SEMBODAI RUKMANI VARATHARAJAN ENGINEERING COLLEGE

SEMBODAI – 614809

(Approved By AICTE,Newdelhi – Affiliated To ANNA UNIVERSITY::Chennai)

CE 6411 STRENGTH OF MATERIALS

(REGULATION-2013)

LAB MANUAL

DEPARTMENT OF CIVIL ENGINEERING

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(REGULATION 2013)

AS PER ANNA UNIVERSITY SYLLABUS

SYLLABUS

LIST OF EXPERIMENTS

1. Tension Test On Mild Steel Rod
2. Compression Test On Wood
3. Double Shear Test On Metal
4. Torsion Test On Mild Steel Rod
5. Impact Test On Metal Specimen (Izod And Charpy)
6. Hardness Test On Metals (Rockwell And Brinell Hardness Tests)
7. Deflection Test On Metal Beam
8. Compression Test On Helical Spring
9. Deflection Test On Carriage Spring
10. Test On Cement

TABLE OF CONTENT

Sl.No	DATE	EXPERIMENTS	MARK	SIGN

TENSION TEST ON MILD STEEL ROD

Experiment No.: **Date:**

Aim:

Toconducttensiontestonthegivenmildsteelrodfordeterminingtheyieldstress, ultimatestress,breakingstress,percentageofreductioninarea,percentageofelon gation over a gauge length and young’s modulus.

Apparatus required:

Universal Testing Machine, Mild Steel Rod, Vernier caliper/Scale.

Theory:

The tensile testismostapplied one,ofall mechanical tests. In thistest endsoftest piece andfixedintogripsconnectedtoastrainingdeviceandtoaloadmeasuringdevice.I fthe appliedloadissmallenough,thedeformationofanysolidbodyisentirelyelastic.A nentirely deformedsolidwillreturntoitsoriginalformassoonasloadisremoved.However,i fthe loadistoolarge,thematerialcanbedeformedpermanently.Theinitialpartofthete nsion curve,whichisrecoverableimmediatelyafterunloading,istermedaselasticandth erestof thecurve,whichrepresentsthemannerinsolidundergoesplasticdeformationister medas plastic.Thestressbelowwhichthedeformationisessentiallyentirelyelasticiskno wnasthe yieldstrengthofmaterial.Insomematerialstheonsetofplasticdeformationisdeno tedbya suddendropinloadindicationbothanupperandaloweryieldpoint.However,som e materialsdonotexhibitasharpyieldpoint.Duringplasticdeformation,atlargerext ensions strainhardeningcannotcompensateforthedecreaseinsectionandthustheloadpas

ses
throughthemaximumandthenbeginstodecrease.Atthisstagethe“ultimatestren
gths”,
whichisdefinedastheratiooftheloadonthespecimentotheoriginalcrosssectiona
lare,
reachesthemaximumvalue.Furtherloadingwilleventuallycause„nick‟ formati
onand rupture.

Usuallyatensiontestisconductedatroomtemperatureandthetensileloadis appliedslowly.Duringthistesteitherroundofflatspecimensmaybeused.Therou
nd
specimensmayhavesmooth,shoulderedorthreadedends.Theloadonthespecim
enis applied mechanicallyor hydraulicallydependingon thetype of testing machine.

Specification:

i. Power supply : 440V
ii. Load capacity : 0 – 40000 kgf / Least count : 08 kgf.

Procedure:

1. Measurethediameter ofthe rod usingVernier caliper.
2. Measuretheoriginal length of therod.
3. Select theproperjawinserts and completetheupperandlowerchuckassemblies.
4. Applysomegraphitegreasetothetaperedsurfaceofthegripsurfaceforthes moothmotion.
5. Operatetheuppercrossheadgripoperationhandleandgripfullytheuppere ndof the test piece.
6. TheleftvalveinUTMiskeptinfullyclosedpositionandtherightvalveinnor mal open position.
7. Opentheright valve andclose it after the lower table is slightlylifted.
8. Adjusttheloadtozerobyusinglargepushbutton.
9. Operatethelowergripoperationhandleandliftthelowercrossheadupandg rip fullythelowerpartofthespecimen.Thenlockthejawsinthispositionbyope rating the jawlockinghandle.
10. Turntherightcontrolvalveslowlytoopenposition(anticlockwise)untilwe

geta desired loadings rate.

11. Afterthatwewillfindthatthespecimenisunderloadandthenunclampthelocking handle.
12. Now thejawswillnotslidedownduetotheirownweight.Then goonincreasingthe load.
13. Ataparticularstagetherewillbeapauseintheincreaseofload.Theloadatthis pointisnotedasyield pointload.
14. Applytheloadcontinuously,whentheloadreachesthemaximumvalue.This is noted asultimate load.
15. Notedowntheloadwhenthetestpiecebreaks,theloadissaidtobeabreaking load.
16. Whenthetestpieceisbrokenclosetherightcontrolvalve,takeoutthebroken pieces of thetestpiece. Thentaper theleft control valve to takethe piston down.

Formula used:

i. Original area of the rod (A_o) = $\frac{\pi d_o^2}{4}$, in mm^2

ii. Neck area of the rod (A_n) = $\frac{\pi d_n^2}{4}$, in mm^2

Where,

D_o- Original diameter of the MS rod

D_n - Neck diameter of the MS rod

Observation:

Yield load (W_y) =

Ultimate load (W_u) =

Breaking load (W_b) =

Tabulation:

Specimen	Length (mm)		Diameter (mm)		Area (mm^2)		Percentage of Elongation in length (%)	Percentage of Reduction area (%)
	Initial	Final	Initial	Final	Initial	Final		
MS rod								

Precautions:

- The specimen should be prepared in proper dimensions.
- Take reading carefully.
- After breaking specimen stop to m/c.

Result:

1. Final length of the specimen = mm
2. Diameter of the Neck (D_n) = mm
3. Percentage of Reduction = %
4. Percentage of Elongation = %
5. Yield stress of MS bar = N/mm^2
6. Ultimate stress of MS bar = N/mm^2
7. Breaking stress of MS bar = N/mm^2
8. Young's Modulus of MS bar = N/mm^2

Graph:

Draw a graph between stress and strain relationship.

