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EXPERIMENTAL INVESTIGATION OF ANGULAR DISTORTION AND TRANSVERSE SHRINKAGE IN CO_2 ARC WELDING PROCESS

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ABSTRACT

Now a days there are numerous types of welding techniques are used according to the application in which the major part of industries employed CO_2 arc welding process is one among the several different types of welding process. CO_2 arc welding process overcomes the restriction of using small lengths of electrodes. The present work is planned to carry out by experimental work to analyze distortions like angular distortion and transverse shrinkage in the welded joints due to the heat input by varying welding speeds for different butt joints keeping other parameters like arc voltage, welding current and electrode extension constant, using CO_2 arc welding process. The different butt joints used in this process are Single V-groove butt joints, Bevel groove butt joints and double V-groove butt joints. Distortion in welding can be classified as (1) angular distortion, (2) transverse shrinkage. Distortion can often controlled by adapting a suitable sequence of welding. A correct welding sequence which reduces the distortion to minimum does not remove or lower the locked up stresses. Further reduced heat input results in less distortion.

KEYWORDS: Experimental Investigation of Angular Distortion

INTRODUCTION

Welding is a reliable and efficient joining process in which the coalescence of metals is achieved by fusion and is used extensively in the fabrication of many structures, buildings, ships, pressure vessels, automobile industries, etc., due to many advantages it has, over the other fabrication processes. Localized heating during welding, followed by rapid cooling, can generate residual stresses and distortion. However, distortion is a problem faced during welding by non uniform heating and unequal cooling of metals. The presence of distortion in weldments poses problems in further assembly. Now a days there are numerous types of welding techniques according to the applications required in which the major part of industries employed CO_2 arc welding process is one among several different types of welding process. CO_2 arc welding process overcomes the restriction of using small lengths of electrodes as manual metal-arc welding and overcomes the inability of the submerged-arc welding process to weld in various positions.

Distortion is caused by the unequal heating and cooling of a metallic body during welding. It is also caused by the contraction of weld metal during solidification and cooling to room temperature and the contraction of the surrounding parent metal as it cools from high welding temperature when those portions contrast they try to pull the parts together and results in distortion.

The CO_2 arc welding is the process in which the source of heat is an arc formed between a consumable metal electrode and the work piece, and the arc and the molten puddle are protected from contamination by the atmosphere with an externally supplied gaseous shield of CO_2 gas. The quality of weld in CO_2 arc welding process is influenced by independent variables such as welding current, arc voltage, welding speed and electrode extensions. The prediction of process parameters involved in CO_2 arc welding process is a very complex with respect to distortion. So there is a need to predict distortion produced during welding.

CO_2 gas is used as the shielding gas in MIG welding of steel plates. The flow characteristics of CO_2 are such that the gas issues in a non-turbulent manner from the MIG gun. With CO_2 shielding gas the metal transfer will be globular and non-axial at low current densities. Hence there will be considerable spatter. The non-axial transfer is caused by electromagnetic repulsive force acting on the bottom of the molten drop. MIG/CO_2 welding with spray type arc (current density 350 amps) is best suited for welding relatively thick parts. For thin sheets dip transfer technique is used with low arc voltage (16 - 22 V) and low current (60 - 180 amps). The low arc voltage results in a reduced arc length and the molten droplet gets transferred into the weld pool by direct contact. With pure argon or a mixture of argon + 20% CO_2, the metal transfer is globular at low current density, but changes to spray type when the current density increases. In the spray type transfer the metal travels across the arc in the form of fine droplets which is induced by the magnetic force acting on the molten electrode tip. 100 per cent pure argon is used for almost all metals except steels. Helium has higher thermal conductivity. So it gives higher arc voltage for a given current and higher heat input. However, helium being lighter (than argon and air) rises in a turbulent manner and tends to disperse into air. So higher flow rate will be required in helium shielding. CO_2 is widely used for welding of mild steel and it gives sound weld deposits. In these the electrode must contain appropriate balance of deoxidizers.

The present work is planned to carry out by experimental work to analyze distortions like angular distortion and transverse shrinkage in the welded joints due to the heat input by varying welding speed for different butt joints keeping other parameters like arc voltage, welding current and electrode extension constant using CO_2 arc welding process. The different butt joints used in this process are Single V-groove butt joints, Bevel groove butt joints and double V-groove butt joints. Distortion in welding can be classified as (1) angular distortion (2) longitudinal distortion (3) transverse distortion. Distortion can often controlled by adapting a suitable sequence of welding. A correct welding sequence which reduces the distortion to minimum does not remove or lower the locked up stresses. Further reduced heat input results in less distortion.

