
The Influence of Welding Ampere Range to ST-40 Shear Strength with Butt Joint

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Abstract

This experiment was conducted on the influence of welding process with ampere range variation and weld joints toward ST-40 shear strength. Furthermore, welded specimen is tested with tensile test. Method of this experiment is testing shear strength by using tensile testing machine where each five-specimens were previously welded by ampere range of 80 A, 90 A, and 100 A. Shear results show the highest shear strength is on 128.4916 N/mm² with 80-ampere range on specimen no. 5, while on 90-ampere range variation the highest shear strength is on 124.7528 N/mm², the specimen no. 5. Meanwhile, on 100-ampere range variation, the highest shear strength is on 120.1484 N/mm², the specimen no. 4. The higher ampere (I) used, the higher heat (Q) resulted. When the heat increases, the welding electrode is perfectly fused. It makes good welding result achieved. The more strength on welding result, the higher shear strength (τ) achieved. On the other hand, the higher ampere range on welding process results higher shear strength.

Keywords: *welding; ampere range; shear strength*

1. INTRODUCTION

Many factors can influence welding result [1], namely method and procedure of welding, equipment, materials needed, electrode, ampere range applied, seam distance, and seam angle applied [2][3]. Ampere range and seam angle are considered to be experimented. Variation on ampere range and seam type for welding are determined to achieve stronger and better welding result [4].

Testing on welding area is divided into two, destructive and non-destructive tests [5]. Destructive test is conducting by giving tensile test to welded material. Tensile test is method aimed to examine material strength by giving linear load. By pulling a material, its reaction to pulling force would be recognized. Moreover, it would show its elongation during it is pulled. Experimental instrument for this tensile test should have strong grip and highly stiff.

2. METHOD

Shear strength was conducted by ampere range variation of 80A, 90A, and 100A. Materials used for this experiment is ST40 steel plate with ASTM E8 cutting standard [6]. It is 200 mm length, 50 mm wide, and 5 mm thickness. Welding process conducted on ampere range variation [7][8] of 80 A, 90 A and 100 A. Shear strength conducted is using tensile test. Collected data is analyzed to achieve deduction of the test result.

2.1 Research variable

Variable is research object or the focus of research. Variable in this experiment is quantitative variable that has correlation to seam type and the use of ampere range of 80A, 90 A and 100A. Variables of experiment are dependent and independent variables.

2.1.1 Independent variable

Independent variable is the influencing variable and it can be varied as the researcher needs [9]. In this experiment, independent variable used based on machine capacity is:

1. Ampere range 1 : five specimens are welded in 80 Ampere
2. Ampere range 2 : five specimens are welded in 90 Ampere
3. Ampere range 3 : five specimens are welded in 100 Ampere

2.1.2 Dependent variable

Dependent variable is variable with no change in this experiment, it is fixed [9]. Dependent variable in this study is shear strength on welding joint.

2.2 Time and place of experiment

This experiment was conducted in Metal Testing Laboratory Mechanical Engineering University of Muhammadiyah Malang.

2.3 Material and equipment

2.3.1 Materials

1. ST40 steel
2. RB26 electrode with 2,6 mm diameter

Tensile test specimen

Shape and size of object for tensile test based on ASTM E8/E8M standard

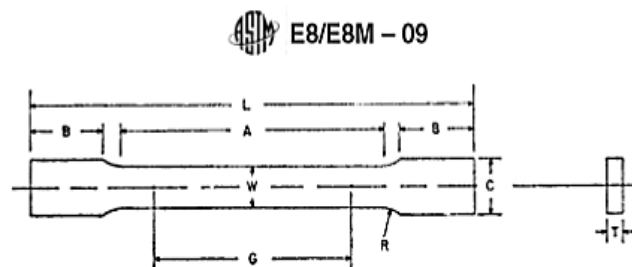


Figure 1. ASTM E8 Specimen standard

Table 2. Dimension of tensile test work-piece

	Dimensions		
	Standard Specimens		Subsize Specimen
	Plate-Type, 40 mm [1.500 in.] Wide	Sheet-Type, 12.5 mm [0.500 in.] Wide	6 mm [0.250 in.] Wide
	mm [in.]	mm [in.]	mm [in.]
G—Gage length (Note 1 and Note 2)	200.0 ± 0.2 [8.00 ± 0.01]	50.0 ± 0.1 [2.000 ± 0.005]	25.0 ± 0.1 [1.000 ± 0.003]
W—Width (Note 3 and Note 4)	40.0 ± 2.0 [1.500 ± 0.125, -0.250]	12.5 ± 0.2 [0.500 ± 0.010]	6.0 ± 0.1 [0.250 ± 0.005]
T—Thickness (Note 5)		thickness of material	
R—Radius of fillet, min (Note 6)	25 [1]	12.5 [0.500]	6 [0.250]
L—Overall length, min (Note 2, Note 7, and Note 8)	450 [18]	200 [8]	100 [4]
A—Length of reduced section, min	225 [9]	57 [2.25]	32 [1.25]
B—Length of grip section, min (Note 9)	75 [3]	50 [2]	30 [1.25]
C—Width of grip section, approximate (Note 4 and Note 9)	50 [2]	20 [0.750]	10 [0.375]

