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**MECHANICS OF SOLID
*(lab)***

PRACTICAL NOTE BOOK

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Experiment # 2

Measurement of strain in a steel bar

Apparatus

- UTM (Universal Testing Machine)
- Steel bars
- Vernier Calliper
- Ruler

Procedure:

- Prepare a test piece
- Measure the diameter of test piece or test specimen at least at three points by screw gauge or vernier calipers, and determine the mean value
- I marked the gauge length on test piece, that is, two marks on test specimen at 8 inch apart
- I inserted suitable jaws for gripping test piece and selected a suitable scale on UTM for applying load
- I started the machine and continue applying loads until specimen break. Then I stopped the machine
- I measured the elongation in gauge length by joining two broken pieces
- Then I calculated strain dividing elongation by original length, that is, 8 inch

Exp # 2

Observation and calculations:

Gauge length = 8 inch

S No	Diameter of Bar	Elongation	Yield	Ultimate	Strain	Yield Strength=Yield Load / Area	Tensile Strength=Yield Load / Area
1	½ in	1 in	5.9	9.28	0.125	67132.04 Psi	104352.26 Psi
2	½ in	1 1/8 in	4.87	7.65	0.140	54650.20 Psi	86023.46 Psi
3	½ in	5/8 in	5.47	8.11	0.078	61509.62 Psi	91196.12 Psi
4	½ in	1 1/8 in	5.43	8.31	0.140	61095.8 Psi	93445.10 Psi

As diameter of bar is = ½ in

Therefore, Area= $\pi /4(1/2)^2 = 0.196$

Yield Load = $5.97*2204=13157.88\text{lbs}$

Now, yield strength = Yield Load / Area = $13157.88 / 0.196$

So Yield Strength = **67132.041**

Now, Tensile Load = $9.28*2204=20453.12$

Tensile Strength = $20453.12/0.198=104352.65$

Experiment # 1

Measurement of yield or tensile strength in a steel bar

Apparatus

- UTM (Universal Testing Machine)
- Steel bars
- Vernier Caliper
- Ruler

Universal Testing Machine:

A machine design to perform tension, compression, shear and bend tests is called universal testing machine or UTM

It mainly consist of two parts

- One is the strainly unit
- Other is the load measuring machine.
- In addition to these two, there are certain accessories such as for gripping test piece, recorders, bending table etc

Procedure:

- Prepare a test piece.
- Measure the diameter of test piece or test specimen at least at three points by screw gauge or vernier calipers, and determine the mean value.
- I marked the gauge length on test piece, that is, two marks on test specimen at 8 inch apart.
- I inserted suitable jaws for gripping test piece and selected a suitable scale on UTM for applying load.
- Continue applying the loads and take the reading at the yield point.
- Also note peak or ultimate value.
- Calculate the yield strength dividing yield load by original area.
- Calculate the tensile strength dividing tensile load by original area.

Exp # 1

Observation and calculations

Gauge length = 8 inch

ASTM Standard

Strength	Grade 40	Grade 60	Grade 75
Minimum Yield Strength	40,000 Psi	60,000 Psi	75,000 Psi
Maximum Yield Strength	60,000 Psi	90,000 Psi	1,00,000 Psi

S No	Dia of Bar	Yield Load(Tons)	Ultimate Load(Tons)	Area of Bar, $A = \frac{\pi D^2}{4}$	Yield Strength=Yield Load *2204/ Area	Tensile Strength= Yield Load*2204/ Area
1	½ in	5.97	9.28	0.196 in ²	67132.04 Psi	104352.65 Psi
2	½ in	4.86	7.65	0.196 in ²	54650.20 Psi	86023.46 Psi
3	½ in	5.47	8.11	0.196 in ²	61509.62 Psi	91196.12 Psi
4	½ in	5.43	8.313	0.196 in ²	61059.85 Psi	93445.10 Psi
5	1/8 in	7.05	10.95	0.306 in ²	50778.43 Psi	78868.62 Psi

Elongation = 9.8 – 8 = 1.9

Experiment # 3

Investigation of Hook's Law

Apparatus

- UTM (Universal Testing Machine)
- Test Specimen (Steel Bar)
- Extensometer
- Divider
- Vernier Caliper
- Measuring Scale

Theory:

According to the Hook's Law:

“Stress is directly proportional to the strain within elastic limit.”

