Report:

Title: Uniaxial compression test

1. Objective

To perform compression test and determine,

(a) Measure the machine compliance to ensure accurate data acquisition.
(b) Determine the compressive flow strength of the sample at approximately 10% strain.
(c) Calculate the Young's modulus in compression and construct the complete true stress vs. true strain curve.

2. Experimental Method(s):

(a) Measure the dimensions of the steel and aluminum test specimens at three different points along their height/length to determine their average cross-sectional area (A_0) and length (h).
(b) Confirm that the specimen is in the shape of a right circular cylinder.
(c) Position the specimen centrally between two compression plates, ensuring that the centre of the movable head is directly above the centre of the specimen.
(d) Apply a constant velocity load to the specimen by moving the movable head.

3. Results and Calculations:

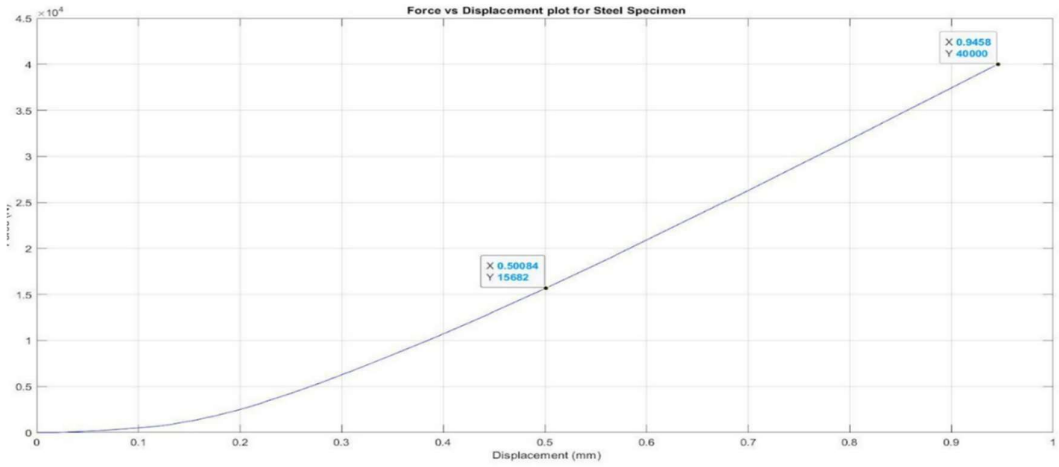
$$C_{system} = \frac{1}{slope\ of\ F\ vs\ s\ graph\ of\ system} \qquad K = \frac{F}{\Delta L} = \frac{AE}{L} \text{ so } C_{steel} = \frac{1}{k} = \frac{L_{steel}}{A_{steel} \cdot E_{steel}}$$

For Aluminium:	For Mild Steel:
• Initial Diameter Do (Al) = 12.7 mm	• Initial Diameter Do (MS) = 20 mm
• Initial gauge length Lo (Al) = 19.05 mm	• Initial gauge length Lo (MS) = 10 mm
• Final Diameter Df (Al) = 12.97 mm	• Final Diameter Df (MS) = 20 mm
• Final gauge length Lf (Al) = 18.55 mm	• Final gauge length Lf (MS) = 10 mm
• Initial Area (Al) = 126.68 mm^2	• Initial Area (MS) 314.16 mm^2
• Final Area (Al) = 132.12 mm^2	• Final Area (MS) = 314.16 mm^2

For Steel Specimen:

Using Esteel = 210 GPa and Lsteel and Asteel from the measured values,

$$C_{steel} = \frac{1}{k} = \frac{L_{steel}}{A_{steel} \cdot E_{steel}} = \frac{10 \times 10^{-3}\ m}{\pi \frac{(20 \times 10^{-3})^2}{4}\ m^2 \times 210 \times 10^9\ Pa} = 1.158 \times 10^{-10}\ m\ N^{-1}$$

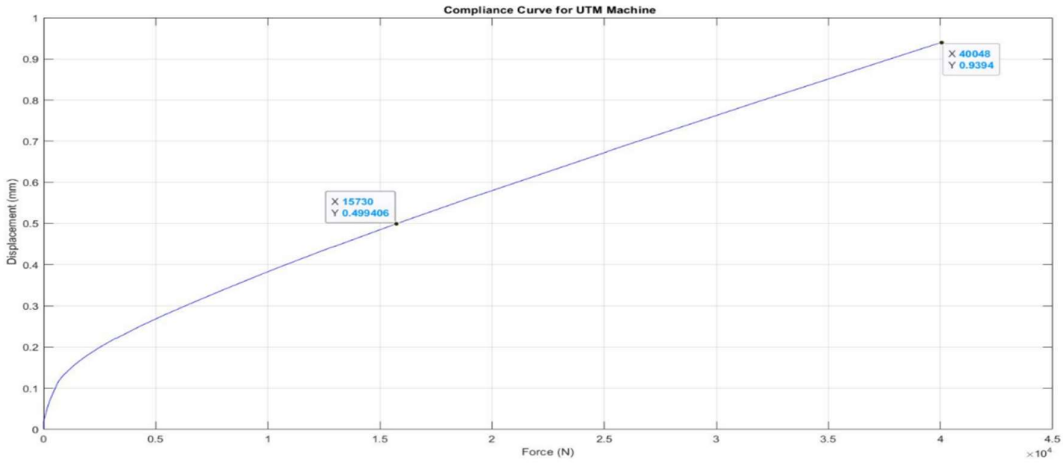


Slope of the Force vs Displacement Graph for Steel Specimen= 54652 . 10356 N mm^{-1}:

$$C_{system} = \frac{1}{slope\ of\ F\ vs\ s\ graph\ of\ system} = \frac{10^{-3}}{54652.10356}\ m\ N^{-1} = \mathbf{1.8298 \times 10^{-8}\ m\ N^{-1}}$$

