CHAPTER 11 – HORIZONTAL ALIGNMENT

CHAPTER 13 – CROSS SECTION ELEMENTS

CHAPTER 14 – ROADSIDE SAFETY

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

1. Undivided Facilities. Revolve about the centerline of the entire roadway section.

2. Flush Medians. Revolve about the centerline of the entire roadway section. Note that this also applies to two-way, left-turn lane sections.

3. Raised Medians. Revolve about the centerline of the entire roadway section.

4. Depressed Medians. On new construction projects, where the median width is sufficient for two additional future lanes, the point of revolution will be about the two inside edges of the two future travel lanes.

   For projects on existing multilane divided facilities with a depressed median, where there is no anticipation of adding future travel lanes in the median, the point of revolution will be about the two edges of the existing median (i.e., the median will remain in a horizontal plane through the superelevated curve).

5. Independent Roadways. On multilane divided facilities where the median is sufficiently wide (i.e., the two roadways are on independent alignments), the points of revolution will be about the centerlines of the two roadways.

11.3.4 Shoulder Treatment on Superelevated Curves

1. Low Side. On new construction projects, the low side shoulder will be transitioned to match the slope rate and direction of the adjacent travel lane when the slope rate exceeds the normal shoulder slope.

2. High Side. The high-side shoulder will be transitioned to match the slope rate and direction of the adjacent travel lane throughout the curve.

11.3.5 Compound Curves

As discussed in Section 11.2.2.3, compound curves should rarely be used on mainline and, then, only two-centered curves should be used. When used, the development of superelevation requires special considerations. These criteria should be met:

1. If the distance between the PC and PCC is less than or equal to 300 feet, use a uniform longitudinal gradient throughout the transition. Develop the superelevation so that, for the first curve, two-thirds of the design superelevation rate for this curve will be attained at the PC. Develop the superelevation so that, for the second curve, the design superelevation rate will be available at the PCC.

2. If the distance between the PC and PCC is more than 300 feet, it may be preferable to consider the two curves separately. Superelevation for the entering curve is developed by the distribution method used for simple curves. This curve's superelevation rate will then be maintained until it is necessary to

develop the remaining superelevation of the second curve as consistent with the Department's superelevation development practices (e.g., for the relative longitudinal gradient).

11.3.6 Reverse Curves

Reverse curves are two closely spaced simple curves with deflections in opposite directions. In some situations, because of the proximity of the curves, it is not possible to adhere to the standard superelevation development criteria for each curve and achieve a normal tangent section between the curves. If this is the case, the designer should use the following steps to adjust the superelevation development:

1. Determine the point where the transitions should meet. The length of transition should favor the curve with the smaller (sharper) radius. Assume that, for the first iteration, the cross slope at this point is the normal crown (2.08 percent, typically).

2. Determine the relative longitudinal gradient (G_R) from Figure 11.3A.

3. Apply the superelevation rate while maintaining G_R and working back from the point determined in Step 1.

4. Examine the superelevation of the curves to insure that:

   - no more than 40 percent of the transitions occur in either curve, and
   - the length of full superelevation on each curve is sufficient.

5. If either of the criteria set forth in Step 4 are not met, recalculate the superelevation with the normal cross slope reduced to no less than 1 percent.

If the superelevation still cannot be developed properly, the designer should consider revising the alignment or possibly adjusting the design speed.

Figure 11.3G illustrates superelevation development for reverse curves.

