EXPERIMENTAL AND MICRO STRUCTURAL ANALYSIS OF WELDED JOINTS

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Abstract
Welded joints are widely used in almost every industry, including automotive, commercial roofing, and many more uses. A welding joint is a feature or component where two or more pieces of metal or plastic are attached to one another. They are created by welding or better painting (metal or plastic) parts that are stable and have a specific geometry. The strengths of these joints are of great concern because, in today's world, they play a significant role in the development of systems and device parts. The strength of these joints and welding determines the service life of these structures, protecting them from loss whether it be a human loss, financial loss, or other kind of loss. In this study, we have examined the microscopic and macroscopic behaviour of a few particular and often used corporate joints under a variety of desired forms of loads. In this project, we took 3 welding joints and welded them using 3 different techniques. Then, using a metallurgical microscope, we obtained the microscopic geometry of the joint, tested it on a UTM machine, and used the results to draw power from it. The strengths were then put on a graph to show the best welding technique for a given joint.
Keywords: Material welding, Weld joint, Microstructure Analysis, FEA Analysis.

Introduction
When two or more elements are fused together, either with or without the use of stress and filler material, a permanent bond is created. This process is known as welding. The materials that need to be bonded may be quite similar or extremely dissimilar. Burning gasoline or creating an electric arc are two methods for producing the heat needed for the material to fuse. Due to faster welding, the latter approach is employed more frequently. In fabrication, welding is frequently used as a substitute for casting, forging, as well as for bolted and riveted joints. It can also be used as a medium for repairs, such as to patch a split in steel, gather a little piece that has broken off, such a tool's enamel, or fix a worn floor that has a bearing ground. The most popular method for permanently joining together device components and systems is welding. A production procedure called welding unites materials (metals or thermoplastics).
Arc welding is the name for the process of joining two metals together while using an electric arc. The power source utilized in arc welding the electricity (electric current). the electrical

contemporary-day used can be both direct (DC) or alternating (AC). The welding location is included with the useful resource of a few protecting types of gasoline, vapours, or slag. The shielding gasoline preserve the weld place from atmospheric infection. The arc welding may be guided, semi-computerized or absolutely automatic. It uses consumable or non-consumable forms of electrodes for the welding cause. This kind of welding is invented in the late nineteenth century. In international conflict II, it becomes commercially essential in shipbuilding. Nowadays its miles are used in the fabrication of metallic structures and vehicles. Arc welding is a fusion welding gadget wherein the warmth required to fuse the steel is acquired from an electric-powered arc many of the backside metallic and an electrode. the electrical arc is produced whilst conductors are touched collectively after which separated by way of using a small hole of two to four mm, such that the cutting-edge modern maintains to flow, through the air. A metal electrode is used which additives the filler metal. The electrode can be flux covered or bare. within the case of the naked electrode, extra flux fabric is furnished. each direct modern (D.C.) and alternating cutting-edge (A.C.) is used for arc welding. The alternating present-day for the arc is received from a step-down transformer. The direct modern-day arc is commonly received from a generator pushed via an electric powered motor, or petrol or diesel engine. It's far the multipurpose welding gadget. it is the most appreciably used welding method in the worldwide due to its simplicity and perfect welding overall performance. Nearly in each manufacturing enterprise, arc welding is used for producing robust joints. nowadays it remains an vital method within the fabrication of metal structures and automobiles. it's far notably utilized in car industries, creative industries, in the advent of homes, shipbuilding industries, and aerospace industries for the safety or restore works.

Literature Review

Prior to welding, a microstructural examination of MS with varying thickness was studied. The welded joint's microstructural characteristics have been mentioned. The results show that in the fusing zone, coarse structure is formed, whereas nice structure is formed in the heat-affected region. As a result, the hardness value is higher in the HAZ area compared to FZ and base metal because the HAZ area has excellent shape. The fillet welded joints frequently experience a variety of welding deformation patterns, including angular distortion, longitudinal & transverse shrinkage, and the fabrication of structural components in the shipbuilding, automotive, and other industries. Utilizing a delicate method to determine the maximum breaking strain and compare the outcomes, the experimental evaluation is completed. According to the articles I've read up to this point, even though this choice will result in a better permissible electricity, it comes at the expense of less ductility in the weld. According to the studies I've read above, the shearing quarter of the weldment was moved, which caused the throat length to expand. the separation between discernible plates will widen from 0.1 mm to about 1.0 mm, the max. This investigation makes it clear that the impact of stress interest decreases as the disparity between parents' plates increases. Due of this, the moderate hollow found in distinguishable plates may be suitable for tensile load. I have researched the effects of stress reduction as the distance between parents' plates increases using the publications mentioned above. According to recent research, the test results demonstrate that the determined ultimate stresses II, which result from the weld failing, have a strong link with the tensile energy of the extra metal. The fillet weld, which produces welded junctions, was theoretically and experimentally analysed to determine the effects of residual stress on its electrical. The theoretical stress levels and experimental pressure values may thus be at odds with one another. For the stress assessment of welded joints, the strain gauge rosette technique can be employed, and the results show a real settlement. Due to the increasing load in this task, the stress and deflection values rise. The good linear relationship is followed here. However, in all stress scenarios, the welded joints' strain distribution pattern became comparable. Costs for crack booms are calculated using regular microscopic observations of fracture duration.

