Design and Construction of a Sonic Crystal

Motivation

How is it possible that permeable structures still effectively attenuate sound?

At the first sight this seems to be impossible, however the current research topic of acoustic metamaterials opens up the possibility to solve this problem. Sonic crystals are a special kind of acoustic metamaterials and they consist of periodic solid structures e.g. cylindrical rods, which act as scatter elements for the acoustic waves. The interference of the incident and the scattered waves causes special effects, which leads to the formation of so called spectral band gaps. Band gaps are regions of frequencies where the sound propagation is restricted and consequently, sonic crystals prevent the transmission of acoustic waves at these stop band frequencies, which leads to a high noise attenuation at these frequency bands. This property is used in many applications such as noise barriers, frequency filters or waveguide systems. The advantages compared to traditional solid noise barriers are the ability that light can pass through and that it allows a free air flow through the structures. This makes sonic crystals a very attractive technology to design open but still effective noise barriers.

Problem definition

The task of this project is to design and build a sonic crystal. You start by building a numerical model using the Finite Element Method (FEM) and the commercial software Comsol Multiphysics in order to model the band structure and predict the transmission loss of a sonic crystal. Based on your numerical model you tune the model parameters in order to achieve a stop band at a predefined frequency range. After the design is finished, you build the sonic crystal using solid wooden rods and finally you measure the effectiveness in sound insulation by performing acoustic measurements and compare the experimental to the numerical results.

Solution steps

- Create a numerical model using the FEM and Comsol
- Compute the band structure and the transmission loss
- Optimize the model parameters on a given stop band
- Finalize your design and buy the parts within a given budget
- Build the sonic crystal based on the optimized model
- Validate your numerical model by performing measurements
- Compare the predicted and the measured sound insulation

Language

- German or English

Contact

Johannes Schmid, M.Sc.
E-Mail: johannes.d.schmid@tum.de
Felix Kronowetter, M.Sc.
E-Mail: felix.kronowetter@tum.de
Chair of Vibroacoustics of Vehicles and Machines