An approach on how an acoustic classification scheme for dwellings can be adopted in Brazil

Mariana Shieko, Elaine Lemos, Carolina Monteiro
Harmonia Acústica, Brazil.

Summary

The on-development standard for acoustic classification scheme for buildings - the future ISO 19488 - establishes quality classes that reflect distinct levels of acoustic comfort to be used internationally. The standard project is based on the proposal from European COST action TU 0901, which establishes harmonized criteria for several acoustic requirements. The purpose of this paper is to provide inputs of how this classification scheme can be adopted in Brazil by analyzing a large database of field measurements performed in typical Brazilian constructions. Results are presented for airborne and impact sound insulation between dwellings and airborne sound insulation for facades.

PACS no. 43.55.+p, 43.15.+s

1. Introduction

The on-development standard project [1] of Acoustic Classification Scheme (ACS) for dwellings - future ISO 19488 - establishes quality classes that reflect distinct levels of acoustic comfort that might be adopted internationally. As stated in the project, *complying with regulatory requirements does not guarantee satisfactory conditions for the occupants* [1]. The main purpose of the ACS is to make it easier for developers and users to be informed and deal with the acoustic quality of the buildings moreover than the requirements established in national regulations.

The standard project is based on the proposal from European COST action TU 0901 [2], which establishes harmonized criteria for several acoustic requirements, aiming to reduce the diversity of descriptors and *facilitate exchange of data and experience between countries* [2].

In Brazil, there are no mandatory national building acoustics requirements for dwellings. However, in 2013 a building performance standard ABNT NBR 15575:2013 [3] was published. The standard establishes criteria for thermal, acoustic, luminous and fire safety performance. In its chapter 12, which is dedicated to acoustic performance, criteria for airborne and impact sound insulation between dwellings, airborne sound insulation for facades and sound levels due to service equipment are presented. Apart from the minimum requirements (M) , defined as mandatory, extra criteria - intermediate (I) and superior (S) – are presented for informational purpose [4].

Theoretically, a standard requirement is not mandatory, however, the Brazilian law that establishes the consumer rights [5], states that it is mandatory that all products that are to be put in the market must accomplish with all related standards. In this context, all dwelling built from 2013 are considered a product that must accomplish with building performance standard ABNT NBR 15575:2013 requirements. It is important to point out that these mandatory requirements do not apply to all dwellings built before 2013, which explains why in 2018 Brazilian buildings acoustic performance is so deficient.

Brazilian typical construction systems are usually heavyweight with the predominance of hollow concrete or ceramic blocks for wall systems, and solid concrete slabs for slabs systems. Lightweight systems are not frequently adopted; however, they have been gradually included in the construction of new dwellings.

After 5 years in force, the mentioned standard will undergo a revision, to improve some points, such as revisions of definitions, greater technical accuracy and clarity in statements. In the absence of a national regulation the ABNT NBR 15575 has been able to promote the come out of a cultural change in the Brazilian construction market, although its rigorous adoption is being irregular throughout the country regions

The lack of knowledge on building acoustic performance led Brazilian Association of Acoustic Quality (ProAcústica) [4] to publish practical guides with procedures for applying all parts of the standard related to acoustics performance [6] [7].

When proposing a Brazilian ACS it is important to take into account the belatedness of Brazilian construction systems and the leniency of acoustics requirements, if compared with Europe. For example, the current requirement for impact sound pressure level of floors in dwellings is $L'_{nt,w} \leq 80$dB. Therefore, the proposal of future ISO 19488 cannot be directly incorporated in Brazil, and a less restrictive ACS would be more realistic.

1.1. Objectives

The main objective of this paper is to propose a preliminary Brazilian ACS:

- Harmonized with the descriptors of the international proposal of future ISO standard 19488 [1]**;**
- For impact, airborne and facade sound insulation criteria based on the requirements of ABNT NBR 15575:2013 and the analysis of a dataset of field measurements performed in typical Brazilian constructions.

Finally, the proposal of Brazilian ACS is compared with proposal of future ISO standard 19488.

2. Methodology

Firstly, a large database of field measurements performed in typical Brazilian constructions, for airborne and impact sound insulation between dwellings and airborne sound insulation of facades was collected. All measurements were performed according to ISO series 16283 [8–10] and the results were presented according to the descriptors required by Brazilian standard ABNT NBR 15575 : $D_{nt,w}$, $L'_{nT,w}$ and $D_{2m,nt,w}$ respectively.

