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 methods, with numerical micro-mechanical finite element analysis and experimental investigations: materials testing and investigating the damage mechanisms by Digital Image Correlation and Thermoelastic Stress Analysis. The novelty of the project will be highlighted by the size and notch effect for cellular materials, and by investigating the effect of microstructural damage on the mechanical response of cellular materials.

Project implemented by

- Politehnica University of Timisoara
- Lublin University of Technology, Lublin, Poland
- Slovak Academy of Science, Bratislava, Slovakia
- Polymer Competence Center Leoben, Austria
- ILK, TU Dresden, Germany

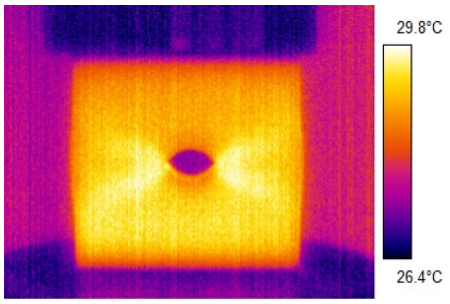
Implementation period

05.10.2011 – 04.10. 2015

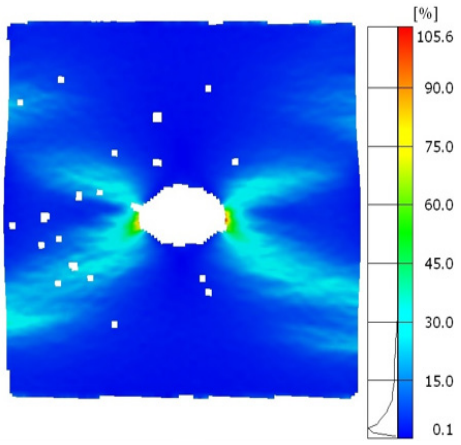
Main activities

- 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.
- dentification 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.

Damage identification



by thermography



by Digital Image Correlation

Financed through/by

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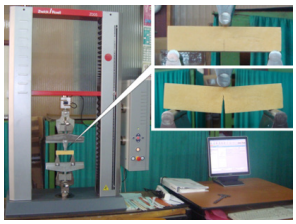
Results

Our results provide a complete characterization of cellular materials, with enhancement on fracture and damage mechanisms. The main results of the project were published in ISI high impact journals:

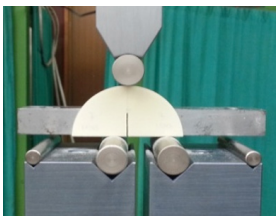
- L. Marsavina, E. Linul, T. Voiconi, T. Sadowski, A comparison between dynamic and static fracture toughness of polyurethane foams, Polymer Testing 32 (2013) 673–680;
- L. Marsavina, D.M. Constantinescu, E. Linul, D.A. Apostol, T. Voiconi, T. Sadowski, Refinements on fracture toughness of PUR foams, Engineering Fracture Mechanics, 129 (2014) 54-66;
- D. Serban, E. Linul, L. Marsavina, N. Modler, Numerical evaluation of two-dimensional micromechanical structures of anisotropic cellular materials: case study for polyurethane rigid foams, Iranian Polymer Journal 24 (2015) 515-529;
- D. Serban, L. Marsavina, N. Modler, Low-cycle fatigue behavior of polyamides, Fatigue and Fracture of Engineering Materials & Structures (Published OnLine);
- L. Marsavina, D.M. Constantinescu, E. Linul, T. Voiconi, D.A. Apostol, Shear and mode II fracture of PUR foams, Engineering Failure Analysis (Published OnLine);
- R. Negru, L. Marsavina, D, T. Voiconi, H. Filipescu, G. Belgiu, Application of TCD for brittle fracture of notched PUR materials, Theoretical and Applied Fracture Mechanics (Published OnLine);

but also in other BDI journals and conference proceedings: Vth ICEAF 2015, Crack Path 2015 .

Testing of PUR foams for fracture toughness determination



Three point bending



Asymmetric Semicircular Bending

Single Edge Crack

Compact Shear

Applicability and transferability of the results

- Results will be used by foams manufacturers Necumer and Spumotim to improve their technologies. Also, companies using foam components like TRW Automotive and Adidas will benefit by our developed micro-mechanical models to characterize their components and in the product design.

Fields of interest:

- Composite and cellular materials
- Mechanical testing
- Finite Element Analysis
- Fracture and Damage Mechanics

Research team

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Eng. Tudor Voiconi, PhD student
Eng. Florin Stuparu, PhD student

"There are no secrets to success. It is the result of preparation, hard work, and learning from failure."
Colin Powell

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