



Announcements

- CBTF Quiz 7 next week

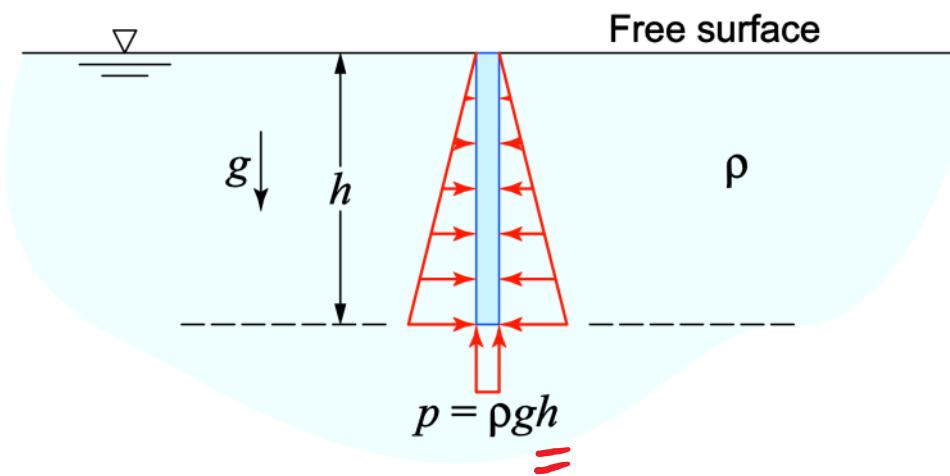
- Upcoming deadlines:

- Friday (12/1)
 - WA #4
- Saturday (12/2)
 - ME HW25
- Tuesday (12/5)
 - PL HW24



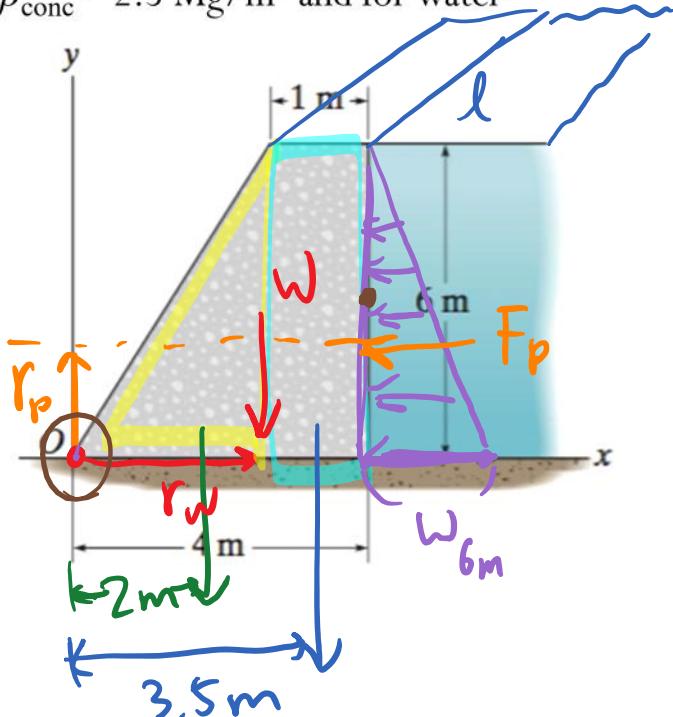
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Recap: Fluid Pressure



Direction of $\mathbf{p} \perp$ surface .

The factor of safety for tipping of the concrete dam is defined as the ratio of the stabilizing moment due to the dam's weight divided by the overturning moment about O due to the water pressure. Determine this factor if the concrete has a density of $\rho_{\text{conc}} = 2.5 \text{ Mg/m}^3$ and for water $\rho_{\text{water}} = 1 \text{ Mg/m}^3$.



$$F.S. = \frac{M_w}{M_p}$$

$$W = fVg$$

$$V = Al$$

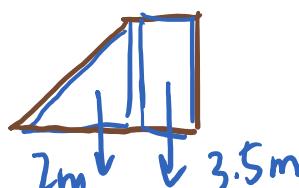
$$= \frac{1}{2}(6\text{m})(1\text{m} + 4\text{m})l$$

$$\Rightarrow W = \rho[(15\text{m}^2)l]g = 367.9 \text{ kN}$$

$$W_{6m} = \rho_{6m} \cdot l$$

$$F_p = \frac{1}{2} W_{6m} \cdot (6\text{m})$$

$$= \frac{1}{2} \rho g (6\text{m}) \cdot 6\text{m} = 176.6 \text{ kN}$$



$$r_p = 2\text{m}$$

$$\Rightarrow M_p = F_p r_p$$

$$= 353.2 \text{ kN}\cdot\text{m}$$

$$r_{wx} = \frac{\sum x_i w_i}{\sum w_i} = \frac{(2\text{m})(9\text{m}^2) + (3.5\text{m})(6\text{m}^2)}{15\text{m}^2}$$

