

CE 8: Highway Engineering and Bridge Design



Midterm Quiz Bee (Group Category)

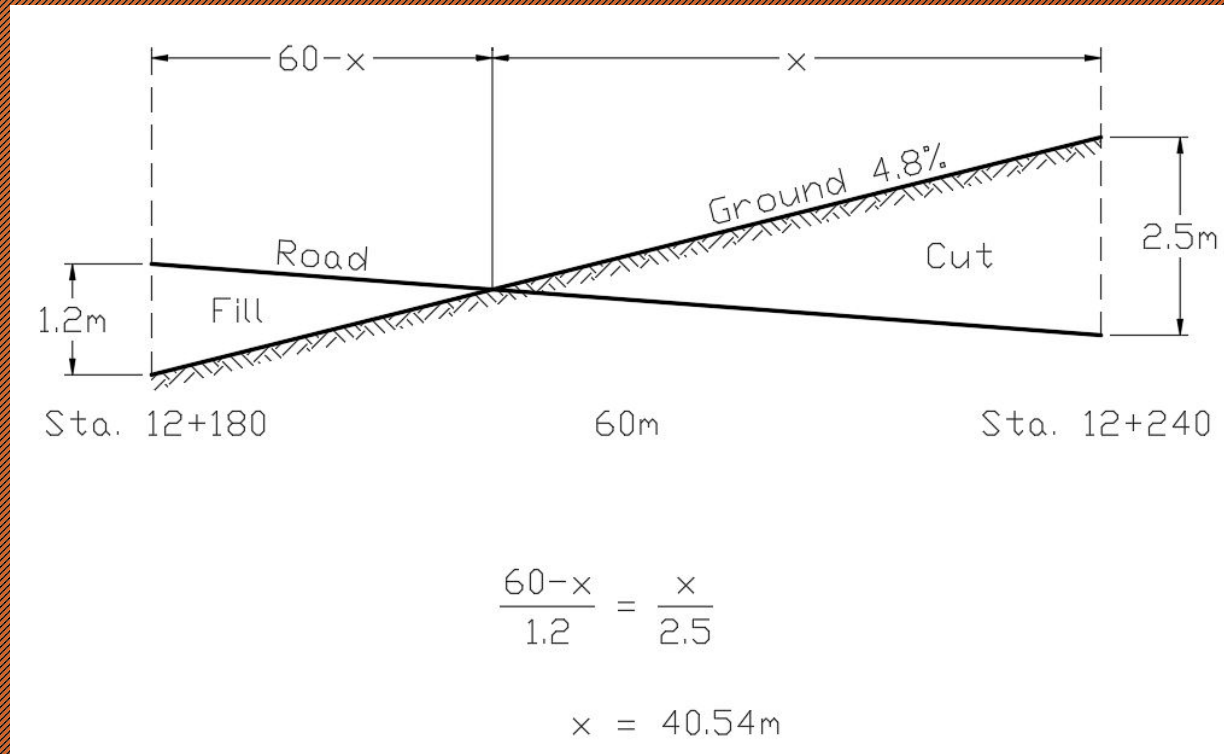


Problem 1: (2minutes)

CE Board May 2000

The ground makes a uniform slope of 4.8% from STA 12+180 to STA 12+240. At STA 12+180, the center height of the roadway is 1.2m fill. At the other station, the center height is 2.5m cut. Find the length of cut in meters.

Ans. **40.54m**



Problem 2: (3minutes)

CE Board May 2000

From point A on a simple curve, the perpendicular distance to the tangent at point Q is 64m. The tangent passes through PC. The distance from Q to PC is 260m. Find the length of the curve from PC to A.

Ans. **270.38m**

$$R^2 = (R-64)^2 + 260^2$$

$$R = 560.125\text{m}$$

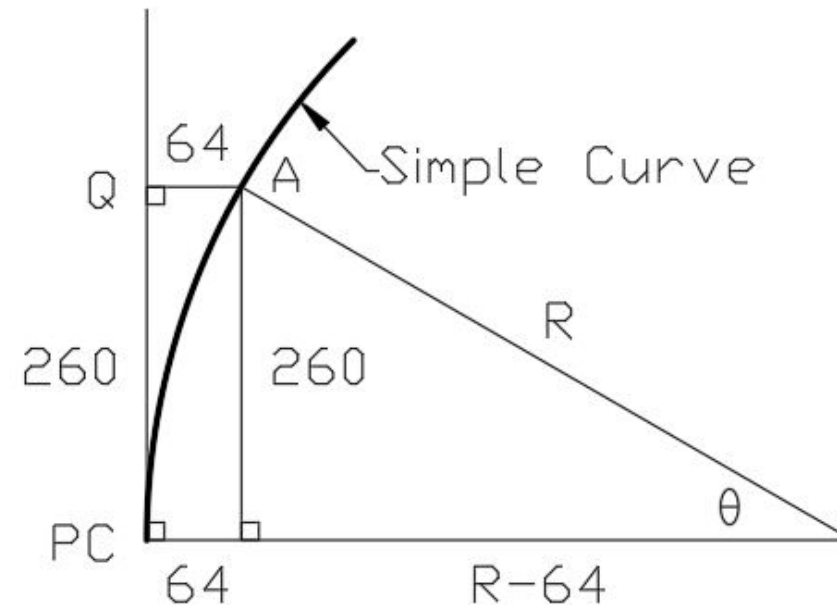
$$\theta = \sin^{-1}(260/560.125)$$

$$\theta = 27.657^\circ \rightarrow \textcircled{A}$$

$$L_c = R\theta(\pi/180^\circ)$$

$$L_c = 560.125 \textcircled{A}(\pi/180^\circ)$$

$$L_c = 270.38\text{m}$$



Problem 3: (3minutes)

