DRONACHARYA
College of Engineering

LABORATORY MANUAL

B.Tech. Semester- IV

STRENGTH OF MATERIAL
Subject code: LC-ME-214G

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DEPARTMENT OF MECHANICAL ENGINEERING
DRONACHARYA COLLEGE OF ENGINEERING
KHENTAWAS, FARRUKH NAGAR, GURUGRAM (HARYANA)

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Vision and Mission of the Institute

Vision:

"To impart Quality Education, to give an enviable growth to seekers of learning, to groom them as World Class Engineers and Managers competent to match the expanding expectations of the Corporate World has been our ever enlarging vision extending to new horizons since the inception of Dronacharya College of Engineering."

Mission:

1. To prepare students for full and ethical participation in a diverse society and encourage lifelong learning by following the principle of 'Shiksha evam Sahayata' i.e. Education & Help.
2. To impart high-quality education, knowledge and technology through rigorous academic programs, cutting-edge research, & Industry collaborations, with a focus on producing engineers& managers who are socially responsible, globally aware, & equipped to address complex challenges.
3. Educate students in the best practices of the field as well as integrate the latest research into the academics.
4. Provide quality learning experiences through effective classroom practices, innovative teaching practices and opportunities for meaningful interactions between students and faculty.
5. To devise and implement programmes of education in technology that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization.

Vision and Mission of the Mechanical Department

Vision:

"To become a Centre of Excellence in teaching and research in the field of Mechanical Engineering for producing skilled professionals having a zeal to serve society."

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts, various experiments and problem solving skills.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Mechanical Engineering and encourage students for pursuing higher education

M4: To inculcate in students ethics, professional values, team work and leadership skills.

Programme Educational Objectives (PEOs)

PEO 1: Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3: Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4: Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5: Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Programme Outcomes (POs)

Over completion of the Course our graduates will have ability to

1. Apply knowledge of computing, mathematical foundations, algorithmic principles, and engineering theory in the modeling and design of systems to real-world problems (fundamental engineering analysis skills).

2. Apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.

3. Design and conduct experiments, as well as to analyze and interpret data (information retrieval skills). Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills.

4. Analyze a problem, identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution(engineering problem solving skills).

5. Understand the appropriate codes of practice and industry standards.

6. Identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques.

7. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues.

8. Communicate effectively, both in writing and orally (speaking / writing skills).

9. Understand professional, ethical, legal, security and social issues and responsibilities (professional integrity).

10. Understand customer and user needs and the importance of considerations such as Aesthetics.

11. Use creativity to establish innovative solutions.

12. Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.

13. To Significantly contribute to delivery of desired component, product, or process.

14. Formulate and solve moderately complex engineering problems, accounting for hardware/software/human interactions.

15. Recognize the importance of professional development by pursuing postgraduate studies or face competitive examinations that offer challenging and rewarding careers in computing.

16. Apply the Knowledge of management techniques which may be used to achieve engineering Objectives within that context.

Program Specific Outcomes (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following:

PSO1: Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.

PSO2: Apply the knowledge acquired to investigate research-oriented problems in mechanical engineering with due consideration for environmental and social impacts

PSO3: Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

University Syllabus

List of Experiments:

1. To study the Brinell hardness testing machine & perform the Brinell hardness test.

2. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.

3. To study the Vickers hardness testing machine & perform the Vickers hardness test.

4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.

5. To study the Impact testing machine and perform the Impact tests (Izod & Charpy).

6. To study the Universal testing machine and perform the tensile test.

7. To perform compression & bending tests on UTM.

8. To perform the sheer test on UTM.

9. To study the torsion testing machine and perform the torsion test.

Note: 1. At least Seven experiments are to be performed in the semester.

Course Outcomes (COs)

At the end of the course, the student shall be able to:

CO214.1. Learn the principles of mechanics of solid and engineering.

CO214.2. Preparation of formal laboratory reports describing the results of experiments.

CO214.3. Acquire to operate basic instruments in mechanics of materials lab.

CO214.4. Able to understand the concepts of stress, strain of materials and ability to interpret the data

CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
C214.1	3	3	3	-	2	-	3	3	3	2	-	3	3	-	-	3
C214.2	-	3	-	-	2	3	-	-		2	-	3	-	-	2	3
C214.3	-	-	3	3		3	-	-	3	-	3	-	3	3	-	
C214.4	3	-	3	-	2	-	3	3	-	2	-	3	-	3	2	3
C214.5	3	3	-	3	-	3	-	-	3	2	3	-	3	3	-	3

