Part – 1

Q(1):

Retarders are

- a. Brakes on rails of receiving yards that are used by control operators
- b. Brakes on freight trains that are used at classification yards
- c. Brakes on passenger trains that are used at terminals
- d. Brakes on rails used for both freight and passenger trains
- e. Brakes on rails of classification yards that are used by control operators

Clear my choice

Q(2):

The toe of a switch is

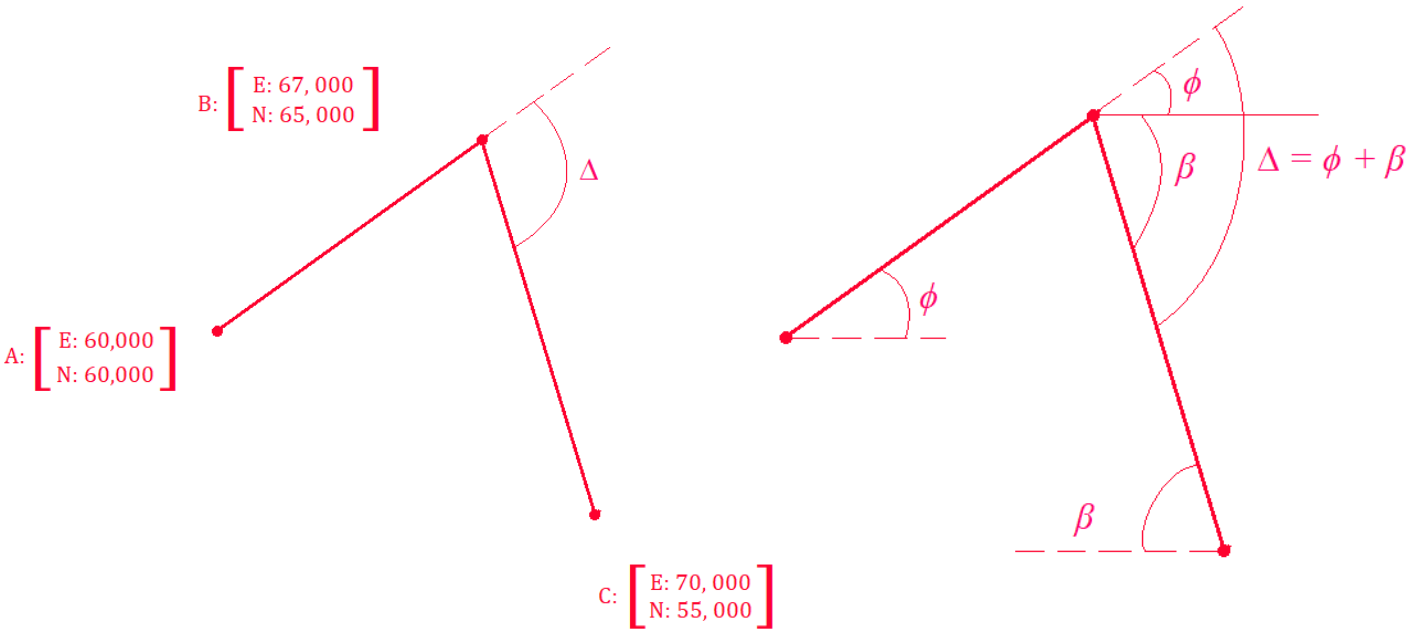
- a. The location of electric switch converter
- b. The end tip of the movable part
- c. The most center part that pivots in two direction
- d. The fixed tip of the movable part
- e. The location of end of rail line

Clear my choice

Q(3):

Given two horizontal alignment tangents AB and BC for a rail line connected at point B. The coordinates of A: N:60000, E 60000, B: N65000, E67000, C:N55000, E70000, determine the deflection angle in degrees and decimals of a degree between the two tangents (answer format example " 21.6 " Only one rounded digit right of the decimal point)

Answer: 108.3



$$\phi = \tan^{-1}\left(\left|\frac{\Delta N_{AB}}{\Delta E_{AB}}\right|\right) = \tan^{-1}\left(\left|\frac{65,000 - 60,000}{67,000 - 60,000}\right|\right) = 35.538^{o}$$

