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SUGGESTIONS FOR THE POTENTIAL REVISION OF THE BASIC DOCUMENT ON PROTECTION AGAINST NOISE OF SPANISH BUILDING CODE

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ABSTRACT

In Spain, the Basic Document DB HR Protection Against Noise, part of the Building Code (CTE), regulates the acoustic conditions in buildings. This regulation, in force since 2009, has accumulated 16 years of implementation and experience, during which maintenance tasks and continuous studies have been conducted to explore potential improvements.

As a result, steps are being taken towards a possible new version of the document, which may address the deficiencies identified over the years and expand its content to include aspects previously not considered.

This paper presents some of the proposals currently under study. For instance, updates to the requirements are being considered, including a slight increase in the performance levels for airborne and impact sound insulation, as well as a review of the sound insulation descriptors currently in use. Additionally, new content is being evaluated, such as criteria for applying the DB HR to existing buildings, construction solutions for wooden buildings, noise from building services, and mandatory field acoustic measurements to verify compliance with the requirements.

Keywords: *DB HR, building acoustics regulations, sound insulation requirements, field measurements, noise from building services*.

1. INTRODUCTION

The Basic Document DB HR on Protection Against Noise, part of the Spanish Building Code (CTE) [1,2], establishes the acoustic requirements for buildings, as well as the rules and procedures to ensure compliance. Published in 2009, it represented a significant change from the previous regulation (NBE-CA-88) [3], as it introduced higher sound insulation requirements and adopted a performance-based approach, using in situ acoustic descriptors instead of laboratory test values. This allowed a final performance of the building to be verified.

Acoustic comfort is a key factor in building quality, with a direct impact on the well-being, health, and productivity of occupants. Noise pollution is recognized as a major environmental issue, with proven effects on stress, sleep quality, and cognitive performance [4]. In residential buildings, inadequate sound insulation can affect privacy and lead to conflicts between neighbours, while in work and educational environments, poor acoustic conditions can impair concentration and learning. In addition to airborne and impact noise insulation, controlling noise from building installations, such as elevators, HVAC systems, and plumbing, is essential to ensuring occupant comfort.

Since its implementation, DB HR has accumulated 16 years of application and experience, during which continuous studies and in situ tests have been conducted to assess its effectiveness. These efforts, carried out in collaboration with the building sector and within the regulatory maintenance activities for the Ministry of Housing, have helped verify

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compliance with acoustic requirements, identify challenges in the application of the regulations, and gain experience in using testing standards such as ISO 16283 [5].

Over the years, the evolution of the construction sector and data analysis have revealed certain limitations and areas for improvement within DB HR. Advances in construction techniques, the introduction of new materials, and changing user expectations make it necessary to adapt the regulatory framework to ensure its effectiveness. Additionally, in situ testing has identified implementation difficulties, variations in execution quality, and specific cases where current requirements may be insufficient.

In this context, Spain is currently reviewing its building acoustics standard, exploring possible modifications to optimize their application and enhance acoustic quality in buildings. This paper provides an overview of the ongoing changes under consideration and the new approaches that could be incorporated into the future revision of the regulations.

2. CURRENT STATE OF DB HR: ANALYSIS OF IDENTIFIED AREAS FOR IMPROVEMENT

The current DB HR is structured into different sections that address each of the regulated aspects: sound insulation (airborne, impact, and exterior noise in facades), reverberation time and sound absorption, and noise and vibration from building services. Among these, sound insulation is the most extensively developed, whereas protection against noise from building services is addressed more generally and with less detail.

Scope of application

Currently, DB HR applies exclusively to new buildings and major restorations, without considering other types of interventions in existing buildings. To facilitate the progressive adaptation of the building stock to current quality standards, it would be advisable to define specific criteria based on the type of intervention, distinguishing between major restorations, partial refurbishments, extensions, and changes of use, among others. Additionally, introducing flexibility conditions in the application of these criteria could be beneficial, considering the context of the intervention and the characteristics of the building.

Sound insulation requirements and descriptors

A critical aspect of DB HR is the selection of sound insulation indices and the corresponding regulatory requirements. Across Europe, building codes show significant disparities in the descriptors used to assess airborne and impact sound insulation between dwellings, as well as in the required performance levels [6, 7].

Acoustic descriptors in building regulations are defined in ISO standards [5, 8]. In Spain, the descriptor used to assess in-situ airborne sound insulation is the Standardized level difference, weighted A ($D_{nT,A}$), over a frequency range of 100 Hz to 5000 Hz, which approximately corresponds to $D_{nT,w} + C_{100\text{-}5000}$, where C represents the Spectrum adaptation term for pink noise.