CO-PSO Mapping

	PSO1	PSO2	PSO3
C214.1	3	2	-
C214.2	2	3	-
C214.3	3	2	-
C214.4	3	2	3
C214.5	2	3	3

Course Overview

Strength of Materials, also known as Mechanics of Materials, is a branch of engineering that focuses on the behavior of solid objects subjected to external forces and loads. It deals with the study of the mechanical properties, stresses, strains, and deformations of materials under different loading conditions. Throughout the course, students typically engage in problem-solving exercises, laboratory experiments, and design projects to reinforce theoretical concepts and develop practical skills in analyzing and designing structures and mechanical components. The course aims to provide students with a solid understanding of the behavior of materials under different loading conditions, enabling them to analyze and design structures that can withstand applied forces and loads safely

List of Experiments mapped with COs

Sr. No	List of Experiments	COs
1	To study the Brinell hardness testing machine & perform the Brinell hardness test.	C214.1
2	To study the Rockwell hardness testing machine & perform the Rockwell hardness test.	C214.1
3	To study the Vickers hardness testing machine & perform the Vickers hardness test.	C214.3
4	To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.	C214.3
5	To study the Impact testing machine and perform the Impact tests (Izod & Charpy)	C214.2
6	To study the Universal testing machine and perform the tensile test.	C214.3
7	To perform compression & bending tests on UTM	C214.4
8	To perform the sheer test on UTM.	C214.4
9	To study the torsion testing machine and perform the torsion test	C214.4

DOs and DON'Ts

DOs

1. Work deliberately and carefully.
2. Keep your work area clean.
3. Students must wear college uniform and carry their college ID.
4. Students should have separate note book for practical.
5. Students should have their own pencil, eraser, scale, along with pen and lab note book.
6. Handle the equipment /models carefully.

DON'Ts

1. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
2. Do not eat food, drink beverages or chew gum in the laboratory.
3. Do not open any irrelevant internet sites on lab computer.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.

2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth, if possible, isolate the burning equipment from the other surrounding equipment.

3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

Emergency: Reception

Security : Main Gate

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows:

1) All files must contain a title page followed by an index page. The files will not be signed by the faculty without an entry in the index page.

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Pre-experiment work (as given by the faculty)

(iii) Lab assignment questions and their solutions

(iv) Test Cases (if applicable to the course)

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab assessment criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes areassessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Pre-Lab written work (this may be assessed through viva)	Complete procedurewith underlined concept is properly written	Underlined conceptis written but procedure is incomplete	Not able to writeconcept and procedure	Underlined conceptis not clearly understood
AC2: Manual Writing/ Modeling	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/tools are applied, Program/solution written is readable	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/tools are applied	Assigned problem is properly analyzed & correct solution designed	Assigned problem is properly analyzed and corrected
AC3: Identification & Removal of errors	Able to identify errors and remove them	Able to identify errors/and remove them with little bit of guidance	Is dependent totallyon someone for identification of errors and their removal	Unable to understand the reason for errors even after theyare explicitly pointed out
AC4:Execution & Demonstration	All variants of input /output are tested, Solution is well demonstrated and implemented concept is clearly explained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output aretested, Solution is well demonstrated but implemented concept is not clearly explained	Solution is not well demonstrated and implemented concept is not clearly explained

AC5:Lab Record Assessment	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % ofthe assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output	Less than 70 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants ofinput and output	Less than 40 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output

EXPERIMENT NO. – 01

AIM :- To study the Brinell Hardness testing machine and the Brinell hardness test.

APPARATUS: - Brinell Hardness testing machine, specimen of mild steel / cast iron/ non ferrous metals and Brinell microscope.

THEORY: - Hardness represents the resistance of material surface to abrasion, scratching and cutting, hardness after gives clear identification of strength. In all hardness testes, a define force is mechanically applied on the test piece for about 15 seconds. The indentor, which transmits the load to the test piece, varies in size and shape for different tstes.Common indenters are made of hardened steel or diamond.

In Brinell hardness testing, steel balls are used as indentor. Diameter of the indentor and the applied force depend upon the thickness of the test specimen, because for accurate results, depth of indentation should be less than $1/8^{th}$ of the thickness of the test pieces. According to the thickness of the test piece increase, the diameter of the indentor and force are changed.

SPECIFICATION OF HARDNESS TESTING OF HARDNESS TESTING M/C AND INDENTORS

A hardness test can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker testing m/c. the specimen may be a cylinder, cube, think or thin metallic sheet. A Brinell-cum-Rockwell hardness testing m/c along with the specimen is shown in figure. Its specification are as follows:

1. Ability to determine hardness upto 500BHN.
2. Diameter of ball (as indentor) used D = 2.5mm, 5mm, 10mm.
3. Maximum application load = 3000kgf.
4. Method of load application = Lever type
5. Capability of testing the lower hardness range = 1 BHN on application of $0.5D^2$ load.

