C FORCES ON SUBMERGED CURVED AREAS

21.
The submerged, curved surface AB in Fig. 21a is one-quarter of a circle of radius 1.2 m. The tank’s length (distance perpendicular to the plane of the figure) is b=1.8 m. Find the horizontal and vertical components of the total resultant force acting on the curved surface and their location.
Answer: \( F_H = 63.6 \text{ kN}, \ F_V = 70.8 \text{ kN} \) The horizontal component line of action is 56 cm above the point B in Fig. 21b. The vertical component line of action is at the distance of 57 cm from point B.

22.
Solve the problem 21 for the same conditions except that water is on the other side of curved surface AB as shown in the figure.
Answer: The same as in problem 21: \( F_H = 63.6 \text{ kN}, \ F_V = 70.8 \text{ kN} \) but vertical component act upward. The horizontal line of action is 56 cm above the point B in Fig. 21b., the vertical - 57 cm from point B.
23. The submerged sector gate AB is one-sixth of a circle of radius 6 m. The length of the gate is 10 m. Determine the amount and location of the horizontal and vertical components of the total resultant force acting on the gate.
Answer:
\[ F_H = 1324.3 \text{ kN}, \quad F_V = 444.6 \text{ kN} \]
The location of the horizontal component \( F_H \) is along a horizontal line \( 5.196/3 = 1.732 \text{ m} \) above the bottom of the gate (A). The location of the vertical component \( F_V \) is \( X = 0.842 \text{ m} \).

24. The curved surface AB shown in Fig. 24a is a quarter of a circle of radius 1.5 m. Determine, for a 2.4 m length perpendicular to the paper, the amount and location of the horizontal and vertical components of the total resultant force acting on surface AB.
Answer:
\[ F_H = 26.5 \text{ kNm} \text{ Acting upward}, \quad F_V = 11.4 \text{ kN} \]
\( F_H \) is located at \( 1.5/3 = 0.5 \text{ m} \) above C. \( F_V \) is located at \( X = 0.335 \text{ from line AD} \).
25. Determine the value and location of the horizontal and vertical components of the force due to water acting on curved surface AB, per meter of its length.

Answer:
\[ F_H = 15.9 \text{ kN}, \text{ acting upward} \quad F_V = 25.0 \text{ kN}, \quad y = 1.2 \text{ m}, \quad x = 0.764 \text{ m} \]

26. The 0.9-m-radius cylinder weighs \( W = 22.3 \text{ kN} \) and is 1.5 m long. Determine the reaction at A and B, neglecting friction.

Answer:
The reaction at A is 19.1 kN to the left. The reaction at B is \( W - (F_V)_\text{net} = 22.3 - 15.0 = 7.3 \text{ kN} \) upward.

27. The 2.4-m-diameter cylinder weighs 2230 N and rests on the bottom of a tank that is 90 cm long. Water and oil are on the left and right-hand portions of the tank to depths of 0.6 m and 1.2 m, respectively. Find the magnitudes of the horizontal and vertical components of the force that will keep the cylinder touching the tank at B.

Answer:
The components to hold the cylinder in place are 3.2 kN to the right and 11.4 – 2.23 = 9.17 kN down.

28. A dam has a parabolic shape \( z = z_0 (x/x_0)^2 \). The fluid is water and atmospheric pressure may be neglected. If \( x_0 = 3 \text{ m} \) and \( z_0 = 7.2 \text{ m} \), compute forces \( F_H \) and \( F_V \) on the dam and the position c.p. where they act. The width of the dam is 15 m.
Answer:

\[ F_H = 3814.1 \text{kN}, F_V = 2119 \text{kN} \]. The location of \( F_H \) is along horizontal line \( 7.2/3 = 2.4 \text{ m} \) above the bottom of the dam. The location \((x,z)\) of \( F_V \) is \( x = 3x_0/8 = 1.125 \text{ m}, z = 3z_0/5 = 4.32 \text{ m} \). The resultant force \( F_{\text{result}} = 4363.2 \text{kN} \) acts down to the right at an angle of \( 29.1^\circ \). \( F_{\text{result}} \) passes through \((x,z) = (1.125 \text{ m}, 2.4 \text{ m})\). If we move down along the \( 29.1^\circ \) line until we strike the dam, we find an equivalent center of pressure on the dam at \((x_{cp},z_{cp})\). Find \( x_{cp} \) and \( z_{cp} \) !!!