Mathematically

Where **E** is constant of proportionality and is known as *Modulus of Elasticity*

Procedure:

- Prepare a test piece.
- Measure the diameter of test piece or test specimen at least at three points by screw gauge or vernier calipers, and determine the mean value.
- I marked the gauge length on test piece, that is, two marks on test specimen at 8 inch apart.
- I inserted suitable jaws for gripping test piece and selected a suitable scale on UTM for applying load.
- Continue applying the loads and take the reading at the yield point.
- Also note peak or ultimate value.
- Calculate stress on rupture point and ultimate point
- Then calculate strain dividing elongation by the gauge length.

Exp # 3

Observation and calculations

Gauge length = 8 inch

S No	Dia of Bar	Load(Tons)	Elongation	Area of Bar	Stress = Load/Area	Strain= Elongation/Gauge Length
01	3/4 in	3.68	0 in	0.441 in ²	8.34 Psi	0
02	3/4 in	6.84	0 in	0.441 in ²	15.51 Psi	0
03	3/4 in	10.28	0 in	0.441 in ²	23.31 Psi	0
04	3/4 in	10.72	1/8 in	0.441 in ²	24.30 Psi	0.0156
05	3/4 in	11.82	3/16 in	0.441 in ²	26.80 Psi	0.0234
06	3/4 in	12.04	1/4 in	0.441 in ²	27.30 Psi	0.031
07	3/4 in	13.04	5/16 in	0.441 in ²	29.56 Psi	0.039
08	3/4 in	13.78	7/16 in	0.441 in ²	31.24 Psi	0.054
09	3/4 in	14.34	9/16 in	0.441 in ²	32.51 Psi	0.070
10	3/4 in	14.88	11/16 in	0.441 in ²	33.74 Psi	0.085
11	1/2 in	12.6 (Rupture)	----- -	0.196 in ²	64.28 Psi	----- -
12	1/2 in	15.86 (Ultimate)	2 1/4 in	0.196 in ²	80.91 Psi	0.218

Experiment # 4

Bent Test on Steel Bar

Apparatus

- UTM (Universal Testing Machine)
- Test Specimen (Steel Bar)
- Certain accessories like Bending Table, Supports, Pins etc

Purpose

To check whether the specimen that we are using in a structure is brittle or ductile, or whether it is suitable for reinforcement or other purpose of construction.

Procedure:

- Prepare a test piece.
- Place the specimen in bend test apparatus in such a position that the plane intersecting the longitudinal ribs is parallel to the axis of the pin
- Apply force to the test specimen continuously and uniformly throughout the bending operation
- Discontinue the application of force, the angle of bend specify the material
- Examine the tension surface of the specimen for cracking. If there are no cracks, then the material is suitable for construction

Exp # 4

Specification for Angel in Bend Test:

Bar # 3 to Bar #11 should bend up to 180° without crack
Bar # 14 & Bar # 18 should bend upto90° without crack

This all specification has been given in **AASHTO** (American Association for Sate Highway and Transportation Officials)

Bend Test Requirements:

Bar No	Grade 40	Grade 60	Grad 75
3, 4, 5	3 ½ d _b	3 ½ d _b	-----
6	5 d _b	5 d _b	-----
7, 8	-----	5 d _b	-----
9, 10	-----	7 d _b	-----
11	-----	7 d _b	7 d _b
14, 18	-----	9 d _b	9 d _b

Experiment # 5

Measurement of Deflection in a Statically Determinate Bar

Apparatus:

- Model of beam
- Loads
- Deflection gauge
- Load hanger

Purpose:

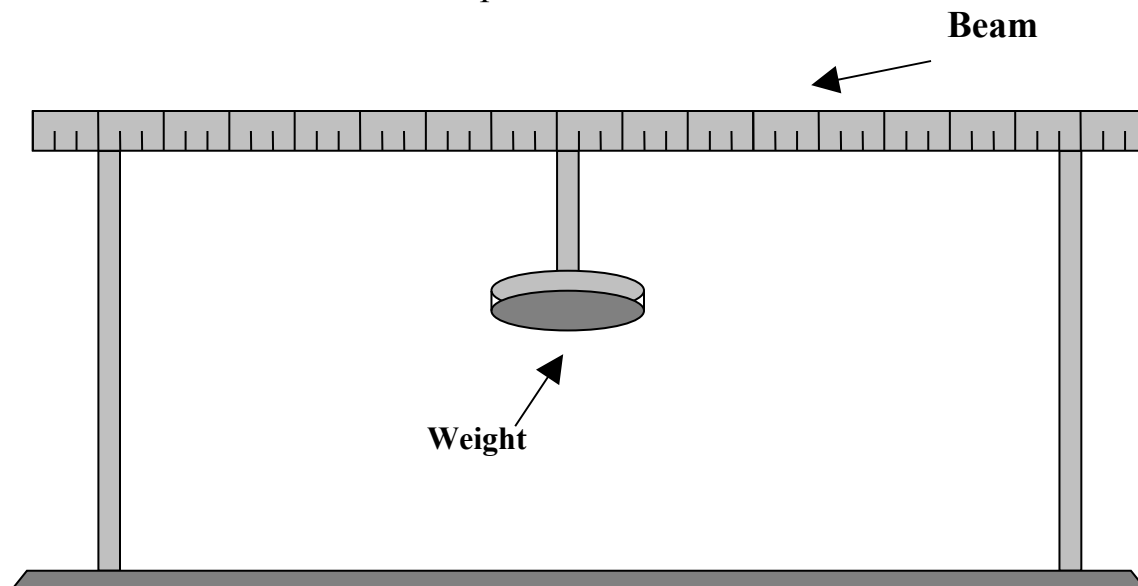
To record the deflection experimentally and compare the measurements with theoretical expressions

Deflection:

Deflection of a point on the axis of beam is the vertical distance between its position before and after bending. It is denoted by " Δy "

Procedure:

- Record the length of the beam and dimensions of cross-section
- Set the deflection gauge at a point where the deflection is to be measured
- Be sure to zero the dial indicator before applying the load
- Apply the load via load hangers
- Record the load, location and deflection
- In addition, record the deflection at some other point
- Record the location of the point



Exp # 5

Observation and Calculation

Calculate the following

- Moment of inertia of the beam, that is, “I”
- Deflection of the point with theoretical expressions

Table # 1

Modulus of Elasticity “E”	Width of Beam “b”	Depth of Beam “h”	Moment of Inertia $I=bh^3/12$
200GPa or 29×10^6 Psi	0.5 in	0.29 in	$= \frac{0.5 \times (0.29)^3}{12}$ $= 0.0010 \text{ in}^4$

Table # 2

Deflection at Free End

Load “P”	Location	Deflection(Experimental) Δy
2 Kg	15 in	7.75
2.5 Kg	9 in	6.81

Table # 3

Deflection at 18 in from Support A

Load “P”	Location	Deflection(Experimental) Δy
2 Kg	12 in	7.48
2.5 Kg	9 in	8.7

Experiment # 6

Measurement of Deflection in a Over Hanging Beam

Apparatus:

- Model of beam
- Loads
- Deflection gauge
- Load hanger

Purpose:

To record the deflection experimentally and compare the measurements with theoretical expressions

Deflection:

Deflection of a point on the axis of beam is the vertical distance between its position before and after bending. It is denoted by “ Δy ”

Procedure:

- Record the length of the beam and dimensions of cross-section
- Set the deflection gauge at a point where the deflection is to be measured
- Be sure to zero the indicator before applying the load
- Apply the load via load hangers
- Record the load, location and deflection
- In addition, record the deflection at some other point
- Record the location of the point

Exp # 6

Observation and calculations

Load "P"	Location	Deflection(Experimental) Δy mm
1.5 Kg	12 in	7.75
1.5 Kg	15 in	6.81
1.5 Kg	18 in	8.7

Modulus of Elasticity = $M = 29 \times 10^6$ Psi

Width "b" = 0.49 in

Depth "h" = 0.19 in

$$I = \frac{bh^3}{12} = 0.00028 \text{ in}^4$$

Experiment # 7

Determination of Bending Moment in Beam

Apparatus:

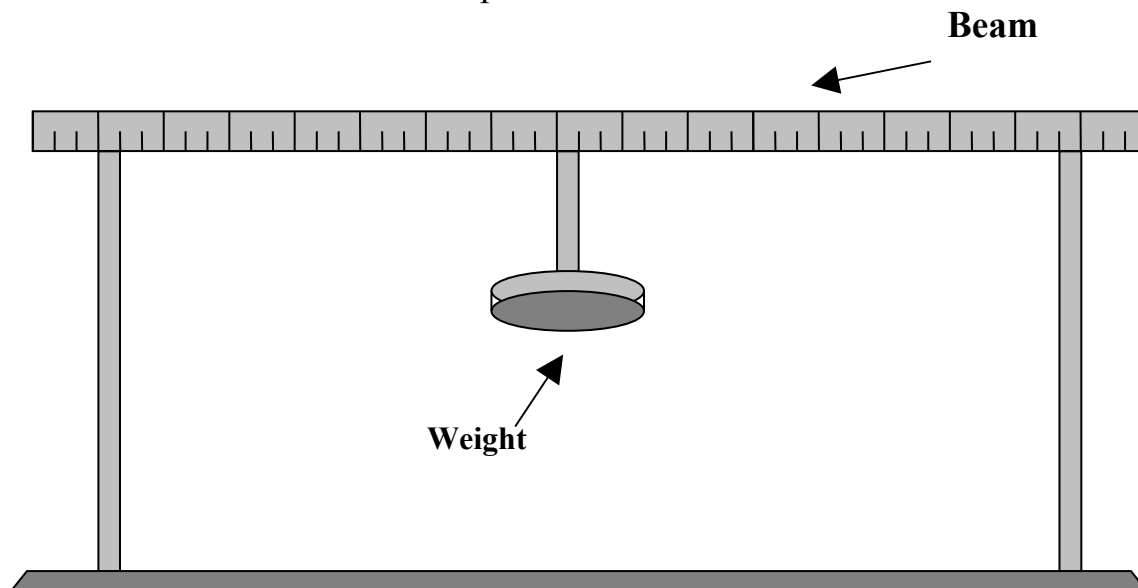
- Model of beam
- Loads
- Deflection gauge
- Load hanger

Purpose:

To record the moment experimentally and compare the measurements with theoretical expressions

Procedure:

- Record the length of the beam and dimensions of cross-section
- Be sure to zero the indicator before applying the load
- Apply the load via load hangers
- Record the load, location and deflection
- In addition, record the deflection at some other point
- Record the location of the point



Exp # 7

Observation and calculations

Length of the beam = **30 in**

Load = P	Initial Value	Final Value	Difference
1 Kg	10.69 mm	5.13 mm	5.5 mm
2 Kg	10.69 mm	3.08 mm	7.56 mm
2.5 Kg	10.64 mm	1 mm	9.64 mm

Experiment # 8

Measurements of Reactions on Supports in Statically Determinate Beams

Apparatus:

- Model of beam
- Weight
- Weight hanger
- Spring Balance

Procedure:

- Place the model beam on the table and measure the length of the beam
- Apply the load W_1 via load hangers and measure location L_1 from left side L_1' from right side
- Now apply another load W_2 and note its value and location L_2 from left side L_2' from right side
- Read the reactions on each support from the spring balance attached to them
- Now also evaluate the theoretical values of reactions at the supports by taking
$$\sum \mathbf{M} = \mathbf{0} \text{ at A and B}$$
- In addition also record reactions by changing the loads and also their location
- Now compare the observed values with theoretical and find the error

Exp # 8

Observation and calculations

Weight of hanger = 0.1 lb

Weight of rod W3 = 5.84 lb

Length b/w the supports = 42 in

W_1	W_2	L_1	L_1'	L_2	L_2'	R_A	R_B
0.6 lb	0.6 lb	10 in	32 in	32 in	10 in	3.5 lb	3.5 lb
0.85 lb	0.6 lb	7 in	35 in	24 in	18 in	3.85 lb	3.74 lb
0.6 lb	0.8 lb	24 in	18 in	7 in	35 in	3.72 lb	3.88 lb

