Q no 1

Solution

$R = 300m \quad \Delta = 60°$

(a) Arc.

$s = 30m$

$$R = \frac{s}{D_a} \times \frac{180}{\pi}$$

$$\therefore \quad 300 = \frac{30 \times 180}{D_a \pi} \quad \text{or} \quad D_a = 5.730$$

(b) Chord.

$$R \sin \frac{D_c}{2} = \frac{s}{2}$$

$$300 \sin \frac{D_c}{2} = \frac{30}{2}$$

$$D_c = 5.732$$

Length of the Curve

$$l = R\Delta \frac{\pi}{180} = 300 \times 60 \times \frac{\pi}{180} = 314.16m$$

Tangent length

$$T = R \tan \frac{\Delta}{2} = 300 \tan \frac{60}{2} = 173.21m$$

Length of Long chord

$$L = 2R \sin\frac{\Delta}{2} = 2 \times 300 \times \sin\frac{60}{2} = 300m$$

Mid-ordinate

$$M = R\left(1 - \cos\frac{\Delta}{2}\right) = 300\left(1 - \cos\frac{60}{2}\right) = 40.19m$$

Apex distance

$$E = R\left(\sec\frac{\Delta}{2} - 1\right) = 300\left(\sec\frac{60}{2} - 1\right) = 46.41m$$

Q no 2

$R = 200m \qquad \Delta = 45°$

$\therefore$ length of tangent $= 200 \tan \frac{45°}{2} = 82.84m$

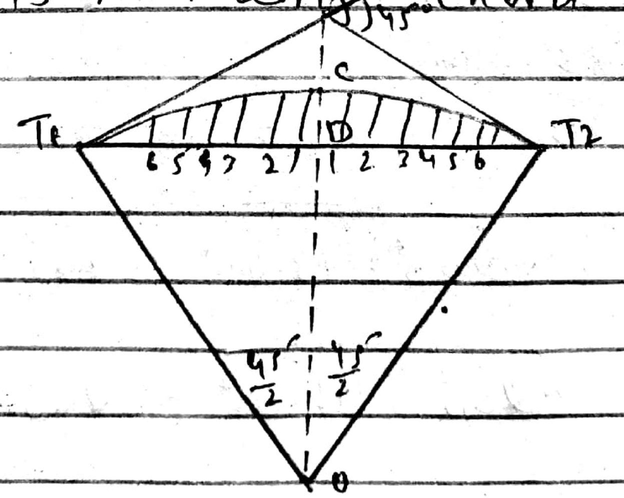
Chainage of $T_1 = 1839.2 - 82.84 = 1756.36m$

length of curve $= R \times 45° \times \frac{\pi}{180} = 157.08m$

Chainage of forward tangent T_2

$= 1756.36 + 157.08 = 1913.44m$

(a) by offsets from long chord



Distance of $DT = L/2 = R \sin \frac{\Delta}{2} = 200 \sin \frac{45}{2}$

$= 76.54$

Measuring 'x' from D

$$y = \sqrt{R^2 - x^2} - \sqrt{R^2 - (L/2)^2}$$

At x_0

$O_0 = 200 - \sqrt{200^2 - 76.54^2} = 200 - 184.78$

$= 15.22m$

$O_1 = \sqrt{200^2 - 10^2} - 184.78 = 14.97m$

$O_3 = \sqrt{200^2 - 30^2} - 184.78 = 12.96m$

$O_4 = \sqrt{200^2 - 40^2} - 184.78 = 11.18m$

$O_5 = \sqrt{200^2 - 50^2} - 184.78 = 8.87m$

$O_6 = \sqrt{200^2 - 60^2} - 184.78 = 6.01m$

$O_7 = \sqrt{200^2 - 70} - 184.28 = 2.57m$

At T_1 $O = 0.60$

(b) Method of bisection

Central ordinate at $D = R\left[1-\cos\frac{\Delta}{2}\right] = 200\left(1-\cos\frac{45}{2}\right)$

$= 15.22$

Ordinate $D_1 = R\left(1-\cos\frac{\Delta}{4}\right) = 200\left(1-\cos\frac{45}{4}\right)$

$= 3.84m$

Ordinate at $D_2 = R\left(1-\cos\frac{\Delta}{8}\right) = 200\left(1-\cos\frac{45}{8}\right)$

$= 0.96m$

(d) offsets from chord produced.

