Institut de Recherche Dupuy de Lôme

IRDL – UMR CNRS 6027
Université Bretagne Sud
Rue de Saint Maudé – BP92116
56321 Lorient Cedex – FRANCE
https://www.irdl.fr

Robustness of virtual forming for multi-step process

PhD position at IRDL – LORIENT, France

Scientific supervisor: Prof Sandrine THUILLIER
References: Google scholar / ORCID

PhD topic

Keywords. Mechanical design, instrumented process, numerical model, mechanical behavior

Framework. Materials are key technology enablers and may become rare and very expensive in the future, thus encouraging massive light-weighting of structures though keeping the safety of the users [1]. This duality leads to the use of materials with always higher and higher mechanical properties, such as advanced high strength steels. Nowadays, the mechanical design of a novel part or structure should make a smart use of materials, choosing ones with very high strength in specific areas and high ductility and/or elasticity in other areas. Such a design requests an intensive knowledge of the mechanical properties, accurate models to represent the materials in finite element simulations, replacing the real material with a virtual one, and fast and reliable calibration procedures to adjust the material parameters. The general framework of this study is related to the reliability of virtual forming of thin sheet materials when considering multi-stage processes. Indeed, as it is highly dependent on the representation of the mechanical behavior of the material, more and more features should be taken into account in the modeling [2].

The challenge is therefore to develop numerical models of not only a single forming stage but of multi-step processes [3,4], with a continuous transfer of the blank from one stage to the other, as illustrated in Fig. 1. This requires a mechanical model for the material, that undergoes monotonic loadings but also strain path changes. Moreover, the quality of the deformed part depends on the interaction with the forming tools, the process parameters and the initial material properties.

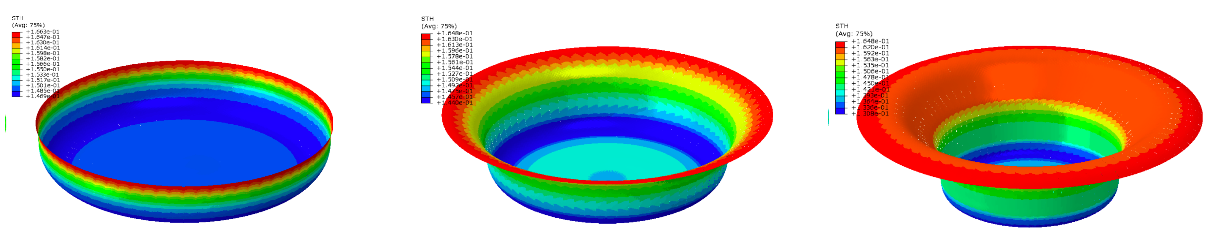

Figure 1: numerical model of a three-stage deep drawing process of a copper alloy material.

The objective of this study is therefore to design a demonstrator at the laboratory scale of complex, multi-step forming process for thin sheet of metallic materials, to provide a large amount of smart data to test the reliability of the numerical prediction of the final state of the material, e.g., the deformed geometry and the residual stresses. The technology readiness level (TRL) of this project is around 2-3 and no direct industrial application is aimed at. However, the general context is essential in mechanical industries facing the challenge of mass reduction of structures, based on the virtual design of forming processes.

Methodology. The project is divided into four main stages, with i) the mechanical characterisation of the behaviour up to fracture of several high strength steels, then ii) the mechanical design of a multi-step forming demonstrator and choice of fine instrumentation to generate meaningful data iii) obtaining an experimental database on the forming of thin metallic sheets and finally iv) developing the numerical model corresponding to the experimental data.

[1] C.L. Huang et al. Copper-induced ripple effects by the expanding electric vehicle fleet: A crisis or an opportunity. Resour. Conserv. Recycl. 161 (2020) 104861
[2] D. Hérault, S. Thuillier, S.H. Lee, P.Y. Manach, F. Barlat. Calibration of a strain path change model for a dual phase steel, International Journal of Mechanical Sciences 194 (2021) 106217 https://doi.org/10.1016/j.ijmecsci.2020.106217
[3] S. Thuillier, P.Y. Manach, L. F. Menezes, M.C. Oliveira, Experimental and numerical study of reverse drawing of anisotropic sheet metals, Journal of Materials Processing Technology 125-126 (2002) 764-771
[4] S. Thuillier, P.Y. Manach, L.F. Menezes, Occurence of strain path changes in a two- stage deep drawing process, Journal of Materials Processing Technology 210 (2010) 226-232

Practical details

The PhD student will be located at IRDL, in Lorient.
Skills: mechanics of materials, numerical simulation of forming processes with Abaqus, constitutive equations in elasto-plasticity, forming processes, experimental mechanics, mechanical design, fine instrumentation
Language skills: very good level in English (writing of papers and oral presentation) ascertained by the results of a test

Starting date: 01/11/2022
Duration: 36 mois
To apply: send a CV and a motivation letter (with people to contact for recommendation) to Sandrine Thuillier, email address **sandrine.thuillier@univ-ubs.fr**