INVESTIGATION AND OPTIMIZATION OF TENSILE STRESS IN MULTIPASS SUBMERGED ARC WELDED BUTT JOINT

Prof. Kishor S. Sarode[1], Dr. Ghayas A. Usmani[2], Dr. Kishor P. Kolhe[3]

[1] *Research Scholar, Department of Mechanical Engineering, JTM COE Faizpur, Maharashtra, India.*
[2] *Research Guide, Department of Oil Technology, North Maharashtra University, Maharashtra, India.*
[3] *PG-Coordinator, Department of Mechanical Engineering, JSPM COE Wagholi, Maharashtra, India.*

ABSTRACT

The high strength welded joint is the demand of today's industrial applications. The Submerge Arc Welding is developed for meeting such demands and having more advantages compare to conventional welding methods. The paper investigates the tensile testing of Submerged Arc welded Butt Joint. The butt joint had been fabricated and the loaded by some load on UTM to inspect the tensile stress. For that event sampling was done by varying the passes in the joint. A solid model also made in solid modelling software and analyzed in finite element software ANSYS 15.0 to determine the tensile stress of butt joint by varying the passes in the joint. An optimum tensile stress of joint had been obtained by maximization principle of optimization.

Keywords: - *Butt Joint, Welded Joints, Submerge Arc Welding, etc.*

1. INTRODUCTION

In 1935, Rothermund and Jones, Kennedy developed welding method which became most popular in industrial sector was the Submerged Arc Welding (SAW). It can be handled by automatic as well as semi-automatic mode. SAW method is fixed and can be easily adopted for automatic conveyer line. It involves the constantly feeding electrode and flux. The slag is use to protect the welded region. The quality of SAW is strongly effected by SAW parameters like speed, voltage, current, electrode and thickness of workpiece. These parameters always have close relationship with weld bead.

It is the type of welding method in which welding takes place under a cover layer of granular flux. In this method a tubular consumable electrode is used continuously to apply arc. When an arc strikes at the same time the flux can be poured over the workpiece surface. The flux defend the arc from atmospheric contamination.

1.1 Construction and Working

The SAW machine consist of Welding head, Electrode and electrode feed mechanism, flux hopper and recovery unit, power source in the form of current and voltage (Fig -1). The welding head is useful in supply of flux metal to the joint for joining. The flux hopper stores, delivers and control the rate of flux to the joint. Typically, lime, silica, calcium floride, MgO, etc. are used as flux material for the joint and fed to weld region by gravity. Generally, the flux is insulator but when heated it become conductor and conducts the current between workpiece and electrode. The solid layer of such flux covers the melted metal totally and avoids the weld sprinkle and flash. The minor part of flux melted and provide deep movement of molten metal. A consumable nonstop electrode wire is used for joining the pieces. The electrode is of steel metal and provides the current for melting the metal. The wire electrode may be of diameter in 1 micron to 10 mm. the electrode is feed by drive rolls which are driven by controlled servo motors. The power source is used the current and either AC or DC supply. Sometimes backing plate or supporting plate is used to obtain smooth current supply in the workpiece and electrode. The flux recovery unit is used to recover the flux after weld. This helpful in optimum flux material requirement.

In this type of welding the flux is deposited first. Initially flux act as an insulator. The arc started by moving the tool over surface covered by flux. The heating produces melts the minor part of flux and it became highly conductive to conduct the current between electrode and workpiece. Separate drive is used to move the top of machine as required. The length of arc is kept stable by self-adjusting arc technology.
It is useful because a small smoke is observed during operation. Also, the edge preparation does not required and there is no chance of weld sprinkles because arc is covered by flux blanket.

