A strategy for the prediction of residual stresses in FSW

ICME 2016

Narges Dialami, Miguel Cervera, Michele Chiumenti and Carlos Agelet de Saracibar

Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE)
Universidad Politècnica de Catalunya (UPC)
Campus Norte UPC, 08034 Barcelona, Spain
e-mail: 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)

ABSTRACT

This work describes the local-global strategy proposed for the computation of residual stresses in Friction Stir Welding (FSW) processes. A coupling strategy between the analysis of the process zone nearby the pin-tool (local level analysis) and the simulation carried out for the entire structure to be welded (global level analysis) is implemented to accurately predict the temperature histories and, thereby, the residual stresses in FSW [1-2].

As a first step, the local problem solves the material stirring as well as the heat generation induced by the pin and shoulder rotation at the heat affected zone. The Arbitrary Lagrangian Eulerian (ALE) formulation is adopted to deal with the rotation of complex pin shapes. A thermo-rigid-viscoplastic constitutive law is employed to characterize the viscous flow of the material, driven by the high strain rates induced by the FSW process [3]. A mixed temperature-velocity-pressure finite element technology is used to deal with the isochoric nature of the strains. The output of this local analysis is the heat generated either by plastic dissipation or by friction and it is used as the power input for the welding analysis at structural (global) level.

The global problem is tackled within the Lagrangian framework together with a thermo-elasto-viscoplastic constitutive model. Also in this case the mixed temperature-displacement-pressure format is introduced to deal with the deviatoric nature of the plastic strains. The outcomes of this analysis are the distortions and the residual stresses after welding.

The proposed numerical strategy is validated by the experimental evidence.

REFERENCES

[1] N. Dialami, M. Chiumenti, M. Cervera and C. Agelet de Saracibar. "Challenges in thermo-mechanical analysis of Friction Stir Welding processes", *Archives of Computational Methods in Engineering* (2015), DOI: 10.1007/s11831-015-9163-y.

[2] N. Dialami, M. Cervera, M. Chiumenti and C. Agelet de Saracibar. "Local-global strategy for the prediction of residual stresses in FSW processes" *Submitted to International Journal of solids and structures* (2015).

[3] N. Dialami, M. Chiumenti, M. Cervera, C. Agelet de Saracibar "On the constitutive modelling and friction laws used for the numerical simulation of Friction Stir Welding process" COMPLAS 2015, 13th International Conference on Computational Plasticity, Barcelona, Spain, 1-3 September 2015