Engineering Surveying
3^{rd} Stage

Methods of setting out a simple circular curve

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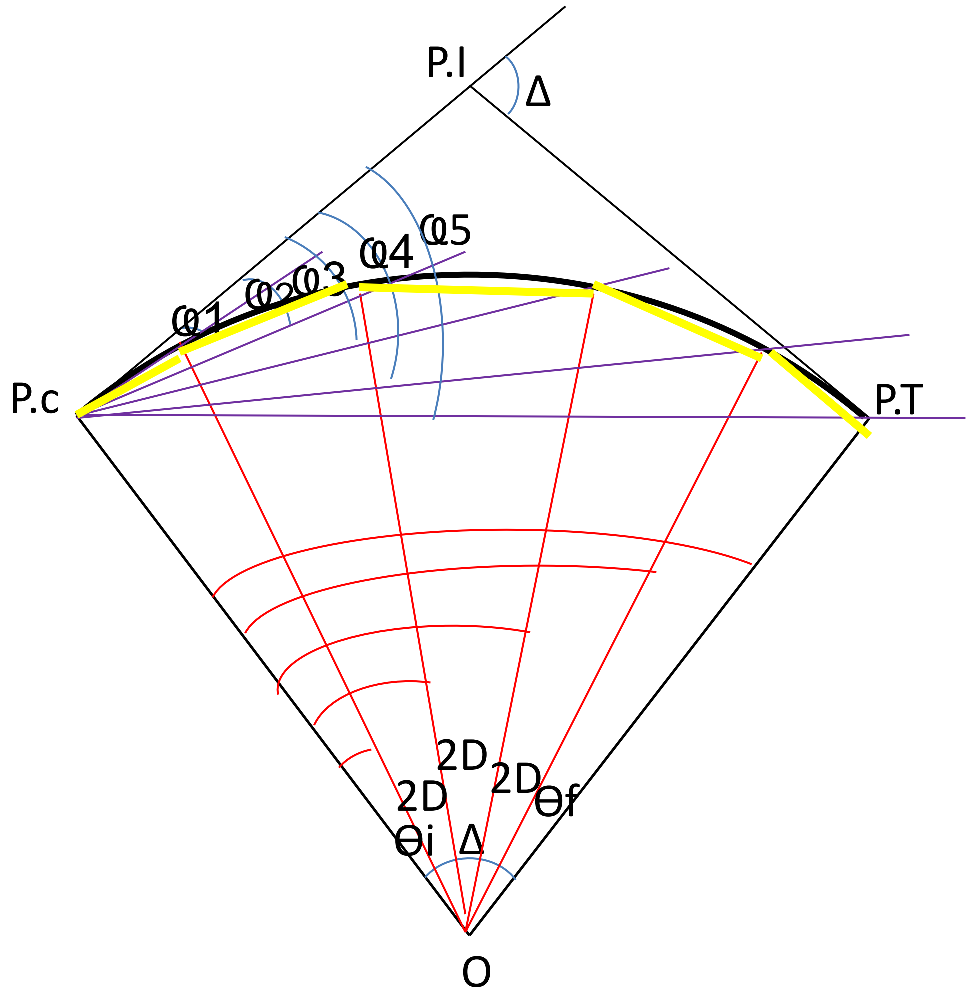
Methods of setting out a simple circular curve

- Tangential angles method (or Deflection angles method)
- Tangent offsets method
- Chord offsets method
- Location from P.I

