

Acoustic Metamaterials for Low Frequency Industrial Applications

NoiseTrap® Acoustic Panels

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Noise – The Hidden Problem

Low-frequency noise is a common component of industrial noise that has received less attention. Low frequencies propagate farther with less attenuation. Also, tonal noise can be perceived more acutely than broadband levels, even with high background noise levels.

Acoustic Metamaterials – A Solution

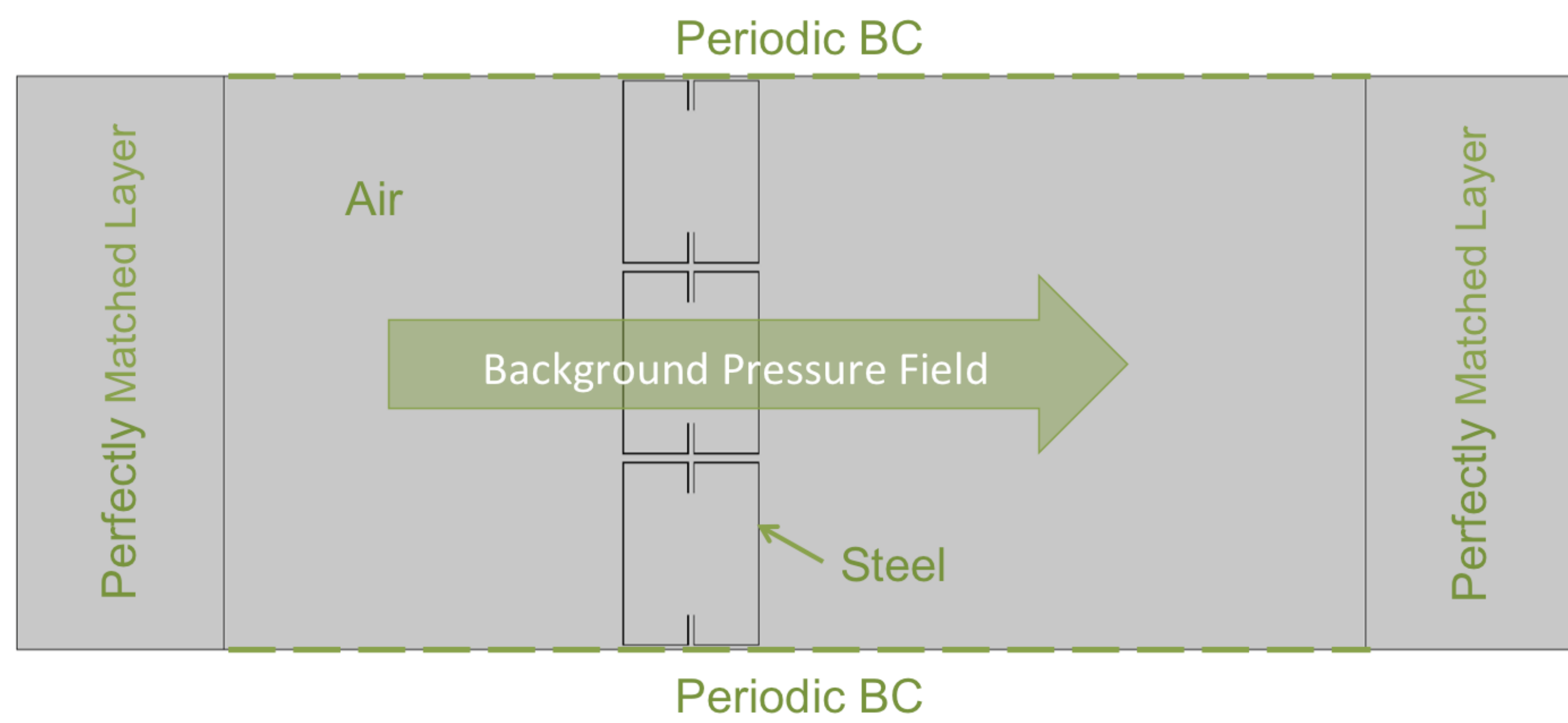
Acoustic metamaterials can offer a particularly efficient solution for low frequency tonal noise. Metamaterial structures can be designed to produce targeted bands of high noise attenuation without relying on the excessive mass or depth of absorber required in conventional solutions for low frequencies.

