MATERIAL TESTING LAB

(2025407)

LAB MANUAL

(4th SEMESTER)

DEPARTMENT OF MECHANICAL ENGINEERING

GOVERNMENT POLYTECHNIC MADHEPURA

FACULTY NAME: BINDESHWER PARIT

PREPARED BY – PRAMANAND KUMAR MANDAL

(LAB ASSISTANT G P MADHEPURA)

List of Practical

1. **Prepare a specimen and examine the microstructure of the Ferrous and Non- ferrous metals using the Metallurgical Microscope.**
2. **Detect the cracks in the specimen using Die penetration test.**
3. **Detect the cracks in the specimen using Magnetic particle test.**
4. **Determination of Rockwell's Hardness Number for various materials like mild steel, high carbon steel,brass, copper and aluminium.**
5. **Finding the resistance of materials to impact loads by Izod test.**
6. **To perform the Charpy impact test on materials.**
7. **Torsion test on mild steel – relation between torque and angle of twist determination of shear modulus and shear stress.**
8. **Finding Young's Modulus of Elasticity, yield points, percentage elongation and percentage reduction in area, stress strain diagram plotting, tests on mild steel.**
9. **Determination of modulus of rigidity, strain energy, shear stress and stiffness by load deflection method (Open & Closed coil spring)**
10. **Single or double Shear test on M.S. bar to finding the resistance of material to shear load.**

EXPERIMENT No 1

AIM: Prepare a specimen and examine the microstructure of the Ferrous and Non- ferrous metals using the Metallurgical Microscope.

APPARATUS: Hand press, flat file, emery papers of various grades, rotary polishing machine, and Metallurgical microscope.

Theory: Micrograph is the study of the structures of metals and their alloys under a microscope at Magnification from x75 to x1500. The observed structure is called the microstructure. The Metallographic studies include;

1. Determination of size and shape of the crystallites which constitute an alloy.
2. Reveal the structure characteristic of certain type of mechanical working operations.
3. Detect the micro-defects such as non-metallic inclusions, micro cracks, etc."
4. Determine the chemical content of alloys.
5. It indicates the quality of heat treatment.

Preparation of specimens for microscopical examination: The various steps involved in Preparing a Specimen for microscopic examinations is given below;

1. **SELECTION OF SPECIMEN:**
   When investigating the properties of a metal, it is essential that the specimen must be homogeneous in composition and crystal structure. A specimen of 10mm diameter or 10mm square is cut from the metal with a saw or water-cooled slitting wheel. The thickness of the specimen should not be more than 12mm. When a specimen is so small that it is difficult to hold, the specimen may be mounted in a suitable compound like thermoplastic resin, by using a hand press. In cases where neither pressure nor heating is desirable, a cold setting thermoplastic resin can be cast round the specimen. A specimen whose surface has been prepared for microanalysis is called micro-section.
2. **GRINDING:**
   It is first necessary to obtain a reasonably flat surface on the specimen. This can be Achieved either by using a fairly coarse file or by using motor-driven emery belt. Care must be Taken to avoid overheating of the specimen by rapid grinding methods; since this may lead to Alterations in the microstructure. When the original hacksaw marks have been ground out, the Specimen should be thoroughly washed.
3. **FINE GRINDING:**
   Fine grinding is carried out on waterproof emery papers of progressively finer grades (220, 320, 400, and 600) that are attached to a plane glass plate. The specimen is drawn back and forth along the entire length of No. 220 paper, so that scratches produced are roughly at right angles to those produced by the preliminary grinding operation. Having removed the primary grinding marks, the specimen is washed thoroughly. Grinding is then continued on No:320 paper, and again turning the specimen through 90° until the previous scratch narks have been removed. This

process is repeated with No. 400, and No. 600 papers. Light pressure should be used at all stages.

4. POLISHING:

The final polishing operation is to remove the fine scratches on the surface by using A rotary polishing machine. The specimen is polished by rubbing it on a soft moist velvet cloth Mounted on a flat rotating disc, with the polishing paste. Suitable polishing pastes are fine alumina, Magnesia. Chromium oxide, or diamond dust. Polishing is continued until a mirror scratch free Finish is obtained. Nonferrous specimens are best finished by hand on a small piece of selvyt cloth Wetted with-silvo polishing. This should be accomplished with a circular sweep of the hand instead Of back and forth motion used in grinding. During polishing a constant trip of water is fed to the Rotating pad. After polishing, the specimen must be washed thoroughly. The grease films if any Can be removed by immersing the specimen in boiling ethanol.

