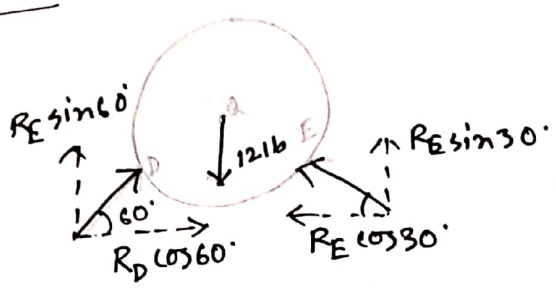
CHAPTER-01

EQUILIBRIUM OF FORCES AND TRUSSES

Problem-01



$$\Sigma F_x = 0$$

$$\rightarrow R_D \cos 60° - R_E \cos 30° = 0$$

$$\rightarrow R_D = R_E \frac{\cos 30°}{\cos 60°}$$

$$\Sigma F_y = 0$$

$$\rightarrow R_D \sin 60° + R_E \sin 30° - 12 \text{ lb} = 0$$

$$\rightarrow R_E \cos 30° \tan 60° + R_E \sin 30° = 12 \text{ lb}$$

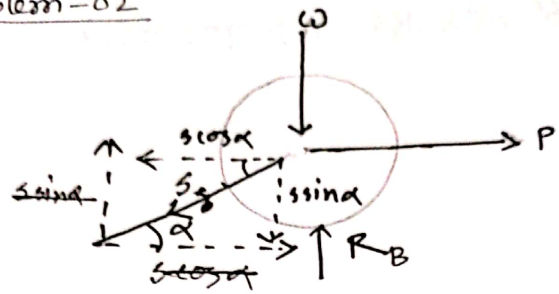
$$\rightarrow R_E \left(\frac{\sqrt{3}}{2} \times \sqrt{3} + \frac{1}{2} \right) = 12 \text{ lb}$$

$$\rightarrow R_E = 6 \text{ lb} \quad \text{Ans.}$$

and $R_D = 6 \times \frac{\sqrt{3}/2}{1/2}$ lb

$= 10.4$ lb Ans.

Problem-02



$$\Sigma F_x = 0$$

$$P - S\cos\alpha = 0$$

$$S = \frac{P}{\cos\alpha} \quad \text{-----(1)}$$

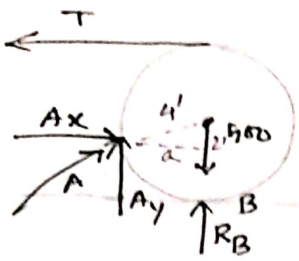
$$\Sigma F_y = 0$$

$$R - (\omega + S\sin\alpha) = 0$$

$$R = S\sin\alpha + \omega$$

$$= P\tan\alpha + \omega \quad \text{Ans.}$$

Problem – 08



$\Sigma F_x = 0$

$A_x - T = 0$

$A_x = T$ ------(I)

$\Sigma F_y = 0$

$A_y - 500 = 0$

$A_y = 500\,lb$ ------(II)

$a = \sqrt{4^2 - 2^2}$

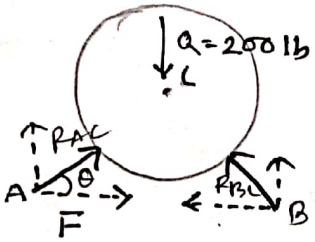
$= 2\sqrt{3}'$

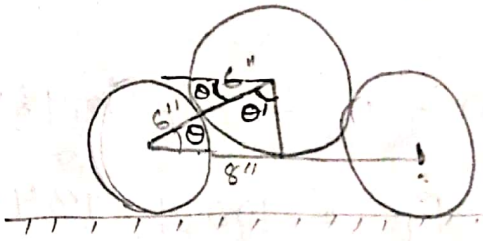
$\Sigma M_A = 0$

$+500 \times 2\sqrt{3} - T \times 6 = 0$

$T = \frac{500\sqrt{12}}{6} = 288.675$ Ans.

Problem – 03





$\Sigma F_x = 0$

$R_{AC}\cos 48.18° - R_{BC}\cos 48.18° = 0$

$R_{AC} = R_{BC}$

$\cos\theta = \frac{8''}{12''}$

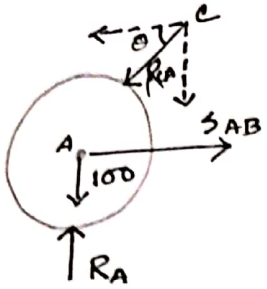
$\theta = 48.18°$

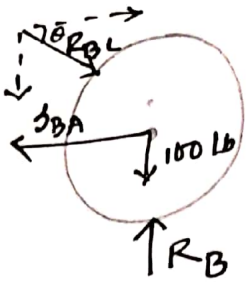
$\Sigma F_y = 0$

$R_{AC}\sin 48.18° + R_{BC}\sin 48.18° - 200 = 0$

$\Rightarrow 2R_{AC}\sin 48.18° = 200$

$\Rightarrow R_{AC} = \frac{200}{2\sin 48.18°} = 134.18\ lb$





$\Sigma F_x = 0$

$S_{AB} - R_{AC} \cos 48.18° = 0$

$S_{AB} = R_{AC} \cos 48.18°$

$= 134.18 \times \cos 48.18°$

$= 89.47$ lb Ans.

$\Sigma F_y = 0$

$-100 + R_A - R_{AC} \sin 48.18° = 0$

$R_A = +134.18 \times \sin 48.18° + 100$

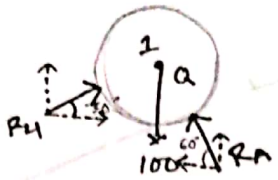
$= 200$ lb Ans.

$-100 + R_B - R_{BC} \sin 48.18° = 0$

$R_B = 100 + 134.18 \sin 48.18°$

$= 200$ lb Ans.

Problem-04



$$\Sigma F_x = 0$$

$$R_{21}\cos 30^\circ - R_A \cos 60^\circ = 0 \quad \text{.....}$$

$$R_{21} = R_A \frac{\cos 60^\circ}{\cos 30^\circ} \quad \text{.....(i)}$$

$$\Sigma F_y = 0$$

$$R_{21}\sin 30^\circ + R_A \sin 60^\circ - 100 = 0 \quad \text{.....(ii)}$$

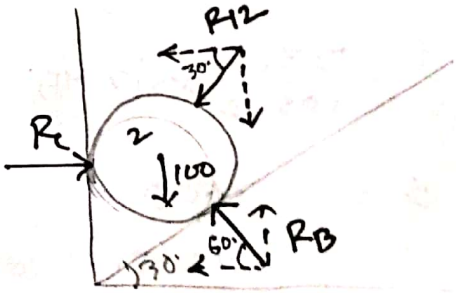
$$R_A \frac{\cos 60^\circ}{\cos 30^\circ} \times \sin 30^\circ + R_A \sin 60^\circ = 100$$

$$R_A \cos 60^\circ \tan 30^\circ + R_A \sin 60^\circ = 100$$

$$R_A = \frac{100}{\cos 60^\circ \tan 30^\circ + \sin 60^\circ}$$

$$= 50\sqrt{3} \text{ lb}$$

$$= 86.60 \text{ lb} \quad \underline{\text{Ans.}}$$



$$\Sigma F_x = 0$$

$$R_{12}\cos 30^\circ + R_B \cos 60^\circ - R_c = 0 \quad \text{.....(iii)}$$

$$\Sigma F_y = 0$$

$$+100 + R_{12}\sin 30^\circ - R_B \sin 60^\circ = 0 \quad \text{.....(iv)}$$

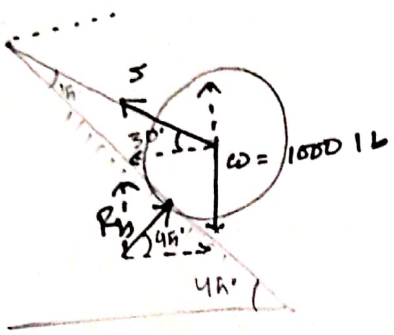
$$R_B = \frac{100 + R_{12}\sin 30^\circ}{\sin 60^\circ}$$

$$= \frac{100 + 86.60 \times \frac{\cos 60^\circ}{\cos 30^\circ} \times \sin 30^\circ}{\sin 60^\circ}$$

$$= 144.33 \text{ lb} \quad \underline{\text{Ans.}}$$

and
$R_c = 115$ lb Ans

Problem – 05



$\sum F_x' = 0$

$S\cos 30° - R_B \cos 45° = 0$

$R_b = S \frac{\cos 30°}{\cos 45°}$

$\sum F_y' = 0$

$R_b \sin 45° + S\sin 30° - 1000 = 0$

$\Rightarrow S \frac{\cos 30°}{\cos 45°} \times \sin 45° + S\sin 30° = 1000$

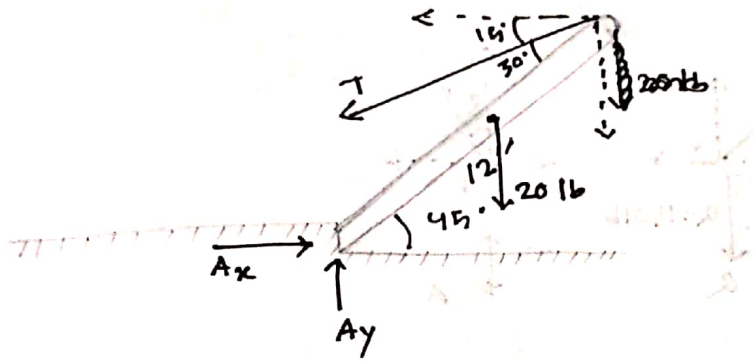
$\Rightarrow S = \frac{1000}{\sin 30° + \cos 30° \tan 45°}$

$= 732.05$ lb Ans.

$R_b = 732.05 \times \frac{\cos 30°}{\cos 45°}$

$= 896.57$ lb Ans.

Problem – 06



$\sum M_A = 0$

$-T\sin 30° \times 12 + 20 \times 6 \cos 45° = 0$

$T = \dfrac{10 \cos 45°}{\sin 30°}$

$= 14.14$ lb Ans.

$\sum F_x = 0$

$A_x - T\cos 15° = 0$

$\Rightarrow A_x = 14.14 \cos 15° = 13.66$ lb Ans

$\sum F_y = 0$

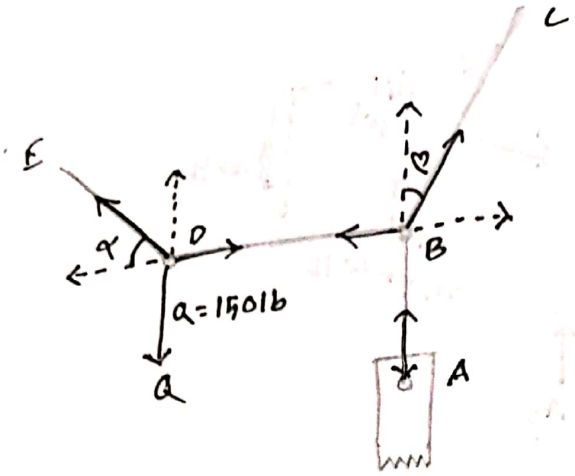
$A_y - 20\text{lb} - T\sin 15° = 0$

$A_y = 20 + 14.14 \sin 15° = 23.66$ lb

$A = \sqrt{13.66^2 + 23.66^2}$

$= 27.32$ lb Ans.

Problem - 09



For D,

$$\sum F_y = 0$$

$$T_{DE} \sin(\cdot 1)^{rad} - 1501b = 0$$

$$T_{DE} = 1502.50\ lb$$

$$\sum F_x = 0$$

$$T_{DE} \cos(0.1)^{rad} - T_{DB} = 0$$

$$T_{DB} = 1495\ lb$$

For B $\sum F_x = 0$

$$T_{BC} \sin(0.1)^{rad} - 1495lb = 0$$

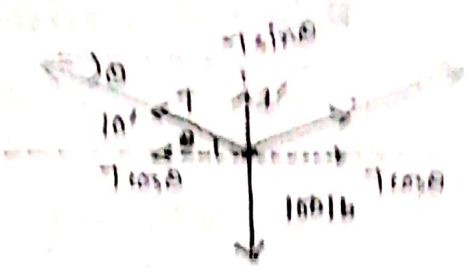
$$T_{BC} = 14975\ lb$$

$$\sum F_y = 0$$

$$T_{BC} \cos(0.1)^{c} - T_{BA} = 0$$

$$T_{BA} = 14900\ lb$$

Problem – 11



$\sin\theta = \frac{1'}{10'}$

$\theta = 5.74°$

$\Sigma F_y = 0$

$\Rightarrow T\sin 5.74° + T\sin 5.74° - 100 = 0$

$\Rightarrow T = 550\ lb$

again in Fig – 02

$S\sin 30° - T\cos 5.74° = 0$

$S = 994.98\ lb$ Ans.

