EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF SAW WELDMENTS OF IS-2062 STEEL PLATES

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ABSTRACT

A study was undertaken to analyze Submerged Arc welding (SAW) of IS-2062 Steel plates keeping in mind the potential capabilities of SAW welding process and selecting IS-2062 Steel Plates as the base metal due to its wide applications in railway industries. Primary welding parameters, viz. welding current, arc voltage, welding speed and nozzle to plate distance were identified and investigations were carried out to study their effect on the weld strength of the weldments by using factorial design. A brief introduction to the SAW welding processes is included, along with the literature review of the research in the field of SAW welding of alloy steels.

KEY WORDS: IS-2062 Steel, Submerged Arc Welding, Weld Strength & ANNOVA

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INTRODUCTION

Mechanical properties of submerged Arc welds determine the quality and life of welded joints. Properties which determine quality of weld are mainly the depth of penetration in welding and the weld strength. Predicting the values of the process parameters on which desired weld quality depends is a very complex process and so many investigators have tried to investigate the process parameters to obtain high quality welds. Present investigation carried for welding IS-2062 steel plates using submerged arc welding process.

**Table 1: IS: 2062-Chemical Composition and Specification
of Steel for General Structural Purposes**

C% Max.	Mn% Max.	S% Max.	P% Max.	Si% Max.	C.E. % Max.
0.23	1.50	0.050	0.050	0.40	0.42

EXPERIMENTATION PLANNING

This study details with an experimental work on IS 2062 steel using SAW process to yield desired quality of bead, in terms of beads geometry, as influenced by voltage, current, welding speed and nozzle to-plate distance which are varied in five different levels. The desired welding parameters are determined based on the standard practice as obtained from literature review. The welding equipment used has the following specifications: welding rod diameter of 3.2 mm and composition C: 0.10%; Mn: 0.4-0.6%; Si: 0.03%; S: 0.03%; P: 0.03%; Cu: 0.4% the weight of copper includes copper coating too. The work piece was in a rectangular shaped plate made of steel alloy grade - IS: 2062 having the dimensions of 300*150*20 mm in size with chemical composition: C 0.23%; Mn: 1.50%; S: 0.050%; P: 0.050%; Si: 0.40%; C.E: 0.42% and remaining iron. The joint was in bead shape on welded junction of plates. Taguchi approach has been carried out for investigation, as from literature review, it was

observed that this technique is used extensively for solving optimization problems in the field of production engineering.

Table 2: Parameters and their Values

Sr No	Symbol	Parameters	Levels					Units
			I	II	III	IV	V	
1	A	Arc voltage	24	26	28	30	32	volts
2	B	Welding Current	375	425	475	525	575	amperes
3	C	Trolley speed	0.25	0.30	0.35	0.40	0.45	m/min
4	D	Nozzle to plate distance	15	16	17	18	19	mm

The experiments were carried out and samples obtained were tested for penetration and weld strength. Further, to determine the significance of factors on the responses, analysis of variance (ANOVA) has been used. Table 2 presents selected parameters with their actual values.

RESULTS

Table 3 presents experimentation planning using L-25 (5^4) orthogonal array. The experimental results of weld strength and bead penetration are plotted in the Figure 1.

Table 3: Experimentation Planning using L-25 (5^4) Orthogonal Array

Exp. No.	Coded values using L-25 (5^4) orthogonal array				Actual values using L-25 (5^4) orthogonal array				Raw output obtained
	A (1)	B (2)	C (3)	D (4)	A	B	C	D	Strength N/mm ²
1	1	1	1	1	24	375	0.25	15	427.61
2	1	2	2	2	24	425	0.30	16	462.08
3	1	3	3	3	24	475	0.35	17	487.36
4	1	4	4	4	24	525	0.40	18	505.00
5	1	5	5	5	24	575	0.45	19	520.23
6	2	1	2	3	26	375	0.30	17	545.29
7	2	2	3	4	26	425	0.35	18	565.25
8	2	3	4	5	26	475	0.40	19	638.45
9	2	4	5	1	26	525	0.45	15	610.07
10	2	5	1	2	26	575	0.25	16	637.21
11	3	1	3	5	28	375	0.35	19	562.39
12	3	2	4	1	28	425	0.40	15	601.34
13	3	3	5	2	28	475	0.45	16	618.64
14	3	4	1	3	28	525	0.25	17	538.49
15	3	5	2	4	28	575	0.30	18	589.26
16	4	1	4	2	30	375	0.40	16	368.45
17	4	2	5	3	30	425	0.45	17	345.74
18	4	3	1	4	30	475	0.25	18	354.85
19	4	4	2	5	30	525	0.30	19	348.56
20	4	5	3	1	30	575	0.35	15	341.94
21	5	1	5	4	32	375	0.45	18	322.65
22	5	2	1	5	32	425	0.25	19	365.45
23	5	3	2	1	32	475	0.30	15	401.33
24	5	4	3	2	32	525	0.35	16	325.18
25	5	5	4	3	32	575	0.40	17	318.46

Figure 1 here shows the main effects of the plots has been generated using Minitab software. The results obtained have been plotted and shows how, each factor like Arc voltage, Welding Current, Trolley speed and Nozzle to plate distance affects the response characteristic ie. Weld strength.

Figure 1: Plot of Mean for Ultimate Tensile

Analysis of variance (ANOVA) was performed to identify the process parameters which significantly affect the weld strength. The ANOVA for the raw data is shown in the Figure 2.

Figure 2: ANNOVA Table for Experimental Observations

Figure 3 shows that the plots exhibit pretty symmetrically distribution and thus reflect a linear regression model of the raw data.

Figure 3: Residual Plots for UTS

CONCLUSIONS

The results of the present investigation indicate that the welding voltage is the most significant parameter that controls the bead penetration as compared to other controlling parameters. The contribution of voltage is found to be quite significant, while the current welding speed and nozzle-to-plate distance have been found to be less significant. Optimal values of the process parameters obtained are voltage 26V, Current 475 A, trolley speed of 0.40 m/min and NPD of 19 mm. Very higher arc voltage results in fluttering of beads thus dilution which further causes porosity defects. Thus optimum voltage is required to reduce defects and for proper bead penetration leading to better strength.

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