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STRENGTH OF MATERIALS LAB

B.Tech. Civil II Year

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.

EXPERIMENT NO:

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:

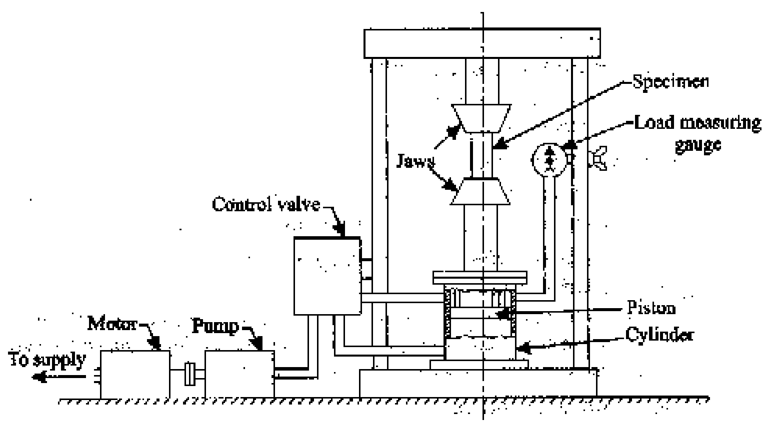
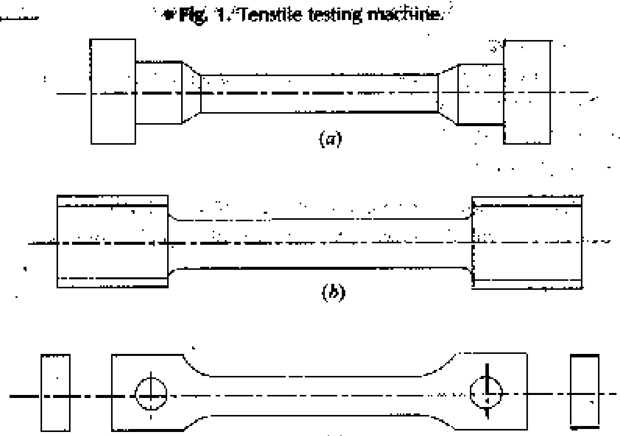


Fig. 1. Tenstile testing machine.



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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	

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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.

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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

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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:

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.

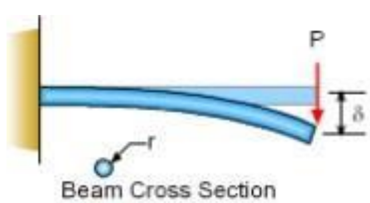

Fig 1. Cantilever beam

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 $I = bd^3/12$

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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

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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:

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:**

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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 $E=Wl^3/48\boldsymbol{\delta}I$

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

L= length of beam in mm

$\boldsymbol{\delta}$ = deflection of beam in mm

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

Case II: Deflection with aneccentricloading $\boldsymbol{\delta}_c =Wa^2b^2/3EIL$

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 ($W/\boldsymbol{\delta}$) ratio and calculate θ from theexpression $E=WL^3/48\boldsymbol{\Delta}i$

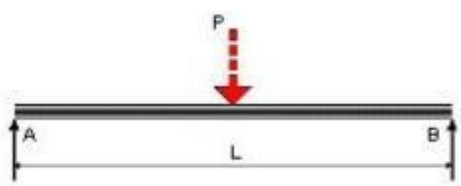

Fig 2. Simply supported beam

<u>PRECAUTIONS</u>:

1. The beam must be loaded below its ultimate load. So that it may not fail underloading.
2. Adjust the dial indicator at the exact 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 gauge 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

<u>RESULT</u>: Young's modulus (E) of beam material is =

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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

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EXPERIMENT NO:

TORSION TEST

AIM:

Torsion test on mild steelrod.

