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Analysis of Distortion in Butt Joints of Mild Steel Plate and Cast-Iron Plate in Manual Metal Arc Welding Process

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Abstract: ***There are some welding defects due to which weldments fails under service conditions and cause damage to the property and loss of human lives. In this work we are going to study one of the welding defects known as Distortion. Distortion is the change in shape and difference between the positions of the two plates before welding and after welding. Distortion occurs due to good amount of temperature difference at various points along the joint and thus at any instant certain area of base metal expands and other including weld bead contact***
In this paper we are going to study how much distortion and welding strength occur in Mild steel and cast iron plate that single v groove 60 angle butt joints using manual metal arc welding process. Current range 80 to 110 A and welding speed 5 to 15 cm/min
Keywords: Mild Steel plate, Cast Iron plate, distortion, Butt welding, manual metal arc welding process, welding strength

I. INTRODUCTION

Manual metal arc welding (MMAW) or shielded metal arc welding (SMAW) is the oldest and most widely used process being used for fabrication. The arc is struck between a flux covered stick electrode and the workpieces. The workpieces are made part of an electric circuit, known as welding circuit. It includes welding power source, welding cables, electrode holder, earth clamp and the consumable coated electrode. Wide application is in the joining and repair of foundry parts associated with the weld of cast iron to mild steel without preheating.Important cast job, including broken cast iron and joining mild steel to cast iron.

II. EXPREMENTAL WORK

In this research work we used A36 low carbon steel and A48 cast iron plate as a base material and its chemical composition is given in table 1. Rectangular MS and CI plates of 100*150*10 mm were Butt-welded by manual metal arc welding process. Thickness of base plate is 10 mm. The lap joints were prepared for single lap and double lap. electrode used for manual metal arc welding is made from AWS E-NI-FE-CI recommended by global electrode pvt. Ltd. . Dimension of electrode is 3.15 mm diameter and 350 mm length. The welding parameters used in this investigation are given in table 2. Outline of single line and double line is shown in fig 2(a) and (b).

TABLE 1: CHEMICAL COMPOSITION OF A 36

ELEMENT	C	CU	FE	MN	SI	S	P
PERCENT	0.25	0.20	98	1.03	0.28	0.025	0.040

TABLE 2 MECHANICAL PROPERTIES OF A 36

MATERIAL	Tensile strength (Mpa)	Yield strength (Mpa)	Elongation (%)	Poisson ratio
percent	400	250	36	0.26

Table 3: chemical composition 0f A48

element	C	Si	Mn	s	P
	2.60	1.80	0.60	0.07	0.12

Table 4 : mechanical properties of A48

material	Tensile strength (Mpa)	Yield strength (Mpa)	hardness	Poisson ratio
A48	320	160	241	0.29

Table 5: The used welding parameters for butt joint

Sr. no.	Current (A)	Welding speed (cm/min)	Distortion(mm)	Tensile strength(N/mm2)
1	80	5	3.85	47.862
2	80	10	3.38	45.184
3	80	15	3.18	41.603
4	95	5	4.19	63.708
5	95	10	3.98	60.352
6	95	15	3.67	55.430
7	110	5	4.39	90.347
8	110	10	4.10	86.212
9	110	15	3.90	80.520

Photographs MS and CI plate butt joint

III.RESULT AND DISCUSSION

From the result, it can be observed that the minimum angular distortion 3.18 mm obtained at the current 80 amps (Lower current) and welding speed 15cm/min (Higher welding speed).Value of maximum distortion is 4.39 mm at current of 110 amps (Higher value) and welding speed is 5 cm/min (Lower Value). When current increases, the distortion will increase; on the other hand, the opposite response behaviour observed that distortion decreases with increasing welding speed. Maximum Tensile strength of weld zone is 90.34 N/mm2, where the current is 110 A (Higher) and welding speed 5 cm/min (Lower). While, minimum tensile strength is 41.60 N/mm2 where current is low and welding speed high.

Regression analysis

Regression analysis for Distortion using MINITAB 16 Software:

Regression Analysis: Distortion versus (Current (A), Welding speed(cm/min)

Weighted analysis using weights in Distortion (mm)

The regression equation is

Distortion (mm) = 2.36 + 0.0215 Current (A) - 0.0556 Welding speed (cm/min) (1)

Regression analysis for welding strength using MINITAB 16 software:

Regression Analysis: Welding strength versus (Current (A), Welding speed(cm/min)

Weighted analysis using weights in Tensile strength (N/mm2)

The regression equation is

Tensile strength (N/mm2) = - 61.2 + 1.40 Current (A) - 0.846 Welding speed (cm/min) (2)

Sr. no.	Current (A)	Welding speed (cm/min)	Experimental distortion (mm) (a)	Predicted distortion value (mm)	Percentage variation ((a-b)/a*100)	Experimental welding strength (N/mm2)	Predicted value of distortion (N/mm2)	Percentage variation((a-b)/a)*100)
1	90	5	4.15	4.02	3.13	64.21	60.57	5.66
2	90	10	3.79	3.73	1.58	59.18	56.34	4.79
3	100	5	4.32	4.23	2.08	76.03	74.57	1.92
4	100	10	4.01	3.95	1.49	73.38	70.34	4.12

IV. CONCLUSIONS

From result we conclude following conclusion

A. When current increases, the distortion will increase; on the other hand , the opposite response behaviour is observed that distortion decreases with increasing welding speed.

