OHIO DEPARTMENT OF TRANSPORTATION

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

October 19, 2007

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2007 Fourth Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, July 2007. 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/se/BDM/BDM2007/bdm2007.htm

Attached is a brief description of each revision.

Summary of Revisions to the July 2007 ODOT BDM

BDM Section	Affected Pages	Revision Description
105	1-11	This revision adds the location of non-standard approach slab details to the list for bridge plan sheet order.
201.2.2	2-3	This revision emphasizes the need to label the roadway width to provide consistency and clarity for review, inventory and rating purposes.
201.2.7	2-7	This revision corrects an improper reference attributed to the L&D Manual in lieu of the Traffic Engineering Manual.
202.2.3.3	2-18 through 2-18.2	This revision provides information supporting the Department's position on belled drilled shafts.
203.1	2-20 through 2-20.2	This revision introduces StreamStats, an on-line resource for determining unregulated stream statistics and basin characteristics, which replaces USGS Report 89-4126.
203.4	2-24 through 2-24.2	This new section addresses the various stake holder responsibilities in the bridge and waterway permit process.
204.6.2.1	2-28 through 2-29.2	The first revision, item B, has been made to clarify the determination of an MSE wall strap length. The second revision, item J, has been made to improve compaction effort between piles and pile sleeves in MSE wall supported abutments.
209.5	2-40 through 2-41.2	This revision provides additional information required for approach slabs located in vertical curves or superelevated sections.
209.13	2-44 through 2-45	This new section address research findings for fatigue damage to overhead sign supports attached to bridges. The new section also addresses sign supports attached to the fascia of overpass bridges.
302.1.3.1	3-10 through 3-10.2	This revision provides a resource for determining the estimated quantity of tack coat.
302.1.4.3	3-13 through 3-13.2	The revision provides information for when to consider the use of graffiti protection sealers.
302.4.2.3	3-28	A section that required slotted holes in cross frame members and final member connections after completion of the deck placement to accommodate differential deflection was removed. In order to reduce the potential for unanticipated girder deflection during deck placement, all cross frames and lateral bracing shall be permanently fastened before deck placement begins.
302.5.1.3	3-38	This revision clarifies the layout of the composite deck slab reinforcement for prestressed box beams.

BDM Section	Affected Pages	Revision Description
303.1	3-48 through 3-48.2	The revision provides information for when to consider the use of graffiti protection sealers.
Fig. 303.5.1-1		The print quality for the July 2007 version of this figure was poor. This figure has only been re-printed to improve the print quality. No revisions have been made.
Fig. 303.5.1-2		This figure has been revised to reflect design and detailing changes now required for MSE walls. Revisions include: lengthening approach slab; quantity pay limits; 3 ft. layer of Item 304 in select granular fill zone; material above select granular fill; material used for undercut replacement; placement of geotextile fabric beneath wall; and sample location for undercut sheeting and bracing.
Fig. 303.5.1-3		This figure has been revised to reflect design and detailing changes now required for MSE walls. Revisions include: lengthening approach slab; quantity pay limits; 3 ft. layer of Item 304 in select granular fill zone; material above select granular fill; material used for wall foundation; and placement of geotextile fabric beneath wall.
Fig. 303.5.1-4		The print quality for the July 2007 version of this figure was poor. This figure has only been re-printed to improve the print quality. No revisions have been made.
Fig. 303.5.1-5		This figure has been revised to reflect design and detailing changes now required for MSE walls. Revisions include: 3 ft. layer of Item 304 in select granular fill zone; material used for undercut replacement; and placement of geotextile fabric beneath wall.
602.7	6-6 through 6-6.2	This new section provides plan notes for graffiti protection sealers.
606.3	6-16 through 6-16.2	This revision updates the contact information for suppliers of steel points for H-piles.
610.6	6-25 through 6-26	This new section addresses construction submittal requirements for shoring designs provided in the plans.
702.12	7-11	Note [702.12-2] has been retired. In order to reduce the potential for unanticipated girder deflection during deck placement, all cross frames and lateral bracing shall be permanently fastened before deck placement begins.
ARN-1	Appendix -1 through Appendix - 2	Retired note [702.12-2] has been added to the Appendix repository.

I. Non-standard approach slab details

J. Reinforcing Steel List

The General Plan sheet does not require an elevation view. The General Plan sheet is only required for:

A. New bridge of variable width or curved alignment.

B. New bridge requiring staged construction

If no General Plan sheet is furnished, the bridge plans may require a line diagram to show stationing and bridge layout dimensions that would not be practical to show on the site plan due to the site plan’s scale. Other details may be required to adequately present information needed to construct the bridge.

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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.

For all waterway crossings, Designers shall reference Supplemental Specification 832 and determine the anticipated area impacted by the potential placement of temporary construction access fills (i.e. temporary causeways or workpads) into the "Waters of the United States". "Waters of the United States" are defined by ODOT CMS 101.03 as waters that are under the jurisdiction of the Corps of Engineers and include: 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. Placement of fill material into the "Waters of the U.S." will require a 404 permit from the U.S Army Corps of Engineers and a 401 permit from the Ohio EPA.

To facilitate the permit process, the Preliminary Structure Site Plan shall show the OHWM and shall include quantities for: (1) the plan area representing the footprint of the temporary fill and (2) the total volume of temporary fill material placed in the waterway below OHWM. To determine these quantities, the Designer should first calculate the surface area of the waterway bounded by the proposed right-of-way lines on each side of the bridge and the OHWM on each bank. (Use existing ROW lines where no right-of-way will be purchased.)

A. If the resulting area does not exceed 1/3 acres [1350 m^2], then include the result as the quantity for (1) above and calculate the total fill volume assuming the flow line as the bottom elevation and the OHWM as the top elevation with 1.5 to 1 (Horz. to Vert.) side slopes. Refer to Figure 201.2.2-1 for more information.

B. If the resulting area exceeds 1/3 acres [1350 m^2], then the site plan quantities should represent a causeway from bank to bank and independent workpads for each pier located in the "Waters of the U.S.". Assume the causeway to be bounded by the flow line at the bottom and the OHWM at the top; and to be trapezoidal in shape, 20'-0" [6 m] wide at the top with 1.5 to 1 (Horz. to Vert.) side slopes. Assume the pier workpads to be bounded by the flow line at the bottom and the OHWM at the top; and to be trapezoidal in shape with at least 10'-0" [3 m] of work area on all sides of the pier with 1.5 to 1 (Horz. to Vert.) side slopes. Refer to Figures 201.2.2-2 for more information.

Unless environmental documentation provides specific areas where placement of temporary construction fills is prohibited, the project plans shall not include a prescribed location for causeways and work pads. Figures 201.2.2-1 and 201.2.2-2 are only to aid in the determination of temporary fill quantities. The actual location, shape and size of causeways and pier work pads may differ.

201.2.3 HYDRAULIC REPORT

The Structure Type Study shall include a Hydraulic Report that includes the following information:

A. Supplemental Site Plan showing information necessary for the determination of the waterway opening. Information shown on the Supplemental Site Plan should not be repeated on the Structure Site Plan. The following information should be include on the Supplemental Site Plan:

1. A small scale area plan showing: approximate location of all stream cross sections used for the hydraulic analysis; an accurate waterway alignment at least 500 feet [150 meters] each way from the structure; and the alignment of the proposed and present highways, taken from actual surveys. Note location of dams or other regulatory work on the waterway above the site, and the pool level, if the bridge is in a pool area above a dam.
2. A stream profile at least 500 feet [150 meters] each way from the bridge showing waterway flow line elevations and low water profile (where materially different) and high water profile if such is obtainable. If a high water profile cannot be obtained, high water elevations, with their locations marked or described, should be shown both above and below the bridge. Show high water elevations with dates and location of reading with relation to the existing structure. The source of high water data should be noted on the Supplemental Site Plan. High water data should preferably be collected from at least two locations and preferably verified by interviewing two local residents.
3. A profile along the centerline of highway so that the overflow section may be computed. This profile should extend along the approach fill to an elevation well above high water. If there are bridges or large culverts located within 1000 feet [300 meters] upstream or downstream from the proposed bridge, show stream cross sections including the structure

When the foundation recommendation for the preferred alternative includes MSE wall supported abutments, the Designer shall provide estimates for factored bearing pressure and factored bearing resistance 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).

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.

C. Proposed temporary lane widths, measured as the clear distance between temporary barriers, shall be shown. A temporary single lane width of 11’-0” [3350 mm] or greater is preferred; 10’-0” [3000 mm] is the minimum allowable. Minimum preferred lateral clearance from edge of lane to barrier is 1’-6” [500 mm] (ODOT’s Traffic Engineering Manual, Section 640-2) but Section 605-11.2 of the Traffic Engineering Manual, allows this lateral distance to be amended for specific sites and conditions. The designer should ensure that lane and lateral clearance requirements are evaluated versus effects of phased construction on a bridge structure.

D. Location of cut lines. The existing structure should be evaluated to determine where the cut-line can be made to provide structural adequacy. Cut lines through stone substructures should be carefully evaluated to maintain structural integrity through staged removals. Temporary shoring may be required and should be considered.

E. Temporary modifications to superelevated sections (existing and/or proposed) on the deck and/or shoulder in order to accommodate the traffic from the phase construction.

F. Width of closure pour. When determining the closure pour width (see Section 300 of this Manual), the designer should investigate the economics of using the lap splices versus using mechanical connectors. Any necessary structure modifications should be included in the cost estimate. Lap splices are preferred and recommended. A reduced closure width may cause transition problems in the finishing of the bridge deck surface when bringing the various phases of construction together.

G. Profile grade, alignment, approximate location and width of temporary structures

H. Location of temporary shoring

201.3 UTILITIES

All utilities should be accurately located and identified on the Preliminary Structure Site Plan. A note should state whether they are to remain in place, be relocated or be removed, and for the latter two, by whom.

Utilities should not be placed on bridges whenever possible.

The type of superstructure selected for a site may be dependent upon the number of utilities supported on the bridge. The request to allow utilities on the bridge shall be made through the ODOT District Utilities Coordinator. Refer to the ODOT Utilities Manual. Utilities shall be installed in substantial ducts or enclosures adequate to protect the lines from future bridge repair and maintenance operations. Utilities shall not be placed inside of prestressed concrete box beams. For some specific detail issues with utilities on bridges refer to Section 300 of this Manual.

