Developing Sonic Crystal Noise Barriers: Cylindrical Shape Approach

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Abstract

This study explores the development of Sonic Crystal Noise Barriers (SCNBs) as innovative solutions for urban traffic noise mitigation, addressing the limitations of conventional barriers that obstruct light and airflow. The research employs a hybrid methodology, integrating computational simulations using COMSOL Multiphysics with finite element analysis and experimental validation in an acoustic chamber. Key design parameters, such as filling fraction, cylinder diameter, and array configuration, are systematically varied to optimize performance. Transmission Loss (TL) serves as the primary metric, with simulations predicting up to 45.8 dB attenuation, while experiments achieve a maximum of 10.1 dB. Despite qualitative consistency in performance trends, significant quantitative discrepancies arise due to factors like visco-thermal effects and material absorption not captured in idealized models. The findings highlight the value of simulations for efficiently screening SCNB configurations, reducing prototyping time and cost, while emphasizing the necessity of experimental validation for real-world accuracy. The study concludes that a validated hybrid approach provides a reliable framework for SCNB design, with future work focusing on field-scale validation, advanced material integration, and adaptive optimization for broadband noise attenuation.

Index Terms

Sonic Crystal Noise Barriers (SCNBS), Computational Simulations, Finite Element Analysis, Transmission Loss (TL), Experimental Validation

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