Practical Workbook

MY-207 Mechanical Behavior of Materials

Name________________________

Roll No______________________

Batch_______________________

Year________________________

Department__________________

Department of Metallurgical Engineering
NED University of Engineering and Technology
Karachi-75270, Pakistan

<u>Practical Workbook</u>

MY-207 Mechanical Behavior of Materials

PREPARED BY

Muhammad Sami (PhD)

This is to certify that this practical book contains __________ pages.

APPROVED BY:

Prof. Dr. Ali Dad Chandio
Chairman (MYD)

Department of Metallurgical Engineering
NED University of Engineering and Technology

CERTIFICATE

It is certified that Mr. / Miss____

Student of class **SE** Batch_______________Bearing Roll No. MY-__________has completed his/her course work in the subject of **Mechanical Behavior of Materials (MY-207)** as prescribed and approved by the Board of Review of the Metallurgical Engineering Department.

His/Her performance is reflected by the performance rubrics of his/her practical workbook. This overall performance of the student is going to address the assigned learning attribute.

____

Course Teacher

TABLE OF CONTENTS

MY-207 MECHANICAL BEHAVIOR OF MATERIALS

General Instructions

1. Each experiment will be carried out jointly by a group of students.
2. Be prompt and punctual, late entry will not be excused.
3. All students must come to lab with shoes, no exception.
4. Keep your area of work neat and clean environment. Handle things carefully because penalties will be there for misbehaviour and/or damaging of the equipment tools.
5. You must come well prepared with the theory/background of the experiment to be done on a particular day.
6. Before entering in to the lab, see the notice board for latest information and instructions, if any.
7. Before leaving the lab, enter your determined values in workbook.
8. Take your seat group wise around the study table for miscellaneous works such as reading, writing, and discursion etc.,
9. Submit individual laboratory workbook with complete observations, calculations and exercises.

Experiment No.1

Aim of the Experiment

Operate UTM machine under supervision to determine the tensile behavior of given material(s).

Determine the following:

- Percentage elongation in length
- Percentage reduction in area
- Working stress or permissible stress or safe stress
- Young's modulus
- Yield stress
- Ultimate stress or Maximum tensile stress
- Breaking stress or Failure stress

Material/ Apparatus

Tensile specimens correct dimensions, Universal tensile testing machine, deflectometer, clamping jaws and Vernier caliper.

Theory

In engineering, tension test is widely used to provide basic design information on the strength of the materials. In the tension test a specimen is subjected to a continually increasing uniaxial tensile force while simultaneous observations are made of the elongation of the specimen. A stress-strain curve is plotted from the load-elongation measurements.

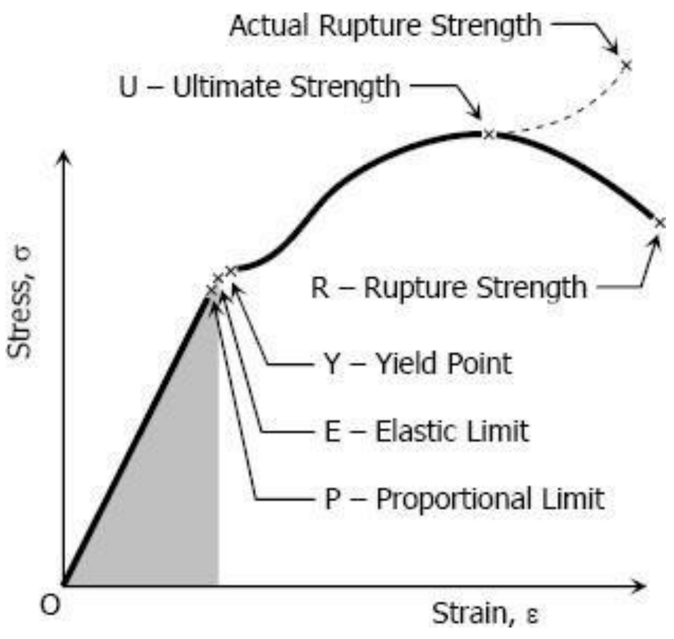

Fig 1: Stress-Strain curve for Steel

The parameters which are used to describe the stress-strain curve of a material are the tensile strength, yield strength or yield point, percent elongation and reduction of area. The first two are strength parameters; the last two indicate ductility.

