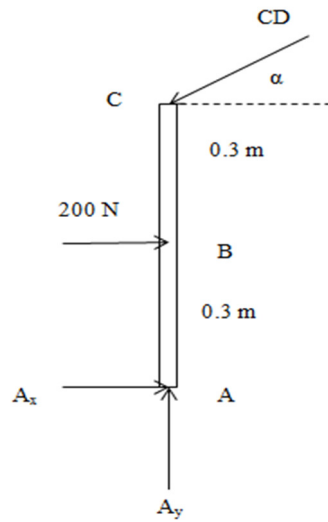
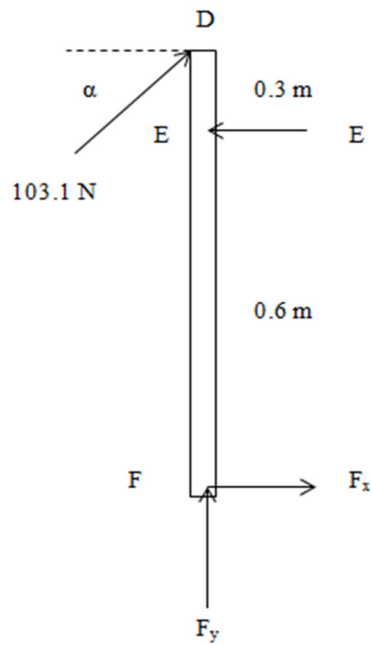


Solution of Question No. 1



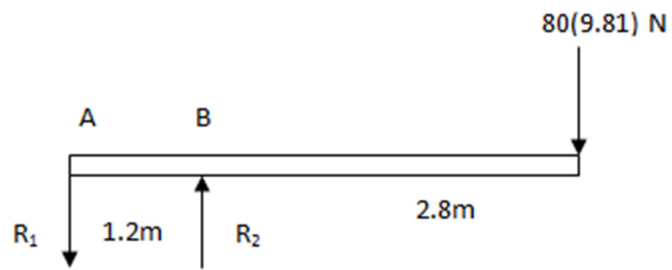
$$\alpha = \tan^{-1} \left(\frac{0.3}{1.2} \right) = 14.04^\circ$$

$$\sum M_A = 0: \quad CD \cos \alpha (0.6) - 200(0.3) = 0, \quad CD = 103.1 \text{ N}$$

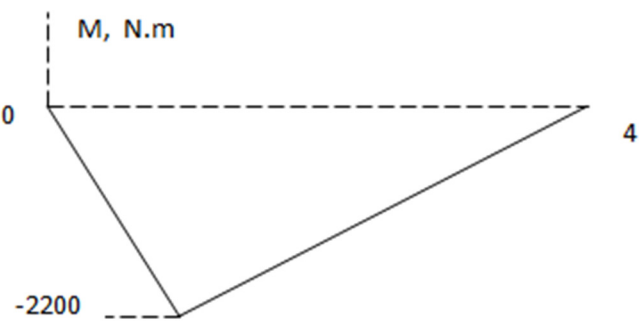
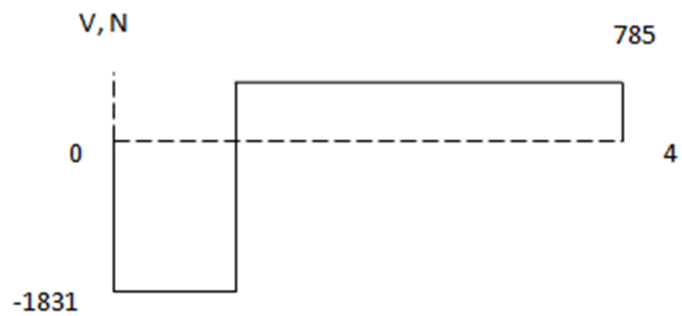


$$\sum M_F = 0: \quad -103.1 \cos \alpha (0.9) + E(0.6) = 0, \quad E = 150 \text{ N}$$

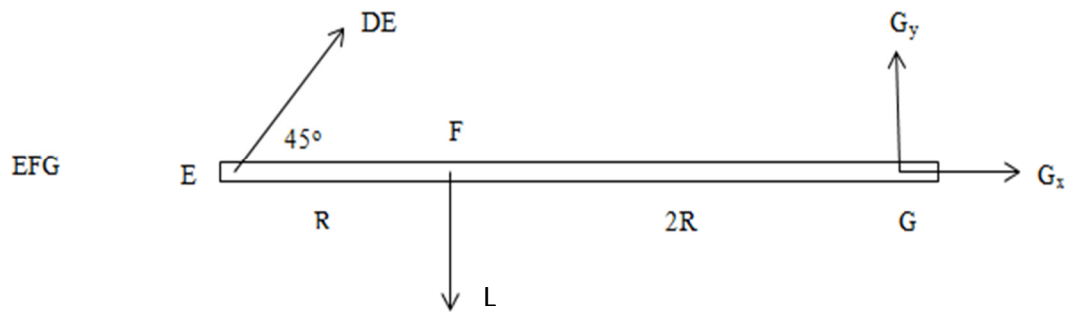
Solution of Question No. 2



$$\begin{aligned} \curvearrowright + \sum M_A = 0: & \quad 80(9.81)(4) - R_2(1.2) = 0, & R_2 = 2620 \text{ N} \\ +\uparrow \sum F = 0: & \quad 2620 - 80(9.81) + R_1 = 0, & R_1 = 1831 \text{ N} \\ M_B = & \quad -1831(1.2) = -2200 \text{ N.m} \end{aligned}$$

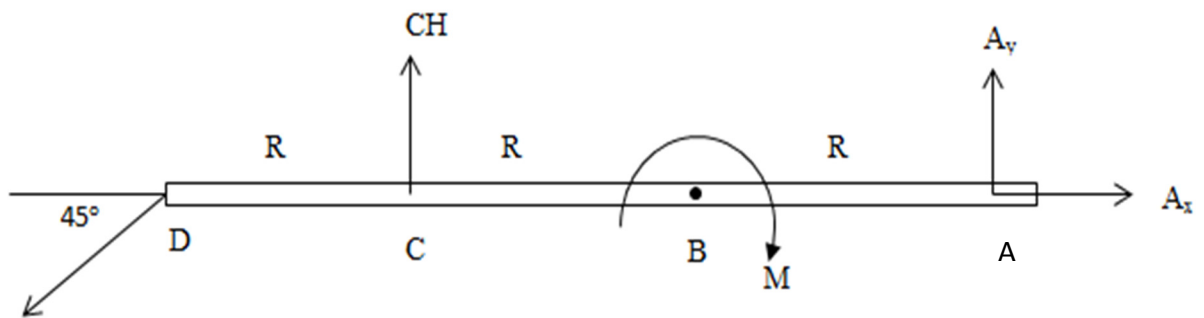


Solution of Question No. 3



$$\sum M_G = 0: \quad L(2R) - DE \frac{\sqrt{2}}{2} (3R) = 0, \quad DE = \frac{4L}{3\sqrt{2}}$$

ABCD:



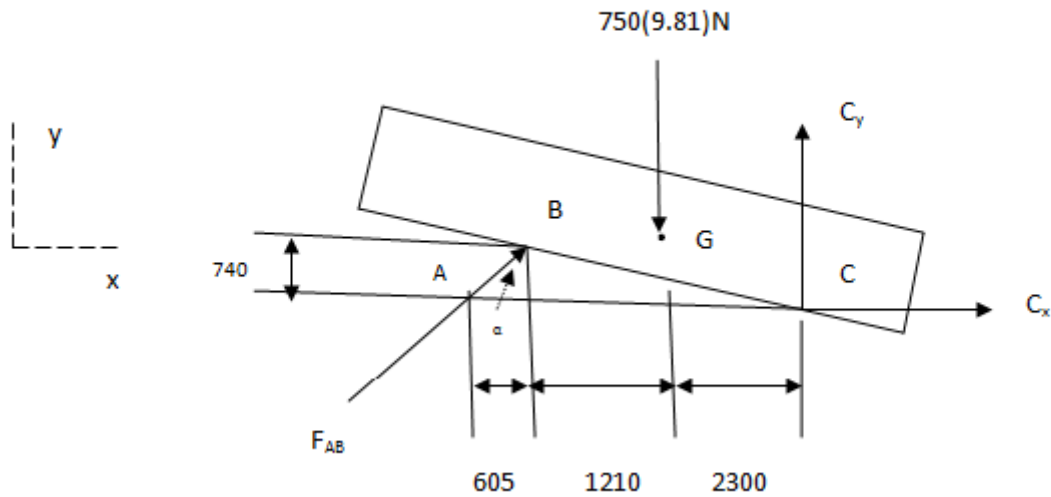
$$\sum M_A = 0: \quad \frac{4L}{3\sqrt{2}} \frac{\sqrt{2}}{2} (3R) - CH(2R) - M = 0$$

$$CH = L - \frac{M}{2R} \text{ (Tension if positive)}$$

$$CH = 0 \quad \text{if} \quad M = 2RL$$

Solution of Question No. 4

(Dim. in mm)



$$\alpha = \tan^{-1}\left(\frac{740}{605}\right) = 50.7^\circ$$

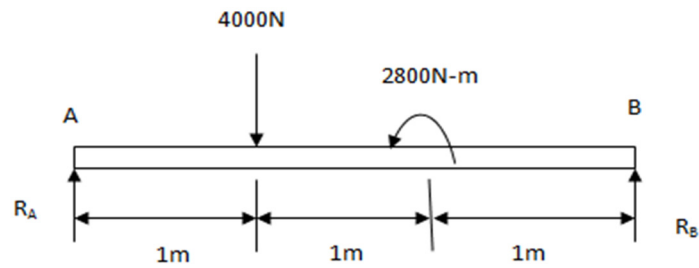
$$\sum M_C = 0: 750(9.81)(2300) - F_{AB} \sin \alpha (4115) = 0, \quad F_{AB} = 5310 \text{ N}$$

$$\sum F_x = 0: 5310 \cos 50.7^\circ + C_x = 0, \quad C_x = 3360 \text{ N}$$

$$\sum F_y = 0: 5310 \sin 50.7^\circ - 750(9.81) + C_y = 0, \quad C_y = 3250 \text{ N}$$

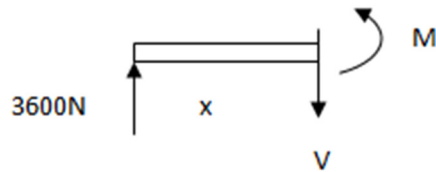
$$C = \sqrt{3360^2 + 3250^2} = 4670 \text{ N}$$

Solution of Question No. 5

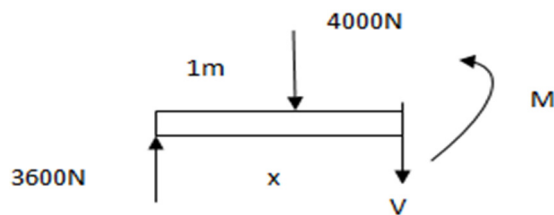


$$\curvearrowright + \sum M_A = 0: -4000(1) + 2800 + R_B(3) = 0, \quad R_B = 400 \text{ N}$$

$$+\uparrow \sum F_y = 0: R_A - 4000 + 400 = 0, \quad R_A = 3600 \text{ N or } 3.6 \text{ kN}$$

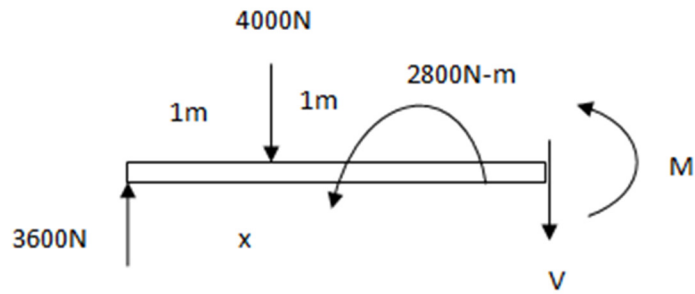


$$0 < x < 1 \text{ m}: \quad V = 3600 \text{ N} \quad M = 3600x$$



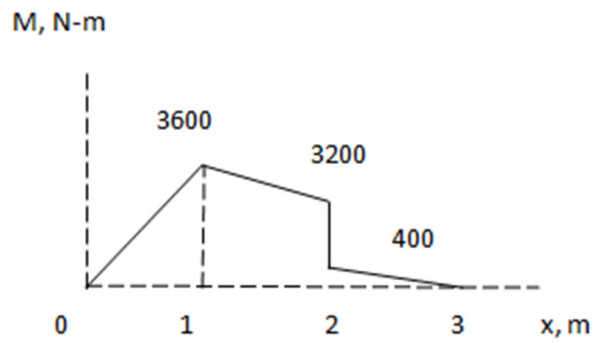
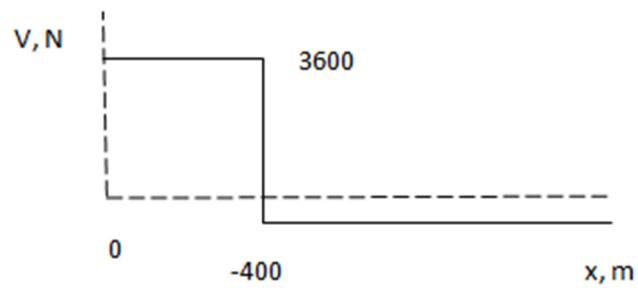
$$1 \text{ m} < x < 2 \text{ m}: \quad +\uparrow \sum F = 0: 3600 - 4000 - V = 0, \quad V = -400 \text{ N}$$

$$\curvearrowright + \sum M = 0: -3600x + 4000(x - 1) + M = 0, \quad M = 4000 - 400x$$



$$2\text{ m} < x < 3\text{ m} : \quad \sum F = 0 : 3600 - 4000 - V = 0, \quad V = -400\text{ N}$$

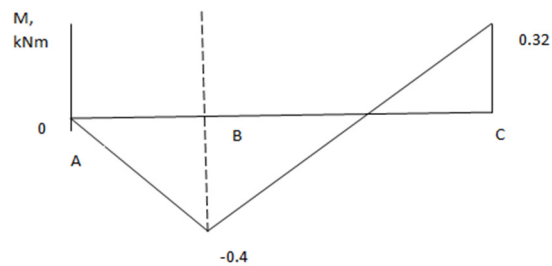
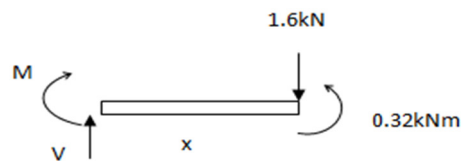
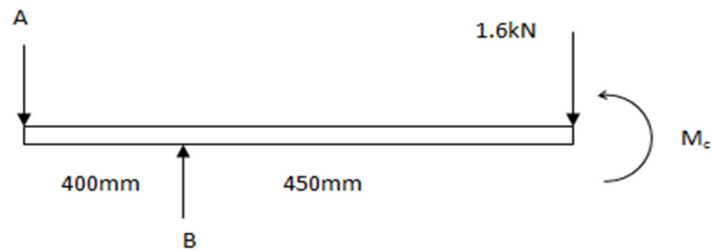
$$\sum M = 0: -3600x + 4000(x - 1) + 2800 + M = 0, \quad M = 1200 - 400x$$



Values at middle

$$V = -400\text{ N} \quad M = 3400\text{ N}\cdot\text{m}$$

Solution of Question No. 6



$$M_C = 1.6(0.200) = 0.32 \text{ kN.m}$$

$$\sum M_A = 0: \quad 0.4B + 0.32 - 0.85(1.6) = 0, \quad B = 2.6 \text{ kN}$$

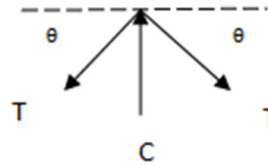
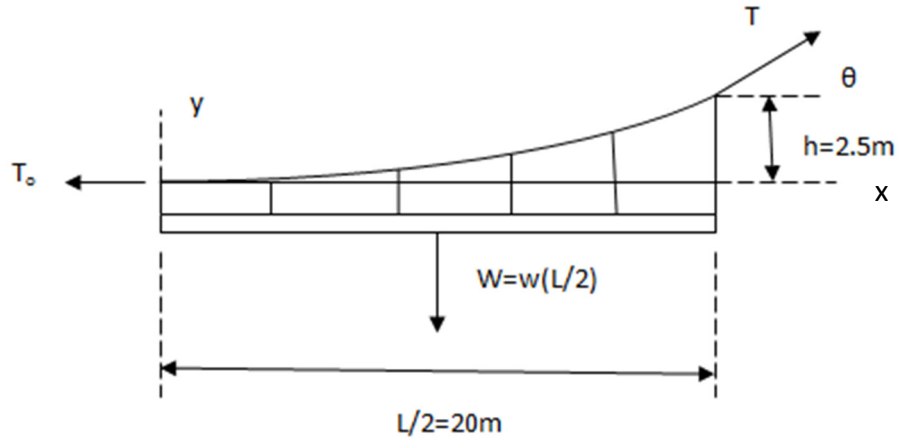
$$\sum F = 0: \quad A + 1.6 - 2.6 = 0, \quad A = 1.0 \text{ kN}$$

$$\sum M = 0: \quad 0.32 - 1.6x - M = 0; \quad M = 0.32 - 1.6x$$

$$\text{At } B \quad x = 0.45 \quad M_B = -0.40 \text{ kN.m}$$

$$M = 0 \quad \text{when} \quad x = \frac{0.32}{1.6} = 0.2 \text{ m}$$

Solution of Question No. 7



$$w = 1.400 (9.81) = 13.73 \text{ kN/m}$$

$$\text{From Eq. 5/15 b, } T = \frac{wL}{2} \sqrt{1 + \left(\frac{L}{4h} \right)^2} = \frac{13.73(40)}{2} \sqrt{1 + \left(\frac{40}{4(2.5)} \right)^2} = 1133 \text{ kN}$$

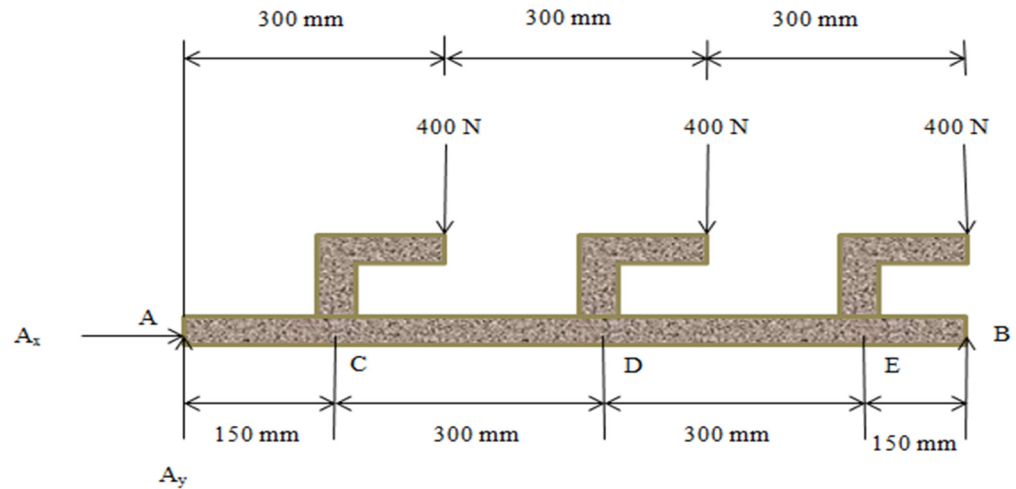
$$T^2 = W^2 + T_o^2, \quad T_o = \sqrt{(1132)^2 - [(13.73)(20)]^2} = 1099 \text{ kN}$$

$$\frac{dy}{dx} = \tan \theta = \frac{w \left(\frac{L}{2} \right)}{T_o} = \frac{13.73(20)}{1099} = 0.250, \quad \theta = 14.04^\circ$$

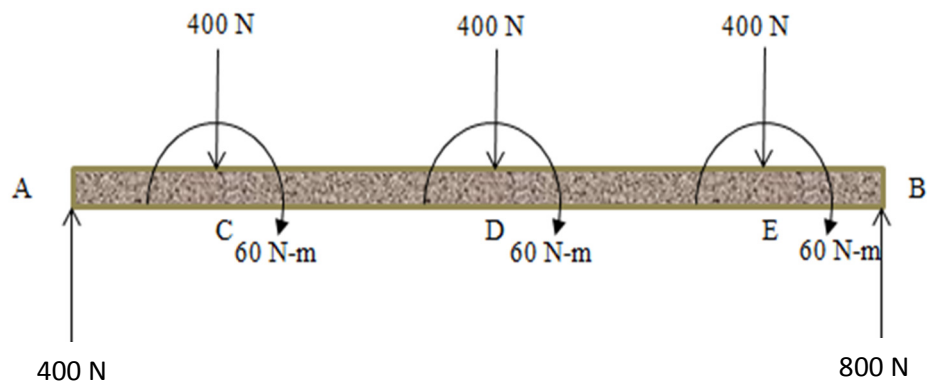
$$\sum F_y = 0 \text{ at support ; } 2T \sin \theta - C = 0, \quad C = 2(1133) \sin 14.04^\circ = 549 \text{ kN}$$

Solution of Question No. 8

Free body: Entire beam



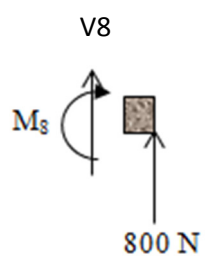
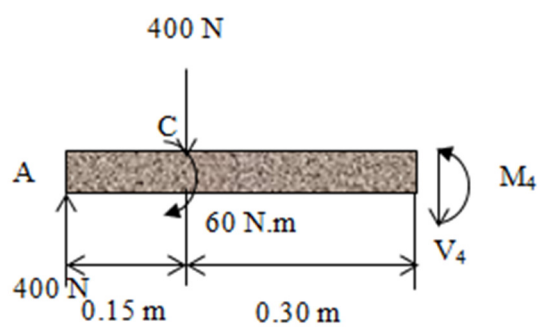
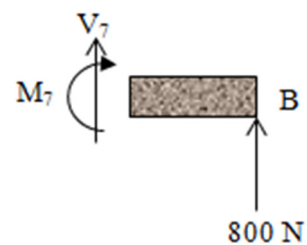
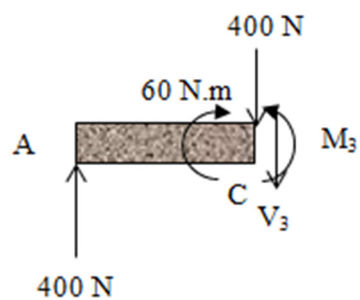
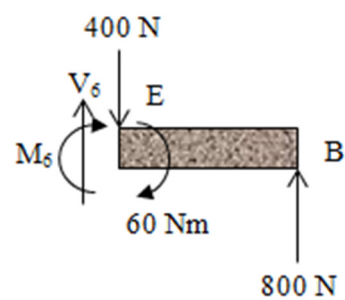
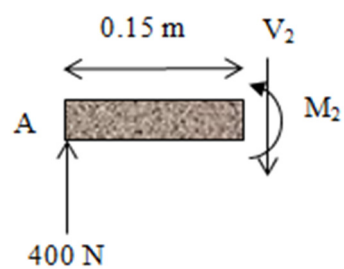
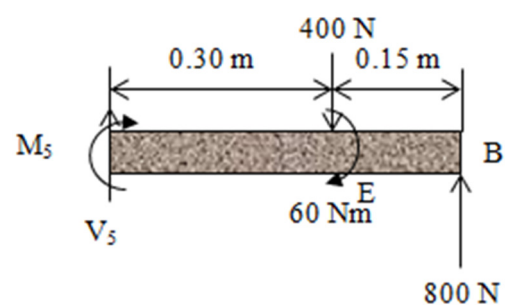
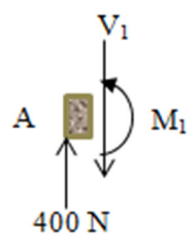
We replace the loads by equivalent force-couple systems at C, D and E.



$$+\curvearrowright \sum M_A = 0: B(0.9\text{m}) - (400\text{N})(0.3\text{m}) - (400\text{N})(0.6\text{m}) - (400\text{N})(0.9\text{m}) = 0, \quad B = +800\text{ N } (\uparrow)$$

$$\sum F_x = 0: A_x = 0 \quad + \uparrow \sum F_y = 0: A_y + 800\text{N} - 3(400\text{N}) = 0, \quad A_y = +400\text{ N } (\uparrow)$$

We consider successively the following F-B diagrams



$$V_1 = +400 \text{ N}, M_1 = 0$$

$$V_2 = +400 \text{ N}, M_2 = +60 \text{ Nm}$$

$$V_3 = 0, M_3 = +120 \text{ Nm}$$

$$V_4 = 0, M_4 = +120 \text{ Nm}$$

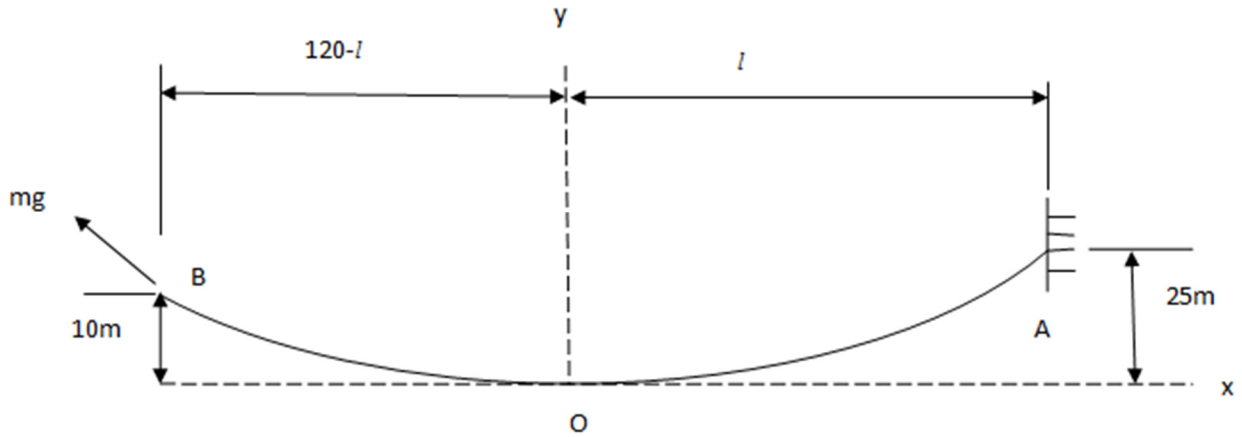
$$V_5 = -400 \text{ N}, M_5 = +180 \text{ Nm}$$

