Experiment No. 2: Center of Gravity

1. Objective

The objective of this experiment is to find the center of gravity of regular and irregular shapes.

2. Apparatus

- Regular Shapes
- Irregular Shapes
- Suspension Board
- Plumb Bob
- Cord

3. Theory

The center of gravity (CG) of a body is the point at which its weight is concentrated. This point may be within or outside the body. This is the point where it balances itself when on knife-edge support. Locating the center of gravity of an object is very important in our daily lives. The earth pulls down on each particle of an object with a gravitational force that we call weight. The net effect is as if the total weight of the object were concentrated in a single point. In general, determining the center of gravity (CG) is a complicated procedure because the (mass and weight) may not be uniformly distributed throughout the object. The general case requires the use of calculus.

If the mass is uniformly distributed; the problem is greatly simplified. If the object has a line or plane of symmetry, the CG lies on the line of symmetry. For a solid block of uniform material, the center of gravity is simply at the average location of the physical dimensions. Regularly shaped bodies have CG at their geometric centers. In irregular elongated bodies CG can be located by balancing method. While, irregular flat bodies like a sheet model or board center of CG is located by locating two or more plumb lines from different points of suspension. The interaction of these plumb lines is the center of gravity.

4. Center of Gravity of Regular Shapes

a. Circle

The center of gravity (CG) of a circle lies at the center of circle (at the midpoint). The radius of a circle is measure of its center of gravity as shown in the Figure 2.1.

$$\mathrm{G} = r \qquad (2.1)$$

Where G is the center of gravity and r is the radius of circle.

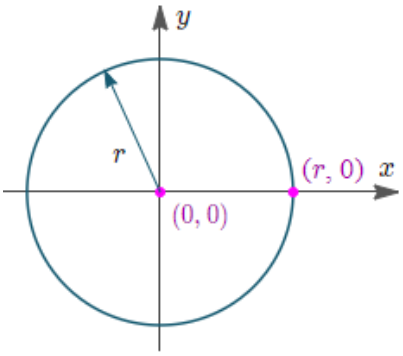

Figure 2.1: Center of Gravity of Circle

b. Trapezium

The center of gravity of the trapezium shown in Figure 2.2 with parallel sides 'a' and 'b' is given by the Equation (2.2)

$$G = [b + 2a/3\,(a + b)] * h \qquad (2.2)$$

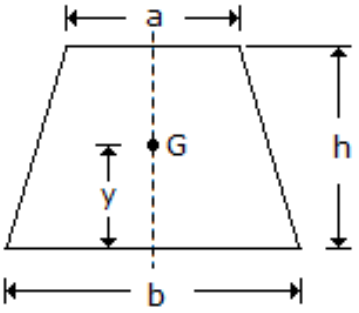

Figure 2.2: Center of Gravity of Trapezium

c. Triangle

The center of gravity G of a triangle lies at a point where the three medians of the triangle intersect as shown in Figure 2.3 and given by the Equation (2.3).

$$G = {}^{h}/_{3} \qquad (2.3)$$

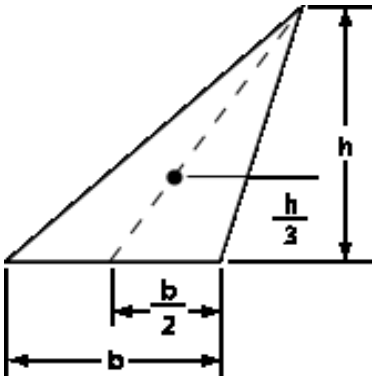

Figure 2.3: Center of Gravity of Triangle

d. Semi-Circle

The center of gravity G of a semi-circle shown in Figure 2.4 lies at distance given by Equation (2.3) from its base measured along the vertical radius.

$$G = \frac{4r}{3\pi} \qquad (2.4)$$

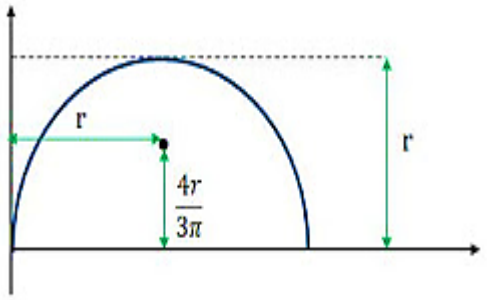

Figure 2.4: Center of Gravity of Semi-Circle

5. Procedure (The Plumb Line Method)

1. You have received different shapes of material. The shapes of regular object and irregular object were cut out from the acrylic pieces.
2. Small holes at non-collinear points were punched on each sample e.g. circle, semi-circle, triangle, trapezium and some irregular shapes.
3. Suspend the sample of circle on the board supplied with the apparatus at the suspending pin at the top center of the body.
4. Hang the sample loosely from the support and it should not touch any surface.
5. Suspend a plumb bob from the support with the cord extending down in front of main body and suspending sample.
6. Drawn a line on the sample along the path of the cord.
7. Remove the sample and suspend again through another hole and draw the line again.
8. Mark the intersection of two lines as CG (center of Gravity).
9. Repeat the above procedure for the other regular and irregular shapes to get the center of gravity.
10. For the regular shapes (circle, semi-circle, triangle, trapezium) record the measured CG in Table 2.1.
11. Calculate the theatrical values of CG for circle, trapezium, triangle and semi-circle by using the Equations (2.1), (2.2), (2.3) and (2.4) respectively.
12. Record the theoretical values in the Table 2.2 and compare these with the measured values.

Table 2.1

S#	Shape	Formula	Theoretical value (cm)	Practical Value (cm)
1	Circle	$G = r$		
2	Trapezium	$G = [b + 2a/3\,(a + b)] * h$		
3	Triangle	$G = {}^{h}/_{3}$		
4	Semi-Circle	$G = \frac{4r}{3\pi}$		

Figure 2.5: Center of Gravity of Triangle

6. Lab Tasks

1. Draw an equilateral triangle in Figure 2.5 having one side length of 5 cm and find its center of gravity?

2. Increase the number of tested holes of trapezium and observes the effect.

7. Conclusions