Transverse Slope Adjustment at Entrances and Safety Ramps

Design Manual
Chapter 3
Cross Sections
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Standard Road Plans EW-501 and EW-502 both show transverse slopes for entrances (see Section 3K-2 for more on entrance design) and safety ramps are to be graded at 8:1 with a pipe and 10:1 without a pipe (see Section 4B-1 for more on entrance and safety ramp pipes). However, when the ditch grade or roadway grade exceeds 4%, designers may want to consider adjusting the transverse slopes to maintain 8:1 and 10:1 slopes relative to the ditch or roadway grade. As the ditch or roadway grade approaches 4%, an 8:1 transverse slope relative to a horizontal plane begins to approach 6:1 relative to the ditch or roadway grade. This is the Acceptable Value for transverse slopes (assumed to be measured relative to a horizontal plane) in the Design Criteria Worksheets of Section 1C-1. In addition, pipe lengths and earthwork can become excessive as ditch or roadway slope increases, see Figure 1.

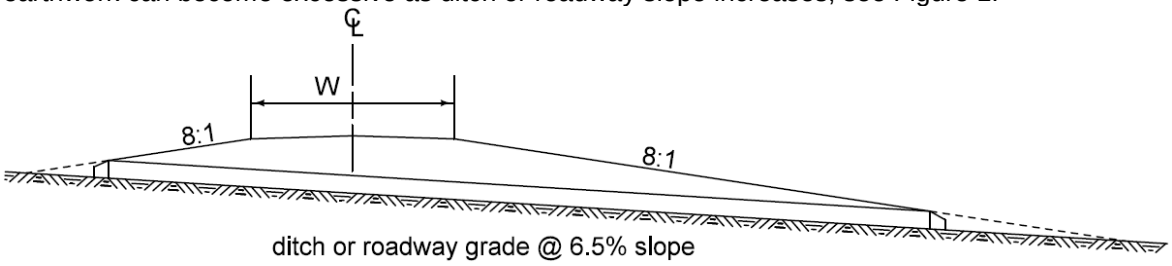

Figure 1: Effect of ditch or roadway grade on transverse slope and pipe length.

To overcome these problems, designers may adjust transverse slopes by adding or subtracting the ditch or roadway grade to or from the transverse slope. This is demonstrated for the example shown in Figure 1.

Upstream Adjustment: $\frac{1}{8} - \frac{6.5}{100} = \frac{6}{100} = \frac{1}{16.67}$

Downstream Adjustment: $\frac{1}{8} + \frac{6.5}{100} = \frac{19}{100} = \frac{1}{5.26}$

The transverse slope adjustments are both rounded to the nearest whole number. Thus, the upstream adjustment is 17:1 and the downstream adjustment is 5:1, both relative to a horizontal plane. Figure 2 illustrates the example shown in Figure 1 with adjusted transverse slopes. Table 1 on the following page provides transverse slope adjustments for various grades relative to a horizontal plane.

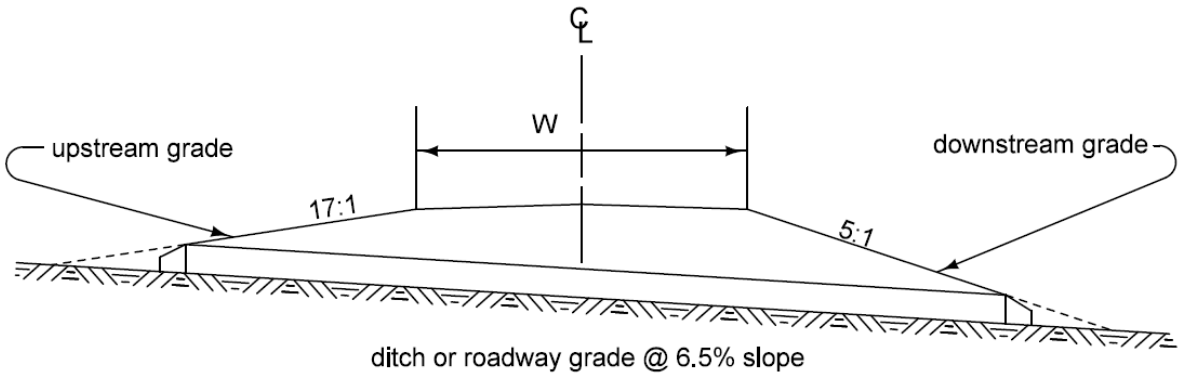

Figure 2: Transverse slopes adjusted for steep ditch or roadway slope.

Table 1: Adjusted Transverse Slopes for Ditch or Roadway Grades 4% or greater.

Grade	With Pipe		Without Pipe	
	Upstream Grade	Downstream Grade	Upstream grade	Downstream Grade
4.0%	12:1	6:1	17:1	7:1
4.5%	13:1	6:1	18:1	7:1
5.0%	13:1	6:1	20:1	7:1
5.5%	14:1	6:1	22:1	6:1
6.0%	15:1	5:1	25:1	6:1
6.5%	17:1	5:1	29:1	6:1
7.0%	18:1	5:1	33:1	6:1
7.5%	20:1	5:1	40:1	6:1
8.0%	22:1	5:1	50:1	6:1

Note: Transverse slopes for side roads normally will not need adjustment. The transition from mainline foreslope to side road foreslope (see EW-503) helps to mitigate potential problems for errant vehicles presented by side road transverse slopes steeper than 6:1.

Typically, roadway and ditch slopes closely parallel each other. In situations where they differ, whether to adjust transverse foreslopes relative to the roadway slope or the ditch slope is up to the designer. However, designers may face situations where the choice is limited, for example situations involving excessive ditch slopes, or situations involving roadway slopes that run opposite of ditch slopes. In cases such as these, designers should base their decision to adjust transverse slopes taking in consideration of roadway slope and the practicality of adjusting transverse slopes.

If the designer chooses to adjust the transverse slopes, a modified version of Standard Road Plan EW-501 and/or EW-502 must be included in the U Sheets (see Section 1F-21). The modification should include the addition of a note to construct slope relative to the roadway or ditch grade. Refer to Section 1E-5 for more information on modifying Standard Road Plans.

Chronology of Changes to Design Manual Section:

003F-003 Transverse Slope Adjustment

2/4/2016 Revised

Corrected formatting issues. Added references to 3K-2 and reference 4B-1.

5/15/2014 Revised

Revised Standard Road Plan references. Rearrange text to flow better. Explained where 4% slope criterion for considering slope adjustment comes from. Added guidance for situations involving excessive ditch slope or ditch slope opposite that of the roadway.

6/13/2012 Revised

Added instruction for conveying slope adjustment information in the plans as a modified Standard.

3/6/2003

New material.