CHAPTER 12
MISCELLANEOUS

12-1 Bridge Approach Slabs

General

Approach slabs are required on all bridges. The following ten standard drawings are available and should be used in plan development:

- BAS1 - "Bridge Approach Slab for Rigid Pavement"
- BAS2 - "Bridge Approach Slab for Rigid Pavement with Barrier Rail"
- BAS3 - "Bridge Approach Slab Details for Rigid Pavement with Barrier Rail"
- BAS4 - "Bridge Approach Slab for Flexible Pavement"
- BAS5 - "Bridge Approach Slab for Flexible Pavement with Barrier Rail"
- BAS6 - "Bridge Approach Slab Details for Flexible Pavement with Barrier Rail"
- BAS7 - "Bridge Approach Slab for Prestressed Concrete Cored Slab"
- BAS8 - "Bridge Approach Slab for Prestressed Concrete Cored Slab with Barrier Rail"
- BAS9 - "Bridge Approach Slab Details for Prestressed Concrete Cored Slab with Barrier Rail"
- BAS10 - "Bridge Approach Slab Details"
- BAS 11- "Bridge Approach Slab Details for Integral Abutments"

The appropriate BAS Standards to use are dependent upon the type of approach pavement, superstructure, and bridge rail. Standards BAS1, BAS4, or BAS7 should be used when a one or two bar metal rail is on the bridge. When the bridge is detailed for a concrete barrier rail, use BAS2 with BAS3, BAS5 with BAS6, or BAS8 with BAS9. Standard BAS10 should always be used in conjunction with the other BAS Standards. BAS7, BAS8 and BAS9 are reserved for use with cored slab bridges. BAS11 is for Integral Abutments.

Figures 12-1 through 12-~~9~~17show examples of the use of the approach slab standard drawings and several plan views to be included therein.

Approach slabs shall be paid for on a lump sum basis. Approach slabs that do not contain an asphalt overlay shall be grooved to the same limits as the deck.

Full Width Approach Slabs

General

Bridges located on NHS routes and/or carrying a design year ADT greater than 5,000 shall have a 25'-0" (7.62m) approach slab. Otherwise specify a 15'-0" (4.57m) approach slab. Use Figure 12-18 for selecting the appropriate length of

approach slab. All approach slabs shall be constructed with a minimum depth of 1'-0" (305mm).

For flexible approach pavements detail both ends of the approach slab parallel to the end bent fill face. The approach slab length shall be measured along the workline.

For rigid approach pavements detail the roadway end of the approach slab perpendicular to the centerline of the roadway. The minimum length shall be measured along the shortest edge. On very wide bridges and/or bridges with a heavy skew, the long edge of the approach slab may become excessive. For such cases limit the length of the longer edge of the approach slab to 50'-0" (15.24m). This may be accomplished by stepping in the approach slab at approach pavement lane lines while maintaining the minimum dimension.

Approach slab reinforcing bars shall be sized and spaced as follows:

Bar	Size	Spacing
A1	#4 (#13)	1'-0" (300mm)
A2	#4 (#13)	1'-0" (300mm)
B1	#5 (#16)	6" (150mm)
B2	#6 (#19)	6" (150mm)

Guidelines for placement of reinforcing steel are as follows:

- 'B' bars shall be placed parallel to the alignment or the chord formed between the beginning (end) of the approach slab and the end bent work point
- 'A' bars shall be placed parallel to the skew
- For approach slabs without parallel ends, orient the 'A' bars to minimize the number of cut bars

~~The end of the approach slab shall be parallel to the fill face of the end bent with a constant length as measured along the centerline of bridge from the back face of the backwall and as specified below:~~

- ~~For structures with a 60° through 120° skew, use a 12 foot (3.66 m) approach slab.~~
- ~~For structures with other skews, use a 17 foot (5.18 m) approach slab.~~
- ~~For special situations, including very deep superstructures, consideration shall be given to an increased length of approach slab.~~

Approach slabs should be detailed individually for dual bridges.

On dual lane highways where one wide bridge is used in lieu of separate bridges, four approach slabs are required using the full width approach slab concept. On the median side, extend the approach slab to the edge of the approach paved shoulder. Detail the approach slab on the median side to be consistent with the Roadway plans.

~~Class AA concrete shall be specified for the approach slab. It will be necessary to compute and report this quantity in the Approach Slab Bill of Material.~~

~~When shoulder berm gutter is required, the end of the approach slab shall be detailed with a vertical face, 2'-4" (710 mm) in width, at the proposed location of the shoulder berm gutter. See Figures 12-1, 12-2 and 12-4.~~

Show the horizontal arc offsets for the left and right edges of approach slabs on a horizontal curve.

~~For approach slabs that tie into roadways with flexible pavement, the approach slab shall have an asphalt overlay beginning 2'-6" (750 mm) from the centerline of the joint, measured perpendicular to the end bent. The limits of the asphalt overlay should be shown on Standards BAS4-6. See Figures 12-1 and 12-4.~~

Reinforcing Steel Details

Reinforcing steel shall have 2 inch (50 mm) minimum clearance in the top and bottom of the slab.

~~Detail #6 (#19) bars at 6" (150 mm) centers for longitudinal reinforcement in the top and bottom of the slab. When the approach slab is on a horizontal curve, consideration should be given to making all longitudinal reinforcing steel the same length.~~

~~Transverse reinforcement shall be placed parallel to the fill face of the end bent with the spacing measured along the centerline of bridge as shown in Figures 12-1, 12-2 and 12-4. The transverse reinforcement in the approach slab shall be detailed as follows:~~

- ~~#5 (#16) bars at 6" (150 mm) centers in the top of the slab and #4 (#13) bars at 1'-6" (450 mm) in the bottom of the slab when barrier rail transitions are used. The increased reinforcement in the top of the slab is due to the traffic loading on the rail.~~
- ~~#4 (#13) bars at 1'-6" (450 mm) centers in the top and bottom of the slab when curbs or sidewalks are used.~~

Reinforced Bridge Approach Fills

Reinforced bridge approach fills shall be detailed on the plans unless directed otherwise by the Foundation Recommendations. The "Reinforced Bridge Approach Fill" is a Roadway pay item.

