Statics - TAM 211

Lecture 29

December 4, 2018

Chap 9.5

Announcements

- Check ALL of your grades on Blackboard! Report issues
- Prof. H-W office hours
  - Monday 3-5pm (Room C315 ZJUI Building)
  - Wednesday 7-8pm (Residential College Lobby)
- Upcoming deadlines:
  - Friday (12/7)
    - Written Assignment 11
  - Tuesday (12/11)
    - HW 12
  - Quiz 6
    - Week of Dec 10
    - CoG thru Fluid Pressure: Lectures 26-30 (Chap 9 material)

Chapter 9 Part II – Fluid Pressure

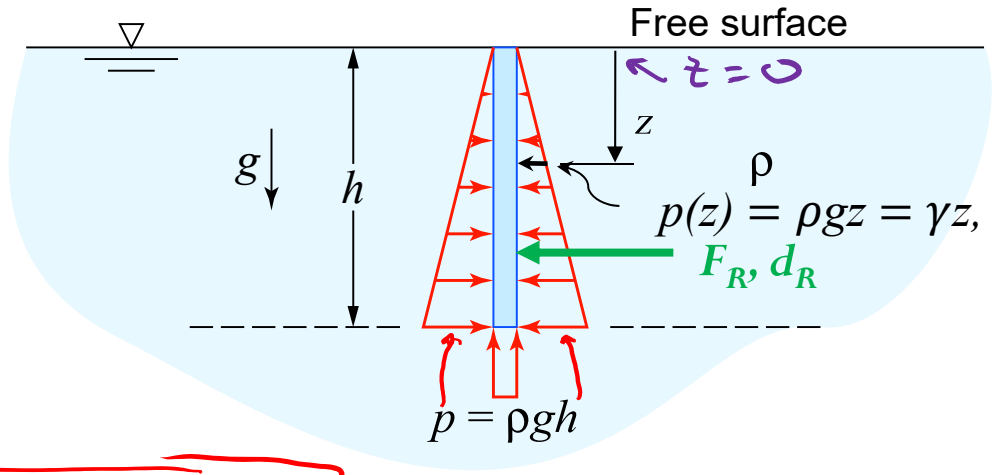
Chap 9.5

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



Object width is b.

$$Pressure = \left[\frac{force}{area}\right]$$

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

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

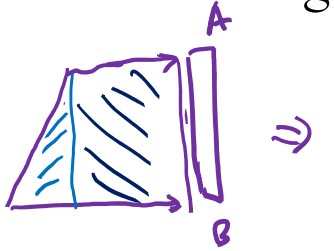
  For fresh water: γ =62.4 lb/ft^3 (9810 N/m^3), ρ = 1000kg/m^3

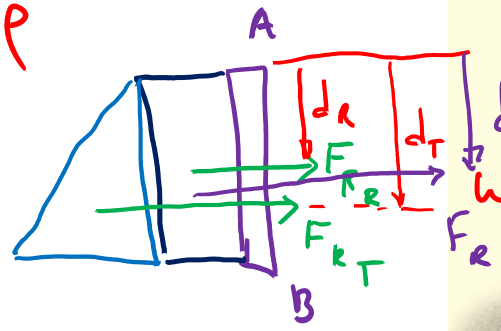
- Pressure $p(z)$ or force due to pressure F_R are always perpendicular to the object's surface.