2.3.2 Equipment

1. Electrical welding
2. Hand grinding
3. Hacksaw
4. Welding mask
5. Hammer slag
6. Steel brush
7. Handled hand files
8. Vice tool
9. Jangka sorong
10. Penggaris
11. Peralatan uji tarik

3. RESULT AND DISCUSSION

Research data

Experiment materials : ST40 steel plate
 Length : 200 mm
 Width : 50 mm
 Thickness : 5 mm
 Ampere range variation : 80A, 90A, 100A



Figure 2. Work-piece

Result of shear strength

Experiment conducted in Metal Testing Laboratory Mechanical Engineering University of Muhammadiyah Malang results loading graphs of shear strength. Each specimen of shear strength conducted to obtain shear strength value.

Table 2. Fracture results of shear test

No	Ampere range	No. Specimen	Fracture	Explanation
1	80A	1		Parent metal fracture
		2		Parent metal fracture
		3		Parent metal fracture
		4		Parent metal fracture
		5		Parent metal fracture
2	90A	1		Parent metal fracture
		2		Parent metal fracture
		3		Parent metal fracture
		4		Parent metal fracture
		5		Parent metal fracture
3	100A	1		Parent metal fracture
		2		Parent metal fracture
		3		Parent metal fracture
		4		Parent metal fracture
		5		Parent metal fracture

80 Ampere

Specimen 1

- Plate thickness (t) : 5 mm
- Plate width (L) : 50 mm
- Welding width (l) : 5 mm
- Welding length (p) : 50 mm
- Maximum loading (F) : 25.3282 KN/mm²
- Fracture load : 17.6550 KN/mm²

a. Tensile stress

$$\begin{aligned}
 A &= \text{thickness} \times \text{width} \\
 &= 5 \times 50 \\
 &= 250 \text{ mm}^2
 \end{aligned}$$

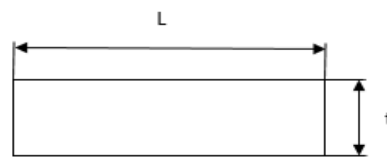


Figure 3. Plate cross-section

$$\begin{aligned}
 \sigma_t &= \frac{F}{A} \\
 \sigma_t &= \frac{25.3282}{250} \\
 &= 0.1013128 \text{ KN/mm}^2 \\
 &= 101.3128 \text{ N/mm}^2
 \end{aligned}$$

b. Tensile stress and electrode shear stress

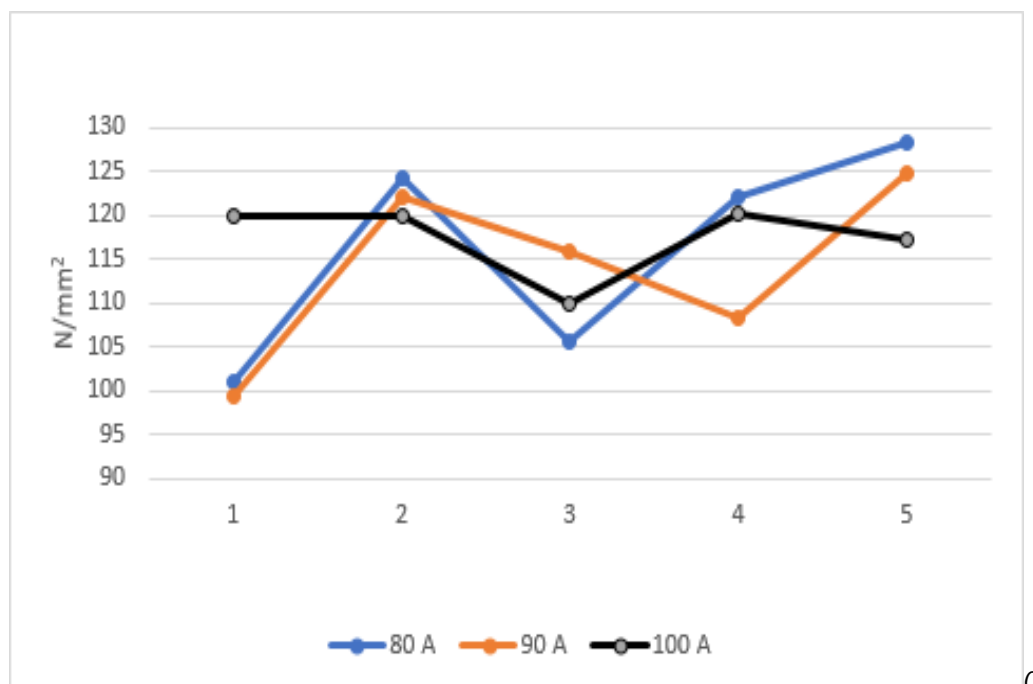
- Electrode tensile stress
 $\sigma_{\text{electrode}} = 60000 \text{ Psi} = 413 \text{ N/mm}^2$
- Electrode shear stress
 $T_s = 0.6 \times \text{electrode tensile stress}$
 $= 0.6 \times 413 = 247.8 \text{ N/mm}^2$