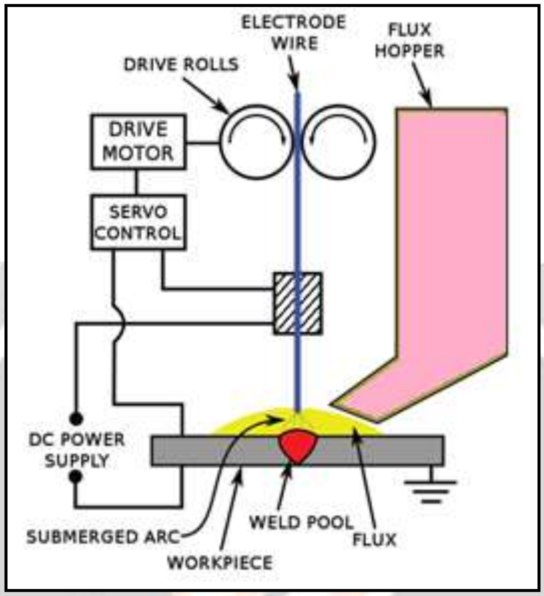

Fig -1 Construction and Working of SAW

2. LITERATURE REVIEW

Ahmed Khalid Hussain et al (2010) was investigated that bevel height, bevel angle and weld speed effects on the strength of weld. The increase in bevel height reduces the depth of weld bead. Usually, it is suitable to use bevel angle in the range of 30-45 degrees for maximizing the tensile strength of weld. At lower speed values the weld is uniform and having maximum strength. Also, reduction in heat affected zone will tend to higher tensile strength of weld. [1]
S. R. Patil and C. A. Waghmare (2013) used Taguchi method successfully to monitor the mild steel failure by loads. The Taguchi array, S-N ratio and ANOVA technique were performed to inspect the weld parameters. The optimum values had been obtained and concluded that the weld speed greatly influenced on tensile strength of weld. [2]
Maneiah. Dakkili (2013) found that butt welded joints have great applications in industries. The joint had assessed for inspecting the lack of penetration and the material behaviour of welded joint. The results of these two reasons leads to fatigue failure of joint. The stress concentration factors and stress intensity factors have been considered for the analysis and found that these factors have more impact on strength of joint. [3]
Talabi (2014) worked on the effect of weld parameters on the mechanical properties of low carbon steel. The weld parameters like voltage, current and speed was considered for the analysis. It was found that the weld voltage and current affects the properties. [4]

3. SYSTEM DEVELOPMENT

3.1 Analytical Formulation

The butt joints are usually designed for tensile or compressive load. A single V butt joint is shown in Fig -2. In case of butt joints, size of weld joint is equal to thickness of plate. Also, for multi pass welded joint number of passes and thickness of each pass is required.

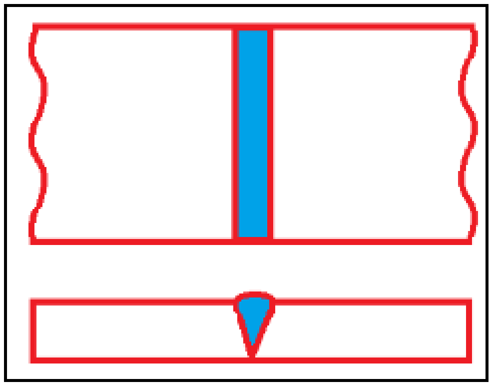

Fig -2 Single V butt joint

Let, P = Tensile or compressive load, N
n = no. of passes in case of multi pass welding
t_i = Thickness of i^{th} pass, mm
b = width of Plate, mm
S_t = Tensile Stress in MPa
The equation of tensile stress is given as,
$P = n \times t_i \times b \times S_t$ …. (Eq. 1)

3.2 Methodology

The paper presents the study on tensile behaviour of butt welded joint by using experimental and FEA method. For that purpose first joint has fabricated by two Mild Steel plates joined by SAW method with 6 passes. The passes are added by considering the total thickness is same for all samples. The Fig -3 shows the various dimensions used for fabrication of joint. The joint is then inspected under UTM to find the tensile strength of joint. ASTM standards are followed for testing of joint. After that the joint has made and analyze in ANSYS 15.0 software to compare the test results.