Application Areas

- Power and distribution transformers
- Pumps and compressors
- Gas / steam turbines
- Diesel and gas generators

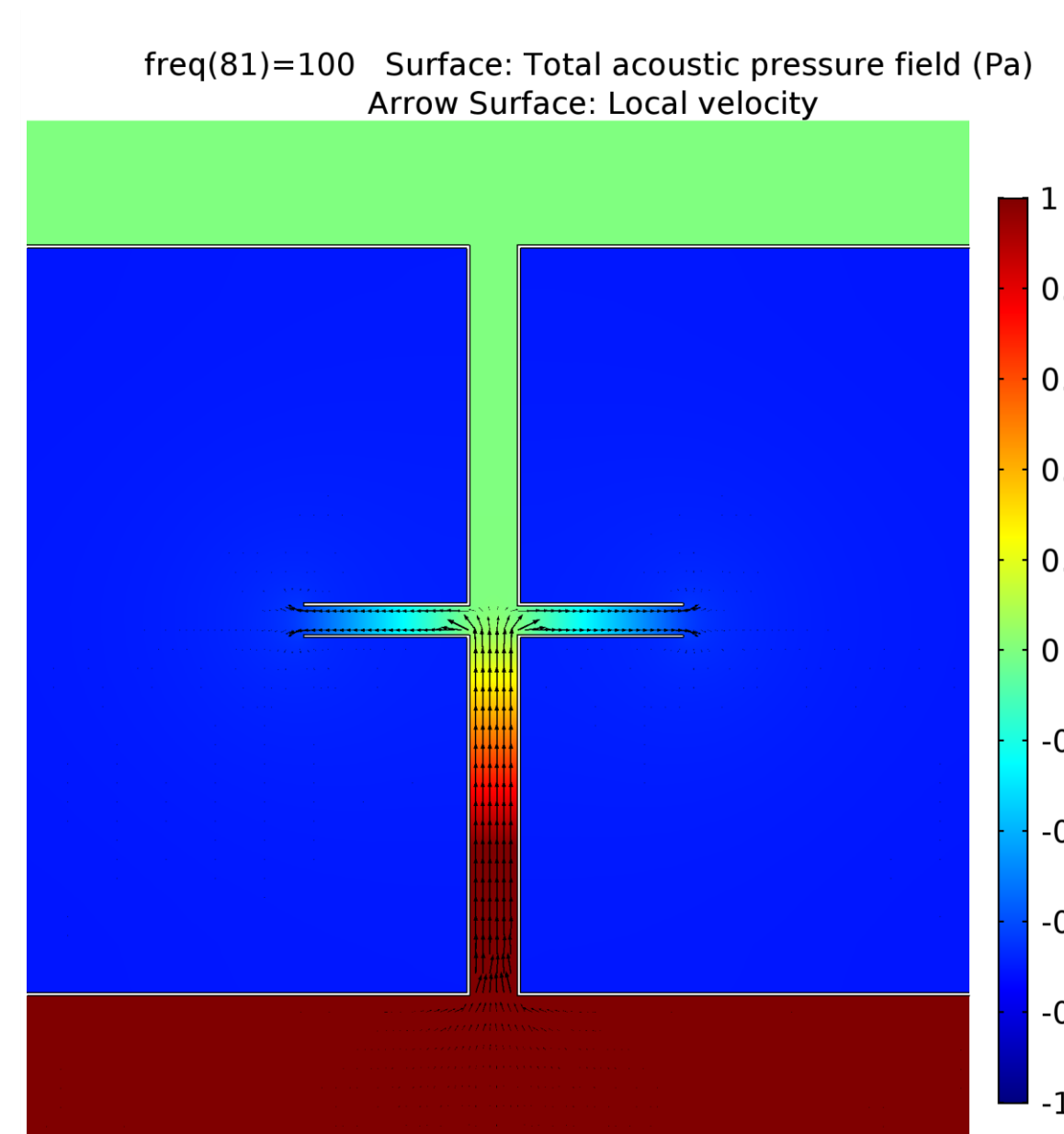
