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Internal Assessment Test I – May. 2021

Sub :	Analysis of Determinate Structures					Sub Code:	18CV42	Branch :	Civil Engg	
Date:	19.05.2021	Duration:	60 min's	Max Marks:	50	Sem / Sec:	4th sem /A section		OBE	

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1 (a)	Calculate the radial shear, normal thrust and bending moment at 4m from the left support of a parabolic arch shown in fig1.a.	[10]	CO5	L3

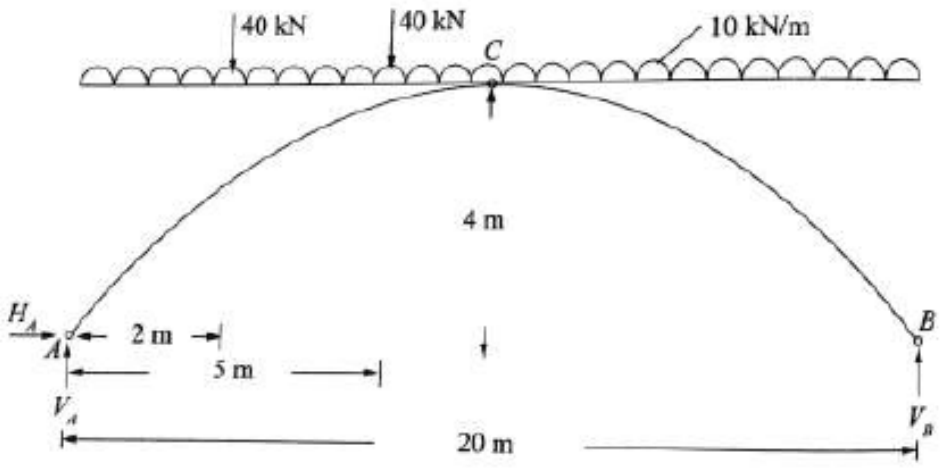


fig1.a.

		MARKS	CO	RBT
2 (a)	A three hinged arch consists of two quarter of circles as shown in fig2.a. It carries a load of 200 kN at 5 m from B. Compute the reactions at the supports and maximum positive and negative bending moments.	[10]	CO5	L3

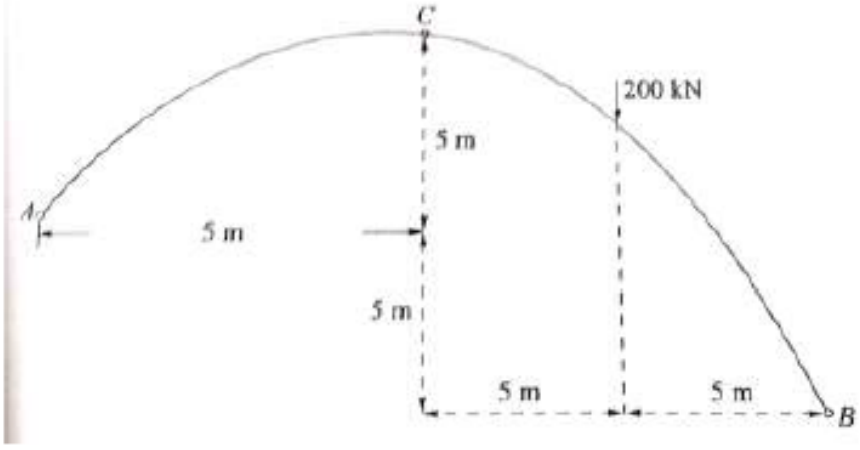


Fig.2.a

3 (a)	A three hinged parabolic arch of span 36 m has its supports at depths 4m and 16 m below the crown C. It carries a udl as shown in fig.3.a. Compute the horizontal thrust and also find radial shear at 5m from point A.	[10]	CO5	L3

