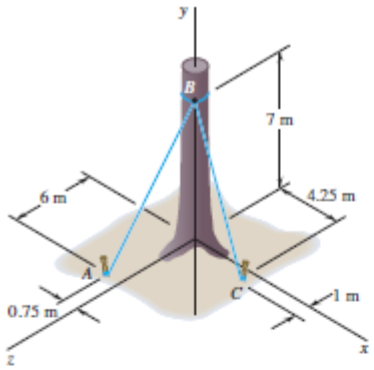

PROBLEM 3.21

Before the trunk of a large tree is felled, cables AB and BC are attached as shown. Knowing that the tensions in cables AB and BC are 555 N and 660 N, respectively, determine the moment about O of the resultant force exerted on the tree by the cables at B.

SOLUTION

$$d_{BA} = \sqrt{(-0.75\text{ m})^2 + (-7\text{ m})^2 + (6\text{ m})^2} = 9.25\text{ m}$$

$$d_{BC} = \sqrt{(4.25\text{ m})^2 + (-7\text{ m})^2 + (1\text{ m})^2} = 8.25\text{ m}$$

Have $$\mathbf{T}_{BA} = T_{BA}\frac{\overrightarrow{BA}}{d_{BA}} = \frac{555\text{ N}}{9.25\text{ m}}(-0.75\text{ m}\,\mathbf{i} - 7\text{ m}\,\mathbf{j} + 6\text{ m}\,\mathbf{k})$$

$$\mathbf{T}_{BA} = -(45\text{ N})\mathbf{i} - (420\text{ N})\mathbf{j} + (360\text{ N})\mathbf{k}$$

$$\mathbf{T}_{BC} = T_{BC}\frac{\overrightarrow{BC}}{d_{BC}} = \frac{660\text{ N}}{8.25\text{ m}}(4.25\text{ m}\,\mathbf{i} - 7\text{ m}\,\mathbf{j} + \mathbf{k})$$

$$\mathbf{T}_{BC} = (340\text{ N})\mathbf{i} - (540\text{ N})\mathbf{j} + (80\text{ N})\mathbf{k}$$

$$\mathbf{R} = \mathbf{T}_{BA} + \mathbf{T}_{BC}$$

$$\therefore \mathbf{R} = (295\text{ N})\mathbf{i} - (980\text{ N})\mathbf{j} + (440\text{ N})\mathbf{k}$$

$\mathbf{M}_O = \mathbf{r}_{B/O} \times \mathbf{R}$ where $\mathbf{r}_{B/O} = (7\text{ m})\mathbf{j}$

$$\mathbf{M}_O = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & 7 & 0 \\ 295 & -980 & 440 \end{vmatrix} \text{N·m}$$

$$= (3080\text{ N·m})\mathbf{i} - (2065\text{ N·m})\mathbf{k}$$

$$\mathbf{M}_O = (3080\text{ N·m})\mathbf{i} - (2070\text{ N·m})\mathbf{k} \blacktriangleleft$$