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ACOUSTIC PERFORMANCE ASSESSMENT OF RESIDENTIAL BUILDING FLOOR SYSTEMS IN MOLDED CONCRETE WALL IN LOCO

Kamila Soares do Nascimento
FUMEC University
Belo Horizonte - MG
http://lattes.cnpq.br/5953049512875544

Edna Alves Oliveira
FUMEC University
Belo Horizonte - MG
http://lattes.cnpq.br/4750588445213248

Otávio Luiz do Nascimento
Ex- teacher of FUMEC University and IBMEC
Belo Horizonte - MG
http://lattes.cnpq.br/2003051305652723

Abstract: In Brazil and in many countries, the modernization of civil construction is a requirement of society, motivating the search for technological innovations in construction processes. However, not all of them meet the minimum desirable requirements for affordable, quality housing. The annoyance caused by sounds and noise in floor systems between autonomous units of housing buildings makes acoustic performance one of the most relevant items of NBR 15575 (ABNT, 2021). Eight (8) tests were carried out in accordance with the NBR ISO 16283-1 (ABNT, 2018) and ISO 16283-2 (ISO, 2020) standards. The tests were carried out in 1 (one) reference floor system, consisting of a solid concrete slab, and 3 (three) different treatment configurations using materials with acoustic properties. The comparison of the results obtained considers the interference of each material and executive process adopted. At the end of the study, it was found that materials with a high potential for improving the overall acoustic performance of the floor, however, if subjected to executive interference and adhesion failures between different materials, affect compliance with the level of acoustic performance required by NBR 15575 (ABNT, 2021).
Keywords: NBR 15575; Acoustic Performance; aerial sound; Impact noise; flooring systems.

INTRODUCTION

Civil construction permanently seeks to modernize construction processes for construction sites, innovations that are not always properly evaluated and recommended for that use. The reduction in the use of conventional processes has been systematically questioned in relation to the consumption of materials, energy, water, execution time and the amount of labor required.

The modernization of civil construction is a requirement of society and a demand of construction companies to guarantee financial survival, especially through productivity gains and cost reduction. In this sense, the implementation of technological innovations in traditional construction processes is very important (ALMEIDA, 2005; SABBATINI, 1994).

Several innovative solutions, with regard to construction systems, are introduced in the market to solve the issue of the Brazilian housing deficit. However, not all of them meet the minimum desirable requirements for affordable, quality housing.

The large-scale construction of concrete wall housing units has been a milestone in technological and market standards for the construction sector in Brazil (IBRACON, 2018). As it is a solution aimed at industrialization, the construction system demands projects directly aimed at production. That is, the degree of detail and simplification must facilitate understanding on the work fronts.

NBR 15575 (ABNT, 2021) evaluates the performance of systems, bringing improvement of executive processes and knowledge of the materials used in the building, with minimum requirements to be met, regardless of the constructive system to be adopted in the building. The application of the performance concept was well accepted on the world stage. The system classification is performed through performance levels. The minimum performance must be compulsorily met by the different systems, and some criteria have two other levels of performance, intermediate and superior.

This rule is totally focused on the user, that is, for those who acquire the property. It serves as an instrument to ensure the receipt of a quality product, in accordance with the specific Brazilian standards in force and meeting the minimum comfort and performance requirements required by NBR 15575 (ABNT, 2021).

The acoustic performance requirements contained in NBR 15575 (ABNT, 2021) aim to minimize noise-related problems, which include hearing loss, stress, hypertension, sleep loss, among others. Controlling noise was generally seen in the past as more of a burden than a benefit. Pressure to control noise is increasingly coming from consumers and users. In the area of consumer products, low noise is becoming an effective marketing tool for everything from buildings to washing machines (BISTAFA, 2006).

In general, negative effects of noise can be minimized by reducing the levels of noise emitted and treating the transmission media, thus restricting the propagation field of sounds.

Sound propagation in closed residential spaces can be divided into study areas, among them:

a. Study of the propagation of aerial sounds between two environments, in which this propagation depends primarily on the mass of the constructive elements, as well as on the connections/connections of the various elements that separate the two environments.

b. The study of the propagation of impact noise, resulting from shocks or other mechanical stresses applied directly to the construction elements, which essentially depends on the type of building structure, the connection between compartmentalization elements and the characteristics of the environment.

MATERIALS AND METHODS

The measurements of aerial sound and impact noise between floors, for the development of this work, were carried out according to methodologies contained in NBR ISO 16283-1 (ABNT, 2018) and ISO 16283-2 (ISO, 2020).

STUDY OBJECT

The case study included in this work was related to the evaluation of the insulation to airborne sound and the impact noise between floors, of a construction system of cast-in-place concrete wall, considering different acoustic treatments composed of materials usually used in civil construction, between two overlapping stand-alone units.

