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EFFECT OF VIBRATION ON MECHANICAL PROPERTIES OF AISI 1018 STEEL WELDED JOINT USING SMAW

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Abstract- In this paper the study was done to investigate the effect of vibratory set up on the mechanical properties of 10 mm thick AISI 1018 Mild Steel welded butt joint. The enhancement of the welding mechanical properties and the quality of the fusion metal was considered recently by using vibration during welding. During the welding of metals along with mechanical vibrations, uniform and finer grain structures can be produced. This increases the toughness and hardness of the metals, because of solidification effects at the weld pool surface. As the weld pool solidifies, grains are not only limited in size, but dendrites growing perpendicular to the fusion line are restricted.

While the process was going on, dendrites can be broken up before they grow to become large in size. Hence, the microstructure of the weld metal is improved during the solidification process.

In this work, dynamic solidification technology was used by applying mechanical vibrations during the 'Arc welding' process. Analyses had been carried out for mild steel pieces having 10 mm of thick butt joints. The results obtained from the current study pointed out that the butt welded joint fabricated with vibratory condition are found to possess relatively high strength, without any considerable loss in its ductility. Following results were obtained during conduction of research work. Tensile strength 18.25 %, Elongation 39.34 %, Force 29.17 %, Reduction in area 50 % and Yield stress is 3.21 % was more with vibration as compared to without vibrations welding with SMAW.

Keywords- Manual Arc Welding (MAW), Vibratory Weld Conditioning (VWC), American Iron and Steel Institute (AISI), Butt joint.

1. INTRODUCTION

Shielded metal arc welding (SMAW), also known as manual metal arc welding (MMA or MMAW) is a manual arc welding process that uses a consumable electrode covered with a flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. The work piece and the electrode melt forming the weld pool that cools to form a joint. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapours that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination.

Due to the low cost of the equipment, the low operating costs of the process and the ease of transporting the equipment, this flexible process is ideally suited to repair work benefits of MMA Welding are: Flexible, Low Cost, and ease of Repairs. Butt welding is used to connect parts which are nearly parallel and don't overlaps. Properties of weld metals are greatly influenced by type of microstructure and grain size. Fine grained materials normally have higher strength and are more ductile than similar coarse grained materials. It is often intended to achieve fine grain structure in the weld bead because fine grain help improve mechanical properties like ductility and toughness of weld metal.

2. LITERATURE SURVEY

Mechanism of Solidification of Weldments under Vibratory Condition

Shashi Prakash Dwevedi (2014) [1] performed an experimental study on the tensile strength of 1018 mild steel plates joined by microwave welding. Three different microwave ovens with rated power of 800, 850, and 900 W and fixed frequency of 2.45 GHz were used in the present investigation. The results show that, with increasing rated power of the microwave oven, the tensile strength decreases, while the tensile strength increases with increasing welding time and temperature. The optimum values of rated power and welding time and temperature were found to be 800 W, 1,000 s, and 800 °C to obtain the maximum tensile strength (predicted 245.2 MPa). There was approximately 4.06 % error between the experimental and modeled results for tensile strength.

Alaa Raad Hussein et al. (2011) [2] studied the enhancement mechanical properties and the quality of the fusion metal by using vibration during welding. In this study, the effect of vibration during welding is employed to improve the welding mechanical properties and to reach the best shape of welding. The vibration method is examined experimentally by using four values of mechanical frequency during welding on the ductility, tensile strength and the homogeneity of the welding line. Five simply supported rectangular plates are supported on the supporting stand and welded using a manual arc-welding machine. The experimental results show that the vibration applied during welding generally improved the bend property of

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the welding line, as well as the tensile strength has been improved distinctively at the resonance case when compared with that one welded without vibration. The morphology of the fillet metal after welding and for each value of frequency show an enhancement in the distribution of the fusion fillet metal, with gradually disappearing of the micro crack that may shown inside the metal with increasing the mechanical frequency. A comparison between the properties of welding without vibration and welding with vibration is discussed.

