Statics - TAM 211

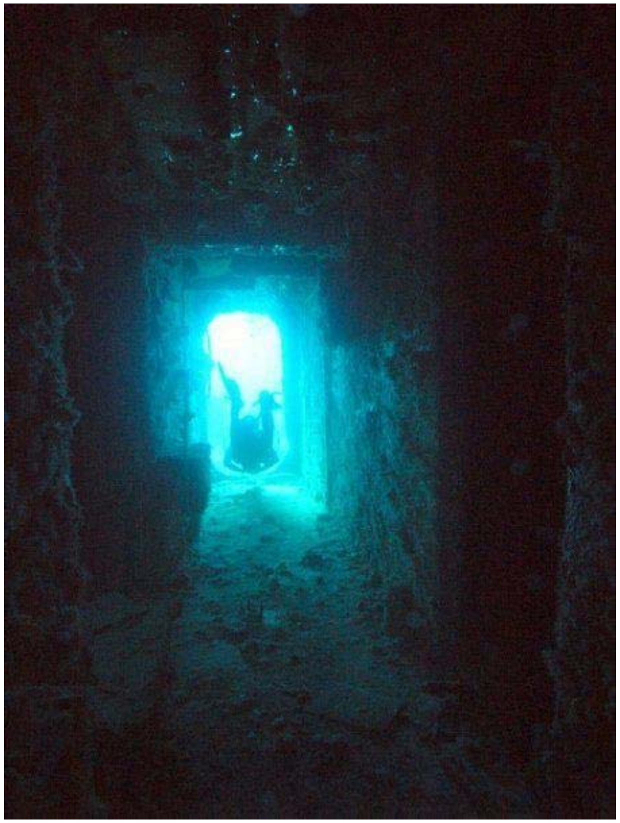
Lecture 38

April 23, 2018

Chap 9.5

Announcements

- Upcoming deadlines:
  - Tuesday (4/24)
    - PL HW 14
  - Quiz 6
    - CBTF (W-F: 4/25-27)
    - CoG thru 3D Rigid Bodies: Lectures 29-36
  - Tuesday (5/1)
    - PL HW 15
  - Wednesday (5/2)
    - Written Assignment 6
  - Quiz 7
    - CBTF (Thurs-Tues: 5/3-8)
    - 50 minutes
    - Fluid Pressure - Virtual Work



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Chapter 9 Part II – Fluid Pressure

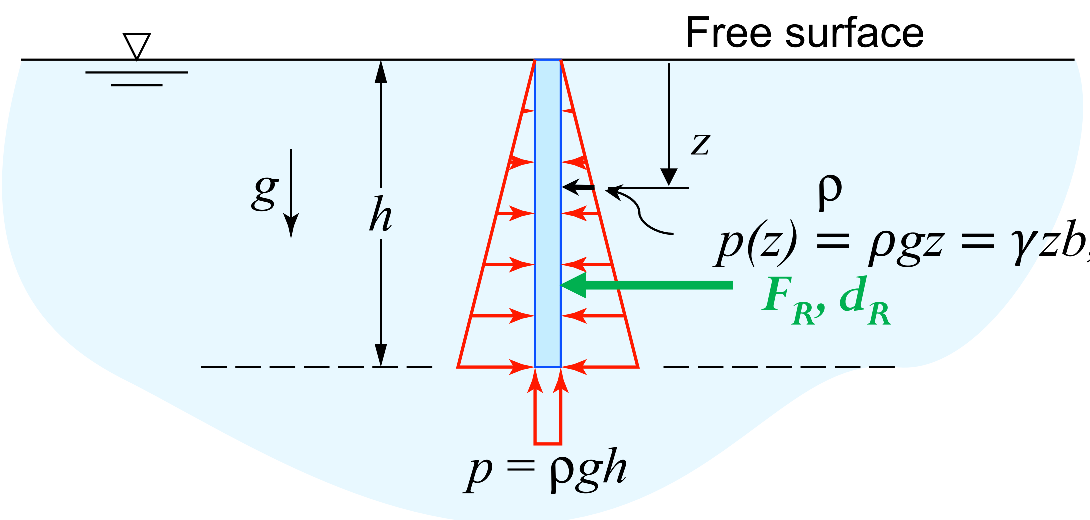
Chap 9.5

Goal and objective

- Present a method for finding the resultant force of a pressure loading caused by a fluid

