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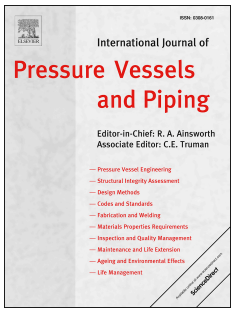

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Study on welding sequence of butt-welded structures based on equivalent heat source parameter

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Abstract: A thermo-elastic-plastic numerical method based on the hybrid inversion combing experiment results and numerical results was developed. The influence of various factors in the welding process on the welding deformation and residual stress was taken into account through the equivalent heat source parameter (EHSP). The out-of-plane displacement and residual stress of the butt-welded plate were measured firstly with electrical measurement method and hole-drilling method respectively. Then, a function was established to evaluate the standard error (*SE*) employing different heat source parameters between numerical and experimental results, and the EHSP corresponding to SE_{min} for the current material and welding conditions was inversed. At last, the EHSP was applied to the investigation of welding sequence. This method is also suitable for other welding methods and weld types.

Keywords: hybrid inversion; equivalent heat source parameter; welding sequence; welding deformation; residual stress

1. Introduction

Welding technology is widely used in the forming of the large metal structures. The welding deformation and residual stress is the inherent product of welding process, which has an important influence on the service performance and safety of structures [1-3]. If a reasonable welding sequence is selected in advance, the welding deformation and residual stress will be effectively reduced.

With the improvement of computer performance and the maturation of finite element (FE) method, numerical simulation has become a very convenient and effective tool to study the residual stress and welding deformation [4-6]. Yaghi et al. [7] introduced a method to predict the residual stress of P91 pipes in FE analysis. Lee et al. [8] investigated the temperature field and residual stress of dissimilar steel during the welding process, and the numerical results demonstrated that welding residual stress in the dissimilar steel butt-welds are by no means of the same magnitude or distribution as those in corresponding similar steel butt-welds. Moraitis et al. [9, 10] developed a two-level three-dimensional FE model to predict the keyhole formation and thermo-mechanical response of flat laser welding. Ye et al. [11] employed the 3-D thermo-elastic-plastic method to study the effect of groove type on welding deformation and residual stress. The results showed that compared with the V-groove, the X-groove and K-groove produce less welding distortion and residual stress. Fallahi et al. [12] proposed a method to obtain the entropy and residual stress resulted from the welding only according to the temperature field distribution, avoiding the complex time-consuming mechanical analysis in the thermo-elastic-plastic FE method, while this method can only quantitatively predict the influence of various factors on the residual stress, and was adopted to explore the influence of different preheating temperature and three welding sequences on residual stress. Mrvar et al.