ENVE 2061 BASIC FLUID MECHANICS

Problem Session

HYDROSTATIC FORCES

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Forces Due to Gas Pressure

4.1 Figure 4.21 shows a vacuum tank with a flat circular observation window in one end. If the pressure in the tank is 0.83 kPa(abs) when the barometer reads 0.78 m of mercury, calculate the total force on the window.

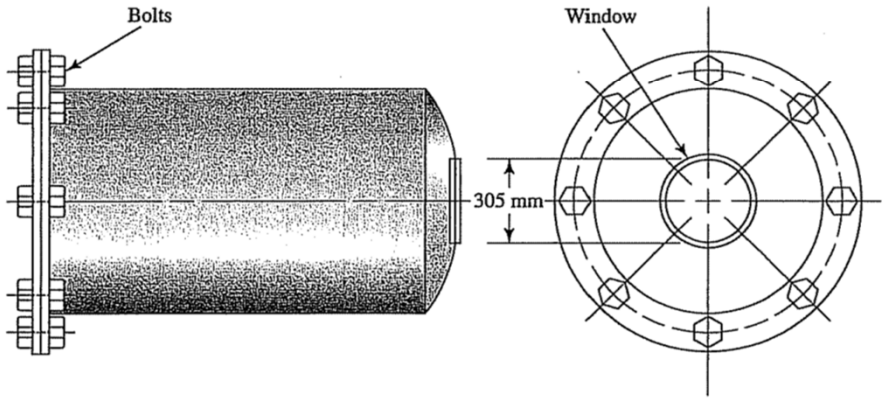


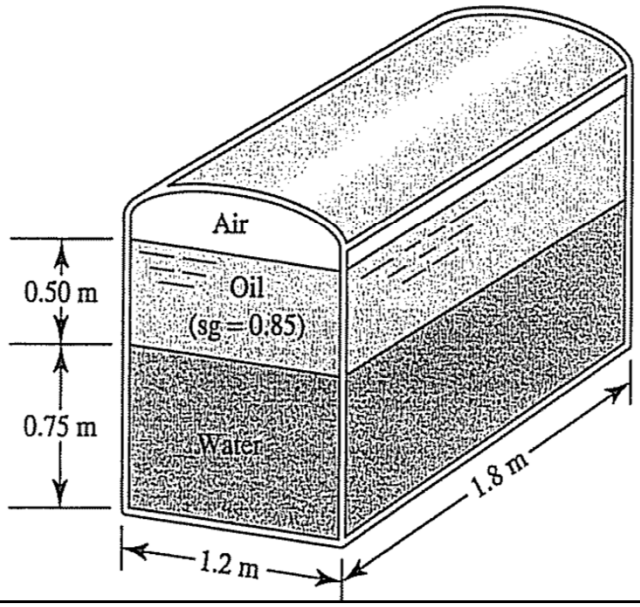
FIGURE 4.21 Tank for Problems 4.1 and 4.2.

Forces on Horizontal Flat Surfaces under Liquids

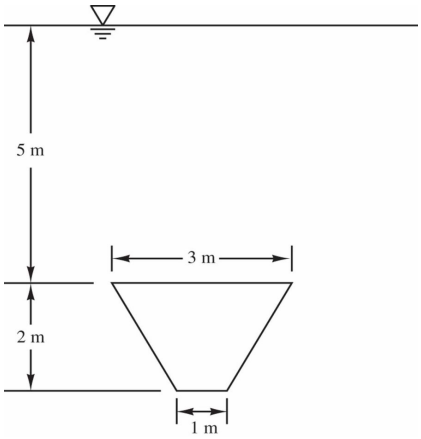
4.8 A tank containing liquid ammonia at 25°C has a flat horizontal bottom. A rectangular door, 0.6 m by 0.5 m, is installed in the bottom to provide access for cleaning. Compute the force on the door if the depth of ammonia is 3.75 m.

