge, for bridges with deep beam railing and concrete barrier railing, station the first guardrail post off the bridge. Typically stationing should be given to the nearest 1/100th of a foot [mm]. Guardrail stationing may be changed during the detail design phase and then revised on the Site Plan.

In addition to the requirements of Section 201.2.2, the Final Structure Site Plan should show the following information in the profile view: profile gradient percent; embankment slopes and top of slope elevations; proposed footing elevations; type of foundations; top of bedrock elevations at each boring location; and shaded areas of the bridge that represent the new bridge components.

For geometrical clarification: spans on straight (tangent) alignments should be measured from center to center of bearings along the centerline of survey; spans on curved alignments should be measured along a reference line, a chord drawn from centerline to centerline of abutment bearings at the centerline of survey or extended tangent along the centerline of survey; spans for concrete slab bridges are measured from a line 1'-0" behind the face of abutment substructure or breastwall; skews should be given with respect to the centerline for straight alignments or to reference lines (chords or tangents) for curved alignments; for straight alignments, the bearing of the centerline of survey should be shown; for curved alignments, the bearing of the reference line (chord or tangent) should be shown; and a superelevation transition table or diagram similar to Figure 209.1.1-1, should be provided if the bridge crown (superelevation) changes across the structure, reference should be made to the table or diagram when detailing the typical bridge transverse section.

Descriptive data for the proposed structure should be shown in a "Proposed Structure" block. The "Proposed Structure" block should be placed in the lower right hand corner for the 22" x 34" [559 x 864 mm] sheet size. An "Existing Structure" block should be shown on the Site Plan if applicable and be placed above the "Proposed Structure" block. Structure blocks should be approximately 6½" [165 mm] wide for 22" x 34" [559 x 864 mm] sheet size.

202.2.2 FINAL MAINTENANCE OF TRAFFIC PLAN

In addition to the Preliminary Maintenance of Traffic Plan requirements of Section 201.2.7, the Final Maintenance of Traffic Plan should include the following information:

A. Plan views and preliminary working drawings to ensure constructability

B. Temporary barrier anchorage details and requirements

C. Location and type of temporary shoring (See Section 208)

D. Location of structural members that require strengthening

E. Temporary structure design information (See Section 500)

F. Additional notes and/or details necessary

For concrete slabs, early standard drawings called for the main reinforcement to be placed perpendicular to the abutments when the skew angle became larger than a certain value. This angle has been revised over the years as new standard drawings were introduced. When considering staged construction requirements and the orientation of the cutline, screen existing concrete single span slab bridges according to the following criteria:

Prior to 1931 the slab bridge standard drawing required the main reinforcement to be placed perpendicular to the abutments when the skew angle was equal to or greater than 20 degrees. This angle was revised to 25 degrees in 1931, 30 degrees in 1933 and finally 35 degrees in 1946. The standard drawing in 1973 required the main reinforcement to be parallel with the centerline of roadway regardless of skew angle. Existing exposed reinforcing steel may be used to confirm the direction of the reinforcing steel.

If the skew angle of the bridge is equal to or greater than the angles listed above for the year built, a temporary longitudinal bent will have to be designed to support the slab where it is cut or if possible locate the cutline parallel to the reinforcing if sufficient room exists. For example a bridge built in 1938 with a 25 degree skew does not require a bent, however a bridge built in 1928 with a 25 degree skew does require a bent to be designed.

When utilizing semi-integral construction, the stability of the new part-width superstructure is to be considered. There exists the potential of the superstructure to move laterally either from the effects of the traffic using the new deck or the lateral earth pressure against the approach slab. See Standard Bridge Drawing "SEMI-INTEGRAL CONSTRUCTION DETAILS" for more information.

202.2.3 FOUNDATION REPORT

The Bridge Preliminary Design Report shall include a Foundation Report in accordance with the ODOT Specifications for Geotechnical Explorations. The Foundation Report shall include:

A. Investigational Findings

B. Analyses and Recommendations

C. Boring Logs

D. Test Data

Substructures for bridges over waterways shall be supported by piling or drilled shaft foundations unless the footings can be founded on bedrock. Where the scour evaluation has identified a potential problem, the probable scour depths, calculated in accordance with Section 0(D), should be considered in the design of the substructures; the location of the bottom of footings; the minimum tip elevations for piles and drilled shafts; and the factored side resistance of piles and drilled shafts. See BDM Section 202.2.3.2.h for more information.

Where downdrag has been identified as a potential contributor to the total factored load, the estimated downdrag load shall be included in the report. See BDM Section 202.2.3.2.c for more information.

The Foundation Report for MSE wall supported abutments shall include calculations for external stability (*LRFD 11.10.5*) and settlement. The report shall also consider the effect of settlement and include all construction constraints, such as soil improvement methods, that may be required.

Specific design considerations for each foundation type are presented in the following sections.

202.2.3.1 SPREAD FOOTINGS

The use of spread footings shall be based on an assessment of the following: design loads; depth of suitable bearing materials; ease of construction; effects of flooding and scour analysis; liquefaction and swelling potential of the soils; frost depth; and amount of predicted settlement versus tolerable structure movement.

For bridges over waterways where bedrock is determined to be at or close to the flow line spread footings or drilled shafts shall be used. Spread footings shall be embedded into the bedrock in accordance with the requirements of Section 204.1, except in laminated bedrock such as interbedded shale and limestone, in which case drilled shaft foundations with sufficient embedment into the bedrock are preferred.

Spread footings shall be designed in accordance with *LRFD 10.6*.

Elevations for the bottom of the footing shall be shown on the Final Structure Site Plan. The estimated size of the footing; estimated settlements; and the factored bearing resistances shall be provided for review with the Foundation Report.

Adjust the footing size, the amount of predicted settlement and the factored bearing resistance during detail design as the design loads for the Service, Strength and Extreme Event Limit State are refined.

All spread footings at all substructure units, not founded on bedrock, are to have elevation reference monuments constructed in the footings. This is for the purpose of measuring footing elevations during and after construction for the purpose of documenting the performance of the spread footings, both short term and long term. See Section 600 for notes and additional guidance.

202.2.3.2 PILE FOUNDATIONS

Pile foundations should be considered when spread footing foundations are prohibited or are not feasible.

The type, size and estimated length of the piles for each substructure unit shall be shown on the Final Structure Site Plan. The estimated length for piling shall be measured from the pile tip to

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the cutoff elevation in the pile cap and shall be rounded up to the nearest five feet [one meter]. To determine the estimated length for different pile types, refer to BDM Section 202.2.3.2.a and 202.2.3.2.b. The estimated length may need to be adjusted during detail design as the design loads for the Service, Strength and Extreme Event Limit States are refined.

202.2.3.2.a PILES DRIVEN TO REFUSAL ON BEDROCK

When piles are driven to refusal on the bedrock, the plans should specify steel 'H' piles.

Refusal is met during driving when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. When estimating pile length, the depth to refusal shall be assumed as the elevation on the nearest soil boring where the rock core begins.

The total factored load ($\sum \eta_i \gamma_i Q_i$) for each pile shall be provided in the structure general notes. A sample note is provided in BDM Section 600. The plan specified value for total factored load shall be the factored load for the highest loaded pile at each substructure unit.

