2.3.1 Experiment 1: Moments of Forces

Principle

Equilibrium of a structure is a function of the forces applied on the structure and the location of these forces. The line of action of a force indicates the direction in which the force is applied. The position and the line of action of an applied force affect the tendency of the structure to rotate. This is related to the concept of *moment* of force. For example, if the line of action of a force passes through the center of rotation of a body, the body will not rotate. However, the further away the force is from the center of rotation, the higher is the tendency of the body to rotate. In addition, the tendency of the structure to rotate is a function of the magnitude of the applied force. For example, the higher the force the larger is the tendency to produce a rotation, that is the larger is the moment produced.

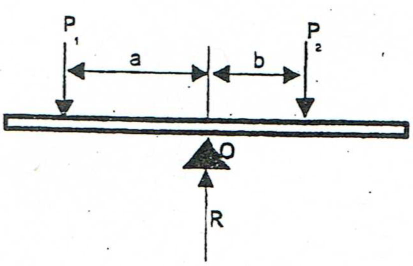
Objective

The objective of this experiment is to demonstrate the effects of force magnitude and its location on the equilibrium of structural members.

Background

The moment of a force about a point or axis provides a measure of the tendency of the force to cause a body to rotate about the point or axis. The larger the force or the distance, the greater the turning effect. This *tendency* for rotation caused by the force which acts about a perpendicular distance from an axis is sometimes referred to as a *torque*.

Consider a seesaw arrangement, such as a beam supported in the middle (at point O) as shown in the schematic diagram below. Consequently, the conditions for equilibrium are that the sum of all external forces must be equal to zero, $\Sigma F = 0$ and that the sum of all moments about any point must be zero, $\Sigma M_O = 0$. Hence the point loads P_1 and P_2 on either side of the support must be balanced by the reaction force R and for the beam to remain horizontally stable, the equation $P_1 \cdot a = P_2 \cdot b$ must be satisfied.



Apparatus

- Beam
- Platform scale
- Test weights

Procedure

- Place the beam over the scale such that the middle of the beam falls on the center of the supporting scale. Reset the scale to read zero.
- Place a 1 lb weight at each end of the beam. Notice that the scale reads 2 lb which is the sum of the weights applied on the body.

- Move the weight that is on the right side of the beam half the distance between the end of the beam and the scale. The beam becomes unbalanced and falls down. The system is not in equilibrium. How many weights should be placed at that point in order to keep the beam in equilibrium?
- Now, move the weights placed on the right side of the beam to a position which is located at one-third the distance between the end of the beam and the scale. How many weights should be placed there in order to maintain equilibrium?

Presentation of Results

Set up a table showing the number of weights needed to maintain the beam in equilibrium versus the distance between the location of the weights and the center of the scale.

Discussion of Results

Find the relationship between the weights and the distances needed to keep the beam in equilibrium. What conclusions can be drawn from this experiment?