



## INSUL software use for predictive assessment of acoustic insulation in partition walls against airborne noise: Towards improved building acoustics in Algeria

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### ICESSE'25

International Conference on Engineering  
Sciences for a Sustainable Environment.  
ICESSE'25  
Tizi Ouzou Algeria 29-30 October 2025

#### Keywords

INSUL;  
Acoustic comfort;  
Partition walls;  
Building acoustics;  
Algeria;

**Abstract:** Controlling noise transmission in buildings is a key factor for ensuring health, comfort, and regulatory compliance. In Algeria, however, acoustic insulation remains an overlooked aspect in the construction process, particularly for partition walls and floors. This study investigates the acoustic performance of typical partition configurations using INSUL software, an internationally recognized sound insulation prediction tool. The objective of this study is to assess the airborne sound reduction index ( $R_w$ , dB) of typical Algerian partition wall configurations using INSUL software, in order to evaluate their insulation performance against international standards. Results demonstrate the significant influence of wall thickness, cavity design, and insulation materials on airborne noise reduction. The findings provide practical insights for architects and engineers to enhance acoustic design from early project stages.

## 1. Introduction

Excessive noise exposure is a growing public health concern, contributing to sleep disturbances, cardiovascular risks, and reduced well-being [1]. While international standards, such as those established by WHO and European bodies, advocate strict limits on environmental noise, the practical implementation of acoustic insulation in Algerian residential buildings remains limited.

Local construction practices, favouring lightweight hollow brick infill and tunnel-form concrete structures for seismic resilience [2], often fail to meet desired acoustic performance levels. This study addresses this gap by applying the INSUL software to predict sound insulation performance of common partition walls, providing decision-making support for improved building design.

## 2. Methodology

### 2.1. INSUL: Software overview

INSUL: Sound Insulation Prediction Software, developed by Marshall Day Acoustics, is widely used for preliminary prediction of airborne ( $R_w$ ) and impact ( $L_{n,w}$ ) sound insulation performance. The software applies mass law principles, coincidence frequency models, and validated databases of construction materials to estimate sound transmission loss. Though not a substitute for laboratory testing, INSUL provides reliable pre-construction

assessments within acceptable error margins ( $\pm 3$  dB for  $R_w$ ,  $\pm 5$  dB for  $L_{n,w}$ ).

### 2.2. Case study configurations

Typical Algerian partition systems were modelled, where Vertical Partitions:

- Single-leaf reinforced concrete walls (200 mm and 300 mm).
- Double brick walls with cork or glass wool insulation.
- Triple-layer composite wall with brick, air cavity, glass wool, and concrete.

Configurations were analysed for their airborne sound insulation properties, with results compared to recommended international thresholds (ISO 717, WHO guidelines).

## 3. Results & discussion

Airborne noise can directly be transmitted horizontally through walls between two adjacent residences or between two bedrooms of the same apartment. In order to reduce the amount of transmitted airborne sound, three sets of parameters must be taken into account when discussing opaque parts of a building's facade: the mass and nature of the material, sound frequency, and lateral and parasitic transmissions. We frequently used INSUL software on multiple partition wall configurations as a case study to highlight the significance of the program and its usefulness in forecasting the levels of STL or  $R_w$  of building

materials, which were particularly derived at a frequency of 500 Hz. For vertical partitions such as single or composite walls, we had these findings:

#### For single concrete walls with a surface mass of 480 Kg/m<sup>2</sup>:

200 mm:  $R_w = 62$  dB

300 mm:  $R_w = 68$  dB

Demonstrating mass-thickness influence in line with mass law principles.

In most Algerian construction projects, owners tend to use reinforced concrete portal frame systems, given their mechanical characteristics and high resistance to earthquakes, with brick infill for the separating walls.

#### For composite walls:

Double brick with cork (surface mass of 276 Kg/m<sup>2</sup>):  $R_w = 66$  dB.

Double brick with glass wool (surface mass of 273 Kg/m<sup>2</sup>):  $R_w = 80$  dB.

Triple-layer wall with central cavity and concrete (surface mass of 615 Kg/m<sup>2</sup>):  $R_w = 94$  dB.

As a result, the first wall can act as mass and reflect some of the sound wave. Also, the sound wave moves to the center cavity, where it is mostly absorbed and dampened by the insulation. It then moves to the second walls, where it is attenuated and reflected in the adjacent room. Therefore, it is recommended to use a high-thickness, soft, fibrous sound-insulating material to achieve a high sound reduction index.

### 3.1. Comparison with mass law, ISO and WHO guidelines

The mass Law formula is:  $R(f)=20\log_{10}(m\cdot f)-47$ . For homogeneous concrete walls, results match well. For multi-leaf systems, INSUL predicts much higher isolation than the simple mass law, because mass law cannot capture cavity resonance, decoupling, and absorption as shown in Table 1. Besides, these results align with international studies highlighting the effectiveness of decoupling and cavity insulation in enhancing acoustic performance. However, practical constraints such as wall thickness (up to 50 cm) and material cost must be considered in design decisions.

**Table 1.** Comparison table

Configuration	Predicted $R_w$ (dB)	Mass Law (500Hz)	ISO 717-1 Classification	WHO Implication
200 mm reinforced concrete wall	62	60.6	Moderate (Category B)	Suitable for basic separation
300 mm reinforced concrete wall	68	64.2	Good (Category C)	Enhanced comfort achievable
Double brick + cork insulation	66	55.8	Good (Category C)	Suitable for bedrooms/living areas

Configuration	Predicted $R_w$ (dB)	Mass Law (500Hz)	ISO 717-1 Classification	WHO Implication
Double brick + glass wool (uncoupled)	80	55.7	Very Good (Category D)	Exceeds typical residential needs
Triple-layer composite wall (brick + cavity + concrete)	94	62.8	Excellent (Category E)	Ideal for high noise environments

## 4. Practical Implications and Limitations

While INSUL offers valuable pre-construction insights, limitations include:

- Inability to model full facade systems (windows, doors).
- Assumption of ideal installation conditions.
- Exclusion of thermal or structural performance considerations.

Future research should include experimental validation through laboratory or in-situ measurements and explore integrated acoustic-thermal optimization for building envelopes [3].

## Conclusion

This study shows how INSUL software can be used to forecast the acoustic performance of partition walls in buildings located in Algeria. The findings highlight how important wall layout, insulation details, and material choice are in reducing airborne noise. A cost-effective way to raise a building's acoustic quality, comply with international standards, and improve occupant well-being is to use such predictive tools during the design phase. The results give engineers, architects, and legislators a technical basis on which to advance acoustically sound building techniques in Algeria. Therefore, it is recommended to:

- Promote the early integration of acoustic design using predictive tools such as INSUL.
- Prioritize double-wall systems in high-noise environments or multi-unit housing.
- Encourage the implementation of national regulations that align with ISO and WHO standards.

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