Experimental Setup

In the experimental work, CO_2 Arc Welding machine and different equipment has been used for the welding of mild steel specimens. The specimens were fabricated using CO_2 arc welding process by considering different heat input by varying process parameters. This CO_2 Arc Welding machine has the provision to vary the process parameters like welding current, arc voltage, electrode diameter, and electrode wire speed and electrode extension. The Single V-groove, bevel groove and double V-groove butt welded joints with varying welding speed keeping other parameter constant were prepared in single pass by using CO_2 arc welding process. Welding consumables like electrode and CO_2 gas were used in this welding process. The electrode used was low manganese copper coated with wire diameter of 1.2 mm, the wire feed rate of 3 m/min and 6 mm electrode extension.

The base plates made up of mild steel was used for welding using above equipment and consumables and prepared specimens of three different grooves such as single V grooves, bevel grooves and double V grooves on a specimen size of 250x250x8 in mm

Variables Selected

The process variable like welding current is selected for conducting experiments for different grooves like single V groove beveled groove and double V groove specimens for varying heat input by varying welding speed. Other parameters like electrode diameter, arc voltage, and electrode extensions were kept constant. Three sets of specimens were selected for different grooves. Each set containing four specimens were chosen to weld by varying welding speeds and time is recorded.

Preparation of Specimens

Length and width of the specimens taken was 250 mm and thickness of plate was taken 8 mm for all the specimens. Root face of 4 mm in single V groove and bevel groove, and 2 mm in double V groove butt joints were used. Groove angle of 45^o in single V groove and double V groove and 22.5^o in bevel groove were used. The compositions of mild steel base plate and electrode are given below with their different composition. Single "V" Groove butt joint, Bevel Groove butt joint and double "V" Groove butt joint are as shown in Figures 1.2, 1.3 and 1.4.

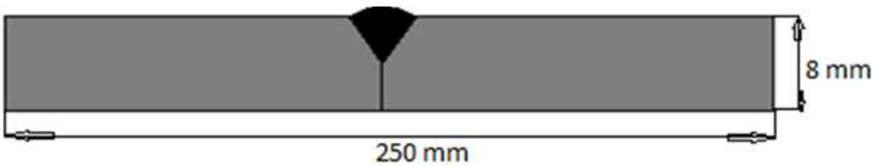


Figure 1.2: Single "V" Groove Butt Joint

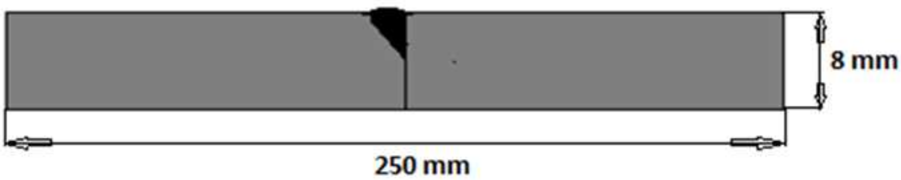


Figure 1.3: Bevel Groove Butt Joint

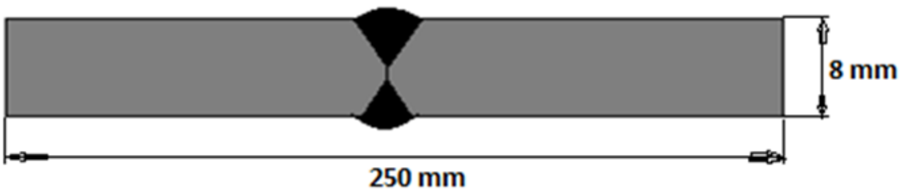


Figure 1.4: Double "V" Groove Butt Joint

The chemical composition of mild steel base plates are given in table 1.1, percentage of carbon, manganese, sulphur, phosphorous, silicon, aluminum nitrate are composed and rest of the part is composed of Fe that is iron in the mild steel plate, which is being welded. Where R indicates the rest of the part

Table 1.1: Chemical Composition of Base Plate

C%	Mn%	S%	P%	Si%	Al%	N%	Fe%
0.18	1.06	0.05	0.01	0.1	0.045	0.004	R

The composition of electrode wire is as shown in table 1.2, which is composed of carbon, manganese, sulphur, phosphorous, silicon, aluminum, nitrate with respective percentage are composed and rest of the part(R) is composed of Fe that is iron, and this is used as filler metal in welding.

