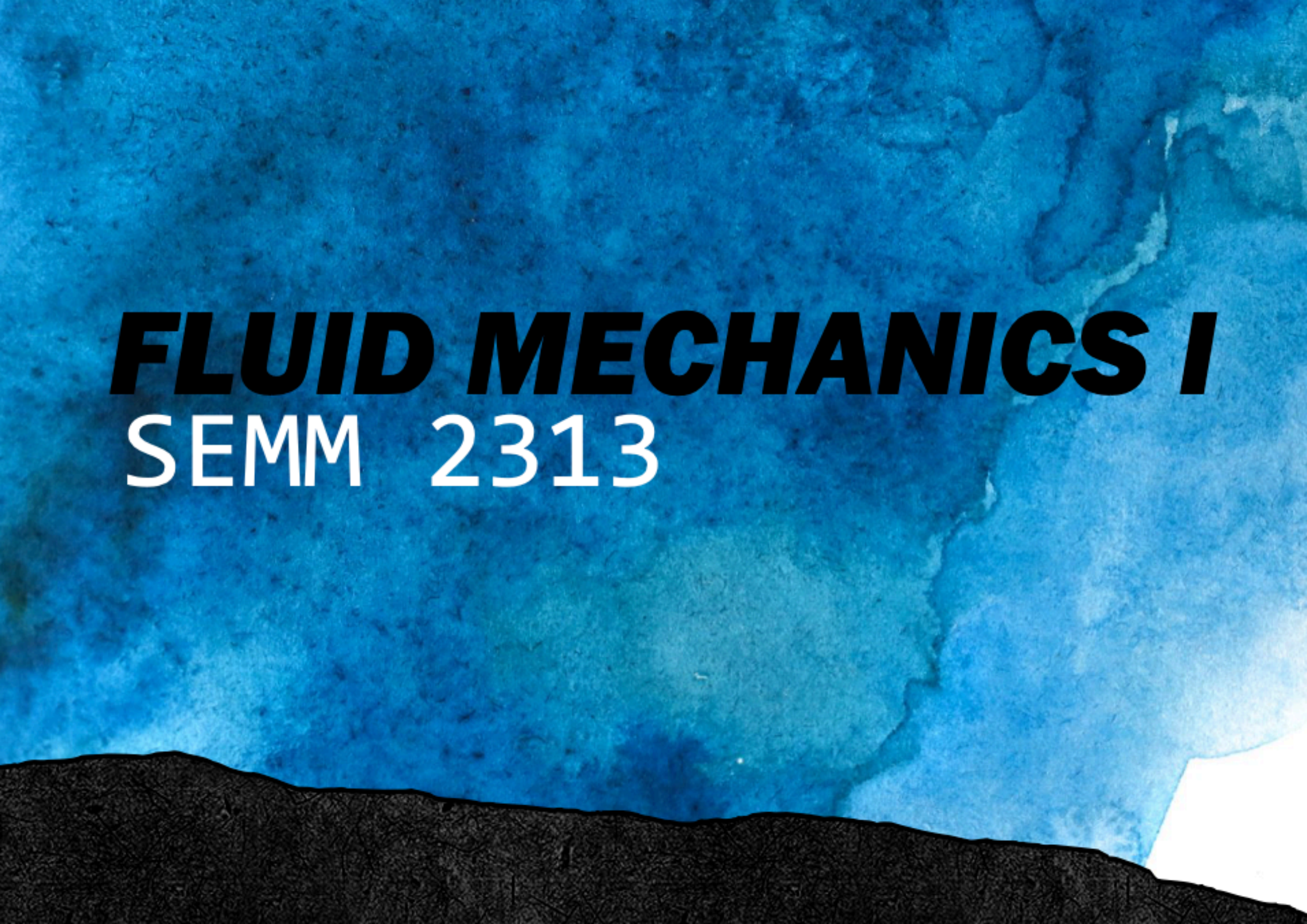

FLUID MECHANICS I
SEMM 2313

HYDROSTATIC FORCE ON CURVE SURFACE

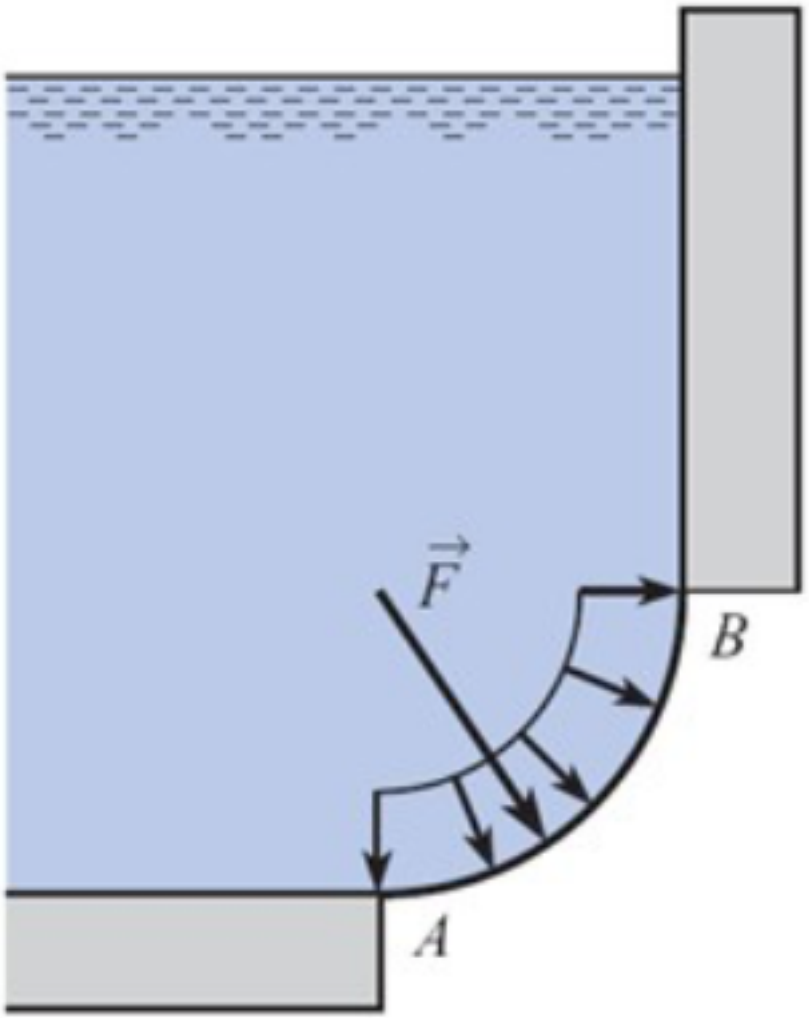
For hydrostatic force on curve surface, we have difficulties of force distribution that act on the curve surface.

They are not act on the same direction.

