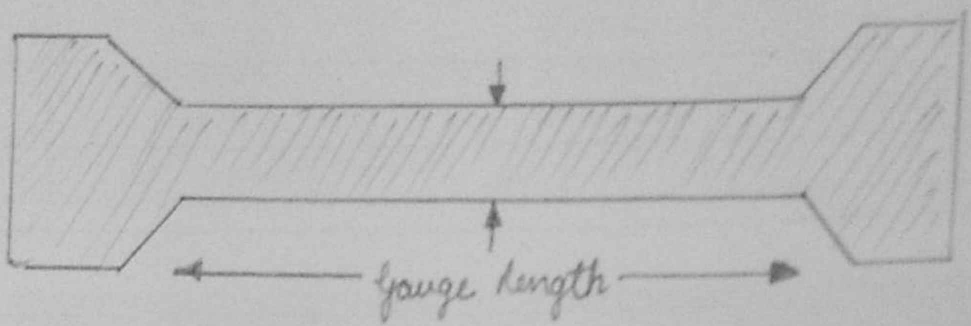
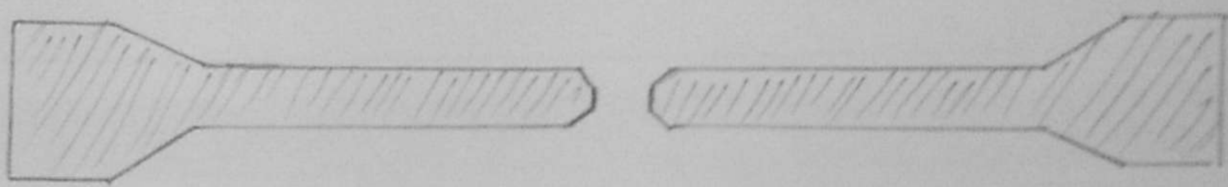


SPECIMEN



SPECIMEN AFTER FRACTURE

EXPT. NO. 1

i-

TENSILE TESTING

● **Objective:** To perform the tensile test and measure the following material properties to compare with data obtained directly from the Universal Testing Machine

a) Young's Modulus (from curve)

b) Upper and lower yield point

c) Percentage of elongation

d) Ultimate strength

e) Breaking strength

f) Modulus of toughness

g) Modulus of resilience (from curve)

● **Apparatus:** 600 KN hydraulic controlled Universal Testing Machine (Tinius Olsen), Vernier Callipers, scale.

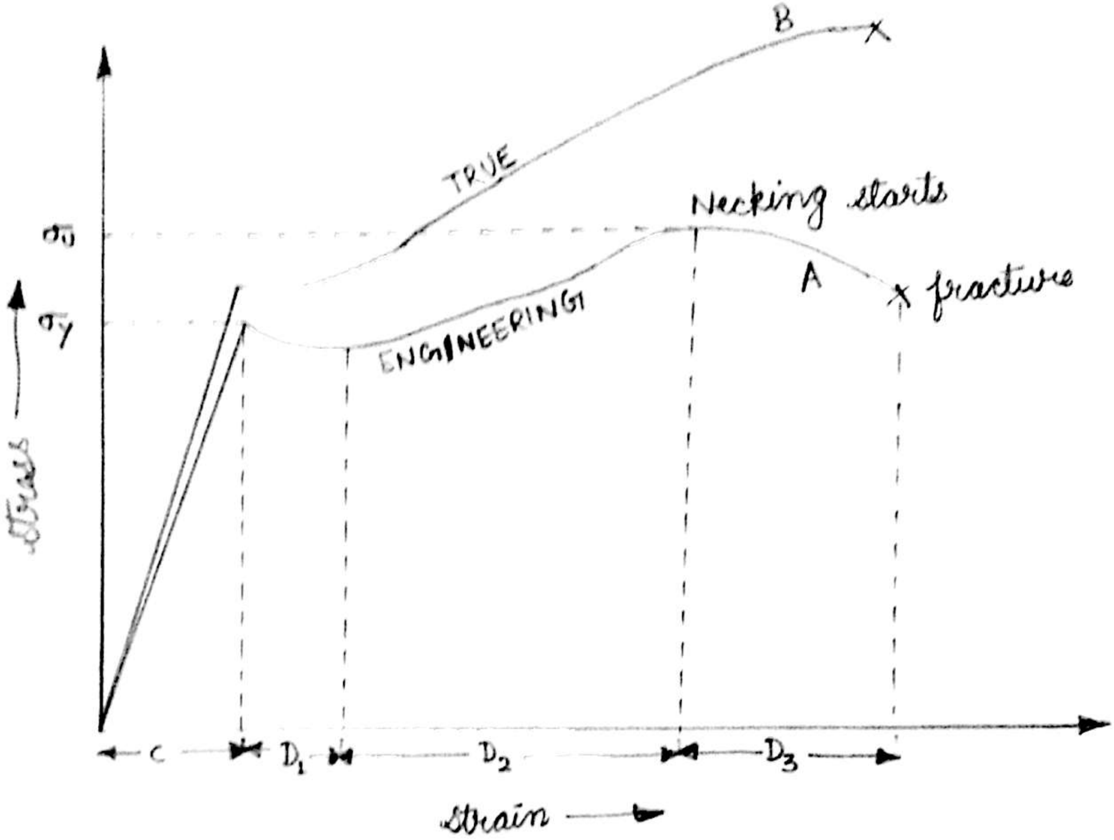
● **Theory:** Engineering strain is the ratio of the deformation to the initial dimension of the material body which undergoes a force application.

