MICRO-MECHANICAL MODELLING OF CELLULAR MATERIALS WITH REFINEMENTS ON FRACTURE AND DAMAGE

Goal of the project

Cellular materials are widely used as cores in sandwich composites, for packing and cushioning. The main characteristics of foams are light weight, high porosity, high crushability and good energy absorption capacity. Present project propose to develop micro-mechanical models in order to predict the mechanical properties of cellular materials with a focus on modeling the fracture and the influence of damage on the mechanical response.

Short description of the project

Project combines analytical, numerical and experimental methods for describing mechanical behavior of cellular materials.

Project implemented by:

Universitatea Politehnica Timisoara

Implementation period

05.10.2011 – 30.11. 2016

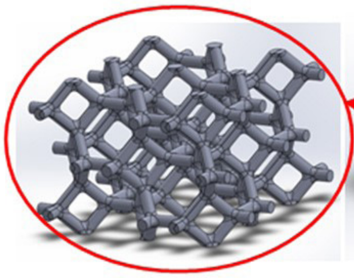
Main activities

- Better understanding of mechanical behavior of cellular materials.
- Develop micro-mechanical models to estimate mechanical properties of cellular materials.
- Implementation of constitutive material models in Finite Element Analysis.
- Investigating the size effect and notch effect on cellular materials Evaluating the behavior of cellular materials under dynamic (impact and fatigue) loading.
- Identification of damage mechanisms in cellular materials using Digital Image Correlation and Thermography.
- Investigating the effect of microstructural damage on the mechanical properties of cellular materials.
- Applixations of cellular structures in sandwich structures and sport industry.

