Study on Impact Strength Against Welding Smaw on Hardening Steel AISI 1050

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Abstract

Results – From a hardening test, we then tested with an impact tester charpy Treviolo H060. The results showed that the impact strength is escalated up to 29.09% post-hardening circle, which was observed using electrical microscope. The value of steel strength increased 2.12 J/mm^2 compared with earlier hardening process, which is, 1.57 J/mm^2. The results showed that the fracture in the welding process without the hardening process is a brittle fracture that is shown by the flat crystal structure; on the other hand, the hardening process before welding shows a form of coarse-looking structure indicating that the specimen has an impact towards which the toughness is higher.

Research Limitations/Implications – The effect influence of the hardening process to the impact strength of welded joints before and after the hardening process SMAW AISI 1050 steel hardening process. The mechanical properties test is done with the equipment impact charpy.

Practical Implications – The field we often encounter is erosion or wear out occurring in the construction, for example, many equipments such as agricultural equipment, bridges, ship construction, motor shaft, machining such as hand tools, small rings, and agricultural tools.

Originality/Value – This is the first reported research on impact strength using the hardening test.

Keywords Steel AISI 1050, Electrode E7016, impact strength, Welding, hardening, electrical microscope

1. Introduction

Farid (2005) gives the effect of hardening and tempering on SMAW ASTM A533 steel welding and results are intended to determine the effect of variation in time on the treatment of weld toughness and to know changes in mechanical properties on the plate steel after welding and treatment. ASTM A533 (*ASTM E23, 2007, Standard Test Method for Notched Bar Impact*

Testing of Metallic Materials, 2007) steel plate has a thickness of 12 mm, a width of 75 mm, and 300 mm long after welded; there are plates that can undergo heat treatment and some not; the heat treatment is done by hardening and tempering with variations in the holding time of 1, 2, and 3 h. The tests are hardness test, impact test, and structure micro; the test is carried out in the parent area, the HAZ area, and the weld area both on the steel plate given heat treatment or not. The result of violent testing obtained by pricing of maximum violence occurs in HAZ areas that have gone through hardening processes, while the price of minimum fracture occurs in the weld area that has been through the tempering process with a hold time of 3 h. *Results*: the impact test obtained at the maximum price occurs on the parent metal and the minimum impact price occurs during hardening process without tempering process (Widya Mukti, 2007). Microstructure found in steel ASTM A533 is ferrite, perlite, and marten site.

Nizam (2016) conducted research of toughness of impact weld on steel St 60 stelah, and found the impact of weld toughness to be highest at 275 J/mm with a value of 2.61 J/mm^2 and lowest on the heat input 175 J/mm with a value of 0.85 J/mm^2. The microstructure test results of the Las region decompose into three types: grain boundary ferrite, widmanstatten ferrite, and acicular ferrite. Grain boundary ferrite spreads evenly on the weld area, and its structure has a tenacious nature. In the parent metal, phase ferrite is more perlite which is spread out evenly. While in the Haz area, the growth of marten site occurs (Suparman, 2006). This matter shows that steel St 60 welding process experienced an increase in the violence in the Haz area along with higher heat input and cooling rate. AISI 1050 steel are widely used in various industries.

2. Materials and methods

Material AISI 1050 steel in the form of a plate with a length of 150 mm, a width of 75 mm, and a thickness of 10 mm. Figure 1 shows Shape and Dimensions of the ASTM E23 Standard Impact Test Specimen.

For the formation of the corner of the veld, prior to the process of welding, the material was first made of welding groove, the veld used in this study was a single V-joint with an angle of 60(and a gap of 3 mm. After the type of welding used in this research, is the process of welding Shielded Metal Arc Welding (SMAW) by using E7016 electrode at 100 A current. Before the impact test, the material first formed according to the needs of the impact test machine. Flatten groove welding using frais machine. For more details, we show in Figures 1 and 2 the shape and dimensions of the ASTM E23 standard impact test specimen.

The hardening process is using a heating oven to heat the test specimen to 830 (C, with a holding time of until 15 min (Prayitno, 1999), for quenching water was used after hardening, and Charpy impact machine was used continuously for impact testing, as shown in Figure 2.
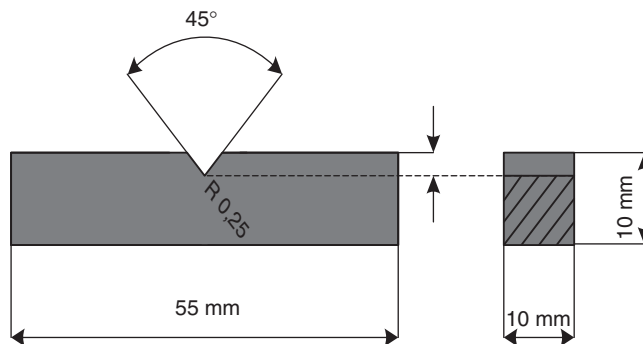

