Hydrostatic Forces on Plane Surfaces (Sec. 3-4)

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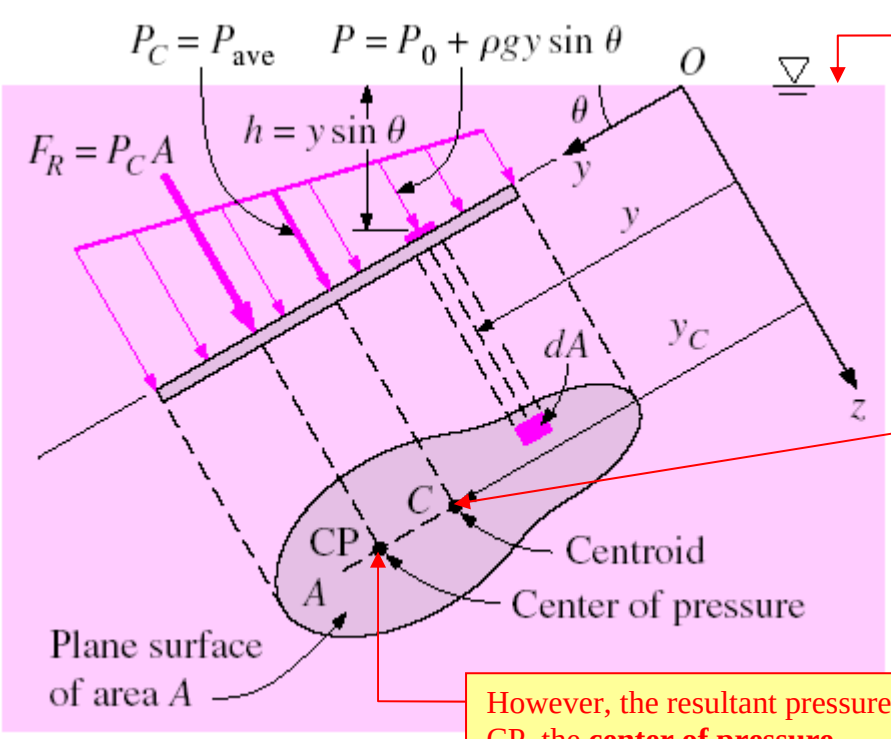
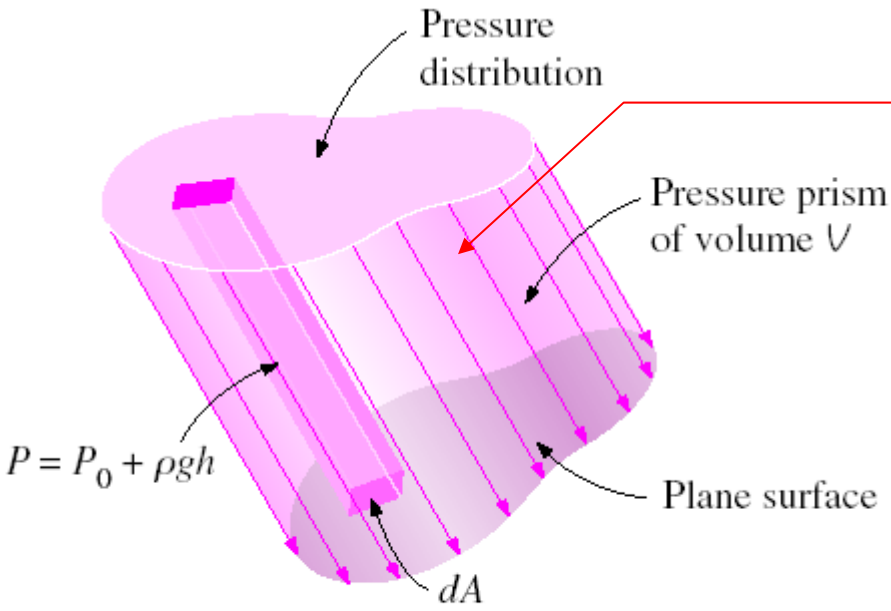


Liquid surface, open to air pressure P_0 (P_0 is usually P_{atm})

The **centroid** *C* is the mathematical center of the plate's area. We calculate the average pressure at the centroid.

