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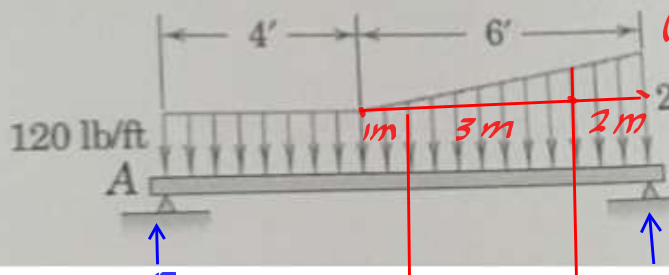
**Example 4.4**

Determine the equivalent concentrated load(s) and external reactions for the simply supported beam which is subjected to the distributed load shown.




(280 − 120) = 160 lb

1m 3m 2m

$R_A$ $R_B$

0.5 * 6 * 160 = 480 lb

120 * 10 = 1200 lb

$F_R = 1200 + 480 = 680$ lb

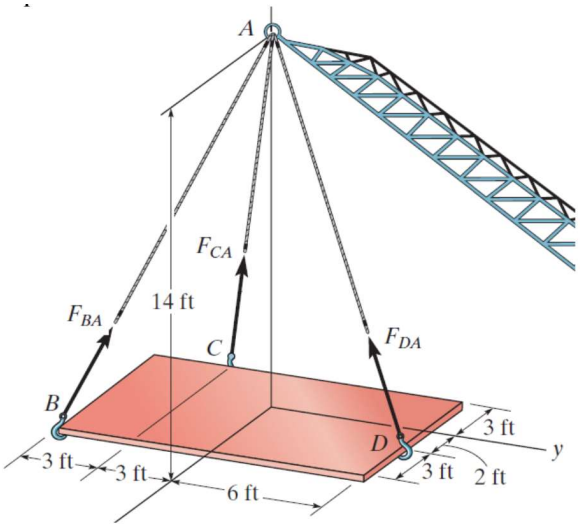
$\curvearrowleft \Sigma M_A = -1200 * 5 - 480 * 8 + R_B * 10 = 0$

$R_B = 984$ lb

$\curvearrowleft \Sigma F_y = R_A - 1200 - 480 + R_B = 0$ (984)

$R_A = 696$ lb

The forces exerted by the three cables are
FBA = 500 lb,
FDA = 350 lb,
FCA = 400 lb.
Express each force as a cartesian vector




$A(0, 0, 14)$

$B(3, -6, 0)$

$C(-3, -3, 0)$

$D(2, 6, 0)$

$\vec{BA} = A - B = (0, 0, 14) - (3, -6, 0)$

$\vec{BA} = -3i + 6j + 14k$

$|\vec{BA}| = \sqrt{(-3)^2 + 6^2 + 14^2} = \sqrt{241}$

Unit vector $\vec{u}_{BA} = \dfrac{\vec{BA}}{|BA|} = \dfrac{-3i + 6j + 14k}{\sqrt{241}}$

$\vec{f}_{BA} = f \cdot u_{BA} = 500\left(\dfrac{-3i + 6j + 14k}{\sqrt{241}}\right)$

$f_{BA} = (-96.6i + 193.25j + 451k)$ lb

$\vec{DA} = A - D = (0, 0, 14) - (2, 6, 0)$

$\vec{DA} = -2i - 6j + 14k$

- unit vector $u_{DA} = \dfrac{-2i - 6j + 14k}{\sqrt{(-2)^2 + (-6)^2 + 14^2}}$

$\vec{F}_{DA} = F_{DA} \cdot u_{DA} = 350 * \dfrac{-2i - 6j + 14k}{2\sqrt{59}}$

$\vec{F}_{DA} = (-45.52i - 136.7j + 319k)$ lb

- $\vec{CA} = A - C = (0, 0, 14) - (-3, -3, 0)$

$\vec{CA} = 3i + 3j + 14k$

-

$u_{CA} = \dfrac{3i + 3j + 14k}{\sqrt{3^2 + 3^2 + 14^2}}$

$\vec{F}_{CA} = 400 * \dfrac{3i + 3j + 14k}{\sqrt{214}}$

$F_{CA} = (82i + 82j + 382.8k)$ lb

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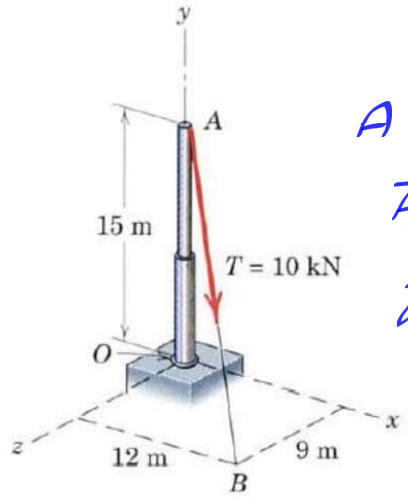
**3.**

A tension **T** of magnitude 10 kN is applied to the cable attached to the top $A$ of the rigid mast and secured to the ground at $B$. Determine the moment $M_z$ of **T** about the $z$-axis passing through the base $O$.




$A(0, 15, 0)$, $B(12, 0, 9)$

$\vec{AB} = B - A = 12\,i - 15\,j + 9\,k$

$\vec{u}_{AB} = \dfrac{12\,i - 15\,j + 9\,k}{\sqrt{12^2 + (-15)^2 + 9^2}}$

$\vec{f} = 10 \cdot \dfrac{12\,i - 15\,j + 9\,k}{15\sqrt{2}} = 4\sqrt{2}\,i - 5\sqrt{2}\,j + 3\sqrt{2}\,k$

$\vec{r} = 0\,i + 15\,j + 0\,k$

$\vec{M} = \vec{r} \times \vec{f} = \begin{vmatrix} i & j & k \\ 0 & 15 & 0 \\ 4\sqrt{2} & -5\sqrt{2} & 3\sqrt{2} \end{vmatrix}$

$= (15 * 3\sqrt{2})\,i - (0)\,j + (-15 * 4\sqrt{2})\,k$

$= 45\sqrt{2}\,i - 60\sqrt{2}\,k$