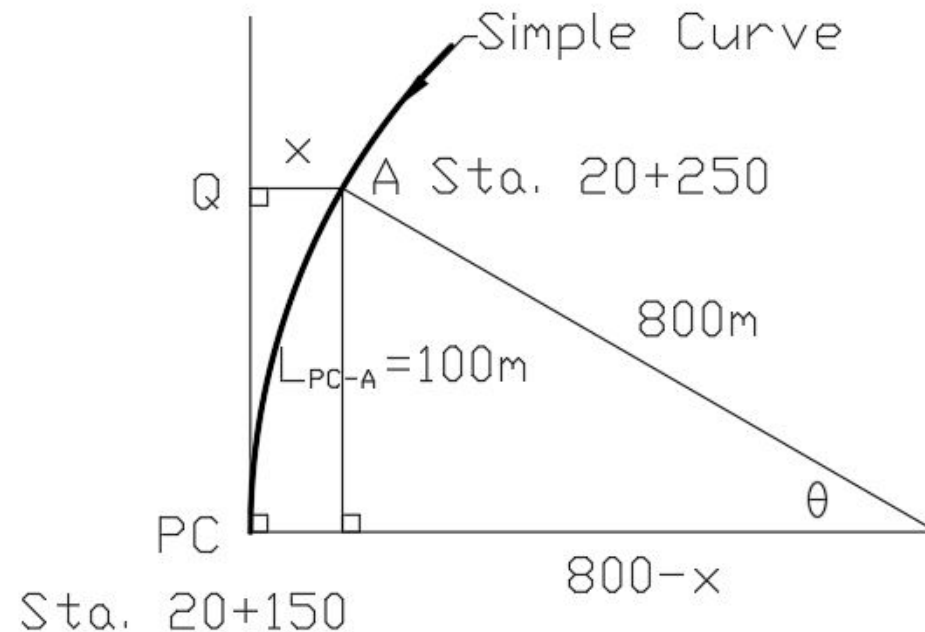
CE Board November 2000

From a point A on a simple curve, the perpendicular distance to the tangent at point Q is x. The tangent passes through PC. Point A is at station 20 + 250 and PC is at station 20 + 150. If the radius is 800m, find x.

Ans. 6.24m

$$L_c = R \theta (\pi/180^\circ)$$
$$100 = 800 \theta (\pi/180^\circ)$$
$$\theta = 7.162^\circ \rightarrow \textcircled{A}$$

$$\cos \textcircled{A} = (800 - x) / 800$$
$$x = 6.24\text{m}$$

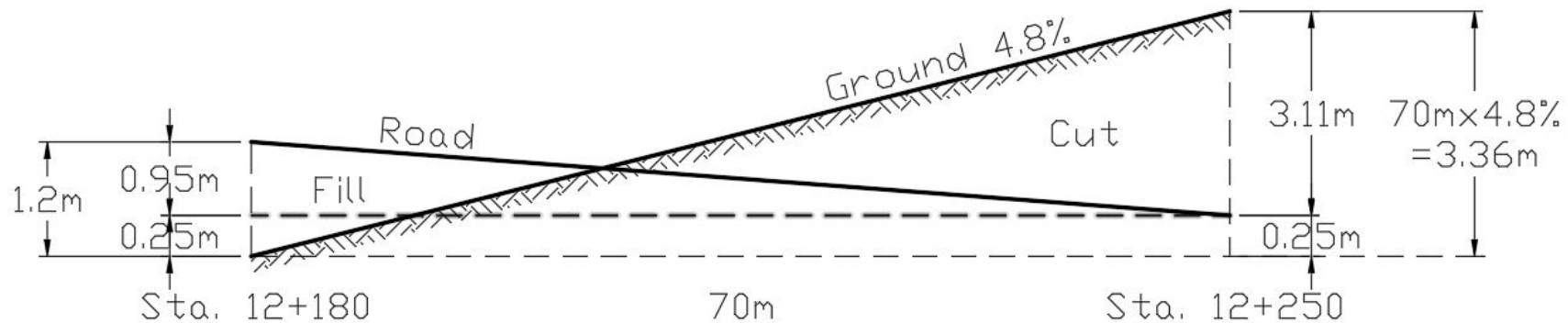


Problem 4: (2minutes)

CE Board November 2000

The ground makes a uniform slope of 4.8% from STA 12+180 to STA 12+250. At STA 12+180, the center height of the roadway is 1.2m fill. At the other station, the center height is 3.11m cut. Find the grade of the finished road.

