International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

EFFECT OF ELECTRODE ON JOINING TWO DISSIMILAR METALS (SS & MS)

P. Varalakshmi[1], A. Bhuvan[2], CH. Pavan[3], CH. Sai Preetham[4], K. Sachin Naik[5]

[1]Assistant professor, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana
[2,3,4,5] UG Scholars, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana

---***---

Abstract - This study examines the challenges associated with joining dissimilar metals, specifically stainless steel and mild steel, and investigates the impact of electrode selection on joint quality and characteristics. Various welding processes, including shielded metal arc welding (SMAW), is explored. Experimental findings indicate that electrode choice significantly influences the formation of intermetallic compounds, fusion zone morphology, and mechanical strength of the joint. Alloying elements in electrodes are found to enhance weldability and performance by facilitating metallurgical bonding and reducing the formation of brittle phases. Furthermore, the study explores variations in welding parameters to optimize the process for desirable joint properties. By deepening our understanding of electrode roles in welding dissimilar metals, this research offers insights crucial for selecting appropriate techniques and parameters, ensuring reliable joints. These insights have broad applicability across industries such as automotive, aerospace, construction, and manufacturing, where dissimilar metal joining is common.

Key Words: dissimilar metals, intermetallic compounds, Weldability, morphology, mechanical strength.

1. INTRODUCTION

Welding is a fundamental process widely used in manufacturing and construction. It is the joining of two or more materials, usually metals, by fusing them together using heat or pressure. Welding plays an important role in the production of structures, machines, vehicles and various components in all industries.

1.1 Importance of Welding:

Welding is the most important method of creating strong and durable bonds between metals. This provides information about continuous connections that are important for structural integrity.

Versatility: Welding can be applied to a wide range of materials, including steel, aluminum, and other alloys. They are used in a variety of industries ranging from automotive, aerospace, construction, and shipbuilding.

Repair and Maintenance: Welding is essential for repairing damaged parts and maintaining the functionality of structures and equipment. Extends the life of various components.

Cost-effectiveness: Welding often provides a cost-effective solution for joining materials compared to alternatives such as mechanical fixation or adhesives.

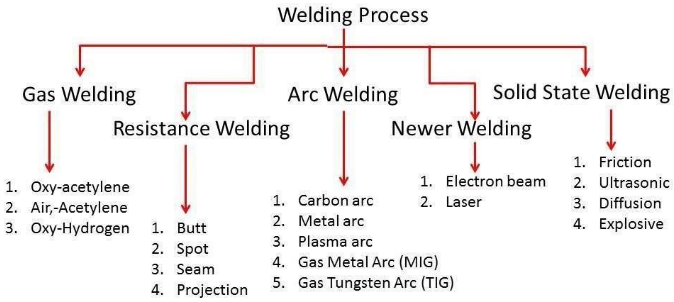


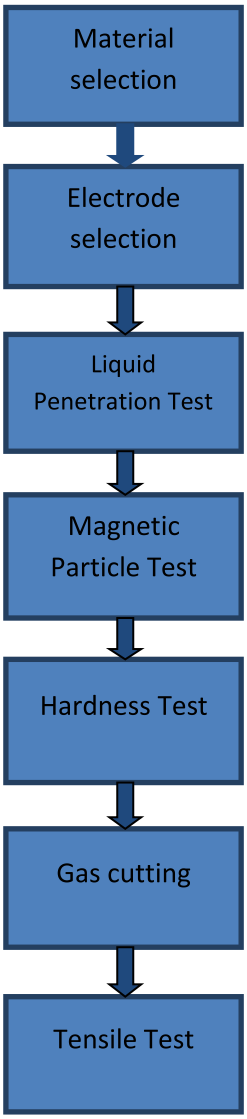
Fig 1: Classification of welding process

