OHIO DEPARTMENT OF TRANSPORTATION
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July 21, 2006

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2006 Third Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, January 2004. This package contains the revised pages. The revised pages have been designed to replace the corresponding pages in the book and are numbered accordingly. Revisions, additions, and deletions are marked in the revised pages by the use of one vertical line in the right margin. The header of the revised pages is dated accordingly.

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

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

The January 2004 edition of the Bridge Design Manual may be downloaded at no cost using the following link: http://www.dot.state.oh.us/se/BDM/BDM2004/bdm2004.htm

Attached is a brief description of each revision.

Summary of MSE Revisions to the ODOT BDM

BDM Section	Affected Pages	Revision Description
201.2.6	2-7 through 2-8	Clarifies that the estimates for bearing pressure, allowable bearing capacity and settlement are for the MSE wall, not a spread footing abutment on the MSE wall.
202.2.3	2-11	Clarifies that the estimates for bearing pressure, allowable bearing capacity and settlement are for the MSE wall, not a spread footing abutment on the MSE wall.
204.4	2-22 through 2-23	This section has been revised to provide guidance as to when abutments can be supported on spread footings on MSE walls.
204.6	2-23 through 2-25	This section has been revised to be consistent with the new SS 840.
204.6.2.1	2-25 through 2-27.2	This section has been revised to be consistent with the new SS 840 and to give guidance on the design of MSE walls.
209.3	2-38 through 2-39	This section has been revised to provide guidance for drainage design around MSE walls.
209.5	2-40 through 2-40.2	Thirty foot approach slabs are required MSE wall abutments.
301.7	3-8 through 3-8.2	A paragraph has been added that gives guidance about utilities around MSE walls.
302.2.7	3-16 through 3-17.2	This section has been revised to describe the issues associated with deck pours and differential deflections.
303.5	3-76 through 3-80	This section has been revised to be consistent with the new SS 840 and to give guidance on the design of MSE walls.
Fig. 329		The MSE wall figures have been revised to be consistent with the new SS 840 and the revisions to the text.
Fig. 330		
Fig. 331		
Fig. 332		
Fig. 333		
AN-1	Appendix-2 through Appendix-37	The MSE wall special provisions have been superseded by SS 840.
AN-2		
AN-3		
AN-4		
AN-1		This section includes the procedure by which the Department will accept MSE wall systems.

analysis should include the initial construction cost and all major future rehabilitation/maintenance costs, converted to present dollars. Sufficient preliminary design must be performed for an accurate cost estimate. Cost data information may be obtained from “Summary of Contracts Awarded”. This publication is available from the Office of Contracts.

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

201.2.6 FOUNDATION RECOMMENDATION

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

A. General foundation type (i.e. Drilled Shafts, Friction Piles, Bearing Piles or Spread Footings)
B. Typed boring logs
C. Laboratory test results as follows:
   1. Soil: Water content, particle size analysis, liquid limit, plastic limit
   2. Rock: RQD

For the scour evaluation, Section 203.3(D), provide D_{50} values from the particle size analysis.

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

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

201.2.7 PRELIMINARY MAINTENANCE OF TRAFFIC PLAN

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

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 Location and Design Manual Section 502.14) but Section 502.22 of the L & D 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.

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

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

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

202.2.3 FOUNDATION REPORT

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

A. Investigational Findings
B. Analyses and Recommendations
C. Boring Logs and Undisturbed Test Data

Where the scour evaluation has been identified a potential problem, the probable scour depths, calculated in accordance with Section 203.3(D), should be considered in the design of the substructures; the location of the bottom of footings; the minimum tip elevations for piles and drilled shafts; and the frictional capacity of piles and drilled shafts.

The Foundation Report for MSE wall supported abutments shall include calculations for bearing pressure and bearing capacity for the in-situ material below the MSE wall and calculations for MSE wall settlement. The report shall also consider the effect of settlement and include all construction constraints, such as soil improvement methods, that may be required.

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

202.2.3.1 SPREAD FOOTINGS

The use of spread footings shall be based on an assessment of design loads, depth of suitable bearing materials, ease of construction, effects of flooding and scour analysis, liquefaction and swelling potential of the soils and frost depth. Generally the amount of predicted settlement of the spread footing and the tolerable movement of the structure control the type of footing. To establish tolerable movements, engineering judgment should be used (also refer to FHWA’s Manual on Tolerable Movements, Report No. FHWA/RD-85/107).

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

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

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

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

202.2.3.2 PILE FOUNDATIONS

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

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

202.2.3.2.a STEEL ‘H’ PILES

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

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. All major rehabilitation work requires a scour evaluation. The scour evaluation may simply consist of determining what the bridge is founded on. For example, on a bridge rehabilitation, noting that the bridge is founded on scour resistant bedrock or deep foundations to bedrock, would constitute the scour evaluation. As a minimum, piles shall be embedded 15 ft [4.5 m] below the streambed elevation.

   When evaluating a structure for scour, review all inspection reports for evidence of stream degradation (lowering of stream bed), scour or previous scour countermeasures. For existing footings founded on shale, test probe the shale to determine its resistance to weathering and note the relationship of the bottom of the footing to the stream bed elevation.

   When it is necessary to calculate scour depths, they are to be calculated by 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.

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. Rehabilitation projects may require special slope considerations.

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 aesthetically pleasing structure.

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

204.3 ABUTMENT TYPES

Preference should be given to the use of spill-thru type abutments. Generally for stub abutments on piling or drilled shafts the shortest distance from the surface of the embankment to the bottom of the toe of the footing should be at least 4'-0" [1200 mm]. For stub abutments on spread footing on soil, the minimum dimension shall be 5'-0" [1525 mm]. For any type of abutment, integral design shall be used where possible, see Section 205.8 for additional information.

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

204.4 ABUTMENTS SUPPORTED ON MSE WALLS

When conditions are appropriate, the designer may consider stub type abutments with piling or spread footings supported on MSE walls. Use spread footings to support the abutment if the MSE wall is on bedrock or shale. If the MSE wall is on soil, then the selection of spread footings or piles to support the abutment should consider possible settlement of the MSE wall. Use piles to support the abutment if the bridge is a continuous multi-span structure, or if the bridge is constructed part width in phases. If the bridge is a single-span structure and is not constructed part width in phases, then either spread footings or piles may be used to support the abutment. Piles require a minimum 15-foot embedment below the MSE wall.

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

204.5 PIER TYPES

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

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

For waterway bridges the following pier type should be used:

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

B. Cap-and-column type piers.

C. Solid wall or T-type piers.

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

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

204.6 RETAINING WALLS

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

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

Some of the wall types listed above consist of the following proprietary systems:

Doublewal Wall type - Cellular Bin Contact Information: Doublewal Corporation 7 West Main St. Plainville, CT 06062 (860)793-0295	Retained Earth Walls Wall type - MSE Contact Information: The Reinforced Earth Company 1444 North Farnsworth Ave, Suite 505 Aurora, IL 60505 (630)898-3334
Mesa Retaining Wall System Wall type - Modular Block Contact Information: Tensar Earth Technologies, Inc. 5883 Glenridge Drive Suite 200 Atlanta, Georgia 30328 (404)250-1290	T-Wall Wall type - Cellular Bin Contact Information: Hydro-Conduit 620 Liberty Road Delaware, Ohio 43015 (800) 395-8383
Ares Retaining Wall System Wall type - MSE Contact Information: Tensar Earth Technologies, Inc. 5883 Glenridge Drive. Suite 200 Atlanta, Georgia 30328 (404)250-1290	Reinforced Earth Walls Wall type - MSE Contact Information: The Reinforced Earth Company 1444 North Farnsworth Ave, Suite 505 Aurora, IL 60505 (630)898-3334
Tricon Retained Soil Wall System Wall type - MSE Contact Information: Tricon Precast, Ltd. 15055 Henry Rd. Houston, TX 77060 (281) 931-9832	

The use of T-Wall and modular block retaining walls is limited to non-critical locations with a wall design height not more than 25 ft [7.6 m]. MSE wall types that are approved for supporting abutments on are Tricon Retained Soil, Reinforced Earth, Retained Earth, and Tensar Ares. However, the Tensar Ares wall shall be limited to pile supported abutments only. The Tensar Ares wall is limited to a maximum height of 30 ft [9.15 m] for all applications.