Recap: Fluid Pressure

For an incompressible fluid at rest with mass density ρ, the pressure varies linearly with depth z



$p(z) = \rho g z = \gamma z b,\ w(z) = \rho g z b = \gamma z b$

$F_R,\ d_R$

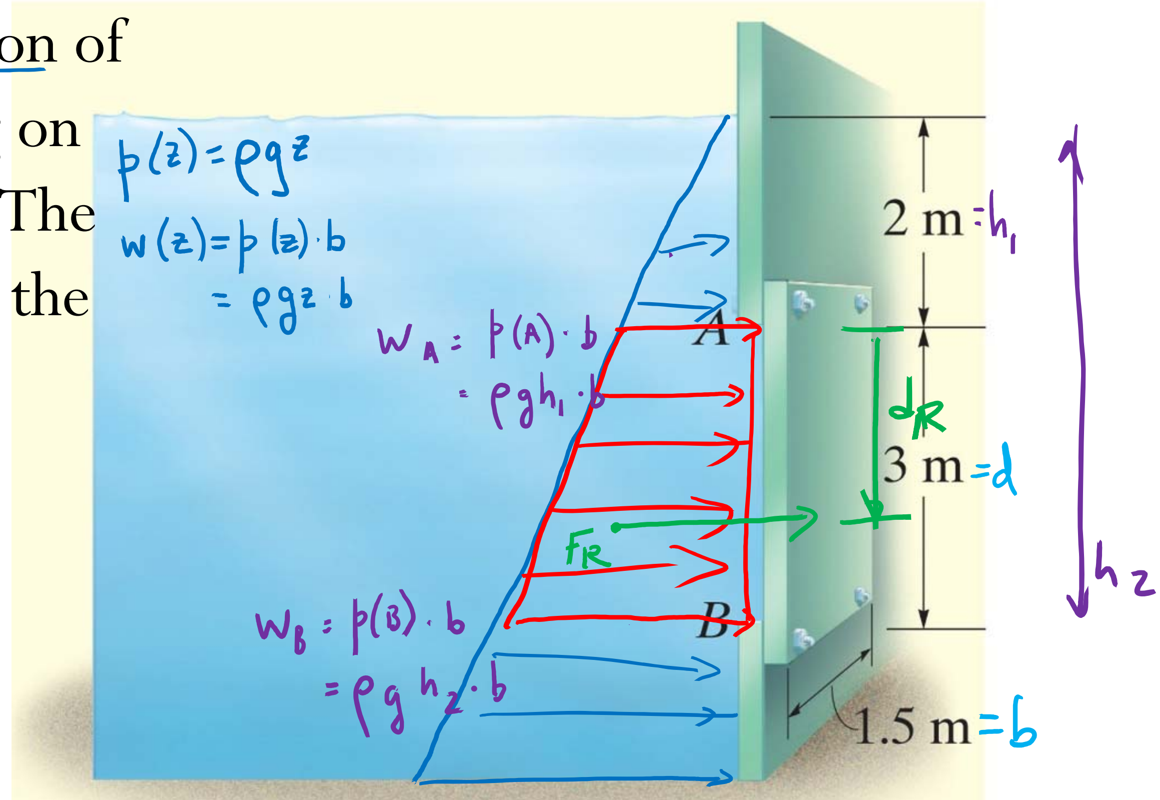
Object width is b.

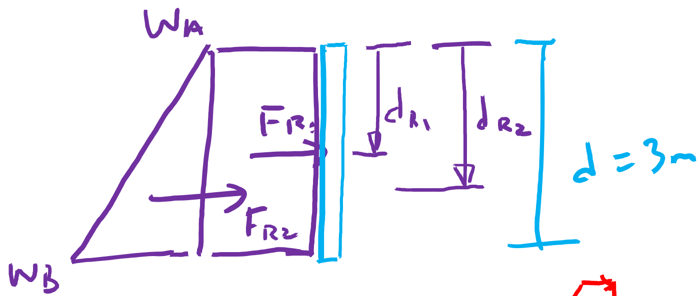
- $p(z) = \rho\ g\ z = \gamma\ z$

  where $\gamma = \rho\ g$ is called the specific weight (weight per unit volume).

