Study of double windows efficiency in order to improve sound insulation in buildings

Marco Aurélio de Oliveira
University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal engenharia@confortus.com.br

Luís Bragança
University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal
braganca@civil.uminho.pt

Dinara Paixão
Federal University of Santa Maria, Acoustic Engineering, Santa Maria (RS), Brazil
dinara.paixao@eac.ufsm.br

Jorge Luis Pizzutti dos Santos
Federal University of Santa Maria, Thermo Acoustics Laboratory, Santa Maria (RS), Brazil
lmcc.ufsm@gmail.com

ABSTRACT: The aim of this research is to evaluate sound insulation behavior of double windows, when a second window is placed upon a previous one, keeping an air layer between them. This was done through standard tests carried out at the insulation chamber of the Acoustics Laboratory of Federal University of Santa Maria in accordance with international norms ISO 10140-2 and ISO 717-1. First, low air hermetic windows were duplicated, each one having R_w = 18 dB. Second, good air hermetic windows were duplicated. The objective, through this technique, was to find out sound insulation improvement of double windows under the two mentioned circumstances. It was verified that low air hermetic double window obtained R_w = 26 dB, with an increase of 8 dB in relation to just one window of the same typology. In relation to good air hermetic double window, a R_w final of 37 dB was obtained, considering that the increase in sound insulation depends on the initial performance of the first installed window. The gain in insulation in the second instance was between 4 to 8 dB, mainly in relation to low and medium frequencies. Therefore, it was possible to quantify which sound insulation improvement could be done on façades employing the technique of double windows in order to contribute to the improvement and quality of buildings in Brazil.

Keywords *Acoustics, sound insulation, double windows.*

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1. INTRUDUCTION

The Brazilian urbanization process, occurred since the mid-twentieth century onwards, brought several improvements and well-being for the population as a whole. However, the emergence of large urban areas in our country caused a lot of problems that deteriorated the quality of life in these cities, such as the sound pollution caused by traffic noise. If on one hand the noise level in cities like São Paulo can easily exceed 75 decibels, the vast majority of residential façades in such cities have deficient sound insulation. This is mainly due to the use of sliding windows with insufficient sound insulation. Considering the foregoing, there is a need to develop and apply new technologies to existing windows, in order to improve the sound insulation of façades in buildings.

2. OBJETIVES

The aim of this research is to evaluate sound insulation behavior of double windows, when a second window is placed upon a previous one, keeping an air layer between them. The specific objectives are as follow:

- Quantify the sound insulation of double sliding windows both with insufficient sound insulation;
- Quantify the sound insulation of double maxim-air windows both with good sound insulation;
- Provide comparative data between the sound insulation of single and double windows, in order to contribute to designers and consultants in the technical specification and procedures for soundproofing projects.

3. METODOLOGY

The research methodology consisted in a comparative analysis between the sound insulation of single and double windows. Windows with insufficient sound insulation were initially evaluated, and later on those ones with good sound insulation.

3.1 Sound insulation experiment of double sliding windows both with insufficient sound insulation

- Masonry wall with solid bricks plastered on both sides, with total thickness of 22 cm;
- One sliding window with aluminum frame having glass sheet of 4 mm of thickness, with dimensions of 1.4 m x 1.6 m;
- One sliding window with aluminum frame having glass sheet of 4 mm of thickness with dimensions of 1.4 m x 1.6 m, placed upon a previous one;
- One maxim-air window with PVC frame having glass sheet of 4 mm of thickness with dimensions of 1.4 m x 1.6 m.

Figure 1 bellow shows a schematic drawing concerning the acoustic experiment of double sliding windows, as previously mentioned:

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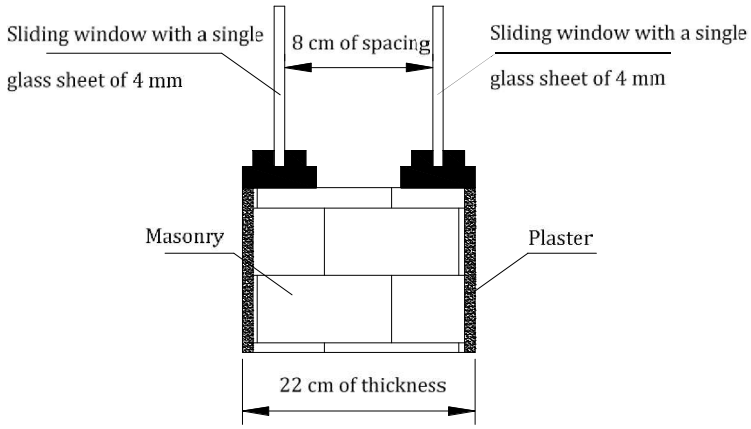