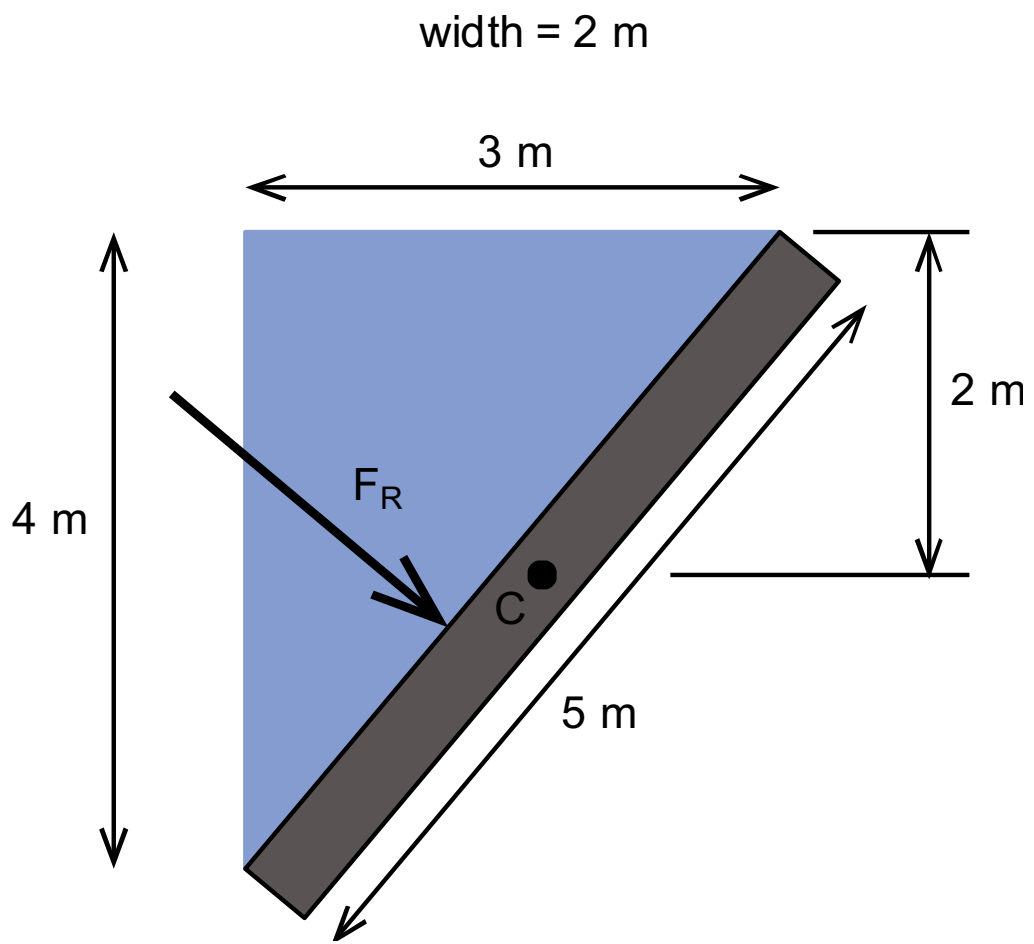
They also (maybe) have different value.

However, we could calculate the resultant force by using component forces (horizontal & vertical forces)

Please be careful about each equation. They have slightly different in definition.


