Ministry of Higher Education
& Scientific Research
Al-Isra'a University College
Civil Engineering
Fluid Mechanics Lab.

Second Class

Experiment No. (3)

Center of Pressure

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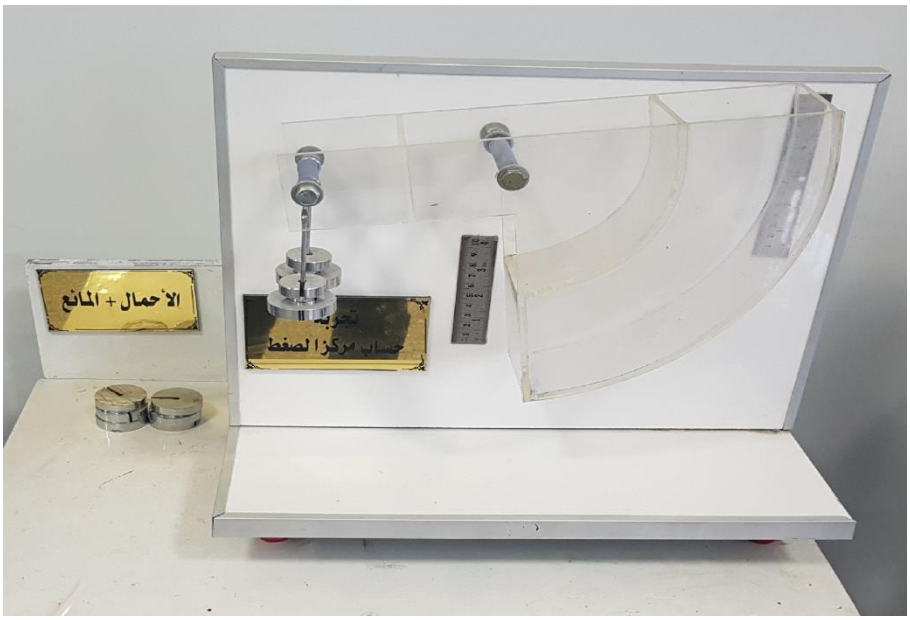
Exp.3: Center of Pressure

Objective:

- To understand the hydrostatic pressure distribution.
- To verify the location of center of pressure.

Theory:

The submerged surface of a static fluid is exposed to the force by which the fluid influences it and this force is proportional to the pressure of the fluid. To calculate the sum of these forces (fluid pressure forces) affecting the plate we take a slice of the plate and the integrity of the forces affecting this plate for the whole area. Because the fluid is in a static state, the force direction is perpendicular to the surface.



Find forces resultant:

$p = F / A = \gamma h$

$F = p * A$

For slice:-

$dF = p * dA$

$dF = \gamma h * dA$

$\int dF = \int \gamma h * dA$

$F = \int \gamma y \sin\Theta \, dA$

$F = \gamma \sin\Theta \int y \, dA$

Where:- $\int y \, dA = y_o A$

$F = \gamma \sin\Theta \, y_o A$

$F = \gamma h_o A$

h_o: Is the vertical dimension from the center of the plate to the free surface.

Calculation center of pressure:

The force effect point is defined on the plate by the pressure center

$$h_c = h_o + \frac{I_o}{h_o * A}$$

$$I_o = \frac{b h^3}{12}$$

$A = h * b$

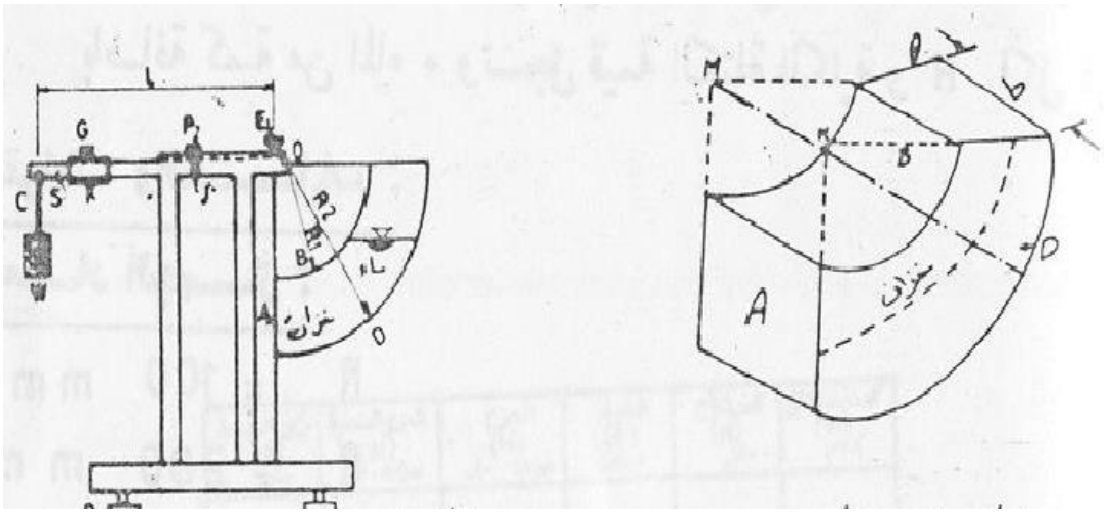
h_c: It is the vertical dimension of the free surface to the effect point of the resultant of forces.

I_o = moment of inertia.

Description of the device

The reservoir consists of two cylindrical surfaces (D) and (B), whose diameters are R_1 and R_2 respectively, and their center is applied to the axis of rotation (o) which is measured by the momentum around it and therefore the force that affects these two surfaces does not have a torque

around the axis of rotation. The only torque is the torque of the force that affects the rectangular surface (gate) and can be measured by weighing the blocks (W) on the weight holder at point (c) and the suspension at the end of the arm (s) connected to the tank.



Device dimensions

R_1 = 20 cm

R_2 = 10 cm

b = 8 cm

L = 13 cm

h = 9.5 cm

Apparatus:

1. Water vessel.
2. Weights.

Procedures:

1. Make sure the device is in the horizontal position by balancing the amount of water in the device with loads equal to it.

2. Add a quantity of water and calculate the amount of weights and height fluid from the surface to the center of the body. This process is repeated and recorded readings.

No.	m (kg)	W (N)	h_o (m)	F (N)	h_c (m)	M (N/m)

Discussion:

1. If the object is horizontal, what is the position of the pressure center (c.p) on the center of the body (c.g)?

2. Discuss the accuracy of the results, the probability of error and its sources?

3. What is the difference in the position of the pressure center (h_c) for the gate if it is (horizontal - vertical - inclined)?

4. Show the effect of each of the following on the position of the pressure center (h_c):

a. Fluid density.

b. Gate area.

c. Position of the center of the body in relation to the pressure center.