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LAB MANUAL

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Year & Semester : **II Year / IV Semester**

CE6411 STRENGTH OF MATERIALS LABORATORY

ANNA UNIVERSITY

CE-6411 STRENGTH OF MATERIAL

OBJECTIVE:

To expose the students to the testing of different material under the action of various forces and determination of their characteristic experimentally

LIST OF EXPERIMENTS:

1. TENSION TEST ON MILD STEEL
2. DOUBLE SHEAR TEST
3. TORSION TEST ON MILD STEEL BAR
4. COMPRESSIVE TEST ON WOOD
5. IZOD IMPACT TEST
6. CHARPY IMPACT TEST
7. ROCKWALL HARDNESS TEST
8. BRINELL HARDNESS TEST
9. DEFLECTION TEST ON METAL BEAM
10. COMPRESSION TEST ON HELICAL SPRING
11. TENSION TEST ON CARRIAGE SPRING
12. TEST ON CEMENT

TOTAL: 45 PERIODS

INDEX

EX.NO	DATE	NAME OF THE EXPERIMENT	STAFF SIGN	REMARKS
1		Determine the tension test on mild steel bar		
2		Determine the double shear test		
3		Determine the torsion test		
4		Determine the compression test on wood		
5		Determine the izod impact test		
6		Determine the charpy test		
7		Determine the Rockwell Hardness test		
8		Determine the Brinell Hardness test		
9		Determine the deflection test on metal beam		
10		Determine the compression test on spring		
11		Determine the tension test on spring		
12		Determine the test on cement		

INTRODUCTION

Strength is particular mean by which a body or thing is strong. Strength of material is the property of the material by virtue of which the material can resist external force applied to it per unit of its cross sectional area. Greater this force with which the external force is resisted by unit cross sectional area of the material is its strength.

The external force acting on a body is called loads. Structure and machines are designed on the basis of loads. The units of load are the same as that of force. The load according to the manner of their member is dead load, live loads. The effect produced on a member is tensile load, compressive load, shearing loads, torsion loads, bending loads.

Stress as a load per unit area. Stress may be either tensile or compressive or shear according to whether member is being stretched, compressed or sheared.

The strength relies on three different type analytical method, strength stiffness and stability.

Strain is a measure of the deformation caused by the loaded body. The ratio of change in dimension of the body to the original dimension.

Mechanical properties can be described as the behavior of material under external loads. The important properties are strength, elasticity, plasticity, ductility, brittleness, malleability, toughness, hardness.

A structural member which carries lateral or transverse forces is termed as beam joint.

For example in grain boundary strengthening, although yield strength is maximized with decreasing grain size, very small sizes make the material.

It is determined by dividing the load at the time of fracture or breaking by the original cross sectional area

EX.NO:1

DATE:

TENSION TEST ON MILD STEEL BAR

AIM:

To conduct a tension test on given mild steel specimen for finding the following:

1. Yield stress
2. Ultimate stress
3. Nominal breaking stress
4. Actual breaking stress
5. Percentage Elongation in length
6. Percentage reduction in area

APPARATUS REQUIRED:

1. Universal testing machine (UTM)
2. Mild steel specimen
3. Scale
4. Vernier caliper

PROCEDUER:

1. Measure the length (L) and diameter (d) of the specimen.
2. Mark the center of the specimen using dot punch.
3. Mark two points P and Q at a distance of 150mm on either side of the center mark so that the distance between P and Q equal to 300mm.
4. Mark two point A and B at a distance of 2.5 times the rod distance on the either side of the center mark so that that the distance between A,B will be equal to 5 times the rod diameter and is known as initial gauge length of rod.
5. Apply the load gradually and continue the application of load. After some times, there will be slightly pause in the increase of load .the load at this points is noted as yield point.
6. Apply load continually till the specimen fails and note down the ultimate load (p_a) and breaking load (p_b) from the digital indicator. Measure the diameter of the rod at neck (d_n)