The factored resistance for piles driven to refusal on bedrock is typically governed by structural resistance. The total factored load for any single pile shall not exceed the maximum factored structural resistance ($R_{R\ max}$). The commonly used H-pile sizes and the maximum factored structural resistance ($R_{R\ max}$) allowed for each are listed below:

H Pile Size	$R_{R\ max}$
HP10X42	310 kips
HP12X53	380 kips
HP14X73	530 kips

H Pile Size	$R_{R\ max}$
HP250X62	1380 kN
HP310X79	1690 kN
HP360X108	2360 kN

The values listed above for the maximum factored structural resistance assume: an axially loaded pile with negligible moment; no appreciable loss of section due to deterioration throughout the life of the structure; a steel yield strength of 50 ksi; a structural resistance factor for H-piles subject to damage due to severe driving conditions (*LRFD 6.5.4.2*: $\phi_c = 0.50$); and a pile fully braced along its length. These values should not be used for piles that are subjected to bending moments or are not supported by soil for their entire length. Examples include piles for capped pile piers and piles in soils subject to scour.

For piers, other than capped pile piers, the preferred H-pile size is HP10X42 [HP250X62]. For information regarding piles for capped pile piers, refer to BDM Section 303.3.2.5.

In order to protect the tips of the steel "H" piling, steel pile points shall be used when piles are driven to refusal onto strong bedrock. When the depth of overburden is more than 50 feet [15 meters] and the soils are cohesive in nature, piles driven to strong bedrock generally should not

C. Design methodologies used to determine unit tip and unit side resistances

D. Resistance factor from *LRFD Table 10.5.5.2.4-1* for each calculated unit resistance

At the detailed design stage, the factored resistance for each drilled shaft shall be provided in the structure general notes. A sample note is provided in BDM Section 600. The factored resistance may need to be adjusted during detail design as the design loads for the Service, Strength and Extreme Event Limit States are refined.

Consult the Office of Structural Engineering before recommending friction type drilled shafts. When drilled shafts with friction type design are used, a minimum of three (3) shafts per pier are recommended.

When lateral loads are controlling the design of drilled shafts, consult the Office of Structural Engineering to determine if lateral load testing should be specified.

The Design Agency should have the Department review any special proposed drilled shaft plan notes during the Stage 1 Review Submission. If casing is to be specified as to be left in place, a plan note will need to be added.

202.2.4 SUPPLEMENTAL SITE PLAN FOR RAILWAY CROSSINGS

For Railway-Highway grade separation structures, a Supplemental Site Plan is required. The Supplemental Site Plan should be completed and submitted with the Final Site Plan. The reproduced tracing of this plan should have the title block deleted so that the railroad can use the plan to show force account work necessary to complete the highway project.

This plan shall show information necessary for the determination of slope lines, probable property requirements, sight distance and other items involved in determining the type of separation. The following information should be shown:

A. A 1” = 100’ [1 to 1000] scale plan of the alignment of the railroad and the highway extended at least 1000 feet [300 meters] each way from the proposed point of intersection, taken from actual surveys.

B. Profile of top of rails of all railroads, extending at least 1000 feet [300 meters] each way from the proposed intersection.

C. Sufficient cross sections along the railroad and highway to determine approximate earthwork limits and encroachment on railroad property.

D. In case a highway underpass type of separation is at all possible, the submitted information should show the line and profile of the nearest or best outlet for drainage.

E. Intersection angle between highway centerline and railroad centerline.

F. Highway stationing and railroad mile post stationing at intersection.

G. Railroad right-of-way lines.

H. Railroad pole lines, signal control boxes, communications relay houses, signal standards and drainage structures.

I. Centerlines of all tracks and location of switch points.

J. Location of buildings or other structures within the railroad right-of-way.

K. Railroad traffic counts including type of movements and speed.

L. Location of all utilities occupying railroad right-of-way and the names of the owners of these utilities.

203 BRIDGE WATERWAY

203.1 HYDROLOGY

Designers shall refer to the ODOT Location and Design Manual, Volume 2, Section 1003 for more information.

203.2 HYDRAULIC ANALYSIS

Designers shall refer to the ODOT Location and Design Manual, Volume 2 for all necessary hydraulic analysis considerations.

203.3 SCOUR

Designers shall refer to the ODOT Location and Design Manual, Volume 2 for all necessary bridge foundation scour considerations.

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203.4 BRIDGE AND WATERWAY PERMITS

Impacts to bridges or waterways may require legal authorization in the form of permits or certifications issued by various regulatory agencies, including:

A. U.S. Army Corps of Engineers .... 404 Permit and/or Section 10 Permit

B. U.S. Coast Guard .... Section 9 Bridge Permit

C. Ohio EPA .... 401 Certification and/or Isolated Wetland Permit

The jurisdictional limit of the U.S. Army Corps of Engineers (USACE) is termed the "Waters of the United States" and, as noted in ODOT CMS 101.03, includes: rivers, streams, lakes and wetlands. For rivers and streams, the jurisdiction begins below the Ordinary High Water Mark (OHWM). The OHWM is defined as the elevation on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

The USACE recently issued a Regional General Permit (RGP) for various activities conducted by ODOT within the "Waters of the United States". This RGP authorizes the Department the responsibility of ensuring compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for transportation projects meeting prescribed conditions. Permitted activities within "Waters of the United States" allowed by the RGP include: construction of permanent fills or structures; rehabilitation of authorized fills or structures; and the temporary placement of fills or structures. A copy of the RGP may be downloaded at:

http://www.lrh.usace.army.mil/permits/

The ODOT Office of Environmental Services – Waterway Permits Unit (OES-WPU) assumes the responsibility for determining project eligibility for the RGP as well as all other bridge and waterway permits. The RGP will not be applicable to all ODOT projects such as those that impact navigable waterways and scenic rivers. When projects exceed the applicable limits of the RGP, the designer, project manager and ODOT District Environmental Coordinator (DEC) should meet with OES-WPU to determine the best course of action. The designer and project manager shall coordinate with the DEC and the OES-WPU throughout the permit determination process to ensure that the final waterway permit applications are indicative of the final project design. For more information refer to the Waterway Permits Manual available from the ODOT Office of Environmental Services.

Special Provisions are the method ODOT uses to attach the waterway permits and certifications to the project construction plans. The waterway permits Special Provisions Package (SPP) is prepared by the OES-WPU and may contain the following:

A. All pertinent waterway permits, certifications and related conditions

B. Drawings and/or mapping submitted with a permit application

C. Specialized plan notes associated with the waterway permits

The designer and the project manager shall confirm that the bridge design plans (e.g. the navigational clearances shown on the site plan, BDM Section 201.2.2.J; etc.) meet the requirements in the project waterway SPP (e.g. U.S. Coast Guard Section 9 Bridge Permit; U.S.A.C.E. 404 Permit; RGP; etc.) and shall ensure the project waterway SPP are submitted with the Final Plan Package.

203.5 TEMPORARY ACCESS FILLS

A Temporary Access Fill (TAF) is a fill or structure that allows a contractor access to work on roads or bridges located within bodies of water. Examples of TAF's include: cofferdams; temporary structures for maintaining traffic; causeways and workpads; and demolition debris. The placement of all TAF's in "Waters of the United States" must be performed according to permits issued by the USACE.

A contractor's means and methods of construction will dictate the TAF required for a project. However, the Department must estimate the potential impacts to "Waters of the United States" during project development to ensure all permits are in-place during contract letting. Furthermore, it is incumbent upon the Department that these permits provide all bidding contractors the ability to construct the project without resulting in expensive delays, change orders or fines. To that end, the Department partnered with the Ohio Contractor's Association to develop the following guidance to estimate the size of TAF's:

A. The TAF shall provide access to all piers located within the Ordinary High Water Mark (OHWM) of the waterway from at least one bank of the waterway.

   Access may be provided by construction staging of the TAF. When considering the constructability of staged TAF's, typical superstructure erection plans for lifting lengths of 50-ft or more require two cranes. Unless the access for member delivery is from an adjacent structure, the TAF must provide access to each end of the lift from one bank. In the case of staging, the permit application shall reflect the construction stage that impacts the largest area of the waterway.

