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Experimental Effect of Angle Variation and Speed Welding Filler Using Vertical Adaptive Sliding System In SMAW Welding

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ABSTRACT

In each welding technology each has advantages in accordance with the placement of its implementation. One of the welding technologies is the SMAW (shield metal arc welding) has an advantage over the current and the welding angle can be varied, and the penetration width of the electrode fuses can be adjusted. This research uses SMAW welding machine with sliding adaptive vertical system design for proper welding speed. this study varied the angle and speed of welding to determine the welding results of SMAW welding machine with sliding adaptive vertical system. In this study the characteristics of welding results based on visual observation and mechanical properties using tensile test. The parameters are varied angles 600, 650, and 750 and welding speed controlled arduino uno with a stepper round of 1.5 Rpm, 1.75 Rpm, and 2 Rpm. The material used is a low carbon steel, using a hometown V with 60 hill angle. In this study the highest metal tackling region is the tensile strength of 571.35 MPa and the lowest value is 475.52 MPa with the number of specimens varied by 9 specimens. Micro welding structure is determined by many factors including heat input, current strength, welding speed, and cooling rate. In this study the HAZ area has a larger grain structure than base metal and weld metal.

KEY WORDS: *Welding, SMAW, tensil strength. HAZ*

NOMENCLATURE

σ	Tensile strength (MPa)
F	Maximum load at test time (N)
Ao	Initial cross-sectional area (mm2)
ε	Strain (%)
l	Extension (mm)
lo	Start length (mm)
E	Modulus of elasticity (N/mm2)
σ	Tensile strength (N/mm2)

1.0 INTRODUCTION

Technology development in advanced industrial construction can not be separated from the welding process because the welding process has an important role in the field of metal engineering and repairs (Wiryosumarto, H ., Okumura, T . 2000) the construction of metalwork in the present involves a lot of welding, especially in the field of design, since the welded joint is one of the making of connections which technically requires high skill for the welder in order to get the connection with good quality. The use of metal in every area of construction and manufacturing industry has increased in accordance with technological developments in meeting human needs. Various kinds of processes for metal processing done among others is the connection process. The metal joining process is welding, wherein the weld utilizes heat energy to melt or ignite metals to obtain a permanent connection (fixed connection).

Various welding techniques are applied intensively to various manufacturing industries, such as: automotive, shipping, aircraft, railways, bridge construction, pressure vessels, etc. According to (Santoso, T.B. 2105) for industries related to metal or steel, especially in the field of development by using welding required

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various studies to obtain a quality welding connection, because it concerns the safety and lifespan. to obtain good quality welded connections many variables to be considered, such as the selection of heat energy used (welding machine), welding speed, welding angle, appropriate added materials, the behavior (treatment) given to the welding process and skill (skills) of the operators that implement them. so that the welding can be obtained optimum quality.

Metal connection by welding process will be important both technologically and commercially, since welding is a permanent or permanent connection (Baroto, B.T. 2015). Each welding technology each has its own advantages according to the placement of its implementation. One of the welding technologies is SMAW (Shield Metal Arc Welding) has its own advantages, such as the current as the heat source used can be varied, easy to use in various welding positions, and penetration and electrode fusing width can be adjusted.

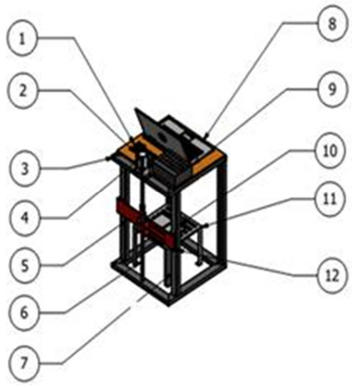
In the SMAW welding process the variables that determine the quality of the welding results are in the appropriate material selection added, the selection of current used on the machine must be adjusted to allow the melting of the added material (electrode) to be perfect, as well as the exact welding speed and position and angle of the welding itself. The selection of these variables depends on the skill of the operators who implement them, so the determination of these variables often changes especially in terms of flow selection and welding speed.

To obtain a good quality of welder SMAW results required a welder engineering, but the speed and position of welding and electrode angles of each welder vary, hence to obtain the constancy of the speed and position of welding difficulties. Unlike the welding process is done using automatic SMAW welding machine to replace the welder so that the parameters of speed and position of welding can be obtained constantly (fixed).

