ASEN 1022 Lab: Strength of Materials – Spring 2017

1. Summary

In this class, we examine the mechanical properties of materials. Among the most important mechanical properties is the stress-strain relationship, which provides a rich set of information, including the Young's modulus, the different types of strength and measures of ductility and toughness.

In this lab, we will experimentally examine the behavior of two types of metallic materials. The lab will help us get a better understanding of the concepts of stress and strain and how we can use these concepts to understand why and how materials fail.

You will be predicting, measuring, and analyzing the failure loads and locations of test specimens made from two types of Aluminum alloys. Each will be tested in a single specimen configuration for a total of two test specimen cases. Each group will test these two cases. You will use a tensile testing apparatus to take each of your test specimens up to failure. The data will be collected from your group's tests and will be made available to you electronically for your analysis and inclusion in a report. You will compare the load at which each of your specimens fail with information available in reference sources.

Each group will be required to submit a single report. Grades will be assigned by multiplying the group lab report score by each group member's average peer evaluation percentage.

2. Experimental Procedure

2.1. Setup

You will test one specimen of a ductile aluminum alloy and one specimen of a brittle aluminum alloy. Each specimen will have a 1/2" x 1/4" dog-bone shape. (Discuss why this shape is used in the tensile test.)

For the ductile specimen, you will be randomly assigned either a specimen of either Aluminum 6061-T6 or Aluminum 3003. For the brittle specimen, you will either have a specimen of Aluminum MIC 6 or Aluminum 711.0-T1. Through your measurements you will need to determine the material of the specimens you tested.

2.2. Tensile Testing of Specimens

Each group will be assigned a one-hour time slot to test both specimens on a tensile testing machine to failure. During the test, you will use automated data acquisition to record the force and extension of the specimen. Also, your group will be recording any qualitative observations you might make.

There are two tensile testing machines manufactured by two different companies: Tinius-Olsen and Instron. Each machine has particular procedures for set-up and data collection. You will use the Instron machine. Information on set-up and operation of the machine is provided in the file named "ASEN 1022 Lab Tensile Test Procedure.pdf" which is available on D2L. It is your responsibility to read over the procedure for operating the machine. A staff member and the CAs will be available during the test to provide assistance.

2.3. Posting Your Data

Read your data into MATLAB using the **`Load`** command. Examine the "ExampleData.mat" file included in this package to see how to format and name your `displacement` and `load` variables. Save your data to a .mat file with the following naming convention: "GroupX_Ductile.mat" and "GroupX_Brittle.mat" where X is your group number.

3. Data Analysis

Testing will take some time, so use your time wisely and be prepared before attending the lab. You can start working on your plotting code right away using the "ExampleData.mat" file until you get your actual tensile testing data. You should use this example data file to debug your code. Do not include results from this example data in your report! Again, recall that the **`load`** function in MATLAB is to be used to import the data.

Required tasks and questions to consider as you examine the two sets of data you have:

1) Identify and remove erroneous data, if there is any, for each data set. If so, can you explain the sources of the errors?
2) Compute the nominal stress and strain from truncated data. Then "re-zero" the strain data using interpolation and off-setting as explained in class.
3) Create a scatter plot of strain (x-axis) vs. stress (y-axis) for each specimen type (2 separate plots). What assumptions did you make about the cross-sectional areas?
4) Estimate the modulus of elasticity (Young's modulus) for each specimen type. Is it the same for the different materials? Why or why not? Look up and compare your modulus of elasticity values to a reference source. Does it make sense?
5) Extract the yield strength, the ultimate tensile strength and the fracture stress for each specimen type. Calculate each value of strength. How do these compare with reference values?
6) Discuss the difference in test results (values of Young's modulus and strength, and mode of failure) between the two materials.

4. Writing a Report

Lab Reports are due Friday, April 7th, 2017, 2:00 PM. Late submissions will not be accepted and will result in a zero lab score.

Upload your reports, the data files of your measurements (see Section 3 for naming conventions), and your MATLAB code for plotting and post-processing the data to the dropbox folder for this lab on D2L. Please zip all of your files into a folder named "GroupX_Submission.zip", where X is your group number.

The report should not exceed 3 pages, not counting appendices and references. The format of the report should follow the guidelines defined in the document *Preparation of Report for ASEN 1022 Tensile Test Lab.doc* which can be found on the D2L course webpage. For convenience, you may use the report template: *Template of Report for ASEN 1022 Tensile Test Lab.doc*, which can be found also on D2L. Your report must be processed electronically, e.g. by WORD; handwritten reports will not be accepted.

Your report should specifically include the following sections.

Title Page. Include the names for all students and indicate who acted as group leader.

Abstract.

Introduction. Discuss the objectives of the lab as you see them. This report should include a brief (1-2 paragraphs) background on basic strength of materials and failure criteria.

Experimental Apparatus/Procedure. This should include a brief outline of the experimental procedure which was followed and a reference to this document for further details. Your detailed specimen measurements go here. You should also include any details noted during your test procedures which are relevant to the results and discussion that follows. This should not be written as a list of instructions like the "Tensile Procedure" document. Rather it should summarize the important steps necessary to reproduce your results by an experienced lab engineer.

Analytical Procedure. This should include a summary of the assumptions and steps involved in your simple calculations using reference sources.

Results. This section should include experimental results and a comparison with results from the literature (textbooks, online sources etc.)

- Include plots of the results from your testing. You will probably want to use a 2x1 subplot to present the 2 specimen cases on a single page. Use a table to present your modulus and critical strength/stress results.
- Include additional columns to the above table incorporating data from the literature (textbooks, online sources etc.)
- Make sure to introduce all figures and tables (e.g., "Figure 1 shows the stress plotted versus strain…"), but save the detailed discussion and interpretation of results for the following section.

Discussion. Compare and discuss your experimental and analytical results here. At a minimum, be sure to address the six questions raised in section 3.0.

Conclusions.

References. List of references cited in the body of the report, e.g. the textbook or experimental description document. References should be cited in the text by numbers enclosed in square brackets. Example: "the experimental procedure provided on page 4 of [3] is used."

Appendices. (as needed)

Note. For sections, such as the introduction, it is recommended that a key rule of technical writing: "context before content", be followed. That is, briefly state what the objectives are and which approach was followed to meet the objectives, before entering into the technical content.

5. Logistics

Lab groups (including group leaders) have been posted on D2L.

Addendum I - Report Grading

The score assigned to the lab report includes technical content (65%) and presentation (35%). This is a more detailed breakdown of the weights:

Category	Weight	Score (out of 100%)	Contribution
Title/Abstract	0.05		
Introduction	0.10		
Experimental Apparatus/Procedure	0.05		
Analytical Procedure	0.05		
Results	0.20		
Discussion	0.15		
Conclusions/Refs/Appendices	0.05		
Organization	0.075		
Flow/Clarity	0.10		
Formatting	0.075		
Grammar	0.05		
Spelling and typos	0.05		
Total	1.0		100%

"Flow" measures smoothness of reading from start to finish and correlation of material from section to section, as well as clarity of technical writing.

The score within each category ranges from 0 to 100%. For example, if the score for "Discussion" is 80%, it contributes 0.15 * 80 = 12% to the report score.