Analysis Of Charpy Method Impact Testing Using ST60 Steel Specimens

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Abstract: In ST60 specimens that before being heat treated, the test was first carried out utilizing an impact tester with the JBW-500B series, from the data collected in this experiment, the impact strength results were an average of 50.3 Joules/mm2. In hardness the results obtained an average of 50VHN. After that, the ST60 specimen was heat treatment process at a temperature of 800C and then quenching process was carried out using oil media. From the results of impact testing using JBW-500B, the specimen has a strength of 105.02 Joules/mm2 while hardness testing using the Vickres Mitutoyo test equipment has an average hardness of 89VHN. With the research performed, it can be concluded that by performing the heat treatment process and then the quenching process can increase the hardness values and impact strength of the ST60 steel material.

Key-Words: ST60 steel, JBW-500B, Vickers Mitutoyo, Quenching

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1 Introduction

The impact test is a test that provides fast and large loading. (rapid loading). In impact testing there is a large energy absorption process at the time of the load hitting or crashing into the specimen. The resulting energy will be absorbed by this material can be calculated using the principle of potential energy difference. The principle of impact testing is to calculate the energy absorbed by the specimen. When the load is raised to a certain height, the load has maximum potential energy, then when it hits the specimen, the kinetic energy reaches a maximum. Kinetic energy will be partially absorbed by the specimen until the specimen is broken. [1]

Sensitivity to brittle fracture is a major problem in steel construction. When these brittle fractures occur in steels with low durability, the fracture can propagate at speeds of up to 2000 mm/sec, which can cause damage in a very short time. Toughness (impact) is the resistance of materials to shock loads. This is what distinguishes impact testing from tensile testing. what distinguishes impact testing from tensile and hardness testing where the loading is done slowly. [3]

2 Historical Perpectives And Current Trens

2.1. Steel

Steel is a metal alloy, iron metal as the base element with several other elements, including carbon. The elemental carbon content in steel ranges from 0.2% to 2.1%, by weight according to its grade. The following elements are always present in steel: carbon manganese, phosphorus, sulfur, silicon and a small percentage of oxygen, nitrogen and aluminum. [6]

1. ST60 Steel

Carbon steel is steel that contains carbon between 0.3% and 1.7%. In this study the shadow used is ST60 steel, this steel is included in the medium carbon steel group, which has a carbon content of 0.564%. Pda ST60 steel is very suitable for making frames on bridges. ST60 steel in plate form often has to undergo a rolling process after the welding process to adjust the construction and design of the bridge. ST60 steel coding comes from DIN (Deutsches Institut For Normung) > ST itself stands for steel (Steel) and the number behind ST is a code that shows the maximum tensile strength. From this statement, ST60 steel is steel that has a tensile strength of 600kg / mm2 [4].Through the phase diagram

can determine 3 types of steel based on carbon content, namely, eutectoid: with carbon content -0.8%, hypoetectoid: with carbon content <0.8%, and hypereutectoit > 0.8% [5].

2. Heat Treatment

Heat treatment is a metal strengthening mechanism where the metal we want to change its properties is already in a solid state. In heat treatment we heat the specimen up to its austenization temperature. The austenization temperature given depends on the carbon content of the steel being processed. After the austenization temperature is reached, the workpiece is left at that temperature for a certain period of time so that the temperature is homogeneous throughout the workpiece. This process is called homogenization. After that, by adjusting the cooling rate, the desired hardness will be obtained. [7]

3. Quenching

There are several factors that involve the quenching process and are interconnected related. First is the type of cooling medium and process conditions used, the second is the chemical composition and hardenability of the metal. Hardenability is a function of the chemical composition and grain size at a specific temperature. The quenching process is a heat transfer at a very fast rate (Sugiarto et al. 2013).

At the time of the quenching treatment process there is accelerated cooling from the final treatment temperature and undergoes changes from austenite to bainite and martensite in order to produce high strength and hardness. High strength and hardness. Maximum hardening performed on quenched steel is almost completely determined by carbon concentration and speed. is almost completely determined by the carbon concentration and cooling rate that is equal to or higher than the critical for the alloy. Quenching media consist of: water, brine, oil, water-polymer, or other. [4]

4. Impact Test

The charpy method impact tester is a material hardness test tool where the specimen gets a sudden shock load from a pendulum which will show the hardness results of the specimen.

