Analysis Of Resistance Of Materials That Have Las Connection In St 37 Steels

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Abstract. This study aims to determine the effect of welding currents on the strength and toughness of SMAW welds with Impact testing. This study uses ST 37 Steel (Medium Carbon Steel), this steel including medium carbon steel. The material is treated with welding with a variation of current 90 Ampere, 110 Ampere, and 130 Ampere using SMAW DC welding, Impact testing is a test to measure the resistance of the material to shock loads. Impact testing simulates material operating conditions that are often encountered where the load does not always occur slowly but comes suddenly. The aim to be achieved in this study is to analyze impact testing for medium Carbon Steel welding position using a flat or down hand welding position, the type of seam used is V with a 90 ° angle. Specimens are tested for impact. Impact test results in the base metal and current variation specimens showed that the highest impact strength values were found in base metal, which was 146 joules and 1,825 joules / mm², compared with the current variation group of 110 amperes, 130 amperes. The types of fracture that occurred were on the base metal and the 90 Ampere current specimen group was brittle fracture, and the 110 Ampere specimen group and the 130 Ampere specimen group were tenacious fractures.

1. Introduction
At present welding is a very important job in industrial technology. Almost all metal connections for all types can be made by welding techniques. Electric arc welding or commonly called electric welding is a process of connecting metals using electric power as a sumnber of heat. one of them is SMAW (Sheilded Metal Arc Welding / shielded electric arc welding), on the welding metal parent is liquefied due to heating from an electric arc arising from the tip of the electrode and the surface of the workpiece. An electric arc is generated from a welding machine. The electrodes used were in the form of a friend wrapped in a protective flux. These electrodes during welding experience melting with the parent metal and freeze together, becoming welded seam [1][2].
Welding procedures, it seems very simple but in practice there are many problems that must be overcome where the solution requires various kinds of knowledge. Based on literature studies, it is necessary to conduct a study to study the defects that occur in weld joints, the literature study shows that defects in joints are due to errors in the welding process and know the strength and toughness of weld metal.

The need for mainly metal materials is very important. Iron and steel is one of the basic needs for a construction. With various kinds of mechanical properties needed by a material is different. The mechanical properties mainly include hardness, tenacity, strength, and the process of welding the material needed as well. Impact test which is one of the methods used to determine the strength, hardness, and tenacity of the material. Materials that experience different electric currents in welding and electrode selection are expected to produce differences in weld quality.[1], [3].

Based on the definition of the Deutsche Industrie Normen (DIN) in [2] defining that welding is a metallurgical bond on alloy metal joints carried out in a melted or liquid state, in other words welding is the local connection of two metals using heat energy. Welding is an integral part of the manufacturing process. Welding is one of the techniques of connecting metals by liquefying some of the parent metal and filler metal with or without press and with or without additional metal and producing a continuous connection [1].

1.1 SMAW Welding (Shielded Metal Arc Welding)
SMAW Welding (Shielded Metal Arc Welding) electric arc shielded welding is welding using an electric arc as a heat melting metal.

The parent metal in the welding experiences liquefaction due to liquefaction which arises between the tip of the electrode and the surface of the workpiece. An electric arc is generated from a welding arc. The electrode used is a shielded wire in the form of flux. These electrodes during welding experience melting together with the parent metal and frost together, becoming welded seam.

The process of electrode metal displacement occurs when the electrode melts and forms grains which are carried by the electric arc current. When a large electric current is used, the granules of molten metal that are carried into smooth and vice versa if the current is small, the grain becomes large [4].

![Welding Process](image)

**Figure 1.** Welding Process [1].

1.2 Webbed Electrodes
The electrode membrane table ranges from 10-50% of the electrode diameter. The standard size of the core wire diameter is 1.5 - 7 mm with a length between 350 - 450 mm. When welding this membrane will melt and produce CO2 gas that protects the weld fluid, electric arc and workpiece against the outside air [1].
1.3 Electrode Classification
Soft steel electrodes and low alloy steel according to the AWS (American Welding Society) classification are expressed with the sign E xxxx which means: E states the xx electrode (two digits) after E states the tensile strength of the weld deposit in thousands lb / inch² [4].

1.4 Impact Testing On Charpy Test
Impact testing is one of the mechanical tests that can be used to analyze material characteristics such as the ability of the material to impact and the characteristics of material tenacity to temperature changes. The impact test tool is one of the test equipment that is often used in the development of material structure materials in measuring shock load capability.

Impact testing is an attempt to immobilize the operating conditions of materials that are often found in transportation equipment or construction where the load does not always occur slowly but suddenly. In the impact test the amount of energy absorbed by the material for fracture is a measure of the impact resistance or toughness of the material. The resilient material will address the large impact price by absorbing potential energy from the load pendulum which swings from a height which will certainly crush the test object so that the test object undergoes a change in shape [5]–[7].