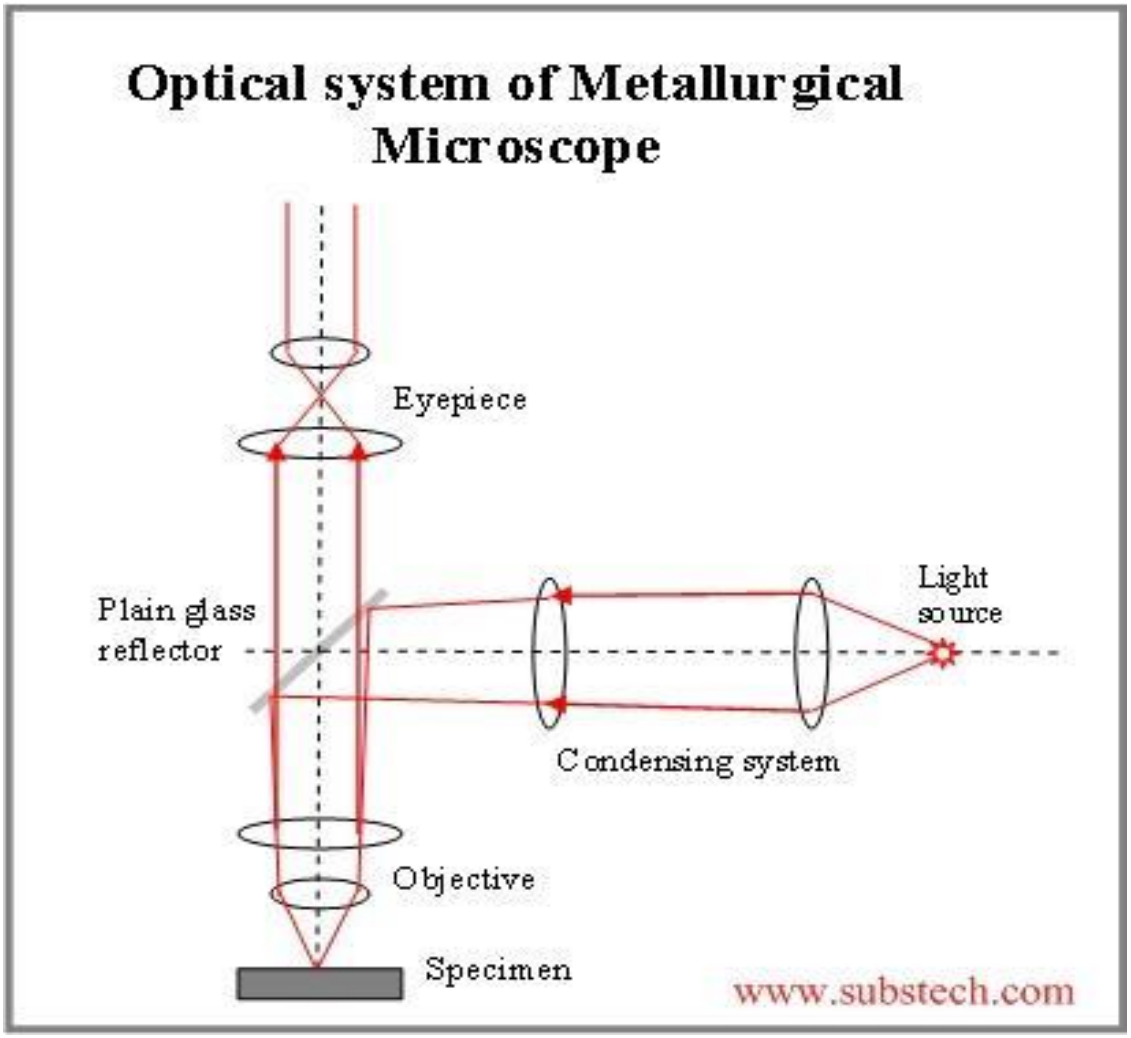
5. ETCHING:

To make its structure apparent under the microscope, it is necessary to impart unlike Appearances to the constituents. This is generally accomplished by selectively corroding or etching The polished surface by applying a chemical etching reagent. Grain boundaries will etch at different Rates than the grains then leaving the grains standing out and they become visible with a reflected Light microscope. Various etching reagents for microscopic examination are given in table-1.

