

1.2.2 Experiment 2: Compression Test

Principle

When a *column* is compressed its length will decrease. The change in length is related to the load applied, the length of the member, the cross sectional area and the material the structural member is made of.

Objective

The objective of this experiment is to demonstrate the types of compression failures.

Background

There are two possible types of failures in compression members.

1. The member is short and is unable to carry the compressive load and the member fails by crushing. Short member is called a *strut*.
2. The member is long and under the influence of the compressive load, the member cannot remain straight and it fails by buckling.

Determination of the compressive load that can be placed lengthwise on a long, thin column before it buckles out sidewise is obtained from Euler's column formula. The critical load P_{cr} to cause buckling is defined as

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

where I is the *moments of inertia*, E is the modulus of elasticity of the column material and L is the length of the column. For a member with rectangular section whose dimensions are b = breadth and h = depth, then $I = \frac{bh^3}{12}$.

Apparatus

- 3 Plastic rulers
- Platform scales
- Sponge
- Test weights

Procedure

Case 1 - Crushing failure:

Take a piece of sponge and apply a 5 lb weight on it and notice how it crushes under the effect of the applied load.

Case 2 - Buckling failure:

- Take the dimensions of the ruler: measure the length, thickness (or depth) and width of each ruler.
- Take the plastic ruler and hold it vertically on the scale.
- Without intentionally bending the ruler, apply vertical force on the ruler by pressing down on it until it bows out of plane.
- While keeping the hand steady, read the load that caused buckling.

- Repeat the steps for other rulers of different length.

Presentation of Results

Plot a graph giving the load at which buckling occurs versus length for the three plastic rulers. Try to find a relationship between these three variables. Which of the rulers buckled at the lowest load?

Determine the critical loads for each ruler using the Euler's column formula, assume modulus of elasticity of the ruler material is $400,000 \text{ lb/in}^2$ approximately.

Discussion of Results

Compare the different ways in which failure occurred under the effect of compressive loads. Generalize the observations to real columns in civil engineering structures: What types of columns are more likely to fail by crushing and which ones are more likely to fail by buckling?