1.4.1 Getas Fault
Fault that occurs in brittle objects, for example: cast iron, can be analyzed Flat and shiny surface, pieces can be paired again, cracks are not accompanied by deformation, the value of the punch is low,

1.4.2 Clay fracture
Faults that occur on soft objects, for example: soft steel, copper, can be analyzed The surface is unevenly opaque and fibrous, the pair of pieces cannot be re-installed, there is deformation in the cracks, the value of the punch is high.

1.4.3 Mixed Fault
Faults that occur in materials that are strong enough but resilient, for example in tempered steel Combined brittle faults and clay fractures, dull and slightly fibrous surfaces, pieces can still be paired, there are deformations in cracks. The principle of measurement is schematically shown in figure 1 where part of the energy to be absorbed is expressed in units of jouledan read directly on the calibrated dial scale contained in the testing machine.

2. Research Methods
HI= E/A
Where:
HI = Impact Price (joule / mm²)
E = Absorbed energy (joule)
A = Area of Section below notch (mm²)
3. Results and Discussion
The test is based on data from mechanical testing on metals, namely Impact test impact testing as follows.

In analyzing the data in the form of pertitugan, one of the data is used on 1 welding current 90 Amper with the steps and data dimensions of the specimen as follows:
Figure 4. Dimensions of specimens[2]

Specimen data is known as follows:
H = 10 mm = 0.01 m, L = 8 mm = 0.08 m, L ' = 6 mm = 0.006 m, Θ = 90°, α = 130°, Pendulum load m = 12.5 kg, Pendulum length R = 960 mm, Uk = 2 Calibration Business

The steps of the calculation business are carried out as follows:

1. Determining L ''
   L '' = L - L '

2. Area of broken field (A)
   A = L x (L - L ')

3. Determine pendulum height (Hi)
   Hi = R + R.\sin (α - 90°)

4. Mass Babdul (m)
   m = 12.5 kg

5. High Calibration Load Tool (Hk)
   Hk = = Uk / (m.g)

6. Determining the pendulum effort to break specimens (U)
   U = m x g x Hi

7. Determine the pendulum height after breaking the specimen (H2)
   H2 = R + R.\sin (β - 90°)

8. Determine the height of the calculation (Hs)
   Hs = Hi - H2 - Hk

9. Attempts to break specimens (Us)
   Us = m x g x Hs

10. Determine the impact value of the material (U1)
    U1 = Us / A
Table. 1 Calculation Result Value Table

| Parameter | Electrode type | RM | RB | RD | NK |
|-----------|----------------|----|----|----|----|
| L         | 8              | 8  | 8  | 8  | 8  |
| L'        | 6.10           | 6.00| 6.00| 6.00|
| A         | 0.0488         | 0.0480| 0.0480| 0.0480|
| R         | 960            | 960 | 960 | 960 |
| β         | 120.0          | 119.5| 118.0| 120.0|
| H2        | 0.01149        | 0.05661| 1.22007| 0.01149|
| α         | 130            | 130 | 130 | 130 |
| Uk        | 2              | 2  | 2  | 2  |
| M         | 12.5           | 12.5| 12.5| 12.5|
| Hk        | 0.0163         | 0.0163| 0.0163| 0.0163|
| Us        | 202.026        | 196.493| 53.824| 202.026|

Figure 5. Specimens that have been tested
Table 2. Relationship between Welding Current to Impact price

| Material / Arus | 90 Amper   | 110 Amper   | 130 Amper   |
|----------------|------------|------------|------------|
| RM             | 3696,862   |            |            |
| RB             | 4093,603 joule/m² | 4208,871 joule/m² | 4208,871 joule/m² |
| RD             | 1121,327 joule/m² | 2334,484 joule/m² | 3413,285 joule/m² |
| NK             | 4208,871 joule/m² | 4208,871 joule/m² | 3730,868 joule/m² |

Figure 6. Graph of the Relationship of Welding Flow to Price Impact

In the figure 6, above shows that the Row Material, where the material that does not undergo the weld connection process has a relatively stable impact strength. Whereas on the RB Electrode shows the material that undergoes weld connection with the electrode from the current of 90 amperes the current is 110 amperes which is a brittle value and at 110 Ampere to 130 Ampere there is no change in brittle value. Where the value of the impact strength at the current of 90 Ampere 4093.603 joule / m² to the current 110 Ampere 4208,871 joule / m² there is an increase in the value of the impact price of The 115,268 joules / m² increase in the impact price caused a decrease in the brittle value of the material in the welding area. While the current 110A 4208,871 joule...
/ m² to 130A current 4208,871 joule / m² does not increase the impact price value, indicating there is no difference in brittle material values in the welding area.