202 BRIDGE PRELIMINARY DESIGN REPORT

202.1 GENERAL

In conformance with Section 1400 of the ODOT Location and Design Manual, Volume Three, a Bridge Preliminary Design Report shall be included in the Stage 1 Detailed Design Review Submission.

202.2 BRIDGE PRELIMINARY DESIGN REPORT SUBMISSION REQUIREMENTS

The Bridge Preliminary Design Report submission should contain the following:

A. Final Structure Site Plan ....Section 202.2.1

B. Final Maintenance of Traffic Plan ....Section 202.2.2

C. Foundation Report ....Section 202.2.3

D. Supplemental Site Plan for Railway Crossings ....Section 202.2.4

202.2.1 FINAL STRUCTURE SITE PLAN

In addition to the Preliminary Structure Site Plan requirements of Section 201.2.2, the Final Structure Site Plan should show the following information in plan view: bridge width and approach pavement widths, showing curb or parapet lines and outer limits of the superstructure and substructure units; skew with respect to the centerline of a substructure unit (not to centerline of stream or centerline of tracks); lateral clearances (both the minimum required and the actual) with respect to railroad tracks or highways under the proposed structure; location of minimum all prebored holes in the plans. For design purposes, ignore the effect of skin friction along the length of the prebored holes. The length shall be the height of the new embankment at each pile location.

202.2.3.2.h SCOUR CONSIDERATIONS

Where the scour evaluation has identified a potential problem, any pile resistance provided by soil in the scour zone shall be neglected. The depth of scour resulting from the design flood shall be considered at the Strength and Service Limit States. The depth of scour resulting from the check flood shall be considered at the Extreme Event II Limit State.

For friction piles, the soil within the scour zone provides side resistance during pile installation. Therefore, the Ultimate Bearing Value must also include the side resistance from the soil within the scour zone. Determine this larger Ultimate Bearing Value using the procedure shown below. A plan note is available in BDM Section 600.

$$R_{ndr} = \frac{\sum \eta_i \gamma_i Q_i}{\phi_{DYN}} + R_{Ssc}$$

Where:

R_{ndr} = Ultimate Bearing Value (Kips)

$\sum \eta_i \gamma_i Q_i$ = Total factored load for highest loaded pile at each substructure unit (kips)

$\mathbf{N}_{DYN}$ = Resistance factor for driven piles. (See BDM Section 202.2.3.2.b)

R_{Ssc} = Additional amount of Ultimate Bearing Value to account for side friction that must be overcome during driving through the scour zone. This value is equal to the nominal (i.e. **unfactored**) side resistance for the soil in the scour zone and shall be calculated using static analysis methods, *LRFD 10.7.3.8.6.* (kips)

Determine the estimated length for friction piles using static analysis methods to calculate the length of pile necessary to develop the larger Ultimate Bearing Value as described in BDM Section 202.2.3.2.b.

Because the pile will lose support along the scour depth, the Designer should investigate the structural capacity of the pile considering the depth of the scour as an unbraced length. The maximum factored structural resistances listed in BDM Section 202.2.3.2.a do not apply.

202.2.3.2.i UPLIFT RESISTANCE OF PILES

When a pile must resist uplift loads, the uplift resistance shall be calculated in accordance with *LRFD 10.7.3.10.* Use static analysis methods (*LRFD 10.7.3.8.6*) to determine the nominal uplift resistance due to side resistance.

Where the estimated pile length is controlled by the required uplift resistance, specify a minimum penetration pile tip elevation. A plan note is available in BDM Section 600.

The Ultimate Bearing Value is not shown on the plans for piles driven to a tip elevation, so the plans must specify the minimum pile wall thickness for cast-in-place reinforced concrete piles. Perform a drivability analysis to estimate the nominal driving resistance at the required tip elevation. Calculate the minimum pile wall thickness using the formula in CMS 507.06, with the Ultimate Bearing Value equal to the nominal driving resistance.

202.2.3.3 DRILLED SHAFTS

Drilled shafts should be considered when their use would:

A. Prevent the need of cofferdams

B. Become economically viable due to high design loads (eliminates the need of large quantities of pile)

C. Provide protection against scour

D. Provide resistance against lateral and uplift loads

E. Accommodate sites where the depth to bedrock is too short for adequate pile embedment but too deep for spread footings

F. Accommodate the site concerns associated with pile driving process (vibrations, interference due to battered piles, etc.).

Drilled shafts shall be designed in accordance with *LRFD 10.8* and constructed in accordance with CMS 524.

Drilled shafts that support pier columns shall be 6 in. [150 mm] larger in diameter than the pier column diameter. The minimum diameter for drilled shafts that support pier columns shall be 42 in. [1065 mm]. The minimum diameter for all other drilled shafts shall be 36 in. [915 mm]. Drilled shaft diameters of less than 36 in. [915 mm] are not recommended.

Underreams or belled shafts should not be used. Belled shafts are difficult to construct under water or slurry and the bell will collapse in non-cohesive soils. Cleaning and inspecting the base of the drilled shaft within the bell are also very difficult.

Drilled shaft diameters shall be shown on the Final Structure Site Plan. For drilled shafts with friction type design, the tip elevation shall also be shown. For drilled shafts supported on bedrock, the tip elevation should not be given. Instead, the approximate top of the bedrock elevation and the length of the bedrock socket shall be shown in the profile view on the Final Structure Site Plan.

Designers should neglect the contribution to skin friction provided by the top 2 ft. [610 mm] of the rock socket.

The Foundation Report shall include the following drilled shaft information:

A. Unfactored unit tip resistance, q_p (ksf)

B. Unfactored unit side resistance, q_s for each soil layer contributing to the nominal shaft side resistance (ksf)

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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

A. Discharges shall be estimated using StreamStats, a USGS web based application for estimating stream flow statistics and basin characteristics on unregulated streams. StreamStats supersedes USGS Report 89-4126 and is available at: http://water.usgs.gov/osw/streamstats/ohio.html. Just click on the link labeled: "Interactive Map". First-time users should familiarize themselves with the on-line StreamStats Limitations, Definitions and User Instructions.

For urban drainage areas less than 4 square miles [10.4 km^2] discharges shall be estimated by the method described in USGS Water-Resources Investigations Report 93-135, "Estimation of Peak Frequency Relations, Flood Hydrographs, and Volume-Duration-Frequency Relations of Ungaged Small Urban Streams in Ohio".

B. Discharge estimates may be calculated by other methods for comparison with StreamStats against verified flood elevations and other known river data to ensure that the most realistic discharge for the area is used for the design of the waterway opening. Calculations and comparisons shall be submitted for review.

C. Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP) Flood Insurance Studies; U.S. Corps of Engineer Flood Studies; U.S. Soils Conservation Studies; U.S. Water Resources Data and other reliable sources may be used as reference information in estimating discharges and flood elevations. However, for waterway crossings located in a NFIP study area, the base discharge (Q_{100}) from the NFIP study takes precedence over all other calculated discharges.

D. Where a U.S. Geological Survey estimate is in conflict with that of another agency, the agencies should be contacted in order that the discrepancy can be resolved. In general, the U.S. Geological Survey estimate shall be given preference.

E. Proposed structures upstream or downstream from a flood control facility shall be designed for discharges as supplied by the U.S. Corps of Engineers, Ohio Department of Natural Resources or the agency responsible for the flood control facility.

203.2 HYDRAULIC ANALYSIS

A. The design flood frequency shall be based on the importance of the highway and the design

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The following table, relating bridge channel mean velocity of the design discharge versus rock type and thickness, shall apply as minimums. Special circumstances such as protection on the outside of curves or in northern regions of the state where ice flow is a concern may require greater rock thickness.

Velocity (ft/s)	Type	Thickness
0-8	C	2'-0"
8-10	B	2'-6"
above 10	A	3'-0"

Velocity (m/s)	Type	Thickness
0-2.4	C	600 mm
2.4-3.0	B	750 mm
above 3.0	A	1000 mm

The locations, length, and the top of slope elevations for the rock channel protection should be shown on the Site Plan. The rock should be shown in greater detail in the roadway section in conjunction with the channel plans. It will generally be economical to provide bank protection during the initial construction in order to provide sufficient embankment protection to minimize future maintenance.

A. Excavation for stream channel work shall be limited to that portion of the channel one foot [300 mm] above normal water elevation in order to minimize intrusion and to preserve the natural low water channel. Where the spill-thru slope infringes upon the natural low water channel, excavation should be made for placement of the rock channel slope protection at the toe of the slope.

B. Substructures for bridges over waterways shall be supported by piling or drilled shaft foundations unless the footings can be founded on bedrock. Substructures for precast reinforced concrete three-sided flat-topped and arch culverts are addressed in the Location and Design Manual, Volume 2.

C. 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.

D. A scour evaluation shall be performed for all bridges not founded on scour resistant shale or bedrock. When evaluating scour for a replacement structure, review all inspection reports for evidence of stream degradation (lowering of stream bed), scour or previous scour countermeasures. Scour depths are to be calculated with the equations in HEC-18 (Hydraulic Engineering Circular No. 18, Pub. No. FHWA NHI 01-001), "Evaluating Scour at Bridges". The text of HEC-18 should be read in order to understand scour and river mechanics. The references cited in Chapter 3 of HEC-18 are also helpful in understanding the concepts of scour and river mechanics. Scour depths should be considered in the design of the substructures and the location of the bottom of footings and minimum tip elevations for piles and drilled shafts.

A value of Q500 should be used as the super flood is to be estimated by 1.3 x Q100.

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 designer and project manager shall coordinate with the ODOT District Environmental Coordinator and the ODOT Office of Environmental Services – Waterway Permits Unit 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; the amount of fill placed below ordinary high water, BDM Section 201.2.2; 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; etc.) and shall ensure the project waterway SPP are submitted with the Final Plan Package.

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:

$D = T + 0.50Y$

Where:

T = Thickness of footing in feet [meters]

Y = distance from bottom of stream bed to surface of bedrock in feet [meters]

The footing depth from the above formula shall place the footing not less than 3 inches [75 mm] into the bedrock.

