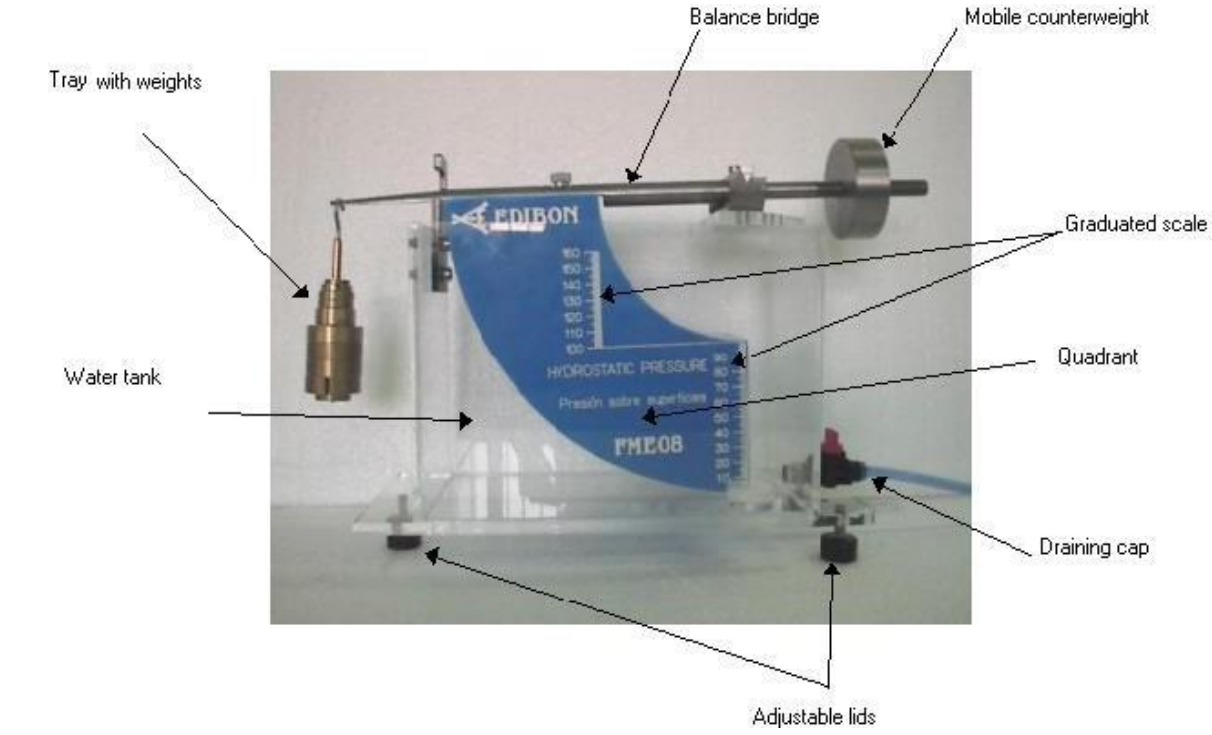
Practical work 1: Determination of the Center of Pressure on a Flat Surface

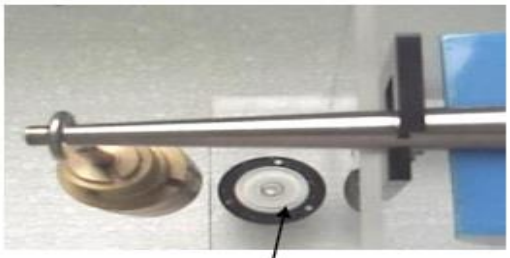
1. Objective:

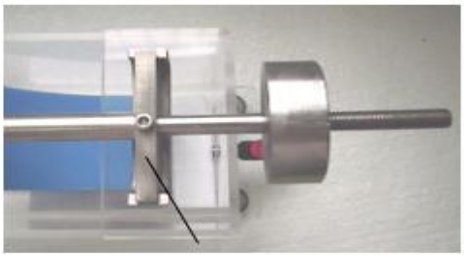
Determination of the position of the center of pressure on a fully submerged rectangular flat surface.

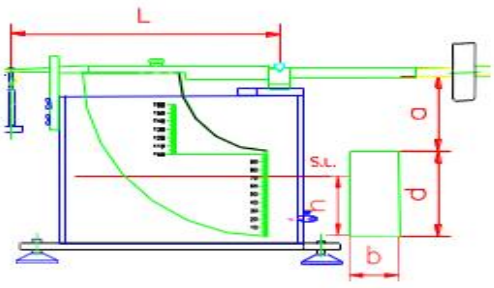
2.Theory:

The center of pressure can be defined as the point of application of the resultant of the pressure forces acting on the plate. The magnitude of the resultant hydrostatic force acting on a surface S=a×b is theoretically estimated by:




Bubble level


Balance support




End hook

Figure 1. General sight of the equipment

$$F_{th} = \rho g h_g S \quad (1)$$

The point of application of this resultant is theoretically determined by:

$$h_{p\,th} = h_g + I/Sh_g \quad (2)$$

Where:

y>a; hg = y-a/2; I = ab ^{3}/12; and S=ab.