VIVA QUESTIONS:

1.

1. What is uniformly distributed load?
2. Define: Shear force.
3. Define: Bending Moment at a section.
4. What is meant by positive or sagging BM?
5. What is meant by negative or hogging BM?

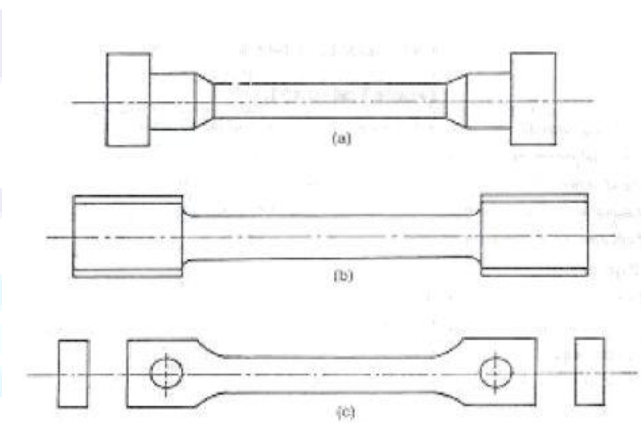


Fig. 2. Mild steel specimens.

COMPRESSION TEST ON WOOD

Experiment No.: **Date:**

Aim:

To determine the compressive strength of wood in given sample material.

Apparatus required:

Compressometer (or) Compression Testing Machine, Wooden specimen.

Procedure:

1. Calculate the material required for preparing the wood of given specification.
2. Immediately after being made, they should be covered with wet mats.
3. Compression tests of wood specimens are made as soon as practicable after removal from making factory. Test-specimen during the period of their removal from the making factory and till testing, are kept moist by a wet blanket covering and tested in a moist condition.
4. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and without shock.
5. Also note the type of failure and appearance cracks.

Formula used:

$$\text{The compressive strength of wooden specimen} = \frac{Taking\ compressive\ load}{Cross\ sectional\ area}$$

Observation and Tabulation:

Specimen	Trial		Mean value N/mm²
	1	2	
Load on wood.KN			

Result:

The compressive stress of the wooden specimen = --------------N/mm²

DOUBLE SHEAR TEST ON METAL

Experiment No.: **Date:**

Aim:

To conduct shear test on given specimen under double shear.

Apparatus required:

Universal Testing Machine with double shear chuck, Mild Steel Rod, Vernier caliper.

Theory:

Inactualpracticewhenabeamisloadedtheshearforceatasectionalwaysco mes toplayalongwithbendingmoment.Ithasbeenobservedthattheeffectofshearingst ress ascomparedtobendingstressisquitenegligible.Butsometimes,theshearingstres sata section assumesmuch importance indesigncalculations.

Universal testingmachine is usedfor performingshear, compressionandtension. There aretwo types ofUTM.

1.Screwtype

2.Hydraulic type.

Hydraulicmachinesareeasiertooperate.Theyhaveatestingunitandcontrolunit connected toeachother withhydraulicpipes. Ithasa reservoirofoil,whichispumpedintoa cylinder,whichhasapiston.Bythisarrangement,thepistonismadetomoveup.Sameoil istakeninatubetomeasurethepressure.Thiscausesmovementofthepointer,which gives reading for the load applied.

Procedure:

1. Measure the diameter ofthehole accurately.
2. Insertthespecimeninpositionandgriponeendoftheattachmentinthe upperportion andtheotherend in the lower portion.
3. Switch on themain switch on the universal testing machine.
4. Bring thedrag indicator in contact with themain indicator.
5. Graduallymovetheheadcontrolleverinlefthanddirectiontillthespe cimen shears.

6. Note down theloadat which specimenshears.
7. Stop themachine andremove thespecimen.

Formula used:

$$\text{Shear strength} = \frac{Maximum\ Shear\ Strength}{Area\ of\ the\ Specimen}$$

Observation and Tabulation:

Diameter of the specimen (d) =

Cross sectional area of the Double shear = $\frac{2\,\pi d^2}{4}$ =

Shear load taken by specimen at the time of failure (P) =

Specification:

Capacity = 400 kN (Range : 0 – 400 kN)

Precaution:

- The inner diameter of the hole in the shear stress attachment is slightly greater than that of the specimen.

Result:

The shear strength of the given metal specimen = ------------------- N/mm^2

VIVA QUESTIONS:

1. Define: Shear strength.
2. Define: Shear Chuck.
3. How to calculate the shear strength of the specimen?

TORSION TEST ON MILD STEEL ROD

Experiment No.: **Date:**

Aim:

To conduct the torsion test on the given specimen for the following.

1. Modulus of Rigidity.
2. Shear stress.

Apparatus required:

Torsion test apparatus, Vernier caliper/Scale, Specimen.

Theory:

Atorsiontestisquiteintrudedindeterminingthevaluesofmodulusofrigidi tyof metallicspecimenthevaluesofmodulusofrigiditycanbefoundoutthroughobser vation made during experimentbyusing torsion equation

T/G= Cα/L

Procedure:

1. Measure the diameter and lengthof the given rod.
2. Therod isfixingintothegrip of machine.
3. Set thepointeronthetorquemeasuringscale.
4. The handle of machine is rotate in onedirection.
5. Thetorqueandangle of test arenotedfor five degree.
6. Nowthehandle is rotated in reversedirection and rod is taken out

Formula used:

Modulus of Rigidity (C) = $\frac{TL}{J\propto}$ in N/mm^2 where,

$\propto -angle\ of\ degree$

Shear stress (t) = $\frac{TR}{L}$ in N/mm^2 .

Observation:

Diameter of the specimen = mm

Gauge length of the specimen = mm

Tabulation:

S.NO	AngleOfTwist	TwistinRod	Torque		ModulusofRigidity(N/mm²)	ShearStress(N/mm²)
			N-M	N-MM		

Precautions:

1. The specimen should be prepared in proper dimensions.
2. The specimen should be properly to get between the jaws.
3. Take reading carefully.
4. After breaking specimen stop to m/c.

Result:

Modulus of Rigidity of the specimen is = ----------------N/m^2

VIVA QUESTIONS:

1. What is torsional bending?
2. What is axial load?
3. Define: Column and strut.
4. What are the types of column failure?
5. What is slenderness ratio (buckling factor)? What is its relevance in column?