4.11 Calculate the total force on the bottom of the closed tank shown in Fig. 4.23 if the air pressure is 52 kPa(gage).

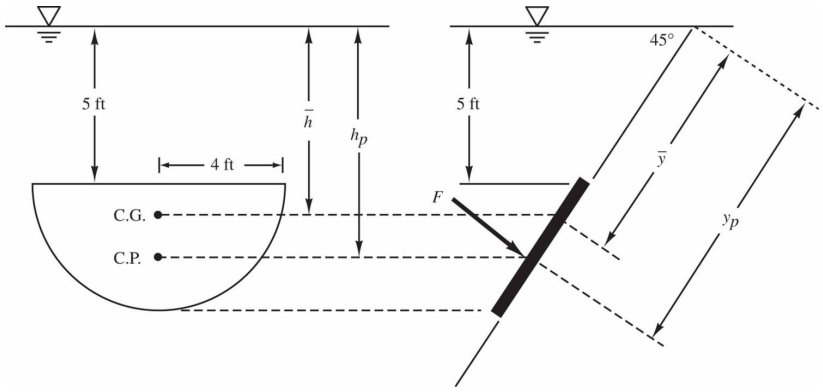
FIGURE 4.23 Problem 4.11.



- **Example 15.1.(Hwang et al., 4th Edition)** A vertical trapezoidal gate with its upper edge located 5 m below the free surface of water is shown in Figure 15.1. Determine the total pressure force and center of pressure on the gate.



Example 15.2 (Hwang et al., 4th Edition): An inverted semicircular gate is installed at 45 °C with respect to the free water surface (Figure 15.2).The top of the gate is 5 ft below the water surface in the vertical direction. Determine the hydrostatic force and the center of pressure on the gate.

