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Effect of Using Ceramic Backing Media on SMAW Welding on Value Reduction of Area on ASTM A36 Steel

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Abstract

ASTM A36 steel is a low-carbon steel often used as a general manufacturing material. Tensile testing is one of the most important and dominant mechanical properties in construction design and manufacturing. Each material or material has different properties (hardness, flexibility, etc.). A test is needed to determine a material's mechanical properties. One of the most frequently performed tests is the tensile test. This test has a function to determine the level of strength of a material and to identify the characteristics of the material. Therefore, this study aims to determine the effect of using ceramic backing media in SMAW welding on the value of area reduction in ASTM A36 steel. Based on the test results, the value of the area reduction varies in each specimen. The specimens that did not use ceramic backing had an average area reduction value of 53.51%, while the variation using ceramic backing had an average area reduction value of 61.17%.

Keywords: ASTM A36 steel; SMAW welding; ceramic backing; reduction of area

1. Introduction

ASTM A36 steel is a type of low-carbon steel often used as a general manufacturing material. Low-carbon steels have a carbon content of less than 0.30% and are often referred to as mild or tool steels. A common and widely used type of steel is cold-rolled steel, which has a carbon content of 0.08% to 0.30% and is commonly used in vehicle bodies. Several factors of low-carbon steel affect its weldability, which can add or reduce carbon (C) levels by increasing the element manganese (Mn). This will decrease the tensile strength's transition temperature as the Mn/C ratio increases. However, low-carbon steel is less susceptible to weld cracking compared with other types of carbon steel and carbon alloy steel. Cracks in this steel can occur very easily in welding processes that use thick materials or contain relatively high levels of free sulfur.

Welding joins two or more metals to produce a good construction value in a molten or melted state. Steel has several types of specifications, and not all have properties that can be welded. In welding, there is a method wherein connecting metals, and each connection has advantages and disadvantages.

In the current development of technology, welding technology is almost used in various industries such as transportation and so on. One type of welding that exists in the world is SMAW welding.

SMAW welding is a process of joining or joining metals using heat energy released from the tip of the electrode. Heat energy is generated because there is a jump of cathode and anode ions at the tip of the electrode. In the welding process, many things must be considered, from the welding method to the knowledge in applying it. Therefore, it requires professional skills and is not careless

in doing so.

In the industrial sector, such as shipping, in carrying out the welding process, the welder usually has to weld back and forth on both sides of the ship. This will lead to wasted time and costs that will be used often. Therefore, ceramic backing media is used in order to speed up the time and processing of welding. The function of the ceramic backing media is to print the welds.

Tensile testing is one of the most important and dominant mechanical properties in construction design and manufacturing. Each material or material has different properties (hardness, flexibility, etc.). A test is needed to determine a material's mechanical properties. One of the most frequently performed tests is the tensile test. This test has a function to determine the level of strength of a material and to identify the characteristics of the material. Therefore, this research was made to determine the effect value of using ceramic backing media and not using ceramic backing on ASTM A36 steel with the SMAW process.

2. Materials and Methods

In this study, data collection techniques were obtained from journals, books, the internet, articles, and direct studies using experimental methods to provide factual and accountable data.

2.1 Backing Ceramic

Ceramic backing is a material or tool (non-consumable) that is placed on the back side of the material connection to be welded. However, it can also be placed on both sides (in the case of electro-slag and electro-gas processes). Its purpose is to support the melted metal during the welding process. By retaining the weld pool, the backing resists leakage or loss of molten metal and facilitates full penetration.

2.2 ASTM A36 Steel

ASTM A36 carbon structural plate is the American standard specified in ASTM A36. This standard applies to riveted, bolted and welded structures for bridges and construction and carbon steel sections, plates and bars for general-purpose structural steel. ASTM A36 is the most commonly used hot-rolled carbon construction steel. It has a minimum yield strength of 36k psi and is easy to weld.

Table 1. Steel Equivalent Standards

ASTM/ASME	HE	DIN/BS	GB
A36	HE G3101 SS330	EN10025 S185	GB700 Q235

Table 2. ASTM A36 Steel Chemical Composition

ELEMENT	CONTENT
Sulfur (S)	0,050 %
Silicon (Si)	0,280 % (max 0,4 %)
Phosphorous (P)	0,040 %
Manganese (Mn)	1,03 %
Iron (Fe)	98 %
Copper	0.20%
Carbon (C)	0.25 - 0.290 % (Depending on thickness)

2.3 SMAW Welding Machine

Shield Metal Arc Welding (SMAW) is one of the metal welding processes using an electric current arc with a very high temperature. SMAW welding usually uses a welding wire that is intended as a filler metal, and there is a coating that will protect the welding metal liquid. In the end, in the welding process, SMAW does not require pressure from inert gas that serves to reduce or eliminate the influence of the ambient air, such as oxygen or compounds of particles in the air that can cause corrosion (rust) or can also cause bubbles in the welding results the said.

SMAW welding occurs when there is a potential difference (voltage) and current resistance on the surface of the base metal or weld metal at the tip of the electrode, and a short circuit current on the surface of the base metal occurs up to 3000 degrees Celsius. The welding process joins the

electrode to the base metal, and a layer of the electrode (flux) rises to the surface of the molten metal and then hardens. This protects the weld metal from the environment and ensures high-quality, defect-free welds.

2.4 Tensile Test Equipment

Tensile strength is one of the most important and dominant mechanical properties in design and manufacturing processes. Each material or material has different properties (hardness, flexibility, etc.). Determination of the mechanical properties of a material requires testing, and one of the most frequently performed tests is the tensile test. This test has a function to determine the strength level of the material and identify the properties of the material.

