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Influence of Mode of Power Source on the Mechanical Properties of Vibratory Weld Joints

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Abstract: ***Welding plays a major role in modern technology. During welding, a portion of the specimen is subjected to heating. Because of different heating and cooling cycles of the specimen, residual stresses induced in the specimen i.e., mechanical properties gets reduced. To enhance the mechanical properties there are different techniques are available i.e., thermal and non-thermal methods. Vibratory welding is the one of the non-thermal method; mechanical properties of steel specimens are analyzed under with and without vibrations under different power source condition. In this paper input parameters which are considered is straight polarity, reverse polarity and alternate current. Tensile and hardness property of the steel specimen are analyzed and compared with the without vibratory condition.***

Keywords: ***AC and DC power source, hardness, tensile strength, Vibratory welding and Welding.***

I. INTRODUCTION

In fusion welding, thermal stresses and strains are induced, which will distort the structures. In this, tensile stresses plays a major role, these will reduce the mechanical properties. Reduction of tensile residual stresses is achieved through various techniques one of them is imparting transverse vibrations during welding. Suresh, B.V., et.al [1-2] investigated effect of stress relieving methods on welded joints. Authors concluded that welding with vibrations is an effective way to eliminate defects encountered by general welding process. The parameters like frequency, current and voltage are considered as the input parameters for the process. The vibrations during welding are the most effective method for better penetration of liquid metal. With these unique techniques the hardness of the mild steel specimens were increased because of suitable excitations during the process. Campbell, S., et.al. [3] Predicted a welding geometry generated using GMAW by an ANN model (Artificial Neural Network).

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This is a new method developed for shielding gases supplied to welding zone where gases are supplied with a range of given frequency. This model predicting the penetration of molten state of metal by alternating frequency of shielding gas. This approach suggests the shielding gases alternation and raised welding speed needed to produce same type of weld geometry materials by using conventional technique on Ar/20%CO2. Dutta, P. and Pratihar [4] generated a CRA (regression analysis conventionally) on TIG welding process data to know the relationship between input–output parameters. The performances of the CRA approach, BPNN (back propagation neural network) and GANN(Genetic algorithm neural network) were tested on randomly generated results, which are completely different from trained experimental cases. It is identified that experimental cases and NN approaches are almost acceptable when compared with CRA. G. Musalaiah et.al introduced vibrations to reduce residual stress on lap-weld joints and hence a novel technique is introduced to eliminate defects encountered by general welding process. G Ramakrishna et.al explained about various welding process with the effect of vibrations and the absence of vibrations and came to a conclusion that specimens which are prepared under the effect of excitations are have much better properties than the specimens prepared without the implication of excitations. And also validated the experimental results with the finite element analysis approach. The results shown with this comparison is concluded that vibration welding is the best alternate method PWHT process.

The mechanical properties which are produced under the effect of excitations are validated with the finite element analysis. J. Kalpana et.al [5-6] introduced another new technique i.e., metal engravers to enhance the weld joint mechanical properties of the welded joints by. Here the dissimilar metals were considered for welding process. The properties of the dissimilar materials were identified and came to a conclusion that specimens which are prepared under the effect of excitations are have much better properties than the specimens prepared without the implication of excitations. By varying the input parameters of the metal engravers like voltage, frequency and vibrational period the process is done and enhancement of properties are taken place. P.Govinda Rao., et.al.,[7-12] introduced the new experimental setup for inducing mechanical vibrations through unbalanced weight's. By considering the input parameters like vibrating period for specimens and voltage of the vibromotor.