PROCEDURE:-

1. Insert ball of dia 'D' in ball holder of the m/c.
2. Make the specimen surface clean by removing dust, dirt, oil and grease etc.
3. Make contact between the specimen surface and the ball by rotating the jackadjusting wheel.
4. Push the required button for loading.
5. Pull the load release level and wait for minimum 15 second. The load will automatically apply gradually.
6. Remove the specimen from support table and locate the indentation so made.View the indentation through microscope and measure the diameter 'd' bymicrometer fitted on microscope.
7. Repeat the entire operation, 3-times.

OBSERVATION AND CALCULATION : - Following observation are recorded from atest on steel specimen using a hardened steel ball as indentor.

Test piece material = ---------------

S.No.	Ball diameter 'D' in mm.	Load applied P inkgf.	Diameter of indentation 'd' (mm)	P/D2	BHN

BHN = Load Applied (kgf.)/ Spherical surface area indentation (in mm.)

$$2P/\pi D(D-\sqrt{D^2 - d^2})$$

PRECAUTIONS:-

1. The specimen should be clean properly.

2. Take reading more carefully and correct.

3. Place the specimen properly.

4. Jack adjusting wheel move slowly

5. After applying load remove the load.

RESULT:-

CONCLUSION:-

VIVA-QUESTIONS:-

*   What is the limitation of Brinell hardness test and why ?

*   Which is the hardest material ? and why ?an we predict the tensile strength of a material if its hardness in known ?

*   What is the unit of B.H.N?

*   Which ball size is recommended for Brinell test?

EXPERIMENT NO. – 02

AIM : To study the Rockwell Hardness testing machine and perform the Rockwell hardness test.

APPARUTS :- Rockwell Hardness testing machine, specimen of mild steel or other material.

THEORY: - Hardness represents the resistance of material surface to abrasion, scratching and cutting, hardness after gives clear indication of strength. In all hardness tests, a define force is mechanically applied on the piece, varies in size and shape for different tests. Common indentors are made of hardened steel or diamond.

Rockwell hardness tester presents direct reading of hardness number on a dial provided with the m/c. principally this testing is similar to Brinell hardness testing. It differs only in diameter and material of the indentor and the applied force. Although there are many scales having different combinations of load and size of indentor but commonly 'C' scale is used and hardness is presented as HRC. Here the indentor has a diamond cone at the tip and applied force is of 150 kgf. Soft materials are often tested in 'B' scale with a 1.6mm dia. Steel indentor at 60kgf.

SPECIFICATION OF HARDNESS TESTING M/C AND INDENTORS:-

A hardness test can be conducted can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker testing m/c. the specimen may be a cylinder, cube, thick or thin metallic sheet. A Brinell-cum-Rocwell hardness testing m/c along with the specimen is shown in figure.

<u>Various scales in Rockwell hardness test are given below:-</u>

Scale	Type of indentor (Dimension)	Initial load (kgf)	Major load (kgf)	Pointer Position non dial	Kind of material
A	Cone, 120º	10	50	0	Much harder such as carburized steel, cemented
					carbides
B	Ball, 1.58mm	10	90	30	Soft steels, copper, aluminum, brass, grey cast iron.
C	Cone, 120º	10	140	0	Hard steels, Ti, W, Va, etc

PROCEDURE:-

1. Insert ball of dia. 'D' in ball holder of the m/c.

2. Make the specimen surface clean by removing dust, dirt, oil and grease etc.

3. Make contact between the specimen surface and the ball by rotating the jackadjusting wheel.

4. Push the required button for loading.

5. Pull the load release lever wait for minimum 15 second. The load will automatically apply gradually.

6. Remove the specimen from support table and locate the indentation so made.

7. Repeat the entire operation, 3-times.

OBSERVATION AND CALCULATION : -

Following observation are recorded are from a test on steel specimen using a hardenedsteel ball as indentor.

- Test piece material =-----------
- $HRA = 100 - (t/0.002)$
- $HRB = 130 - (t/0.002)$
- $HRC = 100 - (t/0.002)$

PRECAUTIONS:-

- The specimen should be clean properly
- Take reading more carefully and

Experiment No.-3

Aim-To study the Vickers hardness testing machine & perform the Vickers hardness test.

APPARATUS:

- Vickers Hardness Testing Machine.
- Diamond cone indentor,
- Specimen.

THEORY:

Very Hard materials (e.g. Mild steel, case hardened steel, etc,) can be tested by the Vickers' method. If the moderately hard materials like Brass, Copper and Aluminum are tested in this machine, the indentor makes a deep impression. Hence, a proper indentation cannot be made on the specimen and correct value of the hardness cannot be obtained for these materials by V. H. Test.

VHN = Load Sloping or pyramidal area of the indentation

This test is similar to the Brinell hardness test similar relationship and eliminates most of the errors. The produced impression is projected onto a focusing screen and the diagonals of the impression are measured by means of the measuring equipment. Due to small impressions, it is very suitable for testing polished and hardened material surfaces. This test is rapid and accurate. The required load as calculated by P/D2 ratio is applied on the specimen for a standard time of 8-10 seconds and BHN is calculated by the ratio of load and the spherical area of indentation. The diameter of the indentation is measured on the focusing screen of the machine.

