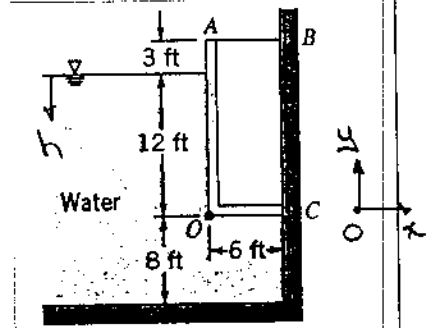


Given: Gate ABC, hinged along O, has width  $b = 6$  ft; weight of gate may be neglected. Gate is sealed at C.

Find: Force in bar AB.

Solution:

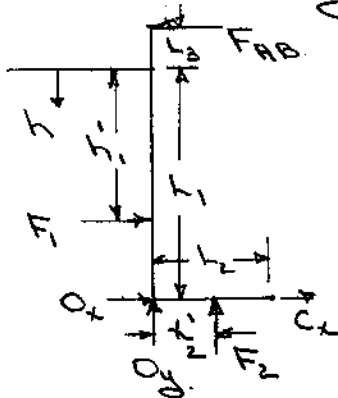


Basic equations:  $\frac{dP}{dh} = \rho g$ ;  $\sum M_O = 0$

Computing equations:  $F_R = P_c A$ ;  $y' = y_c + \frac{I_{xx}}{y_c A}$ ;  $I_{xx} = \frac{bL^3}{12}$

Assumptions: (1) static liquid (2)  $\rho = \text{constant}$   
 (3)  $P_{atm}$  acts at free surface and on outside of gate.  
 (4) no resisting moment in hinge along O.  
 (5) no vertical resisting force at C.

Then on integrating  $dP = \rho g dh$ , we obtain  $P = \rho gh$ .  
 The free body diagram of the gate is as shown.



$F_1$  is resultant of distributed force on  $h_1$ .  
 $F_2$  " " " uniform force on  $h_2$ .  
 $F_{AB}$  is force of bar.  
 $C_x$  is force from seal at C.

$$F_1 = P_c A_1 = \rho g h_c b L_1$$

$$F_1 = 1.94 \frac{\text{slug}}{\text{ft}^3} \times 32.2 \frac{\text{ft}}{\text{s}^2} \times 6 \text{ ft} \times 6 \text{ ft} \times 12 \text{ ft} \times \frac{1 \text{ lb}}{32.2 \text{ ft} \cdot \text{slug}} = 27.0 \times 10^3 \text{ lb}$$

$$h_1' = h_{c1} + \frac{b L_1^3}{12 h_{c1} b L_1} = \frac{L_1}{2} + \frac{L_1^2}{12 \times L_1} = \frac{L_1}{2} + \frac{L_1}{6} = \frac{2}{3} L_1 = \frac{2}{3} \times 12 \text{ ft} = 8 \text{ ft}$$

$$F_2 = P_c A_2 = \rho g h_c b L_2 = \rho g L_1 b L_2$$

$$F_2 = 1.94 \frac{\text{slug}}{\text{ft}^3} \times 32.2 \frac{\text{ft}}{\text{s}^2} \times 12 \text{ ft} \times 6 \text{ ft} \times 6 \text{ ft} = 27.0 \times 10^3 \text{ lb}$$

Since the pressure is uniform over surface (2), the force  $F_2$  acts at the centroid of the surface, i.e.  $x_2' = L_2/2 = 3$  ft.

Then summing moments about O gives

$$\sum M_O = 0 = (L_1 + L_3) F_{AB} + x_2' F_2 - (L_1 - h_1') F_1$$

$$F_{AB} = \frac{1}{(L_1 + L_3)} [(L_1 - h_1') F_1 - x_2' F_2] = \frac{1}{15 \text{ ft}} [(12 - 8) \text{ ft} \times 27,000 \text{ lb} - 3 \text{ ft} \times 27,000 \text{ lb}]$$

$$F_{AB} = 1800 \text{ lb}$$

Thus bar AB is in compression.

$F_{AB}$