Stick Welder Electrode Guide

Electrode AWS Class	Use	Coating	Penetration	Current
E-6010	All Position	High Cellulose Sodium	Deep Penetration	DC+
E-6011	All Position	High Cellulose Potasium	Deep Penetration	DC+ or DC- Or AC
E-6012	All Position	High Titania sodium	Medium Penetration	DC- or AC
E-6013	All Position	High Titania Potasium	Shallow penetration	DC+ or AC
E-7018	All Position	Low Hydrogen Iron Powder	Medium / Shallow	DC+ or AC
E-7028	Flat Fillet welds	Low Hydrogen Iron Powder	Medium / Shallow	DC+ or AC
E-7024	Flat Fillet welds	Iron powder titania	Medium / Shallow	DC+ or AC
E-7048	All position	Low hydrogen potassium iron powder	Medium / Shallow	DC+ or AC

TABLE 1 Types of electrodes and significance

2. METHODOLOGY:



Material Selection:

This experiment uses two mild steel bars with a length of 300 mm, a width of 100 mm, and a thickness of 6 mm. Mild steel has a melting point of approximately 1350-1530°C, depending on the amount of carbon it contains. Mild steel typically has better ductility, machinability, and weldability than high carbon steel or other steels.

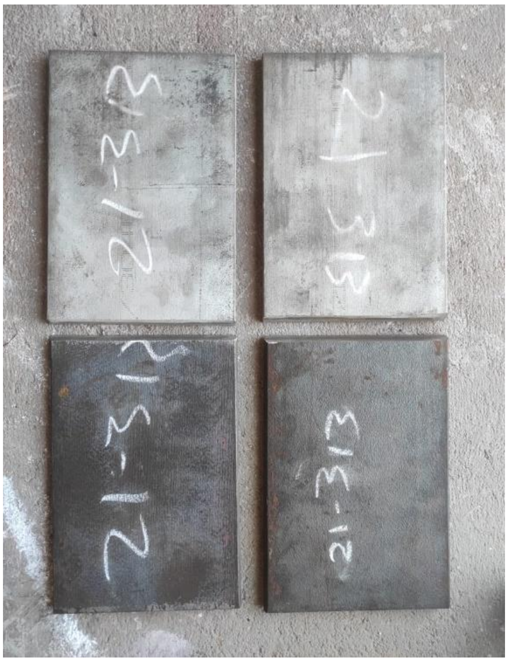


Fig 2: Work Pieces

Electrode Selection:

The selected electrode size is 2.50 x 350 mm, grades E6013 and 308-18, constructed of mild steel 12SWG (standard wire gauge) and stainless steel.

Fig 3: Electrodes

Liquid Penetrant Testing (LPT):

1. Clean the weld with penetrant remover
2. Application of penetrant on area of interest that is weld area.
3. Dwell time is giving penetrant to flow into the defects on weld area (5 Mins)
4. Removal of excess penetrant in one direction
5. Application of Developer.
6. Recording and interpretation of defects
7. Post Cleaning

Fig 4: Applying the penetrant

Magnetic Particle Test:

1. Pre clean the joint with remover, cleaner to ensure that joint is free from slag/rust.
2. Apply white contrast paint on the weld area, so that the magnetic powder will be enhanced.
3. Magnetize the joint with permanent yoke while posting magnetic powder on weld area.
4. Magnetic powder accumulates over flaws/ imperfections.
5. Record (or) inspect the joint.
6. Post clean the joint.

Fig 5: Set up of magnetic particle test

Hardness Testing:

Hardness testing is a method of measuring a material's resistance to deformation, denting, or scratching. This indicates the material's ability to withstand localized loads without permanent deformation.

Fig 6: Hardness test

Gas cutting:

Cut the workpiece through the marked dots by gas cutting equipment.

Fig 7: Gas cutting

Tensile Testing:

Start the test:

Begins applying the load at the constant rate specified in the test standard. Continuously records data such as load and displacement.

Continue loading:

Continue loading until the sample is corrupted. Record the maximum load (highest tensile strength).

Post-Fracture Inspection:

Inspect the fractured sample to determine the type of fracture (ductile, brittle). After testing, measure and record dimensions including final gauge length and diameter.

Data Analysis:

Analyze the collected data to determine mechanical properties such as yield strength, tensile strength, elongation, and area reduction.

Report Creation:

Create comprehensive test reports including all relevant information, data, and observations. Please ensure that the applicable test standards are adhered to.