B. The TAF shall be located directly beneath the superstructure. The surface width of the TAF shall be equal to the out-to-out width of the superstructure plus 50'-0" outboard on one side of the structure and 20'-0" outboard on the other side of the structure.

C. The TAF shall extend at least 40'-0" beyond the furthest pier accessed by the TAF.

D. Side slopes of the TAF shall be no steeper than 1.5:1 (H:V).

E. The top surface of the TAF shall be located 1'-0" above the OHWM.

F. The TAF shall be designed to maintain a flow equal to two times the highest average monthly flow (i.e. the largest of Q1, Q2, Q3, …Q12), as reported by the USGS web based application StreamStats (see L&D Vol. 2), such that no rise in the backwater above OHWM is permitted.

This information is intended for permit application purposes only and should not be included in the project plan set. However, to assist the OES-WPU in the determination process, Designers should use the guidance above to develop a plan view and cross-section of a TAF. An example plan view and cross-section are shown in Figure 203.5-1. These details should be provided to the DEC along with a completed copy of the checklist shown in Figure 203.5-2. The minimum flow to be maintained during construction should be calculated according to item F above. Designers will need to estimate whether this flow can be maintained through conduits or if open channels will be required.

204 SUBSTRUCTURE INFORMATION

204.1 FOOTING ELEVATIONS

Substructure footing elevations should be shown on the Final Structure Site Plan. The top of footing should be a minimum of one foot [0.3 meters] below the finished ground line. The top of footing should be at least one foot [0.3 meters] below the bottom of any adjacent drainage ditch. The bottom of footing shall not be less than four feet [1.2 meters] below and measured normal to the finished groundline.

The number of scuppers used for collecting the deck surface drainage should be minimized or eliminated if possible. The allowable spread of flow, which is used to help determine the need for scuppers, can be computed by the procedures as described in Section 1103 of the ODOT Location and Design Manual. Scuppers when provided, should preferably be located inside the fascia beam.

Drainage collection systems should be sloped as steeply as practical, generally not less than 15 degrees. The system should have a minimum bend radius of 18 inches [450 mm], no 90 degree bends, adequate pipe supports and cleanouts at the low ends of runs. The cleanout plugs should be easily and safely accessible. The necessary deck drainage outlet locations should be included in the Structure Type Study, Hydraulics Report.

Scuppers with drainage collection systems should be placed as closely as possible to the substructure unit which drains them. Uncollected scupper downspouts should be as far away from any part of the structure as possible.

When the deck drainage is to flow off the ends of the bridge, provisions must be made to collect and carry away this run-off. Refer to the ODOT Location and Design Manual, Volume 2, Section 1113.1 for more information.

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 inlet, SCD I-2.3 to collect the drainage. Where possible, the inlet shall be located at least 25-ft beyond the limits of the MSE wall soil reinforcement. Continue the barrier 10-ft past the catch basin. Refer to BDM Figure 209.3-1 for more information.

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:

$$L = [1.5(H + h + 1.5)] \div \cos\theta \leq 30 \text{ ft}$$

$$L = [1.5(H + h + 0.45)] \div \cos\theta \leq 9.15 \text{ m}$$

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.

For bridge replacement projects, 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 3" to 2" [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 LETTERING AND LOGO POLICY ON ODOT FACILITIES

All lettering and logos to be placed on a bridge shall be approved by the Office of Structural Engineering. All lettering and logos to be placed on noise walls shall be approved by the Office of Environmental Services. All lettering and logos to be placed on ODOT facilities through sponsorship naming proposals will be approved by the Division of Innovative Delivery.

The following criteria are required in order for lettering and logos to be approved for use on Bridges and Noise Walls.

A. City names and City logos will be permitted provided the bridge or noise wall is within the territorial jurisdiction of that City.

B. County names and County logos will be permitted provided the bridge or noise wall is within the territorial jurisdiction of that County.

C. Street names and Path names will be permitted provided the bridge carries that public street or public path. Private street names or private path names are not permissible.

D. FHWA approval may also be required.

E. Lettering or logos may not extend above the top of bridge railing, barrier, or fence. Lettering or logos may not extend below the normal lines of the bridge superstructure.

F. Lettering or logos on bridge substructure units must be placed within the normal limits of those units. No extraneous elements may be added for the sole purpose of displaying lettering or logos.

G. Provide 5 copies of a rendering(s) of the proposal with the request.

H. The local agency requesting the lettering or logo may be required to fund the additional cost over what ODOT would normally install on the bridge or noise wall.

   1. ODOT traditionally uses standard concrete form liners on bridges and noise walls. If the lettering or logo will require additional or custom concrete form liners, the cost over a standard concrete form liner may be required to be secured/funded by the local agency.

   2. ODOT traditionally places vandal protection fencing on bridges. If the lettering or logo will require non-standard fence or supports, the cost over the standard fence may be required to be secured/funded by the local agency.

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,

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

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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, measured from centerline of tracks, and 22’-0” [6.7 meters] vertical, measured six feet [1.8 meters] from centerline of tracks, wherever possible.

209.9 BICYCLE BRIDGES

Reference should be made to ODOT’s most current design guidelines and Section 300 of this Manual. The current design guidelines can be found on ODOT’s Office of Local Projects web page, www.dot.state.oh.us/local/. For new structures generally the minimum bridge width should be the same as the width of the paved bicycle path and approach shoulders. A minimum transverse slope of 1/4 inch per foot [0.021] sloped in one direction should generally be used. Bicycle railings should be a minimum of 3’-6” [1065 mm] high. For the design of the railing refer to AASHTO LRFD Article 13.9. If an occasional maintenance vehicle is going to use the bridge, the railing should only be designed as a bicycle railing. The type of bridge deck joints used should be bicycle safe.

If a timber deck is used, a 1½ inch [38 mm] minimum thickness of Item 441, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Consult the Office of Structural Engineering for recommendations before specifying other alternative surfaces.

209.10 PEDESTRIAN BRIDGES

Pedestrian facilities shall meet the grade and cross slope requirements specified in Volume One, Section 306.2.5 of the ODOT Location & Design Manual. For pedestrian bridges over highways an additional one foot [300 mm] of vertical clearance shall be provided. Refer to BDM Section 301.4.2 for additional design guidance.

If a timber deck is used, a 1½ inch [38 mm] minimum thickness of Item 441, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Other alternative surfaces may be used if approved by the Department.

209.11 SIDEWALKS ON BRIDGES

Sidewalks should be provided where significant pedestrian traffic is anticipated and/or the approach roadway has sidewalks or requires provisions for future sidewalks. Refer to Volume One, Section 306.4 of the ODOT Location & Design Manual for specific pedestrian traffic requirements. The width of the bridge sidewalk is generally the width of the approach sidewalk plus 12 inches [300 mm], with the widths typically between 5 and 6 feet [1500 and 1800 mm] wide.

An 1/4 inch per foot [0.02] cross slope should be provided to drain the sidewalk towards the curbline. The sidewalk height shall be 8 inches [203 mm] on the bridge, tapering down to the approach curb height within the length of the approach slab.

A detail of the standard curb (height, face slope, and corner rounding) should be given. Refer to Section 300 of this Manual for vandal protection fencing requirements.