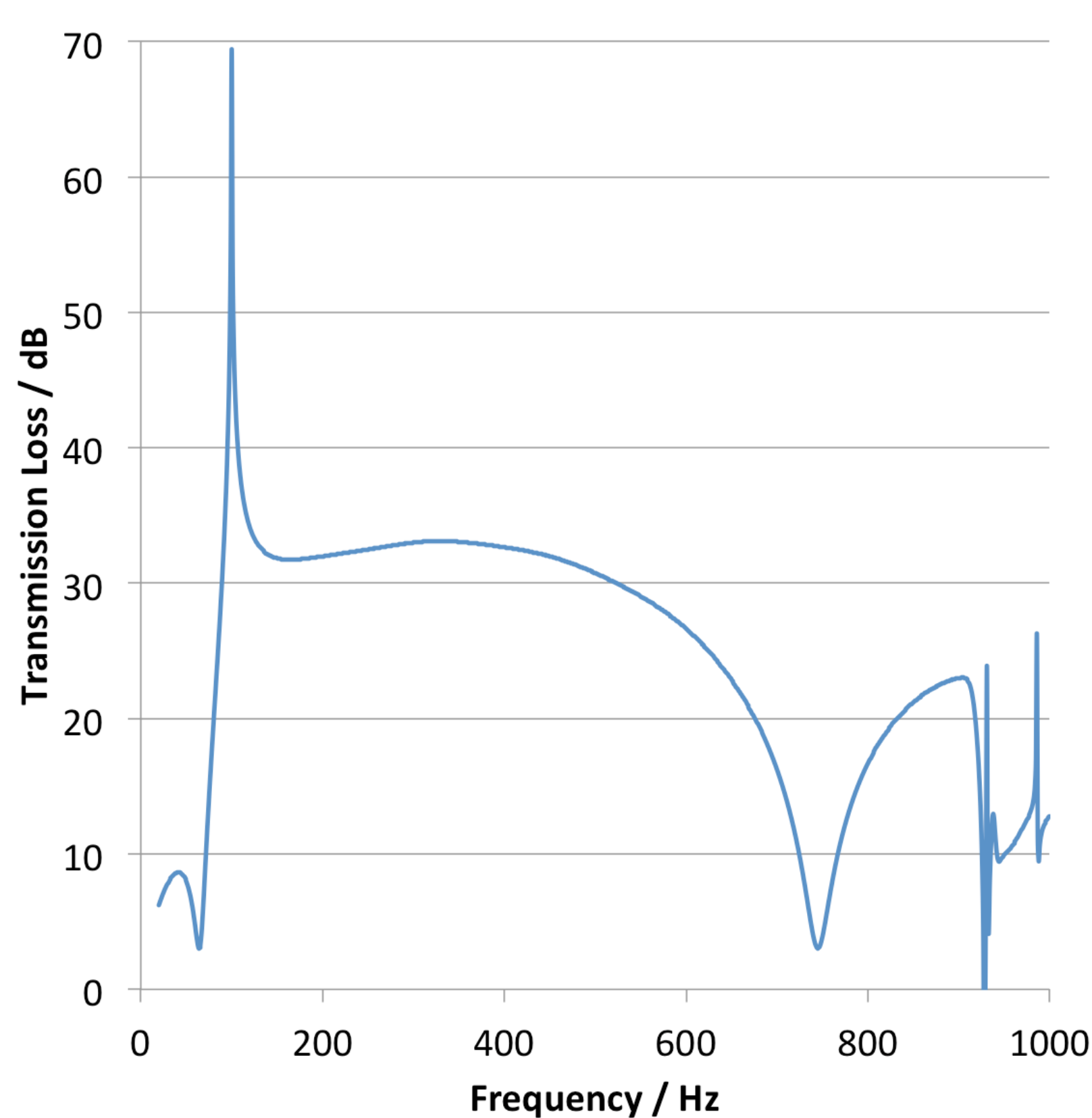
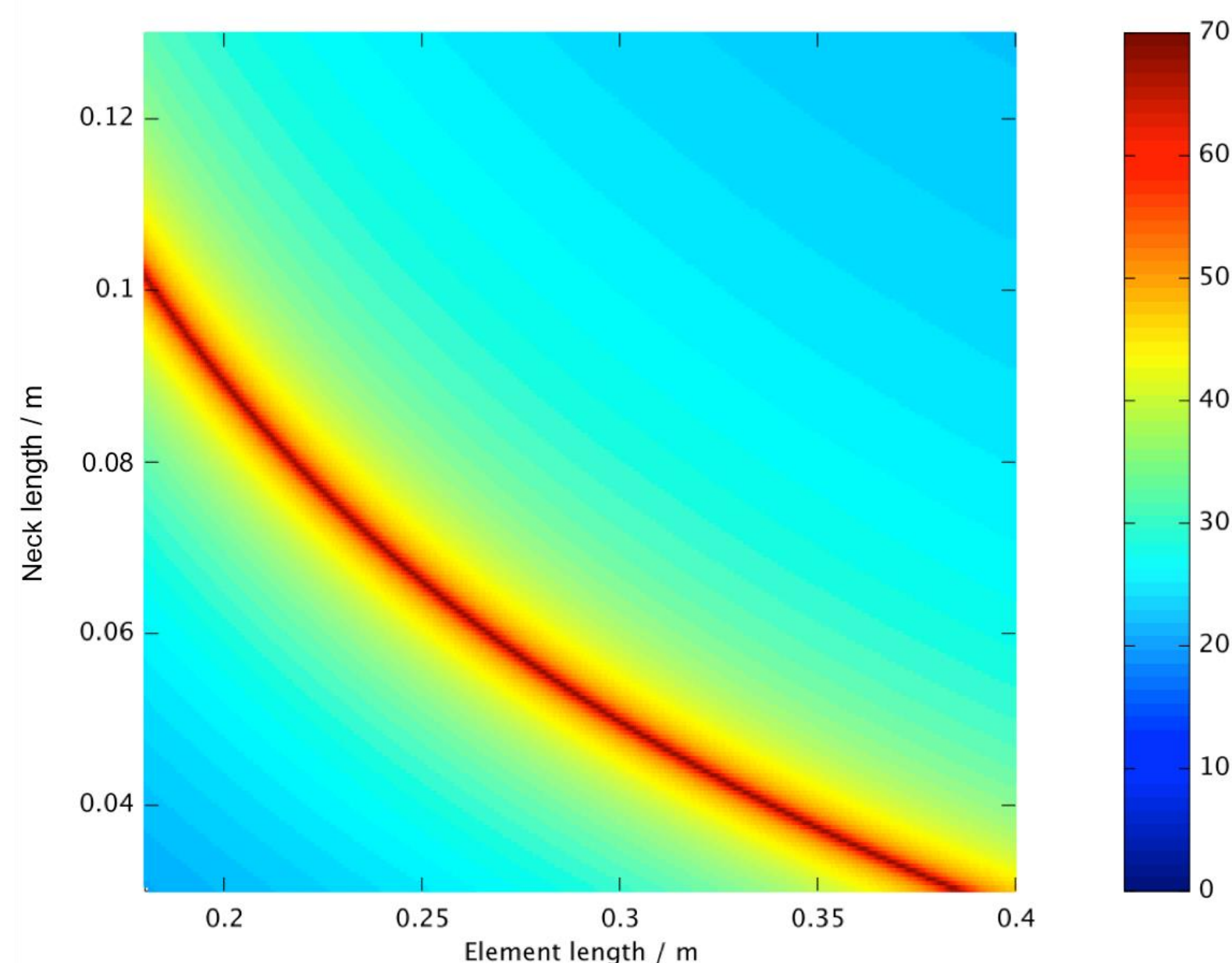
Concept Design