Ans. -1.357%



$$\text{Grade of finished road} = \frac{0.95}{70} = 0.01357$$

$$\text{Grade of finished road} = -1.357\%$$

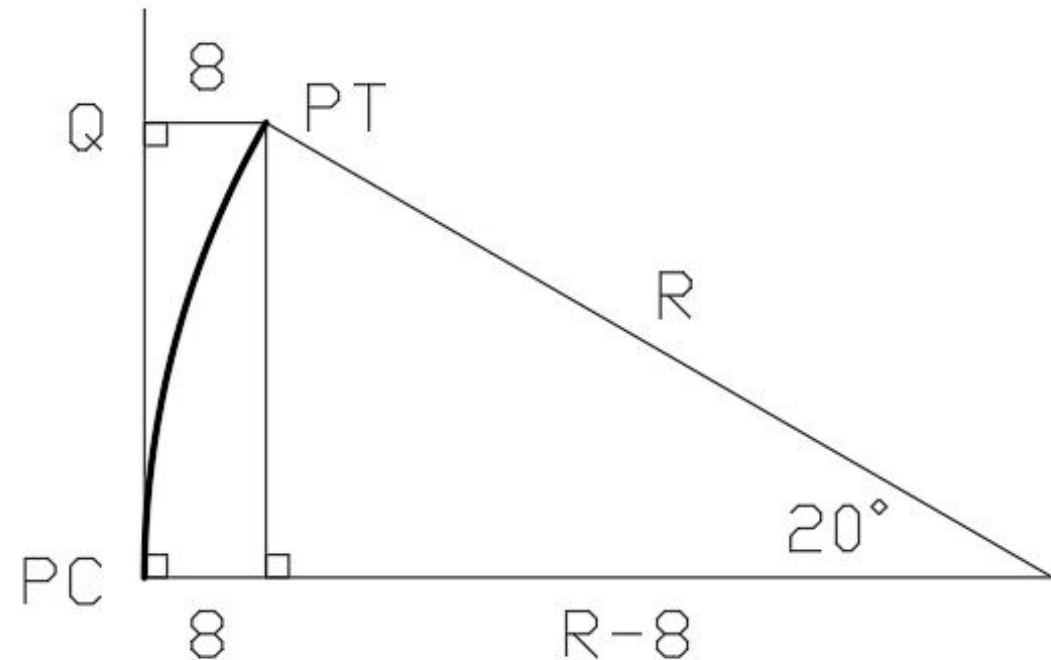
Problem 5: (2minutes)

CE Board May 2001

The offset distance from PC to PT of a simple curve is 8m. If the angle of intersection of the curve is 20° , what is the radius of the curve.

Ans. **132.65m**

$$\cos 20^\circ = (R-8)/R$$
$$R = 132.65\text{m}$$



Problem 6: (5minutes)

CE Board May 2001

A compound curve has the following properties.

$$I_1 = 32^\circ$$

$$I_2 = 24^\circ$$

Length of chord from PC to PCC, $L_1 = 235.98\text{m}$

Length of chord from PCC to PT, $L_2 = 178.23\text{m}$

Find the length of long chord.

Answer: 402.15m

By Cosine Law,

$$L^2 = L_1^2 + L_2^2 - 2L_1L_2\cos 152^\circ$$

$$L^2 = 235.98^2 + 178.23^2 - 2(235.98)(178.23)\cos 152^\circ$$

$$L = 402.15\text{m}$$

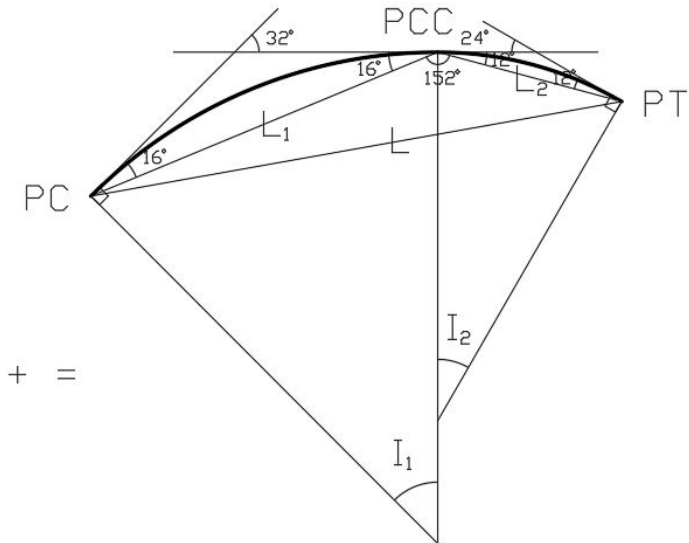
By Calculator Technique,

Mode + 2 (CMPLX)

Shift + hyp (| |) + 235.98 + Shift (-) + 152 + - + 178.23 + =

|235.98∠152-178.23|

$$L = 402.15\text{m}$$



Problem 7: (5minutes)

CE Board May 2001

The longitudinal ground profile and the gradeline shows that the length of cut is 560m while the length of fill is 740m. The width of the roadbed is 10m for both cut and fill. The profile areas between the ground line and the gradeline is, which are parallel are 4800m^2 for cut and 5829m^2 for fill. Find the difference between the volume of fill and the volume of cut in cubic meters, if the side slopes are 1.5:1 for cut and 2:1 for fill.

Ans. **40406.1m^3**

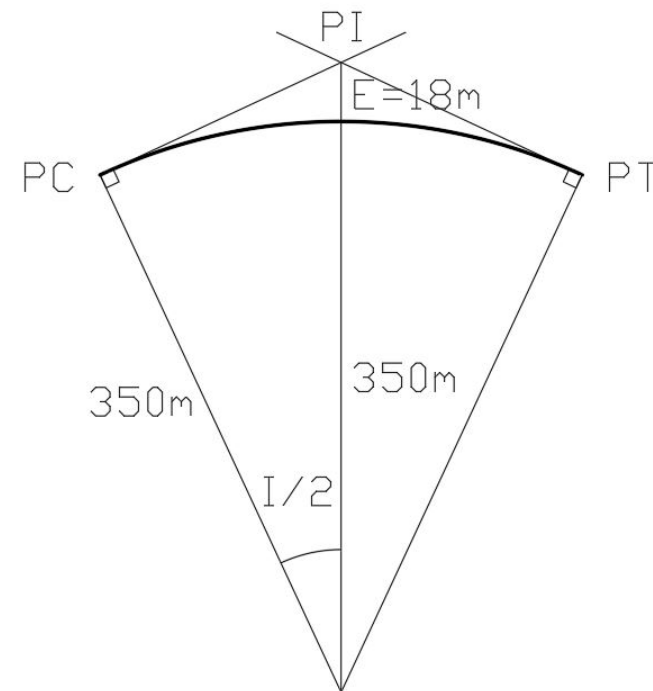
Problem 8: (1minute)

CE Board November 2001

Determine the central angle of a simple curve with radius 350m if the nearest distance from the curve to the point of intersection of the tangents is 18m.

