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A Review On Effect Of Welding Speed On Weld Quality

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ABSTRACT: This paper discusses the effect of welding speed on the weld quality and microstructure of welded joints. The welding was performed using single and double wires and different speeds (16.93, 19.69, 25.4, 29.63 and 33.87mm/s). The weld quality was revaluated using non-destructive testing methods (NDT), while the weld bead characteristics were studied using weld geometry measurements. The weld microstructures were determined by using optical microscopes. A mutual relationship between welding speed, weld quality and microstructure was established. The modern investigation uses arc voltages, current, welding speed, wires feed rate and nozzle-to-plate distance as process parameters. Weld width has been found to increase with increase in voltage, current and wire feed rate and decreases with increase in welding speed and nozzle-to-plate distance.

KEYWORDS: *Submerged arc welding, weld width, welding speed, quality of weld.*

I. INTRODUCTION

Submerged arc welding is widely employed as one of the major fabrication processes in industries to-day due to its inseparable advantages of deep penetration, smooth bead, superior joint quality, good welding speed and excellent weld appearance (without spatter) and high utilization of electrode feed wire. The momentous process parameters include: welding current arc voltage, welding speed nozzle to plate distance and wire feed rate. The present work investigates the effect of these parameters on weld bead width. SAW is one of the ancient automatic welding processes developed during 1930s[1],[2] and contributes to approximately 10% of the total welding needs over the world and is commercially used for welding of low carbon steels, high strength low alloy steels, nickel base alloys and stainless steels [2].The detrimental effect of SAW speed on the quality and microstructure of the welds has been carefully examined by several researchers. Maintaining good and proper weld quality and high mechanical properties (mainly impact toughness and strength), is a big challenge.

Generally, the quality of a weld joint is directly ascendancies by the welding input parameters during the welding process; therefore, welding can be contemplated as a multi-input multi-output process. Unfortunately, a general problem that has faced the manufacturer is the control of the process input parameters to acquire a good welded joint with the required bead geometry and weld quality with minimal detrimental residual stresses and distortion. Traditionally, it has been inevitable to determine the weld input parameters for every new welded product to obtain a welded joint with the required descriptions. To do so, requires a time-consuming experiment and error development effort, with weld input parameters chosen by the skill of the engineer or machine operator. Then welds are examined to define whether they meet the specification or not. Finally the weld parameters can be chosen to produce a welded joint that closely meets the joint requirements. Also, what is not executed or often considered is an optimized welding parameters combination, since welds can often be produced with very different parameters. In other words, there is often a more ideal welding parameters combination, which can be used if it can only define. In order to overcome this problem, various optimization systems can be applied to define the desired output variables through developing mathematical models to specify the affinity between the input parameters and output variables. In the last two decades, Design of Experiment (DoE) techniques have been used to carry out such optimization. Evolutionary algorithms and computational network have also grown rapidly and been adapted for many petitions in different areas. In this paper a comprehensive literature review of the petitions (applications) of these techniques is presented. This review shows that the correlation between the input parameters (current, voltage, welding speed) and the output variables, the paper also presents the optimization of the different welding processes through the mathematical models. The classification of this literature review will be according to the weld joint features.Fig.1 shows the experimental set-up of SAW and fig.2 shows the weld bead width (W).

