Effect of Welding Current Variation on Hardness in S45c Steel with Galvanized Steel A653

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A B S T R A C T

The development of modern manufacturing industry technology era is increasingly rapid. In the era of modern technology when welding is a manufacturing process that is widely used with various types of materials that are increasingly diverse. This study aims to determine the hardness value and strength level of welding on different materials. The materials used in this study are S45C steel and galvanized steel A653 using Gas Metal Arc Welding technology, with different welding current variations, the current variations used are 75A, 100A, 125A, and 150A. From the results of compressive tests that have been carried out, the highest strength value of the 125A current variation with an average value of 12.42 kg/mm^2, the second highest value with a variation of 100A current with an average value of 10.80 kg/mm^2, the third rank with a variation of 75A current with an average value of 8.83 kg/mm^2, while at the lowest value with a variation of 150A current with an average strength value of 7.26 kg/mm2 and the results of hardness tests that have been carried out on welding metal, steel and galvanized steel there is a significant difference. This is due to the influence of current variations carried out during the welding process, the greater the current strength given does not make the welding have strength, the greater the current given will cause damage to the material. Although the hardness test results show fairly high hardness value. However, the area around the welding has a fairly low level of hardness

I. INTRODUCTION

Construction is a description of the development process both static and dynamic. Good construction consists of good and appropriate connection components according to technical instructions. This connection component has various types, but has the same function, namely to connect one structure with another. One type of connection that has developed to date is welding, which is a method of joining metals that utilizes the penetration of heat generated.

Welding is one of the connection processes between two or more metal parts using heat energy (Wiryosumarto, 2000). In general, welding is a technique of joining metals together by heating or lubricating where the two ends of the metal to be joined are made luer or melted with a flame arc or heat obtained from an electric arc so that the two ends or metal fields become a strong mass and are not easily separated.

Choosing the right welding current parameters affects the strength and changes in the mechanical properties of a metal. This will affect the quality of the weld joint results. The greater the strength of the electric current given, the greater the heat (heat input) generated to melt the base metal and metal connector (electrode), and vice versa the smaller the current strength given, the smaller the heat generated to melt the parent metal and metal connector or electrode (Joko Santoso, 2006).

The combination of different types of materials is still quite rare in the world of the manufacturing industry today, this is my attraction to conduct further research on welding different metals entitled "The effect of welding current variations on hardness values in S45C steel with Galvanized steel A653".

II. METHODS

In this study the authors used the type of experimental research which aims to determine the effect of variations in welding current on the hardness and strength of joints in S45C steel with Galvanized steel A653. The research was conducted in several places. Welding specimens were made at the Energy Conversion Laboratory, Department of Mechanical Engineering, Faculty of Engineering, Trunojoyo University, Madura. Compressive testing and hardness testing were carried out at the Mechanical Engineering Education Laboratory, Malang State. The type of connection used is disjoint with the position of galvanized material parallel to S45C steel. Disjoint was chosen because there is a difference in melting point between the materials used. The welding process that has been carried out produces specimens that will be used in compressive and hardness testing After the welding process is completed with the specified current variation, the specimen is then prepared by forming it by cutting it using a grinding wheel with a width of 20mm and an overall length of 80mm. Later this specimen will be used as a testing material.

In this research, the independent variable is the variation of welding current, namely 75 A, 100 A, 125 A, and 150 A. The dependent variables observed in this study were the compressive test value and the hardness test value. Control variables on this research is S45C steel, Galvanis steel A653, las GMAW. The tools used during the research process are as follows:

- Rilon 200 G CO_2 MIG welding machine
- Stainless steel wire 0,5
- License plate scissors

- Clamp
- Welding gloves
- Welding glasses
- Wire brush

Research procedure work as research flowchart show on figure 1.

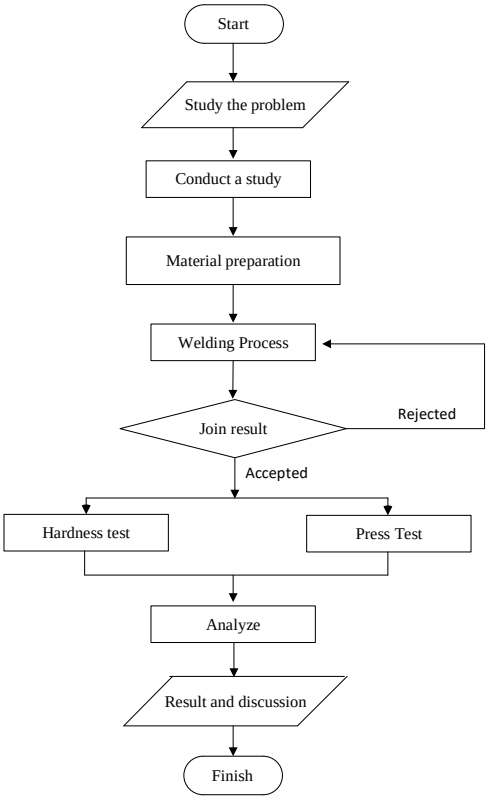

Fig.1. Research Flowchart

III. RESULTS AND DISCUSSION

A. Hardness Test

In general, hardness tests are used to express resistance to deformation and are a measure of a metal's resistance to plastic deformation or permanent deformation (Dieter, 1987). Hardness is often defined as a measure of ease and a specific quantity that says something about the strength and heat treatment of a metal. The hardness test is a test of the hardness value of a material where we can know the description of the mechanical properties of a material or material, even though the measurement is only carried out at one point or a certain area. only. To find out the hardness of steel there is a way of testing steel hardness, namely by using a hardness testing machine (Vickers).