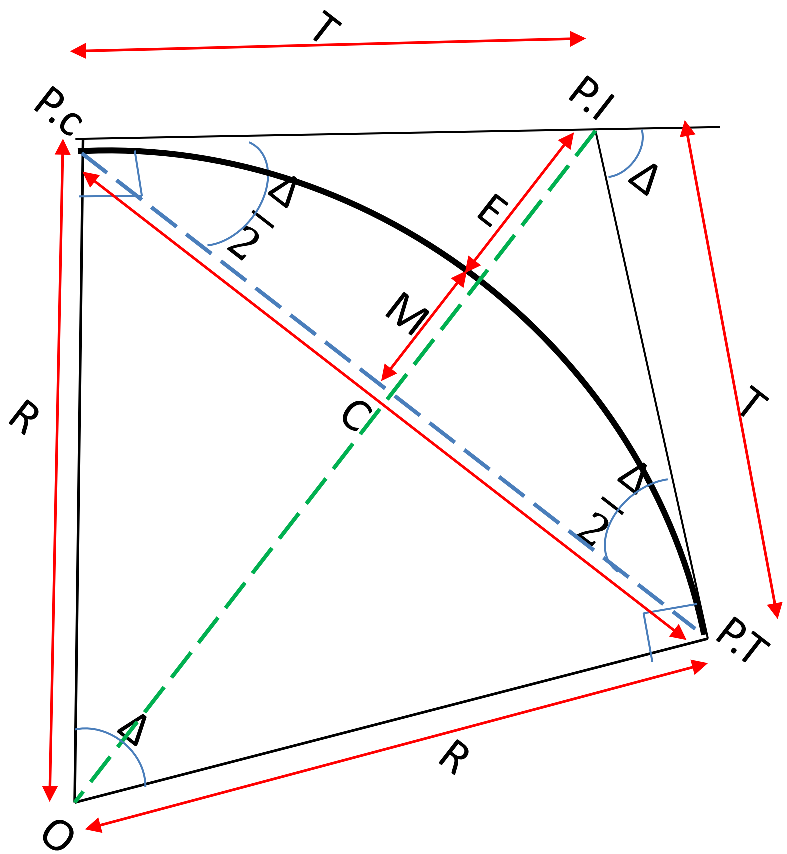
Tangential angles method (or Deflection angles method)

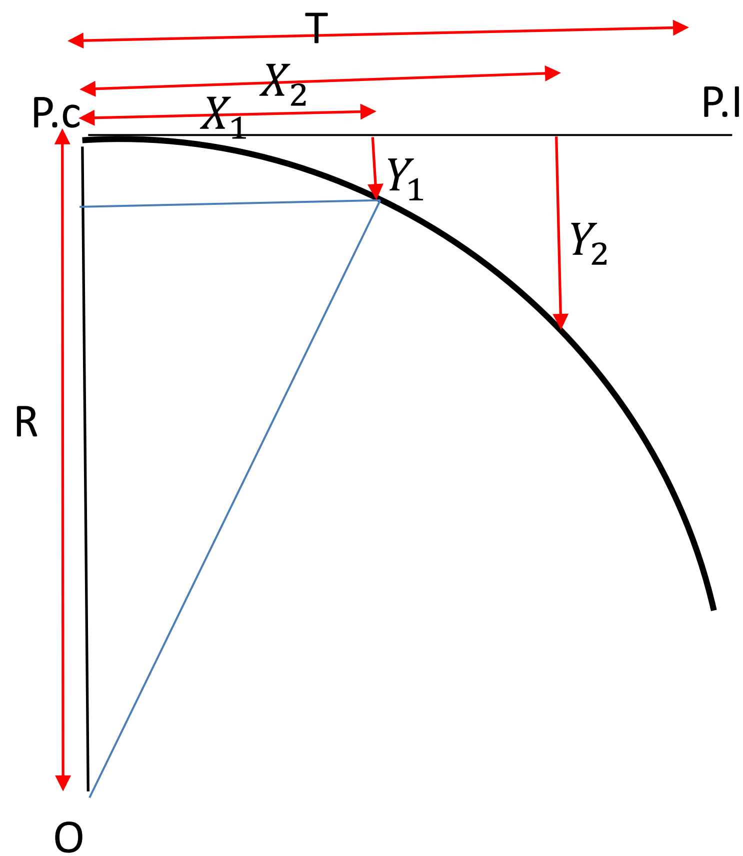


Tangential angles method (or Deflection angles method)