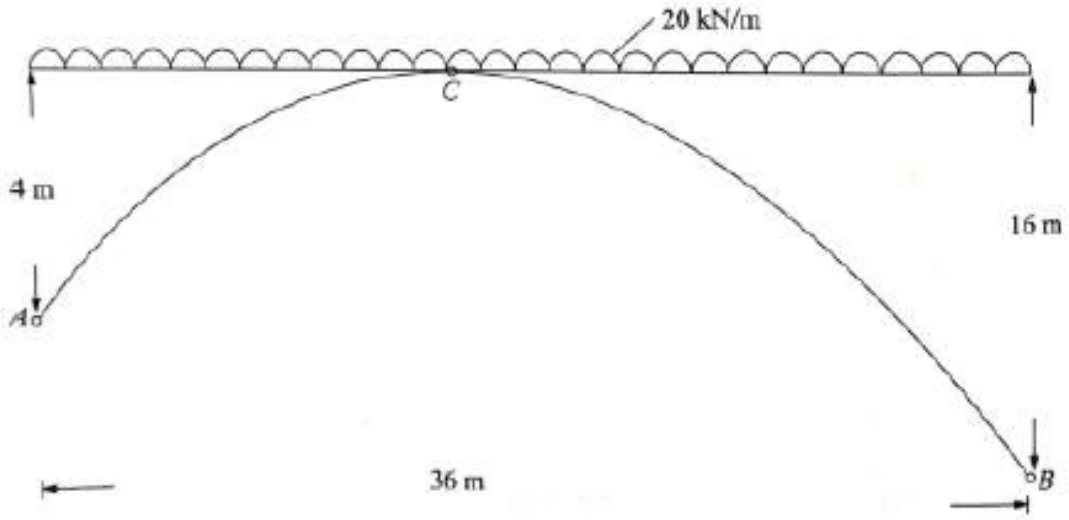
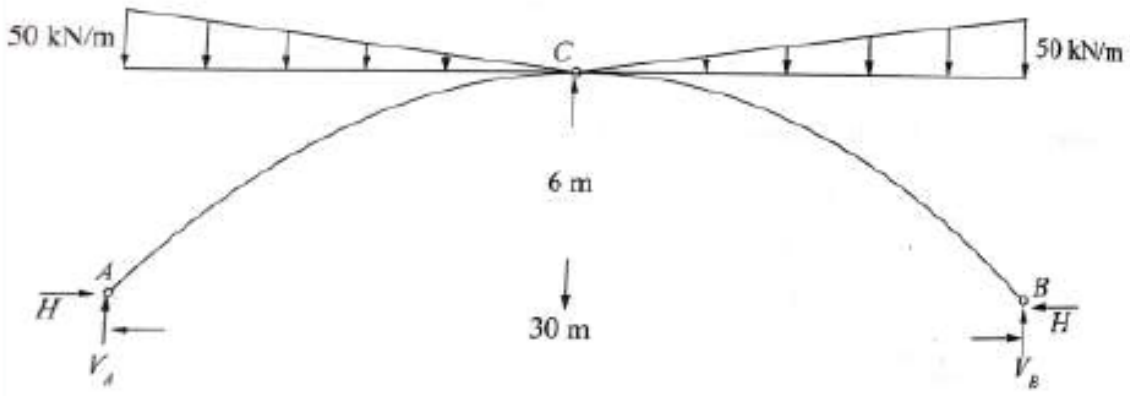