Figure 1.
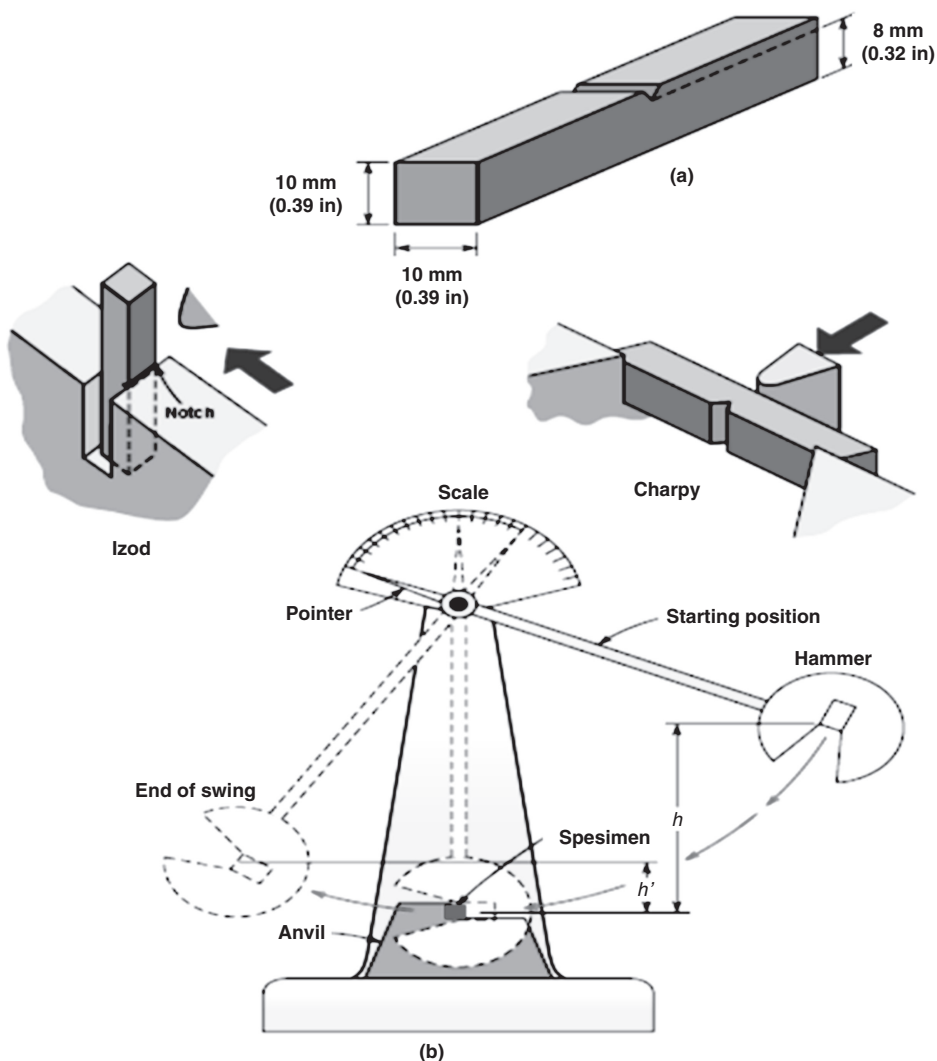Shape and Dimensions of the ASTM E23 Standard Impact Test Specimen

3. Results and discussion

Impact test was conducted to know the mechanical properties of medium carbon steel material as a test material in this research. The result of the impact test is generally the toughness parameter (notch blow value). The impact price can be calculated by the following equation:

$$Essor = mgR(\cos\beta - \cos\alpha) \tag{1}$$

where m is the weight of the pendulum (kg) = 20 kg; g is the gravitational acceleration (m/s^2) = 9.8 m/s^2; R is the arm length (m) = 0.775 m; α is the pendulum angle before swung = 1400;

and β is the angle of the pendulum swing after breaking the specimen, angle at the end of each specimen.

$$Essor = mgR(\cos\beta - \cos\alpha)$$

$= 20\,\text{kg} \times 9.8\,\text{m/s}^2 \times 0.775\,\text{m (cos}\,780 - \cos 1400)$
$= 20\,\text{kg} \times 9.8\,\text{m/s}^2 \times 0.775\,\text{m} \,(0.207 - (-0.766))$
$= 20\,\text{kg} \times 9.8\,\text{m/s}^2 \times 0.775\,\text{m} \,(0.973)$
$= 147.80\,\text{J}$

Impact prices can be calculated by the following equation:

$$HI = Esrp/A^0$$

where HI is the impact price (J/mm^2); Esrp is the absorptive energy (J); and A^0 is the sectional area (height below notch $\times$ width specimen) = 80 mm^2

$$HI = \frac{Esrp}{A^0} = (147.80\,\text{J})/(80\,\text{mm}^2)$$

$$= 1.84\,\text{J/mm}^2$$

The value of the results of the impact test is shown in Figure 3.