$$e = \frac{L_f - L_0}{L_0} = \frac{\Delta L}{L}$$

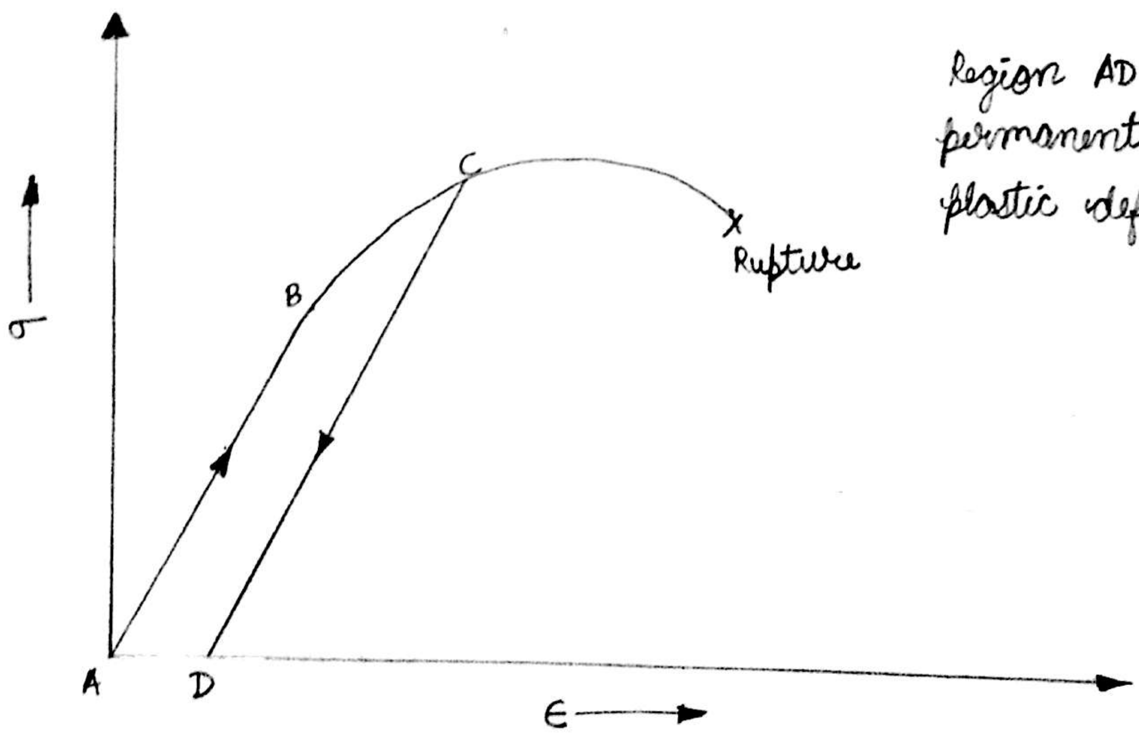
e = engineering normal strain

Engineering stress is calculated by dividing the load P by the cross-sectional area A_0 measured before any deformation has taken place.

$$S = \frac{P_0}{A}$$



STRESS - STRAIN CURVE



Region AD represents permanent strain or plastic deformation.

