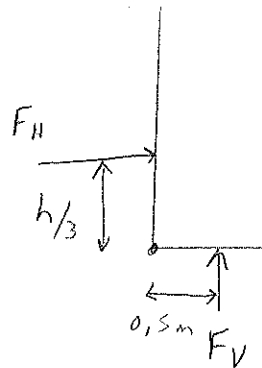
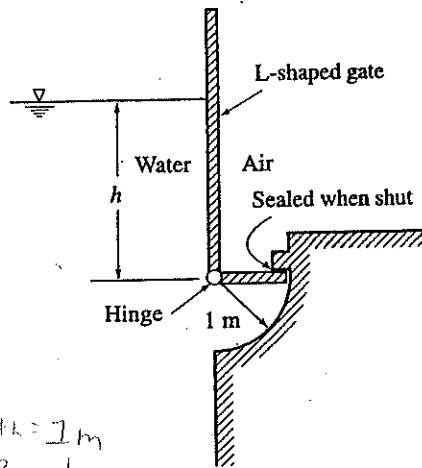


NAME: Kenn Wetch

3

3. (30 pts) An L-shaped, rectangular gate shown below can rotate about the hinge. As the water level rises, the gate will open when the level reaches a critical height, h_c . If the length of the lower horizontal arm is 1 meter, find the critical height, h_c . (Neglect the weight of the gate itself).



Let width = 1 m
 $A_{rez} = 1 m^2$ or h

$$F_H = \left(\frac{h}{2}\right) \gamma (h)(1 m) = \frac{h^2}{2} \gamma$$

$$F_V = \gamma h$$

$$\sum M_H = 0$$

$$\frac{h^2}{2} \gamma \frac{h}{3} = 0.5 \gamma h$$

$$\frac{h^3}{6} = 0.5 h$$

$$h^2 = 3$$

$$h = \sqrt{3} = 1.73 m$$

$$h = 1.73 m$$

(MIN-RECTANGULAR)
Vertical Gate

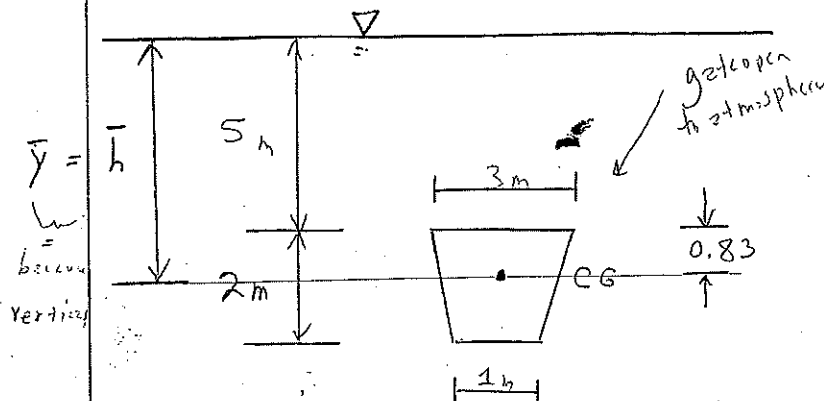
Example 2.3

Submerged

(pg. 30 HWANG)

A vertical trapezoidal gate w/ its upper edge located 5m below the free surface of water.

Determine the total pressure force & the center of pressure on the gate.



$$\text{Centroid} = \bar{y} = 2 - \frac{h(2a+b)}{3(a+b)}$$

$$= 2 - \frac{2(6+1)}{3(4)} = 0.83 \text{ m}$$

$$\text{Area} = \frac{h(a+b)}{2} = \frac{(2)(1+3)}{2}$$

$$\text{Area} = 4 \text{ m}^2$$

Moment of Inertia (x-axis)