  For fresh water: γ =62.4 lb/ft^3 (9810 N/m^3), ρ = 1000kg/m^3
- Pressure $p(z)$ or force due to pressure F_R are always perpendicular to the object's surface.
- Distributed load due to fluid pressure at depth z is due to pressure and width of surface: $w(z) = p(z) \cdot b = \rho g z b = \gamma z b$
- Determine resultant force (magnitude and direction): $F_R,\ d_R$
  - If water, this force is called hydrostatic force

Determine the magnitude and location of the resultant hydrostatic force acting on the submerged rectangular plate AB. The plate has width 1.5m. The density of the water is 1000 kg/m^3





Convert load trapezoid into 2 simpler load shapes △ + □

Corrections to notes written in class:
For $w(z)$, W_A, W_B, I incorrectly had written $W = p \cdot d$, must be $w = p \cdot b$ (↑ width)

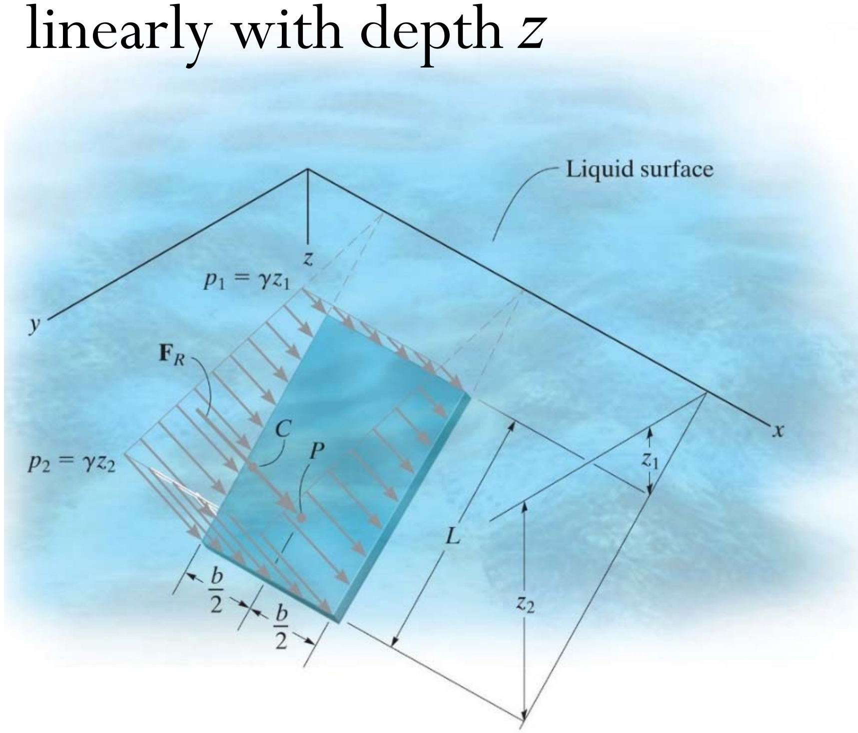
$$F_R = F_{R_1} + F_{R_2} = 154.5\ \text{N}$$