Safety Considerations:

Strictly follow safety protocols and precautions throughout the testing process. Detailed procedures and requirements are always found in specific test standards for structural steel (such as ASTM E8 for metallic materials).

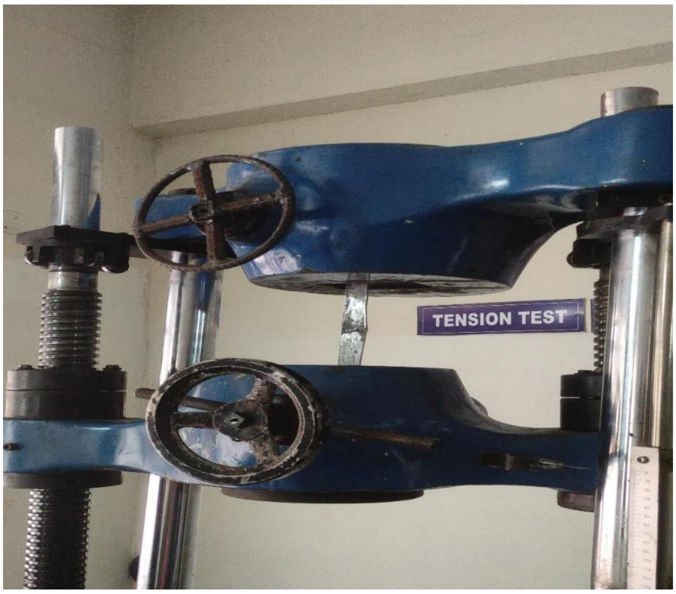


Fig 8: Tensile Testing

3. RESULTS:

Liquid Penetrant Testing:

Liquid Penetrant Testing or Dye Penetrant Testing is a non-destructive testing method that uses capillary forces to identify surface defects such as cracks, overlaps, and porosity. The defect must reach the surface being inspected. However, liquid penetrant testing provides a cost-effective solution for quickly testing large areas.

In the LPT test we have observed some defects they are in the following:

1. Under Cut – UC
2. Excessive Reinforcement – ER
3. Under Fill – UF
4. Lack of Penetration – LOP
5. Excessive Penetration – EP