204.2 EARTH BENCHES AND SLOPES

A bench at the face of abutment shall not be used.

Spill thru slopes should be 2:1, except where soil analysis or existing slopes dictates flatter slopes. The slope is measured normal to the face of the abutment.

For superelevated bridges over waterways, the intersection of the top of slope with the face of abutment shall be on a level line. For other superelevated structures the top of slope shall generally be made approximately parallel to the bridge seat. For structures over streets and roads having steep grades, the intersection of earth slope and face of abutment may be either level or sloping dependent upon which method fits local conditions and gives the most economical and

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204.6.1 DESIGN CONSTRAINTS

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

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

B. Deflection and/or differential settlements

C. Accessibility to the construction site

D. Aesthetics, including wall textures

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

F. Cost (approximate cost analysis)

G. Stage construction

H. Stability (long-term and during construction)

I. Railroad policies

204.6.2 STAGE 1 DETAIL DESIGN SUBMISSION FOR RETAINING WALLS

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

204.6.2.1 PROPRIETARY WALLS

If a proprietary wall is justified, the Design Agency shall include the following information in the Stage 1 Detailed Design Submission: wall alignment; footing elevations; factored bearing resistance at the leveling pad elevation; a global stability analysis; the effect of settlement and settlement calculations; and any construction constraints, such as soil improvement methods, that may be required. Refer to Section 303.5 for plan requirements for Detail Design.

The alignment of proprietary retaining walls should be straight and with as few corners or curves as is practical. When changes in wall alignment are required, use gradual curves or corners with an interior angle of at least 135 degrees whenever possible. Do not use corners with interior angles of less than 90 degrees (acute corners).

The design of the wall shall be in conformance with the 4th Edition of the *AASHTO LRFD Bridge Design Specifications* and the following:

A. Determine the height of the wall (h) for minimum soil reinforcement lengths as follows:

   1. When the surface of the retained soil is level, measure (h) from the top of the concrete

leveling pad to the top of the concrete coping.

2. When the surface of the retained soil is sloping, measure (h) as shown in *LRFD Figure 11.10.7.1-1b*.

3. If the wall will be located at an abutment, measure (h) from the top of the concrete leveling pad to the profile grade elevation at the face of the wall.

B. Determine the minimum soil reinforcement length to meet external stability requirements (sliding, bearing resistance, overturning, overall global stability). However, the minimum soil reinforcement length shall not be less than 70% of the wall height (h) or 8'-0" [2.5 m], whichever is greater. Generally, the soil reinforcement length should not be greater than 150% of the wall height (h).

C. The thickness of the unreinforced concrete leveling pad shall not be less than 6 inches [150 mm]. The minimum distance from the top of the leveling pad the ground surface at a point located 4'-0" [1.2 m] from the face of the wall shall be the larger of 3'-0" [900 mm] or the frost depth. Refer to Figure 303.5.1-4 for more information.

D. The minimum thickness of the precast reinforced concrete face panels may be assumed to be 5½ inches [140 mm].

E. The maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent. Provide slip joints if the estimated differential settlement is greater than one (1) percent.

F. Use the following soil parameters for design:

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

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

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

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

I. For MSE walls supporting abutments on spread footings, the minimum distance between the back face of the MSE wall panels and the toe of the bridge abutment footing shall be 3'-0"

[915 mm] and the minimum distance between the back face of the MSE wall panels and the centerline of the abutment bearings shall be 5'-0" [1525 mm].

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

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

L. The bearing pressure at the service limit state for a spread footing abutment placed on an MSE wall embankment shall be less than or equal to 4 ksf [190 kPa]..

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

204.6.2.2 CAST-IN-PLACE WALLS

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

204.6.2.3 OTHER WALLS

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

205 SUPERSTRUCTURE INFORMATION

205.1 TYPE OF STRUCTURES

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

205.2 SPAN ARRANGEMENTS

The length of a bridge will be determined by the requirements for horizontal clearance at grade

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(highway or railway) separations or by the requirements for waterway opening at stream crossings. Typically for any given bridge, there are a number of combinations of spans and lengths of spans that can be utilized. Generally a preferred span arrangement that minimizes the number of substructure units should be used (i.e. fewer piers with longer spans).

For grade separation structures spanning any divided highway a two-span bridge with spill-thru slopes is preferred.

For waterway crossings, one or three span bridges are typically used. This span arrangement is preferred so that a pier is not located in the middle of the waterway. If a series of precast, three-sided structures are used to produce a multiple span structure over a waterway, spread footings on soil shall not be used to support any of the precast structures.

When a multiple span arrangement (4 spans or more) is required, the Cost Analysis should examine the most economical number of spans required based on total bridge costs, including a substructure and superstructure cost optimization study. Site conditions will govern the location of substructure units with respect to required horizontal clearances, foundation conditions and appearance.

On structures with steep grades, the designer should account for the load effects of the grade on the substructure units.

205.3 CONCRETE SLABS

Cast-in-place concrete slabs are normally used where site geometry dictates a curved alignment or variable superelevation and the use of prestressed concrete box beams is impractical. Since concrete slabs will generally yield the least superstructure depth they should be considered when vertical clearance is limited. For stream crossings where flood waters often inundate the structure, a concrete slab should be considered. When using cast-in-place concrete slabs the construction clearance requirements of the falsework should be considered.

205.4 PRESTRESSED CONCRETE BOX BEAMS

The span limits for prestressed, side by side, concrete box beams generally range from 15 to 100 feet [5 to 30 meters]. These span limits are based on designs with 0.167 in^2 [108 mm^2] low relaxation strands, a concrete 28-day compressive strength of 7000 psi [48.3 MPa], and a release strength of 5000 psi [34.5 MPa]. Prestressed box beams of up to 120 foot spans [36 meters] have been designed using 10,000 psi [68.9 MPa] concrete and larger diameter strands. Concrete compressive strengths should be limited to 5000 psi [34.5 Mpa] at release and 7000 psi [48.3 Mpa] at 28-days. Consult the Office of Structural Engineering for recommendations prior to designing a structure with higher compressive strengths.

The skew angle should be limited to a maximum of 30 degrees. Consult the Office of Structural Engineering for recommendations prior to designing a box beam structure with a higher degree

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. On bridges without MSE walls at the abutments and where the pavement flow from the deck is no more than 0.75 ft^3/s [0.021 m^3/s], a sodded flume, as shown on Standard Construction Drawing DM-4.1, should be provided. Six feet [2 meters] of excelsior matting shall be placed on each side of the flume. On grade separation structures with 2:1 approach embankment slopes and where the pavement flow from the deck exceeds 0.75 ft^3/s [0.021 m^3/s], an integral curb shall be provided on the approach slab with a standard catch basin located off the approach slab in lieu of the sodded flume. At the trailing end of bridge barriers, a bridge terminal assembly is required to protect this curb. The catch basin should be a Catch Basin No. 3A, as shown on Standard Construction Drawing CB-2.2. A properly sized conduit (Type F, 707.05 Type C) shall be used to provide an outlet down the embankment slope and the outlet shall be armored to prevent erosion.

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

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

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

209.4 SLOPE PROTECTION

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

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

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

209.5 APPROACH SLABS

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

L = [1.5(H + h + 1.5)]) Cos θ # 30 ft

L = [1.5(H + h + 0.45)]) Cos θ # 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.

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

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],

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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.

209.8 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 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 4'-6" [1370 mm] high. A smooth rub rail should be provided at a height of 3'-6" [1065 mm]. 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 448, 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 301.4.1 for additional design guidance.

If a timber deck is used, a 1½ inch [38 mm] minimum thickness of Item 448, 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.

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designed to transfer all loads.

302 SUPERSTRUCTURE

302.1 GENERAL CONCRETE REQUIREMENTS

302.1.1 CONCRETE DESIGN STRENGTHS

A. Superstructure Concrete (Class S, HP or QSC2)..4500 psi [31.0 MPa]

B. Substructure Concrete (Class C, HP or QSC1)...4000 psi [27.5 MPa]

C. Drilled Shaft Concrete (Class S Modified)..4000 psi [27.5 Mpa]

302.1.2 SUPERSTRUCTURE CONCRETE TYPES

302.1.2.1 CLASS S & HP CONCRETE, QC/QA CONCRETE FOR STRUCTURES & CONCRETE WITH WARRANTY

Class S Concrete is the Department's traditional concrete mix design for superstructures.

Class HP (High Performance) Concrete mix designs are intended to give a highly dense, very impermeable concrete resulting in a longer structure life. When Class HP Concrete is specified, the Designer shall include the bid item for Class HP Concrete Test Slab. However, the bid item for Class HP Concrete Testing is no longer required because the Department has acquired sufficient test data since the inception of High Performance Concrete.

QC/QA Concrete for Structures, SS898, is a contractor designed mix that meets minimum requirements for strength, permeability and air content. QC/QA Concrete is divided into three classes: substructure (QSC1), superstructure (QSC2) and project specific (QSC3). The contractor assumes responsibility for quality control sampling and testing. Final payment for in-place concrete includes incentives for concrete meeting or exceeding minimum requirements and disincentives for concrete not meeting minimums. QC/QA concrete should not be considered for pay items with less than 100 yd^3 [75 m^3] of concrete.

Class S Concrete for New Bridge Decks with Warranty, SS893, and Class HP Concrete for New Bridge Decks with Warranty, SS894, are standard Class S and HP mix designs that warrant the concrete for a period of seven years against scaling, spalling and cracking. Remedial measures required during the warranty period are to be performed by the original Contractor.

The mix design, curing and placing requirements for both Class S and HP concretes are defined in the CMS.

302.1.2.2 SELECTION OF CONCRETE FOR BRIDGE STRUCTURES

The following concrete types may be specified for superstructure concrete:

A. Class S Concrete

B. Class HP Concrete

C. Class S Concrete for New Bridge Decks with Warranty

D. Class HP Concrete for New Bridge Decks with Warranty

E. QC/QA Concrete Class QSC2

F. QC/QA Concrete Class QSC3

The following concrete types may be specified for substructure concrete:

A. Class C Concrete

B. Class HP Concrete

C. QC/QA Concrete Class QSC1

Contact the District to confirm the selection of concrete type to be used for a specific structure.

