

Field of doctoral studies: Mechanical Engineering

Doctoral supervisor: Prof.dr.Eng.Silviu BUTNARIU

TOPICS FOR THE ADMISSION TO DOCTORAL STUDIES

TOPIC 1: *Study of Impact Behaviour of Kinetic Energy Absorption Structures Used in Vehicle Construction*

Contents / Main aspects to be considered

The proposed research aims at the systematic investigation of the mechanical behaviour of kinetic energy absorption (KEA) structures used in modern vehicle construction, with emphasis on numerical simulation via explicit Finite Element Method (FEM) and experimental validation. KEA-type structures – front side members, impact beams, thin-walled tubular absorbers, honeycomb structures, and metallic foams – are critical components for the passive safety of occupants, managing energy dissipation during an impact event.

Stages:

- *Geometric and numerical modelling of KEA structures*
- *Explicit FEM simulation of axial and lateral impact*
- *Analysis of multi-material and hybrid structures*
- *Topological and dimensional optimisation of KEA structures*
- *Experimental validation and correlation with the FEM model*

Recommended bibliography:

1. Butnariu, S., Mogan, Gh., Finite Element Analysis in Mechanical Engineering. Practical Applications in ANSYS, Transilvania University Publishing House, ISBN 978-606-19-0474-7, Braşov, 2014.
2. Butnariu, S., Analysis of mechanical structures using finite element method, lecture notes, ISBN 978-606-19-0311-5, Transilvania University of Braşov Publishing House, 2013.
3. Abramowicz, W., "Thin-walled structures as impact energy absorbers", Thin-Walled Structures, vol. 41, no. 2–3, pp. 91–107, 2003.
4. Wierzbicki, T., Abramowicz, W., "On the crushing mechanics of thin-walled structures", Journal of Applied Mechanics, vol. 50, pp. 727–734, 1983.
5. Hallquist, J.O., LS-DYNA Theory Manual, Livermore Software Technology Corporation, California, 2006.
6. Fang, J., et al., "Crashworthiness design of foam-filled bitubal structures with uncertainty", International Journal of Non-Linear Mechanics, vol. 95, pp. 86–98, 2017.
7. Sun, G., et al., "Crashworthiness optimization of vehicle thin-walled structures: current status

and future trends", *Thin-Walled Structures*, vol. 198, 111690, 2024.

8. Navodariu, N., et al., "Effect of local heating on the mechanical characteristics of repaired automotive panels", *Materiale Plastice*, vol. 56, no. 4, pp. 750–758, 2019.
 9. Hadryś, D., Miros, M., "Coefficient of restitution of model repaired car body parts", *Journal of Achievements in Material and Manufacturing Engineering*, vol. 28, no. 1, pp. 51–54, 2008.
 10. Deb, K., et al., "A fast and elitist multiobjective genetic algorithm: NSGA-II", *IEEE Transactions on Evolutionary Computation*, vol. 6, no. 2, pp. 182–197, 2002.
 11. Chen, C., et al., "Research on the mechanical properties of repaired clinched joints with different forces", *Thin-Walled Structures*, vol. 152, 106752, 2020.
- European New Car Assessment Programme (Euro NCAP), Technical Bulletin: Frontal and Side Impact Testing Protocol, version 10.1, Brussels, 2023. <https://www.euroncap.com>
- Mori, Ken-ichiro, et al. "Joining by plastic deformation." *CIRP Annals* 62.2 (2013): 673-694.

Prerequisites / Remarks: *to be adapted/ completed/ deleted*

- *Graduates of Automotive Engineering, Mechanical Engineering, Mechatronics, or Robotics study programs.*
- *Solid knowledge of strength of materials, structural dynamics, and plasticity.*
- *Familiarity with an FEM software package (ANSYS, LS-DYNA, ABAQUS, or equivalent).*
- *Knowledge of 3D CAD modelling (SolidWorks, CATIA, or equivalent).*
- *Programming skills (Python, MATLAB, or APDL) are an advantage.*

Scientific Doctorate

Professional Doctorate

without tuition fee (state budget funded)

with tuition fee or with funding from other sources than the state budget

Doctoral supervisor,

Prof. Dr. Eng. Silviu BUTNARIU

Coordinator of the field of doctoral studies,

Prof. Dr. Eng. Maria Luminita SCUTARU