The Effect Of Current On SMAW Welding To Tensile Strength And Micro Structure Of Low Carbon Steel

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Abstract. This study aims to determine the effect of the welding current strength against the tensile strength and microstructure SMAW electrode E 6013. This study used low carbon steel. Material treated with a variation of welding current 65 amperes, 75 amperes and 85 amperes using reverse polarity DC SMAW with E7018 electrode diameter of 2.5 mm. DC reverse polarity that the electrode holder is connected to the positive pole and the metal stem is connected to the negative pole. This type of connection used is a blunt connection. Tensile testing specimens and micro photograph. The tensile strength of the weld joint highest among75 specimens Amper is equal to 319.44 N/but the tensile strength of raw materials was higherthan 75 amperes is equal to 490.97N/, group welding decreased by 171.53 N / under the influence of welding. According to the results of research can be concluded that with a strong variation of welding current structure changes as a result of cooling and therefore contributes to the strength of the material that is an increase of the *raw*materials. Keywords are current, SMAW, tensile strength, microstructure, E 6013

1. Introduction

The development of technology in the field of construction of more advanced can not beseparated from the welding because it has an important role in the engineeringand metal repair. Construction of the metal at the present time involves many elements, particularly the field of welding engineering for welded joints is one of making connections that technically requires a high skill for pengelasnya in order to obtain a connection with good quality. The scope ofthe use of welding techniques in the construction of very broad include shipbuilding, bridges, steel structures, pressure vessels, transportation, rail, pipelines and so forth.Factors affecting the welding is awelding procedure that is a plan for the implementation of the research include ways of making appropriate welded construction plans and specifications to determine all the necessary things in the implementation. Factors of production welding is a schedule of manufacture, process, themanufacturing tools and materials required, the order of execution, preparation for welding (includes: selection of welding machine, welder appointment, election electrodes, the use of the type of hem) (Wiryosumarto, 2000).

Welding based classification of functioning can be divided into three groups: liquid welding, press welding and soldering. Liquid Welding is a welding method in which the objects to be joined are heated to melt with the heat energy source. How to welding the most widely used is liquid with arc welding (electric arc welding) and gas. Type of electric arc welding No 4, namely arc welding with wrapped electrodes, gas arc welding (TIG, MIG, CO2 arc welding), without gas arc welding, submerged arc welding. Type of arc welding electrodes encased one of which is the SMAW*(ShieldingMetalArc*Welding).Basically, not all metals have properties good weldability. Materials that have good weldability characteristics include low alloy steel. These steels can be welded by arc welding electrodes encased, submerged arc welding and MIG welding (metal inert gas welding). Low alloy steel is used for thin plates and general construction (Wiryosumarto, 2000).Adjustment of welding current strength will affect the outcome of the weld. When current isdiguanakan too low will cause difficulty electric arc ignition. Electric arc happens to be unstable. The heat that occurs is not enough to melt the electrode and the base material so that the result is a welding ridges are small and flat and lacking in penetration. Conversely if the current is too high then the electrode will melt too quickly and will result in a wider weld surface and deep penetration resulting in lower tensile strength and add to the fragility of the weld. The strength of the weld resultsare influenced by the arc voltage, large current, welding speed, the amount of penetration and electrical polarity. Determination of the amount ofcurrent in the metal using welding arc splicing affects the efficiency of welding work and materials

2. Basic Theory

2.1 Definition Las

Definition of welding according to DIN (Deutsche Industrie Norman) is a metallurgical bond at the junction of the metal or metal alloy that is carried out in the molten or liquid state. In other words, welding is a local connection ofseveral metal rods by using thermal energy. Weld is an activity to connect two or more body parts by heating or pressing, or a combination of both in a way that blends like objects intact.SMAW process, today known as the MMAW (Manual Metal Arc Welding). In this welding, the parent metal melting due to heating of the electric arc arising between the tip electrode and the workpiece surface. Electric arc that is generated from a welding machine. The electrodes used in the form of wire that is wrapped by a protective form of flux and therefore sometimes called the welding electrode welding wire. These electrodes during welding will undergo liquefaction together with the parent metal which becomes part of the weld seam. With the melting of the seam welds these will be filled by the molten metal from the electrode and the base metal.

3. Research Methodology

This research is a kind of experimental, to obtain a description of the effect of variations in the welding current strength against the tensile strength and microstructure on low carbon steel welding. In the tensile strength test and microstructure using the same specimen, first seen micro structure and then do the tensile test. Welding research object used is low carbon steel, which has a size of each specimen with pan-jang 200 mm, width 60 mm, and a thickness of 60 mm, so that the total of all the specimens was 12 pieces with the same size. Standard tensile test referring to ASTM E8 for *rawmaterial* and JIS Z 2201 1981 forWelding of *Standard Test Methodsfor Tension Testing of Me-tallic*Materials.While the micro-structure of specimens taken one microstructure in *HAZ*,1 raw material microstructure. variations in the current strength of welds used knowl-65A, 75A, and 85A.