Fig 9: LPT Root Side

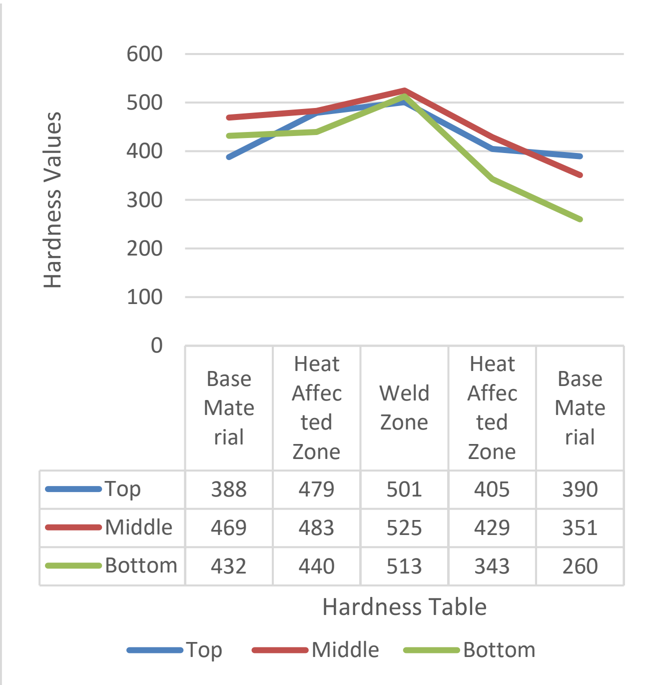
Fig 10: LPT Cap Side

Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

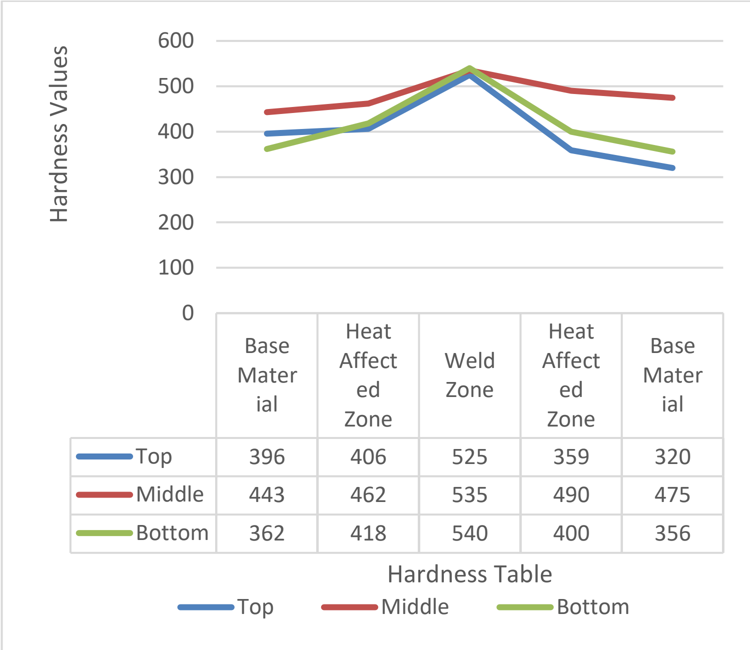
Magnetic Particle Testing:

Magnetic Particle Testing (MPT), also known as magnetic particle testing, is a nondestructive testing (NDE) used to detect surface and subsurface defects in most ferromagnetic materials such as iron, nickel, and cobalt. It's technology. and some of its alloys.

Fig 11: Magnetic Particle Test



Graph 3.1: Hardness test graph (E6013- electrode)

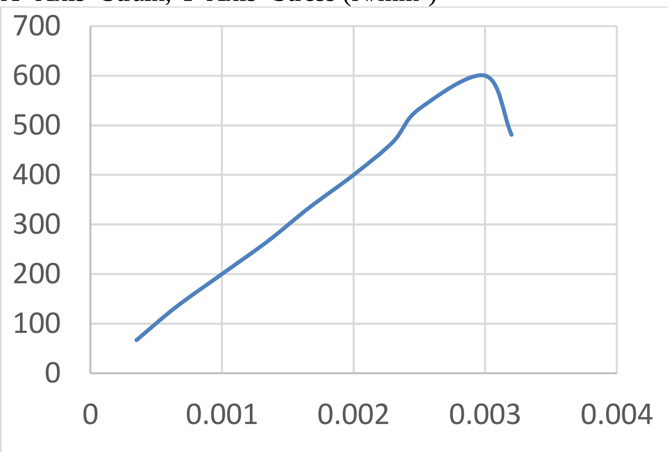


Graph 3.2: Hardness Test graph (308- electrode)

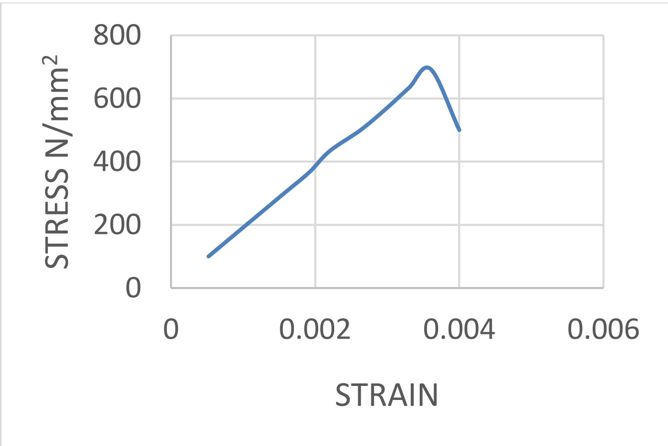
TABLE 3.1 STRESS Vs STRAIN VALUES

STRESS(N/mm^2)	STRAIN
0	0
66.67	0.00035
133.33	0.00065
200	0.001
266.67	0.00135
333.33	0.00166
400	0.002
466.66	0.0023
533.33	0.0025
600	0.003
480.85	0.0032

