Effect of Bevel Angle and Wire Feed Rate in MIG Welding

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Abstract

Metal Inert Gas is a welding process that is widely used for welding a variety of ferrous and non ferrous materials. The essential feature of the process is the small diameter electrode wire, which is fed continuously into the arc from a coil. As a result, this process can produce quick and neat welds over a wide range of joints. The accuracy and quality of welded joints largely depends upon type of power supply (DCEP), welding speed, type of inert gas used for shielding.

This study deals with the investigation of effect of wire feed speed on the mechanical properties of the welded joint. Experiments are conducted on specimens of single V-butt joint having different bevel angles with bevel heights 2 to 3mm. The material selected for preparing the test specimen is MS2062. The strength of the welded joint is tested by a Universal Tensile Testing machine and the results are evaluated along with Rockwell Hardness Test.

1. Introduction

The MIG (Metal Inert Gas) welding, also known as MAG (Metal Active Gas) and in the USA as GMAW (Gas Metal Arc Welding), is a welding process that is now widely used for welding a variety of materials, ferrous and non ferrous. It is the consumable electrode method. The essential feature of the process is the small diameter electrode wire, which is fed continuously into the arc from a coil. As a result this process can produce quick and neat welds over a wide range of joints. Mild steel is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. The variables affecting weld quality in arc welding are welding current, welding voltage, wire feed rate and bevel angles [1].

2. Experimental details

The base material selected for this investigation was IS2062 sheet of 16mm thickness having chemical composition shown in the Table 1. The welds for the present study were prepared by Metal Inert Gas welding with a sheet of MS2062. Firstly 18 specimens of dimensions 150mm×270mm×16mm cut into size using gas cutter and cleaned. The sheets were then bevelled for 15°, 30° and 45° bevel angles for welding. MIG parameters used in this study were listed in Table 2. The electrode used in this study was E-2062 of 1.2mm diameter. The specimens were then welded at three different wire feed rates (50mm/min, 60mm/min and 70mm/min) and three different bevel angles (15°, 30° and 45°). Tensile tests and Hardness tests were conducted and results were taken. To determine the tensile strength of the welded zone, tensile test specimens were sectioned as per ASTM E-8 standards (Fig.2) [2]. Each welded specimen was cut into 3 pieces of size 300mm x 30mm x 16 mm. Each set of 9 specimens were sent to respective laboratories for specific tests. The chemical composition of base metal IS2062 is tabulated below [3][4].

Table 1. Chemical Composition of MS2062

Material	C	P	S	Mn	Si	Al
MS2062	0.18	0.017	0.01	0.79	0.18	0.026

Table 2. Welding Parameters

S.No.	Process Parameters	Values
1	Welding Voltage (Volts)	34
2	Bevel Angles	15°, 30°, 45°
3	Wire feed rate (mm/min)	50, 60, 70

Table 3. Welding conditions

Electrode	E2062
Electrode diameter	1.2mm
Shielding Gas	Carbon Dioxide (CO_2)
Operation type	Semi Automatic

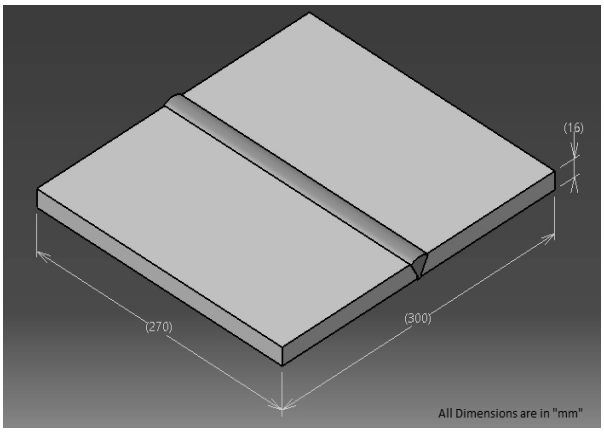


Figure 1. 3-D model of welded joint

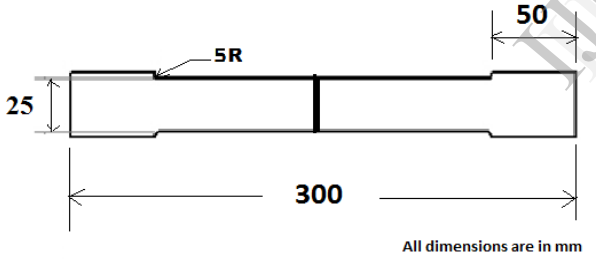


Figure 2. Tensile test specimen

3. Results and Discussion

This study deals with the results and discussions of the experimental findings of welded joints prepared at constant welding voltage, three different wire feed rates (50mm/min, 60mm/min and 70mm/min) and three different bevel angles (15°, 30° and 45°). The specimens prepared under different wire feed rates and different bevel angles with constant voltage are having different effects [5][6].

