Influence of Vibrations on Weld Characteristics

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Abstract

The influence of longitudinal vibration on certain weld characteristics have been studied in the present paper. Longitudinal vibration have been imposed by electrodynamic vibrator in the frequency range of 40Hz to 10Hz and amplitude ·0005 cm. to ·0025 cm. during experimentation with the mild steel work pieces. It has been observed that hardness of the weldment increase due to increase in frequency and amplitude of vibration. Increase of frequency affects more than amplitude increase on hardness.

Percentage elongations of the specimens decrease with increase in frequency and amplitudc of vibration. Porosity is reduced at higher frequency and amplitude.

Introduction

Basic process of metal arc welding incorporates melting of base metal, electrode metal core and electrode covering with the enormous heat of the arc. Alloy produced from the molten base metal, core wire and metal powders in the coverings freezes to form the weld. This process is very much similar to manufacture of a casting in foundry and may be considered as producing casting in metallic mould. Fluxes and electrode coverings used in submerged arc welding produce slags which are similar to those used in steel manufacture. Furthermore, heat of welding imposes thermal cycle on the base metal that is simialr to one used in heat treating steel and other base metals. It has been experimentally determined that mechanical and physical properties of casting solidified under the influence of vibration are generally improved (1,2,3,4). As two processes (casting and welding) have wide areas of similarity, so observing improvement in properties because of vibration imposed during the solidification of the casting, its influence on weld properties has been studied experimentally[5].

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Vibration may broadly be classified in two categories (1) using high frequency vibration in ultrasonic range and (2) using low frequencies in sonic range. Vibration is produced by vibration generator. Depending upon the frequency of vibration, vibration generators can be classified in two broad categories. (1) Sonic vibration generators, (2) Ultrasonic vibration generators. Although there does not exist a strict line of demarcation between these two, it has been a general practice to treat vibration above 16 KHz as ultrasonic.

In the present set up sonic vibration generator has been used in low range of frequency (40 to 80 Hz).

General Arrangement of the Experimental set up :

Figure 1 and figure 2 show schematically the general arrangement of various units and measuring instruments used in the present experimental set up. Transformer is connected to 440 volts, 3 phase mains. Two terminals of the output of transformer are connected to the electrode holder and the ground connector respectively. Electrode holder lead is passed through the core hole of the current transformer. A multimeter having terminals for voltage is connected across the secondary terminals of the transformer. An ammeter 0 to 2 amps is connected to the two terminals of the current transformer, Reading of this ammeter multiplied by 100 gives the actual value of current.

Mechanical vibration exciter is given 50 volts D. C. supply. Frequency control knob of the unit and hand wheel for adjusting the amplitude are operated to achieve various frequencies and amplitude of oscillations respectively.

In order to measure vibrational frequencies and amplitudes, vibration pick up, MB-124 type is placed on the machined surface of work piece. It is connected with cable and connectors to the Bruel and Kjear vibration exciter control type 1025 at displacement generator input point. The Bruel and Kjear type 1025 unit takes about 2 minutes for warming up. Thus warming up period has been given before noting the reading of the displacement scale.

Experimental Procedure

Work pieces have been clamped on the vibration table. Desired frequency and amplitude of vibration are achieved by frequency control and amplitude control respectively incorporated in the vibration unit. Welding current is adjusted for 170 amps. First reading of frequency is taken after calibrating Audio Oscillator with the help of Oscilloscope and subsequent readings for frequency are taken straight away from the former. For recording amplitude pickup is connected to the vibration table and by the automatic vibration control amplitude is recorded. Readings of voltmeter and ammeter are continuously watched for possible variations during welding. Welded joint is made by taking two workpieces and welding them keeping them on vibrating table and recording the readings of frequency and amplitude. Each welded joint for each pair of workpiece has been prepared by three passes of welding electrode.