X- Axis- Strain, Y-Axis- Stress (N/mm^2)



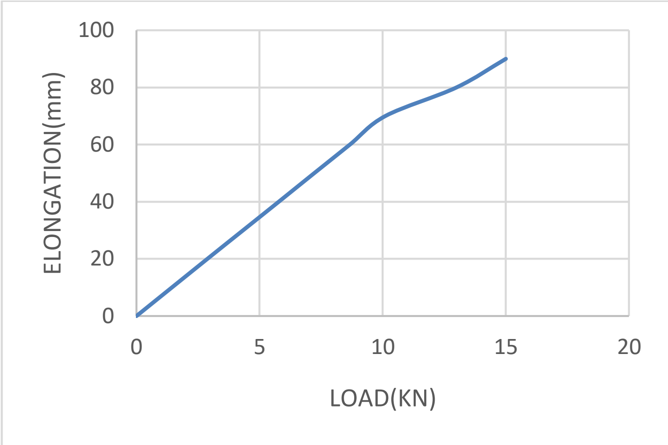
Graph 3.3: Stress Vs Strain Graph (6013 Electrode)



Graph 3.4: Stress Vs Strain (308 Electrode)

Table 3.2 Load Vs Elongation (E-6013)

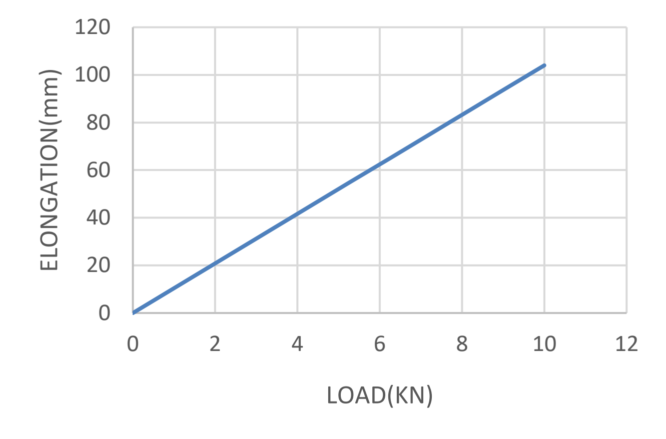
ELONGATION (mm)	LOAD (KN)
0	0
1.44	10
2.88	20
4.33	30
5.78	40
7.22	50
8.67	60
10.11	70
13	80
15	90



Graph 3.5 Load Vs Elongation (E-6013)

Table3.3 Load Vs Elongation (E-308)

ELONGATION (mm)	LOAD (KN)
0	0
1.44	15
2.4	25
3.36	35
4.32	45
5.28	55
6.25	65
7.21	75
8.17	85
9.13	95
10	104



Graph 3.6: Load Vs Elongation (E-308)

4. CONCLUSIONS

A study on the effect of electrodes on joining two different metals, stainless steel (SS) and mild steel (MS), showed that stainless steel has higher strength compared to mild steel. Using E6013 and 308 electrodes, we found that the 308 electrode provides better load carrying capacity and overall strength of the bonded metal. This demonstrates the potential advantages of the 308 electrode in welding dissimilar metals and highlights its practical importance in engineering applications where improved strength properties are required. Additionally, the observed advantages of stainless steel in terms of strength suggest the potential for improved durability and performance of stainless steel in a variety of engineering applications where structural integrity is paramount.

5. ACKNOWLEDGEMENT

We wish to convey our sincere thanks to our internal guide **Mrs. P. VARALAKSHMI** Assistant Professor, Department of Mechanical Engineering, for her professional advice, encouragement in starting this project, and academic guidance during the course of this project.

We wish to convey our sincere thanks to **Dr. B. VIJAYA KUMAR**, Professor& Head of Department, Department of Mechanical Engineering for his masterly supervision and valuable suggestions for the successful completion of our project.

We wish to express our candid gratitude to Principal **Dr. S. SREENATHA REDDY**, and the management for providing the required facilities to complete our project successfully.

