INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

STRENGTH OF MATERIALS LABORATORY								
III Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACEE06	**Core**	0	0	2	1	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Nil								

I. COURSE OVERVIEW:

This course offers a comprehensive exploration of material behaviour through practical experiments. Students delve into the fundamental principles acquired in the classroom, gaining hands-on experience with a 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. Different mechanical properties of different solid engineering materials used in civil engineering applications.
II. Behavior of various material samples under different loads and equilibrium conditions.
III. Characterization of materials subjected to tension, compression, shear, torsion, bending and impact.
IV. Methods of analyzing material testing data for selection of construction materials.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Analyze young's modulus of a mild steel bar for the calculation of tension using Universal testing machine.
CO 2 Analyze the beams under point loads for computing shear force, bending moment, slope and deflection in designing structures
CO 3 Determine the modulus of rigidity of a given shaft for calculating the angle of twist under torsional loading.
CO 4 Analyze the impact strength of steel specimen using Izod and Charpy test for the characterization under suddenly applied load acting on a specimen.
CO 5 Determine the compressive strength of concrete and grade of concrete for designing structures.
CO 6 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, and percentage elongation of HYSD bar by conducting tensile test.

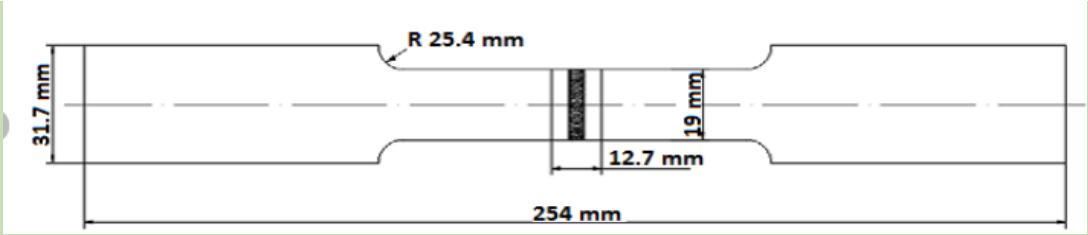

fig.1.1: Direct tension test specimen preparation

Try:

1. Generate stress Vs strain diagram for different materials using servo driven Universal Testing Machine.
2. How does the gauge length of the specimen affect the elongation and reduction in area of the material?
3. What are the differences in tensile properties between samples with different heat treatments or manufacturing processes?

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.

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. How does the applied load affect the deflection of the cantilever beam at various distances from the fixed end?
2. Investigate the effect of using different materials for the cantilever beam.
3. What is the bending stress distribution along the length of the cantilever beam under a uniform load?

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.

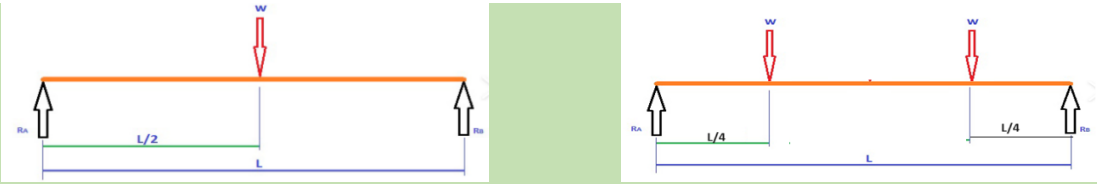

fig. 3.1: Deflection of simply supported beam

Try

1. Examine how changing the material of the simply supported beam influences its bending behavior.
2. How does the span length of the simply supported beam influence its maximum deflection and bending stress under a given load?
3. How does the applied load affect the deflection at the midpoint of a simply supported beam?

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.

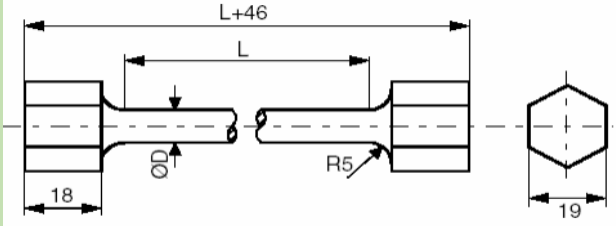

fig.4.1: Torsion test specimen dimensions

Try:

1. Test a round solid aluminum bar under torsion and calculate the shear modulus of the material of the bar and compare with analytical result.
2. How does the applied torque affect the angle of twist in a cylindrical specimen?
3. How does the length of the specimen influence the angle of twist and shear stress under a given torque?