Table : Details of different etchants, composition, and characteristics

Type of etchant	Composition	Characteristics and uses
Nital	2 c.c. Nitric acid and 98 c.c. Ethanol	Iron and steel and ferrite Grey cast iron. Etching time 10-30 sec.
Picral	4 gm. Picric acid and 96 c.c. Ethanol	Good for pearlite and spherodised structure. and cast iron (not for (ferritic structure)
Acid ammonium peroxodisulphate	10 c.c. Hydrochloric acid, 10 gm Ammonium peroxodisulphate, 80 c.c. Water.	Stainless steel.
Dilute hydrofluoric acid	0.5 c.c. Hydrofluoric acid, 99.5 c.c Water	Aluminum and its alloys
Ethanoic acid and nitric acid	3 c.c. Acetic acid, 4 c.c. Nitric acid. 16 c.c. Water.	Lead and its alloys
Dilute hydrochloric acid in alcohol	1 c.c. Hydrochloric acid, 99 c.c. Alcohol.	Zinc and its alloys
Mixed nitric acid and Ethanoic acid	50 c.c. Nitric acid and 50 c.c. Ethanoic acid	Nickel and monel metal.
Ammonia hydrogen peroxide	50 c.c. Ammonium hydroxide, 20-50 c.c. Hydrogen peroxide, 50 c.c. Water	Copper brass and bronze

The specimen is immersed in or swabbed with suitable reagent until the polished surface becomes Very slightly discolored. The reagent is then thoroughly washed off first with water and then with Alcohol. The surface is then dried in warm air, the standard microstructures for various metals are Shown in fig.



Grain size: The grain size of a metal can be reported in several ways:

1. Number of grains in unit area of cross-section.
2. Mean diameter of grains.
3. ASTM grain size index N – where 2N-1 is the number of grains per square inch at a Magnification of x100.

PROCEDURE:

1. Prepare the given specimen as explained above and etch it. .
2. Mount the specimen on the calibrated microscope slide such that the surface is normal to the Axis of the instrument.

3. Record the objective magnification and eyepiece magnification to determine the total Magnification.
4. Focus the surface of the specimen using coarse adjustment and then by fine adjustment.
5. Observe the microstructure and record it.
6. Identify the material by comparing the microstructure with the standard microstructure.
7. Repeat the same for the other specimens.

Experiment no 2

AIM:

Detect the cracks in the specimen using Die penetration test.

APPARATUS: Penetrate, developer, and ultraviolet light source.

THEORY: In the liquid penetrate test, liquids are applied to the surface of the part and allowed to penetrate into surface openings, cracks, seams, and porosity. Two commonly known types of liquid penetrates are:

(a) Fluorescent penetrants which fluoresce under ultraviolet light, and
(b) Visible penetrant, using dyes, usually red in color, which appear as bright outlines on the surface.

The test piece is coated or socked in a1iquid penetrant and the surplus coating is wiped off. The Penetrant can seep into cracks as small as 0.1 m in width. After a short time, a developing agent Is added to allow the penetrant to seep back to the surface (due to capillary action) and spread to The edges of openings. The surface is then inspected for defects, either visually in the case of dye-Penetrants or under ultraviolet light for fluorescent penetrant. The developer includes dry powders, Aqueous liquid, and non-aqueous liquid. This method is capable of detecting variety of surface Defects and is used extensively.

Procedure:

1. Clean the test piece surface to remove scales, oil, and grease.
2. Immerse the test piece in the selected penetrant and hold it for some time.
3. Remove the excess penetrant on the test piece surface.
4. Apply the developer on the surface of the test piece.
5. Examine the surface of the test piece under appropriate viewing conditions.
6. Clean the surface to prevent corrosion, etc.

