CE 201 - 4 & 5 (071)
H.W # 6
Key Solution

Problem 1:

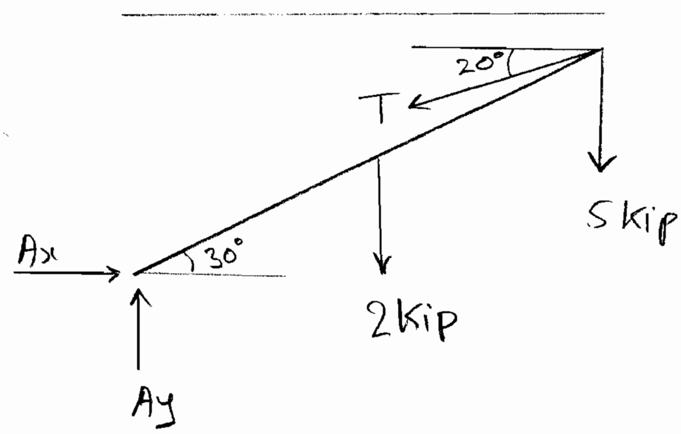


Fig P1

Given:

AB = 40 ft

weight = 2 kips

AG = 20 ft

fig P1

Required:

Tension in cable BC & reaction at A.

Solution:

$\xrightarrow{+} \Sigma F_x = 0$

$A_x - T\cos 20 = 0$ ——— (1)

$+\uparrow \Sigma F_y = 0$

$A_y - 2 - 5 - T\sin 20 = 0$ ——— (2)

$+\circlearrowright \Sigma M_A = 0$

$-(2)(20\cos 30) - (5)(\cos 30) + (T\cos 20)(40\sin 20)$

$-(T\sin 20)(40\cos 30) = 0$

$$(18.794)T - (11.848)T = 207.846$$

$$6.946\,T = 207.846$$

$$T = 29.923 \text{ kip}$$

$$\boxed{T \approx 30 \text{ kip.}}$$

Substituting at ①

$$A_x - T\cos 20 = 0$$

$$A_x = T\cos 20 = (29.923)(\cos 20) = 28.118 \text{ kip}$$

$$A_y = 2 + 5 + T\sin 20 = 7 + (29.923)\sin 20 = 17.234 \text{ kip}$$

$$\boxed{\begin{aligned} A_x &= 28.1 \text{ kip} \\ A_y &= 17.2 \text{ kip.} \end{aligned}}$$

Problem 2:

Given:

Fig P2.

T=1950 N @ C

Required:

Reactions:

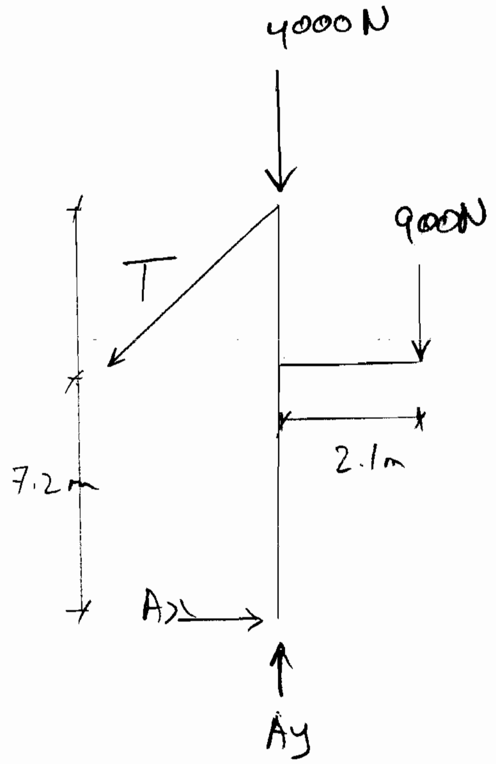


Fig P2 a.

Solution:

a) $\xrightarrow{+} \Sigma F_x = 0$

$A_x - T(3/7.8) = 0$ —— ①

$+\uparrow \Sigma F_y = 0$

$A_y - 4000 - 900 - T(7.2/7.8) = 0$ —— ②

$+\circlearrowright \Sigma M_A = 0$

$-(2.1)(900) + (7.2)(T)(3/7.8) = 0$

$T = 682.5$

$\boxed{T \approx 683 \text{ N.}}$

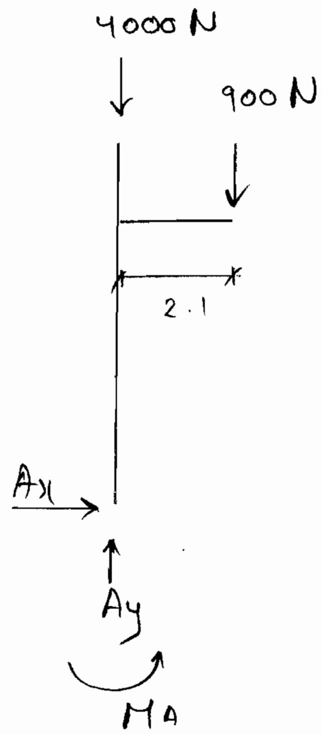
$\therefore\ A_x = (682.5)(3/7.8) = 262.5\ N$

$A_y = 4000 + 900 + (682.5)(7.2/7.8) = 5530\,N.$

$A = \sqrt{262.5^2 + 5530^2} = 5536.2\ N.$

$\theta = \tan^{-1}\left(\dfrac{5530}{262.5}\right) = 87.28^\circ$

$$\boxed{\begin{aligned} A &= 5536\ N \\ \theta &= 87.28^\circ \end{aligned}}$$



b)

$\xrightarrow{+} \Sigma F_x = 0$

$+\uparrow \Sigma F_y = 0$

$A_y - 4000 - 900 = 0$

$A_y = 4900\ N.$

$+\circlearrowleft \Sigma M_A = 0$

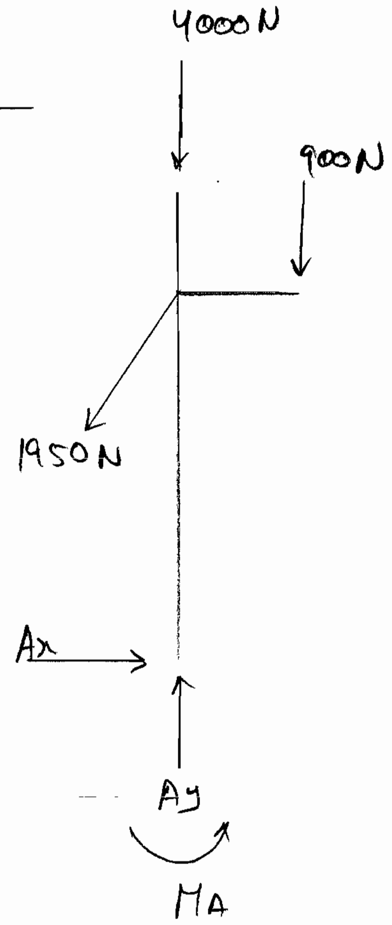
$M_A - (900)(2.1) = 0$

$M_A = 1890\ N.m \circlearrowleft$

$$A = \sqrt{0^2 + 4900^2} = 4900\ N$$

$$\boxed{\begin{array}{l} A = 4900\ N \\ M_A = 1890\ N.m \end{array}}$$

c)



$\xrightarrow{+} \Sigma F_x = 0$

$A_x - 1950\,(3/7.8) = 0$

$A_x = 750\ N$

$+\uparrow \Sigma F_y = 0$

$A_y - 4000 - 900 - 1950\,(7.2/7.8) = 0$

$A_y = 6700\ N$

$A = \sqrt{6700^2 + 750^2} = 6741.847\ N$, $\boxed{A = 6741.8\ N}$

$\theta = \tan^{-1}\left(\frac{6700}{750}\right) = 83.61^\circ$, $\boxed{\theta = 83.61^\circ}$

$\circlearrowleft + \ M_A = 0$

$M_A = (900)(2.1) - (1950)(3/7.8)(7.2) = 0$

$M_A = -3510\ N.m$, $\boxed{M_A = 3510\ N.m \circlearrowright}$

Conclusion:

Best used to support traffic signals is as shown in b

Problem 3:-

Given:-

a- $T = 30$ kip

Fig P_3

Required:-

a) Reaction at E

b) Moment @ $E = 0$, find T

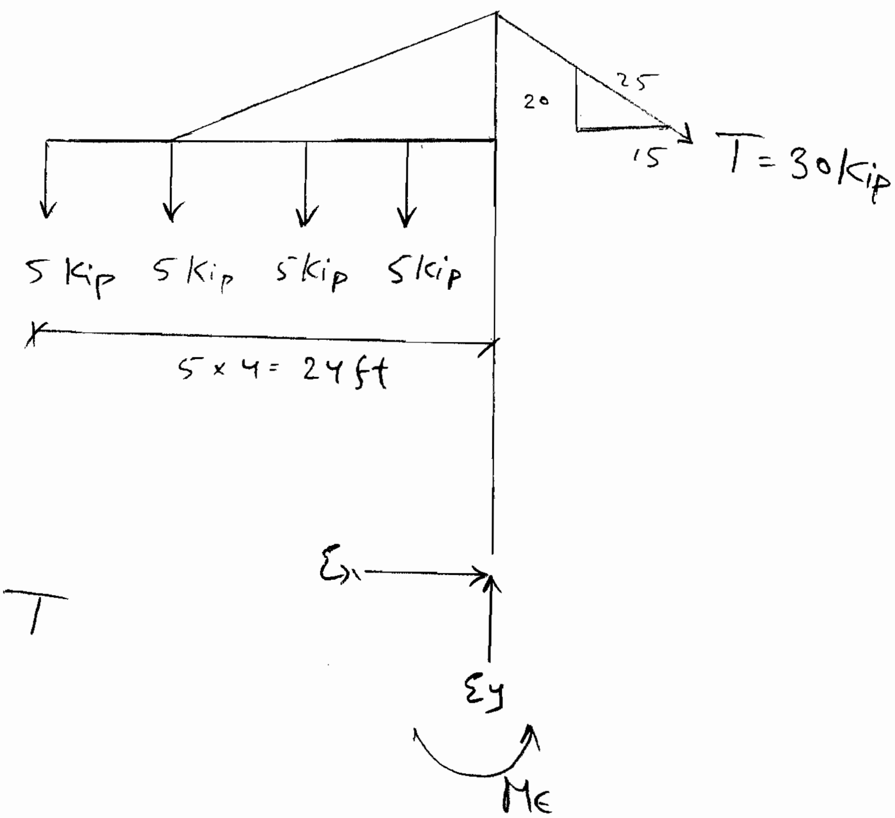


Fig P_3

Solution

a) $\xrightarrow{+} \Sigma F_x = 0$

$$E_x + 30(15/25) = 0$$

$$E_x = -18 \text{ kip}$$

$\overset{+}{\uparrow} \Sigma F_y = 0$

$$E_y - 5 - 5 - 5 - 5 - 30(20/25) = 0$$

$$E_y = 44 \text{ kip}$$

$\overset{+}{\curvearrowleft} \Sigma M_E = 0$

$$M_E - (30)(15/25)(20) + 5(24 + 18 + 12 + 6) = 0$$

$$\boxed{M_E = 60 \text{ kip.ft}}$$

$$E = \sqrt{(-18)^2 + 44^2} = 47.539 \text{ kip}$$

$$\theta = \tan^{-1}\left(44/-18\right) = -67.75°$$

$$\boxed{\begin{array}{l} E = 47.5 \text{ kips} \\ \theta = -67.75° \end{array}}$$

b)

$$M_{E\,\text{Right side}} = M_{E\,\text{Left side}}$$

$$M_{\text{Left side}} = 5(24 + 18 + 12 + 6)$$

$$= 300 \text{ kip.ft}$$

$$M_{\text{Right side}} = (T)(15/25)(20) = 12T$$

$$\therefore \quad 300 = 12T$$

$$\boxed{T = 25 \text{ kip}}$$

Problem 4:-

Given:-

Fig P4

Required:

Reactions at A & E.

