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

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

Attached is a brief description of each revision.

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Summary of Revisions to the January 2004 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	2-7	Due to the relocation of bridge hydraulics noted above, reference to the scour evaluation has been updated.
202.2.3	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	2-17	This information was relocated to the ODOT Location and Design Manual, Volume 2, Section 1003.
203.2	2-17 through 2-21.1	This information was relocated to various sections of the ODOT Location and Design Manual, Volume 2.
203.3	2-7 through 2-21.1	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	2-21.2	The reference to the use of the USGS web based application StreamStats was updated to the L&D Vol. 2.
209.3	2-38 through 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.
209.7.2	2-41.1 through 2-41.1	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.

BDM Section	Affected Pages	Revision Description
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 207		This Figure has been retired and the information was relocated to the ODOT Location and Design Manual, Volume 2, Section 1118.2.1.
Figure 201		This Figure has been relocated to the ODOT Location and Design Manual, Volume 2, Figure 1006-1.
Figure 210		This new Figure clarifies the provisions of BDM Section 209.3 regarding control of surface drainage at MSE walls.
302.1.3.1	3-11	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	3-41	The pay item for asphalt has been updated to Item 441.
303.2.2.7	3-57 through 3-58.2	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	6-16.1	Dynamic pile testing for piles to bedrock has been removed. Refusal on bedrock has been clarified to avoid over-driving.
702.12	7-9 through 7-10	The pay item for asphalt has been updated to Item 441.

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.

For rehabilitations, include color photographs of the portions of the existing structure to be salvaged. To substantiate the proposed salvage decision, all areas of rehabilitation shall be identified by field investigation.

For rehabilitation of steel beam or girder superstructures, include the Fatigue Evaluation defined in Section 400.

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/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.

When a rehabilitation alternate involves salvaging existing concrete members, cost overruns should be anticipated and included in the cost analysis. See Section 400 of this Manual for additional rehabilitation information.

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. Typed boring logs
C. Laboratory test results as follows:
   1. Soil: Water content, particle size analysis, liquid limit, plastic limit
   2. Rock: RQD

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

When the foundation recommendation for the preferred alternative includes MSE wall supported abutments, the Designer shall provide estimates for bearing pressure and allowable bearing capacity for the in-situ material below the MSE wall and an estimate for settlement of the MSE wall. Refer to Section 204.4 for additional considerations.

When unique subsurface conditions arise, include a brief narrative in the Foundation Recommendation for justification to obtain extra soils borings.

201.2.7 PRELIMINARY MAINTENANCE OF TRAFFIC PLAN

The various components of the bridge stage construction shall match those of the approach roadway, and the nomenclature used to identify the various stages (phases) of construction shall be the same for the roadway and the bridge (Stage 1 and Stage 2 or Phase 1 and Phase 2).

For projects that affect ODOT's Permitted Lane Closure Schedule, Designers shall evaluate Accelerated Bridge Construction (ABC) techniques to mitigate negative impacts to the travelling public. Access to the Permitted Lane Closure Schedule is available at: http://plcm.dot.state.oh.us/.

Additional information regarding ABC techniques is available on FHWA's Accelerated Bridge Construction Website: http://www.fhwa.dot.gov/bridge/abc/.

The Preliminary Maintenance of Traffic Plan shall include a transverse section(s) defining all stages of removal and construction. The following information should be provided:

A. The existing superstructure and substructure layout with overall dimensions (field verified) and color photographs.

B. Type of temporary railing or barrier.

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 Subsurface Investigations. The Foundation Report shall include:

A. Investigational Findings
B. Analyses and Recommendations
C. Boring Logs and Undisturbed 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 been identified a potential problem, the probable scour depths, calculated in accordance with L&D Vol. 2, 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 frictional capacity of piles and drilled shafts.

The Foundation Report for MSE wall supported abutments shall include calculations for bearing pressure and bearing capacity for the in-situ material below the MSE wall and calculations for MSE wall 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 design loads, depth of suitable bearing materials, ease of construction, effects of flooding and scour analysis, liquefaction and swelling potential of the soils and frost depth. Generally the amount of predicted settlement of the spread footing and the tolerable movement of the structure control the type of footing. To establish tolerable movements, engineering judgment should be used (also refer to FHWA's Manual on Tolerable

Movements, Report No. FHWA/RD-85/107).

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.

