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Co-Chairs: Jun Qu, Oak Ridge National Laboratory; Yongping Lei, China Nuclear Power Design Company; Peng He, Harbin Institute of Technology; Yunlong Chang, Shenyang University of Technology

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Simulation of the influence of preheating on stress distribution during multi-pass repair welding of cast steel

Wen Wang; Jian-xin Zhou; Ya-jun Yin, Huazhong University of Science and Technology

ABSTRACT

Preheating is an important process for multi-pass repair welding of cast steel to prevent bulking or even crack defects because of stress concentration. In order to obtain the heating parameters, it is important to calculate the stress distribution under various preheating conditions. In this study, a thermal–mechanical computational procedure based on thermal elastic-plasticity theory was developed to understand the evolution of thermal and constraint stress. In the thermal analysis, both temperature dependent property parameters and latent heat of material due to melting and solidification are taken into account; the thermal boundary is a mixture of convection and radiation boundary conditions; a Gaussian volumetric heat source model is adopted to treat the heat put for laser welding; and the multi-pass addition of the material is treated as quiet element method. For the mechanical analysis, a simplified double linear constitutive model is used to reflect the elastic-plasticity behaviors of the base and the filler and also mechanical parameters are varied with temperature. Based on the program, first the thermal and mechanical characterizes in the heating and heat affected zones are studied, and the influence of preheating temperature and holding time on the final stress distribution during multi-pass repair welding are simulated and analyzed. Besides, the effects of heating locations are also simply explored. The present study could do help for increase the effectiveness and lifetime of damaged cast steel treating with repair welding.

KEYWORDS: multi-pass repair welding, preheating treatment, thermo-mechanical model, numerical simulation