High performance concrete shall not be used as a replacement for the drilled shaft concrete specified in 524.

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. 1½ inches [38 mm] of Item 448 Asphalt Concrete Surface Course, Type 1H.

   2. 1½ inches [38 mm] minimum thickness of Item 448 Asphalt Concrete Intermediate Course, Type 2, PG64-28.

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

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

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

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

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

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

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

302.2 REINFORCED CONCRETE DECK ON LONGITUDINAL MEMBERS

302.2.1 DECK THICKNESS

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

Tmin (inches) = (S + 17)(12) ÷ 36 $ 8½0

Tmin (mm) = (S + 5200) ÷ 36 $ 215 mm

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

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

302.2.2 CONCRETE DECK DESIGN

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

Deck designs for superstructures with effective span lengths ranging from 7.0 ft. to 14.0 ft. in 0.5 ft. increments are provided in Figures 302.2.2-1, 302.2.2-2 and 302.2.2-3. These designs apply for the full length of the bridge and preclude the need for additional transverse reinforcement at supported deck ends. The design of overhang reinforcement is valid for BR-1 (36.0 & 42.0 in.), SBR-1-99, BR-2-98 and TST-1-99 barrier systems. A complete list of design assumptions is

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provided with Figure 302.2.2-1.

Transverse spacing of the top and bottom reinforcing in a deck design shall meet section 302.2.4.2.

302.2.3 SCREED ELEVATIONS

Screed elevations shall be furnished to ensure that the bridge deck, including the gutters or deck edges, is completed at its correct elevation.

The bridge plans shall include a diagram or table showing the elevations at the top of the concrete deck that are required before the concrete is placed. Elevations should be shown for all curblines, crownlines, phased construction lines and above all steel beam, girder or prestressed I-beam lines for the full length of the bridge. Bearing points, quarter-span points, mid-span points and splice points shall be detailed as well as any additional points required to meet a maximum spacing between points of 30'-0" [10 meters].

Cases of special geometry, i.e. spirals, horizontal or vertical curves, superelevation transitions, etc., will require additional elevation points to define the concrete deck screed elevations. A sufficient number of screed elevations must be provided so the contractor is not forced to interpolate or make assumptions in the field.

The designer shall furnish all elevation points to allow the proper construction and finishing of the deck.

For bridges with a separate wearing course, the elevations given should be those at the top of the portland cement concrete deck. Provide a plan note stating at what surface the elevations are given in order to eliminate any confusion.

Screed elevations are not required for non-composite box beam bridges or slab bridges. Screed elevations for composite box beam bridges shall meet the same requirements as steel beam, girder and prestressed I-beams; except, elevations are not required above each beam.

302.2.4 REINFORCEMENT

302.2.4.1 LONGITUDINAL

Secondary reinforcement in the top-reinforcing layer of a reinforced concrete deck on steel or concrete stringers shall be approximately 1/3 of the main reinforcement, uniformly spaced.

Research has shown that secondary bars in the top mat of reinforced concrete bridge decks on stringers should be small bars at close spacing. Therefore the required secondary bar size shall be a #4 [#13M]. The only exception to this requirement is if the bar spacing becomes less than 3 inches [75 mm].

completed, the designer should confirm with local galvanizers if a local plant can galvanize the structural members detailed.

Since standard holes may become partially filled with galvanizing, bolted splice designs will require a non-standard hole size equal to the nominal bolt diameter plus 1/8". Bolted crossframes will be required due to field installation issues. Bolted cross frames as detailed in the Standard Bridge Drawing may be specified.

Field welding of end crossframes, intermediate cross frames and bearings is not acceptable because welding onto galvanizing causes damage to the coating and no quality touch-up system is available to handle the number of repairs required.

302.4.2.2 STIFFENERS

Intermediate stiffeners shall only be used when required for cross frames. Stiffeners shall be a minimum 3/8 inch [10 mm] thickness and wide enough to make an adequate and easily accessible cross frame connection. Stiffeners generally should not extend beyond the edge of flange.

Stiffener plates shall have corners in contact with both web and flange clipped. The clip dimensions shall be one inch [25 mm] horizontally and 2½ inches [65 mm] vertically. Dimensions are shown on the Standard Bridge Drawing.

Both sides of the stiffener shall be fillet welded to the beam web and both flanges.

302.4.2.3 INTERMEDIATE CROSS FRAMES

For structures with the stringers placed on tangent alignments, detail cross frames as follows:

A. Cross frames for rolled beams shall be connected directly to the web or to intermediate web stiffeners.

B. Cross frames shall be perpendicular to stringers and be in line across the total width of the structure.

C. Cross frame spacings between points of dead load contraflexure in the positive moment regions shall not exceed 25 ft [7.6 m].

D. Cross frame spacings between points of dead load contraflexure in the negative moment regions shall not exceed 15 ft [4.6 m].

E. Horizontal legs of cross frame angles shall align on both sides of the stringer.

See the General Steel Details Standard Bridge Drawing for standard cross frame configurations.

For structures with flared stringers, the following exceptions apply:

A. If the differential angle between individual stringers is 5 degrees or less, the cross frames shall be perpendicular to one stringer and in line across the total width of the structure.

B. If the differential angle between individual stringers is greater than 5 degrees, the differential angle shall be divided evenly between connections to both stringers.

The design plans shall show:

A. The maximum cross frame spacing for each region along the length of the stringer. Actual spacing of the cross frames should be left to the steel fabricator's detailer .

B. The typical cross frame details or reference to the General Steel Details Standard Bridge Drawing for standard cross frame configurations. If a design requires a specific location of cross frames, clearly show the cross frame locations that cannot be adjusted.

A detail showing a completely bolted connection for cross frame to the steel member is shown in the Standard Bridge Drawing.

Holes for erection bolts are normally provided in the connection of cross frames to stiffeners. Refer to the Standard Bridge Drawing for details.

In phased construction of new steel structures cross frames should not be permanently attached between phases until all deadload (deck, parapet, etc.) has been applied to the members. The crossframes can then be permanently attached and a deck closure pour can be completed to finish the superstructure. See Section 302.2.9.

For curved or flared bridges with "dog-legged" stringers, cross frames should be placed near the bend points. The cross frames should be located approximately 1 foot [300 mm] from the bend point but not interfere with the splice material. The cross frame should be placed normal to the stringer used to set the 1 foot [300 mm] clearance dimension and should be connected to the adjacent stringer only on the same side of the centerline of the splice. The cross frame units should be similar to standard cross frames but should have an additional horizontal angle near the top flange of the stringers.

See Figure 302.4.2.3-1 for plan view layout of cross frames for dog-legged stringers.

Cross frames for curved stringers may be one of the types shown on the Standard Bridge Drawing with an additional top strut. The designer shall confirm that the standard cross frames and their connections meet the additional loading developed in a curved member design. Since

302.5.1.2 STRANDS

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

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

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

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

302.5.1.2.a TYPE, SIZE OF STRANDS

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

   Low-relaxation 12.7 mm diameter (A_S = 99 mm^2) seven wire uncoated strands, ASTM A416M, Grade 270.

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

   Low-relaxation 12.7 mm diameter (A_S = 108 mm^2) seven wire uncoated strands, ASTM A416M, Grade 270.

C. Low-relaxation 0.6 inch diameter (A_S = 0.217 in^2) seven wire uncoated strands, ASTM A416, Grade 270.

   Low-relaxation 15.24 mm diameter (A_S = 140 mm^2) seven wire uncoated strands, ASTM A416M, Grade 270.

Consult the Office of Structural Engineering and the Ohio/Indiana/Kentucky Prestressed Concrete Institute prior to specifying 0.6 inch [15.244 mm] diameter or larger strand sizes.

302.5.1.2.b SPACING

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

The location of the centerline of the first row of strands shall be 2 inches [50 mm] from the bottom of the beam. If possible, all strands shall be completely enclosed by the #4 [#13M] stirrup bars. For designs that cannot meet this requirement, the minimum distance from the side of the beam to the centerline of the first strand shall be 2 inches [50 mm]. Strands near the top flange shall be placed below all transverse and longitudinal reinforcing steel and to the left and right of the void.

302.5.1.2.c STRESSES

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

Initial stress .... $0.75\ f'_s$ = 202,500 psi

Initial tension load .... 30,982 lb/strand (A_S = 0.153 in^2)

33,818 lb/strand (A_S = 0.167 in^2)

Initial stress .... $0.75\ f'_s$ = 1400 Mpa

Initial tension load .... 138 600 N/strand (A_S = 99 mm^2)

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

302.5.1.3 COMPOSITE

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

On multiple span composite box beam bridges additional longitudinal reinforcing steel over the piers is required. The additional bars shall be alternately spaced with the standard longitudinal reinforcement and the pier bar's length shall be equal to the larger of: 40 percent of the length of the longer adjacent stringer span or a length that meets the requirements of *LRFD 5.11.1.2.3*. The pier bars should be placed longitudinally and approximately centered on the pier but with a 3 foot [1000 mm] stagger.

In the negative moment regions of structures made continuous over the piers, the tensile stresses in the precast section shall not exceed the AASHTO allowable stresses for members with bonded reinforcement. 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 302.5.1.3-1 for a sketch of the cross-section of the composite deck superstructure.

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

Cast-in-place concrete, (composite decks, pier diaphragms, intermediate diaphragms, etc.) Shall be Class S or HP superstructure concrete - 4500 psi [31.0 MPa] at 28 days.

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

302.5.2.9 REINFORCING

Unless otherwise specified all reinforcing steel used shall be epoxy coated, Grade 60 [420] F_y = 60 ksi [420 MPa].

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

Reinforcing bars projecting from the prestressed members shall be epoxy coated.

Reinforcing steel stirrups shall completely enclose the strands for the entire length of the beam.

For composite designs the total amount of longitudinal reinforcing steel over the piers, for the deck slab shall be determined in accordance to AASHTO.