Fig.3.a

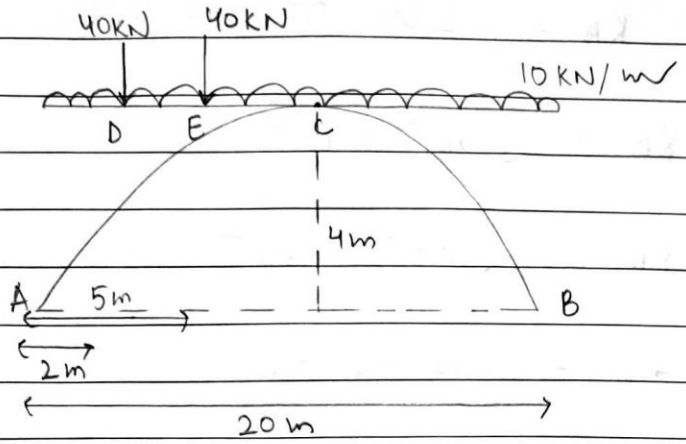
4 (a)	A symmetrical parabolic arch is hinged at the crown. The span 30 m and central rise is 6m and the load varies linearly from 50 kN/m at each abutment to zero at the crown. Calculate the horizontal and vertical reactions at the abutments, position and magnitude of maximum bending moment.	[10]	CO5	L3



5 (a)	A suspension bridge of 100m span has a central dip of 10 m and supports an udl of 12 kN/m throughout the span. Calculate i) The minimum and maximum tension in cable, ii) The size of cable if the permissible stress of the cable material is 180N/mm^2 iii) Length of the cable	[10]	CO5	L3
6 (a)	A cable is hanging from 2 points A and B 30m apart horizontally, B being 3 m lower than A. It supports a uniform load 10kN/m throughout its horizontal length. Determine i) The position of the lowest point, if the cable has a sag of 3 m below B. ii) Length of the cable. iii) Forces on right side tower if cable passes over a smooth pulley, take direction of anchor cable as 30^0 and height of tower as 6m.	[10]	CO5	L3

IAT1 Solutions

1)



To find support reactions

$\Sigma V = 0$

$$V_A + V_B - 40 - 40 - 10(20) = 0$$

$$V_A + V_B = 280 \text{ KN} \quad \text{— (i)}$$

$\Sigma M_A = 0$

$$40 \times 2 + 40 \times 5 + 10(20)(10) = V_B(20)$$

$$80 + 200 + 2000 = 20 V_B$$

$$2280 = 20 V_B$$

$$114 \text{ KN} = V_B$$

Substituting in (i)

$$V_A = 166 \text{KN}.$$

$\Sigma M_C = 0$

$$10 \times 10 \times \frac{10}{2} - 114 \times 10 + 4 \times H = 0$$

$$\frac{30}{2} - 1140 + 4H = 0$$

$$H = 160 \text{ KN}).$$

$$R_A = \sqrt{V_A^2 + H^2}$$

$$R_A = \sqrt{(166)^2 + (160)^2}$$

$$R_A = 230.55 \text{ KN}$$

similarly $R_B = \sqrt{V_B^2 + H^2}$

$$R_B = \sqrt{114^2 + 160^2}$$

$$R_B = 196.45 \text{ KN}$$

$$\theta_A = \tan^{-1}\left(\frac{V_A}{H}\right) = \tan^{-1}\left(\frac{166}{160}\right)$$

$$\theta_A = 46.05^\circ$$

$$\theta_B = \tan^{-1}\left(\frac{V_B}{H}\right) = \tan^{-1}\left(\frac{114}{160}\right)$$

$$\theta_B = 35.47^\circ.$$

- To find rise & slope

$$y = \frac{4h}{l^2} x(l - x)$$

$$y = \frac{4 \times 4}{(20)^2} x(20 - x)$$

$$y = 0.04x(20x - x^2)$$

$$y = 0.8x - 0.04x^2$$

$$\frac{dy}{dx} = \tan\theta = 0.8 - 0.08x$$

∴ To draw BMD.