Experimental results and discussion

Specimens have been tested and following effects been noted :

1. Effect of vibration on hardness
2. Effect of vibration on percentage elongation and porosity.

Effect of vibration on hardness

Table 1 for hardness shows B.H.N. of the various weldments. It is noted that the lowest value of hardness is in the test specimens 1, 2, & 3, made without vibration. So vibration has positive effect on the value of hardness of the weldments. Hardness is observed to increase in weld zone region from upper crest to weld fusion boundary. It is maximum at weld fusion boundary and then again decreases in heat affected zone. Table for hardness reveals that hardness of each zone increases with vibration application. Hardness is also observed to be increasing with increasing amplitude and frequency. Hardness increase due to vibration is for the following reasons :

Hardness of weld metal zone might be increasing due to formation of harder phases in the weld metal zone. Further it has been observed that application of vibration will reduce the gas and shrinkage porosity in the weld metal. This will result in increase in hardness of the weld metal zone.

Observation

Two sets of test specimens tested to observe the effects of vibration on the weld deposit and on the tensil properties of weldment. Details are given in Table 1 & 2 respectively.

Table 1 : Hardness test (*B.H.N.*)

1. Diameter of the steel ball D =2.5 mm.
2. Load applied P =187.5 kg.

Diameter of indentation and Brinell Hardness Number
(*at two location, A & B*)

Specimen No.	Diameter of indentation (mm)		B.H.N. for	
	A	B	A	B
1	1.28	1.28	135.48	135.48
2	1.28	1.28	135.48	135.48
3	1.27	1.28	137.79	137.79
4	1.28	1.27	135.48	137.79
5	1.27	1.27	137.78	137.79
6	1.27	1.28	137.79	135.48
7	1.27	1.27	137.79	137.79
8	1.27	1.26	137.79	140.17
9	1.26	1.26	140.17	140.17
10	1.26	1.26	140.17	140.17
11	1.25	1.26	140.53	140.17
12	1.25	1.25	140.53	140.53
13	1.25	1.24	140.53	145.11
14	1.24	1.25	145.11	140.53
15	1.24	1.24	145.11	145.11

Table 2 :

Tensile test specimen : original cross section of the specimen=43 mm× 10 mm. Area=430 mm(²)

Load at the yield point, ultimate point, breaking point, and percentage elongation at various frequencies and amplitudes :

Speci. No.	Frequency C.P.S.	Amplitude mm.	Load in tonnes at Yield point	ultimate point	Breaking point	% Elongation
1	0	0	—	11	11	13
2	0	0	—	12	12	12
3	0	0	—	12.7	12.7	13
4	40	0.005	12.7	15.4	15.4	9
5	40	0.020	12.8	15.6	15.6	8.5
6	40	0.025	12.9	15.8	15.8	8
7	60	0.010	12.9	15.6	15.6	8.5
8	60	0.015	13.0	16.0	16.0	7
9	60	0.025	13.0	16.4	16.4	6
10	70	0.010	12.9	16.2	16.2	6.5
11	70	0.020	13.0	16.4	16.4	6
12	70	0.025	13.0	16.8	16.8	5.5
13	80	0.015	13.0	17.2	17.2	6
14	80	0.020	13.0	17.6	17.6	5
15	80	0.025	13.0	17.8	17.8	5

Effect of vibration on percentage elongatian and porosity

Percentage elongation decreases as the frequency and amplitude of vibration increases when it is compared with the percentage elongation of the stationary welded specimens. This shows that material of weld zone gains brittleness due to imposed vibration thereby reducing the value of percentage elongation.

Porosity after solidification of metal is caused due to entrapment of evolved gases or because of shrinkage cavities. Positive trend regarding the influence of vibration on porosity is apparent as because of vibration entrapped gases can escape quickly.

Conclusion :

The investigation done, the results obtained and the discussions put forward in the present work may be concluded in the following fashion :

1. Vibration of weld metal pool increases the hardness of the weldment. As we go on increasing the frequency and amplitude of vibration the hardness will increase. Observations show hardness increase with frequency and amplitude. Hardness increase due to formation of harder phases. It is observed that frequency has more pronounced effect on hardness as compared to amplitude.

2. Vibration effect on percentage elongation is that vibration reduces percentage elongation with rise in frequency and amplitude which predicts that material (weld zone) becomes harder.

Vibration reduces porosity in weld zone as it provides easy & quick removal of entrapped gases.