The COMSOL® Pressure Acoustics interface was used to build a 2D transmission model to rapidly test and iterate different types of resonator and sonic crystal unit cell geometries. It was found that a design based on an array of coupled Helmholtz resonators was particularly suitable for low frequency applications, because it allows a deeply sub-wavelength thickness design (approx. $\lambda / 10$).



Tuning and Optimisation

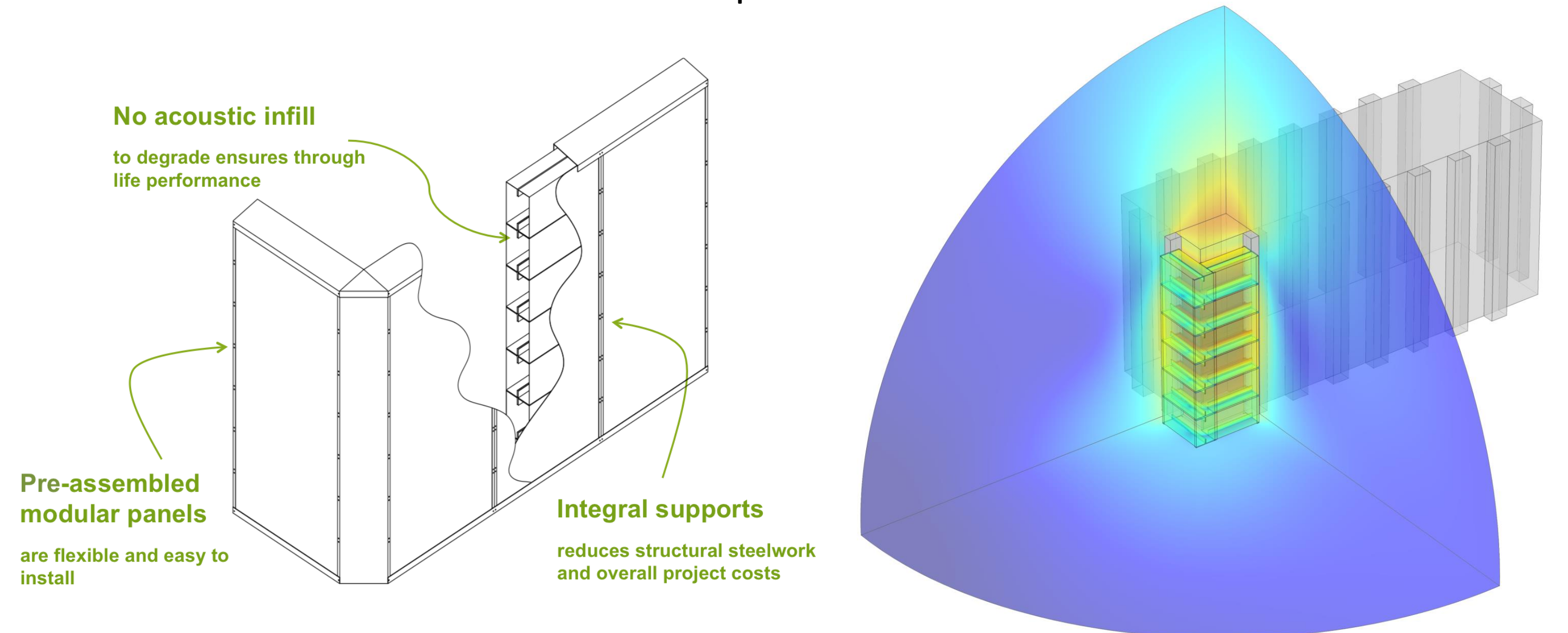
The resonator unit cell geometry was varied using Parametric Sweeps to fine tune it to target 100 Hz for power generation and distribution applications. These results were also used to select dimensions suitable for manufacture using sheet metal fabrication.



Transmission loss spectrum of finalised design (left) and pressure distribution at resonance (above).

