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Tensile and Hardness Tests on Steel Specimen

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Abstract:Steel specimens were subjected to both tensile tests and hardness tests. The tests were carried out Mild steel .The specimens were tested under various conditions. The maximum hardness was for the specimen quenched with water, however the tensile strength of that particular specimen was the minimum. While the tensile strength was highest for slow cooling and furnace cooling .However the hardness for slow cooling was the least. While furnace cooling was comparatively higher. The other specimens had varied tensile strength and hardness and it was not possible to map a relationship of the two. The motivation for this work has been that the students involved have recently been exposed to material strength and its variation with temperature.

Keywords: maximum hardness was for the specimen quenched with water.

I. INTRODUCTION

The Charpy test is a test to determine the energy absorbed by a specimen in the course of a fracture. The tests conducted reveal the amount of energy needed to fracture materials under different conditions. The Brinell Hardness test determines the resistance to indentation in a specimen. Tensile tests were already carried out in our labs and published, where energy absorbed was highest for quenched steel[1]Charpy impact tests determine the energy required to initiate a crack in the specimen and the subsequent energy to propagate the fracture, This test has a hammer in a pendulum which strikes the notch. . The energy absorbed is determined from the motion of the pendulum. The energy absorbed depends on the nature of the specimen. Impact energy is calculated from the height to which the striker rises. Brittle materials absorb lesser energy as compared to ductile materials. The notch serves as a stress concentration zone.[2]

II. MATERIALS AND METHODS.

These tests were carried out on Mild steel specimens with a composition of 0.05-0.25% C, 0.4-1. 65% Mn, 0.6% Si, 0.60.

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The specimen has a yield strength of 2.75MPa,tensile strength ranging between 415 and 550 Mpa and ductility of 25% and a melting point of mild steel is 1510 C. The dimensions of the specimen that was prepared by is given below. Length- 55mm, thickness- 10mm and breadth- 10 mm.The V-notch was made at a depth of 2 mm at an angle of 45 with a width of 1.6mm.

Fig 1 Specimen preparation

The specimens all but one were furnace heated to a temperature of 750C and cooled using various methods. The specimens were then subjected to Charpy tests to determine their tensile strength and subsequently to Brinell tests to elucidate their identenation strength.Materials with higher strength absorb higher energy and brittle materials absorb lesser energy leading to fracture [3]. The fracture mode changes from ductile to brittle in most materials when the temperature is lowered [4]. The transition from ductile to brittle would depend on the nature of the material transition. [5][6]. The fracture depends on the difficulty to fracture through the V-notch leading to a ductile fracture.[7-9]

III. RESULTS AND DISCUSSION

The angle of drop for the Charpy test was 140°. The Impact strength was calculated as

Impact Strength = Strain Energy Absorbed/ Cross Sectional Area

The strain energy is the energy absorbed in the process of the fracture.

The Hardness from Brinell hardness test is calculated from the formula

$$\mathbf{BHN = 2P/\pi D\sqrt{(D-(D^2-d^2)}}$$

Where P -Load

D- Diameter of the Ball (10mm)

d- Depth of the indentation

The cross-sectional area under the notch is calculated taking the breadth(10-2 mm) and the thickness(10mm) of the specimen.

Hence the cross sectional area under the notch is $80mm^2$.The specimens were tested without any heating,quenching with water at room temperature, quenching with ice and then for normal cooling.

The values for the Energy absorbed,and the strength calculated are listed in Table 1. The values for the indentation size and the calculated hardness are listed in Table 2.

It is observed that the energy absorbed for both the slow cooling and furnace cooling are almost comparable and are the highest. The energy reduces for the specimen that was not heated followed by the specimen that was quenched with ice. The lowest energy was for the specimen that was quenched with water. This is reflected in Figure 2.