209.12 MAINTENANCE AND INSPECTION ACCESS

Maintenance and inspection access requirements should be included in the Structure Type Study, Narrative of Bridge Alternatives. For multiple span bridges with 8 feet [2400 mm] or deeper girders, an inspection handrail located on the girders should be provided. Also catwalks should be considered. Safety cables and other fall arrest systems should be considered in addition to handrails and catwalks. Provisions for maintenance and inspection access should be provided for fracture critical girders, cross girders and bents that cannot be inspected from a snooper. The use of fracture critical members is strongly discouraged. For these types of structures, consult the Office of Structural Engineering for details and recommendations. Additional information is provided in "FHWA Guidelines for Providing Access to Bridges for Inspections", dated November 1985.

209.13 SIGN SUPPORTS

Research has shown that overhead sign supports located on bridges are highly susceptible to

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 07-18-14)

Figure 201.2.3-1

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 07-18-14)

Figure 203.2-1

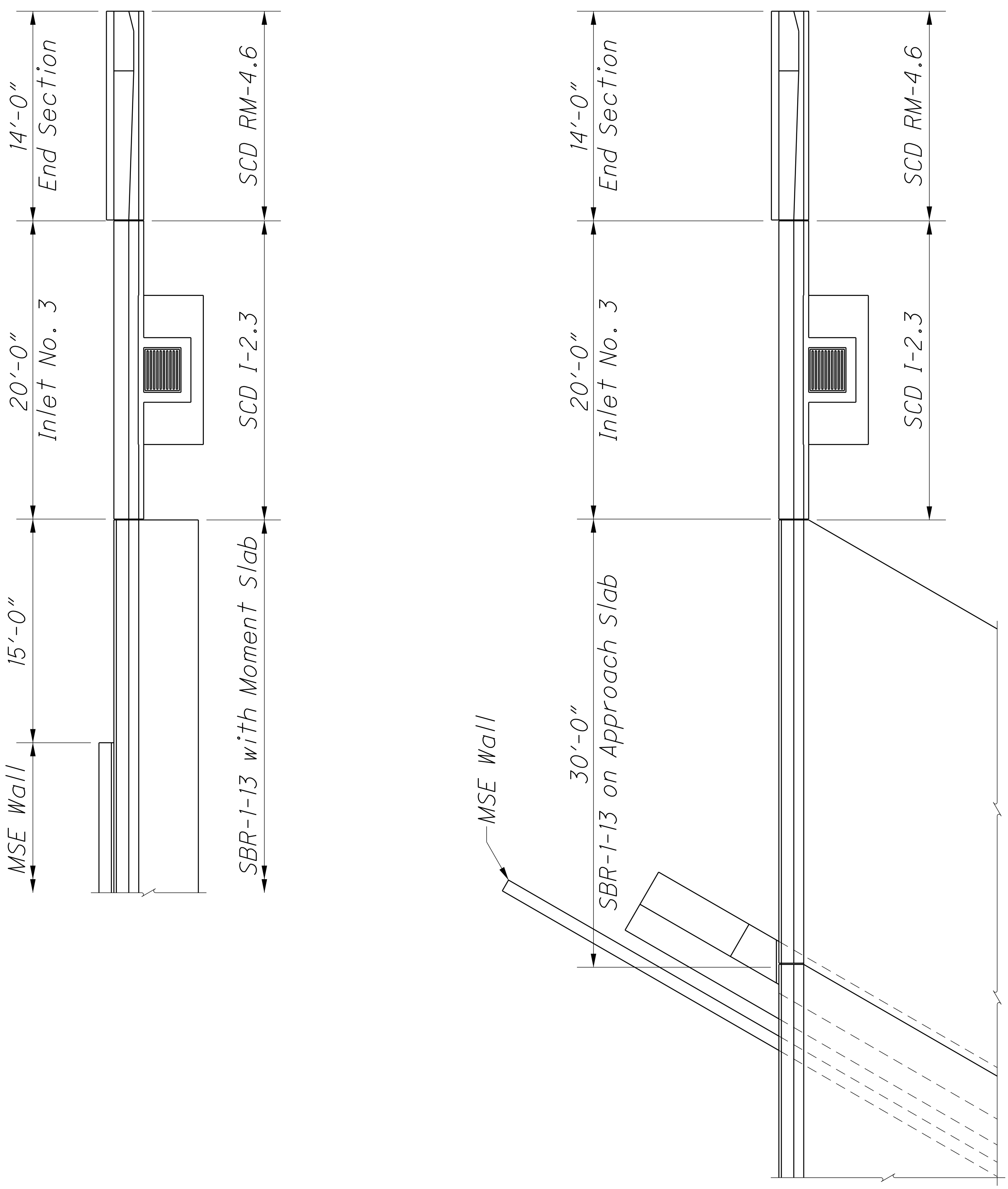

Figure 209.3-1

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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 QC2) .... 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

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 441 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) = $([\text{deck slope}]^2 + [\text{transverse grade}]^2)^{1/2}$

302.5.1.5 CAMBER

The topping thickness on prestressed box beam superstructures will vary along the length of the beams to account for beam camber and other vertical elevation adjustments. Proper determination of the topping thickness is crucial in order to properly establish beam seat elevations.

As shown in Figure 302.5.1.5-1, the topping thickness (T_x) at any point, x, along the length of a prestressed box beam superstructure shall be determined as:

$$T_x = A + B_x + C + D_{t,x} - E$$

Where:

A = Design deck thickness

B_x = Vertical grade adjustment

C = Sacrificial haunch depth

$D_{t,x}$ = Beam camber adjustment at member age equal to Day t

E = Haunch adjustment

302.5.1.5.a DESIGN DECK THICKNESS (*A*)

The design deck thickness shall be in accordance with BDM Section 302.5.1.3 or BDM Section 302.5.1.4.

302.5.1.5.b VERTICAL GRADE ADJUSTMENT (B_x)

The Vertical Grade Adjustment accounts for any elevation differences between a non-linear profile grade and the linear grade connecting the centerline of beam supports. The value of the Vertical Grade Adjustment depends on many geometric factors such as vertical curvature, skew, cross-slope transitions, etc. Designers should attempt to minimize the vertical grade adjustment along the length of the bridge by setting the linear grade between the beam ends parallel to the tangent of the vertical grade at the midpoint of the beam span (see Figure 302.5.1.5-1).

302.5.1.5.c SACRIFICIAL HAUNCH DEPTH (*C*)

The purpose of the Sacrificial Haunch Depth is to account for camber in excess of that calculated in the Beam Camber Adjustment above and account for the roadway cross-slope.

For multiple span box beam bridges with design speeds exceeding 45 mph, the minimum thickness of the Sacrificial Haunch Depth (*C*) shall be 2-inches. For all other box beam bridges, the minimum thickness of Sacrificial Haunch Depth (*C*) shall be 0-in.

Because box beams are set on sloping seats that approximate the cross-slope, the sacrificial haunch depth is typically constant. If, however, the cross slopes are different at the beam bearings as noted in BDM Section 302.5.1, the difference between the cross slope and the beam seat slope will be accommodated by the sacrificial haunch depth. The minimum thickness, *C*, will occur at the outside edge of the fascia beam on the low side of the cross slope.

302.5.1.5.d BEAM CAMBER ADJUSTMENT ($D_{t,x}$)

As prestressed concrete beams age, beam camber will increase due to concrete creep under the constant loading from the prestressing force. Although designers cannot accurately predict the girder age when the deck is placed, general assumptions can be made to prevent camber growth from becoming an issue during construction.

The design plans shall show two values for camber at midspan which the contractor can use to establish seat elevations according to C&MS 511.07 and tolerance according to C&MS 515.17: camber at Day 0 (D_0) and camber at Day 30 (D_{30}). These values shall represent the midspan camber in the beams before application of dead load other than self-weight.