FORMULA:

$$\text{Yield stress} = \frac{\text{yield point}}{\text{Initial area}}$$

$$\text{Ultimate stress} = \frac{\text{uitimate load}}{\text{Initial area}}$$

$$\text{Normal breaking stress} = \frac{\text{breaking load}}{\text{Initial area}}$$

$$\text{Actual breaking stress} = \frac{\text{breaking load}}{\text{Neck area}}$$

$$\text{Elongation in length} = \frac{\text{final length} - \text{initial length}}{\text{Initial length}} \text{ X100}$$

$$\text{Reduction in area} = \frac{\text{Initial area} - \text{neck area}}{\text{initial length}} \text{ X100}$$

OBSREVATION: (TENSION TEST ON MILD STEEL BAR)

1. **Material of the specimen** = _______________
2. Length of specimen , L =_______________mm
3. Diameter of the specimen ,d =_______________mm
4. Initial gauge length of the specimen, L_I =_______________mm
5. Final gauge length of specimen, l_F =_______________mm
6. Diameter at neck, d_n =_______________mm
7. Yield point, p_y =_______________KN
8. Ultimate load ,p_u =_______________KN
9. Breaking load, p_b =_______________KN

CALCULATION:

RESULT:

1. Yield stress = ______________ ***N/mm²***
2. Ultimate stress = ______________ ***N/mm²***
3. Nominal breaking stress = ______________ ***N/mm²***
4. Actual breaking stress = ______________ ***N/mm²***
5. Percentage elongation in length = ______________ ***%***
6. Percentage reduction in area = ______________***%***

EX.NO:2

DATE:

DOUBLE SHEAR TEST ON STEEL BAR

AIM:

To determine the maximum shear strength of the given bar by conducting double shear test.

APPARATUS AND SPECIMEN REQUIRED:

1. Universal testing machine (UTM)
2. Mild steel specimen.
3. Device for double shear test.
4. Vernier caliper /screw gauge

PROCEDURE:

1. Measure the diameter (d) of the given specimen.
2. The inner diameter of the hole in the shear stress attachment is slightly greater than of the specimen.
3. Fit the specimen in the double shear device and place whole assembly in the UTM.
4. Apply the load till the specimen fails by double shear.
5. Note the down the load the specimen fails (p).
6. Calculate the maximum shear strength of the given specimen by using .

FORMULA:

$$\boxed{\text{Maximum shear strength } = \frac{\overline{P}}{2xA}}$$

P= load at failure, N

A= cross-sectional area of bar, mm^2

$A=2X\pi D^2/4$

OBSERVATION: (D0UBLE SHEAR TEST)

1. Material of the specimen =__________________
2. Diameter of the specimen (d) = _________________ *mm*
3. Cross sectional area (A) =__________________*mm²*
4. Load at failure (p) =___________________*KN*

RESULT:

The maximum shear strength of the given specimen = _____________***N/mm²***

EX.NO:3

DATE:

TORSION TEST ON MILD STEEL BAR

AIM:

To conduct torsion test on mild steel round rod and to the value of modulus rigidity and maximum shear stress.

APPARATUS REQUIRED:

1. Torsion testing machine.
2. Venire caliper
3. Steel rule
4. Specimen

PROCEDURE:

1. Before testing, adjust the measuring range according to the capacity of the test piece.
2. Hold the test specimen driving chuck with the help of handles.
3. Adjust the angle measuring dial at zero position, block pointer at the starting position and pen its required position.
4. Bring the red dummy pointer in the line with black pointer.
5. Start the machine and now the specimen will be subjected to torsion.
6. Take the value of the torque from the indicating dial for particular value of angle of twist.
7. Repeat the experiment until the specimen breaks into two pieces. Note the value of torque at this breaking point.
8. Tabulate the reading and draw graph between angle of twist and torque.
9. Find the value of T/θ from the graph and find the value of modulus of rigidity.
10. Find the maximum shear stress.

