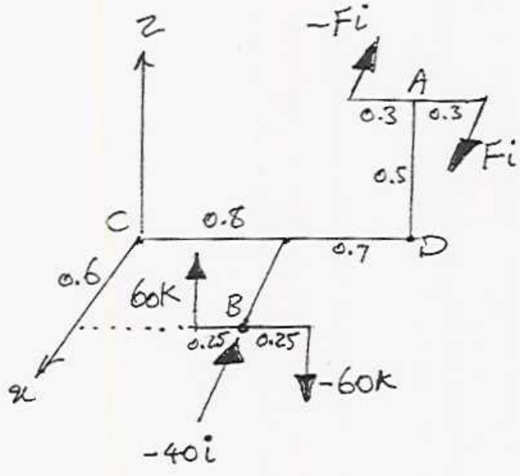
4-135 Solution:

Find the resultant force:

$\vec{F_R} = -40\hat{i} + 60\hat{k} - 60\hat{k} + F\hat{i} - F\hat{i}$

(couple forces are cancelled out)

$\vec{F_R} = -40\hat{i}$



Units are in N and m.

The resultant force is along x direction (negative x) and for having a wrench, the resultant moment should be along x axis as well.

Find all the moments due to couple forces and force (−40i):

$\vec{M}_{Total} = \vec{r}_{CB} \times (-40\hat{i}) + \ominus(60 \times 0.5)\hat{i} + \ominus(F \times 0.6)\hat{k}$

$\vec{M}_{Total} = (0.6\hat{i} + 0.8\hat{j}) \times (-40\hat{i}) - 30\hat{i} - 0.6F\hat{k}$, $\hat{j} \times \hat{i} = -\hat{k}$, $\hat{i} \times \hat{i} = 0$

$\vec{M}_{Total} = 32\hat{k} - 30\hat{i} - 0.6F\hat{k} = -30\hat{i} + (32 - 0.6F)\hat{k}$

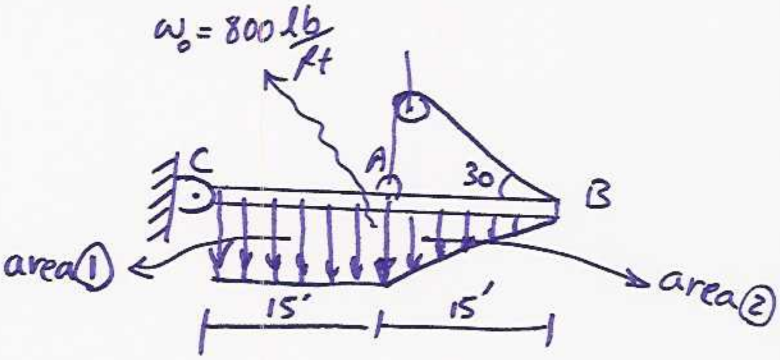
$\vec{M}_{Total} = \vec{M_R} = |M_R|\,\hat{i}$ (the only conclusion we get from having a wrench)

$-30\hat{i} + (32 - 0.6F)\hat{k} = |M_R|\,\hat{i}$ corresponding components are equal

$-30 = |M_R|$ N.m Resultant moment is along negative x

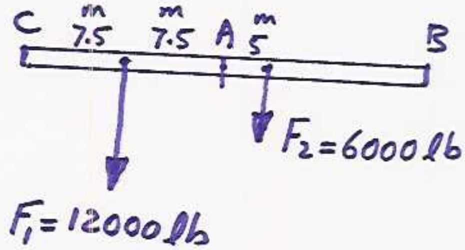
$32 - 0.6F = 0 \Longrightarrow F = \frac{32}{0.6} = 53.3$ N

$\boxed{4\text{-}145}$



F_1 = Resultant force for rectangular distributed load

$= \text{area } 1 = 15 \times 800 = 12000\ lb = 12\ kip$



F_2 = Resultant force for triangular distributed load

$= \text{area } 2 = \frac{800 \times 15}{2} = 6000\ lb = 6\ kip$

$F_R = F_1 + F_2 = 12000\ lb + 600\ lb = 18000\ lb = 18\ kip$

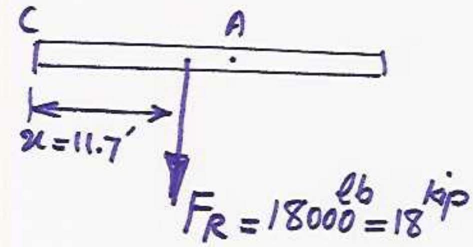
Centroid of area 1 is 7.5′ away from C. $(= \frac{1}{2} AC)$