The frequencies ranges are identified by RMS value because the excitations produced by vibromotor is random vibrations. The microstructure analysis is done to validate the improved mechanical properties of the weldments and by observing it is identified that the grain refinement is taken place with the level of increasing the vibrations during welding process. The dendrites size is breaks down in to fine particles due to weld pool refinement. Along with that in order to identify the range of frequencies for the welding process GRNN tool is used to identify the unknown parameters without conducting the experiment. And the frequency of the motor is regulated up to some extent because whenever the amplitude is crossing 0.5mm the arc gap is increasing and structure is disturbing. And finally concluded that with help of unbalanced weights the excitations can pass over the specimens during welding and the properties can be improved by minimizing the residual stress and the distortions. P. Lakshminarayana., et.al [18] simulated the vibratory welding parameters through finite element analysis and the various parameters introduced to identify the behavior of the weldments with the excitations and without the excitations. With this method the properties of the materials can be easily identified without conducting the experimentation. Concluded that with the finite element simulations the results are very accurate. P. Govinda Rao., et.al., introduced GRNN model to get the relation between the time vibrations and welding parameters. Rao, M. V.et.al.,[13-17] done the same process with the aluminum alloys through TIG welding process. To improve the weld joint mechanical properties of the non-metals through welding vibrations are introduced. These vibrations are improved the weld quality because of weld pool refinement. And finally it is suggested that the fine grain structure is obtained through weld pool refinement and properties are improved with decrease in distortions and gaps.

In this an attempt is made to analyze the influence of mode of power source i.e., alternate current and direct current on the mechanical properties of vibratory welded joints.

II. Experimentation

1018 steel specimens are chosen for the experimentation. Experimentation is carried out on the vibration platform. Vibration platform is mounted on the steel legs supported with springs. Vibromotor is attached to the vibration platform at the bottom. Unbalanced weights are mounted on the either side of the motor shaft. Unbalanced vibrations create transverse vibrations. The speed of the vibromotor is controlled by means of varying voltage input to the vibromotor through dimmerstat. The experimental setup shown in Fig. 1.

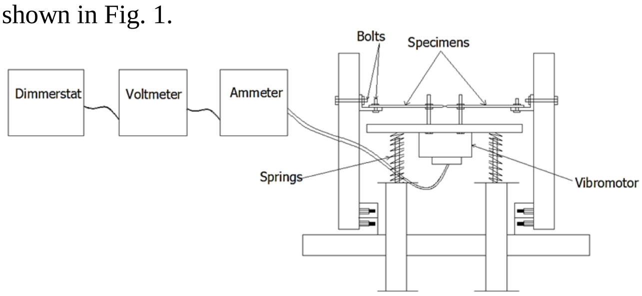

Fig. 1.Vibration setup [15]

Steel specimens of 200mm x 50mm x 5 mm single V-butt joints are prepared. From the literature optimum voltage i.e., 230 V considered as vibromotor voltage input. Vibrations are imparted to the specimen during welding. 1018 steel specimens are clamped directly on the vibration platform by using clamps. After clamping set the voltage as 230 V with the help of dimmerstat, specimens are welded using shielded metal arc welding. The relationship between voltage input to the vibromotor and amplitude of the specimen with which it is vibrated is shown in Fig. 2

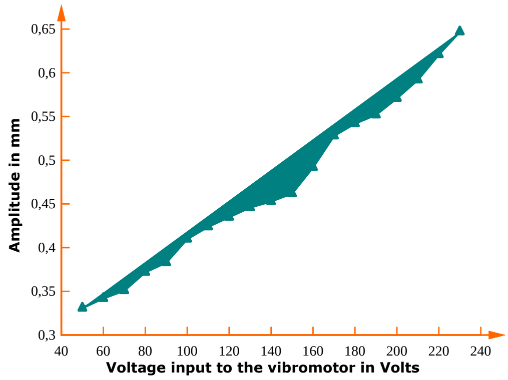

Fig. 2.Relationship between voltages input to the vibromotor and amplitude [17]

In this, specimens are welded at different power sources, i.e., AC, DC work piece negative, DC work piece positive. These specimens are compared with without vibration conditions. The input conditions considered for the welding in DC power source as 25 volts welding voltage and 90 amps as welding current and in AC, welding voltage as 65 volts and 160amps as welding current. Welded Specimens are further tested for their hardness and tensile strength. Fig. 3 shows the specimens for tensile testing.

