Water is kept in a cylindrical container stood upright. The height of the water in the container is 1m and radius of container is 10cm. find out the total force by the water on one half part on the cylindrical container.

Solution

To find out the total force by the water on one half part on the cylindrical container standing upright we need find the total force by the water on one half of the wall and on one half of the bottom:

$$F_{total} = F_{wall} + F_{bottom}.$$

The total force by the water on one half of the bottom:

$$F_{bottom} = P_{bottom} * \frac{1}{2} S_{bottom},$$

where P_{bottom} – pressure on the bottom, S_{bottom} – area of the bottom.

$$S_{bottom} = \pi r^2,$$

where r - radius of container.

$$P_{bottom} = \rho g H,$$

where ρ – density of the water, g – acceleration of gravity, H - the height of the water in the container.

So,

$$F_{bottom} = \rho g H * \frac{1}{2} \pi r^2.$$

To find the total force by the water on one half of the wall we consider infinitely small area of one half of the wall:

$$dF_{wall} = P_{wall} * dS_{wall},$$

where P_{wall} – pressure on the wall at height h ($P_{wall} = \rho g h$), dS_{wall} - infinitely small area of one half of the wall ($dS_{wall} = \frac{2\pi r}{2} * dh = \pi r dh$).

So,

$$dF_{wall} = \rho g h * \pi r dh.$$

Now we need to integrate this from 0 $to\ H$:

$$F_{wall} = \int_0^H \rho g h * \pi r dh = \rho g \pi r \int_0^H h dh = \rho g \pi r \frac{H^2}{2}.$$

The total force by the water on one half part on the cylindrical container:

$$F_{total} = \rho g H * \frac{1}{2}\pi r^2 + \rho g \pi r \frac{H^2}{2} = \frac{1}{2}\rho g \pi r H(H + r).$$

$$F_{total} = \frac{1}{2} * 10^3 * 9.8 * \pi * 10 * 10^{-2} * 1 * (1 + 10 * 10^{-2}) = 1.69 * 10^3 N.$$

Answer: $\mathbf{1.69 * 10^3 N}$.