Construction Elevations

Construction elevations for approach slabs shall be computed for the left edge, centerline, ~~and~~ right edge and along all crown breaks between the gutter lines. ~~of approach slabs.~~ See Figures 12-~~10~~ 19 and 12-~~10a~~ 20 for the "Construction Elevation Layout for Approach Slab". See Section 6-2 "Construction Elevations" for additional information.

~~The approach slab construction elevations shall be adjusted on approach slabs with flexible pavement for the details shown on Standards BAS4-6 to include an asphalt overlay on the approach slab beginning 2'-6" (750 mm) from the centerline of the joint, measured perpendicular to the end bent.~~

Guard Rail Attachment to Barrier Rails

Guardrail attachment to the bridge barrier rails shall satisfy the requirements of NCHRP Report 350. The Roadway Design Unit will recommend the type of guardrail anchor unit (GRAU) and the location of guardrail attachments on the Structure Recommendations or the Roadway plans. Typically the guardrail will be attached to the bridge at all four corners of the bridge. However, the trailing ends of dual structures in the median may not require guardrail if certain conditions are met.

Typically, the Type B-77 GRAU will be specified. The B-77 GRAU attaches to the New Jersey barrier rail on the bridge. Use Standard GRA2 – "Guardrail Anchorage for Barrier Rail" to show the anchor assembly details on the structure plans. See Figures 12-1 through 12-3.

If no guardrail attachment is specified, do not detail an anchor assembly at that location.

The approach slab width shall equal the superstructure gutterline-to-gutterline plus 8" (200mm) on each side to accommodate the triangular curb.

When a flat-faced concrete rail, such as the 1, 2 or 3 Bar Metal Rail, is used on the bridge, then typically the Type III GRAU will be specified. For this type of rail, the Type III GRAU attaches to the flat-faced rail on the bridge. Use the applicable Standards BMR1-8.

Barrier Rail Transitions

When a Type III GRAU is specified for use on a bridge with a New Jersey barrier rail, detail the concrete barrier rail transition to provide a vertical face

for guardrail attachment. The barrier rail transition shall be supported on the approach slab. See Figures 12-4 and 12-5.

~~Barrier Rail Transitions~~

~~When a concrete barrier rail is used on the bridge, concrete barrier rail transitions are required on the approach slab in order to provide a vertical face for the guardrail attachment. The transition and attachment details shall satisfy the requirements of NCHRP Report 350.~~

The approach slab width shall equal the out-to-out superstructure width to accommodate the barrier rail transition.

The barrier rail shall transition from a concrete barrier rail shape to a vertical parapet over the length of the approach slab. The barrier rail transition consists of a 3 foot (915 mm) long vertical parapet, a 5 foot (1.525 m) transition section, and a concrete barrier rail. The length of the concrete barrier rail shall vary depending on the approach slab length and skew conditions. The end of the approach slab shall be squared off where it intersects the rail.

For cored slab structures and cast in place deck bridges, the concrete barrier rail width shall be 1'-6" (457 mm). The width of vertical parapet shall be not less than 9" (240 mm) when it is not protected from traffic impact by guardrail.

Barrier rail transition details are shown on BAS3, BAS6, BAS9, and Figure~~s 12-1a, 12-2a and 12-3~~12-7. Include the concrete and reinforcing steel quantities for the barrier rail transition in the Approach Slab Bill of Material as shown in Figures 12-~~1~~ 4~~and 12-2~~.

The Type III GRAU ~~guardrail attachment to the vertical parapet~~ shall be ~~located~~ attached 1'-10" (560 mm) from the end of the barrier rail transition. Show the location of the anchor assemblies for the guardrail attachment on Standard BAS3, BAS6, or BAS9. See Figure~~s~~ 12-~~1a~~5~~, 12-2a and 12-3~~. If no guardrail attachment is specified, provide the barrier rail transition on the approach slab but do not detail an anchor assembly at that location. ~~Roadway Design will recommend the location of guardrail attachments on the Structure Recommendations or the Roadway plans. Typically, Guardrail Anchor Unit Type III will be specified at all four corners of the bridge. However, the trailing ends of dual structures in the median may not require guardrail if certain conditions are met. In this case, provide the barrier rail transition on the approach slab but do not detail an anchor assembly at that location.~~

Curbs

The approach slab width shall be full width from gutterline to gutterline plus 8 inches (200 mm) on each side for the curb on bridges with one or two bar metal rail. Details of the curb on the approach slab are shown on the BAS1, BAS4, and

BAS7 and in Figures 12-~~4~~1 and 12-~~4a~~2.

~~On cored slab bridges, maintain the 4 inch (100 mm) curb height above the asphalt wearing surface on the approach slab.~~

Sidewalks

When a three bar metal rail with sidewalk is used on the bridge, continue the sidewalk onto the approach slab. The approach slab width shall extend 5'-0" (1.5 m) or 5'-6" (1.65 m) from the gutterline to accommodate each sidewalk. Modify the BAS Standards as necessary. See Figures 12-~~9~~16 and 12-~~9a~~17 for additional sidewalk details to include on the plans.

