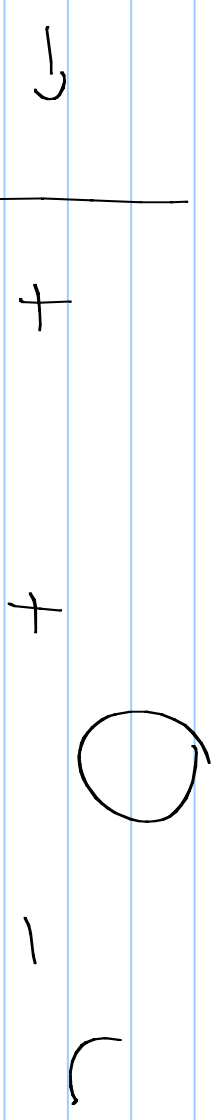
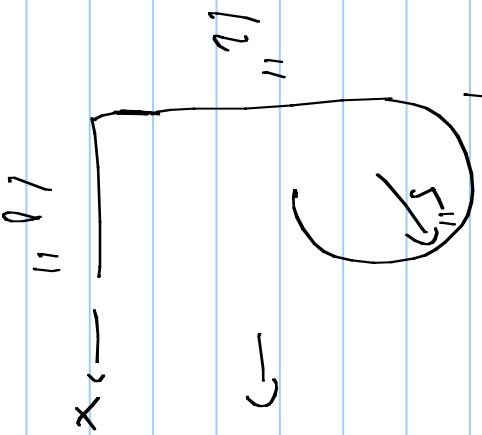


EGR 180

6/22/10

5-211) \vec{r}



x_c 0 5 5 $5 - \frac{10}{\pi}$

y_c 6 0 12 $12 - \frac{10}{\pi}$

L 12 10 10π 2.5π

$$L = 12 + 10 + 10\pi - 2.5\pi = 22 + 7.5\pi$$

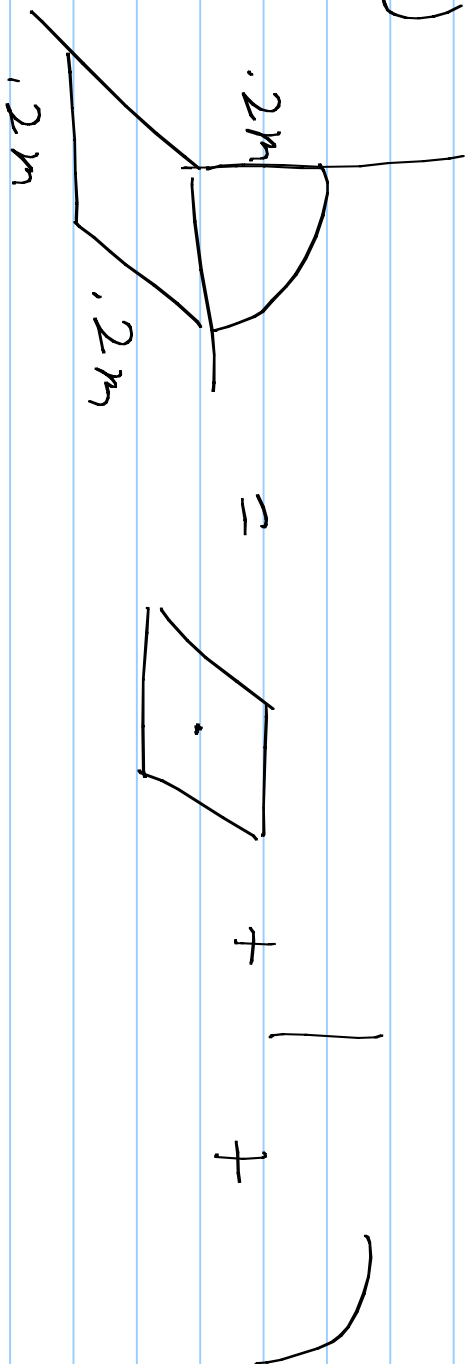
$$\begin{aligned} X_{LL} &= 0.12 + 5.10 + 5 - 10\pi - 2.5\pi \left(5 - \frac{10}{\pi}\right) \\ &= 50 + 50\pi - 12.5\pi + 25 = 75 + 37.5\pi \end{aligned}$$

$$\begin{aligned} X_{LL} &= 6.12 + 0.10 + 12.10\pi - 2.5\pi \left(12 - \frac{10}{\pi}\right) \\ &= 72 + 120\pi - 30\pi + 25 = 97 + 90\pi \end{aligned}$$

