ENGG 202
March 27 Week 11

Problems

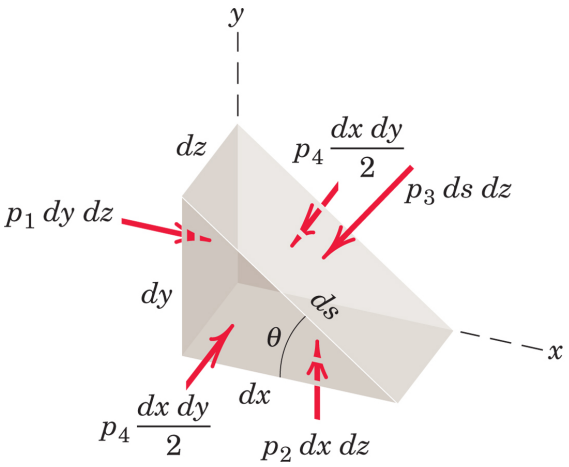
5/9 Fluid Statics

1. Introduction

Pressure – is defined as the force *normally* exerted on a unit area over which that force is distributed.

Fluid pressure – is the pressure at some point within a fluid.

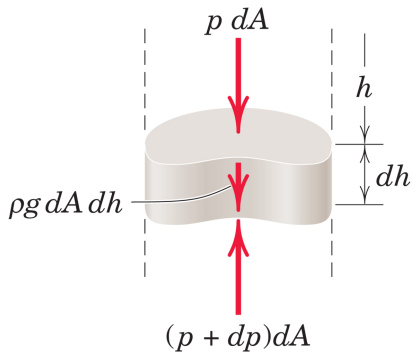
Pascal's law – pressure at any given point in a fluid is the same in all directions.



$$p_1 = p_2 = p_3 = p$$

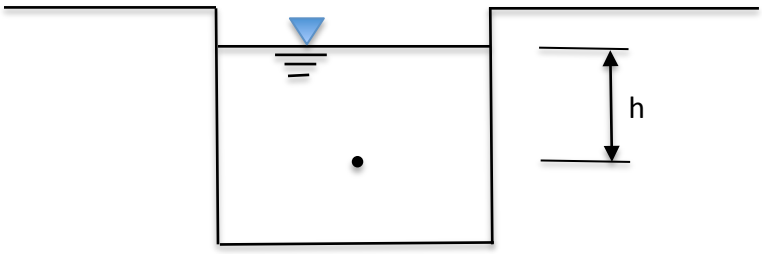
Hydrostatic pressure – the fluid pressure is called hydrostatic pressure when the fluid is still (at rest). *We focus on the hydrostatic pressure in this course*.

When a fluid is at rest, all frictional and inertial forces vanish, the pressure exerted by the fluid is the function of forces exerted by gravity only.



$$dp = \rho g dh$$

Hence the hydrostatic pressure, *p*, at a point within a fluid can be calculated by



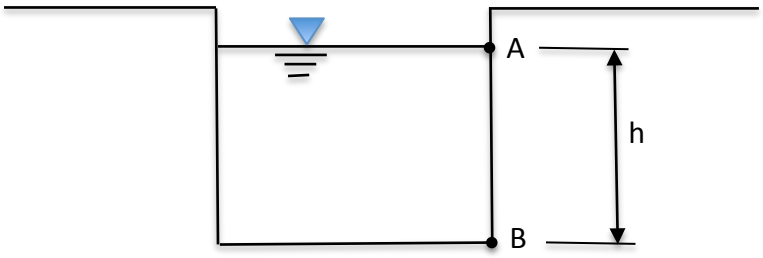
$$p = \rho g h$$

Note that the pressure calculated in above equation is the *gage pressure*, which is the pressure referenced to the atmospheric pressure at the water surface.