The procedure of collecting data in this study to prepare low carbon steel,welding*SMAW*machine,milling machine, metallographic microscope, and, sandpaper. Thencarry outweldingin accordance with the *Welding ProcedureSpecification*(WPS)methodblunt connection. Workpiece weld then formed into tensile test specimens. The shape of the tensile test specimen in accordance with JIS Z 2201, 1981. The establishment of the specimen is performed using chainsaws and milling machines. Formation specimen microstructure done before the specimen through a tensile test in the HAZ.

Step test micro structure as follows:

1. The specimen is cleaned using a cloth, then rubbed the liquid etching (nital, nitrid acid 2% and 98% alcohol) on the surface of the desired ..
2. Place the specimen on the anvil of an optical microscope, turn on the machine, hold the magnifying lens tolook at the surface specimens. Figure capture microstructure with 400x magnification. Look microstructure if less obvious or vague, focus the lens to be seen clearly.
3. Keep at the time of Figure capture is not there anything that makes the optical microscope move, because if the optical microscopemoves will affect the outcome.

Step tensile test as follows:

1. Setting up the material to be tested
2. test specimen began to receive a tensile load using hydraulic power starts dropping objects 0 kg up to the maximum load which can be held to the object.
3. Test specimen that had broken then measured how large cross-section and the length of the test specimen after dropping
4. Then look at charts and record the test results appear on the computer monitor
5. last thing is to calculate the tensile strength, strain of the data has been obtained.

4. Results and Discussion

4.1 Research Results Test microstructure

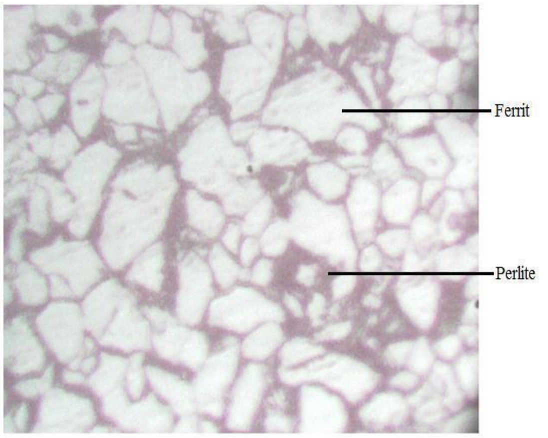

Figure 1. Structure Micro raw material Magnification 400x

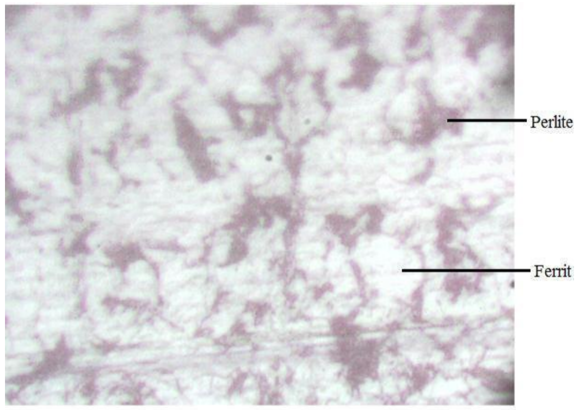

Figure 2. microstructure of HAZ current 65 Ampere Magnification 400x

Microstructure in the Figure above shows that there are grains of ferrite that are white (light), whereas fewer pearlite phase (dark). Ferrite grains tend to be more subtle while more coarse perlite grains. Perlite grains tend to be hard because it contains carbon, while the ferrite grain tends to be soft. In the photo micro structure of the weld 65 A there are grains of ferrite (white) tend to be less than the *raw materials*, while the grains of perlite (black) more is due to the effect of heat welding, so the currents 65A tend to be harder because there are many grains of perlite (black). Violence owned perlite 10-30 HRC and carbon content (0.8%).