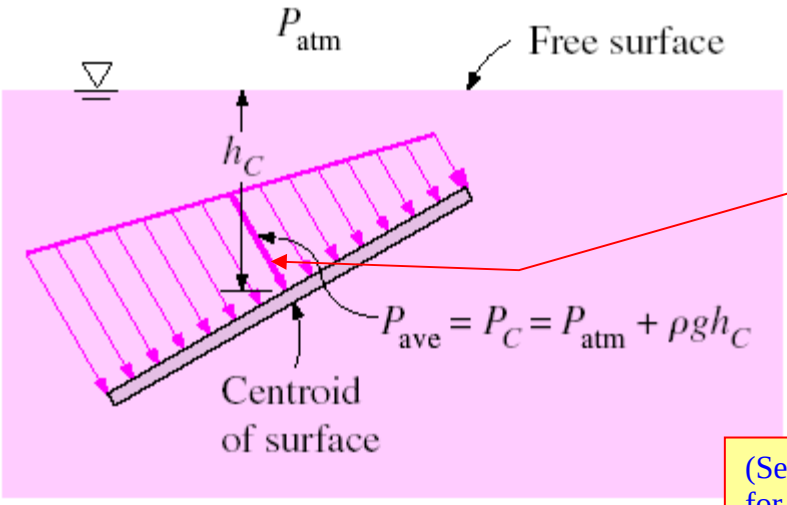
However, the resultant pressure force acts not at *C*, but at CP, the **center of pressure**.

FIGURE 3-27
Hydrostatic force on an inclined plane surface completely submerged in a liquid.



Because pressure increases as you go down in the liquid, the "pressure prism" is thicker towards the bottom, and therefore, the center of pressure CP is located *below* the centroid *C*.

$$F_R = \int P dA$$

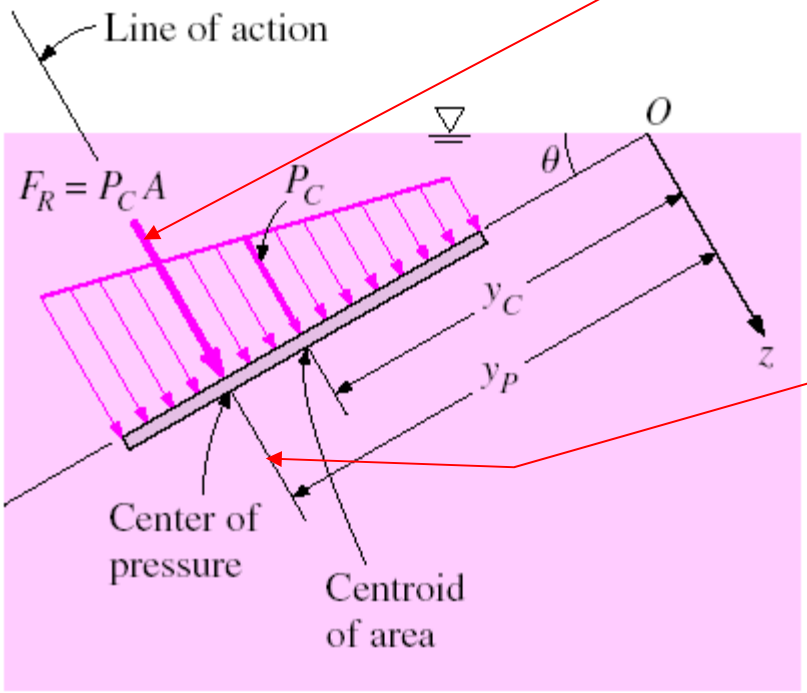


Average pressure P_{ave} is easy to find – it is simply the pressure at the centroid C of the plate's surface area.

(See the text, Fig. 3-30, for centroids of many common shapes.)

FIGURE 3-28

The pressure at the centroid of a surface is equivalent to the *average* pressure on the surface.



The resultant force F_R on the face of the plate is equal to the pressure P_C at the centroid C times the area of the plate. I.e.,

$F_R = P_C A$

But, F_R does *not* act at the centroid!

The line of action of the resultant hydrostatic force passes through the center of pressure CP and acts perpendicular to the plate

FIGURE 3-29

The resultant force acting on a plane surface is equal to the product of the pressure at the centroid of the surface and the surface area, and its line of action passes through the center of pressure.