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Department # BE Civil

Section # A

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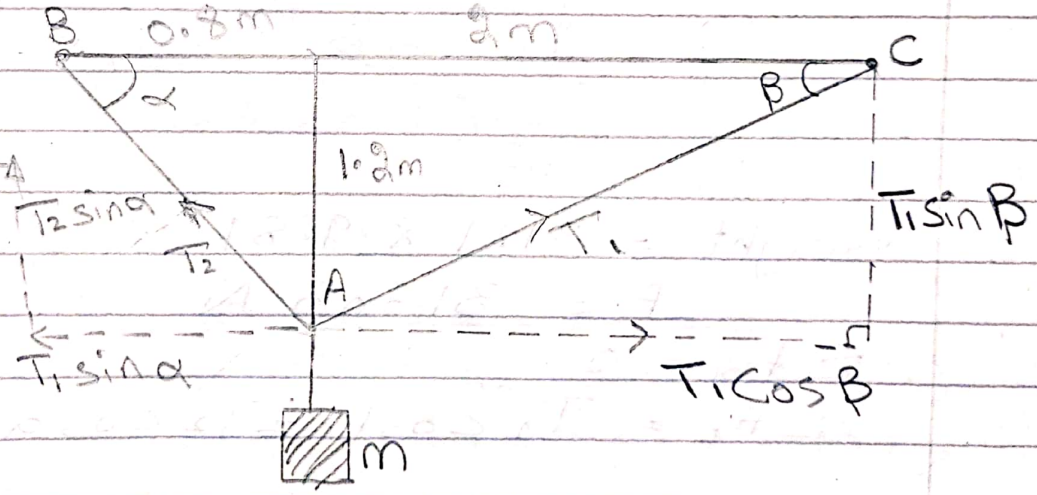
Subject # Engineering Mechanics

Q1 Part (a)

two high strength flexible steel cables AB and AC are - - - - - ---- -- of the system?

(b) if the water tank weight & volume of water are increased - - - - - - - - - - Part (a)?



m = mass of of tank + mass of water

mass of tank = 400 pounds

1 kg = 2.21 pounds

mass of tank = $\frac{400}{2.21}$ $\Rightarrow$ 181 kg

mass of water = ?

Volume = 3000 litres

i.e. $1 m^3 = 1000$ litres

Volume of water = 3000/1000

$= 3 m^3$

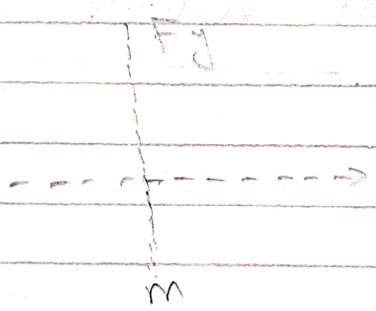
density of water = $1000 kg m^{-3}$

mass = 3×1000

$\Rightarrow$ 3000 kg.

Total mass (m) = 181 + 3000

= 3181 kg.



weight = 3181×9.81

$F = 31205$ N

$\Sigma F_x = 0$

$\Sigma F_x = T_1 \cos\beta = T_2 \cos\alpha$ — (1)

$\Sigma F_y = 0$

$\Sigma F_y = T_1 \sin\beta + T_2 \sin\alpha = mg$ — (2)

From eq (1)

$T_1 \cos\beta = T_2 \cos\alpha$

$$T_2 = \frac{T_1 \cos\beta}{\cos\alpha}$$

Put value in eq (2)

$$T_1 \sin\beta + \frac{T_1 \cos\beta (\sin\alpha)}{\cos\alpha} = mg$$

$$T_1 \left[\sin\beta + \frac{\sin\alpha \cos\beta}{\cos\alpha} \right] = mg$$

$$T_1 = \frac{mg}{\sin\beta + \frac{\sin\alpha\cos\beta}{\cos\alpha}}$$

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

$$\alpha = 56.30^\circ$$

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

$$\beta = 31^\circ$$

$$T_1 = \frac{3120.5}{\sin(31) + \frac{\sin(56.3)\times\cos(31)}{\cos(56.3)}}$$

$$T_1 = 17333.16\ N$$

$$T_2 = \frac{T_1 \cos\beta}{\cos\alpha}$$

$$T_2 = \frac{17333.16 \times \cos(31)}{\cos(56.3)}$$

$T_2 = 26777.63 N$

$AB\% = \frac{26777.63}{31205} \times 100$

$AB = 85.81\%$

Part (b)

tank mass increase 15%.

