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ANALYSIS OF MECHANICAL PROPERTIES IN SMAW WELDED MATERIAL

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Abstract:

The Shielded Metal Arc Welding (SMAW) process is widely used in various industrial applications due to its simplicity, versatility, and ability to produce strong, reliable welds. However, the mechanical properties of SMAW welded materials are significantly influenced by various parameters, including welding current, electrode type, heat input, and post-weld treatment. This project investigates the mechanical properties of materials welded using the SMAW technique, focusing on tensile strength and bending strength. The analysis includes the effects of varying welding parameters on the performance of the welded joints. Specimens were tested under controlled conditions to determine their tensile test, bending test, and radiographic test. Radiographic testing provided critical insights into the hidden defects within the welds, emphasizing the importance of both mechanical testing and non-destructive testing for ensuring the overall quality of SMAW welded joints. The findings of this project provide valuable insights into the relationship between welding parameters and mechanical performance, offering recommendations for improving the quality and durability of SMAW welded joints.

Keywords — SMAW Welding, Mild steel (IS2062 E250 BR), E7019 Electrodes, Tensile testing, Bend testing, Radiographic testing, Enhanced weld strength, Cost effectiveness, Improved durability.

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I. INTRODUCTION

Shielded Metal Arc Welding (SMAW), commonly known as stick welding, is one of the most widely used welding techniques in various industries due to its versatility, simplicity, and effectiveness in creating strong, durable joints. This process involves the use of a consumable electrode coated with flux, which generates a shielding gas to protect the molten weld pool from atmospheric contamination. As a result, SMAW is particularly suitable for welding carbon steels, stainless steels, and other materials in both workshop and field settings. The mechanical properties of materials welded using SMAW play a significant role in determining the quality, strength, and reliability of the welded structure. These properties such as tensile strength, hardness, impact resistance, and ductility are influenced by several factors, including the type of material being welded, the welding parameters (e.g., current, voltage, and travel speed), and the post-weld treatment processes. In welding applications, the assessment of mechanical properties is essential to ensure that the welded joints can withstand the operational loads and environmental conditions they will face in service. Welds often exhibit a heterogeneous structure, with variations in mechanical properties between the base metal, heat-affected zone (HAZ), and weld metal. Understanding the distribution and behaviour of these properties is critical for predicting the performance and durability of welded components.

This study focuses on the analysis of mechanical properties in SMAW welded materials, with an emphasis on evaluating the effects of welding parameters and material selection on the mechanical performance of the welds. By exploring the relationship between welding conditions and the resulting mechanical characteristics, this analysis aims to provide valuable insights for optimizing the SMAW process and improving the reliability and longevity of welded structures in various industrial applications. Tensile strength is a key factor in determining the quality and reliability of a welded joint. It defines the maximum force a material can withstand before failing under stress. In welding, it is critical because the welded joint must endure the forces applied during the operation of the component without breaking or deforming. Welds with insufficient tensile strength are prone to failure when exposed to high mechanical loads, while high-tensile-strength welds are better able to resist these forces and maintain their structural integrity. Furthermore, welds with high tensile strength also improve the safety and durability of the final product. These welds can withstand harsher environmental conditions, such as extreme temperatures or corrosive atmospheres, ensuring the long-term reliability of the welded component. Whether exposed to thermal expansion, corrosion, or repeated loading cycles, high-tensile-strength welds are better suited to endure these challenges, extending the lifetime of the structure.

II. METHODOLOGY

The methodology of Shielded Metal Arc Welding (SMAW) involves using a consumable electrode coated in flux to create an electric arc between the electrode and the workpiece as shown in figure 2.1. This arc generates heat, melting both the electrode and the workpiece material, which then fuse together to form a strong weld. The flux coating on the electrode produces a shielding gas that protects the molten weld pool from contamination by atmospheric gases such as oxygen and nitrogen. The process is typically performed manually, with the welder guiding the electrode along the joint, and it is suitable for various materials and positions. SMAW is commonly used in construction, repairs, and manufacturing due to its versatility and portability.