IMPACT TEST ON IZOD SPECIMEN

Experiment No.: **Date:**

Aim:

To determinethe impact strength ofthe given material usingIzod impacttest.

Apparatus required:

Impact tester, Specimen, Vernier caliper/Scale, Specimen Fitter.

Theory:

Animpacttestsignifiestoughnessofmaterialthatisabilityofmaterialtoabsorbenergyduringplasticdeformation.Statictensiontestsofunnotchedspecimensdonot alwaysrevealthesusceptibilityofametaltobrittlefracture.Thisimportantfactoris determentbyimpacttest.Toughnesstakesintoaccountboththematerial.Several engineeringmaterialhavetowithstandimpactorsuddenlyloadswhileinservice.Impactstrengthsaregenerallylowerascomparedtostrengthsachievedunderslowlyappliedloadsofalltypesofimpacttests,thenotchedbartestaremostextensivelyused.Therefore, impacttestmeasurestheenergynecessarytofractureastandardnotchedbarbyapplying an impulse load. The est measures the notch toughness of materialundershockingloading.Valuesobtainedfromthesetestsarenotofmuchutility todesignproblemsdirectlyandarehighlyarbitrary.Stillitisimportanttonotethatitprovidesagoodwayofcomparingtoughnessofvariousmaterialsortoughnessofsamematerialunderdifferentconditions.Thistestcanalsobeusedtoassesstheductilebrittletransitiontemperatureofthematerial occurring dueto lowering of temperature.

Specification:

i. Impact capacity = 164joule
ii. Least count of capacity (dial) scale = 2joule
iii. Weight of striking hammer = 18.7 kg.
iv. Swing diameter of hammer = 1600mm.
v. Angle of hammer before striking = 90°
vi. Distance between supports = 40mm.
vii. Striking velocity of hammer = 5.6m/sec.
viii. Specimen size = 75x10x10 mm.
ix. Type of notch = V-notch
x. Angle of notch = 45°
xi. Depth of notch = 2 mm.

Procedure:

1. Raise theswingingpendulum weightand lockit.
2. Release thetrigger andallowthe pendulumto swing.
3. This actuatesthe pointer tomove inthedial.
4. Note down thefrictionalenergy absorbed bythebearings.
5. Raise thependulumweightagain andlockitin position.
6. Placethespecimeninbetweenthesimpleanvilsupportkeepingthe"U" notchin the direction opposite tothestrikingedgeofhammer arrangement.
7. Release thetrigger andallowthe pendulumto strikethespecimenat its midpoint.
8. Note down theenergy spentin breaking (or)bending thespecimen.
9. Tabulatetheobservation.

Formula used:

$$\text{Impact strength of the specimen} = \frac{Energy\ Absorbed}{Cross\ sectional\ area}\ \text{in N/mm}^2$$

Observation and Tabulation:

Area of the given sample specimen = mm^2

S.No	Material Used	Energyabsorbedby force(A) (J)	Energyspenttobreakthespecimen(B) (J)	Energyabsorbedbythespecimen(A-B)J	ImpactStrength J/mm^2

Precaution:

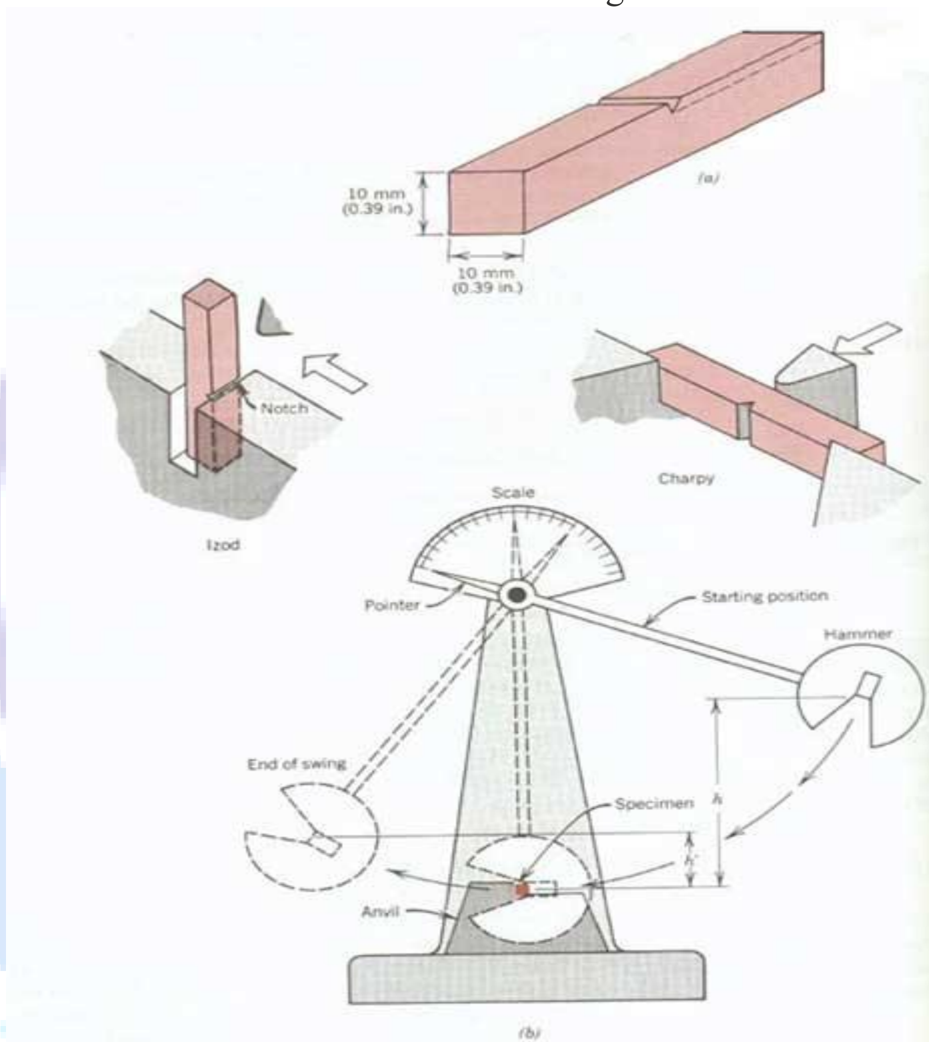
- The specimen should be prepared in proper dimensions.
- Take reading more frequently.
- Make the loose pointer in contact with the fixed pointer after setting the pendulum.
- Do not stand in front of swinging hammer or releasing hammer.
- Place the specimen proper position.

