

Noise requirements in existing buildings in Spain: New proposals and the Existing Building Evaluation Report.

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Summary

In Spain there are approximately 25 million dwellings, 53% of them were built before 1980, which means they were built before any acoustic or thermal requirements were mandatory. Part DB HR Protection against noise of the Spanish Building Code approved in 2009, applies only to new buildings and massive restorations, but given the current situation of the Spanish construction industry, which is still experiencing a drop in the production of new dwellings, the Infrastructure Ministry is trying to promote the retrofitting of the existing building stock with the approval of different laws.

The new proposed amendments in the DB HR include a new scope for works in existing buildings and criteria to define which cases the requirements must apply to.

In addition, there are other initiatives in process: recently part IV “Acoustics” of the Existing Building Evaluation Report (IEE) has been published. This report is mandatory in the case of 50-year-old multifamily buildings and buildings which are being retrofitted with public funds. The IEE assesses the conservation status, energy performance, accessibility and acoustic performance of a building. Although part IV “Acoustics” is undertaken on a voluntary basis, the report is an opportunity to rate and improve the acoustic performance of existing buildings.

This paper shows the proposed changes in the Spanish acoustic regulation and the new IEE report.

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1. Introduction

Spain has 18 million primary homes [1]. Approximately 12,1 million, a 67,2% of the total housing stock, are flats in multifamily houses, which makes Spain the European country with the highest percentage of people living in flats.

Spanish construction industry experienced a sharp drop in past years, and it is recovering from the crisis slowly, but still the number of new build homes is small. According to the CSCAE, Spanish Council of Associations of Architects, the number of new homes built in 2013 was 27.700, far from the figures experienced in the period between 1999 and 2004 [2].

Closer inspection of the housing stock reveals that 53% of the homes were built before 1980, that is to say, they were built before any thermal or acoustic regulation was approved and therefore their thermo-acoustic performance is poor, so it is necessary to consider its improvement in the housing renovation processes.

Regarding sound insulation and regulations, it was in 2009 when the document DB HR Protection against noise was approved. This document established new sound insulation requirements for new housing and it has been a big step towards increasing the acoustic insulation of dwellings, as it upgraded sound insulation requirements and brought them closer to those existing in the most demanding European countries.

Unfortunately this regulation was approved in the first years of the construction sector crisis and very few new buildings have been built, which, in terms

of sound insulation, means that approximately 280.000 dwellings out of a total of 18M (1,6%) meet the actual standards. Most of the population in Spain in 2014 is living in homes with an estimated sound insulation of $D_{nT,A} \leq 40$ dB on average.

According to a social survey conducted in 2013 [3], 18,7 % of homes acknowledged they were disturbed by either neighbor noise, or outdoor noise. This is a higher percentage than the homes which complaint about environmental problems, such as air pollution.

In this scenario, the Ministry of Infrastructure is trying to promote the renovation of the existing building stock by means of different actions:

- The first one is the new proposed amendments in part DB HR Protection against noise [4] of the Spanish building Code, which include a new scope for works in existing buildings and criteria to define which cases the acoustic requirements must apply to.
- The second action is the publication in last November of part IV Acoustics of the Existing Building Evaluation Report [5], which is a report that assesses the conservation status, energy performance, accessibility and acoustic performance of a building.

Although currently, most of the works in existing buildings are aimed at removing architectural barriers or at improving their energy performance, and they are not undertaken for acoustic reasons, the basic motivation of these initiatives is the idea that every renovation work, independently of its extent, could be considered an opportunity to improve the acoustic performance of existing buildings.

In both cases, Eduardo Torroja Institute for Construction Science has assisted the Infrastructure Ministry and both initiatives will be shown in this paper.

2. Requirements in existing buildings (proposal)

As mentioned in the previous section, in 2009 part DB HR Protection against noise of the Spanish Building Code came into force. This document applies only to new buildings and major

restorations, which means that in most of the works undertaken in existing buildings the improvement of the sound insulation performance is not even considered. This situation is really unsatisfactory and not reasonable, and the Ministry of Infrastructure has been working in a proposal to extend the application of the sound insulation requirements to works in existing buildings.