Fig.1 **Experimental set-up**

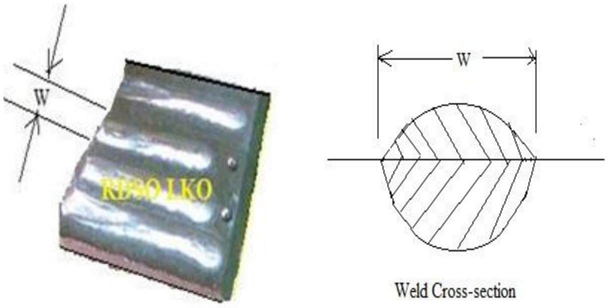

Fig.2 **Weld-bead width**

Weld-bead geometry

Theoretically, an extremely thin fused layer might be sufficient for connecting the parts which are to be joined. The fusion layer should also not be compact or broad than necessary in order to avoid wasting of energy, edge burn-off, sagging of the weld pool and deep weld end craters [3]. Control of weld bead shape is indispensable as the mechanical properties of welds are affected by the weld bead shape [4].Therefore; it is must clear that precise selection of the process parameters is necessary.In 2005, Gunaraj and Murugan [5] spread out their study and managed to found mathematical expressions to predict the penetration size ratio 'PSR' (the ratio of bead width to the height of penetration) and the reinforcement form factor 'RFF' (the ratio of bead width to the height of reinforcement). These expressions and the others developed earlier can be fed into a computer, relating the weld bead dimensions, weld bead geometry to the important SAW parameters, in order to optimize the process to obtain the required bead shape and weld quality.

II. MECHANICAL PROPERTIES

In any welding process, the input parameters have an influence on the weld joint mechanical properties. By varying the input parameters combination the output would be different welded joints with significant variation in their mechanical properties. Accordingly, welding is usually done with the aim of getting a welded joint with pre-eminent mechanical properties. To determine these welding combinations that would lead to pre-eminent mechanical properties. Different methods and approaches have been used to get this aim. The following is a review of some articles that utilized these techniques or methods for the purpose of optimizing the welding process in order to achieve the desired mechanical properties of the welded joint. To obtain good mechanical properties it is necessary to control all input parameters as welding speed, input current, input voltage etc.

III. METHODS FOR CONTROLLING BEAD GEOMETRY PARAMETERS

ANN and Taguchi methods were used to prophesy the bead geometry parameters (front width, back width and depth of penetration) by Seshank et al. [6]. Aluminium plates were bead-on-plate welded using pulsed current GTAW, the input and controlled parameters were: peak current, base to peak current ratio, % time at peak current, frequency and welding speed. Taguchi's orthogonal array method was used to set the welding conditions to be studied. Different ANNs were built to prophesy the responses. The results they achieved were found to be of excellent accuracy. An online relationship has been built to make the foretelling of the depth of penetration possible if the top bead width is known. Moreover, it was found that a simple MLP with a single hidden layer with a Tanh transfer function and momentum learning is more effective and better than the networks that have two or three hidden layers.

Murugananth et al. [7] have coupled ANN model with optimization software, which utilize linear and nonlinear techniques or methods to explore possible combination of carbon, manganese and nickel concentrations for a given set of welding parameters, to prophesy the weld metal composition that would maximize the toughness at – 60 °C. The predicted weld metal construction was Fe-0.034C-0Mn-7.6Ni-0.65Si-0.038O-0.018N-0.013P-0.006S (wt. %) and toughness of 87 J ±20 J at 60 °C.

Factors that affect weld mechanical properties (oxygen, nitrogen, carbon, hydrogen and iron contents in the weld joint as well as the cooling rate) of pure titanium mercantile been investigated by Wei et al. [8].ANNs techniques were used, to predict the ultimate tensile strength, yield strength, elongation, reduction of area, Vickers hardness and Rockwell B hardness. The input data was obtained from mechanical testing of single-pass autogenously welds. The ANN models were developed.

IV. RESULT AND DISCUSSION

The predicted influences of the welding parameters on the weld bead width within the range of parameters used are shown in Fig.3 and the interaction effects between variables are shown in Fig.4.

A. Direct effect or main effect of process parameters on weld width- Fig. 3 shows the effect of input parameters on bead width in submerged arc welding process.. The bead width increases with voltage, current and wire feed rate and decreases with welding speed and nozzle to plate distance.