Definitions:
Limit of proportionality (A): It is the limiting value of the stress up to which stress is proportional to strain.
Elastic limit: This is the limiting value of stress up to which if the material is stressed and then released (unloaded), Strain disappears completely and the original length is regained.
Upper Yield Point (B): This is the stress at which, the load starts reducing and the extension increases. This phenomenon is called yielding of material.
Lower Yield Point (C): At this stage the stress remains same but strain increases for some time.
Ultimate Stress (D): This is the maximum stress the material can resist. At this stage cross sectional area at a particular section starts reducing very fast (fig.1). This is called neck formation.

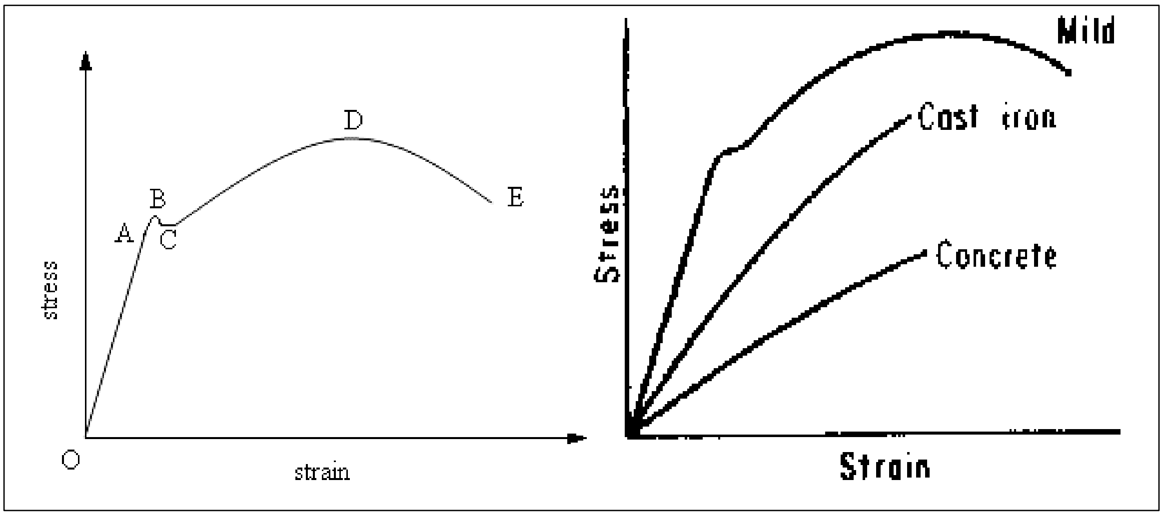

Fig 2: Linear stress-strain Curve

Breaking Point (E): The stress at which finally the specimen fails is called the breaking point. **Hooks law:** Within the elastic limit, the stress is proportional to the strain for an Isentropic material.

A - Elastic Limit
B - Upper Yield Stress
C - Lower Yield Stress
D -Ultimate Stress
E -Breaking Stress

