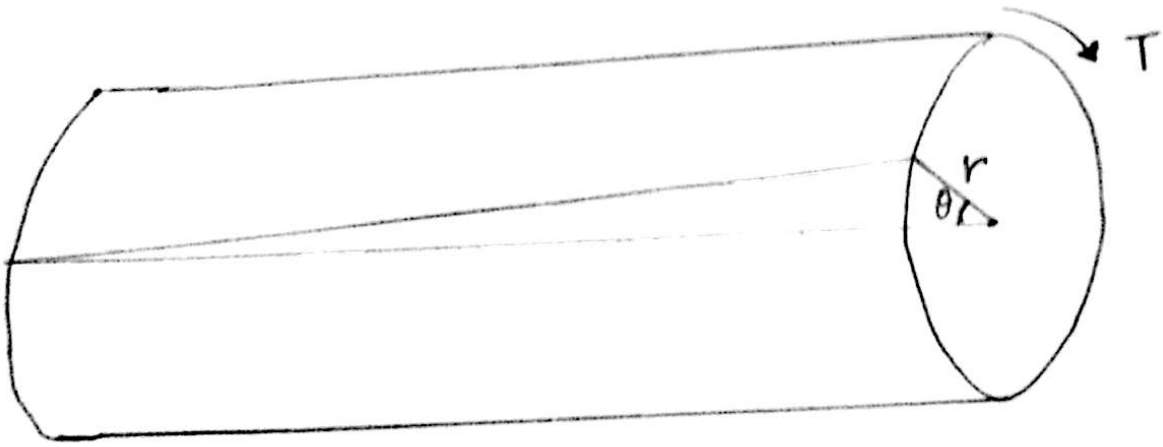
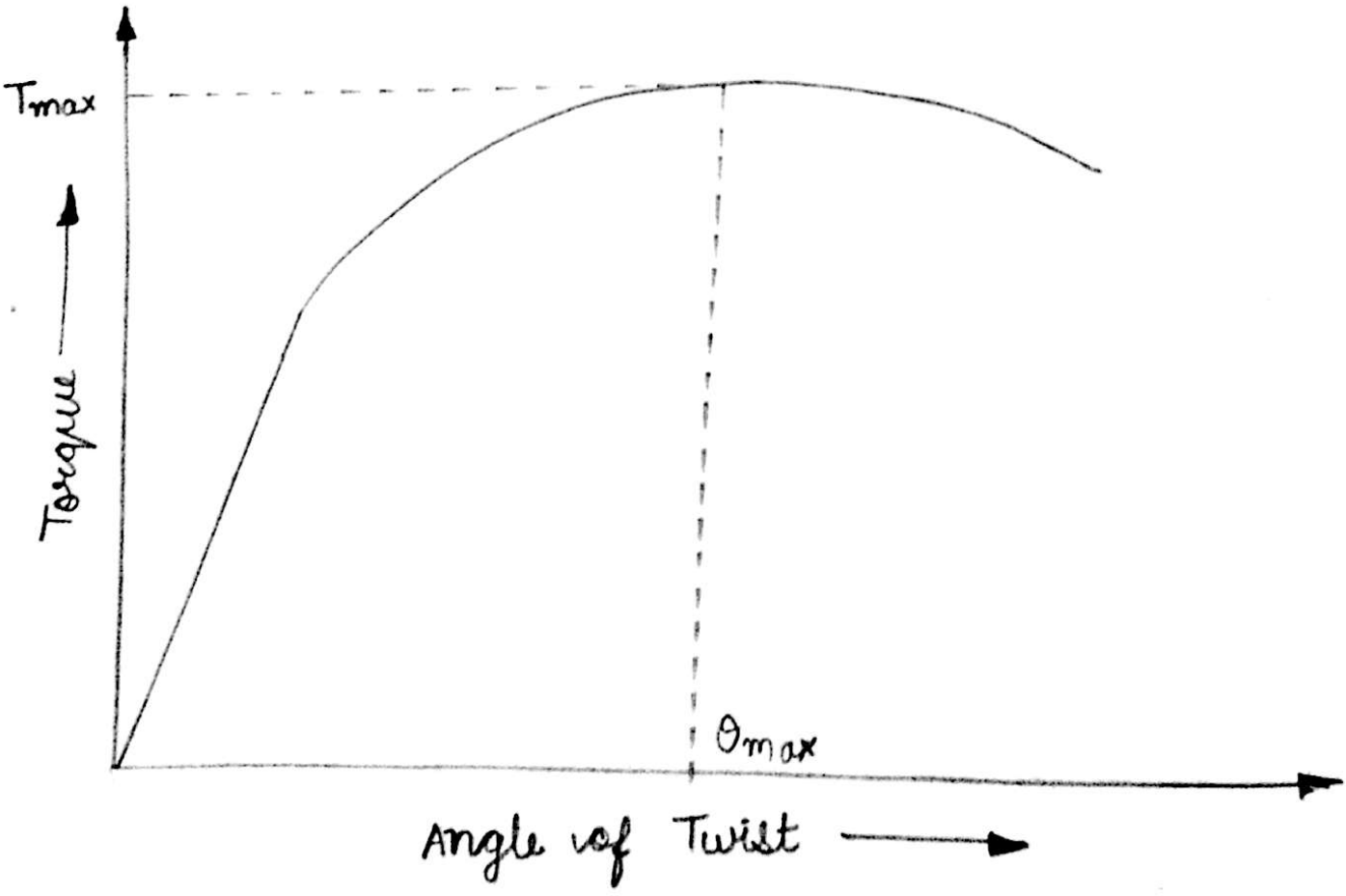