$$I = \frac{h^3(a^2 + 4ab + b^2)}{36(a+b)}$$

$$I = \frac{2^3(3^2 + (4)(3)(1) + 1^2)}{36(1+3)}$$

$$I = 1.22 \text{ m}^4$$

$$F = \gamma \bar{h} A = (9810 \text{ N/m}^3)(5.83 \text{ m})(4 \text{ m}^2)$$

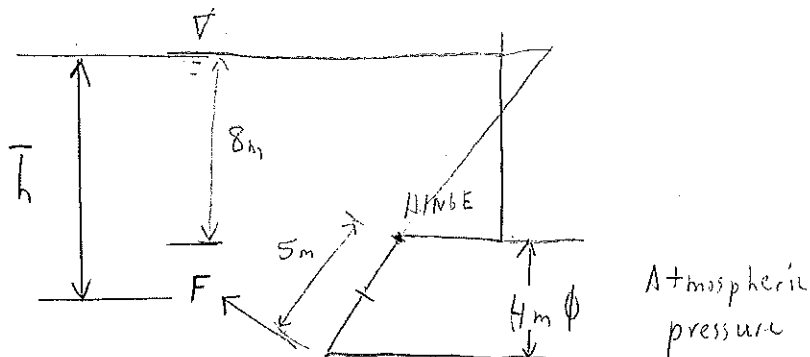
$$F = 228,900 \text{ N}$$

$$\text{Location of C.P.} = Y_{cp} = \frac{I}{A\bar{y}} + \bar{y} = \frac{1.22 \text{ m}^4}{4 \times 5.83} + 5.83 = 5.88 \text{ m}$$

Force = 228,900 N
Acting 5.88m below the surface

An elliptical gate covers the end of a pipe 4m in ϕ . If gate is hinged @ the top, what normal force, F is required to open the gate when water is 8m deep above the top of the pipe & the pipe is open to the atmosphere on the other side?

Neglect gate wt.



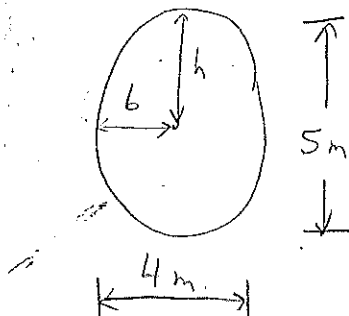
plane surface

hatched
in other
book
for
ellipse

$$Area_1 = \pi b h = (\pi)(2)(2.5)$$

$$Area_2 = 15.7 \text{ m}^2$$

$$\text{Centroid } (\bar{y}) = 2.5 \text{ m}$$



normal to
force

$$\underline{I} = \left(\frac{\pi}{4} \right) b h^3$$

$$= \left(\frac{\pi}{4} \right) (2)(2.5)^3$$

$$\underline{I} = 24.5 \text{ m}^4$$

Force Magnitude = $\bar{\gamma} \bar{h} A$

$$|F| = (9.81 \text{ kN/m}^2) (10 \text{ m}) (15.7 \text{ m}^2)$$

$$|F| = 1,540 \text{ kN}$$

LOCATION OF FORCE

$$Y_p = \frac{I_{xx}}{A \bar{y}} + \bar{y}$$

$$\bar{y} = 12.5 \text{ m}$$

$$Y_{cp} = \frac{24.5 \text{ m}^4}{(15.7 \text{ m}^2)(12.5 \text{ m})} + 12.5 \text{ m}$$

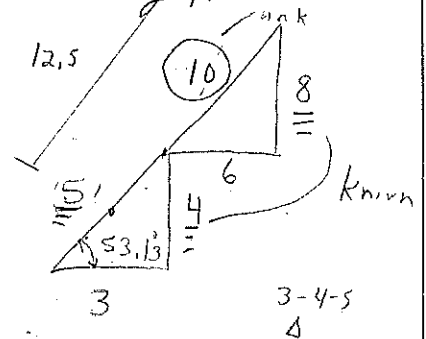
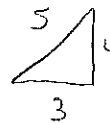
$$Y_p = 12.62 \text{ m}$$

$$\sum M_o (F)(5 \text{ m}) = (1540 \text{ kN})(2.62 \text{ m})$$

$$F = 807 \text{ kN}$$

force
required
to open gate

(Remember $\bar{y}$ is along plane surface.)



$$\sin 53.1^\circ = \frac{4}{5}$$