Ans. **36°**

$$\begin{aligned} I/2 &= \cos^{-1}(350/368) \\ I &= 36^\circ \end{aligned}$$



Problem 9: (3minutes)

CE Board November 2001

A reversed curve has the following properties.

Degree of curve, $D_1 = 3^\circ$

Degree of curve, $D_2 = 4^\circ$

Central angle, $I_1 = 24^\circ$

Central angle, $I_2 = 38^\circ$

Stationing of PC = 67 + 345.23m

Determine the stationing of PRC. Use arc basis.

A

Stationing of PRC = Stationing of PC + L_{c_1}

$$R = 3600 / (\pi \times 3^\circ)$$

$$R = 381.97\text{m} \rightarrow \textcircled{A}$$

$$L_{c_1} = R \theta (\pi / 180^\circ)$$

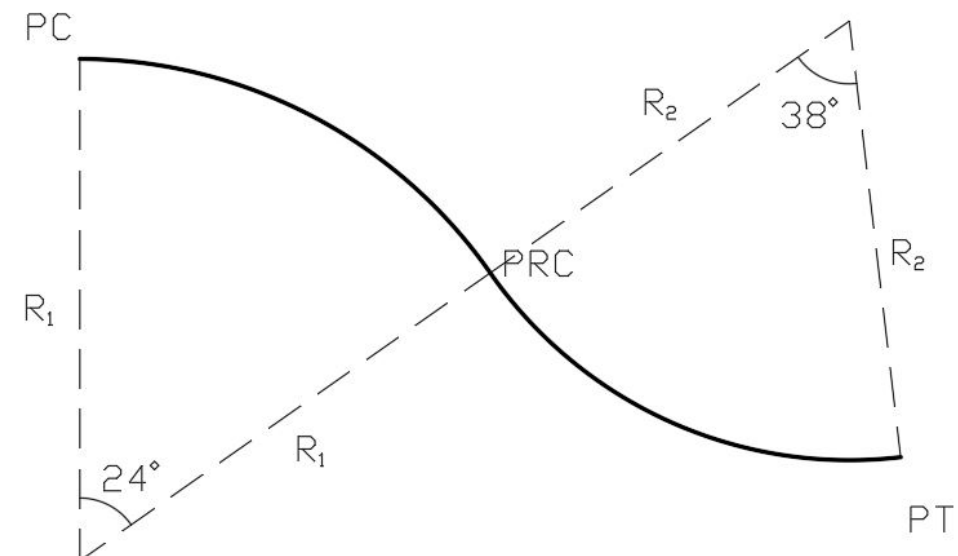
$$L_{c_1} = R (24^\circ) (\pi / 180^\circ)$$

$$L_{c_1} = 160\text{m}$$

Stationing of PRC = Stationing of PC + L_{c_1}

Stationing of PRC = 67 + 345.23 + 160

Stationing of PRC = 67 + 505.23

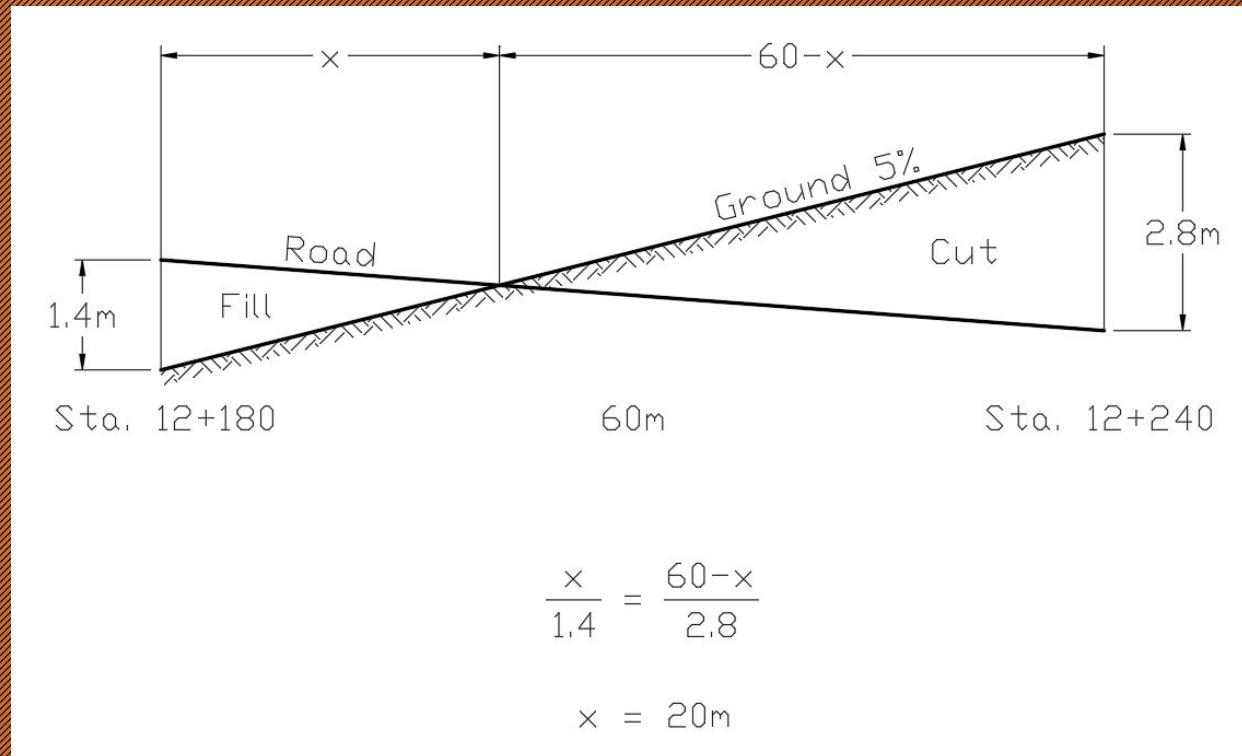


Problem 10: (2minutes)

CE Board May 2002

From STA 12+180 with center height of 1.4m in fill, the ground makes a uniform slope of 5% to STA 12+240 whose center height is 2.8m in cut. How far is the point of intersection of the ground and the road from station 12 + 180.

Ans. **20m**



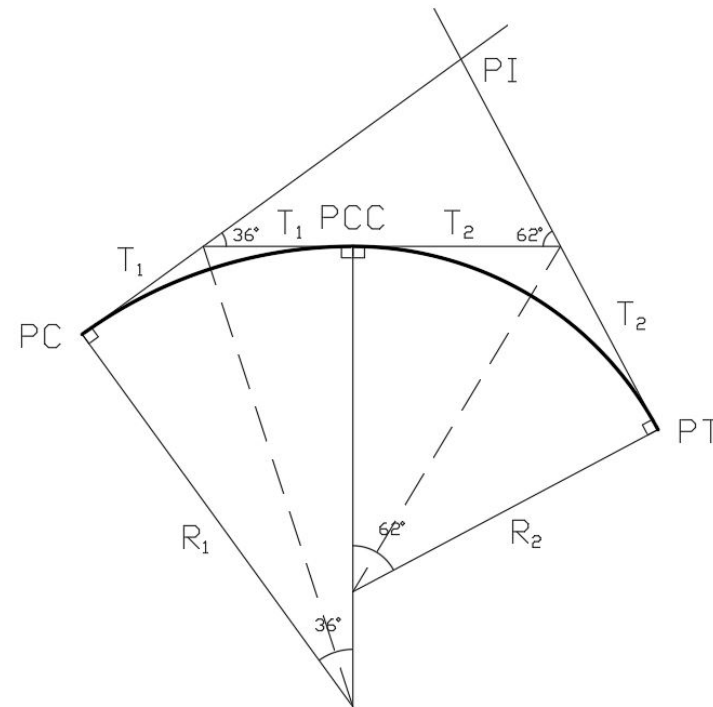
Problem 11: (5minutes)

CE Board May 2002

The length of the common tangent of a compound curve is 321m. $D_1 = 2.5^\circ$, $I_1 = 36^\circ$, $I_2 = 62^\circ$. Find the degree of the second curve. Use arc basis.

Ans. 4°

$$\begin{aligned}T_1 + T_2 &= 321\text{m} \\R_1 &= 3600 / (\pi \times 2.5^\circ) \\R_1 &= 458.366\text{m} \rightarrow \textcircled{\text{A}} \\T_1 &= \textcircled{\text{A}} \tan(36^\circ/2) \\T_1 &= 148.932\text{m} \rightarrow \textcircled{\text{B}} \\T_2 &= 321 - \textcircled{\text{B}} \\T_2 &= 172.068\text{m} \rightarrow \textcircled{\text{C}} \\R_2 &= \textcircled{\text{C}} / \tan(62^\circ/2) \\R_2 &= 286.369\text{m} \rightarrow \textcircled{\text{D}} \\ \textcircled{\text{D}} &= 3600 / (\pi D) \\D &= 4^\circ\end{aligned}$$



Problem 12: (3minutes)

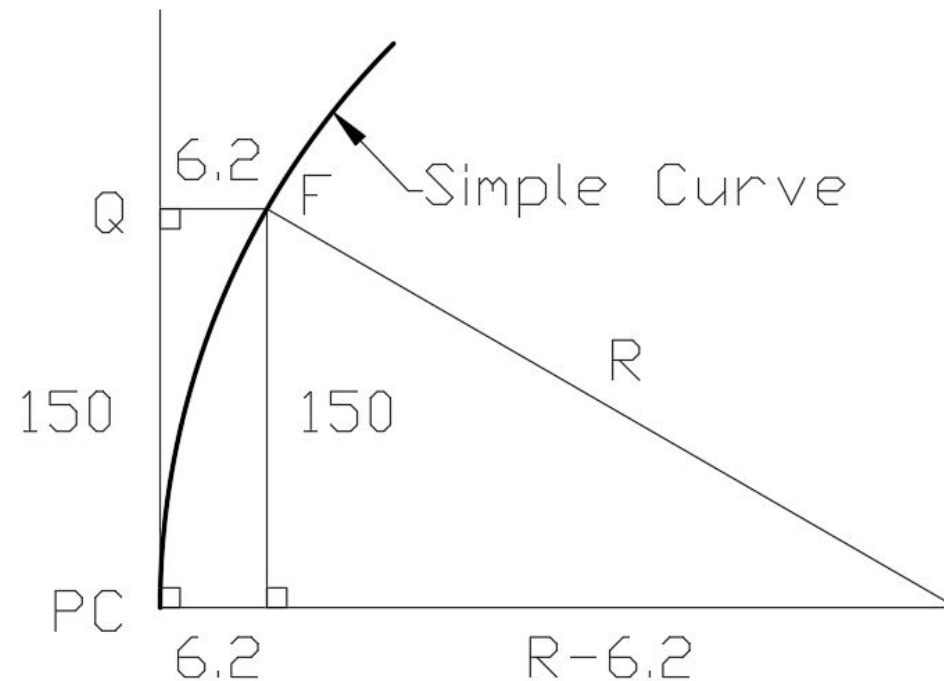
CE Board November 2002

The tangent of a simple curve from PI to PC has a bearing of N 65° E and the other tangent from PI to PT has a bearing of N 55° W. At a point 150m from PC along the tangent through PC, the right angle offset to point F on the curve is 6.2m. Find the radius of the curve.

