Experiment 1: Uniaxial Tensile Test

PAGE NO.:
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Aim: ~~a)~~ To determine the following in an uniaxially loaded mild steel and aluminium ~~p~~ ~~sep~~ specimen
a) The maximum tensile strength
b) The modulus of elasticity
c) Percentage reduction in cross section
d) Construction of the true-stress vs strain ~~c~~ curve

Experimental methods:
The instruments used are
a) The Universal Testing Machine (UTM):
This machine measures the load on the specimen during the experiment. The machine has a capacity of 100 kN. It is called universal because tension, compression, bending and shear test can be performed on the same machine. The load frame consists of two strong supports, the load cells measure reaction force and an output device displays the results.

b) Extensometer:
This is used to measure strain. It contains two ~~mechanical~~ lever arms, which are bound to the specimen using an elastic band. The relative motion of the arms is recorded by an amplifier circuit, which gives a voltage output which is then converted to displacement using a calibration sheet.

c) Vernier Caliper:
It is a length measuring device using to measure diameter of the specimen.

The stress-strain curve varies with temperature and the loading rate; hence we keep room temperature and strain rate = 1mm/min constant.
The UTM measures the load on the specimen. This divided by the area gives us the stress.
The extensometer measures the displacement which divided by the length gives us the strain.

Results

Given the extension and load values we use the following formulae:

$$\sigma = \frac{Load}{Area} \qquad \epsilon = \frac{Elongation}{Length}$$

Engineering Stress and Engineering Strain: (σ_e and ϵ_e)

We calculate the ~~Eg~~ Engineering Stress by dividing the load by the initial area. Engineering Strain can be found by dividing extension by original length

Young's Modulus:

We interpolated a polynomial of degree 1 as plots are non linear

Young's Modulus of Aluminium = 59.963 GPa

Young's Modulus of Steel = 201.231 GPa

Percentage Elongation of Length:

% Elongation of Aluminium specimen = 9.4%

% Elongation of Steel Specimen = 5.6%

Percentage Change in Area:

% reduction in area of Aluminium Specimen = 77.23%

% reduction in area of Steel Specimen = 52.59%

Ultimate Tensile Stress: (UTS)

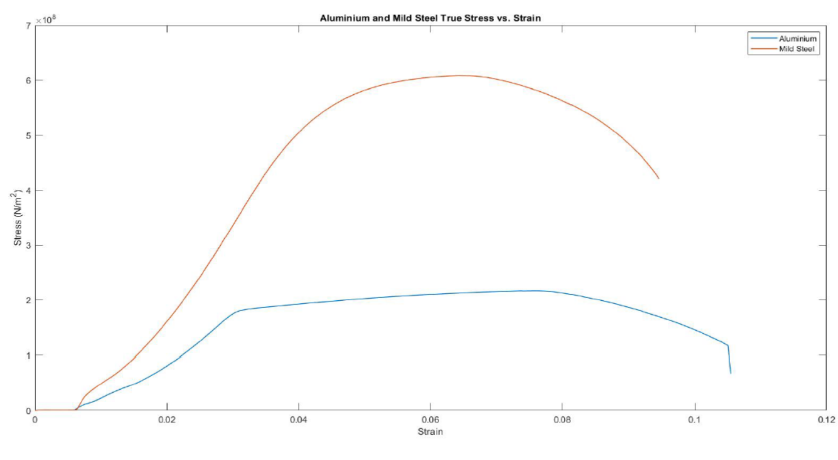
This is the stress that pushes materials from state of uniform plastic deformation to local concentrated deformation. Necking phenomenon begins at this point

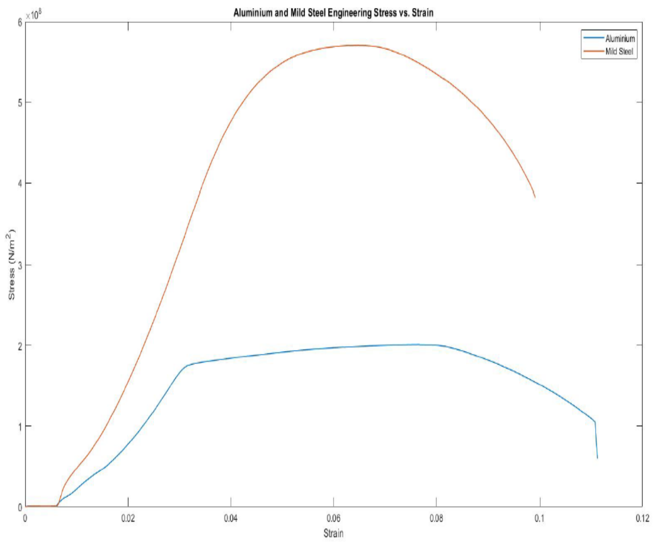
UTS for Aluminium = 0.201 GPa

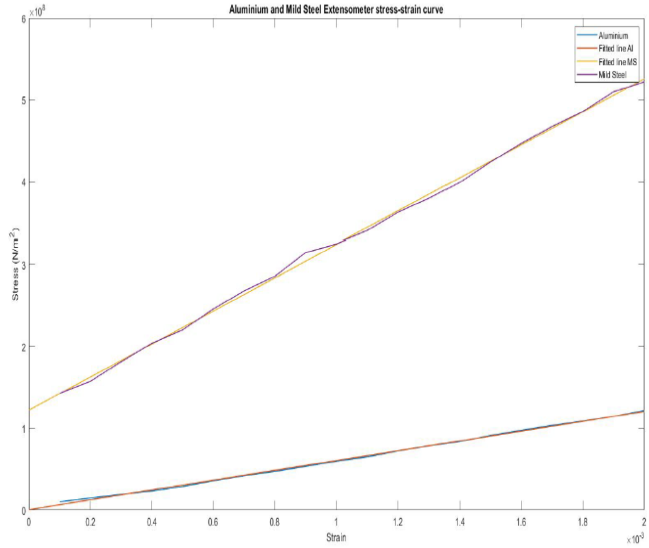
UTS for steel = 0.570 GPa

True Stress and Strain:

$$\sigma_t = \sigma_e(1+\epsilon_e) \qquad \epsilon_t = \log(1+\epsilon_e)$$







Observations :

We observe substanial necking in the specimen ~~where~~ when stress approaches the UTS value. The necking does not occur at the middle of the specimen, which is expected. This might be due to manufacturing defects. After the necking starts, the load is no longer uniaxial and data is inaccurate.

After a point, the specimen breaks with a banging sound and an elongation in length as well as reduction in area is observed. This is more for aluminium, suggesting it is more ductile compared to steel.

Comparing documented values :

Aluminium has Young's Modulus of 70 GPa while we found it to be 59.963 GPa

Mild Steel has Young's Modulus of 207 GPa while we found it to be 201.831 GPa

On observing stress strain data, we conclude

Yield Stress of Aluminium = 173.3 MPa

Yield Stress of Steel = 347.2 MPa