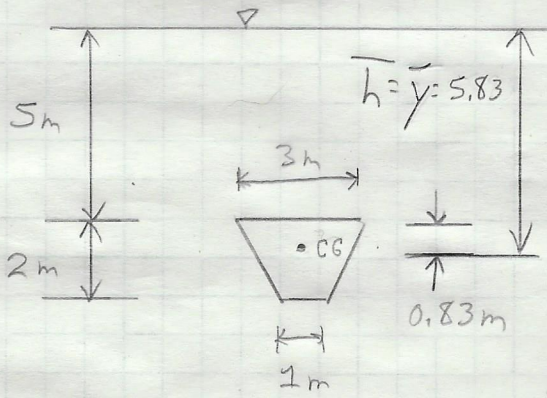
Non-Rectangular | Vertical Gate

A vertical trapezoidal gate with its upper edge located 5 m below the free surface of water is shown below.

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



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

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

$$\text{Centroid from top of gate} = 2 - \frac{h(2a+b)}{3(a+b)}$$

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

$$\boxed{\bar{h} = \bar{y} = 5.83\ m}$$

Moment of Inertia (about centroid)

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

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

$$\boxed{\bar{I} = 1.22\ m^4}$$

Answers

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

$$\boxed{|F| = 228{,}900\ N}$$

C.P Location $y_{cp} = \bar{y} + \frac{\bar{I}}{\bar{y}A} = 5.83 + \frac{1.22\ m^4}{(5.83m)(4m^2)}$

$$\boxed{\text{C.P. Location} = 5.88\ m \text{ from water surface}}$$