APPLICATION OF TORQUE ON A SOLID BAR



PLOT B/W TORQUE AND ANGLE OF TWIST

TORSION TEST

Objective: To measure the shear modulus of the given specimen by performing a torsion test.

Apparatus Required:
- Electronic torsion testing machine (225 Nm)
- Vernier Callipers
- Mild steel specimen

Theory: Torsion testing machines use an electrical motor and gear drive to apply a torque to the cylindrical specimen. The specimen is gripped on both ends, with one end remaining stationary and other rotated by the motor. Combining this twisting information with the applied ~~voltage~~ torque, we are able to determine the mechanical properties of the specimen

TORQUE: The torque is the product of tangential force multiplied by the radial distance from the twisting axis and the tangent.

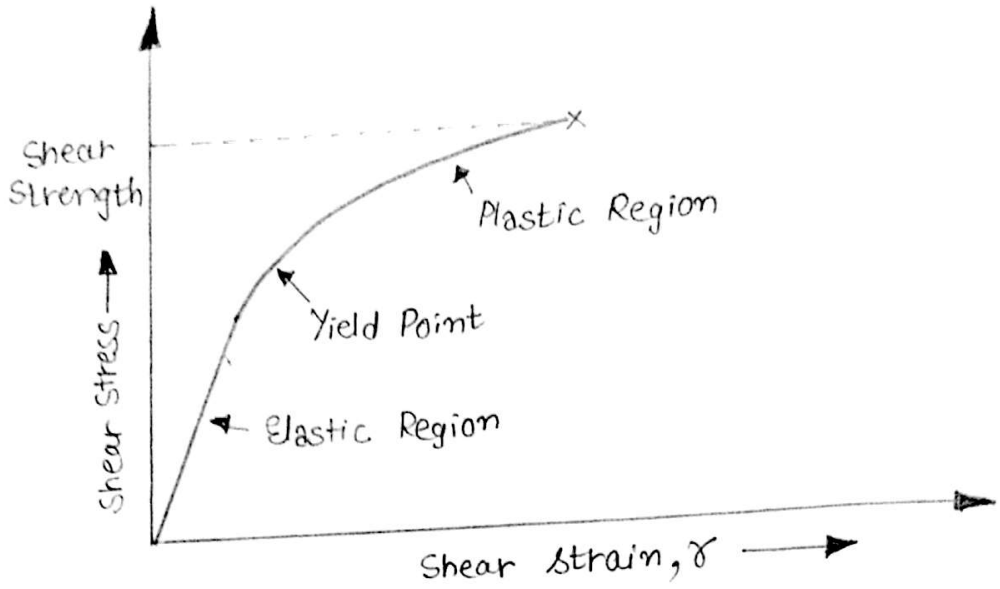
TORSION: Torsion is twisting of an object due to an applied torque.