$$X_L = \frac{\sum X_{LL}}{\sum L} = \frac{75 + 37.5\pi}{22 + 7.5\pi} = 4.2''$$

$$Y_L = \frac{\sum Y_{LL}}{\sum L} = \frac{97 + 90\pi}{22 + 7.5\pi} = 8.3''$$

5-48)



$$x_c \quad 0.1 \quad 0 \quad 0$$

$$y_c \quad -1 \quad 0 \quad \frac{4}{\pi}$$

$$z_c \quad 0 \quad .1 \quad .4\pi$$

$$L \quad .8 \quad .2 \quad .1\pi$$

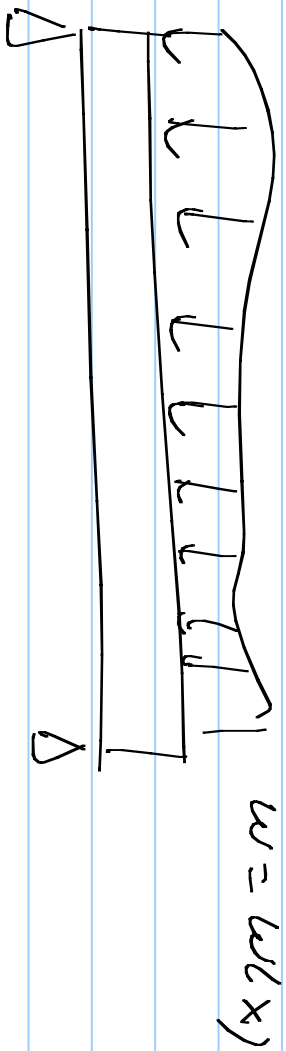
$$\sum x_{cL} = \frac{(.1)(.8) + 0(.2) + 0(.1\pi)}{.8 + .2 + .1\pi} = \frac{.08}{1 + .1\pi} = .061m$$

$$y_c = \frac{\sum y_{cL}}{\sum L} = \frac{(.1)(.8) + (.2) + .1\pi(.4/\pi)}{1 + .1\pi} = \frac{.12}{1 + .1\pi} = .091m$$

$$z_c = \frac{\sum z_{cL}}{\sum L} = \frac{0(.8) + (.1)(.2) + .1\pi(.4/\pi)}{1 + .1\pi} = \frac{.06}{1 + .1\pi} = .046m$$

$$(x_c, y_c, z_c) = (.061, .091, .046) \text{ mm}$$

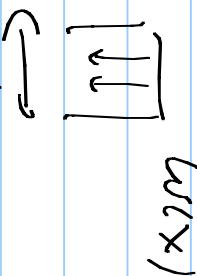
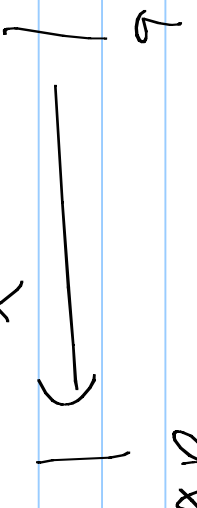
Distributed Loads on Beams



