

Description for the general public

The main objective of the research that will be carried out in the course of the project is the development of a modelling methodology and experimental research standards for intelligent granular structures that can enable the replacement of the traditional materials in a range of engineering applications with their cheaper counterparts.

Vacuum Packed Particles (VPP) are the structures composed of loose grains packed in a sealed elastomeric container in which the vacuum pressure is generated. By changing its values in the real time, we can adjust the macroscopic mechanical properties of the structure. This unusual feature allows using the VPP as a smart material in a various kinds of engineering structures, including controlled energy absorbers or generally adaptive structures.

The planned research methodology can be broadly divided into two equal parts, experimental and modelling. In the empirical part, the comprehensive experimental research will be carried out on the representative material samples and on the manufactured equipment prototypes that use VPP. The study of the representative samples will be carried out in the different states of the material effort, taking into account the differentiated influence of the external conditions such as temperature. Short-term and cyclical states of the load will be considered.

The results of this experiments will help to identify the parameters of the proposed material models. Simultaneously the methodology of simulating the behavior of a granular special structures will be developed, using Finite Element Method (FEM) and Discrete Element Method (DEM). Numerical models, which will be identified based on the results of the material samples, will be used to model the real components. At a later stage of the project results of the conducted computer simulations will be verified with the direct results of the actual construction.

Based on the results of the experiments and simulations, research standards of the examination of the relevant material samples will be developed, in order to simplify identification of the models parameters while maintaining a low cost of research.

Until now, the researchers have focused mainly on testing the granular structures subjected to a relatively simple stress or strain conditions. The lack of the laboratory tests results conducted in the complex states of the strain, which undoubtedly exist in the real constructions, is noted. So far, the appropriate mathematical model or methodology for the modelling of the granulated structures has not been developed, which could be used by engineers to proof the concepts of innovative products using special granulated structures.

To meet the observed need, the intention of this work is to develop universal standards of experimental work and the general methodology for modeling VPP.