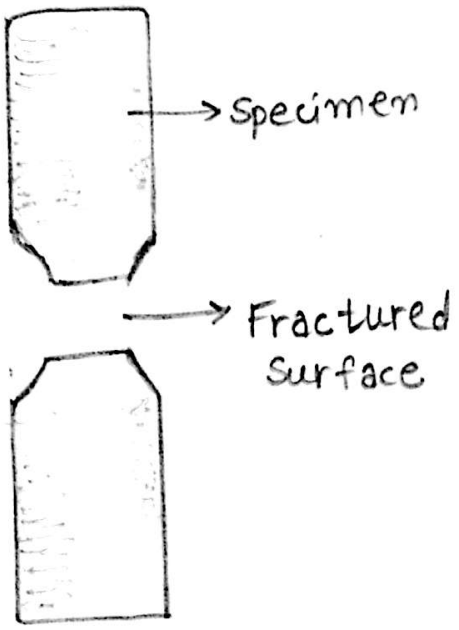
From the general torsion theory for circular specimen

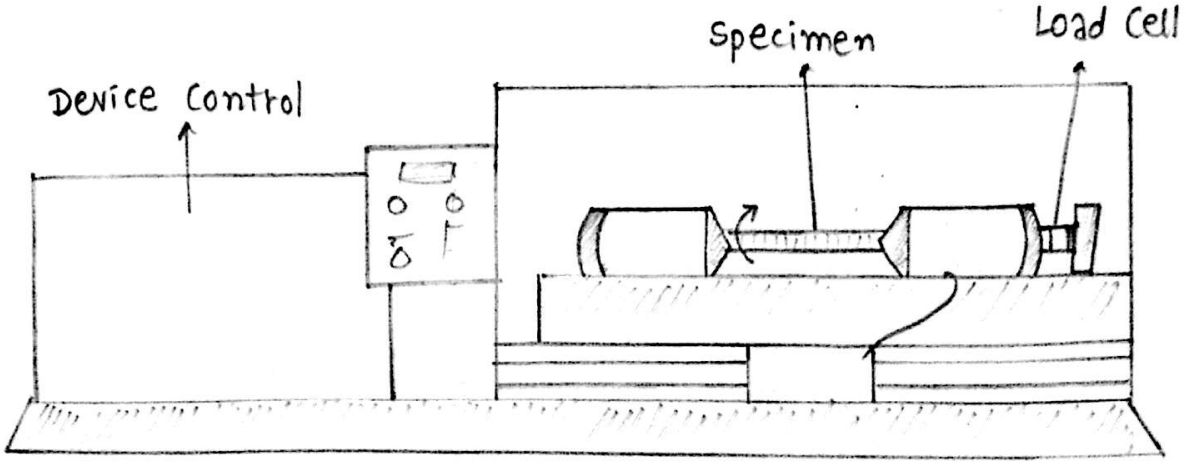
$$\frac{T}{J} = \frac{G\theta}{L}$$

where T → Applied torque (Nm)

J → Polar Moment of Inertia (mm^4)







TORSION TESTING MACHINE

G → Modulus of Rigidity (N/mm^2)
θ → Angle of Twist (rad)
L → Gauge length (mm)

For a cylindrical specimen,

$$J = \frac{\pi D^4}{32}$$ where D → diameter of specimen

MODULUS OF RUPTURE: Ultimate strength determined in a torsion test, i.e. the maximum shear stress in the extreme fibre of a circular member at failure.