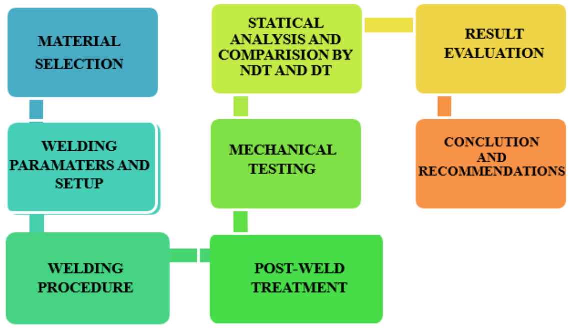

Figure 2.1 Methodology of SMAW Welding

III. EXPERIMENTAL SETUP

The study of SMAW (Shielded Metal Arc Welding) welded materials with increased tensile strength electrodes aims to address the growing demand for stronger and more durable welded joints in industries that require high-performance materials as shown in figure 3.1. In traditional SMAW welding, the tensile strength of the weld is often limited by the properties of the electrode and the base material. By modifying the composition of the welding electrode, this study seeks to enhance the mechanical properties of the welded joint, particularly focusing on increasing tensile strength. Various electrode formulations, including different alloying elements, such as chromium, nickel, and manganese, can significantly influence the final weld's properties. The research investigates how these additives can improve the weld's resistance to stress, fatigue, and cracking, thereby providing a stronger bond that can withstand more demanding applications.

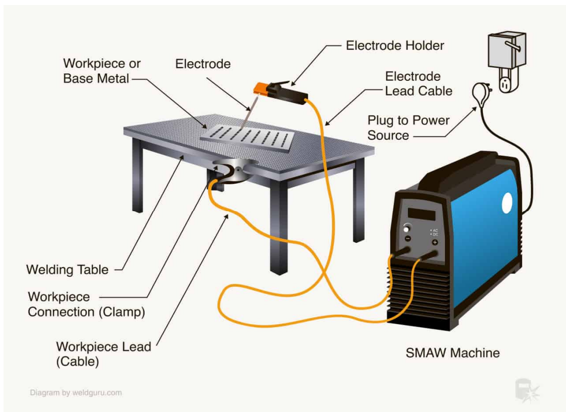

Figure 3.1 Experimental Setup

The study involves a detailed analysis of the effects of different electrode coatings, core materials, and their interaction with various base metals like mild steel, stainless steel, and alloy steels. This research has the potential to contribute to a range of industries, including aerospace, automotive, construction, and oil and gas, where structural integrity is crucial, and welded joints must endure high-stress conditions. Through this study, the objective is to create electrodes that offer improved welding efficiency, longer-lasting joints, and the ability to meet stringent industry standards.

IV. CONCLUSIONS

The analysis of mechanical properties in SMAW welded materials provides valuable insights into the performance and integrity of welded joints. The study emphasizes the significant impact that various factors, such as welding parameters, electrode type, and base material composition, have on the mechanical properties of the weld. By adjusting these factors, it is possible to enhance properties like tensile strength, bend strength, radiographic test and ductility, ensuring the welded joints meet the required standards for strength and durability. And all those tests are tabulated as results. Additionally, the research highlights the importance of proper welding techniques and the role of post-weld heat treatment in improving the mechanical properties of the weld. Post-weld treatments, such as stress-relieving and annealing, help reduce residual stresses and prevent potential defects that could compromise the joint's performance under load. These processes contribute to a more reliable and long-lasting welded structure, especially in critical applications such as construction, aerospace, and automotive industries. Ultimately, understanding the mechanical properties of SMAW welded materials is essential for optimizing welding processes and ensuring the quality of the final product. The study underscores the need for continuous improvement in welding practices, as well as further research to develop advanced techniques and materials that can withstand increasingly demanding conditions. By focusing on these areas, the welding industry can continue to meet evolving performance standards and ensure the safety and reliability of welded structures in various fields.

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