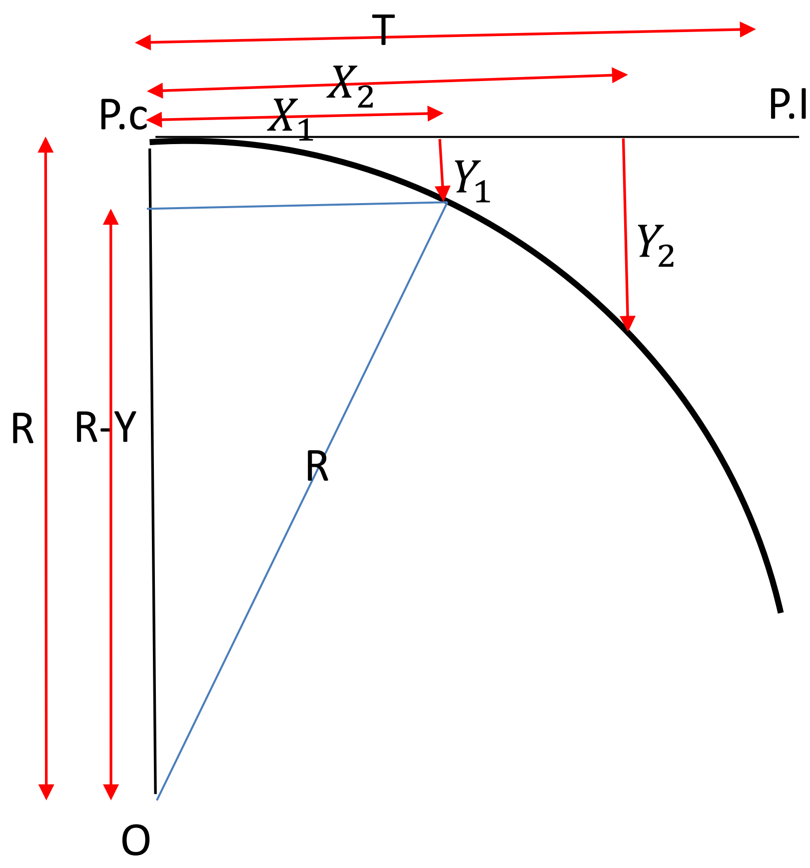
Station	ω	Total Chord Length	Single Chord Length
Stat. P.C	$0^o00'$	**0.00**	**0.00**
Stat. (1)	$\omega_1 = \frac{\theta i}{2} = \frac{\ell_i}{20} * D$	$C_1 = 2*R* \sin \omega 1$	$C_i = 2*R* \sin \frac{\theta i}{2}$
Stat. (2)	$\omega_2 = \frac{\theta i}{2} + D$	$C_2 = 2*R* \sin \omega 2$	$C_2 = 2*R* \sin D$
Stat. (3)	$\omega_3 = \frac{\theta i}{2} + 2D$	$C_3 = 2*R* \sin \omega 3$	$C_3 = 2*R* \sin D$
Stat. (4)	$\omega_4 = \frac{\theta i}{2} + 3D$	$C_4 = 2*R* \sin \omega 4$	$C_4 = 2*R* \sin D$
Stat. P.T	$\omega_4 = \frac{\theta i}{2} + 3D + \frac{\theta f}{2} = \frac{\Delta}{2}$	$C_5 = 2*R* \sin \omega i = 2*R* \sin \frac{\Delta}{2}$	$C_f = 2*R* \sin \frac{\theta f}{2}$