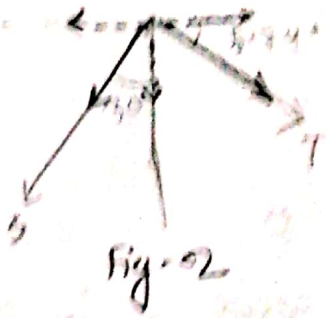
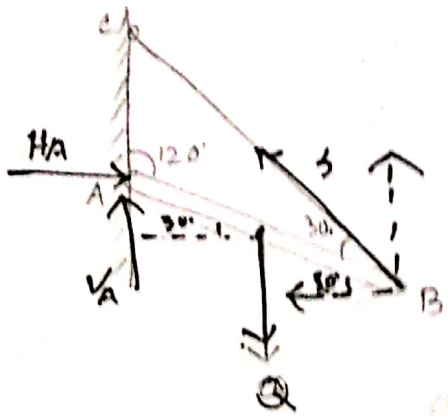


Fig. 02

Problem – 12



$\sum M_A = 0$

$\Rightarrow Q \times \frac{l}{2}\cos 30° + S \times \cos 60° \times l\sin 30° - S\sin 60° \times l\cos 30° = 0$

$\Rightarrow 2 \times \frac{1}{2} \times \frac{\sqrt{3}}{2} + S \times \frac{1}{2} \times \frac{1}{2} - S \times \frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2} = 0$

$\Rightarrow S = \sqrt{3}$ tons Ans.

$\sum F_x = 0$

$H_A - 6\cos 60° = 0$

$H_A = \frac{\sqrt{3}}{2}$

$\sum F_y = 0$

$V_A - Q + 5\sin 60° = 0$

$V_A = 2 - \frac{\sqrt{3} \times \sqrt{3}}{2}$

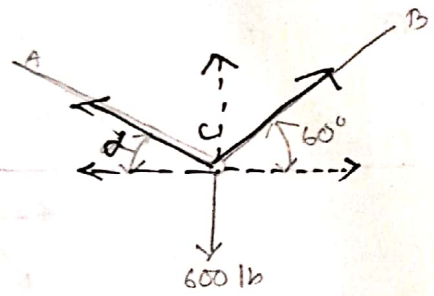
$= 2 - \frac{3}{2}$

$\Rightarrow 0.5$

$F_A = \sqrt{\frac{3}{4} - \frac{1}{4}}$

$= \sqrt{\frac{2}{4}} = 0.7071$ tons.

Problem – 13



(a)

$\sum F_x = 0$

$T_{AC}\cos\alpha - T_{BC}\cos 60° = 0$

$T_{BC} = \frac{T_{AC}\cos\alpha}{\cos 60°}$ ..... (-1)

$\sum F_y = 0$

$T_{AC}\sin\alpha + T_{BC}\sin 60° - 600 = 0$

$\Rightarrow T_{AC}\sin\alpha + T_{AC}\cos\alpha\tan 60° = 600$

$\Rightarrow T_{AC}(\sin\alpha\cos 60° + \cos\alpha\sin 60°) = 600\cos 60°$

$\Rightarrow T_{AC} = \frac{600\cos 60°}{\sin(\alpha + 60°)}$

Now,
when $(\alpha+60°) = 90°$, the tension will be minimum

$\therefore \quad \alpha + 60° = 90$

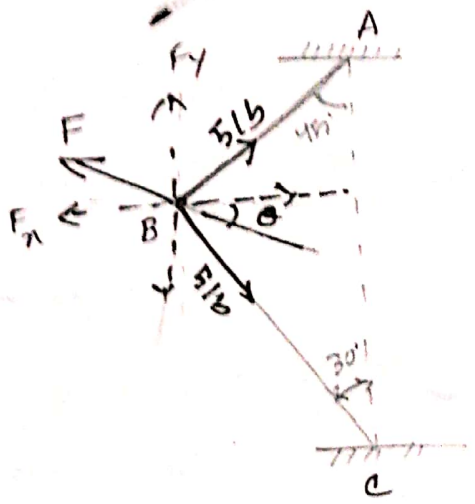
$\alpha = 30°$ Ans.

(b) $T_{AC} = \dfrac{600 \times \frac{1}{2}}{\sin 90°} = 300$ lb

$T_{BC} = \dfrac{300 \frac{\sqrt{3}}{2}}{\frac{1}{2}}$

$= 519.61$ lb Ans.

Problem-14



$\Sigma F_x = 0$

$-F\cos\theta + T_{BA}\cos 45° + T_{BC}\sin 30° = 0$

$F\cos\theta = 6.035$ lb

$\Sigma F_y = 0$

$F\sin\theta + T_{AB}\sin 45° - T_{BC}\cos 30° = 0$

$F\sin\theta = 0.8$

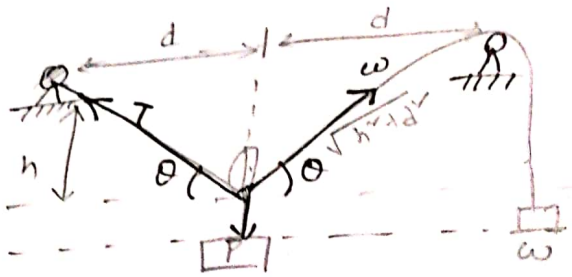
$F = \sqrt{6.035^2 + 0.8^2}$

$= 6.09$ lb Ans.

$\theta = \tan^{-1}\dfrac{0.8}{6.04}$

$= 7.54°$ Ans.

Problem – 15



$\Sigma F_x = 0$

$\omega\cos\theta - T\cos\theta = 0$

$\Rightarrow \omega = T$

$\Sigma F_y = 0$

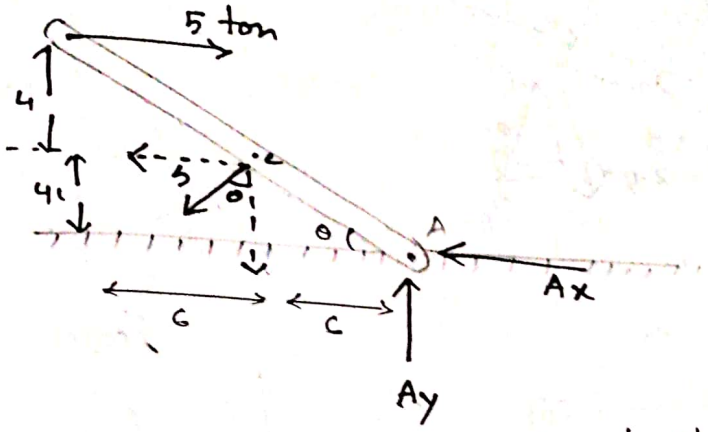
$T\sin\theta + \omega\sin\theta - P = 0$

$\Rightarrow 2\omega\sin\theta = P$

$\Rightarrow 2\omega\frac{h}{\sqrt{h^2+d^2}} = P$

$\Rightarrow \omega = \frac{P\sqrt{h^2+d^2}}{2h}$ (Ans.)

Problem – 16



$\sum M_A = 0$

$5 \times 8 - S \times (\sqrt{6^2 + 4^2}) = 0$

$\Rightarrow S = 5.547$ tons Ans.

$\theta = \tan^{-1} \frac{4}{6}$

$= 33.70$

$\sum F_y = 0$

$A_y - S\cos\theta = 0$

$A_y = 4.62$ tons

$\sum F_x = 0$

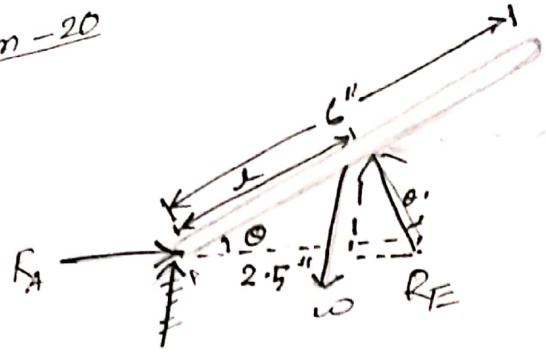
$A_x + S\sin 33.70 - 5 = 0$

$A_x = 5 - 3.1 = 1.9$ tons

$F_A = \sqrt{4.62^2 + 1.9^2}$

$= 5$ tons Ans.

Problem – 20



$\Sigma F_x = 0$

$\Rightarrow R_A - R_E \sin\theta = 0$

$\Rightarrow R_A = R_E \sin\theta$ ——— (i)

$\Sigma F_y = 0$

$\Rightarrow R_E \cos\theta - \omega = 0$

$\Rightarrow R_E = \frac{\omega}{\cos\theta}$ ——— (ii)

$l\cos\theta = 2.5''$

$l = \frac{2.5''}{\cos\theta}$

$\Sigma M_A = 0$

~~$\omega \times 3\cos\theta - R_E \cos\theta \times 2.5 = 0$~~

$\Rightarrow$ ~~$\omega \times 3\cos\theta - \frac{\omega}{\cos\theta} \times \cos\theta \times 2.5 = 0$~~

$\Rightarrow$ ~~$15\cos\theta - 12.5 = 0$~~

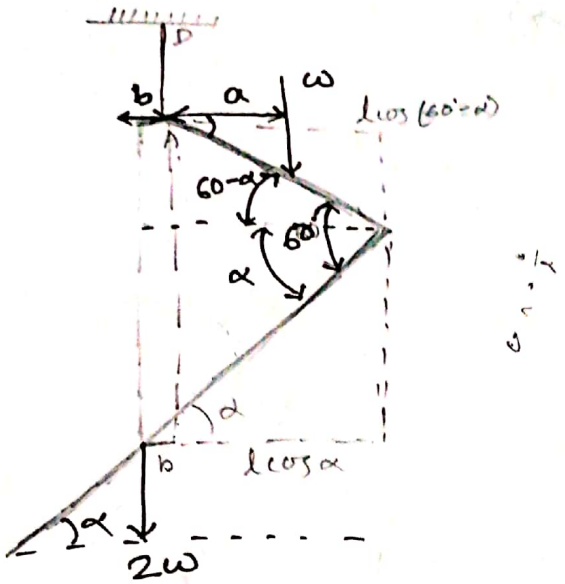
$\Rightarrow \omega \times 3\cos\theta - R_E \times l = 0$

$\Rightarrow 15\cos\theta - \frac{\omega}{\cos\theta} \times \frac{2.5''}{\cos\theta} = 0$

$\Rightarrow 15\cos^3\theta - 12.5 = 0$

$\Rightarrow \theta = 19.85°$ Ans.

