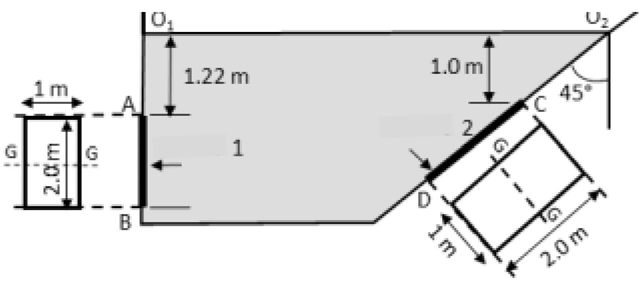
Exercise 1:

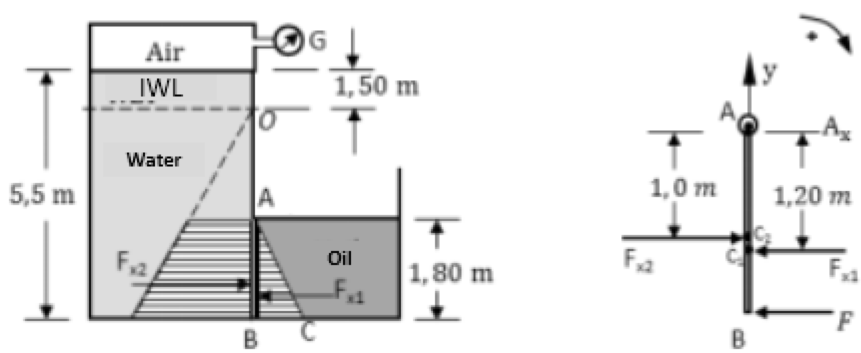
1) Determine the resultant of water pressure forces acting on valves 1 and 2, see the figure.



Exercise 2:

A gate AB pivots about axis A, which connects the two reservoirs, a shown in the figure. The manometer indicates a pressure of P= - 0.147 * 10^5 Pa.

1) What horizontal force must be applied at point B to ensure the equilibrium of the gate AB?



Exercise 3:

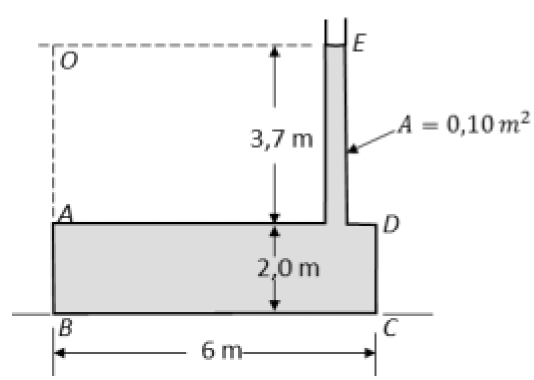
Water rises up to level E in a reservoir chimney, as shown in the figure.

Neglect the weight of the reservoir and the chimney.

1. Determine the magnitude and the position of the resultant pressure force acting on surface AB which has dimensions 2.0 × 2.5 m².

2. Answer the same question for the bottom of the reservoir.

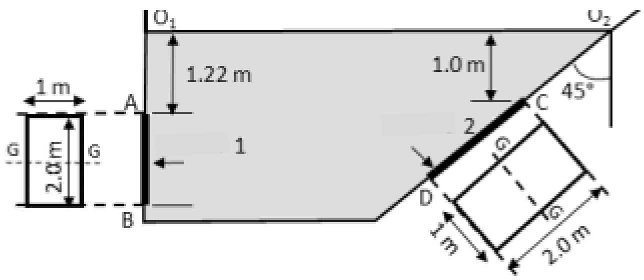
3. Compare the total weight of the water with the result obtained in (b), and explain the difference.



Solutions

Exercise 1

Solution



*** For Valve 1**

$F_{R1} = P_{G1}.S_1 = \rho.g.(1.22+1.0).S_1$

$$= 10^3 \times 9.81 \times 2.22 \times (2.0 \times 1.0) = 43556.4\ N$$

The application point for F_{R1} is given by this formula:

$$h_{C1} = h_{G1} + \frac{I_{GG1}}{h_{G1}.S_1} \quad \text{avec} \quad I_{GG1} = \frac{1.0 \times 2.0^3}{12} = 0.666\ m^4$$ For a regtangular forme

$$h_{C1} = \left(1.22 + \frac{2.0}{2}\right) + \frac{0.666}{\left(1.22 + \frac{2.0}{2}\right) \times (2.0 \times 1.0)} = 2.37\ m$$

