1. FIND F

2. LOCATION OF F ; y_{CP}

3. STATICS $\sum M_{HINGE} = 0$

A semi-circular gate is held closed by force F_g applied 0.6 m from the top edge. The gate is hinged along the upper straight edge. Calculate the minimum force F_g necessary to keep the gate closed against the hydrostatic force of the water.

$$F = \gamma h_{CG} A$$

$$A = \frac{\pi R^2}{2} = \frac{\pi (1.2m)^2}{2} = 2.262 m^2$$

Fig. 2.13

$$\frac{4R}{3\pi}$$

$$\Delta \zeta = \frac{4R}{3\pi} = \frac{4(1.2m)}{3\pi} = 0.5093 m$$

$$h_{CG} = 1.5\,m + \Delta \zeta \sin 45° = 1.5\,m + 0.5093\,m \sin 45° = 1.860\,m$$

$$F = \gamma h_{CG} A = 9800 \frac{N}{m^3} (1.860\,m)(2.262\,m^2) = 41.23\,kN$$

F LOCATION

$$y_{CP} = \frac{I_{xx} \sin \theta}{h_{CG} A} \quad \text{BELOW THE C.G.}$$

$$I_{xx} = 0.1098 R^4$$

$$X_{CP} = 0 \quad (\text{sym.})$$

(TABLE 2.13) ← Actually, Figure 2.13

$$I_{xx} = 0.1098 (1.2\,m)^4 = 0.2277\,m^4$$

$$Y_{CP} = \frac{-0.2277 m^4 \sin 45°}{(1.860m)(2.262 m^2)} = -0.0383 m$$

F.B.D OF GATE

$\sum M_{HINGE}$

$$F\left(-y_{CP} + \frac{4R}{3\pi}\right) = F_g (0.6)$$

$$41.23 kN (0.0383m + 0.5093m) = F_g(0.6)$$

$$F_g = 41.23 kN \frac{(0.548m)}{0.6m} = 37.6 kN \quad ANS/$$

$\frac{4R}{3\pi}$

F

F_v

HINGE

F_H

0.6 m

F_g