5. Hardness Test

5.1 Brinell 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.

5.2 Rockwell hardness test

Determine the Rockwell Hardness Number and calculate the ultimate tensile strength of the metal specimens from the Rockwell Hardness Number by using empirical relationships

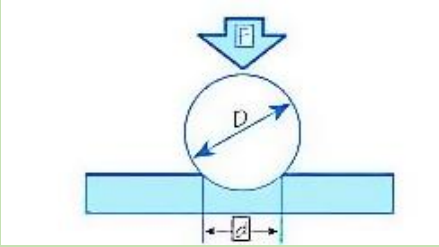

fig.5.1: Brinell's hardness test

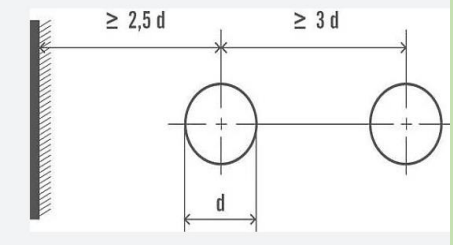

fig.5.2: Rockwell's hardness test

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.
3. What is the effect of indenter size and applied load on the hardness values in the Brinell hardness test?

6. Spring Test

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 .

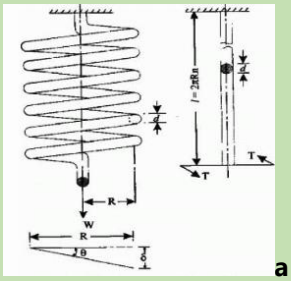

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fig.6.1: Spring test specimen preparation

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.
3. How does the diameter of the spring wire influence the spring constant and the maximum load it can bear?

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 Compression test on cement bricks

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. How does the compressive strength of the material vary with different cross-sectional areas of the specimen?
3. Conduct compression test on wooden block and find the compressive strength of block.

8. Impact Test

Charpy impact test and Izod impact test:

Determine the energy absorbed by the specimen using Charpy impact test and Izod impact test and also find the toughness of the specimen.

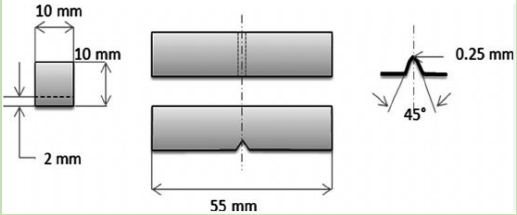

fig.8.1: Charpy impact test

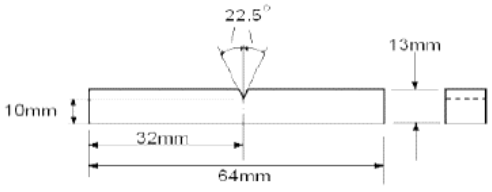

fig.8.2: Izod impact test

Try:

1. Calculate the impact strength of a unnotched specimens

2. What is the relationship between the impact energy absorption and the temperature of the material during testing?
3. 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.

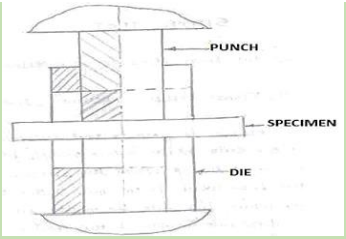

fig.9.1: Shear test using universal testing machine(UTM)

Try:

1. Determine the shear strength of the rectangular specimen.
2. What is the impact of temperature on the shear strength and failure mode of the material during shear testing?
3. Determine the shear strength of the brittle material.

10. Verification of Maxwell's Reciprocal Theorem on Beams

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

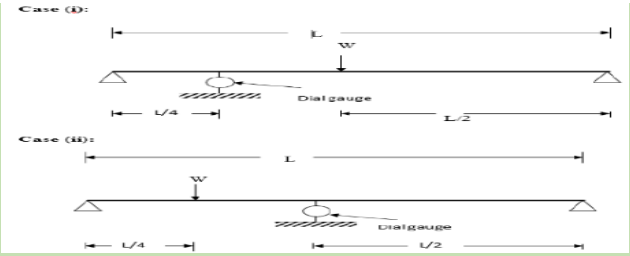

fig.10.1: Verification of maxwell's reciprocal theorem

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?
3. How does the deflection of a cantilever beam vary with the position of a concentrated load along its length?