OBSERVATION: (TORSION TEST ON MILD STEEL)

1. RECORD THE FOLLOWING:

- Initial diameter of specimen =____________*mm*
- Length of the specimen =____________*mm*

SI.NO	Angle of twist ***degrees***	Angle of twist in radian ***θ π/180***	Torque ***N-mm***

TABULATION:

SI.NO	Radius of the Specimen ***mm***	Torque ***N-mm***	Angle of twist (θ) ***radian***	Shear stress ***N/mm^2***	Modulus of rigidity of material ***N/mm^2***	Strain energy ***N/mm***	Ultimate tensile stress ***N/mm^2***

FORMULA:

The general torsion theory for circular specimen:

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

Where,

T =applied torque, (Nm)

J=Polar second moment of area, (mm^2)

G= modulus of rigidity, (N/mm^2)

θ=angle of twist, (radians)

L= gauge length,(mm)

RESULT:

1. Shear stress = _____________ ***N/mm²***
2. Modulus of rigidity = _____________ ***N/mm²***
3. Strain energy = _____________ ***N/mm***
4. Ultimate shear stress = _____________ ***N/mm²***

EX.NO:4

DATE:

COMPRESSIVE STRENGTH ON WOOD

AIM:

To perform compression test of wood in UTM.

APPARATUS:

A UTM or A compression testing machine ,cylindrical or cube shaped specimen of cast iron, aluminum or mild steel ,vernier caliper, liner scale , dial gauge .

PROCEDURE:

1. Dimension of test piece is measured at three different places along its height/length to determine the average cross sectional area.
2. Ends of the specimen should be plane for that the ends are tested on a bearing plate
3. The specimen is placed centrally between the two compression plate such that the centre of moving head is vertically above the centre of specimen.
4. Load is applied on the specimen by moving the movable head.
5. The load and corresponding contraction are measured at different intervals. The load interval may be as 500kg.
6. Load is applied until the specimen fails.

OBSERVATION :(compression test on wood)

Initial length/height of specimen, h = _______mm

Initial diameters of specimen, d = _______ mm

SI.NO	Applied load (p) ***N***	Recorded change in length ***mm***

CALCULATION:

- Original cross section area A_o =_____________ ***mm²***
- Final cross section area A_f =_____________ ***mm²***
- Stress =_____________ ***N/mm²***
- Strain =_____________

RESULT:

The compressive strength of given specimen = ________________ ***N/mm²***

EX.NO:5

DATE:

IZOD IMPACT TEST

AIM:

To determine the impact strength of the given specimen by conducting IZOD impact test.

APPARATUS AND SPECIMEN REQUIRED:

1. Impact testing machine with attachment for IZOD test.
2. Given specimen
3. Vernier caliper
4. Scale

PROCEDURE:

1. Measure the length (l), breath (b), depth (d) of the given specimen.
2. Measure the position of notch from the end, depth of groove, and top width of groove in the given specimen.
3. Lift the pendulum and keep it in the position meant for IZOD test.
4. Adjust the pointer to coincide with initial position in the IZOD scale.
5. Release the pendulum using the lever and note down the initial reading in the IZOD scale.
6. Place the specimen vertically upwards such that the shorter distance between one ends of the specimen and groove will be protruding length and also the groove in the specimen should face the striking end of the hammer.
7. Release the pendulum again using the and note down the final reading in the izod scale
8. Find the impact strength of the given specimen by using the following relation;

Impact strength = (final izod scale reading – initial izod scale reading)

OBSERVATION :(IZOD IMPACT TEST)

1. Material of the given specimen =__________
2. Type of notch =__________
3. Length of the specimen , L =__________ mm
4. Breath of the specimen , b =__________ mm
5. Depth of the specimen ,d =__________mm
6. Position of groove from one end, =__________mm
7. Depth of groove =__________mm
8. Width of groove =__________mm
9. Initial izod scale reading =__________kg.m
10. Final izod scale reading =__________kg.m

TABULATION:

SI.NO	Energy observed Specimen ***J***	Effective cross sectional area ***mm^2***	Impact strength ***J/mm^2***

RESULT:

The impact strength of the given specimen is = _____________ ***N/mm^2***

EX.NO:6

DATE:

CHARPY IMPACT TEST

AIM:

To determine the impact strength of the given specimen by conducting charpy impact test.