Problem Statement:

In welding, joints determined that the various welding techniques have their own traits and modifications the properties of weld joints which affect the microstructure of base steel to optimize this problem we need to determine which approach of welding is suitable for one-of-a-kind weld joint. Welded joints are extensively determined in almost all programs like construction systems, automobiles, commercial roofs, and plenty of more applications. The Weld's joints are fails in bending loading instead of tensile loading.

Gap Identification:

In the latest work, there's no exact identification of the Welding procedure for weld joints. In current studies, the comparison of microstructure with diverse welding joints isn't taken into account. In latest work does not give the right choice of a weld joint for a suitable welding technique.

Objectives

i. To study the various welding joints and welding processes.
ii. To study the microstructure of welded joints.
iii. To compare the microstructure of base material and welding joint.
iv. To study the strength of material for various types of weld joints.
v. To select the welding process for proper welding joint with a comparison of strength.
vi. Comparison of experimental results to the finite element analysis of weld joints.

Methodology

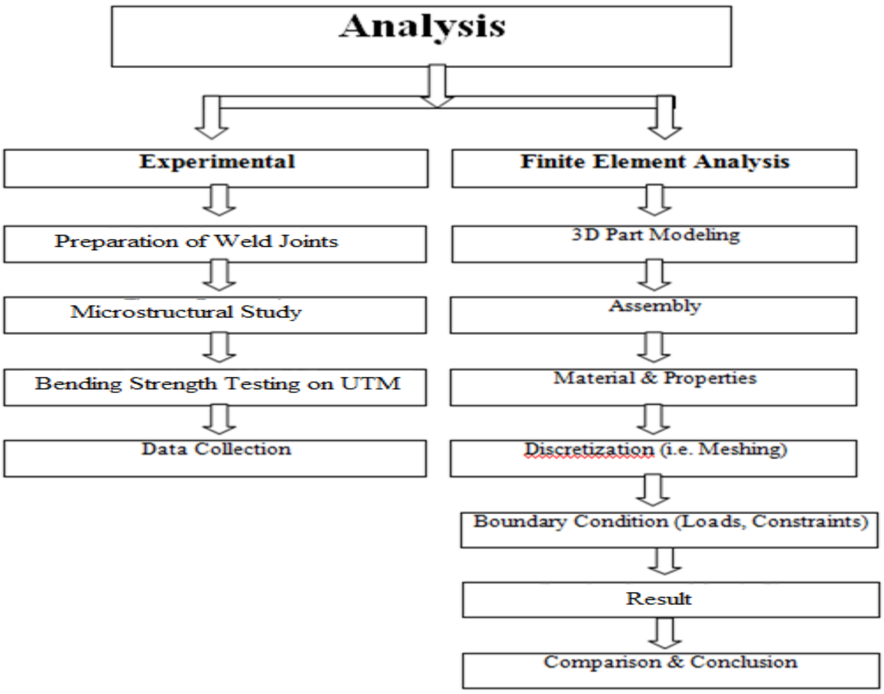

Figure1 Methodology

Microstructural and FEA Analysis

A. Microstructural Analysis:

In this work, we took three welding joints and welded them using three different approaches. We then used a metallurgical microscope to examine its microscopic structure, following which we tested it on a UTM device to determine its strength.

