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Jiamin Sun

Influence of heat input model parameters on the simulated properties in ferritic steel weldments

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	Univ.-Prof. Dr.-Ing. habil. Jean Pierre Bergmann

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Abstract

Up to now, the finite element method has been increasingly employed to predict temperature field, residual stress, and deflection in the welded components. Unfortunately, a few fundamental but very crucial issues in numerical welding simulation are still not sufficiently clear, which hinder the broad adhibition of finite element modeling in the manufacturing industries.

In numerical welding simulations, a heat input model is generally employed to replace the virtual heat generation process. Due to the used heat input model and the unknown net heat input, heat input model parameters (arc/thermal efficiency, and heat source shape parameters) determining the magnitude and the distribution of heat flux are usually required to be adjusted for achieving a good agreement between the calculated and the measured temperatures in the thermal analysis. However, the influence of the individual heat input model parameters on the welding temperature field is not sheerly clear-cut until now. Furthermore, that influence on welding residual stresses as well as deflections is also rarely illuminated so far. In addition, there is no clear guidance on the adjustment of heat input model yet.

Since the Goldak's volumetric moving heat source is universally applied in finite element modeling for arc welding, it was taken as the current research model. The main purpose of the present research work is to rank the influence of arc efficiency and Goldak's heat source shape parameters on the calculated thermomechanical results in the commonly used butt and fillet-welded joints made by arc welding. Then, a detail adjustment procedure of heat input model is provided and clarified. For validation welding experiments were performed to measure temperatures, residual stresses, and distortions.

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