Table 1

Specimen	**Energy absorbed in Joules**	**Strength in J/mm^2**
Normal Condition	162	2.025
Quenching with water	14	0.175
Quenching with ice	124	1.55
Slow cooling	220	2.75
Furnace cooling	222	2.775

Brinell tests reports have been carried out and have also been computationally analysed. [10] Larger the diameter softer the material. From table 2 it can be seen that the size of indentation is the highest for normal specimen and for slow cooling. The value for furnace cooling is a shade lower. Reducing for quenching with ice and then for quenching with water. It is seen that the hardest material is the one quenched with water. This is also reflected in Fig 3

Table 2

Specimen	**Size of indentation in mm**	**Hardness BHN**
Normal	3.6	189.90
Quenching with water	2.4	435.63
Quenching with ice	2.8	318.3
Slow cooling	3.6	189.90
Furnace cooling	3.2	242.14

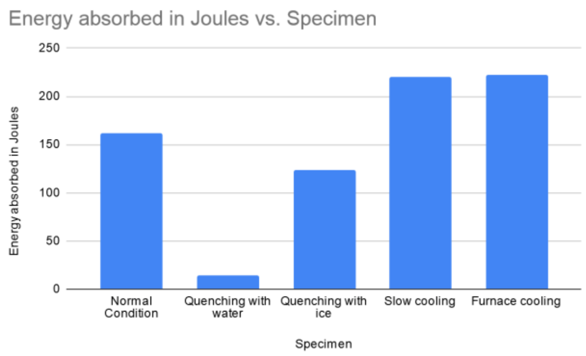

Fig 2

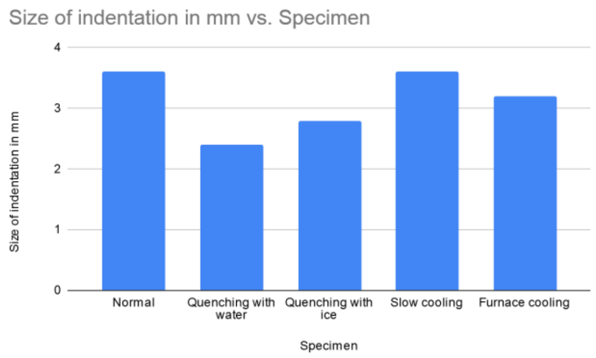

Fig 3

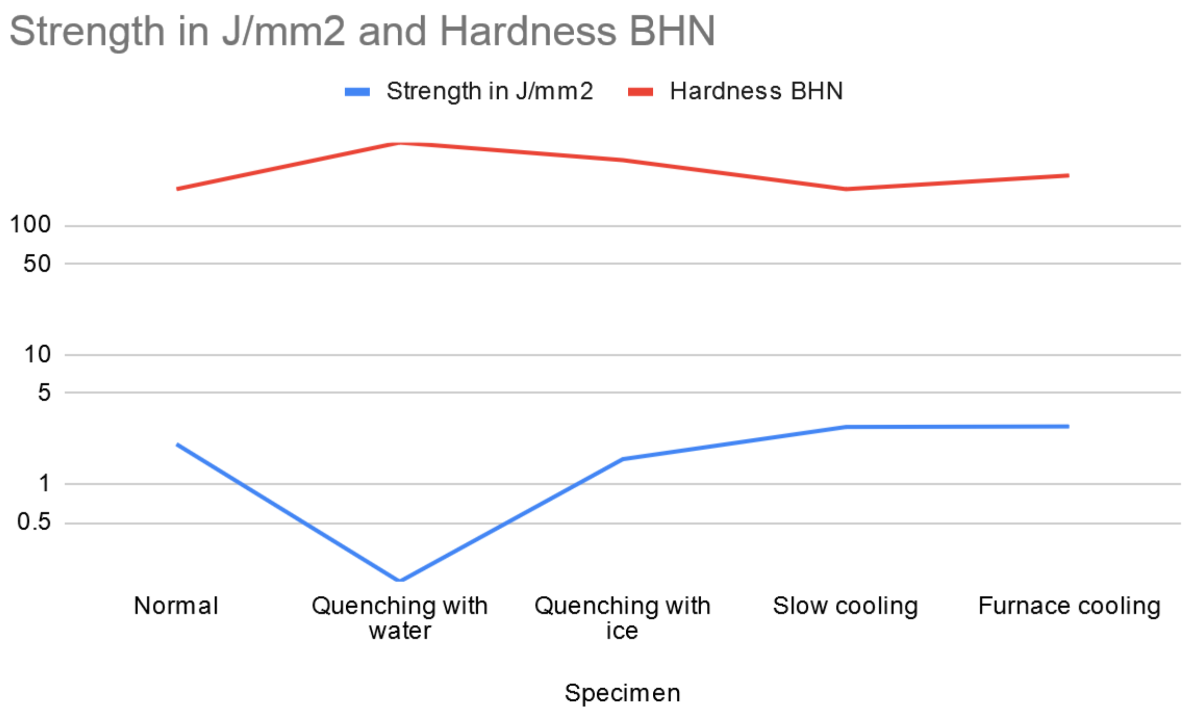

Fig 5

IV. CONCLUSION

Tests conducted on the specimen yielded different tensile strength and different hardness for each of the materials. Tensile strength was highest for slow cooling and furnace cooling .However the hardness for slow cooling was the least. While furnace cooling was comparatively higher. These changes reflect the microstructural changes that have taken place in the specimen in different conditions. A further study on microstructure of these materials is likely to throw more light into the transformations.

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REFERENCES

1. Jishnu Raja, A Aneesh Darrel, R Anten Minuwi,D Divya Jyothi, K Dhayalan, Amrutha R, Charpy Impact Test on Steel Specimens, International Journal of Scientific Research and Review, Vol 8, Issue 3, 2019, page .21