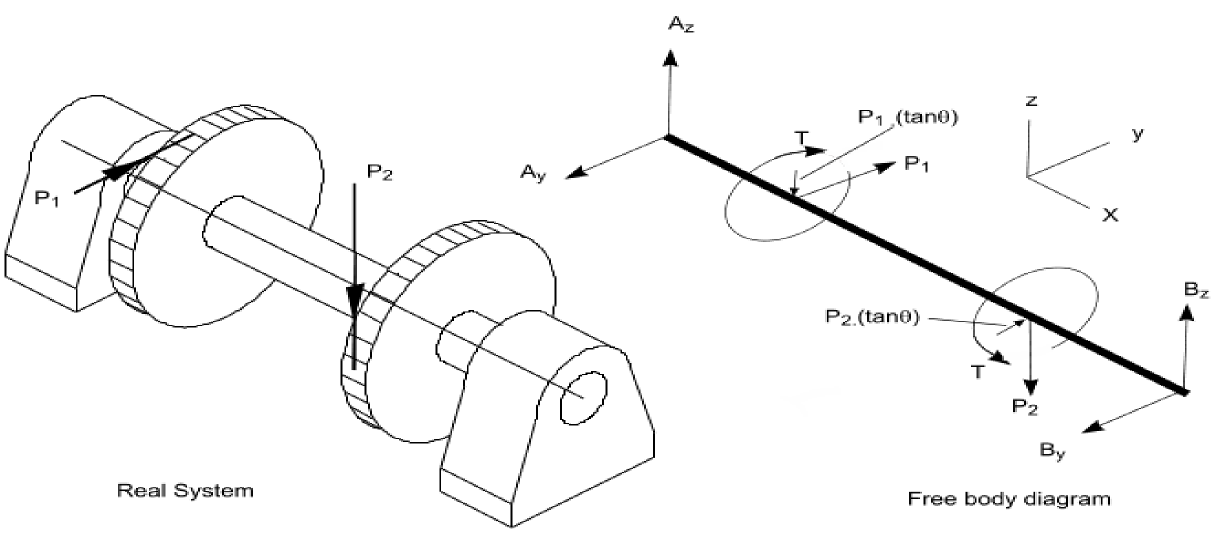
OBJECTIVE:

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:



Vz

Vy

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

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

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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

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OBESERVATION TABLE:

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

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EXPERIMENT NO :

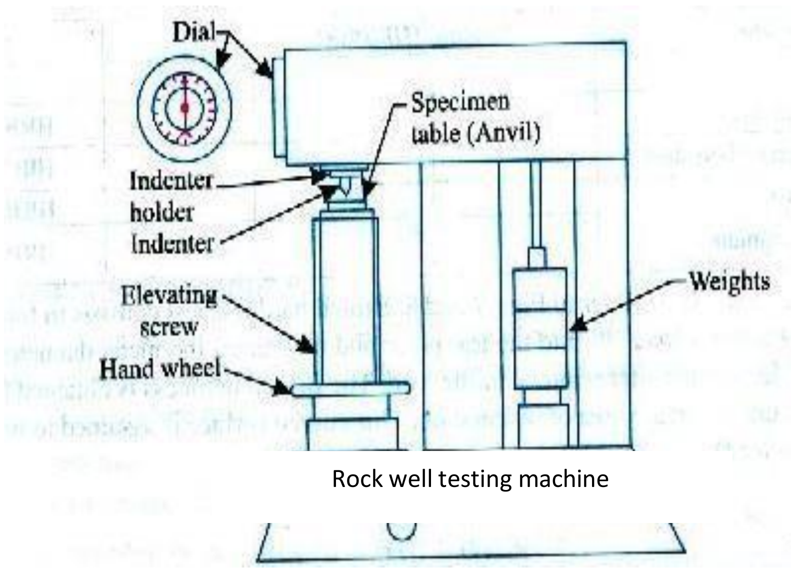
[A] HARDNESS TEST (Rockwell Test)

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:



Rock well testing machine

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

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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:

$$\text{BrinellHardnessNumber} = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

=

Material 2:

$$\text{BrinellHardnessNumber} = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

=

[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.