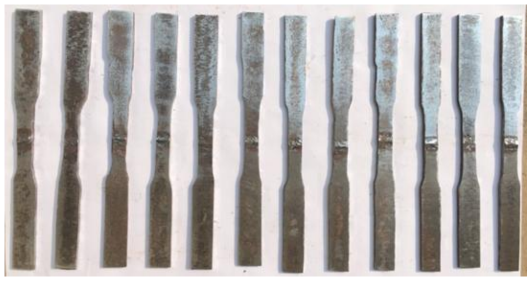

Fig. 3.Specimens for tensile strength before testing

III. RESULTS

Steel Specimens which are welded during vibration are tested for their hardness and tensile strength as per ASTM E18 and ASTM E8 respectively. Vibratory welding has a significance effect on the hardness and tensile strength when compared with non-vibratory weld condition. Hardness of the specimens is more for the specimens which are welded with AC power source with vibration condition. Similarly in DC, work piece negative, electrode positive with vibration has more hardness compared to the without vibration and DC electrode negative condition.

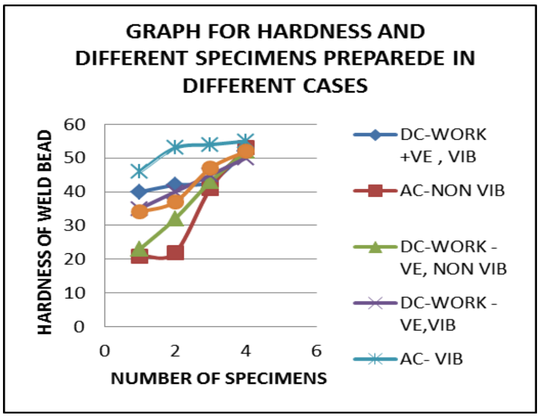

Fig. 4. Hardness of the steel specimens

Prepared tensile test specimens are tested for their tensile strength. Tensile test results are shown in the table.1. In this, DC work piece negative electrode negative with vibration condition has more tensile strength compared to the without and electrode positive condition. In the case of AC power source, Tensile strength is more for the specimen which has vibrated during welding compared with non-vibratory condition. Fig. 5 shows the tensile strength of the specimen welded at different input power source.

Table.1 Mode of power source vs. tensile strength

S. No.	Mode of Power Source and Vibrated /non-vibrated	Code	Tensile strength (Mpa)
1	AC Non-vibrated	ACNV	315.6
2	AC Vibrated	ACV	334.5
3	DC-Work piece negative Vibrated	DCWNV	407.8
4	DC- work piece positive Vibrated	DCWPV	362.5
5	DC-work piece negative Non –Vibrated	DCWNNV	329
6	DC- work piece positive Non –Vibrated	DCWPNV	334.5

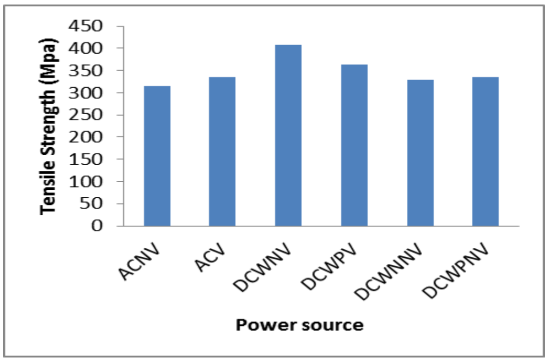

Fig. 5 Tensile strength of the specimens welded at different input power source

IV. CONCLUSIONS

After analyzing the results of hardness and tensile strength the following conclusions are made

a) DC work positive vibrating welding has more ultimate tensile strength compared to non-vibrating welding.

b) DC work negative vibrating welding has more ultimate tensile strength when compared with the non-vibrating welding.

c) AC work vibrating welding has more ultimate tensile strength compared with the non-vibrating welding.

d) Weld bead made by ac vibration having more hardness and weld bead made by ac non- vibration having less hardness.

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