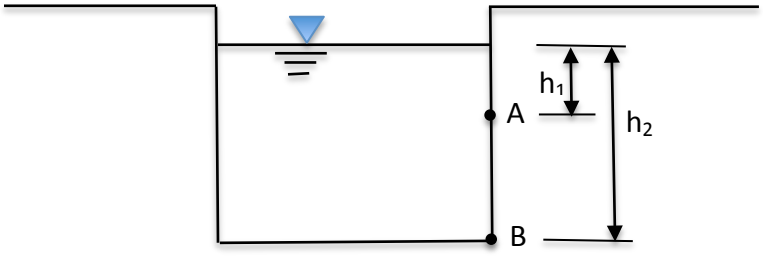
Gage pressure vs. absolute pressure

2. Hydrostatic pressure on submerged rectangular surfaces

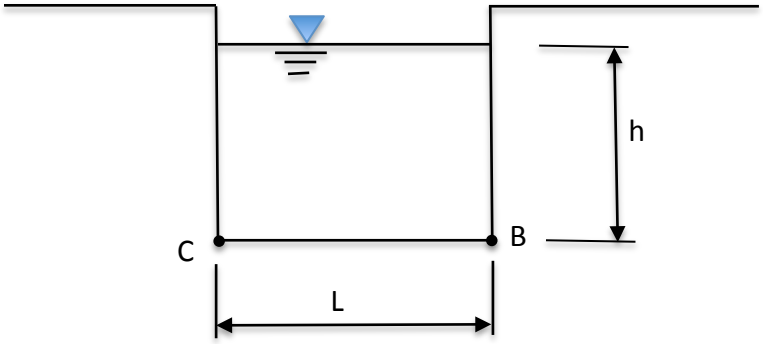
Case 1: on a vertical rectangular flat surface AB



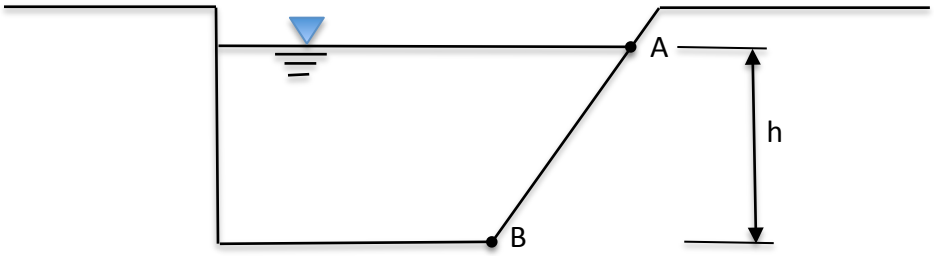
Case 2: on a vertical rectangular flat surface AB



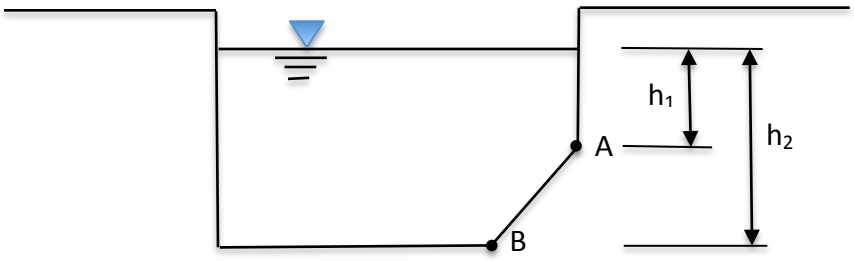
Case 3: on a horizontal rectangular flat surface BC



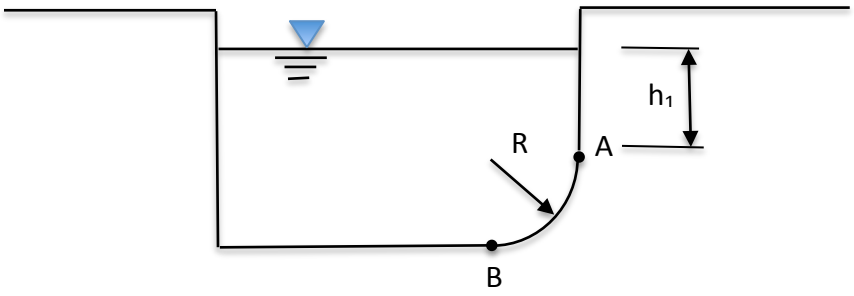
Case 4: on an inclined rectangular flat surface AB