The new proposed amendments of part DB HR are aimed at defining a reasonable scope, that is to say, defining which cases the sound insulation requirements must apply to and which cases are excluded. Tables 1 and 2 show noise insulation requirements in part DB HR.

Table 1. Airborne and impact sound insulation requirements

Type of space	Airborne $D_{nT,A}$ (dBA)	Impact $L'_{nT,w}$ (dB)	Frequency range (Hz)
Between protected spaces, such as bedrooms, living rooms, ...etc. and other premises outside the living unit(*)	≥ 50 dB	≤ 65 dB	100-5000
Between habitable spaces, such as kitchens, bathrooms, halls, corridors, etc. and other premises outside the living unit	≥ 45 dB	-	100-5000
Between noisy areas such as equipment rooms or activity (+) rooms and protected spaces.	≥ 55 dB	≥ 60 dB	100-5000

(*) Noise insulation requirements in Spain also apply to hotels, student halls, schools, and hospitals. Living units are dwellings, hospital rooms, hotel rooms, classrooms, etc.

(+) Activity rooms are premises with an A-weighted sound pressure level up to a 70dBA.

Table 2. Sound insulation of the outer walls and roofs. $D_{2m,nT,Atr}$ (dBA), between protected rooms and external noise sources (function of day L_{eq})

L_d dBA	Type of building			
	Dwellings and hospitals		Cultural, medical, educational centres and office buildings	
	Sleeping rooms	Living areas	Living areas	Classrooms
$L_d \leq 60$	30	30	30	30
$60 < L_d \leq 65$	32	30	32	30
$65 < L_d \leq 70$	37	32	37	32
$70 < L_d \leq 75$	42	37	42	37
$L_d > 75$	47	42	47	42

But first of all, some attention must be paid to two general principles that apply to all works in

existing buildings and to all requirements of the Spanish building code, which are:

- The “**no-deterioration principle**”, which means that any work undertaken in a building must not prejudice its performance in any way. For instance, most of the works undertaken in multifamily houses in Spain are related to removing architectural barriers and installing elevators. When this is the case, the new elevator is a potential source of noise and vibration disturbing adjacent residents, if suitable noise and vibration control elements are not provided.
- The “**flexibility principle**”, which considers that in some cases, it is not possible to upgrade the noise insulation in a building to the current requirements, such as when the building is protected because of its historical or architectural interest, or when the works to upgrade sound insulation values to the current requirements are not technically possible or feasible. In such works, the aim should be to improve the sound insulation of a building to the extent that is possible. Figure 1 shows a scheme of these criteria. When this principle applies, the reasons to apply this principle must be justified in the working project.

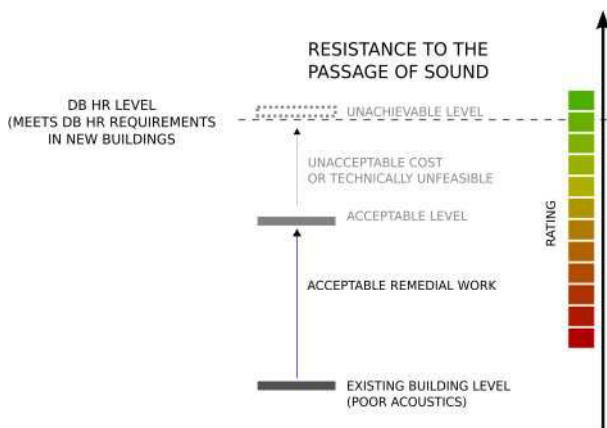


Figure 1. Graph showing the flexibility principle

2.1 Specific criteria for works in existing buildings in part DBHR

Works in existing buildings comprise a wide variety of types, so DB HR contains specific criteria related to the following works [6]:

- **Extensions:** Sound insulation requirements apply fully to extensions, because they are similar to the project of a new building, unless

the work is incompatible with the urban or protection of the building.

- **Conversions,** there are two cases that must be considered:

- When there is a **change of use in the whole of a building**, such as when a block of houses is converted into a hotel. The requirements must apply fully to all the conversion, with the exception of historic buildings and those cases in which the works to adapt the building to the sound insulation requirements are technically unfeasible. In these cases, the flexibility principle must apply, that is to say, the works must improve the building to the extent that is possible or compatible with its historic character.
- When only part of the building is converted. In these cases, the requirements apply to the following cases:
 - Whenever part of a building is converted into a dwelling.
 - Whenever part of a building is converted into a mechanical room or a leisure activity room, adjacent to protected premises, such as bedrooms, living rooms...etc.