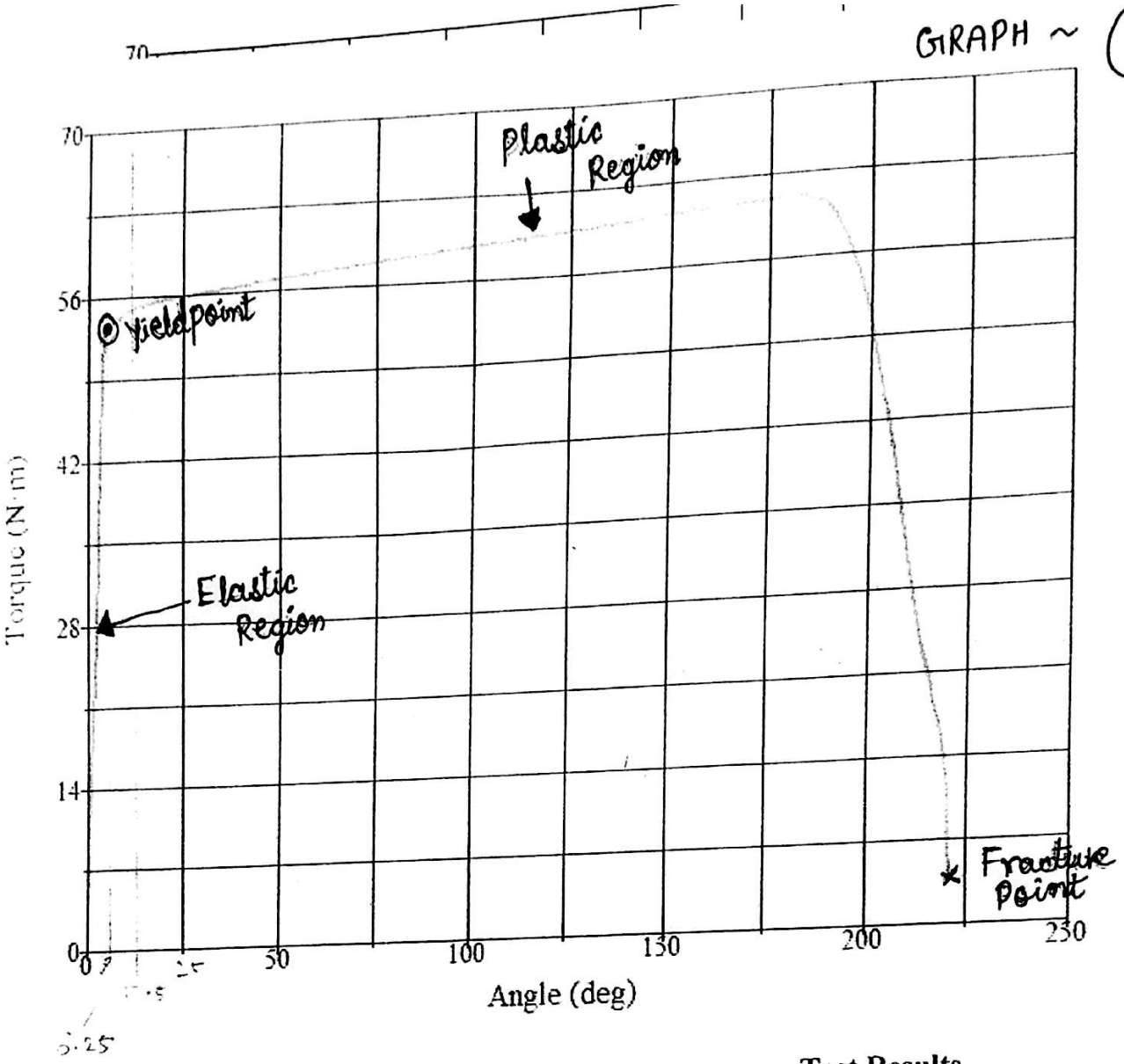
Procedure:

1. Initial gauge length of the specimen is measured. This is done by measuring the length thrice and then taking the average value. Similarly, the diameter of the specimen is also measured.
2. The specimen is gripped on the torsion testing machine using the sockets.
3. The dimensions are fed into the computer program which controls the testing operation.
4. The twisting was started with a constant rate of 35°/min
5. A graph is plotted between the angle of twist and applied torque with the help of machine.
6. This test is continued until the specimen fractures.

