Fall 2018 MET 211 Group 7:
Tensile vs. Shear Loading and Failure

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Directions

Confirm or deny the accuracy of two relationships for ABS Copolymer*. Both relate material properties between shear and tensile loading.

* Prior approval for material substitution from Steel to ABS per Professor Damon Sisk.

Testing Parameters & Materials

Testing Parameters

1. Obtain data on mechanical properties
2. Test in direct normal tension
3. Test in shear with a custom Fixture
4. Compare results

Materials

- Universal Test Machine (UTM)
- Custom Fixture : 6061 Aluminum
- ABS 3mm 3D Printing string samples

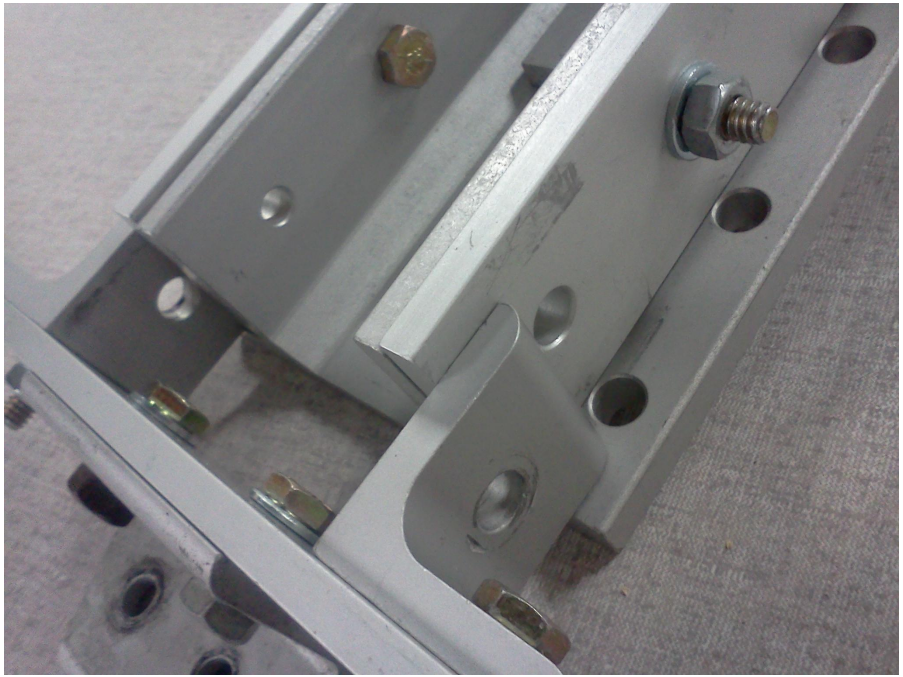

Fig. 1. Third version of Custom Fixture, 6061 Aluminum.

Results: Shear and Direct Normal Testing

Shear

Ultimate: 6,348 psi

Direct Normal Test

Ultimate Strength:

5,551 psi

Yield: 1,196 psi

Elongation

11.4% normal tension

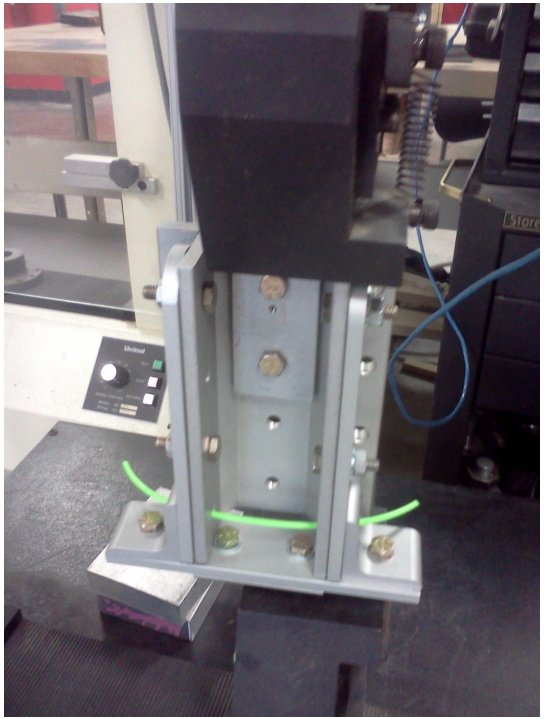

Fig. 2. Custom Fixture in UTM, holding ABS for Shear Testing.

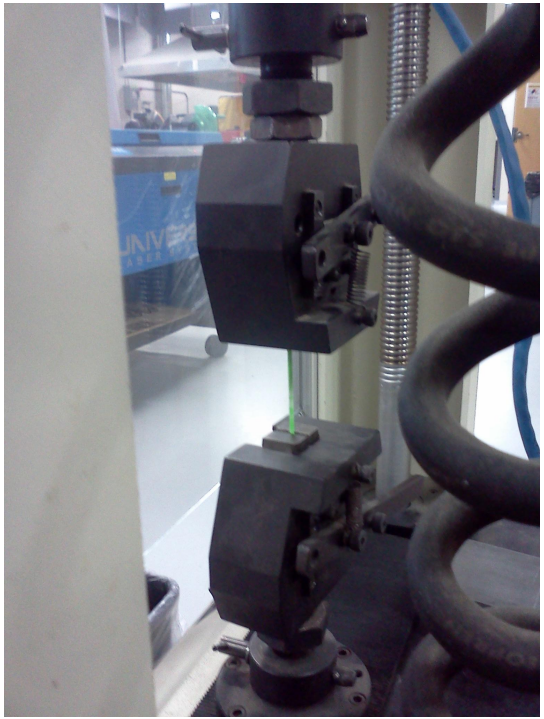

Fig. 3. ABS held in UTM for testing Direct Normal for Tension.

Comparison of Materials

From Directions:

For ABS: (Modified per Sisk, Source: MatWeb)

1) Su = 3,210 to 7,110 psi
2) Sy = 1,890 to 9,430 psi

For Steel: (Original directions)

1) Sus = 0.82 Su (pg. 721)
2) Sys = 0.5 Sy (pg. 721, with N = 1)

Our Findings:

For ABS:

1) Sus = 6,348 psi = 1.14 (5,551psi)
2) Sys = 4,769 psi = 3.98 (1,196psi)

Conclusion and Interpretation

Polymers

- Polymers are more ductile than metal
- With 11.4% elongation, ABS yields easily, but has a proportionally larger range from yield to full fracture compared to metals.
- Would not have guessed that it took more force to shear ABS then to pull it apart (might be because of orientation of polymer chains)

Testing Changes to Consider

- Retesting with different diameter ABS
- Retesting with different density ABS
- Use of transparent material for jig to observe yielding behavior in shear.
- Use of extensiometer on jig to observe strain in shear orientation. (Not required per Sisk.)
    - Would need mounting directly to clamps for direct normal stress testing comparison.

References

Mott, Robert L. *Applied strength of materials - 5th ed*. Upper Saddle River, N.J: Pearson/Prentice Hall, 2008. Print.

“Overview of Materials for Acrylonitrile Butadiene Styrene (ABS), Extruded.” Overview of Materials for Polycarbonate, Extruded, www.matweb.com/search/DataSheet.aspx?MatGUID=3a8afcddac864d4b8f58d40570d2e5aa.

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