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R E S E A R C H U N I V E R S I T Y

CIVIL ENGINEERING DEPARTMENT

TENSILE TEST

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Section / Group		
Lecturer's Name		

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TENSILE TEST

1.0 Objective

The main objectives for this test are to determine the yield stress, tensile stress, Young Modulus and behavior of a mild steel bar when subjected to an axial tensile load.

2.0 Theory

If a test specimen is subjected to an axial load P , as shown in Figure 1, and if the load is increased in increments from zero to the point of fracture, and the stress and strain are computed at each step, a stress-strain curve as shown in Figure 2 can be plotted.

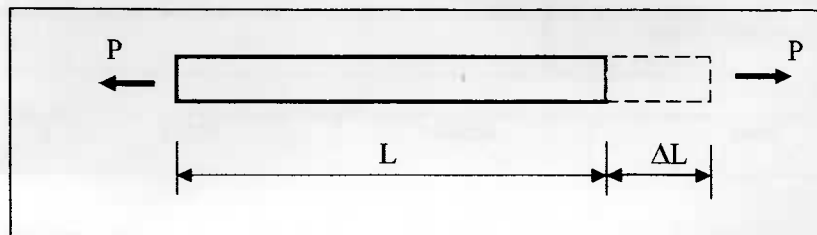


Figure 1

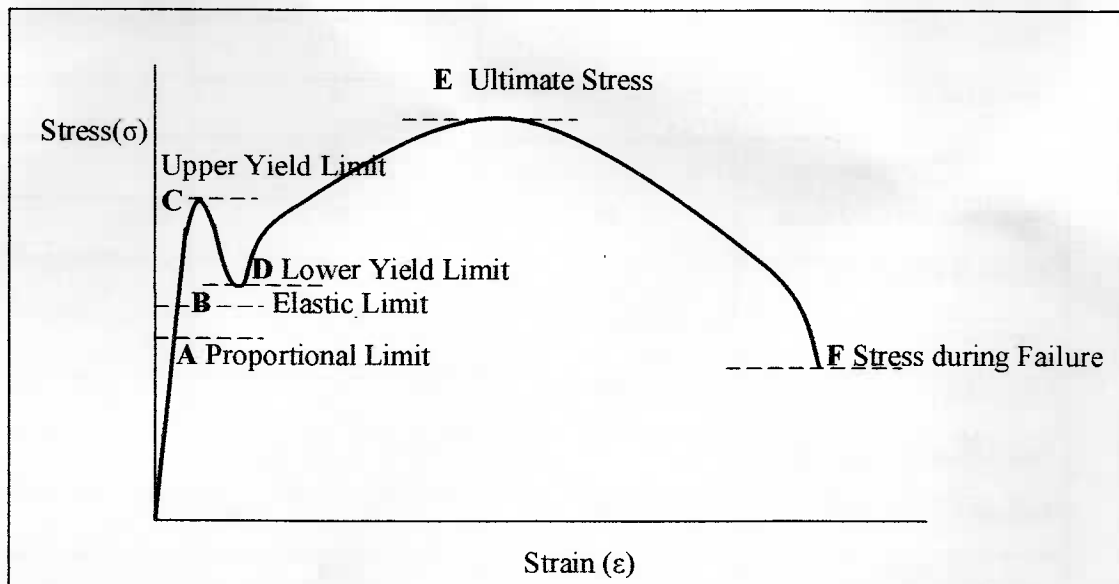


Figure 2

The curve is typical of class of steel known as mild steel. The relationship between stress and strain is linear up to proportional limit, the material is said to follow Hooke's Law until point A, namely Proportional Limit. After this point, Hooke's Law wouldn't happen although the material has an Elastic Characteristic. The B point called Elastic Limit. The elastic limit of the material is a stress that lies between the proportional limit and the upper yield point (Point C). Up to this stress, the specimen can be unloaded without permanent deformation; the unloading will be along the linear portion of the diagram, the same path followed during loading. This part of the stress-strain diagram is called the elastic range. However, the Elastic limit (point B) is seldom determined, since it is very close to the Proportional Limit (point A) and therefore rather difficult to detect.

