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Study the Influence of Input Process Parameters on Mechanical Properties of Mild Steel Plates Joined by Manual Metal Arc Welding

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Abstract

In shielded metal arc welding (SMAW) an arc is developed between the electrode and the work material. Proper selection of weld process parameters plays an important role to achieve the desired mechanical properties in case of shielded metal arc weldments. The primary purpose of this experimental study is to investigate the influence of three weld process parameters viz: welding current, welding voltage, and welding speed on the tensile and hardness properties of mild steel plates having thickness 10 mm.

Keywords; *manual metal arc welding, Tensile properties, Hardness properties, Process parameters.*

I. INTRODUCTION

Shielded metal arc welding (SMAW) is described as a fusion welding method. During the operation, coalescence of the material is obtained with the application of heat provided from an electric arc developed between the filler rod and the parent material [1,2]. In this method two or more metallic pieces are fused together by providing the heat and sometimes pressure. The welding includes a broad range of scientific parameters like welding time, temperature, type of electrode, power intake and welding speed. In this method, welding parameters are considered to be extremely important factors influencing the quality, efficiency and value of weldment .The weldment is ascertained by various weld process parameters such as welding slot forms, electrode diameter, welding current, welding speed, arc length, electrode advancement angle, electrode oscillatory angle etc. [3,4,5]. SMAW finds its application for mainly carbon steel, low and high alloy-steel, stainless-steel, ductile iron and cast iron. However, in case of nonferrous materials, it is able to be utilized on nickel and copper and their alloys and, very rarely on aluminium [6]. The composition of carbon steels greatly influences the weldability and various mechanical characteristics such as tensile strength, yield strength, impact strength, hardness, etc. Several metals are alloyed during the production of steel, but few other undesirable elements may also be present. The strength of carbon steels is increased by alloying carbon, manganese, tungsten, and few other metals but also leading to an undesirable condition namely cold cracking. After achieving ultrafine-grained structural steel, welding can be employed to produce sophisticated structures that are very challenging to make it precisely. The main objective of the present work is to investigate the influence of welding parameters on the mechanical characteristics of low

March - April 2020
ISSN: 0193-4120 Page No. 4906 - 4908

carbon steel using shielded metal arc welding process.

II. MATERIALS AND METHODS

In this experiment, AISI 1016 mild steel plates of thickness 10 mm and electrodes 6018 were utilized. An alternative current (AC) source was used for performing welding operation. The other equipment like electrode holder, grinder, metal cutter, scrapper, pair of pliers, metalworking vice etc., were utilized in this experimentation. Eighteen welded specimens were fabricated by employing SMAW. The hardness properties of the weldments were evaluated by using Brinell hardness tester in accordance with ASTM E 10-08 standard. The tensile properties of the welded joints were determined by using Universal testing machine based on ASTM E8 standard. Chemical composition of AISI 1016 mild steel is shown in the Table 1.

Table1- Chemical composition of AISI 1016

Carbon	Manganese	Chromium	Nickle	Molybdenum	Silicon	Sulfur	Phosphorus	Copper
0.155	0.610	0.030	0.020	0.004	0.110	0.022	0.030	0.001

III. RESULTS AND DISCUSSION

Table 2-Test results for Tensile and Hardness Properties

Sample Number	Welding Current(A)	Welding Voltage(V)	Welding Speed (mm/min.)	Tensile Strength (MPa)	Hardness (HB)
1	85	24	35	418.25	116.4
2	85	24	40	422.35	119.6
3	85	24	45	424.75	122.3
4	85	24	50	428.45	126.3
5	85	24	55	433.35	129.2
6	90	20	50	432.01	128.2
7	90	21	50	431.21	126.1
8	90	22	50	430.32	125.2
9	90	23	50	429.81	124.5
10	90	24	50	428.30	123.2
11	105	22	45	426.12	121.3
12	105	22	45	424.24	120.1
13	105	22	45	422.34	118.3
14	85	20	40	420.32	117.2
15	90	20	40	418.26	115.3
16	105	20	40	416.12	114.9
17	100	20	40	416.02	114.2
18	105	20	40	415.12	113.2