Jaskirat Singh et al. (2012) [3] employed dynamic solidification technology, by applying mechanical vibrations during the solidification in SMAW process. Studies using 10 mm thick stainless steel (AISI202) butt joints. Low and high heat input combinations were used to study the effect of mechanical vibrations on small sized and large sized fusion zone respectively. The results from the present study indicate that the weld joints fabricated with vibratory condition were found to possess relatively high yield strength (YS) and high ultimate tensile strength (UTS), without any appreciable loss in the ductility.

Madhusudhan R., et al. (2013) [4] conducted a study on effect of weld parameters on mechanical and microstructural properties of dissimilar aluminium alloy FS welds. In the present study, dissimilar Aluminum alloy (AA 6262-T6 and AA 7075-T6) plates were FS welded by varying the weld parameters such as Tool rotational speed, weld speed and axial force with square tool pin profile. The mechanical properties (hardness and tensile strength) of the Dissimilar Friction Stir welded (DFS welded) specimens were tested and compared with the base materials.

Kuo Che-Wei, et al. (2007) [5] performed Gas Tungsten Arc Welding (GTAW) on AISI 304 stainless steel; steady- state vibration was produced by a mass-eccentric motor. The vibration weld shows a very small δ-ferrite structure, uniform composition distribution, less residual stress and less δ-ferrite content relative to the weld without vibration. The results illustrate that the vibration reduces the micro supercooling and improves the nucleation of δ-ferrite to form a grain refined structure.

Burzic, Meri, et al. (2012) [6] studied the effect of vibration of residual stresses in butt-welded steel plates and on the impact energy in characteristic zones of a welded joint is analyzed in their work. Residual stress measurements are conducted both on butt-welded plates that were not vibrated during welding on plates simultaneously welded and vibrated. It is concluded that the vibration process noticeably decreases the level of stresses in the zone of butt weld i.e. the result is relaxation and plane stress state.

S. P. Tewari (1993) [7] studied the effects of specimen thickness on tensile properties of medium carbon steel welds prepared under longitudinal oscillation were investigated. Medium carbon steel workpieces were welded at different frequencies and amplitudes of longitudinal oscillation. Frequencies and amplitudes of oscillations were varied in the range of 0 to 400 Hz and 0 to 40μm, respectively. Test specimens 8mm, 10mm and 12mm thick were tested and yield strength, ultimate tensile strength, percentage of elongation, breaking strength, impact strength and hardness were determined.

Hornsey, J.S. (2004) [10] study the Vibratory stress relieving for stabilisation of the size of suitable weldments prior to their machining and stress relief annealing. The VSR process is used for lowering of residual stresses and stabilisation of the size of different weldments.

Verma, Akanksh et al. (2011) [9] studied that welding processes induce a state of residual stress into materials Thermal cycle produced near weld line generates residual stress and inhomogeneous plastic deformation in weldments. Understanding of grain nucleation and grain growth becomes necessary that are influenced under welding conditions. After completion of nucleation, the solidification process will continue with nucleus growth. With vibratory weld conditioning, the enhancement of weld metal microstructure can be achieved.

Qinghua, Lu et al. (2007) [12] studied that the microscopic structure has dramatically changed after V-SAW. Vibratory energy breaks up the growing dendrite grains in the weld and the HAZ. A Significantly higher weld pool velocity which leads to a faster the heat removal during solidification is produced in VWC. Thus, the higher the cooling rate, the more the nuclei coming into play and the smaller the grain size. And a finer grain size benefits the mechanical properties.

Dvornak et al. (1991) [13] while studying the solidification under vibratory conditions concluded
that the grain refinement so observed was due to the lower energy required for the nucleation of the solid phase.

P Sakthivel and P Sivakumar (2014) [14] studied the effects of vibration on properties of welded joints. Studies have revealed that welding of metals along with mechanical vibrations result in uniform and finer grain structures.

Munsi A S M Y, Waddell A J and Walker C A (2001) [15] discussed about the effect of vibratory stress on the welding microstructure and residual stress distribution of steel welded joints. The 25 percent improvement in hardness of weld joint is also discussed.

3. METHODOLOGY

3.1 Experimental Setup

Vibration during welding is provided with the help of vibratory set up shown in figure
1. Vibrating tables are capable of transmitting vibrations to the materials placed or clamped on the table top. The vibrating tables do not include shock tables which pulsate at low frequency and operate on the principle of gravity fall with the help of rotating cams.

Fig. 1: Experimental Setup

Material:-
IS: 727-1955 springs are used in set up V belts for belt drives are conformed to IS: 2494- Specification for V-Belts.
Size and Capacity:-
The size of the vibrating table is given in Table No.1, and its load carrying capacity is 140 kg.

Table 1: Dimensions of Vibration Table

Length, m	Breadth, m
0.5	0.5
1	1
2	1
3	1

Size of given set up = 0.5 × 0.5 m

3.2 Motive Power:-
Electric motor is used in vibrating table for producing the vibrations in welding setup.

3.3 Selection of Material
Mild steel (AISI 1018) is selected for this experiment. The dimensions of the plates are 100×100 mm each and 10 mm thick. Mild steel is the most common high volume steel in production. Mild Steel is used for almost all non-specialist steel products- cars, domestic goods, constructional steel work etc.

Table 2: Chemical Composition of AISI 1018 MS

Element	Weight %
C	0.12-0.20
Mn	0.50-0.80
P	0.040
S	0.060
Fe	98.81-99.29

3.4 Selection of Electrode
E6013 electrode is used for the welding of mild steel.

Table 3: Description of Electrode

Model	E 6013
Deposited metal chemical composition (%)	C = 0.8 Mn = 0.45 Si = 0.18 P = 0.012 S = 0.009
Shape	Stick Electrode
Type	Mild Steel

Coating Type	High titanic coated
Length (mm)	350
Diameter (mm)	2.5, 3.15, 4.0, 5.0
Current (amp)	80-110, 90-130, 140-190, 170-230

3.5 Selection of type of joint & weld type

Single V butt joint is used to join the ends or edges of two plates located approximately in the same plane with each other. Single V- butt joint-with gap is selected as shown in fig. 3.

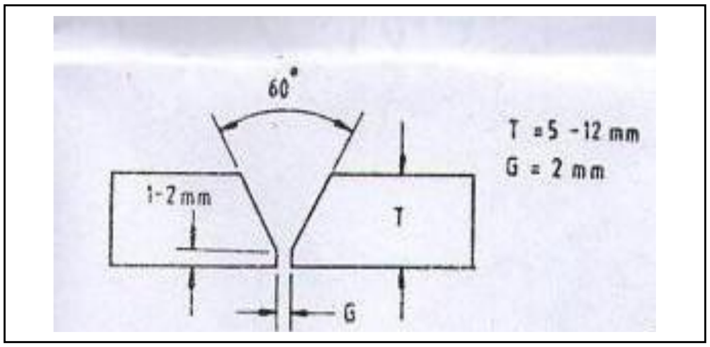

Fig.3: Single V Butt with Gap

Now, Edge is prepared with the help of End mill cutter on milling machine such that the bevel angle becomes 30°and 1 mm is left at the bottom of plate to make root face. The plates are kept at a distance 1-2 mm apart from each other to accommodate root opening as the plates are greater than 6 mm thick.

3.6 Experimental process design

Now, two MS plates each of dimension 100□ 100 mm are placed with the help of C-clamps as shown in figure 5. The plates are kept 1-2 mm apart from each other so that the weld pool fills completely between the two plates during welding.

Fig.5: MS Plates clamped on Vibration Table

Now, Shielded Metal Arc Welding is to be carried out in order to make butt joint on MS plates. First of the vibration table is earthed in order to have MS plate conducting. A current of 140-190 amperes is supplied, and then arc is created by striking in between the plates.

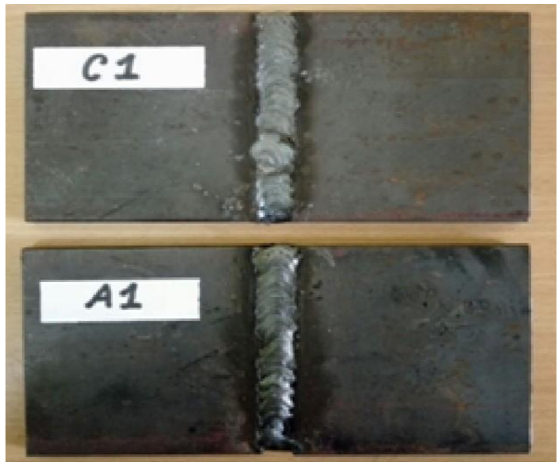

Fig.7: Welded Plates Marked- C1 (With Auxiliary Vibrations) & A1 (Without Auxiliary Vibrations)