Tangent offsets method





Tangent offsets method



$$R^2 = (R-Y)^2 + X^2$$

$$(R-Y)^2 = R^2 - X^2$$

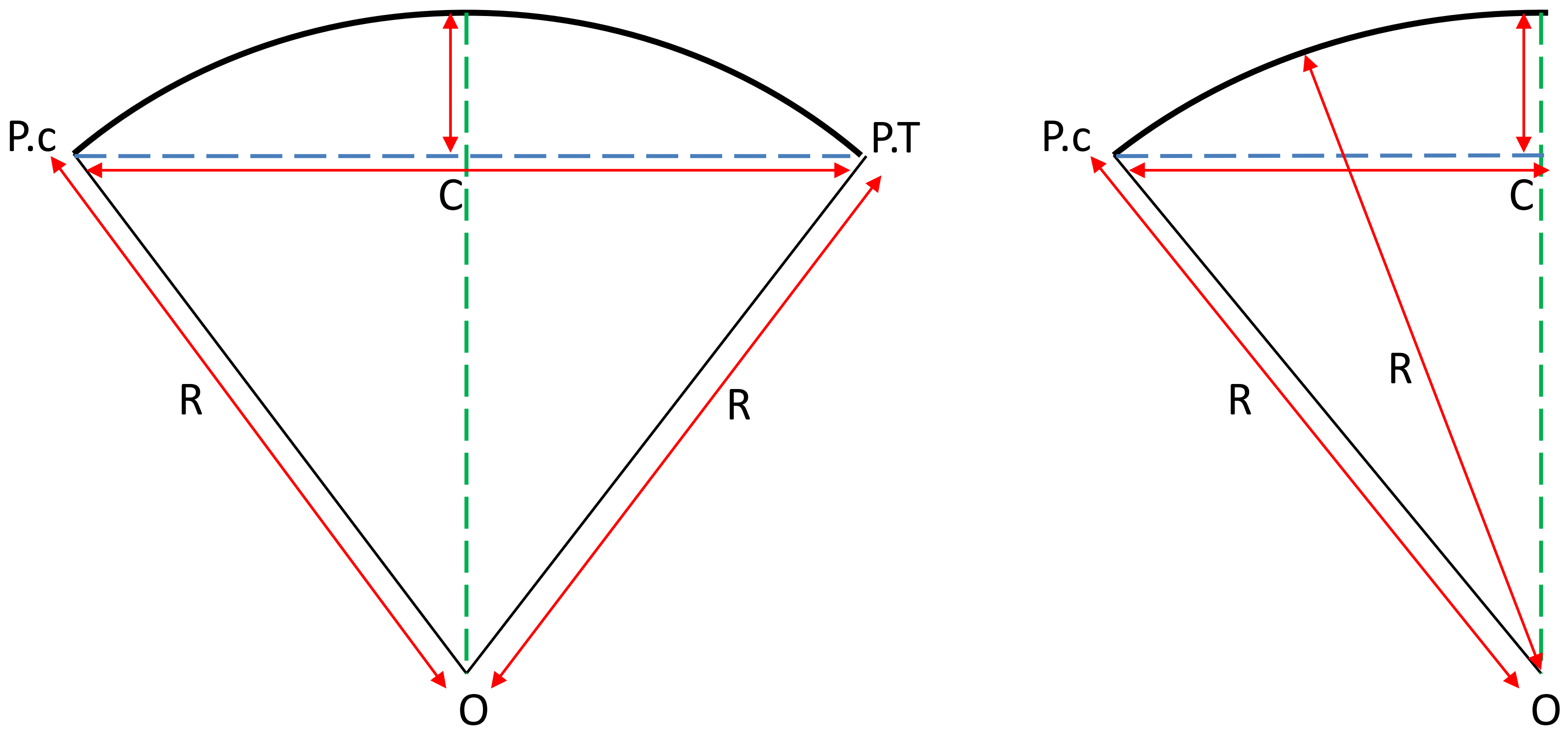
$$(R-Y) = \sqrt{R^2 - X^2}$$

