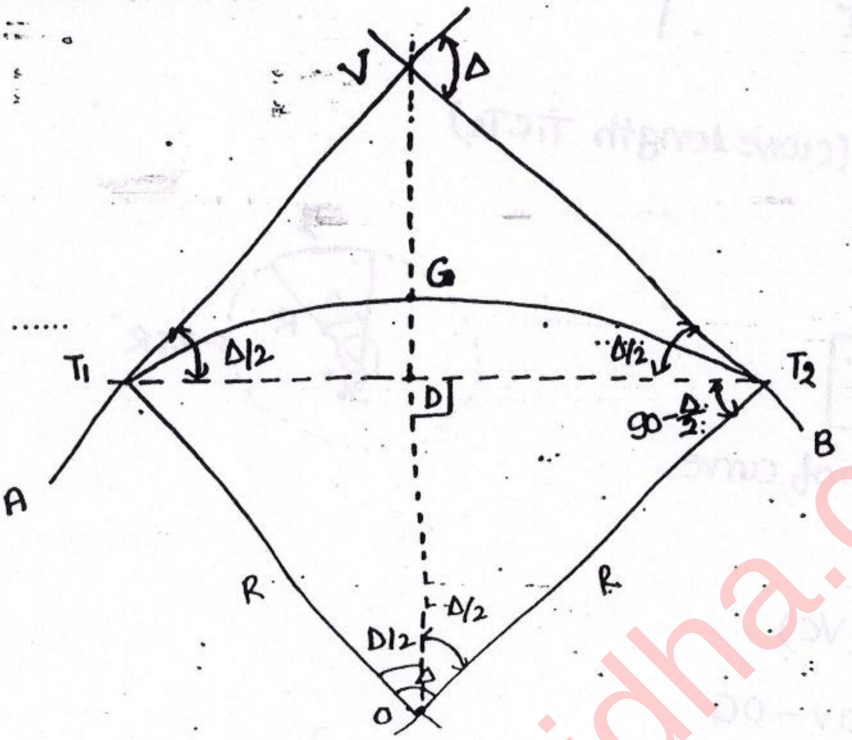
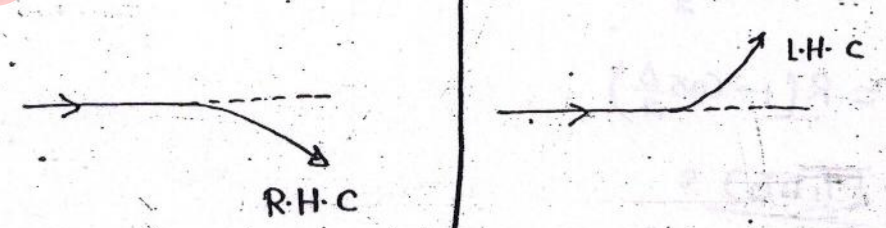
CURVE

(1) Simple curve :-



Important terms :-

1. Point of Intersection (V point)
2. Total deflection Angle (Δ)
3. Point of curve (T_1) P.C
   Point of tangency (T_2). P.T
4. Right hand curve | Left Hand curve



5. Forward tangent (T_2B)
   Backward tangent (T_1A) | for curve from A to B.

(6) Tangent length

$VT_1 = VT_2$

$= R \cdot \tan\frac{\Delta}{2}$

In $\Delta O T_1 V$

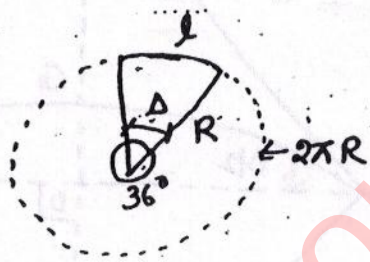
$\tan\frac{\Delta}{2} = \frac{VT_1}{R}$

(7) Length of curve (curve length T_1CT_2)

$\frac{l}{\Delta} = \frac{2\pi R}{360}$

$\boxed{l = \frac{2\pi R}{360} \times \Delta^\circ}$

length of curve.



