MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY & MANAGEMENT
(Approved by AICTE-New Delhi, Accredited by NAAC with 'A' & Affliated to JNTU, Hyderabad)
Recognised Under Section 2(f) & 12(B) of The UGC act, 1956
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DEPARTMENT OF CIVIL ENGINEERING

STRENGTH OF MATERIALS LAB MANUAL

Subject Code	1930173
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Class	II -B. Tech (Civil Engineering)
Semester	II-I

Prepared by	
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CERTIFICATE

This is to certify that this manual is a Bonafide record of practical work in the **Strength of Materials Laboratory** for **First Semester of Second year B.Tech (Civil Engineering) Programme** of academic year **2019-2020**. The book is prepared by **Dr.M.Saravanan,** Associate Professor, Department of Civil Engineering and **Mr. V. Sathish Kumar,** Associate Professor, Department of Civil Engineering of Marri Laxman Reddy Institute of Technology and Management

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PREFACE

This book entitled "**STRENGTH OF MATERIAS LABORATORY MANUAL**" is intended for the use of third semester (II-I) B.Tech (Civil Engineering) students of **Marri Laxman Reddy Institute of Technology and Management**, Dundigal, Hyderabad. The main objective of the Strength of Materials Laboratory Manual is to furnish the conceptual understanding of the basic behavior of solid bodies subjected to various types of loading and to determine the stresses, strains, and deflections produced by the loads in the test specimen with laboratory experiments. This book lays foundation of certain basic concepts and skills that can be repeatedly employed by the students in their future endeavors. This book will be useful to develop the habit of scientific reasoning and provides answers to all the doubts that arise during the course of conducting experiments. The book is written for 2019 - Regulation by referring JNTUH R-18 in a simple language. Hence we hope this book serve for better understanding for the student community with all details of experiments

By,

Dr.M.Saravanan (Associate Professor/CE)
&
Mr.V.Sathish Kumar (Associate Professor/CE)

ACKNOWLEDGEMENT

It was really a good experience, working at strength of material lab manual. First I would like to thank Mr.T.Jaya Krishna, Mr.Purna Chandra sai, Asst.Professor and Mr. Dsvsmrk Chakravathy Assoc.Professor, Department of Civil Engineering, Marri Laxman Reddy Institute of technology & Management for giving the technical support in preparing the document.

I express my sincere thanks to Mr.K.Murali, Head of the Department of Civil Engineering, Marri Laxman Reddy Institute of Technology & Management, for his concern towards me and gave me opportunity to prepare strength of materials laboratory manual.

I am deeply indebted and gratefully acknowledge the constant support and valuable patronage of Dr.R.Kotaiah, Director, Marri Laxman Reddy Institute of Technology & Management. I am unboundedly grateful to him for timely corrections and scholarly guidance.

I express my hearty thanks to Dr.K.Venkateswara Reddy, Principal, Marri Laxman Reddy Institute of Technology & Management, for giving me this wonderful opportunity for preparing the strength of materials laboratory manual.

At last, but not the least, I would like to thank all the faculties of Department Civil Engineering those who have supported me to prepare this strength of materials laboratory manual.

By,

Dr.M.Saravanan (Associate Professor/CE)

&

Mr.V.Sathish Kumar (Associate Professor/CE)

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GENERAL INSTRUCTIONS

1. Students are instructed to come to laboratory on time. Late comers are not entertained in thelab.
2. Students are expected to come prepared at home before the experiments are performed atlab.
3. Students are instructed to display their ID cards and wear apron before entering thelab.
4. Students are instructed not to bring mobile phones to thelab.
5. Breakageamountwillbecollectedfromthestudent(s)forcausingdamagetotheinstruments / Equipment's due to wrong operation or carelessness
7. For each lab class, all the students are expected to come with observation note book, record note book, pencil, eraser, sharpener, scale, divider, graph sheets, French curveetc.
8. Students should update the records and lab observation books session wise.Before leaving the Lab the student should get his lab observation book signed by thefaculty.
9. Students should submit the lab records 2/3 days in advance to the concerned faculty members in the staff room for their correction andreturn.
10. Students should not move around the lab during the labsession.
11. If any emergency arises, the student should take the permission from faculty member concerned in writtenformat.
12. The faculty members may suspend any student from the lab session on disciplinarygrounds.
13. Never change or modify the result by recording false observations or by making manipulated calculations.
14. All the data should be verified with the relevantunits.

SAFETY PRECAUTIONS

1. While working in the laboratory suitable precautions should be observed to prevent accidents.
2. Always follow the experimental instructionsstrictly.
3. The laboratory dress code should be worn while working in the laboratory to protect the clothing from damage by rotatingmachines.
4. Power supply to your test table should be obtained only through the LabTechnician.
5. Use the first aid box in case of anyaccident/mishap
6. Never work in the laboratory unless a demonstrator or teaching assistant ispresent
7. Make sure, while leaving the lab after the stipulated time that all the instruments are returnedcarefully.

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INSTITUTION VISION AND MISSION

VISION

To be as an ideal academic institution by graduating talented engineers to be ethically strong, competent with quality research and technologies

MISSION

To fulfill the promised vision through the following strategic characteristics and aspirations:

- Utilize rigorous educational experiences to produce talented engineers
- Create an atmosphere that facilitates the success ofstudents
- Programs that integrate global awareness, communication skills and Leadershipqualities
- Education and Research partnership with institutions and industries to prepare the students for interdisciplinaryresearch

DEPARTMENT VISION, MISSION, PROGRAMME EDUCATIONAL OBJECTIVES AND SPECIFIC OUTCOMES

VISION

The Civil Engineering department strives to impart quality education by extracting the innovative skills of students and to face the challenges in latest technological advancements and to serve thesociety.

MISSION

1. Provide quality education and to motivate students towardsprofessionalism
2. Address the advanced technologies in research and industrialissues

PROGRAMME EDUCATIONAL OBJECTIVES

The Programme Educational Objectives (PEOs) that are formulated for the civil engineering programme are listed below;

PEO1: Establish a successful professional career in industry, government or academia.

PEO2: Gain multidisciplinary knowledge providing a sustainable competitive edge in higher studies or Research.

PEO3: Promote design, analyze, and exhibit of products, through strong communication, leadership and ethical skills, to succeed an entrepreneurial.

PROGRAM SPECIFIC OUTCOMES

PSO 1 - UNDERSTANDING: Graduates will have ability to describe, analyse and solve problems using mathematical, scientific, and engineering knowledge.

PSO 2 - ANALYTICAL SKILLS: Graduates will have an ability to plan, execute, maintain, manage, and rehabilitate civil engineering systems and processes.

PSO 3 - EXECUTIVE SKILLS: Graduates will have an ability to interact and work effectively in multi disciplinary teams.

PROGRAMME OUTCOMES

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE STRUCTURE, OBJECTIVES & SYLLABUS AND OUTCOMES

COURSE STRUCTURE

Strength of materials lab will have a continuous evaluation during third semester for 25 Sessional Marks and 75 End Semester Examination Marks.

Out of the 25 marks for internal evaluation, day-to-day work in the laboratory shall be evaluated for 15 marks and internal practical examination shall be evaluated for 10 marks conducted by the laboratory teacher concerned.

The end examination will be evaluated for a maximum of 75 marks. The end semester examination shall be conducted with an external examiner and internal examiner. The external examiner shall be appointed by the Principal / Chief Controller of examinations

COURSE OBJECTIVE

In this laboratory, students will have the opportunity to apply loads to various materials under different equilibrium conditions. The student will perform tests on materials in tension, compression, torsion, bending, and impact. These conditions and/or constraints are designed to reinforce classroom theory by having the student perform required tests, analyze subsequent data, and present the results in a professionally preparedreport.

The machines and equipment used to determine experimental data include Universal Testing Machines, Torsion Equipment, Spring Testing Machine, Compression Testing Machine, Impact Tester, Hardness Tester, etc. Data will be collected using Dial indicators, extensometers, strain gauges and strain indicator equipment, as well as load and strain readouts on the machinery.

INTRODUCTION

Strength of material is the body of knowledge which deals with the relation between internal forces, deformations and external loads etc. This laboratory provides the basic knowledge of strength of materials and here, the students can perform different tests on different materials.

1930113: STRENGTH OF MATERIALS LAB

B.Tech. II YearI Sem **L/T/P/D/C**
0/0/3/0/1.5

LIST OF EXPERIMENTS:

1. Tensiontest
2. Bending test on (Steel / Wood) Cantileverbeam.
3. Bending test on simple supportbeam.
4. Torsiontest
5. Hardnesstest
6. Springtest
7. Compression test onconcrete
8. Impacttest
9. Sheartest
10. Verification of Maxwell's Reciprocal theorem onbeams.
11. Use of electrical resistance straingauges
12. Continuous beam – Deflectiontest.
13. Compression test onbricks

COURSE OUTCOME:

Upon the completion of Strength of Materials Lab course, the student will be able to:

CE217.1	Understand the stresses and strains and relations between them.
CE217.2	Evaluate bending moment on supports and beams.
CE217.3	Apply the concept of springs in different conditions.
CE217.4	Determine hardness of standard metals.
CE217.5	Understand the concept of resistance in materials
CE217.6	Determine impact strength of materials.

EXPERIMENT NO: 01

TENSION TEST

AIM: To conduct tensile test for a given mild steel specimen.

OBJECT: To conduct a tensile test on a mild steel specimen and determine the following:

(i) BreakingStrength

(ii) Stress at Elasticlimit

(iii) Yieldstrength

(IV) Ultimatestrength

(v) Young's modulusof elasticity

(VI) Percentageelongation

(vii) Percentage reduction inarea.

APPARATUS:

(i) Universal Testing Machine(UTM)
(ii) Mild steelspecimens
(iii) Scale
(iv) VernierCaliper

DIAGRAM:

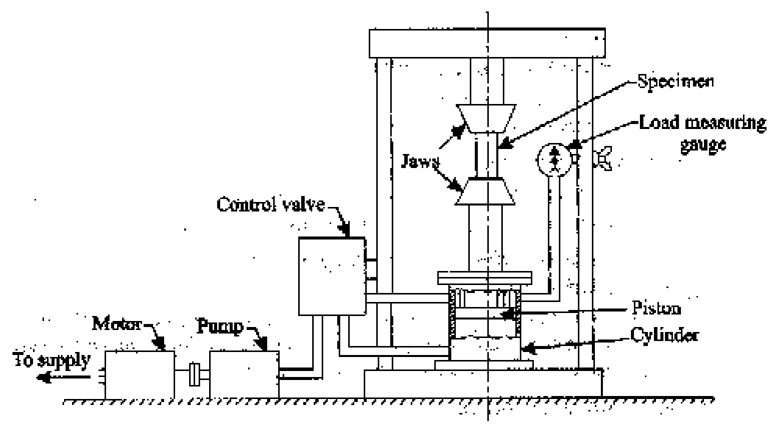
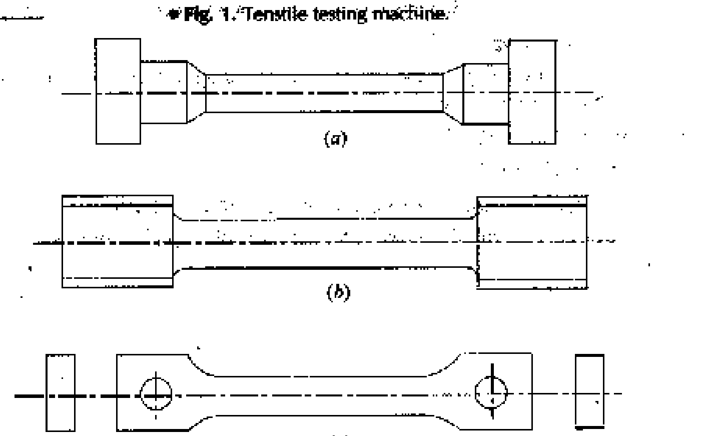


Fig. 1. Tensile testing machine.



TABULATION:

S. No.	Load (N)	Area of Specimen (mm^2)	Increase inlength or Extension	Stress (N/mm^2)	Strain (No Unit)	Modulus of Elasticity (N/mm^2)
					Average	

THEORY:-

The tensile test is most applied one, of all mechanical tests. In this test ends of test piece are fixed into grips connected to a straining device and to a load measuring device. If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original form as soon as load is removed. However, if the load is too large, the material can be deformed permanently. The initial part of the tension curve which is recoverable immediately after unloading is termed. As elastic and the rest of the curve which represents the manner in which solid undergoes plastic deformation is termed plastic. The stress below which the deformations essentially entirely elastic is known as the yield strength of material. In some material the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and a lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation, at larger extensions strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. This stage the “ultimate strength”’ which is defined as the ratio of the load on the specimen to original cross-sectional area, reaches a maximum value. Further loading will eventually cause ‘neck’ formation andrupture/fracture.

PROCEDURE:-

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of thespecimen.
2. Insert the specimen into grips of the test machine &attach strain-measuring device toit.
3. Begin the load application and record load versus elongationdata.
4. Take readings more frequently as yield point isapproached.
5. Measure elongation values with the help of dividers and aruler.
6. Continue the test till Fractureoccurs.
7. By joining the two broken halves of the specimen together, measure the final length and diameter ofspecimen.

OBESERVATION:

Diameter of therodd$_0$

:

Original lengthof rod :

Yieldpointload :

Ultimateload :

Breakingload :

Diameter of the rod at neck: d_f :

Finalgauge length :

CALCULATIONS:

Original area of cross section (A_o) = $\frac{\pi}{4} d_o^2$ =

Area of cross section at neck (A_f) = $\frac{\pi}{4} d_f^2$

Stress at elastic limit = Load at elastic limit / Original Cross sectional area

BreakingStress = Breaking load / Cross sectional area atfailure

= ________ N/mm^2

Ultimatestress = $\frac{ultimate\ load}{original\ area}$

= ________ N/mm^2

Stress at yield point = $\frac{yield\ load}{original\ area}$

= ________ N/mm^2

PercentageElongation = Increase in length / Original (gauge) length x100

=

= ________ N/mm^2

Percentage reduction in area = [(Original Area – Area at Failure) / Original Area] x 100

= ________ N/mm^2

PRECAUTIONS:-

1. If the strain measuring device is an extensometer it should be removed before neckingbegins.
2. Measure deflection on scale accurately &carefully.

RESULTS:-

i) BreakingStress =

ii) UltimateStress =

iii) Stress at yieldpoint =

iv) %Elongation =

v) % reductioninarea =

vi) Young'smodulus =

vii) Young'smodulus(Graph) =

TABULATION:

S No.	Load Applied W in (kg)	Dial Indicator Reading			D(avg) x Least Count (0.01)	Deflection in (mm)	Stiffness (w/y) (N/mm)	Young's modulus (E) (N/mm^2)
		Loading	Unloading	Avg.				
1.								
2.								
3.								
4.								