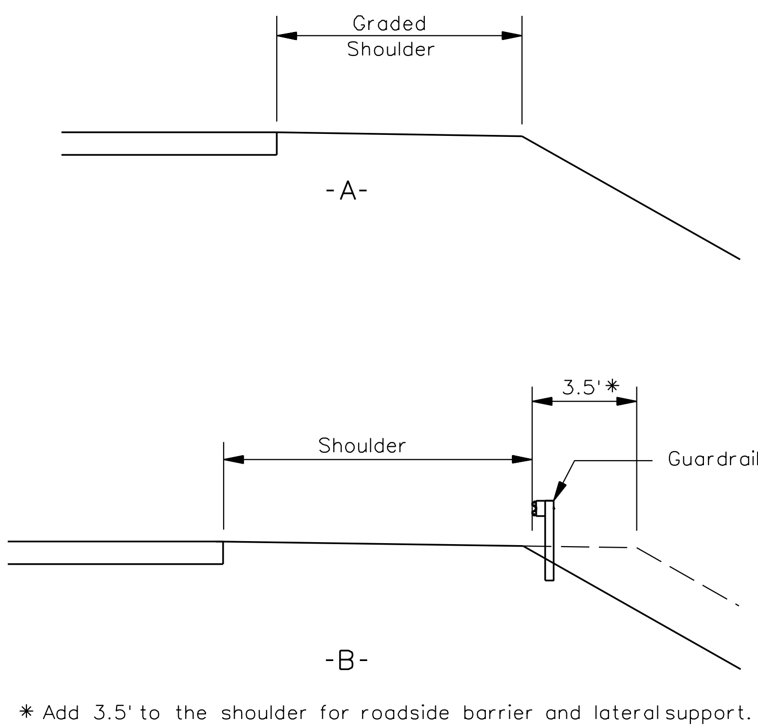
13.2.4 Shoulders

13.2.4.1 Function

Shoulders are defined as that portion of the roadway contiguous to the traveled way. They extend from the edge of the travel lane to the intersection of the foreslope. Shoulders may either be earth type or paved or a combination of both. Useable shoulders constitute the actual width of shoulder available for emergency stopping. For examples of shoulders, see Figure 13.2B.

Shoulders serve many functions, and the wider the shoulder, the greater the benefits. Shoulder functions include:

- providing structural support for the traveled way,
- increasing highway capacity,
- encouraging uniform travel speeds,
- providing space for emergency and discretionary stops,
- improving roadside safety by providing more recovery area for run-off-the-road vehicles,
- providing a sense of openness,
- improving sight distance around horizontal curves,
- enhancing highway aesthetics,



SHOULDERS

Figure 13.2B

- facilitating maintenance operations,
- providing additional lateral clearance to roadside appurtenances,
- facilitating pavement drainage,
- providing space for pedestrian and bicycle use, and
- providing space for bus stops.

13.2.4.2 Shoulder Width

Shoulder widths will vary according to functional classification, traffic volumes and urban or rural location. The design criteria tables in Chapters 19 through 22 present the shoulder width criteria for the various conditions.

In addition, guardrail can influence the shoulder width. Where guardrail is provided, increase the width of the shoulder by 3.5 feet to maintain the desirable useable width and to provide support for the guardrail. See Figure 13.2B.

13.2.4.3 Shoulder Cross Slopes

Greater cross slopes are provided on shoulders than on adjacent travel lanes for two reasons: 1) the runoff carried across the shoulder is a combined total of both the adjacent travel lane and the shoulder; and 2) in many cases, the shoulder surface material is rougher than the adjacent travel lane requiring a steeper slope to maintain a similar flow rate. Not all shoulders are paved, so it is necessary to remove the water as rapidly as possible before it penetrates the shoulder with the potential of reducing its structural support capabilities. Normal shoulder slopes are shown in Figure 13.2C. Note that for superelevated sections on new construction projects, the high side is sloped at the superelevated rate and the low side is sloped at the superelevation rate when the slope exceeds normal shoulder slope. See Figure 13.2D for shoulder treatments with superelevated sections. For additional guidance on superelevated sections, see Chapter 11.

All shoulders should be structurally adequate to support truck usage for emergency purposes. In addition, shoulder materials should also be sufficiently stable to provide lateral support of the adjacent pavements.