In addition to the welding speed and current parameters contained in the automatic SMAW welding machine affecting the quality of the weld is the angle used. Therefore it is necessary to study and study the correlation between angle position of welding and welding speed to get a good quality of welding SMAW.

2.0 METHODOLOGY

This research is to know the result of welding connection from automatic SMAW welding machine by varying angle, and welding speed to micro structure in weld metal and heat affected area of Heat Affected Zone (HAZ) and mechanical properties using tensile test.



No	Quantity	Component
1	1	Arduino
2	1	Driver
3	1	Frame
4	1	Servo Motor
5	1	Tool Holder
6	1	Screw
7	2	Sliding Guide
8	1	Laptop
9	1	Adapter
10	1	Specimen
11	1	Specimen position
12	4	Sliding Bearing

Figure 1: The concept of sliding adaptive vertical engine

2.1 Tools and materials

The equipment used in this research is SMAW welding machine with Adaptive Vertical Sliding System, Frais, Grinder-Polisher Mechine, Computer Servo Control Material Testing Mechine, Liquid Penetrant and Optical Microscope. The material used is low carbon steel.

2.2 Manufacture of test objects

Prepare test specimens according to planned dimensions beginning with literature study and preparation of the SMAW testing machine in accordance with standard operating procedure (SOP).

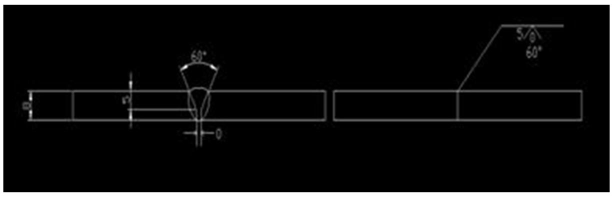


Figure 2 : Specimen welding test

2.3 Data retrieval

In this research the method of data retrieval is done experimentally. That is varying the angle and speed of welding (welding speed) by using electrode E6013. Electrodes with code E6013 for each letter and each number have their respective meanings:

E = Electrodes for electric arc welding.
60 = Declare the voltage value Minimum drag welding results multiplied by 1000 Psi.
1 = Declare the position of welding, 1 means can be used for welding all positions.
3 = Electrodes with penetration and material from powder film Rutil potassium with AC or DC current.

Table 1: Variation angle to welding speed

Spesimen	*Angle*	*Welding*

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		Speed
	(θ)°	rpm
X_1	60	1,5
X_2	60	1,75
X_3	60	2
Y_1	65	1,5
Y_2	65	1,75
Y_3	65	2
Z_1	75	1,5
Z_2	75	1,75
Z_3	75	2

3.0RESULT AND DISCUSSION

3.1 Visual Test Results

Visual Test is a test performed on the weld results by looking at and observing the weld results are visible. In this study the test is done visually to know the width of the welding results.

Tabel 2: Visual test result

Specimen	Ampere (A)	Angle (θ)°	Motor rotation	Width of welding			
			(rpm)	1	2	3	Average (mm)
X_1	70	60	1,5	12	13	13	12,7
X_2	75	60	1,75	10	10	10	10,0
X_3	80	60	2	8	9	11	9,3
Y_1	70	65	1,5	14	14	14	14,0
Y_2	75	65	1,75	13	13	14	13,3
Y_3	80	65	2	11	11	12	11,3
Z_1	70	75	1,5	19	19	19	19,0
Z_2	75	75	1,75	16	16	16	16,0
Z_3	80	75	2	15	17	15	15,7
Width of the average weld result							13,4

3.2 Results of Liquid Penetrant Testing

After doing nine experiments, then the selection is done using liquid penetrant to find the best from the variation of the angle that has been done.

(a) (b)

Figure 3 : (a) Welded specimens and (b) Result of liquid penetrant testing

The results of liquid penetrant testing are sorted for further testing. Tensile testing will be performed on the three best specimens of the nine variations that have been done.

3.3 Tensile Testing

Tensile testing in this study using JIS Z 2201 No. 7. Tensile test using Computer Servo Control Material Testing Mechine conducted in Quality Control Laboratory, Kampar Polytechnic, Bangkinang-Kampar.