To determine these camber values, Designers shall calculate the creep coefficient, $\psi(t,t_i)$, according to *LRFD 5.4.2.3.2* with humidity (H) equal to 70%; age of concrete at release (t_i) equal to 0.75 days; and V/S and f'_{ci} according to the project requirements. To calculate the creep coefficient at Day 0 and Day 30, use a maturity of concrete (t) equal to 0 days and 30 days respectively. The respective camber values are found by multiplying the net midspan camber at the time of release by the appropriate creep coefficient as follows:

$$D_{30} = [1+ \psi(t,t_i)]\ D_0$$

The net camber at the time of release ($\delta_{net,x}$) is the difference between the initial beam camber due to the prestressing force ($\delta_{o,x}$) and beam deflection due to self-weight ($\delta_{sw,x}$) [i.e. $\delta_{net,x} = \delta_{o,x} - \delta_{sw,x}$]. The gross moment of inertia for the non-composite box beam may be used to determine $\delta_{o,x}$ and $\delta_{sw,x}$.

See Figure 303.2.2.6-1.

The horizontal and vertical joint shall be sealed at the back face of the backwall by use of a 3'-0" [900 mm] wide sheet of nylon reinforced neoprene sheeting. The sheeting should only be attached on one side of the joint to allow for the anticipated movement of the integral section. A note for the neoprene sheeting is available in Section 600.

Integral abutments shall be supported on a single, row of parallel piles. If an integral abutment design uses steel H piles, they shall be driven so the pile's web is parallel to the centerline of bearing.

The expansion length at the abutment for an integral structure is considered to be two-thirds (2/3) of the total length of the structure.

For phased construction projects, do not design an abutment phase to be supported on less than three (3) piles.

Phased construction integral backwall details shall have a closure section detailed between sections of staged construction to allow for dead load rotation of the main beams or girders.

The standard bridge drawing shows details for integral abutments with a steel beam or girder superstructure. Cantilevered or turn-back wingwalls shall not be used with integral abutments.

303.2.2.7 SEMI-INTEGRAL ABUTMENTS

Semi-integral abutment use is limited as defined in Section 200 of this Manual. Semi-integral abutments require foundation types that are fixed in position (a single row of piles shall not be used). The expansion and contraction movement of the bridge superstructure is accommodated at the end of the approach slab. Semi-integral design should not be used with curved main members or main members that have bend points in any stringer line.

The expansion length at the abutment for a semi-integral structure is considered to be two-thirds (2/3) of the total length of the structure.

Semi-integral details can be used on wall type abutments, spill-thru type abutments on two or more rows of piles, spread footing type abutments or abutments on drilled shafts.

This design allows the superstructure and the approach slab to move together independent of the abutment. Therefore wingwalls should not be attached to the superstructure and the vertical joints between them should be parallel with the centerline of the roadway.

The joints between superstructure and wingwalls are normally filled with 2 inch [50 mm] performed expansion joint filler material, CMS 705.03.

The horizontal joint in the backwall created between the expansion section of the semi-integral abutment and the beam seat is filled with expanded polystyrene sheet or some equal material to act as form work for the placement of the upper semi-integral abutment concrete.

Both the horizontal and vertical joints shall be sealed at the back face of the backwall by use of a 3 foot [900 mm] wide sheet of nylon reinforced neoprene sheeting. The sheeting should only be attached on one side of the joint to allow for the anticipated movement of the integral section.

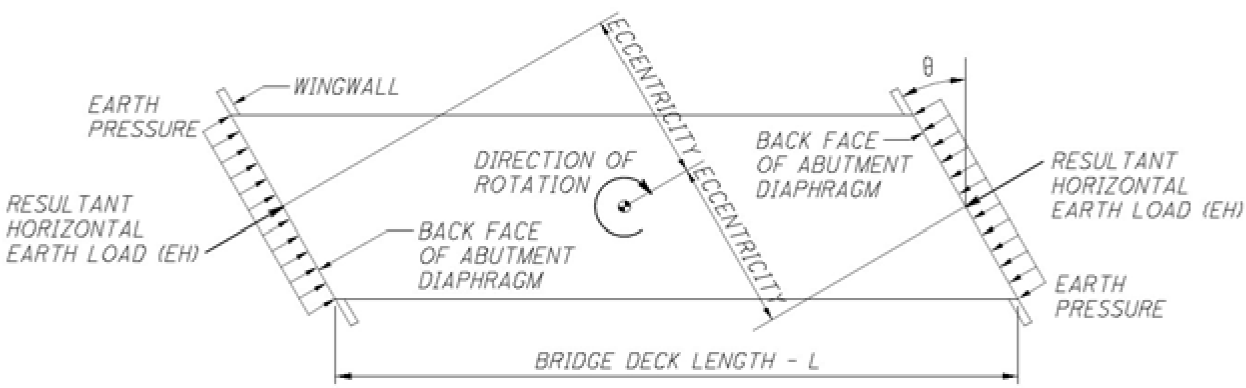
A standard bridge drawing detailing semi-integral abutment is available.

See Figure 303.2.2.7-1.

For phased construction projects, do not design an abutment phase to be supported on less than three (3) piles or two (2) drilled shafts.

Phased construction semi-integral backwall details shall have a closure section detailed between sections of staged construction to allow for dead load rotation of the main beams or girders.

When a semi-integral superstructure expands, earth pressures are generated on the back face of each diaphragm. Because these earth pressures act perpendicular to the diaphragm, an abutment skew will create an eccentricity about the center of the bridge. Without proper restraint, the bridge will rotate causing localized points of high stress at wingwalls and increased stresses in crossframes, flanges, webs and bearings.



FORCE DIAGRAM DUE TO EXPANSION OF THE BRIDGE

For all semi-integral superstructures regardless of skew angle, Designers shall locate at least one diaphragm guide for each abutment as shown in the Standard Bridge Drawing, SICD-2-14. For structures constructed in phases, the guide shall be located in the first phase of diaphragm construction. The amount of thermal movement, the height of the diaphragm, the length of the diaphragm, the amount of skew and soil data may warrant the need for an additional diaphragm guide at each abutment. A simple force analysis of a bridge superstructure with equivalent Resultant Horizontal Earth Loads (EH) at each abutment yields the following design loads on one diaphragm guide at each abutment:

$DG\perp = \gamma EH$ [Sin (θ)]

$DG/\!/ = 0.2\ \gamma EH$ [Sin (θ)]

Where:

$DG\perp$ = Primary factored load acting on Diaphragm Guide in a direction perpendicular to the longitudinal axis of the bridge.

$DG/\!/$ = Factored load acting on Diaphragm Guide in a direction parallel to the longitudinal axis of the bridge.

γ = Load factor, *LRFD Table 3.4.1-1*

θ = Skew angle

Depending upon the amount of thermal movement, the earth pressure acting on each diaphragm could be as little as the at-rest earth pressure or as much as passive earth pressure. As noted in *LRFD C3.11.5.4*, the movement required to mobilize full passive pressure is five percent of the height on which the passive pressure acts. When determining the earth pressure and its load factor, linear interpolation between at-rest and full passive pressure based on the amount of movement necessary to mobilize full passive pressure is acceptable.

Designing the Diaphragm Guides for a seismic horizontal connection force in accordance with *LRFD 3.10.9.2* is not required.

Existing abutments converted to semi-integral abutments shall also have Diaphragm Guides as noted above. If the amount of abutment work will not accommodate the installation of the cast-in-place Diaphragm Guide reinforcement shown in SICD-2-14, then reinforcement installed in accordance with Item 510 using non-shrink, non-metallic grout shall be specified. The Diaphragm Guide shall be fully detailed in the plans, and the pay Item 511 Semi-integral Diaphragm Guide shall be "As Per Plan".