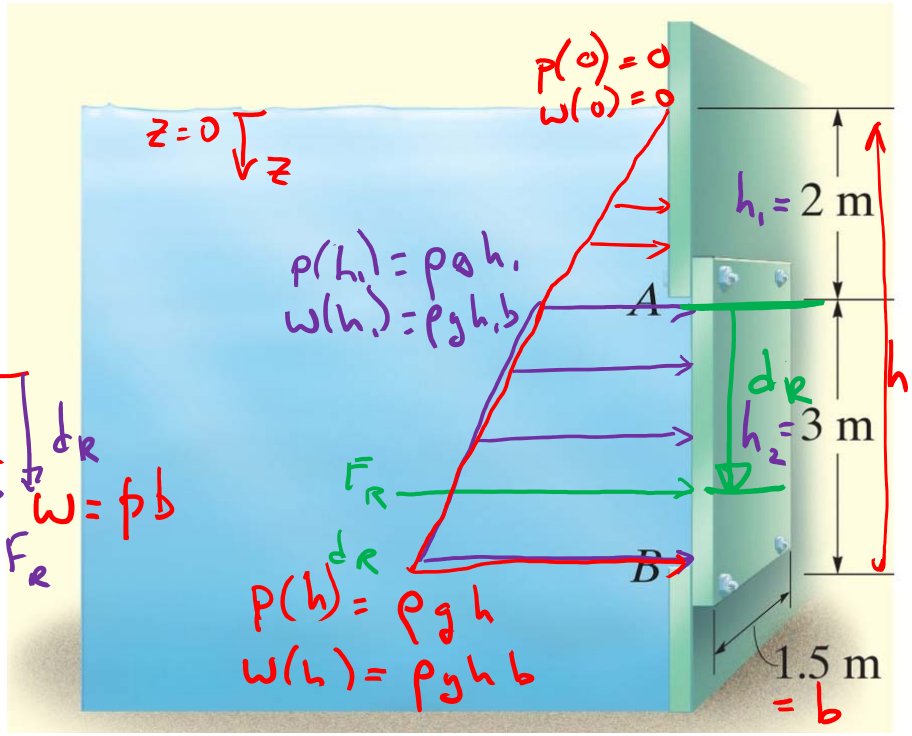
- Distributed load per length due to fluid pressure at depth z is due to pressure and uniform width (b) of object's surface: $w(z) = p(z)\cdot b = \rho gzb = \gamma zb$ $\left[\frac{force}{length}\right]$

- Determine resultant force (magnitude and location): 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 $= \rho$







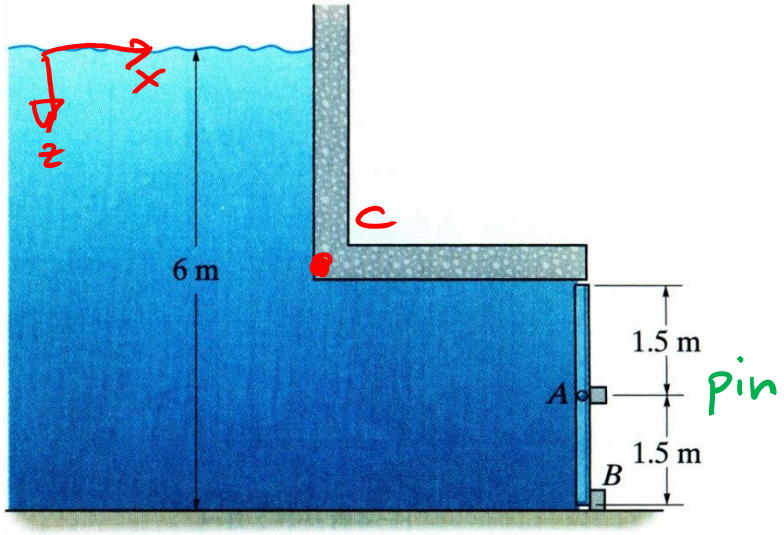
$$F_R = F_{R_R} + F_{R_T}$$

$$d_R = \frac{d_R F_{R_R} + d_T F_{R_T}}{F_R}$$

$F_R = 154.5$ N $\qquad$ $d_R = 1.71$m below point A

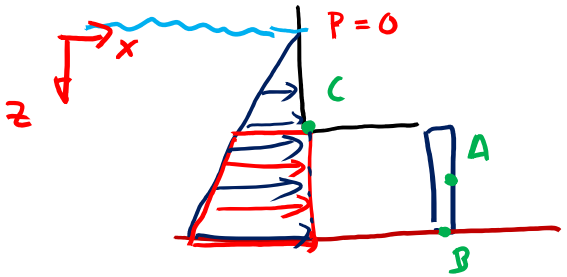
2m wide rectangular gate is pinned at its center A and prevented from rotating by block at B. Determine reactions at supports due to hydrostatic pressure. Water density is 1000 kg/m^3

b = 2m

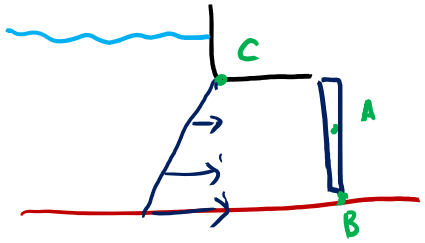


Which FBD for pressure is correct?

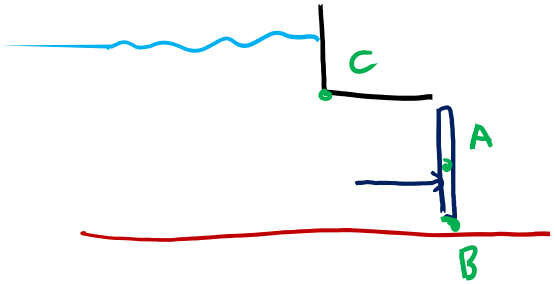
(A)

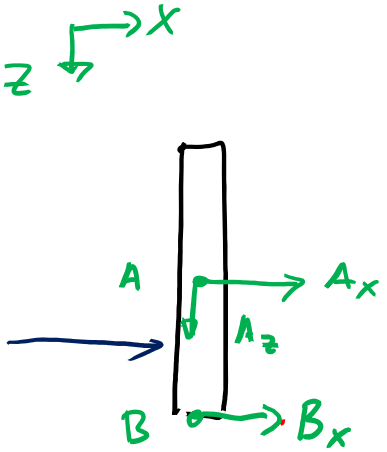


(B)



(C)





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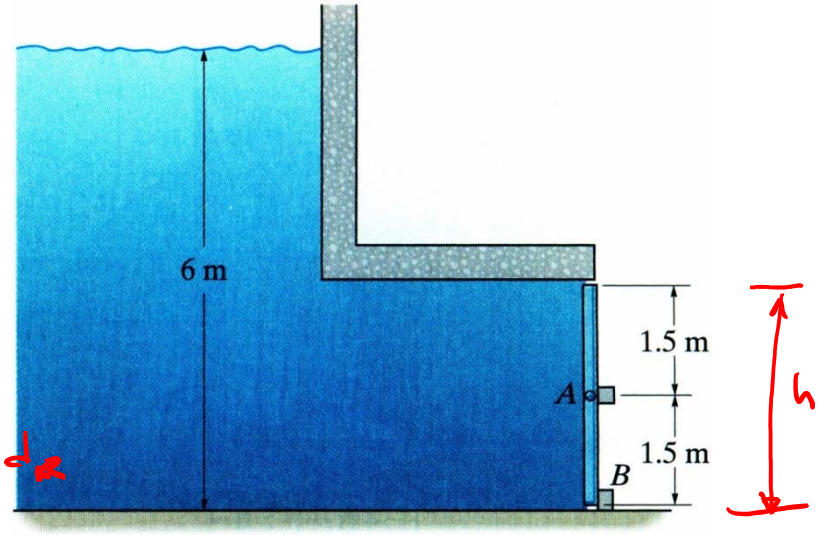
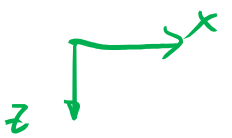
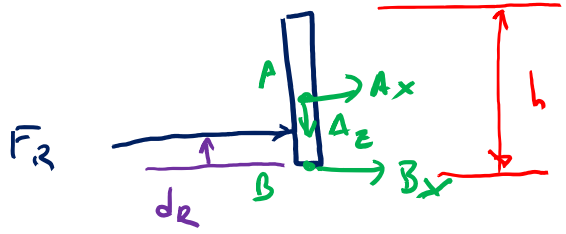






