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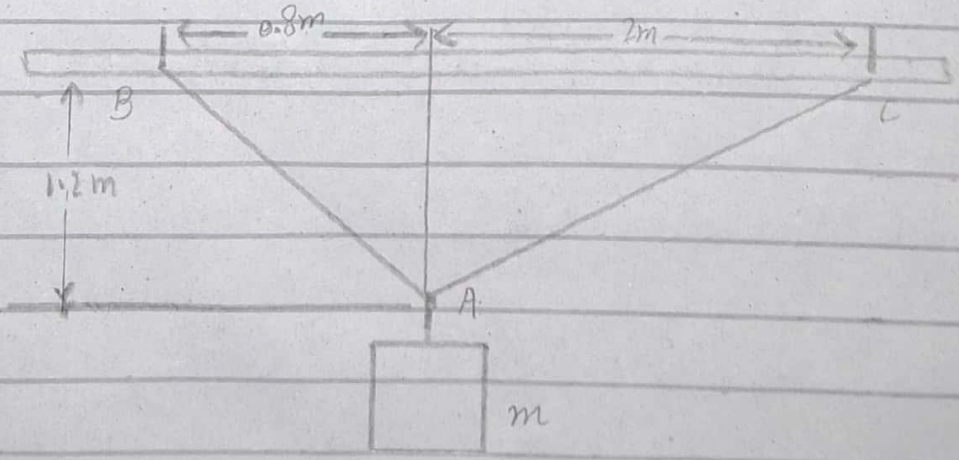
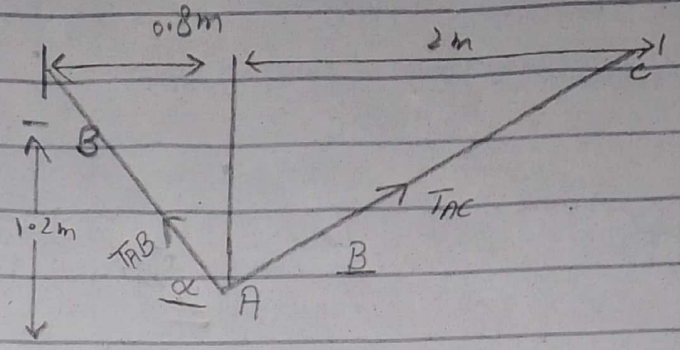
semester 2nd
section A
Paper Engineering Mechanics.

Q1a Part (a): two high strength flexible steel cables AB and AC are fastened to the ceiling of a building through high carbon steel hooks at point B and C. These cables are knotted together to a 3rd Cable at point A which is holding a thick wall water tank weighting 400 pound and is full of 3000 liters of water volume. what percentage of the whole weight is being held by cable AB alone? What amount of tension must be there in both the cables to maintain the static equilibrium of the system?



Solution



$$\alpha = \tan^{-1}\left(\frac{1.2}{0.8}\right)$$

$$= 56.3^\circ$$

$$\beta = \tan^{-1}\left(\frac{1.2}{2}\right)$$

$$\beta = 31^\circ$$

$$\Sigma F_x = AC\cos 31^\circ - AB\cos 56.3^\circ$$

$$AC = \frac{AB\cos 56.3^\circ}{\cos 31^\circ}$$

$$AC = 0.647\ AB$$

$$\Sigma F_y = AC\sin 31 + AB\sin 56.3 - 400$$

$$= 0.647\ AB\sin 31 + AB\sin 56.3 - 400$$

$$= 0.333\ AB + 0.831 - 400$$

$$= AB(0.333 + 0.831) - 400$$

$$1.164\ AB = 400$$

$$AB = \frac{400}{1.164} = 343.64 \text{ lb}$$

$$AC = 0.647\ (343.64)$$

$$= 222.33 \text{ lb}$$

$$AB = \frac{343.64}{400} \times 100 = 85.91\%$$

$$AC = \frac{222.33}{400} \times 100 = 55.58\%$$

$$T_{AB} = T_{AB}\, n_{AB} = (0.8591)(400)(9.81)[-\cos 56.3i + \sin 56.3j]$$

$$= 3370.71\ (-0.555i + 0.832j)$$

$$= -1870.75i + 2804.44j \text{ lb}$$

$$T_{AC} = T_{AC}\, n_{AC} = (0.5558)(400)(9.81)[\cos 31i + \sin 31j]$$

$$= 2180.95\ [0.857i + 0.515j]$$

$$= 1869.07i + 1123.18j \text{ lb}$$

Ans.

Q1b If the water tank weight and volume of water are increased 15% and 35% respectively what effect will occur on results of Part a.

Solution

Weight of tank Increased 15%

Total weight of tank = 400 + 15%(400) = 460 lb

$T_{AB} = T_{AB} n_{AB} = (0.859)(460)(9.81)[-\cos 56.3i + \sin 56.3j]$

$= 3876.323\ [-0.555i + 0.832j]$

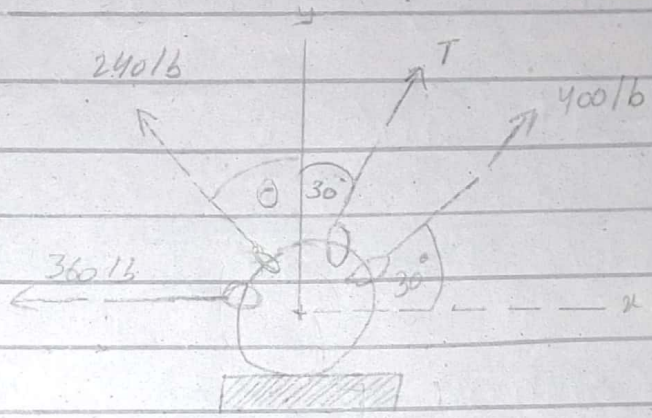
$= 2151.36i + 3225.101j$ lb

$T_{AC} = T_{AC} n_{AC} = (0.5558)(460)(9.81)[\cos 31i + \sin 31j]$

$= 2508.103\ (0.857i + 0.515j]$

$= 2149.444i + 1291.673j$

Q2: Four force are exerted on the eyebolt as shown below. If the net effect on the bolt is a direct pull of 600 pounds in th y-direction determine the values of T and θ



Data = direct pull = 600 lb

Find = T and θ = ?