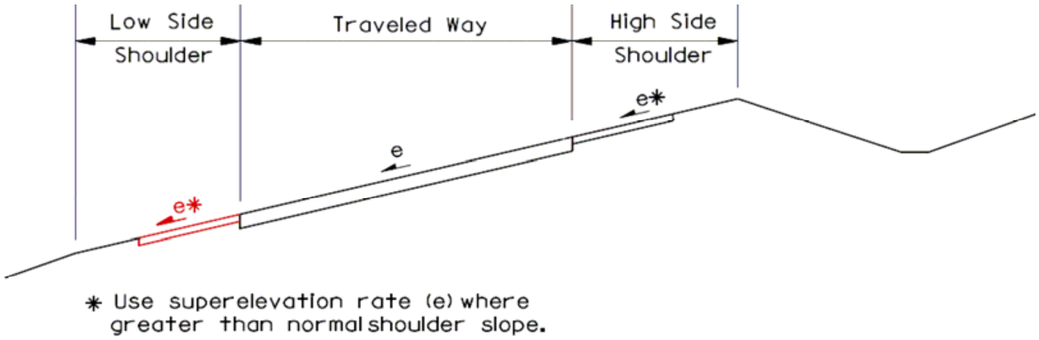
Surface Class	Surface Type	Cross Slope
Paved	Hot Mix Asphalt Concrete or Portland Cement Concrete	4.17%* (24H:1V)
Turf	Compacted Earth with Grass Surface	8.33% (12H:1V)

* If paved shoulder is 2 feet or less, continue the travel way cross slope.

NORMAL SHOULDER CROSS SLOPES

Figure 13.2C

Revised 13.2.4.3 11-2006



SUPERELEVATED SHOULDER SLOPES

Figure 13.2D

For maintenance operations, it is advantageous for the shoulders to be delineated from through traffic lanes. This generally can be accomplished by using a different surface treatment, a different surface gradation and finish, or by pavement markings if the same surface material is used for both the traveled way and shoulder and by use of rumble strips.

13.2.4.4 Use of Rumble Strips on Shoulders

Rumble strips on the shoulder can potentially prevent run-off-the-road crashes by alerting sleepy or inattentive drivers. However, other factors must be considered when using rumble strips, including:

- use of the shoulder by bicyclists,
- impact on pavement life,
- impact on maintenance operations, and
- initial construction costs.

Consider installing continuous, milled shoulder rumble strips on all freeways as an effective means of reducing single vehicle, run-off-the-road crashes caused primarily by any form of motorist inattention. This includes paved inside and outside shoulders of 4 to 10 feet. Do not use mill-in rumble strips on ramps, acceleration lanes or deceleration lanes. Place a note on the plan sheet showing “Begin Mill-in Rumble Strip” and “End Mill-in Rumble Strip” with an arrow to the appropriate location; see *SCDOT’s Standard Drawings*. Typically, SCDOT uses rumble strips only on freeways.

13.2.5 <u>Auxiliary Lanes</u>

Auxiliary lanes are any lanes beyond the basic through travel lanes. They are intended for use by vehicular traffic for specific functions (e.g., TWLTL). The following will apply to the design of auxiliary lanes:

1. Width. With the exception of TWLTL, the width of an auxiliary lane is typically the same as that of the adjacent through lane. Auxiliary lane widths for various classifications of highways are provided in the design criteria tables in Chapters 19 through 22.

2. Types. Auxiliary lanes include:

   - single left- and right-turn lanes at intersections,
   - double left- and right-turn lanes at intersections,
   - truck climbing lanes,
   - acceleration/deceleration lanes at interchanges or intersections,
   - weaving lanes within an interchange,
   - continuous auxiliary lanes between two closely spaced interchanges,
   - two-way, left-turn lanes (TWLTL),
   - parking lanes, and
   - passing lanes.

3. Shoulders. The shoulder width adjacent to the auxiliary lane should be the same as the normal shoulder width for the approaching roadway. At a minimum, the width should be 4 feet assuming the roadway has a shoulder width equal to or greater than 4 feet.

4. Cross Slope. The cross slope for an auxiliary lane will depend on the number of lanes and cross slope of the adjacent traveled way. If the auxiliary lane is the second lane from the crown, it will be sloped at 2.08 percent. If the auxiliary lane is the third or fourth lane from the crown, it will be sloped at 2.78 percent. See Section 13.2.3.3 for additional information on cross slopes.