Figure 1: double sliding windows both with insufficient sound insulation

3.2 Sound insulation experiment of double maxim-air windows both with good sound insulation

- One maxim-air window with PVC frame and glass sheet of 6 mm of thickness with dimensions of 1.4 m x 1.6 m;
- One maxim-air window with PVC frame and glass sheet of 8 mm of thickness with dimensions of 1.4 m x 1.6 m;
- One maxim-air window with PVC frame and double glass sheet of 4 mm and 6 mm of thickness, spaced 8.5 cm between them. The window dimension is 1.4 m x 1.6 m;
- One maxim-air window with PVC frame and a double glass sheet of 4 mm and 6 mm of thickness, spaced 8.5 cm between them, placed upon a maxim-air window with PVC frame and glass sheet of 6 mm of thickness. The windows dimensions are 1.4 m x 1.6 m;
- One maxim-air window with PVC frame and a double glass sheet of 4 mm and 6 mm of thickness, spaced 8.5 cm between them, placed upon a maxim-air window with PVC frame and glass sheet of 8 mm of thickness. The windows dimensions are 1.4 m x 1.6 m.

Figure 2 bellow shows a schematic drawing concerning the acoustic experiment of double maxim-air windows, as previously mentioned:

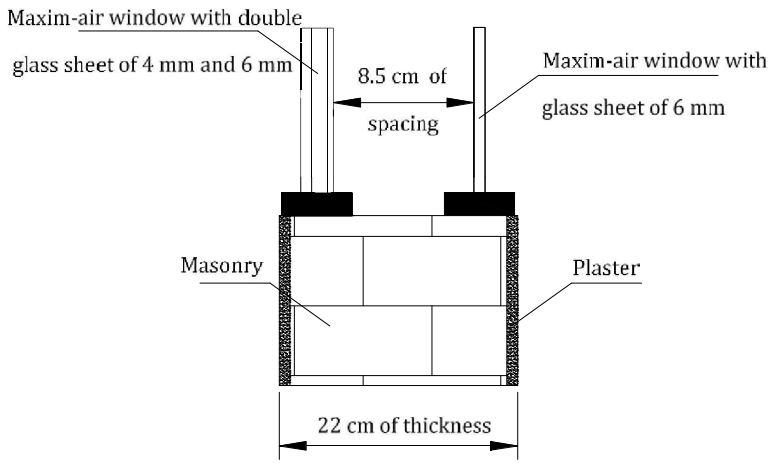

Figure 2: double windows both with good sound insulation

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4. RESULTS

The results of the acoustic experiments are shown in the following Figures 3-6:

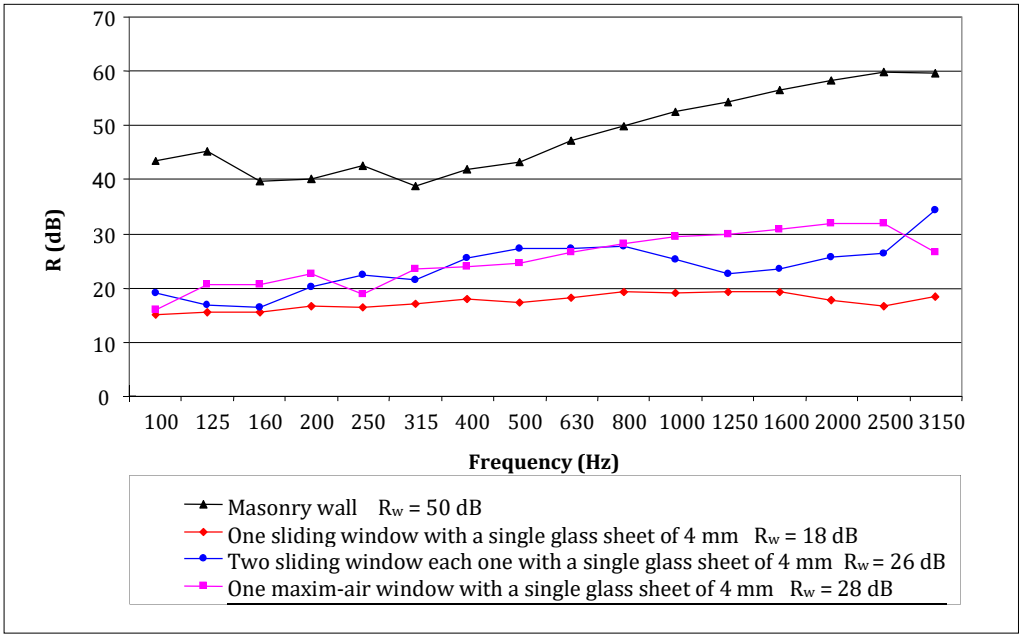

Figure 3: comparative results between one single sliding window, double sliding window and one maxim-ar window

