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A Review Study of Welding Distortion of Thin Plate under Welding

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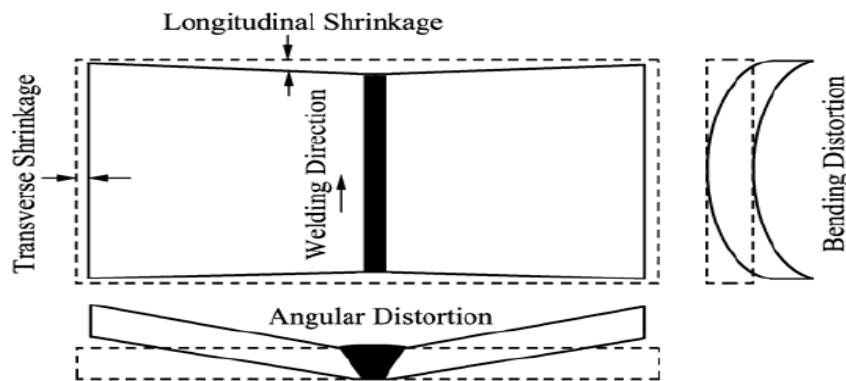
Abstract: The welding distortion of thin plate was selected as research subject, which causes loss of dimensional control, structural integrity and increases fabrication costs for straightening. The test model was a thin plate stiffened structure and a large twisting distortion was observed. The welding distortion of the same structure was analysed as a large deformation problem using a thermal elastic plastic FEM and an elastic FEM based on the concept of inherent deformation. The computed results by both methods showed the twisting distortion which is a typical buckling type deformation and the magnitude of this distortion agreed well with the experimental measurement.

Keywords: MIG, mild steel, tensile properties, hardness, microstructure, distortion.

I. INTRODUCTION

Welding is a joining of two or more parts by the application of heat and pressure, such joints are permanent in nature. In which process coalescence of materials is produced by heating them to recrystallization temperature with or without use of pressure and with or without the use of filler material.

Recently, the design of vehicle such as ship, automobile, train and aircraft in modern manufacturing emphasizes on minimizing weight to improve fuel economy and enhance the carrying capability, the thin plate stiffened structure has become popular. To assemble this kind of steel structures, the welding is widely employed as the main joining method with its significant advantages, however, the welding distortion is always the most complicated difficulties in construction of the welded structures, which not only decreases the geometrical precision but also delays the whole production schedule. Generally speaking, the welding distortion can be divided into the in-plane and out-of-plane distortion. The welding shrinkage distortion is the typical in-plane type; for the out-of-plane type, there are different kinds of welding distortion, such as welding bending distortion, welding buckling distortion and so on. For the thin panel structures, the buckling type distortion can be produced by welding process, which is considered as the most critical mode compared with other welding distortion modes because of its instability and more difficult to straighten



II. THEORY OF COMPUTATIONAL APPROACH

With the development of advanced computer and numerical analysis technology, the thermal elastic plastic FEM is widely accepted to analyse the welding problems for various welded joints and simple welded structures. However, during the TEP FEM analysis of welding phenomenon, it is necessary to solve the whole region as a non-linear problem even in the case where a non-linear region is restricted in a narrow area. So, a thermal elastic plastic FEM utilizing iterative substructure method (ISM) and an elastic analysis based on the inherent deformation theory were proposed to investigate the features of mechanical phenomenon during welding in which the large deformation is considered. An easy way to comply with IJRASET paper formatting requirements is to use this document as a template and simply type your text into it.

A. Thermal Elastic Plastic FEM Analysis

In the in-house code JWRIAN (Joining and Welding Research Institute Analysis), the thermal–mechanical behaviour during welding process is analysed using thermal/mechanical uncoupled formulation. However, the uncoupled formulation considers the contribution of the transient temperature field to stresses through thermal expansion, as well as temperature-dependent thermal–physical and mechanical properties.

The solution procedure consists of two steps. First, the history of temperature distribution is computed using heat conduction analysis. Second, the transient temperature distribution obtained from the heat conduction analysis is employed as a thermal load in the subsequent mechanical analysis. Stresses, strains and displacements are then computed.

