SECTION 11: WALLS, ABUTMENTS, AND PIERS

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11.1 Scope

This Section contains guidelines to supplement provisions of Section 11 of the AASHTO LRFD Bridge Design Specifications for the analysis and design of bridge abutments, piers, and walls. Additional guidance for slope paving, approach slabs, and anchor slabs can be found under General Consideration. Utilization of Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) is addressed in ADOT's Accelerated Bridge Construction (ABC) guidelines.

11.6 Abutments And Conventional Retaining Walls

11.6.1 General Consideration

Abutments shall be designed to withstand dead load, erection loads, live loads on the roadway, wind loads on the superstructure, forces due to stream currents, floating ice and drift, temperature and shrinkage effects, lateral earth and water pressures, scour and collision and earthquake loadings.

Integral abutments shall be designed to resist and/or absorb creep, shrinkage, and thermal deformations of the superstructure.

For computing load effect in abutments, the weight of filling material directly over an inclined or stepped rear face, or over the base of a reinforced concrete spread footing may be considered part of the effective weight of the abutment. Where spread footings are used, the rear projection shall be designed as a cantilever supported at the abutment stem and loaded with the full weight of the superimposed material, unless a more exact method is used.

The anticipated settlement of abutments should be estimated by appropriate analysis, and the effects of differential settlement shall be accounted for in the design of the superstructure.

Consideration shall be given to measures that will accommodate the contraction and expansion of the concrete wall.

The filling material behind abutments shall be free draining, non expansive soil, and shall be drained by 3 inch minimum diameter weep holes placed 6 inches above the ground line at 10 foot centers and sloped ½ inch per foot. Silts and clays shall not be used for backfill. Backfill material shall be compacted to a density no less than 100 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, and as directed and approved by Engineer.

A minimum 2 foot wide bench in front of spill-thru abutments is required on slopes steeper than 2:1.

11.6.1.1 Slope Paving

The requirements for Slope Paving lengths extend 8 feet past the catch point to the end of the wingwall. If slope paving is not needed, the wingwall shall be extended 8 feet beyond the catch point or the end of the approach slab, whichever is longer.

The slope of the embankment in front of the abutment shall be no steeper than 2:1 unless matching existing conditions. Embankment slopes 2:1 and steeper shall be protected with slope paving. The details for Slope Paving are provided in Bridge Group Structure Detail drawing SD 2.04.

11.6.1.2 Approach Slabs

Bridge Group Structure Detail drawing SD 2.01 has been developed for approach slabs on all new bridges. The approach slab has been designed using the load factor design method according to the AASHTO Standard Specifications for Highway Bridges. The slabs have been designed to support an HS-20-44 live load, 25 psf future wearing surface and its own self-weight. A design span equal to 13 feet has been used assuming settlement may occur and the slab is only supported at the abutment seat and near the far end.

Approach slabs serve three major purposes:

1) They provide a smooth transition structure from the bridge to the approach roadway should the roadway embankment settle.

2) They eliminate the live load surcharge on the abutment backwall when the conditions specified in AASHTO 3.20.4 are satisfied.

3) They provide a structural foundation for bridge barriers or transitions.

Three approach slab options are provided.

Plan A is to be used for right angle bridges.

Plan B is to be used for bridges with skews less than or equal to 45 degrees. This option is not appropriate when used in conjunction with anchor slabs.

Plan C is to be used for bridges with skews greater than 45 degrees and less than or equal to 60 degrees; and/or for all skewed bridges where anchor slabs are also used.

The bridge drawings shall specify the length of the approach slab and which of the three plans is to be used. The SD drawings show the minimum length of the slabs as 15 feet. This length is adequate for most applications. The length of the slab may be increased to satisfy any or all of the following conditions:

- Eliminate the need to design a surcharge for an abutment

- When ground conditions indicate potential for possible large settlements
- When bridge barrier transitions require a greater length

In such cases the adequacy of the design must be verified. The bridge designer should consult with the project geotechnical engineer regarding all non-standard approach roadway applications. Inattention to detail in this area could result in serious damage and costly repairs.

No additional reinforcement is required for barriers or transitions. This is already included in the approach slab design.

When bridge approach slabs are to be added or replaced on existing bridges, modification may be required to the approach seats. Either the new bridge approach slab will be pinned to the existing seat, or attached with approach anchors with a widened seat. When the existing bridge end does not provide sufficient support shelf length (12” minimum) any existing substandard approach seat shall be removed, and a replacement seat shall be constructed.

When joints are positioned at the end of approach slabs in conjunction with integral or semi-integral abutments, an angle iron at the asphalt side of the sleeper slab shall be incorporated, aligning with the detail outlined in SD 2.01 Detail A.

11.6.1.3 Anchor Slabs

When approach roadways are paved with Portland Cement Concrete Pavement (PCCP), the use of an anchor slab as shown in SD 2.02 and SD 2.03 shall be required to prevent pavement growth from causing damage to the bridge. For short lengths of pavement less than 200 feet, the Concrete Pavement Alternate detail with a sleeper slab and joint materials shown in SD 2.01 shall be used.

Two anchor slab options are provided.

- Type 1 (SD 2.02) is used when the length of the approach pavement exceeds 700 feet.
- Type 2 (SD 2.03) is used when the length of the approach pavement is between 200 and 700 feet.

The bridge drawings should specify which of the two SD drawings is to be used. The anchor slabs are designed to be used together with an approach slab and sleeper slab. The approach slab must be squared off to be compatible with the anchor slab details. Selection of the appropriate approach and anchor slabs should be performed with close consultation with the project geotechnical engineer and concrete pavement designer. Documentation of the selection should be recorded in the Bridge Selection and Bridge Geotechnical Reports. The transverse reinforcement in the anchor slab is adequate to act as a structural support for a barrier or transition. No additional reinforcement is required for this application.

11.6.1.4 Wingwalls

Wingwalls shall be designed as monolithic with the abutments and cantilevered off of the abutment wall. It is not desirable to add a footing or support at the end of wingwalls for integral abutments unless provision for movement and rotation are provided. The wingwall length is determined by the engineer in accordance with project requirements, and must be long enough to retain the roadway embankment at the abutment. For wingwall lengths greater than 15 feet, the engineer should consider the use of cantilevered retaining walls.

11.6.3 Bearing Resistance and Stability at the Strength Limit State

For a cantilever abutment, the overturning forces must be balanced by the vertical earth load on the abutment heel and the self-weight of the abutment.

The passive earth pressure resistance exerted by the fill in front of the abutment is to be neglected in the design due to the potential for erosion, scour, or future excavation in front of the abutment. A larger relative movement should be applied to activate the passive pressure. Include the vertical load from the toe backfill in the analysis for overturning if it increases overturning.

11.10 Mechanically Stabilized Earth Walls

Mechanically Stabilized Earth (MSE) walls are a technically and economically effective alternative to traditional reinforced concrete earth retaining structures, particularly where substantial settlements are anticipated. MSE walls behave like gravity walls, deriving lateral resistance through the self-weight of the reinforced soil mass behind the facing.

MSE supported bridge abutments shall not be considered.

The Design Engineer shall consult with the project Geoprofessional for the appropriate soil properties and recommended design parameters. MSE wall design shall be in accordance with the AASHTO LRFD Bridge Design Specifications and constructed to the requirements of ADOT's 929 Stored Specification. Pre-Approved MSE wall systems and design support documents can be found on ADOT's Geotechnical Services website.