(8) Apex Distance (VC)

$VC = OV - OC$

$\left[\cos\frac{\Delta}{2} = \frac{R}{OV} \quad || \quad OV = \frac{R}{\cos\Delta/2} = R\cdot\sec\frac{\Delta}{2}\right]$

$VC = \left(R\sec\frac{\Delta}{2} - R\right)$

$= R\left(\sec\frac{\Delta}{2} - 1\right)$

(9) Midordinate (CD)

$CD = OC - OD$

$= R - R\cdot\cos\frac{\Delta}{2}$

$CD = R\left(1 - \cos\frac{\Delta}{2}\right)$

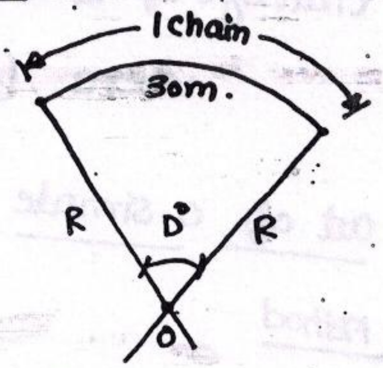
(10) Long chord (T_1DT_2) 8

$= 2T_1D$

$= 2 \cdot R \cdot \sin\frac{\Delta}{2}$

(11) Degree of curve (D°) and Radius of curve (R) :-

Angle made by one chain length of curve at centre is called degree of curve.



(i) For a 30m chain length

$$\frac{30m}{D^\circ} = \frac{2\pi R}{360^\circ}$$

$$D^\circ = \frac{360 \times 30}{2\pi R} = \frac{1718.9}{R}$$

$$\boxed{D^\circ \approx \frac{1720}{R}}$$

Radius of curve

$$\boxed{R = \frac{1720}{D^\circ}}$$

(ii) For a 20m chain

$$\frac{20m}{D^\circ} = \frac{2\pi R}{360}$$

$$R = \frac{360 \times 20}{2\pi D^\circ} \doteq \frac{1146}{D^\circ}$$

$$\boxed{D^\circ = \frac{1146}{R}} \quad \text{or} \quad \boxed{\frac{1146}{D^\circ} = R}$$

Radius of curve :-

D°	1°.	2°	3°	4°	5°
30m	1720m	860 m	573m	430 m	344 m
20m	1146m	573m	382m	287 m	230 m.

(12) chainage of different Points :-

If chainage of P V = given

(i) chainage of T_1 = chainage of V − VT_1

where ($VT_1 = R\tan\frac{\Delta}{2}$)

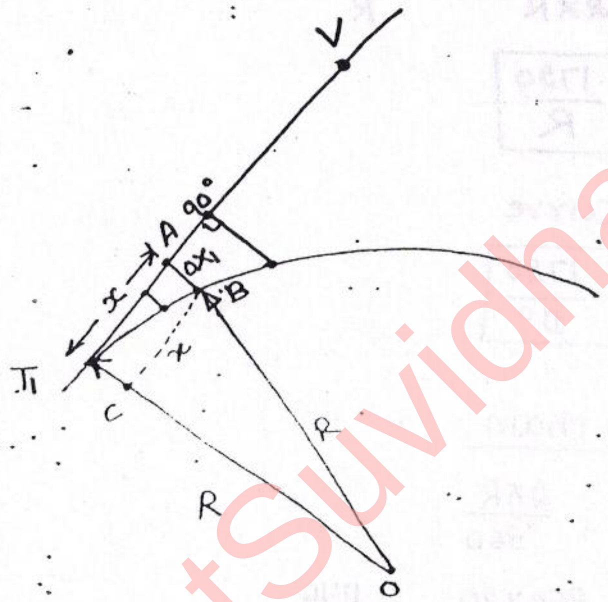
(iii) chainage of T_2 = chainage of $T_1 + l$