A peak value, the upper yield point (Point C), is quickly reached after that, followed by leveling off at the lower yield point (Point D). At this stage of loading, the test specimen continues to elongate as long as the load is not removed, even though the load cannot be increased. This constant stress region is called the plastic range.

When a further load is applied to the specimen, the curve will rise continuously but became flatter until it reaches a maximum stress referred as the Ultimate Stress (Point E). Throughout the test, while the specimen is elongating, its cross-sectional area will decrease. At the Ultimate Stress (Point E), the cross-sectional area begins to decrease in a localized region of the specimen, instead of over the specimen's entire gauge length. This phenomenon is caused by slip planes formed within the material, and the actual strains produced are caused by shear stress. As a result, a constriction or neck gradually tends to form this region

Since the cross-sectional area within this region is continually decreasing, the smaller area can only carry an ever-decreasing load. Hence, the stress-strain diagram tend to curve downward until the specimen breaks at the Fracture Stress (Point F).

3.0 Equipment

1. SHIMADZU 300kN Universal Test Machine (UTM)
2. Series IX Application Software for 3300 Series Load Frames
3. Specimen
4. Measurement apparatus : Venier Calipers, Steel ruler

4.0 Procedure

1. Measure the diameter of the specimen at 3 various places and calculate the average.
2. Mark a 50 mm gauge length on the specimen.
3. Fix the specimen to the machine by pushing the top grip upwards and inserting the specimen into the bottom grip.
4. Apply the load slowly.
5. Record the reading of the load cell and the stroke.
6. Remove the specimen from the grips and join back the broken halves together and measure the final “gauge” length, and the diameter at the broken section.

5.0 Results

Specimen diameter = mm

Cross sectional area = mm²

Specimen Gauge Length (L) = mm

Table 1

[illegible]

Table 2 : Experimental Data

Element	Start experiment	End experiment
Diameter of specimen (mm)		
Area, A (mm ²)		
Gauge length, L (mm)		

1. From the table, plot the graph of Stress versus Strain and mark :

- (i) Upper yield point
- (ii) Lower yield point
- (iii) Maximum load
- (iv) Break point load

2. From the stress-strain graph, determine:

- (i) Elastic Modulus (E) = (N/mm²)
- (ii) Upper yield limit = (N/mm²)
- (iii) Lower yield limit = (N/mm²)
- (iv) Absolute tensile strength = (N/mm²)
- (v) Elastic Limit = (N/mm²)
- (vi) Elongation, e = (%)
- (vii) Reduction cross-sectional area = (%)

6.0 Calculation

a) Determination of Elastic Modulus (E)

$$\text{Elastic Modulus, (E)} = \frac{\text{Stress } (\sigma)}{\text{Strain } (\epsilon)}$$

OR

Elastic Modulus, (E) = Slope of Graph

$$\text{Stress } (\sigma) = \frac{\text{Load (P)}}{\text{Cross sectional Area (A)}}$$

$$\text{Strain } (\epsilon) = \frac{\text{Change in Length } (\Delta L)}{\text{Gauge Length (L)}}$$

b) Determination of Tensile Strength

- i) Maximum load from the table = kN
- ii) Tensile Strength = $\frac{\text{Maximum Load (P}_{\text{max}})}{\text{Original Area (A)}}$

c) Calculate Reduction In Area

- Original Area (A) = mm²
- Area at breakage (A₁) = mm²
- Percentage reduction in area = $\frac{(A) - (A_1)}{(A)} \times 100\%$ mm²

d) Calculate the percentage of elongation, e

- Gauge length (l) = 50 mm
- Gauge length at breakage (L₀) = mm
- Percentage of elongation, e = $\frac{(L_0) - (l)}{(l)} \times 100\%$

7.0 Questions/Discussions

- a) State the significant of tensile test in civil engineering
- b) Compare the stress-strain curve between mild steel and high yield steel