APPARATUS AND SPECIMEN REQUIRED:

1. Impact testing machine with attachment for charpy test.
2. Given specimen
3. Vernier caliper
4. Scale

THEORY:

An impact test of material that is ability of material to absorb energy during plastic deformation. The impact test measures the necessary to fracture a standard notch bar by applying an impact load.

PROCEDURE:

1. Measure the length (l), breath (b), depth (d) of the given specimen.
2. Measure the position of notch from the end, depth of groove, and top width of groove in the given specimen.
3. Lift the pendulum and keep it in the position meant for charpy test.
4. Adjust the pointer to coincide with initial position in the charpy scale.
5. Release the pendulum using the lever and note down the initial reading in the charpy scale.
6. Place the specimen vertically upwards such that the shorter distance between one ends of the specimen and groove will be protruding length and also the groove in the specimen should face the striking end of the hammer.
7. Release the pendulum again using the and note down the final reading in the charpy scale

8. Find the impact strength of the given specimen by using the following relation;

$$\boxed{\text{Impact strength} = (\text{final charpy scale reading} - \text{initial charpy scale reading})}$$

OBSERVATION: (CHARPY IMPACT TEST)

1. Material of the given specimen =______________
2. Type of notch =______________
3. Length of the specimen ,L =_____________mm
4. Breath of the specimen , b =_____________mm
5. Depth of the specimen ,d =_____________mm
6. Position of groove from one end, =_____________mm
7. Depth of groove =_____________mm
8. Width of groove =_____________mm
9. Initial charpy scale reading =_____________kg.m
10. Final charpy scale reading =_____________kg.m

TABULATION:

SI.NO	Energy observed Specimen ***J***	Effective cross sectional Area ***mm²***	Impact strength ***J/mm²***

RESULT:

The impact strength of the given specimen is = ______________ ***N/mm²***

EX.NO:7

DATE:

ROCKWELL HARDNESS TEST

AIM:

To study the Rockwell hardness testing machine and perform the Rockwell.

APPARATUS:

1. Rockwell hardness test
2. Diamond cone intender
3. Mild steel

PROCEDURE:

1. Clean the test piece and place on the special of machine.
2. Make the specimen surface by removing dust, dirt, oil and grease etc.
3. Make the contact between the specimen surface and the ball by rotating the jack adjusting wheel.
4. Push the required button for loading.
5. Pull the load release lever wait for minimum 15second. The load will automatically apply gradually.
6. Remove the specimen from support table and locate the indentation so made.

B scale ball intender -100kg

C scale diamond intender- 150kg

TABULATION: (ROCKWELL HARDNESS TEST)

SI.NO	Specimen scale	Load ***kg***		Intender dimension	Dial reading ***mm***			Average
		major	minor		R1	R2	R3	

RESULT:

Rockwell hardness number =______________________

EX.NO:8

DATE:

BRINELL HARDNESS TEST

AIM:

To study the Brinell hardness testing machine and the given specimen

APPARATUS:

1. Brinell hardness testing machine
2. Mild steel
3. Ball indenter
4. Microscope

SPECIFICATION:

- ❖ Ability to determine hardness up to 500 BHN
- ❖ Diameter of ball d= 2.5mm, 5mm, 10mm.
- ❖ Maximum application of load=3000kgf
- ❖ Method of load application=Lever type
- ❖ Capacity of testing the lower hardness range=1 BHN on application of $0.5D^2$ load.