Result:

The impact strength of the given specimen = ---------------- J/mm^2.

VIVA QUESTIONS:

1. Who postulated the theory of curved beam?
2. What is the shape of distribution of bending stress in a curved beam?
3. Where does the neutral axis lie in a curved beam?
4. What is the nature of stress in the inside section of a crane hook?
5. Where does the maximum stress in a ring under tension occur?



IMPACT TEST ON CHARPY SPECIMEN

Experiment No.: **Date:**

Aim:

To determinethe impact strength ofthe given material usingCharpy impacttest.

Apparatus required:

Impact tester, Specimen, Vernier caliper/Scale, Specimen Fitter.

Theory:

Animpacttestsignifiestoughnessofmaterialthatisabilityofmaterialtoabsorbenergyd uringplasticdeformation.Statictensiontestsofunnotchedspecimensdonot alwaysrevealthesusceptibilityofametaltobrittlefracture.Thisimportantfactoris determentbyimpacttest.Toughnesstakesintoaccountboththematerial.Several engineeringmaterialhavetowithstandimpactorsuddenlyloadswhileinservice.Impac t strengthsaregenerallylowerascomparedtostrengthsachievedunderslowlyappliedlo ads ofalltypesofimpacttests,thenotchedbartestaremostextensivelyused.Therefore,the impacttestmeasurestheenergynecessarytofractureastandardnotchedbarbyapplying animpulse load. Thetest measures the notch toughness of materialundershockingloading.

Valuesobtainedfromthesetestsarenotofmuchutilitytodesignproblemsdirectlyandar e highlyarbitrary.Stillitisimportanttonotethatitprovidesagoodwayofcomparing toughnessofvariousmaterialsortoughnessofsamematerialunderdifferentconditions .

Thistestcanalsobeusedtoassesstheductilebrittletransitiontemperatureofthematerial occurring dueto lowering of temperature.

Specification:

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

- Angle of notch = 45°
- Depth of notch = 2 mm.

Procedure:

1. Raise theswingingpendulum weightand lockit.
2. Release thetrigger andallowthe pendulumto swing.
3. This actuatesthe pointer tomove inthedial.
4. Note down thefrictionalenergy absorbed bythebearings.
5. Raise thependulumweightagain andlockitin position.
6. Placethespecimeninbetweenthesimpleanvilsupportkeepingthe"U"notchin the direction opposite tothestrikingedgeofhammer arrangement.
7. Release thetrigger andallowthe pendulumto strikethespecimenat its midpoint.
8. Note down theenergy spentin breaking (or)bending thespecimen.
9. Tabulatetheobservation.

Formula used:

$$\text{Impact strength of the specimen} = \frac{Energy\ Absorbed}{Cross\ sectional\ area} \ \text{in N/mm}^2$$

Observation and Tabulation:

Area of the given sample specimen = mm^2

S.No	Material Used	Energyabsorbedby force(A) (J)	Energyspenttobreakthespecimen(B) (J)	Energyabsorbedbythespecimen(A-B)J	ImpactStrength J/mm^2

Precaution:

- The specimen should be prepared in proper dimensions.
- Take reading more frequently.
- Make the loose pointer in contact with the fixed pointer after setting the pendulum.
- Do not stand in front of swinging hammer or releasing hammer.
- Place the specimen proper position.

Result:

The impact strength of the given specimen = ----------------- J/mm^2.

VIVA QUESTIONS:

1. What are the planes along which the greatest shear stresses occur?
2. Define: Strain Energy
3. Define: Unit load method.
4. Give the procedure for unit load method.

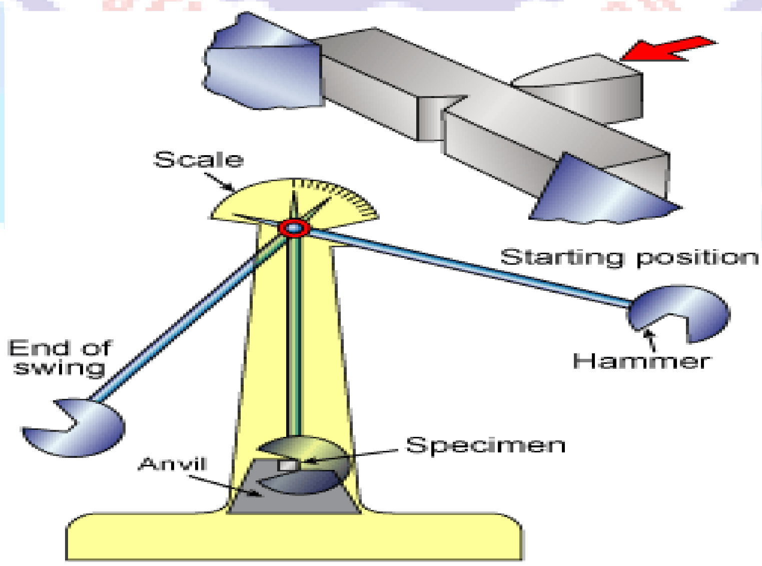


Fig. 1. Impact test specimen (Charpy)

ROCKWELL HARDNESS TEST ON METAL

Experiment No.: **Date:**

Aim:

To determinethe Rockwell hardness number of thegiven specimen.

Apparatus required:

Rockwell Hardness apparatus, Ball indentor, MS bar / Cast-iron Specimen, Microscope.

Theory:

InRockwellhardnesstestconsistsintouchinganindenterofstandardconeor ballinto thesurface ofa testpieceintwooperations and measuring thepermanentincrease ofdepth ofindentationofthisindenterunderspecifiedcondition.FromitRockwellhardnessis deduced.Theball(B)isusedforsoftmaterials(e.g.mildsteel,castiron,Aluminum,brass. Etc.)Andthecone(C)for hard ones(Highcarbonsteel. etc.)