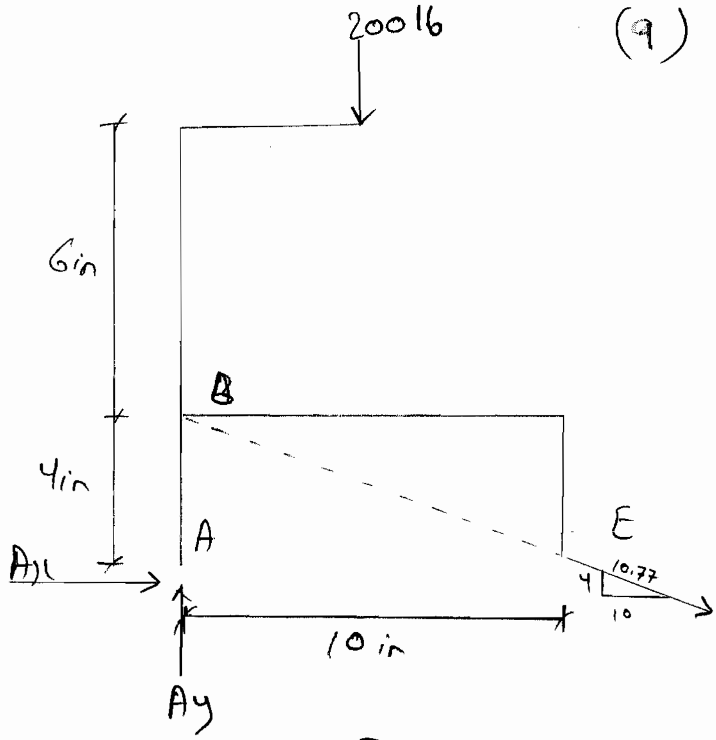


Fig P.4

Solution:-

$\Sigma F_x = 0 \xrightarrow{+}$

$A_x + E \, (10/10.77) = 0$ —— (1)

$\Sigma F_y = 0 \uparrow^+$

$A_y - 200 - E \, (4/10.77) = 0$ —— (2)

$\Sigma M_A = 0 \circlearrowleft^+$

$-(200)(5) - E \, (4/10.77)(10) = 0$

$E = -269.25$ lb

$E = 269.25$ lb $\nwarrow$

$E_y = E \, (4/10.77) = +100$ lb

$E_x = E \, (10/10.77) = -250$ lb

$$\theta_E = \tan^{-1}(-100/250) = -21.8^\circ$$

$$\boxed{\begin{aligned} E &= 269.25 \text{ lb} \nwarrow \\ \theta_E &= -21.8^\circ \end{aligned}}$$

Subtituting at 1

$$A_x + E(10/10.77) = 0$$

$$A_x - 269.25(10/10.77) = 0$$

$$A_x = 250 \text{ lb}$$

Subtituting at 2

$$A_y - 200 - E(4/10.77) = 0$$

$$A_y - 200 + 100 = 0$$

$$A_y = 100 \text{ lb}$$

$$A = \sqrt{250^2 + 100^2} = 269.25 \text{ lb}$$

$$\theta = \tan^{-1}(100/250) = 21.8^\circ$$

$$\boxed{\begin{aligned} A &= 269.25 \text{ lb} \\ \theta &= 21.8^\circ \end{aligned}}$$

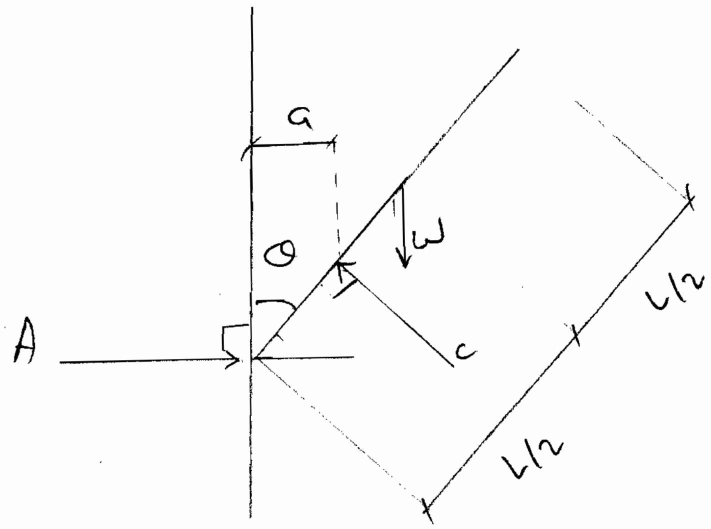
Problem 5:-

Given :-

Fig P_5

Required:-

Angle θ

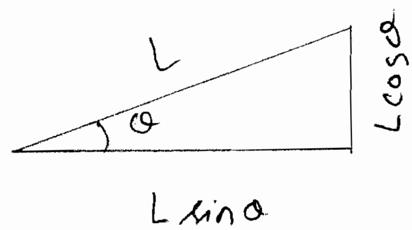


Solution

$\overset{+}{\uparrow} \Sigma F_y = 0$

$C \sin\theta - W = 0$

$W = C \sin\theta .$



$\overset{+}{\circlearrowright} \Sigma M_A = 0$

$- W\left(\frac{L}{2}\sin\theta\right) + C\left(\frac{a}{\sin\theta}\right) = 0$

$\frac{WL}{2}\sin\theta = C\,\frac{a}{\sin\theta}$

$\frac{CL}{2}\sin^2\theta = C\,\frac{a}{\sin\theta}$

$\sin^3\theta = \frac{2a}{L} \implies \boxed{\theta = \sin^{-1}\sqrt[3]{\frac{2a}{L}}}$