2.3.3 Experiment 3: Internal Forces in Truss Members

Introduction

A truss is a structural system formed by members that can carry loads in the axial direction of the members but cannot carry loads in the transverse direction, that is they have no resistance to bending. Wires and cables are typical examples of truss members that can only carry axial loads with the additional condition that the forces must be tensile forces (cables and wires cannot carry compressive forces). For example, if a wire the wire is pulled at, the wire will offer a resistance while if it is pushed on, it will not offer any resistance at all.

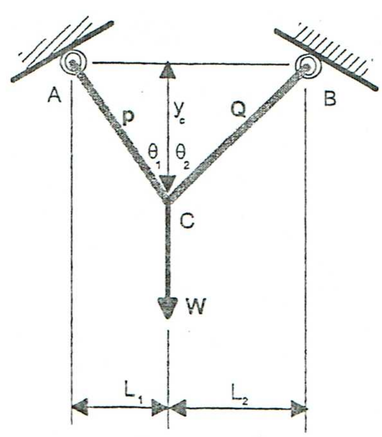
Objective

The objective of this experiment is to illustrate how internal forces develop in a simple truss structure.

Background

When a truss structure is subjected to external loads, the members of the truss will try to transmit these loads to the supports. In doing so, internal forces will develop in each truss member. These internal forces may be a function of the loads applied, the inclination of the members, as well as the properties of the members.

Provided the loading is coplanar with a cable, the requirements for equilibrium are formulated in an identical manner. Consider, for example, the cable as shown in the schematic diagram below, where the distances L_1 and L_2 and the load W are known. The problem here is to determine the *seven unknowns* consisting of the tensions P and Q in the *two* segments, the *four* components of reactions at A and B and the sag y_C at the point C.



Here for equilibrium, $\Sigma F = 0$. This equation requires that $\Sigma F_y = 0$ and $\Sigma F_x = 0$. Therefore, the sum of forces in the vertical direction yield $P\cos\theta_1 + Q\cos\theta_2 = W$ and the sum of forces in the horizontal direction yield $P\sin\theta_1 = Q\sin\theta_2$.

Apparatus

- Cables or wires
- Two hanging scales or force gauges
- Two support stands
- Test weights
- Weight hangers
- Protractor
- Rulers

Procedure

To reduce experimental errors, extra cautions should be exercised when measuring the angles suspended by the cable about an imaginary vertical axis separating the cable segments at loading point.

- Attach a weight by two wires and attach the two wires to two force gauges.
- Keep the wires vertical and read the forces on the gauges. Notice that the two readings add up to the weight applied.
- Now hang the wires to the two stands and apply a 2-lb weight.
- Measure the angles subtended by the cables. The angle between the vertical stand on the left and the wire attached to it will be denoted as the angle θ_1. The angle between the vertical stand on the right and the wire attached to it will be denoted as θ_2.
- The force gauges measure the internal forces introduced in the inclined cables when the vertical weight W is applied. Read the corresponding values of the forces in the force gauges. Denote the force in the right-hand gauge by Q and denote the value in the left-hand gauge by P.
- Repeat the process twice more for different values of angles θ_1 and θ_2.

Presentation of Results

Draw a table giving the values of θ_1, θ_2, P, and Q for each of the configurations studied above.

Analysis of Results

Verify that the conditions for equilibrium are satisfied, that is the resultant of all external and internal forces must be zero. The components of the external forces in the coordinates directions are

$$\Sigma F_x = 0: \qquad -P\sin\theta_1 + Q\sin\theta_2 = 0$$

and

$$\Sigma F_y = 0: \qquad P\cos\theta_1 + Q\cos\theta_2 - W = 0$$