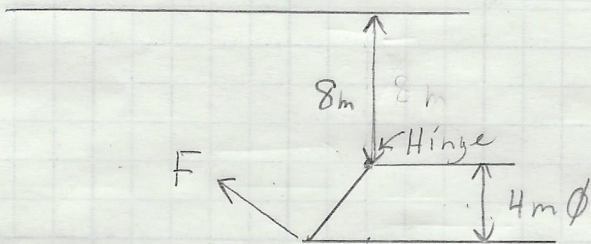


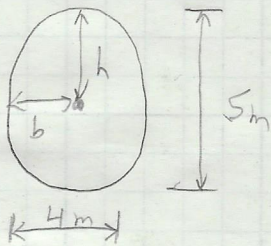
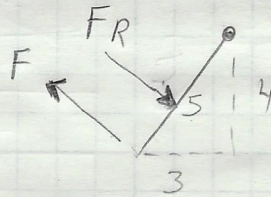
Non-Rectangular

Inclined Surface

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



FBD of gate

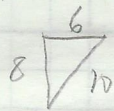


$$\text{Area of gate} = \pi b h = \pi (2m)(2.5m)$$

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

Centroid (Center)

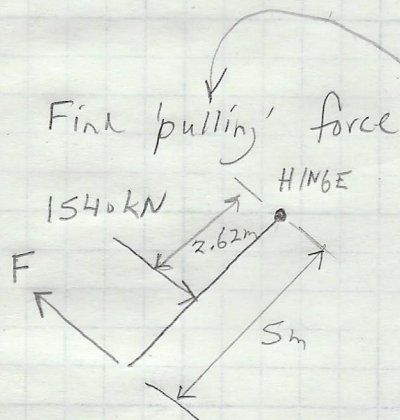
$$\bar{h} = 8m + 2m = 10m$$



$$\bar{y} = 10m + 2.5m = 12.5m$$

$$\bar{I} = \frac{\pi}{4} b h^3 = \frac{\pi}{4} (2m)(2.5m)^3$$

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



$$\sum M_H = 0$$

$$(F)(5m) = (1540kN)(2.62m)$$

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

$$|F| = \gamma \bar{h} A = (9.81 \text{ kN/m}^3)(10m)(15.7 \text{ m}^2)$$

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

$$y_{cp} = \bar{y} + \frac{\bar{I}}{\bar{y}A} = 12.5m + \frac{24.5 \text{ m}^4}{(12.5m)(15.7 \text{ m}^2)}$$

$$y_{cp} = 12.62m \text{ from surface along incline}$$