A

B

R_A, M_A



$$dR = w(x) dx$$

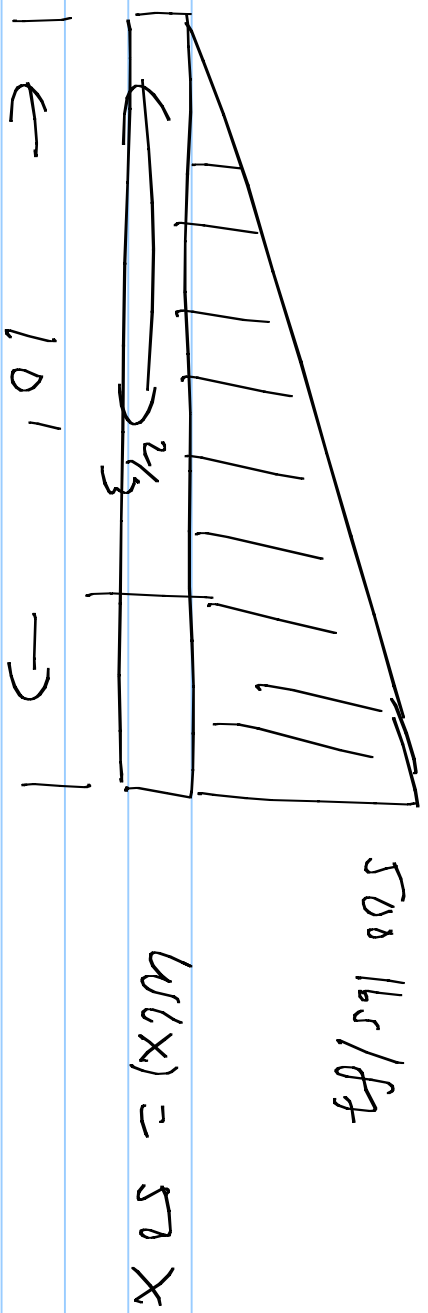
$$R = \int_a^b w(x) dx$$

$$dM = -x dR$$

$$M = -\int_a^b x w(x) dx$$

$$R = -\int_L w(x) dx$$

$$M = -\int_L x w(x) dx$$

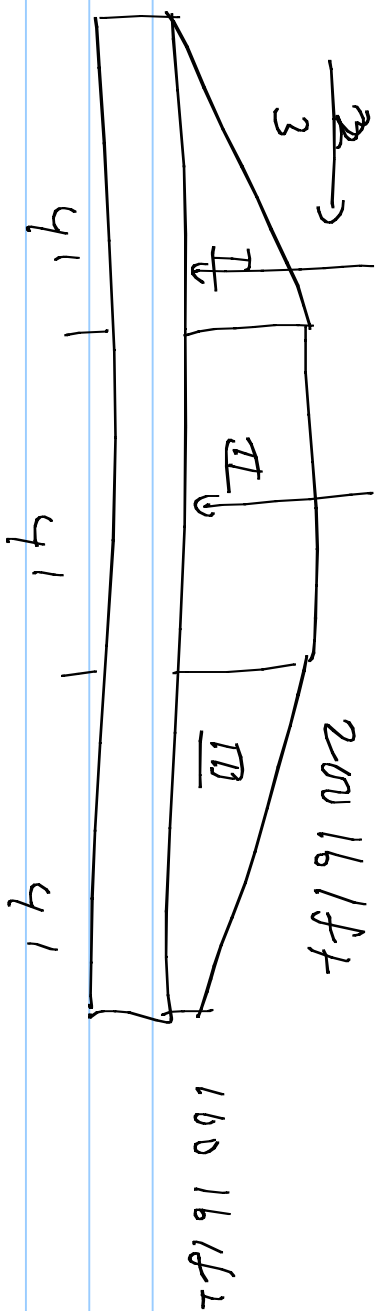


$$R = \frac{1}{2} 10 \cdot 500 = 2500 \text{ lbs}$$

$$M = - \int_0^{10} x \cdot 50x \, dx = -50 \int_0^{10} x^2 \, dx = -\frac{50}{3} x^3 \Big|_0^{10}$$

$$= -\frac{50,000}{3} \text{ ft} \cdot \text{lbs}$$

$$X = \frac{M}{R} = \frac{+50,000}{3 (-2500)} = -\frac{20}{3} \text{ ft} = 6 \text{ ft } 8 \text{ in}$$



$$I: R_I = \frac{1}{2} \cdot 4 \cdot 200 = 400 \text{ lbs} \quad M_I = \left(\frac{8}{3}\right)(400) = \frac{3200}{3}$$

$$II: R_{II} = 4 \cdot 200 = 800 \text{ lbs} \quad M_{II} = 4800$$

$$III: R_{III} = \frac{1}{2} (100 + 200) = 150 \text{ lbs}$$

$$w_{III}(x) = 200 - 25(x-8) = 400 - 25x$$

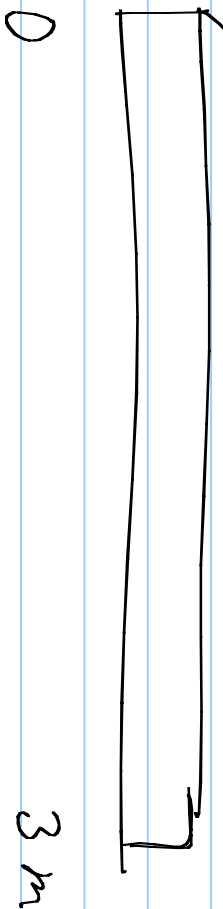
$$(8, 200) \rightarrow (12, 100) \Rightarrow \frac{R = 100 - 200}{12 - 8} = \frac{-100}{4} = -25$$

$$M_{III} = \int_8^{12} (400x - 25x^2) dx = 200x^2 - \frac{25}{3}x^3 \Big|_8^{12} \\ = 16,000 - \frac{30,400}{3}$$

$$R = 400 + 800 + 600 = 1800 \text{ lbs}$$

$$M = \frac{3200}{3} + 4800 + 16,000 - \frac{30,400}{3} = 11,230 \text{ ft}\cdot\text{lbs}$$