Given the European context, it may be advisable to align these indices with those more commonly used in other countries, such as $D_{nT,w}$ and R'_w (with or without the spectrum adaptation term C) for indoor sound insulation, and $D_{2m,nT,w} + C_{tr}$ for facades, within the 100 Hz to 3150 Hz frequency range.

Regarding fundamental acoustic requirements between adjacent dwellings, the values established in DB HR for airborne sound insulation ($D_{nT,A} \approx D_{nT,w} + C_{100\text{-}5000} \geq 50$ dBA) and impact sound insulation ($L'_{nT,w} \leq 65$ dB) are at the lower end compared to most European countries. Other nations generally impose stricter requirements, often exceeding 53-55 dB for airborne sound insulation and setting impact sound limits below 60 dB. The Spanish regulatory values thus reflect a lower level of acoustic protection.

These requirements have remained unchanged since the publication of DB HR in 2009. However, practical experience suggests that most buildings constructed under this regulation comply with the acoustic requirements [9]. In the case of impact sound insulation, measured values often significantly exceed the minimum requirements. This demonstrates that it is possible to achieve higher acoustic quality levels, suggesting that it may be an appropriate time to consider increasing the regulatory requirements for sound insulation.

Design and dimensioning using the simplified method

DB HR provides two methods for designing acoustic solutions: the simplified and the detailed method, both based on the prediction models outlined in ISO 12354 [10]. While the detailed method requires precise calculations of sound insulation, the simplified method offers predefined construction solutions for building elements, ensuring compliance through their combination.

After several years of application, the simplified method could benefit from review and optimization to enhance its accessibility and efficiency. Although Tables 3.2 and 3.3 in DB HR [1] appear to provide a wide range of solutions, in practice, when translating these laboratory-measured insulation values and surface mass densities into commercially available construction systems, the number of viable solutions is relatively limited.

Moreover, the use of the simplified method is complicated by the requirement to comply with numerous additional conditions to control flanking transmissions. While these constraints ensure the validity of the proposed solutions, they also render the application of the method cumbersome and unintuitive.
Finally, the simplified method does not include solutions for lightweight timber structures, such as CLT (cross-laminated timber), light timber frames, or hybrid timber-concrete structures. Timber construction has experienced significant growth in recent years, including multi-story buildings, yet the lack of predefined solutions in DB HR forces reliance on the detailed method or specific testing for compliance. It would be beneficial for DB HR to incorporate acoustic compliance options for such constructions within the simplified method framework.

Noise from Building Services

As previously mentioned, DB HR addresses building service noise in a very general manner, without establishing specific requirements. Instead, it provides guidelines that can be considered best practices for noise and vibration control. However, acoustic requirements for building services are not explicitly defined within DB HR but are instead referenced in Royal Decree 1367/2007 [11], a regulatory development of Law 37/2003 on Noise [12], which remains pending revision and update [13]. This decree establishes noise limit values to transmit to adjacent rooms caused by building services, as well as the corresponding testing and assessment procedures.
However, these procedures are identical to those applied for commercial and industrial noise, leading to interpretation issues regarding whether building services are indeed covered under this regulation. Moreover, applying the same measurement and assessment methodology to building services may be inappropriate, as it fails to consider key aspects such as: the specific characteristics of each type of installation, operating modes and work cycles, and the nature of the noise generated.
It is therefore necessary for DB HR to provide a more detailed and tailored regulatory framework for building service noise, ensuring clearer guidelines adapted to their specific characteristics, in the context of the building.

Finished Building Control: In-Situ Testing

DB HR does not mandate acoustic testing upon completion of construction. However, if tests are conducted, it specifies the technical standards under which they should be performed [5, 14], along with the acceptable tolerances for verifying compliance with acoustic requirements. The following tolerances are permitted for in-situ measurements: 3dBA for airborne sound insulation, 3dB for impact sound insulation, and 0.1s for reverberation time.
Although acoustic control upon completion is not mandatory at the national level, several autonomous communities and municipalities require in-situ testing as a prerequisite to obtain the first occupation license. These controls include verifying sound insulation in walls, floors, and facades, as well as measuring sound pressure levels generated by building services.
Regions such as Andalucía, Castilla y León, and País Vasco, along with cities such as Barcelona, Murcia, Valencia, and Valladolid, have developed specific regulations governing these tests. In some cases, beyond requiring the tests, they also establish sampling procedures and specific evaluation criteria. Details on how these regulations make this control acoustic testing can be found in [15].
The heterogeneity of these regulations highlights the need for greater standardization in the obligation and methodology of finished building acoustic testing, ensuring a uniform and reliable verification of compliance with acoustic requirements across the country.

3. PROPOSALS CURRENTLY UNDER STUDY FOR THE REVISION OF DB HR

In light of the issues discussed above, this section presents some of the proposals currently under study to address areas identified for improvement. Work is underway on a revised version aimed at refining certain aspects and expanding on topics that have not yet been covered in these regulations.