2. Nanstad, Randy & Sokolov, Mikhai,Charpy impact test results on five materials and NIST verification specimens using instrumented 2-mm and 8-mm strikers, Mechanical and Physical Testing of Biocomposites, Fibre-Reinforced Composites and Hybrid Composites, A volume in Woodhead Publishing Series in Composites Science and Engineering Book • 2019 l. (1995).
3. KIM, S. H., PARK, Y. W., KANG, S. S. CHUNG, H. D. Estimation of fracture toughness transition curves of RPV steels from Charpy impact test data. Nuclear Engineering & Design, v. 212, pp. 49-57, 2002.
4. LEI, W. S., YAN X. Q., YAO, M. Determination of characteristic transition temperature of low temperature brittleness in mild steel, Engineering Fracture Mechanics, v. 46, pp. 571-581,1993.International Journal of Scientific Research and ReviewVolume 8, Issue 3, 2019 ISSN NO: 2279-543XPage No: 24
5. WALLE, E. Integridade Estrutural do Vaso de Pressão do Reator Nuclear. Notas de aula, Curso de Pós-Graduação do CDTN/CNEN, June, 2003.
6. BÖHME, W. Experience with instrumented Charpy tests obtained by a DVM round-robin andfurther development, Evaluating Material Properties by Dynamic Testing ESIS 20 (Edited by E. van Walle) 1996, Mechanical Engineering Publications, London, pp. 1-23.
7. D. P. FAIRCHILD, M. L. MACIA, S. D. PAPKA, C. W. PETERSEN, J. H. STEVENS, S. T. BARBAS, N. V. BANGARU, J. Y. KOO, AND M. J. LUTON, Proc. Int. Pipe Dreamer's Conf., M. TOYODA AND R. DENYS, (Eds.), Yokohama, Japan, 2002.
   K. T. CORBETT, R. R. BOWEN, AND C. W. PETERSEN, Int. J. Offshore Polar Eng., vol. 14(2004), pp. 75-80.
8. M. MATSUDA AND H. MIURA, Met. Mater. Int., vol. 9(2003), pp. 537-42.
9. C.-S. OH, H. N. HAN, C. G. LEE, T.-H. LEE, AND S.-J. KIM, Met. Mater. Int., vol.
10. 10(2004), International Journal of Scientific Research and Review
11. Volume 8, Issue 3, 2019, pp. 399

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