Maine Department of Transportation

Highway Program

Design Guidance

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<th>Title: Superelevation Transition</th>
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Background:

A superelevation transition for a curve consists of superelevation runoff and tangent runout sections. Those sections are defined in Chapter 3 of the AASHTO Green Book as follows:

“The superelevation runoff section consists of the length of roadway needed to accomplish a change in outside lane cross slope rate from zero (flat) to full superelevation, or vice-versa. The tangent runout consists of the length of roadway needed to accomplish a change in cross slope from the normal cross slope rate to zero (flat), or vice-versa.”

Guidance:

General:

Use the table titled “Superelevation Runoff Lr (ft) for Horizontal Curves” in Chapter 3 of the AASHTO Green Book to determine the proper runoff length for the design superelevation (e) and speed.

80% of the runoff length shall be placed on the tangent prior to, and following a curve.

To determine tangent runout length, choose the appropriate row in the table for the normal cross slope rate.

If transition lengths are required to be shorter than what is listed in the table and/or need to be applied to a compound or reverse curve, care should be taken not to exceed the maximum relative gradient as determined in Section 3.3.8.2.1 Minimum Length of Superelevation Runoff in the AASHTO Green Book.

Both the runoff and runout lengths are used to determine the first location of full superelevation after the PC, location of zero (0%) cross slope and the location of last normal crown before the PC, and to determine the last location of full superelevation before the PT, location of zero cross slope and first location of normal crown after the PT. See Figure 1 for a diagram of the superelevation runoff and tangent runout application and the following examples below:
Example 1: Transition into a curve

Two lane highway
Design speed = 50 MPH
e = 5.6%
Normal cross slope = 2.0%
PC = Sta. 50+00.00

Determine the first location of full superelevation (e = 5.6%), where there is zero cross slope (e = 0.0%), and the last location of normal crown before the curve.

To determine the locations, the runoff length and runout length will need to be determined first:

From the table titled “Superelevation Runoff Lr (ft) for Horizontal Curves”:

Runoff = 134 feet, Runout = 48 feet

80% of 134 feet = 107.2 feet, 20% = 26.8 feet

Apply 20% of the runoff length after the PC to determine the first location of full superelevation on the curve:

Sta. 50+00.00 + 26.8 feet = Sta. 50+26.80

\[ e = 5.6\% \text{ at Sta. } 50+26.80 \]

Next, apply the 80% remainder of the runoff length before the PC to determine the location where the cross slope is zero:

Sta. 50+00.00 – 107.2 feet = Sta. 48+92.80

\[ e = 0.0\% \text{ at Sta. } 48+92.80 \]

Finally, subtract the runout length from the location of zero cross slope to determine the location of the last normal crown before the curve (beginning of the transition):

Sta. 48+92.80 – 48 feet = Sta. 48+44.80

\[ \text{Normal cross slope (2.0\%) at Sta. } 48+44.80 \]
Example 2: Transition out of a curve

Two lane highway
Design speed = 35 MPH
$e = 3.6\%$
Normal cross slope = 2.0%
PT = Sta. 100+00.00

Determine the last location of full superelevation ($e = 3.6\%$), where there is zero cross slope ($e = 0.0\%$), and the first location of normal cross slope after the curve.

To determine the locations, the runoff length and runout length will need to be determined first:

From the table titled “Superelevation Runoff L_r (ft) for Horizontal Curves”:

Runoff = 70 feet, Runout = 39 feet

80% of 70 feet = 56.0 feet, 20% = 14.0 feet

Apply 20% of the runoff length before the PT to determine the last location of full superelevation on the curve:

Sta. 100+00.00 − 14.0 feet = Sta. 99+86.00

$e = 3.6\%$ @ Sta. 99+86.00

Next, apply the 80% remainder of the runoff length after the PT to determine the location where the cross slope is zero:

Sta. 100+00.00 + 56.0 feet = Sta. 100+56.00

$e = 0.0\%$ @ Sta. 100+56.00

Finally, add the runout length to the location of zero cross slope to determine the location of the first normal cross slope after the curve (end of the transition):

Sta. 100+56.00 + 39 feet = Sta. 100+95.00

Normal cross slope @ Sta. 100+95.00
Reverse, Broken-Back and Compound Curves

Reverse Curves:

For transitions of closely spaced reverse curves, it may not be practical to achieve a normal (crown) section between the curves. Therefore, do not attempt to achieve a normal section between reverse curves unless the length of the tangent between curves is greater than or equal to the sum of the runoff lengths and 80% of the sum of the applicable runoff lengths for each curve.

If the transition to a normal section is not possible, one of the following situations will apply to determine the locations of full superelevation based on the tangent length between each curve:

- If the tangent length is greater than or equal to 80% of the sum of the applicable runoff lengths, then apply 20% of each runoff length before the PT of the first curve and 20% after the PC of the second curve respectively. The distance required to transition between full superelevation locations will either be greater than or equal to the sum of both runoff lengths.

- If the tangent length is less than 80% of the sum of applicable runoff lengths, then attempt to achieve 20-50% of the sum of the applicable runoff lengths before the PT and after the PC respectively for the two curves. The distance required to transition between full superelevation locations will equal the sum of both runoff lengths.

- If the curves have a PRC with no tangent, then locate 50% of the sum of the applicable runoff lengths before the PRC and 50% after the PRC. The distance required to transition between full superelevation locations will equal the sum of both runoff lengths.

In all these instances where a normal section cannot be achieved, the roadway shall remain in a plane between each full superelevation location, continuously rotating about its axis.

Broken-Back Curves:

Similar to transitions between closely spaced reverse curves, for broken-back curves (two curves deflecting in the same direction that are separated by a short tangent), it will not be practical to achieve a normal section between the curves. Therefore, do not attempt to achieve a normal section between two curves deflecting in the same direction unless it can be maintained on the tangent for a minimum of 50 feet, and the superelevation transition requirements can be met for both curves.

If these criteria cannot be met, but a remove crown section can still be maintained for a minimum of 50 feet, transition to a remove crown section between curves.

If a remove crown section cannot be maintained, subtract the runoff value found in the Table for the superelevation of the flatter curve from the runoff value for the superelevation of the sharper curve to determine the transition length between superelevations. To determine the location of the transition, provide the full superelevation for the sharpest curve at a location before the PT or after the PC that is 20% of the value of the difference between runoff lengths. The runoff distribution may be adjusted from 80%/20% to another distribution if necessary. The superelevation transition from lesser to greater or vice versa shall remain in a plane, continuously rotating about its axis.
Compound Curves:

For compound curves, provide the full superelevation for the sharpest curve at a location after or before the PCC that is 20% of the value of the difference in runoff lengths calculated using the same procedure for calculating the difference in runoff lengths for a broken-back curve. Use part of, or if necessary, the entire length of the flattest curve for the 80% of the remaining runoff length.

Superelevation Tables

Superelevation tables shall be provided in the contract documents for each curve that contain the location and superelevation values of the following: last normal crown (beginning of transition), 0% cross slope and remove crown before the PC, the first full superelevation, last full superelevation, and remove crown, zero cross slope and first normal crown (end of transition) after the PT. For reverse, broken-back or compound curves, the zero cross slope and/or remove crown locations may not be applicable. In addition, superelevation values should be provided for every 50-foot or 25-foot station depending on the interval chosen for the project.

Reference:

For more discussion of superelevation transitions, see Section 3.3.8 Transition Design Controls in the AASHTO Green Book.