`

EXPERIMENT NO:02

BENDING TEST ON (STEEL/WOOD) CANTILEVER BEAM

AIM: To determine the young's modulus for the given steel beam byconductingbendingtest.

APPARATUS:

1. CantileverBeam
2. DialGauge
3. Weights

THEORY:

This method is used for testing of the deflection at various points on the beam. Whenever a beam is loaded, it deflects from its original position. The amount by which a beam deflects depends upon its cross section and the applied load i.e. bending moment. To design a beam, strength and stiffness properties are required. As per the strength orientation criteria of the beam designed, it should be strong enough to resist B.M. and S.F. As per the stiffness criteria, it should be strong enough to resist the deflection of the beam.

Consider a cantilever beam 'AB' of length L and carrying a point load 'W' at a given distance 'a' as shown in fig.

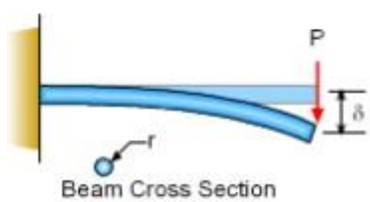


Fig 1. Cantilever beam

With the help of Macaulay's method,

Deflection of the beam at any section of a beam 'C' is $Wa^3/3EI$

And deflection at B i.e at free end is $WL^3/3EI$

Where, W =Deadweights, a = distance of point load from thefixedendL = Length of the beam, E = Young's modulus ofelasticity

I = Moment of inertia . For rectangle $I = bd^3/12$

PROCEDURE:

1. Check the flatness of the given beam with the help of deflectiongauge.
2. Place the hanger with the weights at a given distance on thebeam.
3. Now measure the deflection of the beam at both point load at any section and free end of thebeam.
4. Repeat the experiment at various points on thebeam.
5. Compare the values obtained with theoreticalvalues.

FORMULAE:

δ_c = deflection of the beam at a distance ‘a’ from the fixed end is given by $Wa^3/3EI$.

δ_b= deflection of the beam at free end is given by $WL^3/3EI$

PRECAUTIONS:

1. The beam must be loaded below its ultimate load. So that it may not fail under loading.
2. Adjust the dial indicator at the exact place where deflection needs to becalculated.
3. Note down the dial indicator readingscarefully.

RESULT:

Thus Young’s Modulus E identified for the cantilever beamis____________N/mm^2

OBSERVATIONS:

Material ofthe beam :

Length ofthebeam :

Breadth ofthebeam :

Depth ofthebeam :

Moment ofinertia(I) : $bd^3/12=$

TABULATION:

S No.	Load Applied **W** in (kg)	Dial Indicator Reading (D)			Deflection 'y' in mm {D (avg) x Least Count (0.01)}	Stiffness (w/y)	Young's modulus ."E" (N/mm^2)
		Loading	Unloading	Avg.			
1.							
2.							
3.							
4.							
5.							
6							

EXPERIMENT NO:03

BENDING TEST ON SIMPLY SUPPORTED BEAM

AIM: To determine the deflection of a simply supported beam with center or eccentric point load and also the young's modulus of the beam material.

APPRATUS:

1. Simply supportedbeam
2. Dialgauge
3. Weights

THEORY:

When the loads are placed on the beam, it undergoes deflection. The defection of the beam is determined with the help of the relation between defection of beam and the loading system. The young's modulus of the beam is obtained for this purpose; similarly the deflection of the simply supported beam with an eccentric point load is determined with the help of Macaulay's method.

DIAGRAM:

SUPPORTS: **BEAM:**

DESCRIPTION:

The apparatus consists of wood /steel beam resting on the simply supported knife edges; the load (W) is applied at centre and the maximum deflection is measured at the centre. For this load condition, the deflection at centre is given by $=wl^3/48EI$.

This can be written as $E=Wl^3/48\delta I$

Where, W= concentrated load at centre in 'N'

L= length of beam in mm

δ = deflection of beam in mm

Case I: To determine young's modulus of beam material $E= WL^3/48\delta I$

Case II: Deflection with aneccentricloading $\delta_c = Wa^2b^2/3EIL$

PROCEDURE:

1. Measure the breadth and depth of the beam at three sections along the span and takethe averagevalues.
2. Apply the load at the centre 'C' increasing order and measure the correspondingdeflections with the help of a dial gauge. Similarly apply the loads from A and B as shown in figure to calculate the deflection with an eccentric pointload.
3. Tabulate the deflections corresponding to variousloads.
4. Plot a graph between load and deflection from the graph corresponding to any twoconvenient points, find the values of (W/**δ**) ratio and calculate θ from theexpression

$E=WL^3/48\Delta i$

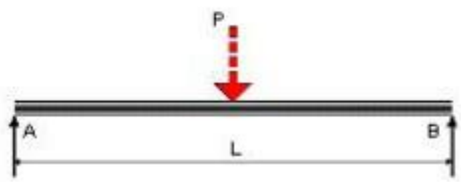


Fig 2. Simply supported beam

PRECAUTIONS:

1. The beam must be loaded below its ultimate load. So that it may not fail underloading.
2. Adjust the dial indicator at the excat place where deflection needs to becalculated.
3. Note down the dial indicator readingscarefully
4. Be sure that the distance marked on the beam isequal.
5. Before applying load do not forget to set the dial guage pointer to the initialpoint.
6. Make sure there is nothing placed on the table except the apparatus a smallest pressure on the table can spoil theexperiment.
7. Make sure that the beam and load are placed in the properposition

RESULT: Young's modulus (E) of beam material is =

OBESERVATION:

Gauge length of the specimen, l =

Side ofsquarespecimen, a

=Diameter of the circular specimen, d =

Polar moment ofinertia,Ip =

OBESERVATION TABLE:-

S.No	**Torque "T"** (N-mm)	**Angle of Twist" θ"**		**Modulus of Rigidity "G"** (N/mm^2)
		Degrees (θ)	Radians (θ x π/180)	
			Average	

Note : 1 N-mm = 1 Kg-cm x 9.81 x 10

EXPERIMENT NO: 04

TORSION TEST

AIM:

Torsion test on mild steelrod.

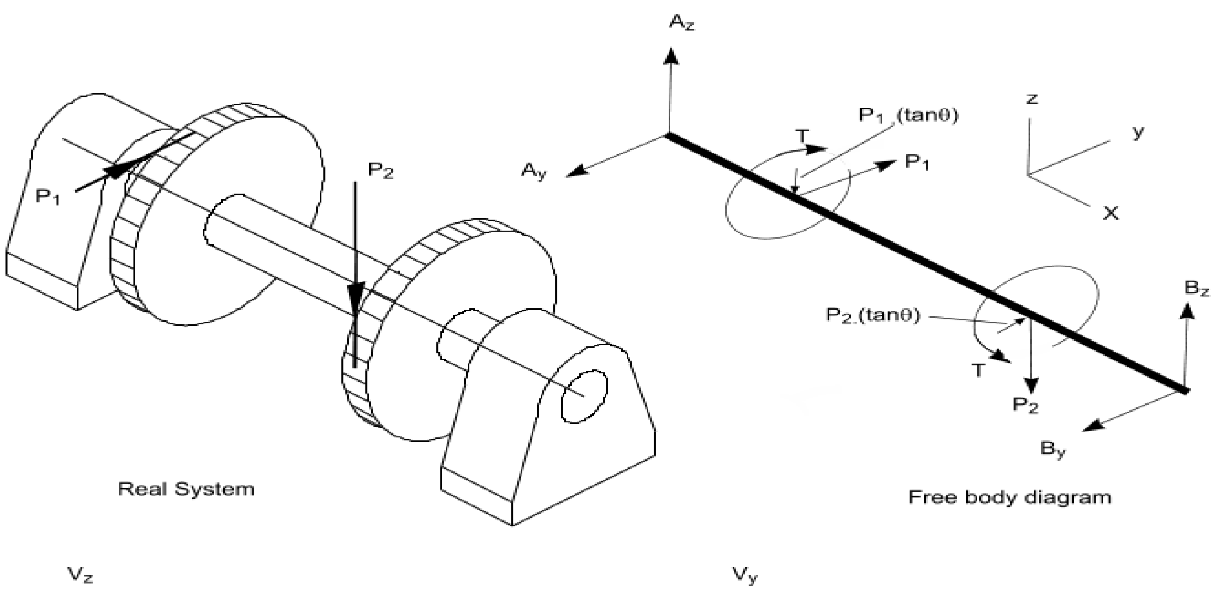
OBJECTIVE:

To conduct torsion test on mild steel or cast iron specimens to findout modulus of rigidity

APPARATUS:

1. A torsion testingmachine.
2. Twist meter for measuring angles oftwist
3. A steel rule and Vernier Caliper ormicrometer.

DIAGRAM:



THEORY:

A torsion test is quite instrumental in determining the value of modulus of rigidity of a metallic specimen. The value of modulus of rigidity can be found out thought observations made during the experiment by using the torsion equation

$$\frac{T}{Ip} = \frac{C\theta}{L} = \frac{q}{r}$$

`

Where, T = Torqueapplied,

I_p = Polar moment ofinertia,

C = Modulus ofrigidity

θ

=Angleoftwist(radians)L

= Length of theshaft

Q = Shearstress

R = Distance of element from center ofshaft

PROCEDURE:-

1. Select the driving dogs to suit the size of the specimen and clamp it in the machine by adjusting the length of the specimen by means of a slidingspindle.
2. Measure the diameter at about three places and take the averagevalue.
3. Choose the appropriate range by capacity changelever
4. Set the maximum load pointer tozero.
5. Set the protector to zero for convenience and clamp it by means of knurledscrew.
6. Carry out straining by rotating the hand wheel in eitherdirection.
6. Load the machine in suitableincrements.
7. Then load out to failure as to cause equal increments of strainreading.
8. Plot a torque- twist (T- θ)graph.
9. 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 C by usingrelation

PRECAUTION:-

1) Measure the dimensions of the specimencarefully.
2) Measure the Angle of twist accurately for the corresponding value ofTorque.

RESULT: Modulus of rigidity of mild steelrodis_________N/mm^2

OBESERVATION TABLE:

S.NO.	Specimens	Reading			Mean
		1	2	3	
1	Brass				
2	Aluminium				
3	Copper				

EXPERIMENT NO : 05

[A] HARDNESS TEST (Rockwell Test)

AIM: To measure the Rockwell hardness number for the given material**.**

APPARATUS:

A. Rockwell Hardness testingmachine
B. Steel and diamond coneindenter
C. Steel ballindenter
D. Specimens –Brass, copper andaluminium.

DIAGRAM:

THEORY: Material Hardness Testing determines a material's strength by measuring its resistance to penetration. Hardness test results can be extremely useful when selecting materials, because the reported hardness value indicates how easily the material can be machined and how well it will wear.The hardness of a material is resistance to penetration under pressure or resistance to abrasion. Hardness tests provide an accurate, rapid and economical way of determining the resistance of materials to deformation. There are three general types of hardness measurements depending upon the manner in which the test is conducted:

a. Scratch hardnessmeasurement
b. Rebound hardnessmeasurement
c. Indention hardnessmeasurement

`

In scratch hardness method the material are rated on their ability to scratch one another and it is usually used by mineralogists only. In rebound hardness measurement, a standard body is usually dropped on to the material surface and the hardness is measured in terms of the height of its rebound .The general means of judging the hardness is measuring the resistance of a material to indentation. The indenters usually a ball coneor pyramid of a material much harder than that being used. Hardened steel, sintered tungsten carbide or diamond indenters are generally used in indentation tests; a load is applied by pressing the indenter at right angles to the surface being tested. The hardness of the material depends on the resistance which it exerts during a small amount of yielding or plastic. The resistance depends on friction, elasticity, viscosity and the intensity and distribution of plastic strain produced by a given tool during indentation

PROCEDURE:

1. Place the specimen securely upon theanvil.
2. Elevate the specimen so that it come into contact with the penetrate and put the specimen under a preliminary or minor load of 100±2N withoutshock
3. Apply the major load 900N by loadinglever.
4. Watch the pointer until it comes torest.
5. Remove the majorload.
6. Read the Rockwell hardness number or hardnessscale.

PRECAUTION:

1. Brielle test should be performed on smooth, flat specimens from which dirt and scale have beencleaned.
2. The test should not be made on specimens so thin that the impression shows through the metal, nor should impression be made too close to the edge of a specimen.

RESULT:

The hardness of the material is found to be,

RHN ofBrass =

RHN ofAluminium =

RHN ofCopper =

TABLE:

S.No	**Material**	**Indenter Diameter (mm)**	**Load (kgf)**	**Diameter of Indentation**		**Average**
				T1	**T2**	
1.						
2.						
3.						

Material 1:

BrinellHardnessNumber= $\frac{2P}{\quad(\qquad)}$

=

Material 2:

BrinellHardnessNumber= $\frac{2P}{\quad(\qquad)}$

=

[B] BRINELL HARDNESSTEST

AIM:

To determine the Brinell's Hardness number (BHN) of the given specimen.

APPARATUS:

A. Brinell Hardness testingmachine
B. Ballindenter
C. Micrometer
D. Givenspecimen.

PRECAUTION:

1 The measuring range should not be changed at any stage during the test.

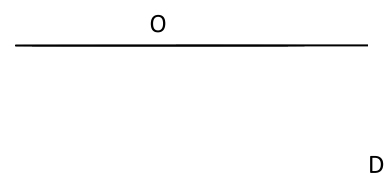
2. The inner diameter of the hole in the shear stress attachment should be slightly greater than that of thespecimen.

3. Measure the diameter of the specimenaccurately.

THEORY:

In case of Brinell hardness test a load `P' into the test specimen forces a steel ball of diameter 'D' and the diameter of the indentation'd' can be taken after the removal of the load.The BHN is obtained by dividing the load `P' by the curved surface area of the indentation. It is assumed to be spherical with diameter `D'. Let `n' be the depth of indentation inmm.

