E2: Uniaxial compression test

1. **Objective:**
   To perform compression test and determine,
   (a) The machine compliance.
   (b) The compressive flow strength at ~10% strain of an aluminum sample.
   (c) The Young's modulus in compression and the complete true stress vs. true strain curve.

2. **Theory/Background (related to the experiments):**

   Compressive loads are commonly applied to machine and structural components such as columns and struts. The Bauschinger effect refers to the differences in properties that may occur when a material is subjected to compressive loads as opposed to tensile loads. For most isotropic materials, tension, compression, and torsion experiments are critical for determining the stress-strain relationship and characterizing the material's constitutive response. The failure mechanisms in metals under compression are typically different from those under tension, and often involve buckling, shear banding, and diametric cracking (in less ductile materials). Conducting compression experiments is also a preferred method for studying the stress-strain behaviour of isotropic materials due to their smaller specimen size and ease of preparation.

   In this experiment, you will examine the response of a ductile aluminum alloy to uniaxial compression by performing two compression tests. The first test will be conducted on a steel sample with a known elastic modulus and high yield strength, and will be loaded below the proportional limit. By plotting the displacement versus force for the machine, you will be able to determine the compliance of the testing machine (UTM) and calculate the specimen's deformation using the elastic modulus and specimen geometry. The second test will be performed on an aluminum sample of unknown elastic modulus and constitutive behavior, and you will extract the force versus displacement curve. Finally, you will use the compliance data obtained from the steel specimen experiment to construct the true stress versus true strain curve for the aluminum sample.

3. **Equipment Required:**
   (a) The Universal Testing Machine with compression platens
   (b) Grease
   (c) Vernier Caliper
   (d) Scale
   (e) Aluminum and steel samples.

4. **Experimental Method:**
   (a) Determine the average cross-sectional area (A_0) and length (h) of the steel and aluminum test specimens by measuring their dimensions at three different points along their height/length.
   (b) Ensure that the shape of the specimen is a right circular cylinder.
   (c) Position the specimen centrally between the two compression plates so that the centre of the movable head is directly above the centre of the specimen.
   (d) Apply load to the specimen by moving the movable head at a constant velocity.

5. **Expected outcomes:**
   (a) Plot the machine compliance curve for the machine, i.e., force vs. displacement.
   (b) Plot the stress-strain curve for steel and aluminium specimens and compare.
   (c) From the stress- strain curve, calculate the value of Young's modulus in GPa of aluminum
   (d) Find the percentage reduction in length and increase in cross-section area.
   (e) Compare the experimental value of modulus with the value given in data book for aluminum
   (f) Comment on your observations during the experiment, data analysis, errors, uncertainty in the measurement of Young's modulus of aluminum.