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; allowable bearing pressure 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 17th Edition of the "AASHTO Standard Specifications for Highway Bridges" 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 AASHTO Figure 5.8.2B.

    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 as the larger of 70 % of the wall height (h) or 8'-0" [2.5 m].

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 202 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. The following factors of safety shall apply:

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

G. Use the following soil parameters for design:

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

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

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

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

J. For MSE walls supporting abutments on 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].

K. 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].

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

M. The maximum allowable bearing pressure for a spread footing abutment placed on an MSE wall embankment shall be 4 ksf [190 kPa].

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

204.6.2.2 CAST-IN-PLACE WALLS

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

204.6.2.3 OTHER WALLS

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

205 SUPERSTRUCTURE INFORMATION

205.1 TYPE OF STRUCTURES

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

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205.2 SPAN ARRANGEMENTS

The length of a bridge will be determined by the requirements for horizontal clearance at grade (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 sub-structure 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.

Standard bridge drawings are available for the design of single span and three span continuous concrete slabs. The Standard Bridge Drawing for single span concrete slab bridges is SB-1-03. The spans range from 11 to 38 feet [3350 to 11 580 mm] with a maximum skew angle of 30 degrees. The Standard Bridge Drawing for three span continuous concrete slabs is CS-1-03. The spans range from 14’ - 17.5’ - 14’ [4260 mm - 5334 mm - 4260 mm] to 46’ - 57.5’ - 46’ [14 020 mm - 17 530 mm - 14 020 mm] with a maximum skew angle of 30 degrees. The drawings are based on a 60 lb/ft^2 future wearing surface and a live load of an HS25 truck and the alternate military vehicle. The edge beam is designed to support live load according to AASHTO 3.24.8 and the weight of the 42” BR-1 deflector parapet.

209 MISCELLANEOUS

209.1 TRANSVERSE DECK SECTION WITH SUPERELEVATION

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

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

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

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

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

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

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

209.1.1 SUPERELEVATION TRANSITIONS

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

209.2 BRIDGE RAILINGS

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

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

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

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

209.3 BRIDGE DECK DRAINAGE

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

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

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

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

When the deck drainage is to flow off the ends of the bridge, provisions must be made to collect and carry away this run-off. 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. Include these detail drawings in the structure plans for review during the detail design review stage. Approach slabs are paid for under Item 526.

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

209.6 PRESSURE RELIEF JOINTS

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

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

209.7 AESTHETICS

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.

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301.5.6 USE OF EPOXY COATED REINFORCING STEEL

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

All approach slabs shall have epoxy coated reinforcing steel.

301.5.7 MINIMUM CONCRETE COVER FOR REINFORCING

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

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

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

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

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

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

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

301.5.8 MINIMUM REINFORCING STEEL

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

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

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

301.6 REFERENCE LINE

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

The reference tangent can be used if appropriate.

301.7 UTILITIES

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

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

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

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

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

Utilities should not be suspended below the bottom of the bridge superstructure.

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

301.7.1 UTILITIES ATTACHED TO BEAMS AND GIRDERS

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

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

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

No utilities shall be placed inside of box beams.

301.8 CONSTRUCTION JOINTS, NEW CONSTRUCTION

Construction joints should be anticipated and provided for in the detail plans. Joint locations should be selected such that they are aesthetically least objectionable, allow construction to be

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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

Distribution 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].

For stringer type bridges with reinforced concrete decks, the secondary bars shall be placed above the top of deck primary bars. This helps in reducing shrinkage cracking and adds additional cover over the primary bars.

For reinforced concrete deck slabs on stringer type bridges, where the main reinforcement is transverse to the stringers, additional top longitudinal reinforcement shall be provided in the negative moment region over the piers. This additional secondary reinforcement shall be equal to the distributional reinforcement (1/3 of the main reinforcement). This additional reinforcement shall be uniformly spaced and furnished in length equal to the larger of: 40 percent of the length of the longer adjacent stringer span or a length that meets the requirements of AASHTO 8.24.3.3.

This reinforcement should be placed approximately symmetrical to the centerline of pier bearings but with every other reinforcing bar staggered 3 feet [1000 mm] longitudinally.

For composite designs, the total longitudinal reinforcement over a pier shall meet the requirements of AASHTO.

302.2.4.2 TRANSVERSE

To facilitate the placement of reinforcing steel and concrete in transversely reinforced deck slabs top and bottom main reinforcement shall be equally spaced and placed to coincide in a vertical plane.

For steel beam or girder bridges with a skew of less than 15 degrees the transverse reinforcing may be shown placed parallel to the abutments. Bridges with a skew greater than 15 degrees or where the transverse reinforcing will interfere with the shear studs should have the transverse reinforcement placed perpendicular to the centerline of the bridge. Refer to the appropriate Standard Bridge Drawing for the requirements on slab bridges.

For prestressed I-beams, transverse reinforcing shall be placed perpendicular to the centerline of the bridge.

For composite box beam decks, the transverse reinforcing steel may be placed parallel to the abutment.

For steel beam or girder bridges, the clearance of the bottom transverse bars over the top of any bolted beam splice plates or moment plates should be checked as reinforcing bars at a skew generally cannot be placed between bolt heads.

302.2.5 HAUNCHED DECK REQUIREMENTS

Concrete decks on steel beam, girder or prestressed I-beam structures shall have a concrete haunch to prevent a thinning of the deck slab as a result of unforeseen variations in beam camber. At a minimum, the design haunch shall allow for 2 inches [50 mm] of excessive camber. For steel beam and girder structures, the haunch shall be tapered back to the original concrete deck thickness in a 9 inch [225 mm] length and the concrete haunch shall encase the edges of the top flange. See Figures 317 & 318.

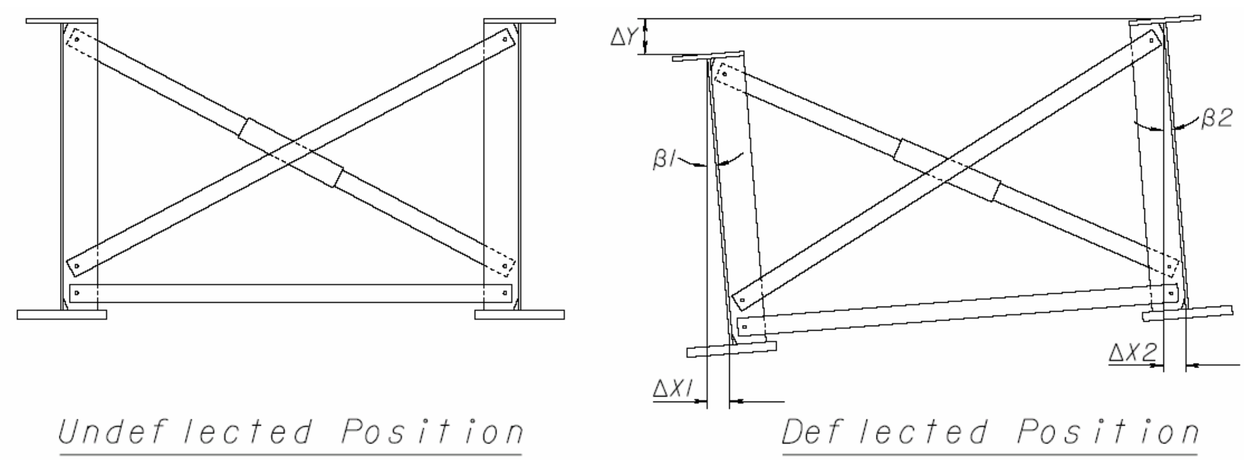
302.2.6 STAY IN PLACE FORMS

Galvanized steel or any other material type, stay in place forms, shall not be used.