From the properties of the circle,



$$OE \times EF = AE \times EB$$

$$(D-h)\, h = d/2 \times d/2$$

$$Dh - h^2 = d^2/4$$

$$h = \frac{D}{2} \pm \frac{\sqrt{\ }}{2}$$

since the value of `h' is always less thFan D/2

$$h = \frac{D}{2} - \frac{\sqrt{\ }}{2}$$

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

P is to be chosen according to the type of material of the specimen and diameter of indenter.

where

P = Load applied in kgs — $P = 30\ D^2$ for mild steel

D = Diameter of the indenter — $P = 10\ D^2$ for brass & copper

d = Diameter of the indentation — $P = 5\ D^2$ for aluminium

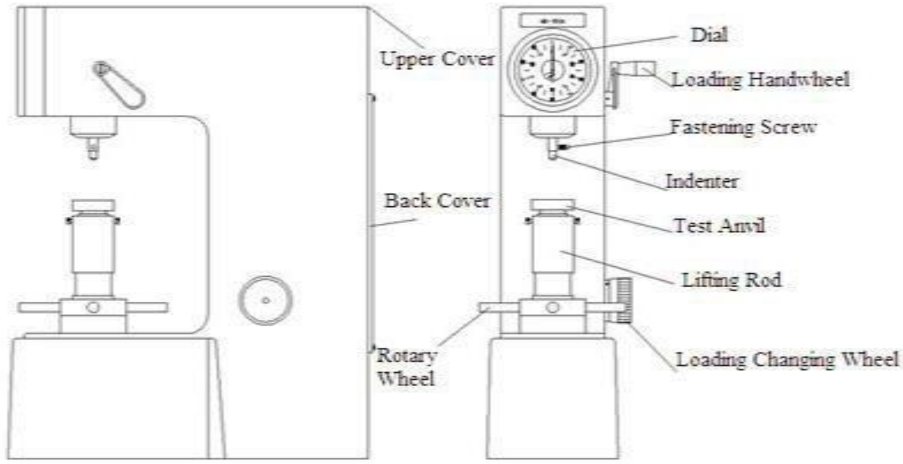
Material 3:

BrinellHardnessNumber= $\frac{2P}{\left(\qquad \right)}$

=

PROCEDURE:

1. Ball indenter is fixed in the socket provided in themachine.
2. The specimen having the thickness is taken and surface upon which the impression is to be done is polished and cleaned to remove any oil orgrade.
3. The specimen is kept on the table meant for supporting and clampedrigidly.
4. Steel ball is brought in contact with the specimen leaving nearly 1mm gap by raiding the table with the help of handle and clamp it rigidly in position. See that the ball is at least 5mm from the edge of thespecimen.
5. The suitable load is applied and the button is pressed. The load is applied for 15seconds.
6. Release the load but make certain that the ball still contacts the specimen. Remove the specimen from themachine.
7. Diameter of the impression on the specimen is measured using micrometer to the nearest 0.1mm.
8. Make five independent hardness determinations in eachspecimen.



RESULT:

1. BHNof =
2. BHNof =
3. BHNof =

A. COMPRESSIONTEST

OBESERVATION FOR COMPRESSION TEST ON OPEN COIL HELICAL SPRING

Least count of Vernier caliper = mm

Diameter of the spring wire, d = mm

Diameter of the spring coil, D = mm

Mean coil diameter (D_m) = mm

Number of turns , n =

OBESERVATION TABLE: COMPRESSION

S. No.	Axial Load applied ‘W’ kgf x 9.81 in (N)	Deflection δ in (mm)	Stiffness of spring k= W/δ(N/mm)	Modulus of Rigidity $C = \frac{8W (D_M)^3 \times n}{\delta d^4}$ (N/mm^2)

EXPERIMENT NO: 06

SPRING TEST

AIM: To determine the stiffness of the spring and modulus of rigidity of the given Spring wire.

APPARATUS:

i) Spring testingmachine.
ii) Aspring
iii) Verniercaliper
iv) Micrometer.
v) SteelRule.

DIAGRAM:

THEORY:

Springs are elastic member which distort under load and regain their original shape when load is removed. They are used in railway carriages, motor cars, scooters, motorcycles, etc. According to their uses the springs perform the following Functions:

1) To absorb shock or impact loading as in carriagesprings.
2) To store energy as in clocksprings
3) To apply forces to and to control motions as in brakes andclutches.
4) To measure forces as in springbalances.
5) To change the variations characteristic of a member as in flexible mounting ofmotors.

B. TENSIONTEST

OBESERVATION FOR TENSION TEST ON CLOSED COIL HELICAL SPRING

Least count of Verniercaliper = mm

Diameter of the spring wire,d = mm

Diameter of the springcoil,D = mm

Mean coildiameter(D_m) = mm

Number of turns,n = mm

OBESERVATION TABLE: TENSION

S. No.	Axial Load applied 'W' kgf x 9.81 in (Newtons)	Deflection δ in (mm)	Stiffness of spring k= W/ δ-N/mm	Modulus of Rigidity C = $\frac{8W (D_M)^3 \times n}{\delta d^4}$ (N/mm^2)

The spring is usually made of either high carbon steel (0.7 to 1.0%) or medium carbon alloy steels. Phosphor bronze, brass, 18/8 stainless steel and Monel and other metal alloys are used for corrosion resistance spring.

Several types of spring are available for different application. Springs are classified as helical springs, leaf springs and flat spring depending upon their shape. They are fabricated of high shear strength materials such as high carbon alloy steels spring form elements of not only mechanical system but also structural system. In several cases it is essential to idealize complex structural systems by suitable spring.

PROCEDURE:

1) Measure the diameter of the wire of the spring by using themicrometer.
2) Measure the diameter of spring coils by using the Verniercaliper
3) Count the number ofturns.
4) Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension orcompression.
5) Increase the load and take the corresponding axial deflection readings.

PRECAUTIONS:-

1) The dimension of spring was measuredaccurately.
2) Deflection obtained in spring was measuredaccurately

RESULTS:

A. Under compression test on open coil helicalspring

1. Rigidity Modulus (N) = ………………………… N/mm^2

2. Stiffness of spring (K) …………………………N/mm

B. Under Tension on closed coil helicalspring

1. Rigidity Modulus (N) = ………………………… N/mm^2

2. Stiffness of spring (K) = …………………………N/mm

OBSERVATIONS:

Concrete cube

L =

B =

H =

S.No	Area LX B (mm ^{2})	3 Days		7 Days		28 Days	
		Load , P in (N)	Compressive Strength P/A(N/mm^2)	Load, P in (N)	Compressive Strength P/A(N/mm^2)	Load, P in (N)	Compressive Strength P/A(N/mm^2)

EXPERIMENT NO: 07

COMPRESSION TEST ON CONCRETE

AIM:- To determine compressive strength ofconcrete.

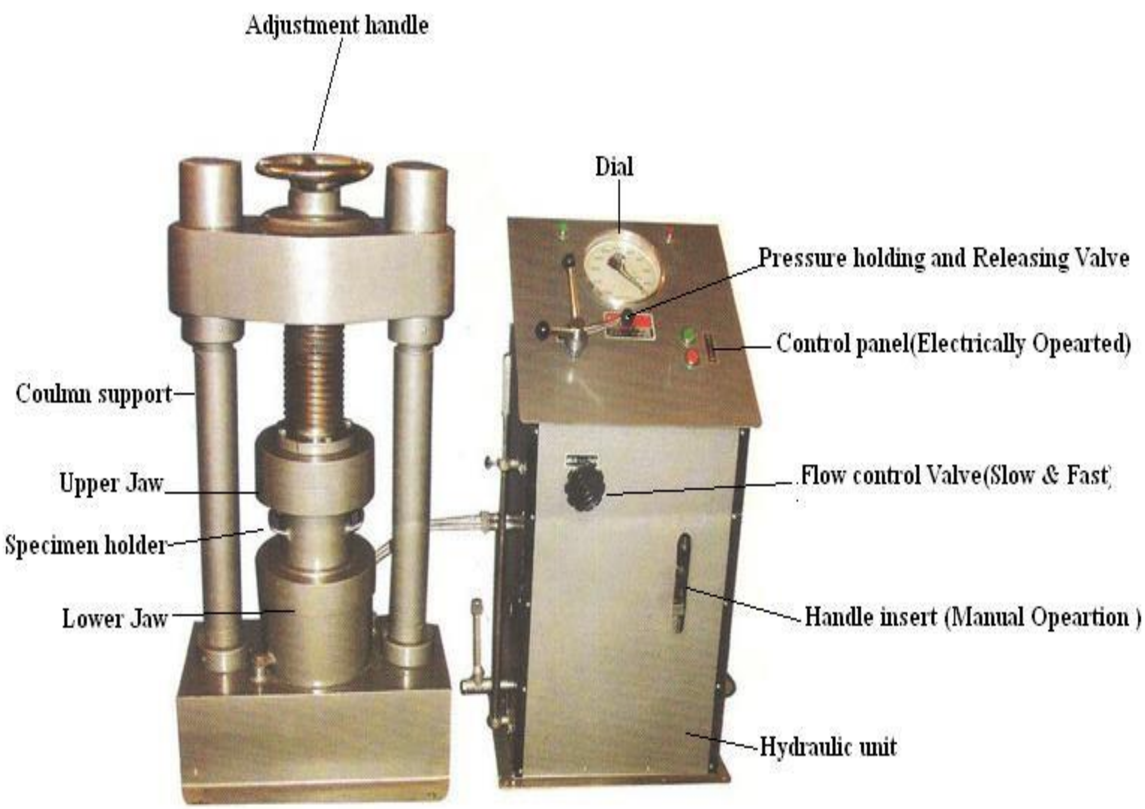
APPARATUS: Moulds for the test cubes, tamping rods , Curing tank, Scale, etc.

FORMULA:- Max.

LoadatfailureCompressiveStrength = --------------------

Loaded Area

DIAGRAM:-



THEORY : -

Concrete is used only for compression, since its contribution to tensile resistance is negligible. The compressive strength is determined by loading moulded concrete specimens (either cubes or cylinders) in uniaxial compression until ultimate failure. While cubes are advantageous because of the fact that loading on the cast side can be avoided (thus avoiding the need for specimen preparation.

PROCEDURE: -

1. Calculate the material required for preparing the concrete of givenproportions
2. Mix them thoroughly in mechanical mixer until uniform colour of concrete is obtained
3. Pour concrete in the oiled with medium viscosity oil. Fill concrete is cube moulds in two layers each of approximately 75mm and ramming each layer with 35 blows evenly distributed over the surface oflayer.
4. Fill the moulds in 2 layers each of approximately 50mm deep and ramming each layerheavily.
5. Struck off concrete flush with the top of themoulds.
6. Immediately after being made, they should be covered with wetmats.
7. Specimens are removed from the moulds after 24hrs and cured in water 28days
8. After 24hrs of casting, Cubes or cylinder specimens are capped by neat cement paste 35 percent water content on capping apparatus. After 24 hours the specimens are immersed into water for finalcuring.
9. Compression tests of cube or cylinder specimens are made as soon as practicable after removal from curing pit. Test-specimen during the period of their removal from the curing pit and till testing, are kept moist by a wet blanket covering and tested in a moistcondition.
10. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and withoutshock.
11. Also note the type of failure and appearancecracks.

PRECAUTIONS: -

1) Measure the dimensions of cubeaccurately.
2) The range of the gauge fitted on the machine should not be more than double the breaking load of specimen for reliableresults.

RESULT

1. The average compressive strength of concrete cube sample is ……………………..
   (N/mm^2) at 3days
2. The average compressive strength of concrete cube sample is ……………………..
   (N/mm^2) at 7days
3. The average compressive strength of concrete cube sample is ……………………..
   (N/mm^2) at 28days

OBESERVATION:-

Izod Test.

S No.	Size of the specimen	Area of cross-section A, m^2	Impact energy factor (k) in joules	Impact strength , I = K/A in (kJ/m^2)
			Average	

EXPERIMENT NO: 08
IMPACT TEST

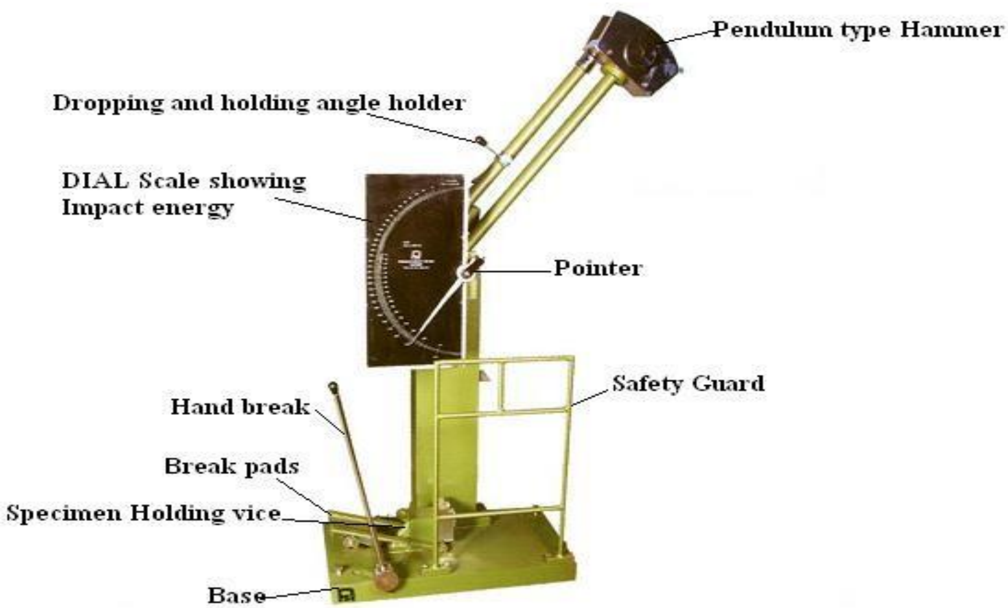
A. IZOD IMPACTTEST

AIM: To determine the impact strength of steel by Izod impacttest

APPARATUS: 1. Impact testingmachine

2. A steel specimen 75 mm X 10mm X 10mm

DIAGRAM:



DESCRIPTION OF APPARATUS:

The machine consists of

I. **PENDULUM TYPE HAMMER:** A swinging pendulum that has an arm and head. This is used to strike the specimen. This pendulum gives the required impact to the specimen. The hammer is used along with the striker. The striker is of 2types.

i. for Charpy
ii. forIzod

HAMMER HOLDER:

This is a spring-loaded and hand operated by means of a lever. It is having 2 positions one is at 140^0 for Charpy and other is at 90^0 for Izod. It is removed with the help of align key by removing thebolts.

HAND BREAK: It is used to stop the swinging hammer care must be taken while stopping the swinging hammer to avoid hand injury.

VICE: It is used to grip the Izod specimen and suppore for the charpy specimen.

DIAL GUAGE: The pointer of the dial guage moves along with the swinging hammer till the speed of the hammer is restricted by any obstruction i.e., specimen.

It is having 2 types of graduations

ForIzodtest 0 to164other

For Charpy test 0 to300

The striking hammer is fixed to rod, which is positioned according to the test i.e., 140^0 for charpy test and 90^0 horizontal for Izodtest.

THEORY:-

An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unnotched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness of the same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering oftemperature.

PROCEDURE:-

(a) lzodtest

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machine's vice in such a way that the notch face the hammer and is half inside and half above the top surface of thevice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at thatposition.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with themachine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost finalposition.
5. Again bring back the hammer to its idle position andback

PRECAUTION:-

1. Measure the dimensions of the specimencarefully.
2. Hold the specimen (lzod test)firmly.
3. Note down readingscarefully.