Observations and Calculations:

Gauge Length = 32 mm

GRAPH ~ (1)



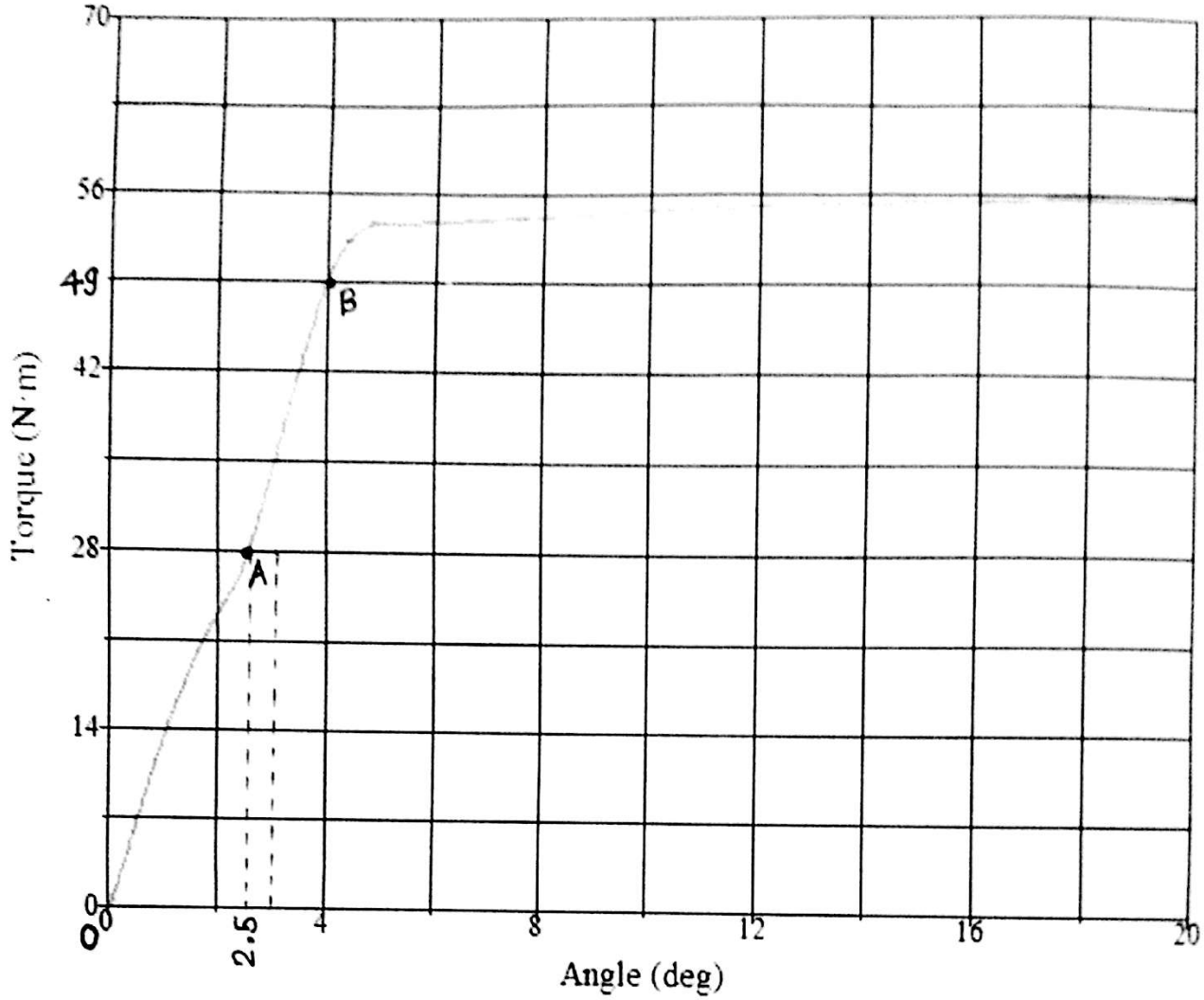
Test Summary

Counter:	64
Elapsed Time:	00:06:20
Procedure Name:	Test unit
Start Date:	10/6/2016
Start Time:	2:26:10 PM
End Date:	10/6/2016
End Time:	2:32:30 PM
Workstation:	HP-PC
Tested By:	Default
Coil:	1

Test Results

Peak Torque:	60.9100 N·m
Peak Angle:	221.1212 deg
Peak Time:	379.2000 s
Torque at Break:	3.8400 N·m
Angle at Break:	221.0624 deg
Time at Break:	379.0998 s
Torque at Peak Torque:	60.9100 N·m
Angle at Peak Torque:	180.0532 deg
Time at Peak Torque:	308.8002 s
Shear Modulus G:	14.2168 GPa
Specimen Gage Length:	0.0320 m
Automatic Modulus:	8.6169 N·m
Torque at AEL:	55.2000 N·m
Angle at AEL:	14.5625 deg
Time at AEL:	25.0998 s
Area:	0.0859 in²
Diameter:	0.0084 m

GRAPH ~ (2)



Test Summary

Counter:	64
Elapsed Time:	00:06:20
Procedure Name:	Test unit
