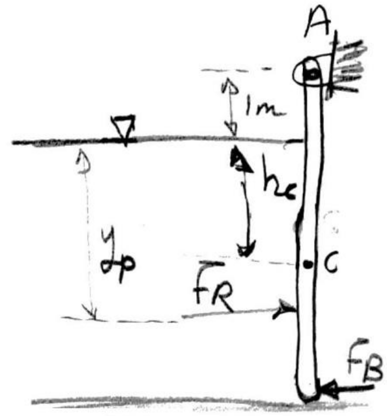
1

$$F_R = (P_0 + \rho g h_c) A = P_c A .$$

$$y_P = y_c + \frac{I_{xx,c}}{y_c A} .$$



$$F_R = \rho g h_c A$$

, $h_c = 4/2 = 2m$
, $\rho = 1000\ kg/m^3$.
, $g = 9.81\ m/s^2$.
, $A = (4 * \ \ )\ m^2$

$\boxed{h_c = y_c = 2m}$
$h_p = y_p$

$$F_R = 1000 * 9.81 * 2 * (4*4) = 313.92\ kN$$

$$I_{xx,c} = ab^3/12 = \frac{4*(4)^3}{12} = 21.3\ m$$

$$y_p = 2 + \frac{21.3}{2*4*4} = 2.67\ m$$

$$\Sigma M_A = 0$$

$$\therefore F_B * (5) = F_R * (1 + y_p)$$

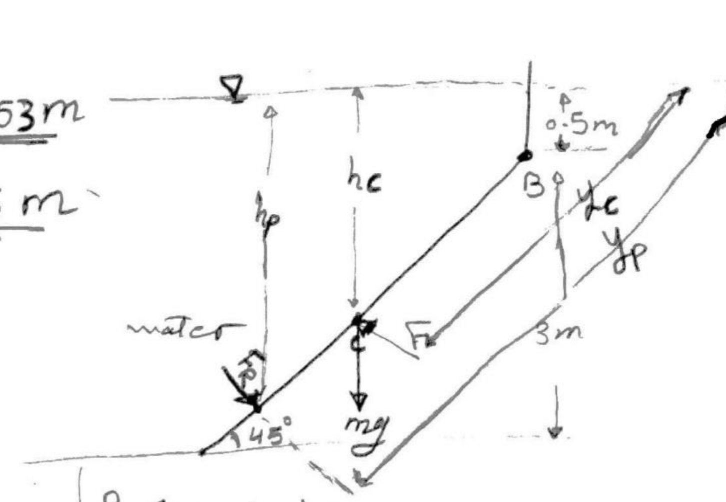
$$\therefore F_B = \frac{313.92 * 3.67}{5} = \boxed{230.42\ kN}$$

3

gate length $= L = \frac{3}{\sin 45} = \underline{3.53\,m}$

$y_c = L/2 + \frac{0.5}{\sin 45} = \underline{2.35\,m}$

$h_c = y_c \sin 45 = \underline{2\ m}$



$F_R = \rho g h_c A$

$= 1000 * 9.81 * 2 * 17.65 = \underline{346.3\,kN}$

$\rho = 1000\ kg/m^3$

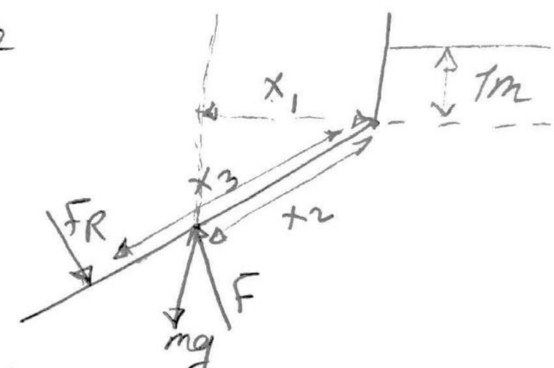
$g = 9.81\ m/s^2$

$A = L * 5 = 17.65\ m^2$

$y_p = y_c + \frac{I_{xx,c}}{y_c A}$

$I_{xx,c} = ab^3/12 = 5 * (3.53)^3/12 = \underline{18.33\ m}$

$y_p = 2.35 + \frac{18.33}{2.35 * 17.65} = \underline{2.79\,m}$



$\Sigma M_B = 0$

$\therefore F_R * x_3 + mg * x_1 = F * x_2$

$\therefore (346.3*10^3)(1.79) + (200*9.81)*(1.5) =$

$(F) * (1.765)$

$\boxed{\therefore F = 352.872\,kN}$

$x_3 = y_p - 1 = \underline{1.79\,m}$

$x_1 = \frac{L}{2} \sin 45 = \underline{1.5\,m}$

$x_2 = L/2 = \underline{1.765\,m}$

Analysis (*a*) We consider the free-body diagram of the liquid block enclosed by the circular surface of the cylinder and its vertical and horizontal projections. The hydrostatic forces acting on the vertical and horizontal plane surfaces as well as the weight of the liquid block are determined as

Horizontal force on vertical surface:

$$F_H = F_x = P_{ave}A = \rho g h_C A = \rho g(s + R/2)A$$

$$= (1000\ \text{kg/m}^3)(9.81\ \text{m/s}^2)(4.2 + 0.8/2\ \text{m})(0.8\ \text{m} \times 1\ \text{m})\left(\frac{1\ \text{kN}}{1000\ \text{kg}\cdot\text{m/s}^2}\right)$$