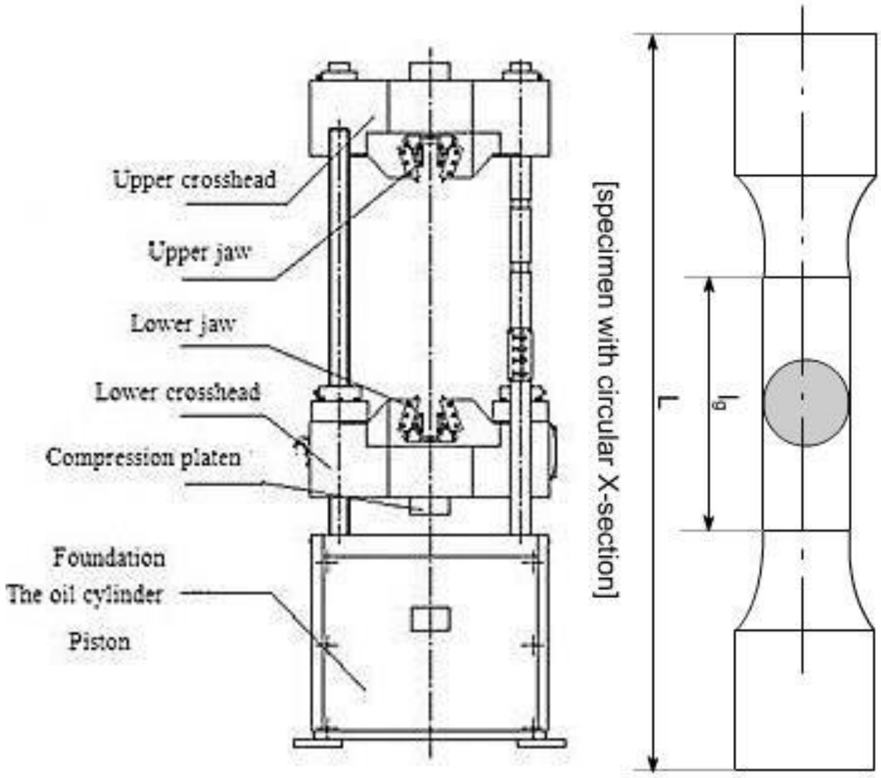

Fig 3: Universal Tensile Machine and Specimen with circular X-section

Procedure

- The original dimensions of the specimen like original diameter, gauge length, etc. is to be measured.
- The specimen is mounted on the Universal Testing machine between the fixed and movable jaws.
- The load range in the machine is adjusted to its maximum capacity
- The dial gauge is mounted on the machine at the appropriate positions and adjusted to zero.
- The machine is switched on and the tensile load is applied gradually.
- For every 5 KN of load, the readings of dial gauge is noted and tabulated.
- Remove the dial gauge at slightly below the expected load at yield point.
- Record the load at yield point, at the yield point the pointer on load scale will remain stationary for small interval of time and blue needle will come back by 2 or 3 divisions that point is lower yield point.
- The specimen is loaded continuously up to the ultimate load where there is formation of cup and cone at neck in the specimen, which is to be noted.
- With further loading the specimen breaks, and breaking load is noted.
- The specimen is removed and final dimensions are measured.

Observations

1. Least count of dial gauge = 0.01mm.
2. Specimen Material = ...
3. Initial length (l_i) = ... mm
4. Initial diameter (d_i) = ... mm
5. Original C/S Area (A_i) = $\frac{\pi \times d^2}{4}$ =....................mm^2
6. Ultimate Load (p_u) =...........KN
   i. Where 'p_u' is the maximum load applied.
7. Final length (l_f) =.................mm
8. Final diameter (d_f) =..............mm
9. Final Area (A_f) = $\frac{\pi \times d_f^2}{4}$ = ...mm^2

Calculations

- Stress = $\frac{\text{Load}}{\text{Area}} = \frac{P}{A_i}$ =...............N/mm^2
- Strain = $\frac{\text{Change in length}}{\text{Original Length}}$ =............
- Young's modulus = $\frac{\text{Stress}}{\text{Strain}}$ = ...N/mm^2 (obtained from the graph)
- Working stress = $\frac{\text{yield stress}}{\text{Factor of Safety.}}$ =......... N/mm^2
- % Elongation= $\frac{\text{Final length-Initial length}}{\text{Initial length}}$ X100 = $\frac{(l_f - l_i)}{l_i}$ x 100 =...%
- % reduction in Area = $\frac{\text{Initial area- Final area}}{\text{Initial area}}$ = $\frac{(A_i - A_f)}{A_i}$ x 100 =......%
- Yield strength = $\frac{\text{Yield load}}{\text{Initial area}} = \frac{p_Y}{A_i}$ = ... N/mm^2
- Ultimate Tensile strength = $\frac{\text{Ultimate load}}{\text{Initial area}} = \frac{p_u}{A_i}$ = ... N/mm^2

Table 1: Tabular column (attach sheet in case of having computerized data)

<table>
<tr><th>Sl. No.</th><th>Load in KN</th><th>Load in N</th><th>Compression (δl) in mm</th><th>Stress in N/mm^2</th><th>Strain</th><th>Young's modulus N/mm^2</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td rowspan="15">$E = \frac{stress}{strain}$

Result from the graph</td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

Results:

F/OBEM 01/05/00

NED University of Engineering & Technology
Department of____________________Engineering
Course Code and Title: ________________________
Laboratory Session No.______________ Date: ______________________

Psychomotor Domain Assessment Rubric-Level P3					
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Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	

Experiment No. 2

Aim of the Experiment

Operate UTM machine under supervision to determine the compressive behavior of given material(s).

Determine the following:

- Modulus of elasticity
- Maximum Compressive strength or ultimate stress
- Percentage Decrease in length
- Percentage Increase in area

Principle

Ductile materials attain a Bulge or a Barrel shape after reaching the maximum compression load. No fracture takes place and there is change in crosssection and compression value remains the same on reaching the maximum load. For brittle materials, there will be no change in the cross-sections or height of the specimen due to the compression load. On reaching the maximum compression load, the specimen suddenly fractures as shown in the Figure.