3.1 Tensile properties

3.1.1 Influence of current, Voltage and Speed on Tensile Properties

Figure 1(a) displays the effects of welding current on tensile properties of the weldment. Usually, when the welding current is increased, tensile strength reduces. At current value of 85 A, tensile strength is 420.32 MPa. When the current is continued to increase up to 105 A, tensile strength is found to decrease up to 415.12 MPa. Figure 1(b) shows the variation of welding voltage with tensile strength for the selected range of voltage from 20V to 24V Tensile strength decreases from 432.01 MPa to 428.30 MPa. The variation between welding speed and tensile strength for the selected range of speed from 35 mm/min to 55 mm/min, is represented in figure 1 (c). Tensile strength is found to increase from 418.25 MPa to 433.35 MPa.

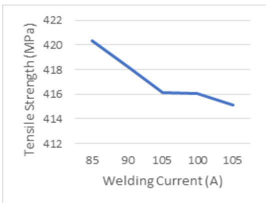

Fig.1(a). Welding Current VS Tensile Strength

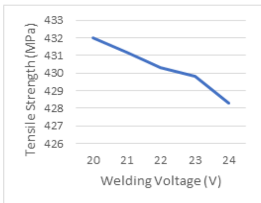

Fig.1(b) Welding Voltage VS Tensile Strength

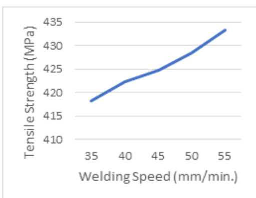

Fig.1(C) Welding Speed VS Tensile Strength

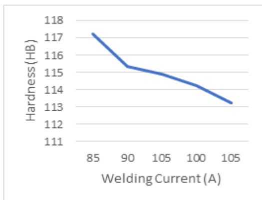

Fig.2(a) Welding Current VS Hardness

3.2 Hardness Properties

3.1.1 Effects of current, Voltage and Speed on Hardness Properties

The influence of current on hardness properties of the weldment is represented in the Figure 2(a).

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March - April 2020
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Generally, hardness decreases with the increase in welding current. At 85 A hardness is 117.2 HB. If the welding current is continued to increase up to 105 A, there occurs a decrease in hardness up to 113.2 HB. The variation of welding voltage with hardness for the chosen range from 20V to 24V is displayed in Figure 2(b). For the above range of voltage, hardness decreases from 128.2 HB to 123.2 HB. Figure 2(c) shows the change between welding speed and hardness of the welded joint. It is found that hardness increases from 116.4 HB to 129.2 HB for the selected range of speed from 35 mm/min to 55 mm/min.

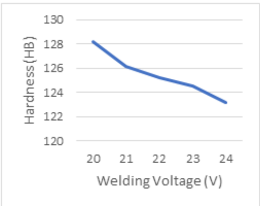

Fig.2(b) Welding Voltage VS Hardness

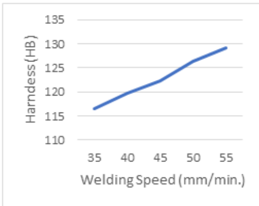

Fig.2(C) Welding Speed VS Hardness

IV. CONCLUSION

According to the results obtained from SMAW applied to low carbon steel AISI 1016 steel plates having 10 mm thickness, the following points have been concluded.

1. With increasing in welding current from 85 to 105 A, tensile strength and hardness both decreased

2. With increasing the welding voltage from 20 to 24 V, both tensile strength and hardness decreased.

3. With increasing the welding speed from 35 to 55 mm/min, both tensile strength and hardness increased.

It is clearly established that an optimum selection of welding current, welding voltage and welding speed yields a strong and high quality welded joints.

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