3.1. Tensile Strength and Hardness

Using the Shaping machine and Hand Grinding machine tensile test specimens were prepared as per ASTM-E8 standards as shown in fig.3.

Figure 3. Specimens prepared for testing

Tensile test was done on each sample using Universal Testing Machine, Hardness test also conducted using Rockwell Hardness Testing machine and results were tabulated.

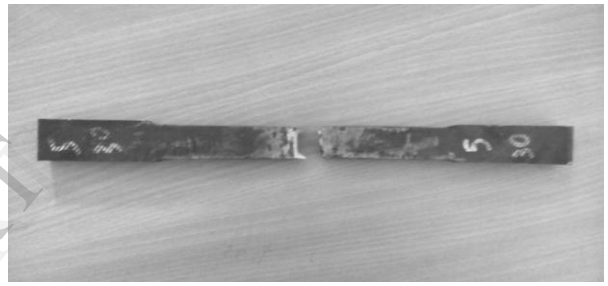


Figure 4. Specimen after Tensile test

Table 4. Tensile Strength and Hardness values

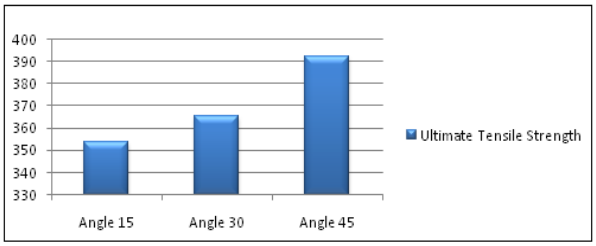
Base Metal: UTS=467.675N/mm^2			Hardness=94 RHN	
S. No.	Wire Feed Rate (mm/min)	Bevel Angle (degrees)	Ultimate Tensile Strength (N/mm^2)	Hardness (RH_B)
1	50	15	353.89	86
		30	365.06	58
		45	392.13	57
2	60	15	390.23	85
		30	405.11	81
		45	429.42	50
3	70	15	375.41	89
		30	386.16	78
		45	391.61	68

From the performed experiments it is observed that as the bevel angle increases, the Ultimate Tensile Strength also increases. The largest Ultimate Tensile Strength value is found to be 429.42N/mm^2 at 60mm/min for 45^0 bevel angle and the lowest Ultimate Tensile Strength is 353.89N/mm^2 at 15^0 bevel angle were observed.

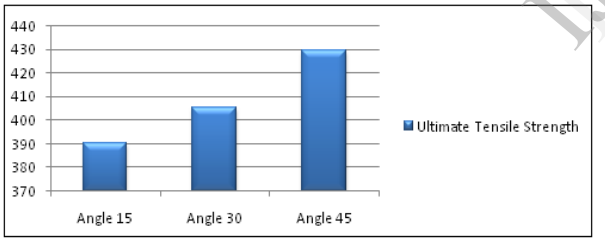
Hardness gradually increases on both the sides from centre to the ends. Hardness of the welded zone showed slightly lower values. The tensile specimen failure occurred at weld interface [8] [9].

3.2. Graphs

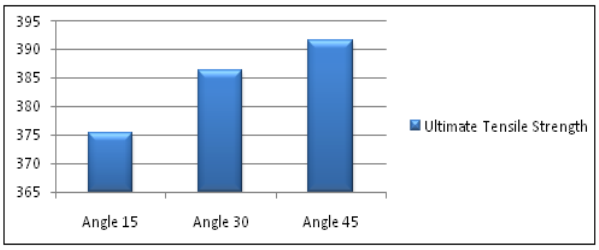
3.2.1. Bevel angle Vs Ultimate Tensile Strength. By the investigation we have analyzed that as the bevel angle increases, the Ultimate Tensile Strength of the weld also increases.



Bevel angle Vs UTS for wire feed rate 50 mm/min.

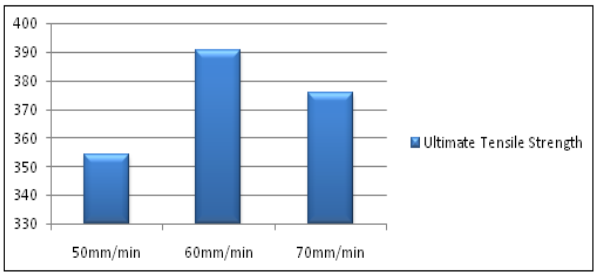


Bevel angle Vs UTS for wire feed rate 60 mm/min.

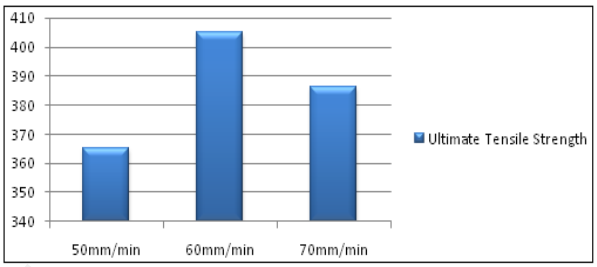


Bevel angle Vs UTS for wire feed rate 70 mm/min.