The test object is made notches in advance in accordance with ASTM E23 05 standard and the test results on the test object occur changes in shape such as bending or breaking in accordance with the ductility or tenacity of the test object. The charpy impact test experiment is carried out by suddenly loading the test object to be tested statically, where the test object is made in advance according to the ASTM E23 05 standard size.

4.1 Potential Energy

Potential energy is the energy possessed by an object due to the influence of the place or position of the object. Potential energy is also called resting energy because the object undergoes a change of potential energy into motion energy. The most common example of potential energy is gravitational potential energy. Gravitational potential energy is possessed by an object due to its relative position to the earth. Any object that has gravitational potential energy can do work when the object moves towards the earth's surface.

4.2 Kinetic Energy

Kinetic energy or energy of motion is the energy possessed by an object due to its motion. The kinetic energy of an object is defined as the effort required to move an object of a certain mass from rest to a certain speed. a certain speed. Kinetic energy is related to the motion of an object in a horizontal vector.

5. Specimens

Standard specimen sizes are commonly used in Charpy method testing. The dimensions have a square cross-sectional area of 10 mm x 10 mm and a specimen length of 55 mm. Right in the center of the specimen is a V-45° notch. The V notch has a depth of 2 mm and a base radius of 0.25 mm. The specimen is placed flat and the unnotched part is subjected to impact loading with a pendulum swing (impact velocity of about 3 m/s - 6 m/s). Then the ASTM E 23 specimen will bend towards the notch and fracture at a high strain rate, approximately 3 -1 10 seconds.

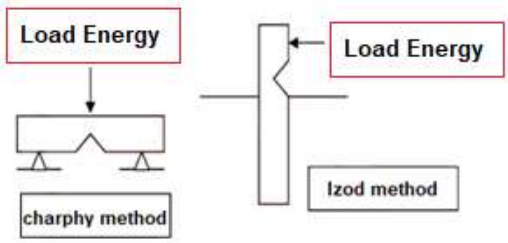

Figure 1. Impact Test

3 Research Methods

3.1 Research Procedure

This research using impact test equipment JBW-500B Models used are to determine the value of measuring how much material can accept the impact load of ST60 steel material, in this research the ST60 material is heat treated with cooling using oil, it is expected to have a greater impact value.