RESULT:

The Impact strength of Mild Steel is found outtobe__________kJ/m^2.

OBESERVATION: (Charpy test)

S No.	Size of the specimen	Area of cross-section A in m^2	Impact energy factor (k) in joules	Impact strength , I = K/A (kJ/m^2)
			Averge	

B. CHARPY IMPACTTEST

AIM: - To determined impact strength of steel using Charpy Impact Test Method**.**

APPARATUS: -1. Impact testing machine

2. A steel specimen 10 mm x 10 mm X 55mm

DIAGRAM: -

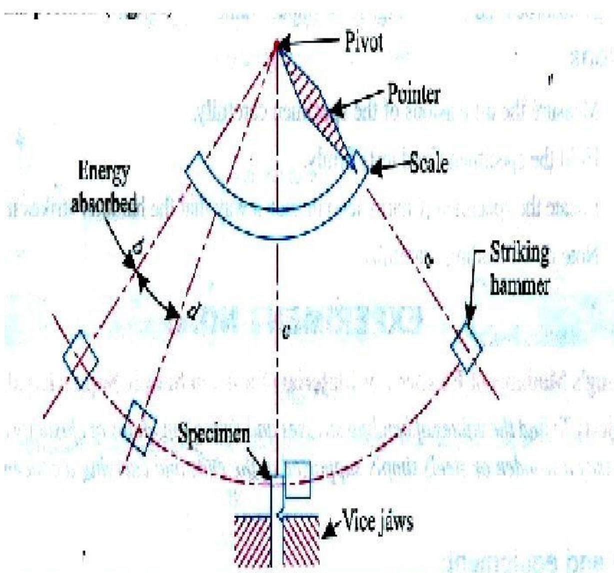
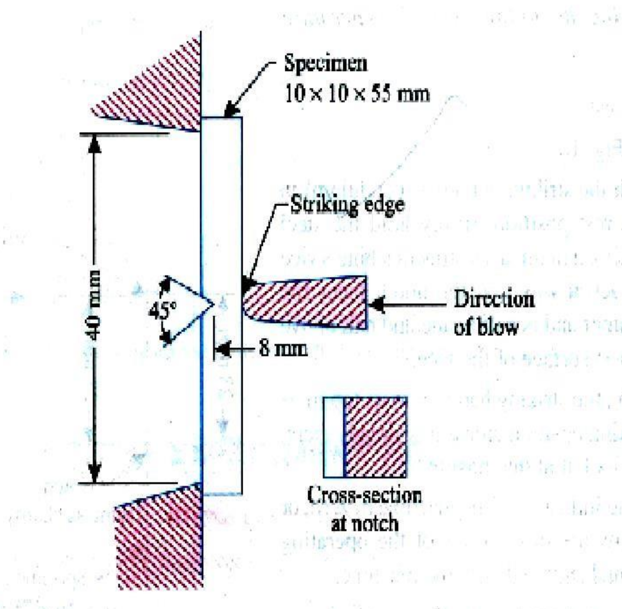


Fig. 11



THEORY:-

An impact test signifies toughness of material that is ability ofmaterial to absorb energy during plastic deformation. Static tension tests of unmatched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness ofthe same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering oftemperature.

PROCEDURE :- Charpy Test

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces s the hammer and is half inside and half above the top surface of thevice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at thatposition.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with themachine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. The specimen is placed on supports or anvil so that the blow of hammer is opposite to thenotch.

PRECAUTION:-

1. Measure the dimensions of the specimencarefully.
2 Locate the specimen (Charpy test) in such a way that the hammer, strikes it at the middle.
3 Note down readingscarefully.

RESULT:

The Impact strength of Mild Steel is found out to be ………………………… kJ/m^2.

OBESERVATIONS:-

Diameter of the Rod, D = mm

Cross-section area of the Rod (in single shear) = $\pi/4 \times d^2$ = mm^2

Cross-section area of the Rod (in double shear) = $2 \times \pi/4 \times d^2$ = mm^2

Load taken by the Specimen at the time of failure, W =

Strength of rod against Shearing $f = P / 2 \times \pi/4 \times d^2$ N/mm^2

Sr.No.	Material	Dia.(d) (mm)	Area(A) (mm^2)	Load P (N)	Stress=P/A (N/mm^2)
1	Mild steel				
2	Mild steel				
				Average	

EXPERIMENT NO: 09

SHEAR TEST

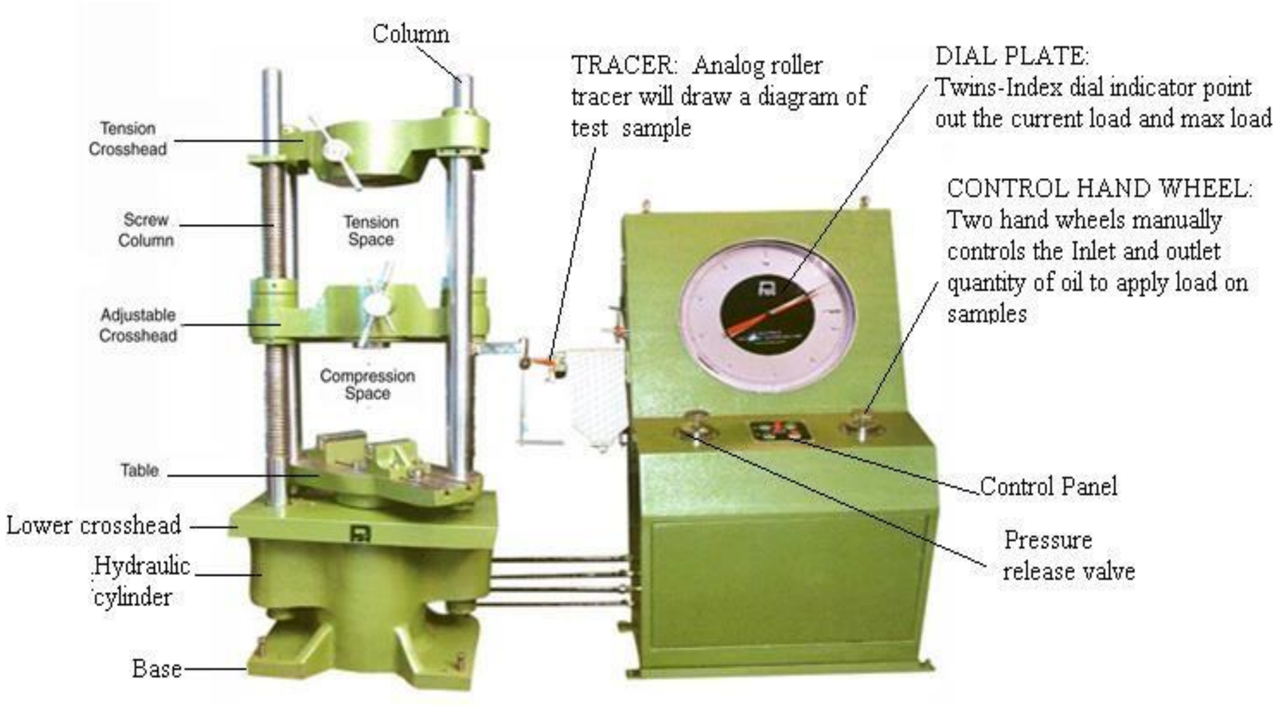
AIM: -To determined Shear Strength of Steel.

APPARATUS:- i) Universal testingmachine.

ii) Shear testattachment.

iii) Specimens.

DIAGRAM:-



<u>THEORY</u>: -Place the shear test attachment on the lower table, this attachmentconsists of cutter. The specimen is inserted in shear test attachment & lift the lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in single
Shear & if it breaks in three pieces then it will be in double shear.

PROCEDURE:

1. Insert the specimen in position and grip one end of the attachment in the upper portion and one end in the lowerportion.
2. Switch on the main switch of universal testingmachine.
3. The drag indicator in contact with the mainindicator.
4. Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancingweights.
5. Operate (push) buttons for driving the motor to drive thepump.
6. Gradually move the head control level in left-hand direction till the specimenshears.
7. Down the load at which the specimenshears.
8. Stop the machine and remove thespecimen
9. Repeat the experiment with otherspecimens.

PRECAUTIONS:-

1) The measuring range should not be changed at any stage duringthetest.

2) The inner diameter of the hole in the shear stress attachment should be slightly greater than that of thespecimen.
3) Measure the diameter of the specimenaccurately.

RESULT:

The Shear strength of mild steel specimen is foundtobe_______________N/mm^2

OBSERVATIONS:

Type of beam =

Width ofbeam(b) = mm

Depth ofbeam(d) = mm

Moment of inertia ($I=bd^3/12$) = mm^4

Span between supports for SSB(L) = mm

TABLE (1)

S.NO.	LOAD (N)	Dial indicating reading (D)			Deflection Y in mm {D(avg)x least count}	Stiffness (w/y)	Young's modulus $E = (Wa^2b^2) / 3LI\delta$
		Loading	Unloading	Avg			
1							
2							
3							
4							

EXPERIMENT NO: 10

VERIFICATION OF MAXWELL'S RECIPROCAL THEOREM ON BEAM

AIM: To verify the Maxwell's reciprocal theorem using simply supported beam and comparing practical and theoretical deflections.

EQUIPMENT: Beam, Weights, Vernier calipers, Scale, Supports, Dial gauge**.**

THEORY:

- Maxwell's Reciprocal Theorem states that when deflection 'δ' is measuredat point A by keeping load at point B then the deflection 'δ' is same when it is measured at point B by keeping same load at point A.
- In the first case for simply supported beam supports are placed at the ends and 'W' is placed at length of L/4 and dial gauge is placed at 3L/4 and deflection δ is measured.
- In the second case load W is placed at length of 3L/4 and dial gauge is placed at L/4 and deflection δ is measured. The deflection should be same in bothcases.
- The theoretical value of deflection at 'x' distance from one support of the beam is

Where
W = concentrated load in Newton.
L = Length of the span in simply supported beam in mm.
I = $bd^3/12$ (M.O.I about N.A)
b = the average breadth of the beam in mm.
d = the average depth of the beam in mm.

PROCEDURE:

1. Measure the width and depth of the beam using Vernier calipers at three different places and takeaverage.
2. Measure the length and mark the centre and edges leaving some minimum distance fromends.
3. Place the supports from the ends and note down the distance between supports(L).
4. Fix the dial at 3L/4 and note down the initialreading.
5. Place the weight 0.5 kg slowly on the beam at L/4 and corresponding deflection isnoted.
6. Add another 0.5 kg at same place total deflection noted from dialgauge.

CALCULATIONS:

The deflection at quarter point due to at the load at centre is given by

$$\delta = \frac{11WL^3}{768EI}$$

7. Repeat the steps for 8readings.
8. Fix the dial at L/4 and note down the initialreading.
9. Place the weight 0.5 kg slowly on the beam at 3L/4 and corresponding deflection isnoted.
10. Add another 0.5 kg at same place totaldeflection.
11. Repeat the steps for 8readings.

VERIFICATION

1. Compare the deflection under different loads in case (1) with those in case (2). They will be found to be the same, thus verifying thetheorem.

2. Superpose the plot of load Vs deflection or case (I) with that of case (2). They will coincide, thereby, verifying the theoremagain.

RESULT

Verification of Clerk-Maxwell's reciprocal theorem

Young's Modulus of the material of the beam =

SPECIFICATION OF CANTILEVER BEAM SET UP

Capacity :1kg

Type :

Straingaugebased.Strain gauge : Foil

type, 120ohms. Gaugefactor

2

Weights : 100gms –

10Nos.Beammaterial : Mildsteel.

Beamwidth

:41mm.B

eamthickness :2.85mm.

TABULAR COLUMN FOR FULL BRIDGE

Sl. No	Load Applied W		Strain Indicator Reading E_s – micro Strain	Measured Strain $E_m = E_s * 10^{-6}$	Bending stress. $\sigma = 6wl / bh^2$ (N/mm2)	Modulus of elasticity. $E = \sigma / E_m$ (N/mm^2)
	kg	N				

EXPERIMENT NO: 11

ELECTRICAL RESISTANCE STRAIN GAUGES

AIM: To determine the elastic constant (modulus of elasticity) of a cantilever beam subjected to concentrated end load by using strain gauges.

APPARATUS: A cantilever beam with concentrated end load arrangement, strain gauges and strainindicator.

THEORY: A body subjected to external forces is in a condition of both stress and strain. Stress can be directly measured but its effect. i.e. change of shape of the body can be measured. If there is a relationship between stress and strain, stresses occurring in a body can be computed if sufficient strain information is available. The constant connecting the stress and strain in elastic material under the direct stresses is the modulus of elasticity,
i.e. $E=\sigma / \epsilon$
the principle of the electrical resistance strain gauge was discovered by Lord Kelvin, when he observed that a stress applied to a metal wire, besides changing resistance strain gauges are made into two basic forms, bonded wire and bonded foil. Wire gauges are sandwiched between two sheets thin paper and foil gauges are sandwiched between two thin sheets of epoxy.
The resistance factor 'R' of a metal depends on its electrical resistively, , its area, a and the length l, according to the equation R = l / a.
Thus to obtain a high resistance gauge occupying a small area, the metal chosen has a high resistively, a large number of grid loops and a very small cross sectional area. The most common material for strain gauge is a copper - -nickel alloy known asAdvance.
The strain gauge is connected to the material in which it is required to measure the strain, with a thin coat of adhesive. Most common adhesive used is Eastman, Deco Cement, etc. as the test specimens extends or contracts under stress in the direction of windings, the length and cross sectional area of the conductor alter, resulting in a corresponding increase or decrease in electricalresistance.

GAUGE FACTOR: The dimension less relationship between the change in gauge resistance and change in length is called Gauge factor of the strain, which is expressed mathematically,
Gauge Factor, g = (R/R) / (l/l)

In this relationship R and I represent, respectively the initial resistance and initial length of the strain gauge filament, while R & l represents the small change in resistance and length, which occurs as the gauge is strained along with the surface to which it is bonded. This gauge factor of a gauge is a measure of the amount of resistance change for a given strain. The higher the gauge factor greater the electrical output for indication or recording purpose. The gauge factor is supplied by the manufacturer and may range from 1.7 to4.
The usual method of measuring the change of resistance in a gauge element is by means of Wheatstone bridge as shown in figure. It consists of Galvanometer, 4 resistor& a battery. Resistance R1 is the strain gauge is used for strain measurement, which is mounted on the specimen. The three resisters R2, R3 and R4 are internal to the device.
Let us assume that the resistance have been adjusted so that the bridge is balanced.