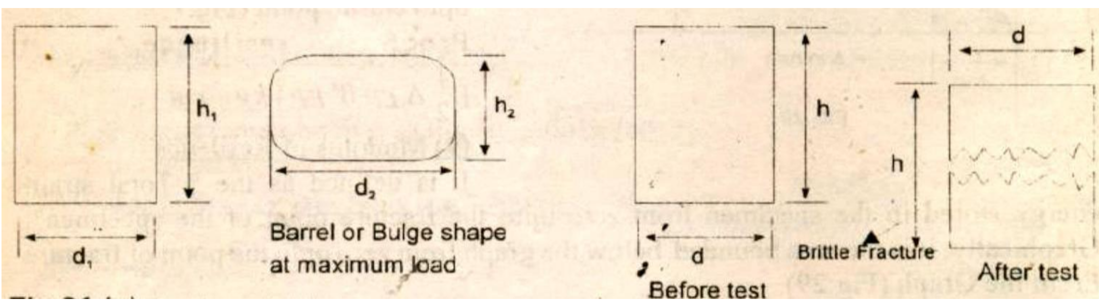

Fig 4: Brittle behavior of sample

Requirements

Universal Testing machine, Dial gauge, Vernier caliper and scale.

Theory

The compression test is just opposite to tension test, with regard to direction. However, there are certain practical difficulties which may induce error in this test. They are difficulty in applying truly axial load and there is always a tendency of the specimen to bend in addition to contraction. To avoid these errors, usually the specimen for this test shall be short in length (not more than 2 times the diameter). In a compression test, stress – strain curve is drawn up to the elastic limit of proportionality. Metals have approximately the same modulus of elasticity as in tension test. The curve, for ductile materials, continues almost without limit as there is no fracture of the material due to its ductility and cross-sectional area increases continuously with increase in load. The specimen will shorten and bulge out. Compression test is mainly used for testing brittle materials such as cast iron, concrete etc. Brittle materials commonly fail along a diagonal plane due to shearing.

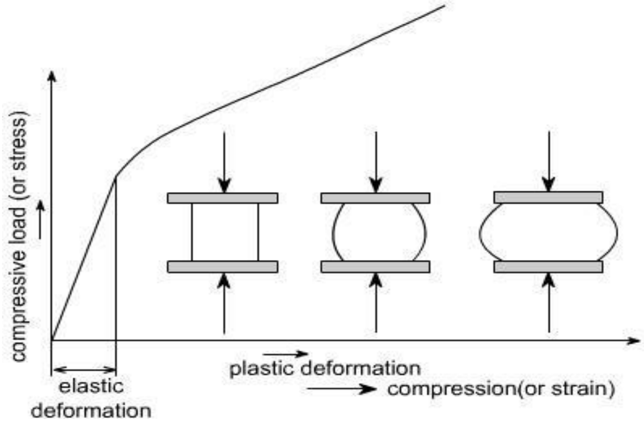

Fig 5: Stress V/S Strain curve under compressive load

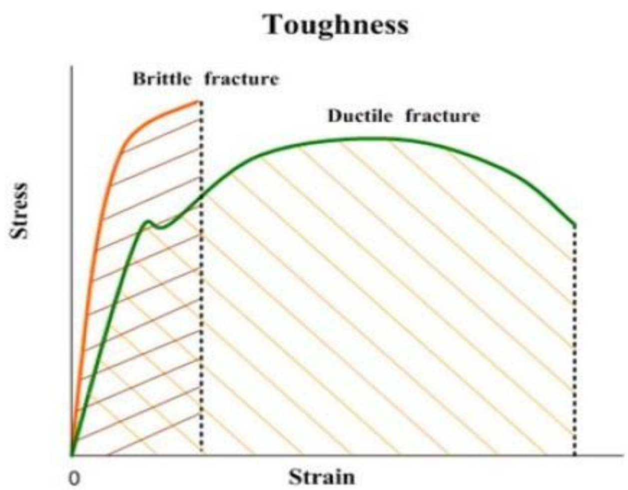

Fig 6: Stress V/S Strain curve

Procedure

- The original dimensions of the specimen like original dia., gauge length etc. is to be measured.
- The specimen is mounted on the Universal Testing machine between the fixed and movable jaws.
- The load range in the machine is adjusted to its maximum capacity
- The dial gauge is mounted on the machine at the appropriate positions and adjusted to zero.
- The machine is switched on and the compressive load is applied gradually.
- For every 10 KN of load, the readings of dial gauge is noted and tabulated.
- Remove the dial gauge at slightly below the expected load at yield point.
- Record the load at yield point, at the yield point the pointer on load scale will remain stationary for small interval of time and blue needle will come back by 1 or 2 divisions that point is lower yield point.
- The specimen is loaded continuously up to the ultimate load (red needle will stops) which is to be noted.
- The specimen is removed and final dimensions are measured.

