TRANSPORTATION

U.S. Customary Units

a = deceleration rate (ft/sec^2)

A = algebraic difference in grades (%)

C = vertical clearance for overhead structure (overpass) located within 200 feet of the midpoint of the curve

e = superelevation (%)

f = side friction factor

$\pm G$ = percent grade divided by 100 (uphill grade"+")

h_1 = height of driver's eyes above the roadway surface (ft)

h_2 = height of object above the roadway surface (ft)

L = length of curve (ft)

L_s = spiral transition length (ft)

R = radius of curve (ft)

S = stopping sight distance (ft)

t = driver reaction time (sec)

V = design speed (mph)

Stopping Sight Distance

$$S = \frac{V^2}{30\left(\left(\frac{a}{32.2}\right) \pm G\right)} + 1.47Vt$$

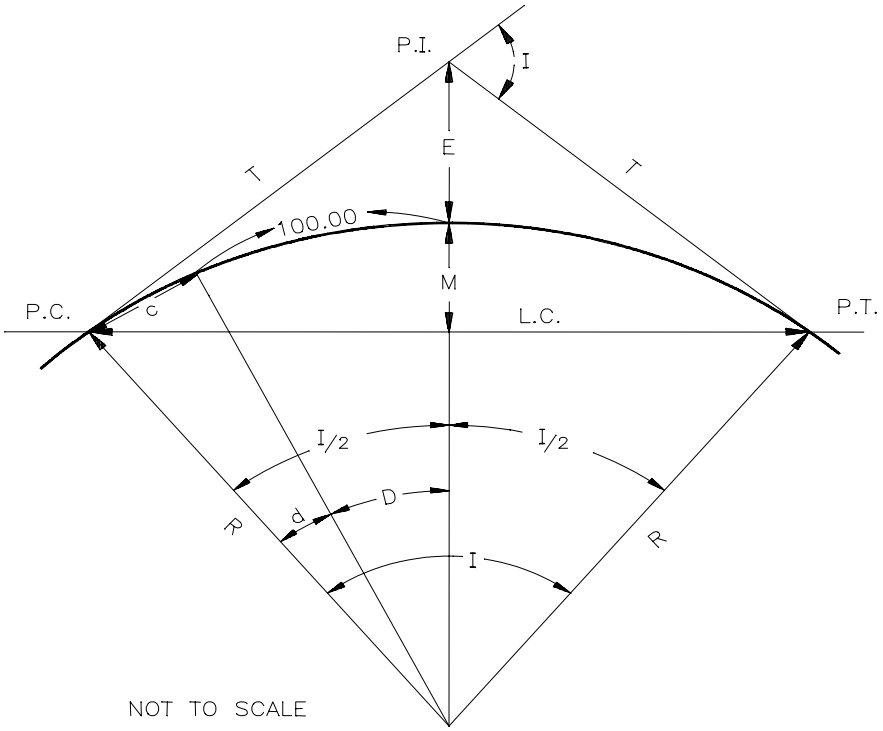
Transportation
See
Traffic

Vertical Curves: Sight Distance Related to Curve Length (Metric)		
	$S \le L$	$S > L$
Crest Vertical Curve General equation:	$L = \frac{AS^2}{100(\sqrt{2h_1}+\sqrt{2h_2})^2}$	$L = 2S - \frac{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}$
For $h_1 = 3.50$ ft and $h_2 = 2.0$ ft :	$L = \frac{AS^2}{2{,}158}$	$L = 2S - \frac{2{,}158}{A}$
Sag Vertical Curve (based on standard headlight criteria)	$L = \frac{AS^2}{400+3.5S}$	$L = 2S - \left(\frac{400+3.5S}{A}\right)$
Sag Vertical Curve (based on riding comfort)	$L = \frac{AV^2}{46.5}$	
Sag Vertical Curve (based on adequate sight distance under an overhead structure to see an object beyond a sag vertical curve)	$L = \frac{AS^2}{800\left(C - \frac{h_1+h_2}{2}\right)}$	$L = 2S - \frac{800}{A}\left(C - \frac{h_1+h_2}{2}\right)$
	$C =$ vertical clearance for overhead structure (overpass) located within 200 feet of the midpoint of the curve	

Horizontal Curves	
Side friction factor (based on superelevation)	$0.01e + f = \frac{V^2}{15R}$
Spiral Transition Length	$L_s = \frac{3.15V^3}{RC}$ $C =$ rate of increase of lateral acceleration [use 1 ft/sec^3 unless otherwise stated]
Sight Distance (to see around obstruction)	$\text{HSO} = R\left[1 - \cos\left(\frac{28.65S}{R}\right)\right]$ HSO = Horizontal sight line offset

