

## TECHNICAL NOTES

### EVALUATION OF ACOUSTICAL PARAMETERS OF A BRAZILIAN POPULAR HOUSING MODEL

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The present survey shows the results obtained from the evaluation of the acoustical parameters in situ, through standardized measurements, inside a popular residence designed to offer an option to combat the housing deficit of the low income Brazilian population.

**Key words:** acoustical insulation index, popular houses.

#### 1. Introduction

Brazil has a housing deficit estimated at 5.3 million houses. 95 of this deficit affects people with a total income up to five minimum wages, which is approximately U\$ 400,00 according to the National Survey by House Sample [1]. It should be taken into account that 48% of the workers in Brazil has a total income up to two minimum wages, which is approximately U\$ 160,00, and from this total only 69.4% is formally registered according to the Brazilian Institute of Geography and Statistics [2]. This way, it is noticeable the urgency in surveying methods for improving such conditions.

Departing from this situation the Easy House 1.0 project has been established. A partnership between surveyors of the Federal University of Paraná and civil construction furnishers has been established with the aid of presenting a good alternative for the low-income people and for the businessman/woman of the civil construction area. The houses should be of easy mounting so that they could be commercialized in kits, and they should offer a possibility of being edified by the own residents, thus putting down the final cost of the house [3].

One of the basic concepts adopted by this project is the progressive performance, in other words, the house has been projected in order to admit that the ideal performance should be achieved by the resident during the period of occupancy, conform his/her

financial conditions. This concept is aimed at the urgent necessity of a home for this resident [3].

This survey has been elaborated in order to evaluate the acoustical parameters of the house, through the determination of insulation indexes of the facades and rooms. At the end the acoustical performance of the house could be determined.

## 2. Methodology

In order to characterize the acoustical performance of the popular residence, measurements have been carried out in a house built in the Federal University of Paraná (UFPR). The following acoustical parameters were evaluated:

For the aerial acoustical insulation:

- $D_{nT}$ : standardized level difference – the level difference corresponding to a reference value of the reverberation time (0.5 s) in the receiving room;
- $R'$ : noise insulation index – it considers the wall surface area, the reverberation time and the volume of the ambient where the sound is received. The guidances of the standard ISO 140-4 [4] were followed, which states about the determination of the indexes in 1/3-octave bands. These parameters are represented by single number quantities: the weighted standardized level difference  $D_{nT,w}$  and the weighted apparent sound reduction index  $R'_w$ , obtained according to the specifications of the standard ISO 717-1 [5].

In order to determine and acoustical performance of the facade, the following parameters have been evaluated: standardized level difference  $D_{tr,2m,nT}$ , and noise reduction index  $R'_{tr,s}$ . These parameters are obtained with the usage of the traffic noise as the noise source, conform stated by the standard ISO 140-5 [6], which states that this type of measurement should be done in 1/3-octave bands, being represented by single-number quantities: the weighted standardized traffic level difference  $D_{tr,2m,nT,w}$  and the weighted apparent traffic sound reduction index  $R'_{tr,s,w}$  which were determined from experimental data according to ISO 717-1 [5].

The following equipments have been used for the measurements: real time analyzer B& K 2260 with two channels, power amplifier B& K 2716 and dodecahedral noise source B& K 4296.

## 3. House description

The project of the house is represented in Fig. 1. This house is located at the entrance of the UFPR and is intended to be evaluated and visited.

The window frames are made of aluminum and 3 mm glasses. Their positions are shown in Fig. 1 and their dimensions are represented in Table 1.

The internal doors are made of 35 mm wood, and the external ones are made of cushioned massive wood, also 35 mm thick. The ceiling is made of 8 mm wood covered by concrete tiles.

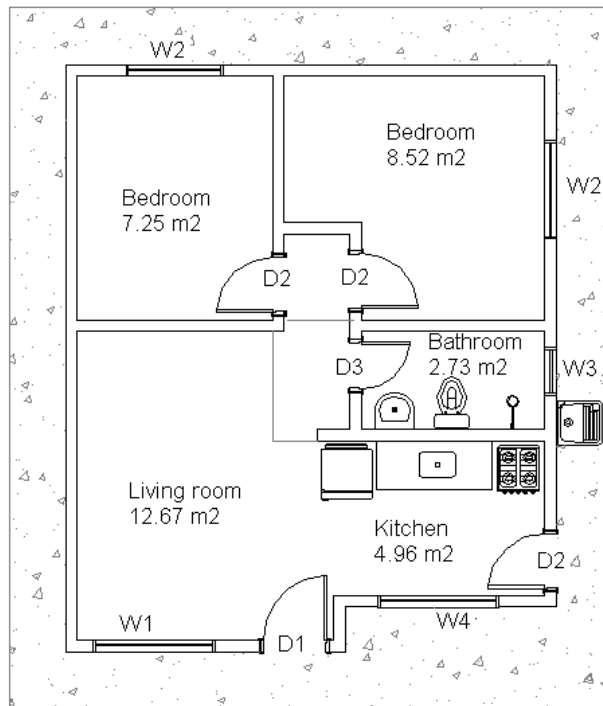


Fig. 1. Project of the house front – Brazilian Association of Portland Cement (ABCP).