Observations

1. Diameter of specimen for single shear = ____________________mm
2. Diameter of specimen for double shear = ______________mm

Calculations

$$\text{Stress} = \frac{\text{Load}}{\text{Area}} = \frac{P}{A_i} \qquad = \ldots\ldots\ldots\ldots\ldots \text{N/mm}^2$$

$$\text{Strain} = \frac{\text{Change in length}(\boldsymbol{\delta l})}{\text{Original Length (l)}} = \quad \ldots\ldots\ldots\ldots\ldots$$

$$\text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad = \ldots\ldots\ldots \quad \text{N/mm}^2 \text{ (obtained from the graph)}$$

$$\text{\% Decrease in Length} = \frac{(l_i - l_f)}{l_i} \times 100 = \ldots\ldots\ldots\ldots\ldots \%$$

$$\text{\% Increase in area} = \frac{(A_f - A_i)}{A_i} \times 100 = \ldots\ldots\ldots\ldots \%$$

$$\text{Ultimate Compressive strength} = \frac{\text{Ultimate load}}{\text{Initial area}} = \frac{p_u}{A_i} = \ldots\ldots\ldots\ldots\ldots \text{ N/mm}^2$$

1. Shear Stress (single shear) $= \dfrac{\text{load}}{\text{c/s Area}} =$ __________ ____N/mm^2

2. Shear Stress (double shear) $= \dfrac{\text{load}}{2 \times \text{c/s Area}} =$ _______________ N/mm^2

Table 2: Tabular column (attach sheet in case of having computerized data)

Sl.No.	Type of Shear	Load(P)		Cross Sectional Area mm^2	Shear Stress N/ mm^2
		K_{gf}	N		

Results:

___

___

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Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	

Experiment No. 3

Aim of the Experiment

Operate UTM machine under supervision to determine the behavior of given material(s) under shear loading.

Material/Equipment

UTM, Vernier Calipers, Standard MS Specimen

Theory

A shear stress acts parallel to a C/S plane whereas tensile and compressive stresses act at normal to the C/S plane. For direct shear test of metals, a bar is usually sheared in the same device that changes the position of the specimen while the remaining position is subject to load by suitable dies.

Procedure

1. Measure the diameter of the specimen
2. Fix the shear Specimen in the Single/Double Shear fixture.
3. Keep the shear equipment on the fixed jaw of UTM and apply the load Slowly at right angles to the axis of piece through the central block.
4. Note the load at fracture.

Observations

Material =………………

Span length (L) =......................mm

Breadth (b) = ... mm

Height (h) = ... mm

Cross-sectional area at centre= b x h= ....mm^2

Load at fracture, Pf =......................kN

Table 3: Tabular column: (attach sheet in case of having computerized data)

Sl. No	Load (p) KN	Deflection (δ) mm	(P/δ) value
1			
2			
3			
4			
5			

Results

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Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	

Experiment No. 4

Aim of the Experiment

Operate impact testing machine under supervision to determine the impact behavior of the given material(s)

Requirement

Impact testing machine, MS Specimen

Theory

In an impact test a specially prepared notched specimen is fractured by a single blow from a heavy hammer and energy required being a measure of resistance to Impact. Impact load is produced by a swinging of an impact weight (hammer) from a height. Release of the weight from the height swings the weight through the arc of a circle, which strikes the specimen to fracture at the notch. Here it is interesting to note that height through which hammer drops determines the velocity and height and mass of a hammer combined determine the energy. Energy used can be measured from the scale given. The difference between potential energies is the fracture energy. In test machine this value indicated by the pointer on the scale. This energy value called impact toughness or impact value, which will be measured, per unit area at the notch.

Specification

Specimen size= 55*10*10 Type of notch = U - Notch Angle of notch= 45o Depth of notch= 2mm

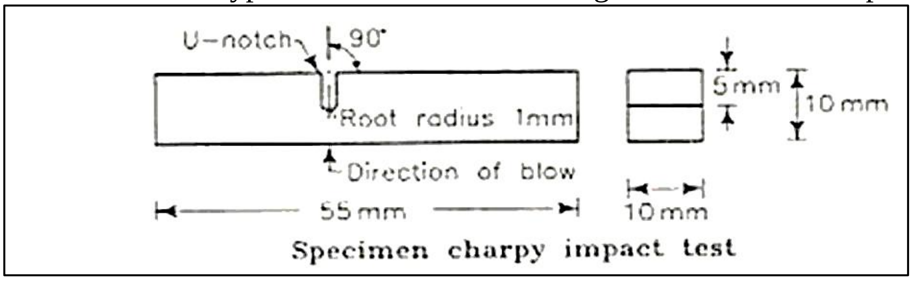

Fig 7: ASTM E-23 standard sample.