where , $\left(l = \frac{2\pi R}{360^\circ} \times \Delta^\circ\right)$

(iii) Setting out of a simple curve :-

(A) offset Method

(1) Perpendicular offset from the tangent :-



$Ox_1 = AB = T_1C$

$= OT_1 - OC$

$\boxed{Ox_1 = R - \sqrt{R^2 - x^2}}$ → exact formula

$\boxed{Ox_1 = \frac{x^2}{2R}}$ Approximate formula

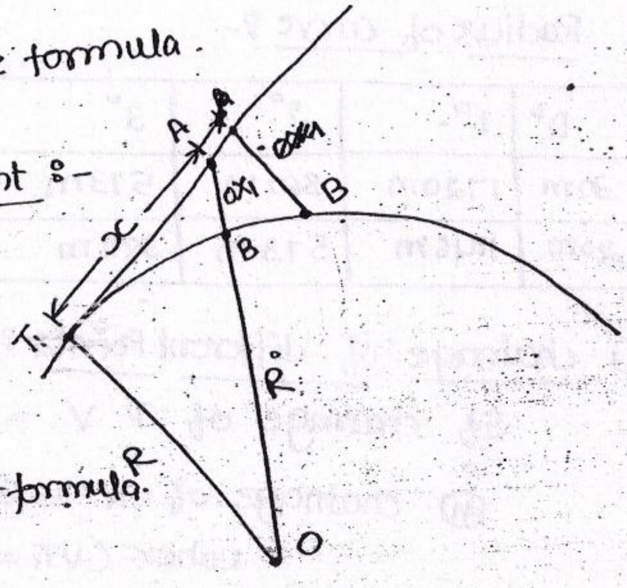
(2) Radial offset from the tangent :-

Radial at x distance from T_1

$Ox_1 = AB$

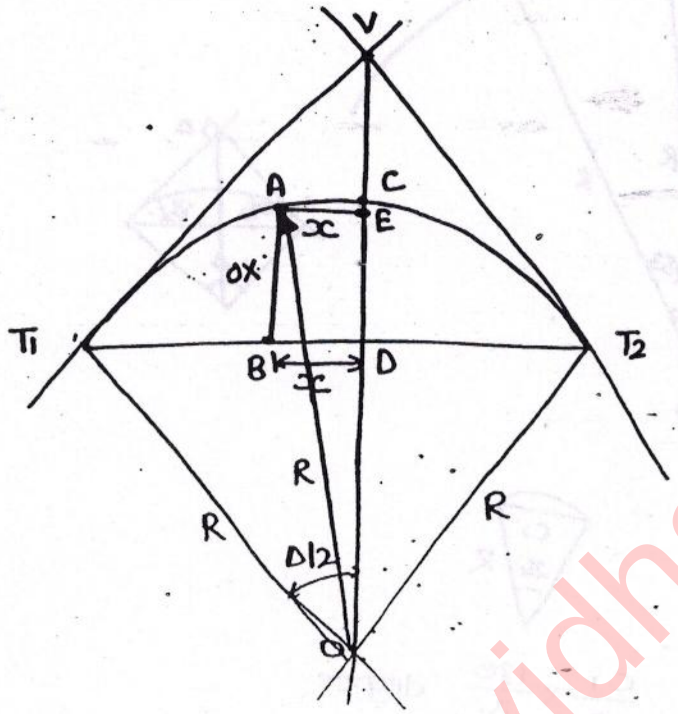
$= OA - OB$

$\boxed{Ox_1 = \sqrt{R^2 + x^2} - R}$ ← exact formula



$$\boxed{OX_1 = \frac{x^2}{2R}}$$ — approximate formula.