We convey our sincere thanks to the staff of the Mechanical Engineering Department and the Lab Technicians for providing enough stuff which helped us in taking up the project successfully. We are also grateful to our well-wishers and friends, whose co-operation and some suggestions had helped us in completing the project. Finally, we would like to thank our parents for their exemplary tolerance and for giving us enough support in our endeavours.

REFERENCES

[1] S. Farrukh Haider, Jahanzeb Bhatti, Imran Ali: "Effect of Shielded Metal Arc Welding (SMAW) parameters on mechanical properties of low carbon, mild and stainless-steel welded joints" ResearchGate –31 October 2019, https://www.researchgate.net/publication/345491475

[2] Andika Wisnujati: “Analysis of Mechanical Properties SMAW Welding Joints of PortableElectric Hydraulic Jack Frame”, INTEK Jurnal Penelitian. 2020, Volume 7 (2): 155-159 http://dx.doi.org/10.31963/intek.v7i2.2134

[3] Edi Widodo, Iswant Iswanto1, Mirtza Adi Nugraha1, Karyanik Karyanik2: “Electric Current Effect on Mechanical Properties of SMAW-3G on the Stainless Steel AISI 304”, MATEC Web ofConferences 197, 12003 (2018),https://doi.org/10.1051/matecconf/201819712003

[4] Narinder Pal Singh Dhaliwal, Rutash Mittal2, Salwinder Gill1, Paras Khullar1: “Comparative Evaluation of Impact Strength of Dissimilar Metal Weld between T91 and 304SS Prepared by SMAW and GTAW Techniques”, Volume 4, No. 2, December 2022, https://www.researchgate.net/publication/309755260

[5] M.D.I. Setiawan, Pradana, Suprayitno: "Robust Parameter Design of Shielded Metal Arc Welding (SMAW) for Optimum Tensile Strength" ,Indian Journal of Science and Technology October 2016, https://iopscience.iop.org/article/10.1088/1742-6596/1700/1/012047gth

[6] Riswan E.W. Susanto , Kris Witono, Agus Setiawan, Risno Bayu: "Analysis of Hydro Test Pressure Variations on A106 Grade B Carbon Steel Pipe Welded Joints with Welding Repair Method", M.D.I. Setiawan et al 2020 J. Phys.: Conf. Ser. 1700 012047, http://e-jurnal.pnl.ac.id/Welding_Technology

[7] Rendi Purnawirawan , Yoto Yoto, Syarif Suhartadi: "Welding Engineering Student Learning Outcomes in SMAW Subjects: The Effect on Interest in Entrepreneurship", Vol. 3(2) 2023, pp. 117 – 126, https://doi.org/10.30862/jri.v3i2.239

[8] Vikash Kumar, Subodh Kumar Yadavb: "Experimental Investigation on the Effect of SMAW Process on the IS 2062 Grade E550 BR Microstructure and Mechanical Properties", Eur. Chem. Bull. 2023, 12 (6), 2399 – 2410 , https://www.researchgate.net/publication/372628759

[9] Tarmizi'M, Nabil Aga Hananda, Irfan: "The Effect of Heat Input on Welding Combination of GTAW and SMAW SA537 Material on Mechanical Properties and Microstructure",11/06/2022, http://ejournal.undip.ac.id/index.php/kapal

[10] Luca Santor, Raffaella Sesana ,Rosario Molica Nardo , Francesca Curá1: "Infrared In- line Monitoring of Flaws in Steel Welded Joints": A Preliminary Approach with SMAW and GMAW Processes, 9/08/2023, https://doi.org/10.1007/s00170-023-12044-2

[11] Pushp Kumar Baghel: "Effect of SMAW Process Parameters on Similar and DissimilarMetal Welds", 29/11/2022, www.cell.com/heliyon

[12] Jie Yuan, Hongchao Ji, Yingzhuo Zhong , Guofa Cui , Linglong Xu and Xiuli Wang : "Effects of Different Pre-Heating Welding Methods on the Temperature Field", Residual Stress, and Deformation of a Q345C Steel Butt-Welded Joint, 2 July 2023 , https://doi.org/10.3390/ma16134782