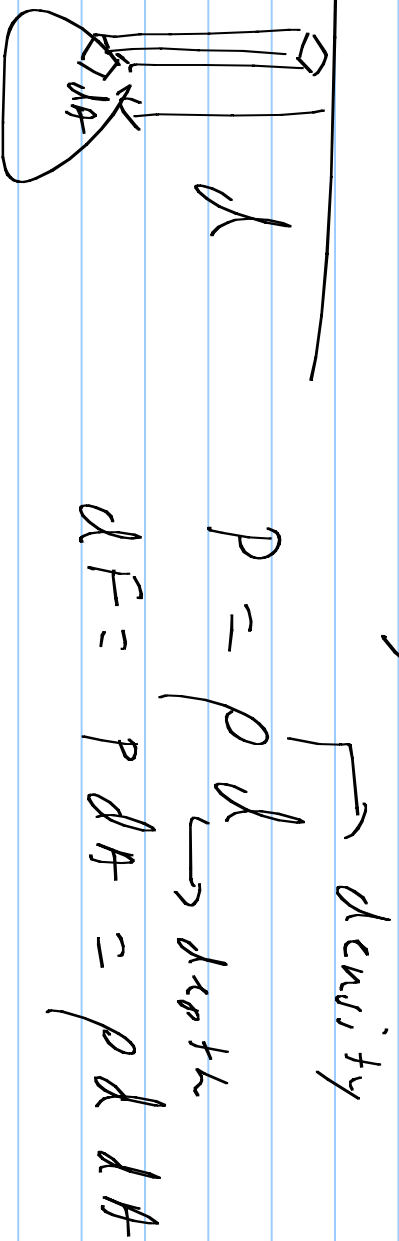
$$X = \frac{M}{R} = 6.52 \text{ ft} \quad \rightarrow w(x) = 400 \sqrt{\frac{x}{3}} \text{ N/m}$$

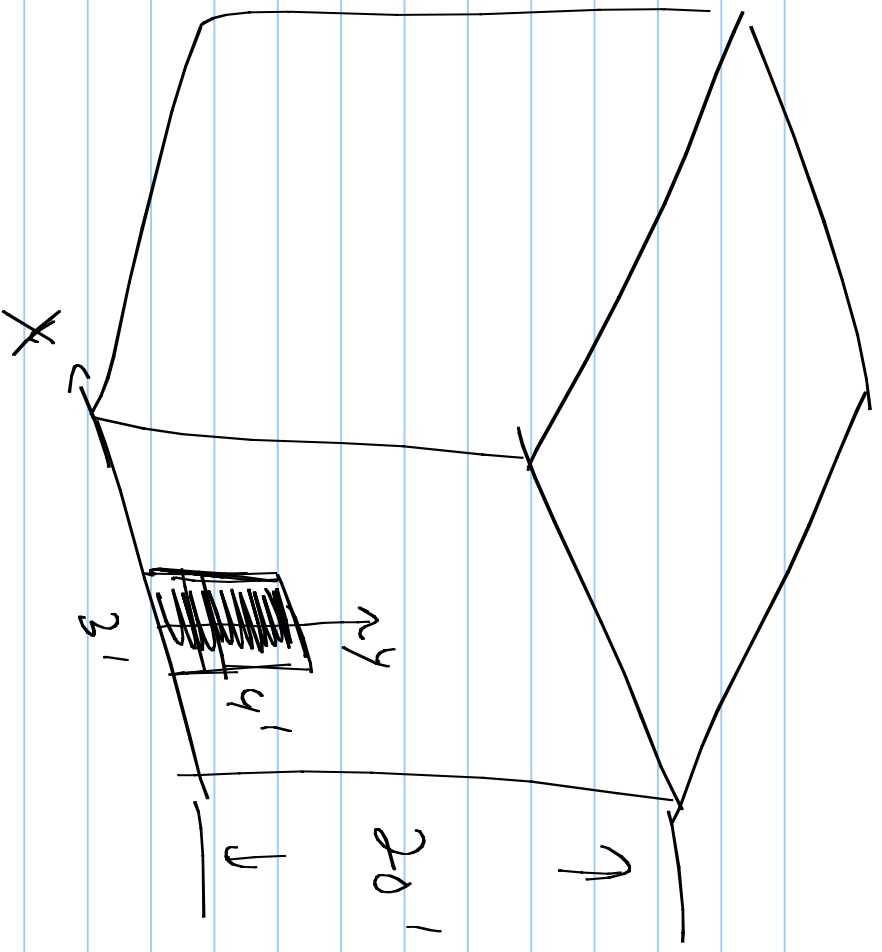


$$\begin{aligned} R &= \int_0^3 400 \sqrt{\frac{x}{3}} dx = \frac{400}{\sqrt{3}} \int_0^3 x^{1/2} dx = \frac{400}{\sqrt{3}} \cdot \frac{2}{3} x^{3/2} \Big|_0^3 \\ &= 800 \text{ N} \end{aligned}$$