Afterwards , all results were harmonized with the correspondent single number quantities to express building performance proposed in [1]**.**

For airborne sound insulation, calculations were made with test data obtained from 50 Hz to deliver the results in the proposed harmonized descriptor $D_{nTA,50\text{-}3150}$ [2]. For the cases where no low frequency measurement data was available, a direct translation was performed according to the proposal presented in [11].

For airborne sound insulation of facades the spectral adaptation term C_{tr} was added to tests results in order to obtain $D_{nt,Atr}$.

For impact sound insulation no calculations were necessary, as the single number quantities to express building performance adopted in Brazil is the same required in [1]**:** $L'_{nT,w}$.

Based on the evaluation of the results of field measurements and the current requirements of ABNT NBR 15575:2013 it was performed a study to identify possible Brazilian typical building acoustic performance for airborne and impact sound insulation and propose a preliminary ACS.

3. Proposal of acoustic classification scheme for Brazil

Inspired by the proposal for an acoustic classification scheme for dwellings in [2], a classification scheme for airborne and impact sound insulation between dwellings and airborne sound insulation for facades is being proposed, based in the existing performance standard ABNT NBR 15575:2013 [3] and the database of field measurements, performed in typical Brazilian constructions, gathered for analysis. This proposal is a preliminary scheme of how [1] can be implemented in Brazil in the future.

In the [1] the classes A-F specify different levels of acoustics conditions in dwellings. The steps between classes for sound insulations and noise levels are generally 4dB. Based on this, in this current paper it was followed the same steps for comparison between the proposed classification and the international classification.

Table I presents the preliminary proposal of a Brazilian classification scheme for airborne sound insulation. This scheme was compared to the classification proposed in ISO/DIS 19488:2017 for the airborne sound insulation between habitable rooms in a dwelling and other rooms outside the dwelling, in the horizontal and vertical directions. This comparison was based on the analysis of 57 dataset of field measurements, presented in percentages divided by class. These results showed that the minimum (mandatory) requirement of performance standard in Brazil corresponds to Classes D and E, which can be compared to international Classes E and F, with a difference of approximately 4dB.

Table II presents the preliminary proposal of the classification scheme for impact sound insulation,

comparing its values to ISO/DIS 19488:2017 for impact sound pressure level in habitable rooms in dwellings from other dwellings. ISO standard however, also considers horizontal impact noise insulation, that cannot be compared, once there is no horizontal impact insulation in the national standard, so it was not considered on the analysis.

The 51 measurements dataset analyzed is presented in percentages divided by class. For Class A, the superior requirement from Brazilian performance standard was adopted as a limit and it can be observed that it only corresponds to classes C and D of the international proposal. It is remarkable that the typical impact sound level performance of Brazilian slabs systems is so low, that 36% of the measurements results would not attend the proposed Class F, and almost 70% present a performance that would be outside the class criteria adopted in [1].

Table III presents the preliminary proposal of the classification scheme of sound insulation for facades. In the performance standard, the facades criteria are divided into three noise classes. Each class have requirements for minimum, intermediate and superior insulation performance. This results in nine requirements, and to incorporate all these values into the proposal, the minimum requirement of the lowest noise class was considered as Class F, and the superior requirement of the highest noise class was considered as Class A. Therefore, the proposed classification is equivalent to the international classification. It is important to highlight the difficulty in Brazil to achieve Class A, once after analyzing 35 field measurements dataset the highest class achieved was Class C, due to low sound insulation windows performance.

Table I. Airborne sound insulation between dwellings.

Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
$D_{nT,A} \geq 56dB$	$D_{nT,A} \geq 52dB$	$D_{nT,A} \geq 48dB$	$D_{nT,A} \geq 44dB$	$D_{nT,A} \geq 40dB$	$D_{nT,A} \geq 36dB$
7%	11%	33%	37%	9%	3%

Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
$D_{nT,A} \geq$ 58dB	$D_{nT,A} \geq$ 54dB	$D_{nT,A} \geq 52dB$	$D_{nT,A} \geq 48dB$	$D_{nT,A} \geq 44dB$	$D_{nT,A} \geq 40dB$

Table II. Impact sound pressure level in dwellings.

Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**	**NPD**
$L'_{nT,w} \leq$ 55dB	$L'_{nT,w} \leq$ 59dB	$L'_{nT,w} \leq$ 63dB	$L'_{nT,w} \leq$ 67dB	$L'_{nT,w} \leq$ 71dB	$L'_{nT,w} \leq$ 75dB	$L'_{nT,w} \geq$ 76dB
8%	6%	14%	10%	12%	14%	36%

Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
$L'_{nT,w} \leq$ 46dB	$L'_{nT,w} \leq$ 50dB	$L'_{nT,w} \leq$ 54dB	$L'_{nT,w} \leq$ 58dB	$L'_{nT,w} \leq$ 62dB	$L'_{nT,w} \leq$ 66dB

Table III. Airborne sound insulation for facades.

Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
$D_{nT,A,tr} \geq L_{den}$ - 20	$D_{nT,A,tr} \geq L_{den}$ - 24	$D_{nT,A,tr} \geq L_{den}$ - 28	$D_{nT,A,tr} \geq L_{den}$ - 32	$D_{nT,A,tr} \geq L_{den}$ - 36	$D_{nT,A,tr} \geq L_{den}$ - 40
0%	0%	3%	34%	46%	17%
Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
$D_{nT,A,tr} \geq L_{den}$ - 20	$D_{nT,A,tr} \geq L_{den}$ - 24	$D_{nT,A,tr} \geq L_{den}$ - 28	$D_{nT,A,tr} \geq L_{den}$ - 32	$D_{nT,A,tr} \geq L_{den}$ - 36	$D_{nT,A,tr} \geq L_{den}$ - 40

4. Conclusions and future work

Based on the existent building performance standard and field measurement data, a preliminary Brazilian ACS is proposed, harmonized with the descriptors of the international proposal of future ISO standard 19488.

This preliminary scheme will be of great value for the future development of a national acoustic classification of dwellings standard, as it can be used as a starting point for the discussions.

It can also be a relevant topic to be discussed in the revision process of building performance standard 15575 when evaluating if existent requirements should be improved. By comparing the preliminary ACS to the international proposal, it is observed that the most challenging aspects in Brazilian building acoustic performance are impact sound level and airborne sound insulation of facades.

The implementation of an Acoustic Classification Scheme for buildings in Brazil is desired as it is believed that it will motivate the Brazilian construction market to invest on research and new building systems, and to give more attention to the guarantee of satisfactory conditions for the occupants.

In future studies, more measurement data will be incorporated to the evaluation to validate the ACS and a proposal for sound levels due to service equipment will be yield.

References

[1] ISO / DIS 19488 Acoustics — Acoustic classification of dwellings. vol. 2017. International Standard Organization; 2017.

[2] Rasmussen B, Machimbarrena M, Fausti P, TU0901 C. Building acoustics throughout Europe. Volume 1: Towards a common framework in building acoustics throughout Europe. 2014.

[3] NBR 15575: Edificações Habitacionais — Desempenho. Associação Brasileira de Normas Técnicas; 2013.

[4] Akkerman D, Holtz M, Monteiro C, Borin M. Brazilian technical standard for acoustic performance of new residential buildings. Mandatory requirements vs Field tests. INTER-NOISE NOISE-CON Congr. Conf. Proceedings, 2016, p. 3997–4999.

[5] Código de Proteção e Defesa do Consumidor - Lei no 8.078, de 11 de setembro de 1990. Brasil, Senado Federal; 2012.

[6] Manual ProAcústica para Classe de Ruído das Edificações Habitacionais. Associação Brasileira para a Qualidade Acústica; 2017.

[7] Juan Frias Pierrard e Davi Akkerman. Manual ProAcústica sobre a Norma de Desempenho. Associação Brasileira para a Qualidade Acústica; 2017.

[8] ISO 16283-1:2014 Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation. Geneva, Switzerland: International Organization for Standardization; 2014.

[9] ISO 16283-2: 2015 Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 2: Impact sound insulation. International Organization for Standardization; 2015.

[10] ISO 16283-3:2016 Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 3: Façade sound insulation. International Organization for Standardization; 2016.

[11] Monteiro C, Machimbarrena M, Tarrero AI, Smith RS. Translation between existing and proposed harmonized airborne sound insulation descriptors: A statistical approach based on in-situ measurements. Appl Acoust 2017;116:94–106. doi:10.1016/j.apacoust.2016.09.017.