Figure 1. Tensile Test Equipment

Tensile testing is carried out to complete basic design information on the strength of a material/material and as a supporting reference for material/material specifications.

3. Results

In this explanation, the researcher will explain the information generated from the tensile testing process carried out on ASTM A36 steel material. In this test, the material is grouped into two groups. The first is the result of the tensile test using ceramic backing media; the second is the result without ceramic backing media.

3.1 Tensile Test

The tensile test is performed on a material by applying a tensile load. By giving the tensile load, we can evaluate the material's behaviour so that the material's mechanical properties will be obtained. The purpose of tensile testing is to complete the basic design information on a material's strength and as a supporting reference for material specifications.

This study only focused on knowing the Reduction of Area. Reduction of the area is the reduction in cross-section when experiencing a fracture. This is useful in determining how much a material subjected to a uniaxial load will experience a reduction in the cross-sectional area. To find out the cross-sectional reduction in the tensile test specimens, the formula used follows:

$$LENGTH = \frac{A_0 - A_1}{A_1} \quad (1)$$

3.1.1 Reduction Value of Tensile Test Area

After the tensile test was carried out, the ROA or area value reduction was obtained. This is done to determine how much the material subjected to tensile testing experiences a reduction in cross-sectional area. The following is the reduction of area value data which can be seen in Table 3.

Table 3. Value Reduction Of Area on the tensile test

No	Variation	Code Material	A_0 (mm)	A_1 (mm)	LONG %
1	Non Backing Ceramics	A1	201.7	91	54.88
		A2	202.46	91.98	54.57
		A3	191.36	93.6	51.09
		Average	198.50	92.19	53.51
2	With Backing Ceramics	B1	209.80	82.46	60.70
		B2	212.60	84.32	60.34
		B3	213.22	79.98	62.49
		Average	211.87	82.25	61.17

Based on Table 3, the results of the reduction of area values have varying values for each specimen. The specimens that did not use ceramic backing had an average area reduction value of 53.51%, while the variation using ceramic backing had an average area reduction value of 61.17%.

Based on the reduction of the area value table above, an increase in value will be described in a graph seen in Figure 2.

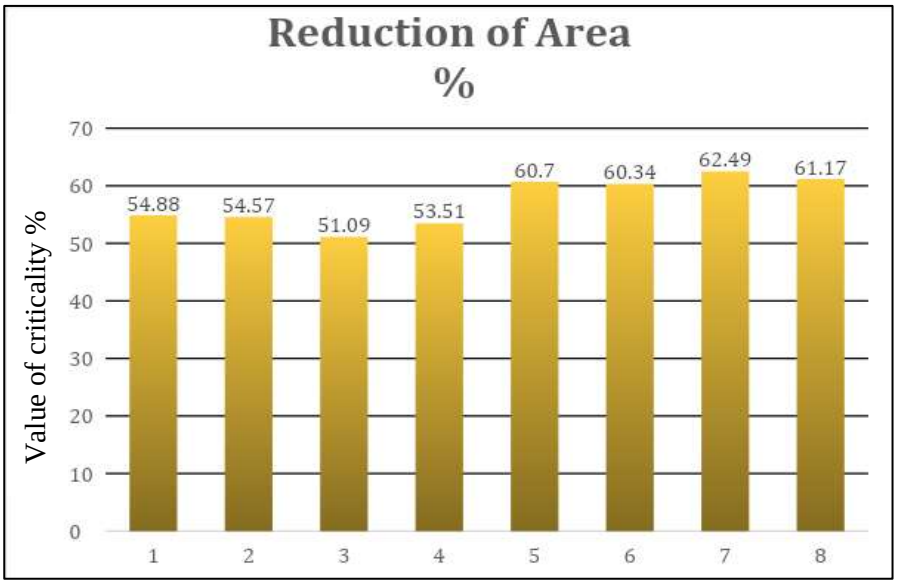

Figure 2. Graph of Reduction of Area Value

Based on the reduction of area graph in Figure 2, it can be seen that the highest reduction of area value is found in the welding specimen using a ceramic backing with a value of 61.17%, and the lowest reduction area value is found in welding without using a ceramic backing with a value of 53.51%.

4. Discussion

This study divided the materials into two groups: those using ceramic backing media and those that did not. The purpose of the tensile test is to evaluate the material's mechanical properties. The purpose of the tensile test is to complete the basic design information on the strength of a material/material and as a supporting reference for material/material specifications.

This research is focused on the Reduction of Area (ROA), which is the reduction of the cross-section when the material fractures. This is useful in determining how much a material subjected to a uniaxial load will experience a reduction in the cross-sectional area.

From the data provided, it can be seen that specimens using ceramic backings have an average ROA value of 61.17%. In comparison, specimens not using ceramic backings have an average ROA value of 53.51%. This shows that ceramic backing can increase the ROA value of the specimen.

Based on the reduction of area graph presented it can be seen that the highest reduction of area value is found in the welding specimen using a ceramic backing with a value of 61.17%, and the

lowest reduction area value is found in welding without using a ceramic backing with a value of 53.51%.

From these results, ceramic backing can increase the value of reducing the area in ASTM A36 steel material. However, to better understand these results, it is necessary to carry out further analysis of how the ceramic backing affects the material's mechanical properties.

5. Conclusions

Based on the test results and analysis data that have been carried out, the results show that the Reduction of Area (ROA) value varies for each ASTM A36 steel specimen that is tensile tested using SMAW welding. In specimens that do not use ceramic backing, the average value of ROA is 53.51%. Whereas in specimens using ceramic backing, the average value of ROA is 61.17%.

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