$\vec{F}$
B
A

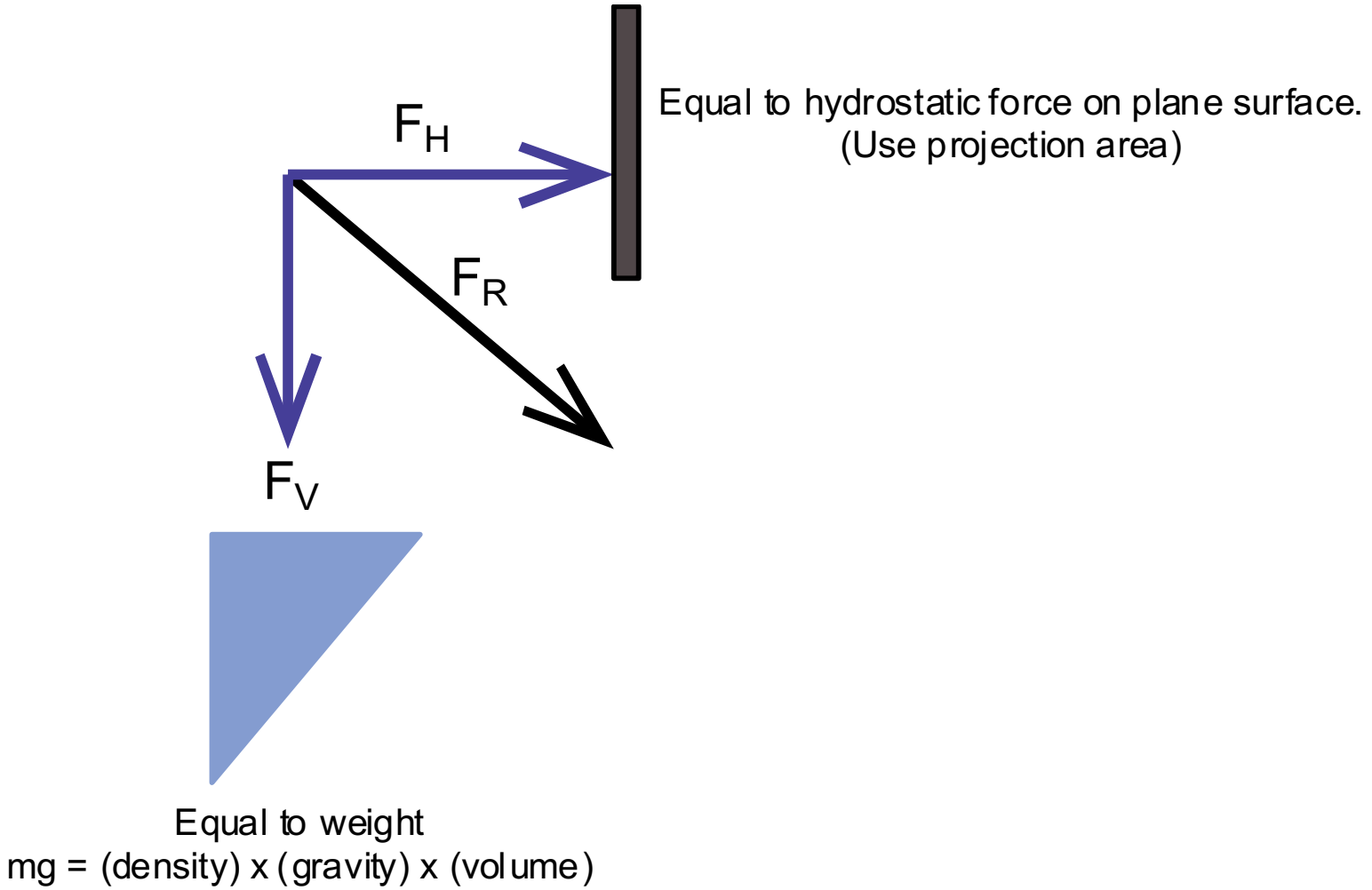
Let calculate the resultant force act on this plane surface.
Use equation on the previous lesson.

