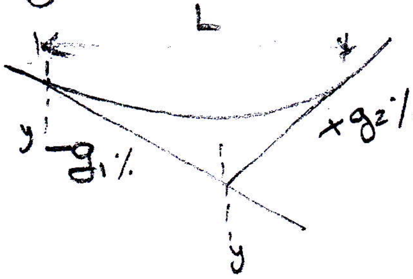
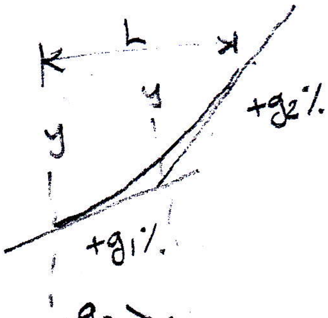
Vertical curves

are the second of the two important transition elements ingeometric design for highways. A vertical curve provides a transition between two sloped roadways allowing a vehicle to negotiate the elevation rate change at a gradual rate rather than a sharp cut. This curve is parabolic and are assigned stationing based on a horizontal axis.

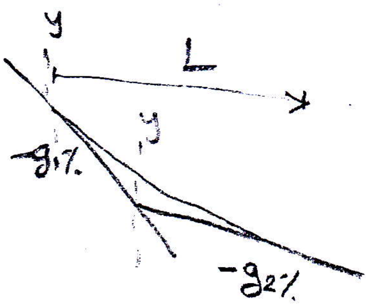
kinds of vertical curve

1. Sag (concave) vertical curve



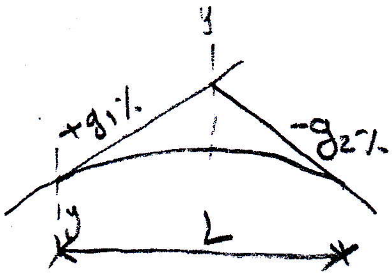


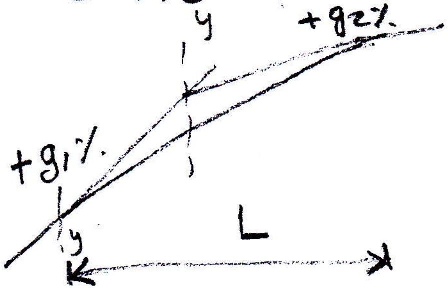
$g_2 > g_1$



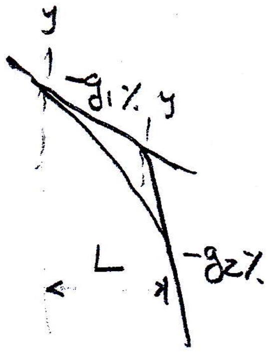
$g_1 > g_2$

2. Crest (convex) vertical curve



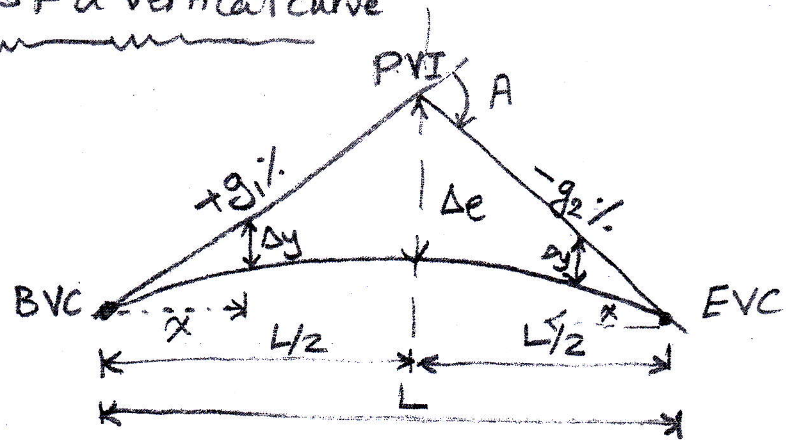


$g_1 > g_2$



$g_2 > g_1$

Elements of a vertical curve



(g_1 and g_2) grade of road in percentage.
(L) is the horizontal length of a vertical curve.
(A) is the total change ingrade (difference between grades ($A = g_2 - g_1$).

(r) is the rate of change ingrade ($r = \frac{A}{L}$). in station.

(BVC) is the begining vertical curve.
(PVI) is the point of vertical curve intersection.
(EVC) is the ending vertical curve.

(x) is the horizontal distance from BVC or EVC in station to the required point.

(Δe) is the difference between elevation of PVI and elevation of curve at middle length of a vertical curve.

(y) is the elevation of point on the curve or (curve elevation).

(Δy) is the difference elevation between tangent and curve @ specified distance (x) in the length of vertical curve.

General equations of computing elevation of point on curve

Since the vertical curve is parabolice, therefore, the general equation is :

$$y = ax^2 + bx + c \quad \text{------}(A)$$

@ $x = 0$, $y = BVC \longrightarrow \therefore \boxed{BVC = c}$

When taken the first derivative of equation(A), we obtain the slope of curve :

$$y' = 2ax + b$$

@ $x = 0$, $y' = g_1 \Rightarrow \boxed{b = g_1}$

The rate of change of slope is given by the the second derivative of equation (A):

$$y'' = 2a$$

$\because y'' = r \Rightarrow r = 2a \Rightarrow \boxed{a = \frac{r}{2}}$

$\because a = \frac{r}{2}$, $b = g_1$, and $c = BVC$, the general equation to find elevation of any point on curve, the equation (A) become :

$$\boxed{y = \frac{r}{2}x^2 + g_1 x + Elev.of\ BVC} \quad \text{-----} (B)$$

Where $r = \frac{A}{L} = \frac{g_2 - g_1}{L}$

station