Three different types of acoustic treatments were considered for the same flooring system consisting of a structural layer in reinforced concrete with a solid slab with a thickness of 10 cm and laminate flooring as the final coating. A test was also carried out on the system identified as a reference, in which there was no type of acoustic treatment.

The tests were carried out in a building intended for residential use. The tested floor system has an area of 8.65 m^2, with the upper bedroom identified as the emitter, and the bedroom in an autonomous unit below the emitter environment, identified as the receiver. The transmitter and receiver bedrooms have a volume of 21.81 m^3 and a ceiling height of 2.52 m.

CONSTRUCTIVE SYSTEMS ANALYZED

The tests were carried out in 8 (eight) different bedrooms, 4 (four) emitter bedrooms and 4 (four) receiving bedrooms, however, with the same dimensional characteristics and construction system in concrete wall. Initially, 4 (four) airborne sound tests were carried out between floors, and later, 4 (four) impact noise tests between floors.

The configurations of the tested floors were identified according to the acoustic treatment performed in the bedroom environments, described in Tables 1 to 4. Resilient materials

CONFIGURATION 1 - REFERENCE	
SYSTEM OF FLOORS	
Structural Layer	Solid slab – Thickness: 10 cm
Acoustic Treatment	No treatment
Final touch	laminate flooring
SEALING SYSTEM	
Structural Layer	Concrete wall – Thickness: 10 cm

Frame 1 - System analyzed – Configuration 1 - Reference.

Source: The authors, 2022

SETUP 2 – ROCK WOOL TREATMENT	
FLOOR SYSTEM	
Structural Layer	Solid Slab - Thickness: 10 cm
Acoustic Treatment	Rock wool – Filling in the gaps at the lighting points, in the switch and socket boxes and in the door, in the sender and receiver environments. The rock wool filling took place during concreting and was supplemented post-concreting at specific points.
Final touch	laminate flooring
SEALING SYSTEM	
Structural Layer	Concrete wall – Thickness: 10 cm

Frame 2 - System analyzed – configuration 2– rock wool.

Fonte: Os autores, 2022

SETUP 3– ROCK WOOL + ACOUSTIC BLANKET	
FLOOR SYSTEM	
Structural Layer	Solid slab – Thickness: 10 cm
Acoustic Treatment	Acoustic Blanket - Application on the entire perimeter of the floor (10 cm up and down at the floor/wall interface) + application with a diameter of 30 cm on the positioning of the luminaire in the apartment below + Rocha Wool - Filling in the gaps of the luminaire points, in the switch and socket boxes and in the door, in the sender and receiver environments. The rock wool filling took place during concreting and was supplemented after concreting at specific points
Final touch	laminate flooring
SEALING SYSTEM	
Structural Layer	Concrete wall - Thickness: 10 cm

Frame 3 - Configuração 3 – Lã de rocha + Manta acústica.

Source: The authors,2022

CONFIGURATION 4 – ADHERED BLANKET	
FLOOR SYSTEM	
Structural Layer	Laje Maciça – Espessura: 10 cm
Acoustic Treatment	Bautech Adhered Blanket – Application on the entire perimeter of the floor (10 cm up and down at the floor/wall interface) + application with a diameter of 30 cm over the positioning of the luminaire in the apartment below.
Final touch	laminate flooring
SEALING SYSTEM	
Structural Layer	Concrete wall - Thickness: 10 cm

Frame 4 - System analyzed – Settings 4 – adhered blanket.

Source: The authors, 2022

Figure 2 - Rock wool application in electrical boxes before concreting

Source: The authors, 2022

Figure 3 - Application of acoustic blanket adhered to the entire perimeter of the floor, at the floor/fence interface.

Source: The authors, 2022.

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Floor Configuration	1	2	3	4	Tests performed	
					aerial sound	**impact noise**
floor structural layer	Slab 10 cm	Slab 10 cm	Slab 10 cm	Slab 10 cm	X	X
acoustic treatment	-	rock wool	Rock wool + acoustic blanket	acoustic blanket	X	X
final finish	Laminate	Laminate	Laminate	Laminate	X	X

Table 5 - Tested floor system configurations.

Source: The authors, 2022

such as rock wool blanket, bonded acoustic blanket composed of elastomers and polymers and flooring were used in the executive process. laminated as a final finish. It is worth mentioning that rock wool was applied at specific points before the concreting of the concrete walls and slabs, however, some points were complemented after concreting.

Table 5 presents a summary of the characteristics of the configurations of the flooring systems analyzed and identifies the tests that were carried out in each configuration.