TABULAR COLUMN FOR HALF BRIDGE

Sl. No	Load Applied W (N)		Strain Indicator Reading E – micro Strain	Measured Strain $E_m = E*10^{-6}/2$ (N/nm^2)	Bending stress. sigma = 6wl / bh^2	Modulus of elasticity E = sigma / E_m (N/nm^2)
	W	N				

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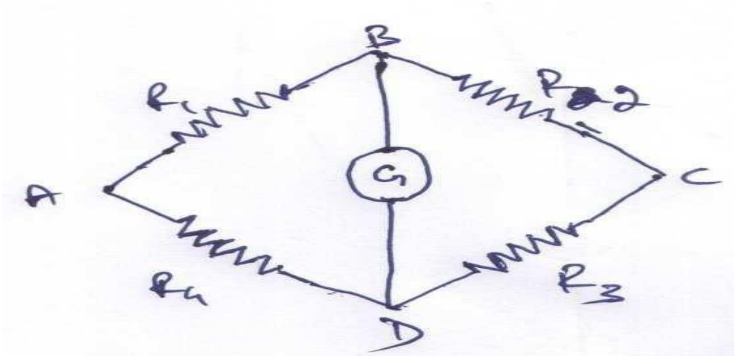


i.e. Voltage Ebd = 0.

Thus for initial balance, R1 * R3 = R2 * R4

Or

R1 = (R2*R4) / R3

If the structural member, to whom the strain gauge is bonded, is to be loaded and strained, there would be a resultant change in the resistance R1. According to the relationship,

R =R1 g * (l/l)

The strain indicator is calibrated for gauges of a given factor, thus it provides accurate reading only when gauges having the same gauge factor are used.

The most common bridge arrangements are single arm, two arm and four arm mode.

Single Arm Mode (Quarterbridge).

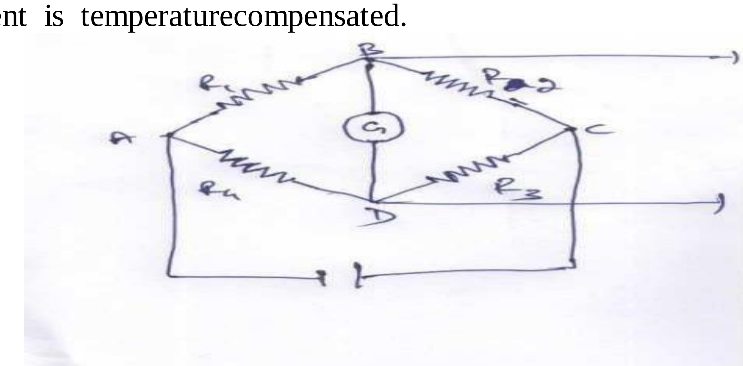
This bridge arrangement consists of a single active gauge in position, say R1 and three resistor are internal to the device. Temperature compensation is possible only if a self temperature compensating strain gauge is used.

Two Arm Mode (Half bridge).

In this mode, two resistor are internal to the device and the remaining two are strain gauges. One arm of this bridge is commonly labeled as active arm and the other as compensating arm. The bridge is temperature compensated.

Four Arm Mode (Full bridge).

In this bridge arrangement, four active gauges are placed in the bridge with one gauge in each of the four arms. If the gauges are placed on a beam in bending as shown in fig of the elastic constant by bending test experiment, the single from each of the four gauges will add. This bridge arrangement is temperaturecompensated.



Consider a cantilever beam .Let,

W = load applied on the beam in N.

l = distance between the center of the gauge to the point of the gauge to the point of application of load.

<u>TABULAR COLUMN FOR QUARTER BRIDGE</u>

Sl. No	**Load Applied W (N)**		**Strain Indicator Reading E– micro** Strain	**Measured Strain E_m=°*10^{-6} / 4**	**Bending stress. sigma = 6wl / bh^2**	**Modulus of elasticity. E = sigma / E_m (N/nm^2)**
	W	N				

b = width of the beam in mm.

h = thickness of the beam in mm.

M = bending moment = WL in N-mm.

I = moment of inertia = bh^3 / 12 mm^4

c = h/2 mm.

The bending equation is,

M / I = σ / c

Bending stress, σ = M c / I.

WI * h/2 * 12 / bh^3 = 6WI / bh^2.

Let,

ϵ = strain indicator reading in micro strain.

i = number of active gauges.

Measured strain, (ϵ_m) = ϵ*10-5 /i

Modulus of elasticity, E = σ / ϵ_m = 6WI / bh^3 ϵ_m

The strain gauges R1, R3 measure the tensile strain while the gauges R2, R4 measure the compressive strains. The strains ϵ1, ϵ2, ϵ3 and ϵ4 as measured by the gauges are of equal magnitude. The bridge is said to be working as full bridge and sensitivity (output) is four times that achievable with a single active gauge.

SET UP:

The set up comprises of cantilever beam made up of mild steel material. Square pipe with opening at one end the other end land for fixing the beam. Bottom of the square pipe has got a provision for fixing the sensor rigidly to the table. A loading pan is provided to load the sensor. Weights up to 1Kg in steps of 10gms will be provided with the setup. Specimen with strain gauges of 120 ohms are bonded on the material and connected in the form of wheat stones bridge and the terminals are brought out through a connector.

DIGITAL STRAIN INDICATOR

Strain indicator comprises of induct power supply, which provides power for strain gauge excitation. Signal conditioning and amplifying circuit’s access input from the strain gauges linearizes and amplifies the signal level. The output of the amplifier is controlled to required level and calibrated to read the strain in micro strain. Any stray forces on the sensor can be balanced by balancing the strain gauge bridge through pot in the front panel till the display reads zero. The system operates by 230V ACsupply.

STRAIN INDICATOR

Display : 3 ½ digital, LEDdisplays.

Accuracy : 1.

Resolution : 1s.

Connection : Through 4 coresshieldedcable.

Powerrequired : 230V,50hz

PANEL DETAILS

POWER ON:

Rocker switch which switches on the supply of the instrument, with red light indication.

ZERO:

Ten turn potentiometer. The display can be adjusted to read Zero when no force is applied.

CAL:

Single turn potentiometer. The output of the amplifier is adjusted by this potentiometer such that the display gives full scale for given range of sensor.

TO SENSOR:

Sensor is connected to the indicator through a four core cable with core male pins at both ends and respective color connections at the other end to connect the instrument.

FUNCTION:

Three position rotary switches is provided to select GF position READ position and CAL position. In READ position display will read directly Micro strain which load applied on the cantilever beam. In CAL position display will read maximum calibrated point i.e. 1000. In GF position display gauge factor i.e. 500

ARM: selector switch is to select the ARM are provided on the panel i.e. 4, 2 & 1.

MAINS INPUT: Power cable. Power cable to be connected to the mains supply of 230V 50Hz.

FUSE: 500 mA cartridge fuse with holder located on the rear side of the instrument to protect the instrument from internal electricalshorting.

CAUTION: Do not remove the fuse cap with power cable plugged to the mains supply.

PROCEDURE:

STRAIN MEASUREMENT IN FOUR ARM MODES (FULL BRIDGE)

1. Switch on the instrument and leave 5 minutes to warmup.
2. Connect the sensor (Cantilever beam) to instrument by 4 core cable with respectivecolored pins.
3. Keep the ARM selector switch to 4positions.
4. Select the FUNCTION switch to GF position and adjust the display to read 500 by GFpot.
5. Select the FUNCTION switch to READ position and adjust the display to read zero byzero pot.
6. Select the FUNCTION switch to CAL position and adjust the display to read 1000 by CAL pot.
7. Apply the load on cantilever beam, in steps of 100 grams and note down thereadings.

STRAIN MEASUREMENT IN TWO ARM MODES (HALF BRIDGE)

1. Switch on the instrument and leave 5 minutes to warmup.
2. Connect the sensor (Cantilever beam) to instrument by 4 core cable with respective colored pins.
3. Keep the ARM selector switch to 4positions.
4. Select the FUNCTION switch to GF position and adjust the display to read 500 by GFpot.
5. Select the FUNCTION switch to READ position and adjust the display to read zero by zeropot.

6. Select the FUNCTION switch to CAL position and adjust the display to read 1000 by CAL pot.
7. Apply the load on cantilever beam, in steps of 100 grams and note down thereadings.

STRAIN MEASUREMENT IN ONE ARM MODES (QUARTER BRIDGE)

1. Switch on the instrument and leave 5 minutes to warmup.
2. Connect the sensor (Cantilever beam) to instrument by 4 core cable with respective coloredpins.
3. Keep the ARM selector switch to 4positions.
4. Select the FUNCTION switch to GF position and adjust the display to read 500 by GFpot.
5. Select the FUNCTION switch to READ position and adjust the display to read zero by zeropot.
6. Select the FUNCTION switch to CAL position and adjust the display to read 1000 by CALpot.
7. Apply the load on cantilever beam, in steps of 100 grams and note down the Readings.

RESULT:

Modulus of elasticity of givenspecimen is_____________ N/mm^2

OBSERVATIONS:

OAD		Observed Deflection at E	Observed Deflection at H	Calculated deflection at E	Calculated deflection at H
AT D	AT G				

EXPERIMENT NO: 12

CONTINUOUS BEAM - DEFLECTION TEST

Aim: To conduct the deflection test on continuous beam

Apparatus: Continuous beam set up, dial gauges, weights

Theory: Consider the continuous beam having three supports as shown below:

1. The left support A is hinged with two roller supports at B andC.
2. The length of the span AB is equal to the length of the span BC which is equal to Leach.
3. The distance between AD=DE=EB=BG=GH=HC =L/3
4. The symmetrical loading W is applied at each one third points (D, G) in each span and deflections are measured using dial gauges at the other one third points in each span (E, and H) as shown in thediagram.
5. Compare the observed values with the theoretical deflection values at E andH.

Using the slope deflection method, the reactions are found as follows:

$$R_A = 14W/27,\ R_B = 26W/27,\ R_C = 14W/27$$

Slope at left end A is $i_A = WL^2 / 27EI$

Consider any section XX in span DB at a distance of x from left end A.

Use Macaulays method to find the the deflection.

$$EI\ d^2y/dx^2 = R_A x - W(x - (L/3))$$

The two conditions used to find constants of integration C1 and C2 are the slope and deflection at point B are zero (symmetrical loading on both the spans and support at B)

C1 = - 0.09259259 WL2

C2 = 6.1722 x 10-3 WL3

Compute the theoretical values of deflection using the following expression

The deflection at any point x in span DB is given by

Y = RA (x3/6) – W(x3/6) + WL (x2/6) + C1x + C2

A Sample calculation for deflection at point E for the sample data is given below:

Take,

W = 10 N L = 1000 mm X = 2/3 m = 666.66 mm E = 2 x 105 N/mm2 Breadth b = 30 mm Depth d = 5 mm I = bd3/12 = 312.5 mm4 EI = 625 x 105 Nmm2 C1 = - 0.09259259 *10 *1000*1000

C2 = 6.1722 x 10-3 *10* 10003

EIY (at x = 666.66 mm) = (140/27) (666.663/6) – 10(666.663/6) + 10.1000 (666.662/6) + 666.66 * (- 0.09259259 *10 *1000*1000) + 6.1722 x 10-3 *10* 10003

Y = 0.841 mm in the downward direction

Result:

Deflectioncalculated =

The observed values of deflection match with the theoretical values.

<u>OBSERVATIONS</u>:

<u>Clay brick</u>

L =

B =

H =

S.No	Volume = L X B XH (mm ^{3})	Area LX B (mm ^{2})	Initial Cracking		Final cracking		Average Compressive Strength P/A (N/mm^2)
			Load , P in (N)	Compressive Strength P/A(N/mm^2)	Load, P in (N)	Compressive Strength P/A(N/mm^2)	
1							
2							
3							
						Average	

EXPERIMENT NO: 13

COMPRESSION TEST ON BRICK

AIM:- To determine compressive strength ofbrick

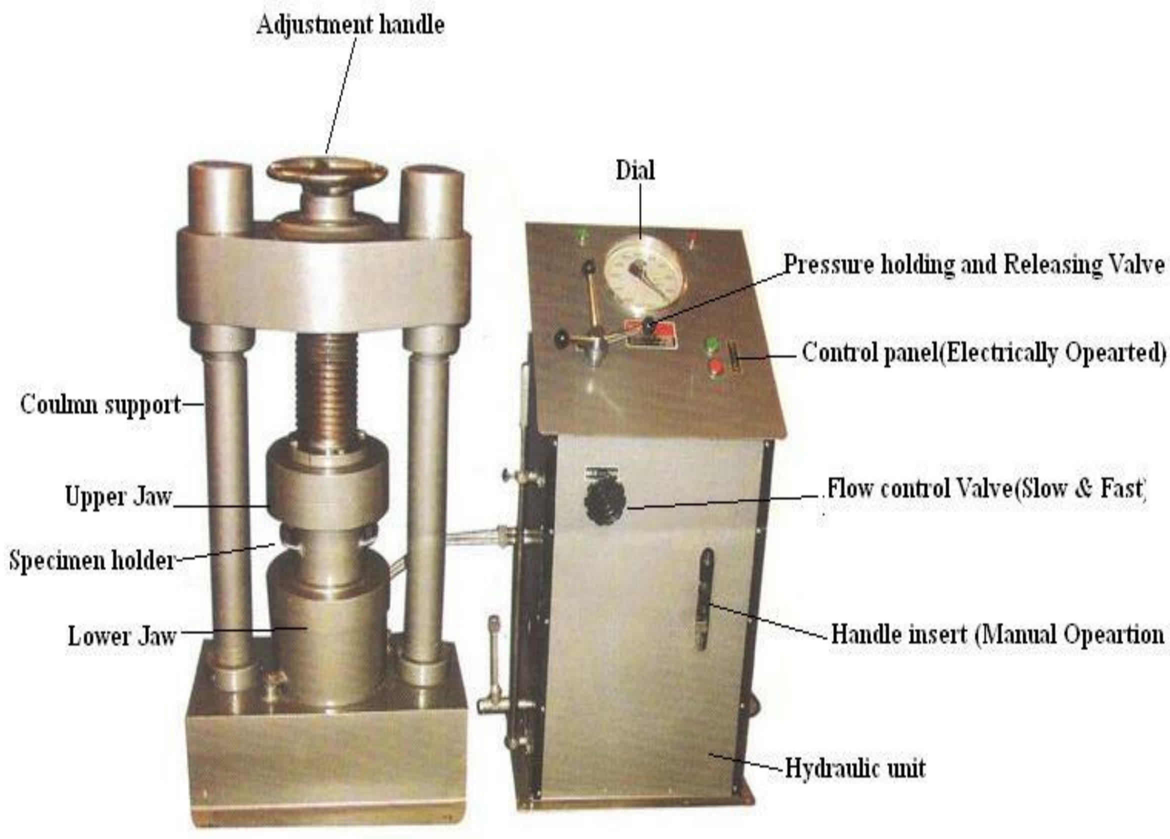
APPARATUS: Bricks, Oven Vernier Caliper, Scale, Etc.

FORMULA:- Max.

