Hardness tests and charpy impact test

OBJECTIVE

To compare the hardness of the carbon steel, mild steel and ASSAB steel using three different hardness tests, which are Vickers Hardness Test, Rockwell Hardness Test and Brinell Hardness Test. 2. To study the hardness of mild steel, carbon steel and ASSAB which is an important in engineering to design structures or components that related in mechanical properties 3. To determine the resistance of carbon steel and mild steel against sudden impact by Charpy Impact Test.

INTRODUCTION

Hardness is a measure of a material’s resistance to localized plastic deformation.

It also is one of the important properties to be considered. Mechanical properties of metals are a vital of engineering to design the components which using predetermined materials such that unacceptable levels of deformation andfailurewill not occur. Hardness is a resistance of properties of material to permanent (plastic) deformation caused by steel ball or pyramid-shape diamond when it is pressed onto its surface. There will be three basic method of Hardness Test that will be carried out on carbon and metal:

- Vickers Test
- Rockwell Test
- Brinell Test

THEORY

Vickers Test

VHN = Applied load / Surface area ofdepression= = 1. 854 P/ d2 (approximate) Where P = applied load (kgf) d = (d1+ d2) / 2 (mm) 2. Rockwell Test HRC = 100 – d /0. 002 HRB = 130 – d /0. 002 Where d = depth of the indentation 3. Brinell Test BHN = Applied force / curve area of indentation P / D/2 [D - (D? - d?)] = P / Dh WhereP = applied load (kgf) D = diameter of steel ball (mm) d = diameter of resulting indentation (mm) h = depth of indentation (mm) = ? [D - (D? - d?)] APPARATUS 1. Set of Vickers Hardness Test Machine . Set of Rockwell Hardness Test Machine 3. Set of Brinell Hardness Test Machine SPECIMENS Mild steel, carbon steel and ASSAB steel A)

VICKERS HARDNESS TEST

From this method square shape pyramid diamond 136° was press to surface of metal using some load (5kgf until 120kgf) under certain time (15 sec) and lastly the load will release. Square shape corner on the metal surface will be used. To obtain the value of hardness, Vickers Hardness Number (VHN) is calculated as below: VHN= Mass of the loadSurface area of depression = 2PSin136°2d2 = 1. 854Fd2approximately Where, P= applied forcekgf d= d1+d22

ROCKWELL HARDENESS TEST

This method has 2 main scales which are: a) Scale B, concavity is a steel ball (1. 58 mm?) and load using is 100 kgf. b) Scale C, concavity is a cone diamond having corner 120° and load is 150 kgf. Rockwell hardness (HR) can be calculated as equation below: HRC= 100-d0. 002 HRB= 130-d0. 002 Where d= concavity

BRINELL HARDNESS TEST

From brinell hardness test, the harden steel ball has good diameter, D under the load and certain time will be use to get diameter concavity effect, d. BHN= LoadArea of concavity = PD2D2-d2 = P? Dh Where, P= loadkgf D= diameter of the steel ballmm = diameter concavity effectmm H= internal concavity effectmm = 12D-D2-d2

PROCEDURE

Vickers Hardness Test

- The specimen (Mild Steel) is put on the anvil of the Vickers hardness machine precisely.
- The sample is focused until the lines on the surface of the sample can be observed clearly.
- The focal lens of the microscope is turned to the indenter.
- The indenter is then pressed into the sample.
- The test force is maintained for a specific dwell time of about 15 seconds.
- The indenter is removed when the dwell time is complete.
- The square shape is appears on the surface of the sample. .
- The indenter is then turned back to the focal lens.
- The size of the indent is determined by measuring the two diagonals of the square indent.
- Step 1 to 9 is repeated for five times by using the same sample but at different part of the sample.
- Step 1 to 10 is then repeated by using different sample, which is carbon steel.
- All the readings taken are recorded in a table.

Rockwell Hardness Test

- The sample of ASSAB steel is placed exactly on the anvil.
- The anvil is wound slowly until the LED begins moving to ‘ SET’ and the test is started automatically.
- The indenter moves down into the position of the part surface of the sample.
- The load is then applied on the sample for a specific dwell time of 15 seconds.
- The readings taken are recorded from the indenter machine.
- Step 1 to 5 is repeated for five times by using the same sample but at different part of the sample.
- Step 1 to 6 is then repeated by using different sample of carbon steel.
- All the readings taken are recorded in a table.

Brinell Hardness Test

- The sample of mild steel is placed accurately on the anvil.
- The anvil is wound slowly until the edge of the indenter touches the surface of the specimen.
- A handle on the right side of the testing machine is lifted slowly until the gauge shows 1000kgf.
- The indenter is pressed on the sample by an accurately controlled force for about 15 seconds of dwell time.
- The indenter is removed slowly after 15 seconds, leaving a round indent in the sample.
- The diameter of the indent is taken by measuring two diagonals of the round indent by using a portable microscope.