302.2.7 CONCRETE PLACEMENT SEQUENCE

Deck placement sequences for standard steel beam/girder superstructures should generally be left to the Contractor. However, the following paragraphs address constructability issues related to deck placement that Designers need to consider.

Large skews; large overhang loads; unbalanced deck loads due to staged construction; and horizontal curvature are possible sources of large differential deflections in the superstructure (see figure below). These deflections may be exaggerated by the inherent flexibility associated with HPS 70 grade steel.



Detrimental effects resulting from these differential deflections may include: web and flange distortion; out-of-plane bending and deflection; out-of-tolerance deck thickness and concrete cover; excessive girder stresses; excessive bearing loads and distortions; excessive crossframe/diaphragm stresses; poor ride quality; and binding of expansion joint systems. In order to avoid these effects, Designers shall analyze the response of the bridge superstructure to the placement of the concrete deck for all stages of construction. In particular, Designers shall determine the differential deflection between adjacent beam/girder lines at each crossframe/diaphragm location. Designers shall also determine the differential deflection between each phase's fascia beam/girder lines at incremental stations along the length of the superstructure. Consult the Office of Structural Engineering for guidance when any single differential deflection between adjacent beam/girder lines exceeds 0.5 in [12 mm] or when any single differential deflection between fascia beam/girder lines exceeds 1.0 in [25 mm].

In addition to the above items, structural response to the deck placement should also be analyzed for: long structures with intermediate expansion devices; bridges with end spans less than 70 percent of internal spans; two span structures; structures whose size eliminates one continuous pour; etc.

Special deck placement sequences are required for multiple span continuous prestressed I-beam superstructures in order to avoid pier diaphragm cracking. Standard Drawing PSID-1-99 specifies an acceptable deck placement sequence for prestressed I-beam bridges.

302.2.8 SLAB DEPTH OF CURVED BRIDGES

For a curved deck on straight steel beams, steel girders or prestressed I-beams, the distance from the top of the slab to the top of the beams or girders will vary from end to end. The slab depth dimension shall show this variation by giving the maximum and minimum depth dimensions with their respective location, over the piers, center of span, etc.

An alternate is to accommodate the differential depth by including it in the Camber Table as geometric camber.

302.2.9 STAGED CONSTRUCTION

For all bridge types, except non-composite concrete box beams, where the differential dead load deflection between adjacent beams, girders or structural slabs is greater than ¼ inch [6 mm], a deck closure is required if the bridge is constructed in stages.

For requirements regarding closure pours on bridge widenings or on existing structures with new concrete decks see Section 400 of this Manual.

The closure pour between the stages shall be a minimum width of 30 inches [800 mm] but should be wide enough to accommodate the required reinforcing steel lap splices. In special cases, this distance may be reduced when mechanical reinforcing steel connectors are used (see Section 200). The mechanical connector system used shall be able to develop 125 percent of the full yield strength of the reinforcing steel as a minimum.

Intermediate cross frames and diaphragms shall not be permanently attached in the closure pour location until the concrete pours on both sides of the closure pour location have been completed.

The two construction joints created by the concrete closure pour should be sealed with High Molecular Weight Methacrylate (HMWM), 705.15. The sealing width shown in the plans should be 2'-0" [600 mm], centered on the construction joints.

Placement of the staged construction joints above beam flanges is not recommended. The preferred location is the positive moment regions of the cast-in-place concrete deck slab.

The designer shall provide plan notes on the stage construction details sheet that detail the

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sequence of construction.

302.3 CONTINUOUS OR SINGLE SPAN CONCRETE SLAB BRIDGES

302.3.1 DESIGN REQUIRMENTS

Continuous reinforced concrete slab bridge design shall be in conformance with AASHTO, latest edition, and additional requirements in this Manual.

For simple span reinforced concrete slab bridges cast in place directly on concrete substructures, the effective span length shall be considered equal to the clear span plus 15" [380 mm].

The Designer shall include a final deck surface elevation table. Elevations shall be shown for all profile grade lines, curblines, crownlines, and phased construction lines for the full length of the bridge. Bearing points, quarter-span points and mid-span points shall be detailed as well as any additional points required to meet a maximum spacing between points of 30'-0" [10 m].

Details for simple span reinforced concrete slab bridge superstructures are provided in Standard Bridge Drawing SB-1-03.

Details for multi-span reinforced concrete slab bridge superstructures are provided in Standard Bridge Drawing CS-1-03.

302.4 STRUCTURAL STEEL

302.4.1 GENERAL

Structural steel shall be designed utilizing a composite section. A non-composite design may be used only if the design is the most economical.

Designs incorporating shear connectors in the negative moment region may be used.

All curved beams or girders shall be designed in accordance with AASHTO, this Manual and the latest AASHTO Guide Specifications for Horizontally Curved Highway Bridges including all interims.

The laterally unsupported length of top flanges of beam and girder members with a concrete deck encasing the top flange or compositely designed with studs shall be considered to be zero. In the absence of such fastening or direct contact of an individual beam or girder member, the unsupported length shall be considered as the distance between the diaphragms, struts, bridging, or other bracing.

For designs that assume the unbraced length of the top flange to be zero as mentioned above, the designer shall investigate the strength of the non-composite section during steel erection, deck

Pier 5 Piles:
52 piles 90 ft long, order length
1 dynamic load testing item

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

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

303.4.3 DRILLED SHAFTS

3'-6" [1065 mm] diameter drilled shafts for piers and 3'-0" [915 mm] diameter shafts for abutments are normally used.

The diameter of bedrock sockets of a drilled shaft are generally 6 inches [150 mm] less in diameter than the diameter of the drilled shaft above the bedrock elevation. The 6 inch [150 mm] downsize can be eliminated for abutment shafts. Reinforcing steel cages should be based on the bedrock socket diameter.

The drilled shaft diameter for the abutment shafts can be shown as one constant diameter for the full length of the drilled shaft (through bedrock and through soil).

Spiral reinforcement used in the drilled shaft is normally a #4 [#13M] bar at a 4½ inch [115 mm] pitch with a spiral diameter of 6 inches [150 mm] less, out to out of spiral cage than the drilled shaft diameter. (Note AASHTO specifications do not recognize a 4½ inch [115 mm] pitch as meeting spiral requirements definition 8.18.2.2.3) When steel casing is left in place, a pitch of 12 inches [300 mm] should be used for the spiral reinforcing.

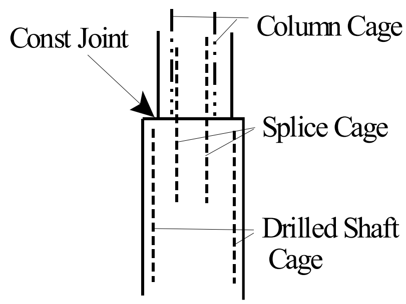
Drilled shafts with diameter s of less than 3'-0" [915 mm] are not recommended.

The diameter of the drilled shafts should be 6 inches [150 mm] larger than the pier column diameter so that if the drilled shaft is slightly misaligned, the pier column can still be placed at plan location, although the pier column would not be exactly centered on a misaligned-drilled shaft.

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

A construction joint between the drilled shaft and any column will be required. Therefore the designer will need to specify reinforcing steel, incorporating the required lap splices, at the construction joint.

The designer should develop a lap splice that will allow both for required lap and minimum cover due to mis-alignment of the drilled shaft versus the column. Possible alternatives are two cages, one for the drilled shaft diameter and a second splice cage for the lap to the column.



When the exposed length of the pier columns is relatively short, one full length reinforcing steel cage, from the bottom of the drilled shaft up into the pier cap, should be designed. The steel cage should be designed to provide a 3 inch [75 mm] concrete cover within the pier column.

When the drilled shaft is socketed into bedrock, the quantity of the reinforcing steel in the drilled shaft, including the portion extending into the rock socket, should be included with Item 524 “Drilled Shaft, Above Bedrock” for payment. For drilled shafts with friction type design where the tip elevation is known, the reinforcing steel should be paid under Item 524, Drilled Shafts. The Designer shall also specify the reinforcing steel to be epoxy coated according to 709.00.