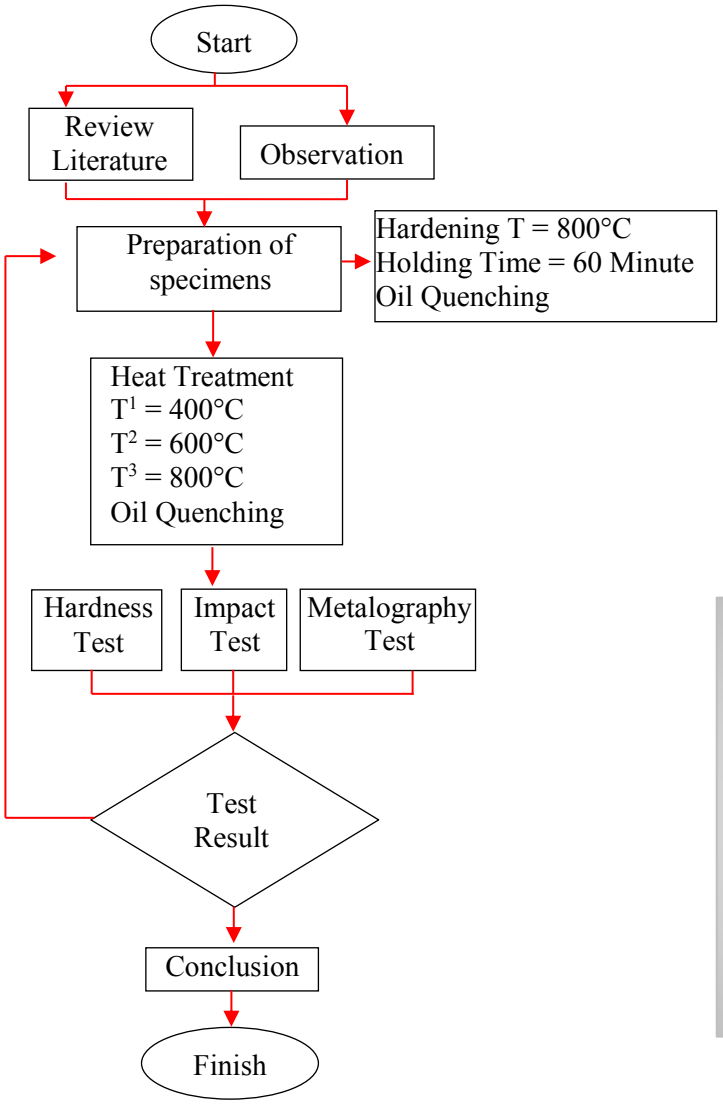

Figure 2. Research Flowchart

4. Result and Discussion

The most commonly used smaller Charpy specimen is the KLST (from German Kleinstprobe, or "small specimen"), and has the following nominal dimensions: thickness = 3 mm, width = 4 mm, length = 27 mm, notch depth = 1 mm. KLST specimens were the first MCVN type to be included in an international test standard, when in 2006 the Amendment entitled "Pendulum impact test of Charpy instrument V-notch impact of sub-size test pieces" was approved for inclusion in the ISO 14556: 2000 standard. The use of KLST specimens is also authorized by ASTM E2248-13.

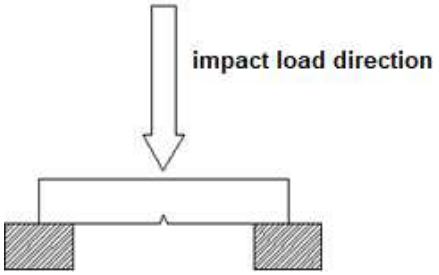

Figure 3 Impact Load Direction of ST60 Steel

Comprehensive :