SUITABLE APPLICATION:

- Vickers hardness test is used for hardness testing of all solid materials, including metallic materials.
- It is suitable for a wide range of applications.
- It can also be used for a sub-group of hardness testing of welds.

EQUIPMENT DESCRIPTION:

Figure 3: Vickers Hardness Testing Machine.

PROCEDURE:

a) Clean the surface at the specimen

b) Fix the indentor in the hardness tester and switch on the power supply.

c) Place the specimen with a cleaned surface facing the indentor on the anvil at worktable.

d) Focus the workpiece surface for clean visibility by rotating the hand wheel at the worktable upwards and downwards.

e) Select the load specified (P) push button available on the right side at the hardnesstester.

f) Actuate the electric push button (Green Button) at the front for loading, the loading lever starts moving up words and reaches the study position.

g) Now release the loading lever slowly and bring it to the downward position.

h) For major reading adjust the display at the indentation made by the indentor to coincide with the micrometre on the display screen.

i) For major (minor) reading adjust the movable side at the micrometre and note down the total reading.

j) The measurement is to be made for two opposite corners of the diagonal indentation denoted as (l).

k) Repeat the above procedure for different material.

OBSERVATION AND CALCULATION:

Type of indentor = Diamond cone

S/No	Specimen	Load applied in Kg-F	Length of Indentation in mm(l)			Average length in mm	VHN= $\frac{1.854P}{l^2}$
			1	2	3		

Vickers Hardness Number **(VHN) =** $\dfrac{1.854P}{l^2}$

Where,
P= Load applied in Kg
l= Average length of the diagonal L in mm
Least count of microscope=0.001mm
1st scale each division =0.1mm
2nd scale each division =0.01
3rd scale each division =0.001mm

PRECAUTIONS:

❖ The specimen should be well cleaned.
❖ Place the specimen properly.

❖ Reading must be taken carefully and correctly.

RESULTS: Vickers hardness Number of the given specimen is

➤ Mild steel =

➤ Hardened mild steel =

CONCLUSION:

REFERENCES:

1. Metals Handbook, 9th ed., *Mechanical Testing*, Vol. 8, 1990.

2. G. Dieter, *Mechanical Metallurgy*, S1 ed., Mc Graw Hill, 1986.

3. N. Dowling, *Mechanical Behavior of Materials*, Prentice Hall, 1993.

Experiment No. - 4

Aim: - To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.

APPARATUS REQUIRED: - Cupping test machine, test specimen, vernier calliper, steel rule.

THEORY:

This is a mechanical test used to determine the ductility and drawing properties of sheet metal. It consists in measuring the maximum depth of bulge or cup which can be formed before fracture.

Cupping number is the depth of impression at fracture, in the cupping test, usually expressed in millimeters.

PROCEDURE:

1. Measure the dimension of the test piece.
2. Place the test piece in the machine dies and touch the penetrator.
3. Rotate the handle of the machine to penetrate the penetrator in the test piece bypressing the retaining ring.
4. As soon as crack appears in the test piece stop rotating the handle.
5. Determine the depth of cup from med, which is the cupping number.

OBSERVATION:-

1. Thickness of test piece: 0.5 to 2 mm.
2. Rotation speed: 5 to 20 mm per minute.
3. Diameter of ball: 20 mm

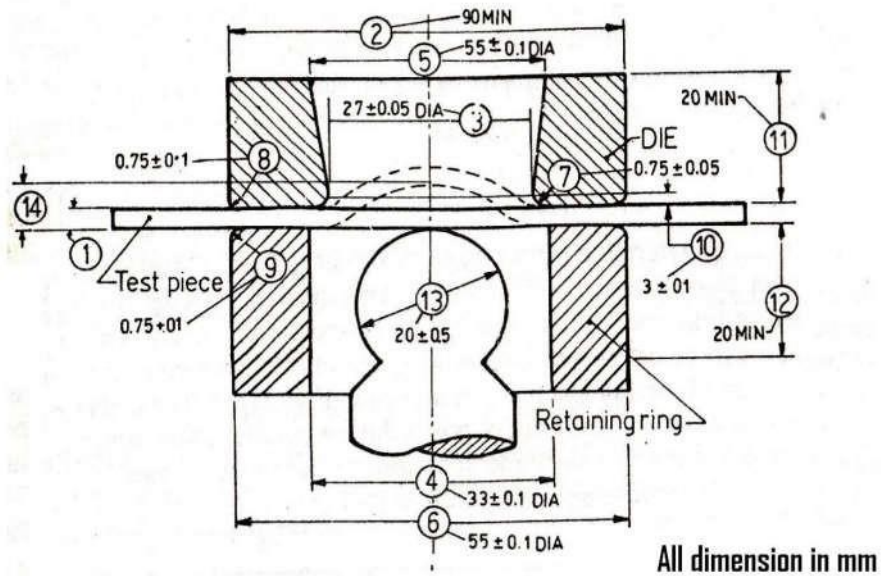| S.No.	Test piece thickness in mm	Reading		Cupping Number
		Initial	Final	