Problem -21



$$a = \frac{l}{2}\cos(60^\circ - \alpha)$$

$$b = l\cos\alpha - l\cos(60^\circ - \alpha)$$

$$\sum M_A = 0$$

$$\Rightarrow \omega \times a - 2\omega \times b = 0$$

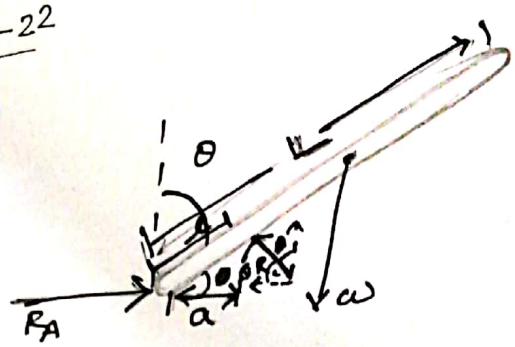
$$\Rightarrow \omega \times \frac{l}{2}\cos(60^\circ - \alpha) - 2\omega\left(l\cos\alpha - l\cos(60^\circ - \alpha)\right) = 0$$

$$\Rightarrow 5l\cos(60^\circ - \alpha) - 4l\cos\alpha = 0$$

$$\Rightarrow 5\cos(60^\circ - \alpha) - 4\cos\alpha = 0$$

$$\Rightarrow \alpha = 19.10^\circ \quad \text{Ans.}$$

Problem – 22



$\Sigma F_y = 0$

$R_L \sin\theta - \omega = 0$

$R_L = \frac{\omega}{\sin\theta}$ ---- (1)

$\Sigma M_A = 0$

$\omega \times \frac{L}{2}\sin\theta - R_L \times l = 0$

$\omega \times \frac{L}{2}\sin\theta - \frac{\omega}{\sin\theta} \times \frac{a}{\sin\theta} = 0$

$a = l\sin\theta$

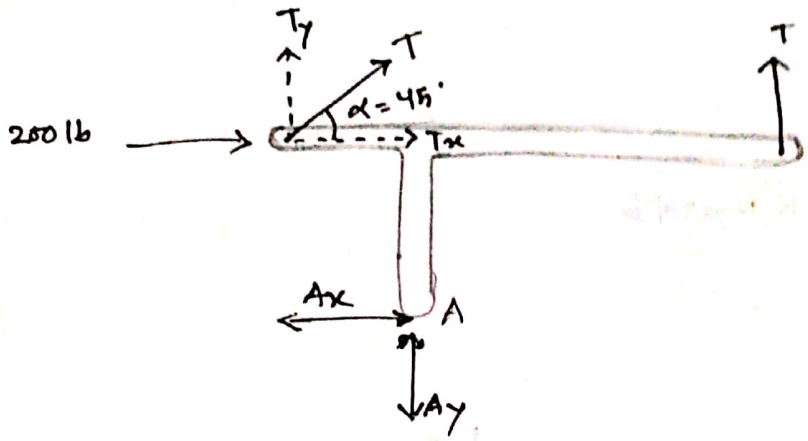
$l = \frac{a}{\sin\theta}$

$\Rightarrow \sin^3\theta \times \frac{L}{2} - a = 0$

$\Rightarrow \sin^3\theta = \frac{2a}{L}$

$\Rightarrow \theta = \sin^{-1}\sqrt[3]{\frac{2a}{L}}$ Ans.

Problem-23



$\sum M_A = 0$

$200 \times 4 + T_x \times 4 + T_y \times 2 - T \times 6 = 0$

$T_x = T\cos 45°$

$T_y = T\sin 45°$

$200 \times 4 + T\cos 45° \times 4 + 2\sin 45° \times 2 - T \times 6 = 0$

$T = 455.23$ lb Ans.

$\sum F_x = 0$

$\Rightarrow T\cos 45° + 200 - A_x = 0$

$\Rightarrow A_x = 521.89$ lb

$\sum F_y = 0$

$T + T\sin 45° - A_y = 0$

$A_y = 777.12$ lb

$A = \sqrt{A_x^2 + A_y^2}$

$= 936.10$ lb Ans.

Problem-25

Consider the free body diagram of body C

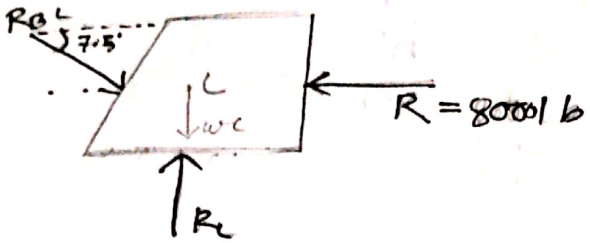


Fig-01

$\Sigma F_x = 0$

$R_{BC}\cos 7.5 - R = 0$

$R_{BC} = \frac{8000}{\cos 7.5}$

$= 8069.03$ lb (Ans)

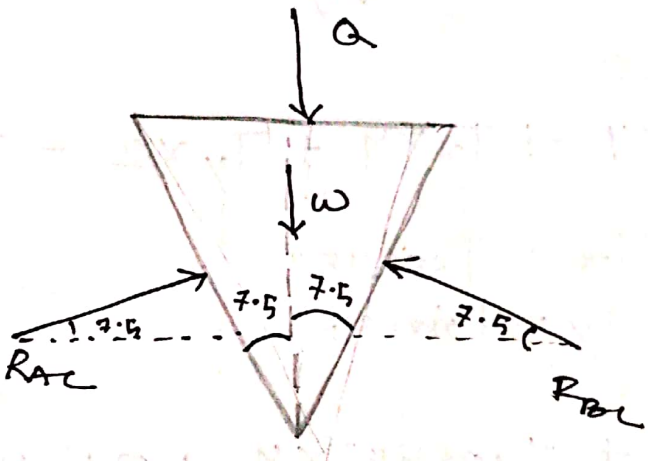


Fig-02

$\Sigma F_x = 0$

$R_{AC}\cos 7.5° - R_{BC}\cos 7.5° = 0$

$\Rightarrow R_{AC} = R_{BC}$ (Ans)

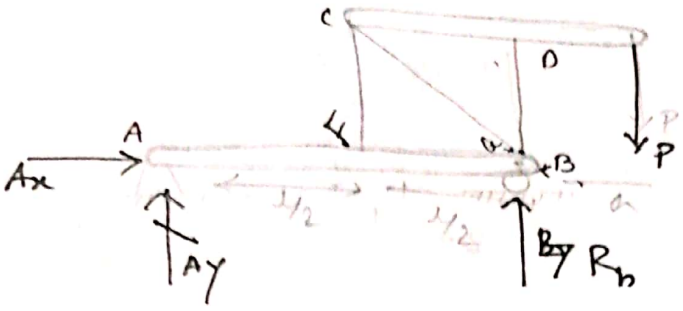
$\Sigma F_y = 0$

$Q + W_B - R_{AC}\sin 7.5° - R_{BC}\sin 7.5° = 0$

$Q = (2R_{BC}\sin 7.5° - 500)$ lb

$= 1606.43$ lb Ans.

Problem-24



$\Sigma M_A = 0$

$P \times (l+a) \phi - R_b \times 12 = 0$

$\Rightarrow P \times 16 - R_b \times 12 = 0$

$\Rightarrow R_b = \frac{4P}{3}$ Ans.

$\Sigma F_x = 0$

$Ax = 0$

$\Sigma F_y = 0$

$-P + R_b + Ay = 0$

$-P + \frac{4P}{3} + Ay = 0$

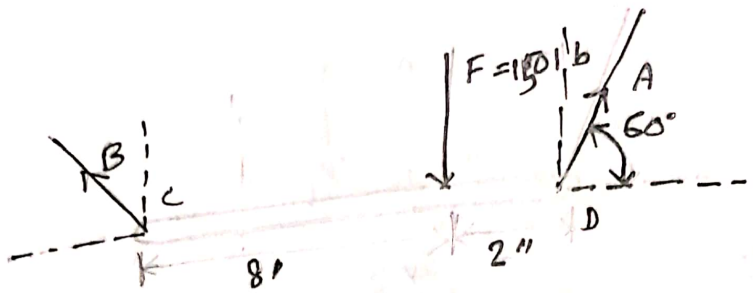
$Ay = -\frac{P}{3}$

$R_a = \sqrt{Ax^2 + Ay^2}$

$= \sqrt{\left(\frac{P}{3}\right)^2 + 0}$

$= \frac{P}{3}$ Ans.

Problem-27



$\sum M_C = 0$

$\Rightarrow F \times 8 - T_A \sin 60^\circ \times 10 = 0$

$\Rightarrow 150 \times 8 - T_A \sin 60^\circ \times 10 = 0$

$\Rightarrow T_A = 138.56$

$= \omega_A = 138.56$ lb Ans.

$\sum F_y = 0$

$T_A \sin 60^\circ + T_B \sin\alpha - F = 0$

$\Rightarrow T_B \sin\alpha = 30$ ——— (i)

$\sum F_x = 0$

$T_A \cos 60^\circ = T_B \cos\alpha$

$T_B \cos\alpha = 69.25$ ——— (ii)

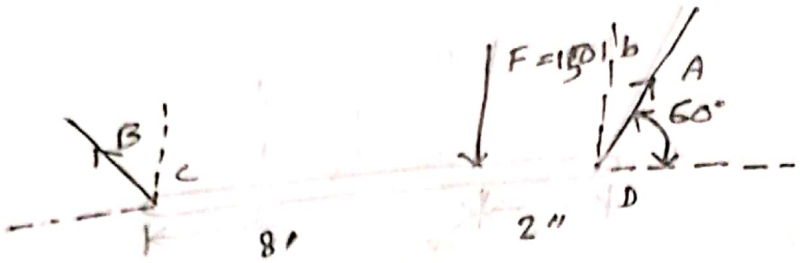
(i) ÷ (ii)

$\alpha = \tan^{-1} \frac{30}{69.25}$

$\alpha = 23.92^\circ$

$\omega_B = T_B = \frac{30}{\sin\alpha} = 75.5$ lb Ans.

Problem-27



$\Sigma M_c = 0$

$\Rightarrow F \times 8 - T_A \sin 60^\circ \times 10 = 0$

$\Rightarrow 150 \times 8 - T_A \sin 60^\circ \times 10 = 0$

$\Rightarrow T_A = 138.56$

$= CO_A = 138.56$ lb Ans.

$\Sigma F_y = 0$

$T_A \sin 60^\circ + T_B \sin\alpha - F = 0$

$\Rightarrow T_B \sin\alpha = 30$ ——— (i)

$\Sigma F_x = 0$

$T_A \cos 60^\circ = T_B \cos\alpha$

$T_B \cos\alpha = 69.25$ ——— (ii)

(i) ÷ (ii)

$\alpha = \tan^{-1} \frac{30}{69.25}$

$\alpha = 23.42^\circ$

$CO_B = T_B = \frac{30}{\sin\alpha} = 75.5$ lb Ans.

Problem-28 =??

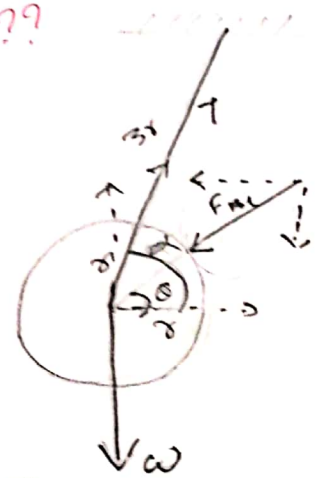


Fig-1

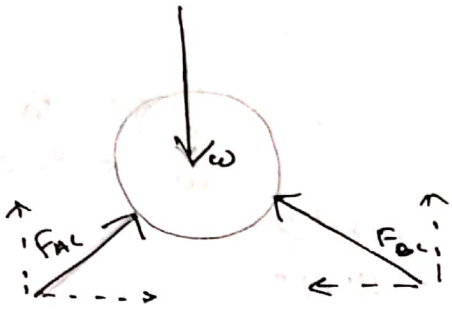


Fig-2

$$\cos\alpha = \frac{\gamma}{4\gamma}$$

$$\alpha = 75.5^\circ$$

$$\cos\theta = \frac{\gamma}{\gamma + \gamma/2}$$

$$\theta = 48.2^\circ$$

For Fig-2

$$\Sigma F_x = 0$$

$$F_{AC}\cos 48.2^\circ - F_{BC}\cos 48.2^\circ = 0$$

$$F_{AC} = F_{BC}$$

and

$$\Sigma F_y = 0$$

$$W - F_{AC}\sin 48.2^\circ - F_{BC}\sin 48.2^\circ = 0$$

$$W = 2F_{AC}\sin 48.2^\circ$$

For Fig-01

$$\Sigma F_x = 0$$

$$F_{AC}\cos 48.2^\circ - T\cos 75.5^\circ = 0$$

$$T = \frac{F_{AC}\cos 48.2^\circ}{\cos 75.5^\circ} \quad \text{——(i)}$$

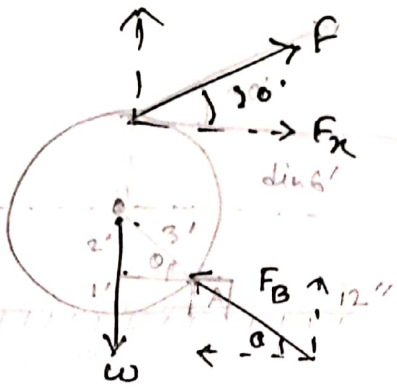
$$\Sigma F_y = 0$$

$$F_{AC}\sin 48.2^\circ + W - T\sin 75.5^\circ = 0$$

$$\frac{3F_{AC}\sin 48.2^\circ}{\sin 75.5^\circ} = T \quad \text{——(ii)}$$

3

Problem-34



$$\theta = \sin^{-1}\frac{2}{3}$$
$$= 41.81°$$

$$\sum F_x = 0$$

$$F\cos 30° - F_B \cos 41.81° = 0$$

$$\Rightarrow F = F_B \times 0.86$$

$$\sum F_y = 0$$

$$F\sin 30° - \omega + F_B \sin 41.81° = 0$$

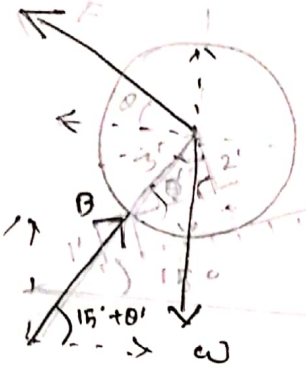
$$F_B \sin 30° \times 0.86 - \omega + F_B \sin 41.81° = 0$$

$$F_B = 455.79 \text{ lb} \quad \text{Ans.}$$

$$F_C = 0 \quad \text{Ans.}$$

$$F = 455.79 \times 0.86$$
$$= 391.97 \text{ lb} \quad \text{Ans.}$$

Problem -32 = ??



