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INFLUENCE OF VIBRATIONS IN ARC WELDING OVER MECHANICAL PROPERTIES AND MICROSTRUCTURE OF BUTT-WELDED-JOINTS

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ABSTRACT
We employed dynamic solidification technology, by applying mechanical vibrations during the solidification in SMAW process. It has the advantages of less investment, more convenient operation, less pollution and shorter manufacturing period. 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. Metallographic studies conducted show that weld metals under vibratory condition possessed relatively finer microstructure and hence high micro hardness, owing to dendrite fragmentation.

1. INTRODUCTION

The aim of this work was to obtain a modification of the microstructure by mechanical vibrations. The final goal consists in an improvement of the hardness and mechanical properties. This study was extended to investigate the effect of vibratory set up on the mechanical properties of 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[1].

Bad bead profile has a considerable effect on the performance of weld. If one pass of a multi-pass welding has a bad bead profile it can cause incomplete fusion or slag inclusions, even though the subsequent weld asses will partially remelt the first pass. In vibratory welding, stirrer produce a disturbance in weld pool during solidification. After completion of nucleation, the solidification process will continue with nucleus growth. Increasing the growth rate will reduce the grain size of metal**.** In welding, as the heat source interacts with the material, the severity of thermal excursions experienced by the material varies from region to region, resulting in three distinct regions in the weldment [2].

2. EXPERIMENTAL DETAILS

The following section highlights the material, its properties and welding process used for laying down the vibratory welding bead and there testing.

2.1 Material used

SS 202 is an Austenitic Standard grade Stainless Steel. It is commonly called AISI Type 202 Chromium-Manganese-Nickel

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steel. It is composed of (in weight percentage) 0.15% Carbon (C), 7.5-10.0% Manganese (Mn), 1.00% Silicon (Si), 17.0-19.0% Chromium (Cr), 4.0-6.0% Nickel (Ni), 0.06% Phosphorus (P), 0.03% Sulphur (S), 0.25% Nitrogen (N), and the base metal Iron (Fe).

2.2 *Welding Process used*

The SMAW process is an arc welding process which produces coalescence of metal by heating them with an arc between a covered metal electrode and the work. Shielding is obtained from decomposition of the electrode covering. Pressure is not used.Filler metal is obtained from the electrode (ANSI/AWS A3.0, Welding Terms and Definitions). This is the most widely used method for general welding application,The SMAW process can be used for welding most structural and alloy steels. These include low-carbon or mild steels; low-alloy, heat treatable steels; and high-alloy steels such as stainless steels. This welding process can be used in all positions flat, vertical, horizontal, or overhead and requires only the simplest equipment. Thus, SMAW lends itself very well to field work [3].

The welding machine was drooping type. This is used generally in manual process like SMAW. The study was on low and high input combinations. For the low heat input current was 90 to 110 A and for high input the current was 130 to 160 A.

2.3 *Vibratory Setup for Welding*

With an aim of improving the mechanical properties of weld joints through inducing of favourable changes in the weld microstructures, an auxiliary vibratory set up capable of inducing mechanical vibrations into the weld pool during shielded metal arc welding (SMAW) was designed and developed. A high frequency with low amplitude is used along the weld length, just trailing behind the welding arc so that weld pool could be mechanically stirred in order to induce favorable micro structural effects [4].

This setup produces frequency around 149 Hz with the maximum amplitude is around 3.08 voltage. Since the setup has to be in direct contact with welding arc, to produce the vibration under the weld pool at very high temperature so we used Thoriated tungsten rod having the melting point around 3410^{0}C which is capable to withstand at this high temperature. The diameter of electrode is 2.0mm [5].

Fig: 2.1Vibratory setup

2.4 *Butt welding by 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

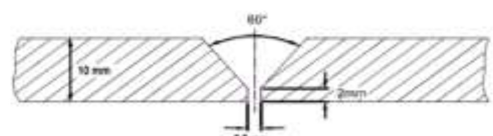

Fig.2.2 Geometry of butt weld joint

2.4.1 ***Butt Welded Joint (at low current)***

This butt welded joints was under the low heat input (90-110 Amp).There were 4 number of passes to fill the gap, in which 3 main passes and 1is root pass. During the root pass there was no role of vibratory

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setup. After the root pass vibratory setup came in action and moved just behind the arc and make a disturbance during the solidification of weld bead.

Butt welds (Low current) top to bottom in longitudinal direction		
Sr. Number	Conventional process	Vibratory Condition
-7	225	261.4
-6	228	271.8
-5	280.1	225
-4	217	240
-3	225	273.9
-2	250	282.5
-1	230	240.4
0	247.3	258.3
1	235.1	282.2
2	233.1	302.5
3	273.1	296.1
4	277.9	279.6
5	252	263
6	247.9	250.5
7	228	230

Table 3.1 Results of Micro-hardness

2.4.2 ***Butt Welded Joints (at high current)***

This butt welded joints was under the low heat input (130-160 Amp).There were 4 number of passes to fill the gap, in which 3 main passes and 1is root pass. Due to high heat input large size of fusion zone forms. So the effect of vibrations on the large fused zone was investigated in this experiment.

3. **RESULTS AND DISCUSSIONS**

3.1 ***Micro-hardness studies***

The readings of microhardness of the pieces were studied by the Vicker hardness machine, under the load of 500 gm with a dwell time of the 20 second

Table 3.2 Results of Micro-hardness
(At High current)

Butt welds (High current) top to bottom in longitudinal direction		
Sr. No.	Conventional process	Vibratory Condition
-7	227	348.1
-6	260	350.5
-5	248	346.4
-4	233	293.2
-3	241	250.7
-2	261.5	273
-1	271.5	263
0	268	269.2
1	250	245.9
2	245	240.9
3	247	252.6
4	255.1	272.2
5	260	259.9
6	270	291.4
7	240	249
8	267	271

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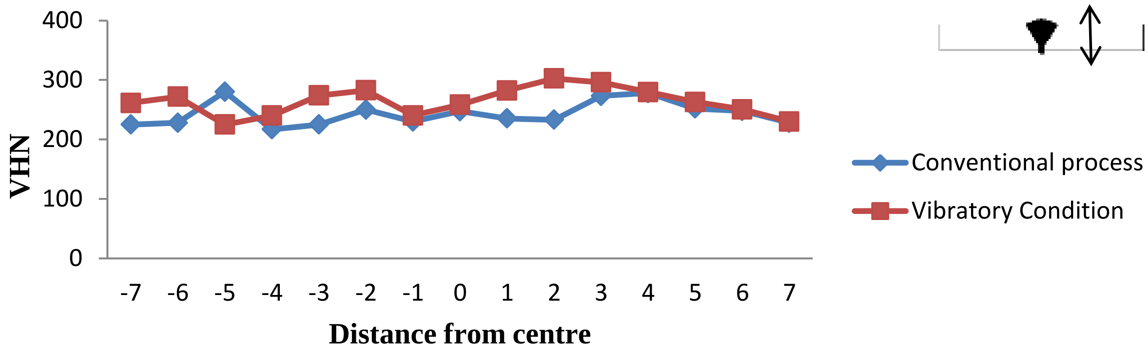

Fig. 3.1 Graph of micro-hardness (at Low current)