Fig. Schematic of Enrichen cupping test

PRECAUTION:

1. Test piece should be perfectly flat.

2. Test piece should be free from foreign matter.

3. The cup formed should be continuously watched.

4. The handle should be rotated uniformly and continuously.

SOURCES OF ERROR:

1. Handle being rotated with jerks.

2. Test piece not perfectly flat.

QUESTIONS:-

1. What is ductility and formability of Metals?

2. Industrial uses of ductility and formability.

EXPERIMENT NO. – 05

AIM:- To study the Impact Testing m/c and Perform Izod impact test &charpy

APPARATUS :- Impact testing m/c, Izod test specimens of mild steel, Aluminium, Vernier caliper, specimen setting fixture.

THEORY :- In manufacturing locomotive wheels, coins, connecting rods etc. the components are subjected to impact (shock) loads. These loads are applied suddenly. The stress induced in these components are many times more than the stress produced by gradual loading. Therefore, impact tests are performed to asses shock absorbing capacity of materials subjected to suddenly applied loads. These capabilities are expressed as (i) Rupture energy (ii) Modulus of rupture and (iii) Notch impact strength.

Two types of notch impact tests are commonly-

1. Charpy test
2. Izod test

In Izod test, the specimen is placed as 'cantilever beam'. The specimens have V-shaped notch of 45°. U-shaped notch is also common. The notch is located on tension side of specimen during impact loading. Depth of notch is generally taken as t.5 to t/3 where 't' is thickness of the specimen.

SPECIFICATION OF M/C AND SPECIMEN DETAILS :

Its specifications along-with their typical values are as follows:

- Impact capacity = 164joule
- Least count of capacity (dial) scale = 2joule
- Weight of striking hammer = 18.7 kg.
- Swing diameter of hammer = 1600mm.
- Angle of hammer before striking = 90°
- Distance between supports = 40mm.
- Striking velocity of hammer = 5.6m/sec.
- Specimen size = 75x10x10 mm.
- Type of notch = V-notch
- Angle of notch = 45°

- Depth of notch = 2

PROCEDURE :-

1.   Lift the hammer to an appropriate knife edge position and notch the energy stored inthe hammer. For the standard Izod test the energy stored should be 164j.

2.   Locate the test specimen on the m/c supports.

3.   Release the hammer. The hammer will break the piece and shoot up the other side ofthe specimen.

4.   Note the residual energy indicated on the scale by the hammer.

5.   Impact strength of the test specimen is the difference of the initial energy stored inhammer and the residual energy.

OBSERVATION :-

S.No.	Initial Energy (E1) in joule	Residual Energy (E2) in Joule	Absorb Energy (E1-E2)

CALCULATION :-

- Modulus of rupture = Rupture / Effective volume of specimen
- Notch impact strength = Absorb energy / Effective cross section area

PRECAUTIONS :-

1.   The specimen should be prepared in proper dimensions.

2.   Take reading more frequently.

3.   Make the loose pointer in contact with the fixed pointer after setting the pendulum.

4.   Do not stand in front of swinging hammer or releasing hammer.

5.   Place the specimen proper position.

RESULT :- The impact strength of given specimen = ------- joule/mm

AIM : To study the Impact testing machine and perform the Impact tests (Charpy)

THEORY :- In manufacturing locomotive wheels, coins, connecting rods etc. the components are subjected to impact (shock) loads. These loads are applied suddenly. The stress induced in these components are many times more than the stress produced by gradual loading. Therefore, impact tests are performed to asses shock absorbing capacity of materials subjected to suddenly applied loads. These capabilities are expressed as (i) Rupture energy (ii) Modulus of rupture and (iii) Notch impact strength.

Two types of notch impact tests are commonly-

3. Charpy test

4. Izod test

In charpy test, the specimen is placed as 'cantilever beam'. The specimens have V-shaped notch of 45°. U-shaped notch is also common. The notch is located on tension side of specimen during impact loading. Depth of notch is generally taken as t.5 to t/3 where 't' is thickness of the specimen.

SPECIFICATION OF M/C AND SPECIMEN DETAILS :

Its specifications along-with their typical values are as follows:

- Impact capacity = 300joule
- Least count of capacity (dial) scale = 2joule
- Weight of striking hammer = 18.7 kg.
- Swing diameter of hammer = 1600mm.
- Angle of hammer before striking = 160°
- Distance between supports = 40mm.
- Striking velocity of hammer = 5.6m/sec.
- Specimen size = 55x10x10 mm.
- Type of notch = V-notch
- Angle of notch = 45°
- Depth of notch = 2 mm.