A general note as listed in Section 600 will be required.

The top of the drilled shaft is defined as 1 foot [0.3 meter] above normal water elevation, for piers in water, and 1 foot [0.3 meter] below the ground surface for piers not in water.

303.5 DETAIL DESIGN REQUIREMENTS FOR PROPRIETARY RETAINING WALLS

Supplemental Specification 840 defines the requirements for construction and design for internal stability for Mechanically Stabilized Earth (MSE) walls. The project plans shall include a reference to SS 840 when MSE walls are shown. Special provisions are required for other types of proprietary walls.

303.5.1 WORK PERFORMED BY THE DESIGN AGENCY

The Design Agency is responsible for providing sufficient information in the plans such that, prior to submitting a bid, the Contractor can select a proprietary company to design the internal stability of the wall after the project is awarded. Detail each wall on a project separately. As a minimum, the project plans for each wall location shall provide the following:

A. Plan View of the wall showing: (Refer to Figure 329)

1. Wall location with station and offset with respect to the centerline of construction for each critical point

2. All complex geometry information

3. Limits of proprietary wall embankment

4. North Arrow

5. Locations of typical sections for (C.) below

6. Locations of abutment footing, piles, utilities, catch basins, and other possible obstructions (Refer to Section 209.3 for drainage and Section 301.7 for utility locations)

7. Parapet/barrier locations

8. Limits of proposed wall excavation

9. Locations of sheeting and bracing

   If sheeting and bracing is required to support an excavation for undercut and backfill, show the location and provide a pay item for Item 503 – Cofferdams, Cribs and Sheeting. Refer to BDM Section 208 for more information.

10. Backfill drainage locations

   Porous backfill with filter fabric and perforated plastic pipe, CMS 707.33, shall be located as low as possible within the undercut for the wall while still providing positive gravity flow in the pipe to an outlet. The porous backfill and pipe shall be located near the back side of the leveling pad and near the free end of the soil reinforcement. The pipe shall be continuous and sloped to provide a positive gravity flow to an outlet. The approximate location of the outlet shall be shown on the plan view. Drainage pipe without perforations shall be used outside the limits of the select granular backfill. If the proprietary wall supports an abutment, provide backfill drainage in accordance with Section 303.2.3.1.

B. Elevation of the wall showing: (Refer to Figure 329)

1. Station and elevation for each critical point on the wall

2. Finished ground surface elevations for each critical point on the wall

3. Leveling pad showing the minimum dimension from the finished ground line to the top of the pad.

4. Locations of abutment footing, piles, utilities, catch basins, and other possible obstructions

5. Backfill drainage

6. Approximate locations of slip joints

C. Typical Sections showing: (Refer to Figures 330, 331, 332 & 333)

1. Coping details

2. Parapet and sleeper slab details

3. Abutment footing details including the dimensions from the back of the proprietary wall to the centerline of bearing at the abutment, dimensions from the back of the proprietary wall to the toe of the abutment footing, and dimensions from the back of the proprietary wall to the centerline of the nearest row of piles.

4. Minimum clearance between the bottom of the footing/sleeper slab and the uppermost wall reinforcement strap. Six inches [150 mm] is preferred.

5. Locations of abutment footing, piles, utilities, catch basins, and other possible obstructions

6. Backfill drainage

7. Soil reinforcements attached to abutment (where required)

   Show soil reinforcements attached to the backside of abutments regardless of foundation types according to the following:

   a. For jointed structures, the soil reinforcement should be attached up to the level of the approach slab seat.

   b. For semi-integral structures, the soil reinforcement should be attached up to the level of the beam seat.

8. Limits of select granular backfill

   Show the limit of the select granular backfill extending from the bottom of the wall excavation sloping upwards at 45 degrees. Include the note that what is shown is the limit of the select granular backfill and not the slope of the required excavation. The upper limit of the select granular backfill shall be at least six inches [150 mm] above the uppermost layer of soil reinforcement, but not lower than six inches [150 mm] above the bottom of the abutment footing.

9. Limits of wall excavation

   Supplemental Specification 840 requires a minimum one foot [0.3 m] undercut for all MSE walls. If more undercut is required, show it on the plans. The backfill material is specified in SS 840.

10. Pay limits of proprietary wall

11. Pile sleeves (if required)

    Pile sleeves shall be shown extending from the bottom of the abutment footing to the bottom of the wall excavation

12. Location of sheeting and bracing (if required)

13. Limits of concrete sealer

D. Requirements for wall surface textures or other aesthetic treatments (i.e. show panel size and shape restrictions specific to the project in the plans)

E. Wall design criteria including:

1. Allowable bearing capacity at the base of the reinforced soil mass

2. Vertical dead and live loads, horizontal loads and actual bearing pressure applied to the reinforced soil mass from the bridge

Plan notes are provided in Section 600.

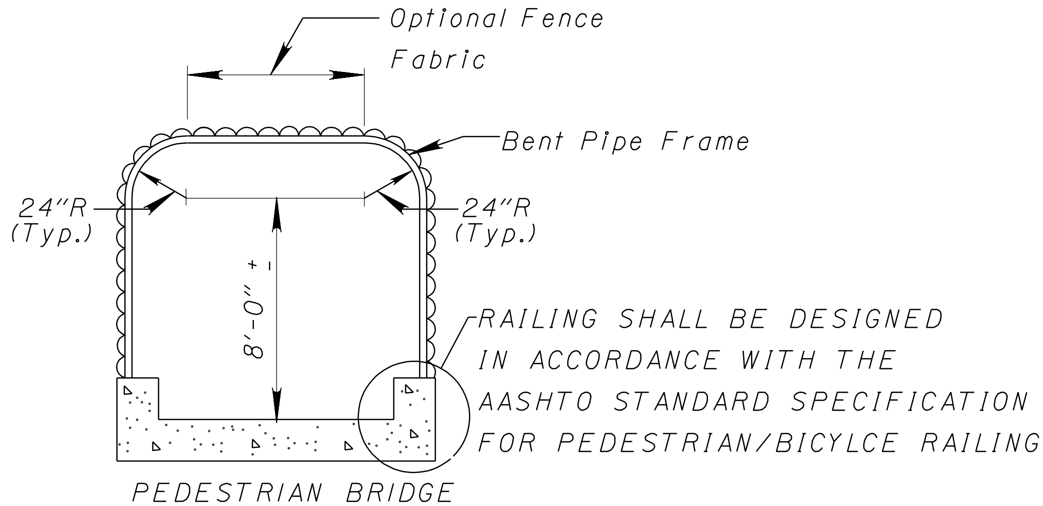
F. Final copy of the Special Provisions for proprietary wall types other than MSE walls.