- Step 1 to 6 is repeated for two times for the same sample but at different portion of the sample.
- Step 1 to 7 is repeated for another sample of carbon steel.

RESULT VICKERS HARDNESS TEST

- We had being tested two specimen which is Carbon steel and Mild steel for Vickers hardness Test. Carbon steel has an average VHN of 225. 6 while the mild steel has an average VHN of 119.
- This means that carbon steel is harder compared to mild steel.
- The carbon steel is harder than mild steel because there is a presence of carbon atoms within the atoms of the structure. When the external force is applied, the carbon atoms prevent the atoms in the structure into sliding over and slipping.

Rockwell Hardness Test

From the Rockwell hardness test, we can conclude that the higher the HRC number of a specimen, the harder the specimen is. . ASSAB steel is a type of alloy steel and thus its composition is much different than that of carbon steel, causing it to possess higher hardness compared to carbon steel. From the result obtained, ASSAB steel has an average HRC number of 57. 27 where as carbon steel has an average HRC number of 27. This mean that AASAB steel is harder compared to the high quality carbon steel. Brinell Hardness Test 1. For two specimens which carbon steel and mild steel is being tested with brinell hardness test. The BHN values are obtained. The values are depends on the diameter of the indentation caused.

We can conclude that the higher the value of the BHN, the harder the specimen is. From the results, carbon steel has an average BHN of 212 while

mild steel only as an average BHN of 99. This confirms that carbon steel is harder than mild steel. Furthermore, the values of BHN obtained might be not accurate because of the limitation that caused human errors. It is difficult for the observer to note the exact diameter of the indentation through the microscope.

CONCLUSION

In conclusion, from the results we obtained, it is conclude that ASSAB steel is the hardest material, followed by carbon steel and then mild steel.

The hardness of the steel is mainly affected by its composition and percentage of carbon. Carbon steel is absorbed energy is lower than the mild steel. Carbon steel is a brittle material compared to mild steel because of the higher percentage of carbon present in the steel. Thus, fractures almost immediately upon sudden impact. Charpy impact test

INTRODUCTION

The Charpy Impact

Test is the most commonly used test to determine material's resistance to the impact or sudden fracture where a sharpstressraiser is present.

Toughness is a measure of the ability of a material to absorb energy up of fracture. For dynamic (high strain rate) loading conditions and when a notch is present, notch toughness is assessed by using an impact test. Material that experiences very little or no plastic deformation upon fracture is termed brittle whereas material that experiences great deformation upon fracture is termed ductile. The fracture surfaces for brittle material, which has low-

energy impact failure, are generally smooth, and in metals have a crystalline appearance.

But for ductile material which has high energy fracture, has regions of shear where the fracture surface is inclined about 45o to the tensile stress, and they have in general a rougher, more highly appearance, called fibrous fracture.

THEORY

45? 2 mm 45 mm 10 mm 30? Figure 1 45? 2 mm 45 mm 10 mm 30? Figure 1 In Charpy impact test, the specimen are arrange as shown in the above picture and every specimen is prepare will has a notch at the centre of the specimen and the hammer will clout at the region of the notch i. e. stress concentration point.

The hammer is release from a specific high which the initial energy having by the hammer is 300J. The scale will show the energy absorbs by each specimen after the experiment and it is recorded.

APPARATUS

Charpy testing machine SPECIMENS Mild steel and carbon steel

PROCEDURE

- Mild steel and Carbon steel is used in this test.
- The load was applied as an impact blow from a weighted pendulum hammer that was released from a cocked position at a fixed height.
- The specimen was positioned at the base of the machine.

Upon release, a knife-edge mounted on the pendulum strikes and fractures the specimen at the notch, which acts as a point of stress concentration for

this high velocity impact blow. After the weighted pendulum hammer has swung to its original position, the specimen was removed from the vice and its fracture surface was observed.

This shows that carbon steel is a more brittle material and mild steel is a more ductile material. According to the result which energy absorbed by mild steel is higher and it is more ductile. In addition, carbon steel is a brittle due to presence of the carbon atoms in steel. The presence of these carbon atoms provide resistance for plastic deformation to occur by preventing atoms in the steel to slip and slide over each other. The high percentage of carbon atoms reduces the ability of the steel to absorb energy upon impact.

As we observe the experiment that we had done in lab, the carbon steel breaks almost immediately when subjected to sudden impact whereas the mild steel shows only deformation and did not fracture. Besides the area where the carbon steel fractures is shinny and smooth which shows that it fractures without much deformation. The diagram below shows fracture surface of the mild steel. The diagram below indicates the fracture surface of the carbon steel. Based on the results, it is clear that the ductility of mild steel is higher than carbon steel.

The presence of carbon in carbon steel has minimized its ability to absorb energy from the impact.

CONCLUSION

In conclusion, we can conclude that mild steel has a high level of ductility than carbon steel. Mild steel is tougher than carbon steel.

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