PROCEDURE :-

1. Lift the hammer to an appropriate knife edge position and notch the energy stored inthe hammer. For the standard charpy test the energy stored should be 164j.

2. Locate the test specimen on the m/c supports.

3. Release the hammer. The hammer will break the piece and shoot up the other side ofthe specimen.

4. Note the residual energy indicated on the scale by the hammer.

5. Impact strength of the test specimen is the difference of the initial energy stored inhammer and the residual energy.

OBSERVATION :-

S.No.	Initial Energy (E1) in joule	Residual Energy (E2) in Joule	Absorb Energy (E1-E2)

CALCULATION :-

*   Modulus of rupture = Rupture / Effective volume of specimen
*   Notch impact strength = Absorb energy / Effective cross section area

PRECAUTIONS :-

6. The specimen should be prepared in proper dimensions.

7. Take reading more frequently.

8. Make the loose pointer in contact with the fixed pointer after setting the pendulum.

9. Do not stand in front of swinging hammer or releasing hammer.

10. Place the specimen proper position.

RESULT :- The impact strength of given specimen = ------- joule/mm^2

VIVA-QESTIONS :-

- In what way the values of impact energy will be influenced if the impact tests are conductedon two specimens, one having smooth surface and the other having scratches on the surface ?

- What is the effect of temp. on the values of rupture energy and notch impact strength ?

- What is resilience? How is it different from proof resilience and toughness?

- What is the necessity of making a notch in impact test specimen ?

- If the sharpness of V-notch is more in one specimen than the other, what will be its effect onthe test result ?

EXPERIMENT NO. – 6

AIM :- To study the UTM and perform the tensile test.

APPARATUS :- A UTM, mild steel specimen, vernier caliper/micrometer, dial gauge & graph paper.

THEORY :- Various m/c and structure components are subjected to tensile loading in numerous application. For safe design of these components, there ultimate tensile strength and ductility one to be determine before actual use. Tensile test can be conducted on UTM.

A material when subjected to a tensile load resists the applied load by developing internal resisting force. These resistances come due to atomic bonding between atoms of the material. The resisting force for unit normal cross-section area is known as stress.

The value of stress in material goes on increasing with an increase in applied tensile load, but it has a certain maximum (finite) limit too. The minimum stress, at which a material fails, is called ultimate tensile strength. The end of elastic limit is indicated by the yield point (load). This can be sen during experiment as explained later in procedure with increase in loading beyond elastic limit original cross-section area (Ao) goes on decreasing and finally reduces to its minimum value when the specimen breaks.

ABOUT OF UTM & ITS SPECIFICATIONS :-

The tensile test is conducted on UTM. It is hydraulically operates a pump, oil in oil sump, load dial indicator and central buttons. The left has upper, middle and lower cross heads i.e; specimen grips (or jaws). Idle cross head can be moved up and down for adjustment. The pipes connecting the lift and right parts are oil pipes through which the pumped oil under pressure flows on left parts to more the cross-heads.

SPECIFICATIONS :-

1. Load capacity = 0-40000 kgf.
2. Least count = 8kgf.
3. Overall dimn. =
4. Power supply = 440V

PROCEDURE :-

1. The load pointer is set at zero by adjusting the initial setting knob.

2.   The dial gauge is fixed and the specimen for measuring elongation of small amounts
     Measuring the diameter of the test piece by vernier caliper at least at three places   d

     Determine the mean value also mark the gauge length.

3.   Now the specimen is gripped between upper and middle cross head jaws of the m/c.

4.   Set the automatic graph recording system.

5.   Start the m/c and take the reading.

6.   The specimen is loaded gradually and the elongation is noted until the specimen breaks.

OBSEVATION :-

(I) Initial diameter of specimen d1 = ------

(II) Initial gauge length of specimen L1 = -----

(III)   Initial cross-section area of specimen A1 = ----

(IV)   Load of yield point Ft. = -----

(V) Ultimate load after specimen breaking F = -----

(VI)   Final length after specimen breaking L2 = ------

(VII)   Dia. Of specimen at breaking place d2 = -------

(VIII)   Cross section area at breaking place A2 = ----

CALCULATION :-

(i) Ultimate tensile strength = ------

(ii) Percentage elongation % = ------

(iii)Modulus of elasticity E = --------

(iv)Yield stress = --------

(v) % reduction in area = -------

PRECAUTIONS :-

1.   The specimen should be prepared in proper dimentions.

2.   The specimen should be properly to get between the jaws.

3.   Take reading carefully.

4.   After breaking specimen stop to m/c.

RESULT :-

CONCLUSION:

VIVA-QUESTIONS :-

- Which steel have you tested ? what is its carbon content ?

- What general information are obtained from tensile test regarding the properties of a material

- Which stress have you calculated : nominal stress or true stress ?

