Optimization of CHARPY Method Carburizing Treatment on the Hardness of Low Carbon Steel

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Abstract: On the example of S45C which was recently pre-treated, testing was initiated using an impact analyzer with a JBW-300B setup, based on the information obtained from this test, the resulting impact quality was a reasonable 54.65 Joule $kg.m^2/s^2$. In terms of hardness, the resulting measurement was a reasonable 45VHN. Afterwards, the S45C material was subjected to a heating treatment of the holder at a temperature of 900°C and afterwards the holder was extinguished using an oil medium. According to the test using JBW-300B, sample was found to have a performance of 106.05 Joule $kg.m^2/s^2$ meanwhile the hardenability test using Vickres Mitutoyo tester was found to have a normal hardness of 65VHN. The research conducted can be summarized that heat treatment preparation and after that quench preparation can improve the hardness value and affect the durability of S45C fabric steel.

Key-Words: S45C, JBW-300B, Vickers, Heat Treatment.

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1 Introduction

Impaction testing refers to testing which applies a heavy and fast force. The process of energy absorbing occurs when the impact test load is applied to the object. The resultant measured energy that these surfaces absorb is determined by the method of potential energy difference. The basic principles for impact grading is to estimate the total energy that has been captured inside the object. When the load is increased to a specific elevation, the load has a maximum specific energy, then when it hits the determined material, until the material fails. [1]

Brittle fatigue fracture resistance is a primary issue in structural materials in the design of a steel structure. When this ductile fracturing takes place in low durability materials, it can spread at rates up to 2,000 mm/sec, causing failure within a remarkably small period. Impact toughness is a material's endurance to impact load. It's how we differentiate between impact tests and tensile tests. it's how we differentiate between fatigue and hardness tests in which the load is delivered in short bursts.[3]

Alloy steel is a type of metallurgy in which iron is the basic substance and other materials, particularly carbons, are included. The content of elemental carbon present in steel varies between 0.2% and 2.1%, by mass corresponding to its grading. Further, the presence of the below minerals is common in steel: carbon manganese, phosphorous, Sulphur, Silicon, and a small percentage of oxygen, nitrogen, and aluminum. [6]

This is carbon based steel that has between 0.3% and 1.7% of carbon. In this research, however, the shade utilized is S45C. These are included in this product's intermediate carbon steel alloy, which have carbon content by 0.5%. S45C steel is highly recommended for bridge trusses. S45C steel as a sheet must be rolled following a process of welding to customize construction and designs of a bridge. S45C steel codes originate in DIN (Deutsches Institut For Normung)

A heat treatment is a method of reinforcement of metal during which the material that we intend to modify its characteristics is concentrated in a compacted condition. For heat treatments, however, our specimens are heated to an annealing temperatures. Austenizing temperatures provided depending at the carbon material concentration level of the processed material. Once the temperature of austenization has been achieved, the specimen is allowed to remain at that specific temperature for a certain duration of time resulting in a homogeneous material throughout the specimen. The process is referred to as homogenizing. Thereafter, by regulating the quenching rate, the required hardenability will be achieved. [7]

Quenching Several different types of processes are implicated in the cooling method and are linked to each other. One is the kind of quenching media and processing condition utilized, the second is the chemical composition and hardenability of the metal. Hardening ability was a result of chemical properties and size of the grains at the given specific temperatures. The process of quenching involves the transmission heat at a rapidly accelerating pace. [4].

During the process of quenching processing, the acceleration of quenching from the finishing treatment temperatures occurs and the conversion from austenite to bainite and martensite occurs to generate a high level of strength and violence. High strength and hardness. The optimum hardenability effected in Quenched steels is nearly ultimately decided by the carbon composition involved. is almost completely determined by the carbon concentration and quenching rate equally to or preferentially superior to those competed grades for that

particular alloying. Quenching media include: aqueous, salt water, oils, aqueous polymers, alternatively. [4]

The impact test device of the charpy methods represents a materials hardener testing instrument in which the material specimen received a load of impact from a pendulum that will indicate the results of the hardness of the material specimen. The specimen is notched beforehand in according to the ASTM E23 05 specification and result of the experiment is a deformed specimen bending or fracturing according to the durability or ductility of the specimen. The charpy test impact experiment is carried out by suddenly applying load to the specimens which will be static controlled, in which the specimens are first notched based on the standard size of ASTM E23 05.

