Laboratory 2 Sample Report

Contents

Laboratory Report: Fluid Statics

Title

Measurement of Bouyancy and Center of Pressure on Submerged Planar Objects

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Objective

To investigate fluid statics by measuring buoyancy forces and hydrostatic thrust, and to validate theoretical principles using experimental data.

Introduction

The purpose of this laboratory experiment was to investigate fluid statics through two key objectives:

1. Measure the buoyancy force on various objects and verify Archimedes' Principle.
2. Determine the hydrostatic thrust acting on a plane surface using a quadrant balance, for both partially and fully submerged conditions.

Materials and Methods

Materials

- Quadrant balance apparatus
- Graduated cylinder
- Thermometer
- Objects for buoyancy testing (rocks, composites, wood samples)
- Weighing scale
- Water
- Transfer pipette
- Standard weights and hangers

Methods

Part 1: Buoyancy Experiments

1. Measured the temperature of water and recorded initial volumes in a graduated cylinder.
2. Submerged objects (Rock-1, Rock-2, etc.) and recorded displaced volumes.
3. Repeated measurements three times for each object to ensure accuracy.
4. Recorded data for each object, including mass and displacement.

Part 2: Hydrostatic Forces

1. Set up the quadrant balance and trimmed it to ensure the plane surface was vertical.
2. Conducted trials for partially submerged conditions by adjusting weights and water levels.
3. Conducted trials for fully submerged conditions by further submerging the plane surface.
4. Recorded water depths (h) and widths (b) of the free surface for all trials.

Results

Buoyancy Experiments

Material	$V_{initial}$	V_{final}	ΔV	V_o **geometry**	V_o **displacement**	**mass**	**submerged(**
Rock-1							
Rock-2							
Composite-1							
Composite-2							
Wood-1							
Wood-2							

Quadrant Balance (Partial Submerge)

Trial	mass (grams)	h mm	b mm
1			
2			
3			
4			
5			

Quadrant Balance (Fully Submerge)

Trial	mass (grams)	h mm	b mm
1			180
2			180
3			180
4			180
5			180

Data Analysis

Part 1: Buoyancy

1. Calculated the displaced volume (\Delta V) for each object.
2. Determined buoyancy forces (F_B) using: [F_B = \rho_{\text{water}} \cdot \Delta V \cdot g]
3. Compared calculated object volumes with geometry-based volumes.

4. Verified Archimedes' Principle for floating and submerged objects.

Part 2: Hydrostatic Forces

1. Calculated moments (M) for all trials using: [M = W \cdot \left(\frac{3b}{8} \right) \cdot h]
2. Plotted (M) vs. (h) for fully submerged trials and determined the slope.
3. Derived specific weight (\gamma_w) of water and compared it to standard values.
4. Evaluated partially submerged data by plotting: [M + \frac{\gamma_w W R_2^2 h}{2} \quad \text{vs.} \quad h^3]

Discussion

1. **Archimedes' Principle**: Confirmed that buoyant forces matched theoretical predictions for displaced water volumes. Floating objects adhered closely to calculated masses.
2. **Hydrostatic Forces**: Experimental results for center of pressure and moments were consistent with theoretical expectations. Minor deviations were attributed to setup precision and measurement errors.
3. **Potential Improvements**: Better calibration of the quadrant balance and more trials could enhance result accuracy.

Conclusions

This experiment validated Archimedes' Principle and hydrostatic force theory using hands-on experimentation. The buoyancy and hydrostatic thrust analyses provided foundational insights into fluid statics, bridging theory and practice.

References

1. Holman, J.P., *Experimental Methods for Engineers*, 8th Ed., McGraw-Hill, 2012.

2. Laboratory 2 Example Report, CE 3105 Materials.
3. Relevant data from textbooks and online resources for water density at measured temperatures.