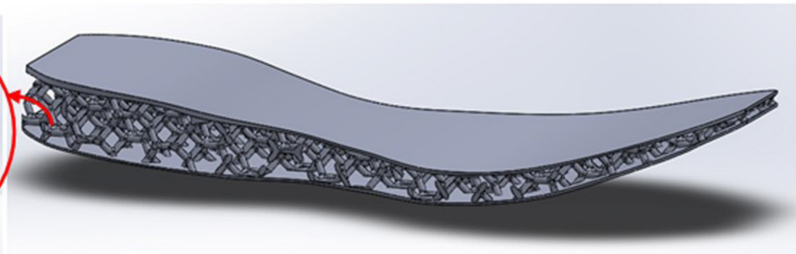
Results

Dissemination of results in ISI journals

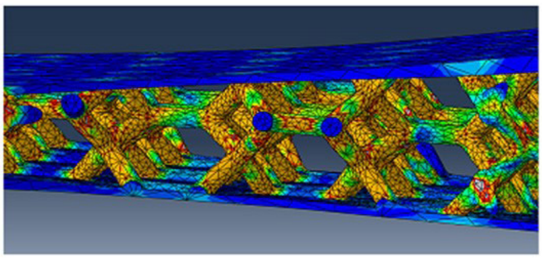
1. L. Marsavina, E. Linul, T. Voiconi, T. Sadowski, A comparison between dynamic and static fracture toughness of polyurethane foams, POLYMER TESTING, 32, 673-680, 2013 (IF 2.35)
2. L. Marsavina, D.M. Constantinescu, E. Linul, D.A. Apostol, T. Voiconi, T. Sadowski, Refinements on fracture toughness of PUR foams, ENGINEERING FRACTURE MECHANICS, 129, 54-66, 2014 (IF 2.024)
3. E. Linul, L. Marsavina, Assessment of sandwich beams with polymeric foam core using failure-mode maps, PROCEEDINGS OF ROMANIAN ACADEMY A, Vol. 16(4), p. 522-530, 2015 (IF 1.735)
4. Serban D., Linul E., Marsavina L., Modler N., Numerical evaluation of two-dimensional micromechanical structures of anisotropic cellular materials: case study for polyurethane rigid foams, IRANIAN POLYMER JOURNAL, Vol. 24 (6), p. 515-529, 2015 (IF 1.684)
5. Marsavina L., Constantinescu D. M., Linul E., Voiconi T., Apostol D., Shear and mode II fracture of PUR foams, ENGINEERING FAILURE ANALYSIS, Vol. 58 (Part 2), p. 465-476, 2015 (IF 1.358)
6. Negru R., Marsavina L., Voiconi T., Linul E., Filipescu H., Belgiu G., Application of TCD for brittle fracture of notched PUR materials, THEORETICAL AND APPLIED FRACTURE MECHANICS, Vol. 80 (Part A), p. 87-95, 2015 (IF 2.025)
7. Serban D., Marsavina L., Modler N., Low-cycle fatigue behaviour of polyamides, FATIGUE & FRACTURE OF ENGINEERING MATERIALS & STRUCTURES, Vol. 38 (11), p. 1383-1394, 2015 (IF 1.838)
8. Marsavina L., Kovacik J., Linul E., Experimental validation of micromechanical models for brittle aluminium alloy foam, THEORETICAL AND APPLIED FRACTURE MECHANICS, Vol. 83, p. 11-18, 2016 (IF 2.025)
9. Serban D., Voiconi T., Linul E., Marsavina L., Modler N., Viscoelastic Properties of PUR Foams Impact excitation and dynamic mechanical analysis, MATERIALE PLASTICE, 52 (4), p. 537-541, 2015. (IF 0.903)
10. Serban D., Weissenborn O, Geller S., Marsavina L., Gude M., Evaluation of the mechanical and morphological properties of long fibre reinforced polyurethane rigid foams, POLYMER TESTING, 49, 121-127, 2016 (IF 2.35)
11. Marsavina L., Constantinescu D.M., Linul E., Apostol D.A., Voiconi T., Experimental and numerical crack paths in PUR foams, ENGINEERING FRACTURE MECHANICS, 167, p. 68-83, 2016, (IF 2.024)
12. Linul E., Marsavina L., Kovacik J., Sadowski T., Dynamic and Quasi-Static compression tests of closed-cell aluminium alloy foams, PROCEEDINGS OF ROMANIAN ACADEMY A, Accepted manuscript, 2016. (IF 1.735)
13. Apostol D., Stuparu F., Constantinescu D. M., Marsavina L., Linul E., Crack length influence on stress intensity factors for the asymmetric four-point bending testing of a polyurethane foam, MATERIALE PLASTICE, 53 (2), p. 280-282, 2016. (IF 0.903)
14. Linul E., Serban D., Marsavina L., Kovacik J., Low-cycle fatigue behaviour of ductile closed-cell aluminium alloy foams, FATIGUE & FRACTURE OF ENGINEERING MATERIALS & STRUCTURES, On Line accepted Manuscript, 2016, doi: 10.1111/ffe.12535 (IF 1.838).



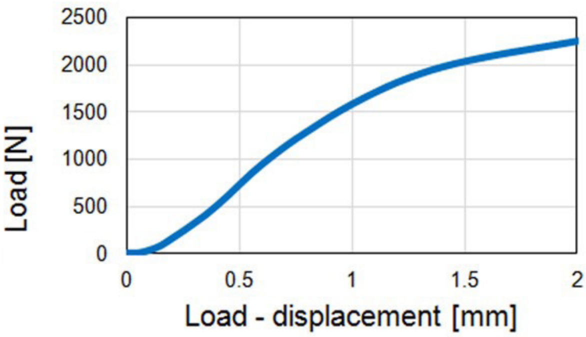
cellular structure



sole with cellular core



displacement results



load - displacement response of sole

Results on mechanical behavior of sole with cellular structure core

Applicability and transferability of the results

Results will be transfered to foams manufacturers to improve their manufacturing process. Also, companies using foam componets and cellular structures (shoes industry) will benefit by our developed micro-mechanical models to characterise their componens and in the product design.

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Research Center

ICER

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