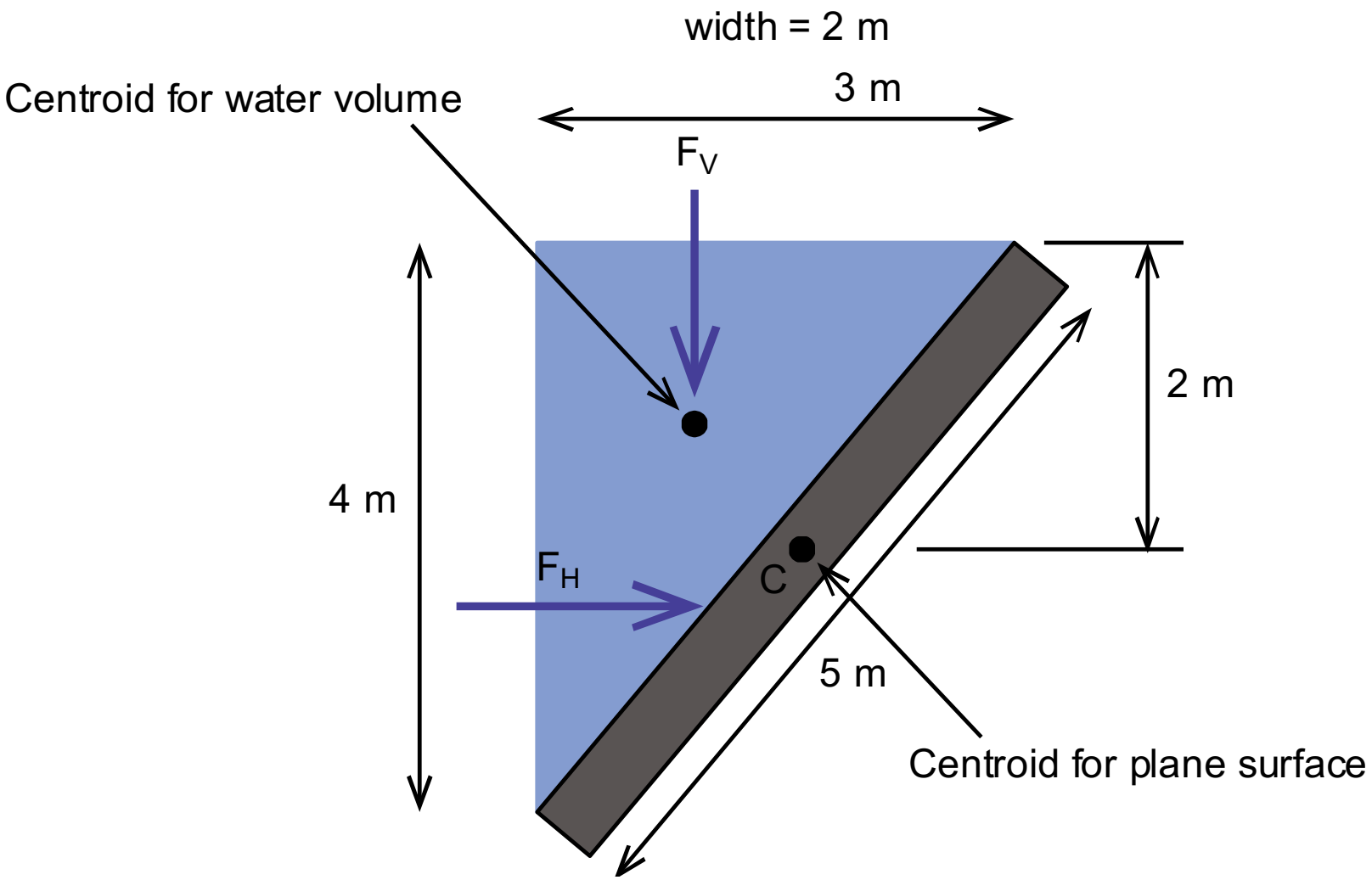


$$F_R = \rho g h_c \cdot A = \rho g(2)(5\times 2) = \rho g(20)$$

$$y_R = \frac{I_x}{y_C \cdot A} + y_C = \frac{\frac{1}{12}(5)^3(2)}{(2.5)(10)} + (2.5) = 3.333\ (m)$$

However, we could calculate the resultant force by using component forces (horizontal & vertical forces)




width = 2 m
3 m
Centroid for water volume
F_V
4 m
2 m
F_H
C
5 m
Centroid for plane surface

Horizontal force:

$$F_H = \rho g h_c \cdot A = \rho g(2)(4\times 2) = \rho g(16)$$

$$y_R = \frac{I_x}{y_C \cdot A} + y_C = \frac{\frac{1}{12}(4)^3(2)}{(2)(8)} + (2) = 2.667\ (m)$$

In this situation, we need to use a projection area as an A.

Thus, the (submerged) area become, $A = 4\times 2$

Vertical force:

$$F_V = \rho g \forall = \rho g \left(\frac{1}{2}(3)(4)(2) \right) = \rho g (12)$$

This vertical force act through the centroid of the volume of water.

Resultant force:

By using simple math, we could calculate the resultant force,

$$F_R = \sqrt{(F_V)^2 + (F_H)^2} = \sqrt{(\rho g 12)^2 + (\rho g 16)^2}$$

$$F_R = \rho g 20$$

This answer is same with the answer obtained from the first method.

It is means that, by using component forces, we could calculate the resultant force.