(3) offset from long chord :-



At distance x from D point

$OX = AB$

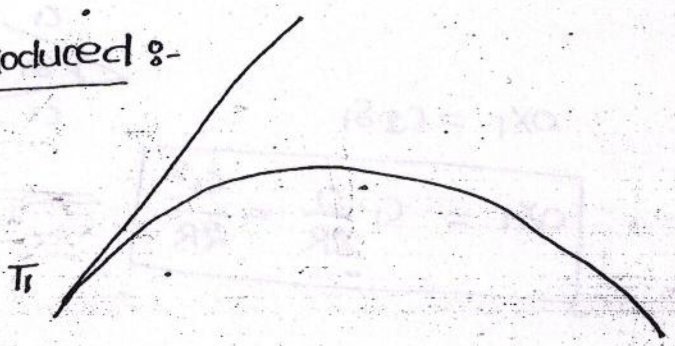
$= ED$

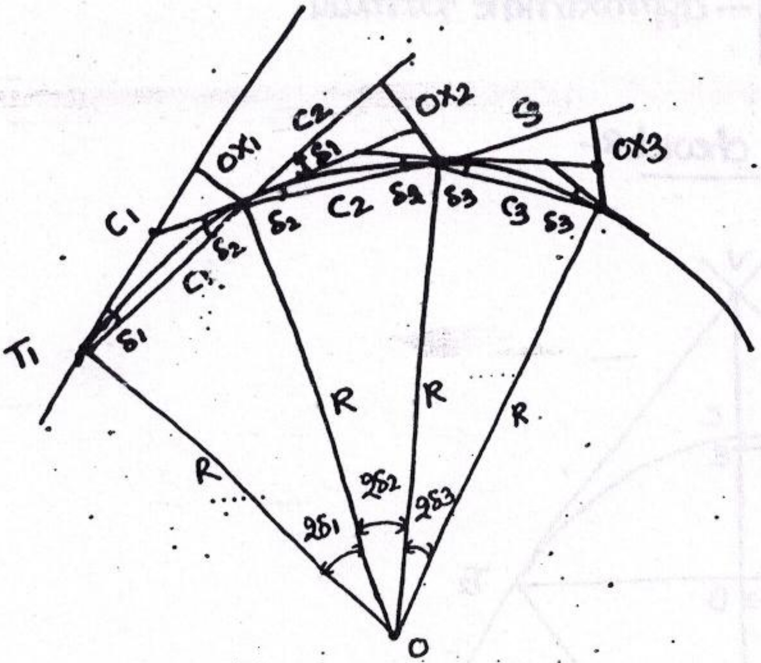
$= OE - OD$

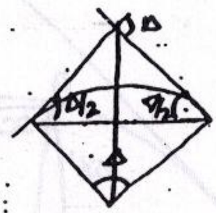
$= \sqrt{R^2 - x^2} - R\cos\frac{\Delta}{2}$

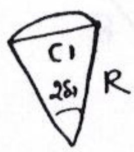
$$\boxed{OX = \sqrt{R^2 - x^2} - R\cos\frac{\Delta}{2}}$$ — (A)

(B) offset from chord produced :-









$$\frac{C_1}{2\pi R} = \frac{2\delta_1}{360^\circ}$$

$$2\delta_1 = \frac{C_1 \times 360^\circ}{2\pi R} = \frac{C_1}{R} \times \frac{180}{\pi} \text{ degree}$$

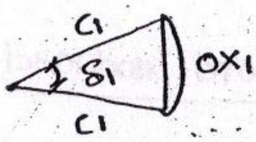
$$\boxed{2\delta_1 = \frac{C_1}{R}} \text{ Rad}$$