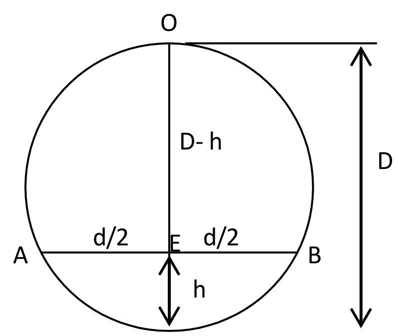
2. The inner diameter of the hole in the shear stress attachment should be slightly greater than that of thespecimen.

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,



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

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

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

$$h = \frac{D}{2} \pm \frac{\sqrt{D^2 - d^2}}{2}$$

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

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

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

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

where

P = Load applied in kgs
D = Diameter of the indenter
d = Diameter of the indentation

$P = 30\ D^2$ for mild steel
$P = 10\ D^2$ for brass & copper
$P = 5\ D^2$ foraluminium

`

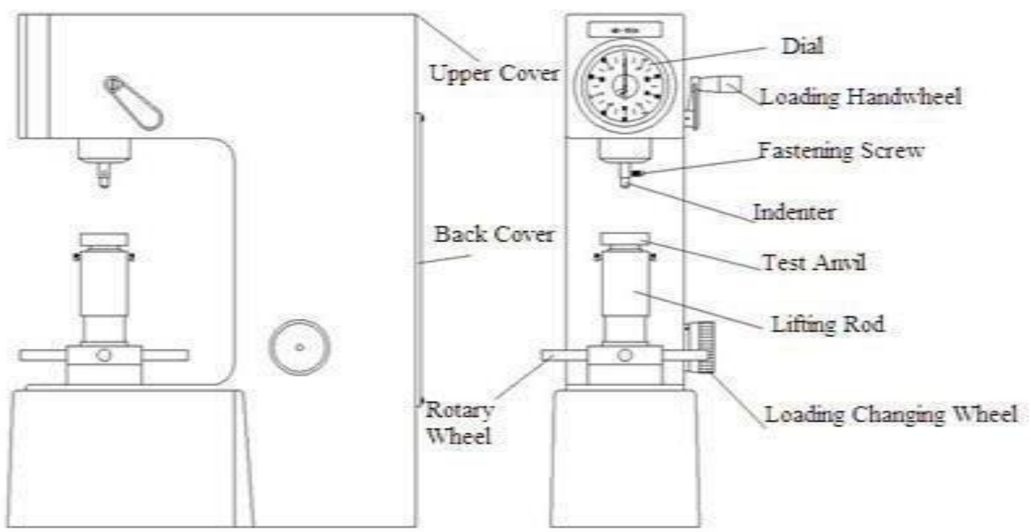
Material 3:

$$\text{BrinellHardnessNumber} = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

=

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)

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EXPERIMENT NO:

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.

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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 $k= W/\delta$-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:

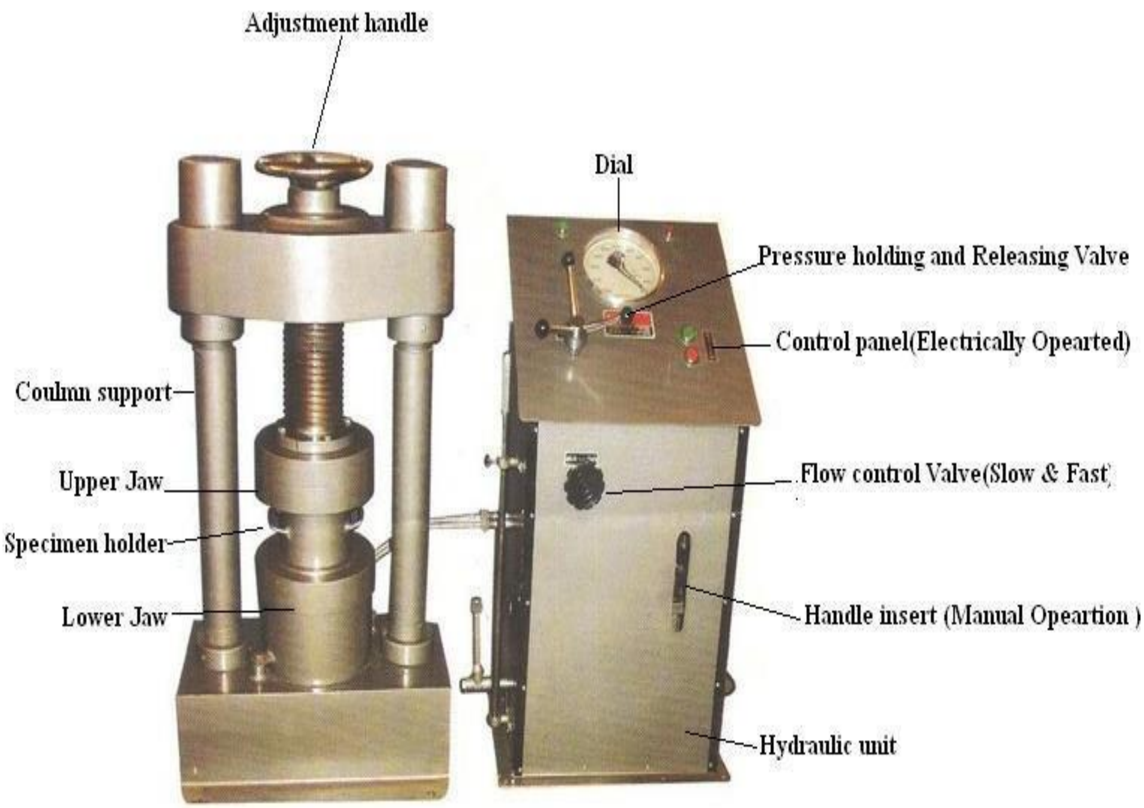
COMPRESSION TEST ON CONCRETE

AIM:- To determine compressive strength ofconcrete.

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

FORMULA:-CompressiveStrength = Load / 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

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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:
IMPACT TEST

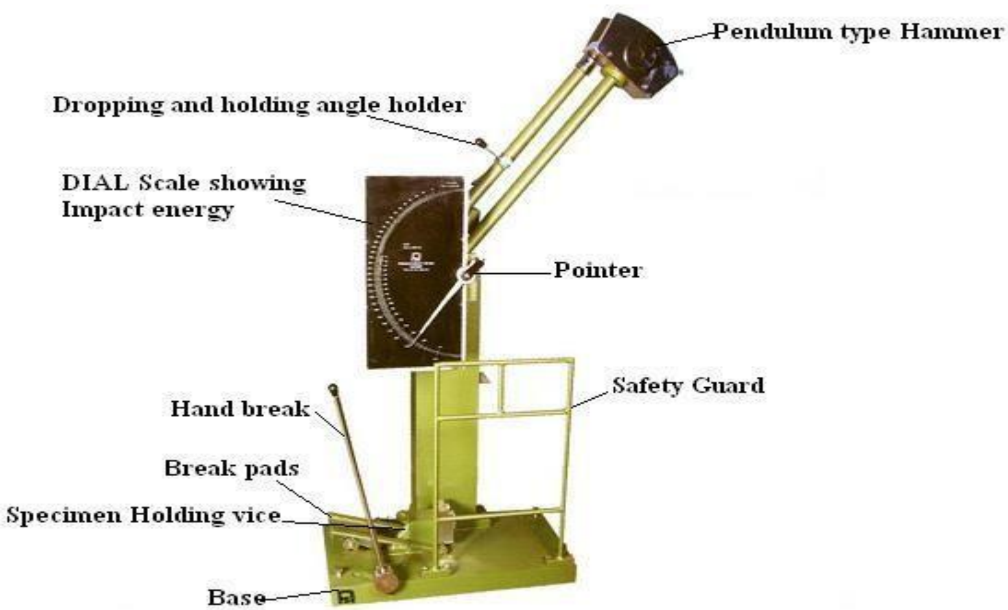
A. IZOD IMPACTTEST

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

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 forcharpy 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	

