Hydrostatic Force

I Horizontally submerged plate

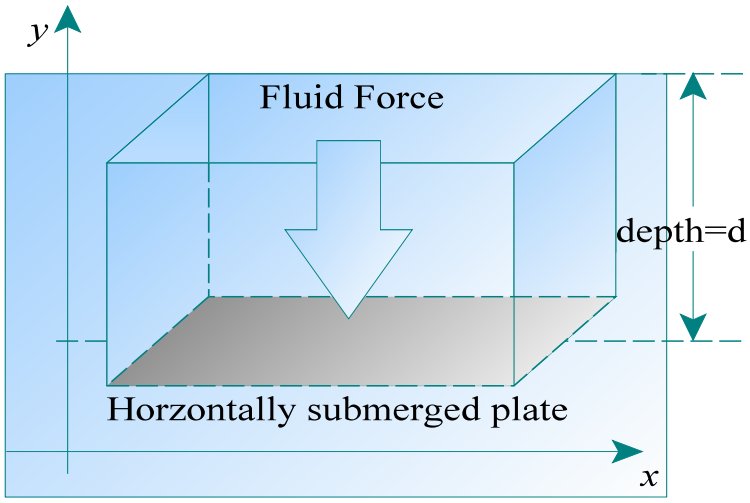


Plate submerged horizontally in a fluid absent any fluid motion. (Static state)

The force acting on the top side of a plate submerged horizontally is equal to the weight of the water above the plate.

Force = the weight of the water above plate.
= weight density of water per units of volume x volume of water above plate.

$$F = \rho g V$$
$$= \rho g A d$$
$$= \rho g d A$$

Where ρg = wieght density per unit volume. and A is the area of the, plate, and d is the depth of the plate below the surface of the fluid

The unit analysis suggests that $\rho g d$ represents the pressure at the depth level of the plate as the force is expressed in terms of pressure per units of area.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$
$$\rho g d = \frac{F}{\Delta A}$$
$$\text{Pressure} = \rho g d$$

II Vertically submerged plate

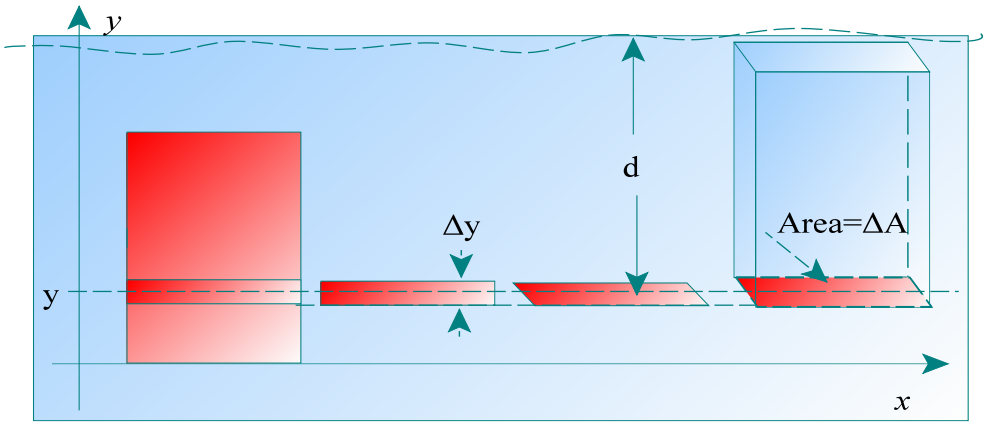
Assumptions

The fluid in a static state which means the only force acting on the plate is due to pressure on both sides of the plate. In this state the plate is assumed to stay vertical.

An alternate set up, is to assume the fluid in a static state, and the plate is maintained in vertical position by support , force, on one side to counter the fluid force on opposite side due to fluid pressure.

Archimedes Principle

The pressure acting at any point inside a fluid, in the absence of any fluid motion, from all directions around the point is constant.



Suppose that the force acting on the plate below level y is known. A change in the area of the plate from level y to level Δy produces change in the force equ ΔF . This change of force is the force acting on the rectangular strip with width Δy .

If the width of the strip, Δy , is relatively small, we assume the variation of the pressure on the entire strip is negligible. So the change in force is approximately equal the area of the strip times the pressure.

This gives

$$F = \rho g \Delta A d$$
$$= \rho g d \Delta A$$

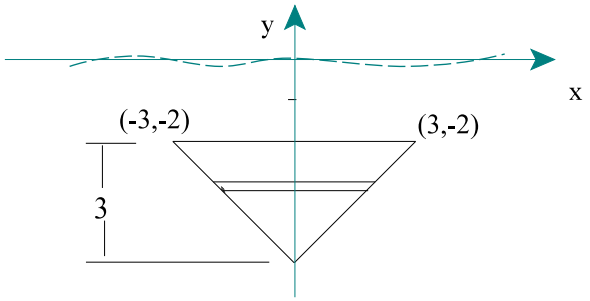
where $\Delta A d$ is the volume of the rectangular parallel pipe of water above the plate

The above figure suggests the following interpretation. If the strip with area ΔA , is cut and turned so it is submerged horizontally, then the force acting on it from above due to water pressure is computed as in the case of a horizontally submerged plate.

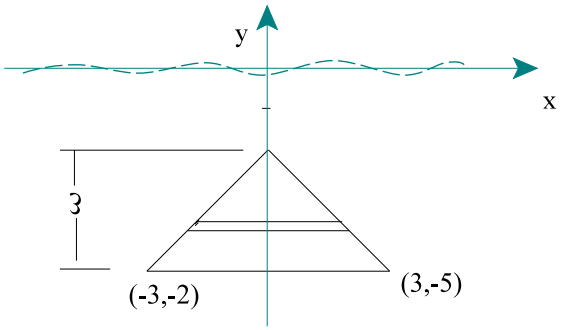
Hydrostatic Force Problems

Consider the two plates below to determine wether the orientation of the same plate as shown will affect the hydrostatic force acting on one side of the plate.

1. Calculate the fluid force on one side of the plate shown. Use the coordinate system given.



2. Calculate the fluid force on one side of the plate shown. Use the coordinate system given.



3. Placing the plates at the same depth d, let b be the length of the base of the triangle and h be its height, for what values b and h is the hydrostatic force acting on the two plates is equal? If there is no solution to the problem, state so and support your answer.