In Figure 3, the strength score graph shows that the mean impact strength on hardening specimens is 2.12 J/mm^2 with an absorbed energy of 170.65 J. While the mean value of impact strength on welding specimen without hardening process is 1.57 J/mm^2 with an absorbed energy of 126.33 J. The impact strength value of the hardening welding specimen is increased by 25.94% against the impact strength of the welding specimen without the hardening process, which is due to the heating process carried out on the AISI 1050 steel at 83 °C for 15 min which can increase the toughness of the welds of the steel. The cross-section of the impact toughness test (Irvan, 2010). The specimen after being subjected to the test at the notch will be broken on the critical cross-section already specified; this section of the fault will be observed. Correct cross-section of the notch test can be seen differently, each fracture has different characteristics; generally, fracture form at the test of notch has three forms, namely brittle/brittle fracture, ductile fracture, and mixture fracture. For more details, we can see in Figures 4 and 5.
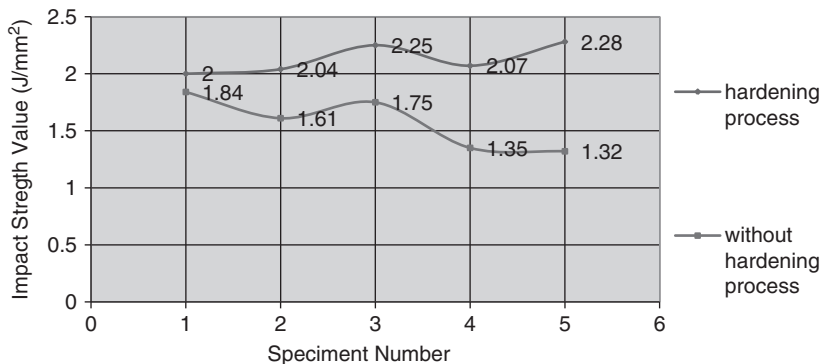

Figure 3.
Graph of Impact Strength Value Without Hardening Process and With Hardening Process
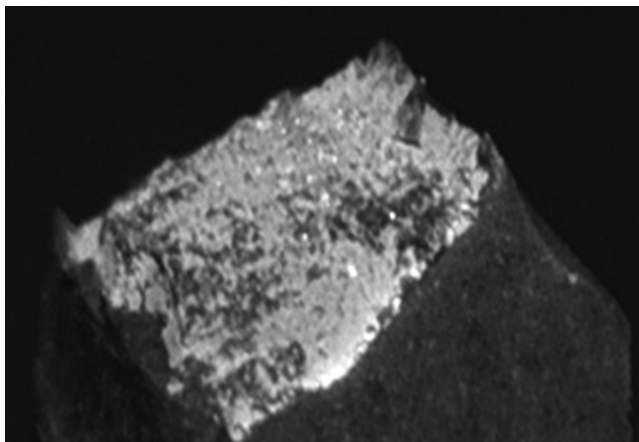
From the observation of the impact fracture in Figures 4 and 5, the fracture occurring on both specimens is very different. Figure 4 shows that the fracture pattern formed is a brittle fracture in which the crystal structure looks more flat, while Figure 5 shows a tenacious fracture in which the crystal form looks coarse and uneven, this indicates that this specimen has higher impact toughness.

4. Conclusion

The value of absorbent energy and impact toughness on welding specimens without the hardening process has a lower value than the welded specimen by the hardening process. The average value of energy absorbed is 126.33 J while the average value of its toughness is 1.57 J/mm^2.

The value of absorbent energy and impact toughness on welded specimens by hardening process has a higher value than welded specimens without the hardening process. The

average value of absorbed energy is 170.65 J and its toughness value is 2.12 J/mm^2, the value
increases by 25.94% against the impact strength of the welding specimen without the
hardening process.

The results of observation of the fracture in the welding specimen without the hardening
process showed that the fracture pattern is formed in the form of a brittle fracture where
the crystal structure is noticeably flatter than the hardening (Farid, 2005) specimen.
While the fracture results in the hardening welded specimen in the form of a ductile
fracture where the crystal form looks coarse and uneven, indicating that this specimen
has higher impact toughness.

For better welding results, welding is done in a vacuum and no contamination should occur
during welding process; numerical reading on impact test results should be manual equipment
(Amstead, 1989) but accurate, using different electrodes for impact testing, using AISI 1050
steel material for hardening material with quenching water medium to compare its impact
strength, and the fracture that occurs is a single fracture/brittle fracture (Amanto, 1999)

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