PROCEDURE:

1. Clean the test piece and place on the special of machine.
2. Make the specimen surface by removing dust, dirt, oil and grease etc.
3. Make the contact between the specimen surface and the ball by rotating the jack adjusting wheel.
4. Push the required button for loading.
5. Pull the load release lever wait for minimum 30second. The load will automatically apply gradually.
6. Remove the specimen from support table and locate the indentation so made.

FORMULA:

Brinell hardness number (BHN) = load/area of indentation of steel ball

$$\boxed{BHN = \frac{P}{\pi D/2\left(D - \sqrt{D^2 - d^2}\right)}}$$

Where,

P-load applied on the indenter, Kg.

D-Diameter of steel ball indenter, mm.

d- Diameter of ball impression, mm

TABULATION:

Specimen material	Diameter of ball intender	Load (P)	Diameter of ball impression			Average Diameter	Brinell hardness number
			d_1	d_2	d_3		
	mm	***Kg***	***mm***	***mm***	***mm***	***mm***	**(no unit)**

RESULT:

1. Brinell hardness number of given material=______________

EX.NO:9

DATE:

DEFLECTION TEST ON BEAM

AIM:

To determine young's modulus of elasticity of material of beam simply supported at ends.

APPARATUS;

1. Deflection of beam apparatus.
2. Pan
3. Weights
4. Beam of different cross section and material(steel beam)

PROCEDURE:

1. Adjust cast iron block the bed so that they are symmetrical with respect to the length of the bed.
2. Place the beam on the knife edges on the block so as to project equally beyond each knife edge. See that the load is applied at the centre of the beam.
3. Note the initial reading of venire scale.
4. Add a weight of 20 N and again note the reading of venire scale.
5. Find the deflection in each case by subtracting the initial reading of venires caliper

FORMULA:

Bending moment $M = \frac{Wl}{4}$

Bending stress $\sigma_Y = \frac{my}{I}$

Young's modulus of elasticity $E = \frac{wl^3}{48\delta I}$

OBSERVATION: (DEFLECTION TEST ON BEAM)

1. Material of the specimen =___________
2. Length of the specimen =___________mm
3. Breath of the specimen =___________mm
4. Depth of the specimen =___________mm
5. Span of the specimen =___________mm
6. Dial gauge least count =___________mm

TABULATION:

Sl.No	Load (P)		Deflection (δ)	Bending moment (M)	Bending stress (σ_b)	Young's modulus (E)
	Kg	***N***	***mm***	***N-mm***	***N/mm²***	***N/mm²***

RESULT:

The young's modulus for steel beam is found to be =_________________***N/mm²***

EX.NO:10

DATE:

COMPRESSION TEST ON SPRING

AIM:

To determine the modulus of rigidity and stiffness of the given compression spring specimen.

APPARATUS:

1. Spring test machine
2. Compression spring specimen
3. Vernier caliper

PROCEDURE:

1. Measure the outer diameter (D) and diameter of the spring coil for the given compression spring.
2. Count the number of turns. i.e. Coil in the given compression specimen.
3. Place the compression spring at the centre of the bottom beam of the spring testing machine.
4. Rise the bottom beam by rotating right side wheel till the spring top roaches the middle cross beam.
5. Note down the initial reading from the scale in the machine.
6. Apply a load of 25kg and note down the scale reading. Increase the load at the rate of 25kg up to a maximum of 100kg and note down the corresponding scale reading.
7. Find the actual deflection of the spring for each load by deducting the initial scale reading from the corresponding scale reading.

