Multi-scale acoustic insulation modeling of lightweight partitions - an industrial case study

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Abstract:

The increasing need to reduce CO2 emissions drives Lafarge's research on innovative lightweight systems that combine lower environmental footprint and optimized performances. In a lightweight system, often an absorbing material, mostly mineral wool, is installed in the cavity between the boards, in order to enhance the acoustic performance.

Recently, Lafarge has patented a system to generate highly porous boards with controlled air-bubble size distribution and its use as acoustic insulation material in partitions. This system has shown that it could provide similar aerial sound insulation as a conventional partition, at same global surface mass but without any use of mineral wool.

This presentation will focus on the research methodology applied in order to develop a new generation of lightweigth construction systems based on this innovative technology : a multiscale numerical approach validated by well-choosen experiments.

In a first step the relation microstructure - relevant material properties has been studied based on the modeling work of Perrot and Chevillotte. This allowed, after model validation, performing a comprehensive study of the impact of microstructure on acoustic dissipation parameters in order to define an optimal porous microstructure that allows to achieve the required acoustic performance parameters as defined by the structure scale study.

Secondly, the system scale has been studied using the Transfer Matrix Method [A-Cell commercial software]. The main issues were to quantify the impact of system design and component characteristics (partition board, insulating material, etc.) on sound insulation. This study determined the potential benefit of using asymmetrical systems and allowed to determine the targetted values for basis acoustic dissipation parameters (described by the JCAL model) of an optimal porous dissipative material.

Finally both the microstructure-material and material-system scales are coupled. This full coupling allowed to optimise the porous material microstructure for a given system performance and to study the needs for production robustness of the porous material used.