

Assessment And Acoustic Enhancement Of A Multi-Purpose Venue With COMSOL Multiphysics.

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Abstract

This study focuses on the acoustic design of a multipurpose hall with a volume of approximately 3,000 m³, which is subject to strict architectural constraints.

These constraints limit interventions to the suspended ceiling only. The primary objective is to reduce the reverberation time (RT60) to values of ≤ 1.4 s while ensuring high acoustic quality across variable spatial configurations and diverse functional uses.

The methodology is structured into three main phases:

(1) A pre-intervention experimental measurement campaign conducted in accordance with ISO 3382.

(2) Predictive modelling using COMSOL Multiphysics® 6.3.

(3) Auralization model for the perceptual evaluation of Room Acoustic Simulations.

The consistency between the numerical model and in-situ measurements was validated by comparing octave-band decay curves and applying Schröder integration and linear extrapolation of the T30 parameter.

Analysis revealed a systematic reduction in reverberation time and significant improvements in parameters such as C80, D50 and STI within critical speech intelligibility frequency bands (500-4000 Hz).

However, alternative parameters to RT, such as C50, D50 and STI, were found to have significant limitations in simulation models, primarily due to source directivity, the absence of wave phenomena and the simplifications inherent in geometrical methods.

The entire study was conducted in compliance with ISO 3382-1, ISO 3382-2 and ISO 23591:2021, incorporating operational criteria derived from the Norwegian standard NS 8178. The findings demonstrate that a combined approach integrating in-situ measurements, numerical modeling and post-operam validation is a robust methodological strategy for acoustically optimizing complex environments. A final experimental verification phase is planned following the intervention to confirm the effectiveness of the acoustic treatment and the accuracy with which the simulation model represents the actual behavior of the treated space.

Reference

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Figures used in the abstract



Figure 1 : Venue in study.

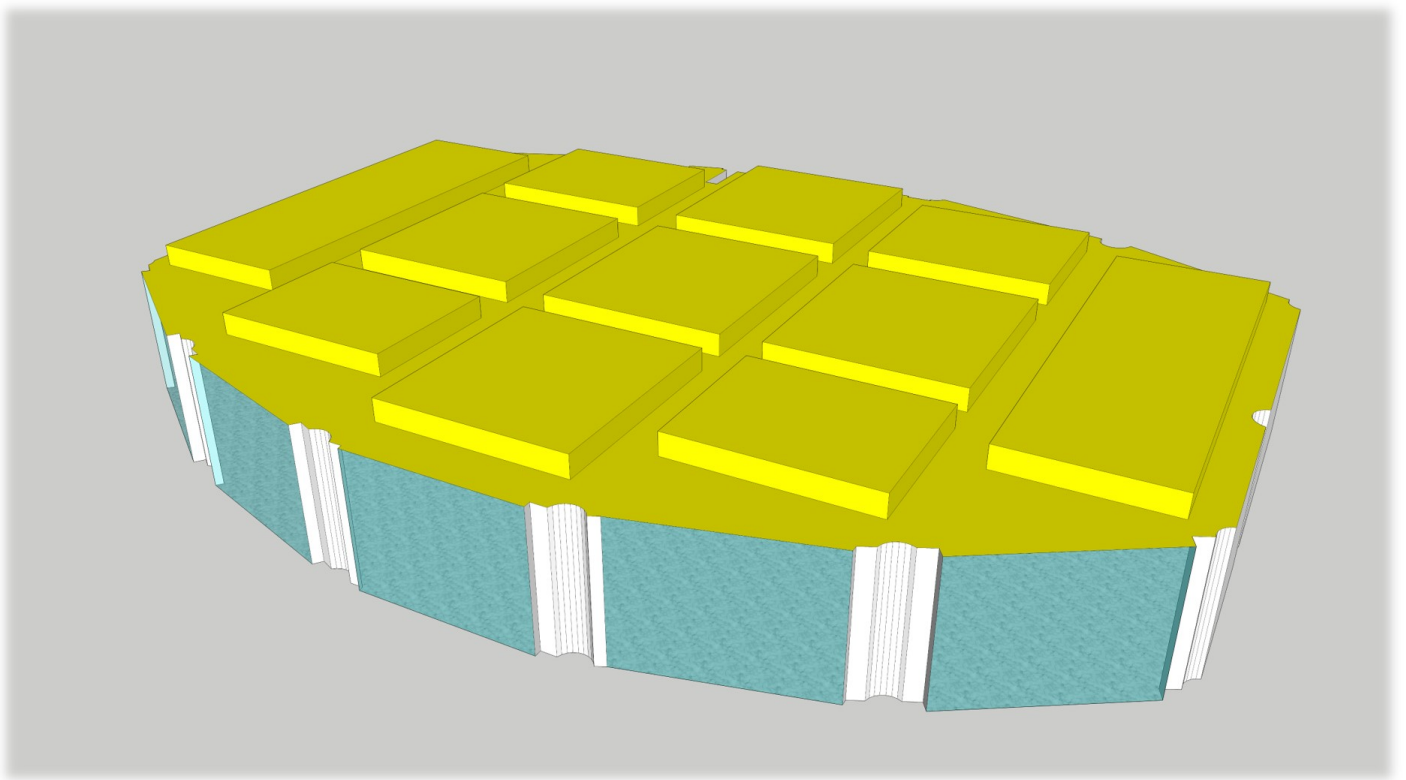


Figure 2 : 3d model of space.