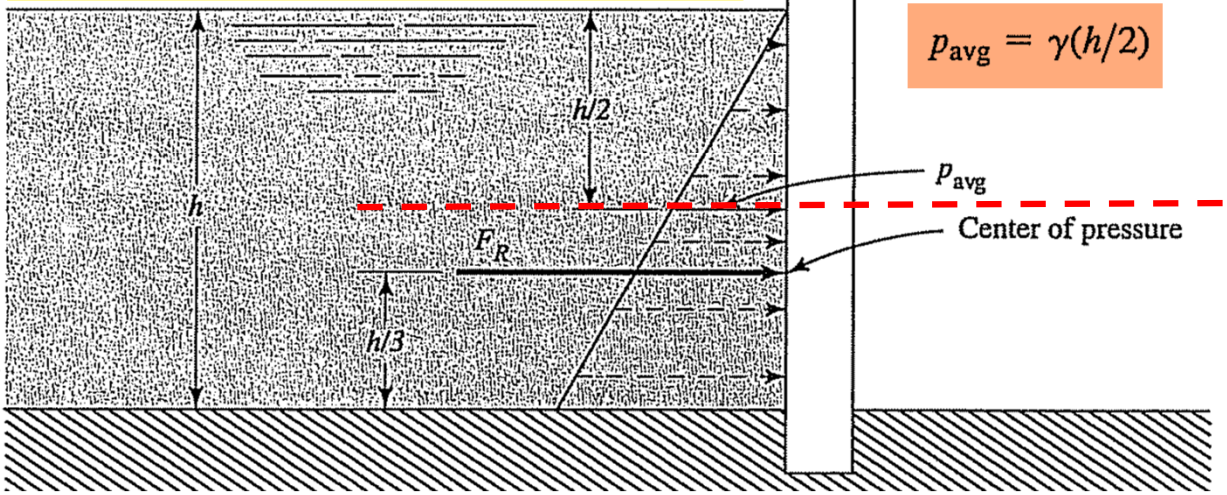


RESULTANT FORCE ON A RECTANGULAR WALL

F_R Resultant force on the area due to the fluid pressure

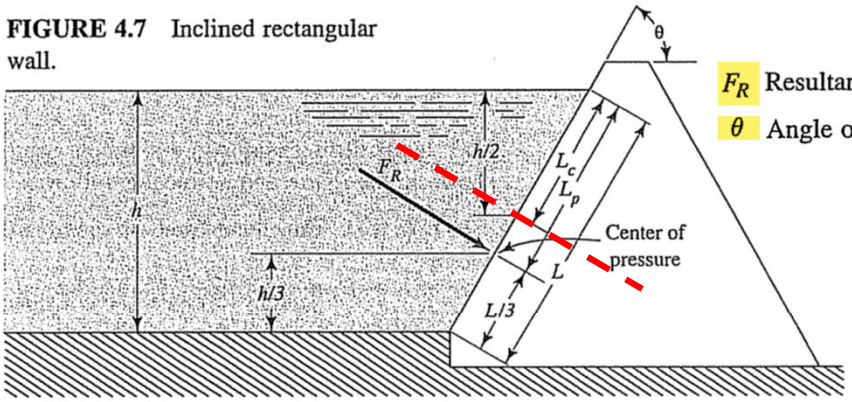
$$F_R = p_{avg} \times A$$

$$p_{avg} = \gamma(h/2)$$



Forces on Submerged Plane Areas

FIGURE 4.7 Inclined rectangular wall.



F_R Resultant force on the area due to the fluid pressure

θ Angle of inclination of the area

h_c Depth of fluid from the free surface to the centroid of the area

L_c Distance from the level of the free surface of the fluid to the centroid of the area, measured along the angle of inclination of the area

L_p Distance from the level of the free surface of the fluid to the center of pressure of the area, measured along the angle of inclination of the area

h_p Distance from the free surface to the center of pressure of the area

4.15 A vat has a sloped side, as shown in Fig. 4.27. Compute the resultant force on this side if the vat contains 4.7 m of glycerine. Also compute the location of the center of pressure and show it on a sketch with the resultant force.

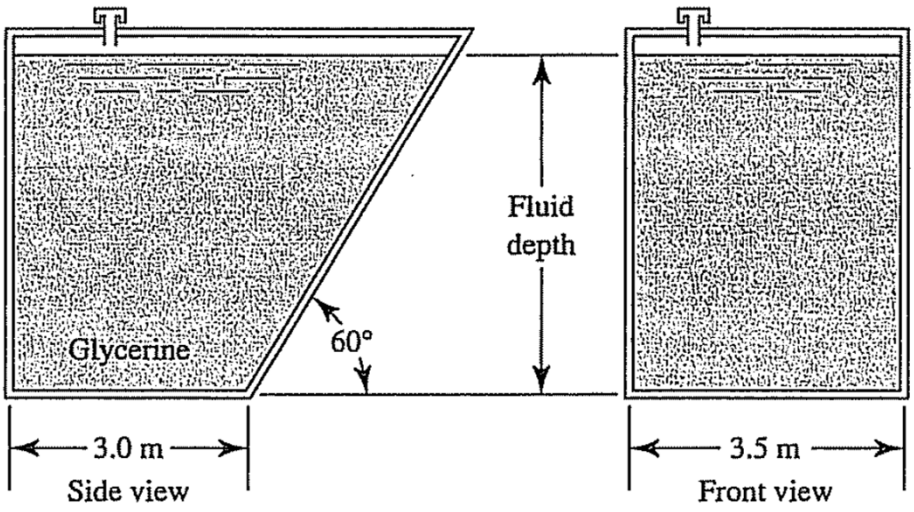


FIGURE 4.27 Vat for Problem 4.15.

4.20 Refer to Fig. 4.32.

For each of the cases shown in Figs. 4.30–4.41, compute the magnitude of the resultant force on the indicated area and the location of the center of pressure. Show the resultant force on the area and clearly dimension its location.

FIGURE 4.32 Problems 4.20, 4.36, 4.37, and 4.44.

