Influence of welding parameters on the welding residual stresses

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ABSTRACT

Welding is a complex process, influenced by a large variety of factors. As a result, it can be studied under many different scopes [1]. For a structural engineer the welding residual stresses and distortions are of great interest, as they have significant impact on the structural integrity of welded components and the manufacturing procedure respectively.

The residual welding stresses and distortions are caused due to the rapid heating and cooling, that takes place inside the component during welding, which causes dilatation and contraction of the metal around the weld pool. Due to the mechanical restraint of the heated material from the adjacent unheated material and in combination with the lowered yield strength, yielding takes place. It is clear that the heat input has a significant influence on the magnitude of the welding residual stresses and distortions. The temperature dependence of metallic material properties is increasing the effect of thermal input [2]. In practice, a balance has to be achieved, in order to have melting of the material and successful joining, while minimizing residual stresses and distortions. Quite often, the welding residual stresses are calculated through validated coupled welding simulation, as strain measurements near the weld are complex and costly [3]. Initially a thermal model is solved, in order to calculate the heat transfer problem inside the simulated component. The thermal part is coupled with the structural second model through transfer of the thermal history of the component.

In the present paper, we report on a parametric study regarding the influence of thermal input parameters (e.g. travelling speed and current of the welding torch) on the resulting residual stresses and distortions. Values for the welding parameters are taken from real welding procedure specifications. Two different components, a butt-weld and a T-joint are investigated, and appropriate boundary conditions are applied [4]. The investigated material is a high-alloy, stainless austenitic steel grade, so that the microstructural changes are negligible [5], and the influence of thermal input influence on the mechanical part is isolated. Both single- and multi-pass welds are investigated. The proposed study clarifies the coupled relation of thermal input parameters and welding residual stresses and contributes to further optimization of welding procedure.

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