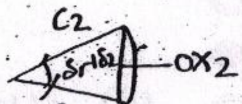
$$\delta_1 = \frac{C_1}{2R}$$

$$\delta_2 = \frac{C_2}{2R}$$

$$- \; - \; -$$

$$\delta_n = \frac{C_n}{2R}$$





$$OX_1 = C_1 \cdot \delta_1$$

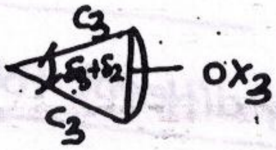
$$\boxed{OX_1 = C_1 \cdot \frac{C_1}{2R} = \frac{C_1^2}{2R}}$$

$$OX_2 = C_2 \times (\delta_1 + \delta_2)$$

$$= C_2\left(\frac{C_1}{2R} + \frac{C_2}{2R}\right)$$

$$\boxed{OX_2 = \frac{C_2(C_1 + C_2)}{2R}}$$

$$OX_3 = C_3(\delta_2+\delta_3)$$



$$\boxed{OX_3 = \frac{C_3(C_2+C_3)}{2R}}$$

$$\therefore \quad \boxed{OX_n = \frac{C_n(C_{n-1}+C_n)}{2R}}$$

$\Rightarrow$ Generally, Ist and last chord will be of different length

C_1 & C_n : are different

$\Rightarrow$ All other chord are of same length = 1 chain

$$\boxed{C_2 = C_3 = C_4 \text{ ---- } C_{n-1} = C = 1 \text{ chain}}$$

Final offset :

$$OX_1 = \frac{C_1^2}{2R}$$

$$OX_2 = \frac{C_2(C_2+C_1)}{2R} = \frac{C(C+C_1)}{2R}$$

$$OX_3 = OX_4 \text{ ------ } OX_{n-1}$$

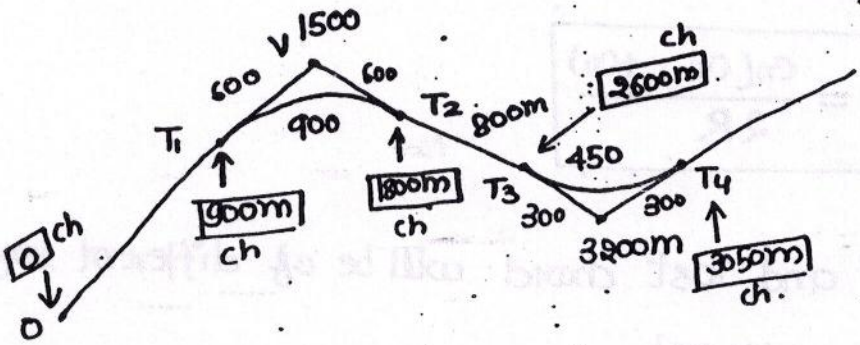
$$= \frac{C_r(C_{r-1}+C_r)}{2R} = \frac{(C+C)C}{2R}$$

$$= \frac{2C^2}{2R} = \frac{C^2}{R}$$

$$OX_n = \frac{C_n(C_{n-1}+C_n)}{R}$$

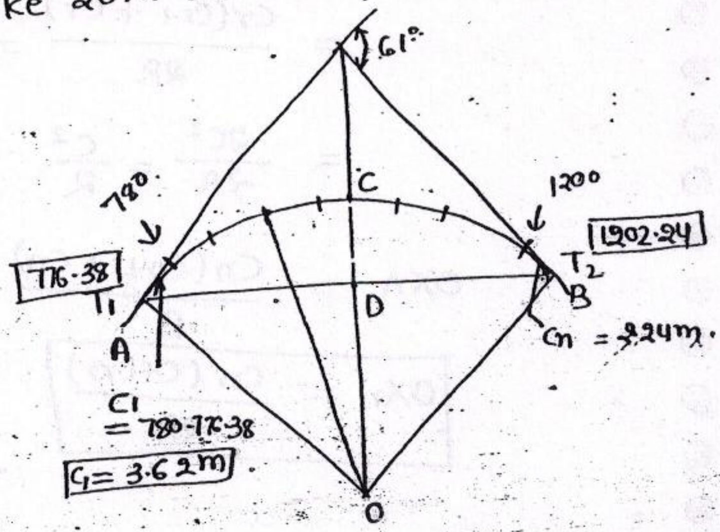
$$\boxed{OX_n = \frac{C_n(C+C_n)}{2R}}$$

(4) **chainage of different Points :-**



⇒ chainage is the distance measured along the route followed.