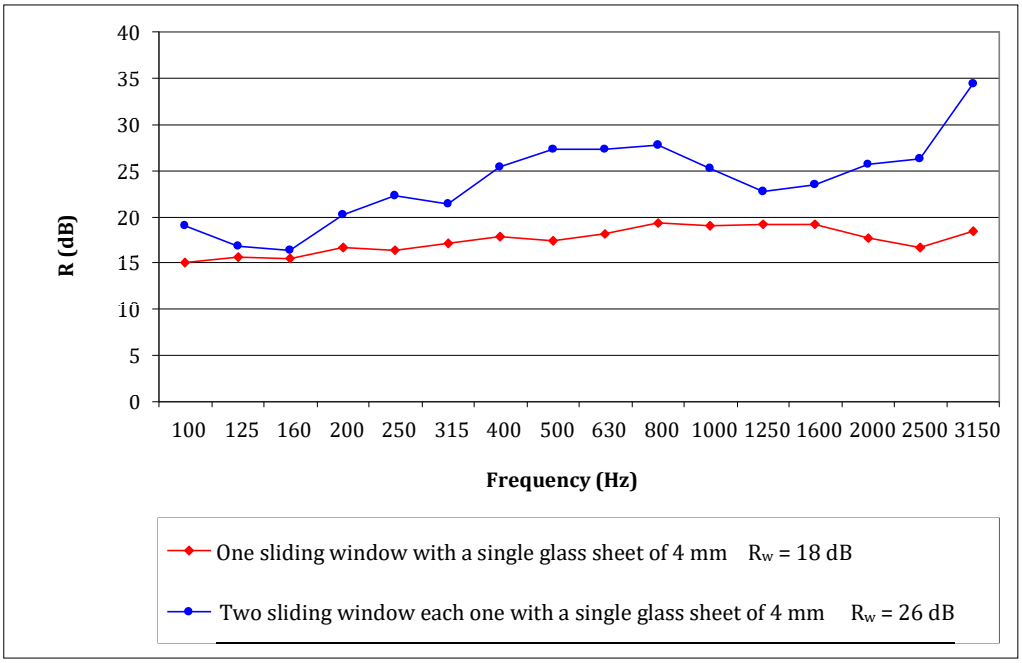

Figure 4: comparative results between one sliding window and two sliding window

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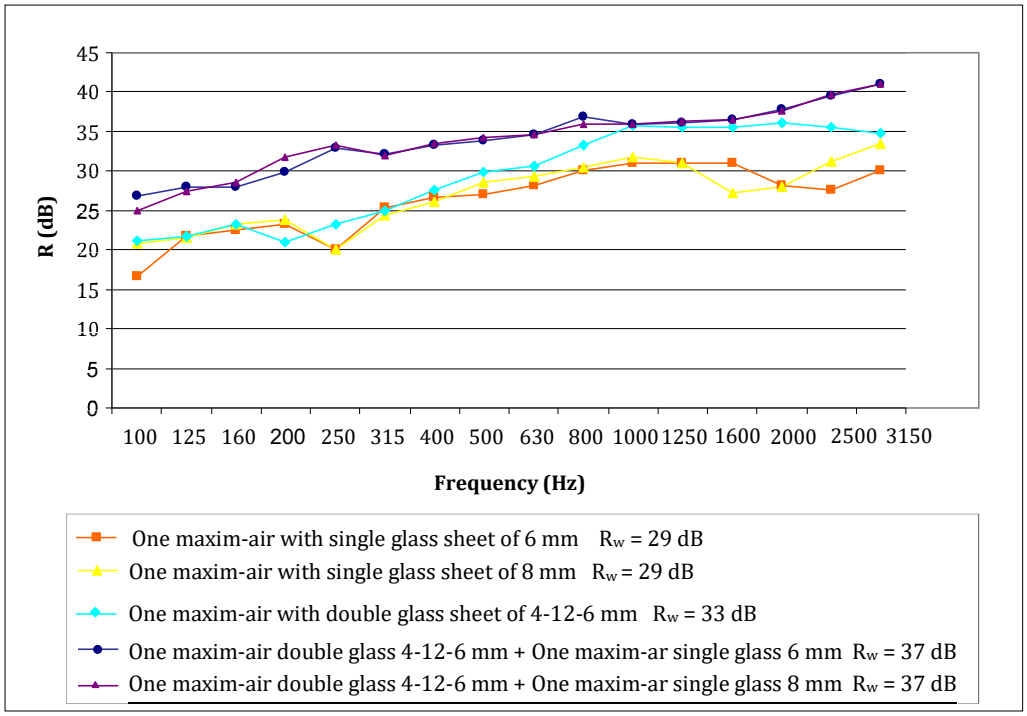