12-2 Title Sheet Procedures

Title Sheet Furnished by Roadway Design Unit

When the structures are part of a project that includes roadway work, a reproducible copy of the title sheet may be obtained from the Roadway Design Unit. Replace the Roadway Design Project Engineer's and Project Design Engineer's names with those of the Structure Design Unit's Project Engineer and Project Design Engineer.

Title Sheet Drawn by Structure Design Unit

When the project does not include roadway work, the title sheet shall be developed by the Structure Design Unit. Obtain the standard from the CADD operator and include the following information:

- Project and TIP numbers in large numerals in left hand margin
- State, TIP and Federal Aid project numbers in the upper right hand corner
- ***STRUCTURE(S)*** or ***CULVERT(S)*** on the left side of the plan sheet
- County name in large letters
- Description of project location
- Description of type of work (when applicable, include "bicycle lanes")
- Design designation
- Vicinity map
- Large scale map of project reflecting the beginning and ending stations of the structure
- Shipping point
- Length of the structure along the project
- North arrow
- Total number of sheets in the plans

- Letting date
- Name of Project Design Engineer and Project Engineer
- Title sheet should be signed and sealed by the State Bridge Design Engineer and signed by the State Highway Design Engineer.

12-3 Removing Existing Pavement In Order to Drive Piles

In cases where the Roadway Design Unit is to remove existing pavement so that end bent piles may be driven, the Roadway plans should state that:

> ***The existing pavement is to be removed and the roadbed scarified to a minimum depth of 2'-0"****(610 mm)* ***below original surface in the area where piles are to be driven through the proposed embankment, as directed by the Engineer.***

Place the following note on the General Drawing:

> ***The existing pavement within the area of the end bent piles shall be removed and the roadbed scarified to a minimum depth of 2'-0"****(610 mm).*

The above notes should be modified to exclude removing the existing pavement for gravel roads.

12-4 Adhesively Anchored Anchor Bolts or Dowels

~~In certain instances, the Contractor has the option of drilling holes in the concrete and filling them with an adhesive bonding material to install anchor bolts or dowels rather than using cast-in-place or preset anchors. This option may apply in the situations listed in Figure 12-11. Where applicable, the following note shall be placed on the plans:~~

> ~~***The Contractor may use adhesively anchored*** *(anchor bolts/dowels)* ***in place of _____. See Special Provision for Adhesively Anchored Anchor Bolts or Dowels.***~~

~~The designer shall also show the yield load of the anchor bolt/dowel on the plans.~~

~~The manufacturer will determine an embedment depth that ensures the adhesive bonding material develops at least 125% of the yield load of the anchor bolt or dowel. The Project Engineer, however, shall be responsible for noting any restrictions on, or special considerations of, the embedment depth of the anchor bolt/dowel such as a 2 inch (50 mm) minimum cover on thin concrete sections. If it is unclear whether there is adequate concrete thickness to develop a reasonable embedment depth, check the manufacturers' catalogs for typical embedment depths. The Project Engineer shall be responsible for placing any clearance requirements, actual required embedment depth or applicable notes on the plans.~~

~~If no special considerations are shown on the plans, the manufacturer's recommended embedment depth will be the minimum applicable depth.~~

~~Some applications of adhesively anchored bolts/dowels will require field testing. For a list of these applications, as well as a note to be placed on the plans, see Figure 12-11. These anchor bolts/dowels will be tested to a load equal to 90% of the yield load of the anchor bolt/dowel. Any special testing requirements shall be noted on the plans. As an example, if the dowels are tested with a centerhole jack apparatus and are installed at an angle in a corner, the Contractor will not be able to use the centerhole jack apparatus since it cannot rest flush against the concrete face. The Contractor will then be required to install additional dowels in either a vertical or a horizontal position so that the dowel can be tested. These test dowels may then have to be removed or cut flush with the concrete. In this situation, the plans should clearly state that additional dowels will be required strictly for testing purposes.~~

~~The Special Provision for Adhesively Anchored Anchor Bolts or Dowels states that there is no special payment for this system but that it shall be included in the unit contract price for the several pay items.~~

For certain applications, the Contractor has the option of drilling holes in the concrete and filling them with an adhesive bonding material to install anchor bolts or dowels rather than using cast-in-place or preset anchors.

Most applications of adhesively anchored bolts/dowels will require field testing. For a list of these applications, as well as the level of testing required, see Figure 12-~~11~~21. These anchor bolts/dowels will be tested to a load equal to either 50% or 80% of the yield load of the anchor bolt/dowel. Place the following note on the plans:

> ***The Contractor may use adhesively anchored*** *[anchor bolts/dowels]* ***in place of _____. Level ___ field testing is required, and the yield load of the [anchor bolt/dowels] is____ kips. For Adhesively Anchored Anchor Bolts or Dowels, See Special Provisions.***

If no field testing is required, place the following note on the plans:

> ***The Contractor may use adhesively anchored*** *[anchor bolts/dowels]* ***in place of _____. No field testing is required. For Adhesively Anchored Anchor Bolts or Dowels, See Special Provisions.***

The manufacturer will determine an embedment depth that ensures the adhesive bonding material develops at least 125% of the yield load of the anchor bolt or dowel. The Project Engineer, however, shall be responsible for noting any restrictions on, or special considerations of, the embedment depth of the anchor

bolt/dowel such as a 2 inch (50 mm) minimum cover on thin concrete sections. If it is unclear whether there is adequate concrete thickness to develop a reasonable embedment depth, check the manufacturers' catalogs for typical embedment depths.