Ques:(1) Two tangents intersect at a chainage 50.60 (50 chains + 60 links). the deflection angle being 61°. Calculate the necessary data to set out a circular highway curve of 20 chain radius to connect the two tangent by the method of offset from chords. Take 20m chain length (100 links)



Radius of curve = 20 chain
= 20×20
= 400m.

chainage of V

= 50.60 chain
= 50 chains + 60 link
$= 50 \times 20 + 60 \times \frac{20}{100}$
= 1012m.

tangent lengths

$$VT_1 = VT_2 = R \cdot \tan\frac{\Delta}{2}$$

$$= 400 \times \tan\frac{61}{2}$$

$$= 235.62m.$$

Length of curve :

$$l = \frac{2\pi R}{360^\circ} \times \Delta^\circ$$

$$= \frac{2 \times \pi \times 400}{360} \times 61^\circ$$

$$\boxed{l = 425.80m}$$

chainage of T_1 :-

$= ch. V - VT_1$

$= 1012 - 235.62$

$= 776.38 m.$

chainage of T_2 :-

$= \text{chainage of } T_1 + l$

$= 776.38 + 425.80$

$= 1202.24m$

(#) Exact Multiple of 20m Just after $T_1 = 780m$

1^{st} chord $= C_1 = 780 - ch. \text{ of } T_1$

$= 780 - 776.38$

$= 3.62m.$

(#) Exact Multiple of 20m Just before $T_2 = 1200m.$

last chord $C_n = ch. T_2 - 1200$

$= 2.24m.$

All other chords

$c_3 = c_3 = \text{-------} c_{n-1} = c = 20m$
$= 1 \text{ chain}$

offsets :-

$$OX_1 = \frac{c_1^2}{2R} = \frac{3.62^2}{2\times 400} = 0.016m$$

$$OX_2 = \frac{c(c_1+c)}{2R} = \frac{20(3.62+20)}{2\times 400} = 0.59\ m$$

OX_3 ———— OX_{n-1}

$$= \frac{c^2}{R} = \frac{20^2}{400} = 1m$$

$$OX_n = \frac{c_n(c_n+c)}{2R}$$

$$= \frac{2.24\times(20+2.24)}{800}$$

$$= 0.06m$$

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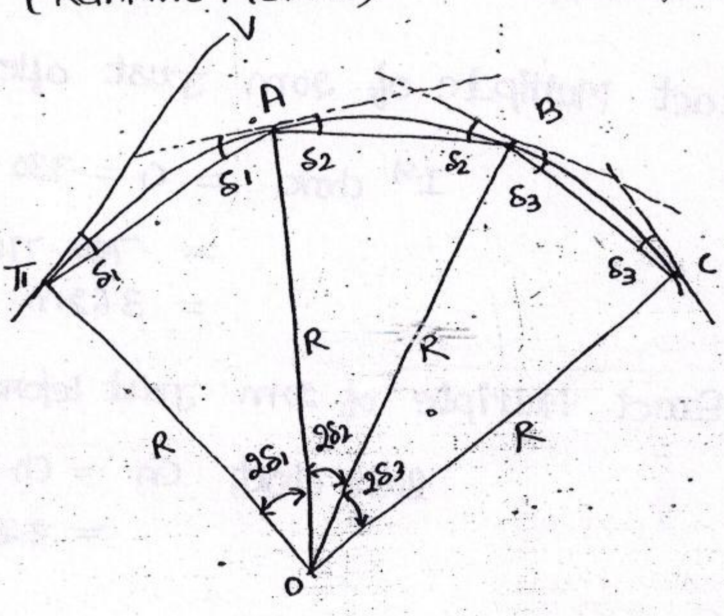
(ii) Setting out of ~~Single~~ Simple Curve :-

