# Reliability and uncertainty of airborne sound insulation modeling ($R_w$) in lightweight floor constructions

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This study investigates the reliability of modeling airborne sound insulation ($R_w$) in lightweight building constructions using predictive tools such as Insul 9. The focus lies on evaluating the deviation between modeled and laboratory-measured $R_w$ values, particularly when constructions are modeled from scratch, without access to reference templates. A dataset of 31 floor assemblies was analyzed, with models prepared independently by experienced engineers. Each modeled result was compared to laboratory data measured in accordance with ISO 10140-2. The findings reveal that even under optimal conditions, the modeling process yields a non-negligible standard deviation of approximately 4.88 dB. This level of uncertainty implies that, in practice, achieving a target $R_w$ alone only provides a 50% probability of success. To reach a 95% confidence level, a safety margin of nearly 10 dB must be applied. When considering the entire design chain, including conversion to in situ values ($R'_w$) using ISO 12354-1, where the typical additional uncertainty is 2 dB, the total standard deviation increases to 5.27 dB, raising the required safety margin to approximately 10.5 dB. The study emphasizes that such margins, while difficult to justify commercially, reflect realistic limits of current modeling practice. A potential solution lies in developing a robust database of validated constructions to reduce uncertainty. Ultimately, the results highlight the importance of integrating modeling uncertainty directly into the design process to prevent performance gaps after construction and to align design expectations with real-world outcomes.