13.2.6 Miscellaneous Roadway Elements

Miscellaneous roadway elements include sidewalks, parking lanes, and curbs and curbed sections. This section provides a brief overview of these elements. For more detail on the design criteria for these elements, see Chapter 21.

13.2.6.1 Sidewalks

Generally, sidewalks are an integral part of city streets. For suburban residential areas, the construction of sidewalks is often deferred. However, sidewalks in rural and suburban areas are still often justified at points of community development such as schools, local businesses, shopping centers and industrial plants that result in pedestrian concentrations along the highway. If pedestrian activity is anticipated, include sidewalks as part of the construction.

For additional guidance on sidewalks, see Section 21.2.10.

Design Speed	Design Year ADT	Fill/Foreslopes		Backslopes		
		6H:1V or Flatter	5H:1V to 4H:1V	3H:1V	5H:1V to 4H:1V	6H:1V or Flatter
40 mph or less	Under 750	7 – 10	7 – 10	7 – 10	7 – 10	7 – 10
	750 – 1500	10 – 12	12 – 14	10 – 12	10 – 12	10 – 12
	1500 – 6000	12 – 14	14 – 16	12 – 14	12 – 14	12 – 14
	Over 6000	14 – 16	16 – 18	14 – 16	14 – 16	14 – 16
45 – 50 mph	Under 750	10 – 12	12 – 14	8 – 10	8 – 10	10 – 12
	750 – 1500	14 – 16	16 – 20	10 – 12	12 – 14	14 – 16
	1500 – 6000	16 – 18	20 – 26	12 – 14	14 – 16	16 – 18
	Over 6000	20 – 22	24 – 28	14 – 16	18 – 20	18 – 20
55 mph	Under 750	12 – 14	14 – 18	8 – 10	10 – 12	10 – 12
	750 – 1500	16 – 18	20 – 24	10 – 12	14 – 16	16 – 18
	1500 – 6000	20 – 22	24 – 30	14 – 16	16 – 18	20 – 22
	Over 6000	22 – 24	26 – 32*	16 – 18	20 – 22	22 – 24
60 mph	Under 750	16 – 18	20 – 24	10 – 12	12 – 14	14 – 16
	750 – 1500	20 – 24	26 – 32*	12 – 14	16 – 18	20 – 22
	1500 – 6000	26 – 30	32 – 40*	14 – 18	18 – 22	24 – 26
	Over 6000	30 – 32*	36 – 44*	20 – 22	24 – 26	26 – 28
65 – 70 mph	Under 750	18 – 20	20 – 26	10 – 12	14 – 16	14 – 16
	750 – 1500	24 – 26	28 – 36*	12 – 16	18 – 20	20 – 22
	1500 – 6000	28	34 – 42*	16 – 20	22 – 24	26 – 28
	Over 6000	30 – 34*	38 – 46*	22 – 24	26 – 30	28 – 30

* *Where a site-specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zones shown in Figure 14.3A. Clear zones may be limited to 30 feet for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.*

Notes:

1. *All distances are in feet and are measured from the edge of the traveled way.*

2. *For clear zones, the "Design Year ADT" will be the total ADT for both directions of travel for the design year. This applies to both divided and undivided facilities. Traffic volumes will be based on a 20-year projection from the anticipated date of construction completion.*

3. *The values in the figure apply to tangent sections of highway. See the discussion in Section 14.3.2.5 for possible adjustments on horizontal curves.*