HRB means Rockwell hardnessmeasured on **Bscale**

HRC means Rockwell hardnessmeasured on **Cscale**

Procedure:

1. Clean the surfaceof thespecimen with anemery sheet.
2. Place thespecimenonthe testing platform.
3. Raise theplatform until the longerneedlecomesto rest.
4. Release the load.
5. Applythe load andmaintainuntil the longerneedle comestorest.
6. After releasing the load,note down thedial reading.
7. Thedial reading gives theRockwell hardness number of thespecimen.
8. Repeat thesameprocedurethree times with specimen.
9. Find the average. Thisgives theRockwellhardness number of thegiven specimen.

Precautions :

- The specimen should be clean properly.

- Take reading more carefully and correct.
- Place the specimen properly.
- Jack adjusting wheel move slowly.

Observation and Tabulation:

Name of the Indentor :

S.No.	Material	Scale	Load (kgf)	Rockwell hardness Number			Rockwell hardness Number (Mean)
				1	2	3	

Result:

Rockwell hardness number of thegiven materialis -------------

VIVA QUESTIONS:

1. Define Stress.
2. Define strain.
3. Define Modulus of Elasticity.
4. State Bulk Modulus.
5. Define poison’s ratio.

BRINELL HARDNESS TEST ON METAL

Experiment No.: **Date:**

Aim:

Tofindthe Brinell Hardness numberforthegiven metal specimen.

Apparatus required:

Brinell hardness apparatus, Diamond Indentor, MS specimen, Brinell microscope.

Theory:

Hardness represents the resistance of material surface to abrasion, scratchingand cutting, hardness after gives clear identification of strength. In all hardness testes, a define force is mechanically applied on the test piece for about 15 seconds. The indentor, which transmits the load to the test piece, varies in size and shape for different tests. Common indenters are made of hardened steel or diamond. In Brinell hardness testing, steel balls are used as indentor. Diameter of the indentor and the applied force depend upon the thickness of the test specimen, because for accurate results, depth of indentation should be less than 1/8 of the thickness of the test pieces. According to the thickness of the test piece increase, the diameter of the indentor and force are changed

Description:

Itconsistsofpressingahardenedsteelballintoatestspecimen.Inthisusually a steelballofDiameterDunderaload'P'isforcedinto thetestpieceandthemeandiameter'd'oftheindentationleftinthesurfaceafterremovalofloadismeasured.AccordingtoASTMspecificationsa10mmdiameterballisusedforthepurpose.Lower loads are used formeasuringhardnessofsoftmaterialsandviceversa.TheBrinellhardnessisobtainedbydividingthetestload'P'bycurvedsurfaceareaofindentation.Thiscurvedsurfaceis assumedtobe portion of thesphereofdiameter 'D'.

Specifications :

- Usualballsizeis10mm$\pm$0.0045mm.Sometimes5mmsteelballisalsoused.It shallbehardenedandtemperedwithahardnessofatleast850VPN.(Vickers Pyramid Number). It shall be polished andfreefromsurface defects.
- Specimenshouldbesmoothandfreefromoxidefilm.Thicknessofthepiecetobe tested shall not be lessthan 8 timesfrom thedepth ofindentation.

- Diameteroftheindentationwillbemeasuredntwodirectionsnormaltoeachother withanaccuracyof$\pm$0.25%ofdiameterofballundermicroscopeprovidedwith crosstables andcalibrated measuringscrews.

Procedure:

1. Specimenisplacedontheanvil.Thehandwheelisrotatedsothatthespecimen alongwith theanvil moves upandcontact with the ball.
2. Thedesiredloadisappliedmechanically(bygeardrivenscrew)andtheballpr esses into thespecimen.
3. Thediameteroftheindentationmadeinthespecimenbythepressedballis measuredbytheuseofamicrometermicroscope,havingtransparentengrave d scale in thefield ofview.
4. Theindentationdiameterismeasuredattwoplacesatrightanglestoeachother , and theaverageof two readingsistaken.
5. TheBrinellHardnessNumber(BHN)whichisthepressureperunitsurfacear eaof theindentation is noteddown.

Formula used :

Brinell hardness number (BHN) $= \frac{2P}{\{\pi D\left(D-\sqrt{(D^2-d^2)}\right)\}}$

Where,

P - Loadapplied in Kgf.

D - Diameter of the indenter in mm.

d- Diameterof the indentation inmm.

Observation And Tabulation:

S.No.	Material	Load in Kgf	DiameterOf theIndenter in mm	Diameter of the indentation in mm			Brinell Hardness Number(BHN)
				1	2	3	

Precautions :

1. Brinelltestshouldbeperformedonsmooth,flatspecimensfromwhichd irtandscale have been cleaned.
2. Thetestshouldnotbemadeonspecimenssothinthattheimpressionsho ws

throughthemetal,norshouldimpressionsbemadetooclosetotheedgeo fthe specimen.