$$\begin{aligned}
 M &= \int_0^3 400 \sqrt{\frac{x}{3}} \cdot x \, dx = \frac{400}{\sqrt{3}} \int_0^3 x^{3/2} \, dx \\
 &= \frac{400}{\sqrt{3}} \cdot \frac{2}{5} x^{5/2} \Big|_0^3 = \frac{800}{5\sqrt{3}} \cdot 9\sqrt{3} = \frac{7200}{5} = 1440 \text{ N}\cdot\text{m}
 \end{aligned}$$

Forces on submerged surfaces





$$d = 20 - y$$

$$dA = 3 dy$$

$$F = \int_0^y \rho (20 - y) 3 dy$$

$$= 3\rho \int_0^y (20 - y) dy$$

$$= 3\rho \left[20y - \frac{y^2}{2} \right]_0^y$$

$$= 3\rho (80 - 8)$$

$$= 216\rho \text{ lbs}$$

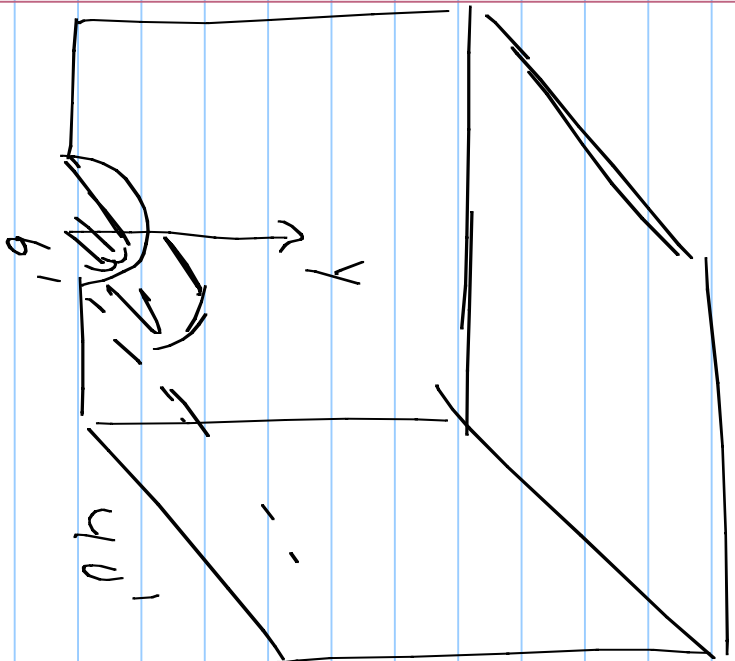
$$F = 13,500 \text{ lbs}$$

$$\Delta M = y \Delta F \Rightarrow M = \int_0^y 3y (P)(20-y) dy$$

$$= 3P \int_0^y (20y - y^2) dy = 3P \left[10y^2 - \frac{y^3}{3} \right]_0^y$$

$$= 3P \left(160 - \frac{64}{3} \right) = 26,500 \text{ ft} \cdot \text{lbs}$$

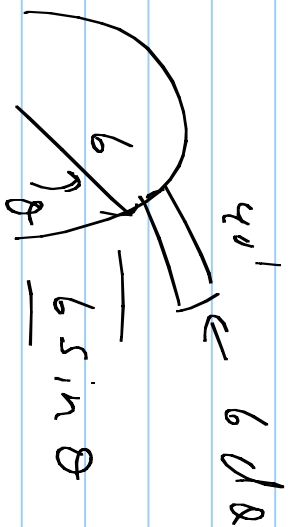
$$\bar{y} = \frac{26,500}{13,500} = 1.93 \text{ ft}$$



20'

$$d = 20 - 6 \sin \theta$$

$$dA = 240 d\theta$$



$$F = \int_0^{\pi} \rho (20 - 6 \sin \theta) (240 d\theta)$$

$$= 240 \rho \int_0^{\pi} (20 - 6 \sin \theta) d\theta$$

$$= 2400 \int_0^{\pi} [20\sigma + 6 \cos\sigma] d\sigma$$

$$= 2400 \pi [20\sigma - 12] = 261 \times 10^3 \text{ lbs}$$

$$= 380 \text{ Tons}$$