Design Data Sheet, SICDD-2-14, provides designers detailing guidance for diaphragm reinforcement around the diaphragm guide.

303.2.3 ABUTMENT DRAINAGE

303.2.3.1 BACKWALL DRAINAGE

The porous backfill immediately behind abutments and retaining walls should be provided according to CMS 518. The porous backfill shall be effectively drained by the use of a corrosion resistant pipe system into which water can percolate. See Section 303.2.3.3 for possible exceptions.

Porous backfill shall be wrapped with filter fabric, CMS 712.09, Type A. The fabric shall cover the vertical face between the porous backfill and the excavation, the bottom of the porous backfill and the excavation and include a 6 inch [150 mm] vertical up turn between the porous backfill and the abutment backwall. The porous backfill excavation should extend up to the horizontal plane of the subgrade or 1'-0" [300 mm] below the embankment surface. The bottom of the porous backfill should extend to the bottom of the abutment footing except when the vertical backface of the abutment footing extends more than 1'-0" [300 mm] out from the vertical backface of the abutment backwall. Then the Porous backfill shall extend down only to the top of the abutment footing. Porous backfill should be 2'-0" [600 mm] thick for its full height behind the abutment and wingwalls except where the vertical backface of the abutment footing extends out 1'-0" [300 mm] or less. A pipe drainage system shall be placed at the bottom of the porous backfill and sloped to allow drainage.

While a single outlet for the pipe drainage systems in the porous backfill can be adequate, the designer should evaluate whether the length of the drainage run requires multiple outlets to supply the porous backfill with a positive drainage system.

The pipe drainage system designs shall make use of standard corrugated plastic pipe segments, tees and elbows (either 90^{o} or adjustable). Overlapping bands should connect pipe segments. Ends of runs, unless intended to function as outlets, should have end caps. While galvanized

SECTION 500 – TEMPORARY STRUCTURES

501 GENERAL

This section is a supplement to CMS 502, Structures For Maintaining Traffic. All design guidelines of CMS 502 apply.

502 PRELIMINARY DESIGN

For the Structure Type Study, the Designer shall show the grade, alignment, approximate location and width of the temporary structure on the Preliminary Structure Site Plan.

For the Preliminary Design Report, the Designer shall show the grade and the alignment of the temporary structure on the Site Plan. The Designer shall also determine the roadway width, hydraulic design , clearance requirements, and all other design parameters in conjunction with the development of the preliminary design . When the temporary structure can adequately be shown on the Site Plan for the permanent bridge, a Site Plan for the temporary structure is not required. The required Site Plan information shall be as detailed in Section 200. The Designer shall submit the preliminary design of the temporary structure concurrently with the Preliminary Design Report at the Stage 1 Detailed Design Review Submission for the permanent structure.

502.1 HYDRAULICS

Designers shall refer to the ODOT Location and Design Manual, Volume 2, Section 1011 for more information.

503 DETAIL DESIGN

The temporary structure detail plans shall be complete and independent of the permanent structure plans. The temporary structure detail plans shall include general plan and elevation views, general notes, a table of estimated quantities, a reinforcing steel bar list and all necessary detail plan sheets. The Designer should clearly indicate that the temporary structure will be paid for under one Lump Sum bid item - Item 502, Structure for Maintaining Traffic, and the table provided for estimated quantities is “For Estimating Purposes Only”.

Temporary bridge structures shall be designed as permanent structures in accordance with the *AASHTO LRFD Bridge Design Specifications* and this Manual except that the design live loading, HL-93, may be reduced by 25 percent. The temporary bridge plans shall include Design Data in the General Notes as defined in BDM Section 600.

For ice pressure loads, the thickness of ice shall be assumed to be 6 inches [150 mm], with a 200 psi [1.4 MPa] effective ice strength. The force shall be assumed to act at the level of the design year highwater elevation.

The bridge railing for the temporary structures shall meet the requirements of Section 304 of this Manual. If the Designer elects to use standard Type 5 or 5A guardrail or standard portable concrete barrier, the Designer should account for the deflection characteristics of the barrier.

Generally a temporary structure should be designed to be easily constructed and removed with minimal cost. The following items should be considered when designing a temporary bridge:

A. Timber decks, H pile bents, and simple spans are commonly used.

B. Locally available lumber should be specified. The allowable design unit stresses of the lumber used in the design shall be specified in the plans . State whether timber sizes are full sawn or standard dressed sizes.

C. The nominal thickness of wood plank or strip floor shall be 3 inches [75 mm] minimum.

D. Timber floors shall be securely fastened to the stringers and stringers shall be securely fastened to the pier and abutment caps.

E. When circumstances permit, all or part of the existing bridge may be used for the run-around.

F. Field welded connections shall require nondestructive testing as per 513. Bolted connections are preferred and generally are more economical.

G. Designs that minimize debris accumulation should be considered.

H. Shop drawings are not required. Adequate plan details need to be provided.

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 expansion bearings only. Longitudinally applied superstructure loads are assumed to be transferred to the substructure as a friction loads (FR) equal to the nominal frictional resistances supplied by the bearings (see BDM Section 301.4.5). This assumption does not apply to fixed bearings. For fixed bearings, provide revised versions of these notes that list all applicable longitudinally applied superstructure loads transferred to the substructure through the bearing connections.

606 FOUNDATIONS

606.1 PILES DRIVEN TO BEDROCK

The following note generally will apply where steel-H piles are to be driven to bedrock:

[606.1-1] PILES TO BEDROCK: Drive piles to refusal on bedrock. The Department will consider refusal to be obtained when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. Select the hammer size to achieve the required depth to bedrock and refusal.

The total factored load is ____(1)____ kips per pile for the ____(2)____ abutment piles. The total factored load is ____(1)____ kips per pile for the ____(2)____ pier piles.

Abutment piles:

____(3)____ piles ____(4)____ feet long, order length

Pier piles:

____(3)____ piles ____(4)____ feet long, order length

NOTE TO DESIGNER:

(1) Specify the total factored load according to BDM Section 202.2.3.2.a.

(2) Specify the location of piles for each total factored load.

(3) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

(4) Specify the order length according to BDM Section 202.2.3.2.a and 303.4.2.1.

The following note, modified to fit the conditions, will apply where piles are located within a waterway and the scour depth is significant.

[606.1-2] PILES TO BEDROCK: Drive piles to refusal on bedrock. The Department will consider refusal to be obtained when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. Select the hammer size to achieve the required depth to bedrock and refusal.

The total factored load is ____(1)____ kips per pile for the ____(2)____ abutment piles. The abutment piles were designed to accommodate ____(3)____ ft. of scour. The total factored load is (1) kips per pile for the (2) pier piles. The pier piles were designed to accommodate (3) ft. of scour.

Abutment piles:

(4) piles (5) feet long, order length

Pier piles:

(4) piles (5) feet long, order length

NOTE TO DESIGNER:

(1) Specify the total factored load according to BDM Section 202.2.3.2.a.

(2) Specify the location of piles for each total factored load.

(3) Specify the depth of anticipated scour.

(4) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

(5) Specify the order length according to BDM Section 202.2.3.2.a and 303.4.2.1.

The following note, modified to fit the conditions, will apply where downdrag loads on the piles are anticipated.

[606.1-3] PILES TO BEDROCK: Drive piles to refusal on bedrock The Department will consider refusal to be obtained when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. Select the hammer size to achieve the required depth to bedrock and refusal.

The total factored load is (1) kips per pile for the (2) abutment piles. The abutment piles include an additional (3) kips of factored load per pile to account for possible downdrag loading. The total factored load is ___(1)___ kips per pile for the ___(2)___ pier piles.