Solution

$\Sigma F_x = 0$

$\Sigma F_x = -360 - 240 \sin\theta + T\sin 30^\circ + 400 \cos 30^\circ$

$= 0 \quad -①$

$\Sigma F_y = 600, 240 \cos\theta + T\cos 30^\circ + 400 \sin 30^\circ = 600 -②$

$\Sigma F_x, \; -240\sin\theta + T\sin 30^\circ + 400\cos 30 = 360$

$-240\sin\theta + T\sin 30^\circ = 360 - 346.41$

$-240\sin\theta + T\sin 30^\circ = 13.58 -Ⓐ$

ΣF_y , $240\cos\theta + T\cos 30^\circ + 400\sin 30^\circ = 600$

$240\cos\theta + T\cos 30^\circ = 600 - 200$

$240\cos\theta + T\cos 30^\circ = 400$ — (B)

Equating eq (A) and (B)

$$-240\sin\theta + T\sin 30^\circ = 13.58$$
$$\pm 240\cos\theta \pm T\cos 30^\circ = \pm 400$$
$$-480\tan\theta - T\tan 30^\circ = -386.42 \rightarrow (C)$$

Common − in eq c in L.H.S

$$\mp(480\tan\theta + T\tan 30^\circ) = \mp 386.42$$

$480\tan\theta = 386.42$, $T\tan 30^\circ = 386.42$

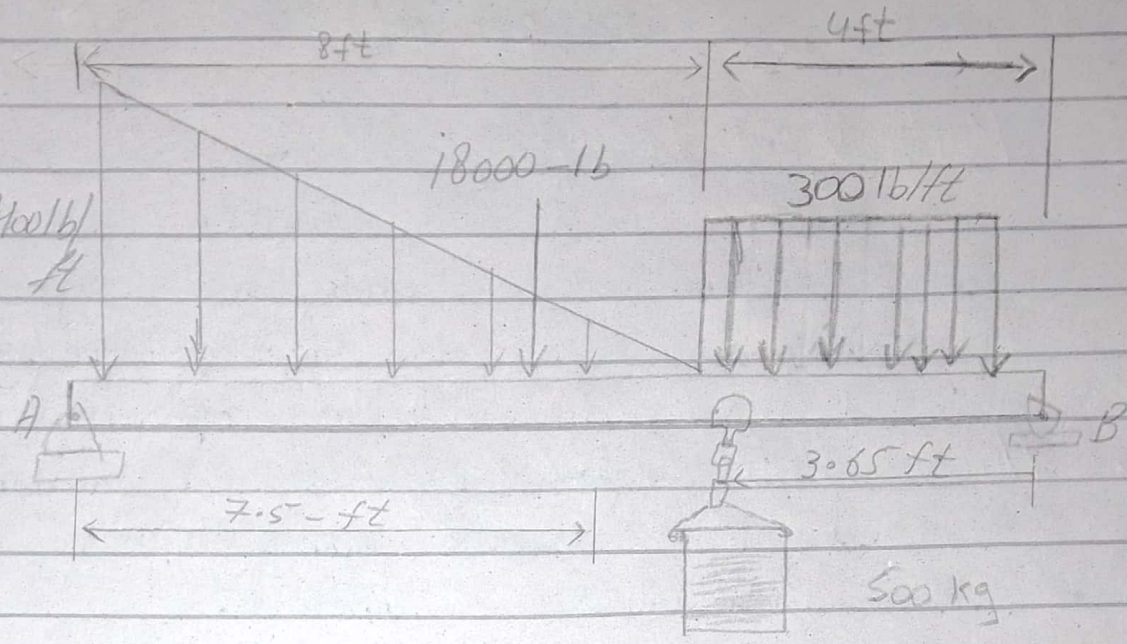
$\tan\theta = \frac{386.42}{480}$, $T = \frac{386.42}{0.577}$

$\theta = \tan^{-1}(0.805)$, $T = 669.7\ lb$

$\theta = (38.8^\circ)$

Ans

Q3: Calculate the reactions at supports



Solution

$\because$ 1kg = 2.205 lb

$\therefore$ 500kg 1102.5 lb

$$\Sigma R_A + \Sigma R_B = 18000 + 300 \times 4 + 1102.5 + \tfrac{1}{2} \times 400 \times 8$$

$$= 21902.5 \text{ lb}$$

$$\Sigma M_B = 0 \quad \text{+} \circlearrowleft$$

$$= 300 \times 4 \times 4/2 + 500 \times 8.35 + 18000 \times 7.5 - R_A \times \tfrac{1}{3} \times 400 \times 8.$$

$$1066.67 R_A = 2400 + 4175 + 135000$$

$$R_A = \frac{141575}{1066.67} \quad \boxed{= 132.72 \text{ lb}}$$

$$\Rightarrow R_B = 21902.5 - 132.72 \text{ lb}$$

$$\boxed{= 21769.78 \text{ lb}} \quad \text{Ans.}$$