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The allowable bearing pressure for the foundation soil is a function of the footing dimensions, depth of overburden and the location of the water table. Procedures for computing allowable bearing pressure for both cohesive and cohesionless soils are given in the FHWA Manual "Soils and Foundations Workshop Manual", Publication No. FHWA-HI-88-009, July 1993. A relationship between Standard Penetration Test (SPT) value, N, and the soil parameters, angle of internal friction, and cohesive strength, c, is given in tables presented in chapter 6 of the FHWA manual. The cohesive strength of soil is taken as one half of the ultimate strength, q_u.

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.

Elevations for the bottom of the footing shall be shown on the Final Structure Site Plan. Preliminary design loads, the estimated size of the footing and the allowable bearing pressure shall be provided for review with the Foundation Report. This information is to be furnished by the design agency preparing the plans.

During the detail design stage, the actual footing size shall be determined based on the actual design loads. Note that the allowable bearing pressure may need to be adjusted for the actual footing size. A safety factor of three (3) shall be used to determine the allowable bearing pressure.

202.2.3.2 PILE FOUNDATIONS

The type, size and estimated length of the piles for each substructure unit shall be shown on the Final Structure Site Plan. Preliminary pile design loads and approximate pile spacings shall be provided with the Foundation Report. This information will be furnished by the design agency preparing the plans. The estimated pay length(s) for the piling shall be measured from the pile tip to the cutoff elevation in the pile cap and shall be rounded up to the nearest five (5) feet [one meter]. Procedures for computing estimated pay length of the piles are given in the FHWA's "Design and Construction of Driven Pile Foundations, Vols. 1 & 2", FHWA-HI-97-013/014. Minimum pile tip elevations for friction designed piles may be required and should be shown on the Final Structure Site Plan.

When installing piles at a batter, the site conditions should be studied to determine if installation is practical. Piles under 15 feet [5 meters] in length should not be battered.

202.2.3.2.a STEEL 'H' PILES

When piles are driven to refusal on the bedrock, steel 'H' piles are generally used. The commonly used pile sizes are:

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 Office of Environmental Services – Waterway Permits Unit 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. TAF’s are work-type specific and are not required on every project. 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 208. These details should be provided to the DEC along with a completed copy of the checklist shown in Figure 209. 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.

Due to possible stream meander, pier footings for waterway crossings in the overflow section should not be higher than the footings within the stream unless the channel slopes are well protected against scour. Founding pier footings at or above the flow line elevation is strongly discouraged.

Where footings are founded on bedrock (note that undisturbed shale is bedrock) the minimum depth of the bottom of the footing below the stream bed, D, in feet [meters], shall be as computed by the following:

209 MISCELLANEOUS

209.1 TRANSVERSE DECK SECTION WITH SUPERELEVATION

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

A. When the roadway break point is located between roadway lanes (not at the edge of pavement) the bridge cross slope is to extend to the toe of parapet. See “CASE a” in Figure 204.

B. When the roadway break point is located at the edge of pavement (adjacent shoulder width is less than four feet [1.2 meters]), the bridge cross slope is to be continued past the break point to the toe of deflector parapet. See “CASE b” in Figure 204.

C. When the roadway break point is located at the edge of pavement (adjacent shoulder width is equal to or greater than four feet [1.2 meters] and less than eight feet [2.4 meters]), a four foot [1.2 meter] rounding distance from the edge of pavement onto the shoulder is used to transition from the bridge cross slope to the ½ inch per foot [0.04] shoulder cross slope. See “CASE c” in Figure 205.

D. When the roadway break point is located at the edge of pavement (adjacent shoulder width is equal to or greater than eight feet [2.4 meters]), a five foot [1.5 meter] rounding distance from the edge of pavement onto the shoulder is used to transition from the bridge cross slope to the ½ inch per foot [0.04] shoulder cross slope. See “CASE d” in Figure 205.

The transition from the roadway approach transverse section to the bridge deck transverse section is to take place within the limits of the approach slab, whenever possible. On bridges with high skews, it may not be possible to do the transition within these limits and other alternatives should be considered during the Assessment of Feasible Alternatives.

For decks with over the side drainage, the treatment of the deck and the shoulder slopes shall be as described in subsections a through d above except that the slope shall continue to the edge of the deck.

209.1.1 SUPERELEVATION TRANSITIONS

Because of the complexities associated with superelevation transitions on bridge superstructures (i.e. beam and girder cambering, crossframe fabrication, deck form construction, slip forming of parapets, etc.) all reasonable attempts should be made to keep such transitions off of bridge decks. Where transitions must be located on bridge decks, preferably, the transitions should be straight. An example of a transition diagram is shown in Figure 206. A table with the information shown in Figure 206 is also acceptable. Where this is not practicable, then transition’s discontinuities should be smoothed by inserting 50 foot [15 meter] roundings at each discontinuity.