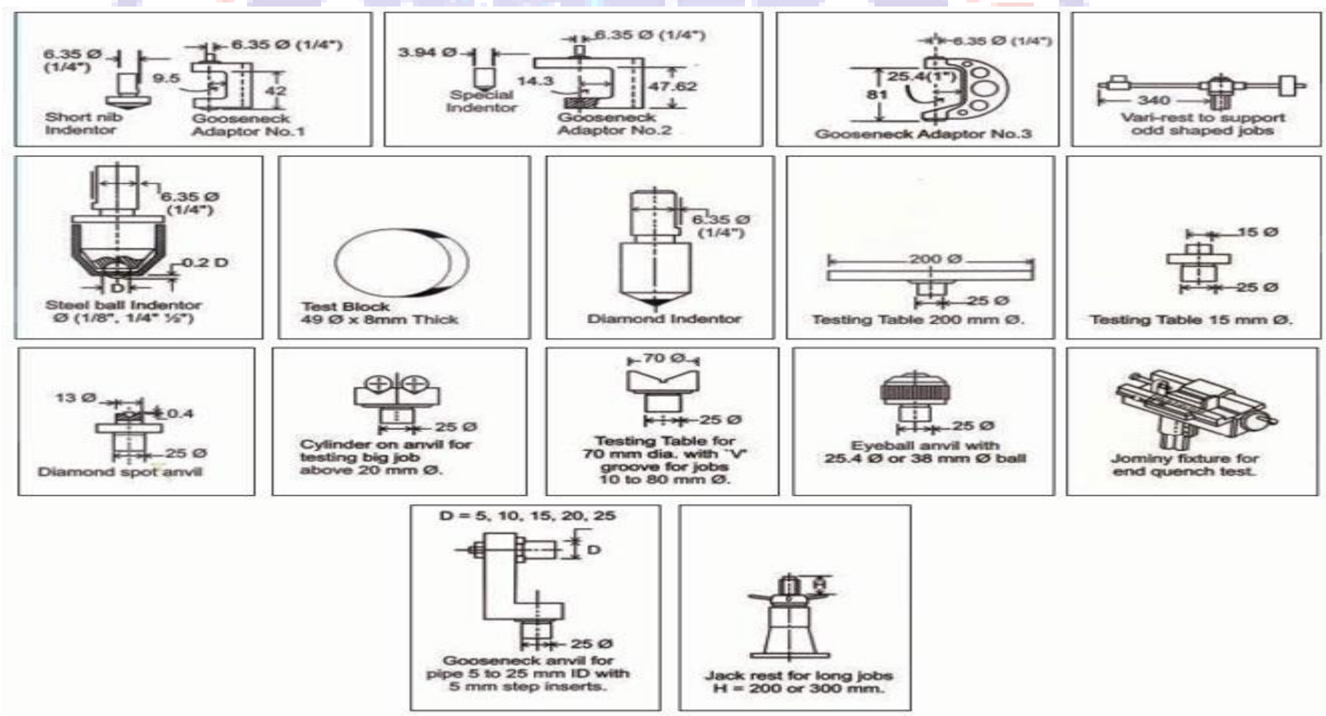
Result:

Thusthe Brinell hardness of theGiven Specimen is

- Mild Steel=-------------------BHN
- EN 8=-------------------BHN
- EN 20=-------------------BHN

VIVA QUESTIONS:

1. Define buckling factor and buckling load.
2. Define safe load.
3. State Hooke’s law.
4. Define Factor of Safety.
5. State the tensile stress & tensile strain.



DEFLECTION TEST ON METAL BEAM

Experiment No.: **Date:**

Aim:

TodeterminetheYoung'smodulusofthegivenspecimenbyconductingbendin g test.

Apparatus required:

Bending test apparatus, Metal beam, Dial gauge, Chalk/Pencil, Scale, weight.

Theory:

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

Procedure:

1. Measure the length (L) of thegiven specimen.
2. Markthecentre of thespecimen usingpencil / chalk.
3. MarktwopointsA&Batadistanceof350mmoneithersideofthecentre mark.The distance between A &B isknown as spanof thespecimen (l)
4. Fixtheattachment for the bending test in themachine properly.
5. Placethespecimenoverthetwosupportsofthebendingtableattachm entsuchthat thepointsA&Bcoincidewithcentreofthesupports.Whileplacing,e nsurethatthe tangential surfacenearerto heartwill be the top surfaceandreceives the load.
6. Measure the breadth(b)and depth(d)of thespecimen usingscale.
7. Placethedialgaugeunderthisspecimenatthecentreandadjustthedial gauge reading tozeroposition.
8. Placetheloadcellattopofthespecimenatthecentreandadjusttheload indicator in thedigital boxto zeroposition.
9. Selecta strainrate of2.5mm / minute using thegear box in themachine.
10. Applytheloadcontinuouslyataconstantrateof2.5mm/minuteandn otedownthe deflectionforeveryincreaseof0.25tonneloaduptoamaximumof6se

tsof readings.

11. CalculatetheYoung'smodulusofthegivenspecimen.

Formula used:

Young's Modulus of Metal beam (E) $= \frac{W\ a\ b\ (L^2 - a^2 - b^2)}{6IL\delta y}$ in N/mm^2

Where,
W = Load in N
a = Deflectometer distance from left support in mm
b = Load distance from left support in mm
I = bd^3/12 mass moment of inertia
L = Span of the beam in mm
δ_y= Deflection meter reading in mm

Observation :

Material ofthe specimen	=	
Length of the specimen,L	=	mm
Breadthof thespecimen, b	=	mm
Depthof thespecimen, d	=	mm
Span of thespecimen,l	=	mm
Leastcount of thedialgauge,LC	=	mm

Tabulation:

S.No	Loadin		Deflectioninmm			Young'sModulusin(N/mm^2)
	kg	N	Loading	Unloading	Mean	
					Average	

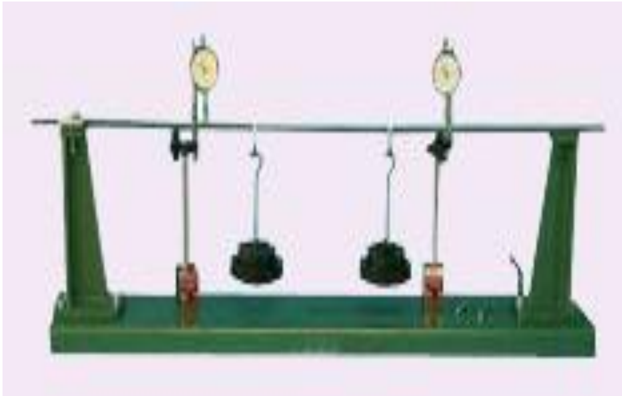
Precautions:

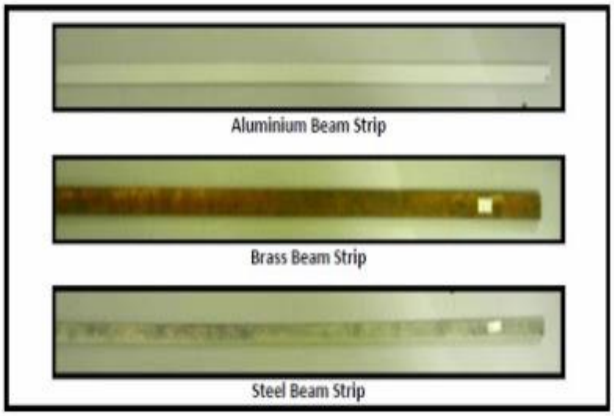
- Test piece should be properly touch the fixture.
- Test piece should be straight.
- Take reading carefully.
- Elastic limit of the beam should not be exceeded.