For bolts, the yield load shown on the plans should be based on the yield stress applied to the tensile stress area of the bolt. For rebar, the yield load is based on the yield stress applied to the cross section area of the bar.
There are a number of approved manufacturers of adhesive bonding systems; refer to the Materials and Tests Unit's approved products list and the respective manufacturer's websites.

No overhead applications of adhesively anchored anchor bolts or dowels will be allowed.

The Special Provision for Adhesively Anchored Anchor Bolts or Dowels states that there is no special payment for this system but that it shall be included in the unit contract price for the several pay items.

12-5 Rip Rap

The type of rip rap to be used for a given structure will be set by the Hydraulics Unit. If the type required is not clear on the Hydraulic Design Report, consult the Hydraulics Unit.

Filter fabric shall typically be placed under the area covered by rip rap for all rip rapped slopes. If filter fabric is not required, it will be indicated on the Bridge Survey Report. Show the filter fabric on the appropriate standard drawing section views showing a straight line between the ground line and the rip rap, denoted as filter fabric. Show the quantity of filter fabric in square yards (square meters) on the plans.

The following three standard drawings are available and should be used in plan development:

- RR1 - "Rip Rap Details - Skew < 90° "
- RR2 - "Rip Rap Details - Skew = 90° "
- RR3 - "Rip Rap Details - Skew > 90° "

The Standards are drawn to show general details. Some modification may be needed to suit a particular structure.

The usual slope condition at stream crossing sites is a 1½:1 front slope and 1½:1 or flatter side slopes with the transition, if necessary, in the cone. The general

intention is not to place rip rap on a slope flatter than 2:1 slope; therefore, the roadway approach slopes flatter than 2:1 should be transitioned to 2:1 before the rip rap limits are reached. Rip rap shall be provided on slopes flatter than 2:1 on both the front and side slopes in some unusual cases, such as bridges over lakes.

In all cases where rip rap is specified, include the rip rap in tons (metric tons), in the structure contract. To convert square yards (square meters) to tons (metric tons), multiply by 0.90 for a 2 foot (0.98 for a 600 mm) layer of rip rap. See Figure 12-~~12~~22.

12-6 Slope Protection

Slope protection shall be used beneath all grade separations. Unless otherwise specified by the Railroad, slope protection shall be used for railroad overheads. An aid for calculating concrete slope protection quantity is provided as Figure 12-~~12a~~23. When slope protection and a crashwall are detailed on the plans, provide a concrete swale behind the crashwall as detailed in Figure 12-~~13~~24.

In general, dual bridges with median widths of 46 feet (14 m) or less shall receive continuous slope protection between the bridges.

See Standards SP1 and SP2 for slope protection details. When using the standard drawings, delete the options and details that are not allowed. Alternate "B" for stone slope protection shall be considered for grade separations with 2:1 end bent slopes in rural, unpopulated areas only. Filter fabric shall typically be placed under stone slope protection. Show the quantity of filter fabric in square yards (square meters) on the plans.

The toe of slope protection elevations should be shown on the Slope Protection Details Sheet. The elevations and corresponding offsets from the survey line under the bridge shall be shown at the permissible construction joint on the slope protection (see Roadway Standard 610.03) at a minimum of two locations as illustrated in Figure 12-25. This data will aid the contractor in locating the toe of the slope protection prior to construction of roadway ditches under the bridge.

12-7 Plans for Falsework and Forms

When preparing plans including cast-in-place deck slabs, hammerhead bents, arch culverts, box culverts with a top slab thickness of 18 inches (455 mm) or greater, or other special structures, place the following note on the plans:

Detailed drawings for falsework and forms for this _____ shall be submitted. See Sheet SN *(Sheet SNSM)****.***

12-8 Temporary Structures

On all temporary structures, place an asphalt wearing surface for traction. This surface could be the same as that used on the detour approaches.

When there is roadway work on the project, the alignment for the temporary structures should be coordinated with the Roadway Design Unit. For projects without roadway work, the alignment shall be shown on the plans, preferably in the Location Sketch.

For grade separations, the specified length of the temporary bridge should be the same length as the permanent bridge.

~~12-9 Removal of Existing Bridge Failure Detection Device and Signal Equipment~~

~~When an existing structure is protected in case of failure by a failure detection device and/or signal equipment, place the following note on the plans:~~

~~***For Removal of Existing Structure and Bridge Failure Detection Device, see Special Provisions.***~~

~~12-10~~12-9 Providing Access Facilities on New Bridges

For bridges where portions of the structure are inaccessible from the bridge deck or below, maintenance and inspection access details shall be included in the plans. These details may include walkways, platforms, or ladders.

The following criteria shall be used as a guide in determining which bridges require access facilities:

- Structures on which mechanical or electrical devices that require periodic maintenance or replacement are installed.
- Bridges with a vertical underclearance of 35 feet (10.7 m) or greater and an out-to-out deck width equal to or greater than that shown in Figure 12-~~14~~26.
- Bridges over water or marshland that have an out-to-out deck width equal to or greater than that shown in Figure 12-~~14~~26.
- For bridges with sidewalks that may require access facilities, the width of each sidewalk should be subtracted from the values shown in Figure 12-~~14~~26 to determine the permissible out-to-out deck width.
- For bridges not meeting the criteria shown in Figure 12-~~14~~26, the Bridge Maintenance Unit should be contacted for their recommendations.
- Out-to-out deck widths shown in Figure 12-~~14~~26 shall be reduced for skewed bridges.

The final decision as to the need and type of access facility should be made in consultation with the Bridge Maintenance Unit. All access facilities shall meet OSHA requirements for structural size and safety criteria.

~~12-11~~12-10 Shoring Adjacent to Existing Bridges

When constructing a new or temporary bridge adjacent to an existing bridge, consideration must be given to the need for temporary shoring.

