Influence of Groove Angle in V-groove Butt joints on Transverse shrinkage in CO_2 Arc Welding process

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Abstract:

Welding induces transverse shrinkages in welded structures that results in reduced strength of welded joints in manufacturing industries. The analysis of transverse shrinkages is important in point of view of performance of welded joints. In view of this of experimental analysis of transverse shrinkage in single and double V-groove butt welded joints by varying groove angle and keeping heat input constant in CO_2 Arc Welding process. It is observed that, the maximum transverse shrinkage increases with increase in the included angle.

Key Words: Distortion; Transverse shrinkage; V-groove; CO_2 Arc Welding; Included angle; Groove angle.

Introduction

A classification of welding distortion into in-plane distortion (rotational, transverse, and longitudinal shrinkage) and out-of-plane distortion (buckling, angular, and longitudinal bending) is presented by Masubuchi. The out of-plane distortion significantly influences the required dimensional precision in structural components [1].

Distortions are caused when the heated weld region contracts non-uniformly causing shrinkage in one part of a weld to exert eccentric forces on the weld cross section. The weldment strains elastically in response to residual stresses, and detectable distortion may appear in butt joints as both longitudinal and transverse shrinkage or contraction and as angular change when the face of the weld shrinks more than the root, the change produces transverse bending in the plates along the weld length [2].

Distribution of transverse shrinkage along the weld is not uniform and depends on various factors including weld length, gaps, tack welds, welding sequences, the preparation of edges, welding conditions, restraint etc. The transverse shrinkage is maximum in the weld center and is minimum near the ends. The welding heat input can influence not only the value of shrinkage but also the distribution of transverse shrinkage along the weld [3]. Welding distortion often causes misalignment between structural components that require additional straightening processes in the fabrication process of welded steel structures. This is not desirable in terms of cost of fabrication. The joint details of any welded structures have significant influence on the integrity of the structures. The predictions of the degree of shrinkages in ship panels due to welding are of great importance from the point of view of dimensional control [4-7]. The transverse shrinkage is the free shrinkage at the groove produced during the cooling stage to room temperature [8]. It has been studied the influence of included angle in V-Groove butt joints on transverse and longitudinal shrinkages and analyzing these shrinkages [7].
Masubuchi discusses the various types of welding induced distortion, including control and mitigation techniques. In thin section structures as frequently used in the shipbuilding, rail road, aerospace, and automotive industries, buckling is a common type of distortion. When it occurs, the magnitude of distortion tends to be very large. Furthermore buckling instabilities reduce the structural integrity of a welded structure [1].

In the present investigation, attempts have been made to study the influence of included angle in V-Groove butt joints on transverse and longitudinal shrinkages and analyzing these shrinkages. In this work, experiments were conducted on different specimens by varying included angle for different root openings in a single V-groove and double V-groove butt welded joints keeping process parameters constant. The distribution shrinkages parallel to the weld line and normal to the weld line i.e. longitudinal shrinkage and transverse shrinkage were presented. The variation of included angle in a single V-groove and double V-groove butt welded joints for different root openings have been studied keeping heat input constant. The effect of included angle on both transverse and longitudinal shrinkages was investigated for different root opening.

Experimental work

In the experimental work, the mild steel is used as the base plate. CO_2 Arc Welding equipment has been used in the welding of specimens. The specimens were fabricated using CO_2 arc welding process by considering different parameters on edge preparations and different electrode wire diameter. The electrode wire diameters of 0.8 mm and 1.2 mm were used. The Single and double V-groove butt joints with varying included angle for different root opening were prepared in single pass by using CO_2 arc welding process. The size of welded plates used were 250 x 250 x 8 in mm (length x 2width x thickness). The plates were tack welded initially at the two

ends of the specimen to ensure the grip during welding. The tack welded specimens were tested for initial evenness. Then specimens were welded in single pass using CO_2 arc welding process. The process parameters were 100 Amp current, 22V voltage, 6 m/min wire feed rate and 6 mm electrode extension were used in the welding process to prepare weld joints.

The transverse shrinkages were measured at different locations of the specimen. Maximum values of transverse shrinkage was measured perpendicular to the weld line using digital vernier caliper and dial gauge before and after welding. Shrinkages were measured as the difference of the values before and after welding. The effect of angular distortion on shrinkages was taken into account during calculation of transverse shrinkages.

Results and Discussions

The maximum values of Transverse shrinkage for variation of included angle for 1 mm and 2 mm root opening and for 0.8 mm and 1.2 mm electrode wire diameter in single V-groove and double V-groove butt weld joints is discussed.

The variation of transverse shrinkage with included angle for 1 mm and 2 mm root opening and for 0.8 mm electrode diameter in single V groove butt welded joints is shown in the figure 1. Transverse shrinkage increases with increase in included angle. The increase in the transverse shrinkage may be due to the decrease in the exposed area of weld metal decreases the rate cooling, which intern increases shrinkage.

