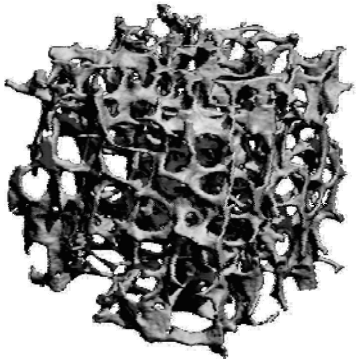
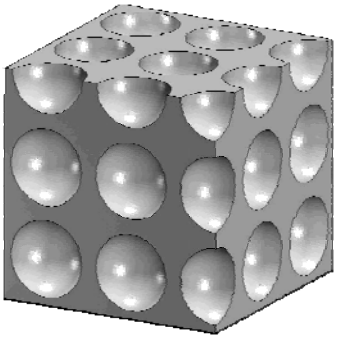
Computational modelling of cellular structures



Matej Vesenjak and Zoran Ren

University of Maribor
Faculty of Mechanical Engineering
Slovenia



The presentation focuses on appropriate computational modelling of closed- and open-cell cellular structures subjected to impact loading conditions. The prime aim of computational modelling is to determine and evaluate the influence of different parameters on macroscopic behaviour of cellular structures subjected to impact loading. Several parameters are considered: (i) type of base material, (ii) type of pore filler, (iii) relative density, (iv) size of the cellular structure, (v) strain rate and (vi) thermal conductivity.

The explicit finite element code LS-DYNA is used for all computational simulations, also for solving a coupled dynamic problem of interaction between the cellular structure and the filler under large deformations. The influence of gas filler inside the closed-cell cellular structure is analysed with the representative volume element and use of the airbag model. The analysis of the pore fluid filler inside the open-cell cellular structures is done with the combination of the finite element method and the Smoothed Particle Hydrodynamics (SPH) meshless method.

The base material properties and macroscopic behaviour of cellular structures with and without fillers are determined with experimental measurements of appropriate specimens under quasi-static and dynamic uniaxial loading conditions.

Computational simulations prove that the base material has the highest influence on the behaviour of cellular structures under impact conditions. The increase of relative density and strain rate results in increase of the cellular structure stiffness. Parametric computational simulations have also confirmed that the filler influences macroscopic behaviour of the cellular structures, which depends on the loading type and the size of the cellular structure. In open-cell cellular structures with higher filler viscosity and higher relative density, increased impact energy absorption is observed.

Computationally determined behaviour of detailed modelled closed-cell cellular structures is used to develop homogenised constitutive models for large scale computational simulations, which can be used in general computational codes by practicing engineers in industry when designing structures made of cellular materials. These models allow for faster, easier and more efficient computational simulations of cellular structures in general engineering applications.