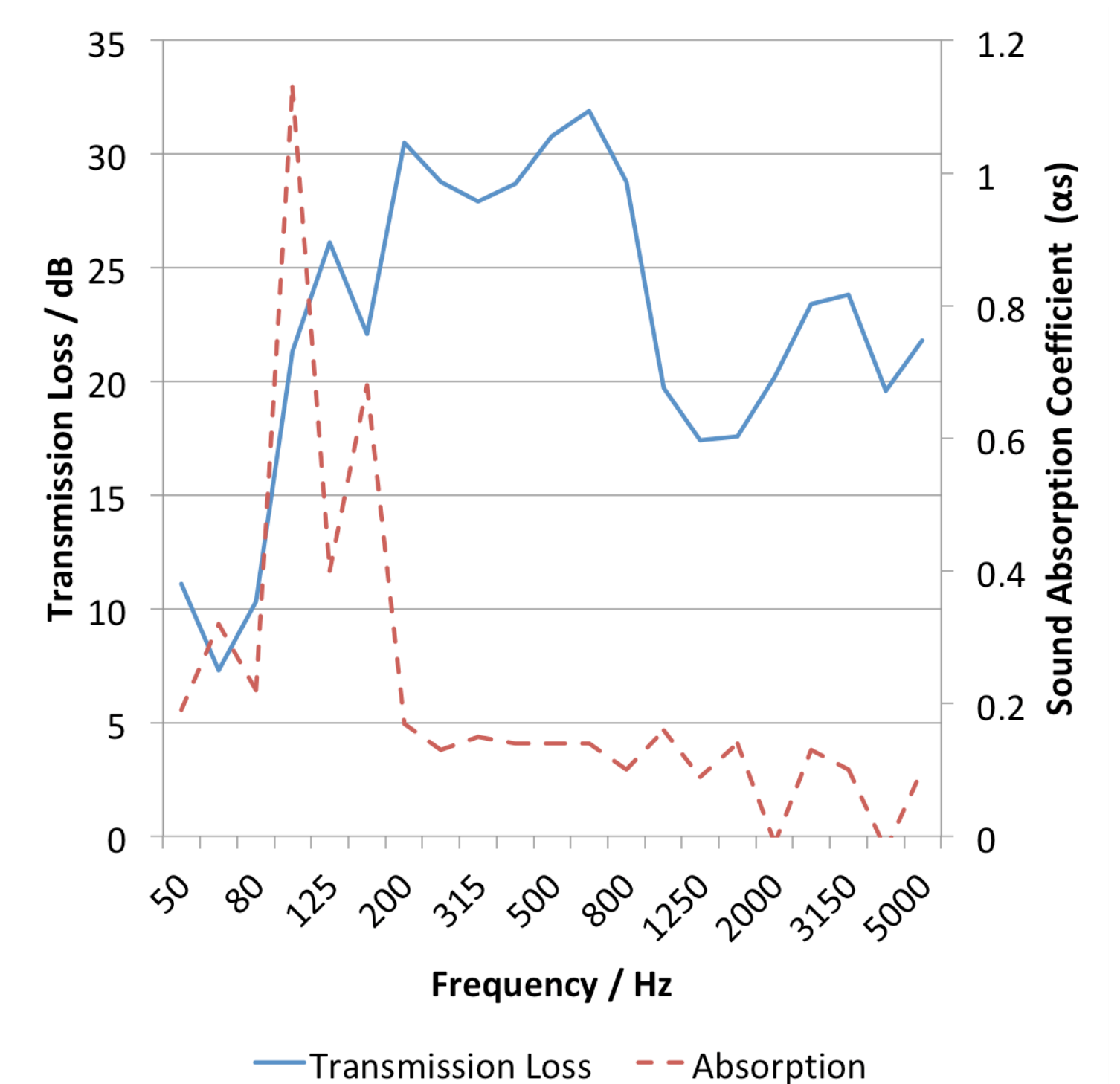
Engineering Design – NoiseTrap® Panels

The finalised metamaterial unit cell design was extrapolated into a modular panel system suitable for steel sheet metal fabrication. Specialised 3D models were used to investigate application-specific situations, e.g. enclosure corner details and panel eigenmodes. Panel variants offering differing levels of natural ventilation and transmission loss were also developed.



