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SECTION : B
PAPER : Engineering Mechanics.
DEPARAMENT : Civil Engineering

QUESTION: 1
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 thank weighting 400 pounds and is full of 300 liters of water volume. what percentage of the whole weight is being held by cable AB alone? what amount of tensions must be there in both the cables to maintain the static equilibrium of the system?

GIVEN DATA:

volume of $\Delta AB = 15\%$.
increase = $\Delta AC = 35\%$.
$V = 3000$ liters
$m = 400$ lbs

TO FIND:

AB = ?

Bc = ?

SOLUTION:

First we have to find angle "θ" of wires.

$$\theta = \tan^{-1}\left[\frac{\text{Opposite side}}{\text{Adjucent side}}\right]$$

$$\theta = \tan^{-1}\left[\frac{1.2}{0.8}\right]$$

$$\theta = 56.3^{\circ}$$

$$\Rightarrow \beta = \tan^{-1}\left[\frac{1.2}{2}\right]$$

$$\beta = 30.9^{\circ}$$

∵ The Body is at staticaly equilibrium

$$\Rightarrow T_{AB} = T_{AB}\,\hat{AB}$$

change of weight, pounds to kilograms.

$$m = 400 \text{ Lbs}$$

$$m = \frac{400}{2.204}$$

(3)

$m = 181.48\ kg$ ∴ kg = Kilogram

$\Rightarrow T_{AB} = T_{AB}\Delta AB$

= Percentage (%) (weight) $(-\cos\theta\hat{i} + \sin\theta\hat{j})$

$= 0.15\,(181.48\ kg)(9.81)(-\cos\theta\hat{i} + \sin\theta\hat{j})$

$= 0.15(181.48kg)(9.81)(-\cos 56.3\hat{i} + \sin 56.3\hat{j})$

$= 267.047\,(-0.5\hat{i} + 0.63\hat{j})$

$= -146\hat{i} + 221\hat{j}$

$\Rightarrow T_{AL} = T_{AL}\Delta AL$

= (percentage) % (weight) $(-\cos\theta + \sin\theta\hat{j})$

$= 0.35\,(181.48)(9.81)(-\cos 56.3\hat{i} + \sin 56.3\hat{j})$

$= 63.117\,(-0.63\,i + 0.63\hat{j})$

$= -534\hat{i} + 320\hat{j}$

$T_{AB} = -146\hat{i} + 221\hat{j}\ N$

$T_{AC} = -534\hat{i} + 320\hat{j}\ N$

PART : B

If the water tank weight and volume of water are increased 15% and 35% respectly what effects will occur on results of part (a).

Solution:

If the water tank increase than weight 10% while stability is not double.

QUESTION: 2

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

GIVEN DATA:

E_N at y-axis = 600 lbs

TO FIND:

θ = ?

T = ?

Solution:

As we know that

$\Sigma F_x = 0$

$-360 - 240 \sin\theta + T \sin 30 + 400 \cos\theta = 0$

$\Sigma F_y = 0$

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

$\Sigma F_x = 0$

$-360 - 240 \sin\theta + T \sin 30 + 400 \cos\theta = 0$

$-240 \sin\theta + T \sin 30 + 400 \cos\theta = 360$

$-240 \sin\theta + (0.5)T = 360 - 348.4$

$-240 \sin\theta + (0.5)T = 13.6$ ——— (i)

$\Sigma F_y = 0$

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

$240 \cos\theta + (0.866)T + 400(0.5) = 600$

$240 \cos\theta + (0.866)T + 200 = 600$

$240 \cos\theta + (0.866)T = 600 - 200$

$240 \cos\theta + (0.866)T = 400$ ——— (ii)

Combinating Equation (i) & (ii)

$$-240 \sin\theta + (0.5)\bar{I} = 13.6 \quad \text{---(i)}$$
$$240 \cos\theta + (0.866)\bar{I} = 400 \quad \text{---(ii)}$$