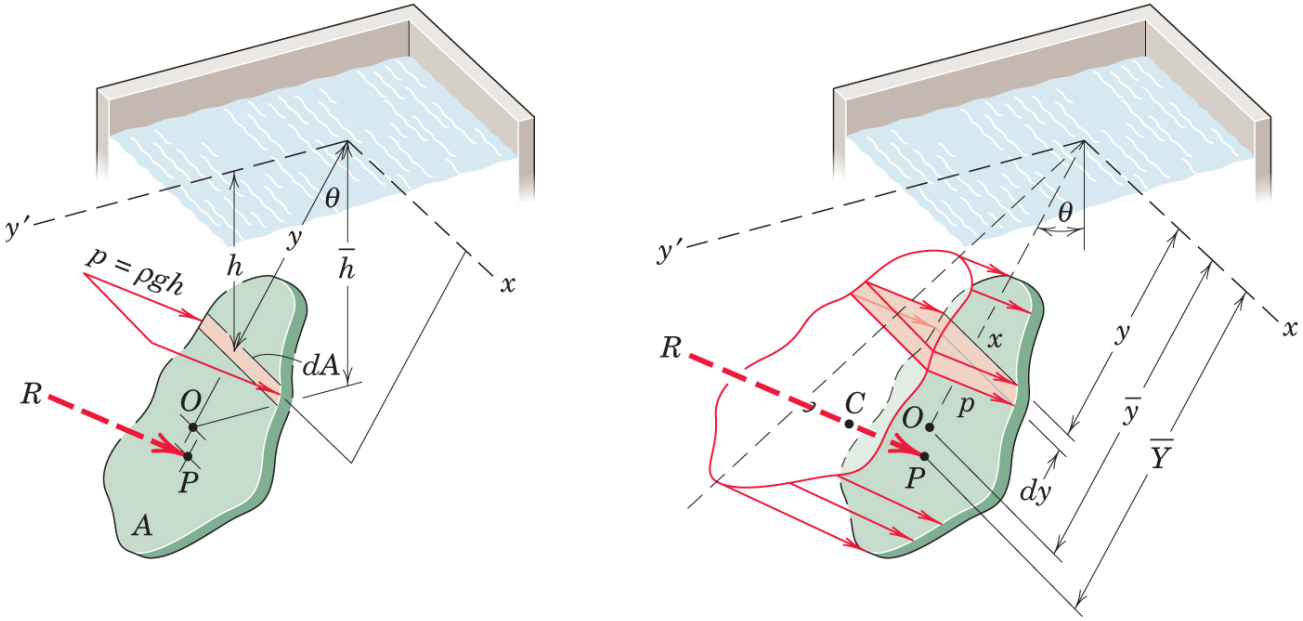
Case 5: on an inclined rectangular flat surface AB



Case 6: on a curved surface AB (a quarter of a circle with a constant width into the page)



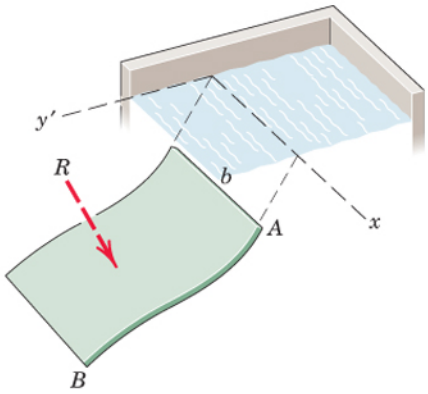
3. Hydrostatic pressure on submerged flat surfaces of any shape



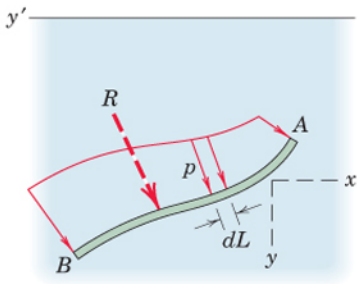
$$R = \rho g \bar{h} A$$

$$\bar{Y} = \frac{\int y(pxdy)}{\int yxdy}$$

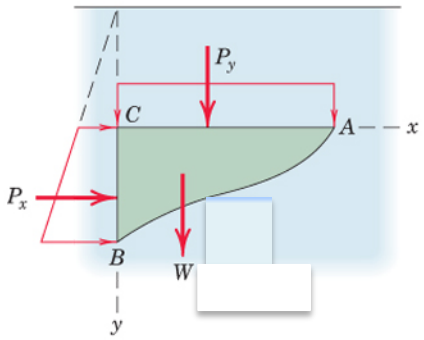
4. Hydrostatic pressure on cylindrical surface



(a)