3.1 Document restructuring

The DB HR document is being restructured into new sections, grouped according to the acoustical characteristics it regulates: Section HR1 for airborne and impact sound insulation, Section HR2 for sound absorption and reverberation time, and Section HR3 for service equipment noise.
This restructuring aims to provide a more systematic and specific approach, ensuring that each section includes its own requirements, scope of application, and specific criteria. Additionally, the original content will be reviewed and adapted accordingly.

3.2 Criteria for application to existing buildings

This section summarizes some of the criteria under study for applying DB HR to interventions in existing buildings, depending on the degree of intervention:

- Full intervention (major restorations): The entire building must comply with the acoustic requirements of DB HR.
- Extension: Any newly added part of an existing building must meet DB HR requirements, and the new separating walls and floors with the existing spaces must ensure compliance.
- Change of use: When the change of use affects the entire building, it must be fully adapted to the requirements. But, when the change of use is partial, affecting only a part of the building, only that part must meet the corresponding requirements. For instance, in a conversion to residential use (a dwelling), the newly created living spaces must comply with DB HR regulations.
- Partial renovation or localized intervention in building elements and installations: The applicable criteria must be defined in greater detail. Depending on whether the intervention significantly affects multiple construction elements, involves simultaneous work in several dwellings, or is more localized, flexibility criteria may be applied to approach DB HR requirements as closely as possible, even if full compliance is not achievable.

In all cases, the non-degradation principle shall prevail, ensuring that the intervention does not reduce the existing acoustic performance before the works.

3.3 Update of requirements and standardization of sound insulation descriptors

In alignment with European regulations, it is proposed to replace $D_{nT,A}$ with $D_{nT,w} + C$ for indoor airborne sound insulation and $D_{2m,nT,Atr}$ with $D_{2m,nT,w} + C_{tr}$ for façades, both within the frequency range of 100 Hz to 3150 Hz.

Additionally, an update to the regulatory requirements is being considered, including a 2 dB increase in airborne sound insulation and a 5 dB reduction in impact noise levels. Table 1 presents the sound insulation requirements currently under study for protected spaces such as living rooms and bedrooms in residential buildings.

Table 1. Sound insulation requirements for protected spaces in dwellings.

Sound insulation	Type of spaces	Current reqs.	New reqs. proposal
Airborne	Between protected spaces and other spaces outside the living unit [1]	$D_{nT,A}$ ≥ 50 dBA	$D_{nT,w} + C$ ≥ 52 dB
	Between protected spaces and noisy areas, such as equipment rooms or activity rooms	$D_{nT,A}$ ≥ 55 dBA	$D_{nT,w} + C$ ≥ 57 dB
Impact	Between protected spaces and other spaces outside the living unit [1]	L'_{nTw} ≤ 65 dB	L'_{nTw} ≤ 60 dB
	Between protected spaces and noisy areas, such as equipment rooms or activity rooms	L'_{nTw} ≤ 60 dB	L'_{nTw} ≤ 55 dB
Façade [2] (Same values)	Bedrooms	$D_{2m,nT,Atr}$ ≥ 30-47 dBA	$D_{2m,nT,w} + C_{tr}$ ≥ 30-47 dB
	Living rooms	$D_{2m,nT,Atr}$ ≥ 30-42dBA	$D_{2m,nT,w} + C_{tr}$ ≥ 30 – 42 dB

[1] A living unit refers to a section of a building designated for a specific function, whose occupants share a functional connection (e.g., dwellings, hospital rooms, hotel rooms, classrooms, etc.). In this case, a living unit is considered a dwelling.

[2] The sound insulation requirements for façades depend on the day noise level (L_{day}) of the area where the building is located.

3.4 Review of the simplified option for sound insulation

The simplified option in DB HR presents several areas for improvement. While its main advantage is ease of application, it also has limitations that need to be addressed in the upcoming revision of DB HR. First, the construction solutions for separating walls and floors (Tables 3.2 and 3.3 in DB HR [1]) must be recalculated to meet the new sound insulation requirements under consideration. Additionally, this simplified option should be reviewed and optimized to make it more accessible and practical, simplifying the adaptation of laboratory sound insulation values to construction elements available on the market. It is also necessary to reduce the complexity of additional conditions for controlling flanking transmissions, aiming for greater flexibility without compromising the technical validity of the proposed solutions. This would facilitate the practical application of viable acoustic solutions in real projects.

Furthermore, the simplified option could incorporate solutions for lightweight timber buildings, such as those built

with CLT, timber frame, or hybrid timber-concrete structures. These should be basic or fundamental solutions, covering the most common cases while ensuring compliance with acoustic requirements. The goal is to integrate these solutions into the regulation without unnecessarily complicating the design and application process, avoiding the need to resort to the general option or conduct specific acoustic tests.