HORIZONTAL CURVE FORMULAS

D = Degree of Curve, Arc Definition
P.C. = Point of Curve (also called B.C.)
P.T. = Point of Tangent (also called E.C.)
P.I. = Point of Intersection
I = Intersection Angle (also called Δ)
Angle between two tangents
L = Length of Curve,
from P.C. to P.T.
T = Tangent Distance
E = External Distance
R = Radius
L.C. = Length of Long Chord
M = Length of Middle Ordinate
c = Length of Sub-Chord
d = Angle of Sub-Chord



$$R = \frac{5729.58}{D}$$

$$R = \frac{L.C.}{2\ \sin\left(I/2\right)}$$

$$T = R\tan\left(I/2\right) = \frac{L.C.}{2\cos\left(I/2\right)}$$

$$L = RI\frac{\pi}{180} = \frac{I}{D}100$$

$$M = R\left[1\ -\cos\left(I/2\right)\right]$$

$$\frac{R}{E+R} = \cos\left(I/2\right)$$

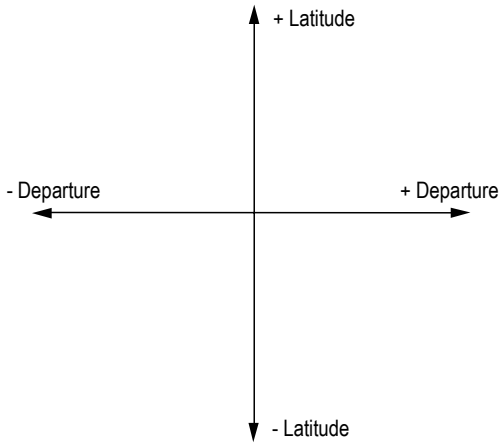
$$\frac{R-M}{R} = \cos\left(I/2\right)$$

$$c = 2R\sin\left(d/2\right)$$

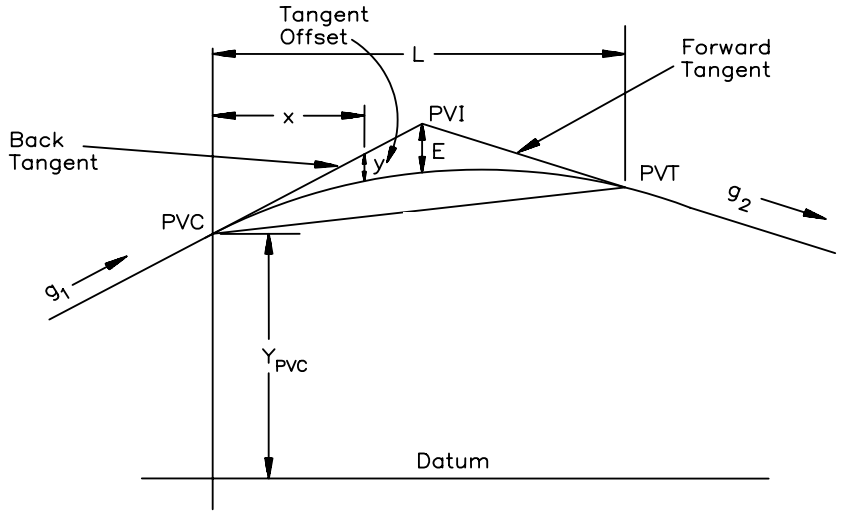
$$E = R\left[\frac{1}{\cos(I/2)}\ -1\right]$$

Deflection angle per 100 feet of arc length equals $D/2$

LATITUDES AND DEPARTURES



VERTICAL CURVE FORMULAS



VERTICAL CURVE FORMULAS
NOT TO SCALE

L = Length of Curve (horizontal)
PVC = Point of Vertical Curvature
PVI = Point of Vertical Intersection
PVT = Point of Vertical Tangency
g_1 = Grade of Back Tangent
x = Horizontal Distance from PVC to Point on Curve
g_2 = Grade of Forward Tangent
a = Parabola Constant
y = Tangent Offset
E = Tangent Offset at PVI
r = Rate of Change of Grade

x_m = Horizontal Distance to Min/Max Elevation on Curve = $-\frac{g_1}{2a} = \frac{g_1 L}{g_1 - g_2}$

Tangent Elevation = $Y_{PVC} + g_1 x$ and $= Y_{PVI} + g_2 (x - L/2)$

Curve Elevation = $Y_{PVC} + g_1 x + ax^2 = Y_{PVC} + g_1 x + [(g_2 - g_1)/(2L)]x^2$

$$y = ax^2 \qquad a = \frac{g_2 - g_1}{2L} \qquad E = a\left(\frac{L}{2}\right)^2 \qquad r = \frac{g_2 - g_1}{L}$$