MECHANICS LABORATORY
AM 317

EXPERIMENT 2
FORCE IN A TRUSS MEMBER
I. OBJECTIVES

1.1 To reinforce the student’s skills in finding the forces in truss members using the method of joints.

1.2 To compare the experimentally measured truss forces with the theoretically calculated forces.

1.3 To check linearity of the measured strain versus the applied load

II. INTRODUCTION AND BACKGROUND

Trusses are used extensively in structural engineering applications. Their main advantage is that they can span large distances using a minimum amount of material. The truss that will be investigated in this experiment is a statically determinate planar truss. A planar determinate truss can have only three unknown reaction forces. The forces in the truss members can be obtained by using the method of joints. In this method, each joint of the truss is isolated in a free body diagram and the unknown member forces are determined from equilibrium ($\Sigma F_x = 0$ and $\Sigma F_y = 0$).

For example, the force $F_{ab}$ in joint “a” could be found as follows:

$$\Sigma F_y = 0$$

$$F_{ab} \sin(\theta) + 100 = 0$$

$$F_{ab} = \frac{-100}{\sin(\theta)}$$

Ray = 100 N

Joint a

$F_{ac}$
When using the method of joints, only two unknown member forces can be solved for at a time. The remaining joints of the truss can be isolated and unknown member forces determined.

The most practical way to experimentally determine the force in the truss member is by use of a strain gage. Since a strain gage measures strain, some conversion must be performed to obtain the force in the member. The measured strain ($\varepsilon$) can be converted to stress ($\sigma$) by using Hook’s Law. For the case where the tensile stress is uniformly distributed over the cross sectional area it has the following form:

$$\sigma = E \varepsilon \quad 2.1$$

where $E$ is the modulus of elasticity of the truss member.

Steel, of which the truss members are made, has a modulus of elasticity: $E = 210 \text{ GN/m}^2$

Once the stress in the member is determined, it can be converted into force ($F$) by multiplying the axial stress by the cross sectional area ($A$):

$$F = A \sigma \quad 2.2$$

III. EQUIPMENT

3.1 Structures test frame
3.2 Digital force display
3.3 Truss with strain gages
3.4 Load cell
3.5 Digital strain display
3.6 Calipers
3.7 Two power supplies for the digital force display and the load cell
IV. Procedure

4.0 Measure the truss dimensions and the member diameters. Record the strain gage number corresponding to each member force.

4.1 Calculate the member forces for a downward 100 Newton load applied center of the bottom span (joint c in the truss figure). Calculate the strain in one member, which will allow you to check the experimental results you measure later.

4.2 Adjust the load adjust screw until the pin that connects the truss to the load cell is free to slide back and forth. Remove this pin once you have adjusted the load to near zero. With the pin removed, turn the small black knob on the load cell to adjust the load reading on the load cell to zero. Replace the pin and, if required, use the load adjust screw to bring the load to zero.

4.3 Record the strain values for each member for the zero Newton load case. Then, use the load adjust screw to increase the load, recording the strain values in each member for 100, 200, 300, 400 and 500 Newton loads. Do not exceed 500 Newtons.
4.4 Check the strain value you calculated in section 4.1 with the experimental value to see if your result is reasonable. For the experimental strain, you must remember to subtract the strain measured for the zero Newton load case.

4.5 Unplug and disconnect the power supplies.

V Report

5.1 Convert the strain readings for the five load cases into member forces. Remember to subtract the strain measured in the zero Newton load case from the loaded values.

5.2 Compare in a table, the experimental and calculated member forces for the 500 Newton load case. Show these member forces on a sketch of the truss. Are they symmetric?

5.3 For any two of the truss members, plot the member force measured versus the applied load. Is the relationship linear?
<table>
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<th>TRUSS MEMBER</th>
<th>ab GAGE#</th>
<th>bc GAGE#</th>
<th>ac GAGE#</th>
<th>bd GAGE#</th>
<th>cd GAGE#</th>
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**TABLE 1**
CALCULATED TRUSS MEMBER FORCES 100 N LOAD

| TABLE 2
<p>| MEASURED STRAIN DATA |
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**TABLE 2**
MEASURED AND ZERO ADJUSTED STRAIN