Condition 1: $M_A = M_B = M_C = 0$

2: $M_D = V_A \times 2 - 10 \times 2 \times \frac{2}{2} - H \times y_D$

$= 166 \times 2 - 20 - 160\left[0.8(2) - 0.04(2)^2\right]$

$= 332 - 20 - 160\left[1.6 - 0.16\right]$

$= 332 - 20 - 230.4$

$= 81.6$ KN-m

3: $M_E = V_A \times 5 - 10 \times 5 \times \frac{5}{2} - 40 \times 3 - H \times y_E$

$= 166 \times 5 - 125 - 120 - 160\left[0.8 \times 5 - 0.04(5)^2\right]$

$= 830 - 245 - 160\left[4 - 1\right]$

$= 830 - 245 - 480$

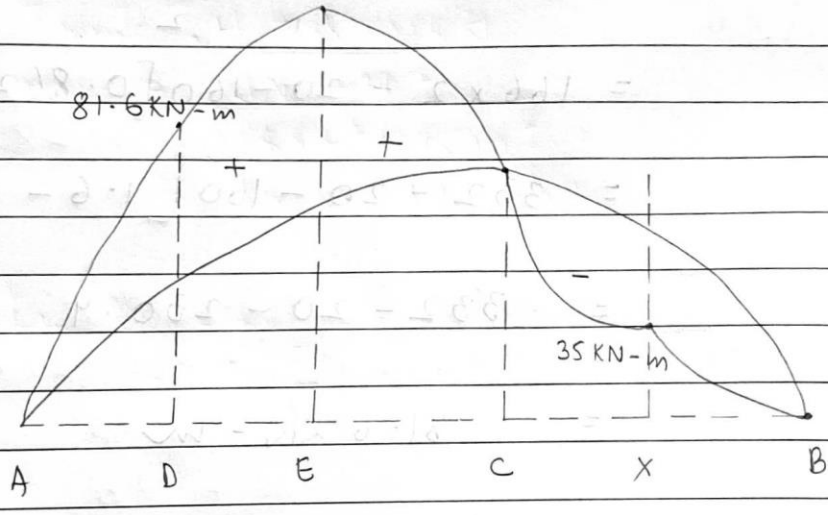
$= 105$ KN-m.

iv) In between CB

$$M_{CB} = V_A \times 15 - 40(10) - 40(13) - 10(15)\left(\frac{15}{2}\right) - H \times y = 0$$

$$= 166 \times 15 - 400 - 520 - 1125 - 160\left[\frac{0.8(15)}{-0.04(15)^2}\right]$$

$$= -35 \text{ KN}$$



- To calculate NF, RS at a distance of 4 m from left hand support.

$$H = 160 \text{ KN}$$

$$\theta = \tan^{-1}(0.8 - 0.08(4))$$

$$\theta = \tan^{-1}(0.48)$$

$$\theta = 25^\circ 38'$$

$$V = V_A - 10(4) - 40$$
$$V = V_A - 40 - 40$$
$$V = V_A - 80 = 86\ KN$$

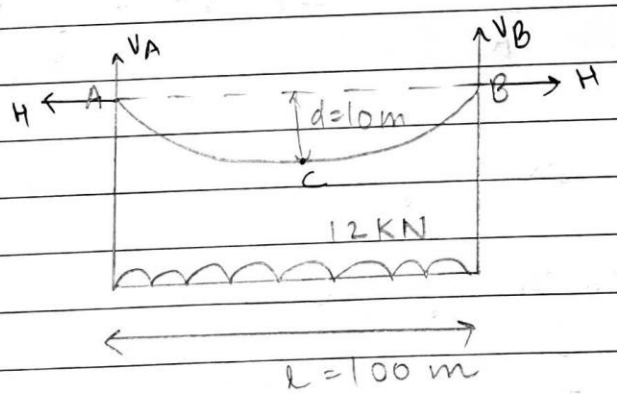
$$N.T. = H\cos\theta + V\sin\theta$$
$$= 160\cos(25°38') + 86\sin(25°38')$$
$$= 181.457\ KN$$

$$R.S = H\sin\theta - V\cos\theta$$
$$= 160\sin(25°38') - 86\cos(25°38')$$
$$= -8.318\ KN$$

(x=4m) Bending moment $= V_A \times 4 - H \times 2.46 - 40(1) - 10 \times 4 \times 2$

$$= 166 \times 4 - 160 \times 2.46 - 80 - 80$$
$$= 664 - 393.6 - 160$$
$$= 110.4\ KN-m$$

