TECHNICAL UNIVERSITY OF KOŠICE
Faculty of Mechanical Engineering

HORIZON-CL4-2023-DIGITAL-EMERGING-01-12: Adaptive multi-scale modelling and characterisation suites from lab to production (RIA)

Ideas for the project:
- numerical investigation (by the finite element method) of nanostructures, functionally graded materials (FGM) and multi-scale metamaterials
- design of internal structures of multi-scale metamaterials
- optimization of internal structure of FGM and metamaterials from the point of view of their mechanical properties
- measurement (by contact as well as contactless optical methods) of deformation and stress states of FGM and metamaterials
- measurement of eigenfrequencies and eigenshapes of parts made of multi-scale metamaterials
- measurement of residual stresses in the structures.

Our ideas for the project:
The design of the internal structure of materials in optimizing the mechanical properties in multi-scale modelling can be based on different concepts with respect to the objectives to be achieved, in addition to weight reduction. In the project, we offer the capacity to create and optimize the structure through the use of different types of materials in the form of composite structures involving functionally graded materials and the use of self-similarity, similar to fractals in mathematics.

Previous solutions:
We have solved problems related to the structure of foamed aluminium, nanostructures, but we also have experience with analysis of composite structures. In the context of the present project, we think it is important that we have experience in topological optimization of structures using our own program based on a genetic algorithm.

Experience and infrastructure offered:
1. Up to date software for structural analysis (Siemens NX, NX Nastran, Abaqus, Ansys, SolidWorks); experiences from analysis, especially nonlinear problems of structural mechanics as well structural optimization.
2. Laboratories of Experimental Stress Analysis, Resistance Tensometry and Redistribution of Residual Stresses, Modern Optical Methods, Transmission Photoelasticimetry, Reflective Photoelasticimetry, Photostress, etc.

Projects solved, related to the issue:
1. Static and dynamic analyses of aluminum foam geometric models using the homogenization procedure and the FEA / C. S. Roszkos ... [et. al.], In: Composites Part B: Engineering. Vol. 171 (2019), p. 361-374. - ISSN 1359-8368, Access: https://www.sciencedirect.com/science/article/pii/S1359836818321607
2. The computation of bending eigenfrequencies of single-walled carbon nanotubes based on the nonlocal theory / J. Bocko ... [et al.], In: Mechanical Sciences. Vol. 9, no. 2 (2018), p. 349-358. - ISSN 2191-9151, Access: https://ms.copernicus.org/articles/9/349/2018/
3. Buckling of single-walled carbon nanotubes with and without defects / J. Bocko, P. Lengvarský, In: Journal of Mechanical Science and Technology. Vol. 31, no. 4 (2017), p. 1825-1833. - ISSN 1738-494X, Access: https://link.springer.com/article/10.1007/s12206-017-0330-y.
4. Sizing and topology optimization of trusses using genetic algorithm / I. Delyová ... [et al.], In: Materials. - Vol. 14, no. 4 (2021), p. 1-14. - ISSN 1996-1944, https://www.mdpi.com/1996-1944/14/4/715.
5. VEGA 1/0500/20 (Slovak Grant Agency) Research of mechanical properties of materials with complex internal structure by numerical and experimental methods of mechanics.

Partners in previous research projects:
TU Darmstadt, TU Stuttgart, University of Valencia, University of Wuppertal, CTU in Prague, Brno University of Technology, Sun Moon University - South Korea, University of Zielona Góra

Contacts to industrial partners:
Oerlikon, Continental, U. S. Steel Košice, BSH Siemens, Eustream, ŠKODA AUTO, IDIADA, Enel, VÚJE, Mondi SCP, Whirlpool, ISD Dunaferr, Slovalco, Slovenské elektrárne, Tatravagónka

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