

Mgr inż. Aleksandra Klimek

Supervisor: prof. dr hab. inż. Andrzej Dobrucki

Abstract of the doctoral thesis:

Application of acoustic metamaterials for the construction of double partitions with increased insulation

The dissertation concerns the analysis of acoustic metamaterials used in lightweight double-panel constructions to enhance their acoustic insulation. The research was conducted using analytical, numerical, and experimental methods, focusing on the properties of constructions incorporating metamaterials with effective negative density, stiffness, and combinations of both properties.

The dissertation's thesis postulates that the application of acoustic metamaterials enables an increase in the acoustic insulation of lightweight double-panel partitions. The study examined the impact of metamaterials on the improvement of the sound insulation index by tuning their resonant frequencies to match the mass-spring-mass resonance of the partition.

Three types of metamaterials were analysed and tested as part of the research:

1. a metamaterial with negative effective density, utilising mechanical resonators, which achieved local increases in sound insulation,
2. a metamaterial with negative effective elasticity, based on Helmholtz resonators, providing enhanced insulation without increasing the overall mass of the partition,
3. a metamaterial with both negative effective density and elasticity, combining both types of resonators and optimised for an increase in the sound insulation index.

The experimental results showed consistency with analytical models, particularly for the metamaterial with negative effective elasticity. Optimising the geometric parameters of the metamaterial resulted in a significant improvement in the acoustic insulation index without increasing the partition's mass or the width of the air cavity. This work positively verifies the thesis that applying acoustic metamaterials can substantially improve the insulation properties of lightweight double-panel partitions.

A. Klimek