B. Press Test

Compressive testing is an attempt to determine the capacity of a material to withstand the maximum load when the maximum compressive strength limit is reached, the specimen experiences cracking which aims to determine the characteristics and mechanical properties of a material. This compressive test has good performance and quality to determine the strength of objects. In general, this press test is used on metals that are brittle, because this press test tool has a clearly visible breaking point when testing the object.

C. Press Test

TABLE I. PRESS TEST RESULT

Current (Ampere)	Repetition (kg/mm2)			Average
	1	*2*	*3*	
75A	8.80	8.60	9.10	8.83
100A	10.80	11.00	10.60	10.80
125A	12.40	12.20	12.80	12.46
150A	7.40	7.60	6.80	7.26

Testing was carried out three times, the value obtained from the compressive test results was not so great because during the testing process the specimen was not broken but curved in the HAZ area. This is also caused by the use of thin material with a thickness of 0.6mm. The 150A current variation has the lowest strength value because the effect of welding heat makes the HAZ area quite extensive.

D. One Way ANOVA analysis

The basis for one-way anova decision making is the comparison of p count with a significant $\alpha = 5\%$ (0.05). With the following conditions:

- If the sig. value of the calculated result is> 0.05, then Ho is accepted, Ha is rejected
- If the sig. value of the calculated result <0.05 then Ho is rejected, Ha is accepted.

The result of ANOVA shown on table 2

TABLE II. ANOVA TEST RESULT OF COMPRESSIVE TEST FORCE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	46.369	3	15.456	167.096	<0.001
Within Groups	0.74	8	0.093		
Total	47.109	11			

Based on significant values of the calculated results in table 2 are < 0.001 Based on the Sig. results in table 2 then the decision can be drawn that Ho is rejected and Ha is accepted, or in other words, there is a significant influence significant influence between variations in welding current on the compressive test.

E. Hardness Test

The hardness test was carried out at three points with the Vickers hardness test. Areas included in this hardness test include Welding Metal area, galvanized HAZ area, and steel HAZ area. The hardness result shown on Table 3.

TABLE III. HARDNESS TEST RESULT ON WELDING AREA

No	Regional	Current			
		75A	*100A*	*125A*	*150A*
1	Weld Metal	205.2	231.9	243.6	272.6
2		207.4	229.8	231.9	281.2
3		212.5	231.2	226.4	262.1

No	Regional	Current			
		75A	*100A*	*125A*	*150A*
4	Galvanized	121.1	128.3	127.9	119.5
5		117.4	137.5	141.1	127.8
6		131.2	118.7	119.5	121.1
7	Steel	159.2	179.8	181.2	177.9
8		141.7	186.4	192.3	184.1
9		132.3	168.6	183.2	172.5

This research shows quite good results, seen in the results of compressive tests that show the results and significant differences from the influence of variations in voltage current used in the specimen welding process. The results of this strength test can prove that the MIG welding current voltage has a very significant effect, the difference in value to the difference in bending in the specimen is also different. This is due to the influence of the current used in welding making the HAZ (Heat Area Zone) area on the specimen also different. Thus, the spread of heat around the welding area is also different.

Apart from the strength value of the connection, the results of this study can be seen from the hardness value which strengthens the hypothesis used. It appears that the results of the hardness test carried out by the method of taking hardness test data show that the VHN (Vicker Hardness Number) value also has a difference. Continuing from the previous hardness test, the HAZ area in the specimen has a different level of hardness, and this significant difference is due to the influence of current variations carried out during the welding process.

The greater the current strength given does not make the welding have strength, the greater the current given will cause damage to the material. Although the hardness test results show a fairly high hardness value. However, the area around the welding has a fairly low level of hardness. This also causes the compressive test to determine the strength value of the welding also proved not to have a good enough strength value. Referring to the issues raised in this study which aims to determine the strength of the connection and hardness of the welding results with different current variations shows a pretty good difference. With this research can prove that the effect of strong welding current has a difference both in terms of strength and in terms of material hardness structure.

IV. CONCLUSIONS

Based results of the compressive tests that have been carried out, it can be seen that the highest strength of the welded joints is found in the 125A current variation with an average value of 12.42 kg/ mm^2, the second highest value with a current variation of 100A with an average value of 10.80 kg/mm2, ranking third with a current variation of 75A with an average value of 8.83 kg/mm^2, while at the lowest value with a current variation of 150A with an average strength value of 7.26 kg/ mm^2.

From the results of hardness tests that have been carried out on welding metal, steel and galvanized steel there are significant differences. This is due to the influence of current variations carried out during the welding process, the greater the current strength given does not make the welding have strength, the greater the current given will cause damage to the material. Although the hardness test results show a fairly high hardness value. However, the area around the welding has a fairly low level of hardness.

To be able to produce better research on welding, the authors provide suggestions for further research. The following suggestions need to be considered: Testing to determine the strength value should use a tensile test in order to get the highest welding value besides knowing the type of fracture and the area of the fracture. In cutting specimens, it is better to use a sitting grinder to get precise cut results. The use of filler is in accordance with the material used, and adjusts the filler size to the thickness of the material.

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