- **Renovations.** Depending on the extent of the renovation, the sound insulation requirements could apply fully or not to the following works:

- **Major renovations,** where walls, floors, façades, roofs and the rest of the structural elements of a building are renovated. This case is similar to a new build project, so requirements apply fully, with the exception of historic buildings and when the application of requirements is technically impossible.
- **Partial renovations,** when only a construction element, such as a wall, floor, windows, etc. or an area within a building is retrofitted. In this case, the every element that is being renovated, has to comply with the regulations, but the flexibility principle can be applied in the cases which follow:
 - In the case of a protected or historic building.
 - When it is not technically possible or the cost is unreasonable in comparison with the work.
 - When the flanking elements, which were not planned to be renovated, must

undertake some treatment to achieve sound insulation values.

In situ tests are not mandatory in Spain. Only in some regions like Castilla y León, Andalucía and the city of Valencia, local administrations require them before the Practical Completion Certificate. In the case of retrofitting, in situ tests are also optional. They must not be used to assess the compliance with the requirements when the flexibility principle is applied.

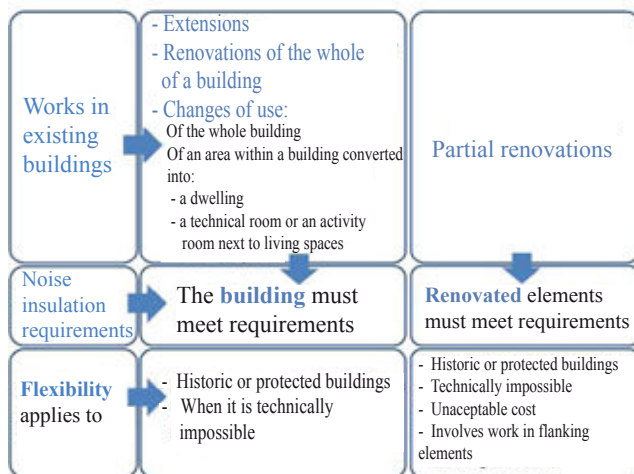


Figure 2. Diagram showing sound insulation requirements in existing buildings.

3. Existing Building Evaluation Report – IEE

Any alteration, conversion or work in an existing building starts with an evaluation of its character and condition. In this way, the Existing building evaluation report or IEE is a report which states the conditions of existing buildings in Spain. It checks four parts:

- The existing physical condition of the building.
- The energy performance, including the energy performance certificate.
- The compliance with the universal accessibility regulations.
- Acoustic conditions.

Not only does this report assess these four aspects, it also contains a part where recommendations must be included if an aspect is rated unfavorable.

This report is mandatory in the case of 50-year-old multifamily buildings and buildings which are being retrofitted with public funds independently

of their use. Local administrations require owners and communities to handle in the report according to a fixed schedule.

The first three parts of the report are compulsory, but acoustics is fulfilled only on a voluntary basis. A computer application to fulfill the IEE report is available at <https://iee.fomento.gob.es>.

3.1 Part IV. Acoustics

Part IV of the Existing building evaluation report assesses acoustic performance of multifamily houses. It was conceived as a checklist, whose aim was to point at the most frequent and potential sources of noise in Spanish multifamily houses. Architects and engineers are usually the professionals who are fulfilling this report, and in most cases they are not familiar to noise propagation concepts, so this report is also an attempt to make the evaluation of a building easier and to spread noise insulation best practices.

One of the drawbacks of this report is that most of the times the evaluation of the building is based on a visual inspection, which means some of the aspects may not be assessed correctly, but architects are encouraged to include test cuts and in situ testing.

The structure of the IEE report is the following:

IV.1 General data. This section contains a checklist with information about two aspects: The building and its exposure to environmental noise: Acoustic area, L_d , etc. and the distribution of rooms in relation with noisy areas within a building.