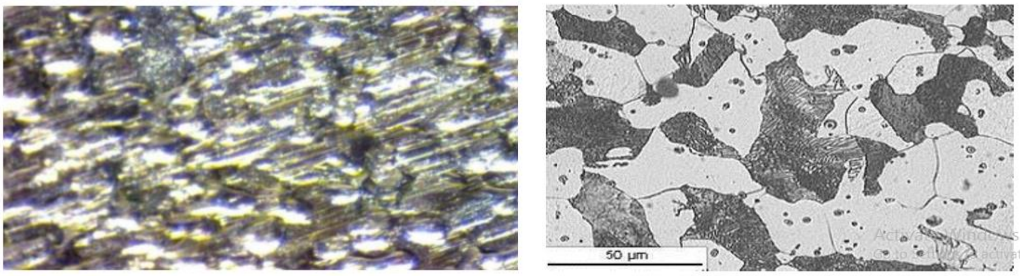

Photo 1 Microstructure of Mild Steel

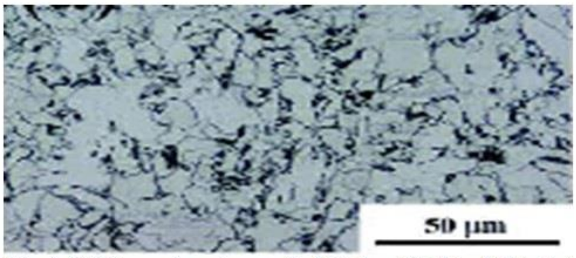

Photo2 Microstructure of AC Arc Welded T joint

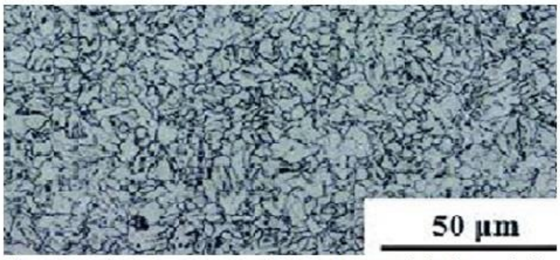

Photo3 Microstructure of AC Arc Welded Lap joint

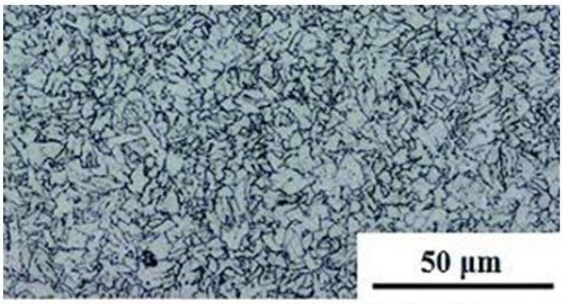

Photo4 Microstructure of AC Arc Welded Butt joint

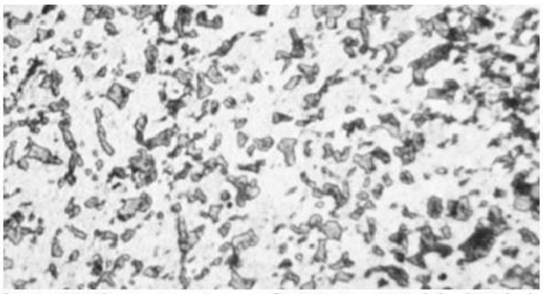

Photo5 Microstructure of DC Arc Welded T joint

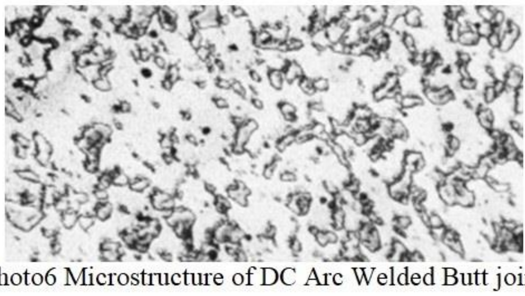

Photo6 Microstructure of DC Arc Welded Butt joint

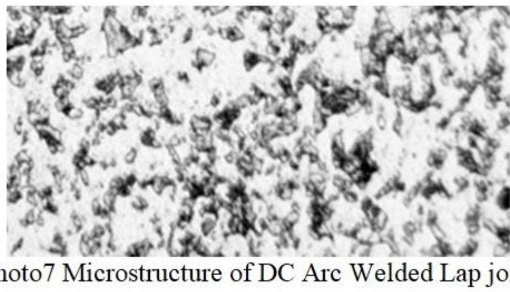

Photo7 Microstructure of DC Arc Welded Lap joint

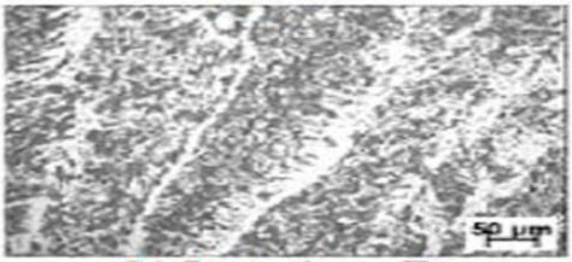

Photo8 Microstructure of CO_2 Welded T joint

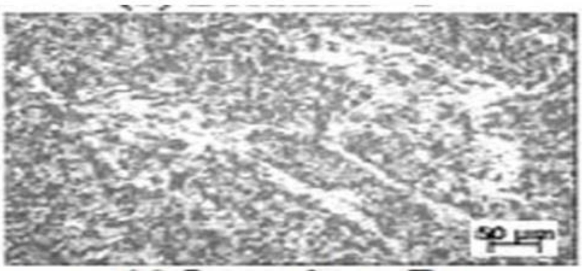

Photo9 Microstructure of CO_2 Welded Butt joint

Photo10 Microstructure of CO_2 Welded Lap joint