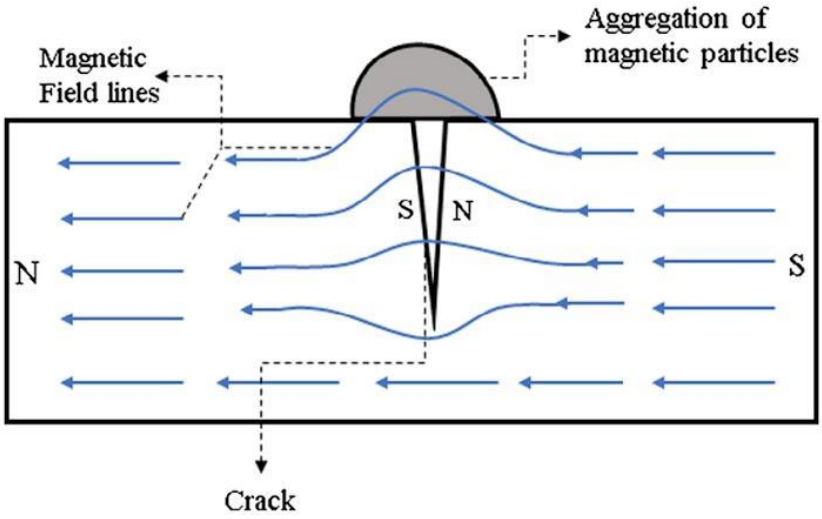
EXPERIMENT NO 3

AIM: Detect the cracks in the specimen using Magnetic particle test.

APPARATUS: Magnetic field generator, and ferromagnetic powder.

Theory: The magnetic particle method of inspection is a procedure used to determine the presence Of the defects at or near the surface of the ferromagnetic objects. This method consists of placing Fine ferromagnetic particles on the surface. The particles can be applied either dry or in a liquid Carrier such as water or kerosene. When the part is magnetized with a magnetic field, a Discontinuity (defects) on the surface causes the particles to gather visibly around it. Thus, the Defects become a magnet due to the principle of flux leakage where magnetic field lines are Interrupted by the defect and collect the ferromagnetic particles. The collected particles generally Take the shape and size of the defects. Sub surface defects can also be detected by this method, Provided they are not deep. The ferromagnetic particles may be colored with pigments for better Visibility on the metal surfaces. The magnetic fields can be generated either with direct current or Alternating current, using yokes, bars, and coils. The equipment may be portable or stationary.

DIAGRAM



Procedure:

1. Clean the surface of the test specimen to remove scales, oils and grease. Apply a thin layer of ferromagnetic particles over the surface to be tested.
2. Magnetize the test piece.
3. Observe the shape and size of the magnetic particles collected, which is the shape and size of The defect.

EXPERIMENT NO 4

AIM: Determination of Rockwell's Hardness Number for various materials like mild steel, high carbon steel, Brass, copper and aluminium.

APPARATUS: Rockwell hardness tester.

Theory: In Rockwell hardness test, the depth of indentation of a diamond core or small steel ball Determines the hardness of the material. The Rockwell test differs from the Brinell test in that the Indenters and the loads are smaller and that the resulting indentation is smaller and shallower.

Rockwell hardness tester consists of an anvil, which can be moved up or down by turning the hand Wheel, which is situated, at the bottom of the spindle. The load can be applied by simply operating A hand lever, which is just below the hand wheel. The indenter or penetrator in the Rockwell test May be either a conical-shaped diamond called a brale with a 1200 Apex angle or a hardened steel Ball 1.5875-mm (1/6-inch) in diameter. The brale is used for testing materials with a high hardness And the steel ball for soft materials. Two consecutive loads intend the brale or the ball, a minor Load F1 (equal to 10 kgf.) which does not deform the metal and is used to seat the indenter, and an Additional major load F2 that equals 90 kgf. (total 100 kgf.) for the ball (scale B) and 140 kgf. (total 150 kgf.) for brale (scale C) is applied for indentation. The depth of penetration effected by the Additional load is the measure of Rockwell hardness. The Rockwell hardness is read directly on The dial of the instrument that is graduated in the hardness units. The dial has two sets of figures, One red (scale B) and the other black (scale C) which differ by 30 hardness number, (i.e., B-30 is At C-0). It is made so, to avoid the negative hardness values on the B-scale, if used to test very soft Materials. This also facilitates in establishing that the highest hardness that can be measured with A 1.5875-mm diameter ball indenter is only B-100 and for higher hardness the C-scale should be Employed.