Experimental testing

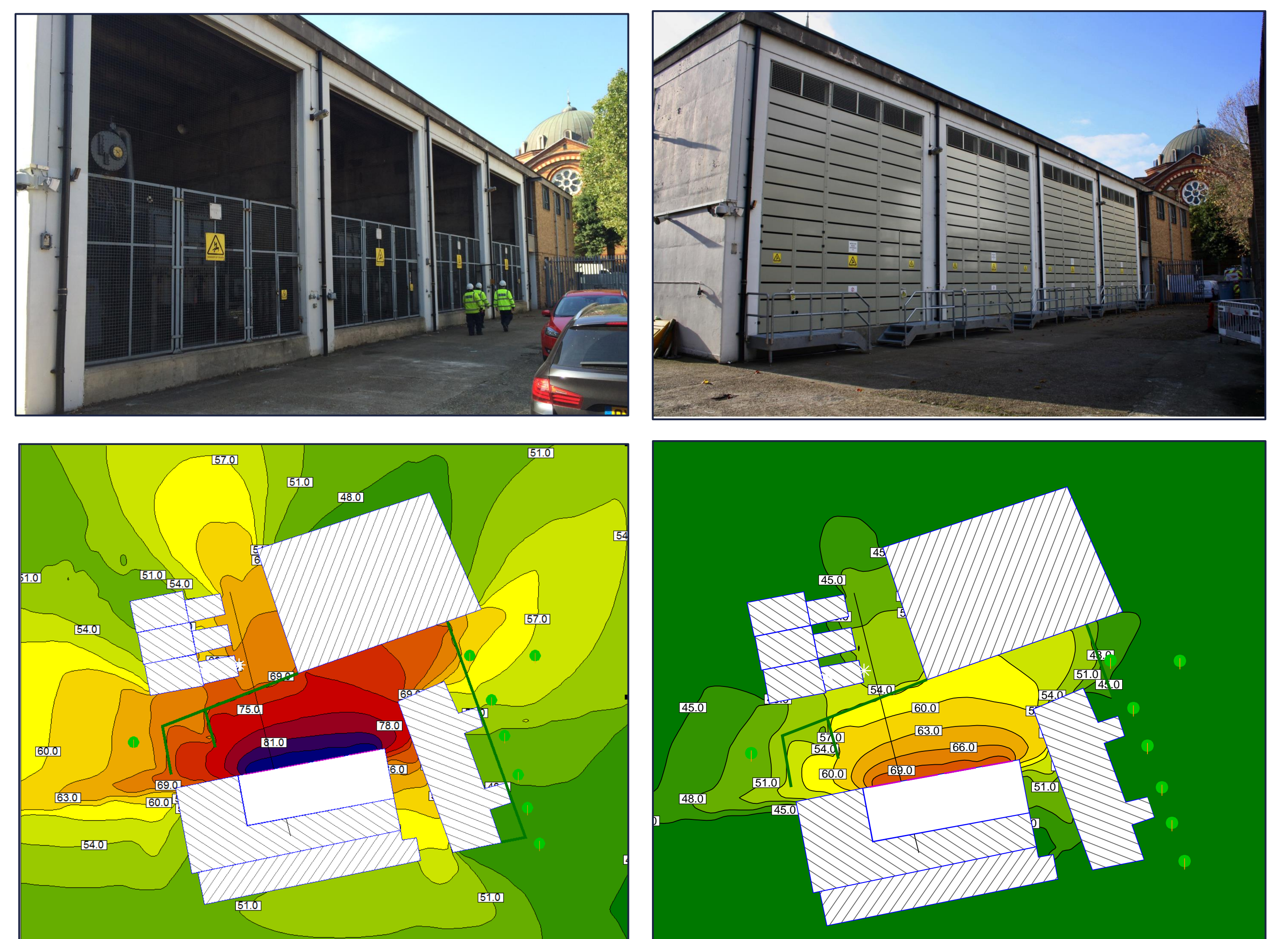
Full scale prototypes were built to verify the design and were tested according to BS EN ISO 10410-2:2010 for sound insulation (transmission loss) and BS EN ISO 354:2003 for sound absorption.



Industrial Case Study – UK Power Networks

NoiseTrap® Panels were installed at a substation in London in August 2017. There was a problem with noise emitted from four concrete transformer bays with open fronts. The main concerns were noise at an adjacent hotel and overheating issues with transformers.

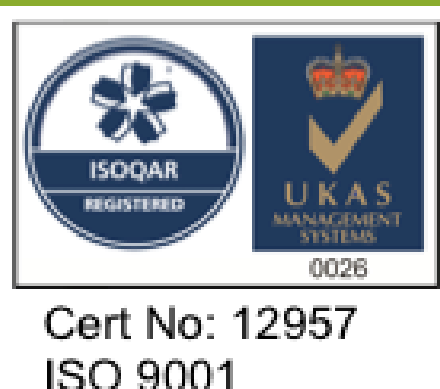
Noise levels were reduced to below WHO night time noise regulations of 30 dB(A) while still providing natural ventilation, meeting the client's requirements.



Patents: United States Patent No. 8789652, United States Patent No. 9607600, European Patent No. 2394266.

Patent Pending: United States Patent Application No. 15/509,360, European Patent Application No.14707832.3, European Patent Application No.15718253.6, European Patent Application No.16189799.6.

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