

# Recent Advances in Residual Stress Simulation Caused by the Welding Process

H. Sallem<sup>\*</sup>, E. Feulvarch<sup>\*</sup>, H.Amin el Sayed<sup>\*</sup>, B. Souloumaic<sup>†</sup>, J-B. Leblond<sup>\*\*</sup>, J-M.Bergheau<sup>\*</sup>

<sup>\*</sup> Laboratoire de Tribologie et Dynamique des Systèmes (LTDS- UMR CNRS 5513)  
Ecole Nationale d'Ingénieur de Saint-Etienne  
Université de Lyon  
58 Rue Jean Parot, 42023 Saint-Étienne, France  
E-mail : haifa.sallem@enise.fr, web page: <http://ltds.ec-lyon.fr>

<sup>†</sup> ESI-Group, Lyon, France,  
70 Rue Robert, 69006 Lyon, France  
E-mail : bruno.souloumiac@esi-group.com

<sup>\*\*</sup> Institut Jean le Rond d'Alembert (IJLRA-UMR CNRS 7190)  
Université Pierre et Marie CURIE  
4 place Jussieu 75252 Paris, France  
Email : jbl@lmm.jussieu.fr

## ABSTRACT

Knowledge of welding residual stress characteristics is essential for structural integrity assessment of weld components. However, in order to improve residual stress and distortion predictability, numerical model should include as much as possible of physical phenomena occurring during welding.

The purpose of the present paper is to improve the description of residual stress field characteristics generated after welding. The behavior of the material both in the liquid and solid states and during all heating and cooling stages including the solidification in the mushy zone is considered, as well as the surface tension effects in the liquid phase. Simulations are conducted on the finite element software SYSWELD [1]. A displacement /pressure mixed formulation, based on the linear tetrahedral element of type P1/P1 in the context of elasto-viscoplastic formulation, is used.

As regards the structure behaviour, the continuous transition between the liquid and the solid phases during the welding is ensured using a mixture law behavior developed by Amin El sayed et al. [2]. Numerical simulations were carried out in the context of Lagrangian approach. In this approach the material over the liquidus temperature is modelled as a Newtonian fluid but the flows in the weld pool are not accounted for.

Concerning surface tension modelling, the standard method usually adopted is to apply an external load on the free surface of the weld pool. In the present study, a surfacic spherical stress state is directly imposed on the surface in membrane elements incorporated in the mesh and representing the interface [3].

Since tetrahedral mesh is easily adapted to complex geometry, a discretization of type P1/P1 is used in the case of welding simulation. It shows the relevance of such tetrahedral finite element for the mechanical analysis of elasto-viscoplastic solid metal.

A representative simulation of a laser welding case is processed. The material considered in this study is the Inconel 600 alloy. Computed residual stress distribution reveal the ability of such approaches to predict residual stress states in assessing the integrity of welded components.

## REFERENCES

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