mgr inż. Kamila Martyniuk-Sienkiewicz
(professional title, name)

Faculty of Civil Engineering
(Faculty/Unit)

Warsaw University of Technology
(University)

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**ABSTRACT OF THE DISSERTATION**

*„Tensegrity structures and metamaterials with a smart internal framework"*

dissertation supervisor: dr hab. inż. Anna Al. Sabouni – Zawadzka, prof. uczelni
assistant supervisor:……----------……..

The growing demands placed on modern structures increase the need for solutions that can adapt to changing operating conditions while reducing material consumption. One promising direction in this field is the study of tensegrity structures, which are characterised by lightness, modularity, and the possibility of controlling their mechanical response. This study focuses on assessing the potential of strengthening such structures by means of an smart internal framework, whose configuration is inspired by the results of topology optimisation and by patterns found in auxetic metamaterials.

The main objective of the study was to determine whether local, non-uniform strengthening of tensegrity structures can lead to a more favourable mechanical response than uniform reinforcement. A second objective was to assess the possibility of introducing auxetic properties into these structures through the use of an smart framework reflecting metamaterial patterns. As part of the research, a database of tensegrity modules and structures was developed, together with an original algorithm in Mathematica for generating, modifying, and analysing the investigated systems. In addition, numerical analyses of a plate-like structure composed of spatial tensegrity modules were carried out in Abaqus.

The results confirmed that regional strengthening of tensegrity structures with an smart framework based on topology optimisation can reduce displacements more effectively than uniform reinforcement. Strengthening may be achieved both by changing the self-stress level in the modules and by modifying the geometry of the elements. The study also demonstrated the possibility of mapping topologically optimal layouts onto continuous modular tensegrity structures. The auxetic effect was observed only in selected cases and was limited and unstable. Overall, the study shows that an smart internal framework can be an effective tool for controlling the behaviour of tensegrity structures.

Keywords: tensegrity, smart internal framework, adaptive structures, adaptable structures, auxetic metamaterials

Kamila Martyniuk-Sienkiewicz

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