5)



To find support reactions.

$$\Sigma V = 0,$$
$$V_A + V_B = 12 \times 100 = 1200\ KN$$

$\Sigma M_A = 0$,

$$12 \times 100 \times \left(\frac{100}{2}\right) - V_B \times 100 = 0$$

$$V_B = 600\ kN$$

we get, $V_A = 600\ kN$

$\Sigma M_C = 0$,

$$12 \times 50 \times \frac{50}{2} - 600 \times 50 + H \times 10 = 0$$

$$15000 - 30000 + 10H = 0$$

$$10H = 30000 - 15000$$

$$H = 1500\ kN$$

T_{min}, $H = 1500\ kN$

$$T_{max.} = \sqrt{V^2 + H^2}$$

$$= \sqrt{600^2 + 1500^2}$$

$$= 1615.549\ kN$$

To find size of cable

$$\sigma = \frac{F}{A} \quad \Rightarrow 180 = \frac{1615.549 \times 10^3}{\pi/4\,(d_1)^2}$$

$\therefore$ Diameter of cable = 106.90 mm.

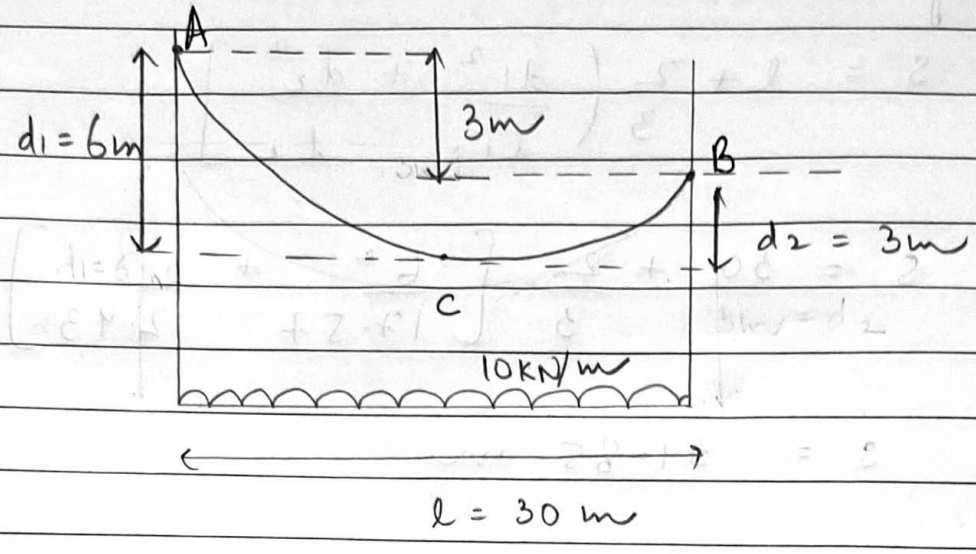
To find length of cable

$$S = l + \frac{8}{3}\frac{d^2}{l} \quad (\because \text{supports are at same level})$$

$$S = 100 + \frac{8}{3}\left(\frac{10^2}{100}\right)$$

$$S = 102.66\ mm$$

6)



To find position of lowest pt in the cable

$l = 30$ m $= l_1 + l_2$ — (i)

$$\frac{l_1}{l_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{d_1}{d_2}} = \sqrt{\frac{6}{3}}$$

$$\frac{l_1}{l_2} = \sqrt{2} = 1.414 \text{ m}$$

$$l_1 = 1.414\, l_2$$

From i)

$$30 = 1.414\, l_2 + l_2$$

$$l_2 = 12.43 \text{ m}$$

$$l_1 = 17.57 \text{ m}.$$

To find support rxn at A & B.