$$\boxed{Y = R - \sqrt{R^2 - X^2}}$$

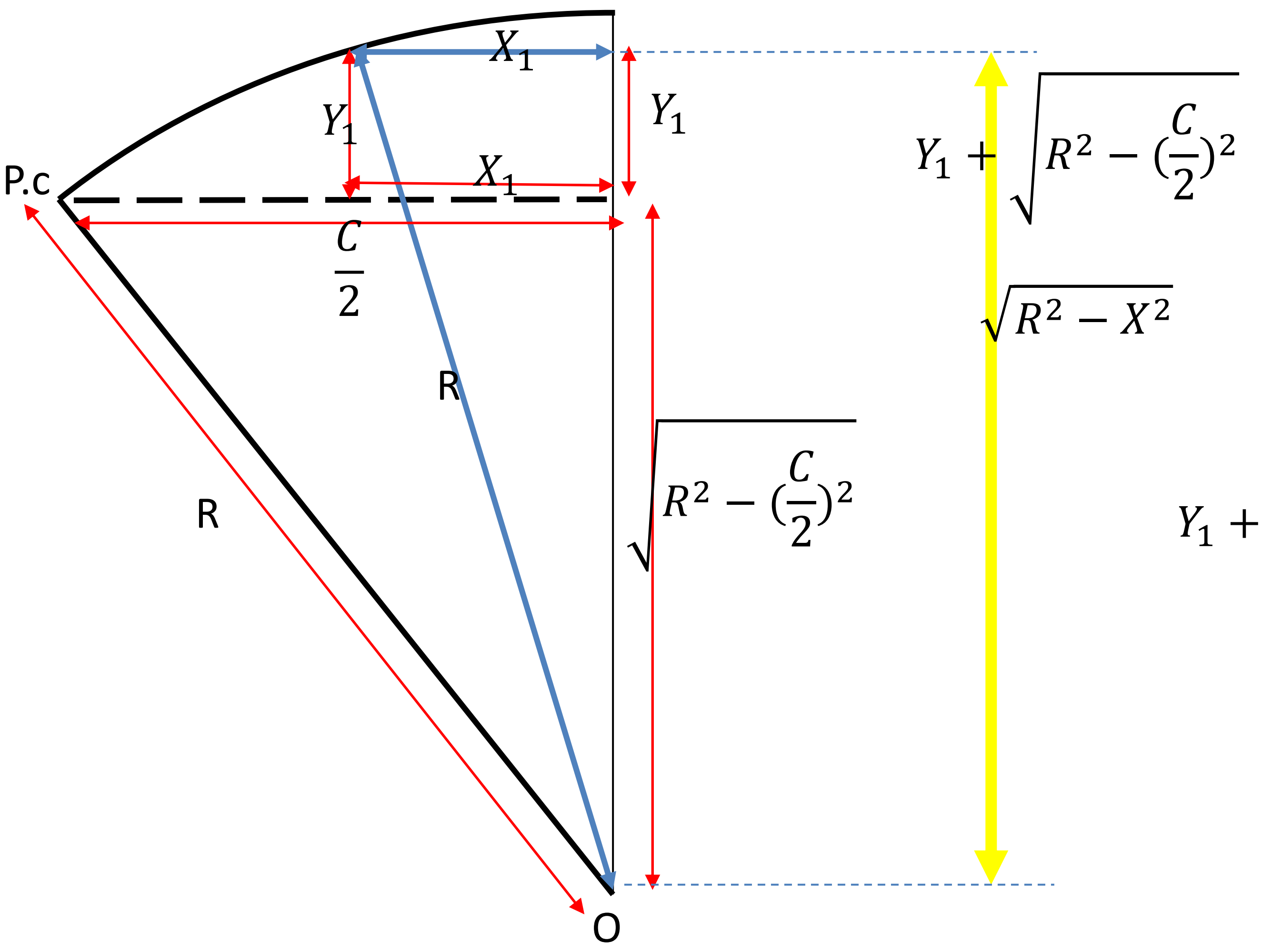
Tangent offsets method

X	Y
0	0
X_1	$R - \sqrt{R^2 - {X_1}^2}$
X_2	$R - \sqrt{R^2 - {X_2}^2}$
X_3	$R - \sqrt{R^2 - {X_3}^2}$

