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Prediction of residual stresses in FSW process

N. Dialami[1], M. Chiumenti[1], M. Cervera[1] and C. Agelet de Saracibar[1]

[1] International Center for Numerical Methods in Engineering (CIMNE),
Technical University of Catalonia, Module C1, North Campus
C/ Gran Capitán s/n 08034 Barcelona, Spain
E-mail addresses: narges@cimne.upc.edu (N. Dialami),
michele@cimne.upc.edu (M. Chiumenti), mcervera@cimne.upc.edu (M. Cervera),
agelet@cimne.upc.edu (C. Agelet de Saracibar),

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This work deals with the FE-based simulation of the residual stresses in Friction Stir Welding (FSW) processes. FSW is a solid-state joining technique used in many practical applications where the quality of the resultant joint is of essential importance. This feature decreases the harmful effects of high heat input, including distortion, and removes solidification defects.

A non-consumable tool, rotating at a constant speed, is inserted into the line between the two plates to be welded. The heat is produced by the friction between the tool shoulder and the work-pieces and the mechanical mixing/stirring process.

During FSW process, thermal and mechanical stresses develop in the weld and its vicinity due to the localized heat and constraint. The very rigid clamping creates generally the residual stresses in FSW as it impedes the contraction of heat affected zone. Therefore during the cooling phase longitudinal and transverse stresses are generated.

High values of residual stresses have a significant effect on the post-weld mechanical properties, particularly the fatigue ones. Therefore, it is of practical importance to carefully investigate the residual stress distribution in the FSW welds.

In the present paper, a coupled thermo-mechanical analysis by the nonlinear finite element method is carried out to accurately predict the temperature histories and thereby the residual stresses in FSW.

The results obtained from the proposed numerical method are validated by the experimental evidence.