INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

STRENGTH OF MATERIALS LABORATORY								
IV Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC13	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 45				Total Classes:45		

I. COURSE OVERVIEW:

This course offers a comprehensive exploration of material behaviour through laboratory experiments. Students delve into the fundamental principles acquired in the classroom, gaining hands-on experience with a wide range of equipment. The course covers various testing methodologies, including tensile and compression testing to determine material strengths, flexural testing for bending behaviour, and torsional testing for shear properties. Impact tests assess material toughness, while experiments on deflection and fatigue provide insights into structural performance.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The different mechanical properties engineering materials used in civil engineering applications.
II. The behaviour of various material samples under different loads and equilibrium conditions.
III. The characterization of materials subjected to tension, compression, shear, torsion, bending and impact.
IV. The analyzation of material testing data for selection of suitable construction materials

III. COURSE OUTCOMES

CO1	Analyze tension test results on mild steel bars for calculation of tensile strength and Young's modulus using universal testing machine.
CO2	Analyze the beams under point loads for computing shear force, bending moment, slope and deflection in designing structures.
CO3	Determine the modulus of rigidity of a given shaft for calculating the shear strength and angle of twist under torsional loading.
CO4	Analyze the impact strength of steel specimen using Izod and Charpy test for the characterization under suddenly applied load acting on a specimen.
CO5	Determine the compressive strength of concrete and grade of concrete for understanding the strength attainment with time duration.
CO6	Analyze stiffness and modulus of rigidity of the spring wire for designing shock absorbers in aerospace and automobile industries.

IV. COURSE CONTENT

EXPERIMENTS ON STRENGTH OF MATERIALS LABORATORY

INTRODUCTION:

Strength of Materials Laboratory is a crucial component of engineering education, specifically in the field of mechanical, civil, and materials engineering. The primary goal of this laboratory is to provide students with hands-on experience in understanding and analyzing the mechanical behavior of materials under various loading conditions. The laboratory activities focus on applying theoretical principles learned in classroom lectures to practical situations, fostering a deeper comprehension of material properties and structural behavior.

1. Direct Tension test

1.1 Tension test on mild steel bar

Evaluate the mechanical (tensile) properties such as modulus of elasticity, yield strength, ultimate tensile strength, percentage elongation of mild steel bar by conducting tensile test.

1.2 Tension test on HYSD bar

Evaluate the mechanical (tensile) properties such as modulus of elasticity, yield strength, ultimate tensile strength, percentage elongation of HYSD bar by conducting tensile test shon in fig. 1.1.

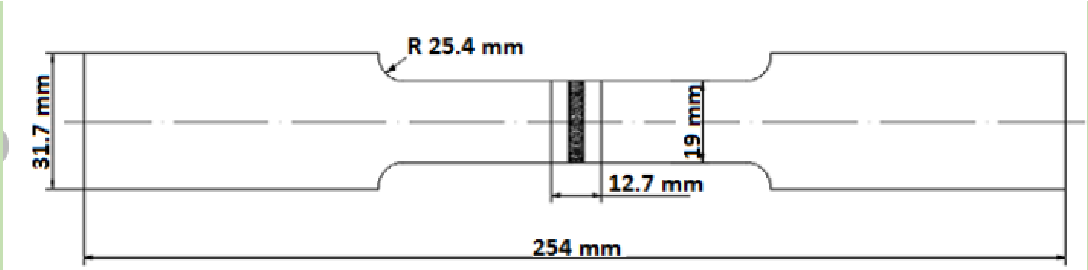

fig.1.1: Direct Tension test specimen preparation

Try:

1. Generate stress Vs strain diagram for different materials using servo driven Universal Testing Machine.

2. Bending Test on Cantilever Beam

2.1 Bending test on cantilever with single point load acting at free end

Determine the Young's modulus of the material of the cantilever beam of steel material, conducting bending test with single point load, and compare the same with theoretical value shown in fig 2.1.

2.2 Bending test on cantilever with two point loads one at free end another at midspan

Determine the Young's modulus of the material of the cantilever beam of steel material, conducting bending test with two point load, and compare the same with theoretical value.

fig. 2.1: Deflection of cantilever beam

Try:

1. Investigate the effect of using different materials for the cantilever beam.

3. Bending Test on Simply Supported Beam

3.1 Bending test on simply supported beam with central point load

Analyze the bending behaviour of a simply supported beam subjected to central point load and compare the same with theoretical value.

3.2 Bending test on simply supported beam with two point loads

Analyze the bending behaviour of a simply supported beam subjected to two point loads and compare the same with theoretical value shown in fig. 3.1.

fig. 3.1: Deflection of simply supported beam

Try

1. Examine how changing the material of the simply supported beam influences its bending behavior.

4. Torsion Test

1.1 Torsion test on solid mild steel bar

Test a round mild steel specimen under torsion and calculate the shear modulus of the material of the bar and compare with analytical result.

1.2 Torsion test on hollow mild steel bar

Test a round hollow mild steel bar under torsion and calculate the shear modulus of the material of the bar and compare with analytical result.