302.5.2.10 TRANSPORTATION & HANDLING CONSIDERATIONS

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

303 SUBSTRUCTURE

303.1 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE

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

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

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

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

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

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

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

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

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

303.2 ABUTMENTS

303.2.1 GENERAL

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

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

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

To allow for slight tilting of wall type abutments after the backfill has been placed, batter the front face 1/16" for each foot [5 mm for each 1000 mm] of abutment height. Height is measured from bottom of footing to the roadway surface.

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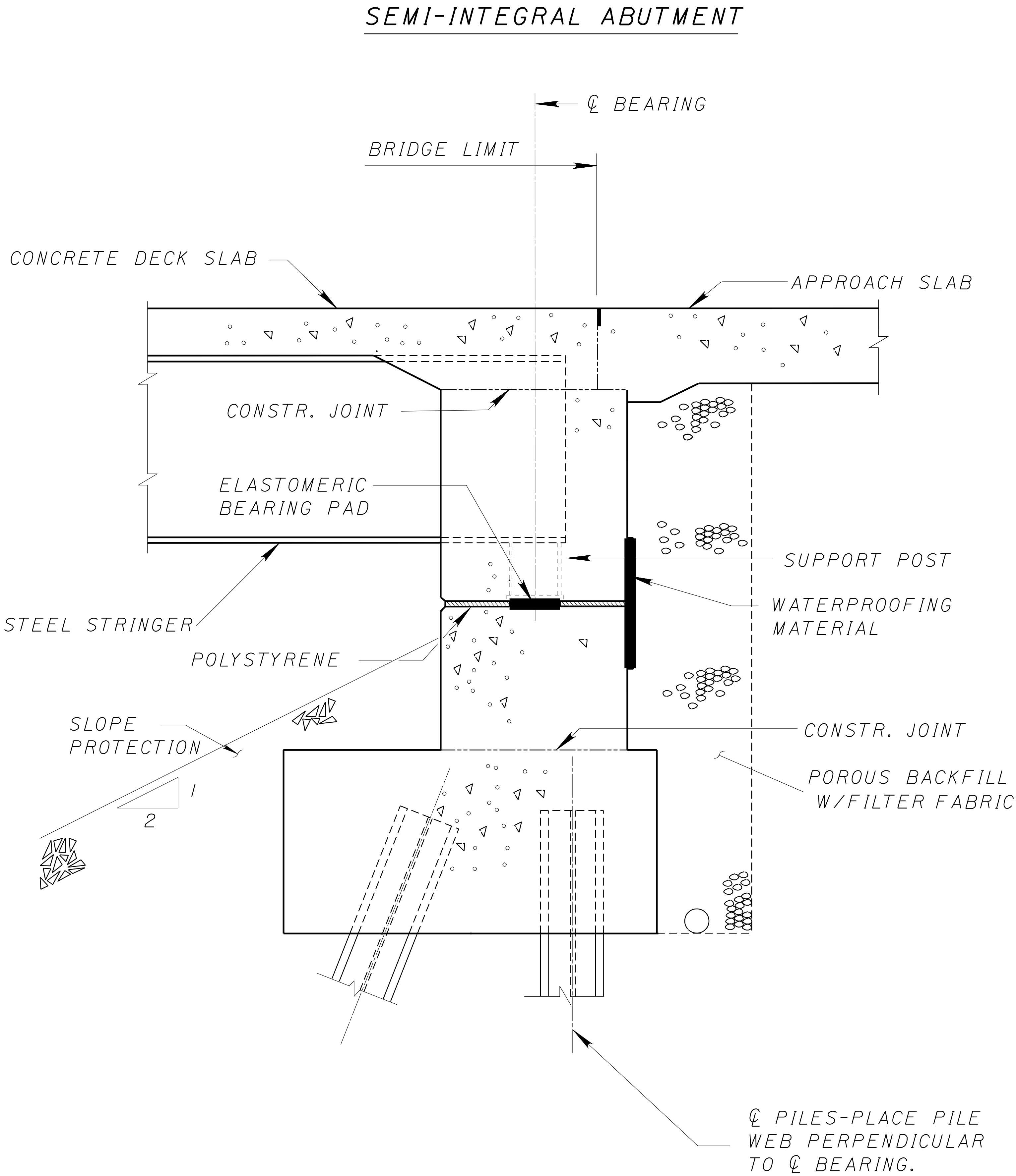
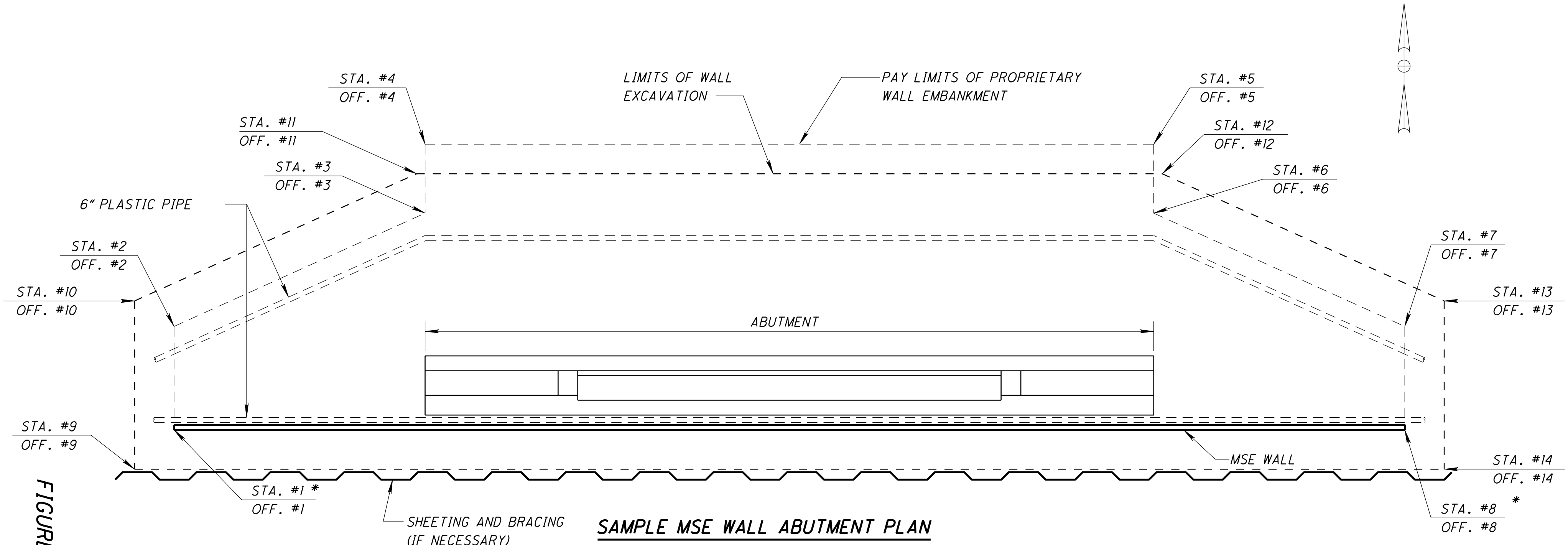


