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Effect of Metal Inert Gas Welding Process Parameters to Tensile Strength on ST 37 Steel Sheet Joint

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Abstract. Welding technology still used in manufacturing industries, however welding process affected to decrease a joint performance. This study discussed about the welding parameters of Metal Inert Gas (MIG) which affected to tensile strength of weld joint. Welding process parameters used in this study such as welding current, welding time, and welding speed. The level of welding current was 80 A, 90 A, and 100A. Wire Speed was leveled with 55 inch/min, 60 inch/min, and 65 inch/min. The levels were 5 mm/sec, 6 mm/sec, and 7 mm/sec as welding speed. Tensile testing was used to measure strength of weld joint joined by each welding parameters combination. Welding current 100 A, wire speed 60 inch/min, welding speed 5 mm/sec could join ST 37 steel sheet up to 51.41 kg/mm2 of tensile strength. Welding current affected to increase tensile strength when values of welding current were increased between 80 A and 100 A.…

1. Introduction

Welding technology is still important for joining process in manufacturing industries, however welding process affected decreasing of metals weld joint performance[1]. Welding parameter is importance to get weld joint quality[2]. Researchers have developed welding technology and optimizing process to improve the weld joint from steel sheet. Steel sheet has mechanical properties better than other metals[3]. Some researchers have also studied such as micro Resistance Spot Welding used to join aluminum AA 1100 with stainless steel sheet SS301[4].

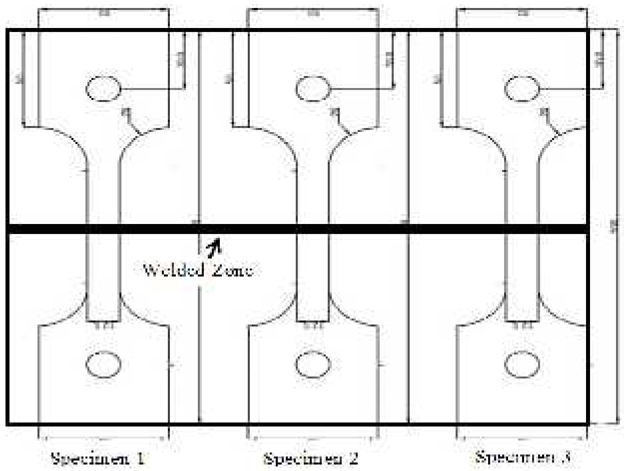
Some welding technologies were studied by researchers to get good quality and effectiveness in joining process. Yong Zhang et al compared a laser and a TIG welding for laminated electrical steel. They state that TIG welding had higher strength than laser welding however welding process effect to stress, magnetization properties, and eddy current losses from welded lamination [5]. Mohammad Mahdi Tafarroj and Farhad Kolahan developed a simulation model to comparative method analysis in welding GTA, ANN and regression method used to analyze hear source. They resulted that regression model near agreement with the result of experiment[6]. Combination from a laser welding with TIG was studied by M. Ragavendranet al. They joined a 316LN Steel with a hybrid TIG-Laser welding and then optimize the process parameter with Respon Surface Method[7]. Performance of weld joint can be known from mechanical properties such as tensile strength, hardness, toughness.

Some studies about mechanical properties of weld joint have been studied by some researchers. Mechanical properties of Aluminum to Magnesium joint with Sn-coated steel as interlayer welded by Resistance spot welding were studied by M. Sun et al[8]. Piotr Lacki DSc and Judyta Niemiro MSc studied the strength on beam made of titanium grade 2 and 5 welded by Resistance spot welding[9]. Xiao-yong WANG et al also studied mechanical properties of magnesium to steel used Metal Inert Gas (MIG) welding[10]. Mechanical and microstructure properties of a new alloy join of Al-Zn-Mg-Cu welded by TIG and Laser were compared by Liang Zhang et al [5]. I. Tomashchuk et al studied the evolution of mechanical and microstructure properties from the titanium alloy and stainless steel with copper as interlayer welded by an electron beam welding[11]. M.H. Razmpoosh et al also studied the mechanical properties and microstructural evolution from TWIP steel joint welded by Resistance spot welding[12].

Mechanical properties of weld joint had been studied by researchers however tensile strength from steel joint used Metal Inert Gas (MIG) welding was not enough many. This study explained the effect from welding current, wire speed, and welding speed of MIG welding which was welded by arm robotic welding.

2. Material and method

ST 37 steel sheet was used in this study. Steel sheet was cut with 10 cm of Length, 21 cm of Wide, 0.03 cm of Thin, this stage method was same with Hui Li et al which was cut the plat [13]. Two pieces of specimen were join with welding process used the MIG welding[14]. Each welding parameter combination was used to weld the two steel sheets which were cut[15]. A joint from piece was cut as tensile test specimen, the shape and dimension according to ASTM E8/E8M dimension system standard[16]. A schematic of specimen was shown in figure 1.



. Figure 1. tensile test specimen

A MIG welding machine was used for studying the effect of welding parameter to tensile strength of weld joint. A Miller Dynasty 350 AC-DC inverter TIG welder is used by Qihao-Chen el al although this study used Millermatic 180 auto-set[17]. The specification of welding machine the type Millermatic 180 auto-set, this machine can produce welding current form 30 to 180, type and diameter of wire are solid with 0.24 - 0.35 inch or between 0.6 and 0.9 mm, when the type of wire is flux cored from 0.34 to 0.45 and between 0.8 and 1.2 mm, this machine also can move welding wire with 60 - 540 lpm or 1.5 up to 13.7 m/min, specification of this machine is similar with machine used by Yu li-Gu et al[18]. Figure of the welding machine was shown in figure 2.