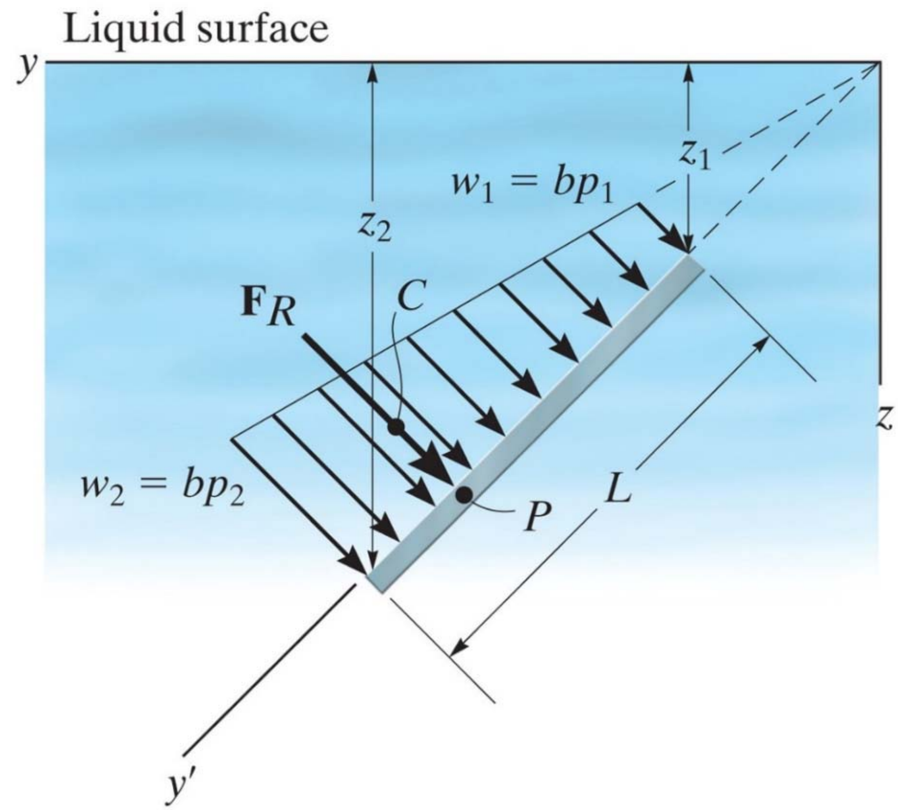
$$d_R = \frac{d_{R_1} F_{R_1} + d_{R_2} F_{R_2}}{F_R} \quad \Big\} \text{ from } \left(\sum M_R\right)_A = \sum M_A$$

$d_R = 1.71$ m below point A

Fluid Pressure of a flat plate with constant width

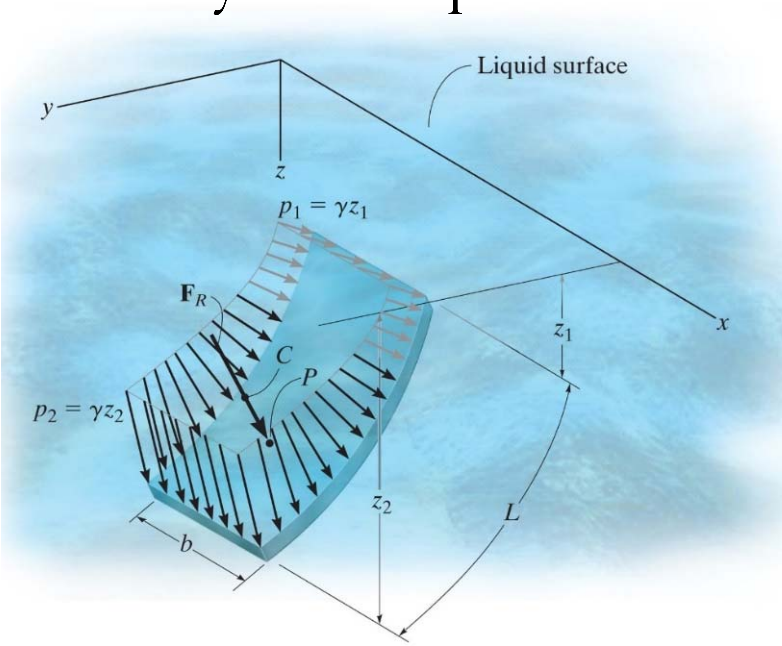
For an incompressible fluid at rest with mass density , the pressure varies linearly with depth *z*

