**Department of Mechanical Engineering**

**ME 222A**

**Nature and Properties of Material**

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**Lab Report**

**Experiment No. : 7**

***Study on Hardness using Poldi and Portable***

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**AIM**

To calculate hardness of hardened steel, mild steel and brass using Poldi and Portable hardness tester.

**INTRODUCTION**

First we used Portable Rockwell Hardness Tester to measure hardness of hardened steel and mild steel. We fix the specimen between jaws and then apply load by rotating the screw. Load is applied according to the table given to us. The table shows the scale upto which the needle must be moved in order to apply the required load. The load is classified according to the material of specimen.

In other part, we used Poldi Hardness Tester to measure the hardness of mild steel and brass. We fix the calibrated bar inside the square slot and then put the specimen below the hardened steel ball. Then we hit the pin. This results in a mark on both calibrated bar and the specimen. Measuring the diameter of marks can give the hardness of the specimen by using the table of hardness number of respective materials.

**THEORY**

Hardness is defined as property of material to resist deformation. Hardness is a measure of how resistant solid matter is to various kinds of permanent shape change when a compressive force is applied. It is a relative quantity and it also depends upon scale. Some materials (e.g. metals) are harder than others (e.g. plastics). Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness.

Hardness may correlate to tensile strength, wear resistance, ductility, or other physical characteristics of metallic materials, and may be useful in quality control and selection of material.

Hardness is dependent on ductility, elastic stiffness, plasticity, strain, strength, toughness, viscoelasticity, and viscosity.

Indentation hardness: Indentation hardness measures the resistance of a sample to material deformation due to a constant compression load from a sharp object; they are primarily used in engineering and metallurgy fields. The tests work on the basic premise of measuring the critical dimensions of an indentation left by a specifically dimensioned and loaded indenter.

Common indentation hardness scales are Rockwell, Vickers, Shore, and Brinell.

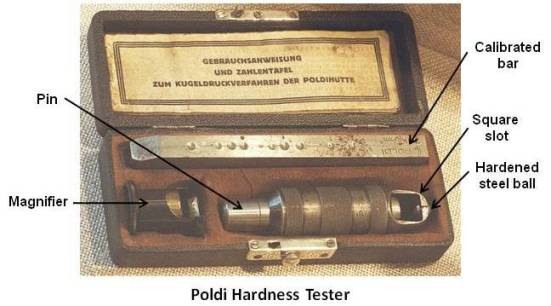
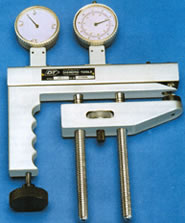
We used two different methods in this experiment.

**Portable Hardness Tester:**

In Portable Hardness Tester or PHT, CANTILEVER MECHANISM is followed. The load is applied through a loading screw against one end of a weight bar. The weight bar is pivoted at a single point . As load is applied, the weight bar is deflected, the amount of deflection is directly proportional to the applied load and depends upon the point of pivot. The force can be calculated by torque balancing. The quantitative value of this deflection is indicated by the dial load indicator. The load indicator can be moved in or out . The four points, “SET”, “A”, “B”, and “C” on the dial correspond respectively to loads of 10, 60, 100 and 150 Kg at the penetrator.

**POLDI:**

Load is applied by a hammer hit on the pin and a standard test bar through a hardened steel ball of 10 mm diameter. The extent of indentation on the specimen and the test bar depends on their hardness. The two diameters of indentations on test bar and specimen are measured by a magnifier supplied along with the tester. The hardness of the specimen can be determined by referring the hardness chart.

**PROCEDURE**

**Portable Hardness Tester:**

1. Make sure loading screw is sufficiently above the jaw so that penetrator does not project beyond the upper clamp.
2. Clamp work firmly between upper clamp and anvil by means of adjusting knob on lower clamp. Apply only sufficient force.
3. Check zero setting of load indicator. Rotate bezel to bring pointer over small black dot for zero load.
4. Apply 10 kg minor load (Pointer to “set”) by means of loading screw.
5. Check zero setting of penetration indicator. Rotate bezel to bring pointer “0” on the Black Scale.
6. Apply Major Load (C scale for Hardened Steel and A scale for Mild Steel)
7. Reduce to Minor Load.
8. Hardness is indicated on the Penetration indicator on the black scale.
9. Release load completely by backing off loading screw.
10. Turn knob to left to loosen clamp.

**Poldi**

1. Insert the standard test bar between the ball and the plunger.
2. Place the setup on the material to be tested and hammer gently so as to make a small depression on both the test bar and the material.
3. Measure the diameter of both the depressions using a magnifier.

**Observations:**

Observation table for hardness from PHT

|  |  |  |
| --- | --- | --- |
| **MATERIAL** | **OBSERVATION NO.** | **READING (BHN)** |
| Hardened Steel | 1 | 65 |
| 2 | 63 |
| 3 | 64 |
| Mild Steel | 1 | 51 |
| 2 | 52 |
| 3 | 52 |

Observation table for hardness from Poldi

|  |  |  |  |
| --- | --- | --- | --- |
| **MATERIAL** | **Standard bar Indentation** | **Specimen Indentation** | **BRINELL HARDNESS** |
| Mild Steel | 2.1 | 2.2 | 197 |
| 2.1 | 2.0 | 221 |
| 2.5 | 2.4 | 217 |
| Brass | 1.8 | 2.3 | 119 |
| 2.5 | 3.1 | 127 |
| 2.0 | 2.6 | 114 |

**Calculations and results:**

**From PHT**

Average hardness of Hardened Steel = 64

Standard Deviation = 1.00

Average hardness of Mild Steel = 51.6

Standard Deviation = 0.57

**From Poldi**

Average hardness of Mild Steel = 211.6

Standard Deviation = 12.85

Average hardness of Brass = 120

Standard Deviation = 6.55

**Discussions:**

Through this experiment we measured the hardness of few samples provided to us using the instrument Poldi and Portable. The instrument works on the principle of cantilever principle. Hardness is measured by intending a mark and then measuring its diameter. Using these dimensions and with the help of hardness table, we measured the hardness. During the experiment many errors happened, so we take more than three readings, if the results of a particular reading are more deviated then the results of other two readings. It is also clear from the average values of specimen that mild steel has comparatively less values of hardness parameters than hardness steel. Also the average values of brass has comparatively lesser than that of mild steel.

**Conclusions:**

**From PHT**

Hardness of Hardened Steel = 64 ± 1.00

Hardness of Mild Steel = 51.6 ± 0.57

From the above calculation, we can conclude that hardened steel is harder than steel.

**From Poldi**

Hardness of Mild Steel = 211.6 ± 12.85

Hardness of Brass = 126 ± 6.55

From the above calculation, clearly mild steel has higher hardness than brass.

**Precautions:**

* Avoid previous impressions made on the specimen.
* Avoid twisting motion.
* Do not leave tester unsupported.
* Do not change calibration during the experiment.
* Frequently change the test blocks to avoid previous impressions instead of refinishing.
* Keep instruments in carrying case at all times when not in use.

**References:**

* William D. Callister, Jr., and David G. Rethwisch, Material Science and Engineering an Introduction, 8th Ed.
* Fundamentals of material science and engineering by William D. Callister, Jr. 4th edition.
* Wikipedia