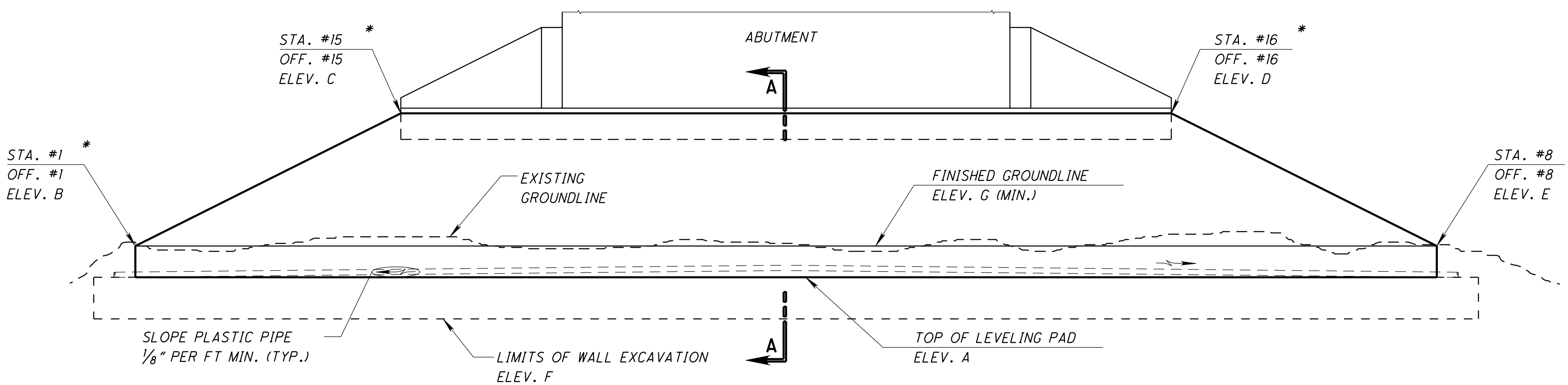
Figure 303.2.2.7-1



SAMPLE MSE WALL ABUTMENT PLAN

* - MEASURED TO FRONT FACE OF MSE WALL FACING PANELS

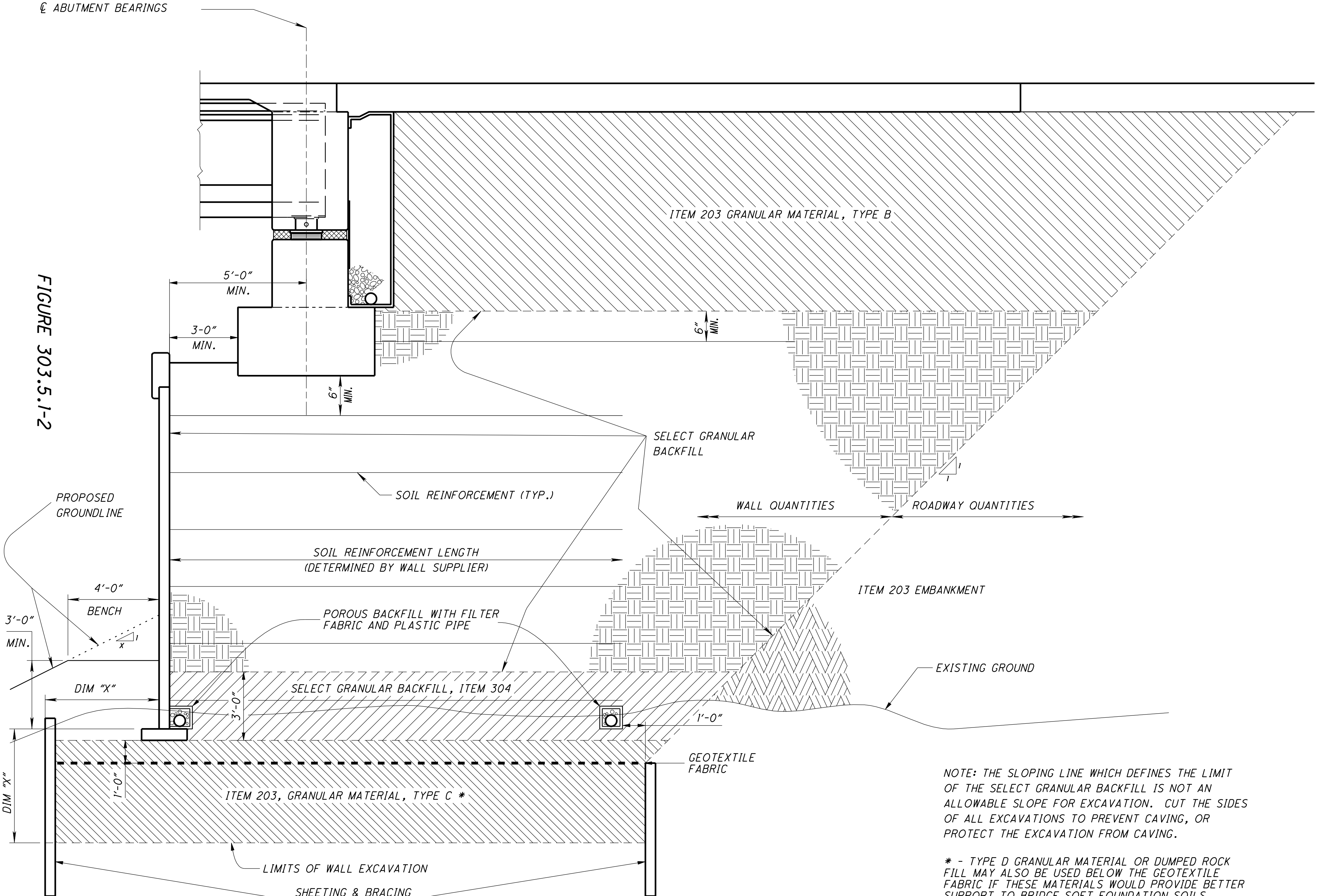
SEE FIGURE 330 FOR SECTION A-A (WITH ABUTMENT SUPPORTED ON SPREAD FOOTING AND ADDITIONAL WALL EXCAVATION)
SEE FIGURE 331 FOR SECTION A-A (WITH ABUTMENT SUPPORTED ON PILES)



SAMPLE MSE WALL ABUTMENT ELEVATION

* - MEASURED TO FRONT FACE OF MSE WALL FACING PANELS

FIGURE 303.5.1-1



SECTION A-A

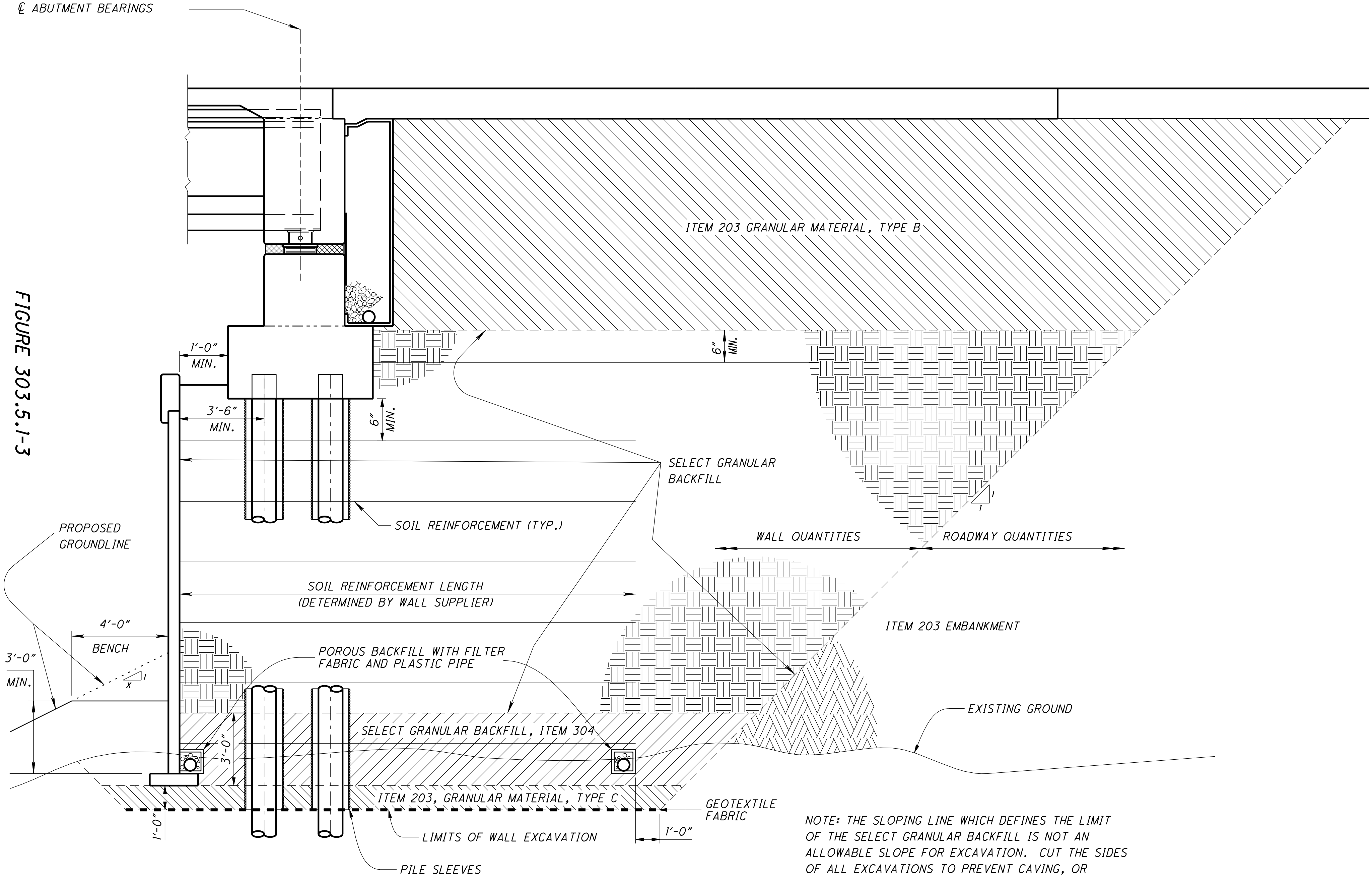
(ALL DIMENSIONS PERPENDICULAR TO MSE WALL)

NOTE: THE SLOPING LINE WHICH DEFINES THE LIMIT OF THE SELECT GRANULAR BACKFILL IS NOT AN ALLOWABLE SLOPE FOR EXCAVATION. CUT THE SIDES OF ALL EXCAVATIONS TO PREVENT CAVING, OR PROTECT THE EXCAVATION FROM CAVING.

* - TYPE D GRANULAR MATERIAL OR DUMPED ROCK FILL MAY ALSO BE USED BELOW THE GEOTEXTILE FABRIC IF THESE MATERIALS WOULD PROVIDE BETTER SUPPORT TO BRIDGE SOFT FOUNDATION SOILS.

FIGURE 303.5.1-2

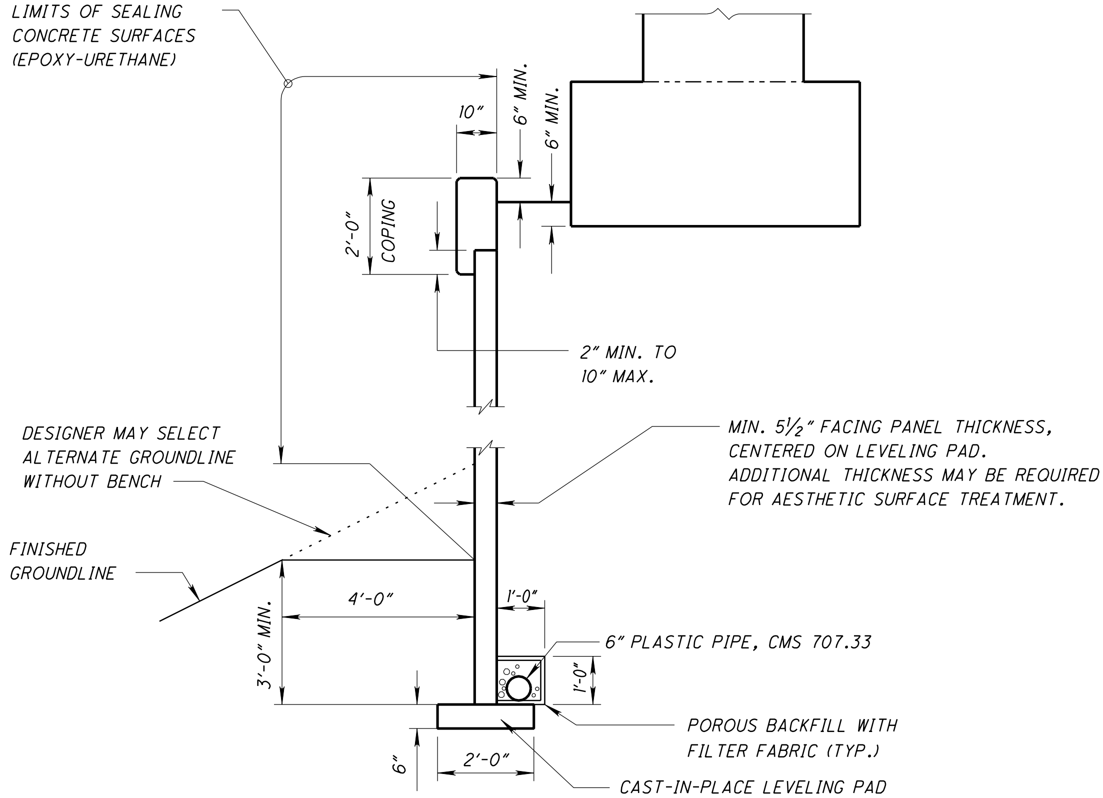
FIGURE 303.5.1-3



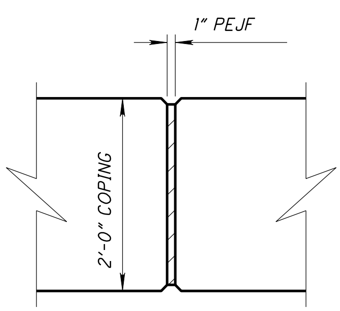
NOTE: THE SLOPING LINE WHICH DEFINES THE LIMIT OF THE SELECT GRANULAR BACKFILL IS NOT AN ALLOWABLE SLOPE FOR EXCAVATION. CUT THE SIDES OF ALL EXCAVATIONS TO PREVENT CAVING, OR PROTECT THE EXCAVATION FROM CAVING.