$$\theta' = \sin^{-1}\frac{2}{3}$$
$$= 41.81°$$

$$\Sigma F_x = 0$$

$$F\cos\theta - F_B \sin\cos 15° + \theta' = 0$$

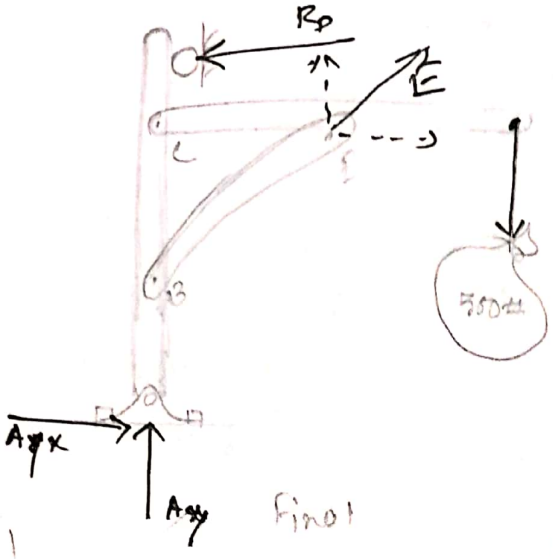
$$F\cos\theta = F_B \cos 56.81°$$

$$\Sigma F_y = 0$$

$$F\sin\theta + F_B \sin(15° + \theta') - \omega = 0$$

$$F\sin\theta = 1000 - F_B \sin 56.81°$$

Problem – 38



Full fig-01

$\Sigma M_A = 0$

$R_D \times 14 - 500 \times 10 = 0$

$\Rightarrow R_D = 357.14$ lb ——— (*)

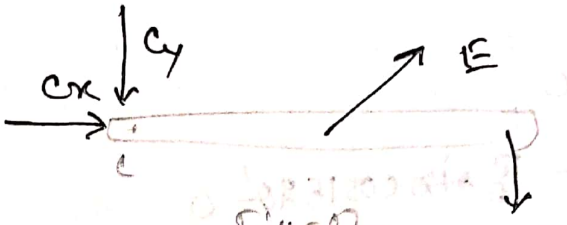


Fig-02

$\Sigma F_x = 0$

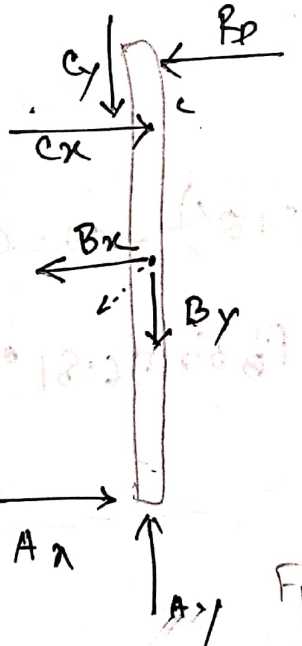
$A_x - R_D = 0$

$A_x = 357.14$ lb ——— (*)

$\Sigma F_y = 0$

$A_y - 500 = 0$

$A_y = 500$ lb ——— (*)



For fig-02

$\Sigma M_C = 0$

$500 \times 10 - E_y \times 8 = 0$

$E_y = 625$ lb ——— (*)

$\Sigma M_B = 0$

$A_x \times 4 + C_x \times 8 + R_D \times 10 = 0$

$\therefore C_x = 625$ lb ——— (*)

Fig-03

For fig-02

$\Sigma C_y = 0$

$500 + C_y - 625 = 0$

$C_y = 125$ lb ——— (*)

For fig – 03

$\Sigma F_x = 0$

$-B_D \cancel{A_y}^{+} A_x + C_x - B_x = 0$

$B_x = 625 \text{ lb}$ ——— ⊛

$\Sigma F_y = 0$

$C_y + B_y - A_y = 0$

$125 + B_y - 500 = 0$

$B_y = 375$ ——— ⊛

$F_B = \sqrt{625^2 + 375^2}$

$= 728.86$ Ans.

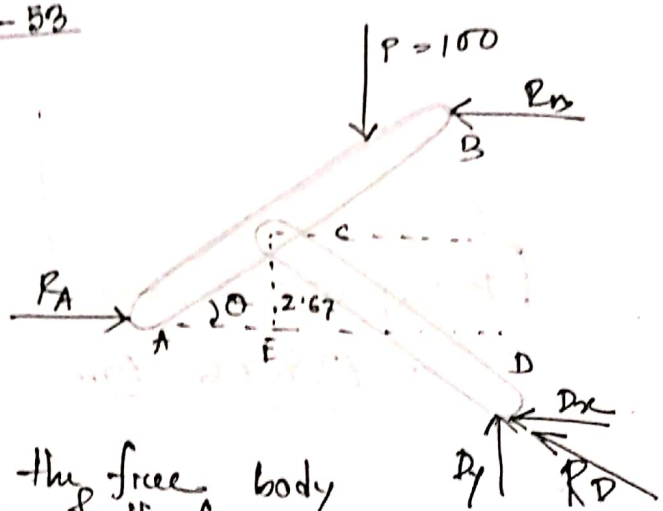
$C_x = 625 \text{ lb}$

$C_y = 125 \text{ lb}$

$\therefore F_C = \sqrt{625^2 + 125^2}$

$= 637.35 \text{ lb}$ Ans.

Problem - 53



Consider the free body diagram of the frame.

$\theta = \tan^{-1}\frac{8}{12}$

$= 33.69$

$CE = 4 \times \tan\theta$

$= 2.67$

$\Sigma M_C = 0$

$\Rightarrow 100 \times 6 - R_B \times 5.33 - R_A \times 2.67 = 0$

$\Rightarrow 2.67 R_A + 5.33 R_B = 600$ ——— (i)

$\Sigma M_D = 0$

$R_A \times 4 - 100 \times 2 - R_B \times 12 = 0$

$R_A - 3R_B = 50$ ——— (ii)

Solving R_A and R_B

$R_A = 154.9$ lb Ans.

$R_B = 34.97$ lb Ans.

$\Sigma F_y = 0$

$P - D_y = 0$

$D_y = 100$ lb ——— (iii) Ans

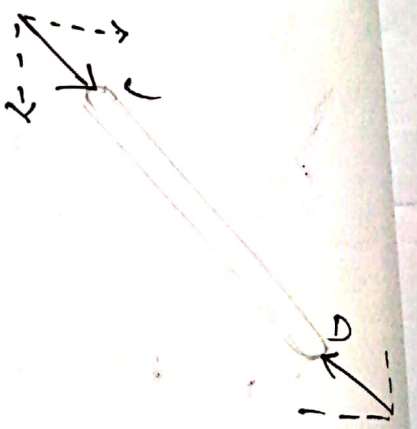
$\Sigma F_x = 0$

$R_A - R_B - D_x = 0$

$154.9 - 34.97 - D_x = 0$

$D_x = 119.93$ lb Ans.

Consider the free body diagram of CD



$\Sigma F_x = 0$

$C_x - D_x = 0$

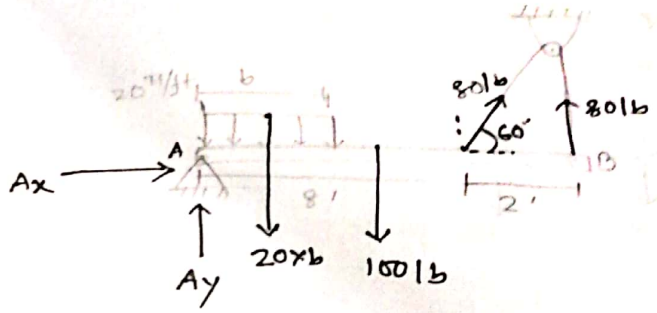
$C_x = 119.93$ lb Ans.

$\Sigma F_y = 0$

$D_y - C_y = 0$

$C_y = 100$ lb Ans.

Problem-37



$\Sigma M_A = 0$

$20 \times b \times \frac{b}{2} + 160 \times 5 - 80 \times 10 - 80 \sin 60° \times 8 = 0$

$\Rightarrow b = 9.24'$ Ans.

Again,

$\Sigma F_x = 0$

$\Rightarrow A_x + 80 \cos 60° = 0$

$\Rightarrow A_x = -40$ lb ($\leftarrow$)

$\Sigma F_y = 0$

$A_y + 80 \sin 60° - 9.24 \times 20 - 160 + 80 = 0$

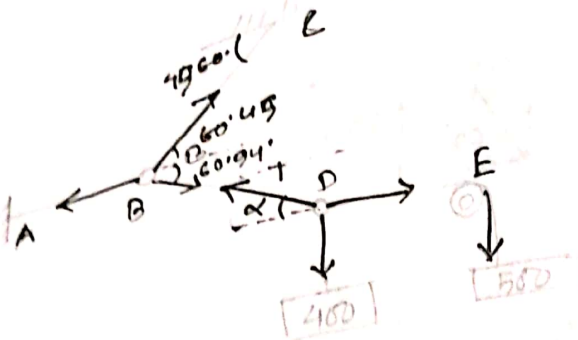
$A_y = 135.31$ lb

$R_A = \sqrt{A_x^2 + A_y^2}$

$= \sqrt{40^2 + 135.31^2}$

$= 141.29$ lb Ans.

Problem-69



At point D

$\Sigma F_x = 0$

$\Rightarrow T\cos\alpha = 500$ ---- (1)

$\Sigma F_y = 0$

$\Rightarrow T\sin\alpha - 400 - 500 = 0$

$\Rightarrow T\sin\alpha = 900$ 400 ---- (2)

$T^2 = 500^2 + 900^2$ 400^2

$T = 1029.56$ 640.312

$\tan\alpha = \frac{9}{5}$

$\alpha = \tan^{-1}\frac{9}{5} = 60.94°$ 38.65°

At point B, $\Sigma F_y = 0$

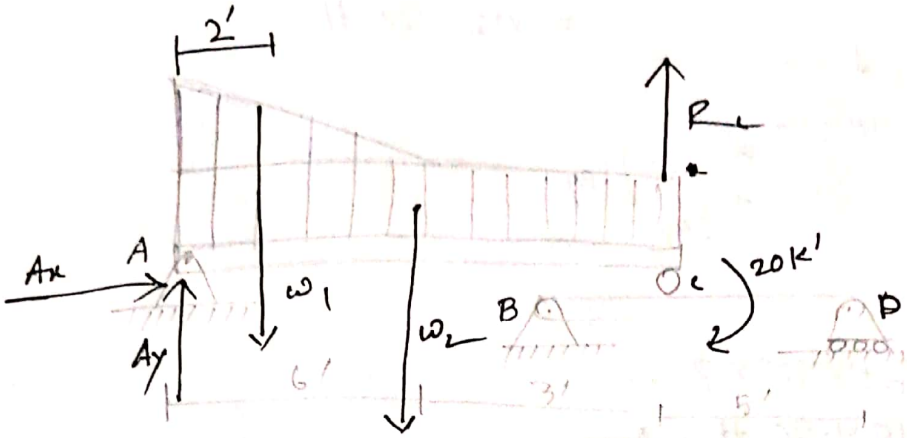
$T_{BD}\sin 60.94 - T_{BC}\sin 60° = 0$

640.312 38.65

$\Rightarrow T_{BC} = \frac{1029.56 \sin 60.94}{\sin 60.49}$

$= 565.44$ lb Ans.

Problem - 75



$\Sigma M_A = 0$

$30 \times 2 + 45 \times 5 - R_L \times 9 = 0$

$R_L = 29.16$ lb Ans.