Chord offsets method



Chord offsets method



$$Y_1 + \sqrt{R^2 - (\frac{C}{2})^2} = \sqrt{R^2 - X^2}$$

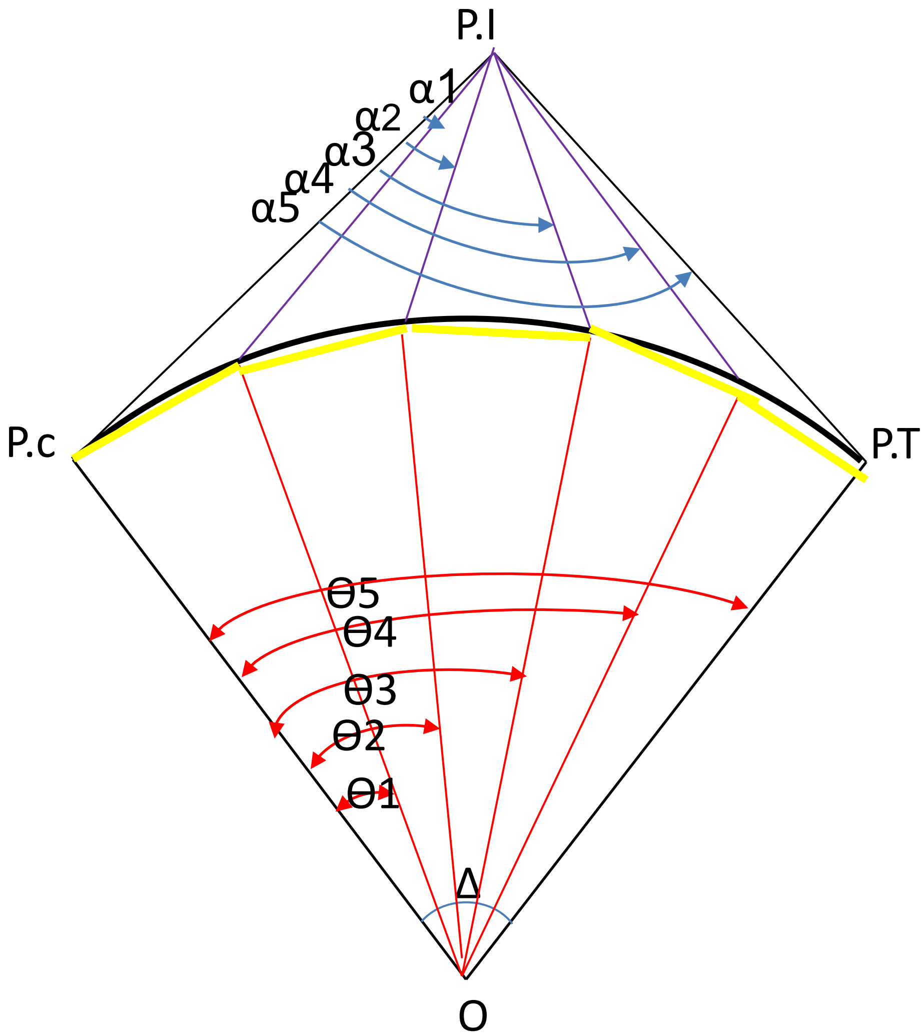
Chord offsets method

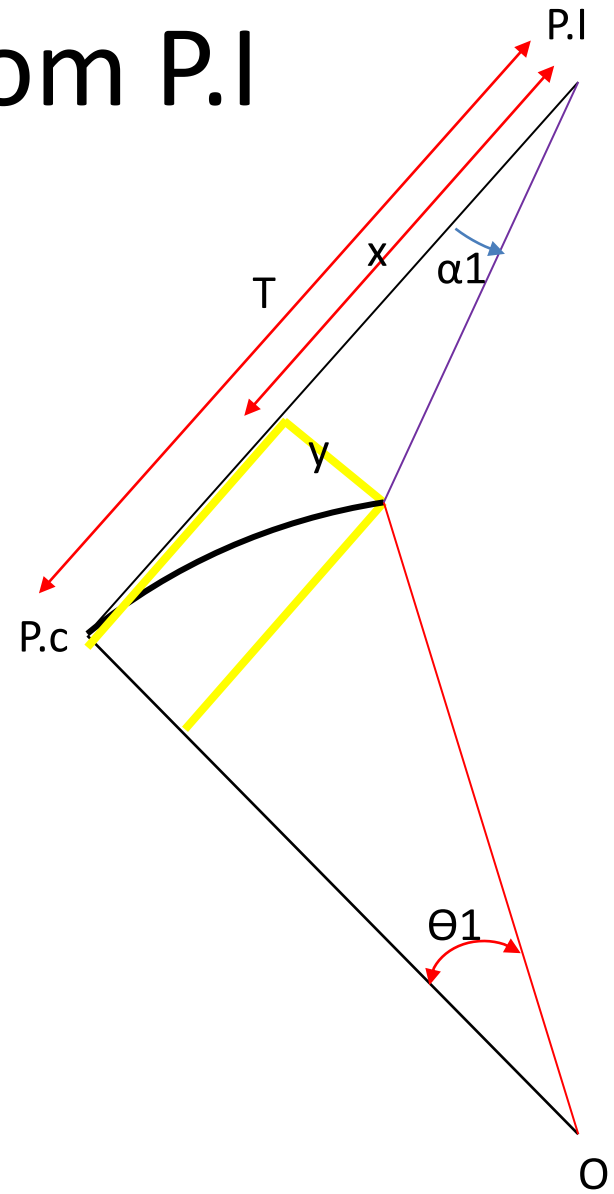
- $Y_1 + \sqrt{R^2 - (\frac{C}{2})^2} = \sqrt{R^2 - X^2}$
- $Y_1 = \sqrt{R^2 - X^2} - \sqrt{R^2 - (\frac{C}{2})^2}$

