CEEN 043 - Behavior & Properties of Engineering Materials
Laboratory Experiment No. 7 - Tension and Shear of Metals

OBJECTIVES: To give the student an opportunity to conduct tension and shear testing for 1018 and 1045 grade steels and 6061-T6 aluminum to determine the behavior of these metals when subjected to stress and to experimentally determine mechanical properties of these materials suitable for design. The student will also be given the opportunity to observe Charpy Impact Testing and to apply experimental data for design and analysis.

EQUIPMENT: Riehle universal tension-compression, extensometer, shear testing apparatus, data collection equipment, Charpy Tester.

PROCEDURES:

Tension Testing

1. Measure and record the diameter of the reduced section of each tensile specimen.

2. Place two marks, approximately 2 inches apart, centered on the reduced portion of the specimen and record this dimension as the gauge length. Mount the tensile specimen within the testing machine and affix the extensometer within the reduced portion of the tensile specimen. Zero all readings.

3. Apply the tensile load at a strain rate between 0.05 and 0.50 in/in per minute. Continue loading until 10 % strain has been observed. Remove extensometer and continue loading until failure.

4. After specimen failure, fit the fractured ends together carefully and measure both the distance between the gauge marks and the reduced diameter of the specimen to the nearest 0.01 in. If the reduced shape is elliptical, the reduced area may be calculated by $\pi d_1 d_2 / 4$, where d_1 and d_2 are the major and minor diameters, respectively.

5. Repeat steps 2 through 4 for each remaining tensile specimen.

Shear Testing

1. Measure and record the diameter and length for each shear specimen.

2. Mount each shear specimen in the shear apparatus for <u>double shear</u> and load at approximately 0.10 inches per minute. Record the maximum load prior to failure for each test.

3. Observe and record the characteristics of the failure surface of each specimen.

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CALCULATIONS

Part A – Tension Testing

1. Compute the tensile strength of each material: $\sigma_{ut} = \frac{P_u}{A_o}$

2. Compute the percentage elongation of each specimen: $100\left[\frac{L_f - L_o}{L_o}\right]$

3. Compute the percent reduction in area for each specimen: $100\left[\frac{A_f - A_o}{A_o}\right]$

4. Compute the modulus of elasticity for each material: $E = \frac{P/A_o}{\varepsilon}$. Use the appropriate stress and strain levels that are consistent with the ease in which the yield point can be seen in the experimental data.

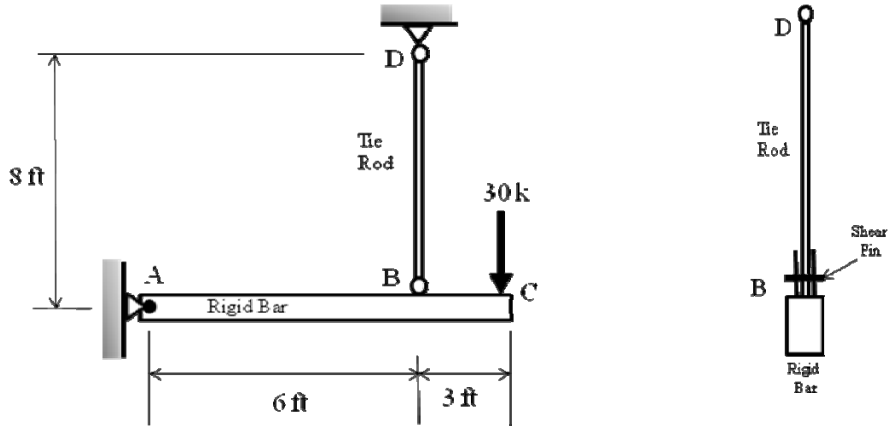
5. Compute the yield strength of each material: $\sigma_{yt} = \frac{P_y}{A_o}$

Part B – Shear Testing

1. Calculate the ultimate shear strength for each specimen tested in double shear: $\sigma_{ut} = \frac{P_u}{2A_o}$

Part C – Design Problem

Consider the rigid bar and tie rod system shown below.



1. Design rod ***BD*** for the given system, i.e., determine the minimum required cross-sectional area for a 6061-T6 Aluminum rod to: (a) maintain a factor of safety of 1.7 against the limit state of yielding in rod BD; (b) ensure the deflection at point *C* on the rigid bar does not exceed 0.05 inches.

2. Design the shear pin at B for the given system, i.e., determine the minimum required cross-sectional area for a 1018 steel shear pin to maintain a factor of safety of 1.7 against shear failure.

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DATA SHEET 1 - TENSION TESTS

	Specimen Type		
	1018 Steel	**1045 Steel**	**6061-T6 Aluminum**
Initial Diameter; d_o			
Initial Gauge Length (in.); L_o			
Final Diameter (in.); d_f			
Final Gauge Length (in.); L_f			
Peak Load (kips); P_u			

DATA SHEET 2 – SHEAR TESTS

Specimen Type	Diameter in	Maximum Load, lbs	% Ductile Shear
1018 Steel			
1045 Steel			
6061-T6 Aluminum			