$\omega_1 = \frac{1}{2} 6 \times 10 = 30$ K

$\omega_2 = 5 \times 9 = 45$ K

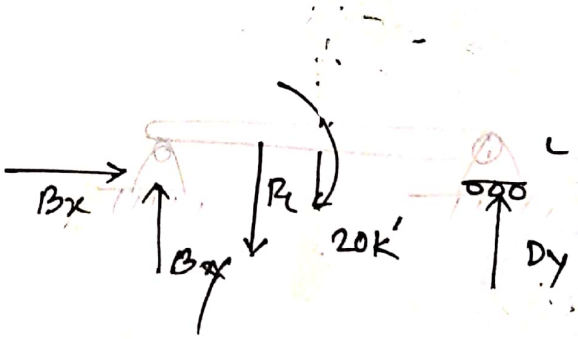
$\Sigma F_x = 0$

$Ax = 0$

$\Sigma F_y = 0$

$-Ay + 30 + 45 - 29.16 = 0$

$Ay = 45.84$ lb Ans.



$\Sigma M_B = 0$

$20 + R_L \times 3 + D_y \times 8 = 0$

$\Rightarrow 20 + 29.16 \times 3 + D_y \times 8 = 0$

$\Rightarrow D_y = 13.435$ Ans.

$\Sigma F_x = 0$

$\Rightarrow B_x = 0$

$\Sigma F_y = 0$

$B_y - R_L + R_D = 0$

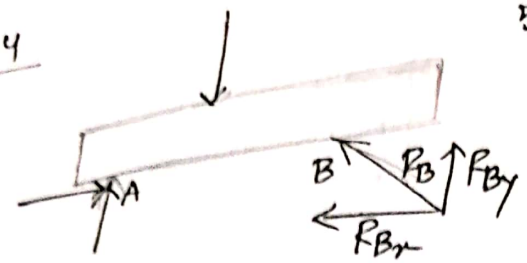
$B_y = 15.731$ lb

$R_B = \sqrt{15.73^2}$

$= 15.731$ lb Ans

Problem – 74

$50 \times 12 = 600\ \#$



$\Sigma M_A = 0$

$600 \times 4 - R_B \sin 45° \times 8 = 0$

$R_B = 424.26\ \#$ Ans.

$\Sigma F_x = 0$

$A_x = R_B \cos 45°$

$= 300\ \#$

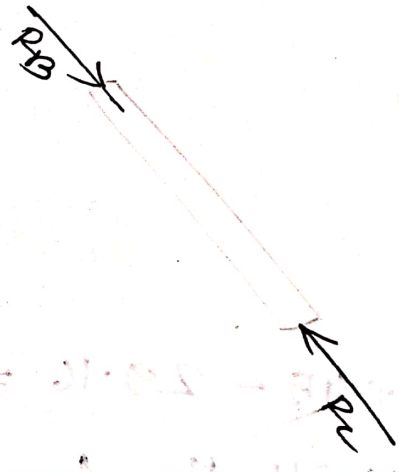
$\Sigma F_y = 0$

$A_y + R_B \sin 45° = 600$

$A_y = 300$

$R_A = \sqrt{300^2 + 300^2}$

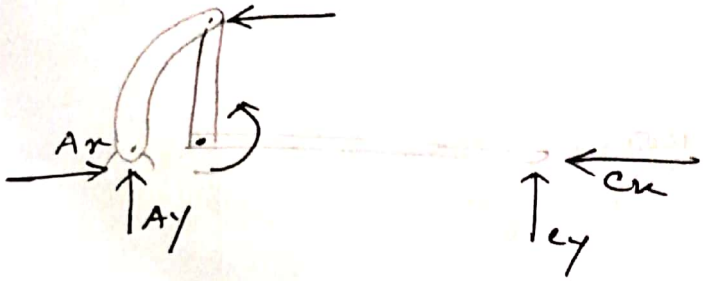
$= 424.26\ \#$ Ans.



$R_B = R_c$

$\therefore R_c = 424.26\ \#$ Ans.

Problem-73

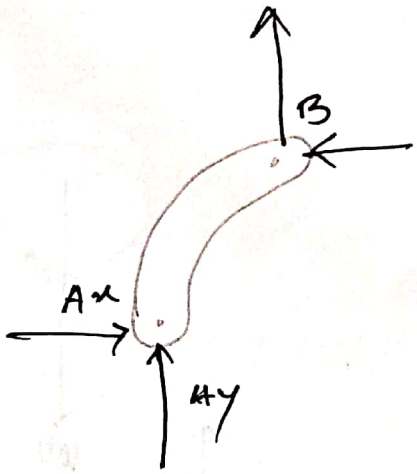


$\Sigma M_A = 0$

$-10 - C_y \times 6 = 0$

$C_y = -1.67\ k$

$\therefore C_y = 1.67k\ (\downarrow)$ Ans.



$\Sigma F_y = 0$

$A_y - C_y = 0$

$A_y = 1.67\ k$ Ans.

$\Sigma F_x = 0$

$A_x = C_x$

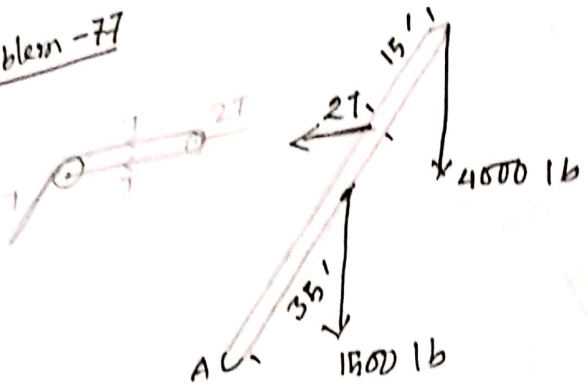
$\Sigma M_B = 0$

$A_y \times 2 - A_x \times 2 = 0$

$A_x = 1.67$ Ans.

$C_x = 1.67$ Ans.

Problem -7

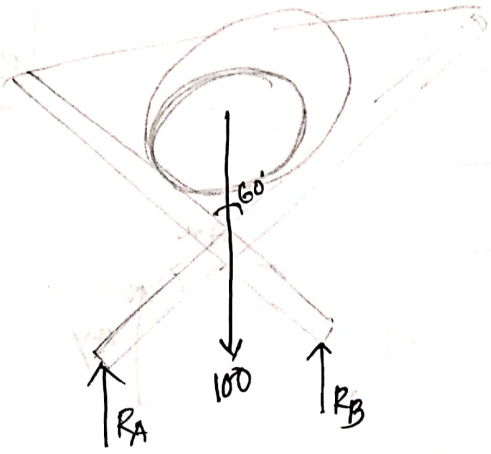


$\Sigma M_A = 0$

$1500 \times 25 \sin 30^\circ + 41000 \times 50 \sin 30^\circ - 2T \sin 75^\circ \times 35 = 0$

$\Rightarrow T = 1756.272$ lb Ans.

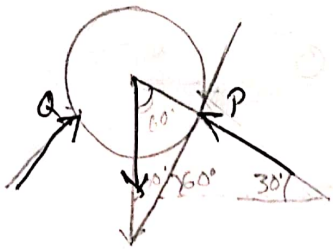
Problem-8



$\Sigma F_y = 0$

$R_A + R_B = 100$

$R_A = R_B = 50$ lb



$\Sigma F_y = 0$

$R_P \sin 30^\circ + R_Q \sin 30^\circ = 100$

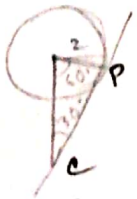
$R_P + R_Q = 50$

$\Sigma F_x = 0$

$R_P \cos 30^\circ = R_Q \cos 30^\circ$

$\Rightarrow R_P = R_Q$

$\therefore R_P = R_Q = 100$ lb



$\tan 30° = \frac{2}{CP}$

$CP = 3.464$

$\Sigma M_C = 0$

~~50×7.464~~

$\sin 30 \times 80 \times 4 + 100 \times 3.464 + d - T \sin 60° \times 6 = 0$

$\Rightarrow T = 85.83$ lb Ans.

88.

$\omega_2 = 20$ lb Ans.

$\omega_3 = 40$ Ans.

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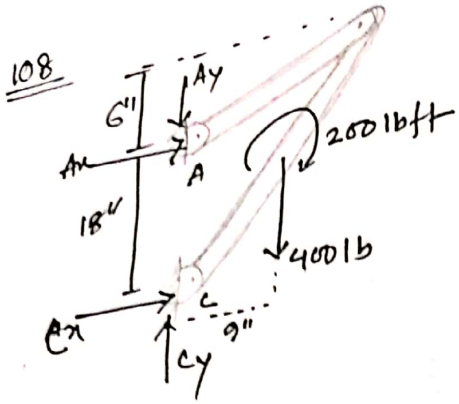

$\Sigma M_C = 0$

$450 \times 9 + 200 \times 12 + Ax \times 18 = 0$

$Ax = -333.33$ lb ($\leftarrow$) Ans.

$\Sigma F_x = 0$

$Cx = Ax = 333.33$ lb Ans.

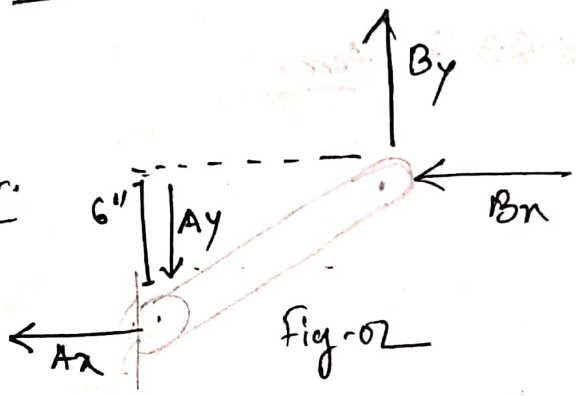

Fig-02

Fig-02

$\Sigma M_B = 0$

$Ax \times 6 - Ay \times 18 = 0$

$Ay = 111.11$ lb Ans.

Fig-01

$\Sigma F_y = 0$

$Cy - 400 + 111.11 = 0$

$Cy = 511.11$ lb Ans.

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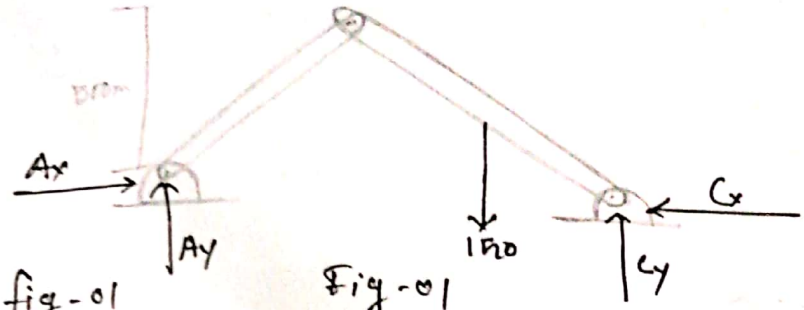
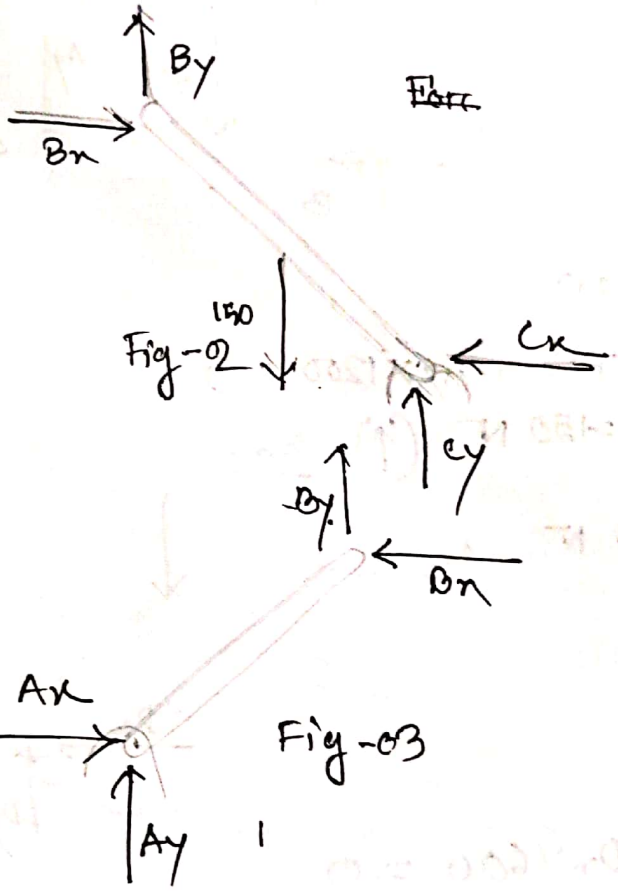


For fig-01 Fig-01

$\Sigma M_A = 0$

$150 \times 1000 - C_y \times 1400 = 0$

$\Rightarrow C_y = 107.14\ N$



For Fig-02

$\Sigma F_y = 0$

A_y

$150 - 107.14 - B_y = 0$

A_y ~~B_y~~ $= 42.86\ N$

~~$\Sigma M_B = 0$~~ $\Sigma F_x = 0$

$A_x = C_x$

~~$C_y \times 107.$~~

~~$C_y \times 1000$~~

Fig-03

For fig-03

$\Sigma M_B = 0$

$\uparrow A_y \times 400 - A_x \times 350 = 0$

$A_x = 34.288\ N$

$C_x = 34.288\ N$

$F_A = \sqrt{42.86^2 + 34.288^2}$

$= 54.89\ N$ Ans.