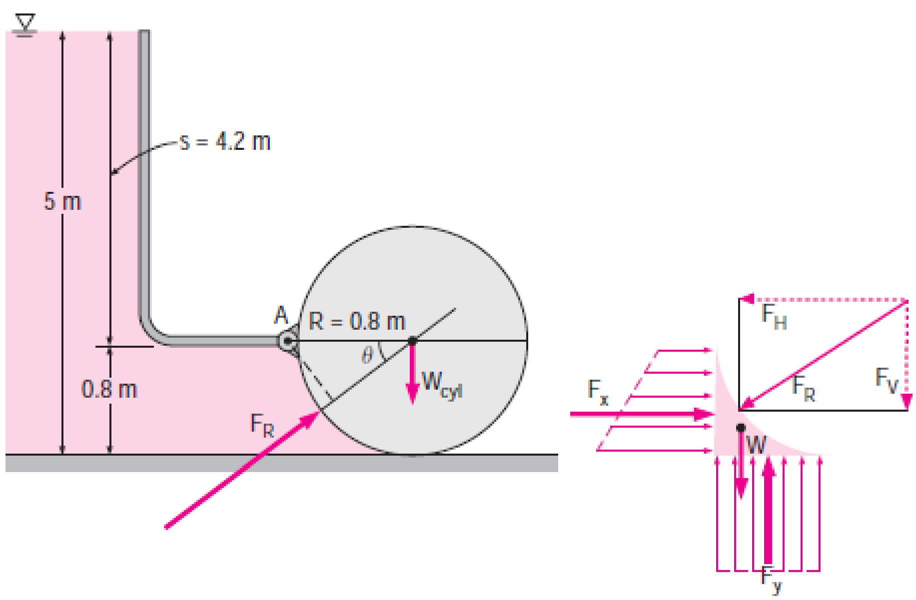
$$= \mathbf{36.1\ kN}$$

Vertical force on horizontal surface (upward):

$$F_y = P_{ave}A = \rho g h_C A = \rho g h_{bottom} A$$

$$= (1000\ \text{kg/m}^3)(9.81\ \text{m/s}^2)(5\ \text{m})(0.8\ \text{m} \times 1\ \text{m})\left(\frac{1\ \text{kN}}{1000\ \text{kg}\cdot\text{m/s}^2}\right)$$

$$= 39.2\ \text{kN}$$



Weight of fluid block per m length (downward):

$$W = mg = \rho g V = \rho g(R^2 - \pi R^2/4)(1\text{ m})$$

$$= (1000\text{ kg/m}^3)(9.81\text{ m/s}^2)(0.8\text{ m})^2(1 - \pi/4)(1\text{ m})\left(\frac{1\text{ kN}}{1000\text{ kg}\cdot\text{m/s}^2}\right)$$

$$= 1.3\text{ kN}$$

Therefore, the net upward vertical force is

$$F_V = F_y - W = 39.2 - 1.3 = 37.9\text{ kN}$$

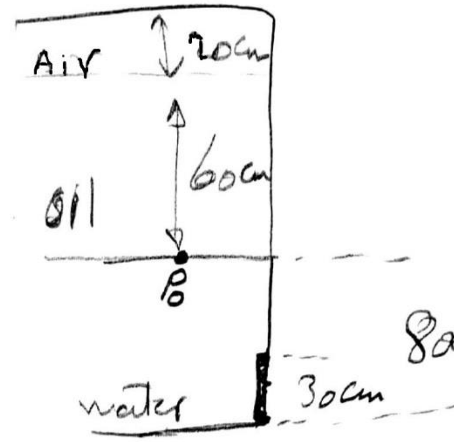
Then the magnitude and direction of the hydrostatic force acting on the cylindrical surface become

$$F_R = \sqrt{F_H^2 + F_V^2} = \sqrt{36.1^2 + 37.9^2} = \mathbf{52.3\text{ kN}}$$

$$\tan\theta = F_V/F_H = 37.9/36.1 = 1.05 \rightarrow \theta = 46.4^\circ$$

Therefore, the magnitude of the hydrostatic force acting on the cylinder is 52.3 kN per m length of the cylinder, and its line of action passes through the center of the cylinder making an angle 46.4° with the horizontal.

8



$$F_R = (P_o + \rho_w g h_c) A$$

$$h_c = 15 + 50 = 65\ \text{cm} = 0.65\ m$$

$$A = 30 * 40 * 10^{-4} = 0.12\ m^2$$

$$\therefore 8450\ N = (P_o + 1000 * 9.81 * 0.65) * 0.12$$

$$\therefore P_o = 64.04\ kPa = \rho_{oil}\, g\, h_{(60cm)} + P_{air} = (876 * 9.81 * 0.6) + P_{air}$$

$$\boxed{\therefore P_{air} = 58.884\ kPa}$$

$$\because P_{air} = \rho_m g h = 13600 * 9.81 * h = 58884\ Pa$$

$$\boxed{\therefore h = 0.441\ m = 441\ mm}$$