$$V_6 = -400 \text{ N}, M_6 = +60 \text{ Nm}$$

$$V_7 = -800 \text{ N}, M_7 = +120 \text{ Nm}$$

$$V_8 = -800 \text{ N}, M_8 = 0$$

Solution of Question No. 9



Eq. 5/14: $y = \frac{wx^2}{2T_0}$

At A: $25 = \frac{40 \times l^2}{2T_0}$, At B: $10 = \frac{40(120-l)^2}{2T_0}$

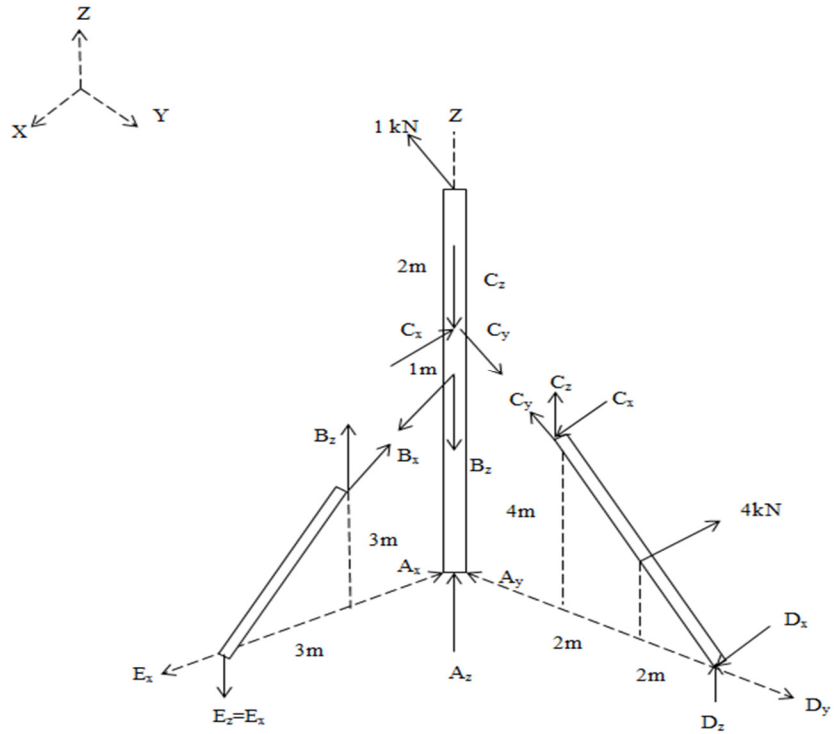
Eliminate T_0 : $0.6l^2 - 240l + 14400 = 0$, $l = 73.5 \text{ m}$ (or $l = 326 \text{ m}$)

$T_0 = \frac{4}{5}l^2 = \frac{4}{5}(73.5)^2 = 4320 \text{ N}$

Section O-B: $(mg)^2 = T_0^2 + (wx)^2$

$(9.81m)^2 = (4320)^2 + [40(120-73.5)^2]$, $m = 480 \text{ kg}$

Solution of Question No. 10



$$CD: \quad \sum M_{Dy} = 0: \quad 4(2) - C_x(4) = 0, \quad C_x = 2 \text{ kN}$$

$$ABC: \quad \sum M_{By} = 0: \quad 2(1) - A_x(3) = 0, \quad A_x = 0.667 \text{ kN}$$

$$\sum F_x = 0: \quad B_x - 0.667 - 2 = 0, \quad B_x = 2.67 \text{ kN}$$

$$EB: \quad B_z = E_z = B_x = E_x = 2.67 \text{ kN}$$

$$ABC: \quad \sum M_{Ax} = 0: \quad 1(6) - C_y(4) = 0, \quad C_y = 1.50 \text{ kN}$$

$$CD: \quad \sum M_{Dx} = 0: \quad C_z = C_y = 1.50 \text{ kN}$$

$$ABC: \quad \sum F_z = 0: \quad A_z - 2.67 - 1.50 = 0, \quad A_z = 4.17 \text{ kN}$$

$$\sum F_y = 0: \quad A_y + 1 - 1.50 = 0, \quad A_y = 0.50 \text{ kN}$$

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2} = 4.25 \text{ kN}$$