Procedure

1. Fix the charpy striker in its respective position; place the charpy test specimen on supports.
2. Align the centre at the specimen notch with respect to centre of support by means of setting gauge.
3. Touch the striker to the test specimen and adjust the indicating pointer to 300J.
4. Lift the pendulum till it gets latched in its position at 1400 from its vertical axis.
5. Allow the pendulum to swing freely and break the specimen.
6. After rupture apply the break to the pendulum slowly by operating break lever.
7. Note down the reading at observed energy directly on the dial as indicated by the indicating pointer.
8. Before proceeding for next test, remove the broken piece of the tested specimen and bring indicating pointer, striker to its original position at 300J.

Calculations

Average impact value of Mild Steel =------------ Joules

Average impact strength = ------------Joules/cm2

Table 4: Impact strength of the material.

Sl. No.	Specimen	Trials	Initial Reading K_1 in J	Final Reading K_2 in J	Izod Impact Value $K=K_1-K_2$ J	Izod impact Strength I=K/A (J/Cm^2)
1.	M.S	1				
2.	M.S	2				

Results

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Remarks	
Instructor's Signature with Date:	

Experiment No. 5

Aim of the Experiment

Operate Rockwell hardness tester under supervision to determine the hardness of the given metal/alloy.

Principle

A standard load (Based on type of material) is applied through a standard indentor (cone or ball indentor) for a standard duration of time. The hardness number is directly obtained in the experiment.

Practical importance

Hardness is the property of the material by which it offers resistance to scratch or indentation. It is the most important property, as the material is subjected to friction and scratch. By this experiment, we can determine the Hardness of the given material.

Requirements

- Rockwell hardness testing machine.
- Diamond cone indentor, ball indentor.
- Specimens (Hardened steel, Mild steel, Brass, Copper, Aluminium)

Theory

The hardness of a material is generally defined as Resistance to the permanent indentation under static and dynamic load. When a material is required to be used under direct static or dynamic loads, only the indentation hardness test will be useful to find out resistance to indentation. Rockwell test was developed by the Wilson Instrument co U.S.A in 1920. This test is an indentation test used for smaller specimens and harder materials. In this test indentor is forced into the surface of a test piece in two operations, measuring the permanent increase in depth of an indentation from the depth increased from the depth reached under a datum load due to an additional load. Measurement of indentation is made after removing the additional load. The indentor used is the cone having an angle of 120 degrees made of black diamond.

Specification

Rockwell hardness tester gives the direct reading of hardness number on a dial provided with the machine. The specimen may be a cylinder, cube, or thick or thin metallic sheets. Specifications are as follows.

1. Ability to determine hardness up to = 100 RHN
2. Maximum application of load = 150 Kgf
3. Method of load application = Lever type
4. Least measuring hardness number= 1 RHN

Procedure

1. Keep the loading and unloading lever at position “A” which is unloading position.
2. Select the suitable indentor & weights according to the scale.
3. Place the specimen on testing table anvil.
4. Turn the hand wheel to raise a job until it makes contact with indentor & continue turning till the longer pointer at the dial gauge makes 2 ½ rotations. Then it stops at zero continue

turning slowly till the small pointer reaches the red spot at „3", this is automatic zero setting dial gauge.

5. Turn the lever position „A" to „B" i.e. from unloading to loading position so that the total load will act.

6. When the longer pointer of the dial gauge reaches steady position, take back the lever to the unloading position „A". [Avoid sudden release at the lever]

7. Now note down the reading in the last dial indicator by notifying the large pointer

8. Turn back the hand wheel and remove the job.

9. Similarly repeat the step from 1-9 for different trials and for different metals.

Observation

Table 5: Given parameters as per material requirement.

Type of Specimen	Type of Indentor	Scale	Total Load Kg-F
Hard			
Soft			

Table 6: Material(s) response to hardness testing.

