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EMCH 316
Lab #4

Prediction of Yielding
For General States of Stress

OBJECTIVE: To predict the yielding experienced by an aluminum 6061 pipe for general states of stress.

PROCEDURE

1. Record the outer diameter and the wall thickness of the aluminum tube.
2. Insert the longer section of an end plug in each of the openings of the tube, if not done correctly the specimen will be damaged and can be dangerous.
3. Now place the specimen into the torsion machine and close it with the grips placed together. Make sure that the full length of the grips is holding and tighten them until the specimen is engaged. These grips tighten automatically under load, no need to tighten them too much.
4. Record the gauge length of the specimen, which is the distance between the machine's grips.
5. Now rotate the hand crank until a small initial torque is indicated on the gauge. That angular displacement will be set to zero, and everything else will be relative to this zero.
6. Keep twisting the specimen by 4-degree increments until the relative angular displacement is 40 degrees. Record the angle and torque values.
7. Unload the specimen and remove it from the machine.
   Note: Further displacement than 40 degrees will yield the tube too much which will cause it to buckle, and the end plugs will jam in the tube.

DATA AND RESULTS

Table 1. Specimen dimensions.

Outer Diameter, O.D.	**25.3 mm**
Wall Thickness, t	**2.24mm**
Gauge Length, Lo	**360 mm**

Table 2. Angle/ Torque data.

Torque (in-lb)	Torque (Nm)	Angle (degrees)
80	9.0384	4
340	38.4132	8
680	76.8264	12
1000	112.98	16
1400	158.172	20
1720	194.3256	24
1940	219.1817	28
2040	230.4792	32
2100	237.258	36
2120	239.5176	40

ANALYSIS OF DATA

Figure 1. Torque vs Angle of Twist

- Determination of 0.2% offset angle of twist:

$$\theta(0.2\%) = \frac{\gamma Lo}{ro} = 0.002 * 360 * \frac{2}{12.65 + 12.65 - 2.24} = 0.06244579358\,rad$$

- Shear Yield Strength: 276 MPa
- T= 240 Nm
- Experimental: τmax = (T) / (2π*r^2t) = 132MPa
- DET: τmax = (σy) /1⁄2 = 159.34 MPa
- MSST: τmax =(σy)/2= 276 MPA/2= 138 MPa

Figure 2. MSST and DET Yield Envelopes

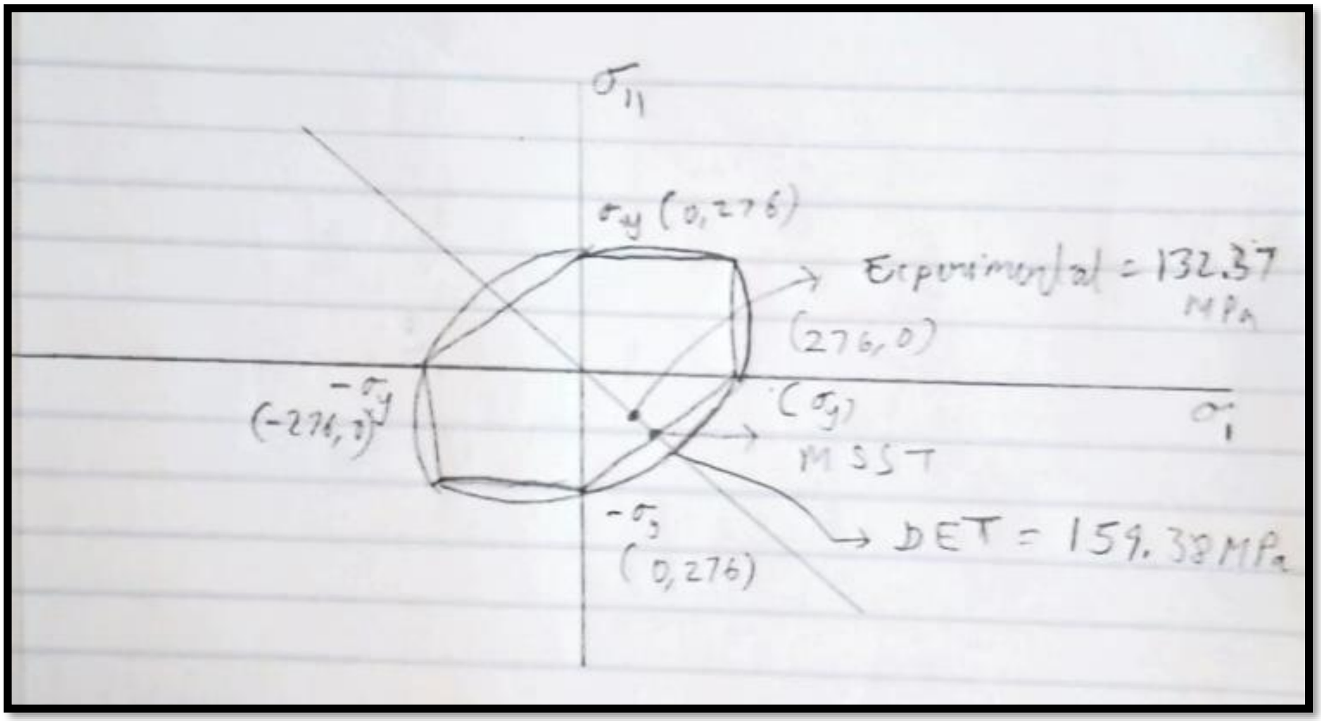

Table 3. Summary of shear yield strengths.

Method	Shear Yield Strength (MPa)
DET	**159.34 MPa**
MSST	**138 MPa**
Experimental	**132 MPa**

MSST is closer.

DISCUSSION OF RESULTS

1. Based on this experiment, explain which theoretical shear yield strength seems to be more accurate for your results.
    a. After calculating and computing MSST value was closer to the experimental value calculated from the experiment. The value calculated was in the stress envelopes of both DET and MSST.
2. Postulate why a thin-walled tube was used in this experiment as opposed to a solid bar. Use illustrations of the shear stress distribution to support your argument.
    a. Thin-walled tube uses lesser material, and it can also show the inner and outer layer forces in the tube as equal. It basically is a more efficient way of doing this experiment. Several tubes can be made instead of one solid rod.

CONCLUSIONS

In this lab we used an aluminum 6061 tube and we performed an experiment to find the yielding by using a turning wheel machine. We discovered that the experimental value that we calculated is closer to the MSST value rather than being closer to DET which would be a little unsafe.