FORMULAE USED:

$$\boxed{\text{Modulus of rigidity } C = \frac{64PR^3n}{d^4\delta}}$$

Where,

P=load in, N

R=mean radius of the spring, mm (D-d/2)

d= diameter of the spring coil, mm

δ=deflection of the spring, mm

D=outer diameter of the springs, mm

$$\text{Stiffness, } k = \frac{p}{\delta}$$

P=load in N

δ=Deflection on spring in mm

OBSERVATION: (COMPRESSION TEST ON SPRING)

Material of the springs specimen	=			
Outer diameter of the springs, D	=	mm		
Diameter of the springs coil, d	=	mm		
Number of coils/turns	=	nos.		
Initial scale reading	=	cm	=	mm

TABULATION:

Sl.No	Applied load		Scale reading		Actual deflection	Modulus of elasticity	Stiffness
	Kg	***N***	***cm***	***mm***	***mm***	***N/mm^2***	***N/mm***

RESULT:

1. The modulus of rigidity of the given spring = ________________ ***N/mm^2***

EX.NO:11

DATE:

TENSION TEST ON SPRING

AIM:

To determine the modulus of rigidity and stiffness of the given tension spring specimen.

APPARATUS:

1. Spring test machine
2. tension spring specimen
3. Vernier caliper

PROCEDURE:

1. Measure the outer diameter (D) and diameter of the spring coil for the given tension spring.
2. Count the number of turns. i.e. Coil in the given tension specimen.
3. Place the tension spring at the centre of the bottom beam of the spring testing machine.
4. Raise the bottom beam by rotating right side wheel till the spring top roaches the middle cross beam.
5. Note down the initial reading from the scale in the machine.
6. Apply a load of 25kg and note down the scale reading. Increase the load at the rate of 25kg up to a maximum of 100kg and note down the corresponding scale reading.

Find the actual deflection of the spring for each load by deducting the initial scale reading from the corresponding scale reading

FORMULAE USED:

Modulus of rigidity C = $\frac{64PR^3n}{d^4\delta}$

Where,

P=load in N

R=mean radius of the spring mm (D-d/2)

d= diameter of the spring coil in mm

δ=deflection of the spring in mm

D=outer diameter of the springs in mm

Stiffness, k= $\frac{p}{\delta}$

Where,

P=load in N

δ=Deflection on spring in mm

OBSERVATION: (TENSION TEST ON SPRING)

Material of the springs specimen	=			
Outer diameter of the springs, D	=	mm		
Diameter of the springs coil, d	=	mm		
Number of coils/turns	=	nos.		
Initial scale reading	=	cm	=	mm

TABULATION:

Sl.No	Applied load		Scale reading		Actual deflection	Modulus of elasticity	Stiffness
	Kg	***N***	***cm***	***mm***	***mm***	***N/mm^2***	***N/mm***

RESULT:

1. The modulus of rigidity of the given spring = ________________ ***N/mm^2***

EX.NO:12

DATE:

TEST ON CEMENT

AIM:

To determine the initial and final setting time of cement paste.

APPARATUS:

1. Vicat apparatus
2. Stop watch
3. Measuring jar
4. Trowel
5. Balance

PROCEDURE:

1. Weigh 400gms of the sample of cement on to a non porous plate form and make it a heap with a depression in the center
2. Calculate the amount of water required for gauging as 0.85 times the amount of water required to procedure a paste of standard consistency. Add this calculated quantity of water to heap and simultaneously start stop watch.
3. Gauge the cement and water together in a manner specified till the mould is completely filled. Strike the top level with the trowel and slightly tap the mould to the extent necessary to drive out all the entrapped air.
4. Place the mould under the vicat needle apparatus with 1mm square needle in position. Release the moving rod and note the reading against the index. Now raise the moving rod, clear off the cement paste and wipe the needle clear.
5. Note the time elapsed from the moment of adding water to dry cement to the moment when the reading is 5mm.
6. Now remove the 1mm needle the rod and the special needle for determine the final set.

7. As before allow the moving rod to travel downwards at every two minutes intervals when the needle makes a move but the metal attachment fails to so, note total time elapsed.
8. Remove the needle, clean the application used and put them aside.

<u>RESULT:</u>

The Initial setting time of cement is = ________________ ***minutes.***

The Final setting time of cement is = ________________ ***minutes.***