Unknowns A_x, A_z, B_x, F_R, d_R

$\Sigma F_x = 0 : \quad F_R + A_x + B_x = 0$

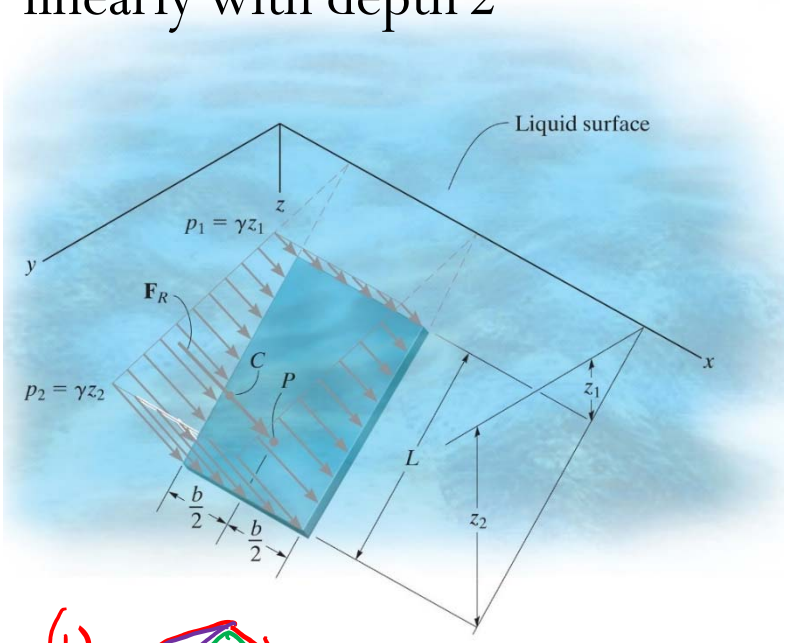
$\Sigma F_z = 0 : \quad A_z = 0$

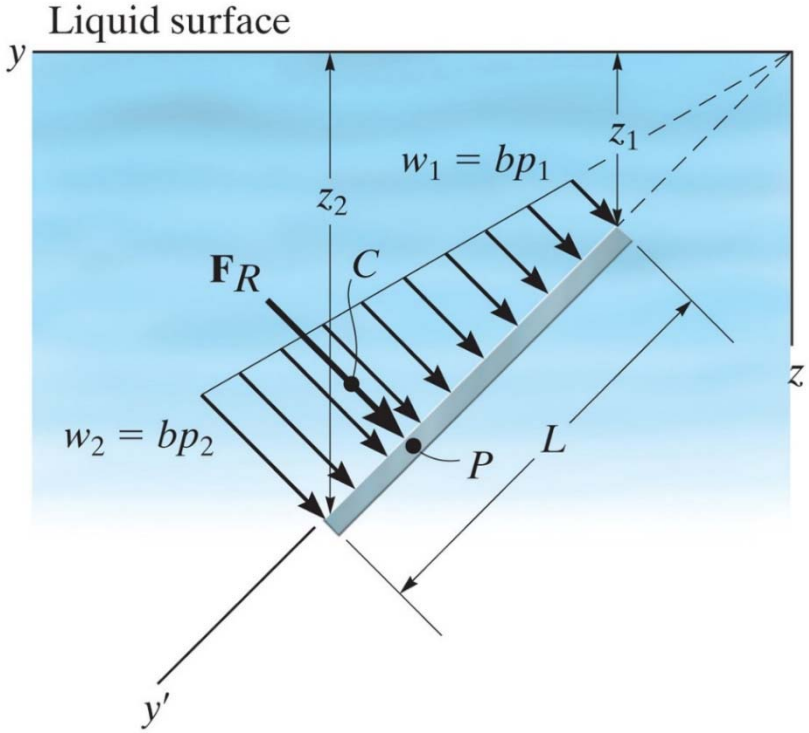
$+\circlearrowleft \Sigma M_A = 0 : \quad B_x\left(\frac{h}{2}\right) + F_R\left(\frac{h}{2} - d_R\right) = 0$

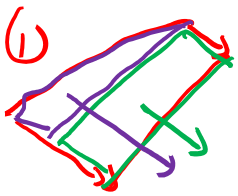
To find F_R, d_R use same approach as previous problem!

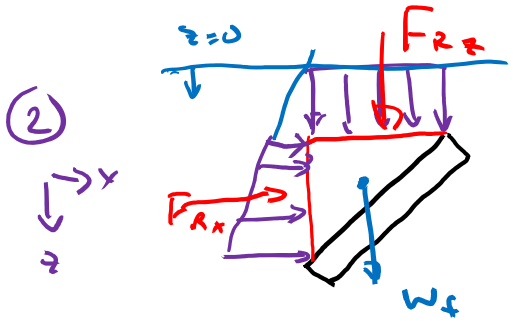
Fluid Pressure of a flat plate with constant width

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









$\Sigma F_x : F_{Rx}$

$\Sigma F_z = F_{Rz} + W_f$

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