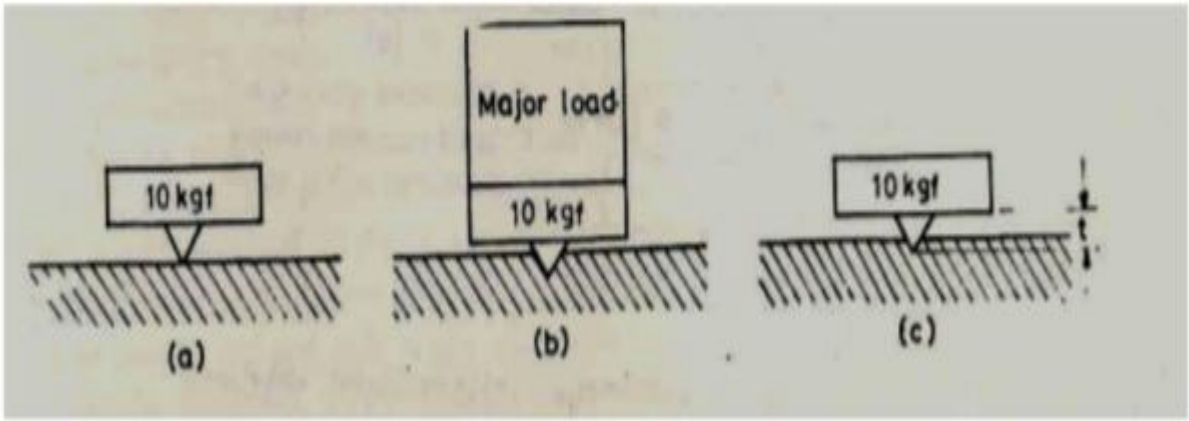


Fig. stages of Rockwell hardness tests.

DIAGRAMS of Rockwell Hardness Tester

PROCEDURE:

Place the specimen on the anvil so that its surface will be normal to the direction of The applied load. Note the type and size of the indenter. Raise the anvil and the test specimen by Means of the elevating screw. The small pointer in the dial starts to move, once the specimen Touches the indenter. Continue to raise the work slowly until the small pointer comes to the red Dot. This indicates that the minor load of 10 kgf. Is acting upon the indenter. Turn the dial until the Mark B-30 (i.e.,C-0), which is also designated by the red arrow and the word 'SET' is directly Behind the pointer. Release the operating handle so as to apply the major load, which is the Increment over the already applied minor load. The indenter starts to go down into the specimen. This can be seen from the dial. The pointer starts to move during the period of loading. Immediately after the major load has been fully applied gently bring back the operating handle to Its latched position. Read the position of the pointer on the selected scale, which gives the Rockwell Hardness number. Make three independent hardness determinations on each specimen.

OBSERVATION AND TABULATION:

EXPERIMENT NO 5

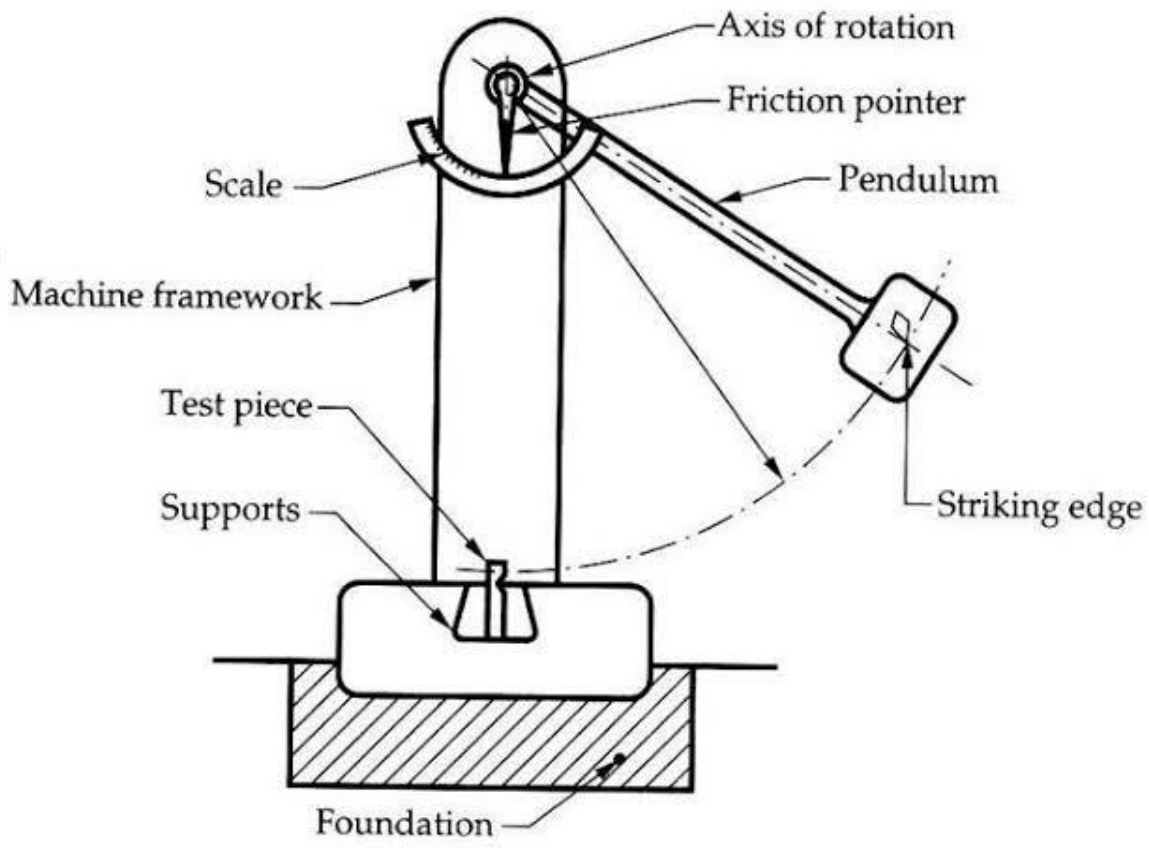
AIM: Finding the resistance of materials to impact loads by Izod test.

APPARATUS: Impact testing machine, MS Specimen.

THEORY: Impact test signifies toughness of material that is the ability of material to Absorb energy during plastic deformation.Toughness takes into account both the Strength and ductility of the material.There are two distinct type of toughness Mechanism and in this case it is appropriate to consider notch as a very high local Stress concentration.

The first type of mechanism occurs in ductile material. This is because very High stresses at the end of the notch produce local yielding of the material and local Plastic flow at the crack tip. This has a action of blunting the sharp tip of the notch And hence reduces the stress concentration effect.

The second mechanism occurs in fibers, wood materials etc which have a weak Interface. Local tensile stress developed at the front of a propagated crack opens up The interface and produces a crack sink i.e., blunts the crack by the radius of the crack tip. The stress-concentration at the notch increases with decreasing notch radius.



PROCEDURE:

1. With the striking hammer (pendulum) in safe position, hold the specimen in impact testing Machine's vice in such a way that the notch face the hammer and hammer and is half inside And half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it At that position.
3. indicator of the machine it zero, or follow the instructions of the operating manual Supplied with the machine.
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 top most height after breaking the specimen, the indicator stops moving, while the Pendulum falls back. Note the indicator at that topmost final position.
5. Again bring back the hammer to its idle position and back.

Mild steel	
Length L (mm)	76.6
Breadth B (mm)	9.42
Depth D (mm)	9.23
Depth of Notch d (mm)	5

Total loss of energy during transit of hammer Et= 49 J

Energy for failure of Specimen = Et- Ef= 45 J

Observation:-

Initial energy of the hammer = 164 J

Average loss of energy due to friction Ef = 4 J

Total loss of energy Et during transit of hammer = 49 J

Energy for failure of specimen = Et- Ef = 45 J

Trial	Loss of energy due to friction Ef (J)	Total loss of energy Et during transit of hammer (J)	Energy for failure of specimen = KU/ Impact Value = Et – Ef in J
1	4	49	45
2	2	51	49
3	2	44	42

Average energy for failure of specimen = 45.33 J

Results :- The energy absorbed for mild steel is found out to be 45.33 J.