SECTION A-A

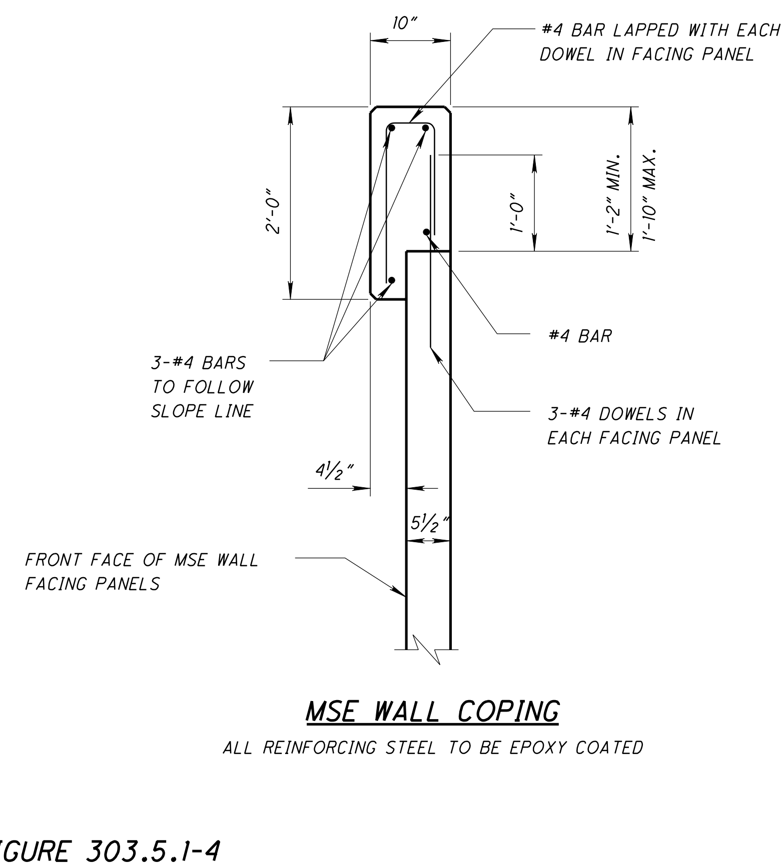
(ALL DIMENSIONS PERPENDICULAR TO MSE WALL)



MSE WALL AND COPING DETAIL



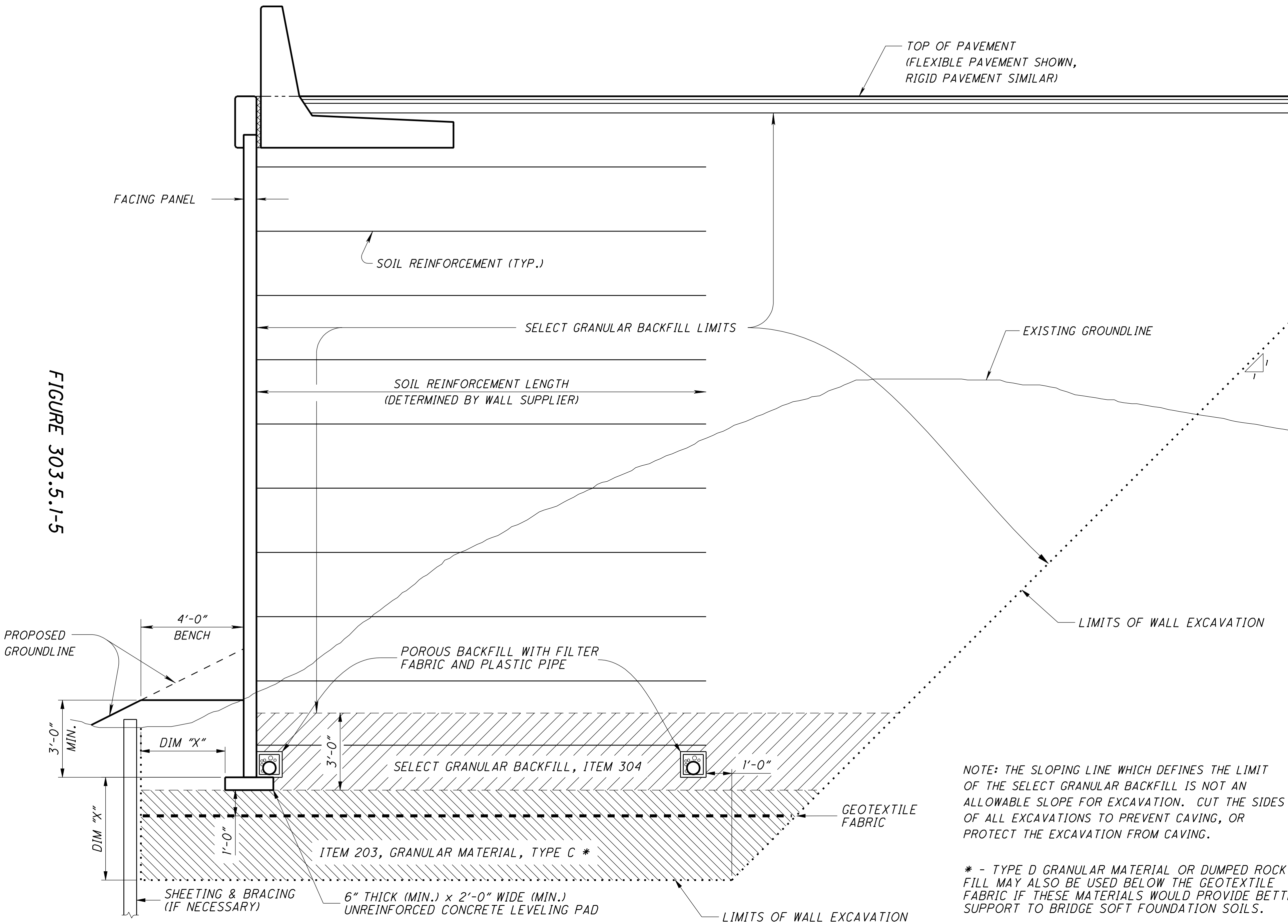
COPING EXPANSION JOINTS



MSE WALL COPING

ALL REINFORCING STEEL TO BE EPOXY COATED

FIGURE 303.5.1-4



NOTE: THE SLOPING LINE WHICH DEFINES THE LIMIT OF THE SELECT GRANULAR BACKFILL IS NOT AN ALLOWABLE SLOPE FOR EXCAVATION. CUT THE SIDES OF ALL EXCAVATIONS TO PREVENT CAVING, OR PROTECT THE EXCAVATION FROM CAVING.

* - TYPE D GRANULAR MATERIAL OR DUMPED ROCK FILL MAY ALSO BE USED BELOW THE GEOTEXTILE FABRIC IF THESE MATERIALS WOULD PROVIDE BETTER SUPPORT TO BRIDGE SOFT FOUNDATION SOILS.

FIGURE 303.5.1-5

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[602.3-2] DESIGN DATA:

Concrete for prestressed beams:

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

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

Prestressing strand:

Area = __(3)__ in^2

Ultimate Strength = 270 ksi

Initial stress = 202.5 ksi (Low relaxation strands)

NOTE TO DESIGNER:

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

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

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

602.4 FOR RAILWAY PROJECTS

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

[602.4-1] DESIGN SPECIFICATIONS: Except for concrete and reinforced concrete items, this structure conforms to the requirements of the "Manual for Railway Engineering" by the American Railway Engineering and Maintenance-of -way Association, XXXX * Edition. Design of concrete and reinforced concrete conforms to the "LRFD Bridge Design Specifications", AASHTO, XXXX * including the XXXX * Interim Specifications and the ODOT Bridge Design Manual, 2007.

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

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

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

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

602.5 DECK PROTECTION METHOD

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

[602.5-1] DECK PROTECTION METHOD:

Epoxy coated reinforcing steel

2½" concrete cover

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

Waterproofing and asphalt concrete overlay

Steel drip strip

Other (Specify)

602.6 MONOLITHIC WEARING SURFACE

Furnish the following note for concrete bridge decks.

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

602.7 SEALING OF CONCRETE SURFACES

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

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

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

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

603 EXISTING STRUCTURE REMOVAL NOTES

603.1 GENERAL REMOVAL NOTES

The following sample notes will serve as a guide in composing the note(s) for the removal of the existing structure. Modify the notes as required to fit the conditions. Use the following note if it is the desire of the owner to salvage any portion of the bridge.

[603.1-1] REMOVAL OF EXISTING STRUCTURE: Carefully dismantle the _________ and store along the right-of-way for disposal by the State's forces.

Describe the degree of care to be exercised in the removal in sufficient detail to allow accurate bidding. If this option is used, the pay item shall be "as per plan".

Use the following note when removal of structure to 1 foot [300 mm] below ground line as specified in CMS 202 will not fill the specific requirements of the project.

