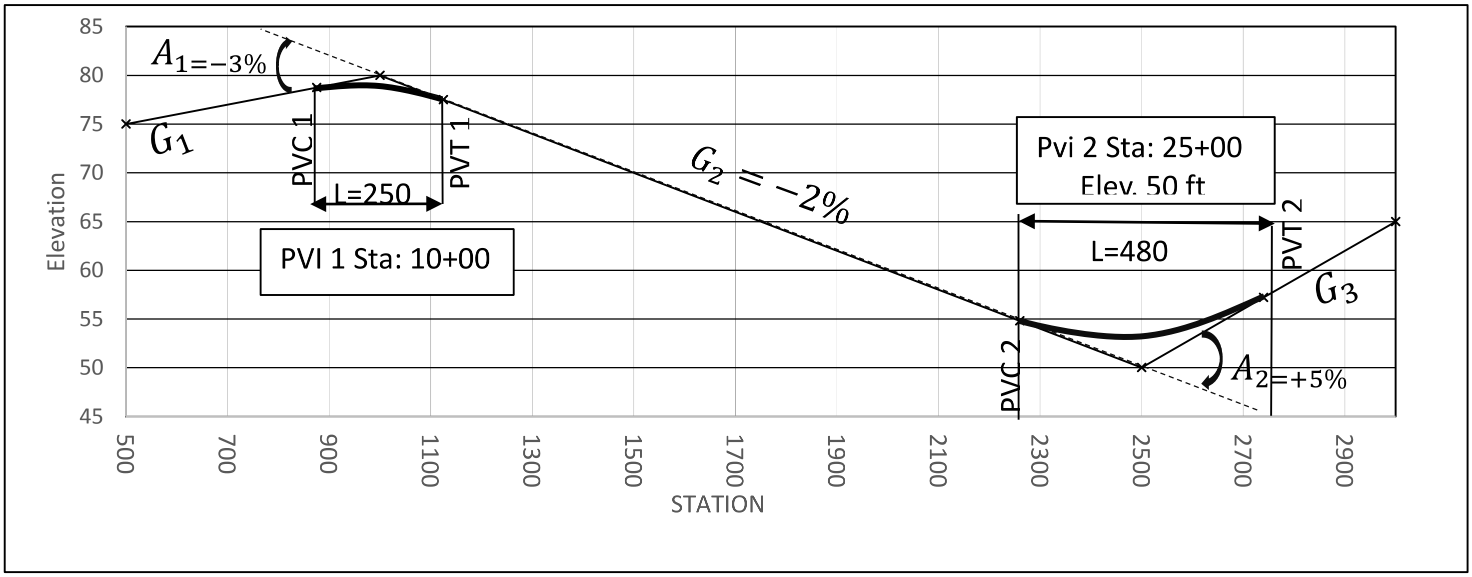
Problem in Vertical Curve and Sight Distance

In Figure Below calculate the following

1. **Station and Elevation of (PVC 1 , PVC 2 , PVT 1 and PVT 2)**
2. **Station and Elevation of highest point in Curve 1 and lowest point in Curve 2.**
3. **Maximum save operating Speed to satisfy stopping sight distance.**



<u>Solution:-</u>

$A_1 = G_2 - G_1 \rightarrow -3 = -2 - G_1 \rightarrow \quad \boldsymbol{G_1} = \boldsymbol{+1}\ \%$

$A_2 = G_3 - G_2 \rightarrow +5 = G_3 - (-2) \rightarrow \boldsymbol{G_3} = \boldsymbol{3}\ \%$

<u>in Curve (1)</u>

PVC 1 $_{sta}$ = PVI 1 $_{sta}$ - $\frac{L}{2}$ = 1000 – 125 = 875 ft = 08+75

PVT 1 $_{sta}$ = PVI 1 $_{sta}$ + $\frac{L}{2}$ = 1000 + 125 = 875 ft = 11+25

$E_{Pvc1} = E_{Pvi1} - \frac{G1}{100} \times \frac{L}{2}$

$E_{Pvi1} = E_{Pvi2} - \frac{G2}{100} \times (2500 - 1000) = 50 - \frac{-2}{100} \times 1500 = 80\ ft$

