Hardness testing lab report

Business

The purpose of the following experiments is to study the hardness of different types of materials, and to understand the significance of this property in materials. The materials and the aforesaid property have significant use in civil engineering.

Hardness is defined as a measure of a material's resistance to localised plastic deformation (i. e. small dents or scratches). As said above, a variety of metal alloys were used in the experiments to understand how each of these metals is characterised as a hard metal and to compare the hardness of different metal alloys.

A study of how the molecular structure and the carbon content affects the hardness of each metal alloy used is also done during the course of the experiment.

Three different tests are used, namely: (i) Vicker's Hardness test (ii) Rockwell Hardness test (iii) Brinell Hardness test A further experiment, known as the Charpy Impact Test is conducted to study the toughness of some specimens of steel. Toughness is the measure of the ability of a material to absorb energy up to fracture. It has been discovered that the larger the area under a material's stress-strain curve, the tougher it is.

Therefore a more ductile material is tougher. An impact test is used to ascertain the fracture characteristics of the material, and it merely offers a relative sense of a material's toughness.

2. APPARATUS (i) Vicker's Hardness Tester is shown in Figure 1. Figure 1 (ii) Rockwell Hardness Tester, as shown in Figure 2. Figure 2 (iii) Brinell's Hardness Tester, as shown in Figure 3. Figure 3 (iv) Mild steel specimen (v)

Carbon steel specimen (vi) High carbon steel specimen (vii) ASSAB steel specimen 3.

TESTS 4. 1 VICKER'S HARDNESS TEST 4. 2. 1 Experimental Procedure i.

We used a mild steel specimen and a carbon steel specimen for this experiment.

ii. We placed the specimen on the stand under the lens. iii. We then ensured that the image of the specimen could be clearly seen on the screen. iv.

We then ensured that the indenter touched the surface of the specimen. v. We turned on the machine, and an indentation was made on the surface of the specimen. vi. We then adjusted two lines on the screen, and recorded the horizontal and diagonal distances of the indentation made. vii.

We were also able to obtain the Vicker's Hardness, HV, for the specimens used. viii.

We conducted the test three times for each specimen. ix. The data is recorded in Tables 1a and 1b.

Table 1a Indentation on mild steel specimen Dimension/value| Data | Mean| | x1| x2| x3| x| Horizontal diagonal, DH (mm)| 362. 1| 367. 1| 356. 2| 361. 8| Vertical Diagonal, DV (mm)| 366.

0| 367. 1| 357. 6| 363. 6| Vicker's Hardness, HV| 140| 138| 146| 141| Table 1b Indentation on carbon steel specimen Dimension/value| Data | Mean| | x1| x2| x3| x| Horizontal diagonal, DH (mm)| 263. 6| 294.

10| 312. 7| 290. 1| Vertical Diagonal, DV (mm)| 263. 1| 290. 3| 316.

6| 290| Vicker’s Hardness, HV| 267| 217| 181| 222| . 2 ROCKWELL’S HARDNESS TEST 4. 3. 2 Experimental Procedure 1. We used a high carbon steel specimen and an ASSAB specimen for this experiment. 2.

We placed the specimen on the stand. 3. We turned the lever until the tip of the indenter touched the surface of our specimen. 4. We turned on the machine, and an indentation was made on the surface of the specimen.

5. We then obtained the Rockwell’s Hardness value of the specimens from the machine. 6. We conducted the test three times for each specimen. 7. The data is recorded in Tables 2a and 2b.

Table 2aHardness values for the high carbon steel specimen

Hardness| x1| x2| x3| Rockwell’s Hardness, HRC| 28. 0| 28. 0| 27. 8| Vicker’s Hardness, HV| 286| 286| 284. 6| Table 2bHardness values for ASSAB specimen Hardness| x1| x2| x3| Rockwell’s Hardness, HRC| 57| 57. 8| 57.

2| Vicker’s Hardness, HV| 623| 649| 637| 4. 3 BRINELL’S HARDNESS TEST 4. 4. 3 Experimental Procedure 1. We used a mild steel specimen and a carbon steel specimen for this experiment.

2. We placed the specimen on the stand. 3. We then moved the pressure lever up and down repeatedly to apply pressure into the hydraulic cylinder, until the pressure gauge showed a value of 1000. 4.

An indentation was then made on the surface of the specimen. 5. We then used an indentation magnification viewer with a scale on the lens to measure the indentation on the specimen, and thus determine the Brinell Hardness value. 6. We conducted the test three times for each specimen.

7. The data is recorded in Tables 3a and 3b. Table 3aHardness values for the mild steel specimen Diameter of indentation (cm)| 3. 2| 3. 15| 3.

2| Brinell’s Hardness, HB| 121| 125| 121| Vicker’s Hardness, HV| 130| 130| 130| Table 3bHardness values for the carbon steel specimen Diameter of indentation (cm)| 3. 0| 3. 0| 3. 0|

Brinell’s Hardness, HB| 138| 138| 138| Vicker’s Hardness, HV| 141| 141| 141| 4. 4 CHARPY IMPACT TEST 4. 5.