Ans. 1817.62m

$$R^2 = (R - 6.2)^2 + 150^2$$

$$R = 1817.616\text{m}$$



Problem 13: (1minute)

CE Board November 2002

Given the following cross-section notes of an earthwork on an 8-m wide roadway:

6.7	0	4.75
1.8	1.4	0.5

Determine the area of the cross-section.

Ans. **12.615m²**

Problem 14: (5minutes)

CE Board November 2002

A reversed curve of equal radii connects two parallel tangents, 12m apart. The length of chord from PC to PT is 140m. Determine the total length of the reversed curve.

Ans. **140.17m**

$$\theta = \sin^{-1}(12/140)$$

$$\theta = 4.917^\circ \rightarrow \textcircled{A}$$

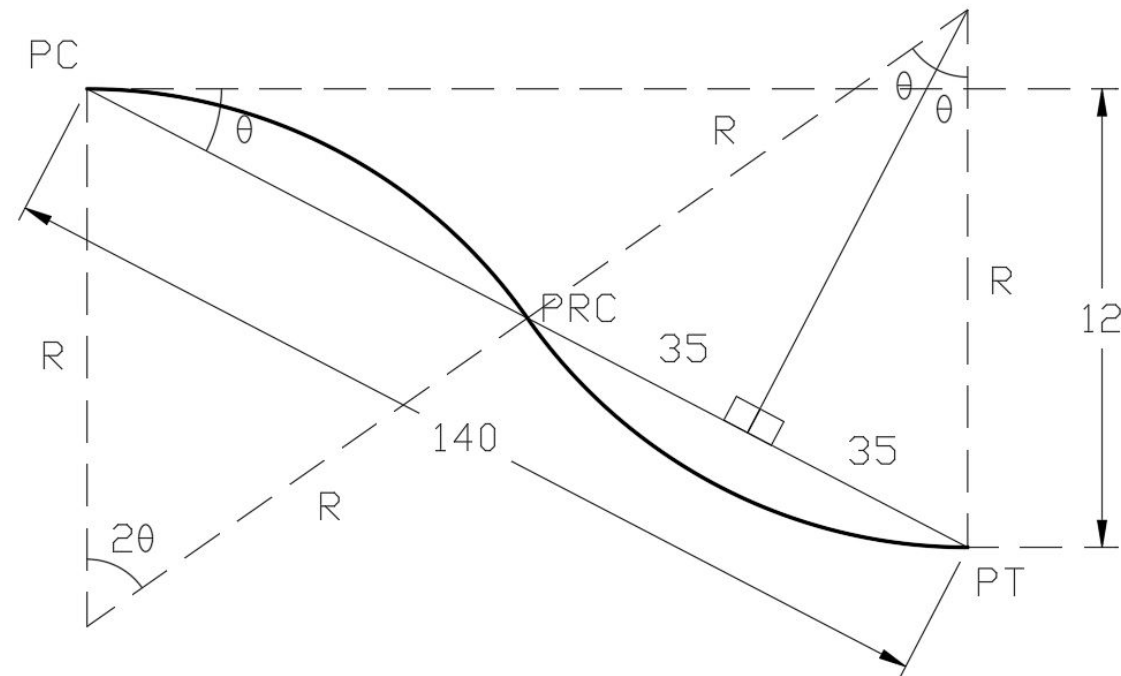
$$R = 35/(\sin \textcircled{A})$$

$$R = 408.33\text{m} \rightarrow \textcircled{B}$$

$$L_c = 2 \times R I (\pi/180^\circ)$$

$$L_c = 2 \textcircled{B} \times 2 \textcircled{A} (\pi/180^\circ)$$

$$L_c = 140.17\text{m}$$



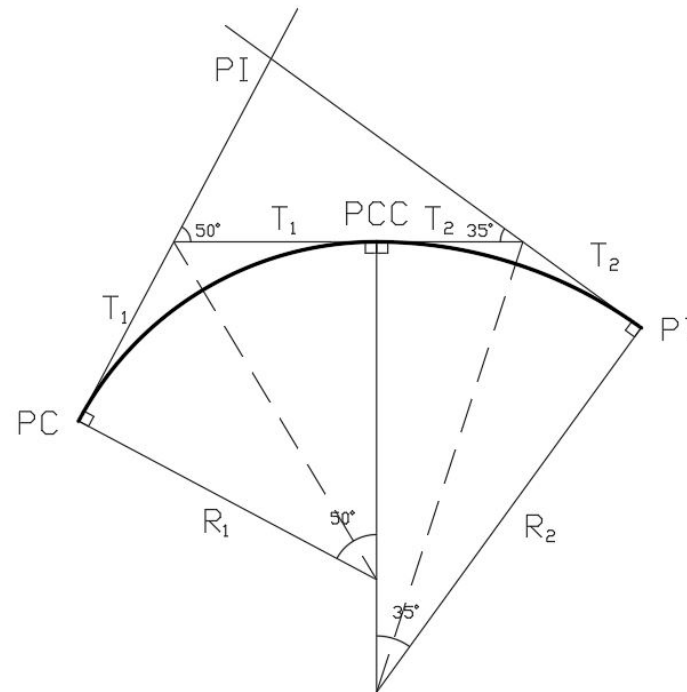
Problem 15: (5minutes)

CE Board May 2003

A compound curve has a common tangent 520m long. The first curve passing through the PC is a 3-degree curve with a central angle of 50° . Find the radius of the second curve if its central angle is 35° .