Table 1.2: Chemical Composition of Electrode

C%	Mn%	S%	P%	Si%	Cu%	N%	Fe%
0.08	0.5	0.018	0.018	0.017	0.32	0.004	R

Table 1.3: Process Parameters Recorded for Single V-Groove, Bevel Groove and Double V Groove Butt Joints for Different Specimens

Sl. No.	Welding Current, Amps	Welding Voltage, Volts	Time Taken for SVG, Min	Time Taken for DVG, Min	Time Taken for BG, Min
1	100	20	1.09	1.07	1.05
2	100	20	1.26	1.22	1.25
3	100	20	1.54	1.59	1.55
4	100	20	1.87	1.93	1.9

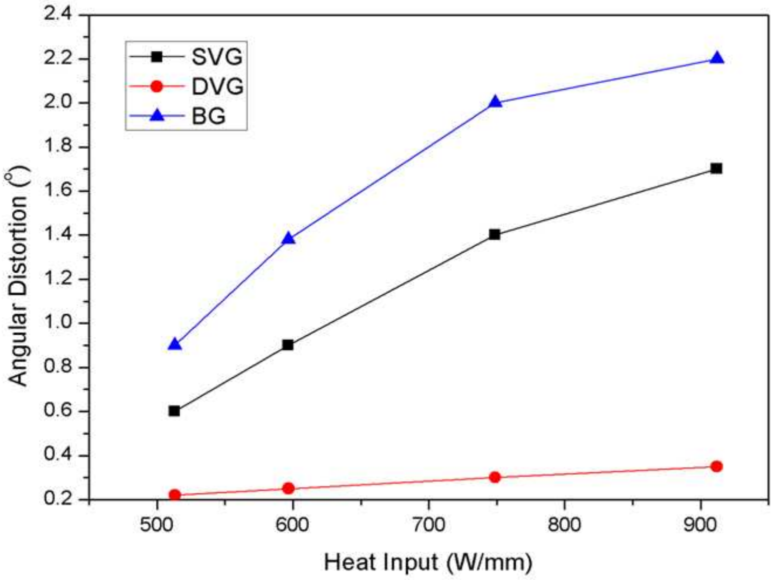
Figure 1.5: Specimen Welded Using CO_2 Arc Welding

RESULTS AND DISCUSSIONS

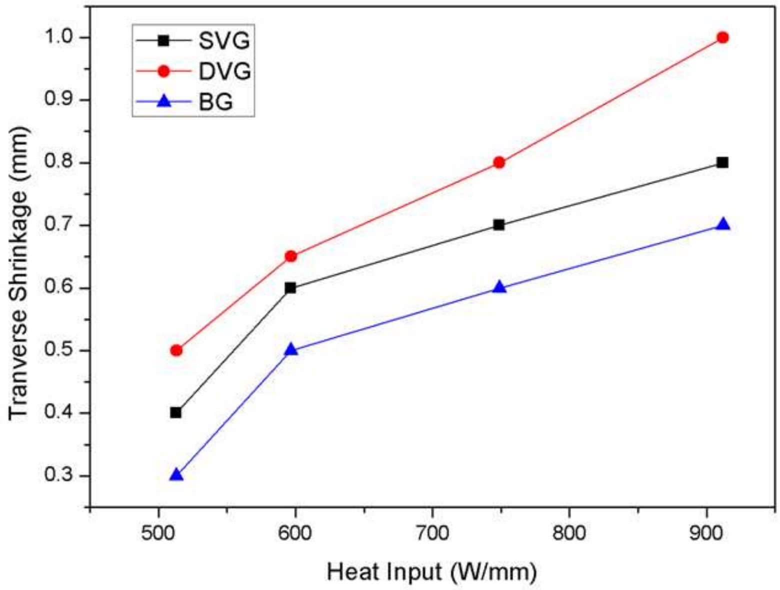
The experimental work was carried out by welding mild steel plates using CO_2 Arc Welding process and studied on the effect of heat input with respect to angular distortions and transverse shrinkages. The results obtained are discussed and presented for angular distortion and transverse shrinkage for bevel groove, single V groove, and double V groove welded butt joints.

Angular Distortion

The effect of heat input on angular distortion for single V-groove, bevel groove and double V groove butt joints are presented. The surface profiles for all the specimens are also given. The angular distortions for different butt joints are compared.



Figure



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CONCLUSIONS

The experimental studies on distortions on the welded plates for mild steel plates with increasing heat input by varying welding speed for different butt joints had been carried out using CO_2 arc welding process. Following are the conclusions drawn within the scope of the investigation.

- As heat input increases, the angular distortion increases in single V-groove, bevel groove and double V-groove butt welded joints.
- For same heat input angular distortion is maximum in bevel groove welded joints when compared to the single V-groove and double V-groove welded joints and minimum for double V-groove welded joint.
- The distribution of transverse shrinkage is maximum at the center of the weld and minimum at the ends in single

V-groove, bevel groove and double V-groove butt welded joints.

- As heat input increases transverse shrinkages increases in single V-groove, bevel groove and double V-groove butt welded joints.
- For same heat input transverse shrinkage is maximum in double V-groove welded joints when compared to the single V-groove and bevel-groove welded joints and minimum for bevel-groove welded joint.

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