(C) Deflection Method (Rankine Method)



$$\frac{C_1}{2\pi R} = \frac{2\delta_1}{360^\circ}$$

$$\delta_1 = \frac{360\, C_1}{4\pi R} = \frac{90 C_1}{\pi R} \quad \text{—①}$$

Similary,

$$\delta_2 = \frac{90 C_2}{\pi R}$$

$$\delta_3 = \frac{90 C_3}{\pi R}$$

- - - - - - - -
- - - - - - - -

$$\delta_n = \frac{90 C_n}{\pi R}$$

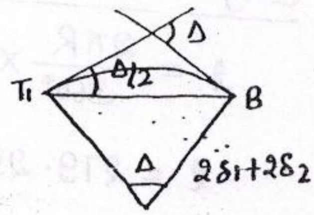
Total deflection angle for different point.

Total deflection angle is the angle b/w I^{st} tangent and the line joining T_1 point to the point.

for A $\Rightarrow$ $\Delta_1 = \delta_1$

for B $\Rightarrow$ $\Delta_2 = \delta_1 + \delta_2 = \Delta_1 + \delta_2$

for C $\Rightarrow$ $\Delta_3 = \delta_1 + \delta_2 + \delta_3 = \Delta_2 + \delta_3$



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for any point $\Delta = \Delta_{n-1} + \delta_n$

There are two methods:-

(1) One theodalite Method.

(2) Two theodalite Method.

Ques: 6(b) Two tangent intersect at chainage 1200m, the deflection angle being 40°. Compute the data to set
ES-1990
out a simple curve of radius 400m by defl^n angle & offsets. take 30m chord length in the general bridge.
(one theodolite).

Solution : $R = 400m$.
$\Delta = 40°$
chainage $= 1200m = V$

tangent length –

$$VT_1 = VT_2 = R\tan\frac{\Delta}{2}$$
$$= 400 \times \tan\frac{40}{2}$$
$$= 145.58m$$

Length of curve –

$$l = \frac{2\pi R}{360°} \times \Delta$$
$$l = 279.25m$$

chainage of T_1 :

ch. of $V - VT_1$
$= 1200 - 145.59$
$= 1054.41$ m

chainage of T_2

ch. of $T_1 + l$
$= 1054.41 + 279.25$
$= 1333.66$ m.

C_1 chainage $T_1 = 1054.41m$

Just after T_1 exact multiple of 30 = 1080 m

$$C_1 = 1080 - 1054.41$$

$$\boxed{C_1 = 25.59\,m}$$

C_n chainage $T_2 = 1333.66\ m$

Just before T_2 exact multiple of 30m = 1320m.

$$C_n = 1333.66 - 1320$$
$$= 13.66\,m.$$

deflection angle →

$$\delta_1 = \frac{90C_1}{\pi R} = \frac{90 \times 25.59}{\pi \times 400}$$

$$= 1^\circ 49' 58''$$

$$\delta_2 = \delta_3 = \delta_4 \text{ ------- } \delta_{n-1}$$

$$= \frac{90 \times C}{\pi R} = \frac{90 \times 30}{\pi \times 400}$$

$$= 2^\circ 8' 55''$$

$$\delta_n = \frac{90 \times C_n}{\pi \times R} = \frac{90 \times 13.66}{\pi \times 400} = 0^\circ 58' 42''$$

Points	δ	Δ	
1	1°49'58'	1° 49' 58"	
2	2°8'55'	3° 58' 53"	
3	2°8'55'	6° 7' 48"	
4	---	8° 16' 43"	
5	---	10° 25' 38"	
6	---	12° 34' 33"	
7	---	14° 43' 28"	
8	---	16° 52' 23"	20°0'0"
9	---	19° 1' 18"	
10	---		
11	0°58'42"		