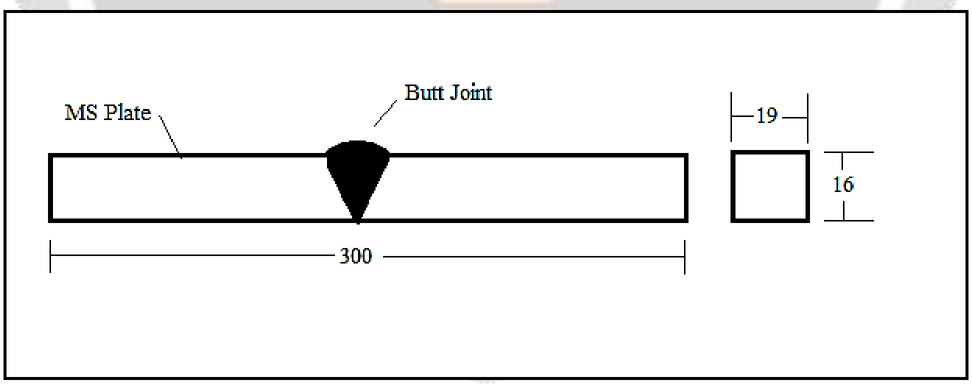

Fig -3 Experimental sample for tensile test

4. RESULT AND DISCUSSION

The samples are made as discussed in methodology. The analytical calculations ad been made based on equation 1 and samples are tested on Universal Testing Machine (UTM) for tensile test as per ASTM Section X standards. The results are tabulated in Table -1.
It can be seen that the experimental stress values are less than analytical stress values for all passes of welds. This is because of improper material distribution in welded joint. The single pass joint have experimental value of 464.17 MPa and analytical value of 470.23 MPa forming a percent error of 1.28 %. The maximum percent error observed in three pass welded joint which has experimental value of stress is 436.20 MPa and that of analytical one is 455.09 MPa. The minimum percent error has been observed in 2 passes welded joint which is 0.2% and the stress values of

experimental are very closed to analytical value of stress. For higher passes (3 or more than 3), the variation in stress values has been observed. This shows that, the more than 3 passes of welded joint causes the variation in tensile stress. Thus, it is concluded that the two pass weld joint is more suitable or optimum in compare with these all passes welded joint.

Table -1: Results of Experimental and Analytical Method for all Passes of Welded Joint

Sr. No.	Number of Pass (No.)	Thickness of each Pass, mm	Load (KN)	Experimental Tensile Stress (MPa)	Analytical Tensile Stress (MPa)	% Error
1	6	2.67	142.75	463.25	469.57	1.35
2	5	3.20	138.25	447.74	454.76	1.54
3	4	4.00	138.35	436.20	455.09	4.15
4	3	5.33	142.10	463.14	467.43	0.92
5	2	8.00	143.25	470.23	471.21	0.20
6	1	16.0	142.95	464.17	470.23	1.28

5. CONCLUSIONS

The study presents the tensile stress investigation in multi pass butt welded joint. Therefore, it draws following conclusions.

1) The multi pass welded joint could be fabricated easily by adding the number of passes.
2) The tensile stress is most important parameter in designing welded joints because it directs effects on tensile load.
3) The strength of welded joint is depends on number of passes and thickness of each pass under consideration.
4) It can be concluded that the 2 or 3 passes gives better results as compare to other passes in tensile stress analysis out of that 2 pass welded joint can be said to be optimum by this study.

6. REFERENCES

[1]. Ahmed Khalid Hussain, Abdul Lateef, Mohd Javed, Pramesh.T, Influence of Welding Speed on Tensile Strength of Welded Joint in TIG Welding Process, International Journal of Applied Engineering Research, Dindigul, 1(3), 2010, pp. 518-527.

[2]. S. R. Patil, C. A. Waghmare, Optimization of MIG Welding Parameters for Improving Strength of Welded Joints, International Journal of Advanced Engineering Research and Studies, 2(4), 2013, pp. 14-16.

[3]. Maneiah. Dakkili, K. Prahlada Rao, Stress Analysis of Weld Penetration Problem in Butt Welded Joints, International Journal of Engineering Research & Technology, 2(12), 2013, pp. 2366-2379.

[4]. Talabi, S.I., Owolabi, O.B., Adebisi, J.A., Yahaya, T., Effect of welding variables on mechanical properties of low carbon steel welded joint, Advances in Production Engineering & Management, 9(4), 2014, pp. 181-186.

[5]. Chavan Vikrant Vijaykumar, Dr. Deshpande S.V., Valsange P.S., Tensile Strength Analysis of Lap Welded Joint of Similar Plates With F.E.A., International Journal of Innovations in Engineering Research and Technology, 3(8), 2016, pp. 1-19.

[6]. Prof. N. B. Landge, Prof. V. R. Lawande, Prof. R. K. Belkar, Prof. A. C. Mande, Tensile Strength Analysis of V Groove Butt Weld Joint For Aluminium Alloys AA 2025 & AA 7025, International Journal of Advance Research and Innovative Ideas in Education, 2(6), 2016, pp. 1196-1202.

[7]. Mr. Ashutosh Jayasing Kate, Prof. S. V. Jadhav, a Theoretical and Experimental Analysis of Fillet Weld, International Journal of Science Technology & Engineering, 3(4), 2016, pp. 101-103.

[8]. Nerella. Kranthi Teja, Dr. B. Amar Nagendram, Effect of Welding Parameters on the Strength of Butt Weld Joint using TIG Welding, International Journal of Science, Engineering and Technology Research, 6(11), 2017, pp. 1461-1467.