G. Estimated Quantities Table (list each wall on a project separately)

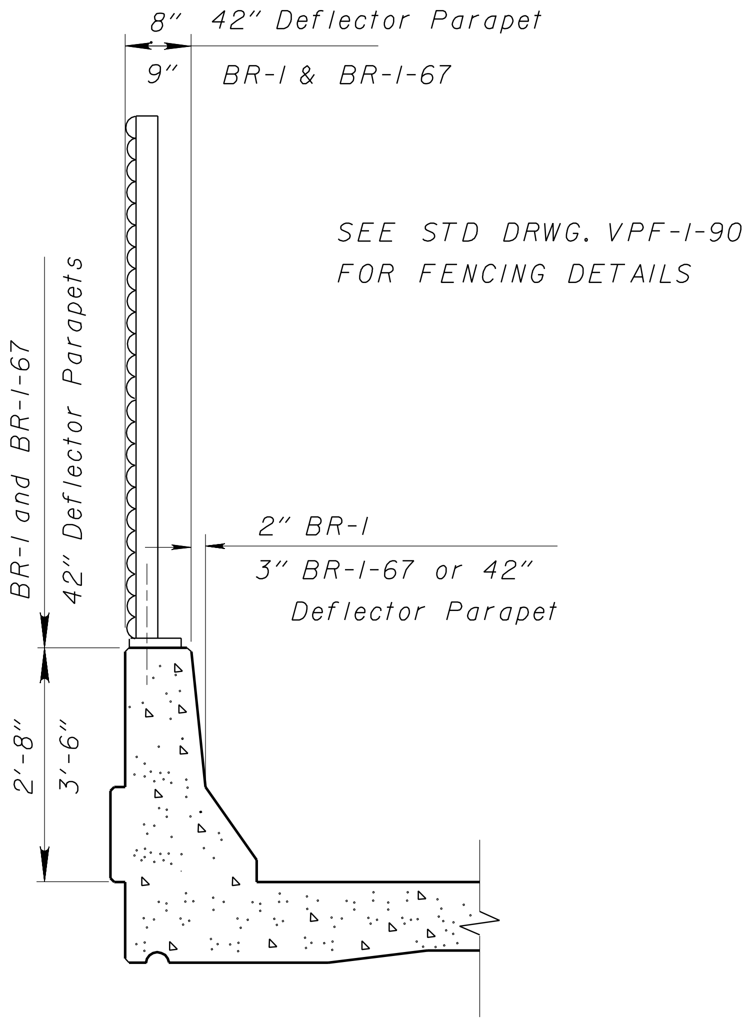
Include all pay items listed in SS 840. Also include as necessary; Item 203 – Embankment; Item 512 – Sealing of concrete surfaces (epoxy urethane); and Item 503 - Cofferdams, Cribs and Sheeting.

303.5.2 WORK PERFORMED BY THE PROPRIETARY WALL COMPANIES

The proprietary wall companies will be responsible for designing the internal stability of the wall in accordance with the project plans and either Supplemental Specification 840 for MSE walls or the special provisions for other proprietary wall types.