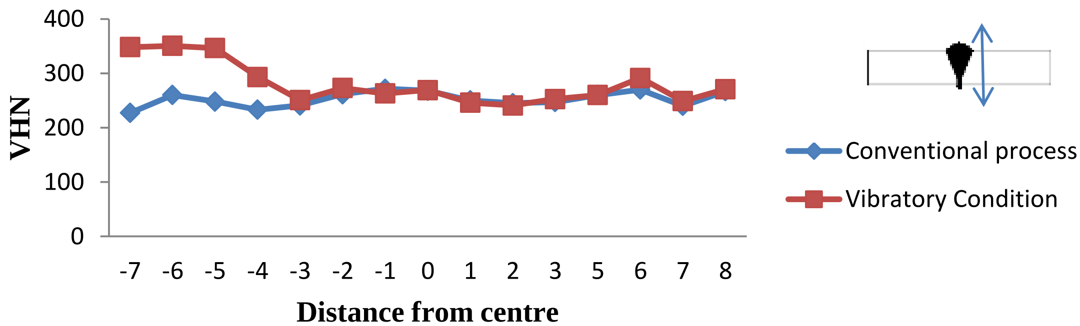

Fig. 3.2 Graph of micro-hardness (at High current)

3.2 Mechanical testing of butt joints

This testing was to investigate the effect of vibratory set up on the mechanical properties of 10 mm thick stainless steel 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.

Table 3.3 Tensile properties of Butt welded joints with High and low heat inputs

Properties	**High current conventional**	**High current vibratory**	**Low current conventional**	**Low current vibratory**
Yield strength	367.313 MPa	409.862 MPa	363.947 MPa	367.313 MPa
Tensile strength	636.947 MPa	625.263 MPa	576.789 MPa	606.474 MPa
Percentage Elongation	13.00%	14.80 %	15.40%	11.00 %

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During tensile test the breaking point of the High current vibratory (HCV) & low current vibratory (LCV) specimen's was away from the welding zone where as in case of Low current conventional (LCC) and high current conventional (HCC) it was near the welding zone which shows that the joint efficiency in case of HCV and LCV is higher than the HCC and LCC.

3.3 ***Metallurgical study of specimens***

Metallographic study shows that during conventional butt-welding the uniform long dendrites which show that a uniform solidification process took place with uniform dentrites shown in the fig.3.3 and fig 3.5 with low and high welding current respectively, Long dendrites show Corse structure of the weld joint. The microstructure shows the uniform solidification process.

Under vibratory conditions In fig. 3.4 and fig. 3.6 with low and high welding current respectively, the microstructure of vibratory butt-weld joints, long dendrites get fragmented and break in small dendrites break and forms a new nucleation sites. Here dentritic fragmentation took place due to which fine structures form. which enhanced the hardness and mechanical properties of weld joints [6].

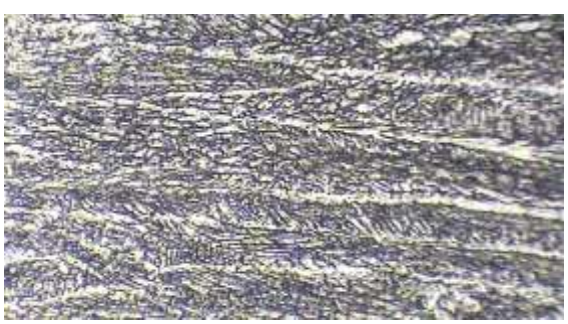

Fig. 3.5 Microstructure of conventional SMAW

(High current)

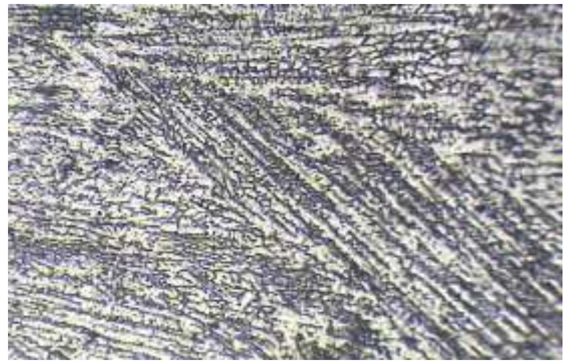

Fig. 3.3 Microstructure of conventional SMAW (Lowcurrent)