Ans. **1084.32m**

$$\begin{aligned}T_1 + T_2 &= 520\text{m} \\R_1 &= 3600 / (\pi \times 3^\circ) \\R_1 &= 381.97\text{m} \rightarrow \textcircled{\text{A}} \\T_1 &= \textcircled{\text{A}} \tan(50^\circ/2) \\T_1 &= 178.116\text{m} \rightarrow \textcircled{\text{B}} \\T_2 &= 520 - \textcircled{\text{B}} \\T_2 &= 341.884\text{m} \rightarrow \textcircled{\text{C}} \\R_2 &= \textcircled{\text{C}} / \tan(35^\circ/2) \\R_2 &= 1084.32\text{m}\end{aligned}$$



Problem 16: (2minutes)

CE Board May 2003

Given a side slope of 2:1, a road width of 10m and a cross sectional area of 31.7m^2 , find the value of x in the following cross-section notes:

9.8	0	7.4
2.4	x	1.2

Ans. **2.64m**

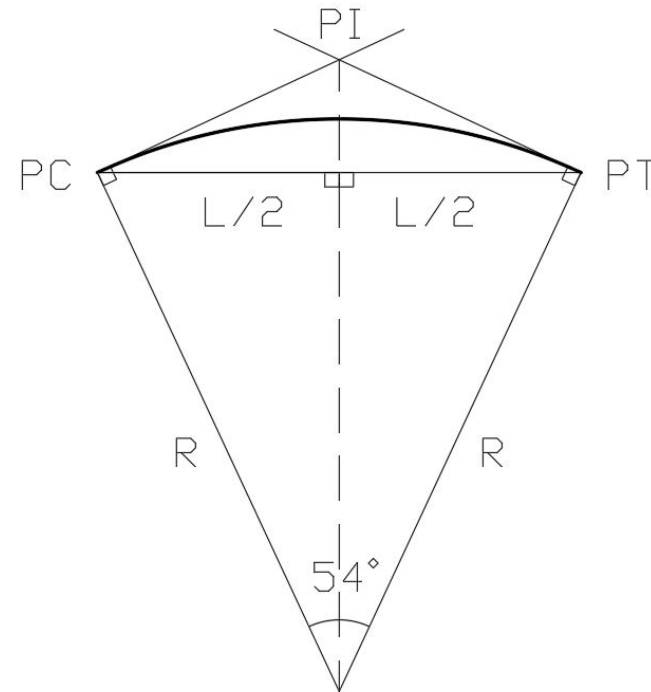
Problem 17: (2minutes)

CE Board November 2004

A 4-degree simple curve has an angle of intersection of 54° . The PC of the curve is at station 34 + 523. Determine the length of the long chord.

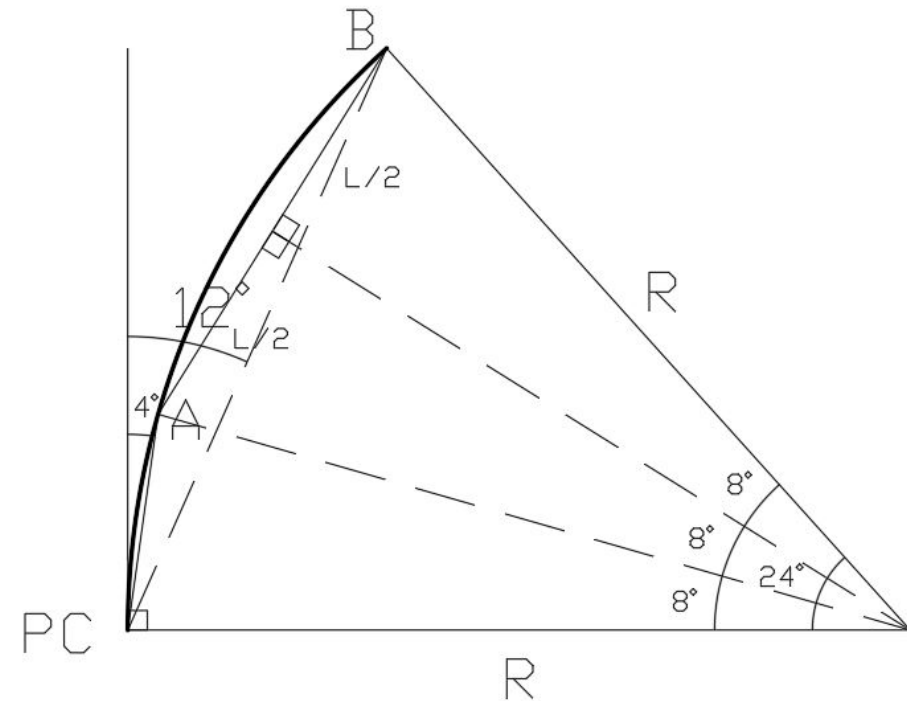
Ans. **260.12m**

$$\begin{aligned} R &= 3600/(\pi \times 4^\circ) \\ R &= 286.48\text{m} \rightarrow \textcircled{A} \\ L/2 &= \textcircled{A} \sin(54^\circ/2) \\ L &= 260.12\text{m} \end{aligned}$$



From the PC, the deflection angles of two intermediate points A and B of a simple curve are 4° and 12° , respectively. Find the chord distance between A and B if the length of the curve from the PC to B is 146.61m.

$$L_c = R \theta (\pi/180^\circ)$$
$$146.61 = R (24^\circ) (\pi/180^\circ)$$
$$R = 350\text{m}$$

$$L/2 = (350) \sin 8^\circ$$
$$L = 97.42\text{m}$$


Problem 19: (5minutes)

CE Board November 2016

Given the following cross-section notes for a road grading work:

-3.2	1.2	1.2	2.8
x_1	0	3.5	x_2

The roadbed is 9m wide and the side slope for cut is 1:1 and for fill is 1.5:1. Determine the area of cut of the section.