209.2 BRIDGE RAILINGS

All bridge structures on the National Highway System (NHS) or the State System require the use of crash tested railing meeting the loading requirements of TL-3 as defined by NCHRP report 350. The requirement for the NHS became effective October 1, 1998. For detailed information, refer to Section 304.

For structures with over the side drainage on the National Highway System, Twin Steel Tube Bridge Guardrail, Standard Bridge Drawing TST-1-99 should be used.

Over the side drainage shall not be used for bridges over highways and railroads. For four lane divided highways concrete deflector parapets shall be used. For bridges with heights of 25 feet [7.6 meters] or more above the lowest groundline or normal water, concrete deflector parapets should be used.

Refer to Section 305 of this Manual for vandal protection fencing requirements.

209.3 BRIDGE DECK DRAINAGE

The preferred minimum longitudinal grade of the bridge deck surface, when using concrete parapets, is 0.3 %, whenever possible.

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 catch basin to collect the drainage. Where possible, the catch basin 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 210 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:

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

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

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

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

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

209.6 PRESSURE RELIEF JOINTS

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

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

209.7 AESTHETICS

209.7.1 GENERAL

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

Some basic guidelines that should be considered are as follows:

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

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

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

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

E. All structures should blend in with their surroundings.

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

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

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

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

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

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

209.7.2 LOGO AND LETTERING POLICY

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 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 obtained from ODOT’s Office of Multi-Modal Planning. 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. Except as noted herein, refer to AASHTO Section 2.7.2 for additional bicycle railing design requirements. 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. The current AASHTO design guide for pedestrian bridges should be followed.

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 fatigue damage. Every effort shall be made to locate overhead sign supports off of bridge structures. When this is not possible, only two locations on the structure are acceptable and are listed below in order of preference:

A. Mounted directly to the substructure unit.

B. Mounted to the superstructure directly over a substructure unit.

Sign supports attached to the fascia of overpass bridges, as shown on Standard Construction Drawings TC-18.24 and TC-18.26, should also be avoided. Consult with the District Bridge Engineer before specifying their use.