- What kind of fracture has occurred in the tensile specimen and why ?

- Which is the most ductile metal ?How much is its elongation ?

EXPERIMENT NO. – 07

AIM:- To Perform compression & bending test on UTM.

APPARATUS :- A UTM or A compression testing m/c, cylindrical or cube shaped specimen of cast iron, Alumunium or mild steel, vernier caliper, liner scale, dial gauge (or compressometer).

THEORY :- Several m/c and structure components such as columns and struts are subjected to compressive load in applications. These components are made of high compressive strength materials. Not all the materials are strong in compression. Several materials, which are good in tension, are poor in compression. Contrary to this, many materials poor in tension but very strong in compression. Cast iron is one such example. That is why determine of ultimate compressive strength is essential before using a material. This strength is determined by conduct of a compression test.

Compression test is just opposite in nature to tensile test. Nature of deformation and fracture is quite different from that in tensile test. Compressive load tends to squeeze the specimen. Brittle materials are generally weak in tension but strong in compression. Hence this test is normally performed on cast iron, cement concrete etc. But ductile materials like aluminium and mild steel which are strong in tension, are also tested in compression.

TEST SET-UP, SPECIFICATION OF M/C AND SPECIMEN DETAILS :

A compression test can be performed on UTM by keeping the test-piece on base block (see in fig.) and moving down the central grip to apply load. It can also be performed on a compression testing machine. A compression testing machine shown in fig. it has two compression plates/heads. The upper head moveable while the lower head is stationary. One of the two heads is equipped with a hemispherical bearing to obtain. Uniform distribution of load over the test-piece ends. A load gauge is fitted for recording the applied load.

SPECIMEN :- In cylindrical specimen, it is essential to keep h/d ≤ 2 to avoid lateral instability due to bucking action. Specimen size = h ≤ 2d.

PROCEDURE :-

1. Dimension of test piece is measured at three different places along its height/length todetermine the average cross-section 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 plates, such that the centre ofmoving 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

intervalmay be as 500 kg.

6.   Load is applied until the specimen fails.

OBSERVATION :-

1.   Initial length or height of specimen h =-------mm.

2.   Initial diameter of specimen do =--------------mm.

S.No.	Applied load (P) in Newton	Recorded change in length (mm)

CALCULATION :-

- Original cross-section area Ao = -----

- Final cross-section area Af = --------

- Stress = -------

- Strain = -------

   For compression test, we can

- Draw stress-strain (σ-ε) curve in compression,

- Determine Young's modulus in compression,

- Determine ultimate (max.) compressive strength, and

- Determine percentage reduction in length (or height) to the specimen.

   PRECAUTIONS :-

- The specimen should be prepared in proper dimensions.

- The specimen should be properly to get between the compression plates.

- Take reading carefully.

- After failed specimen stop to m/c.

RESULT :- The compressive strength of given specimen = ------- Nmm^2
Bending test-

THEORY :- Bending test is perform on beam by using the three point loading system. The bending fixture is supported on the platform of hydraulic cylinder of the UTM. The loading is held in the middle cross head. At a particular load the deflection at the center of the beam is determined by using a dial gauge. The deflection at the beam center is given by:

$$\delta = WL^3 / 48EI$$

PROCEDURE :-

1. Measure the length, width and thickness of test piece, by vernier caliper.
2. Place the bending fixture on the lower cross head of the testing m/c.
3. Place the test piece on the rollers of the bending fixture.
4. By loading the dial gauge in a stand, make its spindle knob the test piece.
5. Start the m/c and note down the load and dial gauge readings.
6. Plot the graph between load and deflection.

OBSERVATION :-

1. Least count of vernier caliper = -----
2. Length of beam (L) = --------
3. Width of beam (b) = ------
4. Thickness of beam (t) = ------

S.No.	Load 'W' in Newton	Deflection 'δ' in mm.	Young's Modulus 'E' N/mm^2

CALCULATION :-

- $I = bt^3 / 12$

- $\delta = WL^3 / 48EI$

PRECAUTIONS :-

1. Test piece should be properly touch the fixture.
2. Test piece should be straight.

3. Take reading carefully.

4. Elastic limit of the beam should not be exceeded.

RESULTS

VIVA QUESTION

- What is deflection ? how will define ?
- What is moment of inertia ?
- What is young modulus ?
- Write Euler's formula.
- How many types of column ?

EXPERIMENT NO. – 08

AIM :- To perform the shear test on UTM.

APPARATUS USED :- A UTM, Specimen, shearing attachment, vernier caliper etc.

THEORY :- A type of force which causes or tends to cause two contiguous parts of the body to slide relative to each other in a direction parallel to their plane of contact is called the shear force. The stress required to produce fracture in the plane of cross-section, acted on by the shear force is called shear strength.