$\Sigma V = 0$

$$VA + VB = 10 \times 30 = 300 \quad \text{—(i)}$$

$\Sigma M_A = 0$

$$10 \times 30 \times \frac{30}{2} - VB \times 30 - H \times 3 = 0$$

$$30\,VB + 3H = 4500 \quad \text{—(iii)}$$

$\Sigma M_C = 0$

$$-VB \times 12.43 + H \times 3 + 10 \times \frac{(12.43)^2}{2} = 0$$

$$-12.43\,VB + 3H = -772.52 \quad \text{—(iv)}$$

Solving,

$$VB = 124.26\ KN \quad , VA = 175.74\ KN.$$
$$H = 257.36\ KN$$

Max. Tension $= T_{max.} = \sqrt{VA^2 + H^2}$

$$T_{max.} = \sqrt{(175.74)^2 + (257.36)^2}$$

$$= 311.63\ KN.$$

length of the cable

$$S = l + \frac{2}{3}\left(\frac{d_1^2}{l_1} + \frac{d_2^2}{l_2}\right]$$

$$S = 30 + \frac{2}{3}\left[\frac{6^2}{17.57} + \frac{3^2}{12.43}\right]$$

$$S = 31.85 \text{ m}$$

Force in right tower

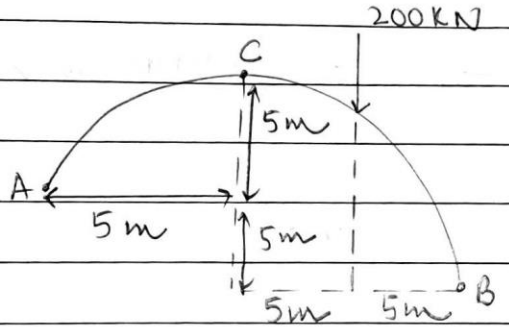
We have, $\theta_A = 30°$

$$T = \sqrt{V_B^2 + H^2}$$

$$= \sqrt{124.26^2 + 257.36^2}$$

$$= 285.78 \text{ KN}$$

2)



To find horizontal distance or span diameter.

$$l_1 + l_2 = l$$

$$5 + 10 = l$$

$$l = 15 \text{ m}$$

To find supports reaction

$\Sigma V = 0$

$$V_A + V_B - 200 = 0$$

$$V_A + V_B = 200 \quad \text{— (i)}$$

$\Sigma M_A = 0$

$$200 \times 10 - V_B \times 15 + H \times 5 = 0$$

$$-V_B(15) + 5H = -2000 \quad \text{—(ii)}$$

$\Sigma M_C = 0$

$$200 \times 5 - V_B \times 10 + H \times 10 = 0$$

$$-10V_B + 10H = -1000 \quad \text{— (iii)}$$

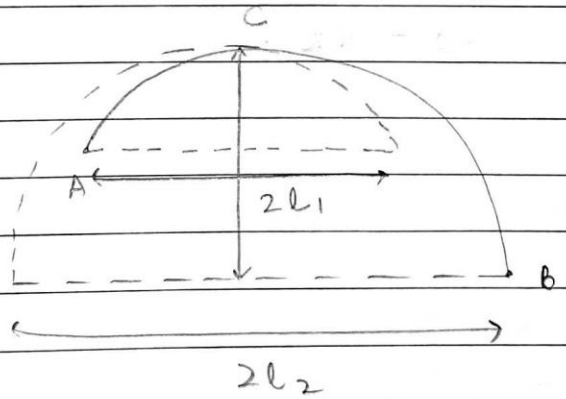
Solving (ii) & (iii)

$V_B = 150\,kN$

$V_A = 50\,KN$.

$H = 50\,KN$.