new mass $= 181 \times 1.15$

$= 208.15 kg$

Volume of water increase 35%.

new volume $= 3 \times 1.35$

$= 4.05 m^3$

mass of water $= 4050$

Total mass $= 4258.15 kg$

$F = 41772.45 N$

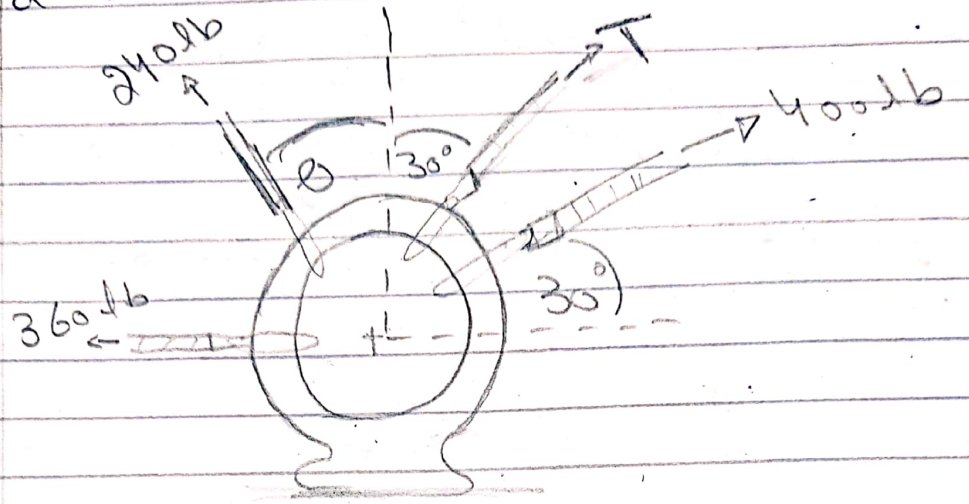
T_1 will be $= 23203 N$

$T_2 = 35846 N$

AB % will be same

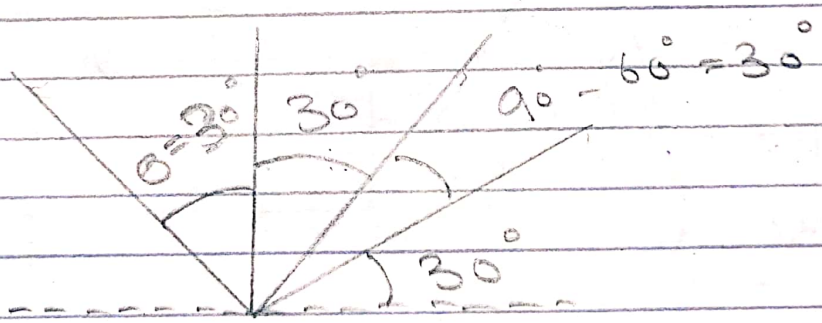
AB % $= 85.81\%$

Q2 Four forces exerted on the eyebolt as shown. If the net effect on the bolt is a ---------- T and θ