RB electrodes from the graph shown above the material that has welded connection with this electrode has decreased the brittle value of the current 90A to the current 110A while in the current 110A to 130A there is a decrease in brittle value. Where the value of the impact strength of the current 90A 1121,327 joule / m² to the current 110A 2334,484 joule / m² increases in the value of the impact price of 1213,157 joules / m² the price increase indicates a decrease in brittle material value in the welding area.

Whereas on the NK Electrodes from the Graph shown above the material that undergoes weld connection with this electrode does not change the brittle value of the 90A current to the 110A current while in the 110A to 130A currents a brittle increase occurs. Where the value of the impact strength of the current 90A 4208,871 joule / m² to the current 110A 4208,871 joule / m² does not change the value of the impact price indicates that there is no change in the brittle value of the material in the welding area.

While the current of 110A 4208,871 joule / m² up to 130A current 3730,868 joules / m² a decrease in the value of the impact price of 478,003 joule / m² the price increase of the impact shows a decrease in brittle value.

The increase or decrease in the impact strength of a material is influenced by the increase in welding temperature on the increase in the value of welding current on the material, while the cooling process in each welding process at different welding currents is the same as using free air at standard temperature (room temperature) 25°C.

Changes in the impact strength of increasingly brittle materials are also influenced by the shifting of the microstructure in the welding process, the small size of the shift is influenced by the large welding current which ultimately affects the increase in temperature in the welding area. The shift in the microstructure of the material at high temperatures, the metal structure will experience stretching so that the meeting structure becomes smaller. High temperatures will also result in hardening of material properties.

4. Conclusion

- Of the 3 types of currents used during welding, it is known that the current 90A has the lowest impact value or has a high brittle value with an average impact of 3141,267 joules / m², whereas for welding currents 110A has an average the average impact value of 3584.075 joules / m² is higher than welding at 90A, and for welding at 130A the average value of the impact is 3784,341 joules / m² this value is higher than the welding on current 90A and 110A which means it has a low brittle value.

- From the 3 types of electrodes used, it can be concluded that the electrodes that have the lowest impact value are RD electrodes with an impact value of 2289,699 joule / m², which means that the RD electrode has a high brittle value compared to the NK and RB electrodes, respectively. has an impact value of 4049,537 joules / m² and 4170,448 joules / m² or RB has the highest impact value where the brittle value is the lowest.

Reference

[1] ____, Analisis Kekuatan Sambungan Las Smaw (Shielded Metal Arc Welding) Pada Marine Plate St 42 Akibat Faktor Cacat Porositas Dan Incomplete Penetration,” Kapal, vol. 5, no. 2, pp. 102–113, 2012.
[2] Muhammad nur, Awal syahrani, Naharuddin, “Analisis Kekuatan Tarik, Kekerasan, Dan Struktur Mikro Pada Pengelasan SMAW Stainless Steel 312 Dengan Variasi Arus Listrik,” J. Mek., vol. 9, no. 1, pp. 814–822, 2018.

[3] P. Oxy, A. Pada, and M. Baja, “Jurnal Jurusan Pendidikan Teknik Mesin (JJPTM) Vol : 8 No : 2 Tahun : 2017 Jurnal Jurusan Pendidikan Teknik Mesin (JJPTM),” 2017.

[4] T. Prasetyawan, “Analisa Kekuatan Pada Sambungan Las Baja St 37 Dengan Pengelasan Smaw Di Dalam Air Tawar, Air Laut Dan Di Halaman Persetujuan Analisa Kekuatan Pada Sambungan Baja St 37 Dengan Pengelasan Di Dalam Air Tawar, Air Laut Dan Di Darat 2016.

[5] K. A. Rahangmetan, F. Sariman, and D. Parenden, “The Effect of Riser Use in the Quality of Casting Al 7075 for Ship Propeller,” Int. J. Mech. Eng. Technol., 2019.

[6] D. Parenden and Cipto, “Estimation of emissions for petrol vehicles in some roads in Merauke city,” Int. J. Mech. Eng. Technol., 2019.

[7] F. Sariman, A. P. Bayuseno, and S. Muryanto, “Crystallization of Barium Sulfate (BaSO 4 ) in a Flowing System: Influence of malic acid on Induction Time and Crystal Phase Transformation,” MATEC Web Conf., 2018.

[8] S. A. Jalil, Z. Zulkiifli, and T. Rahayu, “Analisa Kekuatan Impak Pada Penyambungan Pengelasan Smaw Material Assab 705 Dengan Variasi Arus Pengelasan,” J. POLIMESIN, vol. 15, no. 2, p. 58, 2017.