**Table 1.** Windows and doors frames.

Code	Dimensions [cm <sup>2</sup> ]	Location	Quantity
W1	1.40 x 1.20	Living room	01
W2	1.20 x 1.20	Bedrooms	02
W3	0.6 x 0.6	Bathrooms	01
W4	1.40 x 0.6	Kitchen	01
D1	0.8 x 2.10	Living room	01
D2	0.7 x 2.10	Bedroom / Kitchen	03
D3	0.6 x 2.10	Bathroom	01

Concrete blocks with structural function, specific weight 2010 kg/m<sup>3</sup>, compound the internal and external walls. They have the following dimensions: 14 × 19 × 39 cm with 2 cm-thick walls.

#### 4. Results and discussions

The acoustical parameters of the internal partitions are presented in Table 2. These parameters show values below the accepted ones if they are compared to the values stated by the international standards such as DIN 4109 [7], which states the  $R'_w$ , the noise insulation index, for the insulation between internal rooms. The recommended value is 37 dB and the minimum one is 32 dB.

**Table 2.** Acoustical evaluation of the internal partitions.

Local of evaluation	$R'_w$	$D_{nT,w}$
Between living room and bathroom	25	18
Between living room and bedroom 1	26	24
Between living room and bedroom 2	26	24

The low internal insulation values found in the house are due to the doors used, which present  $R'_{w}$  between 10 and 20 dB(A) [8]. Such doors are commonly used in civil construction in Brazil but according to [8] they are not adequate to be used in bedrooms. On the other hand, the concrete blocks present high insulation values,  $R_w = 49$  dB(A) determined in laboratory by SILVA [9].

The results of the acoustical insulation parameter measurements are found in Table 3, carried out along the building facades. They show unaccepted insulation indexes if they are compared to the specifications of the international standards such as DIN 4109 [7], which states the values presented in Table 4.

**Table 3.** Acoustical evaluation of the facades.

Local of evaluation	$R'_{tr,s,w}$	$D_{tr,2m,nt,w}$
Facade of living room	20	22
Facade of bedroom 1	20	21

**Table 4.** Demanded levels by DIN 4109.

External noise	Living rooms, bedrooms, classrooms and similars
Leq – dB(A)	$R'_w$ – Minimum of the facade
Below 55	30
56 to 60	30
61 to 65	35
66 to 70	40
71 to 75	45
76 to 80	50
Over 80	–

The poor performance for the facade insulation level is due to the window used, mainly because of its frame, which is the main responsible element for the determination of the noise insulation of a window [10].

The window adopted is widely used in the Brazilian buildings. Its noise insulation determined in laboratory  $R_w$  was 17 dB(A), carried out by RECCHIA [11]. Another measurement carried out in his survey was the evaluation of this window inserted in a masonry wall. The result obtained in the laboratory was  $R_w = 20$  dB(A).

## 5. Conclusions

After analyzing the acoustical parameter results in the Easy House 1.0, it is noticeable that this house has presented a satisfactory performance if compared to the standard of the Brazilian residences, according to the scope of the project. Anyway, such houses should be edified in peripheral areas, thus not subjected to high noise levels.

If the noise insulation levels are compared to the demands of the international standards, the house is considered acoustically inadequate.

The divergence observed in the house performance, if compared to the Brazilian civil construction and to the demands of the international standards, lead to the reflection that, in general words, the Brazilian residences are offering a poor acoustical performance.

## References

- [1] Fundação Instituto Brasileiro de Geografia e Estatística – Pesquisa Nacional por Amostra de Domicílio, Fibge 1997.
- [2] IBGE – Instituto Brasileiro de Geografia e Estatística.
- [3] A. SANTOS *et al.*, Diretrizes para concepção, Projeto Casa Fácil 1.0., Universidade Federal do Paraná 2002.
- [4] ISO 140 – 4: Acoustics – Measurement of sound insulation in building and of building elements – Part 4: Field measurements of airborne sound insulation between rooms, 1998.
- [5] ISO 717 – 1: Acoustics – Rating of sound insulation in buildings and of building elements – Part 1, Airborne sound insulation, 1996.
- [6] ISO 140 – 5: Acoustics – Measurement of sound insulation in building and of building elements – Part 5: Field measurements of airborne sound insulation of facade elements and facades, 1998.
- [7] DIN 4109: Schallschutz im Hochbau; Anforderungen und Nachweise, 1989.
- [8] W. LIPS, *Lärmbekämpfung in der Haustechnik*; Germany, 1999.
- [9] D. T. SILVA, *Estudo da Isolação Sonora em Paredes Divisórias de Diversas Naturezas*, Dissertação (Mestrado em Engenharia Civil) – Universidade Federal de Santa Maria, Santa Maria 2000.
- [10] J. G. BARING, *O desempenho Acústico de Caixilhos de Fachada no Contexto do Controle da Poluição Sonora Urbana*, São Paulo 1990 Tese (Doutorado em Arquitetura) – Universidade de São Paulo.
- [11] C. RECCHIA, Dissertação de Mestrado – Universidade Federal de Santa Maria, Estudo do Desempenho Acústico dos Elementos Construtivos que Compõe a Fachada, 2001.