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# WELDING ASSEMBLY SIMULATION OF LARGE STRUCTURES

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## SUMMARY

Fusion welding processes are widely used to assemble large thin plate structures such as ships, automobiles and passenger trains because of the high productivity. However, welding-induced distortion often inevitably occurs during the assembly process. Welding distortion not only reduces fabrication accuracy of a welded structure but also decreases productivity due to correction works. If welding distortion can be predicted using a practical method beforehand, the prediction will be helpful for taking appropriate measures to control the dimension accuracy. In this study, an elastic FEM to predict the distortion accumulated in large and complex structures during the welding assembly process from cutting through straightening is developed based on inherent strain theory and interface element formulation.

There are two methods which can be employed for the prediction of welding distortion and residual stress. One is the thermal elastic plastic analysis in which the welding is treated as a transient nonlinear problem. The other is the inherent strain method in which the distortion and residual stress are computed by elastic analysis using the inherent strain as initial strain. They have both advantages and disadvantages. The latter is advantageous in computational time and disadvantageous because the detail of the welding condition may not be fully considered in some cases. The concept of inherent strain is closely related to those of inherent stress, inherent deformation and inherent force. Since the inherent strain is transformed into the deformation when the restraint is small and it is transformed into the stress when the restraint is strong, the framework of FE code for welding simulation can be naturally and conveniently constructed by combining these concepts. The idea how they are integrated in the FE code is presented in this paper. The entire assembly process consists of cutting, forming, fitting, welding and straightening. The cutting is regarded as separation of steel plate along the cutting line while the fitting and the welding are processes to join the members along the welding line. Since the gap and the misalignment between the members to be assembled is also a primary cause of the distortion of welded structures in addition to the local shrinkage due to welding, the interface element is introduced to the proposed FEM to describe the change of connection state between parts with the process of assembly stage. The versatility of the proposed FEM is demonstrated through typical examples.