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

Figure 201

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 202

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

Figure 207

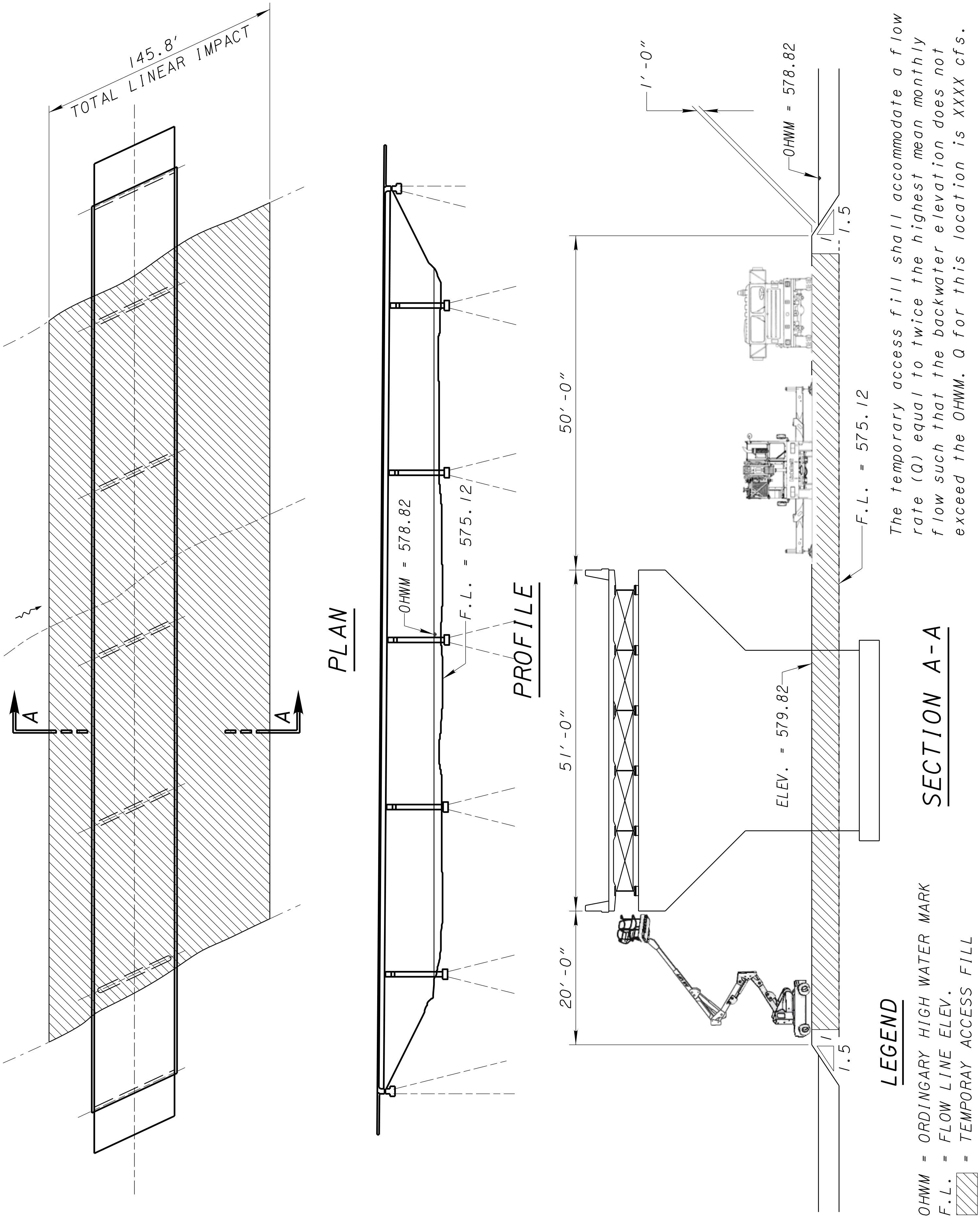

145.8'
TOTAL LINEAR IMPACT
A
A
PLAN
OHWM = 578.82
F.L. = 575.12
PROFILE
1'-0"
OHWM = 578.82
1.5
1
50'-0"
F.L. = 575.12
51'-0"
ELEV. = 579.82
20'-0"
SECTION A-A
The temporary access fill shall accommodate a flow rate (Q) equal to twice the highest mean monthly flow such that the backwater elevation does not exceed the OHWM. Q for this location is XXXX cfs.
LEGEND
OHWM = ORDINGARY HIGH WATER MARK
F.L. = FLOW LINE ELEV.
= TEMPORAY ACCESS FILL

Figure 208

Temporary Construction, Access and Dewatering Activities

ODOT Regional General Permit (RGP) (Part C) Determination Checklist

The purpose of this form is to aid the Office of Environmental Services – Waterway Permits Unit (OES-WPU) in the permit determination process and in determining eligibility for the ODOT RGP-Part C. A completed copy of this form and a temporary construction access plan shall be forwarded to the DEC to be included in the Permit Determination Package submitted to OES-WPU.

Co-Rte-Sec: ______________________________PID: ____________________________________

Description:____

During the construction of this project, the following activities in the waters of the United States are anticipated: (check all that apply)

- ☐ Temporary structure for maintaining traffic
- ☐ Cofferdams
- ☐ Temporary access fill (e.g. causeways and work pads)
- ☐ Demolition and debris removal

The RGP requires an authorized temporary activity to accommodate a minimum flow equal to twice the highest mean monthly flow without creating a rise in backwater above the OHWM. **The minimum flow to be maintained throughout construction for this location is _______ cfs**. The means that will most likely be implemented by the Contractor to maintain this flow will be:

- ☐ Conduit(s)
- ☐ Open channel(s)\Temporary Bridge

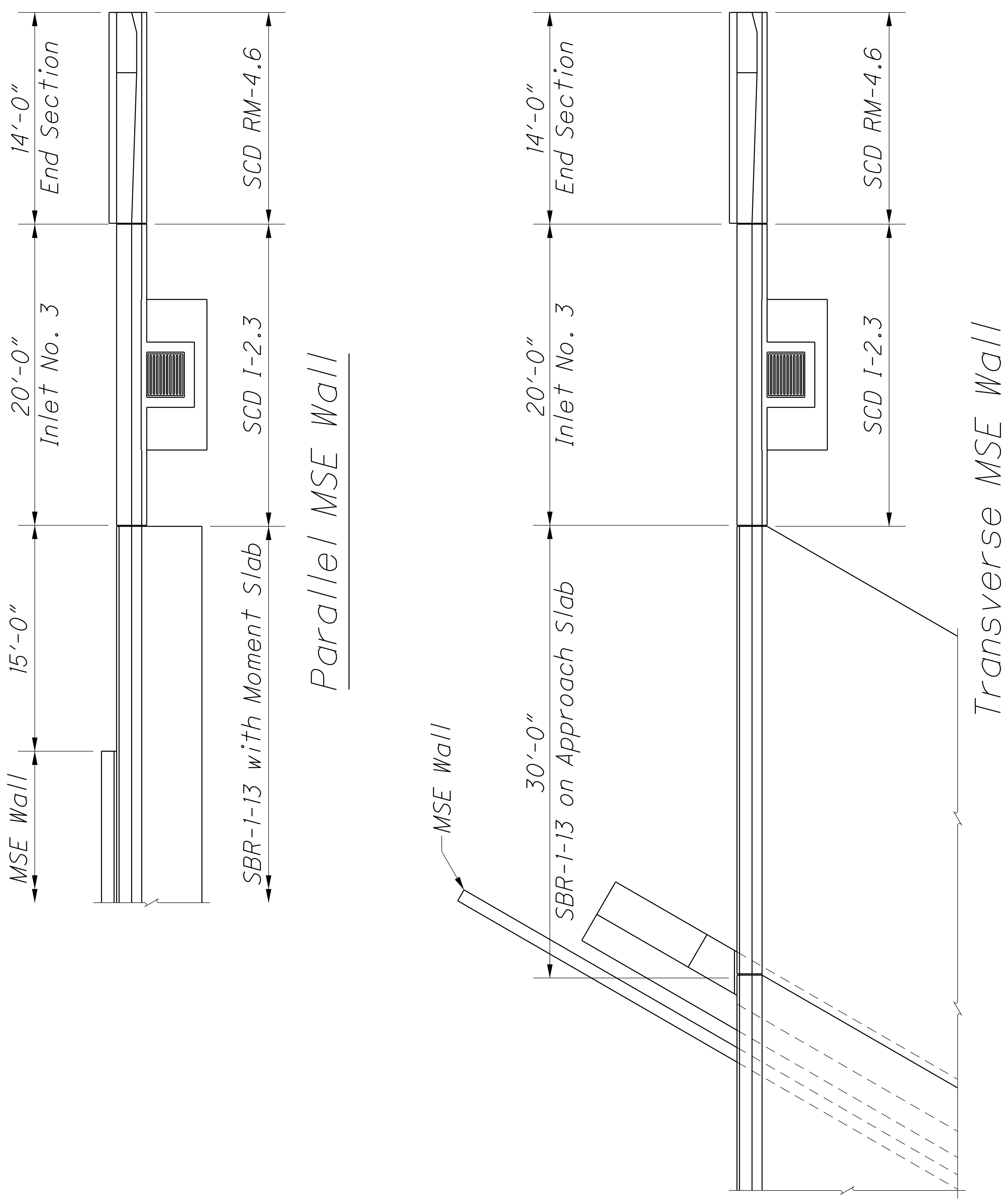
The RGP has limitations. Please read the limitations and provide the required measurement as it applies for this project.

- ☐ The maximum length of temporary impact, as measured upstream to downstream along one bank, cannot exceed 250-ft. **Proposed impact length for this project is ____ ft.**
- ☐ The proposed activity cannot be located within 2000-ft of a flood control facility or within 1000-ft of a stream gage. **Distance to flood control facility is _____ ft. Distance to stream gage is _____ ft.**
- ☐ The duration of the impact to waters of the United States cannot exceed 2 years. **Proposed temporary impact duration is ___ years.**

A complete copy of the RGP with the OEPA conditions may be downloaded at the following website: http://www.dot.state.oh.us/Divisions/TransSysDev/Environment/Ecological_Resources_Permits/WATERWAY_PERMITS/Pages/default.aspx

cc. District Environmental Coordinator (DEC)

Figure 209



14'-0"
End Section
SCD RM-4.6
20'-0"
Inlet No. 3
SCD I-2.3
15'-0"
MSE Wall
SBR-1-13 with Moment Slab
Parallel MSE Wall
14'-0"
End Section
SCD RM-4.6
20'-0"
Inlet No. 3
SCD I-2.3
30'-0"
SBR-1-13 on Approach Slab
MSE Wall
Transverse MSE Wall

Figure 210

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(EFFECTIVE 07-18-14)

Figure 201M

wearing surface shall be composed as follows:

1. Two separate 1½ inch [38 mm] minimum lifts of Item 441 Asphalt Concrete Surface Course, Type 1, PG70-22M. The first lift shall be variable thickness to accommodate beam camber. The second lift shall be a uniform 1½ inch [38 mm] thickness.