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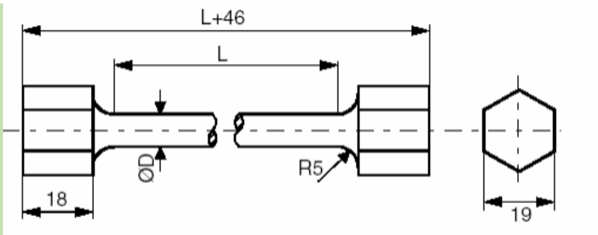

fig.4.1: Torsion test specimen dimensions

Try:

1. Test a round solid aluminium bar under torsion and calculate the shear modulus of the material of the bar and compare with analytical result

5. Hardness Test

5.1 Brinnel Hardness Test

Determine the Brinell hardness number and calculate the ultimate tensile strength of the metal specimens from the Brinell hardness number by using empirical relationships shown in fig. 5.1.

5.2 Torsion test on hollow mild steel bar

Determine the Rockwell Hardness Number and calculate the ultimate tensile strength of the metal specimens from the Rockwell Hardness Number by using empirical relationships shown in fig. 5.2.

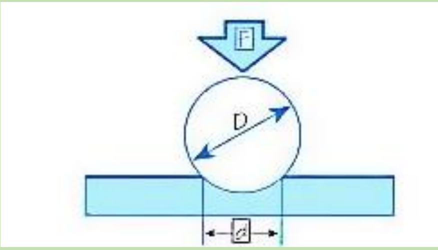

fig.5.1: Brinell's hardness test

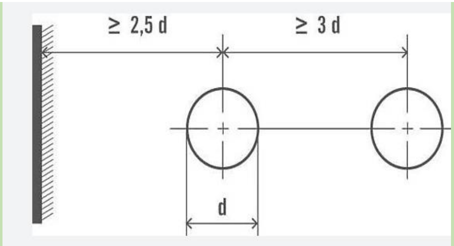

fig.5.2: Rockwell's hardness test

Try:

1. Investigate how changing the size of the indenter affects the Brinell hardness measurement.
2. Investigate the impact of heat treatment on Rockwell hardness. Test materials before and after heat treatment to observe changes in hardness.

6. Compression test on Spring

Test a helical spring under compressive load, draw the load-deflection curve for the specimen and determine modulus of rigidity and stiffness of the spring shown in fig. 6.1.

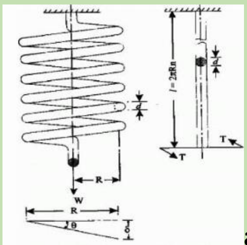

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fig.6.1: Spring test specimen preparation

Try:

1. Analyze how the spring behaves under dynamic loading conditions and study any resonance effects.

2. Perform fatigue testing on the spring by subjecting it to repeated loading and unloading cycles.

7. Compression Test

7.1 Compression test on Concrete cube

Conduct compression test on concrete cube and find the compressive strength of the cube.

7.2 Torsion test on hollow mild steel bar

Conduct compression test on cement bricks and find the compressive strength of the brick.

fig.7.1: Compressive testing machine with specimen

Try:

1. Conduct compression test on clay bricks and find the compressive strength of the brick.
2. Conduct compression test on wooden block and find the compressive strength of block.

8. Impact test

8.1 Charpy Impact test and Izod Impact test:

Determine the energy absorbed by the specimen using Charpy impact test and Izod impact test Shown in fig 8.1 and fig. 8.2. Find the toughness of the specimen.

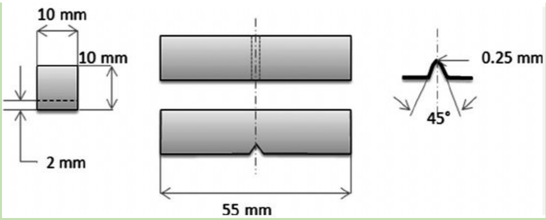

fig.8.1: Charpy Impact Test

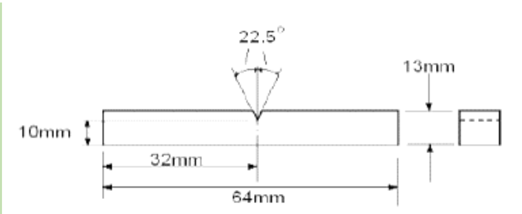

fig.8.2: Izod Impact Test

Try:

1. Calculate the impact strength of a unnotched specimens
2. Determine the impact strength of U-Notched specimens.

9. Shear test

Determine the shear strength of the specimen and calculate the modulus of rigidity of the material shown in fig.9.1.

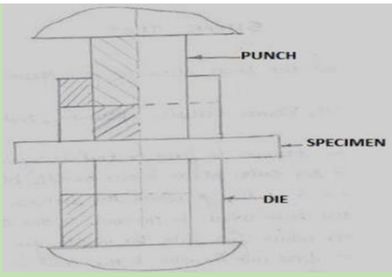

fig.9.1: Shear test using Universal Testing Machine (UTM)

Try:

1. Determine the shear strength of the rectangular specimen.
2. Determine the shear strength of the brittle material.

10. Beam Deflections

Verify the Maxwell's reciprocal theorem using simply supported beam and compare practical and theoretical deflections shown in fig.10.1.