For grade separations, the Structure Design Project Engineer will coordinate with the Roadway Design Unit and the ~~Soils and Foundation Section~~Geotechnical Engineering Unit to determine the shoring requirements. If shoring is required, Structure Design will provide Roadway Design with a detail of the end bent slopes of the new bridge with the existing slope shown in dashed lines. For the note to be placed on the General Drawing, see Section 5-2 "Excavation and Shoring".

For stream crossings, the Structure Design Project Engineer will coordinate with the ~~Soils and Foundation Section~~Geotechnical Engineering Unit to determine the shoring requirements. If shoring is required and there is a pay item for "Temporary Shoring" in the Roadway plans, the shoring quantity will be included in the Roadway plans. If there is not a Roadway pay item, include a square foot (square meter) pay item for "Temporary Shoring" on the Structure plans. For the note to be placed on the General Drawing, see Section 5-2 "Excavation and Shoring".

Temporary Shoring for the Maintenance of Traffic shall be detailed when needed to provide lateral support to the side of an excavation or embankment parallel to an open travelway when a theoretical 2:1 or steeper slope from the bottom of the excavation or embankment intersects the existing ground line closer than five feet from the edge of pavement of an open travelway. Shoring required for foundation or culvert excavation is considered Temporary Shoring for the Maintenance of Traffic if it also satisfies the above requirement.

The need for Temporary Shoring for Maintenance of Traffic shall be determined through coordination with Soils and Foundation, Traffic Control, and Roadway Design. This shoring will be shown on the Traffic Control Plans and the pay quantity provided in the roadway plans. When this shoring is required, indicate the shoring in the plan view of the general drawing and label it as "Temporary Shoring for the Maintenance of Traffic. See Notes." The beginning and ending stations for this shoring are not required on the plans. See Section 5-2 "Excavation and Shoring" for the note to be placed on the General Drawing.

Confer with Soils and Foundation to determine the limits and pay quantity of this shoring. The quantity of temporary shoring to be paid for will be the actual number of square feet (square meters) of exposed face of the shoring measured

from the bottom of the excavation or embankment to the top of the shoring, with the upper limit not to exceed 1 foot (300 mm) above the retained ground line.

~~12-12~~12-11 Foundation Excavation on Railroad Right of Way

General

Details for foundation excavation on railroad right of way shall be shown in the contract plans. Excavations may be detailed as either sloped open cuts or with temporary shoring.

When several substructure units are on the Railroad right of way, the Railroad may only require excavation details for the units closest to the track. In this situation, the Assistant State Bride Design Engineer will assist in obtaining permission from the Railroad to exclude the unnecessary excavation details from the plans.

To eliminate the need for foundation excavation for railroad crashwalls, bents shall be located to provide 25 feet (7.62 m) horizontal clearance from the centerline track whenever practical.

Shoring or Open Excavation Plans

When circumstances allow an open cut excavation, provide plan and section view details to show the limits of the excavation. The ~~Soils and Foundation Section~~Geotechnical Engineering Unit must be consulted to determine the maximum permissible cut slope for the soil conditions. The plans should include the minimum distance from the centerline of the track to the top of the nearest excavation cut slope.

When temporary shoring is required, the design and plans shall be prepared in accordance with the requirements illustrated in Figure 12-~~15~~27. The plans shall contain details of the shoring system including the size of all structural members, connection details, embedment depth and the distance from the centerline of track to the near face of shoring. The plans shall also include a section showing the height of the sheeting and the track elevation in relation to the bottom of the excavation (additional survey data may be needed in order to show this information). The inside face of the shoring shall be a minimum of 1'-6" (450 mm) outside the edge of the footing. Where it is not possible to design a shoring system without struts extending through the crashwall, place the details of Figure 12-~~16~~28 on the plans.

Unless prior approval is received from the Railroad, all excavations on Railroad right of way shall be detailed with handrails. In addition, open excavations adjacent to tracks that are located within what is termed “normal walkways” by the Railroad shall be detailed with a walkway and handrails. Handrails shall not be located closer than 10 feet (3 m) horizontally from the centerline of the track.

Design

Allowable stresses for concrete and steel shall be in accordance with the AREMA Specifications. Railroad surcharge loads shall be computed using the equation for a continuous strip of surcharge load from the AREMA Specification and shall be based on a Cooper's E80 live load model. The ~~Soils and Foundation Section~~Geotechnical Engineering Unit is to be consulted in determining soil pressures, possible pile or sheeting penetrations, and slope stability of the highway approach fills and the open foundation excavations.

Coordination with the ~~Soils and Foundation Section~~Geotechnical Engineering Unit may also be required to ensure that the Foundation Recommendations do not detail the footing at an elevation that interferes with the railroad ditch.

Plans prepared for shoring or open cut foundation excavation shall provide for the possibility of spread footings being lowered up to 3 feet (1 m).

Pay Items

When the foundation excavation at a bent involves shoring that fully or partially encloses the excavation, each affected substructure unit will require two lump sum pay items as follows:

- "Shoring For Bent _____ "
- "Foundation Excavation For Bent _____ "

When the foundation excavation at a bent involves only an open cut, each affected substructure unit will require one lump sum pay item as follows:

- "Foundation Excavation For Bent _____ "

For a bridge that spans both a railroad and a highway or a stream, some of the substructure units may fall outside the Railroad right of way. Pay items and payment for "Foundation Excavation" for these units will be handled as outlined in Section 7-6 of this manual.

For the note to be placed on the General Drawing when Railroad approval has not been received prior to the letting, see Section 5-2 "Excavation and Shoring".