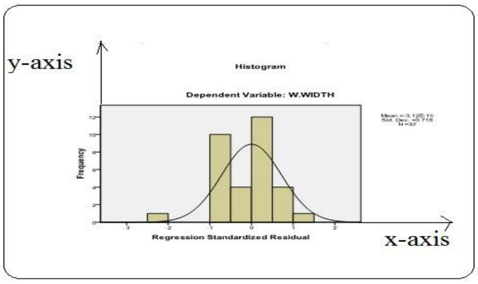

Fig.3 **Normality distributed errors**

B. Interactive effect of open circuit voltage, current, wire feed rate, welding speed and nozzle to plate distance: Fig.4 shows the combined effect of open circuit voltage, current, wire feed rate, welding speed and nozzle to plate distance on the weld width.

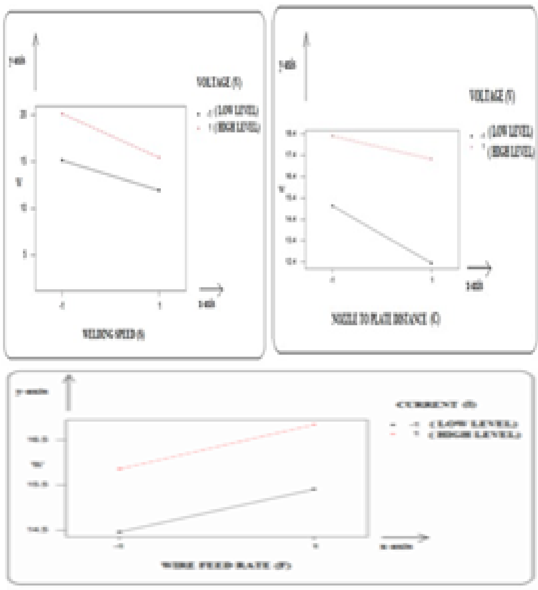

Fig.4 **Interaction Effect plot for weld width**

[1] It is final that at high voltage value as the current increases the weld width also increases but at low voltage value as the current increases the weld width decreases at a constant rate.
[2] It is must clear that at high voltage value the weld width increases with increase in wire feed rate the weld width decreases at low voltage value with increases in wire feed rate.
[3] The bead width is decrease with increase in welding speed at high voltage and bead width is less at low voltage. This is due to the fact that at high welding speed, the heat input per unit length decreases and therefore the bead width also decreases.
[4] At high voltage the bead width decreases with increase in nozzle to plate distance, however at low voltage value the width of bead also decreases at very fast rate with increase in nozzle to plate distance. This is due to longer the nozzle to-plate distance.
[5] At high input current value the weld width increases with increase in wire feed rate, however at low input current value weld width increase with increase in wire feed rate. This is due to the fact that at higher wire feed rate, the current is very high, so the effect of resistance heating will be very small as compared to arc heating. Therefore, the weld width increases.
[6] That at the high current value, the weld width decrease swiftly with increases in welding speed, however at high current value the weld width also decreases with increase in welding speed.
[7] At the high current value, the weld width decreases very quickly (swiftly or rapidly) with increases in nozzle to plate distance. However at low current value the weld width decreases at a lower rate with increase in nozzle to plate distance.

V. CONCLUSIONS

The present investigation scrutinizes and identifies the effects of welding parameters on weld quality. The welds were divided into four classes according to surface weld discontinuities, geometrical errors and internal weld discontinuities. The mechanical properties of the weld joints were uniform. On the basis of the results of this investigation the following conclusions can be drawn:

[1] Weld width swiftly increases with voltage, slowly increases with current and wire feed rate and decreases with welding speed and nozzle to plate distance.
[2] Welding current and welding speed are the most important welding parameters.
[3] The allowable range of variation of welding parameters, especially for the highest weld quality, is steep.
[4] Incomplete penetration (caused by inadequate welding current in relation to welding speed), extreme penetration (caused by excessive welding cur- rent in relation to welding speed), and undercut (excessive welding speed) are the most common weld discontinuities.
[5] It is possible to achieve defect-free high-quality welds with excellent strength and impact toughness properties. When the composition and strength of base material increase, toughness can be the limiting factor with regard to ductility.

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