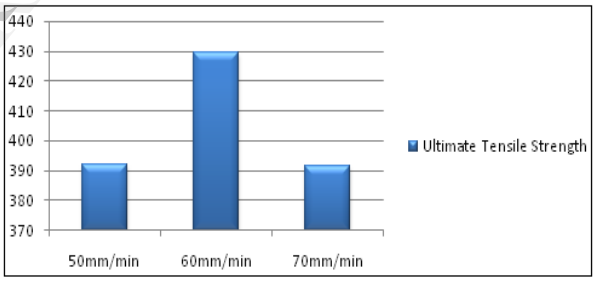
3.2.2. Wire feed rate Vs UTS. The ultimate tensile strength increases with increase in wire feed rate up to 60 mm/min., which was the optimum value to obtain the maximum tensile strength. Increasing the wire feed rate beyond this optimum value results in a decreased Tensile Strength.



Wire feed rate Vs UTS for Bevel angle 15^0

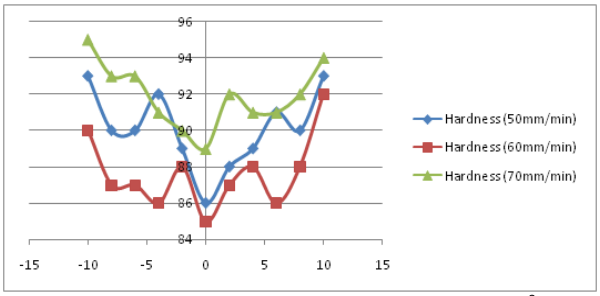


Wire feed rate Vs UTS for Bevel angle 30^0

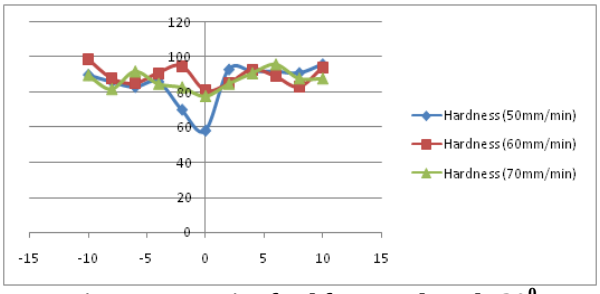


Wire feed rate Vs UTS for Bevel angle 45^0

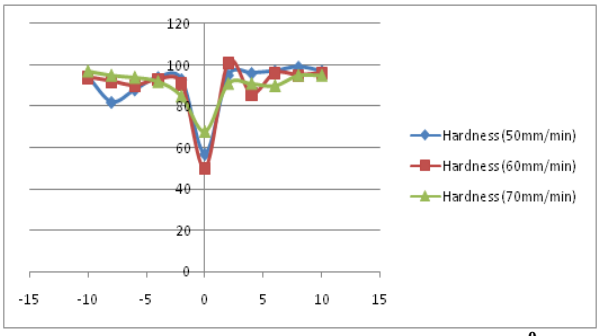
3.2.3. Hardness Test graphs. Hardness is lower in the weld region compared to the HAZ and base metal regions irrespective of wire feed rate or bevel angle.



Distance Vs Wire feed for Bevel angle 15^0



Distance Vs Wire feed for Bevel angle 30^0



Distance Vs Wire feed for Bevel angle 45^0

4. Conclusions

In this study, the "Effect of Bevel Angle and Wire Feed Rate in MIG Welding" technique on tensile properties and Hardness of welded IS 2062 Mild Steel has been analyzed. From this investigation, the following important conclusions have been derived:

a) As the bevel angle increases, the Ultimate Tensile Strength of the weld also increases. The Largest tensile value at bevel angle 45° with 429.4219N/mm^2 tensile value for the wire feed rate 60mm/min and the lowest tensile value at bevel angle 15° with 353.897N/mm^2 tensile value for the wire feed rate 50mm/min were observed. Bevel angle of the weld joint has profound effect on the tensile strength of weldment. Among the bevel angles 15°, 30°and 45°, the largest Tensile Strength is obtained at 45°.

b) The variations in Ultimate Tensile Strength values were analyzed with the help of graphs which are related with wire feed rates. The Ultimate Tensile Strength increases with increase in wire feed rate up to 60mm/min internally which was the optimum value to obtain maximum Tensile Strength. Increasing the wire feed rate beyond this optimum value results in a decreased Tensile Strength.

c) Hardness gradually increases on both the sides from centre to the ends. Hardness of the welded zone showed slightly lower values. Hardness is lower in the weld metal (WM) region compared to the HAZ and BM regions irrespective of wire feed rate or bevel angle. Very low hardness is recorded in the 60mm/min wire feed rate with 45° bevel angle joint (50 RHN) and the maximum hardness is recorded in the 70mm/min wire feed rate with 15° bevel angle joint (89 RHN). The tensile specimen failure occurred at weld interface.

5. References

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