Start Date:	10/6/2016
Start Time:	2:26:10 PM
End Date:	10/6/2016
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Time at AEL:	25.0998 s
Area:	0.0859 in²
Diameter:	0.0084 m

Initial diameter = 8.41 mm = Avg (8.4 + 8.44 + 8.39) mm

$J = \frac{\pi D^4}{32} = 491.11\ mm^4$

We know, $\frac{T}{J} = \frac{G\theta}{L} \Rightarrow G = \frac{L}{J}\left(\frac{T}{\theta}\right)$

$\frac{T}{\theta}$ = slope in elastic region

① For the entire elastic region, (OB) (shown in graph ①)

$\frac{T}{\theta} = \frac{49\ Nm}{4^\circ}$

$\therefore G = \frac{0.032}{\frac{\pi \times (0.00841)^4}{32}} \times \frac{49}{\frac{\pi}{180} \times 4}\ \frac{N}{m^2}$

$= 45.95\ GPa$

② For a linear segment AB (shown in the graph ②)

$\frac{T}{\theta} = \frac{21\ Nm}{1.5^\circ}$

$\therefore G = \frac{0.032}{\frac{\pi \times (0.00841)^4}{32}} \times \frac{21}{\frac{\pi}{180} \times 1.5}\ \frac{N}{m^2}$