Conclusion:

To calculate the (magnitude) resultant force on curve surface, we could use:

$$F_H = \rho g h_c \cdot A$$

Which A is the projection area.

$$F_V = \rho g \forall$$

Which $\forall$ is the volume of liquid above the curve surface.

$$F_R = \sqrt{(F_V)^2 + (F_H)^2}$$

y_R

Location of the resultant force on curve surface. It can be determined by calculation but depend on the curve's shape.

Question 1

The 6-m-diameter drainage conduit of Figure 1 is half full of water at rest. Determine the magnitude and line of action of the resultant force that the water exerts on a 1-m length of the curved section BC of the conduit wall.

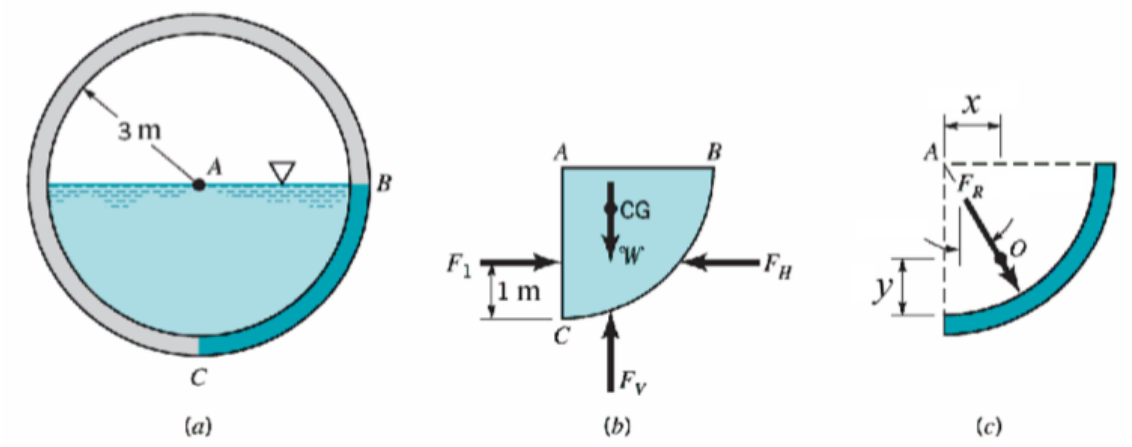
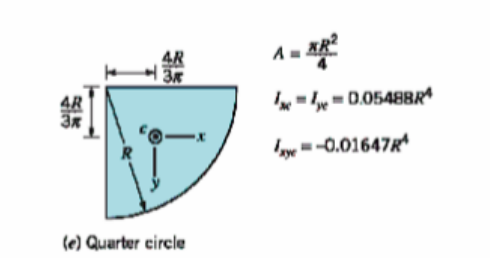


Figure 1



Question 2

A 4-m-long curved gate is located in the side of a reservoir containing water as shown in Figure 2. Determine the magnitude of the horizontal and vertical components of the force of the water on the gate. Will this force pass through point A? Explain.