Result:
Theyoung'smodulus of thegiven specimen is ---------------------------- N/mm^2.

VIVA QUESTIONS:

1. Difference between Beam & Cantilever beam & Overhanging & Propped cantilever & Simply supported beam.
2. What is meant by transverse loading on beams?
3. How do you classify the beams according to its supports?





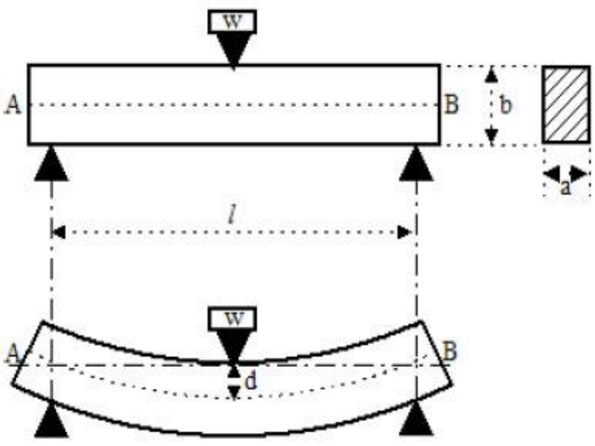
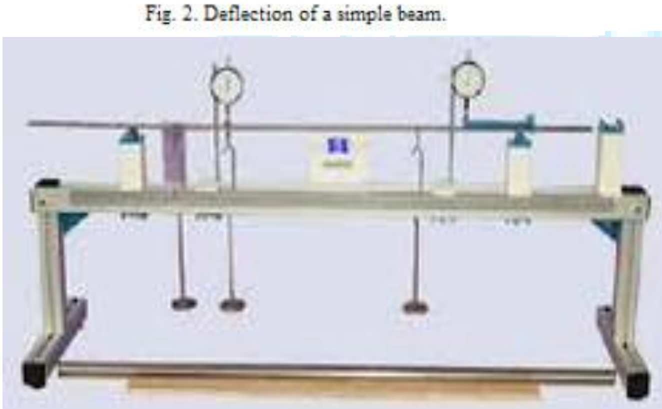


Fig. 2. Deflection of a simple beam.



COMPRESSION TEST ON HELICAL SPRING

Experiment No.: **Date:**

Aim:

To determinethestiffness ofspring,modulus of rigidityof thespring wire and maximumstrainenergystored.

Apparatus required:

Spring testing machine, Open helical coil, Vernier caliper.

Theory:

This is the test to know strength of a material under compression. Generallycompression test is carried out to know either simple compression characteristics of material or column action of structural members. It has been observed that for varying height of member, keeping cross-sectional and the load applied constant, there is an increased tendency towards bending of a member. Member under compression usually bends along minor axis, i.e, along least lateral dimension. According to column theory slenderness ratio has more functional value. If this ratio goes on increasing, axial compressive stress goes on decreasing and member buckles more and more. Effective length is taken as 0.5 L where L is actual length of a specimen.

Procedure:

1. ByusingVerniercalipermeasurethediameterofthewireofthespringandals o thediameter ofspring coil.
2. Count thenumber of turns.
3. Insertthespringinthespringtestingmachineandloadthespringbyasuitable weight and note the correspondingaxial deflection in compression.
4. Increasethe load andtakethecorrespondingaxial deflectionreadings.
5. Plotacurvebetweenloadanddeflection.Theshapeofthecurvegivesthe stiffness of thespring.

Formula used :

(i) Deflection $(\delta) = \frac{64\, WR^3 nSec\theta \{\frac{Cos^2\theta}{N} + \frac{2Sin^2\theta}{E}\}}{d^2}$ in mm.

Where, W - Loadapplied in Newton.

R - Mean radius ofspring coil

$= \frac{(D-d)}{2}$

n - No ofCoils.

θ - Helix angle ofspring.

N - Modulus ofrigidityof spring Material.

E - Young's modulusof the spring material.

(ii) Tan $\propto$ = Pitch / 2πR

(iii) Pitch = (L-d) / n

Where,

d - Dia of spring wire in mm.

L - Length of spring in mm.

N - no of turns in spring.

(iv) Stiffness of spring (K) = W / δ

Where,

δ - Deflection of spring in mm.

W - Load applied in Newtons.

(v) Maximum energy stored = 0.5xW_{max}xδ_{max}

Where,

W_{max} - Maximum load applied

δ_{max} − Maximum deflection

Observation :

Outer diameter of spring (d_o) =

Length of th spring (l) =

Number of turns (n) =

Material of spring = Steel

Young's modulus (E) =

Tabulation:

Sl.No	Load in N	Scale readings in Mm		Deflection in Mm	Rigidity modulus in N/mm^2	Stiffness in N/mm

Precation:

- Place the specimen at center of compression pads.
- Stop the machine as soon as the specimen fails.
- Cross sectional area of specimen for compression test should be kept large as compared to the specimen for tension test: to obtain the proper degree of stability.

Result:

Under compression test on open coil helical spring

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

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

3. Maximum energy stored = ----------------

VIVA QUESTIONS:

1. Define principal stresses and principal plane?
2. What is the radius of Mohr's circle?
3. What is the use of Mohr's circle?