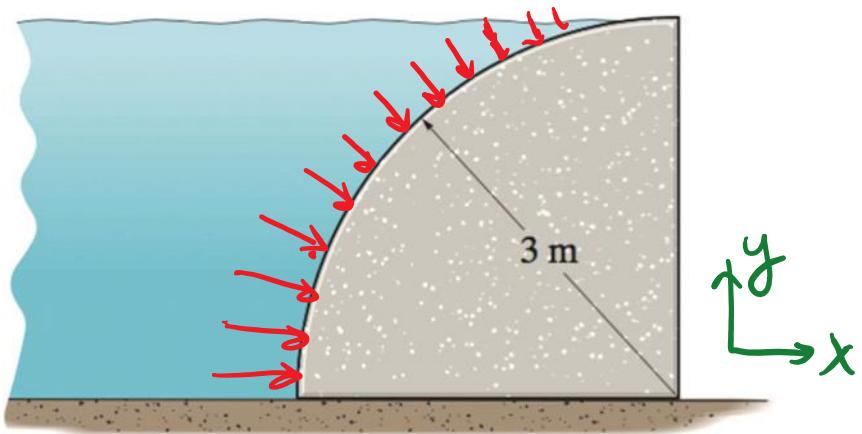
$$r_{wx} = \frac{\sum w_i r_i}{\sum w_i} = \frac{(1m)(1m) + (1.8m)(0.8m)}{15m^2} = 552.6 \text{ mm}$$

$$\Rightarrow M_w = W r_w \\ = 956.4 \text{ kN}\cdot\text{m}$$

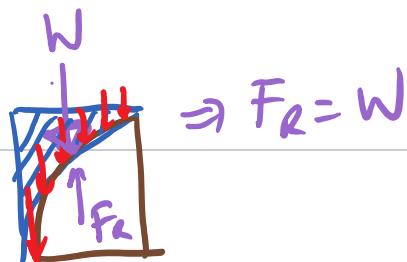
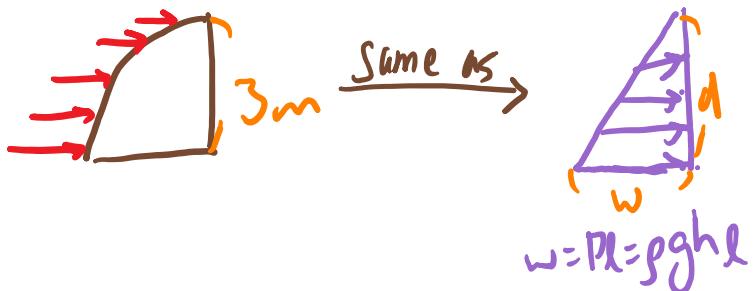
$$\Rightarrow F.S = \frac{W r_w}{F_p r_p} = 2.71$$

Determine the magnitude of the resultant force acting on on the 10-m wide dam due to hydrostatic pressure.
 $(\rho_{\text{water}} = 1 \text{ Mg/m}^3)$

$$\begin{aligned}\vec{F}_R &= \vec{F}_x + \vec{F}_y \\ &= \vec{F}_x + \vec{W}_L\end{aligned}$$

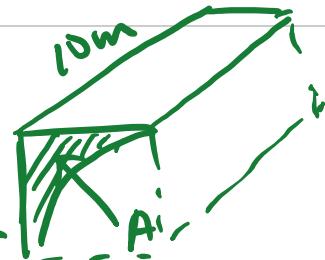


$$\begin{aligned}F_x &= \frac{1}{2}wd \\ &= \frac{[\rho g(3m)(10m)](3m)}{2} \\ &= 46.145 \text{ kN}\end{aligned}$$



$$F_y = W = \rho V g, \quad V = A(10m)$$

$$A = (3m)^2 - \frac{\pi(3m)^2}{4}$$



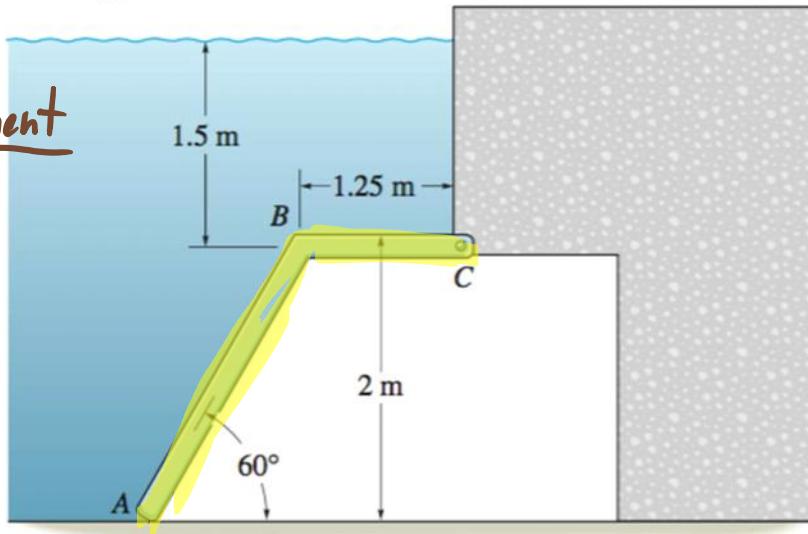
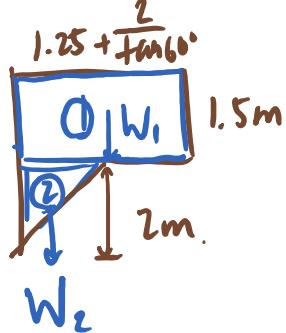
$$F_y = \rho \left(9m^2 - \frac{9\pi}{4}m^2 \right) (10m) g = 18.95 \text{ kN}$$

$$\vec{F}_R = F_x \hat{i} - F_y \hat{j}, \quad \boxed{F_R = 48 \text{ kN}}$$

Determine the magnitude of the resultant force acting on gate ABC due to hydrostatic pressure. The gate has a width of 1.5 m.

$$(\rho_{\text{water}} = 1 \text{ Mg/m}^3)$$

Vertical component



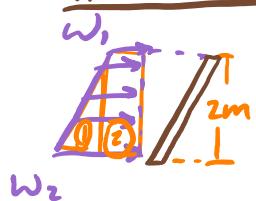
$$W_1 = \rho g V_1, V_1 = \left(1.25 + \frac{2}{\tan 60^\circ}\right)(1.5 \text{ m})(1.5 \text{ m})$$

$$W_2 = \rho g V_2, V_2 = \frac{1}{2} \left(\frac{2}{\tan 60^\circ}\right)(2 \text{ m})(1.5 \text{ m})$$

$$W_1 = 53.08 \text{ kN}$$

$$W_2 = 16.99 \text{ kN} \quad F_y = 70.07 \text{ kN}$$

Horizontal Component



① Equivalent force from the triangular distributed force

$$F_{x1} = \frac{1}{2}(w_2 - w_1)(2 \text{ m}) \quad w_2 = \rho g h_1 l = [\rho g (3.5 \text{ m})](1.5 \text{ m})$$

$$F_{x2} = (w_1)(2 \text{ m})$$

$$w_1 = \rho g h_2 l = [\rho g (1.5 \text{ m})](1.5 \text{ m})$$

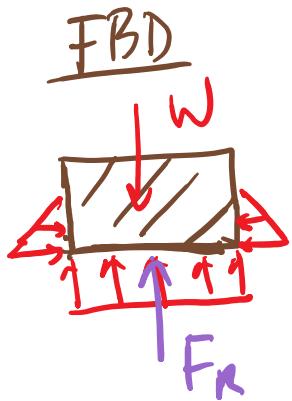
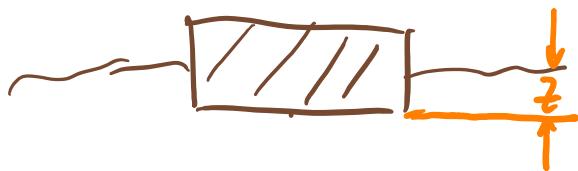
$$\Rightarrow F_x = F_{x1} + F_{x2} = 73.58 \text{ kN}$$

$$\Rightarrow \boxed{F = \sqrt{F_x^2 + F_y^2} = 102 \text{ kN}}$$

When a rectangular block of wood of cross sectional area A, height h, and mass m is placed in a lake. How far below the surface z is the bottom of the block? ($\rho_{\text{water}} = 1 \text{ Mg/m}^3$)



Side View



E6E

$$\sum F_y = F_R - W = 0$$

$$\begin{aligned} F_R &= P(A) \\ &= \rho_w g z(A) \end{aligned}$$

$$z = \frac{W}{\rho_w g z A} = \frac{m g}{\rho_w g z A} = \frac{m}{\rho_w z A}$$