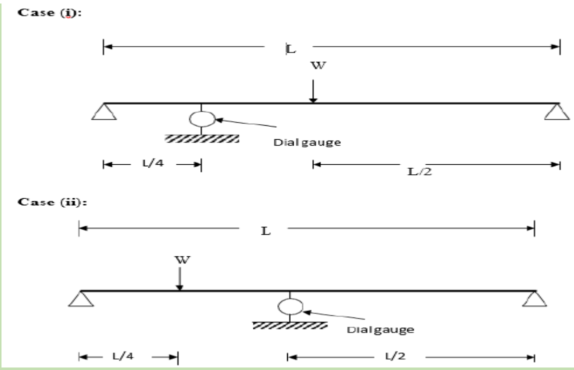

fig.10.1: Deflection of beams

Try:

1. How does increasing the length of a simply supported beam affect its deflection?
2. What is the significance of the elastic modulus in the deflection of simply supported beams?

11. Electrical Resistance Strain Gauges

Determine the elastic constant (modulus of elasticity) of a cantilever beam subjected to concentrated end load by using strain gauges shown in fig.11.1

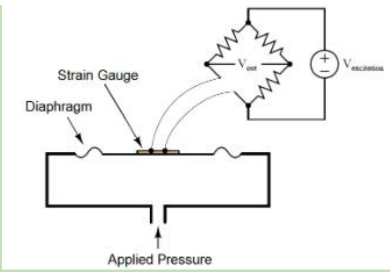

fig.11.1: Strain Measurement using strain gauge

Try:

1. What is the basic principle behind strain measurement using strain gauges?
2. How does a strain gauge work to detect deformation in a material?

12. Deflection of Continuous beam

Determine the deflection in a continuous beam and hence calculate the Young's modulus of the material of the beam shown in fig.12.1 and fig.12.2.

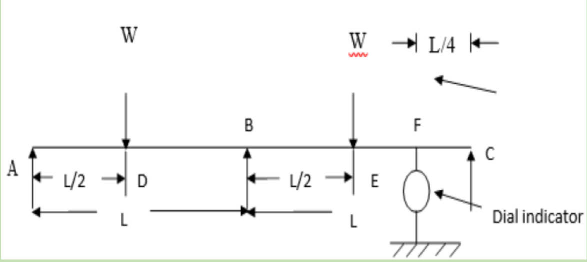

fig.12.1: Continuous beam deflection

fig.12.2: Setup of Continuous beam deflection

Try:

1. What factors influence the deflection of a continuous beam?
2. How does the distribution of loads impact the deflection profile of a continuous beam?

13. Tension Test on Composite Material

Evaluate the mechanical (tensile) properties such as modulus of elasticity, yield strength, ultimate tensile strength of composite bar by conducting tensile test shown in fig.13.

fig.13: Direct Tension test on composite bar

Try:

1. Generate stress Vs strain diagram for other combinations of materials using Universal Testing Machine.

14. Bending Test on Over-Hanging Beam

Bending test on over hanging beam with point load at free end

Analyze the bending behaviour of a over-hanging beam subjected to point load at free end compare the same with theoretical value shown in fig 14.

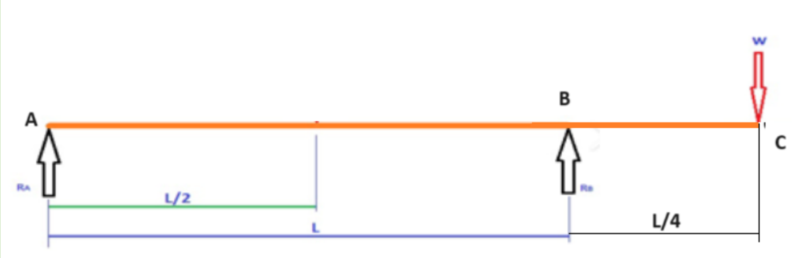

fig. 14: Deflection of simply supported beam

Try

1. Examine how changing length of over-hanging portion influences its bending behavior.

V. REFERENCE BOOKS:

1. B. C. Punmia, Ashok K Jain and Arun K Jain, "Mechanics of Materials", Laxmi Publications Pvt. Ltd., New Delhi, 12th edition, 2007.
2. R. Subramanian, "Strength of Materials", Oxford University Press, 2nd edition, 2010.
3. Hibbeler, R. C., "Mechanics of Materials", East Rutherford, NJ: Pearson Prentice Hall, 6th edition, 2004
4. R. K. Bansal, "A Textbook of Strength of Materials", Laxmi publications Pvt. Ltd., New Delhi, 2nd edition, 2007.

VI. ELECTRONICS RESOURCES:

1. https://home.iitm.ac.in/kramesh/Strength%20of%20Materials%20Laboratory%20Manual.pdf
2. http://www.atri.edu.in/images/pdf/departments/SOM%20LAB%20MANUAL.pdf
3. https://www.iitg.ac.in/mech/lab_sml.php