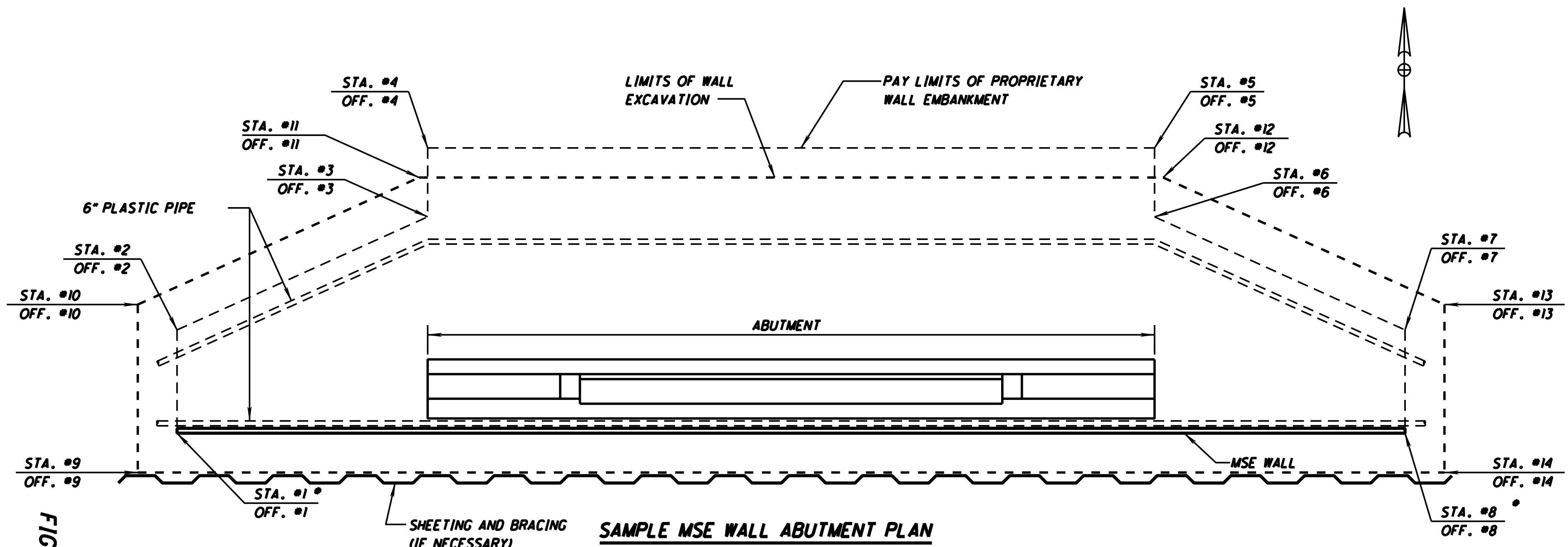


PEDESTRIAN FENCING ON STRUCTURES



DEFLECTOR PARAPET WITH FENCING

Figure 328

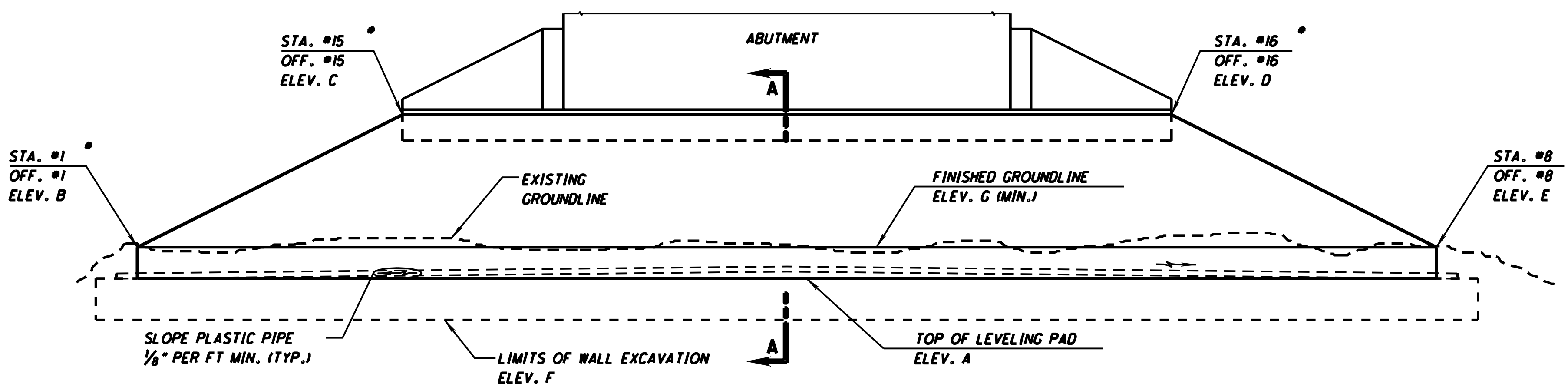


SAMPLE MSE WALL ABUTMENT PLAN

• - MEASURED TO FRONT FACE OF MSE WALL FACING PANELS

FIGURE 329

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

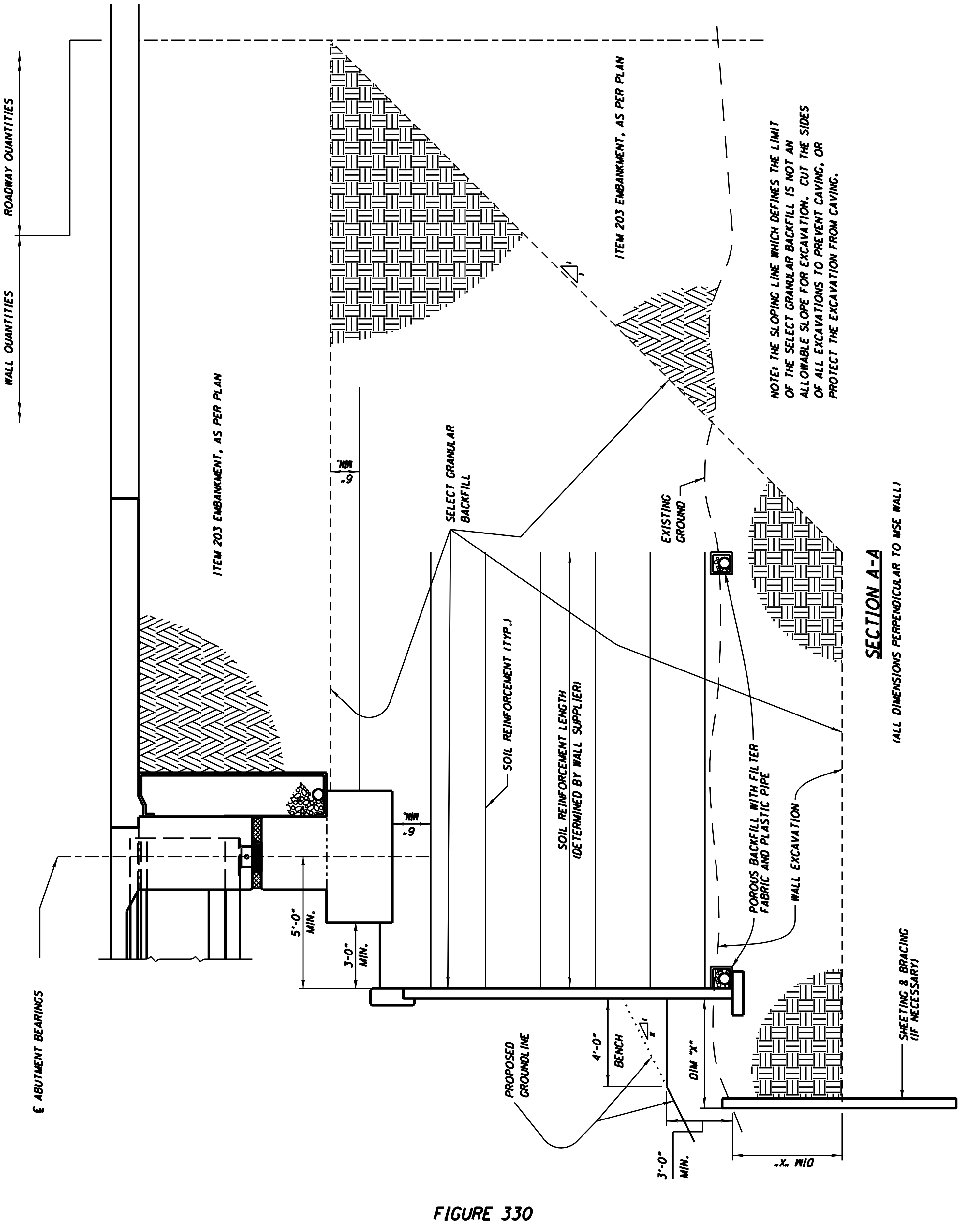
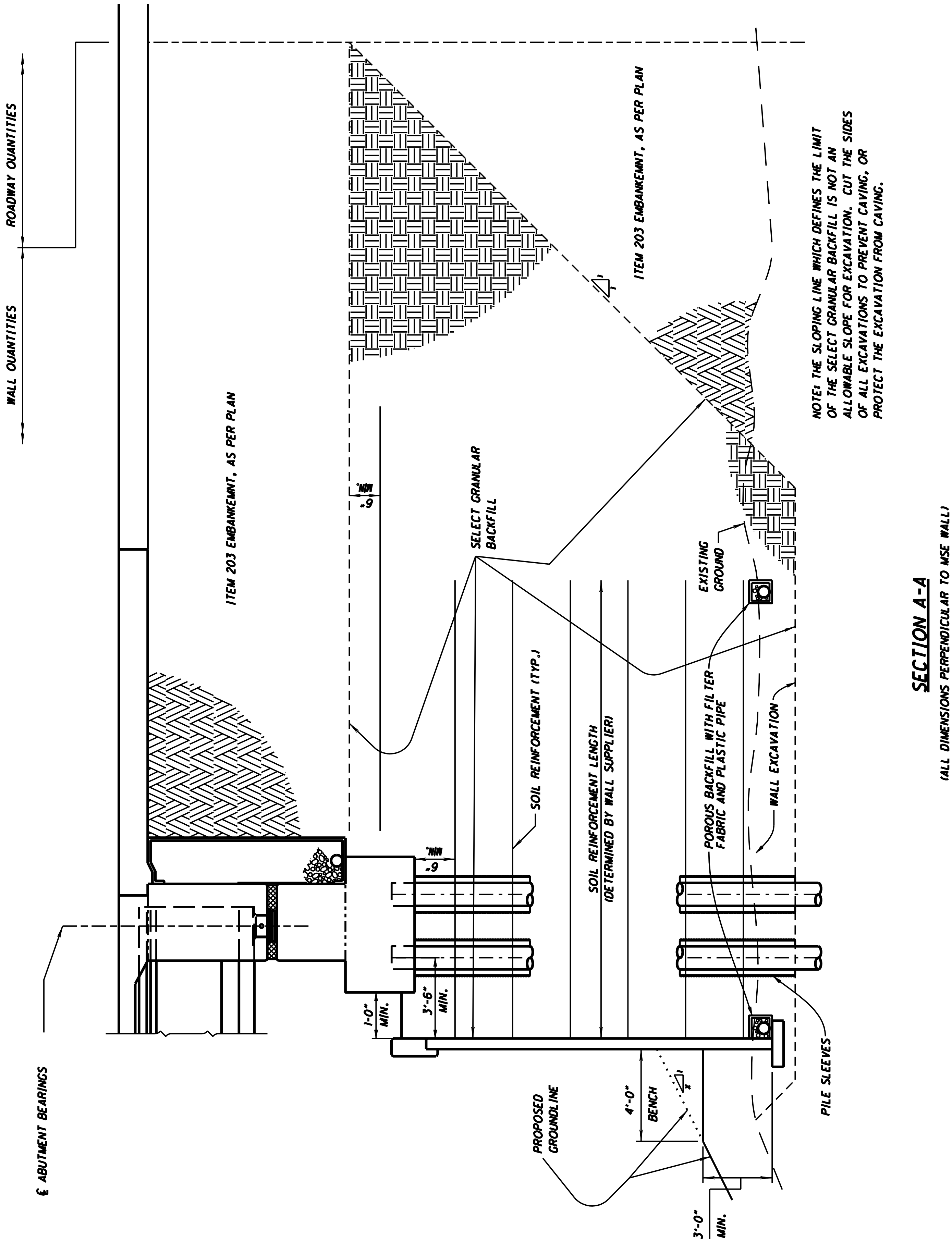
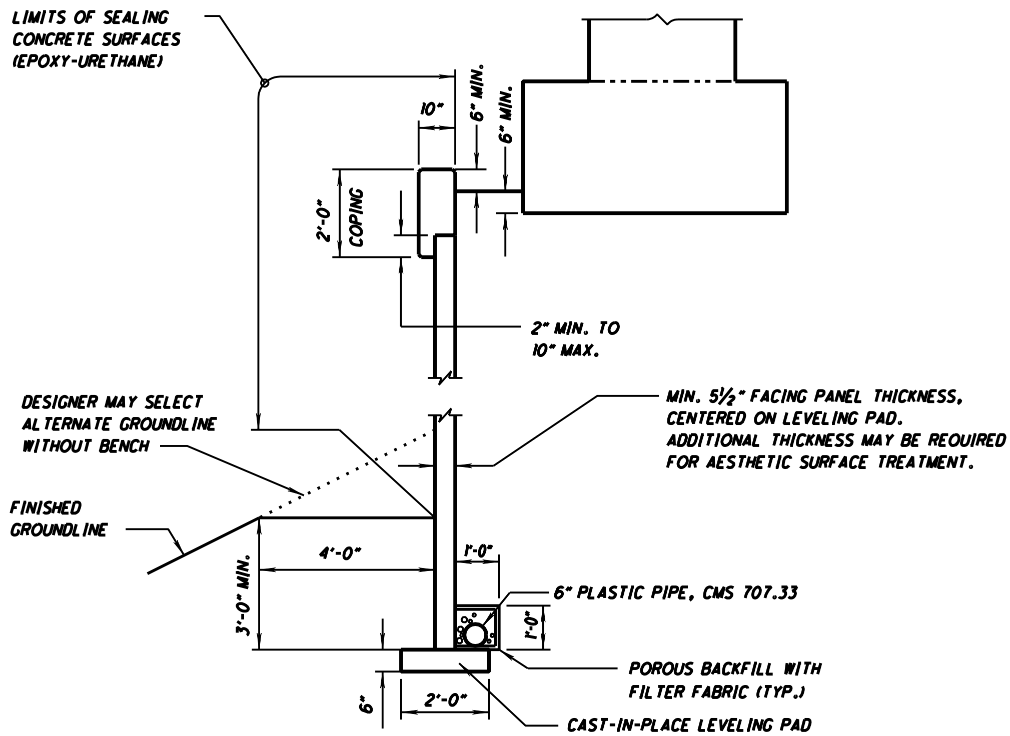