~~12-13~~12-12 Corrosion Protection

General

Corrosion protection is achieved through the use of one or more of the following measures: Increased clear cover for reinforcing steel, epoxy coating reinforcing steel, adding calcium nitrite corrosion inhibitor, silica fume, fly ash or granulated blast furnace slag, specifying Class AA concrete for substructures, and limiting the use of uncoated structural steel.

Corrosion protection is used to varying degrees for bridges on or east of the Corrosive (blue) Line of Figure 12-~~17~~29 and in Divisions where significant road salt is applied. Figure 12-~~16a~~ ~~28~~30 provides a flowchart to determine the extent of corrosion protection necessary for any bridge.

In Divisions 5, 7, or 9-14, corrosion protection focuses on the bridge deck, where mineral admixtures are added to the concrete to reduce permeability.

For Corrosive Sites, the corrosion protection is more comprehensive. Corrosive Sites are limited to stream crossings on or east of the Corrosive (blue) Line as defined by Figure 12-~~17~~29. For these bridges, mineral admixtures may be required in all or some of the bridge members. Additionally, calcium nitrite is specified to increase corrosion resistance of the reinforcing steel. See Figure 12-~~16a~~30 for instructions on applying the various protection systems to each location.

For bridges located east of the Highly Corrosive (red) Line, all concrete will receive at least one corrosion protection measure. For bridges located between the Highly Corrosive (red) and Corrosive (blue) Lines of Figure 12-~~17~~29, apply corrosion protection measures and notes to only those structural elements (i.e. prestressed concrete girder, cored slab, bent cap, column, etc,) that are located within 15 feet (4.5 m) of mean high tide. When any structural element is within 15 feet (4.5 m) of mean high tide, all similar elements in the bridge shall receive the same corrosion protection.

Corrosion Protection Measures

Corrosion protection measures are determined through the use of the flowchart of Figure 12-~~16a~~30 and the map of Figure 12-~~17~~29. The notes below shall be used as directed by Figure 12-~~16a~~30.

Note #1: ***The class AA concrete in the bridge deck shall contain fly ash or ground granulated blast furnace slag at the substitution rate specified in Article 1024-1 and in accordance with Articles 1024-5 and 1024-6 of the Standard Specifications. No payment will be made for this substitution as it is considered incidental to the cost of the Reinforced Concrete Deck Slab.***

Note #2: ***All metallized surfaces shall receive a seal coating as specified in the Special Provision for Thermal Sprayed Coatings (Metallization).***

Note #~~32~~3: ***Class AA concrete shall be used in all cast-in-place columns, bent caps, pile caps, and footings, and shall contain calcium nitrite corrosion inhibitor. For Calcium Nitrite Corrosion Inhibitor, see Special Provisions.***

Note #~~43~~: ***Prestressed concrete girders are designed for 0 psi*** *(0 MPa)* ***tension in the precompressed tensile zone under all loading conditions.***

Note #~~5~~54: ***Precast panels shall be designed for an allowable tensile stress of 0 psi*** *(0 MPa)* ***in the precompressed tensile zone under all loading conditions.***

Note #~~6~~65: ***The water/cement ratio for concrete piles shall not exceed 0.40.***

Note #~~7~~76: ***All bar supports used in the*** *(barrier rail, parapet, sidewalk, deck, bent caps, columns, pile caps, footings)* ***and all incidental reinforcing steel shall be epoxy coated in accordance with the Standard Specifications.***

Note #~~8~~87: ***Prestressed concrete*** *(girders, precast deck panels, cored slab units, piles)* ***shall contain calcium nitrite corrosion inhibitor. See Special Provisions for Calcium Nitrite Corrosion Inhibitor.***

For those elements of the structure that may undergo repeated wetting and drying cycles due to tidal fluctuations, 5% of the portland cement shall be replaced with silica fume. For mass concrete elements subject to repeated wetting and drying cycles, use fly ash in lieu of silica fume. Place the note below on the General Drawing. If precast elements require silica fume, also place the note on the precast element sheet or standard drawing:

Note #~~9~~98: ***The concrete in the*** *(columns, bent caps, pile caps, footings, and/or piles)* ***of Bent No. ____ shall contain silica fume. Silica Fume shall be substituted for 5% of the portland cement by weight. If the option of Article 1024-1 of the Standard Specifications to partially substitute Class F fly ash for portland cement is exercised, then the rate of flay ash substitution shall be reduced to 1.0 lb*** *(1.0 kg)* ***of fly ash per 1.0 lb*** *(1.0 kg)****. No payment will be made for this substitution as it is considered incidental to the various pay items.***

In general, metal stay-in-place forms shall not be permitted. In special situations, such as in those channel spans of high level bridges where the use of prestressed concrete deck panels is not feasible, removable forms shall be required.

~~Painted Steel~~12-13 Weathering Steel and Steel Coatings

Weathering steel (AASHTO M270 Gr. 50W or Gr. 70W) shall not be used in "low-level" water crossings nor "tunnel-like" grade separations. Stream crossings that are less than 10 ft (3 m) above the normal water surface shall be considered "low-level". Grade separations where a depressed roadway is bounded by abutments or retaining walls, typically found in urban areas, shall be considered "tunnel-like".