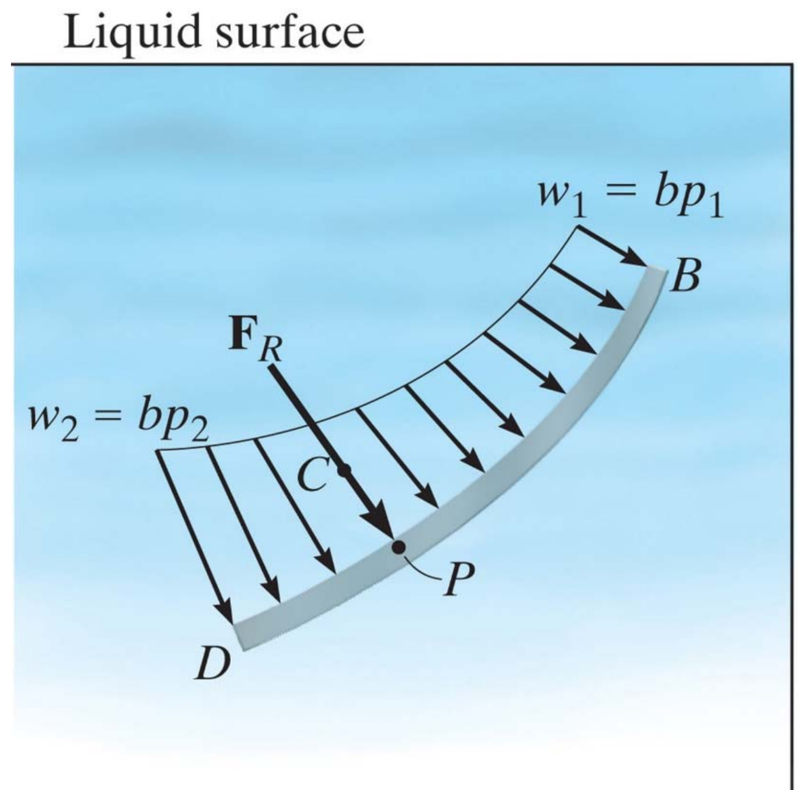




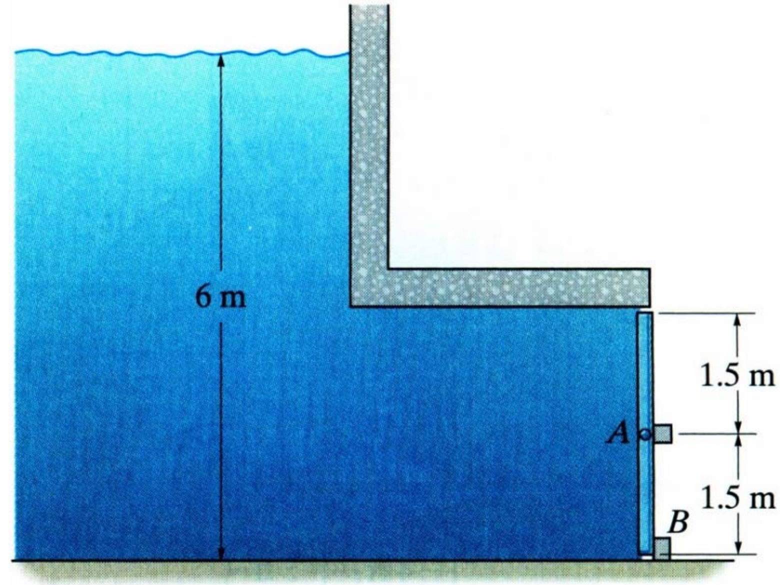
Fluid Pressure of a curved plate with constant width

For an incompressible fluid at rest with mass density , the pressure varies linearly with depth *z*