This size of specimen is a standard typically utilized in testing the Charpy method. It has a square cross-sectional area of 10 mm x 10 mm and a length of 55 mm. Directly in the center from the specimen is a V-45° notch. This notch measures 2 mm in depth and has a bottom diameter is 0.25 mm. Since the specimen is laid flat, it is subjected to a pendulum swing (approximately 3 m/s - 6 m/s impact velocity) and the unnotched portion is subjected to impact loading. ASTM E 23 specifications would then buckle in the direction of the notch and yield at a higher strain level, about 3 - 10 seconds.

Figure 1: Impact Testing JBW-300B

2 Materials and Methods

This experiment utilizes the JBW-300B Model impact test instrument which is used to measure the amount of material that can receive a load of impact from the S45C raw material, in this experiment using S45C heat treatment process using oil quenching, which is assumed to result in a high impact rate.

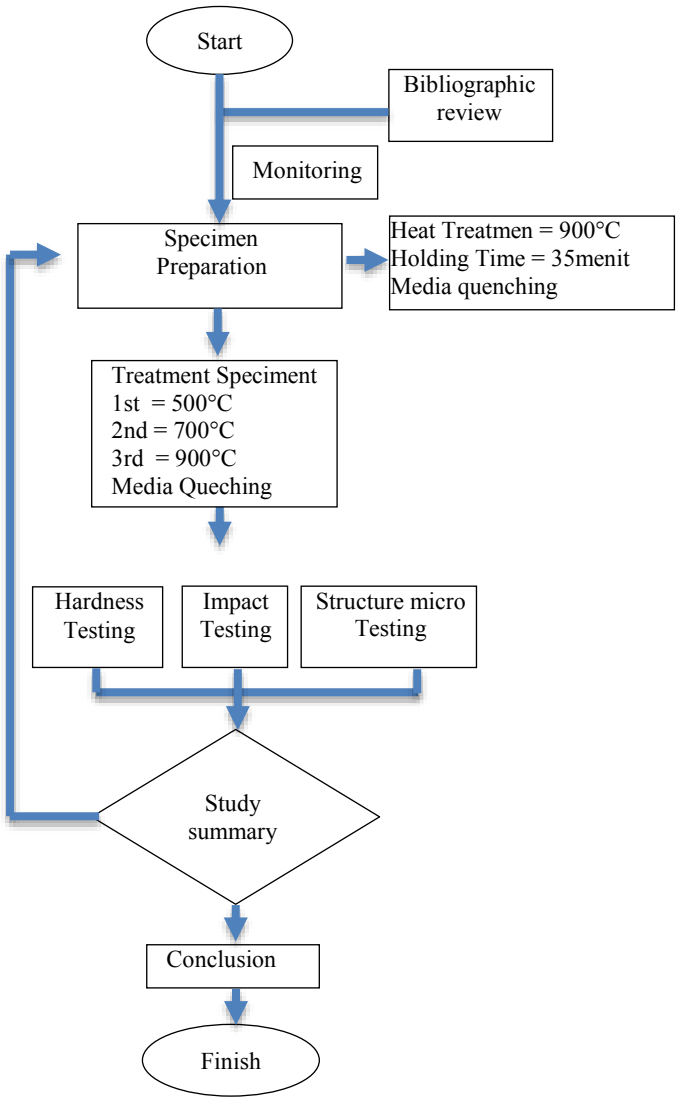

Figure 2: Research Flowchart

3 Result and Discussion

The small Charpy specimens that are most commonly used are KLST (from German Kleinstprobe, or “small specimen”), and they have the nominal specifications as following: girth = 3 mm, breadth = 4 mm, long = 27 mm, deep notch = 1 mm. KLST Specimen was the first kind of MCVN included in an internationally recognized testing parameter, as in 2006 an Addendum titled “Charpy instruments V-notch pendulum impact testing of specimens of different size” has been approved to be included in the ISO 14556 standard: 2000. The usage of KLST specifications is also legalized by ASTM E2248-13. Carburizing is one of the heat treatment methods to increase the surface hardness of steel while maintaining the core strength which remains ductile. In this process, carbon is added to the steel surface which will form a layer with a higher carbon content compared to the core of the material. By increasing the carbon content at the surface, once this process is completed and

the steel is quenched, the surface layer will become harder and more wear-resistant.

