

**Application form for research topics
in the field of engineering and technology
for candidates to the Doctoral School
in the academic year 2024/2025**

Proposed subject matter of a doctorate
Constitutive material model of composite structures produced by the additive manufacturing
Scientific discipline (<i>delete as appropriate</i>)
AUTOMATION, ELECTRONICS, ELECTROTECHNICS AND SPACE TECHNOLOGIES CIVIL ENGINEERING, GEODESY AND TRANSPORT MECHANICAL ENGINEERING
Proposed doctoral thesis supervisor
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Brief description of the research topics with an indication of the scientific issues (max. 350 words)
The purpose of the research work within the proposed research topic is to develop a constitutive model (material model) for 3D printed structures. The structures are to be developed using filaments reinforced with dispersed carbon fibers. The developed material model will be intended for the design of usable composite structures produced by additive manufacturing. The essence of the project is an innovative approach to the development of a constitutive model based on the theory of hyperelastic materials. As a consequence, it is expected to obtain a combination of non-linear-elastic model with brittle fracture phenomena. As part of the research, it is assumed that a number of tensile tests will be carried out on structures made of filaments reinforced with dispersed carbon fibers (e.g. CF-PA-12). These tests are: static tensile, compression and shear tests. Measurement samples produced in the Department of Structural Mechanics will be tested. The test results will be used to calibrate the material model using the optimization technique and Finite Element Method modeling using the ABAQUS and Isight software from SIMULIA. The purpose of the research is to demonstrate the possibility of using additive manufacturing to produce composite structures for the needs of the construction, automotive and aviation industries.
Justification of the purposefulness of taking up the research topics (max. 150 words)
The design and analysis of additively manufactured composite structures is a key challenge in the field of additive manufacturing. This is due to the fact that the final properties of the developed structure differ from the properties of the material used for the production purposes. In order to fully exploit the advantages of additive manufacturing technology, the issues of elastic and strength properties of printed composite structures need to be explored. In addition, the effective design of

large scale additively manufactured structures remains a major challenge, and the numerical modeling methodology for their effective design is not yet fully explored. Therefore, to enable effective design and analysis of such structures, current research focuses on estimating the final properties of 3D printed structures using computational models.

Proposed topics of doctoral theses within the proposed research subject matter (up to 3 topics)

1. Constitutive material model of composite structures developed by additive manufacturing technology.
2. Topological optimization of polymer structures produced by additive technology.

The sources of financing of the research topics (the subject matter of currently implemented research grants financed from external sources or as part of subsidies)

Projekt BNI-UE-2023-5 Narodowa Agencja Wymiany Akademickiej, Realizacja 01.01.2024 - 31.12.2024,

Confirmation of the possibility of ensuring access to scientific apparatus and software necessary for the realization of the proposed research topics (*delete as appropriate*)

FULLY/ PARTIALLY/ NONE

If the answer is PARTIALLY or NONE please indicate a type of missing scientific apparatus and/or software and the sources of financing an access to them

A list of up to 5 major supervisor's publications related to the proposed research topics, published in journals indexed in the Web of Science or Scopus for the period of the last 3 years (taking into account the IF Impact Factor and the MNiSW score)

1. Wesolowski Miroslaw, Ruchwa Mariusz, Rucevskis Sandris, Nonlinear static analysis of truss core sandwich beams in three-point bending test, **(2023)**, ARCHIVES OF CIVIL ENGINEERING, (IF=0.7, **100pt.**)
2. Wesolowski Miroslaw, Ruchwa Mariusz, Skukis Eduards, Kovalovs Andrejs, Numerical and experimental extraction of dynamic parameters for pyramidal truss core sandwich beams with laminated face sheets, **(2020)**, **Materials**, (IF=3.057, Web of Science – **140pt.**)
3. Kovalovs Andrejs, Rucevskis Sandris, Kulakov Vladimir, Wesolowski Miroslaw, Optimum Position of Electrodes to Detect Delaminations in Composite Materials Using the Electric Resistance Change Method, **(2020)**, **Mechanics of Composite Materials**, (IF=1.007, Web of Science – **40pt.**)
4. M. Wesolowski, E. Barkanov, Improving material damping characterization of a laminated plate, (2019), **Journal of Sound and Vibration**, Vol. 462, pp. 1-12, (IF=3.429, Web of Science – **200pt.**)

A list of research grants financed by the National Science Centre, the National Centre of Research and Development and the European Research Council in which the supervisor has participated during the last 5 years

N/A

A list of research services provided for industry related to the proposed research topics for the period of the last 5 years

N/A