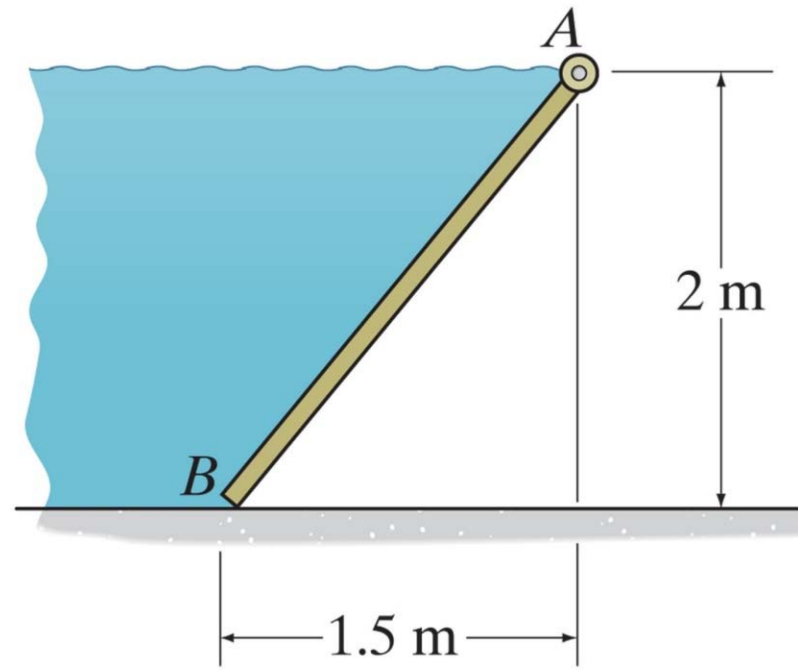




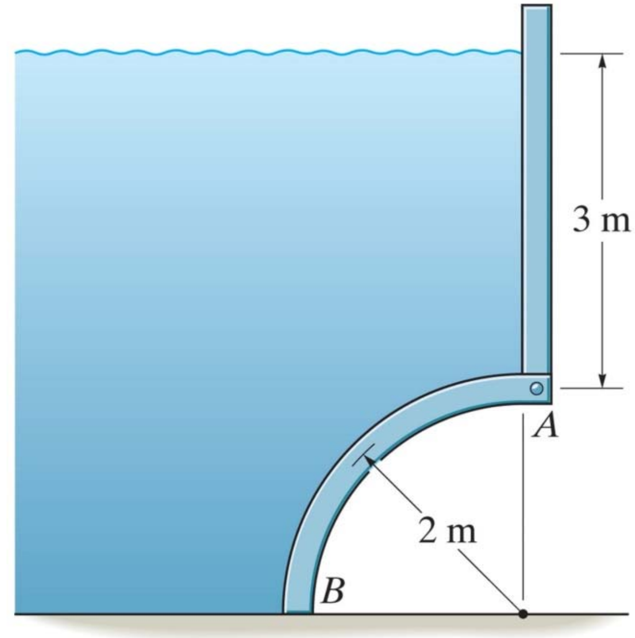
2m wide rectangular gate is pinned at its center A and prevented from rotating by block at B. Determine reactions at supports due to hydrostatic pressure. Water density is 1000 kg/m^3

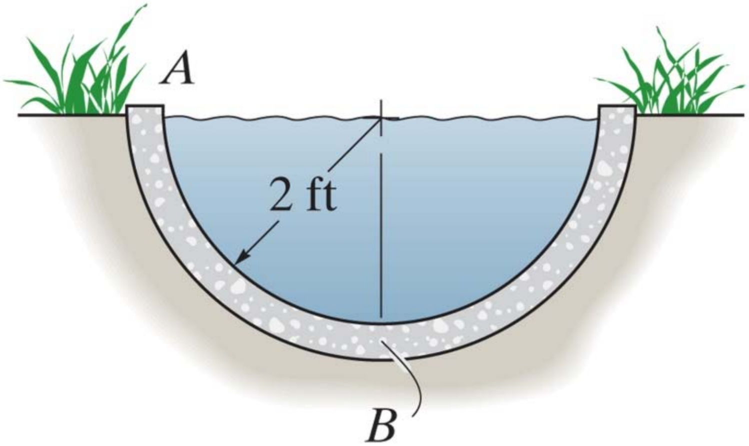


Determine the magnitude of the resultant hydrostatic force acting on the gate AB. The gate has width 1.5m.



The arched surface AB is shaped in the form of a quarter circle. If it is 8 m long, determine the horizontal and vertical components of the resultant force caused by the water acting on the surface.





The semicircular drainage pipe is filled with water. Determine the resultant force that the water exerts on the side AB of the pipe per foot of pipe length. The specific weight of the water is $\gamma = 62.4\ \text{lb/ft}^3$