RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering, computational mechanics

Title: Prediction of plastic buckling for thin structures using advanced constitutive models

ParisTech School: Arts et Métiers Sciences et Technologies

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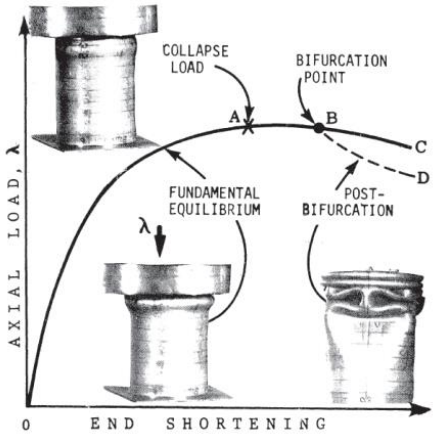
Short description of possible research topics for a PhD:

Plastic buckling is a physical phenomenon that involves a sudden loss in strength for a structure due to the resulting post-buckling shape. This catastrophic behavior is one of the most common structural instability phenomena that a thin structure may encounter during plastic loading. Hence, it is essential to carefully study this phenomenon and to develop the associated numerical tools that are capable of accurately predicting its occurrence. Despite the significant progress accomplished in this area, the existing numerical tools suffer from several limitations, such as the poor description of the mechanical behavior of buckled structures. The current project aims to overcome these limitations by developing several reliable numerical tools in standalone codes or within the Abaqus FE code. In these tools, some advanced constitutive models, allowing for an accurate description of the mechanical behavior, will be implemented and used (based on crystal plasticity approaches or phenomenological models incorporating destabilizing effects). For validation purposes, the results obtained by the developed tools will be compared to benchmarks available in the literature as well as to some theoretical or experimental published results.

Required background of the student:
- Solid background in solid mechanics and numerical methods;
- Good analytical and programming skills (e.g., Matlab, Mathematica, C/C++, Fortran);
- Experience with Finite Element modeling would be an asset.

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

1. **M. Ben Bettaieb**, **F. Abed-Meraim (2015),** "Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses", *International Journal of Plasticity*, Vol. 65, pp. 168–190.
2. H.K. Akpama, **M. Ben Bettaieb**, **F. Abed-Meraim (2017),** "Localized necking predictions based on rate-independent self-consistent polycrystal plasticity: Bifurcation analysis versus imperfection approach", *International Journal of Plasticity*, Vol. 91, pp 205–237.
3. M.Y. Jedidi, **M. Ben Bettaieb**, **F. Abed-Meraim**, A. Bouguecha, M.T. Khabou, M. Haddar **(2019),** "Prediction of necking in HCP sheet metals using a two-surface plasticity model", *International Journal of Plasticity,* doi.org/10.1016/j.ijplas.2019.102641.
4. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Numerical investigation of necking in perforated sheets using the periodic homogenization approach", *International Journal of Mechanical Sciences,* doi.org/10.1016/j.ijmecsci.2019.105209.
5. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Investigation of the competition between void coalescence and macroscopic strain localization using the periodic homogenization multiscale scheme", *Journal of the Mechanics and Physics of Solids*, doi.org/10.1016/j.jmps.2020.104042.



Plastic buckling of a cylindrical shell subjected to axial compression.

Buckled axially compressed axially stiffened cylindrical shell.