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Comparative Study of SMAW Welding Results Using RD460 Ø3.2 Electrodes and LB52 Ø3.2 Electrodes with Bending Test on Low Carbon Steel with 10mm Thickness

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INTISARI

Penelitian ini bertujuan untuk mengkaji perbedaan kekuatan hasil pengelasan menggunakan elektroda SMAW RD460 Ø3,2 dan LB52 Ø3,2 pada baja karbon rendah melalui uji lengkung (bending test). Pengujian dilakukan pada sambungan kampuh V-groove dengan ketebalan baja 10 mm dan prosedur pengelasan diatur sesuai standar Welding Procedure Specification (WPS). Proses pengelasan menggunakan variasi arus 80-120 A dengan posisi 1G (downhand) dan tarikan las zigzag serta spiral. Hasil pengujian menunjukkan bahwa pengelasan dengan elektroda LB52 Ø3,2 menghasilkan kekuatan tekan lebih tinggi (3-3,5 ton) dibandingkan dengan RD460 Ø3,2 (2-2,5 ton), meskipun terdapat cacat las seperti retak, undercut, dan slag inclusion. Dari hasil ini, dapat disimpulkan bahwa elektroda LB52 Ø3,2 memiliki ketangguhan lebih baik dibandingkan RD460 Ø3,2 dalam pengelasan baja karbon rendah. Penelitian ini diharapkan dapat memberikan wawasan baru dalam pengelasan dan sebagai acuan praktis untuk industri.dan sebagai template di mana Anda dapat mengetik teks Anda sendiri.

Kata Kunci: Pengelasan, SMAW, Elektroda RD460, LB52, Baja Karbon Rendah, Uji Lengkung, Kekuatan, Cacat Pengelasan

ABSTRACT

This study aims to examine the differences in the welding strength using SMAW electrodes RD460 Ø3.2 and LB52 Ø3.2 on low carbon steel through bending tests. The testing was conducted on V-groove joint welds with a 10 mm thickness, and the welding *procedure was regulated according to the Welding Procedure Specification (WPS). The welding process used a current range of 80-120 A, with a 1G (downhand) position and zigzag and spiral weld patterns. The results showed that welding with the LB52 Ø3.2 electrode produced higher tensile strength (3-3.5 tons) compared to RD460 Ø3.2 (2-2.5 tons), despite defects such as cracks, undercuts, and slag inclusions. Based on these results, it can be concluded that the LB52 Ø3.2 electrode has better toughness than RD460 Ø3.2 in low carbon steel welding. This study is expected to provide new insights into welding and serve as a practical reference for the industry.*

Keywords: Welding, SMAW, RD460 Electrode, LB52, Low Carbon Steel, Bending Test, Toughness, Welding Defects

1. INTRODUCTION

Welding is a technology widely used in various industries, such as steel building construction, machinery, shipbuilding, bridges, and pipelines, as it can produce lighter and simpler structures. In addition, welding is also used for repairs, such as filling holes in castings, thickening worn parts, or creating hard layers on tools. Although not the primary objective of construction, welding serves as an essential means of achieving better results by considering the strength and compatibility of joints. Many variables, such as welding position, electrode movement technique, and welding procedures, influence the quality of the outcome. Therefore, this study aims to examine the differences in the strength of welds using the SMAW method with RD460 Ø3.2 electrodes and LB52 Ø3.2 electrodes on low-carbon steel through bending tests.

This research focuses on welding low-carbon steel with a thickness of 10 mm using V-groove joints and air cooling as the cooling medium. The electrodes used adhere to the standards of the Welding Procedure Specification (WPS). The aim of this study is to determine the differences in welding strength between RD460 Ø3.2 electrodes and LB52 Ø3.2 electrodes. This research is expected to provide benefits in the form of knowledge about the comparison of welding quality, offer new insights in the field of welding, and serve as a practical reference for the industrial sector.

The origins of welding to join metals date back to the Bronze Age, and it is difficult to trace when the term "welding" first came into use. Around 3000 BC, the Mesopotamians had already implemented soft soldering processes—deer antlers were soldered as decorative reliefs. Two centuries later, silver soldering was used in the production of flower vases in Entemene (Didit Yantony, S.S.T., M.Pd Simon Perekke, ST., 2023). Welding is the most widely used method because it is a cost-effective way to join metal parts to assemble a structure.

Most people agree that welding is utilized in the construction of bridges, nuclear power plants, spacecraft, and submarines. However, some may not realize that many critical components, such as high-pressure piping systems, transducers, vacuum tubes, and many others, require welding in their assembly. Without welding, it would be challenging to build jet aircraft, ships, and many devices that support our modern lifestyle. In its broadest context, welding is a process in which metals of the same type or class are joined, causing them to fuse (and become one) through the formation of primary (and sometimes secondary) chemical bonds by the combination of heat and pressure (Suherman, ST., MT, Prof. Dr. Ilmi Abdullah, 2020).

Currently, there are many welding processes published by the American Welding Society (AWS), which provide official abbreviations for each process. For example, RSW stands for resistance spot welding. Shielded Metal Arc Welding (SMAW) is an arc welding process that fuses metal by heating it with an electric arc created between a covered metal electrode and the metal being joined. The primary difference between various welding processes lies in the method by which heat is generated to melt the metal (Hamdani et al., 2023).

