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***Lab #10: Beam Torsion***

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| **Course Number and Name:**  **ASE 269K Measurements and Instrumentation** | |
| **Semester and Year:**  **Fall 2013** | |
| **Name of Reporter:**  Zachary Tschirhart | **EID of Reporter:**  zst75 |
| **Unique Number and Meeting Time:**  13580 Monday 1-3pm | **Name of Lab Instructor**  **Shixuan Yang** |
| **Title of Experiment:**  Beam Torsion | |
| **Date of Experiment Performed:**  November 11, 2013 | **Instructor Comments:** |
| **Date of Report Submitted:**  November 25, 2013 |
| **Names of Group Members:**  Dayle Chang |
| **Grade:** |

**ABSTRACT**

This lab was indented to show several concepts about using a beam under a torque when finding properties of a c-channel beam. In the lab, the students found that the beam had a pretty standard shear center, which explains the forces in the beam while it’s under a moment. The calculated values for the beam’s torsional stiffness had some unexpected results, but this may have been caused by incorrect values assumed.

**OBJECTIVE AND INTRODUCTION**

The objective of this lab is to familiarize students with the behavior of beams loaded under a torque. Equipment used in the experiment was a Dell Optiplex computer, angle measuring device, and a aluminum c-channel beam.

**THEORY AND EXPERIMENTAL METHODS**

The shear center of a c-channel cantilever beam:

(1)

Where t is the thickness of the channel of the beam, h is the height of the beam from the center of both flanges, b is the measurement of the beam from the center of the vertical section, I is the moment of inertia of the cross-section of the beam, and e is the shear center position from the vertical channel with positive moving away from the c-shape.

The deformation of a beam in torsion:

(2)

Where P is the load force, m is the distance the load is applied from the shear center, L is the length of the beam, J is the polar moment of inertia, G is the Modulus of rigidity which is given as 26 GPa (3.7e6 psi) for the purposes of this lab, and ∅ is the torsional deflection at the end of the beam.

**RESULTS AND DISCUSSION**

Question 1 – Plot the ø vs. x WRT a well-chosen reference point (explain your choiced results).

Figure 1: Twist of beam versus distance the weight was hanging from the reference point.

The reference position was positioned at the left side of the beam if looking at it from the front. This position was picked because of the ease of using an end to measure from. This allowed for better measurement. The bar to hang the weight from had a total length of 8.1875 inches, and attached to the middle of the c-channel beam cross-section area.

Question 2 – Find the shear center and validate expected position.

Using equation 1, a value of 0.014 inches is found for e, this translates to a value of 3.833 inches in our reference frame. According to the collected data in the graph and solving for a linear trend line of y = -3.3389x + 12.29, the shear center of this beam is at 3.681 inches. This is a difference of 0.153 inches or roughly 4%. This error could be from many different sources, including beam deformation, non-linear thickness, or errors in measurements.

Question 3 – Validate torsional stiffness (Show calculation of theoretical model and discuss accuracy and possible causes of error).

Using equation 2 and finding the mid-span max torsional rotation of 0.12 (mPL/GJ), this allowed me to find the theoretical Pm/∅ or torsional stiffness with the found moment of inertia, length of beam, and given Modulus of rigidity. The theoretical torsional stiffness comes out to be 2.092x105 lb-in./rad. Using the collected data the torsional stiffness calculated was different in every measured value set. The mean of the calculated torsional stiffness was 5.3x102 lb-in./rad with a variance of 1.7x102 lb-in./rad. This large difference in values could have come from the way that the equations were calculated. This looks to be like a difference of 3 orders of magnitude, which may have been a problem with values that were given. Under the assumption that a value given was wrong, the theoretical value was almost half of what was found using the collected data. The errors could have come from measurements taken or other human errors.

**CONCLUSIONS**

In conclusion, this lab showed several concepts about finding properties of a beam in torsion, including finding the shear center and torsional stiffness. In the lab, the students found that the beam had a pretty standard shear center, which explains the forces in the beam while it’s under a moment. The calculated values for the beam’s torsional stiffness had some unexpected results, but this may have been caused by incorrect values assumed.