STRAIN HARDENING

True stress is instantaneous in nature and is defined using the instantaneous values of length / dimension and infinitesimal changes.

$$\bar{\epsilon} = \int_{L_0}^{L_f} \frac{dL}{L} = \ln \frac{L_f}{L_0}$$

After necking $d\bar{\epsilon} = -\frac{dA}{A}$ or $\boxed{\bar{\epsilon} = \ln \frac{A_0}{A_f}}$

True stress is $\sigma = \frac{P}{A_t}$, where A_t = instantaneous area. The difference in engineering and true stress becomes apparent in ductile material after yield point.

$$\bar{\sigma} = k\bar{\epsilon}^n$$

This is the power law expression approximated from true stress - true strain curve.

$$\bar{\epsilon} = \ln(1+e) ; \quad e = \exp(\bar{\epsilon}) - 1$$

since, total mass is constant in specimen

$$A_0 L_0 = A_t L_t \Rightarrow \frac{A_0}{A_t} = \frac{L_t}{L_0}$$

Now, true stress, $\bar{\sigma} = \frac{P}{A_t} = \frac{P_0}{A_0} \cdot \frac{A_0}{A_t} = s\frac{L_t}{L_0} = s(1+e)$

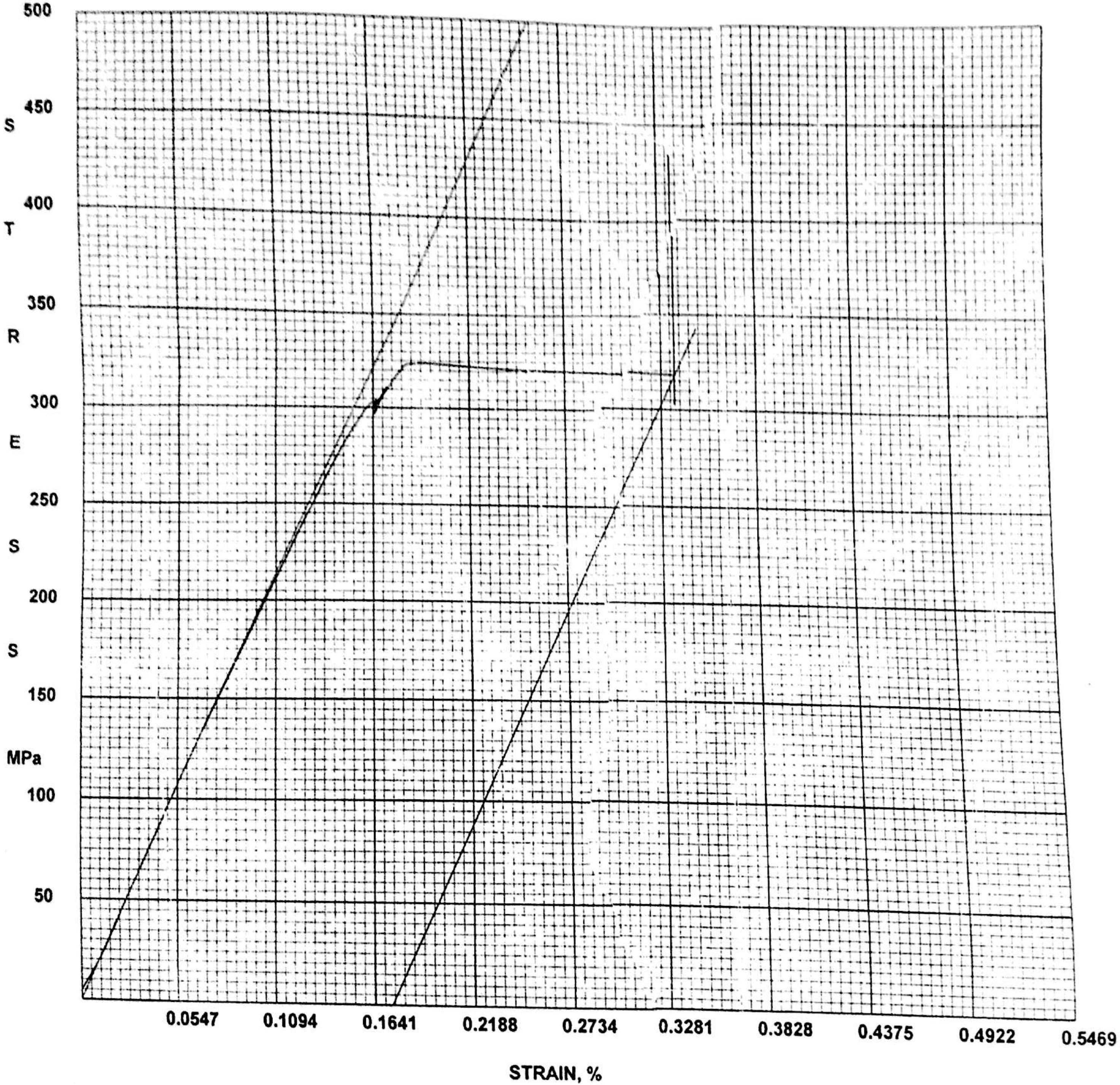
$$= s(\exp(\bar{\epsilon}))$$

➤ <u>Modulus of Resilience:</u>

Strain energy that gives an index of the material's ability to store or absorb energy without permanent deformation

$$\boxed{U_y = \frac{\sigma_y^2}{2E}}$$

GRAPH - 1



Indian Institute of Technology
Kharagpur
Dept of Mechanical Eng
India

<u>Metals Tensile w/ Ext.</u>

Lot Number	1
Operator	Biswajit
Test Setting	Metal Tensile round bar (with extensometer)
Test Date	09/29/2016
Sample:	MS
Sample No.:	1
Diameter, mm:	13.1870
Area, mm²:	136.6
Modulus, N/mm²:	195500
Ultimate, kN:	59.3
Ultimate, N/mm²:	435
Yield, MPa:	303
Yield, N:	41400
Break, N:	43100
Break, MPa:	316

$\frac{320}{0.1641} \times 10$

DATE	
29/9/16	
EXPT. NO.	1

➤ **Modulus of Toughness**

strain energy that gives an index of the material's ability to absorb energy upto fracture.

$$U_T = \frac{E\epsilon_R^2}{2}$$

➤ **Strain Hardening**

After the elastic limit, due to strain hardening, we get to the yield point and an increase in load bearing capacity beyond the yield point.

