E36 Spring 2005
Homework 11 Solutions
5/164,168,180,186,189

5/164 Force on bottom = weight of water

$= \rho g V = \left(1000 \frac{kg}{m^3}\right)\left(9.81 \frac{m}{s^2}\right)(0.3\,m)(0.7\,m)(0.4\,m)$

$= \underline{824\ N}$ (down, at center of bottom)

Force on front & back $= P_{av} A_f = \frac{\rho g h}{2} A_f$

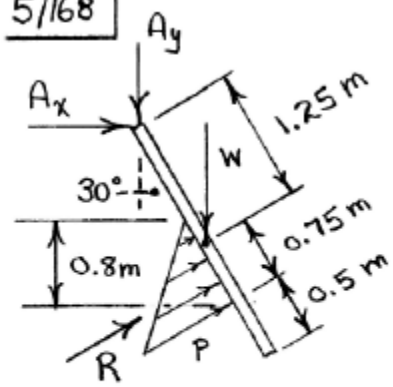
$= \frac{1000(9.81)(0.4)}{2}(0.7)(0.4) = \underline{549\ N}$ (outward, at $\frac{2}{3}$ depth)

Force on each end glass $= P_{av} A_e = \frac{\rho g h}{2} A_e$

$= \frac{1000(9.81)(0.4)}{2}(0.3)(0.4) = \underline{235\ N}$ (outward, at $\frac{2}{3}$ depth)

(All side forces centered horizontally)

5/168



$P = \rho g h = 1000(9.81)(0.8)$

$= 7850\ Pa$

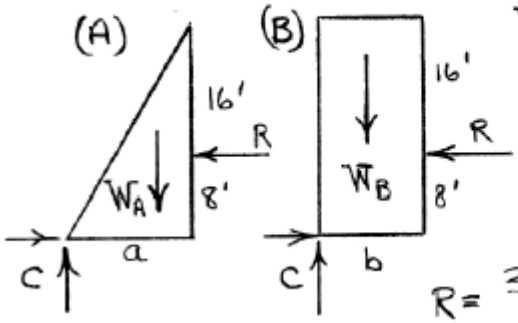
$R = \frac{1}{2}(7850)\left(\frac{0.8}{\cos 30°}\right)$

$= 3620\ N/m$

$+\circlearrowright \Sigma M_A = 0: \quad W(1.25 \sin 30°) - 3620\left(2.5 - 0.5 - \frac{1}{3}\frac{0.8}{\cos 30°}\right)$

$= 0; \quad \underline{W = 9810\ N/m}$

5/180 Per foot of length



$W_A = \frac{1}{2}(24a)(150)$
$= 1800a$ (lb/ft)

$W_B = (24b)(150)$
$= 3600b$ (lb/ft)

$R = \frac{24}{2}(62.4)(24) = 17,970$ lb/ft

(A) $\Sigma M_C = 0$: $17,970(8) - \frac{2}{3}a(1800a) = 0$

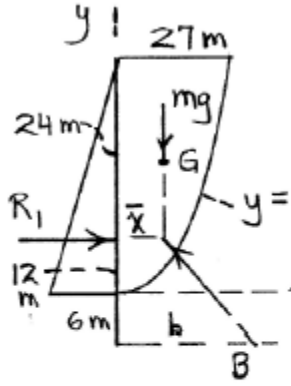
$a = 10.95$ ft, $W_A = 1800(10.95) = 19,700$ lb/ft

(B) $\Sigma M_C = 0$: $17,970(8) - \frac{b}{2}(3600b) = 0$

$b = 8.94$ ft, $W_B = 3600(8.94) = 32,200$ lb/ft

So A requires $32,200 - 19,700 = 12,470$ lb/ft less than B.

5/186 Take a vertical section of water of unit horizontal length. Let ρ be the water density in t/m^3.



$y = kx^2$: $36 = k(27)^2$, $k = \frac{4}{81}$ m^{-1}

$\bar{x} = \frac{\int x\,dA}{\int dA}$, $dA = x\,dy = 2\frac{4}{81}x^2\,dx$

$\therefore \bar{x} = \frac{\int_0^{27} \frac{x}{2}\frac{8}{81}x^2\,dx}{\int_0^{27}\frac{8}{81}x^2\,dx} = 10.12$ m

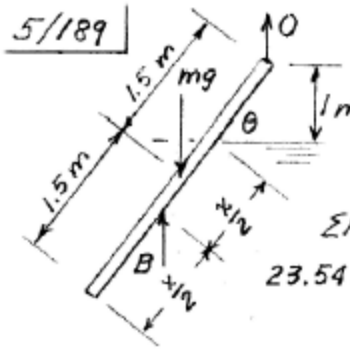
$A = \int dA = 648$ m^2, $mg = 648\rho g$

$R_1 = \frac{1}{2}\,36\rho g\,(36)(1) = 648\rho g$

Resultant of mg & R_1 passes through B, so $\Sigma M_B = 0$. Thus $648\rho g(18) = 648\rho g(b - 10.12)$

$b = 28.1$ m

5/189



Let A = cross-sectional area of plank

$mg = 800(3)A(9.81) = 23.54(10^3)A$ N

$B = \rho_w g A x$

$= 1000(9.81)A\left(3 - \frac{1}{\sin\theta}\right)$

$\Sigma M_O = 0;$

$23.54(10^3)A(1.5\cos\theta) - 9.81(10^3)A\left(3 - \frac{1}{\sin\theta}\right) \cdot \left[\frac{1}{2}\left(3 - \frac{1}{\sin\theta}\right) + \frac{1}{\sin\theta}\right]\cos\theta = 0$

Simplify & get $23.54(1.5) = \frac{9.81}{2}\left(9 - \frac{1}{\sin^2\theta}\right)$

& $\sin^2\theta = 0.5556$, $\sin\theta = 0.7454$, $\underline{\theta = 48.2^\circ}$