Reverse Curve Design

Design Manual
Chapter 2
Alignments
Originally Issued: 09-22-00

This section provides information pertaining to the design of reverse curves. Reverse curves are commonly used to redirect through lanes at channelized intersections and high-speed median crossovers. They are also utilized in interchange ramps and to realign crossroads at skewed intersections.

A reverse curve is two circular curves with opposite deflection angles. The curves may have equal or unequal radii and/or deflection angles. The curves may be continuous or separated by a short tangent section, see Figure 1. The tangent length is normally determined by superelevation transition requirements. Each of the curves in a reverse curve is treated in a similar manner as a horizontal curve (see Section 2A-1).

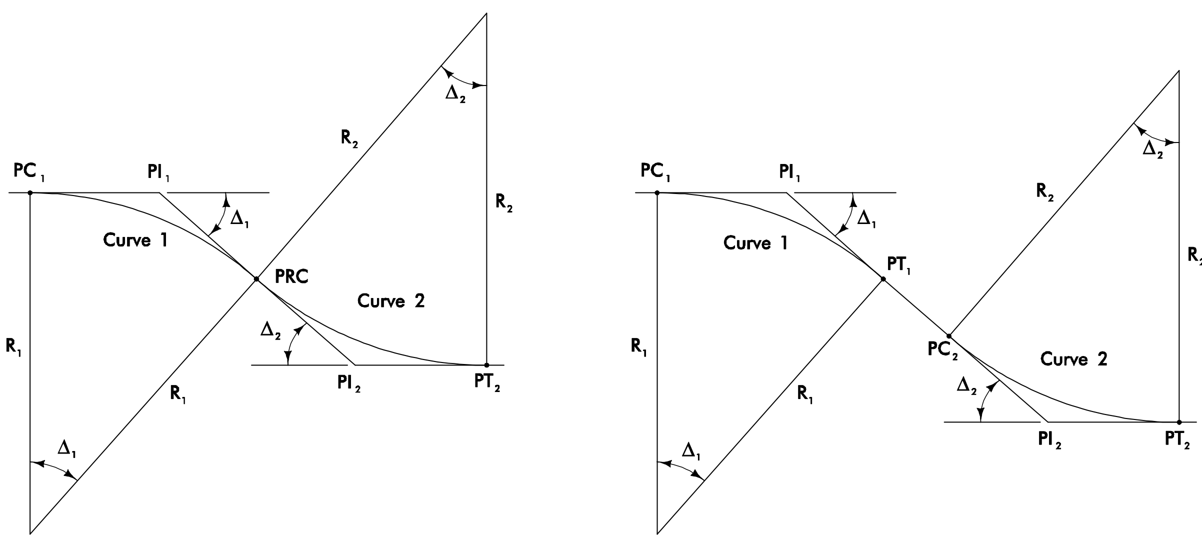

Figure 1: Reverse curves without and with a tangent section between.

Lane Redirection

Channelized Intersections

At channelized intersections with redirected through lanes, a PRC (Point of Reverse Curve) is preferred because superelevation is undesirable. In most cases, the radii R_1 and R_2, and deflection angles Δ_1 and Δ_2 will be the same, as will the deflection angles. The designer may take advantage of this symmetry to reduce calculations. Minimum radii are selected based upon maintenance of normal crown cross slopes at design speed.

Median Crossovers

Reverse curves in median crossovers are separated by a short tangent section from PT_1 to PC_2 (see Figure 1) that allows the superelevation to transition from the slope of Curve 1 to the slope of

Curve 2. Determining the length of this tangent is the first step in designing the reverse curve. The minimum length of this tangent will be equal to the superelevation tangent runout length (x) of Curve 1 plus the superelevation tangent runout length (x) of Curve 2. Sections 2A-2 and 2A-3 of this manual provide more information concerning superelevation and Section 3E-3 provides more information regarding median crossovers. The designer is encouraged to consult the Methods Section in the Office of Design for further assistance with median crossover design.

Interchange Ramps

Reverse curves are used on interchange ramps when necessary. Tangent sections between the curves are required to accommodate the high-speed superelevation transitions. The minimum tangent length between the curves is equal to the sum of 70% of the tangent runoff length (L) for each curve. More specific criteria for reverse curve interchange ramps will be detailed in a section to be issued in the future.

Realignment of Crossroads

Reverse curves may also be used when realigning crossroads to reduce skew. Refer to Section 6A-8 of this manual for more details concerning intersection alignment.

Example: Lane Redirection at an Intersection

Given a design speed of 50 mph and a lane width of 12’, we wish to design a reverse curve to redirect a through lane to accommodate a 16’ median for a left turn lane, as seen in Figure 2. Assume a normal crown (NC) section.

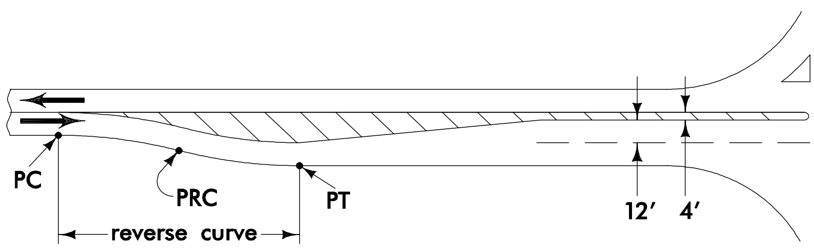

Figure 2: Reverse curve used to redirect a through lane at an intersection.

1. Simplify calculations by setting R_1 and R_2 in Figure 1 equal to each other. Parallel offsets result in Δ_1 and Δ_2 being equal to each other. This produces the situation illustrated in Figure 3.

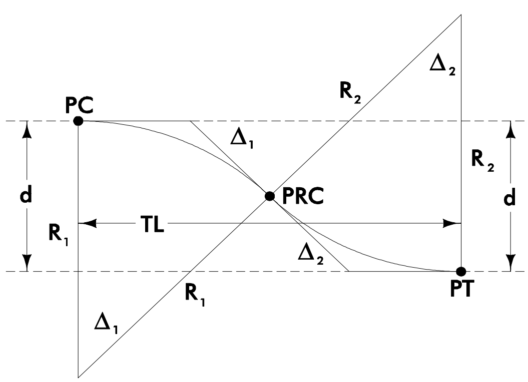

Figure 3: Reverse curve for lane redirection in example problem.

2. Using Table 1 in Section 2A-3 with a normal crown (NC), R = 8000 feet.
3. Since the median is 16’, d in Figure 3 is 16’. With trigonometry it can be shown that

   $\cos\Delta = \frac{2R - d}{2R}$ from which Δ = 2.562559° (2°33′45.21″).

4. Using the formulas in Section 2A-1 with R and Δ as knowns, the remaining circular components may be calculated:

   T = $R \times \left(\tan\frac{\Delta}{2} \right)$ = 178.93’

   L = $\frac{\Delta \times \pi \times R}{180}$ = 357.80’

   E = $T \times \left(\tan\frac{\Delta}{4} \right)$ = 2.00’.

   This information will be identical for both curves in the reverse curve.

5. The total length (TL) for the reverse curve can be calculated with the following formula:

TL = $\sqrt{(R_1 + R_2)^2 - (R_1 + R_2 - d)^2}$ = 715.36’