International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

EVALUATION OF WELDED JOINT (SMAW) AFTER POST WELD HEAT TREATMENT (PWHT)

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ABSTRACT

Joining of two materials having similar physical, chemical, and thermal properties and to make the joint tough and stiff, special attention and investigation are required. In this research, the welding joint between two mild steel (MS) of IS 2062 grade E, was accomplished by using shielded metal arc welding (SMAW). To investigate the effect of electrode in the welding joint, MS electrode was exercised. For post-weld heat treatment (PWHT), temperature of 700 °C were investigated over the welded specimen. To explore the optimum welding process and PWHT process for this joint, both tensile and bending tests were carried out. Destructive tests have suggested that PWHT at 700 °C is better for the SMAW process with MS electrode. As the smallest hardness values were observed in the heat-affected zone (HAZ) which makes the sample susceptible to failure. The hardness values have decreased after PWHT which justified the achievement of higher ductility after heat treatment.

I. INTRODUCTION

WELDING

Welding is a fabrication process that joins materials, usually metals, by using high heat to melt and cool the parts together to create a fusion. The welded pieces unite into one entity. Welding differs from low-temperature techniques such as brazing and soldering, which do not melt the base material instead they deposit other material as joining material. In addition to melting the base metal, filler metal is usually added to the joint to form a pool of molten material (weld puddle). As it cools, the weld configuration (butt, full penetration, fillet, etc.) is stronger than the base metal. Pressure can also be used in combination with heat or alone to create welds. Welding also requires some form of protective shielding to protect the filler metal or molten metal from contamination and oxidation. Welding can use a variety of energy sources including gas flames (chemical), arcs (electrical), lasers, electron beams, friction, and ultrasound. Welding is often an industrial process, but it can be performed in a variety of environments, including outdoors, **u**nderwater, and in space. Welding is a dangerous activity and requires precautions to avoid burns, electric shock, visual impairment, inhalation of toxic gases and fumes, and exposure to intense UV radiation.

II. LITERATURE SURVEY

Sanjeev Gupta 2016 [1] Performed the experiment to optimize the condition for performing the welding on Utra-90 specimen in which he varies the current and voltage while keeping the gas flowrate constant and observed that welding joint not made property below 50A and 200A since then burning of specimen stated.

Ravinder & S.K. Jaral 12 [2] studied the parametric optimization of Arc welding on stainless steel1202] and mild steel by using Taguchi method and found the control factor which had varying effect on the tensile strength, are voltage having the highest effect and also found the optimum parameter for tensile strength current 80A. Are voltage 30V.

Dr. Simha 13 [3] carried on the effect of welding process parameters on the mechanical properties of stainless steel -316 [18C-8N] welded by TIG welding. The specimen size is 40x15×15mm for experimentation observed that the welding current has a significant effect though filler rod does have some effect similar to current but compared to current it is less significant. MINI TAB software is used for the prediction of the hardness, impact strength and depth of penetrations.

Javed Kazi et al [4] represent a review on various welding techniques in international journal of modern engineering research publications in 2015. Their prime focus is on fulfilment of objectives of industrial application of welding with producing better quality product at minimum cost and increases productivity. The attempt is made to understand various welding techniques and to find the best welding technique for steel. Special focuses have been put on TIG and MIG welding. For this study they analysed strength hardness, modulus of rigidity, ductility, breaking point, % elongation etc. at constant voltage on hardness testing machine and UM.

Naitik s Patel et al [5] they carried out the features highlighting the TIG as a better prospect for welding then other processes especially for joining of two dissimilar metals with heating therapy or applying the pressure or using the filler material for increasing productivity with less time and cost constrain.

EXPERIMENTATION

Problem Statement:

The primary objective: is to investigate and understand how surface contaminants during the welding process contribute to flaws, weaknesses, and potential failures in welded joints. This research aims to identify the specific challenges posed by oil, grease, rust, and scale, and to propose effective mitigation strategies to enhance the durability and performance of welded connections.

Reduced Weld Integrity: Surface contaminants act as barriers between the welding material and base metal, compromising the fusion and integrity of the weld. This canlead to weak points and susceptibility to cracking.

Weakening Mechanical Properties: The presence of contaminants may alter the mechanical properties of the welded joint, including tensile strength, ductility, and impact resistance. Understanding these changes is crucial for ensuring the structural adequacy of welded components.

.**Corrosion Susceptibility:** Rust and scale, in particular, introduce corrosion potentialto welded joints. This corrosion can propagate within the joint, accelerating deterioration and reducing the overall lifespan of the structure.

Inconsistent Weld Quality: Contaminants can cause variations in weld quality, leading to uneven distribution of stress and strain. This inconsistency can result in premature fatigue failure and compromise the overall performance of the welded joint.