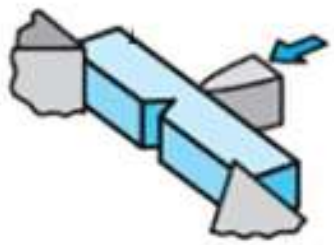

Figure 3: Impact Load Direction of S45C

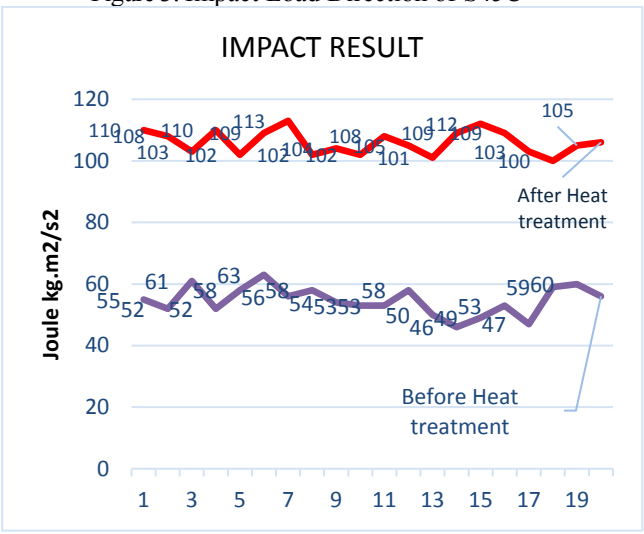

Figure 4: Graph line Impact Value of S45C

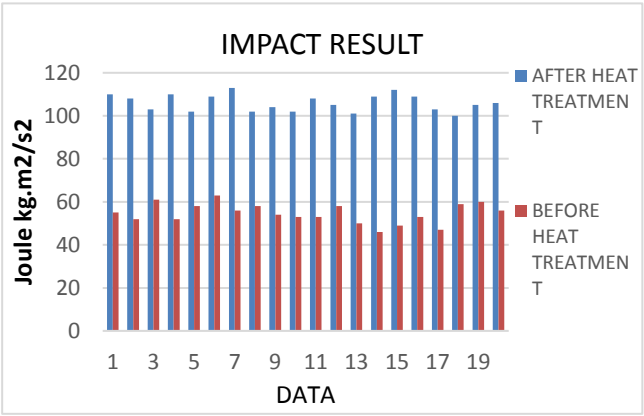

Figure 5: Graph Statistical Impact Value of S45C

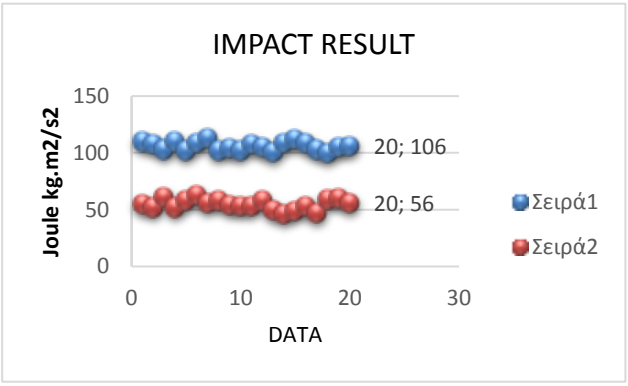

Figure 6: Graph stock Impact Value of S45C

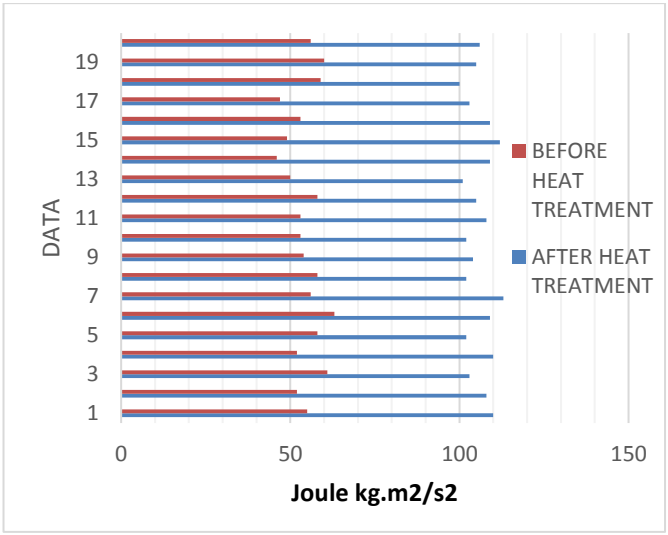

Figure 7: Graph 2 D Impact Value of S45C

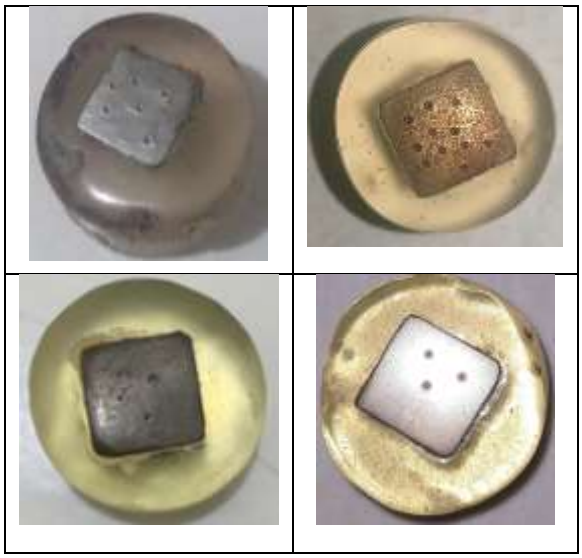

Figure 8: S45C

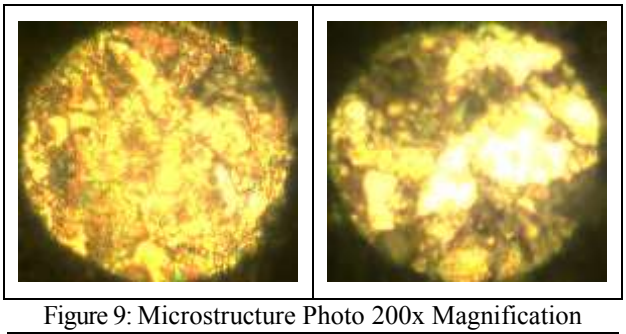

Figure 9: Microstructure Photo 200x Magnification

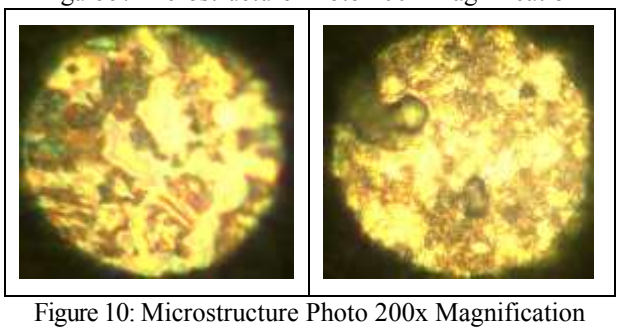

Figure 10: Microstructure Photo 200x Magnification

When low density quenching media are utilized, the quenching process is slowed down as the indirect heat transfer process affects long-range Molecules. The resulting slower processing results in the development of a formidable and durable material structure.

Figure 11**:** S45C Steel Impact Testing Results

4 Conclusion

According to the study conducted, I made several observations and recommendations as below: S45C material: Based on the research findings, We can conclude that the fracture force of S45C heat treated unprocessed steel is 54.65 Joules/mm2. Hardness is found to be 45VHN. Afterwards, the S45C samples were heat-treated at 900°C followed by quenching by using oil media. This specimen had an increase in impact strength of 106.05 Joule/mm2 meanwhile the hardness test had an improvement of 65VHN. The results of this study show that the heat treatment method and then the quenching method can increase the hardness and impact strength of the S45C raw material.

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