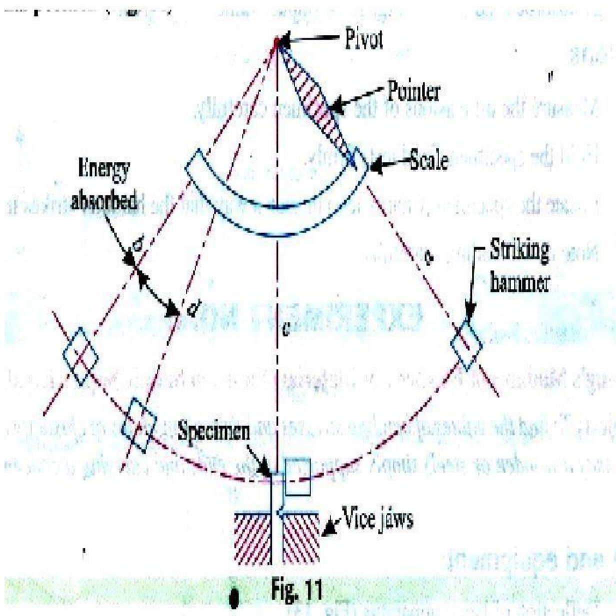
B. CHARPY IMPACTTEST

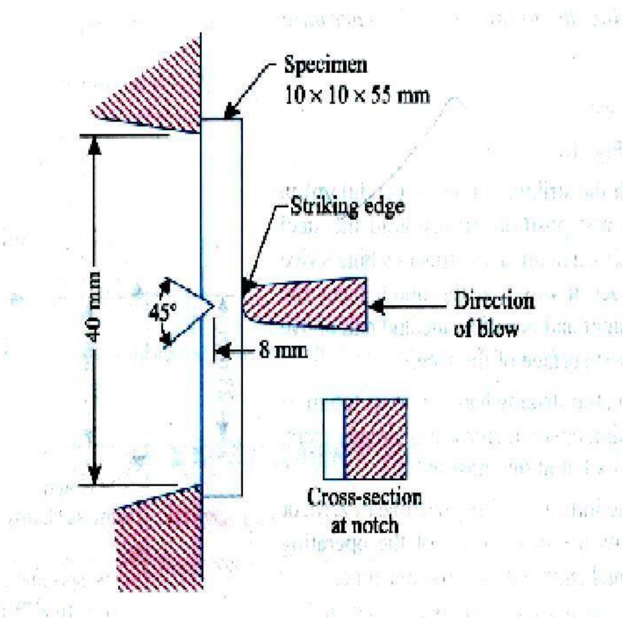
AIM: - To determined impact strength of steel using Charpy Impact Test Method**.**

APPARATUS: -1. Impact testing machine

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

DIAGRAM: -





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:

SHEAR TEST

AIM: -To determined Shear Strength of Steel.