LoadatfailureCompressiveStrength = -------------------

Loaded Area of brick

DIAGRAM:-



THEORY : -

Bricks are used in construction of either load bearing walls or in portion walls in case of frame structure. In bad bearing walls total weight from slab and upper floor comes directly through brick and then it is transverse to the foundation. In case the bricks are loaded with compressive nature of force on other hand in case of frame structure bricks are used only for construction of portion walls, layers comes directly on the lower layers or wall. In this case bricks are loaded with compressive nature of force. Hence for safely measures before using the bricks in actual practice they have to be tested in laboratory for their compressive strength.

PROCEDURE: -

1. Select some brick with uniform shape andsize.
2. Measure it's all dimensions. ($L_X B_X H$)
3. Now fill the frog of the brick with fine sand. And Place the brick on the lower platform of compression testing machine and lower the spindle till the upper motion of ramis offered by a specimen the oil pressure start increasing the pointer start returning to zero leaving the drug pointer that is maximum reading which can be noteddown.

PRECAUTIONS: -

1) Measure the dimensions of Brickaccurately.
2) Specimen should be placed as for as possible in the of lowerplate.
3) The range of the gauge fitted on the machine should not be more than double the breaking load of specimen for reliableresults.

RESULT

1. The average compressive strength of brick sample is …… ……………...(N/mm^2)

ANNEXURE

VIVA QUESTIONS

EXPERIMENT 1: TENSION TEST

1. **Define Strength ofMaterials.**

   Ans. The strength of a material is ability to withstand an applied stress without failure.

2. **Definestress.**

   Ans. Internal resistance force offered by the body against deformation per unit area is called stress.

3. **What is the unit ofstress?**

   Ans. N/mm^2 or N/m^2

4. **DefineStrain.**

   Ans. Strain is the relative change in dimension (size or shape) of an object due to externally applied forces.

   Strain = Change is dimensions / original dimensions

5. **What is the unit ofstrain?**

   Ans. Dimension Less - No unit

6. **State Hookeslaw.**

   Ans: It States that when the material is loaded within the elastic limit the stress is directly proportional to strain. Stress α Strain or Stress = Constant x Strain , Constant = Young's Modulus (E)

7. **Hookes law holds goodupto ________**

   Ans: Elastic Limit

8. **What is the yield strength of Mild steel grade ofFe250?**

   Ans. 250 N/mm^2

9. **Define young's modulus ofelasticity.**

   Ans. It is the ratio of stress to strain. Or Normal stress / Normal strain

10. **What is the unit for young's modulus ofelasticity**

    Ans. KN/mm^2 or N/mm^2

11. **The ratio of Lateral strain to liners strain is knownas**

    Ans. Poisson's Ratio

12. **What is gauge length? How it ismeasured?**

    Ans. The gauge length denotes the length of the specimen used for testing purposes. It is measured with the help of vernier calipers or Extenso meter .

13. **Give the examples for ductilematerials**

Ans. Steel, Aluminium and copper

14. What is the capacity of UTM used in SMLab?

Ans. 40kN to 400 kN in SM lab

15. UTM Standsfor

Ans. Universal Testing Machine

16. DefineUTM.

Ans. A Universal Testing Machine is used to test the tensile stress, compressive strength and shear strength of materials. It is named after the fact that it can perform many standard tensile and compression test on materials, components and structures.

17. What is proportionallimit?

Ans. In this limit stress is directly proportional to strain.

18. Differentiate between Elastic limit and Yieldpoint.

Ans. Elastic limit: stress is directly proportional to strain, in this stage, if the applied stress is removed, the strain returns to an original position that is material gains to originalposition.

Yield point: the stress increased beyond the elastic limit, the material undergoes deformation at some points. Which means the permanent extension occurs, the mild steel rod does not regain its original shape even after the stress is removed.

19. What do you mean by Ductilematerial?

Ans. If a material can undergo considerable deformation without rupture then it is said to be ductile material.

20. What do you mean byElasticity?

Ans. Ability to regain shape on removal of external force.

21. What do you mean byplasticity?

Ans. Member undergoes permanent or plastic deformation at constant load.

22. What do you mean by ultimatestress?

Ans. Ultimate stress is the maximum stress that the material can withstand.

23. What is the formula to findstress?

Ans. Stress = Load / Area

24. How the Ultimate Stress can becalculated?

Ans: Ultimate Stress = Ultimate load / Original Area of cross section

25. What do you mean by Factor ofSafety?

Ans: Ultimate stress to permissible stress.

26. What do you mean by Breakingstress?

Ans: Breaking stress is the stress at which the specimen rupture.

27. What do you mean by Yieldpoint?

Ans: Yield point is the stress beyond which when the material is loaded, plastic deformations take place.

28. Write the formula to find the area of the steelrod?

Ans: $\pi \times D^2 / 4$, where D is Diameter of the steel rod

29. Write the density of mildsteel?

Ans: 7850 kg / m^3 (or) 78.5 kN / m^3

30. List the constituents ofsteel?

Ans: Iron, carbon are the main constituents, Manganese and chromium also included

31. If the carbon content increases in steel then the strength and hardness of steel will be_____

Ans: Increases

32. Give examples for brittlematerials.

Ans: Cast Iron, Concrete, Brick and glass are the examples for brittle materials.

33. What do you mean bydeformation?

Ans. Deformation is change in dimension of any object due to applied load.

34. Which steel you have performed tension test. What is its carboncontent?

Ans. On Mild Steel (0.3 to 0.6% carbon)

35. What kind of fracture has occurred in tensile specimen during tensiontest?

Ans. Ductile fracture

36. Define temperaturestress.

Ans. Stress introduced by uniform or nonuniform temperature change in a structure or material which is constrained against expansion or contraction.

37. DefineHardness.

Ans. Hardness is the resistance of a material to localized deformation.

38. DefineToughness.

Ans. Toughness is the amount of energy per volume that a material can absorb before rupturing. It is also defined as the resistance to fracture of a material when stressed.

39. Name the types ofstresses.

Ans. Normal Stresses (Tensile or Compressive), Shear stresses

40. Name the types ofStrain.

Ans. Tensile or Compressive strain, shear strain and volumetric strain.

41. What do you mean by volumetricstrain?

Ans. Change in volume to Original volume.

42. What do you mean by Ultimatestrength?

Ans. Absolute maximum compressive, shear or tensile stress of a material which can bear without failure is called ultimate strength.

43. State Newtons third law

Ans. It States that for every action there is an equal and opposite reaction.

44. What are uses ofUTM.

Ans. UTM is used to test the tensile strength, compressive strength and shear strength of amaterial.

45. Differentiate force andload

Ans: **Force** is applied by the object and **load** is applied on the object.

Ans. Force is a pull or push applied on a body to change its state.

a. Load is the combined effect of externally applied forces at anypoint.

46. What do you mean by rigidbody?

A rigid body is an idealization of a solid body of finite size in which deformation is neglected.

47. What do you mean by deformablebody?

A deformable body is a physical body that deforms, meaning it changes its shape or volume while being acted upon by an external force.

48. What do you mean by Homogeneousmaterial?

Ans: **Homogeneous Material** – A material is said to be homogenous when it exhibit same elastic property at any point in a given direction (i.e elastic properties are independent of point)

49. What do you mean by Isotropicmaterial?

Isotropic Material - A material is said to be Isotropic when it exhibit same elastic property in any direction at a given point (i.e elastic properties are independent of direction.)

50. State Principle ofSuperposition.

Ans: The **principle of superposition** says that when a number of loads are acting on a body, the resulting strain, according to the **principle of superposition**, will be the algebraic sum of strains caused by individual loads.

VIVA QUESTIONS

EXPERIMENT 2: BENDING TEST ON CANTILEVER BEAM

1. What do you mean by cantileverbeam?

Ans: A beam with one end is fixed and another end is free is known as cantilever beam.

2. Name the types of materials you have used in thetesting?

Ans: Aluminum and Mild steel bar

3. Name the types of beams based on its supportcondition.

Ans. simply supported beam, over hanging beam, Cantilever beam, continuous beam, fixed beam.

4. Define shearforce.

Ans. Shear force is the algebraic sum of all the vertical forces acting on either left or right side of the section. It is also defined as unbalanced vertical force at any section.

5. Define bendingmoment.

Ans. Bending moment is the algebraic sum of all the moments of the forces acting on either left or right side of the section.

6. What is point ofinflection?

Ans. The point on beam at which the moment is zero is called point of inflection or point of contra flexure.

7. What are sagging and hoggingmoments?

Ans. If clockwise bending moments are taken as negative, then a negative bending moment within an element will cause "sagging", and a positive moment will cause "hogging". It is therefore clear that a point of zero bending moment within a beam is a point of contra flexure that is the point of transition from hogging to sagging or viceversa.

8. Bending moment will be when shear forceis_______

Ans. zero.

9. What is Moment ofinertia?

Ans. Moment of inertia is second moment of area or second moment of mass.

10. What is Polar moment ofinertia?

Ans. The Polar Moment of Inertia is a geometric property of a cross section. Physically, it is a measure of how difficult it is to turn a cross-section about an axis perpendicular to it.

11. Definedeflection.

Ans. The deflection at any point on the axis of the beam is the distance between its position before and after loading.

Or. The vertical displacement of a point in a beam in the direction of the load is called deflection.

12. DefineSlope.

Ans. Slope at any section in a deflected beam is defined as the angle in radians which the tangent at the section makes with the original position.

13. In the cantilever beam where the B.M. will bezero?

Ans. At free end

14. In the cantilever beam where the B.M. will bemaximum?

Ans. At fixed end

15. Whether the point of contra flexure and point of inflection are same ornot?

Ans. Both are same.

16. How to convert UDL into pointload?

Ans. Load multiplied by span of UDL

17. Write the formula to find maximum deflection in cantileverbeam.

Ans. Maximum Deflection = WL^3 / 3EI

18. Where will you get maximum deflection in cantileverbeam?

Ans. At Free End

19. Where will you get maximum bending moment in cantileverbeam?

Ans. At Fixed End

20. What do you mean by flexuralrigidity?

Ans. The product of Young’s modulus and Moment of inertia is called as flexural rigidity.

21. Differentiate force andload

Ans. Force is a pull or push applied on a body to change its state and Load is the combined effect of externally applied forces at any point.

22. DefineBeam

Ans. Beam is the horizontal member carrying transverse load. It is rectangular in cross section. It carries floor slab as well as roof slab. It transfer all the loads including its self weight to the column or wall.

23. What is meant by beam withoverhang?

Ans. The supports are not provided at the ends of the beam. There is a left overhang or right overhang or both.

24. What do you mean by Young’sModulus?

Ans. It is the ratio of normal stress to normal strain

25. Write the unit for deflection and youngsmodulus.

Ans. mm and N/mm^2

26. What do you mean by Shear ForceDiagram?

Ans. A Shear force diagram is the one which shows the variation of the shear force along the length of the beam.

27. What do you mean by Bending MomentDiagram?

Ans. A Bending Moment diagram is the one which shows the variation of the bending moment along the length of the beam.

28. Define concentratedload.

Ans. A concentrated load is one which is considered to act at a point, although in practice it must really be distributed over a small area.

29. Define Uniformly Distributedload.

Ans. A Uniformly Distributed load is one which is spread over a beam in such a manner that rate of loading w is uniform along the length.

30. Define Uniformly Varyingload.

Ans. A Uniformly Varying load is one which is spread over a beam in such a manner that rate of loading varies from point to point along the length of the beam in which load is zero at one end and increases uniformly to the other end.

31. The ratio of maximum deflection of a beamtoits________is called stiffness of thebeam.

Ans: Span

32. The stiffness of a beam is a measure of it’s resistanceagainst _______

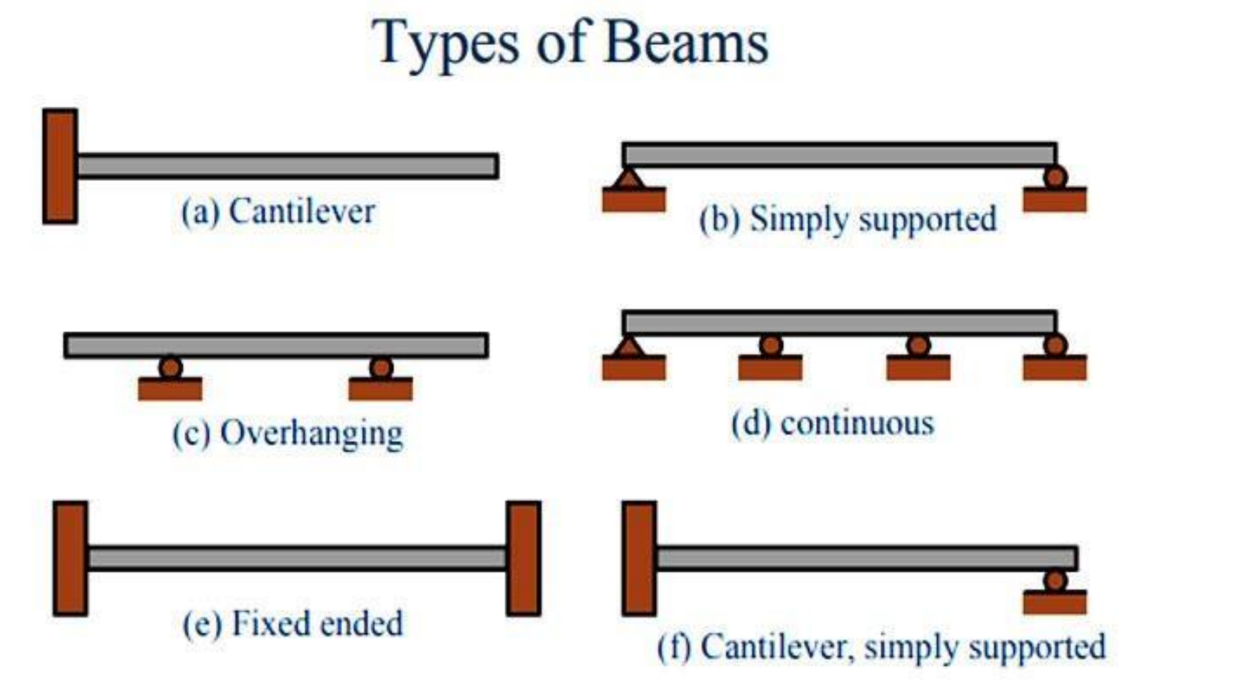
Ans: Deflection

33. Stiffness of the beam is inversely proportionaltothe_______of thebeam.
Ans: Deflection
34. The maximum deflection in cantilever beam of span "l"m and loading at free end is "W"kN.
Ans: $Wl^3/3EI$
35. The amount of deflection of a beam subjected to some type of loadingdependsupon_________ and _______
Ans: Cross- section and Bending Moment
36. What is determinatebeam?
37. What is indeterminatebeam?
38. Cantilevers are determinate. True orfalse?
39. Give a real time example for fixedsupport.
40. Give a real time example for Pinnedsupport.
41. Give a real time example for rollersupport.
42. What isequilibrium?
43. What is a portalframe?
44. What is a spacestructure?
45. Draw SFD and BMD for cantileverbeam
46. What are the advantages of cantilever beam over simply supportedbeam?
47. What are the types of loading onbeams?
48. Give a practical example forUDL
49. Give a practical example ofUVL
50. Give a practical example of Concentratedmoment.

