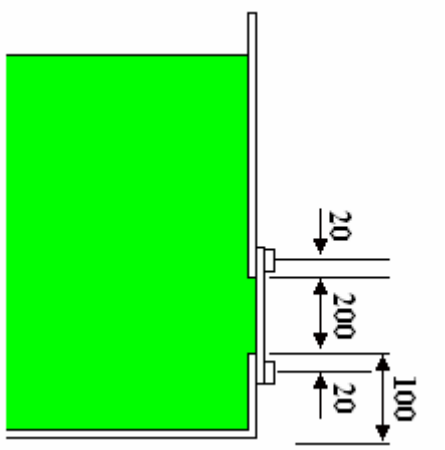
ENGINEERING SCIENCE C103
EXAM SOLUTIONS 2005

Q 5 A plate that covers a hole in the side of a tank is held in place by **four** m10 bolts as shown. The tank is filled to a depth of 1000 mm. Determine the total force acting on the plate and the additional force in each bolt due the water pressure.



SOLUTION

Total force = R = ρ g A $\bar{y}$
A = 200 x 200 = 40 000 mm^2
A = 0.04 m^2

$\bar{y}$ = (1000 – 100 – 100) = 800 mm

R = 1000 x 9.81 x 0.04 x 0.8 = 313.92 N

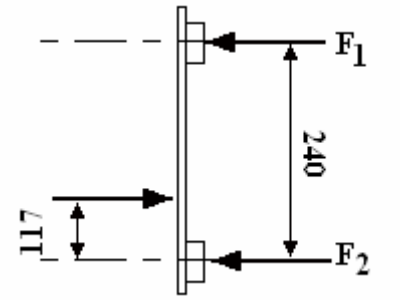
$\bar{h}$ = 2nd mom. of Area/ 1st mom. of Area

1st moment of Area = A $\bar{y}$ = 0.04 x 0.8 = 0.032 m^3.

2nd mom of area = $\mathbf{I_{SS}}$ = B(D^3- d^3)/3 = 0.2 ($0.9^3 - 0.7^3$)/12
$\mathbf{I_{SS}}$ =0.0257 m^4.

$\bar{h}$ =0.0257/0.032= 0.804 m

The distance from the bottom edge to the centre of pressure
= 1 - 0.804 = 0.196 m
Distance from C of P to centre of bottom bolts
X = 0.196 – 0.08 = 0.116



Moment about the bottom centre line
M = Rx =313.92 x 0.116 = 36.4 Nm.
M = 36.4 = $0.24F_2$
F_2 = 36.4/0.24 = 151.7 N
This is shared by two bolts at the top so F = 75.9 N

The force in the bottom bolts is 313.92 – 151.7 = 162.2 N
Force in each = 162.2/2 = 81.1 N