[13] G. Ramakrishna, P Srinivasa Rao, P Govind Rao: "Methods to Improve Mechanical Properties of Welded Joints", International Journal of Mechanical Engineering and Technology, 7(6), 2016, pp. 309–314 https://www.researchgate.net/publication/311581556

[14] Sanjay Singh, Dr. Sanjay Kumar Gupta: "Analysis and Optimization of Shielded Metal Arc Welding Parameters on Mechanical Properties of Dissimilar Materials", Volume 10, Issue 3 May-June-2023, https://doi.org/10.32628/IJSRSET23103183

[15] Hugo Alexander Gonzalez Romero, Edinson Alfonso Bastos Blandón, Lissette Patricia Casadiego Miranda and Enrique Esteban Niebles Nuñez: "Influence of Heat Input on the Weldability of ASTM A131 DH36 Fillet Joints Welded by SMAW Underwater Wet Welding", 19 July 2023 https://doi.org/10.3390/su151411222

[16] Usman, Saifuddin, Usman, Saifuddin: "Analysis of the Effect of Current on Tensile Strength of AISI 1050 Material in the SMAW Welding process", Journal of Welding Technology. Volume 4, No. 1, June 2022, http://e-jurnal.pnl.ac.id/welding_technology

[17] Toni Okviyanto, Sutrimo, Gugun Nugraha, Hanni Maksum Ardi, Toni Okviyanto: "Analysis of Mechanical Properties of ST 37 Carbon Steel on the Variation of SMAW Current Strength and Bending Angle, Journal of Welding Technology". Volume 4, No. 1, June 2022, https://www.researchgate.net/publication/371206714

[18] Abdelaziz, EL Abdelsalam, Magdi Ahmed El Hadiri Naji and S. Abdelwanis: "Investigating the Effect of SMAW Parameters on The Hardness of Commercial Carbon Steel", Vol. 12 Issue 01, January-2023, https://www.researchgate.net/publication/367332757

[19] Noor Ajian Mohd-Lair, Yuselley Yuyut, Zabidi Ahmad and Abdullah Mohd Tahir: "The Effects of Currents and Welding Rod Diameters on Welded Joint Ultimate Tensile Strength Using the Full Factorial DOE", Journal of Physics: Conference Series 2129 (2021) 012071 IOP Publishing ,https://iopscience.iop.org/article/10.1088/1742-6596/2129/1/012071

[20] I Bunaziv et al, X Ren and V Olden, "A comparative study of laser-arc hybrid welding with arc welding for fabrication of offshore substructures, Journal of Physics": Conference Series 2626 (2023), https://iopscience.iop.org/article/10.1088/1742-6596/2626/1/012033

[21] Subodh Kumar Yadav, Subodh Kumar Yadavb: "Experimental Investigation on the effect of SMAW process on the IS 2062 grade E550 BR microstructure and Mechanical properties",July 2023 DOI:10.31838/ecb/2023.12.6.219, https://www.researchgate.net/publication/372628759

[22] Muhammad Aditya, Anis Hanifah, Muhammad Aditya Pratama, Fikan Moubarak Rohimsyah: "Study of the Effect GMAW and SMAW Welding Combination with WAAM Method, SPECTA Journal of Technology", 7(2), 549 - 555. 10.35718/specta.v7i2.938 31/08/2023, https://journal.itk.ac.id/index.php/sjt

[23] Raffaele Sepe, Venanzio Giannella, Alessandro Greco and Alessandro De Luca : "FEM Simulation and Experimental Tests on the SMAW Welding of a Dissimilar T-Joint", Metals 24/6/2021, 11, 1016, https://doi.org/10.3390/met11071016

[24] Dr. B. Vijaya Kumar, R. Raghuram Reddy, D. Babulal, S. Pavan Nayak: "A Reviews and compares the weld joint efficiency of E6010 and E7018 electrodes in Shielded Metal Arc Welding (SMAW)", 2022/7, Journal: International Journal of Scientific Research in Engineering and Management (IJSREM), Volume 6, Issue 6, Pages 1-9.