Horizontal Curve Design

Design Manual
Chapter 2
Alignments

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Circular curves are used to join intersecting straight lines (or tangents). This section provides information relevant to simple circular curves. A simple circular curve is a constant radius arc used to join two tangents. Figure 1 shows the components of a simple circular curve.

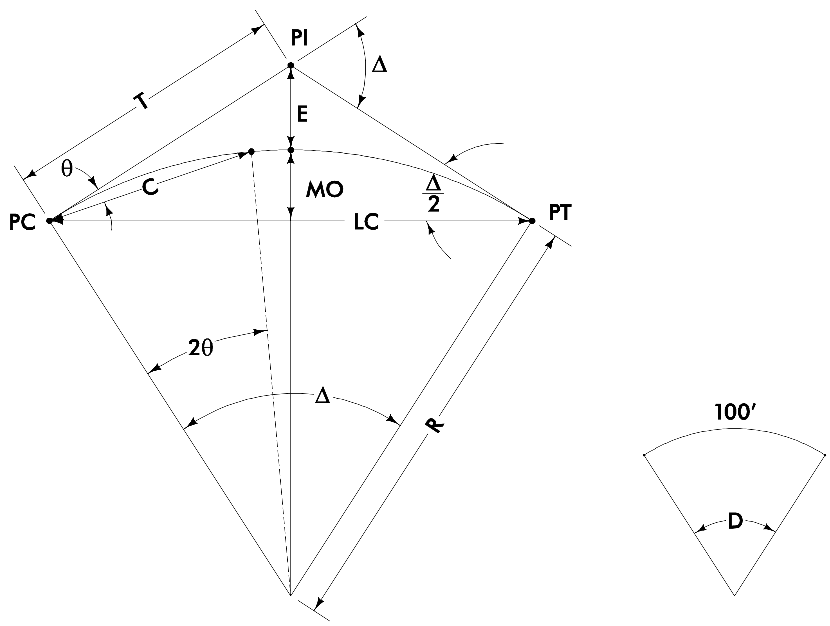

Figure 1: Components of a simple circular curve

Definitions

PI = Point of Intersection of back tangent and forward tangent.

PC = Point of Curvature – point of change from back tangent to circular curve.

PT = Point of Tangency – point of change from circular curve to forward tangent.

LC = Total chord length, or long chord, from PC to PT in feet for the circular curve.

D = Degree of curvature. The central angle which subtends a 100 foot arc, see Figure 1. The degree of curvature is determined by the appropriate design speed.

Δ = Total intersection (or delta) angle between back and forward tangents.

T = Tangent distance in feet (meters). The distance between the PC and PI or the PI and PT.

L = Total length in feet (meters) of the circular curve from PC to PT measured along its arc.

E = External distance (radial distance) in feet (meters) from PI to the mid-point of the circular curve.

R = Radius of the circular curve measured in feet (meters). The radius is determined by the appropriate design speed: Sections 1C-1, 2A-2, and 2A-3 of this manual provide further information, or refer to AASHTO's *A Policy on Geometric Design of Highways and Streets*, 2001.

θ = Deflection angle from a tangent to a point on the circular curve.

Δ/2 = Deflection angle for full circular curve measured from tangent at PC or PT.

C = Chord length in feet (meters), where a chord is defined as a straight line connecting any two points on a curve.

S = Arc length in feet (meters) along a curve.

MO = Middle ordinate. Length of the ordinate from the middle of the curve to the LC.

Formulas

$D = \frac{18000}{\pi \times R}$ (D in decimal degrees, English units only)

$\Delta = \frac{180}{\pi} \times \frac{L}{R}$ (Δ in decimal degrees)

$L = \frac{\Delta \times \pi \times R}{180}$ (Δ decimal in degrees)

$R = \frac{180 \times L}{\Delta \times \pi}$ (Δ in decimal degrees)

$T = R \times \left(\tan \frac{\Delta}{2} \right)$ (Δ in decimal degrees)

$E = T \times \left(\tan \frac{\Delta}{4} \right)$ (Δ in decimal degrees)

$LC = 2 \times R \times \left(\sin \frac{\Delta}{2} \right)$ (Δ in decimal degrees)

$MO = R \times \left(1 - \cos \frac{\Delta}{2} \right)$ (Δ in decimal degrees)

$C = 2 \times R \times \left(\sin \frac{\theta}{2} \right)$ (θ in decimal degrees)

$S = \frac{\pi \times R}{90} \arcsin \frac{C}{2R}$ (D in decimal degrees)

Superelevation

Sections 2A-2 and 2A-3 of this manual provide information regarding superelevation.

Redefining English Curves for Use in Metric Projects

When a metric alignment incorporates a previously defined English horizontal curve, how it will be redefined in metric is determined by whether the curve will be defined from a previous English survey or defined by office relocation. When a metric curve is defined from a previous English survey, a soft conversion is used. For example, a 3-degree English curve would have assigned to it a radius of 582.125 meters. This is accomplished by first converting the curve from degree of curvature to radius in feet (using the equation on page 2), and then soft converting to metric units (conversion factor = 0.3048). When a metric curve is defined by office relocation, a hard conversion is used with an increment of 5 meters. After the radius of a curve has been determined, then the length is determined. Table 1 demonstrates this. The P.I. of a curve remains constant, thus it is always soft converted. When soft converted, P.I. STA 302+68.57 (English) becomes P.I. STA 92+25.879 (metric) (US survey conversion factor = 12/39.37). Note that the metric curve distances are given to the closest 0.001 meter.

Table 1: Converting English Horizontal Curve to Metric

English curve	Using Previous Survey	Using Office Relocation
P. I. = STA 302+68.57	P. I. = STA 92+25.879	P. I. = STA 92+25.879
Δ = 12° 30’	Δ = 12° 30’	Δ = 12° 30’
D = 3° 00’, R = 1909.86 ft.	R = 582.125 m	R = 580.000 m
L = 416.67’	L = 127.000 m	L = 126.536 m

Plan Curve Data

The following Plan Curve Data should be provided on the plan sheets for each horizontal curve: Δ, R, D (with English units only), T, L, and E. For superelevated curves the rate of superelevation (e) and runout length (x) should also be shown. The length of transition in the circular curve (m) should be included if a spiral is not used.