B. Tensile strength increases with increase of welding current. While tensile strength increases with decrease of welding speed.

C. From the result, it can be observed that the minimum angular distortion 3.18 mm and maximum distortion 4.39 mm.

D. From result of tensile test can be observed that maximum strength 90.347 N/mm2 and minimum strength 41.603 N/mm2.

E. Regression analysis by MINITAB software find equation for distortion is Distortion (mm) = 2.36 + 0.0215 Current (A) - 0.0556 Welding speed (cm/min) and welding strength for equation is Tensile strength (N/mm2) = - 61.2 + 1.40 Current (A) - 0.846 Welding speed (cm/min)

F. It can be seen very close agreement between experimental value and predicted value of distortion as percentage variation was found that reason less error 8%

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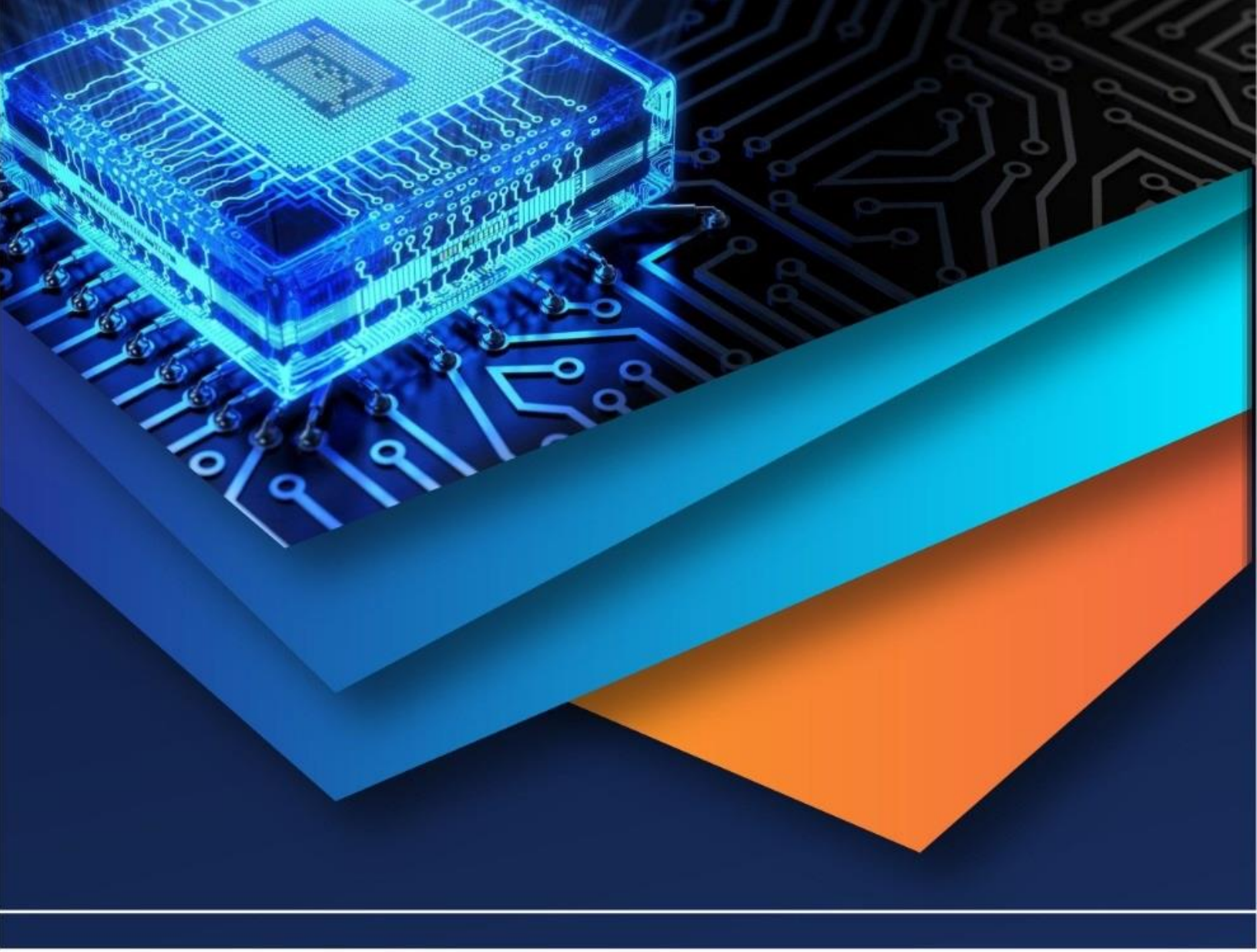

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