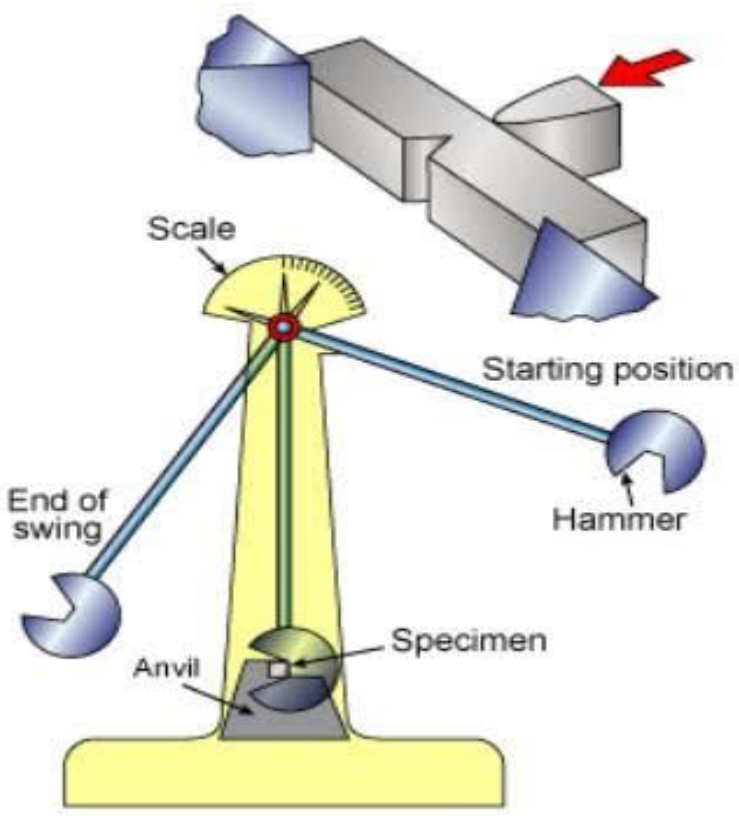
EXPERIMENT NO 6

AIM: To perform the Charpy impact test on materials.

APPARATUS: Izod Impact test machine, test specimen, Vernier calipers, and steel rule.

IMPACT STRENGTH: The resistance of a material to fracture under sudden load Application.

DIAGRAM OF CHARPY TEST



THEORY: An impact test signifies toughness of material that is ability of material to absorb energy During plastic deformation. The type of test specimen used for this test is a Square Cross-section. The specimen may have single, two or three notches.

The testing machine should have the following specifications.

- angle 0 between top face of grips and face holding the specimen Vertical=90° The angle of tip of hammer =75°±1°
- The angle between normal to the specimen and underside face of the hammer at Striking point= 10°±1°
- Speed of hammer at impact=3.99 m/sec
- Striking energy=168N-m or Joules

• Angle of drop 0°of pendulum =90°

• Effective weight of pendulum=21.79kg

• Minimum value of scale graduation=2 Joules.

• Permissible total friction loss of corresponding energy=0.50%

• Distance from the axis of rotation of distance between the base of specimen Notch and the point of specimen hit by the hammer=22mm±0.5mm

The longitudinal axes of the test piece shall lie in the plane of swing Of the center of gravity of the hammer. The notch shall be positioned so that it is in the Plane of the hammer .the notch shall be positioned its plane of symmetry coincides with The top face of the grips .for setting the specimen the notch impact strength I is Calculated according to the following relation. Where I= impact strength in joules/m2

PROCEDURE:

1. For conducting charpy test, a proper striker is to be fitted firmly to the bottom of the Hammer with the help of the clamming piece.
2. The latching take for charpy test is to be firmly fitted to the bearing housing at the Side of the columns.
3. The frictional loss of the machine can be determined by free fall test, raise the Hammer by hands and latch in release the hammer by operating lever the pointer will Then indicate the energy loss due to friction.

4. The specimen for izod test is firmly fitted in the specimen support with the help of Clamping screw and élan key. Care should be taken that the notch on the specimen should Face to pendulum striker.
5. After ascertaining that there is no person in the range of swinging pendulum, release Them pendulum to smash the specimen.
6. Carefully operate the pendulum brake when returning after one swing to stop the Oscillations.
7. Read-off position of reading pointer on dial and note indicated value.
8. Remove the broken specimen by loosening the clamping screw.
9. The notch impact strength depends largely on the shape of the specimen and the Notch. The values determined with other specimens therefore may not be compared with Each other.

TABLE: