STATICS

Equilibrium of the Particle

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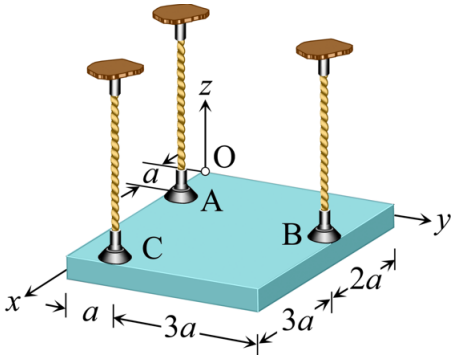
Question : A plate that is restricted by three cables is in static condition. Determine the forces of the cables. ($a = 2\,\text{m}$ and $W = 300\,\text{kN}$).



Solution:

The free body diagram is drawn by using the unknown forces of cables. The moment equilibrium at the point A must be equal to zero in order to satisfy the static equilibrium,

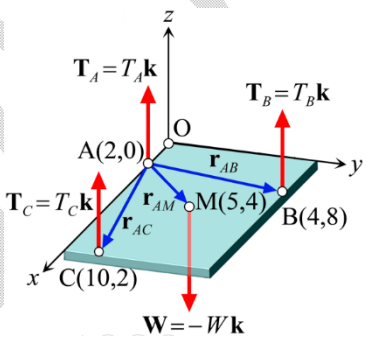
$$\sum M_A = 0; \quad r_{AC} \times T_C + r_{AB} \times T_B + r_{AM} \times W = 0$$

where, the forces and directions vectors are given as follows,

$$\mathbf{T}_C = T_C\mathbf{k} \qquad \mathbf{r}_{AC} = 8\mathbf{i} + 2\mathbf{j}$$

$$\mathbf{T}_B = T_B\mathbf{k} \quad ; \quad \mathbf{r}_{AB} = 2\mathbf{i} + 8\mathbf{j}$$

$$\mathbf{W} = (-300\mathbf{k})\,\text{kN} \qquad \mathbf{r}_{AM} = 3\mathbf{i} + 4\mathbf{j}$$



The cross product is applied using the forces and direction vectors in Cartesian coordinates, the final form is given as,

$$(2T_C + 8T_B - 1200)\mathbf{i} + (-8T_C - 2T_B + 900)\mathbf{j} = \mathbf{0}$$

The both components must be equal to zero,

$$\left.\begin{aligned} 2T_C + 8T_B - 1200 = 0 \\ -8T_C - 2T_B + 900 = 0 \end{aligned}\right\} \quad T_B = 130\,\text{kN}\,;\, T_C = 80\,\text{kN}$$

The cable force T_A is obtained using the equilibrium equation for the whole system,

$$\sum F_z = 0; \quad T_A + 80 + 130 - 300 = 0 \quad \Rightarrow \quad T_A = 90\,\text{kN}$$