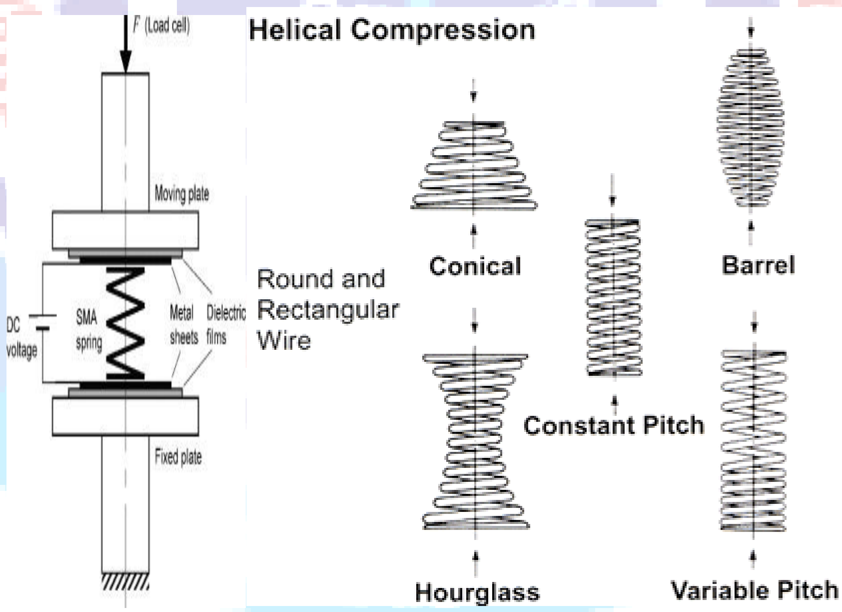


Fig.2.Open Helical springs.

CONSISTENCY OF CEMENT

Experiment No.: **Date:**

Aim:

To determine the consistency of given cement sample.

Apparatus required :

Vicat's apparatus, Needle, Weighing balance, Measuring jar, Mixing trowel and tray.

Procedure :

1. Weight out 400 grams of cement on to a large non – porous plate from and make it into a depression in center to hold the mixing water.
2. Find out the volume of water to give a percentage of 25 by weight of dry cement and this amount carefully to the cement.
3. Mix the cement and water together throughly the process of mixing shall includes kneading and threading. The total time elapsed from the amount of moment of adding water to the cement and mixing completed shall not be less than 4 minutes.
4. Fill the mould completely with the cement paste so gauged and strike off the top to a level with the top of the mould, slightly shake the jar and the mould with the cement to drive at entrapped air.
5. Keep the mould under the vicat plunger and supporting the moving ring by the plunger of the dash pot, release the rod.
6. After the plunger has come to rest, note the reaching against the index.
7. Repeat the experiment with trial paste of varying percentage of water till the plunger comes to rest between 5mm and 7mm from the bottom used.

Specification :

- The limitation of the standard consistency of plunger penetrate depth is 33 – 35 mm.

Observation :

Weight of cement sample = grams.

Tabulation :

Sl No	Water cement ratio (%)	Water content (ml)	Depth of penetration (mm)

Result:

The standard consistency of the cement = ------------------%, -------------------- mm.

VIVA QUESTIONS :

1. Define: Consistency.
2. Define: Workability.
3. What are the composition of cement?
4. What are the types of cement?
5. Enlist the grade of cement.

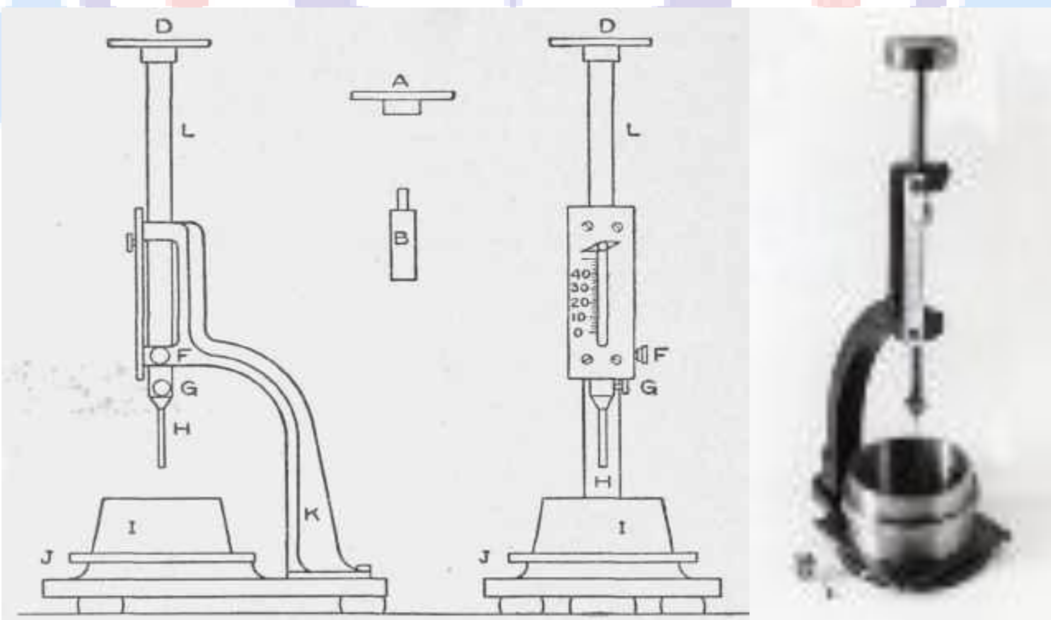


Fig. 3. Consistency of cement.

SETTING TIME OF CEMENT

Experiment No.: **Date:**

Aim:

To determine the Initial and Final setting time of cement.

Apparatus required:

Vicat's apparatus, 1 mm needle, plunger, stopwatch, measuring jar, tray, trowel.

Procedure:

1. Take 400 grams of cement and 85% water required for making cement paste of normal consistency.
2. The paste shall be gauged and filled into the vicat mould in specified manner with in 3 – 5 minutes.
3. Start the time watch the moment water is added to the cement. The temperature of water and that of the test room at the time of gauging temperature shall be within 27$\pm$ 2^{o}c.
4. When the needle for initial setting time brought in contact with the top surface and release quickly, fails to penetrate the paste block for 5 to 7 mm measure from the bottom of the mould is taken as initial setting time.
5. When the needle for final setting time place gently on the surface makes an impression on the paste but the circular setting edge to the attachment fails to do so, it takes as final setting time.

Observation :

Sl.No	Weight of cement (g)	Water content (g)	Initial setting time (min)	Final setting time (min)

Tabulation :

Sl.No	Initial time (min)	Penetration (mm)

Result:

- The Initial setting time of cement is ------------ minutes.
- The Final setting time of cement is ------------ minutes.

Viva questions :

1. Define: Initial setting time.
2. Define: Final setting time.
3. What are the limitation of consistency?