Concrete or ~~Painted~~ fully-painted steel(i.e., AASHTO M270 Gr. 36, 50 or 70) ~~or concrete~~ shall be used in lieu of weathering steel for superstructures of stream crossings, grade separations and railroad overheads in the following counties:

Brunswick Hyde

New Hanover	Dare
Pender (on or East of NC 53)	Tyrrell
Onslow	Washington
Carteret	Chowan
Craven (on or east of US 17)	Perquimans
Jones (on or east of US 17)	Pasquotank
Pamlico	Camden
Beaufort	Currituck

~~Weathering steel shall not be used in "low-level" water crossings nor "tunnel-like" grade separations. Stream crossings that are less than 10 ft (3 m) above the normal water surface shall be considered "low-level". Grade separations where a depressed roadway is bounded by abutments or retaining walls, typically found in urban areas, shall be considered "tunnel-like".~~

Thermal Sprayed Coatings

When thermal sprayed coatings are required, place the applicable note(s) on the plans stating the type of alloy required and its required thickness. For most applications the alloy and thickness will be prescribed in the Special Provision. ~~Is Zinc-Aluminum (W-ZnAl-1) with a minimum thickness of 8 mils, H~~however, for some applications the alloy and thickness are required ~~other chemical compositions are required~~ as outlined below.

~~When thermal spayed coatings are required, add the applicable note(s) on the plans stating the type of alloy required and it's required thickness.~~

Steel Piles in Corrosive Environments

For steel piles in a corrosive environment, 99.5 percent Aluminum (W-Al-1350) and~~AND~~ a seal coat is required. Place the following note on the plans:

> ***Apply an 8 mil thick 1350 Aluminum (W-Al-1350) thermal spray coating with a 0.5 mil thick seal coat to the piles, ~~and subsequently apply a 0.5 mil thick seal coat~~ in accordance with the Thermal Sprayed Coatings Special Provision and ~~–~~Section 442 of the Standard Specifications. For Thermal Sprayed Coatings, see Special Provisions.***

System 1 Paint is required on the portion of the steel pile (H or pipe piles) that is ~~partially~~ embedded in concrete. Place the following note on the plans:

> ***After driving the piles, ~~application of the seal coat,~~ apply 1~~2~~ coat each~~s~~ of 1080-12 Brown and 1080-12 Gray paint ~~System 1 paint~~ to the embedded***

section of the metallized pile prior to concrete embedment in accordance with Section 442 of the Standard Specifications. ~~For Thermal Sprayed Coatings, see Special Provisions.~~

In corrosive sites, e~~E~~xposed steel piles shall be used for fender systems only, ~~and~~ shall contain 0.2% copper ~~(Marine Steel)~~, be metallized and have a seal coat. Place the following note on the detail sheet:

Steel piles for fender systems shall contain 0.2% copper, be metallized and have a seal cost. ~~Apply an 8 mil thick 1350 Aluminum (W-AL-1350) thermal spray coating to all piles, and subsequently apply a 0.5 mil thick seal coat in accordance with Section 442 of the Standard Specifications.~~ For Thermal Sprayed Coatings, see Special Provisions.

Steel Girders

When thermal sprayed coatings are used on girders an approved seal coat is required. Place the following note on the plans:

Apply an 8 mil thick 99.99 percent Zinc (W-Zn-1)~~ 1350 Aluminum (W-Al-1350)~~ thermal spray coating with a 0.5 mil thick seal coat to all girder surfaces in accordance with the Thermal Sprayed Coatings Special Provision and ~~, and apply a 0.5 mil thick seal coat in accordance with~~ Section 442 of the Standard Specifications. Prior to application, create a companion coupon for approval by the Engineer. For Thermal Sprayed Coatings, see Special Provisions.

Aesthetic Considerations ~~Bridge Hardware~~

For applications where aesthetics are a major concern, add the following note to the plans: ~~When bridge hardware, such as armored joint angles or bearing plates are in direct contact with concrete, the thermal sprayed coating shall consist of 99.99 percent Zinc (W-Zn-1) with a minimum thickness of 8 mils. A seal coat is **NOT** required when using W-Zn-1. Place the following note on the plans:~~

~~Apply an 8 mil thick 99.99 Zinc (W-Zn-1) thermal spray coating to all surfaces. A seal coat is not required. For Thermal Sprayed Coatings, see Special Provisions.~~Prior to beginning metallization, the Contractor will provide metallized samples to the Engineer for approval.

~~**Drip Beads for Unpainted Weathering Steel**~~

~~The use of unpainted weathering steel for bridge superstructures can cause staining of bridge substructures during the period when the superstructure steel oxidizes. Their purpose is to diminish unsightly staining on bridge substructures during this period.~~

~~Drip beams are normally used only on structures having substructure units clearly visible to the public, such as piers or high abutments adjacent to grade separations.~~

~~Use of drip beams is determined at the Preliminary Plan stage of a project. If used, they are attached to the bottom flange of each fascia stringer at the low end of appropriate spans, see Figure 12-25.~~

~~12-14~~12-13 Retaining Walls

Reinforced Concrete Retaining Walls

Use a minimum footing depth of 12 in (300 mm) for all retaining walls. For other design criteria, see Section 2-6 "Earth Pressures".

Provide vertical contraction joints in the wall at approximately 30 ft (9 m) centers and expansion joints at approximately 90 ft (27 m) centers. Dovetail the expansion joints and use 1 in (25 mm) expansion joint material up to within 12 in (300 mm) of the top of the wall. Provide a 6 in (152 mm) ϕ plastic waterstop to extend from the construction joint in the footing to 6 in (150 mm) below the top of the wall. Plastic waterstops are not required in retaining walls adjacent to a stream.

Consider special construction requirements, such as temporary sheeting that may require Special Provisions or notations on the plans.

Proprietary Retaining Wall and Abutment Structures

Proprietary retaining wall and abutment structures (i.e., Reinforced Earth, Retained Earth, or Hilfiker Wall) are included in the Structure plans. In the case where there are no bridges or culverts on the project, the proprietary retaining wall and abutment structure will be the only structure in the Structure plans.

Provide a sheet in the plans showing the plan and elevations of the proposed retaining walls.