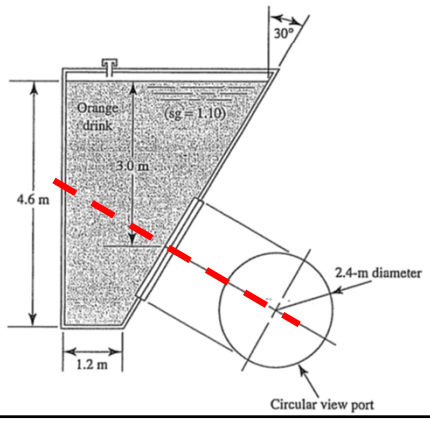
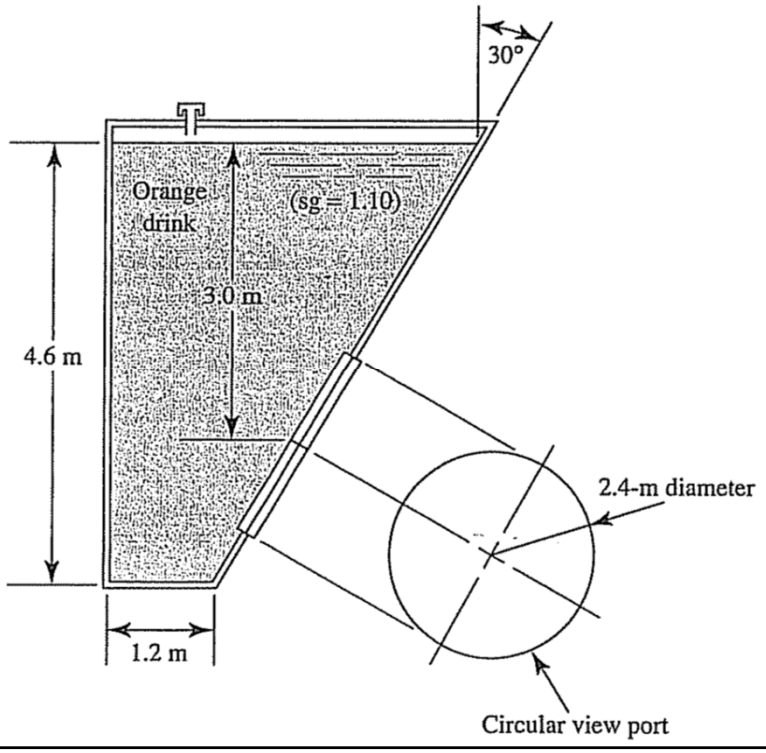


FIGURE 4.32 Problems 4.20, 4.36, 4.37, and 4.44.



$h_c = L_c \sin\theta$

$F_R = \gamma h_c A$

I_c, the moment of inertia of the area about its centroidal axis.

$L_p - L_c = \frac{I_c}{L_c A}$

$h_p = L_p \sin\theta$

$h_p = h_c + \frac{I_c \sin^2\theta}{h_c A}$

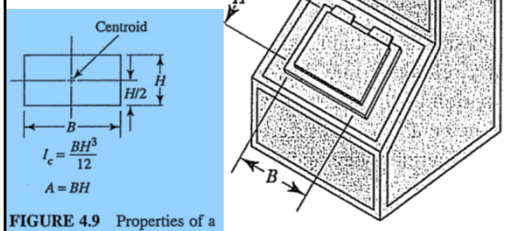


FIGURE 4.9 Properties of a rectangle.

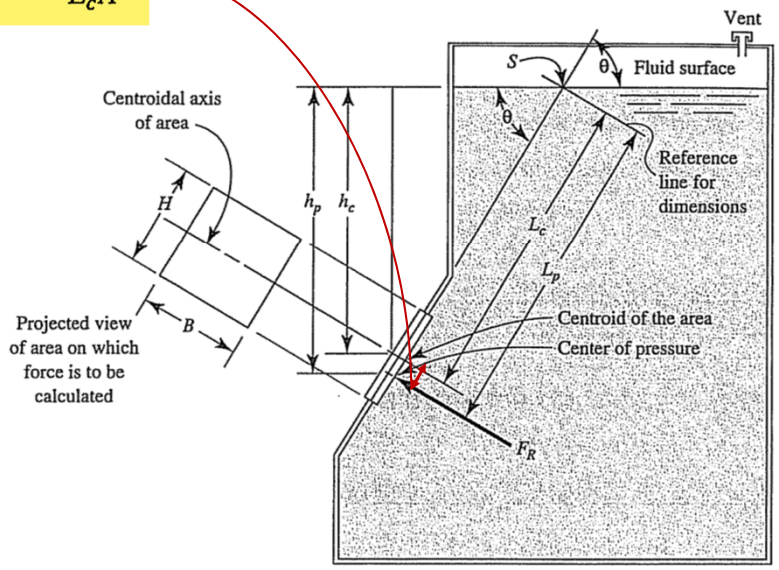


FIGURE 4.8 Force on a submerged plane area.