ROADWAY QUANTITIES
WALL QUANTITIES
ITEM 203 EMBANKMENT, AS PER PLAN
ITEM 203 EMBANKMENT, AS PER PLAN
NOTE: THE SLOPING LINE WHICH DEFINES THE LIMIT OF THE SELECT GRANULAR BACKFILL IS NOT AN ALLOWABLE SLOPE FOR EXCAVATION. CUT THE SIDES OF ALL EXCAVATIONS TO PREVENT CAVING, OR PROTECT THE EXCAVATION FROM CAVING.
6" MIN.
SELECT GRANULAR BACKFILL
EXISTING GROUND
SOIL REINFORCEMENT (TYP.)
SOIL REINFORCEMENT LENGTH (DETERMINED BY WALL SUPPLIER)
6" MIN.
POROUS BACKFILL WITH FILTER FABRIC AND PLASTIC PIPE
WALL EXCAVATION
SECTION A-A
(ALL DIMENSIONS PERPENDICULAR TO MSE WALL)
5'-0" MIN.
3'-0" MIN.
℄ ABUTMENT BEARINGS
4'-0"
BENCH
DIM "X"
PROPOSED GROUNDLINE
3'-0" MIN.
DIM "X"
SHEETING & BRACING (IF NECESSARY)

FIGURE 330

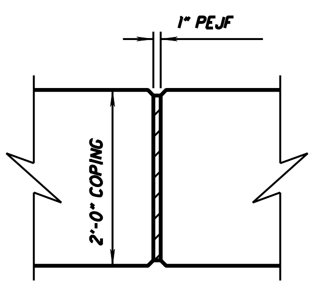


WALL QUANTITIES
ROADWAY QUANTITIES
ITEM 203 EMBANKEMNT, AS PER PLAN
ITEM 203 EMBANKEMNT, AS PER PLAN
SELECT GRANULAR BACKFILL
6" MIN.
6" MIN.
SOIL REINFORCEMENT (TYP.)
SOIL REINFORCEMENT LENGTH (DETERMINED BY WALL SUPPLIER)
POROUS BACKFILL WITH FILTER FABRIC AND PLASTIC PIPE
EXISTING GROUND
WALL EXCAVATION
PILE SLEEVES
1'-0" MIN.
3'-6" MIN.
4'-0"
BENCH
PROPOSED GROUNDLINE
3'-0" MIN.
℄ ABUTMENT BEARINGS
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)