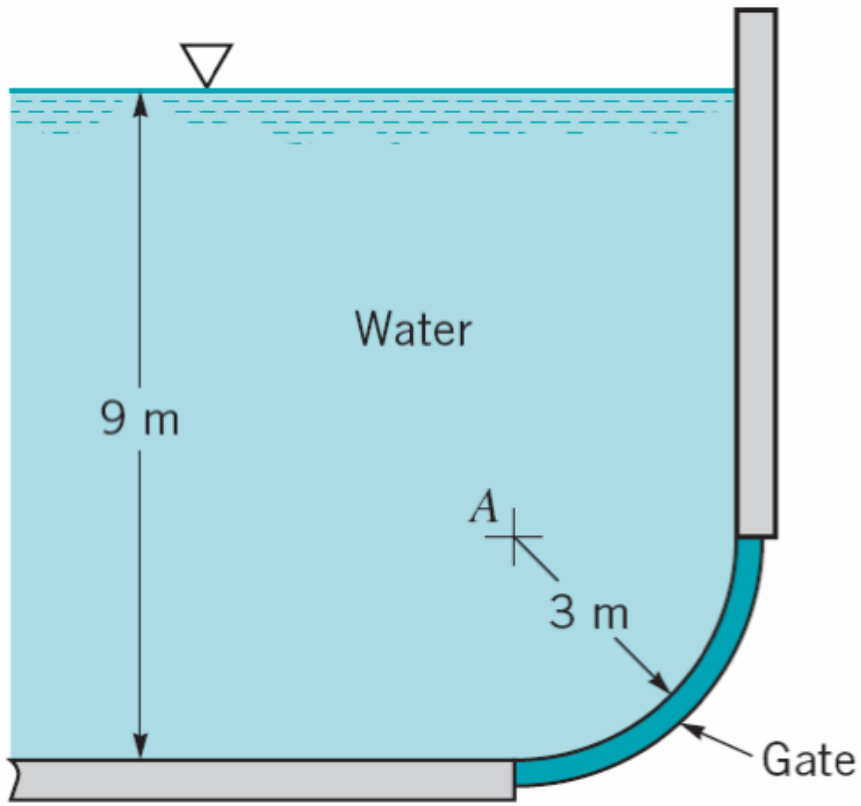


Figure 2

Question 3

Determine the magnitude of the horizontal and vertical components of the force (per unit length) of the water on the concrete seawall of Figure 3.

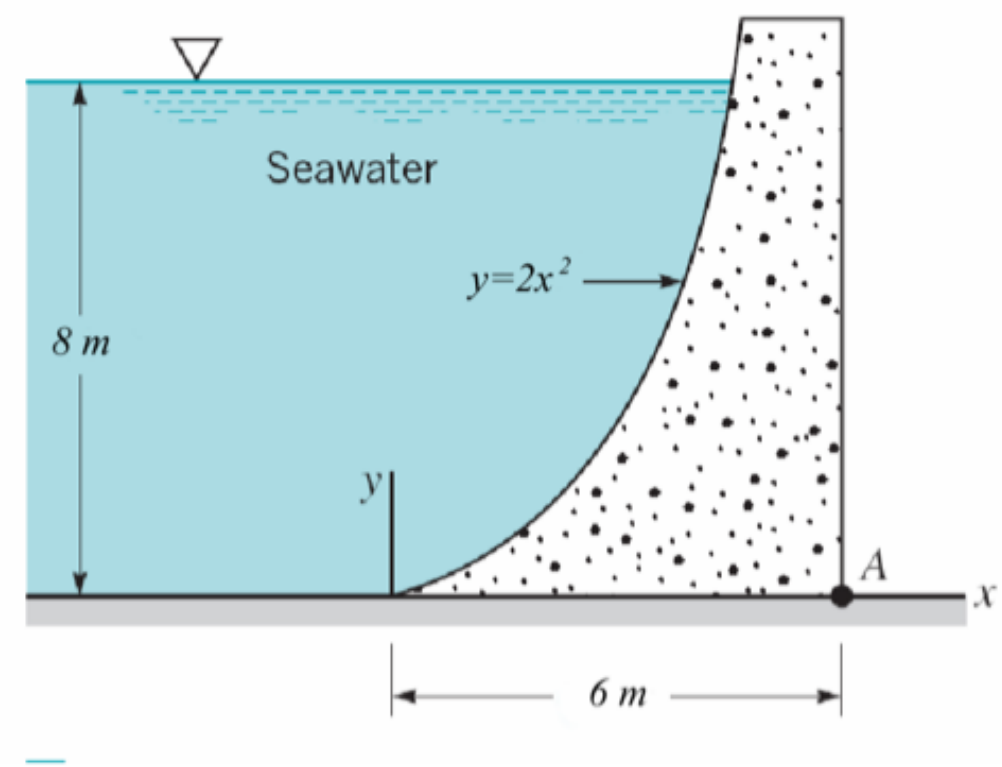


Figure 3

Question 4

A 4-m wide tank with curved surface, AB as shown is used to store oil of specific gravity, SG = 0.72. The tank is vent to the atmosphere. Determine the resultant hydrostatic force acting on the curved surface, AB.