Figure 5: double maxim-air windows with good sound insulation

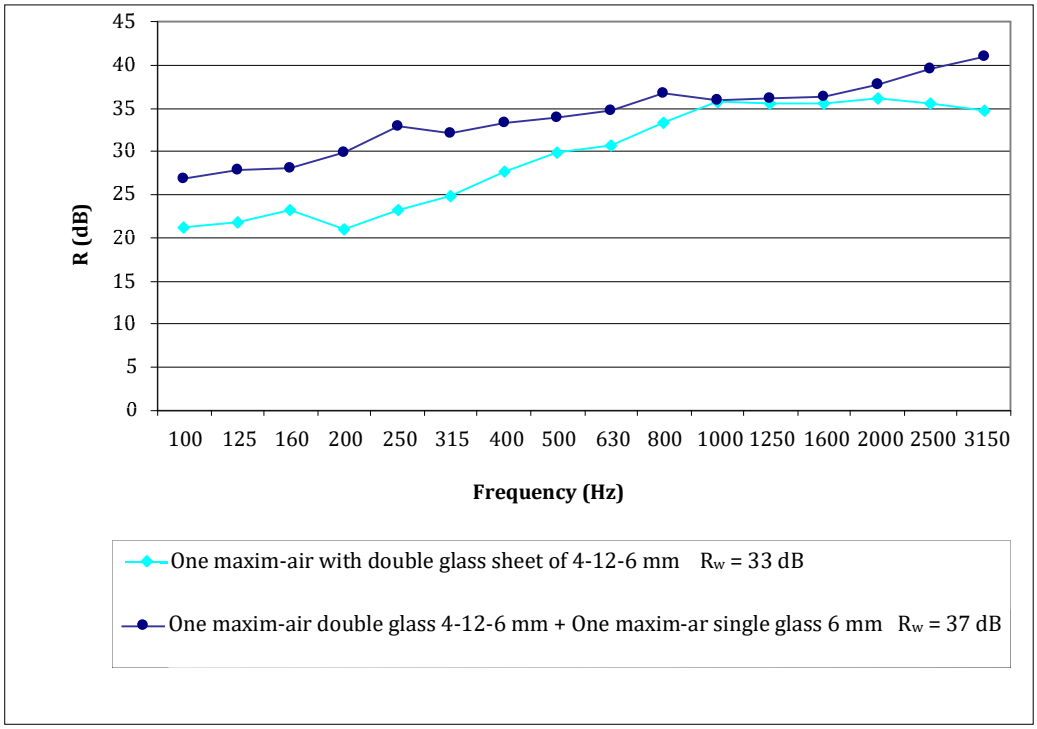

Figure 6: comparative results between single and double windows with good sound insulation

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Figure 7 bellow shows an experiment in the insulation chamber at the acoustic lab:

Figure 7: experiment in the acoustic laboratory

Figure 8 bellow shows a rotating microphone boom in the insulation chamber at the acoustic lab:

Figure 8: rotating microphone boom in the insulation chamber at the acoustic lab

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5. CONCLUSIONS

Considering duplicated windows with insufficient sound insulation, it was found that:

• When a sliding window with R_w = 18 dB is duplicated with a previous one, from the same typology, there is an increase of 8 dB in the sound insulation resulting in a R_w = 26 dB;

• When a sliding window is duplicated with a previous one, from the same typology, the sound insulation does not achieve the same value as one maxim-air window with 4 mm of glass sheet thickness. The results were 26 dB and 28 dB, respectively;

• The sound insulation gain mainly occurs in relation to low and medium frequencies. In the frequency of 160 Hz occurs a resonance, whose position in the sound spectrum is slightly displaced from the f0 frequency of a sealed double glass with the same spacing and thickness.

Considering duplicated maxim-air windows with good sound insulation, it was found that:

• Duplicate maxim-air windows, both with good sound insulation, increases the sound insulation index R_w. Depending on the R_w of the first window, the increase can be from 4 until 8 dB. This research achieved maximum index R_w = 37 dB;

• The sound insulation gain mainly occurs in relation to low and medium frequencies. Given that the traffic noise has a predominance of energy at low and medium frequencies, it can be said that the duplication windows with good sound insulation are effective to vehicular noise.

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