M.Sc. Thesis Project

Designing granular metamaterials

Multiscale Mechanics (Utwente)

Background: From Wikipedia: A metamaterial (from the Greek word *meta-* meaning *beyond*) is a material engineered to have a property that is still not found in nature.

Future materials will be capable of actively and precisely changing their internal structure, shape and effective properties to meet our need. An example of this is given by materials with negative Poisson's ratio.

In particular, it is already well-known that granular mixtures exhibit exceptional properties. Preliminary results of experiments on wave propagations in glass-rubber mixtures show that it is possible to obtain mixtures much lighter than a 100% glass aggregate, having high effective stiffness and high damping properties. Eventually, the combination of these properties is highly desirable in engineering practice.

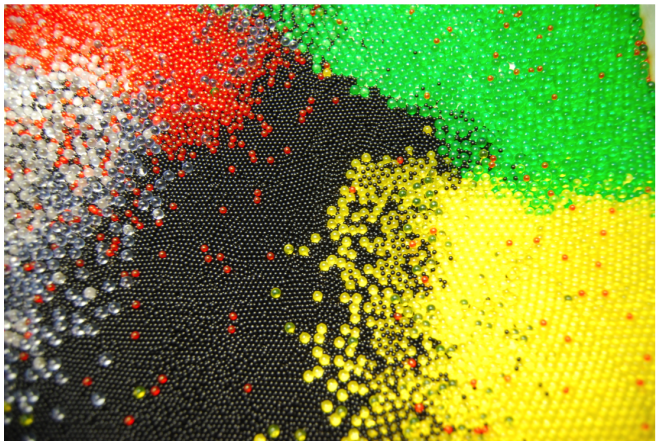

Figure 1: Glass beads in different colors and size.

By means of particle simulations, we want to explore the combined role of size ratio and stiffness ratio, in order to design microgranular metamaterials exhibiting optimized dynamic mechanical behavior and wave propagation. This could enable a new class of highly damped microstructured materials.

Main Goal: The research will focus on numerical simulations of wave propagation in granular mixtures, with varying composition of stiff-soft and small-large particles.

Method: A particle level numerical simulation technique known as the Discrete Element Method (DEM) will be used for developing the understanding of enhanced granular mixtures and drive focused experiments. The numerical method is state of the art in the MSM group, where the algorithm has been recently used to simulate soft-stiff mixtures and optimized for highly different particle size. Numerical results can reveal certain other aspects of the behaviour of granular mixtures that it is impossible to observe by regular laboratory techniques. By means of DEM simulation of wave propagation we aim to "follow" the wave path along force chains formed by particles of different types.

The option of experimental validation of the numerical finding, to be performed at partner institutions will be considered.

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