Figure 2. Welding Machine

This machine has a welding current and wire speed switching, 80, 90, 100 Ampere were adjusted as welding current, and wire speed was leveled 55, 60, 65 inch/min. Welding speed was also used as welding parameter in this study.

Welding speed is affected by moving form a torch or an electrode of welding so this study used arm robotic to get a constant moving. Robotic welding used in this study is usually used for practicum device of automation laboratory at Mechanical Engineering Department of Universitas Trunojoyo Madura. The figure of the robot was presented in Figure 3.

Figure 3. Arm Robotic Welding used for welding process

SCORBOT-ER 9Pro is an arm robotic produced by INTELITEK, USA company. This robot can move to vertical, horizontal, and rotation ward. The Scorbot-Er 9 Pro also has a microcontroller ARM7TDMI Processor; 32-bit RISC Architecture with 256 Kbytes of Internal High-speed Flash. The actuator of this arm robotic has 5 cylinders that each cylinder can moved or rotate, this arm robotic has motor for moving the 24VDC servo motor. Robot can move 5, 6, 7 mm/second. Level of each welding parameter process was presented by figure Table 1.

Table 1. welding parameter process

No	Welding Process	Unit	Level 1	Level 2	Level 3
1	Welding Current	Ampere	80	90	100
2	Wire Speed	inchi/min	55	60	65
3	Welding Speed	mm/sec	5	6	7

Weld join which had been welded with each welding parameter was cut according to shape and dimension of ASTM E8 / E8M standard as tensile test specimen. A Specimen tensile tested was shown in figure 4.

Figure 4. Tensile Tested Specimen

Tensile tests results have difference values for each welding process parameter combination. Result and discussion of tensile test result would be discussed as tensile strength which represents the welding performance.

3. Result and analysis

Tensile test results were calculated to get tensile strength. Recapitulation of tensile strength was shown in the table 2.

Table 2. Tensile Strength for a weld joint of each combination welding parameter

No	Welding Parameter			Repetition (kg/mm2)		
	Welding Current	Wire Speed	Welding Speed	1	2	3
1	80	55	5	43.70	39.77	45.44
2	80	60	6	41.06	42.94	43.04
3	80	65	7	40.33	42.83	44.73
4	90	55	6	39.82	40.00	45.88
5	90	60	7	40.97	49.81	42.59
6	90	65	5	41.73	51.00	44.38
7	100	55	7	48.80	38.86	39.57
8	100	60	5	49.53	51.41	42.00
9	100	65	6	49.62	40.68	41.01

The highest tensile strength from 80 A of welding current was 45.44 kg/mm2 that could get when welding current 80 A, and wire speed 55 inch/min, welding speed 5 mm/sec, and repetition 3. The highest of welding current 90 A was 51.00 kg/mm2. The highest tensile strength of welding current 90 A could be achieved when wire speed 65 inch/min, welding speed 5, at repetition 2. Tensile strength 51.41 kg/mm2 could be achieved when welding current 100 A, wire speed 60 inch/min, welding speed 5 mm/sec, and repetition at 2. Tensile strength average from each parameter combination was represented by Figure 5.

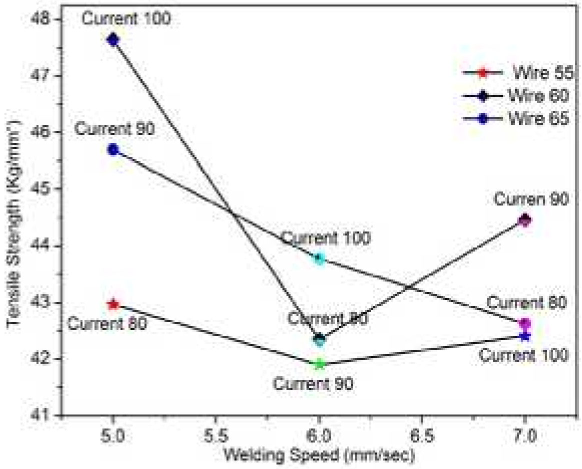


Figure 5. Tensile Strength Average of Welded Joint

Figure 5 represented that welding speed 5 mm/sec when wire speed 55, 60, 65 and Welding Current 80, 90, and 100 A was higher than 6 and 7 mm/sec. Increasing welding speed affected the Tensile strength tend to decrease, it was different with welding current, increasing welding current effected tensile strength average also increase. Welding current 100 A, wire speed 55 inch/min, and welding speed 5 mm/sec could produce average of tensile strength highest than other.

4. Conclusion

The highest tensile strength could been achieved whit welding current 100 A, 60 inch/min for wife speed and 5 mm/sec of welding speed when 2 repetition, however the lowest value was also achieved 38.86 kg/mm2 with welding current 100 A, 55 inch/min of wire speed, and welding speed at 7 mm/sec when reputation 2.

Tensile Strength Average could be represented as performance of weld joint, welding parameters welding current shows that increasing welding current affected to tensile strength average increasing. Welding time increases from 5 to 7 so the tensile strength average tends to decrease.

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