Finally, it is important to clarify that the simplified option is merely a guideline providing examples of possible solutions. Other alternatives exist beyond those explicitly included in DB HR. In its current wording, the simplified option may be mistakenly interpreted as a mandatory requirement, which needs to be addressed.

3.5 Service equipment noise

Currently, DB HR regulates service equipment noise in buildings by referencing Law 37/2003 on Noise [12] and Royal Decree 1367/2007 [11], which sets maximum permissible noise levels in adjacent spaces. However, since building service equipment is an integral part of the building itself, it is necessary to regulate this aspect more specifically within DB HR, adopting a more architectural approach rather than treating it similarly to commercial or industrial activities, as is currently the case.

The objective is to define specific noise requirements for building service equipment by establishing appropriate noise indices, their corresponding limit values, and a measurement method adapted to the characteristics and operating cycles of each type of installation. The testing procedure could be based on ISO 16032 [16], which includes the measurement of both the equivalent continuous sound pressure level (L_{eq}) and the maximum sound pressure level (L_{max}) for different types of installations.

At the same time, maintaining a degree of compatibility with the methodology of RD 1367/2007 is desirable, while incorporating some improvements, such as:

- Averaging measurement points instead of using only the most unfavorable measurement.
- Defining a sampling methodology based on the operating cycles and working modes of each system, instead of the current minimum measurement duration of 5 seconds.
- Applying the corrections for impulsive, tonal, and low-frequency components only when they exceed the hearing threshold [17].
- Normalizing measurement results relative to the reverberation time of the spaces.

A key step is the correct classification of service equipment according to their characteristics and operating conditions, as these factors determine the generated sound pressure levels, the appropriate measurement procedure, and the noise index to be used ($L_{A,max}$, $L_{A,eq,Ti}$, $L_{Aeq,cycle}$, etc.). While some systems operate continuously (e.g., HVAC), others operate intermittently or by events (e.g., plumbing, elevators), making it essential to define specific criteria for their evaluation. In particular, an index based on maximum noise levels is proposed for systems with intermittent operation, as well as those with start-up phases or changing working modes that generate noise peaks.

Finally, while most European countries establish a single noise limit for service equipment (whether in terms of $L_{Aeq,T}$, $L_{A,max}$, or both), Spain differentiates limit values depending on the period (day, evening, night). Aligning this approach with international practice should be considered.

3.6 On-site testing for final compliance verification

It is proposed to establish mandatory in-situ testing at the national level to verify compliance with sound insulation, reverberation time, and service equipment noise level requirements. Currently, some regional governments already require these tests before granting the first occupancy license. Implementing this requirement nationwide would help standardize quality control in building construction.

To ensure proper implementation, a minimum sampling procedure must be defined to guarantee compliance with the DB HR of the CTE without interfering with regional competencies. This minimum approach will allow regions that have already developed their own testing systems to maintain them without regulatory conflicts. Additionally, clear criteria for compliance declarations must be established, studying aspects such as measurement uncertainty and the application of tolerances to limit values.

In this regard, it is proposed to reduce the tolerance in sound insulation compliance measurements from 3dB to 2dB. This proposal is based on an analysis of European regulations [7], where 21 out of 28 countries do not establish any tolerance or uncertainty, requiring strict compliance with the regulatory values. Among the countries that do consider tolerances, Denmark sets a 1 dB tolerance, Austria, Belgium, and Sweden apply 2 dB, while Spain, France, and Portugal allow a 3 dB tolerance.

4. CONCLUSIONS

The analysis of the Basic Document DB HR Noise Protection, part of the Spanish Building Code (CTE), highlights the progress made in the acoustic regulation of buildings since its publication in 2009. However, it also reveals areas that require improvement and updates to meet

current industry demands and align with international practices. In this regard, a series of enhancements have been identified and proposed, starting with the reorganization of the document to facilitate its application.

Regarding the current sound insulation requirements, they are among the lowest in Europe, making it advisable to revise and raise the standards to improve acoustic quality in buildings. Additionally, it is necessary to optimize the simplified option to enhance its applicability and incorporate timber construction solutions, and develop more specific regulations for building service noise, ensuring they are appropriately tailored to the characteristics of each type of project.

Furthermore, it is essential to establish specific criteria for applying DB HR to existing buildings, considering different levels of intervention. It must be ensured that interventions do not degrade the initial acoustic conditions and, when full compliance with the requirements is not feasible, promote improvements that bring the building as close as possible to the established standards.

Finally, the implementation of mandatory field acoustic testing at the national level is proposed to verify compliance with the requirements. This would ensure more uniform and rigorous quality control across the country.

Overall, these proposed revisions to the Basic Document DB HR represent a key opportunity to enhance the acoustic quality of buildings in Spain and ensure greater comfort for users.

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