Abutment piles:

___(4)___ piles ___(5)___ feet long, order length

Pier piles:

___(4)___ piles ___(5)___ feet long, order length

NOTE TO DESIGNER:

(1) Specify the total factored load according to BDM Section 202.2.3.2.a.

(2) Specify the location of piles for each total factored load.

(3) Specify the anticipated factored downdrag loading.

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(4) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

(5) Specify the order length according to BDM Section 202.2.3.2.a and 303.4.2.1.

606.2 FRICTION TYPE PILES

The following notes, modified to fit the specific conditions for the foundation required, will apply in all cases except where the piles are to be driven to bedrock. Provide the actual calculated Ultimate Bearing Value as shown below:

[606.2-1] PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value is __(1)__ kips per pile for the __(2)__ abutment piles. The Ultimate Bearing Value is __(1)__ kips per pile for the __(2)__pier piles.

Abutment piles:

__(3)__ piles __(4)__ feet long, order length

__(5)__ Dynamic load testing items

Pier piles:

__(3)__ piles __(4)__ feet long, order length

__(5)__ Dynamic load testing items

NOTE TO DESIGNER:

(1) Specify the Ultimate Bearing Value according to BDM Section 202.2.3.2.b.

(2) Specify the location of piles for each Ultimate Bearing Value.

(3) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

(4) Specify the order length according to BDM Section 202.2.3.2.b and 303.4.2.1.

(5) Specify the number of dynamic load testing items according to BDM Section 303.4.2.7.

The following note, modified to fit the conditions, will apply where piles are located within a waterway and the scour is anticipated.

[606.2-2] PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value is __(1)__ kips per pile for the __(2)__ abutment piles. The Ultimate Bearing Value is __(1)__ kips per pile for the pier piles. The pier piles include an additional __(3)__ kips per pile of Ultimate Bearing Value due to the possibility of losing __(7)__ ft. of frictional resistance due to scour.

Abutment piles:

__(4)__ piles __(5)__ feet long, order length

__(6)__ Dynamic load testing items

Pier piles:

_(4)_ piles _(5)_ feet [meter] long, order length

_(6)_ Dynamic load testing items

NOTE TO DESIGNER:

(1) Specify the Ultimate Bearing Value according to BDM Section 202.2.3.2.h.

(2) Specify the location of piles for each Ultimate Bearing Value.

(3) Specify the additional amount of Ultimate Bearing Value according to BDM Section 202.2.3.2.h.

(4) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

(5) Specify the order length according to BDM Section 202.2.3.2.h and 303.4.2.1.

(6) Specify the number of dynamic load testing items according to BDM Section 303.4.2.7.

(7) Specify the scour depth.

The following note, modified to fit the conditions, will apply where downdrag loads on the piles are anticipated.

[606.2-3] PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value is _(1)_ kips per pile for the _(2)_ abutment piles. The Ultimate Bearing Value is _(1)_ kips per pile for the _(2)_ pier piles. The addition of _(3)_ kips of Ultimate Bearing Value per abutment pile is due to possible downdrag loads caused by settlement and to account for side friction within the downdrag zone that must be overcome during pile driving.

Abutment piles:

_(4)_ piles _(5)_ feet long, order length

_(6)_ Dynamic load testing items

Pier piles:

_(4)_ piles _(5)_ feet long, order length

_(6)_ Dynamic load testing items

NOTE TO DESIGNER:

(1) Specify the Ultimate Bearing Value according to BDM Section 202.2.3.2.c.

(2) Specify the location of piles for each Ultimate Bearing Value.

(3) Specify the additional amount of Ultimate Bearing Value according to BDM Section 202.2.3.2.c. This amount includes the factored downdrag load and the unfactored side resistance from the soil in the downdrag zone.

(4) Specify the size of pile (e.g. HP 10 x 42 or 12 inch diameter).

reinforcement in the bearing seats with adjustable lap splices such that the minimum lap length coincides with D_{30}. Do not include deflection due to the weight of FWS.

[702.9-2] DECK SLAB THICKNESS FOR CONCRETE QUANTITY: The estimated quantity of deck concrete is measured according to C&MS 511. In addition to the design slab thickness, the quantity includes a variable haunch thickness that provides an allowance for: vertical grade adjustment and beam camber.

NOTE TO DESIGNER: Delete "vertical grade adjustment" from the above note when the project does not include such an adjustment.

For prestressed non-composite box beam bridges with asphalt wearing surface, compute the topping depth over the top of the beams according to BDM Section 302.5.1.5. Provide a longitudinal cross section showing the thickness of the Item 448 Intermediate course and the Item 448 surface course at each centerline of bearing and at midspan. Refer to BDM Figure 702.9-1. Additionally, provide the following note in the plans for every beam:

[702.9-4] CAMBER:

Estimated camber at Day 0 (D_0) is _____ inches.

Estimated camber at Day 30 (D_{30}) is _____ inches.

Deflection due to remaining dead load (e.g. concrete deck, diaphragms, barriers, utilities, etc.) is _____ inches.

The beam seat elevations assume estimated camber D_{30}. Increase the thickness of the intermediate course at each centerline of bearing by the same distance each seat elevation was lowered per C&MS 511.07. No adjustment shall be made to the overlay thickness at midspan.

NOTE TO DESIGNER: Refer to BDM Section 302.5.1.5 for description of camber values. In accordance with C&MS 511, the Contractor will adjust the bearing seat elevations based on the actual project schedule. To accommodate this adjustment, Designers shall detail vertical reinforcement in the bearing seats with adjustable lap splices such that the minimum lap length coincides with D_{30}. Do not include deflection due to the weight of FWS.

Use the following note when the length of the box beam, measured along the grade, differs from the length, measured horizontally, by more than 3/8" [10mm]:

[702.9-3] NOTE TO FABRICATOR: The dimensions measured along the length of the beam, marked with a _*_, do not contain an allowance for the effect of the longitudinal grade. Include the proper allowance for these dimensions in the shop drawings.

NOTE TO DESIGNER: Indicate the dimensions that require a grade adjustment with an asterisk or some other easily recognizable symbol and include that symbol in the note above.

702.10 ASPHALT CONCRETE WEARING COURSE

Place note **[702.10-1]** on the plans for prestressed concrete box beam bridges having an asphalt concrete wearing course. If the nominal thickness of 441 varies from the 1½" [38 mm] shown, revise the note accordingly.

While this note specifies how to place only the two 441 bid items, the designer should recognize that two Item 407 tack coat items are also required. One tack coat is applied before the first surface course. The other tack coat is applied between the first and second surface courses.

[702.10-1] ASPHALT CONCRETE WEARING COURSE shall consist of a variable thickness of 441 asphalt concrete surface course, Type 1, PG70-22M and a second 1½" thickness of 441 asphalt concrete surface course, Type 1, PG70-22M. Place the first 441 surface course in two operations. The first portion of the course shall be of 1½" uniform thickness. Feather the second portion of the course to place the surface parallel to and 1½" below final pavement surface elevation.

702.11 PAINTING OF A588/A709 GRADE 50 STEEL

Provide the following note for bridge superstructures using unpainted A588/A709 Grade 50W steel and having deck expansion joints at the abutments. Modify the note accordingly for structures with intermediate expansion joints. Bridges with an integral or semi-integral type abutment will not require painting of the beam ends.

[702.11-1] PARTIAL PAINTING OF A709 GRADE 50W STEEL: Paint the last 10 ft of each beam/girder end adjacent to the abutments including all cross frames and other steel within these limits. The prime coat shall be 708.01. The top coat color shall closely approach Federal Standard No. 595B - 20045 or 20059 (the color of weathering steel).