4. RESULT AND DISCUSSION

To measure the mechanical properties tensile test, hardness test, impact test are performed on test specimen. Tensile test was used to determine the ultimate tensile strength and yield point under static loading of base metal, weld metal and welded joint. Percentage elongation has also determined

Table 4: Comparison Table of Mechanical Properties

S.No.	Mechanical Properties	Sample A1	Sample C1	Improvement
1	Maximum Force (Fm)	63.960KN	82.620KN	29.17 %
2	Tensile Strength (Rm)	342.12 3 MPa	404.56 1 MPa	18.25 %
3	Elongation	12.623%	17.589%	39.34 %
4	Reduction in Area (Z)	21.212%	31.922%	50.14 %
5	Yield Stress	330.25 8 MPa	319.65 3 MPa	3.21 %

5. CONCLUSION

In this study, vibrations are induced with SMAW for improving the mechanical properties of the base material and the weld metal. Due to auxiliary mechanical vibrations, long dendrites break and form a new nucleation sites and a non-uniform solidification process took place. Following results were obtained during conduction of research work. Tensile strength 18.25 %, Elongation 39.34 %, Force 29.17 %, Reduction in area 50 % and Yield stress is 3.21 % was more with vibration as compared to without vibrations welding with SMAW.

6. REFRENCES

[1] Dwivedi, Shashi Prakash, et al., 'Effect of Process Parameters on Tensile strength of 1018 Mild Steel Joints Fabricated by Microwave Welding', Metallography, Microstructure, and Analysis February 2014, Volume 3, Issue 1, pp 58-69.

[2] Hussein, A. R., Jail N. A., Talib, A. R. A., Improvement of mechanical welding properties by using induced harmonic vibration, Journal of Applied Sciences, vol. 11, 2011, p. 348- 353.

[3] Singh, Jaskrit Singh, et al.., 'Influence of Vibrations in Arc Welding over Mechanical Properties and Microstructure of Butt-Welded-Joints' International Journal of Science & Technology, vol. 2, Issue 1, February 2012.

[4] Madhusudan, R. et al., 'Study on Effect of Weld Parameters On Mechanical And Micro Structural Properties Of Dissimilar Aluminium Alloys FS Welds' International Journal Of Mechanical And Production Engineering, 1/1 (2013), 25-30.

[5] Kuo, Che-Wei, et al., 'Characterization And Mechanism Of 304 Stainless Steel Vibration Welding', The Japan Institute Of Metals, 48/9 (2007), 2319-2323.

[6] Burzic, Meri, et al., 'Effect Of Vibration On The Variation Of Residual Stresses And Impact Energy In Butt-Welded Joints', Structure Integrity And Life, 12/3 (2012), 215-220.

[7] Tewari, S. P., Shanker, A., Effects of Longitudinal Vibration on Hardness of Weldment, Journal of Engineering Manufacture, vol. 207, no. B3, 1993, p. 173-177.

[8] PARMAR, R.S., 'Welding Engineering And Technology', (Kalyani BO Press, 2010) 135-145.

[9] Verma, Akanksha, et al., 'Vibratory Stress, Solidification and Microstructure of Weldments under Vibratory Welding Conditions-A Review', International Journal of Engineering Science And Technology, 3/6 (2011), 5215-5220.

[10] Hornsey, J.S., 'Vibratory Stress Relieving – It's Advantages as an Alternative to Thermal Treatment', VSR (Africa) (2004).

[11] Verma, Akanksha, et al., 'Vibratory Stress, Solidification And Microstructure of Weldments Under Vibratory Welding Conditions-A Review', International Journal of Engineering Science And Technology, 3/6 (2011), 5215-5220.

[12] Qinghua, Lu, 'Improving Welded Valve Quality By Vibratory Weld Conditioning', Materials Science and Engineering (2007) 246–253.

[13] Dvornak, M.J.,et al., 'Influence Of Solidification Kinetics On Aluminium Weld Grain Refinement', Welding Journal, 70/10 (1991), 271.