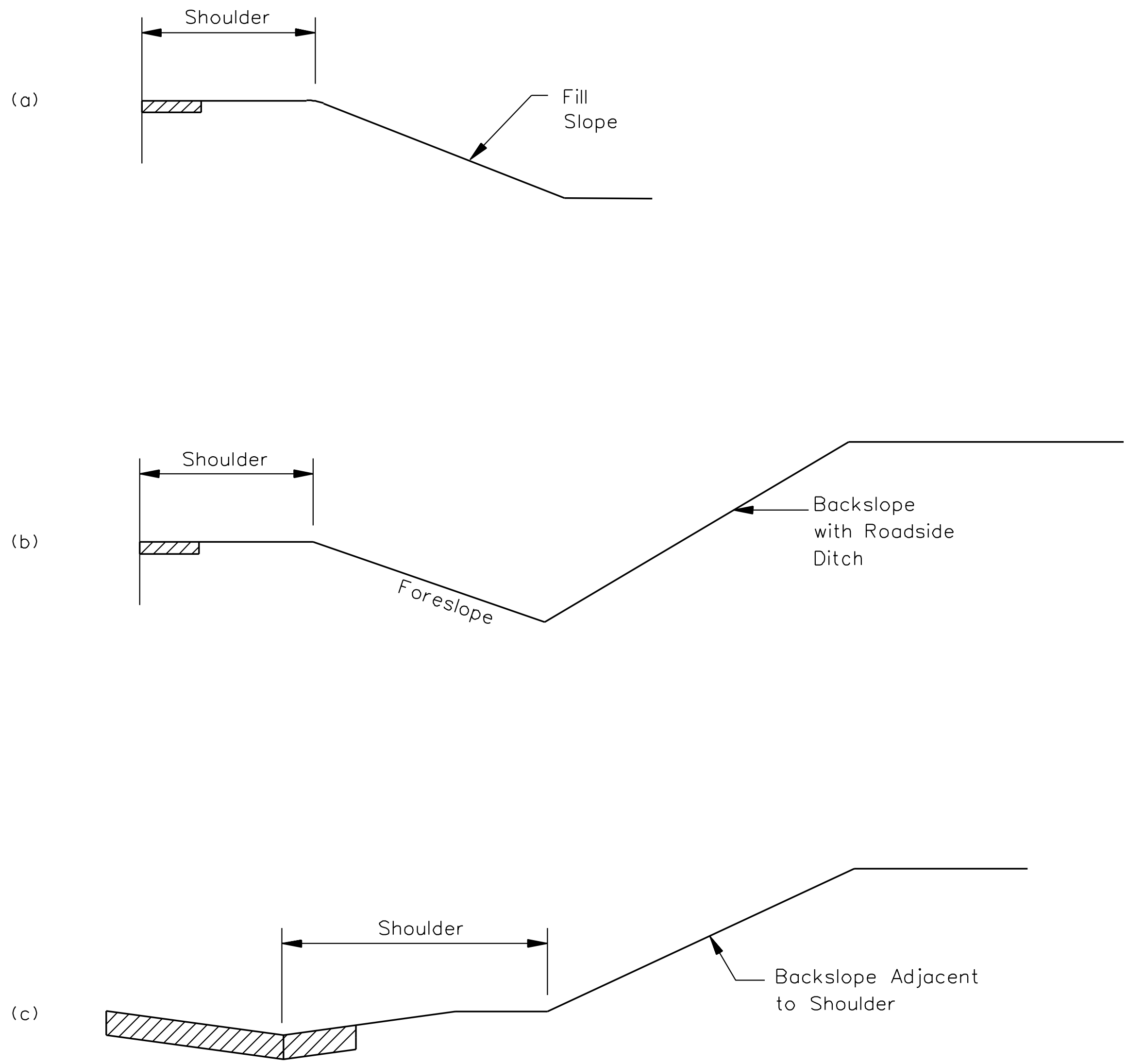
4. *The values in the figure apply to all facilities without curbs. See Section 14.3.2.6 for curbed sections.*

5. *Clear zone distances for the 3H:1V fill slope have been omitted, because it is not typically used in South Carolina. See the* AASHTO Roadside Design Guide *for clear zone calculations where a 3H:1V fill slope is used.*

RECOMMENDED CLEAR ZONE DISTANCES
(New Construction/Reconstruction)

Figure 14.3A

Revised Clear Zone Distances 11-2006



SIDE SLOPE CONFIGURATIONS

Figure 14.3B