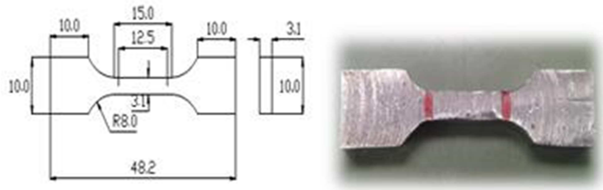

Figure 4 : Specimen of tensile test (JIS Z 2201 No. 7)

The strength of a material can be seen from the value of its tensile strength, the higher its tensile strength the material is stronger. After performing the test and knowing the tensile test results, it can be determined the tensile strength (σ), Renggangan (ε) and elastic modulus (E) with the formula:

- Tensile strength

$$\sigma = \frac{F}{A_o} \quad (1)$$

Information :
Σ = The deep pull strength (Mpa)
F = Maximum load at test in time (N)
A_o = Initial cross-sectional area (mm^2)

- Strain

$$\varepsilon = \frac{(l-l_o)}{l_o} x\ \% \quad (2)$$

Information :
E = Deep strain (%)
l = Deep extension (mm)
lo = Initial long in (mm)

- Modulus of elasticity (E)

$$E = \frac{\sigma}{\varepsilon} \quad (3)$$

Information :
E = Modulus of elasticity in (N/mm^2)
σ = The deep pull strength (N/mm^2)
ε = Deep strain (%)

Table 3: Tensile test results

Specimen	Max. Force (F)	Yield Strength (E)	Tensil Strength (σ)	Elongation (ε)

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	(N)	*(N/mm²)*	*(MPa)*	*(%)*
X_1	3.126,20	348,48	571,35	2,041
Y_2	6.815,20	281,03	475,52	5,600
Z_3	7.636,00	318,82	520,22	5,208
Mild Steel	7.251,90	288,52	489,33	11,373

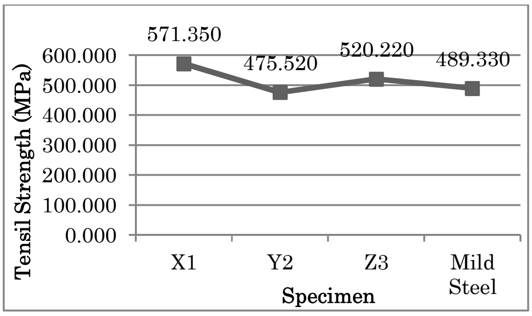

Figure 5: Tensile test result chart (Tensile Strength)

From figure 6 can be seen the highest tensile strength value occurs on x1 specimens of 571.350 Mpa. And the lowest value occurred on the specimen y2 of 475,520 Mpa.

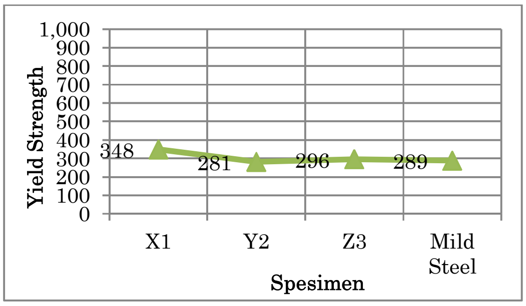

Figure 6: Tensile test result chart (Yield Strength)

From figure 7 we can see the highest yield strength value occurring on x1 specimen of 348N / mm2. And the lowest value occurred on the specimen y2 of 281N / mm2.

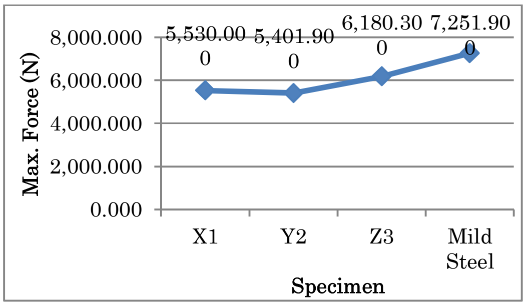

Figure 7: Tensile test result chart (Max. Force)

From figure 8 it can be seen that the highest yield max-force value occurs on a mild steel specimen of 7,251,900 N. And the lowest value occurs on specimen y2 of 5,401,900N.