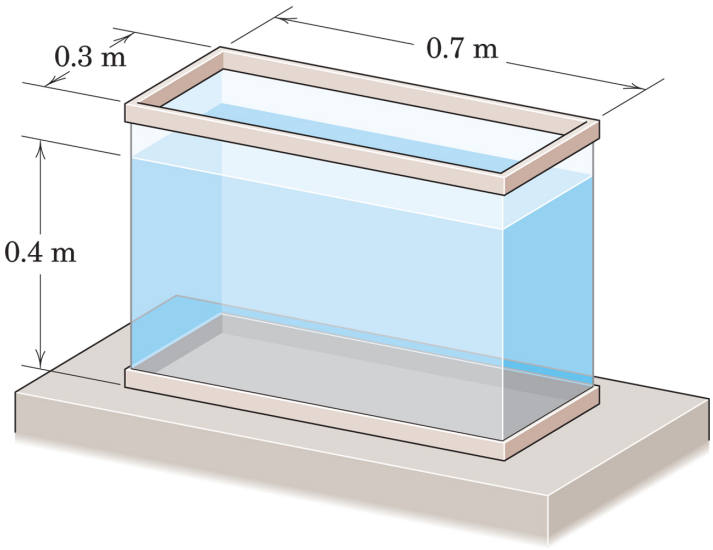
(b)



(c)

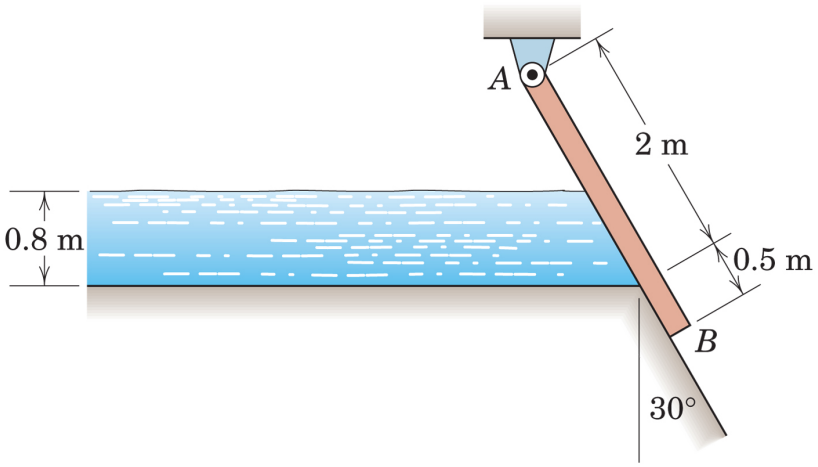
Problem 5/187

Specify the magnitude and location of the resultant force which acts on each side and the bottom of the aquarium due to the fresh water inside it. Density of fresh water = 1000 kg/m^3.



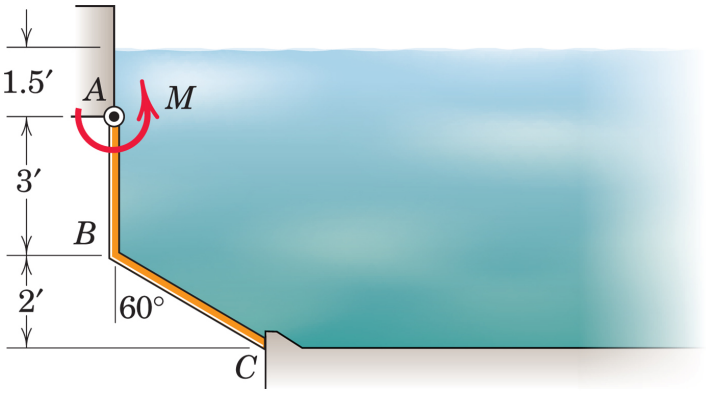
Problem 5/191

Fresh water in a channel is contained by the uniform 2.5 m plate freely hinged at A. If the gate is designed to open when the depth of the water reaches 0.8 m as shown in the figure, what must be the weight *w* (in N/m of horizontal length into the paper) of the gate? Density of fresh water = 1000 kg/m^3.



Problem 5/201

A gate is used to hold fresh water in a storage. Determine the required moment *M* to just hold the gate closed against the lip of the container at C if the width of the gate is 5 ft. Neglect the weight of the gate. Density of fresh water = 1000 kg/m^3.



Problem

The concrete dam is in the shape of a quarter circle. Determine the magnitude of the resultant hydrostatic force that acts on the dam per meter of length. The density of water is 1000 kg/m^3.