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.

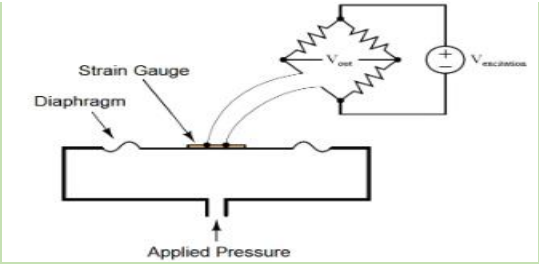

fig.11.1: Strain measurement using strain gauge

Try:

1. What is the basic principle behind strain measurement using strain gauges?
2. What is the sensitivity of the strain gauge, and how does it vary with different gauge lengths and widths?
3. 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.

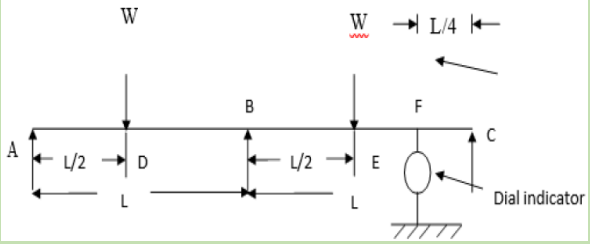

fig.12.1: Continuous beam deflection

fig.12.2: Setup of continuous deflection

Try:

1. What factors influence the deflection of a continuous beam?
2. How does the deflection of a continuous beam vary with the number of supports and their spacing?
3. 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.

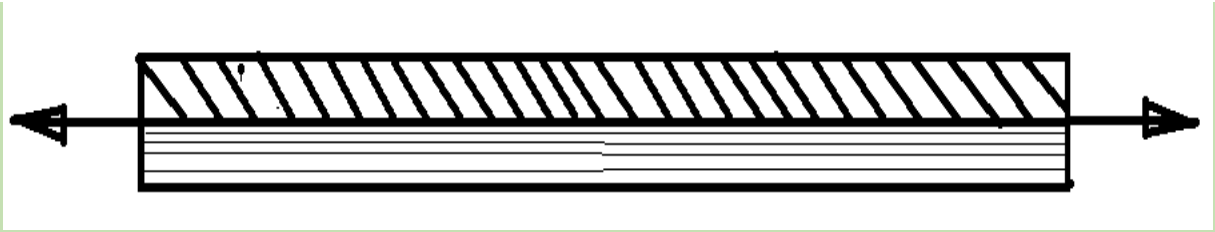

fig.13: Direct tension test on composite bar

Try:

1. Generate stress Vs strain diagram for other combinations of materials using Universal Testing Machine.
2. How does the tensile strength of a composite material vary with different fiber orientations?
3. What is the impact of environmental conditions (e.g., moisture absorption, temperature variations) on the tensile properties of composite materials?

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.

fig.14: Bending test on over-hanging beam

Try

1. Examine how changing length of overhanging portion influences its bending behavior.
2. What is the influence of the overhanging length on the maximum deflection and bending stress of the beam under a uniform load?
3. How does the deflection at the free end of an overhanging beam vary with different applied loads?

V. TEXTBOOKS:

1. Hibbeler, R. C. "*Mechanics of Materials",* East Rutherford, NJ: Pearson Prentice Hall, 6th edition, 2004.
2. Crandall, S. H., N. C. Dahl, and T. J. Lardner. "*An Introduction to the Mechanics of Solids".* 2nd edition. New York, NY: McGraw Hill, 1979.
3. William Kendrick Hatt, "*Laboratory Manual of Testing Materials*", Andesite Press, 2017.

VI. 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.

VII. ELECTRONICS RESOURCES:

1. https://www.labtesting.com/about/capabilities/metal-and-material-analysis/metallurgical-analysis/

2. https://archive.nptel.ac.in/courses/105/105/105105108/
3. https://nptel.ac.in/courses/112107146

VIII. MATERIAL ONLINE:

1. Course outline description
2. Lab manual