$$\boxed{Y = \sqrt{R^2 - X^2} - \sqrt{R^2 - (\frac{C}{2})^2}}$$

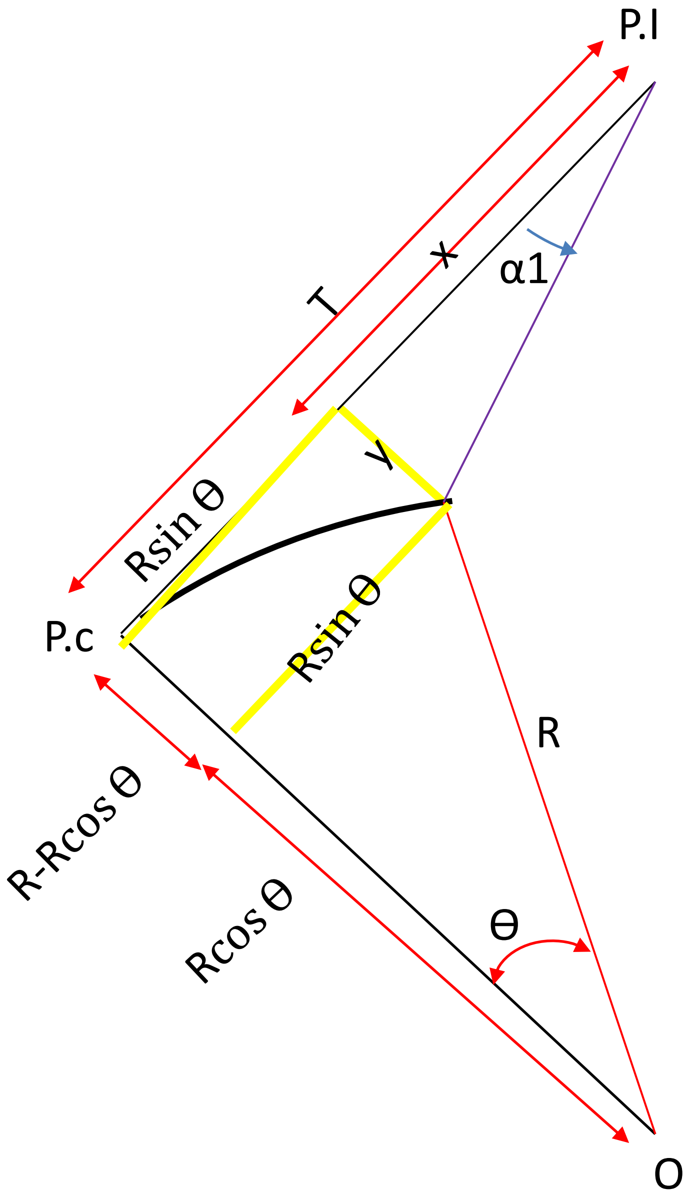
X	Y
0.00	M
X_1	$\sqrt{R^2 - {X_1}^2} - \sqrt{R^2 - (\frac{C}{2})^2}$
X_2	$\sqrt{R^2 - {X_2}^2} - \sqrt{R^2 - (\frac{C}{2})^2}$

Location from P.I





Location from P.I



$$\tan\alpha = \frac{y}{x} = \frac{R - R\cos\theta}{T - R\sin\theta}$$

$$\alpha = \tan^{-1}\frac{R - R\cos\theta}{R\tan\frac{\Delta}{2} - R\sin\theta}$$

$$\boxed{\alpha = \tan^{-1}\frac{1 - \cos\theta}{\tan\frac{\Delta}{2} - \sin\theta}}$$