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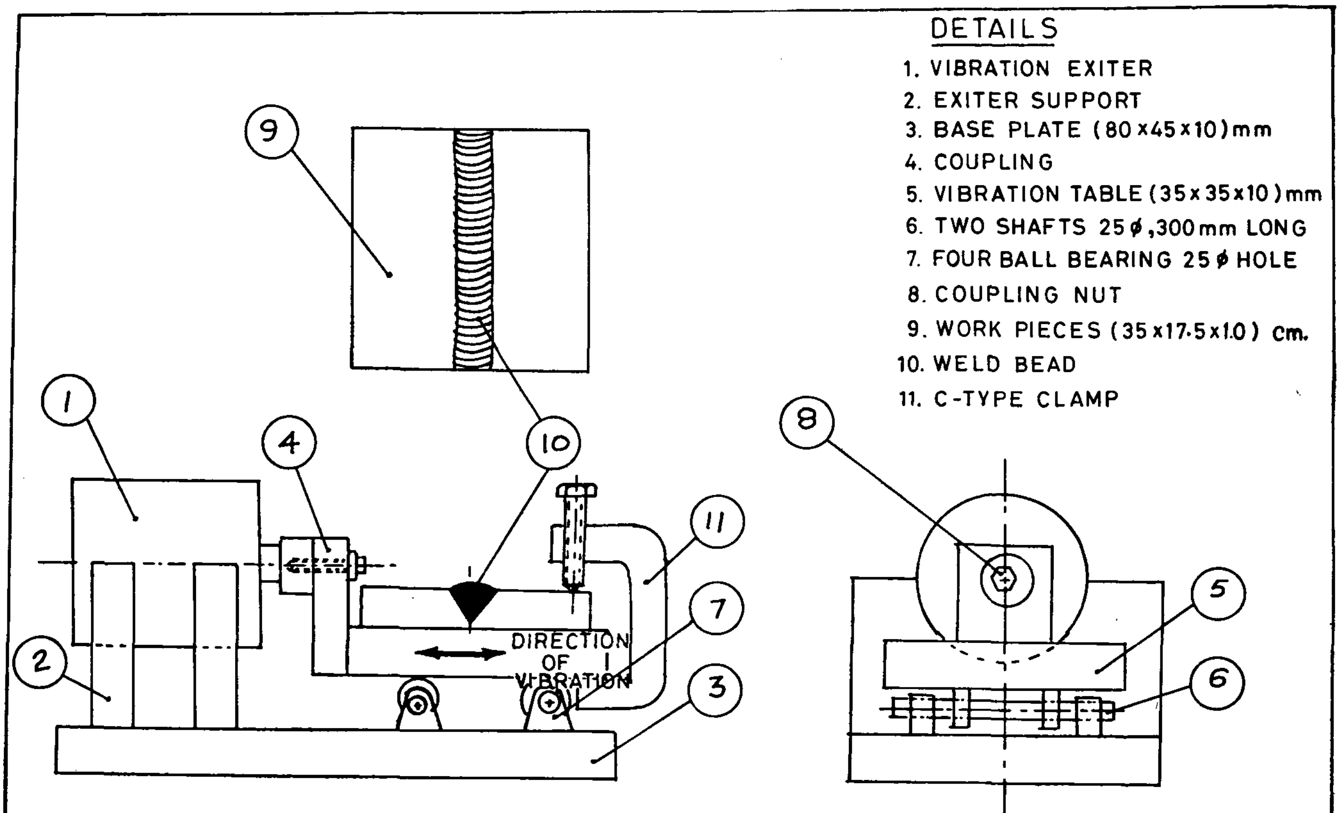
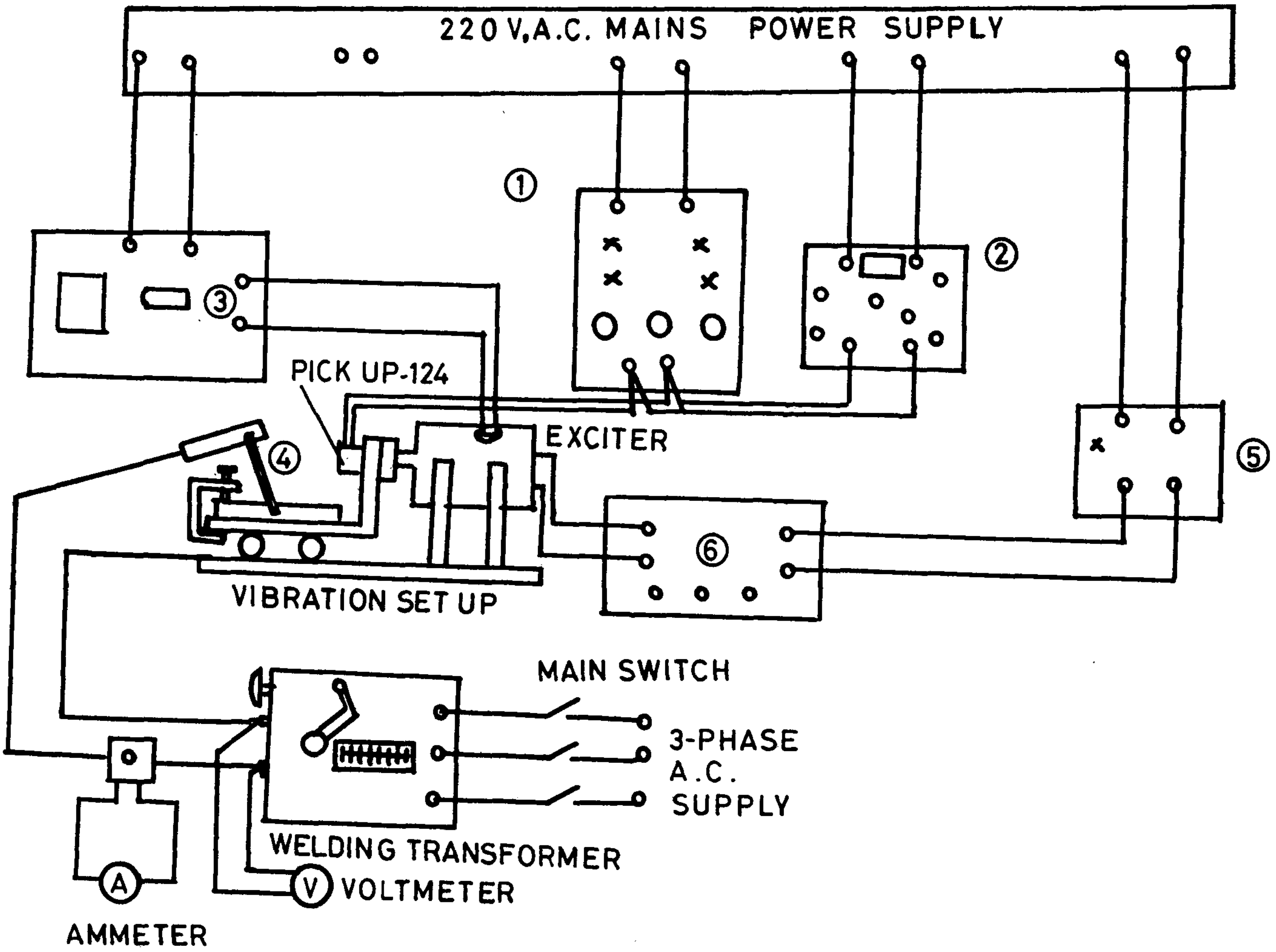


FIG. 1 - VIBRATION SETUP

for schematic diagram see next page



① AUTOMATIC VIBRATION EXCITER CONTROL TYPE-1025 ② TYPE 502A DUAL-BEAM OSCILLOSCOPE ③ 50 V D.C. POWER SUPPLY ④ ELCTRODE ⑤ AUDIO-OSCILLATOR ⑥ POWER AMPLIFIER.

Fig. 2 Schematic diagram of the experimental set up.

Corrigendum

In the news section (Page 103) of October 1985 issue of IWJ (Vol. 17, No. 4) under the heading—Information on the existing Indian Books on SAW & MIG/MAG Welding—the name of Mr. A. C. Lahiri has been erroneously mentioned as the Chairman of Commission XII of The Indian Institute of Welding. In fact Mr. N. S. Subbanna, Vice President Quality and Reliability of Kirloskar Electric Company Ltd., Bengalore is Chairman of Commission XII of The Indian Institute of Welding and Mr. A. C. Lahiri is a Member of Commission XII of the International Institute of Welding. The request from the International Institute of Welding came to Mr. Lahiri in his capacity as a Member of its Commission XII. This inadvertent error is regretted—Editor.