VIVA QUESTIONS

EXPERIMENT:3 BENDING TEST ON SIMPLY SUPPORTED BEAM

1. Define beam.
Ans. Beam is structural member, which is acted upon by a system of external loads at right angles to theaxis.
2. What is meant by bending?
Ans. Bending is defined as the deformation of a bar produced by loads acting perpendicular to its axis.
3. 1 kg =_____N
Ans. 9.81 N
4. Define plane bending
Ans. If the plane of loading passes through one of the principle centroidal axis of the cross section of the beam; the bending is said to be plane or directbending.
5. Define oblique bending.
Ans. If the plane of loading does not pass through one of the principle centroidal axis of the cross section of the beam, the bending is said to be oblique.
6. Name the types of loads acting on the beam.
Ans. i) Concentrated or Point load ii) Uniformly Distributed Load iii) Uniformly Varying Load
7. What do you mean by Shear Force Diagram?
Ans. A Shear force diagram is the one which shows the variation of the shear force along the length of the beam.
8. What do you mean by Bending Moment Diagram?
Ans. A Bending Moment diagram is the one which shows the variation of the bending moment along the length of the beam.
9. UDL Standsfor______
Ans. Uniformly Distributed Load.
10. Name the types of beams based on its support conditions.
Ans. a) Cantilever beam b) Simply (or) freely supported beam c) Over hanging beam d) Fixed beame) Continuous beam
11. Draw cantilever beam
12. Draw Simply supported beam
13. Draw Continuous beam
14. Draw Fixed beam
15. Draw Overhanging beam



16. Define Cantilever beam
Ans. A beam which is fixed at one end and free at the other end is known as cantilever beam.
17. Define Simply supported beam
Ans. A beam supported or resting freely on the supports at its both ends is known as simply supported beam.
18. Define Continuous beam
Ans. A beam which is provided more than two supports is known as continuous beam.
19. Define fixed beam.
A beam whose both ends are fixed or built-in walls is known as fixed beam.
20. Define overhanging beam.
Ans. If the end portion of the beam is extended beyond the support, such beam is known as overhanging beam.
21. Write Moment of Inertia for a rectangular section.
Ans. $I = BD^3 / 12$, where B is Breadth of the beam and D is Depth of the beam.
22. Define Stiffness with an example.
Ans. It is defined as the property of a material which is rigid and difficult to bend.
The example of stiffness is rubber band. If single rubber band is stretch by two fingers the stiffness is less and the flexibility is more. Similarly if we use the set of rubber band and stretched it by two fingers, the stiffness will be more but rigid and flexibility isless.
23. What is the least count of dial gauge?
Ans. 0.01
24. Write the expression of stiffness for an elastic body and its unit.
Ans. k = Load / Deflection
The unit of stiffness is Newtons per meter

25. In simply supported beam bending moment at both supportis _______
Ans. Zero
26. Where will you get maximum B.M in simply supported beam subjected to central point load.
Ans. At Center
27. What is the aim of this experiment?
Ans. To determine the deflection of a simply supported beam with center or eccentric point load and also the young's modulus of the beam material.
28. List the apparatus required for doing this experiment.
Ans. i. Simply supported beam
ii.Dial gauge
iii.Weights
29. What do you mean by concentrated load?
Ans. A concentrated load is one which is considered to act at a point, although in practice it must really be distributed over a small area.
30. Define Uniformly Distributed load.
Ans. A Uniformly Distributed load is one which is spread over a beam in such a manner that rate of loading w is uniform along the length.
31 What is Youngs modulus of steel?
32 What is Youngs modulus of Concrete?
33 Why in India we use more concrete beams than steel beams?
34 Which is better material for column construction, steel or concrete? Justify.
35 Define bending stress and shear stress.
36. What is determinate beam?
37. What is indeterminate beam?
38. Simply supported beams are determinate. True or false?
39. Give a real time example for fixed support.
40. Give a real time example for Pinned support.
41. Give a real time example for roller support.
42. What is equilibrium?
43. What is a portal frame?
44. What is a space structure?
45. Draw SFD and BMD for cantilever beam
46. What are the advantages of cantilever beam over simply supported beam?
47. What are the types of loading on beams?
48. Give a practical example for UDL
49. Give a practical example of UVL
50. Give a practical example of Concentrated moment.

Strength of Materials Lab Manual - **M**arri **L**axman **R**eddy **I**nstitute of **T**echnology and **M**anagement

VIVA QUESTIONS:
EXPERIMENT NO: 4 TORSION TEST

1. Define torsion.
2. What is the formula torsion equation for circular shafts.
3. Write assumptions for torsion on shafts.
4. What are the effects of torsion?
5. Define modulus of rigidity?
6. Define angle of twist.
Ans: Angle of Twist: If a shaft of length L is subjected to a constant twisting moment T along its length, than the angle q through which one end of the bar will twist relative to the other is known is the angle of twist.
7. Define shaft.
Ans: The shafts are the machine elements which are used to transmit power inmachines.
8. What are the torque carrying engineering members?
9. Write formula to calculate polar moment of inertia (J) for a square section.
Ans. J = a4 / 6
10. Write formula to calculate polar moment of inertia (J) for a rectangular section.
Ans. J = bd (b2 + d2) / 12
11. Write formula to calculate polar moment of inertia (J) for a Circular Section.
Ans. J = π D4 / 32
12. Write formula to calculate polar moment of inertia (J) for a Tubular Section.
Ans. J = π (D4 – d4) / 32 Where D is External Dia of section and d is internal dia of section.
13.Write the formula for power transmitted by the shaft.
14. Define torsional rigidity of a shaft.
Torsional rigidity of a shaft is defined as the torque required producing a twist of one radian per unit length of the shaft.
15. Define Inertia
16. Define Polar Moment of Inertia
17. What is torsional bending.
18. Write the unit of force, deflection, stress, strain, E, G, K.
19. What is axial load ?
20. What is the objective of this experiment?
21. Name the apparatus required for this experiment.
22. Explain torque.
23. What is torsional force?
24. Write Moment of Inertia for a rectangular section.
25. Define section modulus.
26. How to apply turning force ?

27. Turning force is applied which part of pulley
28. Define polar modulus
29. In circular plane where the polar moment of inertia is acting
30. Justify the torque transmitted by new shaft & replaced shaft
31. What is principal plane?
32 What is principal stress?
33. What is poisson ratio?
34. What is relation between E and G
35. What is relation between E, G and K
36. What is pure shear?
37. Why torsion is said to be of pure shear?
38. Shear stress will be maximum at extreme fiber. True or false
39. Why modulas of rigidity is important?
40. Shaft are designed on the basis of ………….
41 Which shaft is economical, Hollow or solid?
42. Shaft will be designed for stress at extreme fibre. True or false.
43.What is the modulas of rigidity of mild steel.
44. What is the formula for Power?
45. How much power is transmitted in your experiment.
46. What is the unit for Theta in the torsional equation.
47. What is shear strain?
48. Shear strain is unitless. Justify.
49. What do you mean by derived units?
50. What is the modulas of rigidity of Concrete.

VIVA QUESTIONS
EXPERIMENT NO: 5 HARDNESS TEST

1. **The ability of the material to resist stress without failure is called**
Ans: Strength
2. **In universal testing machine, for a circular section specimen, the gauge length is taken to be**
Ans: 5.65 (A) ^1/2
3. **During hardness test the indenter is usually a**
Ans: All of the above
4. **The indenter used in Brinell hardness test is a**
Ans: Cone
5. **For hardness test of copper in Brinell hardness tester, the diameter of ball is**
Ans: 5 mm
6. **The impact test is donetotest_______of amaterial**
Ans: Toughness
7. **Which machine records the change in length of specimen?**
Ans: Universal testing machine
8. What is hardness?
Ans. Hardness is the resistance of a material to localized deformation. Or
Hardness is the mechanical resistance which a material asserts against the mechanical penetration of a harder test body.
10. Define suddenly applied load
Ans. When the load is applied all of sudden and not step wise is called as suddenly applied load.
11. Define gradually applied load
Ans. A body is said to be acted upon by a gradually applied load if the load increases from zero and it reaches its final value stepwise is called gradually applied load.
12. Enumerate the advantages of Rockwell Hardness Test over Brinell Hardness Test.
13. Why is it necessary to check hardness?
14. When do we call the failure to be fatigue?
15. Write the formula to find Brinell hardness number.
16. Name the materials which are used for testing Rockwell hardness.
17. Name the materials which are used for testing Brinell hardness.
18 In Brinell harness test for steel requireforceis_________(Ans. 187.5kg-f)
19. In Brinell harness test for Copper requireforceis_________(Ans. 62.5 kg-f)
20. What are applications of Rockwell Harness?
21. Name different types of hardness testing machine.
22. What is the intender diameter of ball used in Brinell hardness test?
23. What is the intender diameter of ball used in Rockwell hardness test?

24. What is the selection of load in Rockwell hardness test?
25. What is the selection of load in Brinell hardness test?
26. Justify the impact test about the toughness of a material
27. The shape of indenters are usually which shape
28.When do we use
29. Type of indenters used in indentation test
30. The hardness of the material depends upon which parameter
31. What are the types of Scale in Rockwell hardness equipment?
32. What is tempering?
33. What is quenching?
34. What is hardened steel?
35.Why hardening is required?
36. What is the relation between Rockwells hardness and Brinells Hardness?
37.What is Mohrs Scale of hardness?
38. What is the use of Vickets apparatus?
39.Tell the value of hardness of few construction materials.
40. What should be the minimum thickness of specimen used in Rockwells equipment?
41. What is hardness in water?
42. Tell the difference between water hardness and Solid hardness.
43. Can we improve the hardness of a material?
44. How to improve the hardness of steel?
45. What is the hardest material on earth?
46. Differentiate hardness and toughness.
47. Is hardness dependent on temperature?
48. Is hardness depend on ductility?
49. Tell few hardened materials being used in your laboratory?
50. What will happen if your lab equipment is not hard?

VIVA QUESTIONS
EXPERIMENT NO: 6 SPRING TEST

1. What is meant by stiffness?
2. If deformation is decrease stiffnessis__________
3. The stiffness is denotedby__________
4. Units ofstiffness__________
Ans.Kg/m
5. Define stiffness
Ans. It is defined as ratio of load and unit deflection
Stiffness (k) = load (p)/ unit deflection
6. Define spring
Ans The springs are resilient members and extensively used to absorb shocks.
7. How many types of springs are there?
8. Define helical spring
Ans Coiling the wire in the form of helix forms the helical spring.
9. Define load
Ans The combined effect of external forces acting on a body is called load.
10. Write formula for stress
Ans. Force/area
11. Define Strain energy.
12. Define Resilience
13. Define proof resilience
14. Define modulus of resilience
15. How is potential energy related to strain energy?
16. Differentiate between closed and open coil helical spring.
17 A spring is use to absorb energy due to which parameter
18 How to justify the quality of a spring
19 To absorb shocks the type of spring used is?
20 Application of carriage springs
21 Carriage sprigs are gives what type of feeling to passengers
22 When the spring is loaded what is central deflection reaction
23 What is the role of bending stress compared to torsional stresses
24 Closely coiled helical spring is subjected to types of loaings
25 Open coiled helical spring is subjected to which types of loas
26 Where laminated springs are used
27 Explain stiffness with an example.
28 Differentiate between closely coiled &openl coile helical springs
29 The Least count of Micrometer is

30 The Least count of Vernier calipers is
31. What is stifness?
32. What is the formula for calculation of Stifness?
33. What is the formula for calculation of deflection of open coil helical spring?
34. What is the formula for calculation of deflection of closed coil helical spring?
35. Where do we use leaf spring?
36. What is pitch?
37. When do we increase the wire diameter of a spring?
38. When do we increase the diameter of a spring?
39. When do we go for open coil helical spring?
40. When do we use tension spring?
41. When do we use compression spring?
42. When do we increase the pitch of a spring?
43. What is proving ring?
44. What is a dial gauge?
45. When do we increase the helix angle in a spring?
46. What is formula for energy stored in open coil helical spring?
47. What is formula for energy stored in closed coil helical spring?
48. What is bearing in bridges?
49. What are the types of bearing used in bridges?
50. Why do vehicles have springs?

VIVA QUESTIONS
EXPERIMENT NO: 7 COMPRESSION TEST ON CONCRETE

1. What are all the types ofcement
2. What are all the raw materials of thecement?
3. Differentiate dry process and wet process of manufacturingcement
4. Definebatching
5. What are all the methods ofbatching
6. What iscuring?
7. What is steamcuring?
8. Define non destructivetesting?
9. What are all the types of concretetest?
10. How do you measureconcrete?
11. What isaggregate?
12. What are the uses of alloys in daily life and how are alloysmade?
13. What is the worlds largest concretedam?
14. State the buildingcodes?
15. What are the steps involved in the concreting process,explain?
16. What is BougesCompound
17. What is setting ofcement.
18. What is initial setting time ofcement?
19. What is final setting time ofcement?
20. What is the function of C_2S
21. What is the function ofC_3S
22. What is the function of C_2A
23. What is the function ofC_4AF
24. What isworkability?
25. What are the tests on freshconcrete?
26. What are the tests on hardenedconcrete?
27. What is rapidhardenening?
28. What is consistency ofcement?
29. What is optimum moisturecontent?
30. What size of coarse aggregate did youuse?
31. What is sieveanalysis?
32. What is fineaggregate?
33. What is gradation in fineaggregate?
34. What type of sand did youuse?
35. Tell the difference between M sand and Psand
36. How M sand ismanufactured?
37. How P sand ismanufactured?
38. What is W/Cratio?
39. Why W/C ratio plays a vital role in strength oofconcrete?
40. What ishydration?
41. What is heat ofhydration?
42. When concrete attain its fullstrength?
43. What M refers inM20?
44. What 20 refers inM20?
45. What is nominalmix?
46. What is designmix?
47. What is Mixdesign?

48. What is standard size of cube moulds used for concretetest.
49. What is standard size of cylinder moulds used for concretetest.
50. Compare compressive strength test of concrete with cube andcylinder.