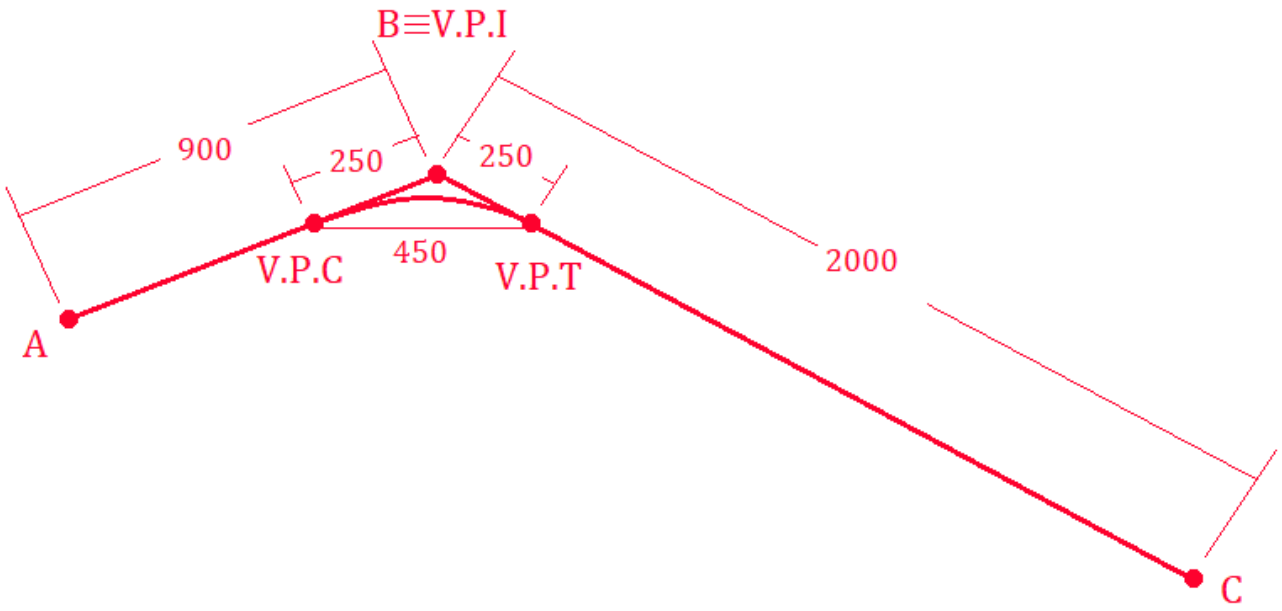
$$\beta = \tan^{-1}\left(\left|\frac{\Delta N_{BC}}{\Delta E_{BC}}\right|\right) = \tan^{-1}\left(\left|\frac{55,000 - 65,000}{70,000 - 67,000}\right|\right) = 73.301^{o}$$

$$\Delta = \phi + \beta = 35.538^{o} + 73.301^{o} = 108.8^{o}$$

Q(4):

Given two horizontal alignment tangents, AB and BC, length AB is 900m, and length BC is 2000m. The tangent PI to PT is 250m and length of curve is 450m, if the station at point A is 12+15.5m (20 meter stations), what is the station at PT? (answer format example "11+5.5 " Note: no spaces in the answer)

Answer: 67 + 15.5



$St(A) = 12\ + 15.5\ m = 12(20) + 15.5 = 255.5\ m$

$St(V.P.C) = St(A) + L_{AB} - L_{V.P.C-B} = 255.5 + 900 - 250 = 905.5\ m$

$St(V.P.T) = St(A) + L_{curve} = 905.5 + 450 = 1355.5\ m = 67 + 15.5\ m$

Q(5):

What is the design speed in km/h for trains on a railroad radius of 814m, gauge centerline to centerline 1.27m, and equilibrium elevation of 152mm

Answer must be in the following format "e.g., 15.11" or two digits right of decimal point

Answer: 111.29

$$\frac{E}{G} = \frac{V^2}{gR} \Longrightarrow V = \sqrt{\frac{EgR}{G}} = \sqrt{\frac{(0.152)(9.81)(814)}{(1.27)}} = 111.29\ m$$

Part – 2

Question 1: (30 marks)

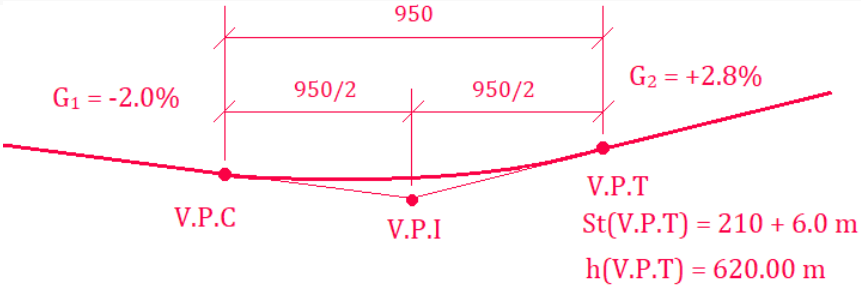
Group D: Last digit of student number 85-99 and 00-09 (inclusive)