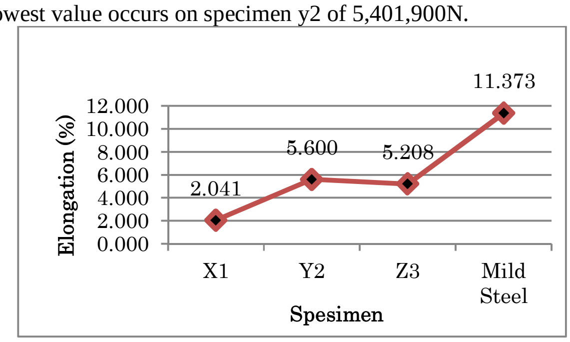

Figure 8: Tensile test result chart (Elongation)

From figure 9 can be seen the highest yield strength value occurs on mild steel specimens of 11.373%. And the lowest value occurred in X1 specimens by 2.041%.

3.4 Metalografy Testing

In this study, microstructure observation aims to find out the shape, arrangement, and grain size in the weld and HAZ areas. Micro welding structure is determined by many factors including heat input, current strength, welding speed, and cooling rate.

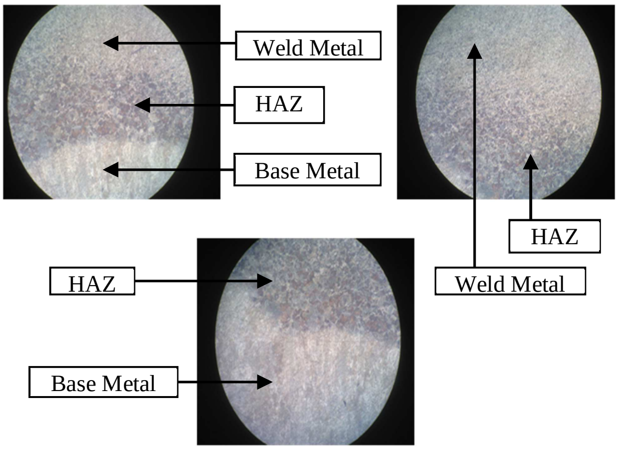

Figure 10: Composition grain structure of the welding

From Figure 10 it is known that the composition of grain structure dimensions, in which the HAZ region has a larger grain structure than the base metal and weld metal. The grain structure on the weld metal is larger than the base metal. Based on the results of the analysis, it can be concluded that the welded materials added stronger than the base metal material.

4.0 CONCLUSION

The experimental study was conducted by varying angle and

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welding speed against mild steel material with a total of 9 specimens. These 9 specimens were then subjected to visual testing, liquid penetrant testing and tensile testing. The results of the test can be summarized as follows:

- By visual testing of 9 specimens the average welding width is 13.4 mm, the highest welding width of 19.0 mm occurs on the Z1 specimen and the lowest welding width of 9.3 mm occurs on the X3 specimen.
- Liquid penetrant testing was performed on 9 specimens, of which 3 had the least welding defects, X3, Y2 and Z1.
- The highest tensile strength occurs on x1 specimens of 571,35MPa, the lowest value occurring on y2 specimens of 475.52MPa and mild steel without welding specimens having a tensile strength of 489.33. In this case the tensile strength after welding is better than the strength of the material without welding.

REFERENCE

1. Baroto, B.T. 2015. *Optimasi Pengelasan Smaw E6013 Pada Sambungan I Baja Carbon Rendah Terhadap Kekuatan Tekan Dengan Metode Taguchi*14 (2): 2-7
2. Santoso,T.B., Solichin, dan Hutomo, T.B., *Pengaruh Kuat Arus Listrik Pengelasan Terhadap Kekuatan Tarik dan Struktur Mikro Las Smaw Dengan Elektroda E7016*1(1): 2-6
3. JIS HANDBOOK Z2201, 1980, *Methode Of Testing Materials Standar JIS*
4. Wiryosumarto, H. 2000. *Teknologi Pengelasan Logam, Edisi 8 Erlangga, Jakarta*
5. Setiawan, A. Dan Asra, Y.W.2006. *Analisa Ketangguhan dan Struktur Mikro pada Daerah Las dan HAZ Hasil Pengelasan Sumerged Arc Welding pada Baja SM 490 Jurnal Teknik Mesin Vol. 8, No. 2,pp: 57 – 63*

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