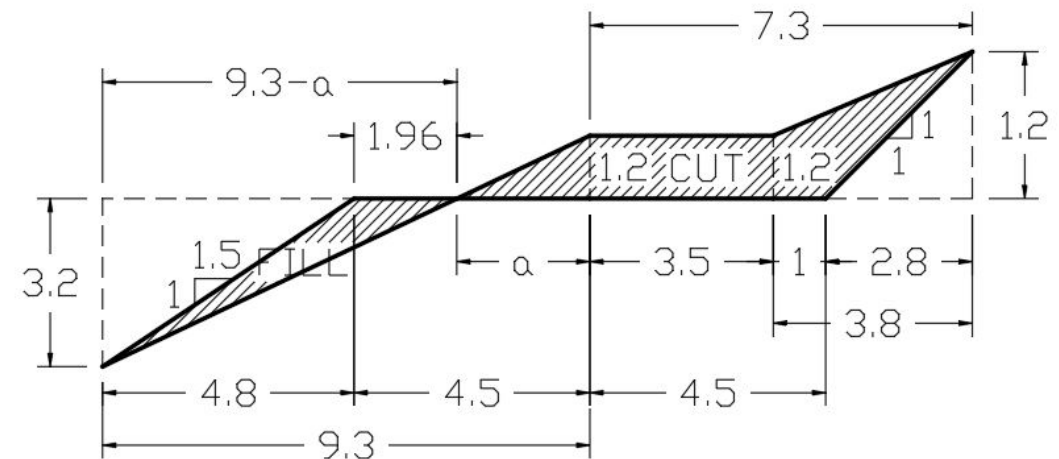
Aps. 9.402m²

$$a/1.2 = 9.3/(1.2+3.2)$$

$$a = 2.536\text{m} \rightarrow \textcircled{A}$$

$$A_{\text{cut}} = 0.5 \textcircled{A} (1.2) + 3.5(1.2) + 0.5(1.2+2.8)(3.8) - 0.5(2.8)(2.8)$$

$$A_{\text{cut}} = 9.402\text{m}^2$$



Problem 20: (5minutes)

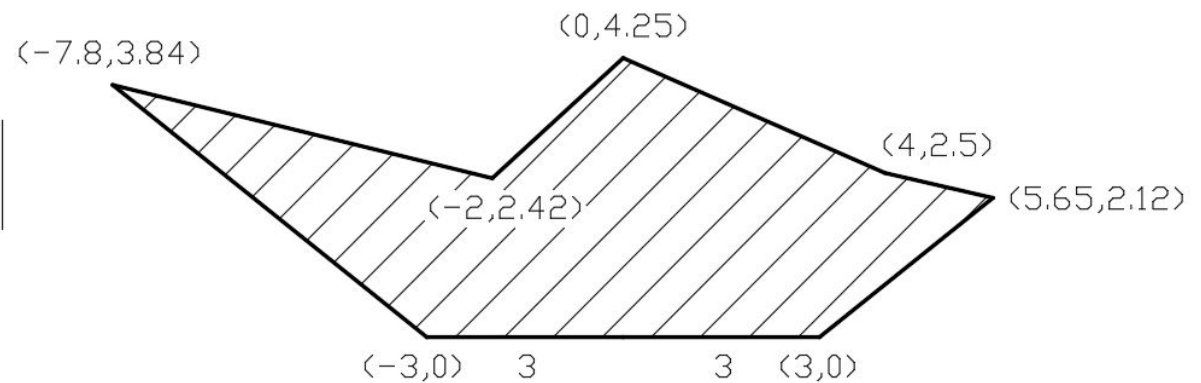
Given the cross-section of a proposed road to be constructed, find the cross-sectional area in sq.m.
The base of road is 6m and the side slopes are 1.25:1.

7.80	2.0	0	4.0	5.65
3.84	2.42	4.25	2.5	2.12

Ans. **30.11m²**

$$A = 1/2 \begin{vmatrix} 3 & 5.65 & 4 & 0 & -2 & -7.8 & -3 & 3 \\ 0 & 2.12 & 2.5 & 4.25 & 2.42 & 3.84 & 0 & 0 \end{vmatrix}$$

$$A = 30.11\text{m}^2$$



Problem 21: (2minutes)

A sample of saturated soil weighs 588N and has a volume of 0.03m^3 . If the voids ratio of the soil is 0.75, determine the specific gravity of the solids.

Ans. **$G = 2.75$**

Problem 22: (3minutes)

The mass of a sample of saturated soil is 520grams. The dry mass, after oven drying is 405grams. Assuming $G = 2.7$, calculate the effective unit weight of the soil mass in kN/m^3 .

Ans. $\gamma_b = 9.44 \text{kN/m}^3$

Problem 23: (3minutes)

CE November 1999

A soil sample was compacted. The result of the standard proctor test shows that at 100% compaction, the soil weighs 131.1pcf with optimum moisture content of 14%. What is the maximum dry unit weight of the soil (at zero air voids) in pcf? $G = 2.67$

Ans. $\gamma_d = 121.28\text{pcf}$

Problem 24: (5minutes)

A 50 cc of moist clay was obtained by pressing a sharpened hollow cylinder into the wall of a test pit. The extruded sample had a initial weight of 85grams. After oven drying, it weighs 60grams. If $G = 2.72$, determine the degree of saturation of the sample.

Ans. **$S = 89.5\%$**

Problem 25: (3minutes)

CE May 2000

A soil sample has a moisture content of 30% and degree of saturation of 45%. The solids have specific gravity of 2.61. Determine the dry unit weight of the soil in kN/m^3 .

Ans. $\gamma_d = 9.34 \text{kN/m}^3$

Thank you