$E_{pvc\ 1} = 80 - \frac{1}{100} \times 125 = 78.75\ ft$

$E_{pvt\ 1} = E_{pvi\ 1} + \frac{G2}{100} \times \frac{L}{2}$

$E_{pvt\ 1} = 80 + \frac{-2}{100} \times 125 = 77.5\ ft$

To find the highest point elevation, we should be calculate the distance of this point by follow equation:

$X_{m\ 1} = \left| \frac{G1\ L}{A1} \right| = \left| \frac{1 \times 250}{-3} \right| = 83.33\ ft$

$X_{m\ 1\ sta} = 875 + 83.33 = 09 + 58.33\ ft$

$E_{xm1} = E_{pvc\ 1} + \frac{G_1}{100} \times X_{m\ 1} + \frac{(G_2 - G_1) \times {X_{m\ 1}}^2}{200\ L} =$

$E_{xm1} = 78.75 + \frac{1}{100} \times 83.33 + \frac{(-2-1) \times 83.33^2}{200 \times 250} = 79.17\ ft$

In Curve (2)

PVC 2 $_{sta}$ = PVI 2 $_{sta}$ - $\frac{L}{2}$ = 2500 – 240 = 2260 ft. = 22+60

PVT 2 $_{sta}$ = PVI 2 $_{sta}$ + $\frac{L}{2}$ = 2500 + 240 = 2740 ft. = 27+40

$$E_{pvc\ 2} = E_{pvi\ 2} - \frac{G2}{100} \times \frac{L}{2} = 50 - \frac{-2}{100} \times 240 = 54.8\ ft$$

$$E_{pvt\ 2} = E_{pvi\ 2} + \frac{G3}{100} \times \frac{L}{2}$$

$$E_{pvt\ 1} = 80 + \frac{3}{100} \times 240 = 57.2\ ft$$

To find the lowest point elevation, we should be calculate the distance of this point by follow equation:

$$X_{m\ 2} = \left|\frac{G2\ L}{A2}\right| = \left|\frac{-2 \times 480}{5}\right| = 192\ ft$$

$$X_{m\ 2\ sta} = 2260 + 192 = 2452\ ft = 24 + 52$$

$$E_{xm2} = E_{pvc\ 1} + \frac{G_1}{100} \times X_{m\ 2} + \frac{(G_2 - G_1) \times {X_{m\ 2}}^2}{200\ L} =$$

$$E_{xm1} = 54.8 + \frac{1}{100} \times 192 + \frac{(-2-1)\times 192^2}{200 \times 480} = 52.88\ ft$$

Save operating Speed

Curve (1)

Assume S > L: $L = 2\ S - \left(\frac{2158}{|A|}\right) \rightarrow S = \frac{250+\frac{2158}{3}}{2} = 484.67\ ft\ > L\ \ ok$

Curve (2)

Assume S > L : $L = 2\ S - \left(\frac{400-3.5\ S}{|A|}\right) \rightarrow 480 =\ 2\ S - \frac{400}{5} - \frac{3.5}{5}\ S$

$$480 =\ 2\ S -\ 133.33 -\ 1.67\ S \ \rightarrow\ S = \frac{560}{1.3} = 430\ ft < L\ \ not\ ok$$

Assume S < L: $L = \left(\frac{A\ S^2}{400+3.5\ S}\right) \rightarrow \frac{480\times 400}{5} + \frac{480\times 3.5\ S}{5} = S^2$

$S^2 - 336\ S - 38400 = 0$

$\boldsymbol{S = 426.11\ ft\ < L\ \ \ \ ok}$

We should chose the smallest value of S which is = 426.11 ft

$$S = 1.47\ \times t \times V + 1.075\ \frac{V^2}{a}$$

$426.11 = 1.47\ \times 2.5\ \times V + 0.096\ V^2\ \rightarrow\ \ 0.096\ V^2 + 3.675\ V - 426.11 = 0$

$V\ = 50.178\ mph$

$\therefore \boldsymbol{V = 50\ mph\ (\ Save\ operation\ speed\ )}$