IV. 2. Acoustic performance, which is a part where the building elements must be described. This section is divided in 5 different checklists:

- External walls and roofs
- Separating walls
- Separating floors
- Junctions
- Service and equipment

This part includes a description of every element and points at the most common problems in Spanish multifamily houses affecting sound insulation performance:

- Windows which lack airtightness
- Roller shutters

- Single leaf separating walls with surface mass less than 125 kg/m^2
- Lack of floating floors
- Pipes penetrating walls or floors.
- Back to back electrical outlet boxes.
- Crosstalk noise via ductwork
- Imperfections in linings, cracks or any other kind of gap which allows noise to intrude into a dwelling.
- Rigid connections between floor, walls, pillars, façade, etc.
- Airborne and structure-borne sound coming from bathrooms and kitchens located upstairs. It is common practice that drainage pipes penetrate the floor and run along the bathroom located downstairs thus being a major source of disturbance, especially at night.
- Inappropriate ceiling in bathrooms, kitchens or in technical rooms.
- HVAC equipment located near windows or in interior courtyards, where the noise is disturbing.
- Noise coming from elevator machinery, when it is located next to living spaces.
- Noise from garage doors next to dwellings.

To fulfil this part, it is advisable to check all the available documentation of the building, make a little survey among the neighbours to check which noise sources are found most disturbing, make cut tests whenever possible, and perform in situ measurements.

IV. 3. Evaluating the acoustic performance

This section contains the evaluation of the acoustic performance of the building, where airborne, impact, external noise insulation and sound levels produced by the service and equipment, must be rated.

The rating consists of 4 levels: “Good”, “Reasonable/Regular”, “Poor” and “Bad”.

The challenge is to establish a criteria to rate a building. Knowing that most buildings do not comply with the current requirements, one of the ideas was to rate the building depending on how far from complying with the requirements the building is.

IV.4. Recommended remedial works

After the evaluation, the report contains a part in which remedial works must be proposed and must

be analysed in terms of efficiency and budget. The idea is that whenever possible, the improvement of the acoustic conditions is considered.

Another important aspect that pursues this report is the integrated or holistic approach: Any remedial work proposed must be analysed in terms of how this work can affect the performance of other requirements, such as thermal insulation, passive fire resistance, ventilation performance, etc.

IV.5. Tests

In this part, all test or documents which support the report must be attached: in situ tests, photos, a relation of inspections, available documentation, etc.

4. Conclusions

More than half (53%) of the Spanish homes can be regarded as having an inadequate thermal and sound insulation, and according to the last survey, 20% of the owners of homes, regard noise insulation as the most important problem of their homes, ahead of other environmental problems, such as pollution.

On the other hand, new build housing rates have experienced a sharp drop. Such scenario brought the Ministry of Infrastructure to take action to promote the retrofitting of the building stock.

The two initiatives regarding noise insulation requirements are:

- New proposed amendments in part DB HR Protection against noise, which include a new scope for works in existing buildings and criteria to define which cases the requirements must apply to.
- Part IV of the Existing Building Evaluation Report (IEE) which assesses noise insulation performance of buildings. This report is in most of the cases fulfilled by professionals who are not familiar to acoustics, so it consists of a series of checklists which contain the description of the most common sources of noise in typical Spanish multifamily housing. Although fulfilled on a voluntary basis, this is an attempt to rate and improve acoustics in houses.

Acknowledgement

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References

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RUIDO EXTERIOR

FACHADAS

- ☐ LIGERAS: Madera, panel sándwich, ventilada ligera, etc.
- ☐ PESADAS: Fachada con al menos una hoja de fábrica u hormigón de al menos 135 kg/m²

CUBIERTAS

- ☐ LIGERAS: Madera, panel sándwich, etc.
- ☐ PESADAS: El soporte resistente es un forjado o losa de hormigón

VENTANAS Y LUCERNARIOS

- ☐ Sencillas
- ☐ Dobles

Vidrios

- ☐ Acristalamiento simple
- ☐ Acristalamiento doble
- ☐ Acristalamiento triple

Sistema de apertura

- ☐ Correderas
- ☐ Abatibles y oscilobatientes
- ☐ Fijo

Figure 3. Image showing IEE computer application.
<https://iee.fomento.gob.es>