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PhD proposal
CIFRE fellowship between UBS – ESI Group

Virtual forming of metallic sheet materials: prediction of forming and in-life behaviors within an integrated approach

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Industrial supervisor: Mr Jean-Louis DUVAL
Date of recruitment: 1st June 2015 (after validation by ANRT)
Duration: 3 years
How to apply: send CV+motivation letter by email to S. Thuillier
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The project takes place within the general framework of the virtual forming of metallic sheet structures, like automotive structural parts, that undergo firstly deep drawing operations involving large equivalent plastic strains and ductile damage, and secondly cyclic loadings during their lifetime. In order to gain weight via decreasing the material thickness, accurate and predictive new models of the material behavior should be implemented, that will consider both the forming steps and the subsequent in-service loadings.

This PhD work is part of a global project in virtual forming, aiming at developing an original model for the static and cyclic mechanical behavior of steel metallic sheets, including ductile damage and rupture. ESI Group coordinates this project, which involves three academic partners: University of Technology of Troyes in France (UTT, http://www.utt.fr/en/index.html in France), Pohang University of Science and Technology (POSTECH, http://www.postech.ac.kr, in South Korea) and LIMATB, University of South Brittany. Two advanced models [1,2] of the mechanical behavior at room temperature of metallic materials will be implemented in the finite element code Abaqus (via UMAT and VUMAT). This task will be performed in collaboration with UTT and POSTECH.

As these models both involve complex hardening, anisotropy and its evolution with strain, viscosity, ductile damage and rupture, a dedicated procedure should be proposed. Therefore, **the aim of this PhD** is dedicated to the identification procedure of material parameters for these models and validation for forming and in-life predictions. A combined experimental and numerical approach is to be developed.

A first part of the work is dedicated to the identification of optimized material parameters. Conventional tests, like tension on straight or notched samples, simple shear, plane strain tension, biaxial tension [3,4] as well as heterogeneous tests [3,5] will be considered. This step should lead to a reliable parameter set; indeed, as the number of material parameters increases with the model complexity, issues related to the stability of the solution will also be addressed. Moreover, dedicated indicators relevant to analyze the quality of the mechanical information related to a specific test, with regards to the mechanical model, have to be proposed, in order to build a reliable database for the identification.

Secondly, a validation step is necessary, in order to highlight the interest of such models. Validation should involved multi-step forming operations and loadings representative of in-service conditions. LIMATB has gained a recognized competence in developing specific devices in order to represent, at the laboratory scale, phenomena occurring at a larger scale in the industry, e.g. for surface defects [6], hemming [7] and twisting [8], and up to rupture [4,9].

Finally, the industrial aim is to contribute to the development of optimization of material parameters for complex models involving a large number of parameters, within the dedicated ESI product Virtual Performance Solution (VPS). The idea is to provide to the end user a numerical tool to determine the optimal number and type of tests necessary for the identification.

The PhD student will conduct this work mainly at LIMATB (Lorient – France) in interaction with ESI. Due to the international collaboration of the global project, the applicant should have a good level in English.
Skills: numerical simulation with finite element codes (Abaqus, PamStamp2G), computational plasticity, constitutive equations, post-treatment of experimental data (experiments can be performed by an engineer), digital image correlation data post-processing and comparison with experiments, optimization algorithms for material parameters identification

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