The equilibrium of forces about the pivot O gives:

$$h_{p\,exp} = \frac{W_{exp}\,L}{\rho g h_g\, S} - H + y \quad (3)$$

Where:

I : second moment of area of the surface SSS with respect to the axis passing through G, perpendicular to the plane of the plate.

W : experimental weight placed on the platform to maintain equilibrium, and h_{pexp} is the experimentally determined center of pressure relative to the free surface.

ρ and g : density of water and acceleration due to gravity, respectively.

h_g : height of the center of gravity of the plate.

h_{pth} : theoretical height of the center of pressure.

h_{pexp} : experimental height of the center of pressure.

y : water height.

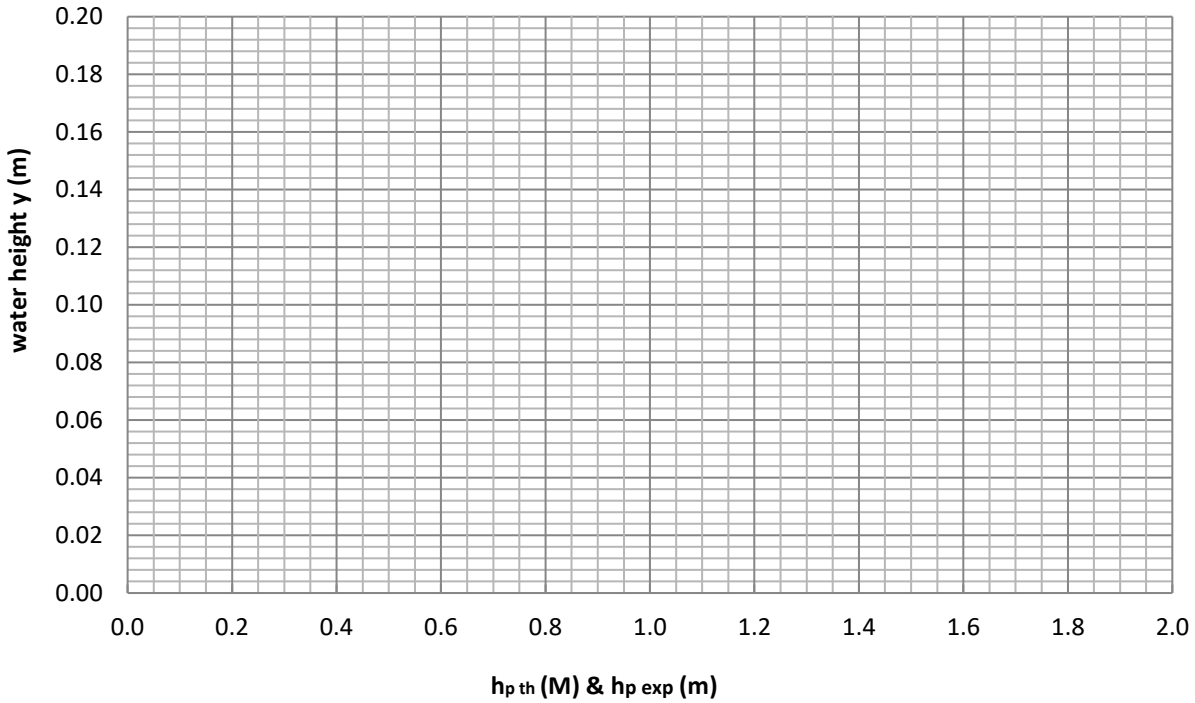
2. Tasks:

Given the values:

H=0.20 m, L=0.285 m, b=0.075 m, a=0.10 m, ρ=1000 kg/m³, g=9.81 m/s²

1. Calculate h_{pth} and h_{pexp} using equations (2) and (3), and complete the table below.
2. Plot the graph of h_{pth} as a function of y.
3. Plot the graph of h_{pexp} as a function of y on the same graph.
4. Compare the two graphs.
5. On the same graph (using a different scale), indicate the percentage errors for the various measurements and discuss the results.

Filling of the Tank		Emptying of the Tank		Average Values		Center of Pressure		Error (%)
Weight w_{exp} (g)	Water Height y (mm)	Weight w_{exp} (g)	Water Height y (mm)	Water Height y (mm)	Water Height y (m)	$h_{p\ exp}$ (m)	$h_{p\ th}$ (m)	



Conclusion:
