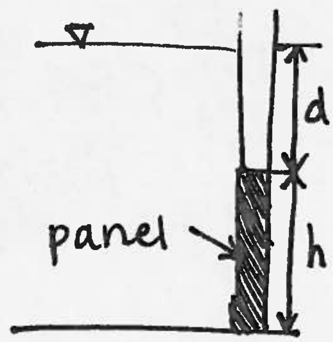
3.70) As shown, water (15°C) is in contact with a square panel; d = 1 m and h = 2m.

UNKNOWN:

a) calculate the depth of the centroid
b) Calculate the resultant force on the panel
c) Calculate the distance from the centroid to the CP.

SKETCH:



KNOWN:

$T = 15°C$
$\gamma = 9800\ N/m^3 \Rightarrow$ Table A.5.

GOVERNING EQNS:

$$F = \bar{p}A$$
$$y_{cp} - \bar{y} = \bar{I}/(\bar{y}A)$$

SOLUTION:

Depth of the centroid of area:

$$\bar{z} = d + h/2 = 1m + (2m)/2 \Rightarrow \boxed{\bar{z} = 2m}$$

Hydrostatic EQN:

$$\bar{p} = \gamma\bar{z} = 9800 N/m^3 (2m) = 19.6 kPa$$

Resultant force:

$$F = \bar{p}A = (19.6 kPa)(2m)(2m)$$

$$\boxed{F = 78.4\ kN}$$

3.70 continued)

Distance to CP

Find $\overline{I}$ using formula from Fig. A.1.

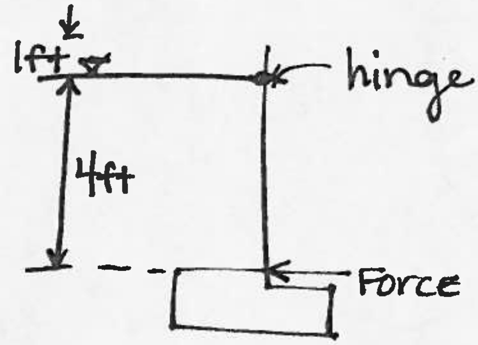
$$\overline{I} = \frac{bh^3}{12} = \frac{(2m)(2m)^3}{12} = 1.333\,m^4$$

$$\overline{y} = \overline{z} = 2m$$

$$y_{cp} - \overline{y} = \frac{\overline{I}}{\overline{y}A} = \frac{(1.333\,m^4)}{(2m)(2m)^2}$$

$$\boxed{y_{cp} - \overline{y} = 0.167\,m}$$

3.74) A rectangular gate is hinged at the water line, as shown. The gate is 4ft high and 8ft wide. The specific weight of water is 62.4 lbf/ft³. Find the necessary force (in lbf) applied at the bottom of the gate to keep it closed.



UNKNOWN:

Force to keep gate closed.

KNOWN:

$\gamma_{water} =$ 62.4 lbf/ft³

rectangular gate

$h = 4ft$

$b = 8ft$

SOLUTION:

Hydrostatic Force (magnitude):

$F_G = \bar{p}A$

$= \gamma_{H_2O} \times \bar{y}\,(32ft^2)$

$= 62.4\,lb_f/\cancel{ft^3}\,(2\cancel{ft})(32\cancel{ft^2}) = 3993.6\,lb_f$

Center of pressure. Since gate extends from the free surface of the water, F_G acts at 2/3 below the water surface.

$$\Sigma M = 0$$

$$(F_G \times \tfrac{2}{3}(4ft)) - (4ft)F = 0$$

$$F = \frac{3993.6\,lb_f\,(2.67\cancel{ft})}{4\cancel{ft}}$$

$\boxed{F = 2662.4\ lb_f}$ to the left.