4.23 Refer to Fig. 4.35.

For each of the cases shown in Figs. 4.30–4.41, compute the magnitude of the resultant force on the indicated area and the location of the center of pressure. Show the resultant force on the area and clearly dimension its location.

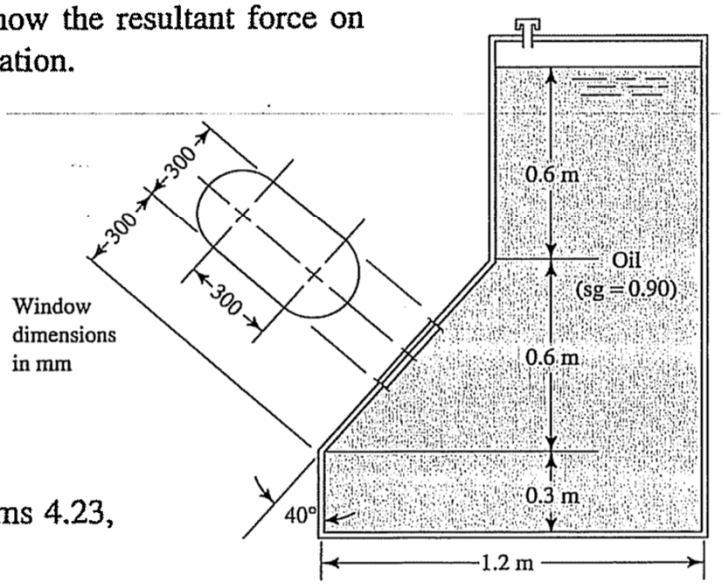


FIGURE 4.35 Problems 4.23, 4.38, and 4.39.

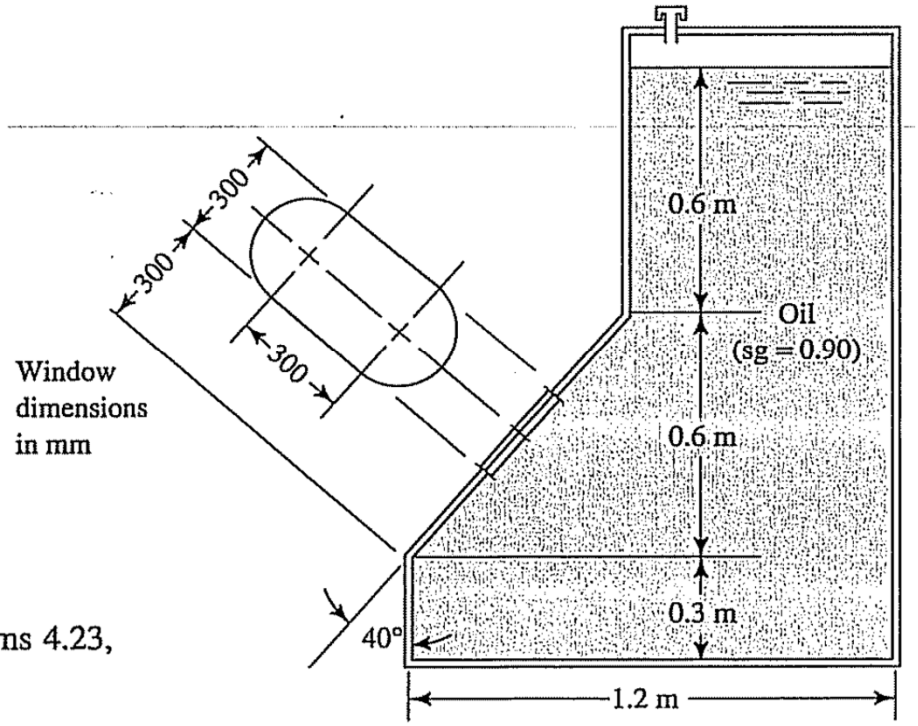


FIGURE 4.35 Problems 4.23, 4.38, and 4.39.