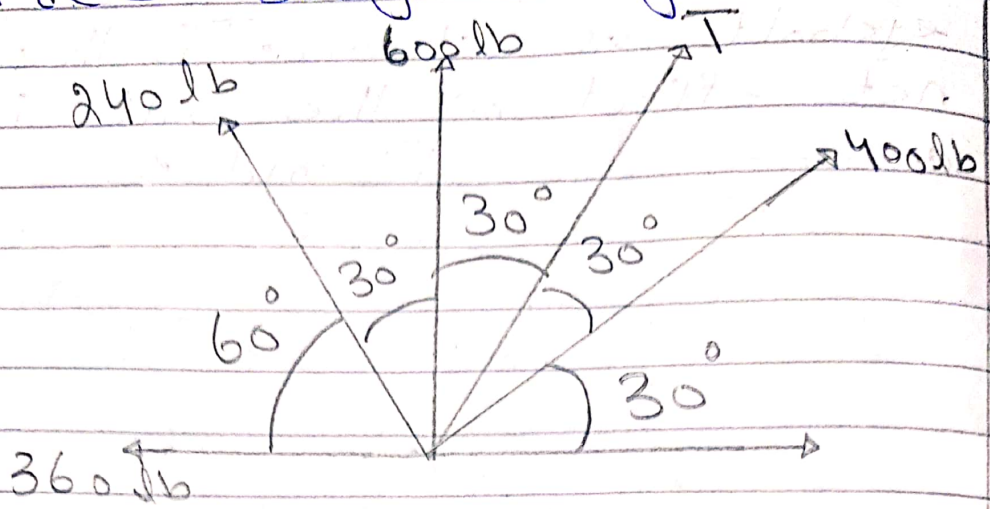
Sol:-
First we have to find θ

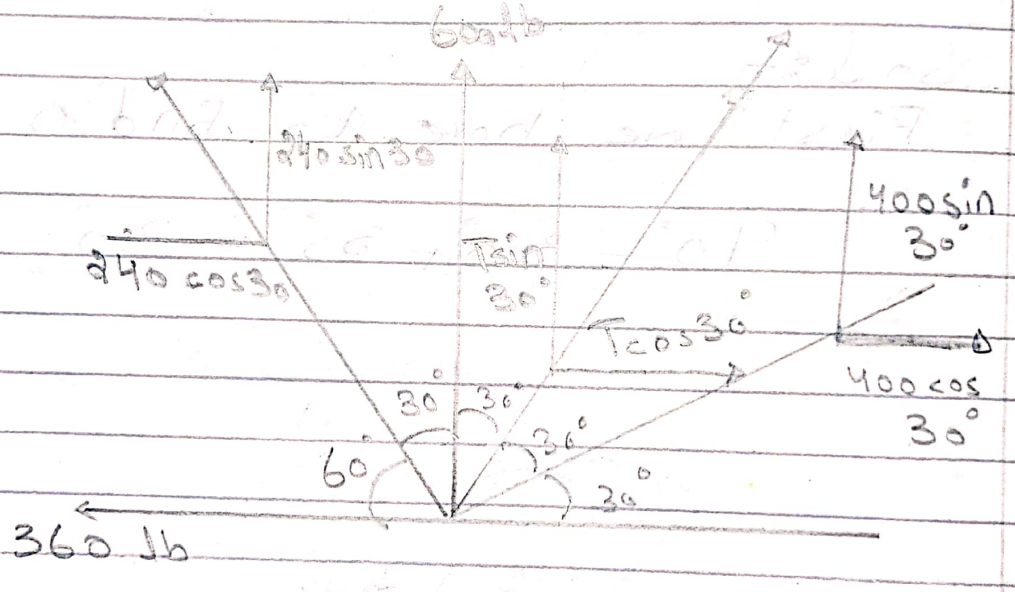
$$90^\circ - 30^\circ + 30^\circ = 30^\circ$$



These two lines are symmetrical on right quadrent where the angle is 30° so on left side quadrent it is also 30° because of symmetry.