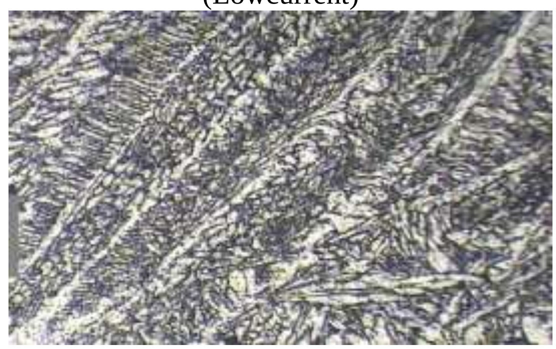

Fig. 3.4 Microstructure of vibratory SMAW (Low current)

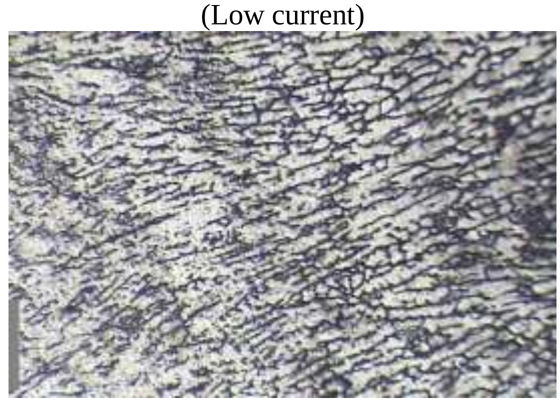

Fig. 3.6 Microstructure of vibratory SMAW (high current)

4. CONCLUSIONS

- Weld metal micro-hardness was found to increase in almost all the cases under vibratory condition to a significant extent

- During conventional butt-weld joints uniform long dendrites which show that a uniform solidification process took place with uniform dentrites
- Due to auxiliary mechanical vibrations long dentrites break and forms a new nucleation sites.
- 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.

5. REFERENCES

[1] Ch. Vives.. Effect of electromagnetic vibration on the microstructure of continuously cast alloys", Material Science Eng. A, , A 173:169-172(1993).

[2] M.C. Flemings, Solidification Processing ,New York: McGraw Hill, 1974.

[3] Erokhin, A. A. The basic stages in arc welding and theirmetallurgical characteristics. IZVEST. AKAD. NAUK SSSR MET.i TOPL. **2:77 -82,**1961.

[4] Sindo Kou, Welding Metallurgy, second edition, John Wiley & Sons, inc., Publication (2003).

[5] Miclosi, V., Solomon, G.H. and Tonoiu, l., Research regarding the influence of axial electromagnetic pulsation of liquid metal bath upon the characteristics of the weld, Euromat 93, The Third European Conference on Advanced Materials and Processes, Vol. 1, (Proc. Conf.) Paris, Framce, 8-10 June 1993, J. Phys. (France) IV, 3:119-122(1993).

[6] Yamamoto, H. Harada, S., Ueysama, T., Ogawa, S., Matsuda, F., Nakata, k. and Yosetsu, K.K., The beneficial effect of low frequency pulsed mig welding process on grain refinement of weld metal and improvement of solidification crack susceptibility for al alloy, Journal of Light Metal Weld Construction, Vol.31, No.2:12-20(1993).

[7] Sobolev, V.V., Study of liquid solidification during the welding process in the ultrasonic field, Metals Abstract, 55-0159:203 (1995).

[8] Watanabe, T. and Nakamura, H., Solidification control of austenitic stainless steel weld metal by electromagnetic stirring, National Research Institute for Metals (Japan), Trans, Japan Welding Soc., Vol. 21, No.2:37-43(1990)

[9] Nagy, M. J., Jr. and D. M. Kelman, Application of ultrasonic vibrations during solidification of vacuum-arc melted Ingots. METALS ENGINEERING QUARTERLY 1:72-82, Nov 1961.