11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

AN EXTENDED CONTINUUM MODEL FOR METAL FOAMS

Anne Jung[1 *], **Stefan Diebels**[1]

[1] Universität des Saarlandes, Lehrstuhl für Technische Mechanik,
Campus A4.2, 666123 Saarbrücken, Germany,
anne.jung@mx.uni-saarland.de, s.diebels@mx.uni-saarland.de
http://www.ltm.uni-saarland.de

Key words: *Metal Foams, Phenomenological Model, Multiscale Modelling, Micro structure, Experiments.*

Metal foams are a very interesting class of bionic micro heterogeneous materials which mimic the construction elements of wood and bone. Based on their distinct micro structure they show a special stress-strain characteristics with a nearly constant stress over a long range of deformation [1, 2]. That is why they are often used as kinetic energy absorber. The micro structure of open cell metal foams consist of an interconnected 3D network of pores. Metal foams exhibit localised deformation states under inelastic strain conditions. According to the compressible behaviour of foams there is a localisation of damage in crushing zones with a thickness of several porous layers. The macroscopic properties of such materials are strongly influenced by the micro structural constitution especially if the sample size is in the same order of magnitude than the micro structural size. Such size effects have to be taken into account for the meaningful computational modelling of foams and other micro heterogeneous materials.

The aforementioned strain localisations causes stress fluctuations in the macroscopic stress-strain diagram. In the present contribution a new modelling approach has been developed which allows the explicit consideration of size effects and other micro structural effects on the macroscopic continuum properties in a phenomenological way. The model is based on a multiscale approach. The macroscopic crushing zones in the experiment are built by a representative volume element (RVE) comprising of several pores on the microscale. The micro model is founded on a phenomenological rheological spring model offering the possibility to reflect the macroscopic fluctuation in the stress-strain response. Each pore layer of the RVE is represented by a spring. A damage criterion for the springs is a crucial component of the micro model. Connecting a micro structural size with the rheological model leads to a modified Hooke's law as micro model and allows the description of localisation effects. By introducing a rheological model for the RVE on the microscale the constitutive equations still contain fundamental parameters but these are motivated by the micro structure, whereas the phenomenological model is able to account

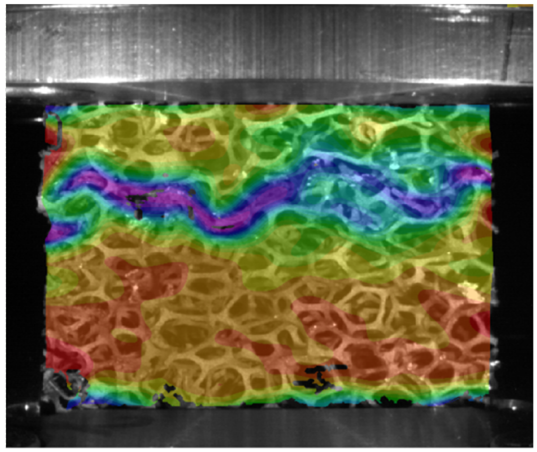

Figure 1: Localisation of strain in foams using DIC.

for size effects.
The build up of the localisation zones as crushing bands can be macroscopically seen in compression tests. The strain localisations phenomenons were investigated using digital image correlation (DIC) to determine the parameters for the micro model. A first comparison of the model with respect to compression tests showed promising results.

REFERENCES

[1] M. F. Ashby. The mechanical properties of cellular solids. *Metall. Trans. A*, Vol. **14 A**, 1755-1769, 1983.

[2] M. F. Ashby, A. G. Evans, J. W. Hutchinson and N. A. Fleck. *Metal Foams: a Design Guide*. Butterworth Heinemann, 1998.