length of first sub-chord $= 13.64m = C_1$

length of normal chord $= 30m = C_2$

Since length of chain is 157.08m $C_3 = C_4 = 30m$

Chainage of forward tangent $= 1913.44m$

$= 63$ chains $+ 23.44m$

length of last chord $= 23.44m = C_n = C_6$

$$O_1 = \frac{C_1^2}{2R} = \frac{13.64^2}{2 \times 200} = 0.47m$$

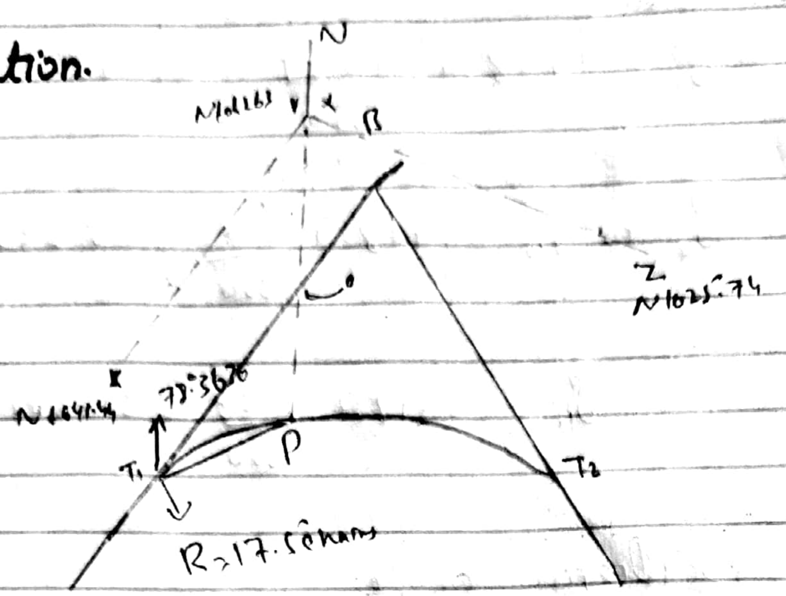
$$O_2 = \frac{C_2(C_1 + C_2)}{2R} = \frac{30(30 + 13.64)}{2 \times 200} = 3.27m$$

$$O_3 = \frac{C_2^2}{R} = \frac{30^2}{2 \times 200} = 4.5m = O_4 = O_5$$

$$O_6 \quad \frac{C_n(C_{n-1} + C_n)}{2R} = \frac{23.44(23.44 + 30)}{2 \times 200} = 3.13m$$

Q no. 3

Solution.



$$R = 17.5 \times 20 = 350 m$$

$$\Delta = 32°40' = 32.667°$$

$$\frac{\Delta}{2} = 16°20'$$

Tangent length $T = R \tan \frac{\Delta}{2}$

$$350 \times \tan 16°20' = 102.57 m$$

length of curve $l = \frac{\pi R \Delta}{180}$

$$= \frac{\pi \times 350 \times 32.667}{180} = 199.57 m$$

Chainage of T_1 = Chainage of P.I $- T$

(2)

$= (51 + 9.35) - 102.57$

$= (51 \times 20 + 9.35) - 102.57$

$= 926.78\,m = 46 + 6.78$

Chainage of T_2 = Chainage of T_1 + l

$926.78 + 199.55 = 1126.33\,m$

$= 56 + 6.33$

length of 1st sub chord $C_1 = (46 + 6.78) = 13.22\,m$

length of last sub chord $C_n = (56 + 6.33 - (56 + 0)) = 6.33\,m$

number of normal chords $N = 56 - 47 = 9$

Total number of chords $n = 9 + 2 = 11$

Co-ord of T_1 and T_2

Bearing of $IT_1 = \alpha = 180° +$ bearing of $T_1 I$

$= 180° + 78°36'30''$

$= 258°36'30''$

Bearing of $IT_2 = \beta =$ Bearing of $IT_1 - \Phi$

Bearing of $IT_1 - (180° - \Delta)$

$= 258°36'30'' - (180° - 32°40')$

$111°16'30''$

Coordinate of T_1

Easting of $T_1 = E_{T_1} =$ Easting of $I + T \sin \alpha$

$= 1058.55 + 102.57 \times \sin 258^\circ 36' 30''$

$= E\ 958.00m$

northing of $T_1 = N_{T_1} =$ northing of $I + T \cos \alpha$

$= 1045.04 + 102.57 \times \cos 258^\circ 36' 30''$

$= N\ 1024.78m$

Coordinate of T_2

Easting of $T_2 = E_{T_2} =$ easting of $I + T \sin \beta$

$1058.55 + 102.57 \times \sin 111^\circ 16' 30''$

$= E\ 1154.13m$

Northing of $T_2 = N_{T_2} =$ Northing of $I + T \sin \beta$

$= 1045.04\ 102.57 \times \sin 111^\circ 16' 30''$

$N\ 1007.812m$

tan central angle

$\delta = 1718.9 \frac{C}{R}$ minutes

$$\delta_1 = 1718.9 \frac{13.22}{350} = 64.925'$$

$$\delta_2 \text{ to } \delta_{10} = 1718.9 \frac{20}{350} = 98.223'$$

$$\delta_{11} = 1718.9 \frac{6.33}{350} = 31.688'$$

Deflection angle

$$\Delta_1 = \delta_1 \quad 64.925' = 1°04'55''$$

$$\Delta_2 = \Delta_1 + \delta_2 = 64.925' + 98.223' = 163.148'$$

$$2°43'09''$$

Curve ranging.

$$\Delta_3 = \Delta_2 + \delta_3 = 163.148' + 98.223' = 261.371 = 4°21'22''$$
$$\Delta_4 = \Delta_3 + \delta_4 = 261.371' + 98.223' = 359.594' = 5°59'36''$$
$$\Delta_5 = \Delta_4 + \delta_5 = 359.594' + 98.223 = 457.817' = 7°37'39''$$
$$\Delta_6 = \Delta_5 + \delta_6 = 457.817 + 98.223 = 556.040' = 9°16'02''$$
$$\Delta_7 = \Delta_6 + \delta_7 = 556.040' + 98.223 = 654.263' = 10°54'16''$$
$$\Delta_8 = \Delta_7 + \delta_8 = 654.263 + 98.223 = 752.486' = 12°32'29''$$
$$\Delta_9 = \Delta_8 + \delta_9 = 752.486' + 98.223 = 850.709 = 14°10'43''$$
$$\Delta_{10} = \Delta_9 + \delta_{10} = 850.709' + 98.223' = 948.932' = 15°48'56''$$
$$\Delta_{11} = \Delta_{10} + \delta_{11} = 948.088' + 31.088' = 980.020 = 16°20'00''$$

$$\text{Check } \Delta_{11} = \frac{\Delta}{2} \quad 16°20' \text{ (okay)}$$