The most commonly used welding methods are fusion welding with arcs (electric arc welding) and gas. There are four types of electric arc welding: shielded electrode arc welding, gas arc welding (TIG, MIG, CO2 arc welding), gasless arc welding, and submerged arc welding. One type of shielded electrode arc welding is SMAW (Shielded Metal Arc Welding). The strength of the weld is influenced by arc voltage, current, welding speed, penetration depth, and electrical polarity. Determining the appropriate current for arc welding significantly affects the efficiency of the work and welding materials. This study uses construction steel plates of the JIS G3350 type, treated with SMAW welding at current variations of 80A, 90A, and 100A, using

RD-460 or E6013 electrodes with a diameter of 2.6 mm. For the SMAW weld joint, a V-groove joint is used, and the specimens will undergo impact testing and microstructure photography (Ilahi et al., 2023).

The Shielded Metal Arc Welding (SMAW) method is a type of welding that uses an electric arc to melt the welding electrode. The SMAW welding process is suitable for most ferrous and non-ferrous metals with varying thicknesses. This method can be used in all positions and is relatively economical. However, the quality of the weld primarily depends on the skill of the welder (Suherman, ST., MT, Prof. Dr. Ilmi Abdullah, 2020).

SMAW welding machines can be categorized into three types based on their current: direct current (DC) welding machines, alternating current (AC) welding machines, and dual-current welding machines, which can be used for welding with both direct current (DC) and alternating current (AC). DC welding machines can be operated in two ways: straight polarity and reverse polarity. DC welding with straight polarity (DC-) is used when the base material has a high melting point and large capacity. In this setup, the electrode holder is connected to the negative terminal, and the base metal is connected to the positive terminal. Conversely, DC welding with reverse polarity (DC+) is used when the base material has a low melting point and small capacity. In this case, the electrode holder is connected to the positive terminal, and the base metal is connected to the negative terminal. Adjusting the welding current strength will significantly affect the welding results (Pratama et al., 2020).

The bending test is a type of testing used to visually determine the quality of a material. In the bending test, a load is applied to the material, causing tensile, compressive, and shear stresses to form simultaneously. The maximum load will occur on the surface of the specimen, while it will be zero at the neutral axis. In general, the testing is conducted using two types of loading: 3-point bending and 4-point bending. The following are the test schematics for both, along with their shear force and bending moment diagrams. When a material is subjected to a load in the elastic region, stress will develop on the cross-section as a result of the bending moment (Gundara & Biggunah, 2021).

The bending test is conducted to assess the material's strength under loading or to determine the material's ability to withstand tensile stress without causing deformation. The bending process of steel plates using the bending line heating treatment results in an average increase in material hardness by 14.31%, while specimens that are only bent show an average increase in hardness by 9.04% compared to the hardness of the normal plate condition (Oktarina & Indriyanti, 2020).

2. RESEARCH METHODS

This research was conducted over two months using a true experimental research method to obtain valid data on the strength of SMAW weld joints on low-carbon steel. The testing was carried out on V-groove joints to compare welding strength. The research took place at the Mataram Motor workshop and the Mechanical Engineering Student Association workshop. The equipment used in this study includes a bending test press machine to test welding strength, handheld and stationary grinding machines, an SMAW AC welding machine, a slag hammer, calipers, a workbench, a steel ruler, and personal protective equipment. The materials used include low-carbon steel plates, RD460 electrodes, LB52U electrodes, LB52 electrodes, as well as cutting and smoothing grinding discs.

3. RESULTS AND DISCUSSION

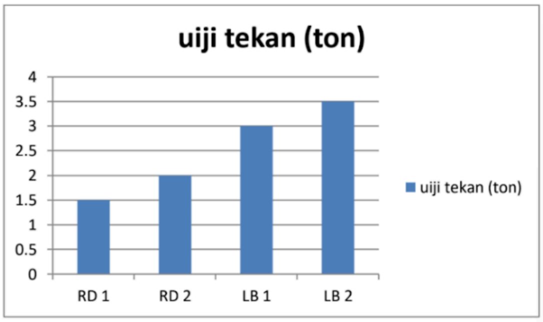
In this study, welding was performed using the 1G downhand method with zigzag and spiral weld runs on RD460 Ø3.2 and LB52 Ø3.2 electrodes with a current range of 80-120 A. Mechanical testing was carried out using a bending test in the Mataram Motor workshop with a press testing machine. The testing steps included specimen preparation, marking the support points, positioning the specimen, setting the indentor, and applying pressure until a bending angle of approximately 90˚ was achieved.

Table 1. Results of ±90˚ Bending Test

Workpiece	Weld Pull	Size	Types of Welding Defects	Results of ±90˚ Bending Test
RD 1	Spiral	200mm x 50mm x 10mm	Crack	1,5 tons
RD 2	Zigzag	200mm x 50mm x 10mm	Cold Crack/ Fracture at the Edge	2 tons
LB 1	Spiral	200mm x 50mm x 10mm	Undercut and Cluster Porosity	3 tons
LB 2	Zigzag	200mm x 50mm x 10mm	Slag Inclusion	3,5 tons

The bending test results show a variation in welding strength between RD460 and LB52 electrodes. The weld produced with RD460 Ø3.2 electrode in a spiral motion resulted in a compressive force of 1.5 tons with cracking defects, while the zigzag motion produced a compressive force of 2 tons with cold crack defects at the edges.

Figure 1. Welding Test Results Graph of Specimens



Welding using the LB52 Ø3.2 electrode in a spiral motion resulted in a compressive force of 3-3.5 tons with defects such as undercut, cluster porosity, and slag inclusion.

4. CONCLUSION

This study shows that the workpieces welded using the LB52 Ø3.2 electrode have higher compressive strength (3 tons) compared to RD460 Ø3.2 (2 tons). The LB52 electrode also exhibits better toughness in welding low-carbon steel, with fewer weld defects compared to RD460 Ø3.2, which has more cracks and defects. The authors suggest that further testing be conducted using tensile testing methods and consider variations in welding positions and methods for future research.

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