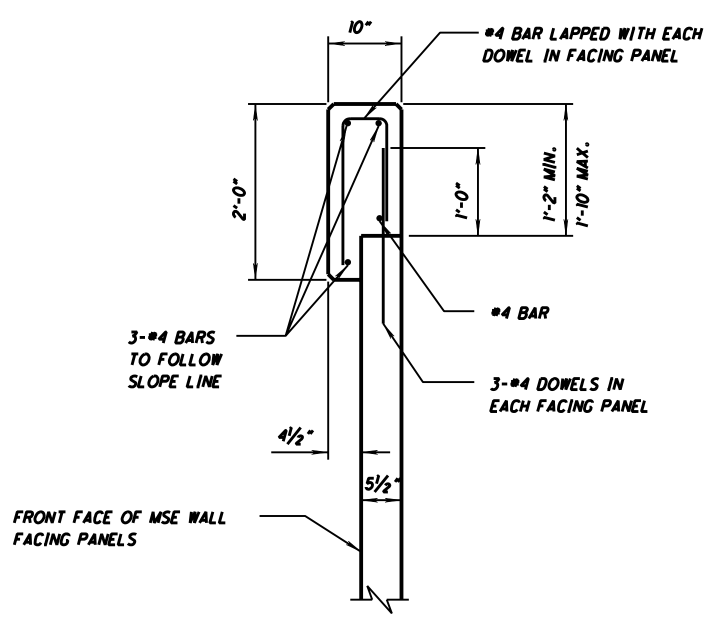
FIGURE 331



MSE WALL AND COPING DETAIL



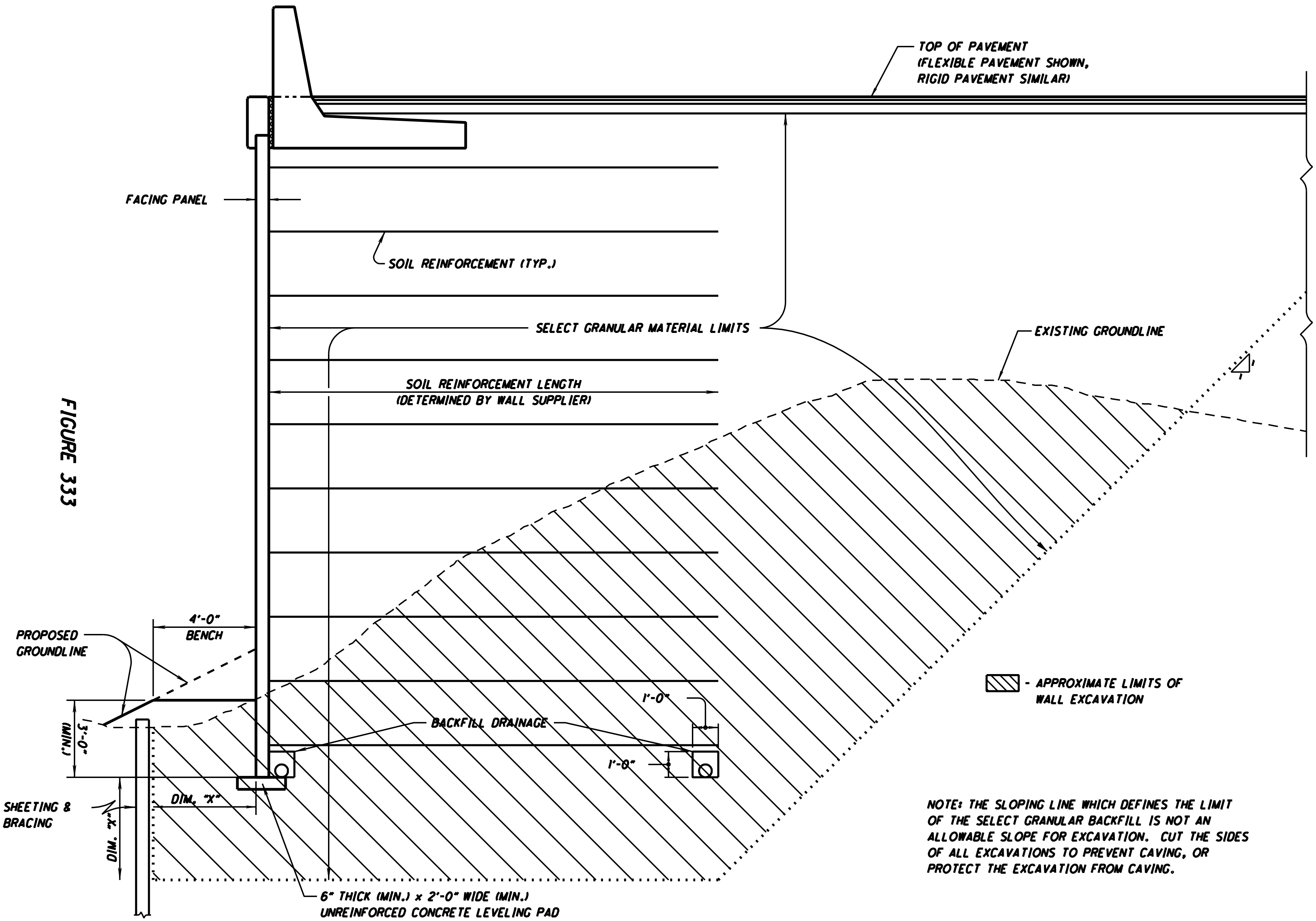
COPING EXPANSION JOINTS



MSE WALL COPING

ALL REINFORCING STEEL TO BE EPOXY COATED

FIGURE 332



TOP OF PAVEMENT
(FLEXIBLE PAVEMENT SHOWN,
RIGID PAVEMENT SIMILAR)
FACING PANEL
SOIL REINFORCEMENT (TYP.)
SELECT GRANULAR MATERIAL LIMITS
EXISTING GROUNDLINE
SOIL REINFORCEMENT LENGTH
(DETERMINED BY WALL SUPPLIER)
4'-0"
BENCH
PROPOSED
GROUNDLINE
3'-0"
(MIN.)
BACKFILL DRAINAGE
1'-0"
1'-0"
SHEETING &
BRACING
DIM. "X"
DIM. "X"
6" THICK (MIN.) x 2'-0" WIDE (MIN.)
UNREINFORCED CONCRETE LEVELING PAD
- APPROXIMATE LIMITS OF
WALL EXCAVATION
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.

FIGURE 333

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.

AN-1 ACCREDITATION PROCEDURE FOR MSE WALLS

1.0 DESCRIPTION

This document describes the process by which the Department will review and approve mechanically stabilized earth (MSE) wall systems that are listed as "Accredited MSE Wall Systems" in Supplemental Specification 840.

2.0 ACCREDITATION

Submit the following information to the Office of Structural Engineering.

A. A copy of the HITEC evaluation report for the MSE wall system. HITEC is the Highway Innovative Technology Evaluation Center. Identify any aspects of the MSE wall system that have changed since the HITEC evaluation was performed.
B. A letter from the MSE wall supplier that states the following:
    1. The MSE wall supplier is aware of the following Department publications that pertain to MSE walls: Supplemental Specification 840, the Bridge Design Manual, Location and Design Manuals, Construction Inspection Manual of Procedures, and Construction and Material Specifications.
    2. The MSE wall supplier is responsible for the design for internal stability of MSE walls using the system and that the design will be according to the latest AASHTO Standard Specifications or the latest AASHTO LRFD Bridge Design Specifications, whichever specification is indicated on the project plans.
    3. The design of the MSE wall system will be in accordance with Supplemental Specification 840.
C. Provide the names of at least two engineers who will design and check MSE wall working drawings and calculations prepared by the MSE wall supplier. Also include their Ohio Professional Engineer registration number and contact information (address, phone number, e-mail address, etc.). This information is required to conform with Ohio Revised Code and Department policy for prequalification of design consultants,
D. Attach a recent set of sample working drawings and calculations.
E. Provide design drawings and structural design calculations for all standard facing panels
F. Provide details and materials specifications for standard connections, related hardware and soil reinforcement used with the MSE wall system.
G. Provide details of typical frames and frame connections used with the MSE wall system to avoid obstructions in the reinforced soil zone.
H. Provide information on differential settlements that the MSE wall system is able to accommodate without distress.
I. Provide all laboratory and field test data for the MSE wall system. This should include, at a minimum, the following: durability test data for the facing panels; connection strength test data; soil reinforcement pullout resistance test data and failure modes; for metallic soil reinforcements, the corrosion coating requirements and related corrosion test data; for welded wire mesh soil reinforcement, the weld test data and weld requirements; for geogrid soil reinforcements, creep performance and related test data. Also provide other test data unique to the MSE wall system.

J. List all precast concrete manufacturers that will manufacture the facing panels for the MSE wall system, and confirm that they have been certified according to Supplemental Specification 1073.
K. Provide the precast concrete manufacturer's quality control plan that applies to the MSE wall system. Also provide the criteria for acceptance or rejection of precast concrete facing panels.
L. Provide the quality control plan that applies to materials, other than concrete, that are part of the MSE wall system. Also provide the criteria for acceptance or rejection of those materials. This quality control plan does not apply to the soil or granular material that is used to construct the MSE wall system.
M. Provide detailed repair methods for replacing full panels, repairing parts of panels, and stopping the loss of select granular backfill from between the panel joints.

3.0 LOSS OF ACCREDITATION

The Department will remove an MSE wall system from the list of Accredited MSE Wall Systems in Supplemental Specification 840 if the MSE wall system has substantially or repeatedly failed to perform satisfactorily in the field. An MSE wall system which has been removed from the list will not be placed back on the list until the MSE wall supplier identifies the reason for the failure and the problem has been corrected to the satisfaction of the Department. The Department may consider the experiences of other state or governmental agencies in this decision.

3.0 MODIFICATIONS TO AN ACCREDITED MSE WALL SYSTEM

The Department recognizes that MSE wall suppliers may wish to modify certain details of their MSE wall system after the Department's review and accreditation. Notify the Department of any proposed modifications to an Accredited MSE Wall System and resubmit all the submittal items listed in "2.0 Accreditation" that are affected by the modifications. The Department will review the proposed modifications and determine if the MSE wall system will remain on the list of Accredited MSE Wall Systems with the proposed modifications. MSE wall systems that are modified without notifying the Department will be removed from the list of Accredited MSE Wall Systems.

PAGES APPENDIX – 4 THROUGH APPENDIX – 36
HAVE BEEN INTENTIONALLY DELETED

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AN-5 3 COAT SHOP PAINT SYSTEM IZEU

Un-numbered plan note to define specification requirements for shop application of the 3 coat IZEU paint system. To use this note The 863 item shall be AS PER PLAN.

As example:
Item 863 Lump Sum STRUCTURAL STEEL MEMBERS, LEVEL ?, AS PER PLAN

The note AN-4 follows as the AS PER PLAN specifications to have a a three (3) coat shop paint system applied.

1.0 DESCRIPTION

In addition to the requirements of Supplemental Specification 863, this item shall consist of furnishing all necessary labor, materials and equipment to clean, apply a three(3) coat shop applied IZEU system for Item 863 Structural Steel, including requirements for field cleaning and coating of surfaces only prime coated at the shop, and methods of repair for surfaces damaged in shipping, handling and erecting the structural steel and any other damages during construction. Section 863.29 and 863.30 shall not apply.

This specification shall also include galvanizing, CMS 711.02, of all nuts, washers, bolts, anchor bolts, and any other structural steel items requiring galvanizing as part of item 863.

All shop painting shall be applied in a structural steel fabrication shop having permanent buildings per SS863.07 and pre qualified at the same SS863 level as the structural steel fabricator. The painter is under the supervision of a QCPS and is the SS863 Fabricator, the field painting sub-contractor performing touch up work in the field and or shop coating at the 863 Fabricator's facility or an independent painter meeting the qualifications of SSPC QP3 with facilities evaluation and acceptance by the Department.

2.0 MATERIAL

A. A three coat paint system consisting of an:

1. Inorganic Zinc Prime Coat meeting the requirements of CMS 708.17

2. Epoxy Intermediate Coat meeting the requirements of Supplemental Specification 910 entitled "OZEU Structural Steel Paint".

3. Urethane Finish Coat meeting the requirements of Supplemental Specification 910 entitled "OZEU Structural Steel Paint".

B. A tie coat consisting of an Epoxy Intermediate Coat, meeting the requirements of Supplemental Specification 910, "Epoxy Intermediate Coat" and thinned 50%, by volume,