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1002 LRFD SECTION 2 – GENERAL DESIGN AND LOCATION FEATURES

S2.3.2.2.2 *PROTECTION OF USERS*

For routes with design speeds in excess of 45 mph, pedestrian traffic and vehicular traffic shall be separated by a crash tested barrier system. For routes with design speeds of 45 mph or lower, the Department requires a crash tested barrier to separate vehicle and pedestrian traffic when the pedestrian railing does not meet NCHRP 350 crash testing requirements. Refer to BDM Section 304 for more information.

S2.3.3.2 *HIGHWAY VERTICAL*

The Department's requirements for vertical clearance are provided in the ODOT Location & Design Manual, Section 300. ODOT's "Preferred" vertical clearances include 6.0 in. for possible future overlays.

Apply the additional 1.0 ft. of vertical clearance provided for sign supports and pedestrian overpasses to ODOT's "Preferred" vertical clearance.

S2.5.2.3 *MAINTAINABILITY*

For structures with High Load Multi-rotational (HLMR) bearings, the plans shall show the location of permanent or temporary jacking points and provide jacking forces in accordance with *LRFD 3.4.3.1*. Both the superstructure and substructure shall be designed for the location and forces provided. Jacking points and forces are not required for other bearing types.

S2.5.2.4 *RIDEABILITY*

Where concrete decks without an initial overlay are used, the top 1.0 in. of thickness shall be considered sacrificial to permit a maximum correction of the deck profile by grinding of 0.5 in. and to compensate for a maximum thickness loss due to abrasion of 0.5 in. This top 1.0 in. is commonly referred to as the monolithic wearing surface. Refer to BDM Section 302.1.3 for more information.

S2.5.2.6.2 *CRITERIA FOR DEFLECTION*

Designers shall apply the deflection limits shown. Do not include the stiffness contribution of railings, sidewalks and median barriers into the design of the composite section.

S2.5.2.6.3 *OPTIONAL CRITERIA FOR SPAN-TO-DEPTH RATIOS*

Designers shall apply the minimum span-to-depth ratios shown in *Table 2.5.2.6.3-1*.

S2.6.6.3 *TYPE, SIZE AND NUMBER OF DRAINS*

Refer to Section 1103 of the Location and Design Manual, Volume 2 for ODOT's design criteria for deck drainage.

S2.6.6.4 *DISCHARGE FROM DECK DRAINS*

ODOT requires the minimum projection of scuppers below the lowest adjacent superstructure component to be 8.0 in. Refer to Standard Bridge Drawing GSD-1-96 for more information.

1003 LRFD SECTION 3 – LOADS AND LOAD FACTORS

S3.4.1 *LOAD FACTORS AND LOAD COMBINATIONS*

The load combinations and load factors specified in *Table 3.4.1-1* shall apply. If a bridge design warrants the use of a special design vehicle analysis, the scope of services will provide the necessary information. Otherwise, the Department does not require an analysis using a special design vehicle, and the Strength II limit state will not apply.

S3.5.1 *DEAD LOADS: DC, DW, AND EV*

In lieu of more specific information, the assumed unit weight of normal weight reinforced concrete shall be 0.150 kcf.

Design all bridges for a future wearing surface of 60 psf applied to the clear roadway width between curbs and/or barriers. Refer to BDM Section 301.4 for more information.

S3.6.1.3.1 *GENERAL*

The investigation of load effects produced by two tandem vehicles spaced from 26.0 ft. to 40.0 ft as specified in *Article C3.6.1.3.1* is not required.

S3.6.1.3.2 *LOADING FOR OPTIONAL LIVE LOAD DEFLECTION EVALUATION*

The live load deflection criteria specified in *Article 2.5.2.6.2* applies.

S3.6.1.3.3 *DESIGN LOADS FOR DECKS, DECK SYSTEMS, AND THE TOP SLABS OF BOX CULVERTS*

Use the approximate strip method of analysis. Do not apply the Empirical Design Method specified in *Article 9.7.2*. Refer to BDM Section 302.2.2 for more information.

S3.6.1.3.4 *DECK OVERHANG LOAD*

This article does not apply. Design deck overhangs in accordance with BDM Section 302.2.2.

S3.6.1.4.2 *FREQUENCY*

The *ADTT* shall be estimated as follows:

$ADTT = ADTT_{20} \times 4$

Where:

ADTT = the number of trucks per day in one direction averaged over the design life

$ADTT_{20}$ = the number of trucks per day in one direction occurring in the design year (year 20)

S*3.6.1.6 PEDESTRIAN LOADS*

For bridges that can accommodate service vehicles, refer to BDM Section 301.4.1 for loading requirements.

S*3.6.2.1 GENERAL*

For deck joints at all limit states, the Dynamic Load Allowance, IM, shall be taken as 125% of the static effect of either the design truck or the design tandem.

S*3.6.5.1 PROTECTION OF STRUCTURES*

The provisions of *Article 3.6.5.2* need not be considered for redundant substructures which are protected according to the ODOT Location and Design Manual, Volume One, Section 600.

The provisions of *Article 3.6.5.2* need not be considered for non-redundant substructures which are protected by:

- An embankment;
- A structurally independent, ground-mounted 54.0-in. high TL-5 barrier, located within 10.0 ft. from the component being protected; or
- A 42.0-in. high TL-5 barrier located at more than 10.0 ft. from the component being protected.

S*3.6.5.2 VEHICLE AND RAILWAY COLLISION WITH STRUCTURES*

For bridges over roadways, unless protected as specified in *Article 3.6.5.1*, abutments and piers located within a distance of 30.0 ft. to the edge of the roadway shall be designed for an equivalent static force of 400 kip, which is assumed to act in any direction in a horizontal plane, at a distance of 4.0 ft. above ground.

For bridges over railways, refer to BDM Sections 204.5 and 209.8 for abutment and pier protection requirements.

S*3.10.4* *SEISMIC PERFORMANCE ZONES*

All bridges in the state of Ohio fall within Seismic Zone 1.

S*3.10.9.2* *SEISMIC ZONE 1*

The entire State of Ohio shall be assumed to have an acceleration coefficient above 0.025 but less than 0.09.

Design the connection of the superstructure to the substructure to resist a horizontal seismic force in the restrained direction equal to 0.2 times the vertical reaction due to the tributary permanent load. The tributary area refers to the uninterrupted segment of a superstructure contributing to the load on the seismic restraint. The restrained direction for an expansion bearing is typically transverse to the structure. The tributary permanent load shall include an allowance for future wearing surface.

Assume the Extreme Event I load factor for live load (γ_{EQ}) is equal to 0.0.

Standard integral and semi-integral abutment types do not require the addition of seismic restraints. The horizontal restraint provided by these abutment types is sufficient to resist the seismic force generated by the tributary area contributing dead load to the abutment. For multiple span structures with integral or semi-integral abutments, additional seismic restraints located at one or more piers may be required to resist the remaining seismic force acting on the superstructure. Diaphragm Guides, as specified in BDM Section 303.2.2.7, are required for every semi-integral abutment.

If seismic restraints are provided, design the substructure units for an earthquake force (EQ) at the Extreme Event I limit state equal to 0.2 times the tributary dead loads applied in the restrained direction resulting in the maximum load effect.

Refer to *Article 4.7.4.4* for minimum seat width requirements.

S*3.11.2* *COMPACTION*

The Department typically ignores the effect of additional earth pressure from mechanical compaction equipment on retaining walls. For situations requiring special compaction equipment by plan note, proposal note or special provision, contact the Office of Structural Engineering for additional guidance.

S*3.11.6.5* *REDUCTION OF SURCHARGE*

Do not reduce the Live Load Surcharge regardless of the presence of an approach slab.