2. Two applications of Item 407 Tack Coat - one prior to placement of the first lift of surface course and one prior to placement of the second lift of surface course. Refer to the ODOT Pavement Design Manual, Section 400 for application rates.

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

302.1.3.2 FUTURE WEARING SURFACE

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

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

302.1.4 CONCRETE DECK PROTECTION

302.1.4.1 TYPES

A. Epoxy Coated Reinforcing Steel - CMS 709.00

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

C. Class QC2 Concrete

D. Drip Strips

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

F. Asphaltic concrete wearing surface

302.1.4.2 WHEN TO USE

All reinforcing steel shall be epoxy coated.

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

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

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

302.5.1.4 NON-COMPOSITE WEARING SURFACE

Non-composite box beam bridges with asphalt overlays shall have either Type D Waterproofing or Type 3 Waterproofing as specified in CMS 512 placed on the boxes before the 1½ inch 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) = $([\text{deck slope}]^2 + [\text{transverse grade}]^2)^{½}$

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 320A, 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 320A).

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 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.

Where an existing structure is being rehabilitated into a semi-integral abutment design, the designer should investigate whether the existing fixed bearings and piers can accept the stresses due to the differential movement caused by the concept of movement for semi-integral abutment designs.

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.

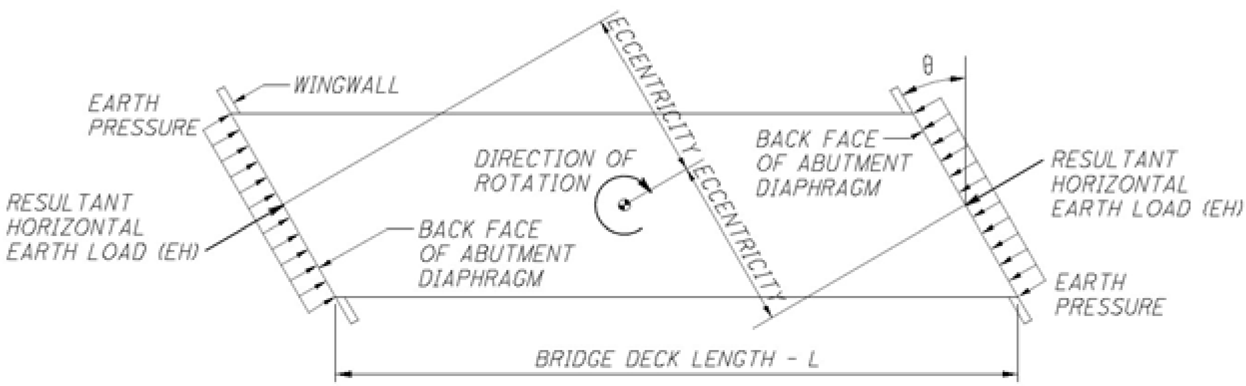
A standard bridge drawing detailing semi-integral abutment is available.

See Figure 325.

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.

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 to withstand the same loads as the permanent structure as defined in the current AASHTO Standard Specifications for Highway Bridges and this Manual. These loads and forces shall include, but not be limited to, dead load, live load with impact, wind, thermal effects, centrifugal effect, earth pressure, buoyancy, ice pressure, stream current, longitudinal and transverse forces and erection stresses.

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 temporary bridge plans shall show all the yield and/or allowable stresses used in the design. An increase of the allowable stresses over AASHTO requirements or this Manual is not permitted.

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.

abutment. The design for internal stability shall include an unfactored horizontal strip load from the superstructure of _____ k/ft [kN/m] applied perpendicular to the face of wall at the base of the concrete footing.

606 FOUNDATIONS

606.1 PILES DRIVEN TO BEDROCK

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

[29] 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 Ultimate Bearing Value is __#__ tons per pile for the _____ abutment piles. The Ultimate Bearing Value is __#__ tons per pile for the ____ pier piles.

Abutment piles:
____ piles ____ feet long, order length

Pier piles:
____ piles ____ feet long, order length

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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. Additionally, provide the following note in the plans for every beam:

[76B] 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 D30. 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]:

[95] 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.

702.12 ASPHALT CONCRETE WEARING COURSE

Place note **[77]** 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" 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.

[77] 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 1 ½" below final pavement surface elevation.