PROCEDURE :-

The method for determining the shear strength consists of subjecting a suitable length of steel specimen in full cross-section to double shear, using a suitable test rig, in a testing m/c under a compressiveload or tensile pull and recording the maximum load 'F' to fracture.

OBSERVATION :-

- Applied compressive force (F) = -----------kgf.
- Diameter of specimen = ----------mm.

CALCULATION :-

The shear strength shall be calculated from the following formulae :

$\tau_s = (F/2) / (\pi d^2/4) = 2F / \pi d^2$

where 'd' is the actual diameter of the specimen

PRECAUTIONS :-

- The specimen should be all place equal dia.
- Measure the diameter of specimen carefully.
- The specimen should be properly grip between the test rig.
- Take reading more carefully.
- After shearing specimen stop to m/c.

RESULT :- Shear strength of specimen = --------

CONCLUSION :-

VIVA-QUESTIONS :-

- Does the shear failure in wood occur along the 45° shear plane ?

- What is buldging? Why does it occur?

- What is single & double shear ?

- What is find in shear test?

- What is unit of shear strength ?

Experiment No. -9

Aim:- To study the torsion testing machine and perform the torsion test.

Apparatus:- 1. A torsion test machine along with angle of twist measuring attachment.

2. Standard specimen of mild steel.

3. Steel rule.

4. Vernnier caliper or a micrometer.

Theory:- For transmitting power through a rotating shaft it is necessary to apply a turning force. The force is applied tangentially and in the plane of transverse cross section. The torque or twisting moment may be calculated by multiplying two opposite turning moments. It is said to be in pure torsion and it will exhibit the tendency of shearing off at every cross section whichis perpendicular to the longitudinal axis.
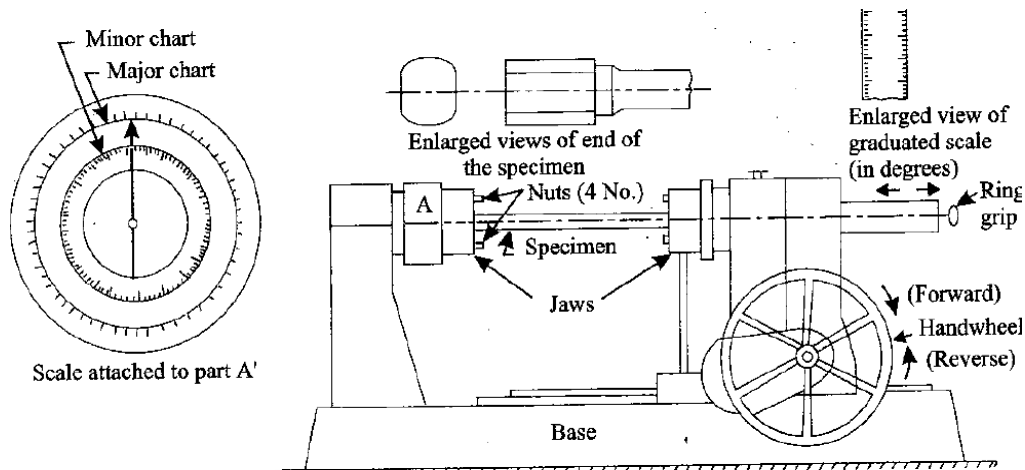

Fig:- Torsion Testing Machne

Torsion equation:-

T/J = τ/R= Gθ/L

G = T L/J θ N/mm²

T= maximum twisting torque (N mm)

J = polar moment of inertia (mm^4) = π d^4/32

τ = shear stress (N/mm^2)

G = modulus of rigidity

(N/mm^2)θ = angle of

twist in radians

L= length of shaft under torsion (mm)

Procedure:-

1. Select the driving dogs to suit the size of the specimen and clamp it in the machine by adjustingthe length of the specimen by means of a sliding spindle.
2. Measure the diameter at about three places and take the average value.
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero.
5. Set the protractor to zero for convenience and clamp it by means of knurled screw.
6. Carry out straining by rotating the hand wheel in either direction.
7. Load the machine in suitable increments.
8. Then load out to failure as to cause equal increments of strain reading.
9. Plot a torque- twist (T- θ) graph.
10. Read off co-ordinates of a convenient point from the straight line portion of the torque twist(T- θ) graph and calculate the value of G by using relation.

Precautions:-

1) Measure the dimensions of the specimen carefully
2) Measure the Angle of twist accurately for the corresponding value of Torque.
3) The specimen should be properly to get between the jaws.
4) After breaking specimen stop to m/c.

Result And Obeservations:-

L=Gauge length of the

specimen,

d=Diameter of the specimen,

J=Polar moment of inertia,

$$J = \pi \, d^4/32 =$$

Viva Question:

1. Define torsion.
2. What is the formula for torsional equation?
3. What is SI unit of Polar Moment of Interia.
4. SI Unit of Polar moment of inertia of Hollow shaft.