For Valve N° 2

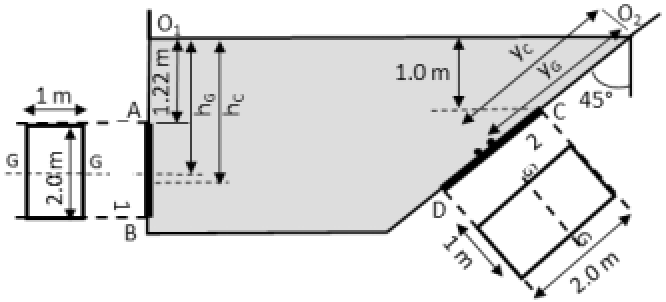
$$F_{R2} = P_{G2}.S_2 = \rho.g.\left(1.0 + \frac{2.0 \times \sin(45°)}{2}\right).S_2$$

$$= 10^3 \times 9.81 \times \left(1.0 + \frac{2.0 \times 0.707}{2}\right) \times (2.0 \times 1.0) = 33491.34\ N$$

The application point for F_{R2} :

$$y_{C2} = y_{G2} + \frac{I_{GG2}}{y_{G2}.S_2} \quad ; \quad I_{GG2} = \frac{1.0 \times 2.0^3}{12} = 0.666\ m^4$$

$$y_{C2} = \left(\frac{1.0}{\sin(45°)} + \frac{2.0}{2}\right) + \frac{0.666}{\left(\frac{1.0}{\sin(45°)} + \frac{2.0}{2}\right) \times (2.0 \times 1.0)} = 2.55\ m$$



Exercise 2

Solution

We calculate the resultant of pressure forces acting on the gate and their point of application

On the right side:

$$F_{x1} = \rho_h . g . h_h = (0.750\ x\ 9.81)(0.9)(1.8\ x\ 1.2) = 14.3\ KN$$

With a horizontal direction acting on c_1

$h_{c1} = 0.9 + \frac{1.2\times 1.8^3/12}{0.9(1.2\times 1.8)} = 1.20$ According to point A

On the left side:

The negative pressure included by the air must be converted on its equivalent Hight:

$$h = -\frac{P}{\rho . g} = -\frac{0.147\times 10^5}{1000\times 9.81} = -1.50\ m$$

This negative pressure corresponds to a pressure decrease of 1.50 m at a level above A. It is therefore important to consider a reference level of water = 1.5 under the real level to solve the problem.

$$F_{x2} = \rho_e . g . h_e = (1000\ x\ 9.81)(2.20 + 0.9)x0.8x1.2 = 65.7\ KN$$

With a horizontal direction acting on c_2

$h_{c2} = 3.1 + \frac{1.2\times 1.8^3/12}{3.1(1.2\times 1.8)} = 3.1 + 0.99 = 3.19\ m$ According to point O

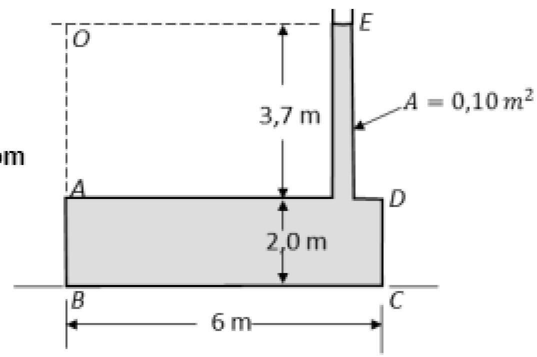
In static equilibrium, $M_{/A} = 0)$ According to A gives:

$$+F_{x1} \times 1{,}2 + 1.8F - F_{x2} \times 0.99 = 0$$

$$+14{,}3 \times 1{,}2 + 1.8 \times F - 65{,}7 \times 0.99 = 0 \; et \; F = 27\,kN$$ To the left

Exercise 3

Solution



1) The depth of gravity center of surface (S = $\overline{AB} \times 2.5$) is 4.70 m from From the surface of water E

$$F_R = P_G.S = \rho.g.h_G.(2.0 \times 2.5) =$$

$$= 10^3 \times 9.81 \times (3.7 + \frac{2.0}{2}) \times (2.0 \times 2.5)$$
$$= 230{,}53\; 10^3\,N$$

The point of application is:

$$h_c = h_G + \frac{I_{GG}}{h_G.S}$$

$$hc = 4.7 + \frac{2.5\times 2^3/12}{4.7(2.0\times 2.5)} = 4.77\,m$$ According to O

2) The resultant force on the bottom

The acting pressure on the bottom (S_F = BC × 2.5) Is uniform

$$F_R = P.S_F = (\rho.g.h).S_F = 9\,810 \times 5.7 \times (6 \times 2.5) = 839\,kN$$

3) The total weight of water is $\varpi = 9\,810(6 \times 2 \times 2.5 + 3.7 \times 0.10) = 298\,kN$