After the letting, the ~~Soils and Foundation Section~~Geotechnical Engineering Unit receives proprietary wall plans from the wall manufacturer. The ~~Soils and Foundation Section~~Geotechnical Engineering Unit will check the wall for bearing capacity, sliding, overturning and other items pertaining to soil mechanics. The Structure Design Project Engineer will receive this package from the ~~Soils and Foundation Section~~Geotechnical Engineering Unit to check the structural elements of the wall.

Place the following note on the plans:

For MSE Retaining Walls, see Special Provisions.

Show a sketch on the plans indicating the structure excavation limits for the installation of the walls. See Figures 12-~~18~~31 and 12-~~19~~32 for examples of appropriate sketches for various types of walls.

~~12-15~~12-14 Closed Structure Drainage System

When required by the Hydraulics Unit, a closed structure drainage system shall be detailed on the plans. Payment for the drainage system shall be shown on the Total Bill of Material at the lump sum price for "Structure Drainage System". For structure drainage system details, see Figures 12-~~20~~33 through 12-~~22~~35.

Place the following notes on the plans:

For Structure Drainage System, see Special Provisions.

The Contractor shall submit a plan for the drainage system, including, but not limited to, attachments to the bridge, scupper and inlet grate details, scupper support system, pipe alignment and pipe lengths, and all necessary fittings, elbows, wyes, adapters, guides and joints.

Shear studs or stirrups may be cut as approved by the Engineer to avoid interference with the bridge scupper.

Locate scuppers in the Plan of Spans as directed by the Hydraulics Unit. Provide reinforcement around the scupper as detailed on Standard BS2, "Bridge Scupper Details." Size inlet grates based on overhang and flange widths and recommendations from the Hydraulics Unit. Locate corresponding downspouts on an elevation view of the drainage system. Provide a general schematic drawing of the system but do not detail pipe lengths, fittings, elbows, or other such details. See Figure 12-~~20~~33.

Detail a longitudinal drain pipe with a minimum slope of 0.5% or as otherwise directed by the Hydraulics Unit. Typically, this drain pipe will be located immediately inside an exterior girder. Provide expansion joints in the drain pipes at a maximum spacing of 25 feet (7.5 m). Detail the location of pipe hangers and concrete inserts at a maximum spacing of 6 feet (2 m). Reduce this spacing to a maximum of 5 feet (1.5 m) surrounding each downspout and pipe expansion joint. A detail of the concrete insert placement is provided in Figure 12-~~21~~34. Detail a cleanout at each end of each longitudinal drain pipe and along the column downspout as detailed in Figure 12-~~20~~33.

Include section views on the plans that show the position of the drain pipe relative to the diaphragms as shown in Figure 12-~~22~~35. The cleanouts over the bent should be aligned to avoid interference with the bent diaphragm.

If a junction box is required to accept the drainage from the system, coordinate with the Roadway Design Unit to locate the junction box. Place the following note on the plans:

See Roadway Plans for details and pay item for junction box at approximate Station _____.

~~12-16~~12-15 Sound Barrier Walls

Pile panel sound barrier walls shall be in accordance with Standards SBW1 and SBW2 and the Special Provisions. The wall components shall be designed for the wind pressure as determined by the Exposure Category map of Figure 12-~~23~~36. Options and details shall be provided on the standard drawings to allow the use of either a 10 foot (3.1 m), or 15 foot (4.6 m) panel.

The appropriate pile selection table from Standard SBW1 should be placed on the plans. The dead load, ice load, and wind loads have been considered in the panel and pile design. For walls subject to any additional loadings, the pile and panel shall be designed on a case by case basis. In addition, walls exceeding 29 feet (8.840 m) in height shall be designed on a case by case basis.

The ~~Soils and Foundation Section~~Geotechnical Engineering Unit will determine the drilled pier lengths to be shown on Standard SBW1. Calculate the soil loads based on Figure 12-~~24~~37, excluding the weight of the pile and drilled pier. Submit the loads and a copy of the Roadway Plan sheet that locates the wall to the Soils and Foundation Unit.

The required horizontal reinforcement in the precast panels, as determined by Figure 12-~~24~~37, should be detailed on Standard SBW2 and the quantity tables for one precast panel shall be completed. The number and size of panels does not need to be computed; however, the estimated area, as computed from the Roadway plans, of the wall should be reported on Standard SBW2.

The completed standard drawings for the wall shall be transmitted to the Roadway Design Unit for inclusion with the wall layout and envelope in the Roadway plans.

~~12-17~~12-16 Electrical Conduit System

The design of the Electrical Conduit System is categorized by its attachment to the superstructure. The three options are attachment to SIP forms, precast deck

panels, or overhangs. Use the overhang option only when designing a stream crossing or a railroad crossing.

Every structure designed with an electrical conduit system shall use a conduit Expansion Joint Fitting and a Transition Adapter at each end bent and an Expansion Joint Fitting at each expansion joint in the deck. A Stabilizer should also be detailed midway between deck expansion joints. A Deflection Coupling is to be used only on structures on a horizontal curve that require the conduit to bend laterally to complete the installation. When a Deflection Coupling is required, place the following note on ECS1 or ECS1SM:

Install Deflection Coupler at each bent. See Detail "F".

When the Electrical Conduit System is used on bridges designed for precast deck panels, place the following note on the Precast Panel Standard PDP1:

¾" (19 mm) diameter pipe sleeve inserts shall be installed at a maximum of 10 foot (3m) centers to accommodate the Electrical Conduit System. See Electrical Conduit Systems Details.

Payment for the Electrical Conduit System will be as "Lump Sum". No bill of material for the Conduit System will be required.