Location from P.I

Point	Ө	α	Single Arch Length	Single Chord Length
1	$\frac{\Delta}{n}$	$\alpha_1 = \tan^{-1}\frac{1-\cos\theta}{\tan\frac{\Delta}{2} - \sin\theta 1}$	$\frac{L}{n}$	$\mathbf{2R}\ \boldsymbol{sin}\frac{\Delta}{\mathbf{2}\boldsymbol{n}}$
2	$\frac{2\Delta}{n}$	$\alpha_2 = \tan^{-1}\frac{1-\cos\theta}{\tan\frac{\Delta}{2} - \sin\theta 2}$	$\frac{L}{n}$	$\mathbf{2R}\ \boldsymbol{sin}\frac{\Delta}{\mathbf{2}\boldsymbol{n}}$
3	$\frac{3\Delta}{n}$	$\alpha_3 = \tan^{-1}\frac{1-\cos\theta}{\tan\frac{\Delta}{2} - \sin\theta 3}$	$\frac{L}{n}$	$\mathbf{2R}\ \boldsymbol{sin}\frac{\Delta}{\mathbf{2}\boldsymbol{n}}$
4	$\frac{4\Delta}{n}$	$\alpha_4 = \tan^{-1}\frac{1-\cos\theta}{\tan\frac{\Delta}{2} - \sin\theta 4}$	$\frac{L}{n}$	$\mathbf{2R}\ \boldsymbol{sin}\frac{\Delta}{\mathbf{2}\boldsymbol{n}}$
5	$\frac{n\Delta}{n} = \Delta$	$\alpha_5 = \tan^{-1}\frac{1-\cos\theta}{\tan\frac{\Delta}{2} - \sin\Delta}$ = 180º- Δ	$\frac{L}{n}$	$\mathbf{2R}\ \boldsymbol{sin}\frac{\Delta}{\mathbf{2}\boldsymbol{n}}$

Example

- Setting out a horizontal circular curve by all methods if you know :
- $\Delta=43^o24'$, $D= 4^o30'$ and Stat. P.I=38+20
- Deflection angles method for 20 m
- Tangent offsets method for 10 m
- Chord offsets method for 10 m
- Location from P.I divided Δ over 5

Elements of a Simple Circular curve

- R = $\frac{573}{D} = 127.33\ m$
- T = 50.67 m
- L = 96.45 m
- C = 94.16 m
- E = 9.71 m
- M = 9.02 m
- Stat. P.C = stat.P.I – T =
- 38 + 20 – 00 + 50.67 = 37 + 69.33
- Stat. P.T = stat P.C + L =
- 37 + 69.33 + 00 + 96.45 = 38 +65.78

Setting out a horizontal circular curve by Deflection angles method)

- $\theta_i = \frac{\ell_i}{R} * \frac{180^0}{\pi}$
- $\ell_i = (37+80)-(37+69.33)$
- $\ell_i = 10.67$ m
- $\theta_i = \frac{10.67}{127.33} * \frac{180^0}{\pi}$
- $\theta_i = 4^o48'$
- $\theta_f = \frac{\ell_f}{R} * \frac{180^0}{\pi}$
- $\ell_f = (38+65.78)-(38+60)$
- $\ell_f = 5.78$ m
- $\theta_f = \frac{5.78}{127.33} * \frac{180^0}{\pi}$
- $\theta_f = 2^0 36'$

Setting out a horizontal circular curve by Deflection angles method)

Station	Central angle	Deflection angle(ω)	Total Chord	Single Chord
Stat. P.C 37 + 69.33	00 00	00 00 00	0.00	0.00
37 + 80	$\theta_i = 4^o48'$	$2^o24'$	10.66	10.66
38 + 00	$\theta_i + 2D = 13^o48'$	$6^o54'$	30.59	19.98
38 + 20	$\theta_i + 4D = 22^o48'$	$11^o24'$	50.34	19.98
38 + 40	$\theta_i + 6D = 31^o48'$	$15^o54'$	69.77	19.98
38 + 60	$\theta_i + 8D = 40^o48'$	$20^o24'$	88.77	19.98
Stat. P.T 38 + 65.78	$\theta_i + 8D + \theta_f = \Delta = = 43^o24'$	$21^o42'$	94.16=C	5.78

Setting out a horizontal circular curve by Tangent offsets method

X	Y = R - $\sqrt{R^2 - X^2}$
0	0
10	0.39
20	1.58
30	3.58
40	6.45
50	10.23

Setting out a horizontal circular curve by Chord offsets method

X	$Y = \sqrt{R^2 - X^2} - \sqrt{R^2 - (\frac{C}{2})^2}$
0	9.02
10	8.63
20	7.44
30	5.44
40	2.58

Setting out a horizontal circular curve from P.I

Point	Ɵ	α	Single Arch Length	Single Chord Length
1	8.68^0	$2^039'$	19.29	19.27
2	17.36^0	$24^035'$	19.29	19.27
3	26.04^0	$112^001'$	19.29	19.27
4	34.72^0	$133^057'$	19.29	19.27
5	43.40^0	$136^036'=180^0-\Delta$	19.29	19.27