Sl.No	Specimen	Type of Indentor	RHN			Average RHN
			1	2	3	
01	Hardened steel	Diamond cone				
02	Mild steel	Ball (1/16")				
03	Brass	Ball (1/16")				
04	Copper	Ball (1/16")				
05	Aluminium	Ball (1/16")				

Results:____

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Psychomotor Domain Assessment Rubric-Level P3					
Skill Sets	Extent of Achievement				
	0	1	2	3	4
Equipment Identification Sensory skill to ***identify*** equipment and/or its component for a lab work.	Not able to identify the equipment.	--	--	--	Able to identify equipment as well as its components.
Equipment Use Sensory skills to ***demonstrate*** the use of the equipment for the lab work.	Doesn't demonstrate the use of equipment.	Slightly demonstrates the use of equipment.	Somewhat demonstrates the use of equipment.	Moderately demon strates the use of equipment.	Fully demonstrates the use of equipment.
Procedural Skills ***Displays*** skills to act upon sequence of steps in lab work.	Not able to either learn or perform lab work procedure.	Able to slightly understand lab work procedure and perform lab work.	Able to somewhat understand lab work procedure and perform lab work.	Able to moderately understand lab work procedure and perform lab work.	Able to fully understand lab work procedure and perform lab work.
Response Ability to ***imitate*** the lab work on his/her own.	Not able to imitate the lab work.	Able to slightly imitate the lab work.	Able to somewhat imitate the lab work.	Able to moderately imitate the lab work.	Able to fully imitate the lab work.
Observation's Use ***Displays*** skills to use the observations from lab work for experimental verifications and illustrations.	Not able to use the observations from lab work for experimental verifications and illustrations.	Slightly able to use the observations from lab work for experimental verifications and illustrations.	Somewhat able to use the observations from lab work for experimental verifications and illustrations.	Moderately able to use the observations from lab work for experimental verifications and illustrations.	Fully able to use the observations from lab work for experimental verifications and illustrations.
Safety Adherence Adherence to ***safety*** procedures.	Doesn't adhere to safety procedures.	Slightly adheres to safety procedures.	Somewhat adheres to safety procedures.	Moderately adheres to safety procedures.	Fully adheres to safety procedures.
Equipment Handling ***Equipment care*** during the use.	Doesn't handle equipment with required care.	Rarely handles equipment with required care.	Occasionally handles equipment with required care.	Often handles equipment with required care.	Handles equipment with required care.
Group Work ***Contributes*** in a group based lab work.	Doesn't participate and contribute.	Slightly participates and contributes.	Somewhat participates and contributes.	Moderately participates and contributes.	Fully participates and contributes.

Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	

Experiment No. 6

Aim of the Experiment

Operate Brinell hardness tester under supervision to determine the hardness of the given metal/alloy.

Principle

Brinell hardness number (BHN) is obtained by the ratio of the calculated load and the spherical area of the Indentation or Impression made on the specimen by the corresponding Indentor Ball.

Practical importance: This Brinell Hardness Test is used to determine the Hardness Number of hard, moderately hard, and soft material i.e., Brass, Bronze, Aluminum, Gold, Copper, Etc. Very hard material and Brittle material cannot be tested by Brinell hardness tester.

Requirements

- Brinell hardness testing machine and Brinell Microscope.
- Ball Indentor of diameter 2.5mm and 5mm
- Specimens (Mild steel, Brass, Copper, Aluminium)

Specification

In Brinell hardness test, a steel ball of diameter (D) is forced under a load (F) on to a surface of test specimen. Mean diameter (d) of indentation is measured after the removal of the load (P). Specifications are as follows.

1. Ability to determine hardness up to =1411 BHN
2. Maximum application of load =250 Kgf
3. Method of load application = Lever type
4. Least measuring hardness number= 1 BHN3

Procedure

1. Keep the loading and unloading lever at position "A" which is unloading position.
2. Select the suitable indentor & weights according to the scale.
3. Place the specimen on testing table anvil.
4. Turn the hand wheel to raise a job until it makes contact with indenter & continue turning till the longer pointer at the dial gauge makes 2 ½ rotations. Then it stops at zero continue turning slowly till the small pointer reaches the red spot at „3‟, this is automatic zero setting dial gauge.
5. Turn the lever position „A‟ to „B‟ i.e. from unloading to loading position so that the total load will act.
6. When the longer pointer of the dial gauge reaches steady position, take back the lever to the unloading position „A‟. [Avoid sudden release at the lever]
7. Remove the job from the platform and note down the diameter of the indentation using Brinell microscope.
8. using appropriate formula calculate BHN.
9. Similarly repeat the step from 1-8 for different trials and for different metals.