Centroid of area 2 is 20′ away from C $(= AC + \frac{1}{3} AB)$

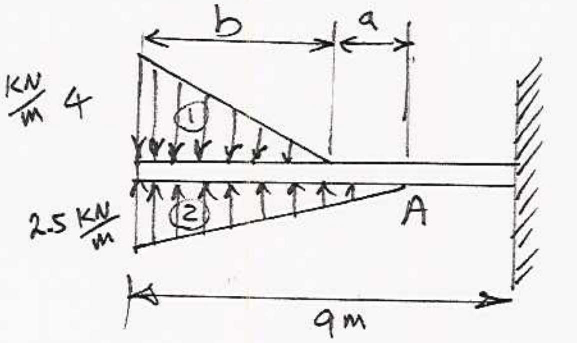
$M_C = -F_1(7.5) - F_2(20) = -12 \times 7.5 - 6 \times 20 = -210\ kip\,ft$

$M_R = -F_R \cdot x = -18 \cdot x$

$M_C = M_R = -18x = -210 \longrightarrow x = \frac{210}{18} = 11.7\ ft$



Problem 4-147



$F_1 = \text{area } ①$

$F_2 = \text{area } ②$

$$F_1 = \frac{4 \times b}{2} = 2b$$

$$F_2 = \frac{2.5 \times (a+b)}{2} = \frac{5}{4}(a+b)$$

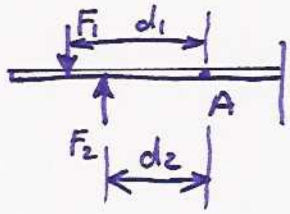
Since $F_R = 0 \Longrightarrow F_1 = F_2 \rightarrow 2b = \frac{5}{4}(a+b) \Longrightarrow \boxed{b = 5/3\, a}$

$\therefore \Sigma M_A = 8 \text{ kN.m}$ (the book should read counter clockwise)

This is a couple moment (since two forces are equal) and you can consider it about any point.

$$\Sigma M_A = F_1\big(\underbrace{\tfrac{2}{3}b + a}\big) - F_2\big(\underbrace{\tfrac{2}{3}(a+b)}\big) = 8 \text{ kN.m}$$

$$\text{or } \Sigma M_A = F_1 \cdot d_1 - F_2 \cdot d_2 = 8 \text{ kN.m}$$



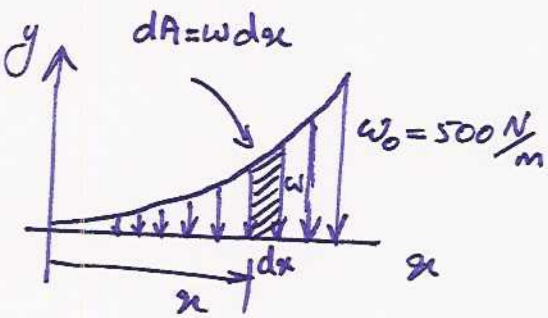
subsituting F_1 & F_2:

$$2b\left(\tfrac{2}{3}b + a\right) - 1.25(a+b)\left(\tfrac{2}{3}(a+b)\right) = 8$$

$$\tfrac{4}{3}b^2 + 2ab - (1.25a + 1.25b)\left(\tfrac{2}{3}a + \tfrac{2}{3}b\right) = 8$$

$$b = 5/3\, a \Longrightarrow \quad 1.12\, a^2 = 8_{\text{ KN.m}} \longrightarrow a = 2.682^{\text{ m}}, \quad b = 4.47^{\text{ m}}$$

Problem 4-156



$\omega_{(x)} = \frac{1}{2} x^3\ N/m$

$$F_R = \int_0^{10} \omega\, dx$$

$$= \int_0^{10} \frac{1}{2} x^3 dx = \frac{x^4}{8}\Big|_0^{10}$$

$$F_R = \frac{10^4}{8} - 0 = 1250\ N$$

$$\bar{x} = \frac{\int_L x\, \omega(x)\, dx}{\int_L \omega(x)\, dx} = \frac{\int_0^{10} x \cdot (\frac{1}{2} x^3) dx}{1250} = \frac{1}{1250}\left(\frac{1}{2} \cdot \frac{x^5}{5}\right)\Big|_0^{10} = \frac{x^5}{12500}\Big|_0^{10} = 8^m$$

this is F_R