- Long : 50 mm
- Wide : 10 mm
- Thick : 10 mm

Loading : Small Pendulum

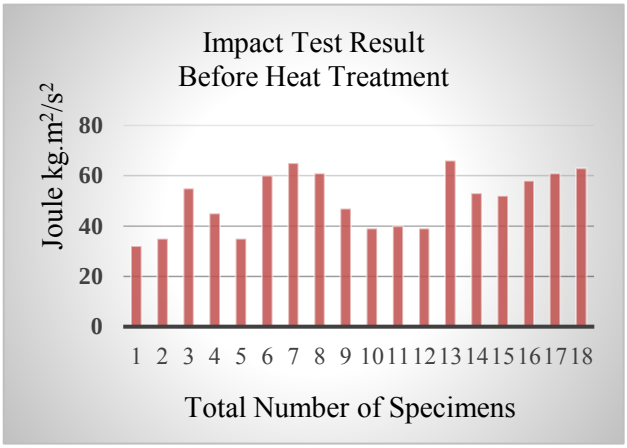

Figure 4. Graph Impact Value of ST60 Steel

Figure 5.A ST60

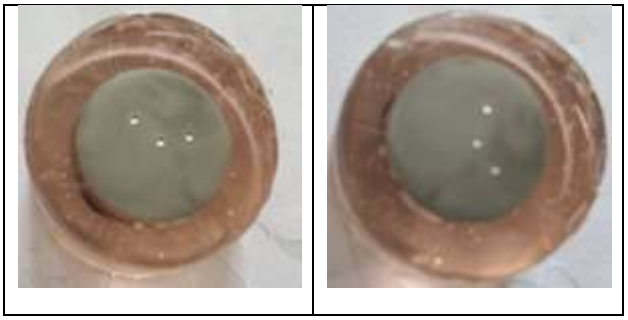

Figure 5.B ST60

Figure 5.C ST60

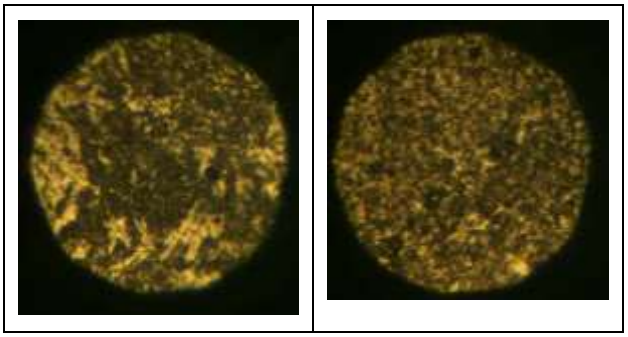

Figure 6.A Microstructure Photo 200x Magnification

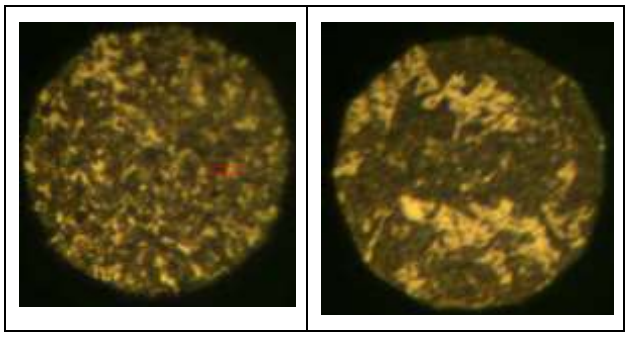

Figure 6.B Microstructure Photo 200x Magnification

Quenching Process

When a low-density quenching media is used, the cooling process is slow because the heat transfer process does not readily affect long-distance molecules. This slow process results in the formation of a tough and ductile structure. The two phases formed in this process are ferrite and cementite.

- Ferrite: This phase has malleable and ductile properties with a carbon content of 0.008%
- Cementite: This phase has a carbon content of 1% for 3 Fe atoms, making it tough.

In this quenching media, the recrystallization process is slower, allowing some of the carbon toms to be redistributed into their bonds.

Figure 7. Heat Treatmnet process of ST60 steel specimens at 800℃

Figure 8.A ST60 Steel Impact Testing Results

Figure 8.B ST60 Steel Impact Testing Results

Figure 8.C ST60 Steel Impact Testing Results

Figure 8.D ST60 Steel Impact Testing Results

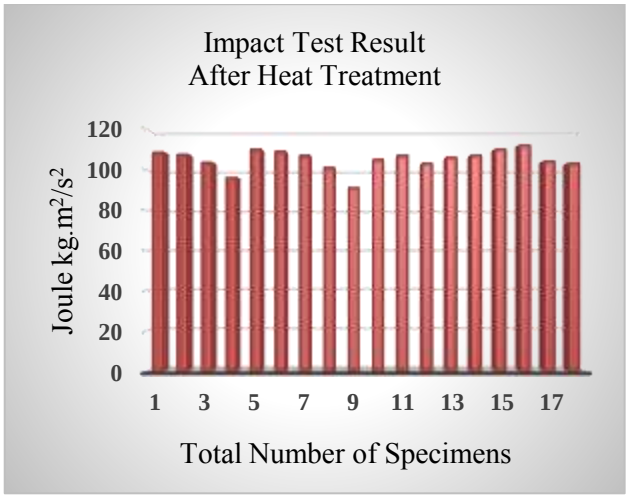

Figure 9. Graph. Hardness value after heat treatment of ST60 steel

5 Conclusion

Based on the research that has been done, the author made the following conclusions: ST60 steel material: From the research results, it can be summarized that the impact strength of ST60 steel which is not processed by heat treatment is 50.3 Joule/mm2. The hardness value is 50VHN. After that, the ST60 specimens were processed heat treatment at 800 ℃ and then quenching process using oil media. The ST60 specimen increased the impact strength by 105.02 Joule/mm2 while the hardness test increased by 89VHN. With this research it can be summarized that by performing a heat treatment process and then carrying out a quenching process can improve the hardness value and impact strength of the ST60 steel material.

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