$R_e = \sqrt{107.14^2 + 34.288^2}$

$= 112.49\ N$ Ans.

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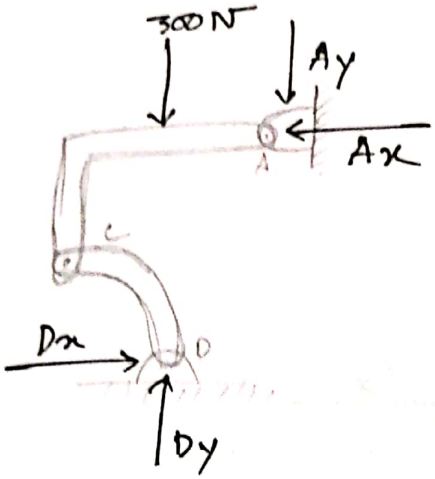


$\Sigma F_x = 0$

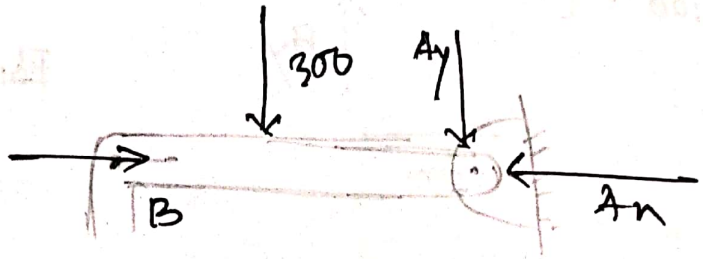
$A_x - D_x = 0$

$A_x = D_x$ ——— (I)

$\Sigma F_y = 0$

$A_y + 300 - D_y = 0$

$A_y = D_y - 300$ ——— (II)

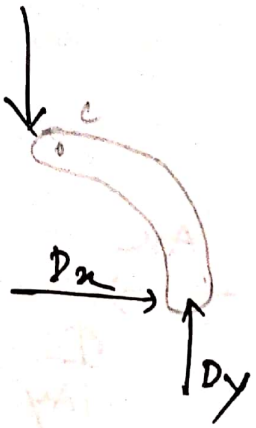


$\Sigma M_B = 0$

$300 \times 600 + A_y \times 1200 = 0$

$A_y = -150$ N (↑) Ans.

$D_y = 150$ N Ans.



$\Sigma M_C = 0$

$-D_y \times 600 - D_x \times 600 = 0$

$D_x = -150$ N (←) Ans.

$A_x = -150$ N (→) Ans.

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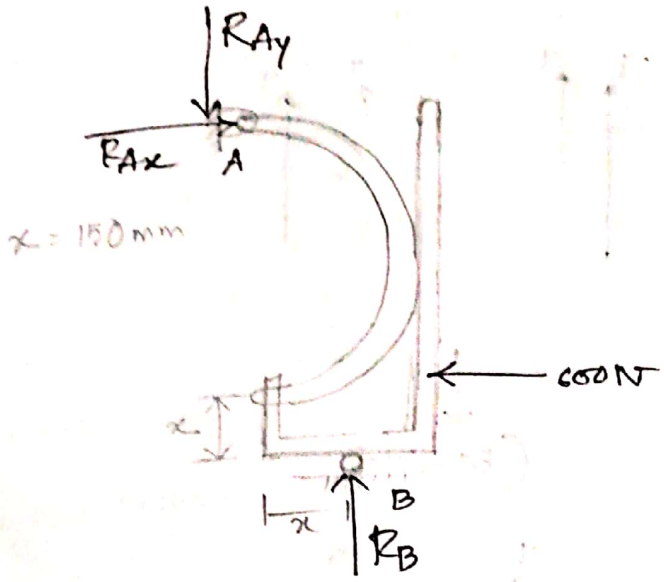


$\Sigma F_x = 0$

$\Rightarrow R_{Ax} = 600\ N$ Ans.

$\Sigma F_y = 0$

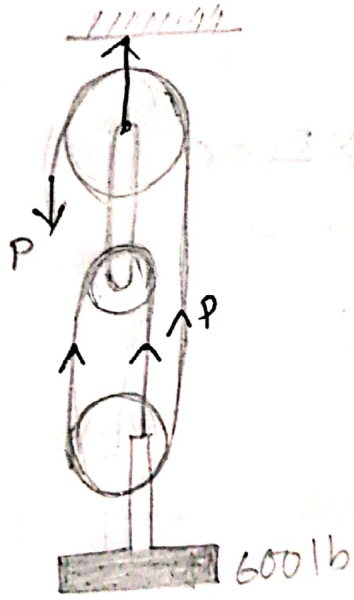
$R_{Ay} = R_B$

$\Sigma M_A = 0$

$-R_B \times 150 + 600 \times 600 = 0$

$R_{Ay} = R_B = 2400$ Ans.

140



$P + P + P - 600 = 0$

$P = 200\ lb$

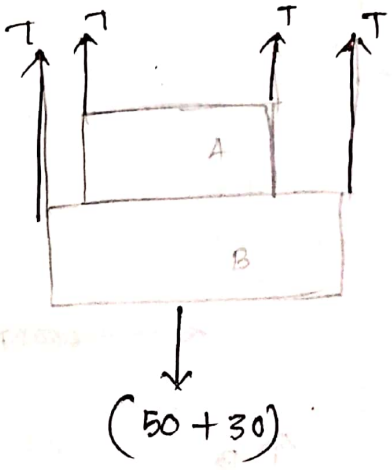
$T_{CD} - P - P - P - P = 0$

$T_{CD} = 800\ lb$ Ans.

145

$T+T+T+T = 80\ lb$

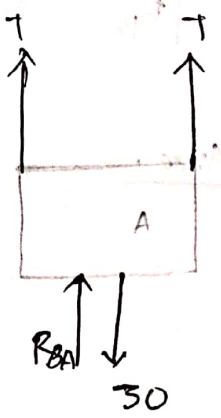
$T = 20\ lb$ Ans.



$\Sigma F_y = 0$

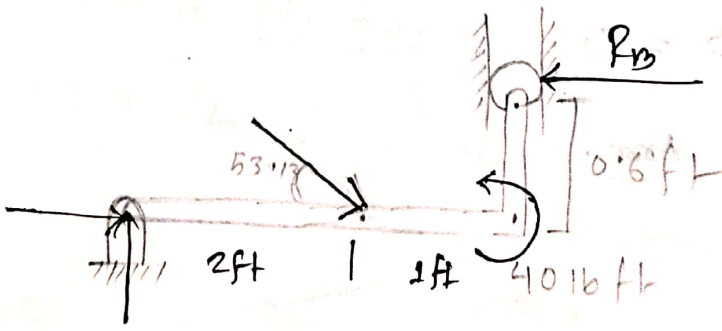
$T+T+R_{BA}-80 = 0$

$R_{BA} = 10\ lb$ Ans.



~~148~~

102

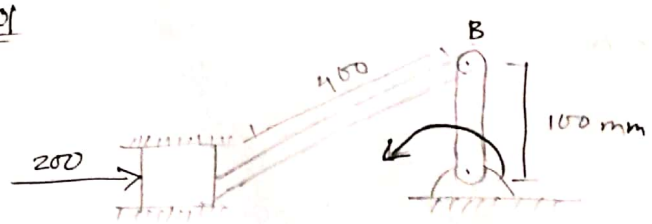


$\Sigma M_A = 0$

$-R_B \times 0.6 - 40 + 80 \sin 53.13 \times 2 = 0$

$\Rightarrow R_B = 146.67\ lb$ Ans.

110)

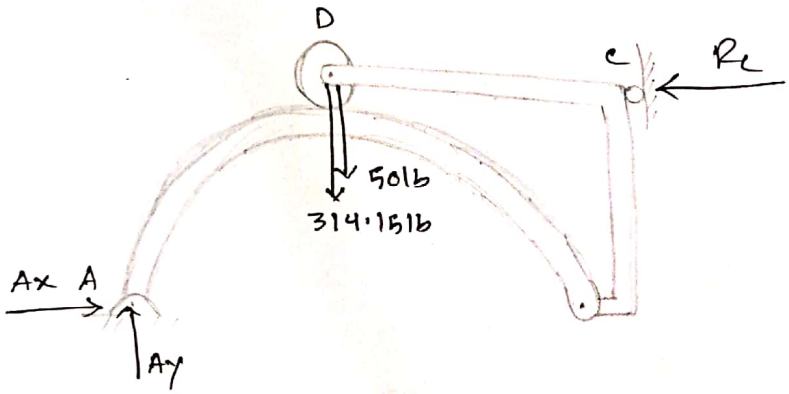


$\Sigma M_B = 0$

$-200 \times 0.1 + M = 0$

$M = 20$ N-m

148)



$\Sigma M_A = 0$

$50 \times 5 + 314.15 \times 5 - F_c \times 6 = 0$

$R_c = 303.45$ lb Ans.

$\Sigma F_x = 0$ $\qquad$ $\Sigma F_y = 0$

$A_x - R_c = 0$ $\qquad$ $A_y - 50 - 314.15 = 0$

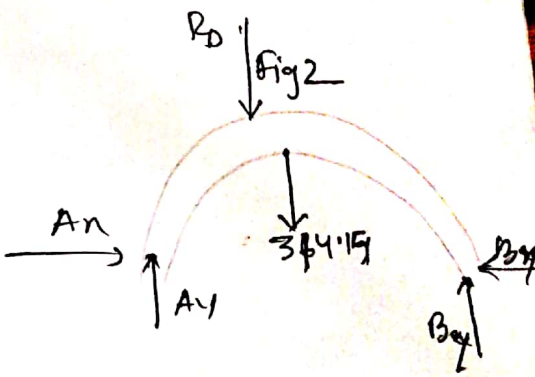
$A_x = 303.45$ lb $\qquad$ $\Rightarrow A_y = 364.15$ lb

for fig-02

$\Sigma F_x = 0$

$A_x = B_x = 303.45$ lb Ans.

~~$\Sigma F_y = 0$~~



$\Sigma M_B = 0$

$A_y \times 10 - 314.15 \times 5 - R_D \times 5 = 0$ $\qquad$ $R_D =$ ~~121.66~~ 414.15

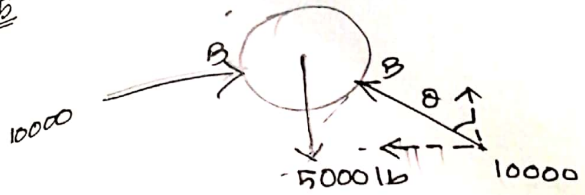
$\Sigma F_y = 0$

$314.5 + 414.15 - 364.15 - B_y = 0$

$B_y = 364.5$ Ans.

233

205

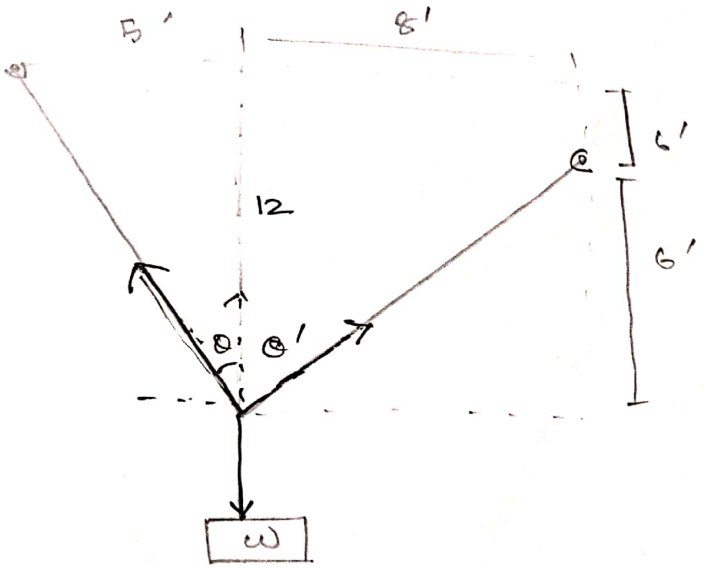


$\Sigma F_y = 0$

$1000 \cos\theta = 5000$

$\theta = 60°$ Ans.