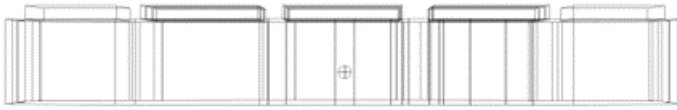


Figure 3 : Ray Tracing from source and receiver in same position as real measurements in the venue.

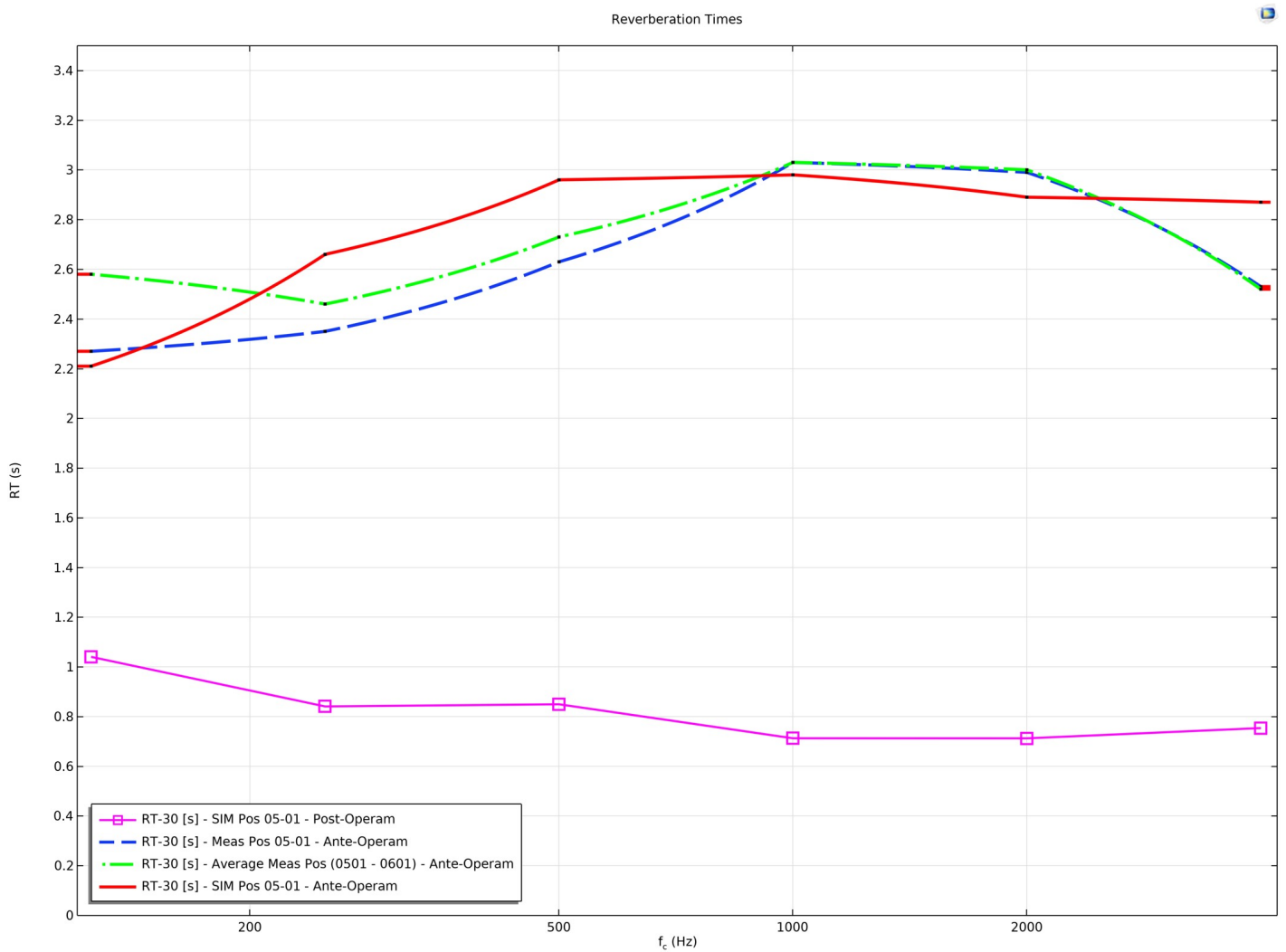


Figure 4 : Simulated reverberation times at position matching the measurements and new reverberation times after treatment applied in model.