Health and Safety Concerns: Beyond structural implications, the presence of oil andgrease introduces safety hazards during the welding process, posing risks to both thewelder and the surrounding environment.

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RESULT AND DISCUSSION

LEEB HARDNESS TEST:

The Leeb hardness test is a non-destructive testing method used to determine the hardness of metals. It involves measuring the rebound velocity of a small, spherical indenter striking the surface of the material underexamination.

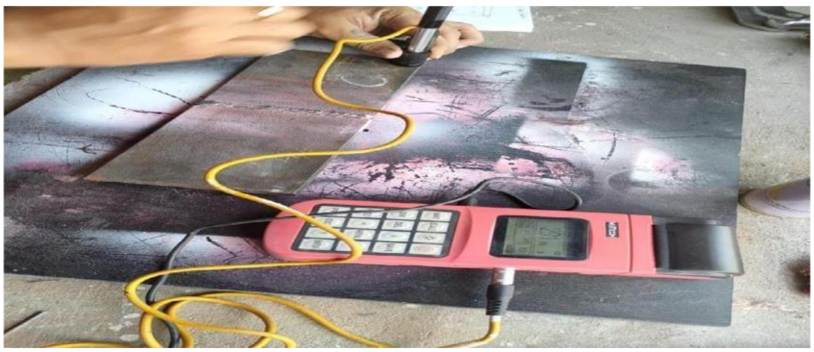
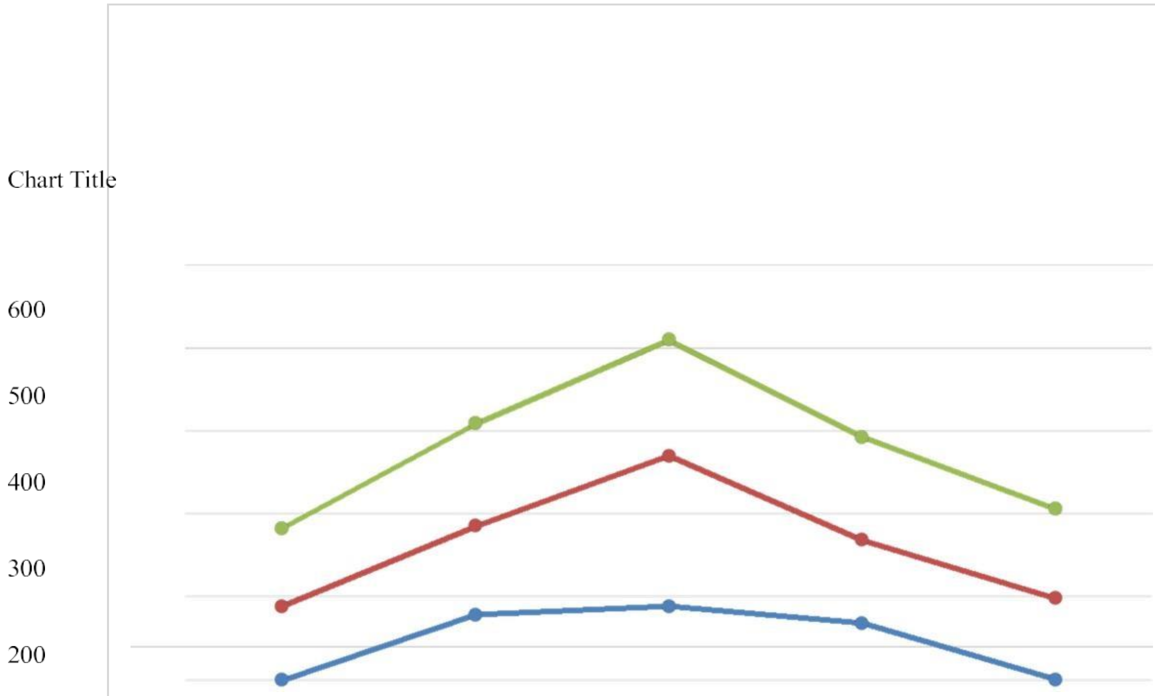


Fig 4.1: Leeb hardness test

Table 4.1. Hardness Test

S.No	Base metal	Heat Affected Zone	Or weld Zone	Heat Affected Zone	Base metal
Top	363	353	459	429	329
middle	459	382	505	432	390
Bottom	368	288	392	359	322

Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930



Graph-1: Hardness Test

Base metal

100

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Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

4.2 LPT TEST:

In Penetration test the weld material is applied with penetrant which expose the internal defects of the weld joint

Fig 4.2: Cap Side of MS plate

Cap Side Defects:

- ER: Excess reinforcement

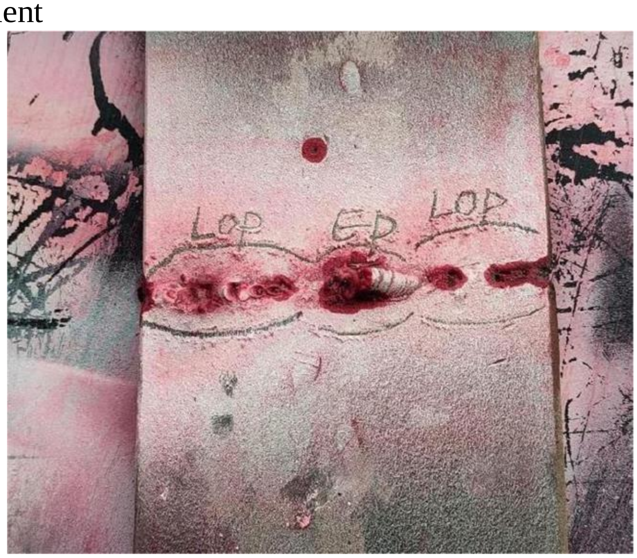

Fig 4.3: Root Side of MS Plate

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Root Side Defects:

- L.O.P - Lack of Penetration
- EP -Excess Penetration

4.3 TENSILE TEST:

Test is carried on Universal Testing Machine to find out the tensile strength, Elastic Modulus, Strain and Poison's Ratio. The following figures 4.3.1(before testing) and 4.3.2(after testing) shows the breaking point of work piece on UTM.

Fig 4.4: Before Testing on UTM

Fig 4.5: After Testing on UTM

CONCLUSION

In conclusion, the post-weld heat treatment (PWHT) process for the evaluated welded joint, fabricated using Shielded Metal Arc Welding (SMAW), has proven to be effective in enhancing the overall quality, integrity, and performance of the joint. the evaluation of the welded joint after post-weld heat treatment (PWHT) has demonstrated significant improvements in terms of reduced residual stresses, microstructural refinement, enhanced mechanical properties, and mitigation of potential failure mechanisms. The successful implementation of PWHT has resulted in a welded joint that meets the stringent requirements of quality, integrity, and performance, thereby ensuring its suitability for critical applications across various industries. Continued adherence to proper welding practices, rigorous quality control measures, and regular inspection and maintenance will be essential to sustain the integrity and longevity of the welded joint over its service life.

FUTURE SCOPE

In the realm of welded joint evaluation following post-weld heat treatment (PWHT), there exists a promising trajectory for future advancements and enhancements. Moving forward, research and development efforts are poised to focus on several key areas to further refine and expand the capabilities of evaluating SMAW-welded joints subjected to PWHT.

One avenue of exploration lies in the advancement of non-destructive testing (NDT) techniques tailored specifically for assessing the integrity and quality of welded joints post-PWHT. Emerging technologies, such as phased array ultrasonics, digital radiography, and advanced electromagnetic methods, hold the potential to provide more detailed and accurate insights into the internal structure and properties of welded joints, allowing for more comprehensive evaluation and defect detection.

Furthermore, there is a growing emphasis on incorporating advanced computational modeling and simulation tools to predict and analyze the behavior of welded joints during and after PWHT. Finite element analysis (FEA), coupled with multi-physics modeling, offers a valuable means of simulating the thermal, mechanical, and metallurgical effects of PWHT on welded joints. By leveraging these predictive capabilities, engineers can optimize PWHT parameters, refine welding procedures, and anticipate potential issues such as residual stresses, distortion, and microstructural changes.

Another area of future exploration involves the development of in-situ monitoring and sensing technologies for real-time assessment of welded joints during PWHT processes. Integrated sensors capable of measuring temperature, strain, and other relevant parameters directly within the weldment can provide valuable feedback and enable proactive adjustments to PWHT conditions, leading to enhanced control over the treatment process and improved outcomes.

In addition, there is a growing recognition of the importance of environmental considerations in PWHT procedures for welded joints. Future research endeavors may focus on exploring sustainable heat treatment methods, minimizing energy consumption, and reducing greenhouse gas emissions associated with PWHT processes, thereby aligning with broader efforts towards environmental stewardship and sustainability in welding and fabrication industries.

Overall, the future scope for the evaluation of welded joints subjected to SMAW and PWHT holds great potential for advancements in NDT techniques, computational modeling, in-situ monitoring technologies, and sustainability initiatives. By embracing these opportunities for innovation and collaboration, researchers and practitioners can further enhance the reliability, performance, and safety of welded structures across diverse industrial sectors.

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