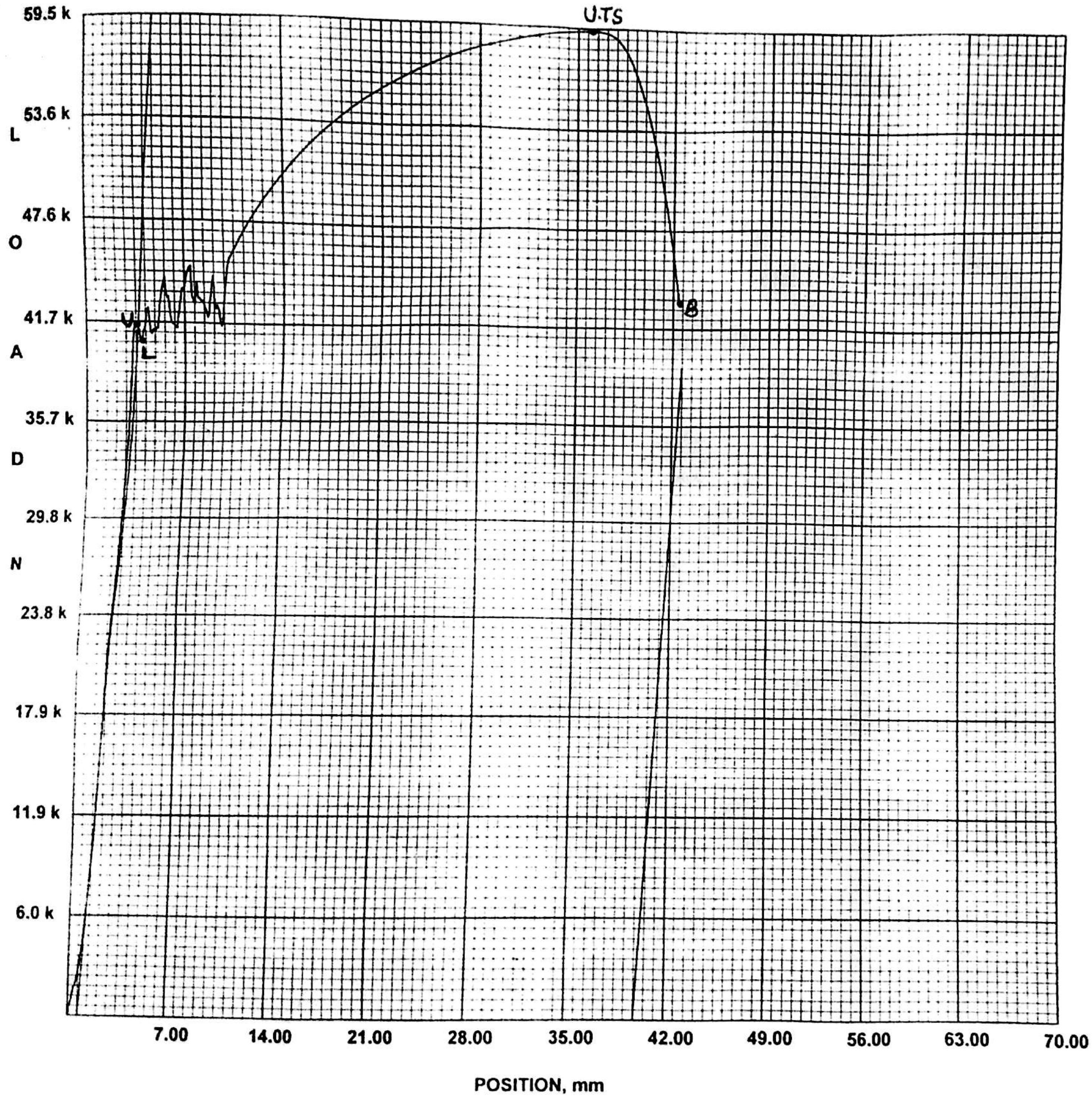
Procedure:

1. The specimen is fit into the UTM securely to prevent slipping.
2. The gauge length and diameter are noted down.
3. The extensiometer is fit on the specimen and before unlocking it all quantities on the display are forced to zero.
4. The gauge length and diameter are fed to the computer program and the rate of extension is set.
5. The process starts and the computer program automatically plots graphs until fracture.
6. Once upper yield point has been crossed, the extensiometer is removed as the modulus of elasticity needs only to be calculated in the elastic region.

Observations:

Material of the rod: Mild steel

GRAPH-2



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. NO.

Diameter of the rod: 13.187 mm

Initial gauge length: 197.6 mm

Final gauge length: 240.3 mm

Material Properties	From Machine	From Curve
Young's Modulus	1.955×10^5 N/mm^2	1.95×10^5 N/mm^2
Upper Yield Point	303 MPa	305.27 MPa
Lower Yield Point	—	296.48 MPa
% of elongation	21.609 %	21.609 %
Ultimate Strength	435 N/mm^2	435.578 N/mm^2
Breaking Strength	316 N/mm^2	318.228 N/mm^2
Modulus of Toughness	4564.55 MPa	4552.88 MPa
Modulus of Resilience	234.805 KPa	238.948 KPa

Discussions:

- It helps us to have a clear idea about the elasticity, elongation, stress, strain, modulus of elasticity and their co-relation with each other.
- It has many applications in several fields of technology like Automotive Industry, shear and tensile strength testing of fastners.
- After it had fractured (the specimen), the surfaces of the metal were rough, the two halves being in the shape of "cup and cone".
- Ductile materials fracture due to shearing, this is the reason necking occurs as the crack formation is transverse to the axis.