$= 52.26\ GPa$

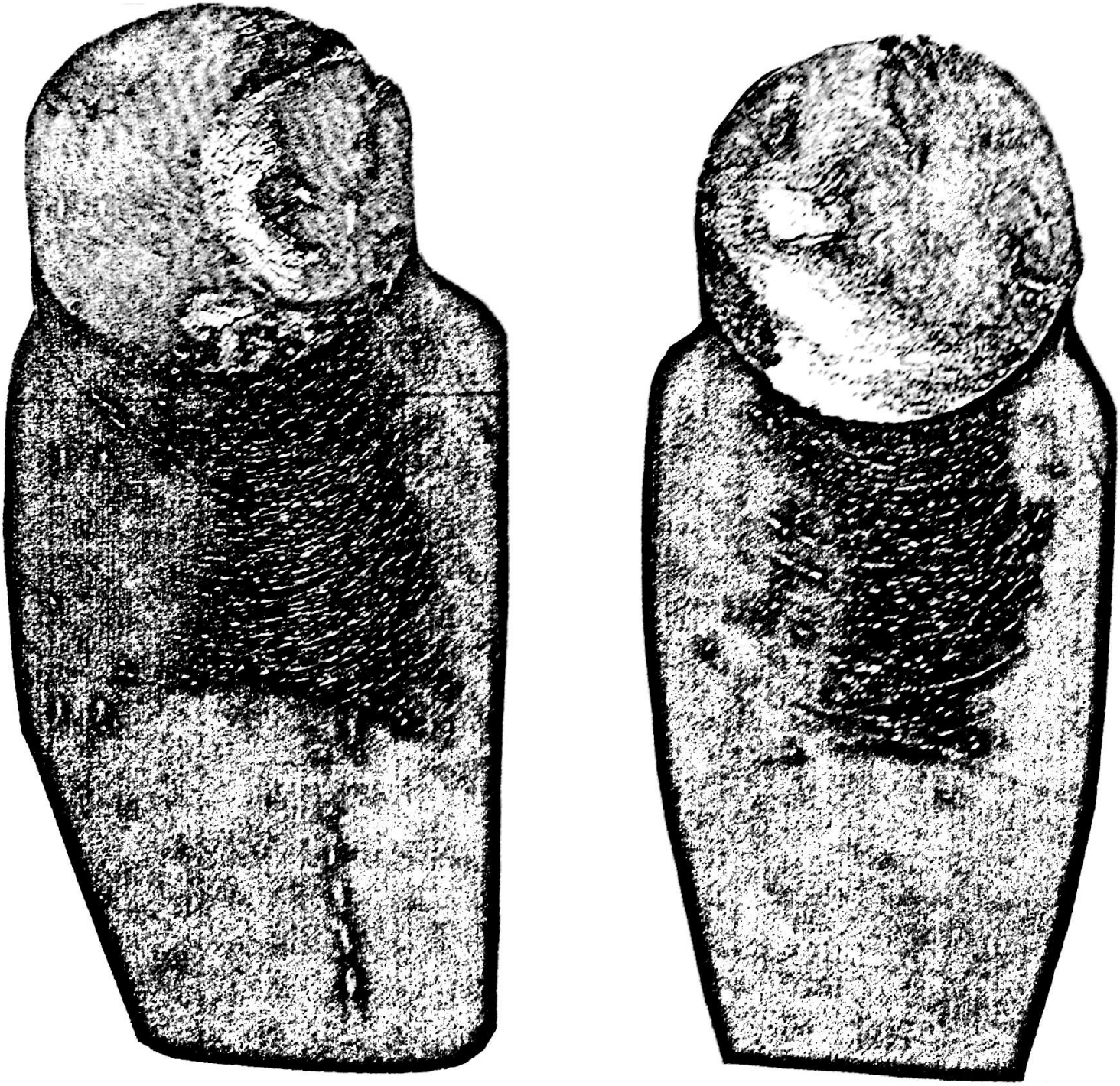
③ For linear segment OA, G = 41.81 GPa

∴ Avg ②, ③ = 47.03 GPa

⑤ Discussions:

➤ The machine is called torsion testing machine because of its tendency to measure various parameters like torque, angle, energy, time through which we can find modulus of rigidity

➤ The machine has only one transducer named load cell. The limit-



HIGH RESOLUTION IMAGE OF FRACTURED SURFACES

DATE 6/10/16

PAGE NO. 8

EXPT. NO. 2

-ing value or safe limit of load cell used is 225 Nm.

- Servo motor is used to rotate or twist the specimen at one end. Also, no slipping of the gripper is assumed.
- The fracture of the specimen was perpendicular to the axis and hence this indicates that the material used is ductile.
- The fracture forms outwards and moves inwards. No necking is observed unlike tensile testing.
- Increasing the guage length increases the time of the experiment (duration).