B. FEA Analysis:

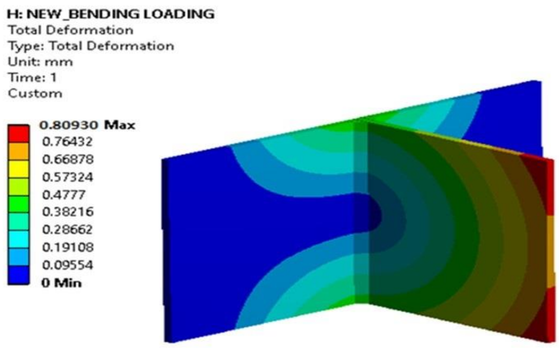

Figure1 Total Deformation for AC Arc Welded T in Bending loading
In the above figure total Deformation is maximum 0.80930mm.

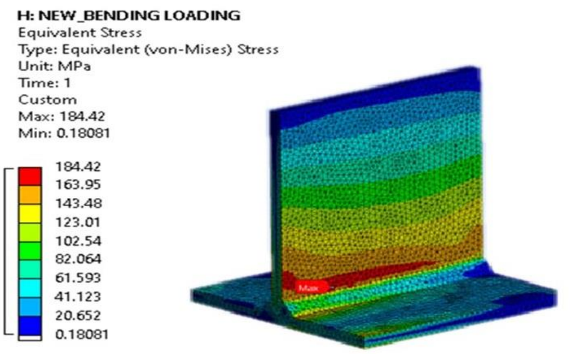

Figure2 EQVI – Von Misses Stress for AC Arc Welded T in Bending loading

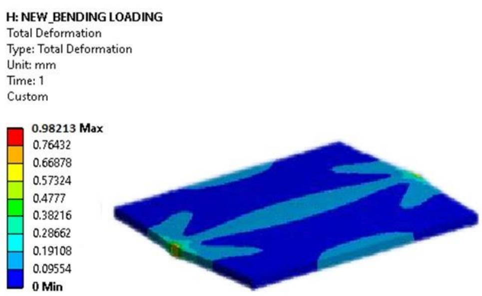

Figure3 Total Deformation for AC Arc Welded Butt in Bending loading
In the above figure total Deformation is maximum 0.9821mm

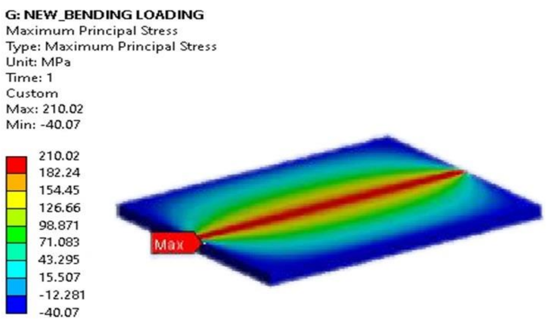

Figure4 Maximum principal Stress for AC Arc Welded Butt in Bending loading
In the above figure Maximum Principal Stress is 210.02 MPa and Minimum Principal Stress is -40.07

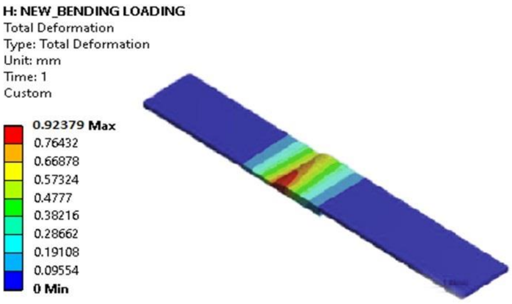

Figure5 Total Deformation for AC Arc Welded Lap in Bending loading
In the above figure total Deformation is maximum 0.92379mm