B. Iterative Substructure Method

The most characteristic aspect in welding problems is that the region in a strong non-linear state as a result of a thermal elastic plastic behaviour is restricted in the vicinity of a welding heat source, while the area which is more wider than the restricted region is in an elastic or weakly non-linear state; the second feature is that the non-linear area moves together with the heat source.

III. MIG WELDING EFFECTING PARAMETERS

MIG gives high quality of weld and weld deposition rate both are influenced very much by the various welding parameters and joint geometry. Proper execution of process and control of different numbers of parameters is essential for successful and best output. Normally a welded joint is produced by different combinations of welding parameters and joint geometries. The weld bead geometry, penetration depth and total weld quality depends on the following operating variables.

- A. Electrode size, Welding current.
- B. Arc voltage. Arc travel speed.
- C. Welding position. Filler material size.
- D. Gas Flow rate, Shielding Gas

IV. LITERATURE REVIEW

A. Review of Technical Research Paper

1) Paper 1

- a) *Title:* “Transient distortion behaviour during TIG welding of thin steel plate”
- b) *Author:* Shigetaka Okano Masahito Mochizuki
- c) *Summary:* To examine the generation characteristics of excessive distortions involved with the welding-induced buckling of a thin steel plate, the temperature profiles and distortion behaviours of welded plates during tungsten inert gas (TIG) welding were experimentally measured. Large-deformation thermal elastic–plastic analysis based on arc physics-based heat source modelling was utilized to accurately simulate the thermomechanical behaviour of the plate during welding. The calculated and measured temperature profiles and distortion behaviours were compared to validate the developed numerical analysis technique. On the basis of the developed analysis technique, the effect of geometric imperfections on the thermomechanical behaviour of welded thin steel plates was further investigated. Both angular and longitudinal bending distortions were found to monotonically increase with increasing heat input because of excessive longitudinal bending distortion and the secondary generation of angular distortion during the cooling process when buckling occurred.

2) Paper 2

- a) *Title:* ‘Effects of welding condition on weld shape and distortion in electron beam welded Ti2AlNb alloy joints’
- b) *Author:* Yanjun Li, Yue Zhao, Quan Li, AipingWu, Ruican Zhu, Guoqing Wang
- c) *Summary:* Ti2AlNb alloy is an attractive material for advanced aerospace applications. Welding of the alloy can lead to severe distortion, influencing dimensional precision of the welded workpiece and structural integration. In this study, the effect of welding parameters on the weld shape of the Ti2AlNb alloy jointed by electron beam welding was investigated. A three-dimensional thermal-elastic-plastic finite element method was developed to simulate the welding distortion. The simulation results agreed with experimental measurements very well. It showed that the developed computational approach has sufficient accuracy and can be used to predict welding distortion. Because of the low longitudinal shrinkage force, the workpiece was bent to a concave-concave shape

V. CONCLUSIONS

Through the experiment and computed results, it is shown that the twisting distortion of the thin plate stiffened structure can be predicted accurately by using ISM thermal elastic plastic FEA and elastic FEA employing inherent deformation method in which the large deformation is considered. The following conclusions also can be drawn:

- A. The measured result of experiment shows that the twisting distortion can be produced by welding process when stiffeners are designed on thin plate structure.
- B. ISM is practical and useful to improve the computational efficiency of thermal elastic plastic FEA for large-scale and complex welded structure and the computed result has enough accuracy compared with experiment.
- C. To simulate the twisting distortion, the large deformation theory is essential.
- D. The magnitude of the inherent deformation can be estimated according to its definition using the TEP computational result which is validated by experiment

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- [5] EXPERIMENTAL ANALYSIS OF DISSIMILAR METAL WELDS OF MILD STEEL AND STAINLESS STEEL by Brijesh Kumar Maurya¹, Balwant Pratap², Avaneesh Kumar³, Gopal Rana⁴ 2 3 4 Students, Department of Mechanical Engineering, IMS Engineering College, Ghaziabad, U.P. India (IRJET)



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