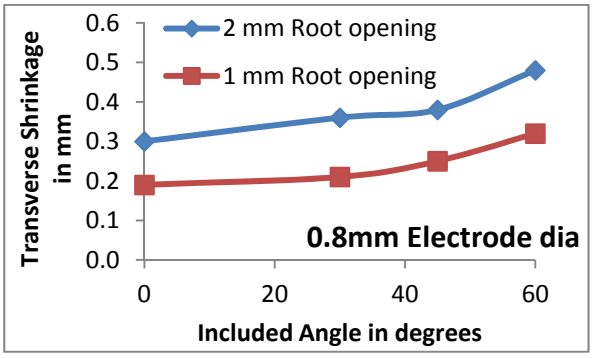

Figure 1: Variation of transverse shrinkage with included angle for 0.8 mm electrode diameter in V groove butt welded joints.

Similar observation can be seen that, the variation of transverse shrinkage with included angle for 1 mm and 2 mm root opening and for 1.2 mm electrode diameter in single V groove butt welded joints is shown in the figure 2. The transverse shrinkage increases with increase in included angle. This may be due to the decrease in the exposed area of weld metal decreases the rate cooling, which intern increases transverse shrinkage.

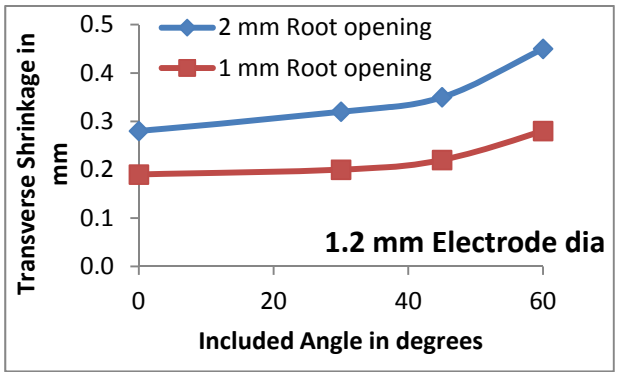

Figure 2: Variation of transverse shrinkage with included angle for 1.2 mm electrode diameter in V groove butt welded joints.

Similar to single V-groove welded joints, the variation of transverse shrinkage with included angle for 1 mm and 2 mm root opening and 0.8 mm and 1.2 mm electrode diameters in double V groove butt welded joints is shown in the figure-3 and 4. Transverse shrinkage increases with increase in included angle. The increase in the transverse shrinkage could be due to the change in rate of cooling of the weld metal for different included angle.

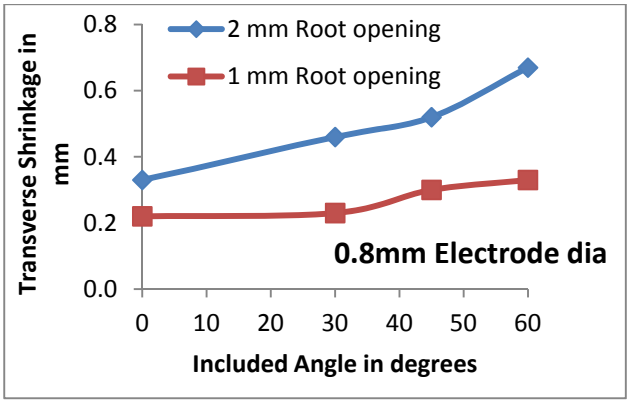

Figure 3: Variation of transverse shrinkage with included angle for 0.8 mm electrode diameter in double V groove butt welded joints.

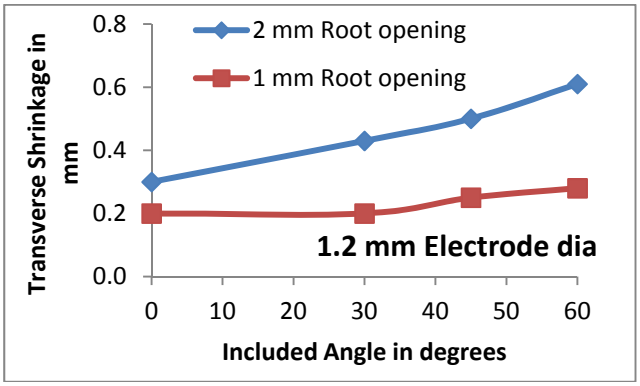

Figure 4: Variation of transverse shrinkage with included angle for 1.2 mm electrode diameter in double V groove butt welded joints.

Conclusions

The main conclusions are drawn within the scope of the present investigation are as follows:

1) The transverse shrinkage increases with increase in the included angle in case of single V-groove butt joints for both 0.8 mm and 1.2 mm electrode wire diameter.

2) Similar observation can be made on double V-groove butt joints that, the transverse shrinkage increases with increase in the included angle for both 0.8 mm and 1.2 mm electrode wire diameter.

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