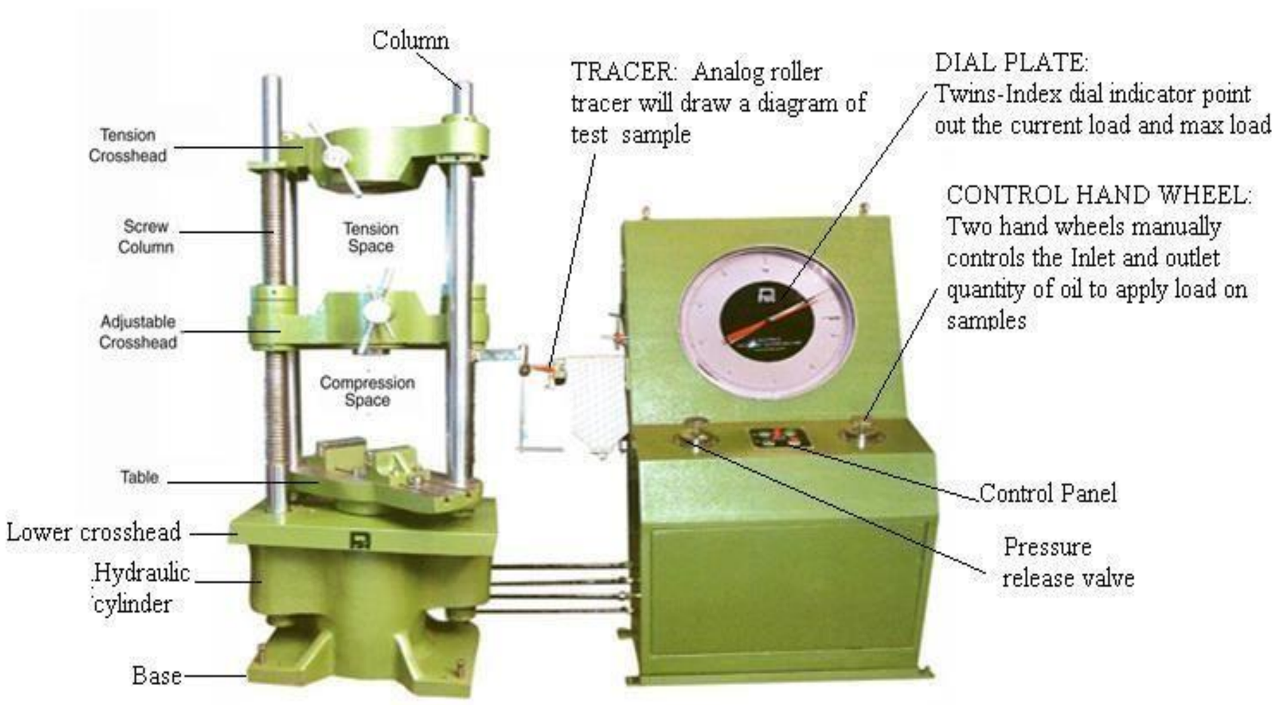
APPARATUS:- i) Universal testingmachine.

ii) Shear testattachment.

iii) Specimens.

DIAGRAM:-

0



<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.

Beamthickness :2.85mm.

TABULAR COLUMN FOR FULL BRIDGE

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

`

EXPERIMENT NO:

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.

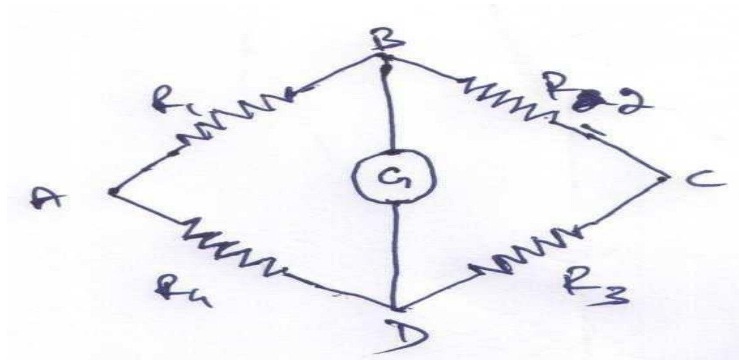
THEORY: A body subjected to external forces is in a condition of both stress and strain. Stress can be directly measured but its effect. i.e. change of shape of the body can be measured. If there is a relationship between stress and strain, stresses occurring in a body can be computed if sufficient strain 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/nm²)	Bending stress. sigma = 6wl / bh²	Modulus of elasticity E = sigma / E_m (N/nm²)
	W	N				



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).

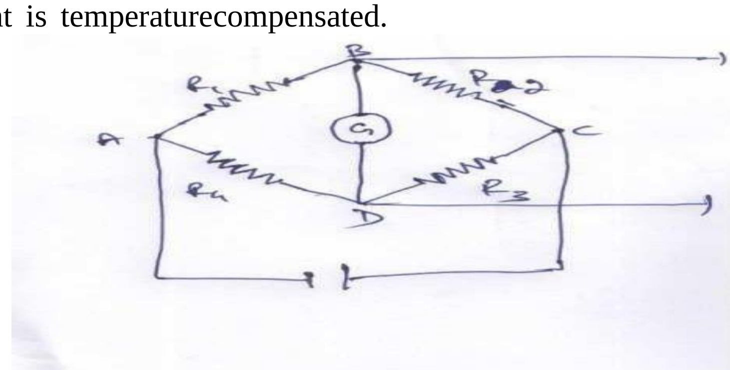
This bridge arrangement consists of a single active gauge in position, say R1 and three resistor are internal to the device. Temperature compensation is possible only if a self temperature compensating strain gauge is used.