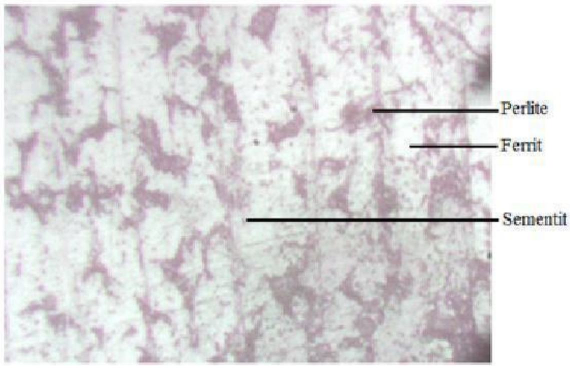

Figure 3. HAZ micro-structure the current 75 Ampere Magnification 400x

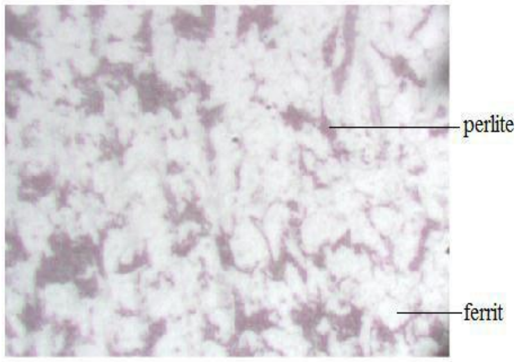

Figure 4. microstructure of HAZ current 85 Ampere Magnification 400x

In the weld microstructure 75 A here is explained that there are grains of perlite + ferrite + cementite. In these specimens can be seen that the grains of cementite and perlite more than ferrite grains indicates that this specimen sufficiently high carbon content so that the hardness is higher than 65A current. Cementite itself contains carbon of about (6.65%) In the Figure the microstructure of HAZ 85 grains of ferrite tends to be rough and grains of perlite becomes a little more, this is because the cooling conducted after welds only use cooling at room temperature, resulting in violence on the steel plate welds 85 A decreased compared welds 65 A and 75 A.

4.2 test results tensile Strength

Testing was conducted to determine tensile mechanical properties of low carbon steel material as the material tested in this study. Tensile testing results in this study are tensile strength and elongation.Tests using a machine *Universal Testing Machine*on a scale varying load and ambient temperature. Test specimens consisted of tensile testing for quality low-carbon steel tensile strength results with the SMAW welding electrode E 6013.The data results of tensile tests ongroup*raw* *materials* and a group of welding current variation that has been obtained is then incorporated into the existing equation.

Table 1. Result Testing Low Carbon

Parameter	Spesimen			
	Raw material	Arus 65 A	Arus 75 A	Arus 85 A
τ (N/mm^2)	506.12	-	297,61	315.47
	457.14	35,71	327,38	321.42
	509.67	17.85	333.33	309.52
Rata-rata	**490.97**	**26.78**	**319.44**	**315.47**
Parameter	Spesimen			
	Raw material	Arus 65 A	Arus 75 A	Arus 85 A
Ɛ (%)	26,15 %	-	[illegible]	
	17,91 %			
	29,35 %			
Rata-rata	24,47 %			

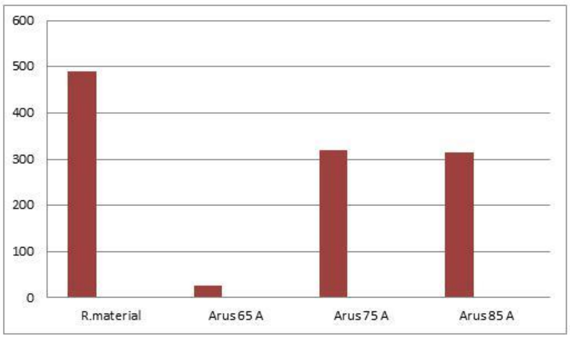

Figure 5. Tensile strength values

Tensile strength values in the group of raw materials amounted to 490.97 N / value65A group tensile strength is 26.78N/, this means decreased by 464.19 N / groups raw material. Tensile strength values group 75 A is 319.44N/, this means increased voltage Of 292.66N / groups 65 A, but decreased strength tensile than the raw material 171.31 N /. Tensile strength valuesgroup 85A was 315.47N /, this Shows a decrease of 75 group A of 3.97 N / and from the group of raw materials amounted to 175.5 N/.

5. Conclusions and Recommendations

5.1 Conclusion

From the testing that has been done didapatlah conclusion as follows:

a. Test microstructure

1. On the raw material ferrite grains tend to be more than indicate that theperlite*rawmaterials.* soft
2. While the welding specimen microstructure on current 65 A ferrite grains are less than perlite.
3. To Flow 75 A there are grains of perlite + cementite + ferrite, but at this current ferrite grain very little, while the on raw materials.
4. Flow 85 A ferrite grains tend to be more of perlite and no grain cementite, is due at the time of cooling weld results using only the cooling temperature of the room.

b. Tensile Strength Test

average value of tensile strength test results of*raw materials* and welds areas follows:

1. Group of *raw material* with tensile stress by an average of 490.97 N /
2. Groups current 65 Ampere tensile stress by an average of 26.78 N /
3. Groups current 75 Ampere tensile stress by an average of 319.44 N /
4. Groups current 85 Ampere by voltage pull an average of 315.47 N /From the results of tensile tests conducted on a group of specimens welding all specimens fractures in the welding area, so that the group of specimens welds are not strained.

5.2 Suggestion

1. You should do the heating electrode beforewelding to remove hydrogen contained in flux, since hydrogen will cause a weld-quality welds become ugly.
2. If using electrodes E 6013 should use the current 70-95 A, because if you use less than 70 A current lasnya unfavorable results.
3. Further studies should be done after the completion of welding workpieces should do *heat treatment* to minimize the occurrence of cracking and reduce residual stresses that occur.

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