Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids.

Subfield: **Mechanical Engineering**.

Title: Improving the characterization of a plasticity yield criterion using digital image correlation over enhanced heterogeneous tensile tests.

ParisTech School: Arts et Métiers – ParisTech (ENSAM)

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Short description of possible research topics for a PhD:

To perform accurate numerical simulations of industrial process requiring plastic deformation of metals (e.g. forging, metal sheet forming), high parameter number constitutive laws of the mechanical behavior were developed. But their use in industry faces the complexity of the identification protocol of 10 to 200 parameters which requires a large number of standard mechanical tests.

This PhD project aims the development and the implementation of an identification procedure of the parameters of a plasticity yield criterion in the frame of large plastic deformation. This identification protocol will use a finite element model updating (FEMU) method based on both the total applied force–displacement curve and the full-field strain measurements obtained with a limited number of tensile tests performed with a non-standard sample which will be designed. This sample will have the merit of enhancing simultaneously: the heterogeneity of the strain fields and their sensitivity to the yield criterion. The stability of the identification algorithm will be tested on virtual tensile tests performed on the same sample type by adding perturbations to numerical simulation results. Finally, the protocol will be validated by performing tensile tests on another non-standard sample which was not included in the identification data.
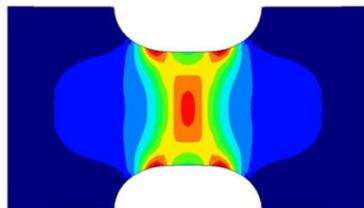
Heterogeneous tensile test: longitudinal strain field [Haddadi and Belhabib, 2012]

Required background of the student:
 - Mechanical engineering, Mechanical behavior of materials
 - Finite element method and Matlab tools will be appreciated.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

- H. Haddadi, S. Belhabib, (2012), Improving the characterization of a hardening law using digital image correlation over an enhanced heterogeneous tensile test, International Journal of Mechanical Sciences, 62, 1, 47-56.
- H. Haddadi, S. Belhabib, (2008), Use of rigid-body motion for the investigation and estimation of the measurement errors related to digital image correlation technique, Optics and Lasers in Engineering, 46, 185-196.
- S. Belhabib, H. Haddadi, M. Gaspérini, P. Vacher, (2008), Heterogeneous tensile test on elastoplastic metallic sheets: Comparison between FEM simulations and full-field strain measurements, International Journal of Mechanical Sciences, 50, 14-21.
- H. Haddadi, S. Bouvier, M. Banu, C. Maier, C. Teodosiu, (2006), Towards an accurate description of the anisotropic behaviour of sheet metals under large plastic deformations: Modelling, numerical analysis and identification, International Journal of Plasticity, 22, 2226-2271.