EXPERIMENTAL STUDY ON ANGULAR DISTORTION IN SHIELDED-METAL ARC WELDING AND GAS METAL ARC WELDING

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ABSTRACT— Welding is the most commonly used process in manufacturing industries. It is used for joining two or more similar or dissimilar metals. It is made by fusion of materials to be joined and inserting filler material. Shielded metal arc welding (SMAW) and Gas metal arc welding these two processes are used widely but it presents a number of technical challenges to the designer, manufacturer and end user of the welded structure. The welding process causes a highly non uniform heating of the parts being joined. The local heating and subsequent cooling induce volumetric changes producing transient and residual stresses and deformation. Angular distortion is the major problem which is taken in to consideration for this project, which is most pronounced among different types of distortion in butt welded plates.

I. INTRODUCTION

In Shielded metal arc welding and Gas metal arc welding angular distortion cannot be fully eliminated but can be brought in to tolerable limits. In this project a multi pass butt welding specimen is used for experimentation to illustrate the distortion in the weldment. The process is performed for different process parameters to compare effect of individual parameters on welding. These values are verified by theoretical calculations. By means of variation in process parameters we can correlate both processes for optimum values.

Also as a part of further study, we have done Linear Static analysis and Modal analysis on models of welded plates to identify effect of angular distortion on strength of weld joint and to find natural mode of vibration .i.e. natural frequency. In this we have modeled plates with distortion and then performed analysis so we can get effect of angular distortion on plates. The finite element method is effective tool to predict effect of various process parameters and flexible too.it can be effectively be used to predict effect of distortion so one can understand importance of suppressing the distortion to avoid failures in welded joints.

II. LITERATURE SURVEY

P. E. MURRAY. A method for analysing gas metal arc welding procedures was developed to select welding parameters that lead to a desired operating condition. Analytical relationships between welding parameters and process variables were established by regression and dimensional analysis of experimental data. This data was obtained from a detailed GMA welding experiment in which the welding parameters were precisely controlled and the process variables precisely measured and correlated. Using no dimensional variables to correlate experimental data, accurate analytical relationships between welding parameters, arc process variables, and bead geometry were obtained. The analytical relationships for bead geometry extended the work of previous researchers by introducing a no dimensional mass transfer number and demonstrating the dependence of bead geometry on mass transfer as well as heat transfer. These relationships were used to identify a range of stable welding parameters and to find the welding parameters needed to ensure process constraints were met. Specific welding parameters were found by controlling arc length and weld bead geometry to ensure arc stability, adequate weld bead size, and adequate joint penetration.

III. PROBLEM DEFINITION

To study effect of process parameters like current and weld speed on structural steel plates of 6, 8, 10 and 12 mm thickness for shielded metal arc welding and gas metal arc welding and to find optimum values of angular distortion for parameters mentioned above analytically and experimentally, also to carry further study related to static and modal analysis of welded plates.

The welding process causes a highly non uniform heating of the parts being joined. Areas of the work piece close to the welding arc are heated up to several thousand degrees Celsius (depending on the welding process) and then subsequently cooled down, conducting the heat further to the bulk of the body. The local heating and subsequent cooling induce volumetric changes producing transient and residual stresses and deformation.

Comparison of the Types of Welding

The GMAW and SMAW plates have higher tensile stresses near the center of the weld (513 and 568 MPa) as compared to FSW plate (480 MPa). However, the FSW plate has a wider tensile zone (100 mm) at the weld centerline as compared to that generated by the arc processes (50 mm).• The FSW plate has the highest longitudinal compressive stress at the plate's free edges (–153.4 MPa, Table 4) making it most susceptible to buckling distortion. Comparison of the welding heat input in Table 1 and peak compressive residual stress in Fig. 14 indicates that there may be a orrelation between compressive residual stress and welding heat input. Such a correlation has been observed
in arc welding processes However, more data are needed for FSW to confirm this correlation. Since the arc processes were performed without any edge restraints, the GMAW and SAW plates show considerable angular distortion (6 and 12 mm, respectively) as compared to the FSW platem(3 mm), where the edge restraints limit angularmdistortion
• The through the thickness stress variations for GMAW and SAW processes were uniform, suggesting uniform longitudinal bowing. In the FSW case, however,m the through the thickness variation is less at the weld centerline and gradually increases toward the edges, suggesting nonuniform bending, which is indicative of buckling.

IV. PROPOSED SOLUTION

Implementation of the following design principles should be considered to minimize distortion in welded structures. Elimination of Welding: Welding can often be eliminated by Utilizing plates and profiles in the largest sizes available thus reducing the frequency of joining. Forming plates rather than cutting and welding. Using rolled or extruded sections rather than welded sections. Using stiffeners, thus allowing reductions in weld sizes. Weld Placement :The location of welds as close as possible to neutral axes is important in minimizing distortion. The closer a weld is to the neutral axis of a member, the lower the leverage effect of the shrinkage forces and hence the final distortion.

V. EXPECTED RESULTS

Shielded Metal Arc Welding we can observe that as angular distortion increases that localized stress value also increases to much higher extent and ay leads to excessive straining in weld bead which will cause excessive plastic deformation and weld may fail in case of SMAW. When distorted plates are loaded (tensile) they shows local failure in vicinity of metal surfaces and weld bead. In some of the cases the local stress are much more higher that ultimate tensile stress which shows if distortion is not in limits it may cause catastrophic failure.
Gas Metal Arc Welding we can observe that as angular distortion increases that localized stress value also increases to much higher extent and ay leads to excessive straining in weld bead which will cause excessive plastic deformation and weld may fail in case of GMAW. Also the stresses are much higher than SMAW this is because of in GMAW CO2 provides shielding and there is no chance of inclusions but weld material deposits in form of either globule or drop wise or spray of metal which is at much higher temperature which induces residual stresses supported by uneven cooling.

VI. CONCLUSION

Experimental comparison of the SAW,GMAW, and FSW processes was performed in terms of the longitudinal residual stress and out-of-plane distortion. Different fixturing conditions resulted in significant magnitude of angular distortion in SAW and GMAW plates than the FSW plate. However, the FSW plate results show high compressive stress at the edges indicating the process being more prone to buckling. In fact, the test plate did buckle. Larger plates under the same welding conditions are expected to result in significantly higher buckling distortion if FSW is used instead of SAW or GMAW. The longitudinal residual stress measurements indicate that there is a correlation between the welding heat input and the longitudinal residual stress. Further work is needed using FSW plates of different heat inputs to explore this correlation and to develop methodologies for minimizing residual stress.
Using Linear Static and Modal analysis effect of distortion can be predicted so importance of avoiding distortion can be justified. Out of selected process parameters current has strong effect on angular distortion, as current increase the distortion decreases. Using mathematical model for distortion its values can be predicted and thus methods can be employed to suppress distortion. Though shielded metal arc welding shows less distortions but it is more prone to welding defects and on other side in case of gas metal arc welding there are no problems of defects like inclusions which severely reduced the weld strength but distortions in case of GMAW are much higher. To avoid excessive thermal stresses optimum magnitude of current should be selected.

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