6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

PROPAGATING INSTABILITIES IN ARCHITECTURED MATERIALS

A.-E. VIARD[a,b,*], J. DIRRENBERGER[a] and S. FOREST[b]

[a] Laboratoire PIMM, Arts et Métiers-ParisTech, CNRS, 151 bd de l'Hôpital, Paris 75013, France, antoine-emmanuel.viard_1@ensam.eu

[b] Centre des Matériaux, Mines-ParisTech, CNRS UMR 7633, BP 87, 91 003 Evry Cedex, France

Keywords: *Instabilities, Lüders bands, Architectured materials, Periodic media, Homogeneisation, Computing Methods*

Under tension low carbon steels exhibit inhomogeneous deformation. This phenomenon driven by dislocations is called Lüders banding. This instability creates fronts of localised strain that propagate through the structure. Kyriakides and Ok [1] emphasise propagation pattern of located deformation in tubes under bending and point a curvature fragmented along the sample. To date, only simple geometries, sheets and tubes, have been studied. On the other hand, additive manufacturing enlarge the field of development for architectured materials. This emerging class of advanced materials provides new possibilities in terms of mechanical properties. This work deals with such materials, topologically optimised or with predetermined morphology, in order to develop lightweight metallic structures with capability to localise deformation thanks to their geometry. We investigate the effect of the architecture on the global behavior of the entire structure. Especially, how bands can interact with a lattice and how to control initiation and propagation of localised strain with the architecture. Consequently, controled local instabilities could lead to singular macroscopic behavior. Finite element simulations use isothermal and irreversible models to explore relevant topological configurations. The softening-hardening constitutive law [2] allows the simulation of the Lüders bands phenomenon. Futhermore, we are concerned by studying the spread of instabilities in those periodic media. Effective properties for each configuration are obtained through computational homogeneisation [3]. A micro-level architecture of the constitutive phases achieved through additive manufacturing could potentially enable control the actuation strain and the transformation temperature. Therefore, introducing multiple length scales optimisation in the structure.

REFERENCES

[1] S. Kyriakides, A. Ok, E. Corona, *International Journal of Solids and Structures*, **45**, pp. 3074-3087, 2008.

[2] M. Mazière and S. Forest, *Continuum Mechanics and Thermodynamics*, **27**, pp. 83-104, 2015.

[3] J. Dirrenberger, S. Forest, D. Jeulin, *Computational Materials Science*, **64**, pp. 57-61, 2012.