[603.1-2] ITEM 202, PORTIONS OF STRUCTURE REMOVED, AS PER PLAN:

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

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

Provide the following note when Static Load Testing is required according to Section 303.4.2.5. Modify the note as necessary to fit the specific condition.

[606.2-4] STATIC LOAD TEST: Perform dynamic testing on the first two production piles to determine the required blow count for the specified Ultimate Bearing Value. Perform the static load test on either pile. Do not over-drive the selected pile. Drive the third and fourth production piles to 75% and 85% of the determined blow count, respectively. The test piles and the reduced capacity piles shall not be battered. After installation of the first four production piles, cease all driving operations on piling represented by the static load testing for a minimum of 7 days. After the waiting period, perform pile restrikes on the static load test pile and each reduced capacity pile. The Engineer will review the results of the pile restrikes and establish the driving criteria for the remaining piling represented by the testing.

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

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

Provide the following note when battered friction piles are specified.

[606.2-5] BATTERED PILES: The blow count for battered piles shall be the blow count determined for vertical piles of the same Ultimate Bearing Value divided by an efficiency factor (D). Compute the efficiency factor (D) as follows:

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

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

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

The following note, modified to fit the specific conditions for the foundation required, will apply when uplift loads control the design of the pile. In this case, the piles are typically driven to a pile tip elevation and dynamic load testing of the pile is not performed.

[606.2-6] PILES DRIVEN TO TIP ELEVATION FOR UPLIFT: Drive the piles to the pile tip elevation shown on the plans. Do not perform dynamic load testing on piles driven to a tip elevation. Select the hammer size to achieve the required depth. Provide plain cylindrical casings with a minimum pile wall thickness of __(1)__ inch for piles driven to a tip elevation.

Abutment piles:

__(2)__ piles __(3)__ feet long, order length

NOTE TO DESIGNER:

(1) Specify the minimum pile wall thickness for cast-in-place reinforced concrete piles. Determine the minimum pile wall thickness from a pile drivability analysis. Remove this sentence if the piles are H-piles.

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

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

606.3 STEEL PILE POINTS

Use the following note where steel points are required, and see Section 202.2.3.2.a.

[606.3-1] ITEM 507, STEEL POINTS, AS PER PLAN: Use steel pile points to protect the tips of the proposed steel "H" piling. Furnish steel points from the following manufactures/suppliers: Associated Pile and Fitting Corporation, 262 Rutherford Blvd., Clifton, New Jersey 07014, phone: (973)773-8400, (800)526-9047, fax: (973)773-8442; International Construction Equipment, Inc., 301 Warehouse Drive, Matthews, North Carolina 28015, phone: (704)821-8200, (888)423-8721, fax: (704)821-8201; Dougherty Foundation Products, Inc., P.O. Box 688, Franklin Lakes, New Jersey 07417, phone: (201)337-5748, fax: (201)337-9022; Versa Steel Inc., 1618 N.E. First Ave., Portland, Oregon 97232, phone: (503)287-9822, (800)678-0814, fax: (503)287-7483; Versabite Piling Accessories, 1704 Tower Industrial Dr., Monroe, North Carolina 28110, phone: (800)280-9950, (704)225-1566, fax: (704)225-1567; or by a manufacturer that can furnish a steel point that is acceptable to Director. The material used for the manufacturing of pile points shall conform to ASTM A27/A27M 65/35 [450/240] – Class 2 – Heat Treated or AASHTO M103/M103M 65/35 [450/240] – Heat Treated. Weld the pile points to the pile in accordance with AWS D1.5 or the manufacturer's written welding procedure supplied to the engineer before the welding is performed. Submit a notarized copy of the mill test report to the Engineer.

606.4 PILE SPLICES

Provide the following note when H-piles are specified.

[606.4-1] PILE SPLICES: In lieu of using the full penetration butt welds specified in CMS 507.09 to splice steel H-piles, the Contractor may use a manufactured H-pile splicer. Furnish splicers from the following manufacturer:

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610.6 COFFERDAMS, CRIBS AND SHEETING

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

[610.6-1] ITEM 503, COFFERDAMS, CRIBS, AND SHEETING, AS PER PLAN:
The design shown on the plans for temporary support of excavation is one representative design that may be used to construct the project. The Contractor may construct the design shown on the plans or prepare an alternate design to support the sides of excavations. If constructing an alternate design for temporary support of excavation, prepare and provide plans in accordance with C&MS 501.05. The Department will pay for the temporary support of excavation at the contract lump sum price for Cofferdams, Cribs, and Sheeting. No additional payment will be made for providing an alternate design.

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702.12 ERECTION BOLTS

Where erection bolts are specified for attaching crossframes on steel girder or rolled beam bridges, and the expected dead load differential deflection at each end of the crossframes is less than or equal to ½" [13 mm] provide the following note. (Do not use the note if standard drawing GSD-1-96 is being referenced.)

[702.12-1] ERECTION BOLTS: The hole diameter in the cross frames and girder stiffeners shall be 3/16" larger than the diameter of the erection bolts. Erection bolts shall be high strength bolts and shall remain in place. Supply two hardened washers with each high strength bolt. Fully torque the bolts or use a lock washer in addition to the two hardened washers. Furnish erection bolts as part of Item 513.

[702.12-2] Note Retired – See Appendix

702.13 WELDED ATTACHMENTS

Provide the following note on plans for steel beam or girder bridges:

[702.13-1] WELD ATTACHMENT of supports for concrete deck finishing machine to areas of the fascia stringer flanges designated "Compression". Do not weld attachments to areas designated "Tension". Fillet welds to compression flanges shall be at least 1" from edge of flange, be no more than 2" long, and be at least 1/4" for thicknesses up to 3/4" or 5/16" for greater than 3/4" thick.

702.14 SCREED ELEVATION TABLES

Screed elevation tables are required for concrete decks on structural steel beams, structural steel girders, prestressed I-beams and composite deck box beams. General criteria for screed elevation tables are defined in section 302.2.3. Refer to Figure 702.14-1 for an example screed table for structural steel members and Figure 702.14-2 for an example screed table for composite box beams.

702.14.1 SCREED ELEVATION TABLES – STRUCTURAL STEEL MEMBERS

In lieu of a table format, the designer may supply screed elevations through the use of a deck plan view showing elevations and stations of the points required in section 302.2.3.

In addition to the screed elevation table or diagram, provide a screed elevation note similar to the one below to describe the elevations that are given.

[702.14.1-1] SCREED ELEVATIONS shown are for the deck slab surface prior to concrete placement. Allowance has been made for anticipated calculated dead load deflections.

702.14.2 SCREED ELEVATION TABLES – PRESTRESSED I-BEAM MEMBERS

See the requirements of 702.14.1 for example tables, notes and format.

702.14.3 SCREED ELEVATION TABLES – COMPOSITE BOX BEAM MEMBERS

In lieu of a table format, the designer may supply screed elevations through the use of a deck plan view showing elevations and stations of the points required in section 302.2.3.

In addition to the screed elevation table or diagram, provide a screed elevation note similar to **[702.14.1-1]** to describe the elevations that are given.

702.15 ELASTOMERIC BEARING MATERIAL REQUIREMENTS

Use the following note for elastomeric bearings designed in accordance with *LRFD 14.7.6* (i.e. Method A)

[702.15-1] ELASTOMERIC BEARINGS: The elastomer shall have a hardness of ___ (50 or 60) durometer. The bearings were designed in accordance with Section 14.7.6 (Method A) of the AASHTO LRFD Bridge Design Specifications. The Long-term Compression Proof Load Test (AASHTO Standard Specifications for Highway Bridges, Division II, Section 18.7.2.6) is not required.

Use the following note for elastomeric bearings designed in accordance with *LRFD 14.7.5* (i.e. Method B)

[702.15-2] ELASTOMERIC BEARINGS: The elastomer shall have a hardness of ___ (50 or 60) durometer. The bearings were designed in accordance with Section 14.7.5

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APPENDIX – MISC. BRIDGE INFORMATION

APPENDIX PURPOSE

The Bridge Design Manual's appendix serves three purposes.

A. One is to serve as a repository for special plan notes that are infrequently used or subject to frequent revision. These notes are generally large and detailed documents. When a bridge design requires the use of appendix notes one of two methods should be used to incorporate the notes into the project plans. One, the designer transfers the notes to plan sheets for inclusion into the bridge plans. The second method is to treat the note as un-numbered proposal note. This method requires the designer to include with the bid item(s) a reference to the proposal and supply electronic versions, or typed hard copies, of the note with the final plan submission. If the proposal note method is used, the designer shall ensure the notes are presentable, that it is clear what notes are to be used as proposal notes, and that the agency receiving the completed plans understands the notes must be included in the project's actual proposal. The choice of methods is the option of the owner.

B. The second purpose is to serve as a historical archive for old plan notes, old general notes or old proposal notes which are no longer active or not recommended for use.

C. The third purpose is to serve a repository for special bridge policy criteria and other items of similar concept.

ARN-1 RETIRED NOTE 702.12-2

If the differential dead load deflection at each end of the crossframes is greater than ½" [13 mm], provide the following note. (Note - if part of a structure's crossframes have a differential deflection of greater than ½" [13 mm] and part of the structure does not, use the following ERECTION BOLT note.)

[702.12-2] ERECTION BOLTS AND CROSS FRAME FIELD WELDING: The hole diameter in the girder stiffeners shall be 3/16" [4 mm] larger than the diameter of the erection bolts. The cross frame members shall have slotted holes, 3/4" [19 mm] longer than the bolt diameter and 1/16" [2 mm] wider than the erection bolt diameter. The slot shall be parallel to the longitudinal dimension of the cross frame member. Erection bolts shall be high strength bolts and shall remain in place. Supply two hardened washers with each high strength bolt. Fully torque the bolts or use a lock washer in addition to the two hardened washers. Furnish erection bolts as part of Item 513.

Do not weld the cross frame members to the stiffeners until the concrete deck has been placed.

HISTORY: Note **[702.12-2]** was retired in order to reduce the potential for unanticipated girder deflection during deck placement. All crossframes and lateral bracing shall be permanently fastened before deck placement begins.