* Free body- Diagram





By Equilibrium equation

$$\leq F_x = 0 \quad \xrightarrow{+} \quad \xleftarrow{}$$

$$-360 - 240\cos 30^\circ + T\cos 30^\circ + 400\cos 30^\circ = 0$$

$$T\cos 30^\circ + 400\cos 30^\circ = 360 + 240\cos 30^\circ$$

$T\cos 30^\circ + 400\cos 30^\circ = 360 + 207.84$

$T\cos 30^\circ + 400\cos 30^\circ = 567.84$

$T(0.866) = 567.84 - 400\cos 30^\circ$

$T(0.866) = 567.84 - 346.41$

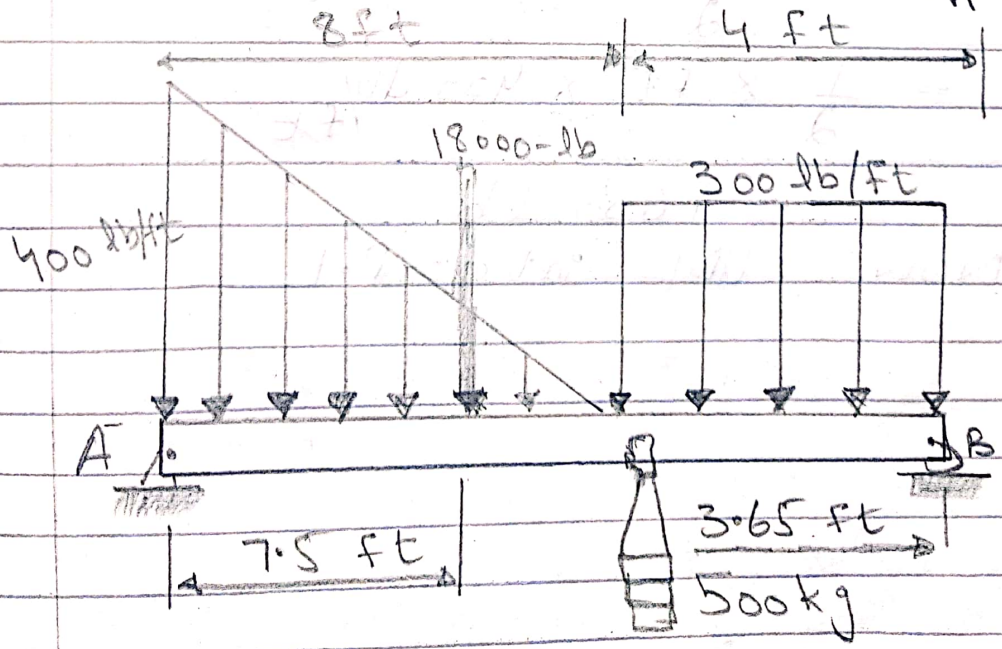
$T(0.866) = 221.43$

$$T = \frac{221.43}{0.866}$$

$T = 255.69$ lb

So T and θ are Finded.

Q3 Calculate the reactions at supports.

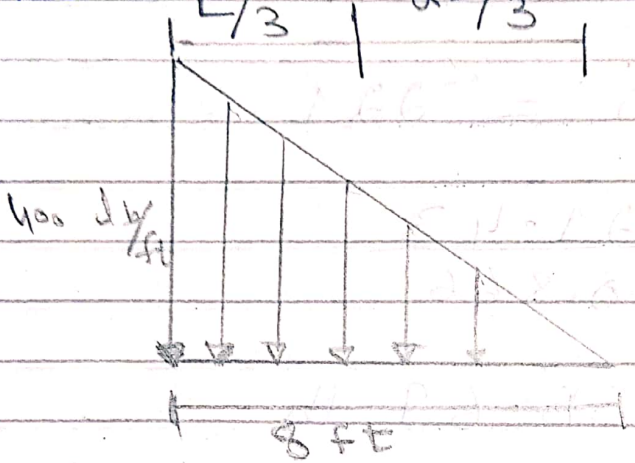


Solution :-

First convert the UDL and UVL into pointed load.