4 Experimental Procedure 1. We placed the specimen on the stand. 2. The hammer was then released from the hold. 3.

The hammer swung and made an impact with the specimen. 4. We then recorded the value of the energy expended due to the impact. 5. The data is recorded in Table 4. 6.

The result of the impact on the specimen is shown in Figures 4a and 4b. Figure 4a Mild steel specimenFigure 4b Carbon steel specimen Table 4Result of Charpy Impact Test Specimen| Energy expended (J)| Mild steel| 299|

Carbon steel| 38| 4. 5. 5 4. DISCUSSION The results of the Vicker’s hardness test on the mild steel and the carbon steel specimens give a higher Vicker’s hardness for the carbon steel specimen, as shown in Table 1a and Table 1b. This means that the carbon steel specimen is harder than the mild steel specimen.

This can be determined by looking at the diagonal lengths of the indentations of the materials as well. Since the carbon steel specimen is harder, the dimensions of the indentation on it are much smaller as compared to that of the mild steel specimen, as shown in Table 1a and Table 1b.

Theoretically, the reason that carbon steel is harder than mild steel could be attributed to the carbon content of each material. Carbon steel has much higher carbon content than mild steel (Carbon steel: 0. 30-0.

59% carbon content; mild steel: 0. 16-0. 29% carbon content). The addition of these carbon atoms forms a structure that contributes more strength to the alloy, and thus there is a higher resistance to any scratch or indentation on the surface of carbon steel. This is because the carbon sits in the interstitial sites of the lattice structure and hinders the movement of dislocation lines.

This also increases the strength of the material but it decreases the ductility.

The results of the Rockwell Hardness test on the high carbon steel specimen and the ASSAB steel specimen give a higher Vicker's Hardness for the ASSAB steel specimen. This means that the ASSAB steel specimen is harder than the high carbon steel specimen. This observation can be explained by the fact that ASSAB steel has higher carbon content than that of high carbon steel (ASSAB steel: 0. 88-0. 90% carbon content; high carbon steel: 0.

60-0. 79% carbon content).

The results of the Brinell's hardness test once again show that the carbon steel specimen is harder than the mild steel specimen, as shown in Table 3a and Table 3b. The results obtained in the experiments may differ from the known values of hardness of each material. This is because of the various inaccuracies that may have occurred while conducting the experiments. Inaccuracies could have occurred in the Rockwell Hardness test if the indentations were made too near the specimen's edge, or if two indentations were made very close to each other.

To ensure as much accuracy as possible, the specimen should be ten times thicker than the indentation depth, and the experiment should be conducted more than once (Callister, 2003). It is also very important that the specimen have a smooth flat surface, especially for the Brinell hardness test, as the indentation needs to be well-defined. This is because the diameter is measured with a low power microscope, so accuracy is relatively low. Other possible types of error that could have occurred would be parallax error; this could have occurred when applying pressure in the Brinell's Hardness tester.

The placement of the red line might have not been determined accurately. Error could have occurred when converting the hardness values from Rockwell Hardness (HRC) and Brinell's Hardness (HB) to Vicker's Hardness (HV).

Instrumental error could occur if the valve of the Brinell Hardness tester is not closed properly. In the Charpy Impact test, we found that the energy expended when the hammer struck the mild steel specimen was almost 8 times more than the energy expended when it struck the carbon steel specimen, as shown in Table 4.

From this, we can deduce that mild steel is much tougher than carbon steel. Toughness can also be deduced from the area under a stress-strain curve. Therefore a ductile material is tougher than a brittle one.

From Figure 1a, we can see that the mild steel specimen has been deformed, but it has not fractured. In Figure 1b, however, the carbon steel specimen has fractured after absorbing only 28 J of energy. The mild steel specimen is therefore more ductile than the carbon steel specimen, and is hence tougher.

The differences in hardness and toughness of the various kinds of metals explain why each is used for a different purpose. For example, high carbon steel is used in the production of knives, masonry and cutting tools due to its hardness, but cannot be used in welding due to its brittleness (i. e.

low toughness). Mild steel is used in automobile body parts due to the ease with which it can be plastically deformed (i. e. high ductility). ASSAB steel is used when designing components that would be subject to heavy loads and corrosion due to its high value of hardness.

. CONCLUSION From the results we obtained, it is possible to arrange the materials that were tested in order from the hardest to the softest: ASSAB ; gt; high carbon steel ; gt; carbon steel ; gt; mild steel From this we can construe that the amount of carbon that the alloy has affects the hardness of the material. As the carbon content rises, the steel becomes harder, but at the same time it becomes less ductile (and hence less tough). In comparing the properties of mild steel and carbon steel, we find that mild steel is softer, yet tougher than carbon steel.

This basically means that mild steel is more easily deformed than carbon steel, but it does not fracture as easily as carbon steel.

This shows us that each of the materials we tested is used for different purposes because of the variety of properties and characteristics they have. It proves to us how important it is to know the mechanical characteristics of different types of materials in order to put them to the best use. References

William D. Callister, Jr. (2003), Materials Science and Engineering: An Introduction, (6th ed.), New York: Wiley, p137.