DESCRIPTION FOR THE GENERAL PUBLIC

The project is dedicated to the development and investigation of functionally graded tensegrity metamaterials with extremal mechanical properties, taking into account their potential application in civil engineering. The main focus will be put on two aspects: 1) development of an algorithm that will be used for the identification of extremal properties of functionally graded metamaterials, which will account for scale effects and rigid joints; 2) experimental testing of metamaterial samples produced with the use of an additive manufacturing technology (3D printing). Gradient properties will allow the author to obtain new enhanced properties of metamaterials.

Metamaterials are usually defined as human-designed and human-made, not observed in nature, composite structures with unusual or non-typical properties. Their features are determined mainly by morphology of the structure in the scale bigger than molecular, and to a smaller degree – by chemical or phase composition.

Tensegrities can be defined as cable-strut structures with a particular configuration of elements, which ensures occurrence of infinitesimal mechanisms balanced with self-stress states. Tensegrity structures consist of a discontinuous set of compressed elements inside a continuous net of tensioned members, which have no compressive stiffness.

One of the possible ways of obtaining a mechanical metamaterial is to construct it from basic tensegrity modules of different type. They can be arranged in various ways to form a structure with desired properties. Example of such a metamaterial is presented in Fig. 1. It is constructed from one of the most popular tensegrity modules, which is a 4-strut simplex.

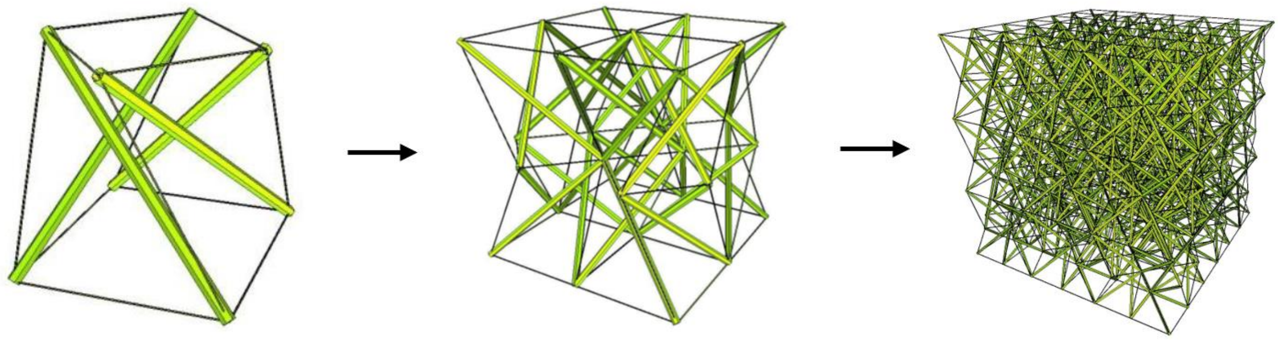

Fig. 1. Tensegrity metamaterial: single cell – supercell – metamaterial.

The research will be limited to 3D systems, with a special focus put on creating a novel algorithm used for the analysis of tensegrity metamaterials with functionally graded properties. The considered metamaterials will have a cellular structure and will be based on regular tensegrity modules with varying geometrical proportions, different arrangement patterns, varying stiffness. Various ways of achieving gradient properties will be analysed and an influence of graded mechanical properties on extremal properties of the whole system will be investigated. The algorithm will be verified based on the results of experimental tests planned within the project, which will be carried out on samples of tensegrity single modules, supercells and metamaterials, produced with the use of additive manufacturing technology (3D printing).

As a result of the planned theoretical and experimental research, at least two graded tensegrity metamaterials with extremal mechanical properties will be proposed and investigated, and possible application fields in civil engineering will be indicated. Moreover, a data base will be created, which will contain results of laboratory tests performed on various 3D-printed tensegrity modules, supercells and metamaterials.