RESULTS AND DISCUSSIONS

As shown, 8 (eight) tests were carried out in total, 4 (four) of airborne sound measurement between floors and 4 (four) of impact noise measurement between floors. The tests were carried out in 1 (one) configuration of a reference flooring system, consisting of solid concrete slab and laminate flooring and in 3 (three) floor configurations in which resilient materials were inserted in the executive process to verify possible performance improvement. acoustic.

The results obtained in the acoustic measurements consider the slab and final coating as references, the interference of each material constituting the system and the executive process adopted for its application. It was found that materials with a high potential for improving the overall acoustic performance of the system, such as rock wool, if subjected to executive interference that causes adhesion failures between different materials, presenting gaps between two types of materials and consequent decrease in density in these localized points directly affect compliance with the minimum acoustic performance level required by NBR 15575 (ABNT, 2021), indicating results lower than those obtained in the reference configuration, without any treatment.

It was found that the treatments performed contributed to significant changes in the results of the criterion of aerial sound between floors, however, they interfered little in the alteration of the results in the criterion of impact noise between floors. This small change in impact noise is due to the fact that all configurations have laminate flooring as a final finishing coating, which is considered a floating floor that disconnects the elements and that presents good results in controlling the transmission of vibration between the constructive elements, being one of the solutions already implemented in the market for the control of impact noise between floors of residential buildings.

FLOOR CONFIGURATION	REHEARSAL	MINIMUM PARAMETER FOR DORMITORIES	VALUE OBTAINED	CLASSIFICATION PERFORMANCE
1 Slab + Laminate Flooring	Aerial sound between floors - $D_{nT,w}$	≥ 45 dB	42 dB	Does not meet the minimum required performance
	Impact noise between floors - L´nT,w	≤ 80 dB	62 dB	Intermediary
2 Slab + Laminate Flooring + Rock wool	Aerial sound between floors - $D_{nT,w}$	≥ 45 dB	41 dB	Does not meet the minimum required performance
	Impact noise between floors - L´nT,w	≤ 80 dB	66 dB	Minimum
3 Slab + Laminate Floor + Rock wool + Acoustic blanket	Aerial sound between floors - $D_{nT,w}$	≥ 45 dB	42 dB	Does not meet the minimum required performance
	Impact noise between floors - L´nT,w	≤ 80 dB	64 dB	Intermediary
4 Slab + Laminate Floor + Acoustic Blanket	Aerial sound between floors - $D_{nT,w}$	≥ 45 dB	45 dB	Minimum
	Impact noise between floors - L´nT,w	≤ 80 dB	62 dB	Intermediary

SUMMARY RESULTS OBTAINED

Table 1 Summary results obtained for the criteria of aerial sound and impact noise between floors.

Source: The authors, 2022.

Table 5 presents the summary of the results obtained in the tests carried out on the floor system, for each configuration tested.

CONCLUSIONS

The acoustic performance between floors that separate autonomous units is one of the most relevant items in a residential building. The post-occupancy nuisance caused by aerial sounds such as music and impact noise, such as falling objects, furniture dragging and people walking, must be considered even in the design phase of the residential building, so that it is feasible. the analysis and indication of possible solutions if the proposed initial floor system does not have the potential to meet the minimum acoustic requirement required by NBR 15575 (ABNT, 2021).

In this work, experimental tests were carried out in different configurations of flooring systems, in environments with and without specific treatments. In the tests, resilient materials known for their properties were used, which have the potential to contribute to acoustic insulation, in 4 (four) different configurations of floor systems, incorporated into commonly known structural elements and final coating, such as slab and solid molded concrete walls. on site and final finishing in laminate flooring, a system in which it was used as a reference configuration. From the results of these tests, it was possible to compare the performance of each acoustic treatment performed. All the materials incorporated are solutions with great potential for use in buildings with the standard of the building analyzed, part of the MCMV program, built on a concrete wall molded in place.

It was observed that the rock wool applied before concreting resulted in a weak point in the system, since the fresh concrete did not adhere to the rock wool, causing localized areas with the presence of voids, and a consequent decrease in the density of the system in these areas. specific points. It was found that although rock wool has the potential for acoustic improvement, if used with application methodology before concreting, it can create interference points that are harmful to the final acoustic performance of the flooring system.

It was also found that the floor configuration with treatment using only the adhered acoustic blanket helped in the treatment of the floor/sealing interface, in the region of cold joint between the slab and wall concreting, bringing benefits to this critical region, as well as the realization of the plugging of possible concreting failures at this location. The adoption of this treatment showed an improvement in acoustic performance, and the results obtained for this configuration showed satisfactory results, meeting the minimum performance level required for the air sound criterion between floors and intermediate performance level for the impact noise criterion. between floors, according to NBR 15575 (ABNT, 2021). The other tested configurations showed satisfactory results only in the criterion of impact noise between floors, and did not meet the minimum performance required for the criterion of aerial sound between floors.

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