Using $C_{system} = C_{machine} + C_{sample,} \Rightarrow C_{machine} = 1.8146 \times 10^{-8}\ m\ N^{-1}$

Percentage Increase in Length and Cross-Sectional Area = **0%** (as there was no change in initial & final values)

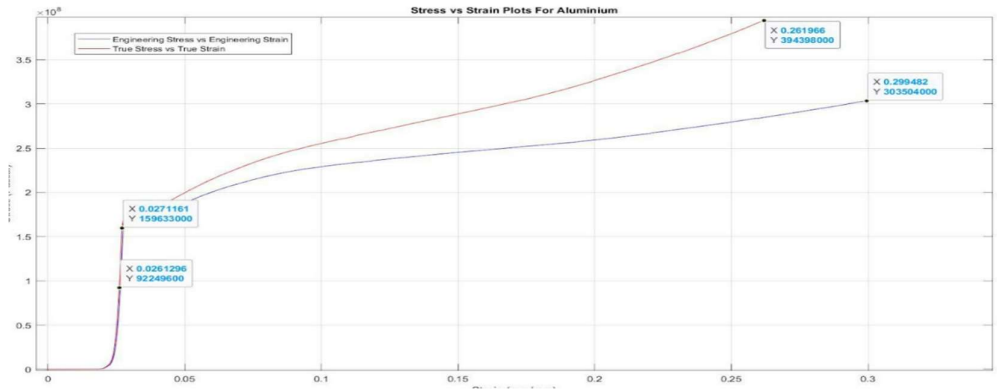


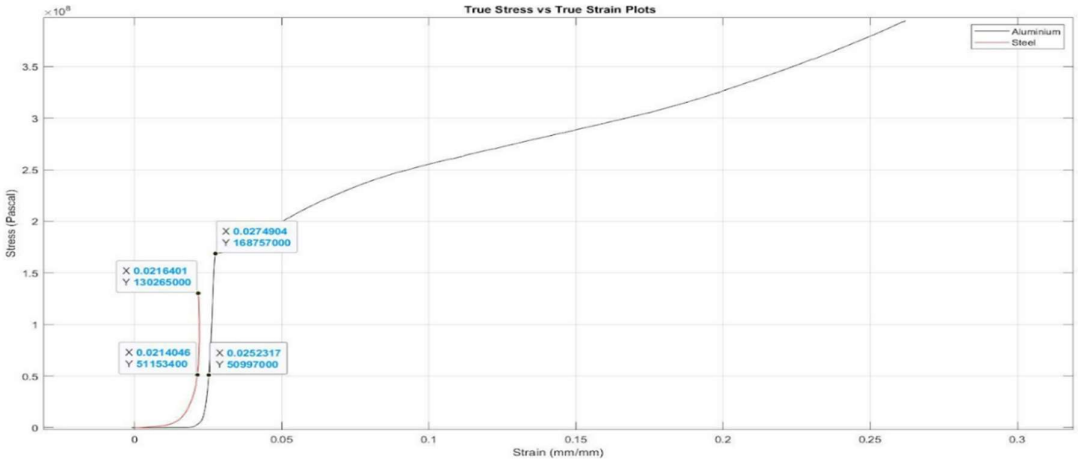
For Aluminium Specimen

Young's Modulus of Aluminium (Eexp)= Slope of Linear Region of True Stress - Strain Curve =

$$: \frac{159633000 - 92249600}{0.0271161 - 0.0261296} = 68.313\ GPa$$

Actual Young's Modulus of Aluminium (Eth) = 69 GPa.
% Error in Young's Modulus Obtained Experimentally =(Eth – Eexp)/Eth x100
= (69 -68.313)/69 =1%
Percentage Decrease in Length = (19.05-18.55)/19.05 = 2.62%
Percentage Increase in Cross-Sectional Area = (132.12-126.68)/132.12 = 4.11%





4. Analysis/observations/discussion

(a) As the load is applied, steel remained in the elastic limit while Aluminium undergo plastic deformation. (Evident from the true stress – strain plot of both the materials)

(b) Young's Modulus of Steel is greater than that of Aluminium.

5. Summary/conclusions.

(a) The deflection behavior of a structural component is largely determined by its Young's modulus, and aluminium exhibited a higher level of ductility compared to mild steel.

(b) Minor deviations between the experimental and target values can be attributed to instrument error and variations in atomic structure properties of the materials.

(c) The failure of the specimen during the test can be influenced by the presence of any defects in the specimen or rod.

(d) The measured material qualities of the tested specimens were found to be within a few percentage points of their stated values. These results indicate the accuracy and reliability of the testing method used.

(e) **Sources of error**:

(a) Material of the Test Specimen may not be Homogenous.
(b) Human Error in the measurement of the dimensions of the samples.
(c) Additional strain may get added up due to the use of grease.
(d) The test specimen might not be placed centrally between the compression plates.
(e) Error may arise due to high loading speed of Universal Testing machine.