VIVA QUESTIONS
EXPERIMENT NO: 8 IMPACT TEST

1. What is the range of dialogue for izodtest
Ans: 0-170 Joules
2. What is the range if dialogue forcharpy
Ans: 0-300 Joules
3. Hammer holder kept for izod test whatangle
Ans: Angle for izod test is 90degrees
4. Hammer holder kept for charpy test whatangle
Ans: Angle for izod test is 135 degrees
5. Define impactstrength.
Ans.The ability of a material to withstand shock loading.
6. The impact strength of a material is an index ofits
Ans: Toughness
7. The property of a material which allows it to be drawn into a smaller section iscalled
Ans: Ductility
8.What is the purpose for conducting impacttest
A. An impact test signifies turning of the material i.e., ability of material to absorb energy during plastic deformation.
9. How many types of Impact test wehave
Ans. Charpy & Izod
10. Thermal strain of a body does not dependon______
Ans: Length
11. Differentiate impact and suddenload.
12. How do you place the material in I-zodtest?
13. How do you place the material in charpytest?
14. what do you mean byductility?
15. What is the purpose of the impacttest?
16. Why V-notch is used in impacttest?
17. which material is used in impacttest?
18. What is the pupose of charpy impact test?
19. What is the pupose of I-zod impact test?
20. Differentiate charpy and Izod impacttest?
21. Write the formula to find impactstrength.
22. Name the apparatus required for impacttest.
23. What do you mean by modulus ofrupture?
24. Defineresilience.
25. Define proofresilience.
26. Definetoughness.
27. Write the unit of impactstrength.
28. If the sharpness of V-notch is more in one specimen than the other, what will be its effecton the test result?
29. What is the effect of temp. on the values of rupture energy and notch impact strength?

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30. In what way the values of impact energy will be influenced if the impact tests are conducted on two specimens, one having smooth surface and the other having scratches on thesurface?
31. What istoughness?
32. Impact load is directly proportional to Height of fall. True or false?
33. What isacceleration?
34. What is acceleration due togravity?
35. What is the toughness material onearth?
36. What is the IS code book for conducting Charpy impacttest?
37. What is the IS code book for conducting Izod impacttest?
38. What is the application of impact strength in civil engineeringperspective?
39. Which test has more efficiency, Izod orcharpy?
40. How to increase the toughness of amaterials?
41. Is toughness related with Youngsmodulus?
42. Is toughness related withDuctility?
43. Can toughness be increased with increase intemperature?
44. What is fracture
45.What is brittle fracture?
46.What is ductilefracture?
47. Brittle fracture need more energy than ductile fracture. True or false?
48.What is the prescribed size of specimen for Charpy impact test?
49.What is the prescribed size of specimen for Izod impact test?
50.Why do we have notch in ImpactTest.

VIVA QUESTIONS

EXPERIMENT NO: 9 SHEAR TEST

1. Definestrength.
2. Define Strength ofmaterials.
3. Define shearstrength.
4. How shear strength ismeasured?
5. Why shear strength ismeasured?
6. What is unit of shearstrength?
7. What is shearforce?
8. What is the unit of Shearforce?
9. What isbending?
10. Differentiate shear andbending.
11. Differentiate single and doubleshear?
12. Name the apparatus used in sheartest.
13. What isstrain?
14. Differentiate Shear Strain and Shearstress.
15. Purpose ofUTM.?
16. What is difference between force andload?
17. What do you mean by modulus ofrigidity?
18. Differentate shear force and bendingmoment.
19. Define sectionmodulus.
20. What is the use of Hydraulicjack.
21. Write the unit of shearstrength.
22. Differentiate compressive stress and shearstress.
23. Write the formula for shear stress in singleshear.
24. Write the formula for shear stress in doubleshear.
25. What is the aim of shear testexperiment?
26. Definemalleability
27. Definerigidity.
28. State principalstress.
29. What is principalplane?
30. What are the theories offailure?
31. What is Maximum shear stresstheory?
32. Maximum shear stress theory is useful for what type ofmaterial?
33. What is Maximum shear strain energytheory?
34. Maximum shear strain energy theory is useful for what type ofmaterial?
35. What is the usual range of carbon content in cast iron, wrought iron and mildsteel?
36. What do you mean by staticloading?
37. What do you mean by dynamicloading?
38. What do you mean gaugelength?
39. Name the various types offracture.
40. What is the permissible shear stress of mild steelbar?
41. How you will identify the material fails byshear?

42. What is thermalstress?
43. Will thermal stress affect shearstrength?
44. What isductility?
45. Ductility is proportional to shear strength. True orfalse?
46. Which is strong in shear, Concrete orsteel?
47. How will you add shear strength in RCBeam?
48. Why shear failure occurs at 45 degree to the plane ofbeam?
49. What is flexuralrigidity?
50. What isflexure?

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VIVA QUESTIONS

EXPERIMENT NO: 10 VERIFICATION OF MAXWELL RECIPROCAL THEOREM

1. The law of reciprocalTheorem.

The Clerk-Maxwell's reciprocal theorem states that in case of a linearly elastic structure, the deflection may occur at any point. A. Because of load exerted at the other point B shall be equivalent to the deflection at B when the similar load is exerted at A.

2. Define Moment ofInertia.
3. Why the depth of beam is less than the width in Maxwell's reciprocalapparatus?
4. Define Sectionmodulus.

Ans. The elastic section modulus is defined as S = I / y, where I is the second moment of area (or moment of inertia) and y is the distance from the neutral axis to any given fibre.

5. What is a compositebeam?

Ans. A structural member composed of two or more dissimilar materials joined together to act.

6.State Maxwell reciprocal theorem.
7. Differentiate simply supported and continuousbeam.
8. Differentiate simply supported and fixedbeam.
9. Differentiate simply supported and cantileverbeam.
10. What is the least count of dialgauge?
11. Differentiate deflection anddeformation.
12. Differentiate stress andstrain.
13. Definedeflection.
14. Definedeformation.
15. Differentiate load anddeflection.
16. Differentiate slope anddeflection.
17. Where will you get maximum deflection in simply supported beam when the load is actingat centre?
18. Write the formula to find maximum deflection of a simply supported beam subjected topoint load atcentre.
19. Definebeam.
20. Name the types ofbeam.
21. Define simply supportedbeam.
22. Define cantileverbeam
23. Define fixedbeam.
24. Define continuousbeam.
25. Define concentratedload.
25. Define uniformly distributedload.
26. Define uniformly varyingload.
27. Define overhangingbeam.
28. Differentiate load andforce.
29. What is the aim of thisexperiment?
30. Name the apparatus required for thisexperiment.
31. What method is used to analyse a continuous beam forBM?

32. Will the deflection in a simply supported beam of same span be equal to the continuousbeam with same intensity ofloading?
33. Will the deflection in a fixed beam of same span be equal to the continuous beam with same intensity ofloading?
34. Will the deflection in a propped cantilever beam of same span be equal to the continuous beam with same intensity ofloading?
35. Is continuous beam construction feasible in steel structures?Explain.
36. Where will be the slope maximum in a continuousbeam?
37. How to reduce the maximum BM in a continuous beam with samespan?
38. How to make a continuous beam to be of uniformstrength?
39. What cause deflection ofbeams?
40. Will SF cause deflection ornot?
41. What is Elasticlimit?
42. What is Proportionalitylimit?
43. What will be value of Youngs modulus for Ductilematerial?
44. Is deflection related with ductility or Elasticity orboth?
45. What is flexuralrigidity?
46. What isflexure?
47. Give few theoretical methods to finddeflection.
48. What is Principal Moment ofInertia?
49. What is difference between Moment of Inertia and Polar moment ofinertia?
50. What is second moment of areacalled?

VIVA QUESTIONS

EXPERIMENT NO: 11 ELECTRICAL RESISTANCE STRAIN GAUGES

1. What are the objectives of thisexperiment?
2. What isstrain?
3. Why strain calculation isrequired?
4. What do you mean by modulus ofelasticity?
5. Why do we find young'smodulus?
6. What are the advantages of using straingauge?
7. Name the apparatus required for thisexperiment.
8. What are the alternative apparatus for straingauges?
9. What is the formula for finding bendingstress?
10. What is the formula for finding modulus of elasticity inbeams?
11. What type of material istested?
12. Definestress
13. Define bendingstress
14. Define Strainenergy.
15. DefineResilience
16. Define proofresilience
17. Define modulus ofresilience
18. How is potential energy related to strainenergy?
19. Write the formula to find strain energy inbeams.
20. Write the formula to find modulus ofresilience.
21. Differentiate bending stress and axialstress.
22. What are directstresses?
23. What are indirectstresses?
24. Name the types ofstrain.
25. Define compressivestrain.
26. Define shearstrain.
27. Define tensilestrain
28. What are directstrain?
29. What are indirectstrain?
30. Why strain should berestricted?
31. What is the maximum compressive strain permitted inconcrete?
32. What is the maximum compressive strain permitted in steel used forRCC?
33. Whether strain is related with elasticity or ductility orboth?
34. What is difference between ductility andmalleability?
35. Give the highly ductile construction material used inIndia.
36. Give the highly malleable construction material used inIndia?
37. Differentiate compressive strain and tensilestrain.
38. Differentiate shear stress and shearstrain.
39. Differentiate resilience and proofresilience.
40. How the electrical gauge is connected with theDAS?
41. What issoldering?

42. What is the temperature insoldering?
43. What is the efficiency of electrical straingauge?
44. What isLVDT?
45. Where is LVDTused?
46. What is the difference between mechanical strain gauge and Electrical straingauge?
47. Differenciate LVDT and StrainGauge.
48. What is workingstrain?
49. What is ultimatestrain?
50. What is lateralstrain?

VIVA QUESTIONS
EXPERIMENT NO: 12 CONTINUOUS BEAMDEFLECTION

1. What is the aim of thisexperiments?
2. What are the apparatus used in thisexperiment?
3. What is the final output of thisexperiment?
4. What are the formula used in thisexperiment?
5. what are the uses of thisexperiments?
6. A vertical column has two moments of inertia (i.e.$I\ xx$ and $I\ yy$). The column will tend to buckle in the direction ofthe…………………
7. The neutral axis of the cross-section a beam is that axis at which the bending stressis…
8. of a beam is a measure of its resistance againstdeflection
9. Elastic line is also calledas____
10. In simply supported beams, the slope is______atsupports.
11. In simply supported beam deflection is maximumat _____
12. Define simply supportedbeam.
13. What do you mean by young'smodulus?
14. What do you mean by moment of inertia for rectangularsection?
15. What isstiffness?
16. What isdeflection?
17. Give one example for continuousbeam.
18. What is mean by workingstress?
19. What is mean by load andforce?
20. What type of forces can be resisted by continuousbeam?
21. What type of forces cannot be resisted by continuousbeam?
22. Deflection of a simply supported beam when subjected to central point load is givenas…
23. A simply supported beam where slope iszero….
24. The design of a beam is based on strength criteria, if the beam is sufficiently strong to resist……………
25. The vertical distance between the axis of the beam before and after loading at a point is calledas ____
26. Write the differential equation fordeflection
27. What is the difference between and simply supported beam and continuousbeam?
28. What is the difference between a continuous beam and fixedbeam?
29. Which type of beam is preferred for construction of buildings?Why?
30. Where will be BM maximum when a continuous beam is loaded fully withUDL?
31. Where will be the deflection maximum when the continuous beam is loaded fully withUDL?
32. What are the advantages of continuousbeams?
33. Where will be the Shear force maximum in a continuousbeam?
34. What method is used to analyse a continuous beam forBM?
35. Will the deflection in a simply supported beam of same span be equal to the continuous beam with same intensity ofloading?
36. Will the deflection in a fixed beam of same span be equal to the continuous beam with same intensity ofloading?

37. Will the deflection in a propped cantilever beam of same span be equal to the continuous beam with same intensity ofloading?
38. Is continuous beam construction feasible in steel structures?Explain.
39. Where will be the slope maximum in a continuousbeam?
40. How to reduce the maximum BM in a continuous beam with samespan?
41. How to make a continuous beam to be of uniformstrength?
42. What cause deflection ofbeams?
43. Will SF cause deflection ornot?
44. What is Elasticlimit?
45. What is Proportionalitylimit?
46. What will be value of Youngs modulus for Ductilematerial?
47. Is deflection related with ductility or Elasticity orboth?
48. What is flexuralrigidity?
49. What isflexure?
50. Give few theoretical methods to finddeflection.

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VIVA QUESTIONS
EXPERIMENT NO: 13 COMPRESSION TEST ON BRICK

1. Compression members always tend to buckle in the directionofthe______
Ans. least radius ofgyration
2. What is Ultimatestrength?
3. Define elastic constants E,K&G.
4. What is YieldStrength?
5. Differentiate between ductile and brittlefracture.
Ans. In brittle materials, fracture occurs on application of excess stress without deforming the material.
In case of ductile stress, the material undergoes permanent deformation before fracture.
6. Define Nominal breakingstress.
Ans. It is the ratio of breaking stress to nominal area of cross section.
7. Define Actual breakingstress.
Ans. It is the ratio of breaking stress to necking area of cross section.
8.What is the standard size of quality brick
Ans. 19 cm x 9 cm x 9 cm
9. What is the average weight of quality brick?
Ans. 3 to 3.5 kg
9. What is the average compressive strength of qualitybrick?
Ans. 3.5 N /mm^2
10. Give example for brittlematerial.
Ans. Concrete, Glass, Bricketc.
11. The shape of specimen used in compression test is cube andcylinder
a) True
b) False
Ans. a)True
12. The ability of material to resist stress without failureiscalled _______
Ans.Strength
13. The property of material that resist penetration or indentation by means of abrasionor scratching is known as______
14. Differentiate compressive stress and compressivestrain.
15. What do you mean bycompression?
16 Compressive strength of first classbricks
17 Compressive strength of concrete is taking tensile strength of concretepercentage
18 Maximum permissible water absorption ofbricks.
19 What is the use of bricks
20 Use of frog in brick
21 How many specimens are required for testing of concrete as per IS code
22 Average compressive strength of brick
23 How to classifybricks
24 Capacity of compression testingmachine
25 How to convert ton tonewton
26 Concrete material tests
27 Brick material tests
28 Applications ofbricks
29 Difference between load bearing non load bearingwalls
30 Difference between tension andcompression
31 What is homogenous material?
32 What is Isotropic materials?

33 Brick is brittle material. True or False.
34 when do we calculate poisons ratio?
35 What is load bearing structure?
36 When do we go for 9” BW
36 When do we go for 4½”BW
37 When a brick is loaded, the compressive stress will be maximum at…………..Fibre
38 What is brick onedge?
39 When do we construct brick on edge?
40 What is bond in brick masonry
41. What is Englishbond
42. What is Flemishbond
43. What type of bond is practiced inIndia?
44. What is Soundness ofbrick?
45. Tell few tests onbrick?
46. How do we classifybrick?
47. What is the advantages of flyash brick on Claybrick?
48. What are the ingredients of brick youtest?
49. How bricks aremade?
50. What are the types offurnaces?