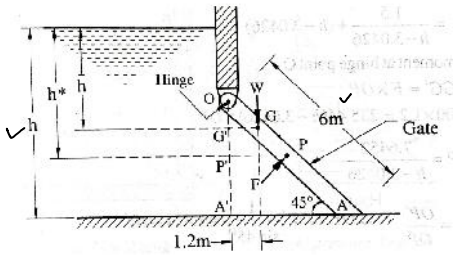
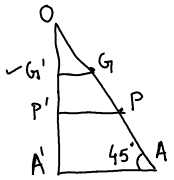
A Rectangular sluice gate (4m wide and 6m long) hinged at point o as shown in fig. the gate is kept close by a weight fixed to the gate. Total weight of gate is 1500 kN (weight of gate and weight fixed to gate). The center of gravity of the weight and gate is at G. Calculate depth of Water (h) so that cause the gate open.





area of gate $A = 6 \times 4 = 24 m^2$

$\bar{h} = h - G'A'$

$= h - (OA' - OG')$

$\sin 45^\circ = \frac{OA'}{OA} = \frac{OA'}{6}$ $\quad OA' = 6 \sin 45^\circ$

$= 4.2426 m$ $\quad OA' = OG' + G'A'$

$\tan 45^\circ = \frac{OG'}{GG'} = \frac{OG'}{1.2}$ $\quad OG' = 1.2 \tan 45^\circ$ $\quad G'A' = OA' - OG'$

$OG' = 1.2 m$

$\bar{h} = h - (4.2426 - 1.2) = h - 3.0426$

Total Pressure force

$F = \rho g A \bar{h}$

$= 1000 \times 9.81 \times 24 \times (h - 3.0426)$

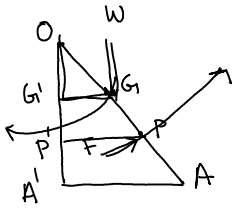
$= 235.44 (h - 3.0426)$ kN

Centre of Pressure (h^*)

$h^* = \frac{I_G \sin^2 \theta}{A \bar{h}} + \bar{h}$ $\quad I_G = \frac{bd^3}{12} = \frac{4 \times 6^3}{12} = 72 m^4$

$h^* = \frac{72 \times \sin^2 45^\circ}{24 \times (h - 3.0426)} + (h - 3.0426)$

$h^* = \frac{1.5}{h - 3.0426} + (h - 3.0426)$



Now Taking moment at hinged Point

$W \times GG' = F \times OP$

$1500 \times 1.2 = 235.44 (h - 3.0426) \times OP$

$$OP = \frac{7.6452}{h - 3.0426} \quad \text{— (I)}$$

$\sin 45^\circ = \frac{OP'}{OP}$

$OP = OP' \times 1.42$

$OP = OP' / \sin 45^\circ$

$$= (h^* - \bar{h} + OG') \, 1.42$$

$$= 1.42 \left[\frac{1.5}{h - 3.0426} + (h - 3.0426) - (h - 3.0426) + 1.2 \right]$$

$$= 1.42 \left[\frac{1.5}{h - 3.0426} + 1.2 \right] \quad \text{— (II)}$$

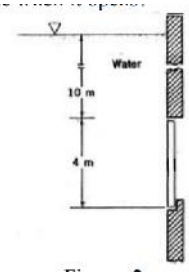
$$\frac{7.6452}{h - 3.0426} = 1.42 \left[\frac{1.5}{h - 3.0426} + 1.2 \right]$$

$$7.6452 = 1.42 \left[1.5 + 1.2 (h - 3.0426) \right]$$

$$\boxed{h = 6.2977 \text{ m}}$$

Q.2

A rectangular gate that is 2 m wide is located in the vertical wall of a tank containing water as shown in figure.2. It is desired to have the gate open automatically when the depth of water above the top of the gate reaches 10 m. (a) At what distance "d" should the frictionless horizontal shaft be located? (b) What is the magnitude of the force on the gate when it opens?



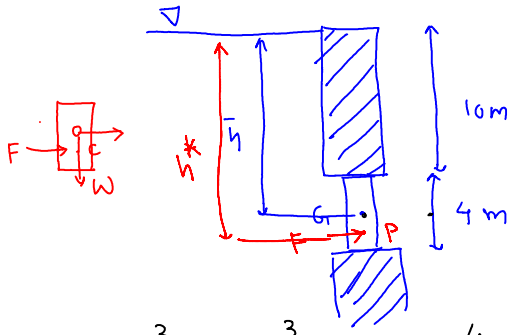
Given Data

$w = 2$, $h = 4$

area $= 4 \times 2 = 8\ m^2$

$\bar{h} = 10 + 4/2$

$= 12\ m$



Total Pressure force

$F = \rho g A \bar{h}$

$= 1000 \times 9.81 \times 8 \times 12$

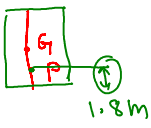
$= 941.76\ kN$

Centre of Pressure

$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$

$= \frac{10.66}{8 \times 12} + 12 = 12.11\ m$

$I_G = \frac{bd^3}{12} = \frac{2 \times 4^3}{12} = 10.66\ m^4$



Location of Shaft from bottom edge of gate

$d = (10+4) - 12.11 = 1.8\ m$