Submerged Curved Surface:

A 3-meter long curved gate is located in the side of reservoir containing water, as shown in Figure 1, below.

**Determine:**

a. The magnitude of the horizontal and vertical components of the force of the water on the gate, kN
b. The resultant force, kN
c. The direction of the resultant force, Angle from the vertical.

Take the density of water to be 9.80 kN/cubic meter. The radius of the gate is 2 meters. The depth of the water in the reservoir is 6 meters.

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**Figure 2.18**

- **Centroid Data from Figure 2.18**
- **Diagram (a):** Hydrostatic Force on a Curved Surface
FBD:

\[ X = \frac{4R}{T} = \frac{4(2)}{T} = 2.55 \text{ m} \]
\[ Y = 2 - \frac{2}{3} = 1.333 \]

\[ A = \frac{\pi}{4} \times 3 = \frac{\pi(4)}{4} \times \frac{3}{4} = \frac{3\pi}{4} \text{ m}^3 \]

For static equilibrium: \[ 2F_x = 0 \]
\[ F_H = F_2 = \gamma h_c z \quad A = 9.8 \times 10^3 \left[ \frac{4 + \frac{2}{2}}{2} \right] \left[ 2 \times 3 \right] \]
\[ F_H = 294 \text{ kN} \]

\[ \Sigma F_y = 0 \quad h_r = 4 \text{ m} \]
\[ F_V = F_1 + W \quad F_1 = \gamma h_l A \]
\[ F_1 = 9.8 \times 4 \times (2 \times 3) = 235.2 \text{ kN} \]
\[ W = \gamma A = 9.8 \times \frac{3\pi}{4} = 23.09 \text{ kN} \]
\[ F_V = 258.3 \text{ kN} \]

Resultant Force:
\[ F_R = \left[ F_V^2 + F_H^2 \right]^{1/2} \]
\[ F_R = \left[ 258.3^2 + 294^2 \right]^{1/2} \]
\[ F_R = 391.35 \text{ kN} \quad \theta = 87.98 \text{ krad} = 43. \]