From Equation (i) & (ii) we get;

$$\boxed{\theta = 21.7^\circ}$$

Now putting the value of $\theta = 21.7^\circ$ in Equation (i)

$$-240 \sin(21.7) + (0.5)\bar{I} = 13.6$$

$$-88.73 + (0.5)\bar{I} = 13.6$$

$$(0.5)\bar{I} = 13.6 + 88.73$$

$$(0.5)\bar{I} = 102.33$$

Divide both side by 0.5

$$\frac{(0.5)\bar{I}}{0.5} = \frac{102.33}{0.5}$$

$$\frac{(0.5)\bar{I}}{0.5} = \frac{102.33}{0.5}$$

$$\bar{I} = \frac{102.33}{0.5}$$

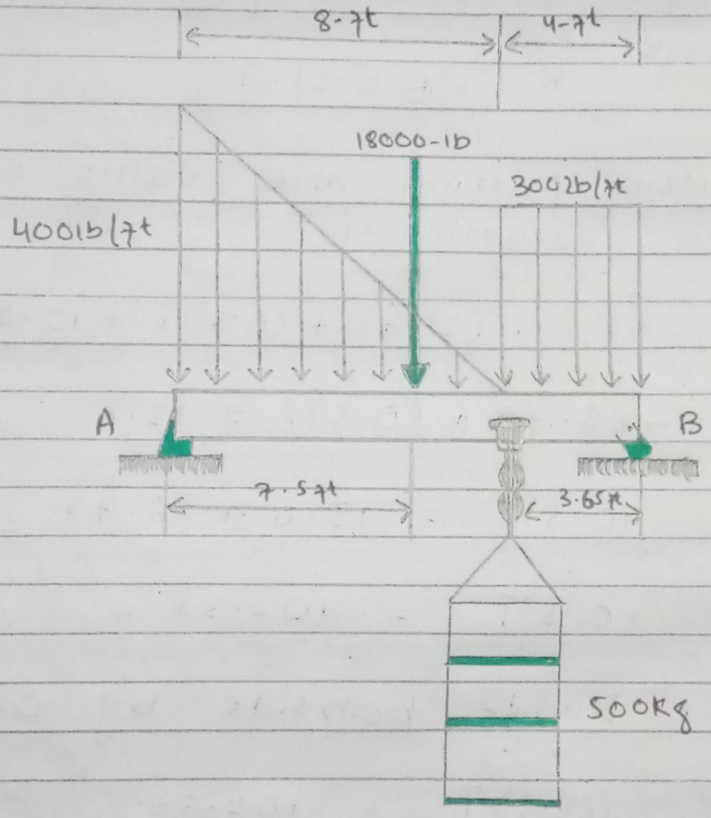
$$\bar{I} = 204.66$$

Hence;

$$\boxed{\theta = 21.7^\circ} \qquad \boxed{\bar{I} = 204.66}$$

QUESTION: 3

Calculate the reaction at supports.



TO FIND:

Reaction of supports = ?

Solution:

UDL converts into point load

300 x 4 = 1200Lb

At point = 1/2 x 4 , from point "B"

UVL = 1/2 x 400 x 8

UVL = 1600 lb

At distance = 1/3 x 8

= 2.66 from point "A"

∴ converts load kg into pounds

500 x 2.204 = 1102.31 lb

∴ $\Sigma A_x = 0$

= 1600 x 2.66 - 1800 x 7.5 - 1200 x 10 - 1102.31 + By x 12

= 4256 - 135000 - 12000 - 9204.28 + By12

By12 = 16040.12

Divide bothside by 12

$\frac{By12}{12} = \frac{16040.12}{12}$

$\frac{By\cancel{12}}{\cancel{12}} = \frac{16040.12}{12}$

By = 1337.69-Lb

$A_y = \Sigma$ Total Load $- B_y$

$A_y = 1200 + 1102.31 + 18000 + 1600 - 13371.69$

$A_y = 21,902.31 - 13371.69$

$A_y = 8530.31 - lb$

Load of $A_x = 8530.31$ lb

Load of $B_y = 13371.89$ lb

For conversion of pounds into Kg we have;

$Kg = lb / 2.204$

FINISH!