Given the length of vertical curve is 950 meters, the station and elevation of PVT are 210+6.0m and 620.00m respectively, if G1 = - 2.0% and G2 = + 2.8%, determine:

a) (18 marks) The elevation of station 200 +1.5

b) (12 marks) The station and elevation of the highest and lowest points on the vertical curve

Note: Use 20-meter stations



a)

$St(V.P.T) = 210 + 6.0\,m = 210(20) + 6 = 4206\,m$

$St(V.P.C) = St(V.P.T) - L = 4206 - 950 = 3256\,m$

$St(200 + 1.5\,m) = 200(20) + 1.5 = 4001.5\,m$

$St(V.P.C) < St(200 + 1.5\,m) < St(V.P.T) \Longrightarrow The\ point\ is\ on\ the\ parabola\ (not\ on\ the\ tangents)$

$$h(V.P.C) = h(V.P.T) - \frac{L}{2}(|G_2|) + \frac{L}{2}(|G_1|) = 620 - \frac{950}{2}(2.8\%) + \frac{950}{2}(2.0\%) = 616.20\,m$$

$$h(x) = \frac{(G_2 - G_1)}{2L}x^2 + G_1 x + h(V.P.C) = \frac{\big(0.028 - (-0.020)\big)}{2(950)}x^2 + (-0.020)x + 616.20$$

$$h(x) = 2.526(10)^{-5}x^2 - 0.020x + 616.20$$

$For\ point\ of\ Station = 200 + 1.5\,m, x = St(200 + 1.5) - St(V.P.C) = 4001.5 - 3256 = 745.5\,m$

$$h(745.5) = 2.526(10)^{-5}(745.5)^2 - 0.020(745.5) + 616.20 = 615.33\,m$$

b) To find the lowest point we differentiate, and equalize with zero:

$$\frac{dh}{dx} = 5.052(10)^{-5}x - 0.020 = 0 \Longrightarrow x_{lowest} = 395.88\,m$$

$$St(P_{lowest}) = St(V.P.C) + x_{lowest} = 3256 + 395.88 = 3651.88\,m = 182 + 11.9\,m$$

$$h(x_{lowest}) = 2.526(10)^{-5}(395.88)^2 - 0.020(395.88) + 616.20 = 612.24\,m$$

$P_{highest} = V.P.T \Longrightarrow$

$St(P_{highest}) = St(V.P.T) = 210 + 6.0\,m$

$h(P_{highest}) = h(V.P.T) = 620.00\,m$

Question 2: (25 marks)

Group E: Last digit of the student number is 6 & 7

Due to roadside trees the available sight distance on a road segment 110 meters. Given the wet pavement coefficient of friction of 0.28 and 1% downgrade, what should be the design speed in km/h (maximum safe speed)?

To get the maximum allowable speed, we must have $MRSSD = ASSD$

$$MRSSD = d_r + d_b$$

$$MRSSD = (V_i)(t_r) + \frac{V_i^2 - V_f^2}{2g(f \pm G)} = (V_i)(2.5) + \frac{(V_i)^2 - (0)^2}{2(9.81)(0.28 - 0.01)} = 2.5V_i + 0.189V_i^2 = 110$$

$$0.189V_i^2 + 2.5V_i - 110 = 0 \ (quadrtic\ equation\ could\ be\ solved\ using\ the\ general\ quadratic\ formula)$$

$$V_i = \frac{-2.5 \pm \sqrt{(2.5)^2 - 4(0.189)(-110)}}{2(0.189)}$$

$$V_i = -31.63 \frac{m}{sec}\ (Rejected)$$

$$V_i = 18.40 \frac{m}{sec} = 66.24 \frac{Km}{hr}$$

Question 3: (15 marks)

Group C: Last digit of the student number is 5 & 6

What is the desirable length of a railroad spiral for minor short distance routes of passenger intercity trains for a design speed of 80km/h and using equilibrium elevation of 12cm and unbalance elevation of 9.5cm according to the American Railway Engineering Association (AREA)?

Since it is a minor short route, we must use the (0.04g intercity metric equation):

$$L_{Spiral}(m) = 0.0091E_u(mm)V\left(\frac{Km}{hr}\right) = 0.0091(95)(80) = 69.16\ m$$