UVL into P.L

Here:



Magnitudge of pointed load = Area of UVL

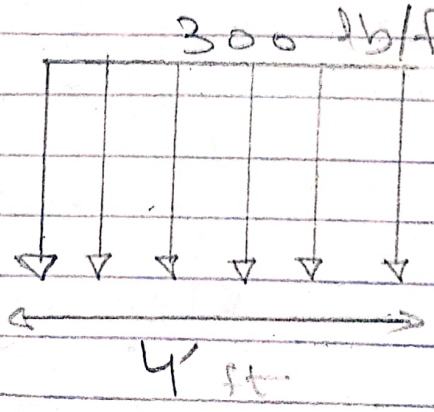
So we get

$$= \frac{1}{2} \text{ base} \times \text{height}$$

$$= \frac{1}{2} 8\,\text{ft} \times 400\,\text{lb/ft}$$

$$= 1600\,\text{lb}$$

Now UDL into P.L



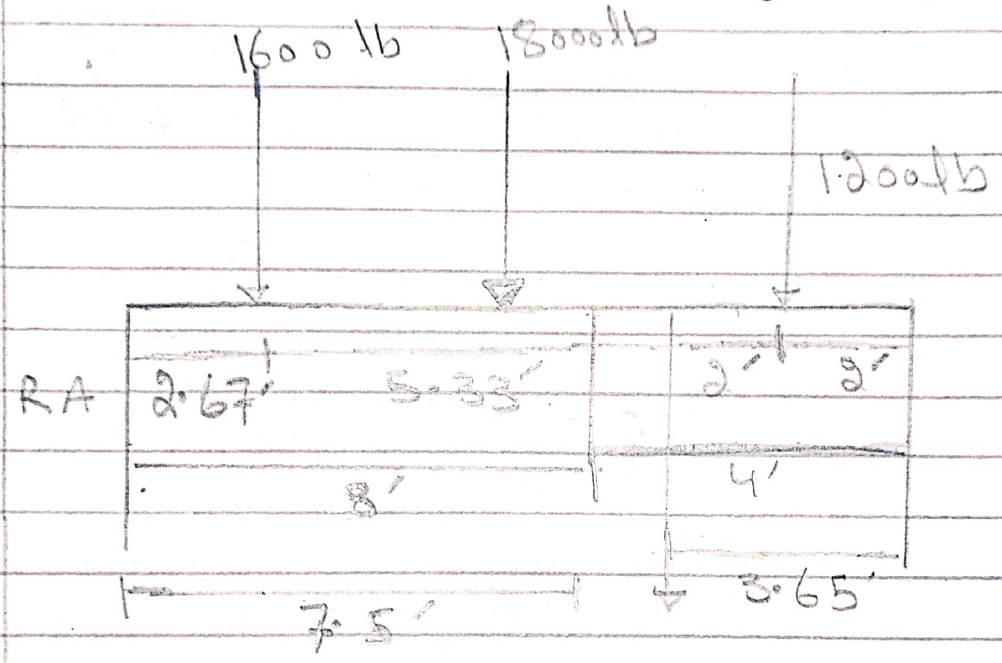
Magnitude of P.L = Area of UDL

$= B \times h$

$= 4\,ft \times 300\,lb/ft$

$= 1200\,lb$

Now draw Free body diagram



$\frac{L}{3} = \frac{8}{3} = 2.67'$

$\frac{2L}{3} = \frac{2 \times 8}{3} = 5.33'$

Now Find reaction 'R_A' & 'R_B'

⇒ Find R_B

$\Sigma M_A = 0$ (+ ↻ ↺ −)

$\Rightarrow 1600 \times 2.67 + 18000 \times 7.5 + 1200 \times 10 + 1100 \times 8.35 - R_B \times 12 = 0$

$\Rightarrow 4272 + 135000 + 12000 + 9185 = 12 R_B$

$\Rightarrow 12 R_B = 151272 + 9185$

$\Rightarrow 12 R_B = 160457$

$R_B = \frac{160457}{12}$

$R_B = 13371.41 \text{ lb.ft}$

* Now 'R_A'

$\leq M_B = 0$ (+ ↻ ↺ −)

$\Rightarrow -1200 \times 2 - 1100 \times 3.65 - 18000 \times 4.5 - 1600 \times 9.33 + R_A \times 12 = 0$

$\Rightarrow 12 R_A = 2400 + 4015 + 81000 + 14928$

$\Rightarrow R_A = \frac{102343}{12}$

$R_A = 8528.58 \text{ lbft}$