Calculations

$$\text{Brinell Hardness Number (BHN)} = \frac{2P}{\pi D\left[D - \sqrt{D^2 - d^2}\right]}$$

Where, D = Diameter of ball indentor in mm. d= Diameter of Indentation in mm. P= Load applied in Kgf. d=MSR+ (CVSD×LC). Least Count of Brinell Microscope=0.01mm

Based on BHN for Mild Steel, the Relation between the tensile strength and Hardness Number is given as follows,
Tensile Strength of Mild Steel = K*BHN for MS
Where K= constant between 3.4 to 3.9 for types of steel.

Observations
Type of indentor = ___________________.

Table 7: Material(s) response to hardness testing.

Sl. No	Specimen	Load applied in Kgf	Length of Indentation in mm(l)			Average length in mm	VHN= $\frac{1.854P}{l^2}$
			1	2	3		

Results:

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Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	

Experiment No. 7

Aim of the Experiment

Operate beam apparatus under supervision to determine the deflection and bending stress of the cantilever beam.

Material/Apparatus

Beam apparatus, Bending fixture, vernier caliper, meter rod, test piece & dial gauge.

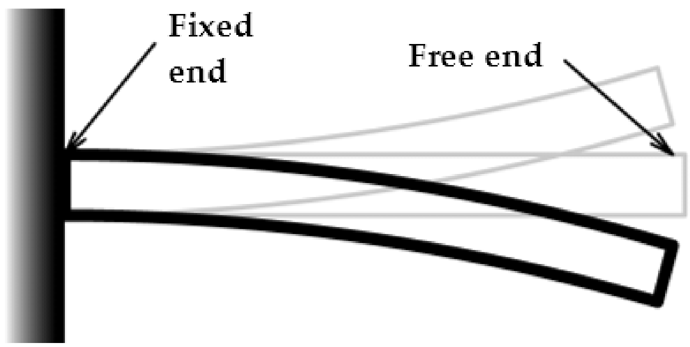

Fig 8: Deflection in the beam.

Theory

A Cantilever is a Beam one end of which is clamped and the other end is free. A beam with a length of L is fixed at one end and the other end is free. Let the moment of inertia of the Beam is ‘I’ about its neutral axis and the Young’s Modulus be ’E’. Moment of inertia about the neutral axis $\boldsymbol{I}=\boldsymbol{bh}\mathbf{312}$

Deflection at the end where point load is acting = δ

The deflection at the end (Max deflection) δ is related to the load ‘W’, length ‘L’ moment of Inertia ‘I’, and Young’s Modulus ‘E’ through the equation. $\boldsymbol{\delta}=\boldsymbol{WL}\mathbf{33}\boldsymbol{EI}$

Procedure

1. Clamp the Beam horizontally on the clamping support at one end.
2. Measure the length of cantilever L (distance from clamp end to loading point)
3. Fix the dial gauge under the beam at the loading point to Read down-ward Moment and set zero.
4. Hang the loading Pan at the free end of the cantilever.
5. Load the cantilever with different loads (W) and note the dial gauge readings (δ)
6. Change the length of the cantilever for two more different lengths and repeat the Experiment.
7. Change the position of the cantilever and repeat he experiments for the other value of I for the rectangular cross-section.

Table 9: Material(s) response to deflection and bending stress.

S.No	Load 'W' in N	Deflection 'δ' in mm.	Young's Modulus 'E' $\frac{N}{mm^2}$

Calculations

1. $I = \frac{b\,h^3}{12}$

2. $\delta = \frac{WL^3}{3EI}$

Precautions

1. The length of the cantilever should be measured properly.
2. The dial gauge spindle knob should always touch the beam at the bottom of the loading point.
3. Loading hanger should be placed at a known distance of cantilever length.
4. All the errors should be eliminated while taking readings.
5. The elastic limit of the Beam should not exceed.
6. The beam should be positioned horizontally.

Result: The Bending strength of given specimen = ----------------------$\frac{N}{mm^2}$

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Laboratory Session No._____________ Date: ______________________

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Remarks	
Instructor's Signature with Date:	

Open ended lab

The objective of this lab experiment is to understand and visualize dislocations in a crystalline material using the bubble raft method. Through this experiment, students will gain insights into the behavior and movement of dislocations in metals.

Following calculations need to be performed;

1. Calculation of Burgers Vector
2. Estimation of Dislocation Density:
3. Analysis of Dislocation Slips:
4. Calculation of Shear Stress:

Students are required to attach instruction sheet and rubric assessment sheet along with the report.