To find Rise & slope equation



For A C

$$y = \frac{4h_1}{2l_1} x(2l_1 - x)$$

$$y = \frac{4 \times 5}{2 \times 5} x(2 \times 5 - x)$$

$$y = 20x - 2x^2$$

$$\frac{dy}{dx} = 20 - 4x$$

For B C

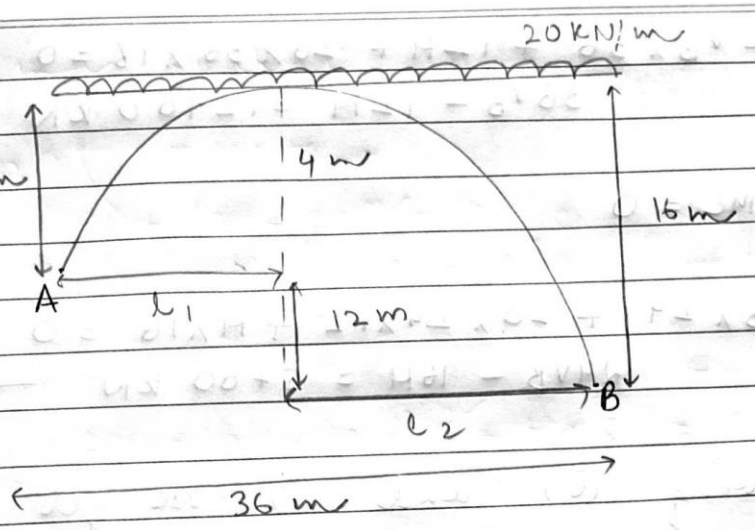
$$y = \frac{4h_2}{2l_2} x(2l_2 - x)$$

$$y = \frac{4 \times 10}{2 \times 10} x(2 \times 10 - x)$$

$$y = 40x - 2x^2$$

$$\frac{dy}{dx} = 40 - 4x .$$

3)



To find horizontal distance

$$l = l_1 + l_2$$

$$\frac{l_1}{l_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{4}{16}} = 0.5$$

$$l_1 = 0.5\, l_2$$

$$0.5\, l_2 + l_2 = 36$$

$$l_2 = 24 \text{ m}$$

$\therefore$ we get $l_1 = 12$ m

To find support rxns.

$$\Sigma V = 0$$

$$V_A + V_B = 20 \times 36$$

$$V_A + V_B = 720 \text{ KN}$$

$$\Sigma M_A = 0$$

$$-V_B \times 36 + 12H + 20 \times 36 \times 18 = 0$$

$$36V_B - 12H = 12960 \text{ KN} \quad \text{— (i)}$$

$$\Sigma M_C = 0$$

$$-V_B \times 24 + 20 \times 24 \times 12 + H \times 16 = 0$$

$$24V_B - 16H = 5760 \text{ KN} \quad \text{— (ii)}$$

Solving (i) and (ii) we get

$V_B = 480$ KN, $V_A = 240$ KN

$H = 360$ KN.

To find rise and slope :-

$$y_1 = \frac{4h_1}{l^2} x(l - x)$$

$$y_1 = \frac{4 \times 4}{(24)^2} x(24 - x)$$

$$y_1 = 0.66x - 0.027x^2$$

$$\frac{dy_1}{dx} = 0.66 - 0.054x$$

$$y_2 = \frac{4h_2}{l^2} x(l - x)$$

$$y_2 = \frac{4 \times 16}{(48)^2} x(48 - x)$$

$$y_2 = 1.33x - 0.027x^2$$

$$\frac{dy_2}{dx} = 1.33 - 0.054x$$

To find NT, RS at $x = 5$ m from left hand support.

$$y_1 = 0.66x - 0.027x^2$$

$$\theta = \tan^{-1}(0.66 - 0.054x)$$

Shear force $V = V_A - 20 \times 5$

$= 240 - 100$

$= 140$ KN

$$\theta = \tan^{-1}(0.66 - 0.054 \times 5)$$

$$\theta = 21.30^\circ$$

Normal thrust $= H\cos\theta + V\sin\theta$

$= 360\cos(21.30) + 140\sin(21.30)$

$= 386.26$ KN

$R.S = H\sin\theta - V\cos\theta$

$= 360\sin(21.30) - 140\sin(21.30)$

$= 79.915$ KN