Table 3. Result of shear strain

No	Ampere range	Fracture load (KN)	F max (kN)	$\tau_s = F/A$ (KN/mm)
1	80	17.655	25.3282	101.3128
2	80	18.3602	31.0532	124.2128
3	80	16.1528	26.3969	105.5876
4	80	18.997	30.5134	122.0536
5	80	19.6604	32.1129	128.4916
Average				116.33168
1	90	17.6916	24.8725	99.49
2	90	19.1639	30.5356	122.1424
3	90	19.6585	28.9852	115.9408
4	90	18.2575	27.0535	108.214
5	90	18.8675	31.1882	124.7528
Average				114.108

Table 3. Result of shear strain (continued)

No	Ampere range	Fracture load (KN)	F max (kN)	$\tau_s = F/A$ (KN/mm)
1	100	18.0751	30.0005	120.002
2	100	19.3039	30.0131	120.052
3	100	19.3125	27.4896	109.9584
4	100	19.048	30.0371	120.1484
5	100	17.2327	29.2879	117.1516
Average				117.46248



Graphic 1. Data of shear strength calculation

Analysis on shear strength results

- Result of shear stress shows that the highest value of 128.4916 N/mm² is on 80 ampere in specimen 5. Meanwhile, in 90 ampere range, the highest shear strength is 124.7528 N/mm² in specimen 5. Moreover, 100 ampere range variation shows the highest value 120.1484 N/mm² in specimen 4. The higher ampere range applied, the heat is higher. Pressure on electrode formed the welding joint. Yet, it is not always that increasing current will result better joint. There is a condition where the higher current will damage the welding result. It occurs because the melting point of each materials is different. If heat resulted exceeded the melting point of material, it would result the defecting welding joint.
- Fracture occurs in shear strength with tensile test is not damaging the welding joint but in parent metal. Shear strength with maximum load on 80-ampere variation has tensile strength of 128.4916 N/mm². It is defected on parent metal. Meanwhile, maximum tensile strength on ST40 steel before treatment is 461.6 N/mm². With maximum tensile strength of 128.4916 N/mm², the specimen should not be fractured. As the tension is not exceeding maximum tensile stress of parent metal, the fracture occurs because of

tension concentration on the tested specimen. Therefore, tension concentration triggered excess breakage and fracture on low load.

- Meanwhile, observed from tensile strength of welding electrode, its maximum value is 413 N/mm² and shear strength is 247.8 N/mm². The weld is not defected. It can be explained that maximum load on welding area is designed on the joint to have maximum shear strength of 128,4916 N/mm². This value is still smaller than shear strength of electrode material.
- As it is recognized, welded metal can be categorized into three; they are base metal (initial tested object). It is parent metal where heat and temperature of welding is not causing change on structure of metal characteristic. The second is Heat affected zone, it is basic metal adjacent to parent metal, which during welding process encounters heat thermal cycle and fast cooling that this area is being the most critical of welding joint. The third is Weld metal. It is the part of metal that in welding process, it melts and freezes up. Welding composition consists of parent metal and other materials from electrode. Fracture in welding area is the best fracture during shear strength because this area has high repetition heating.

4. CONCLUSION

From the result of testing, it can be concluded that ampere range variation has no correlation to shear strength of butt joint welding. What had been occurred in this test is pure tensile strength. Welding process is too long that when the specimen has tensile test, the parent metal is breakage or fractured.

Specimen is improved by adding radius and length of area. The seam is also improved to develop further research.

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