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.

`

TABULAR COLUMN FOR QUARTER BRIDGE

Sl. No	**Load Applied W (N)**		**Strain Indicator Reading E– micro** Strain	**Measured Strain $E_m = ^o * 10^{-6} / 4$**	**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:

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

EXPERIMENT NO:

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	

`

COMPRESSION TEST ON BRICK

AIM:- To determine compressive strength ofbrick

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

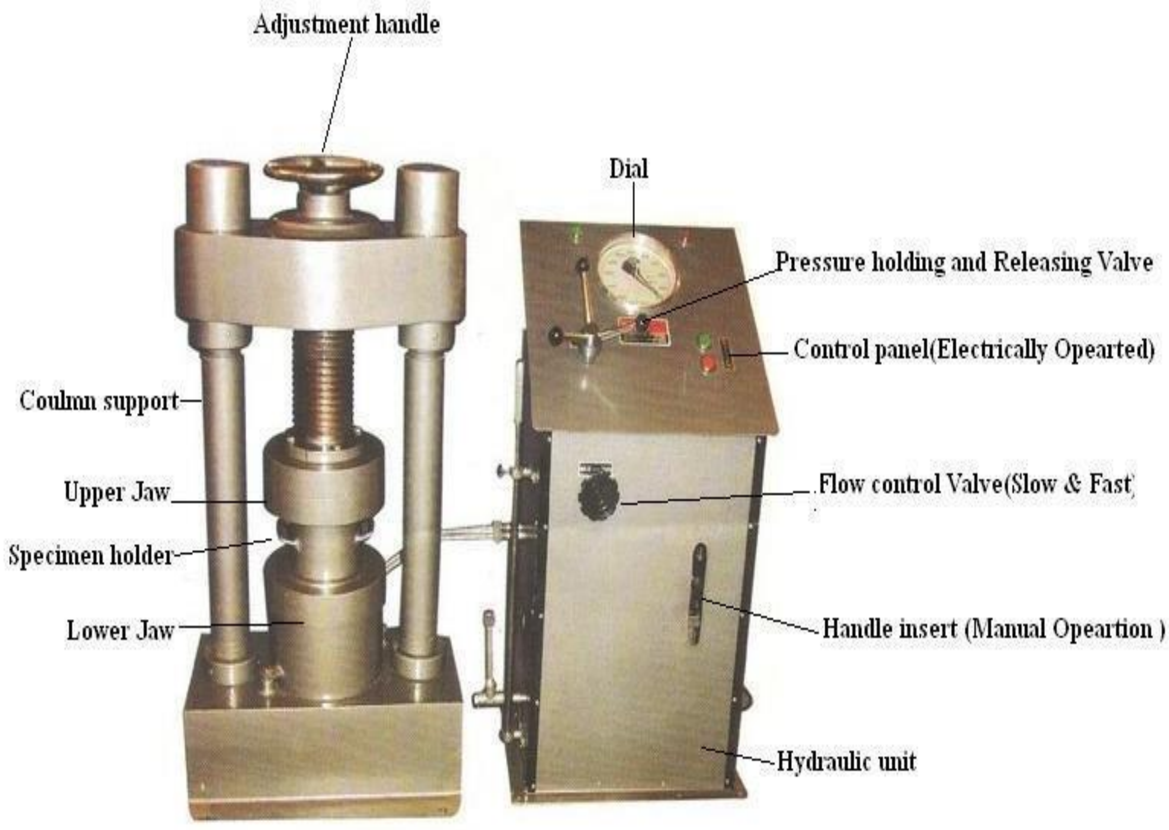
FORMULA:- Max.

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

- - - - - - -

Loaded Area of brick

DIAGRAM:-



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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