230



$\theta = \tan^{-1}\frac{5}{12}$ $\quad \theta' = \tan^{-1}\frac{8}{6}$

$= 22.61$ $\quad \theta' = 53.13$

$\Sigma F_y = 0$

$650 \cos\theta + 650 \cos\theta' = w$

$\Rightarrow w = 990 \text{ lb}$ Ans.

248

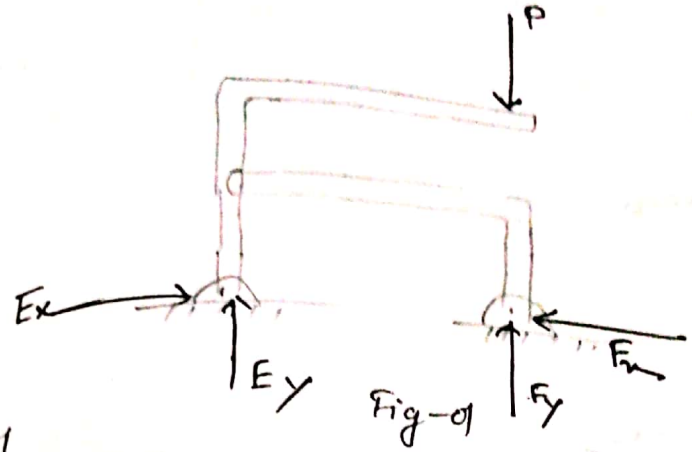


Fig-01

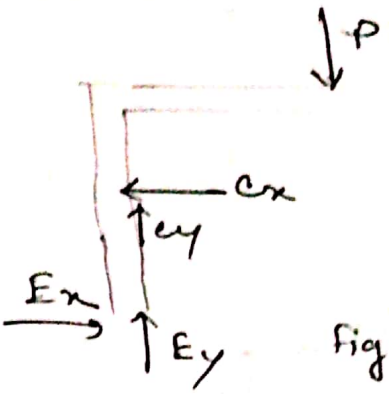


Fig-02

for-01

$\Sigma M_F = 0$

$E_y \times 12 = 0$

$E_y = 0$ Ans.

$\Sigma F_y = 0$

$E_y + F_y = 180$

$F_y = 180$

fig-02

$\Sigma F_x = 0$

$E_x = C_x$

$\Sigma F_y = 0$

$E_y + C_y = 180$

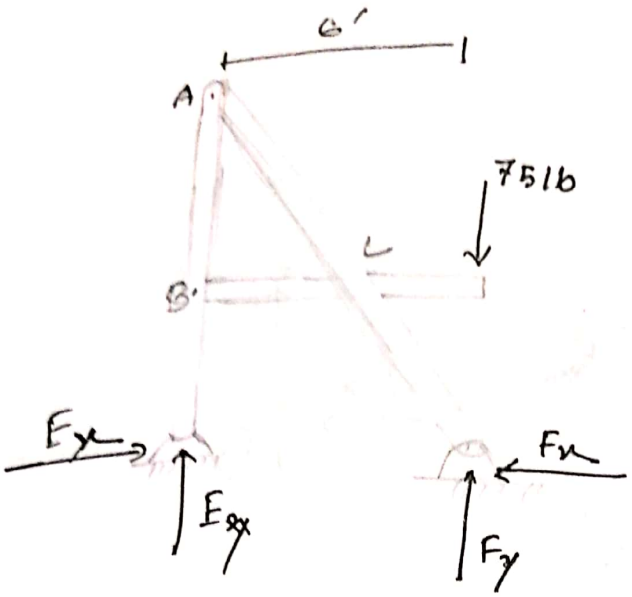
$C_y = 180$ lb Ans.

$\Sigma M_e = 0$

$180 \times 12 - E_x \times 5 = 0$

$E_x = C_x = 432$ lb Ans.

25)



$\Sigma M_E = 0$

$75 \times 6 - F_y \times 8 = 0$

$\Rightarrow F_y = 56.25$ lb

$\Sigma F_x = 0$

$F_x = F_x$

$\Sigma F_y = 0$

$56.25 + E_y = 75$

$\Rightarrow E_y = 18.75$ lb Ans

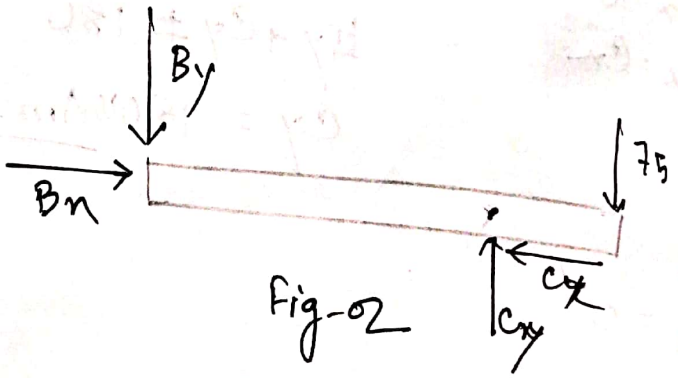


Fig-02

For fig-02

$\Sigma M_B = 0$

$75 \times 6 - C_y \times 4 = 0$

$C_y = 112.5$ lb

$\Sigma F_x = 0$

$B_x = C_x$

$\Sigma F_y = 0$

$C_y - B_y - 075 = 0$

$\Rightarrow B_y = 37.5$ lb

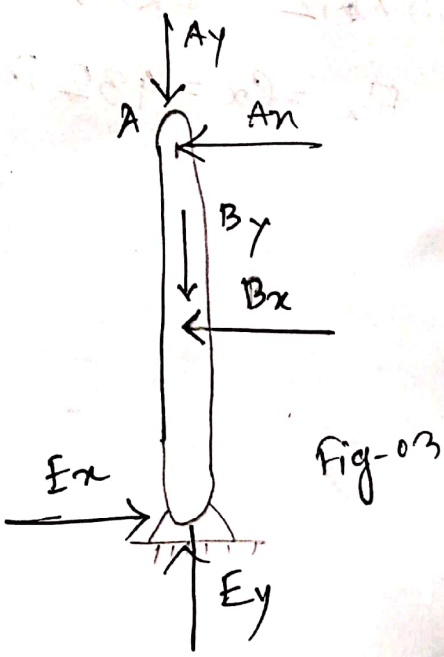


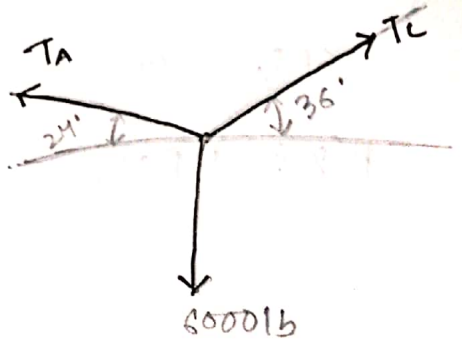
Fig-03

for fig-03

$\Sigma M_A = 0$

$\Sigma M_E = 0$

17.4



from fig-02

$\Sigma F_{Rx} = 0$

$T_A \cos 24° - T_C \cos 36° = 0$

$\Sigma F_{Ry} = 0$

$T_A \sin 24° + T_C \sin 36° = 6000$

$T_A = 6033.1\ lb$

$T_C = 6033\ lb$

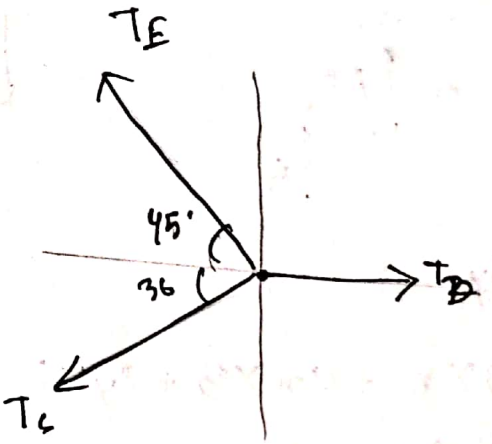
for fig-02

$\Sigma F_{Rx} = 0$

$T_C \cos 36° + T_E \cos 45° = T_D$

$T_D - T_E \cos 45° = 4880.8$

$T_D = 8426.90\ lb$ Ans.

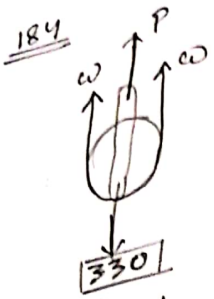


$\Sigma F_{Ry} = 0$

$T_E \sin 45° = T_C \sin 36°$

$T_E = 5014.95\ lb$

184



For fig-01

$2\omega + P = 330$

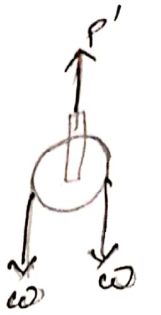
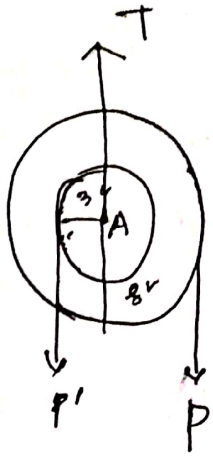


fig-02

$2\omega = P'$



$\Sigma M_A = 0$

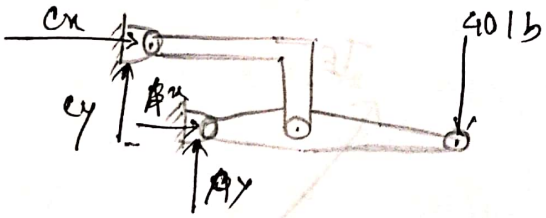
$-P' \times 3 + P \times 8 = 0$

$-2\omega \times 3 + (330 - 2\omega) \times 8 = 0$

$\Rightarrow -6\omega + 2640 - 16\omega = 0$

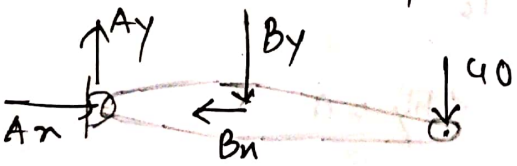
$\Rightarrow \omega = 120\ lb$ Ans.

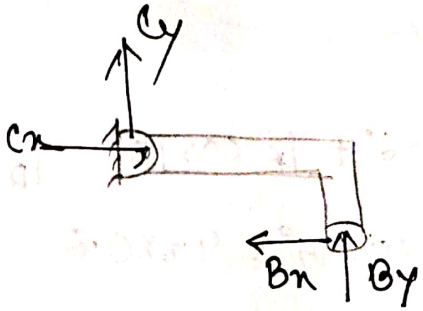
294



$-\Sigma M_A = 0$

$40 \times 8 + C_x \times 3 + C_y \times 1 = 0$





$\Sigma M_A = 0$

$By \times 3 + 40 \times 8 = 0$

$By = 106.66\ lb\ (\uparrow)$

for fig-03

$\Sigma M_c = 0$

$+ B_x \times 3 ~~-106 \times 4 = 0$

$B_x = 142.21$ lb

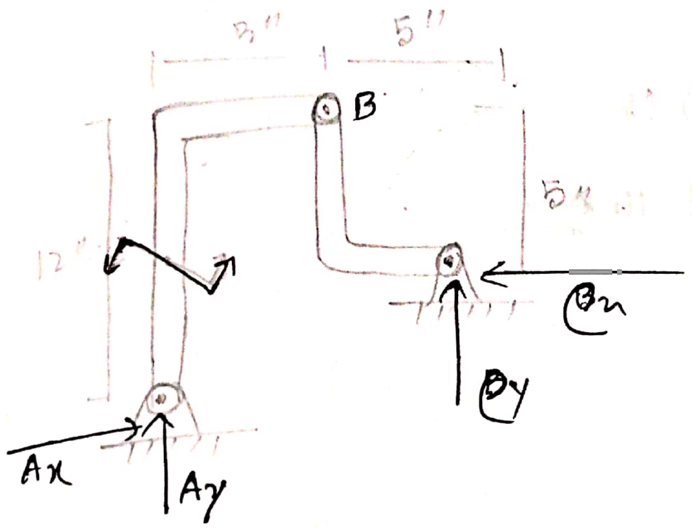
$\Sigma F_x = 0$

$C_x = B_x = 142.21$ lb

$\Sigma F_y = 0$

$A_y = -B_y = 106.66$ lb ($\downarrow$)

295



$\Sigma M_A = 0$

$~~-C_x \times 7 - C_y \times 10 - 50 \times 12 = 0$

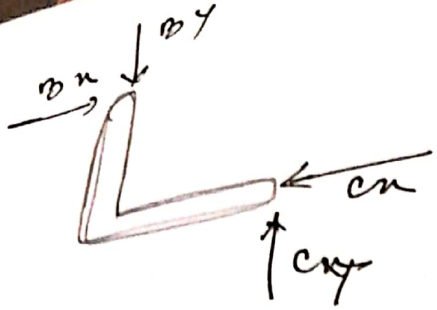
$\Rightarrow 7C_x + 10C_y + 600 = 0$

$\Sigma F_x = 0$

$A_x = C_x$

$\Sigma F_y = 0$

$C_y = -A_x$



$\Sigma M_B = 0$

$C_x \times 5 - C_y \times 5 = 0$

$C_x = C_y$

$\therefore 7C_x + 10C_x = -600$

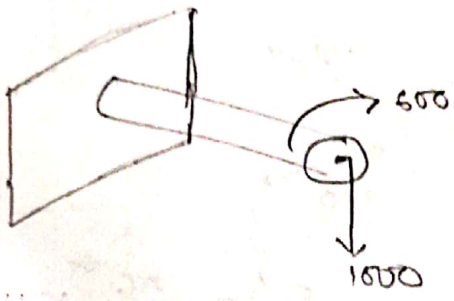
$C_x = -35.29 \ (\longleftarrow) \ lb$

$C_y = -35.29 \ (\downarrow) \ lb$ Ans.

$A_x = 35.29 \ lb$

$A_y = 35.29 \ lb$ Ans

167

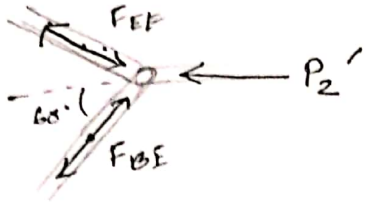


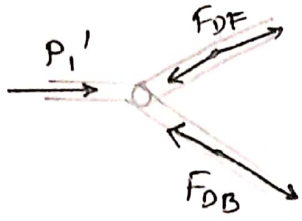
$1000 \times x_1 - 600 \times 12 = 0$

$x_1 = 7.2''$ Ans.

168

159





$$P_2 = \frac{\pi 6^2}{4} \times 60$$

$$= 1696.41b$$

$$\Sigma F_y = 0$$

$$F_{EF} \cos 60° - F_{BE} \cos 60° = 0$$

$$\therefore F_{EF} = F_{BE}$$

$$\Sigma F_x = 0$$

$$F_{EF}' \cos 60° + F_{BE}' \cos 60° - 1696.4 = 0$$

$$2 F_{EF}' \cos 60° = 1696.4 \text{ lb}$$

$$\therefore F_{EF}' = F_{BE}' = 1696.4 \text{ lb}$$

$$P_1' = \frac{\pi 6^2}{4} \times 100$$

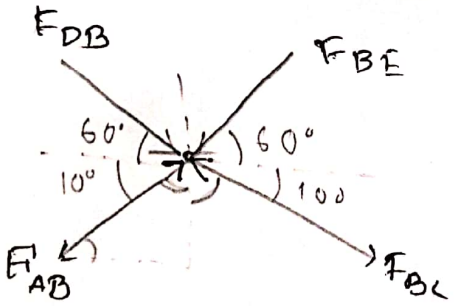
$$= 2827.43$$

$$\Sigma F_y = 0$$

$$F_{DB} = F_{BF}$$

$$\Sigma F_x = 0$$

$$F_{DB}' = F_{BF}' = 2827.43 \text{ lb}$$



$$\Sigma F_x = 0$$

$$\Rightarrow F_{AB}' \cos 60° + 1696.4 \cos 60° + F_{DB}' \cos 60° - F_{BC}' \cos 10° = 0$$

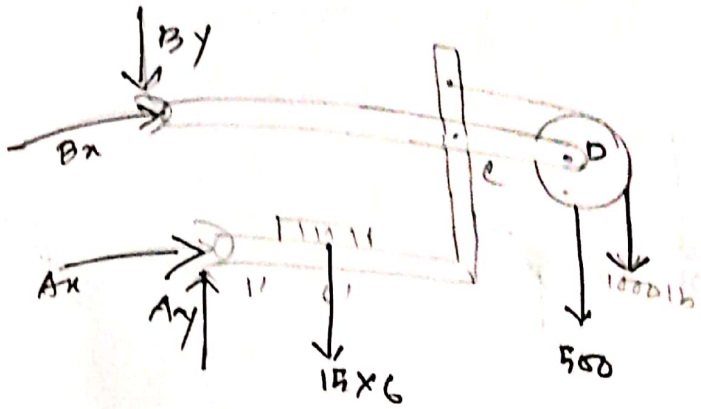
$$\Rightarrow F_{AB}' - F_{BC}' = -565.515$$

$$\Sigma F_y = 0$$

$$F_{AB}' + F_{BC}' = 22561.28$$

$$\therefore F_{AB} = 11567.75 \text{ Ans.}$$

157



$\Sigma M_A = 0$

$1000 \times 22 + 500 \times 20 + 15 \times 6 \times 4 + B_x \times 8 = 0$

$B_x = -4045$ lb (←)

$\Sigma F_x = 0$

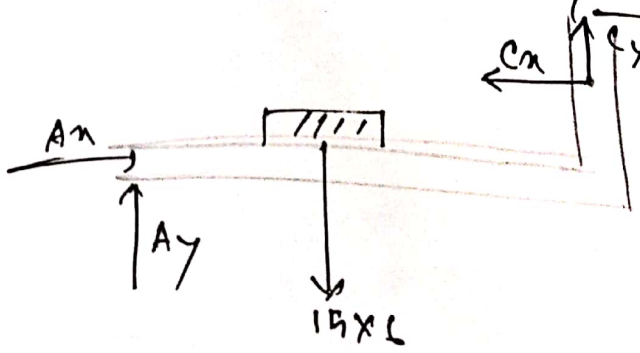
$A_x = B_x$

$A_x = 4045$ lb →

$\Sigma F_y = 0$

$A_y - B_y - 15 \times 6 - 1000 - 500 = 0$

$A_y - B_y = 1590$



$\Sigma F_x = 0$

$1000 + 4045 - C_x = 0$

$C_x = 5045$ lb Ans.

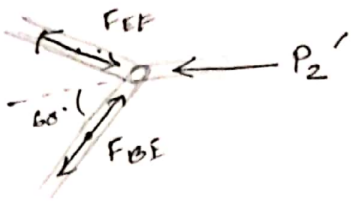
$\Sigma F_y = 0$ $\quad \Sigma M_A = 0$

15×6

$-C_x \times 8 + 1000 \times 10 + 15 \times 6 \times 4 - C_y \times 12 = 0$

$C_y = 2500$ lb Ans.

159



$P_2 = \frac{\pi 6^2}{4} \times 60$

$= 1696.41b$

$\Sigma F_y = 0$

$F_{EF} \cos 60° - F_{BE} \cos 60° = 0$

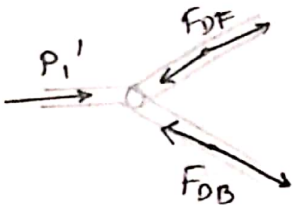
$\therefore F_{EF} = F_{BE}$

$\Sigma F_x = 0$

$F_{EF} \cos 60° + F_{BE} \cos 60° - 1696.4 = 0$

$2 F_{EF} \cos 60° = 1696.4\ lb$

$\therefore F_{EF} = F_{BE} = 1696.4\ lb$



$P_1' = \frac{\pi 6^2}{4} \times 100$

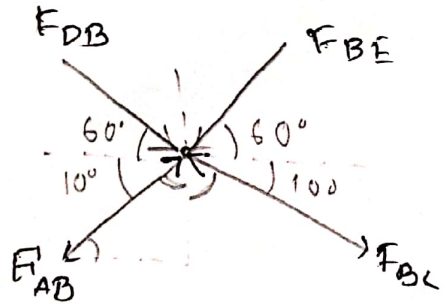
$= 2827.43$

$\Sigma F_y = 0$

$F_{DB} = F_{BF}$

$\Sigma F_x = 0$

$F_{DB} = F_{BF} = 2827.43\ lb$



$\Sigma F_x = 0$

$\Rightarrow F_{AB} \cos 60° + 1696.4 \cos 60° + F_{DB} \cos 60° - F_{BC} \cos 10° = 0$

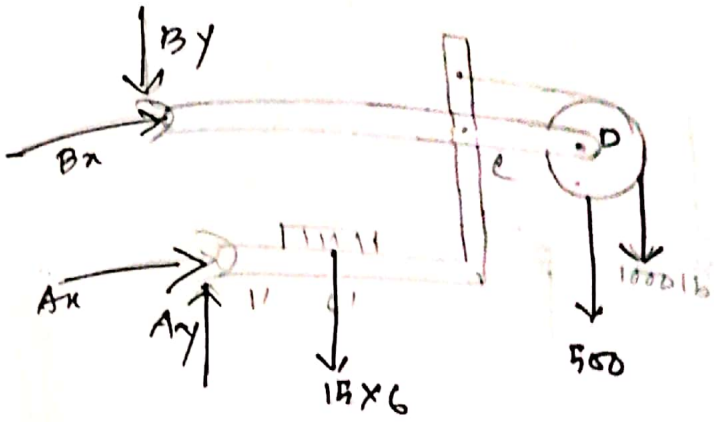
$\Rightarrow F_{AB} - F_{BC} = -565.515$

$\Sigma F_y = 0$

$F_{AB} + F_{BC} = 22561.28$

$\therefore F_{AB} = 11567.75$ Ans.

167



$\Sigma M_A = 0$

$1000 \times 22 + 500 \times 20 + 15 \times 6 \times 4 + B_x \times 8 = 0$

$B_x = -4045$ lb (←)

$\Sigma F_x = 0$

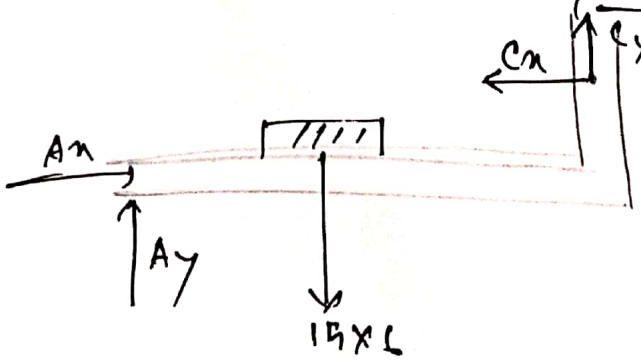
$A_x = B_x$

$A_x = 4045$ lb →

$\Sigma F_y = 0$

$A_y - B_y - 15 \times 6 - 1000 - 500 = 0$

$A_y - B_y = 1590$



$\Sigma F_x = 0$

$1000 + 4045 - C_x = 0$

$C_x = 5045$ lb Ans.

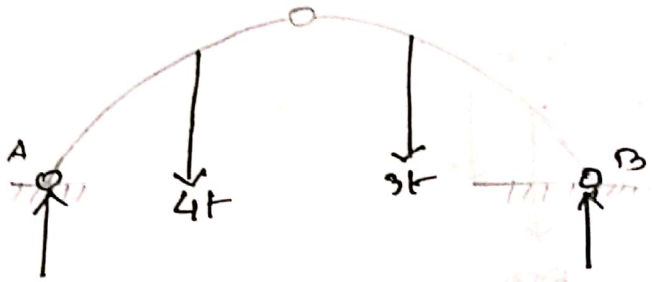
$\Sigma F_y = 0$ $\quad \Sigma M_A = 0$

15×6

$-C_x \times 8 + 1000 \times 10 + 15 \times 6 \times 4 - C_y \times 12 = 0$

$C_y = 2500$ lb Ans.

50



$\Sigma M_A = 0$

$4 \times 33.33 + 3 \times 75 - By \times 100 = 0$

$By = 3.58\ t$

$\therefore B = 3.58\ t$ Ans.

$\Sigma M_B = 0$

$-3 \times 25 - 4 \times 66.66 + A \times 100 = 0$

$A = 3.416\ t$ Ans.