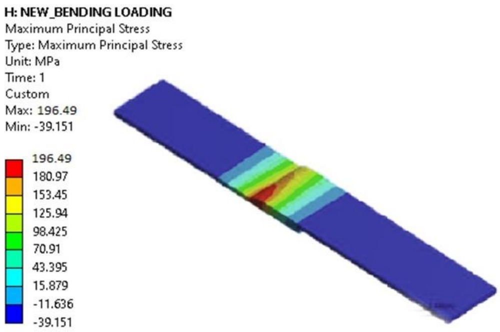

Figure6 Maximum Stress for AC Arc Welded Lap in Bending loading
In the above figure Maximum Principal Stress is 196.49 MPa and Minimum Principal Stress is -39.151

Results and Conclusion

Experimental Analysis of AC Arc Welding

Table1 Experimental Analysis of AC Arc Welding

Types Joints	Maximum Stress (MPa / N/mm^2)	Strain (micron)	Deformation (mm)
T Joint	193.81	0.001237	0.8326
Butt Joint	217.23	0.002125	1.136
Lap Joint	207.77	0.001592	0.9834

FEA of AC Arc Welding

Table 2 FEA Analysis of AC Arc Welding

Types Joints	Max. Principal Stress (MPa / N/mm^2)	Elastic strain (micron)	Deformation (mm)
T Joint	184.42	0.00099568	0.80930
Butt Joint	210.02	0.0018736	0.98213
Lap Joint	!96.49	0.0013273	0.92379

Experimental Analysis of DC Arc Welding

Table3 Experimental Analysis of DC Arc Welding

Types Joints	Maximum Stress (MPa / N/mm^2)	Strain (micron)	Deformation (mm)
T Joint	203.41	0.001396	0.8642
Butt Joint	229.34	0.002457	1.4321
Lap Joint	216.27	0.001783	1.1463

Experimental Analysis of CO_2 Welding

Table4 Experimental Analysis of CO_2 Welding

Types Joints	Maximum Stress (MPa / N/mm^2)	Strain (micron)	Deformation (mm)
T Joint	181.23	0.0009357	0.7829
Butt Joint	198.87	0.0016932	0.9734
Lap Joint	193.34	0.0011964	0.9328

Conclusion:

The following conclusions are drawn from the present work.

- In order to find the best technique for various types of joints, we have conducted a variety of experiments to determine the welding strength of mild steel. We've talked about how different welding methods affect the microstructure of various welded connections. Talk about the bending moment information for several welded connections.
- Therefore, careful examination of the results above demonstrates that the following combinations would produce the greatest results when a welding procedure is chosen:
- LAP JOINT – CO2 ARC WELDING
- BUTT JOINT – CO2 WELDING
- T-JOINT – AC WELDING
- FEA and Experimental Results have a good correlation with each other this validates this work.

REFERENCES:

1. Bijaya Kumar Khamari, Pradip Kumar Sahu and B B Biswal, "Microstructure Analysis of Arc Welded Mild Steel Plates," International Conference on Mechanical, Materials and Renewable Energy IOP Conf. Series: Materials Science and Engineering 377 (2018) 012049.
2. Arunkumar.A.P, Ravichandran.S.P, "Theoretical and Experimental Analysis of Tjoint in Tig Welding Process," International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-2, Issue-6, June 2016.
3. Pierluigi Mollicone, Thomas GF Gray, Duncan Camilleri, "Experimental Investigation and Finite Element Analysis of Welding Induced residual Stresses," Strain Analysis, 47(3) 140–152 IMechE 2012.
4. Rabih Kassab, Henri Champliaud, Ngan Van Lê, Marc Thomas, "Finite Element Modeling of a Welded T-joint," CSME FORUM 2010 June 7-9, 2010, Victoria, British Columbia, Canada.
5. Ashutosh Jayasing Kate, Prof. S. V. Jadhav, "A Theoretical and Experimental Analysis of Fillet Weld," IJSTE - International Journal of Science Technology & Engineering, Volume 3, Issue 04, October 2016.
6. Sinjo Jose. V, M. James Selvakumar, "An Overview of Fillet Weld Joints Subjected to Tensile and Compressive Loads," International Journal of Science and Research (IJSR), Volume 3 Issue 5, May 2014.
7. Z. Tonkovic, M. Peric, M. Surjak, I. Garasic, I. Boras, A. Rodic, S. Svaic, "Numerical and Experimental Modeling of a T-joint Fillet Welding Process," 11th International Conference on Quantitative InfraRed Thermography.
8. Akash Srivastava, Sumeet Sekhar, Prayass Rai, Anusheen Nema, "Analysis of Welding Joints and Processes," International Journal of Computer Applications (0975 – 8887).
9. Chetan S Baviskar, R M Tayade and Vinay G Patil, "Determination of Failure Strength of Curved Plate Weld Joint Using Finite Element Analysis," Int. J. Mech.Eng. & Rob. Res. 2012Vol. 1, No. 3, October 2012.