The Portuguese policy for building acoustics assessment

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This paper presents the Portuguese policy to assess the overall acoustic quality of residential buildings, in order to issue the corresponding permission for use and trade them within the urban market.
The Portuguese policy rely on the legal frame set forth by the national Building Acoustics code, which imposes the existence of an acoustic project for each new building, covering the sound insulation in terms of airborne and impact noise, and requirements for service equipment noise and reverberation times.
The assessment is done by testing after the construction has been completed and when all the service equipment is installed and operating accordingly. The tests have to be done by accredited laboratories.
In order to avoid testing all possibilities in terms of partitions, service equipment, volumes and surfaces, a simplified sampling is adopted.

1 INTRODUCTION

In Portugal, under the scope of acoustic quality assessment of buildings and in buildings, the corresponding evaluation relies fundamentally in the compliance of the system (building) with the legal requirements set for, respectively the Noise Pollution Act (Decree-Law 09/2007) [5] and the Building Acoustics Code (Decree-Law 96/2008) [5].

The first legal document establishes the framework related to the exterior noise environment, expressed in terms of land use planning and construction permissions, and the second one establishes the acoustic comfort inside buildings, expressed by the sound insulation indicators (airborne sound and impact sound), the maximum noise level due to service equipment, and whenever necessary the reverberation time.

Whenever a housing building has been rehabilitated, renovated or simply is a new one, a process of conformity assessment with legal requirements has to be done before human occupation. So, in this context, a set of sequential steps has to be followed, in accordance with

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some criteria established in the Portuguese Building Acoustics Code, which includes an assessment process conducted by a building acoustics expert, whom based on the in situ testing results obtained by an accredited lab, will assume the responsibility of the building conformity with the appropriate acoustic requirements, in order to declare that the housing permission could be issued by the municipality.

Thus, the objective of this paper is to describe the referred steps, the main options that can be taken accordingly, and the constraints that procedure may raise.

2 LEGAL FRAME

In terms of urbanization concepts and land use permissions, the Decree-Law on environmental noise assumes two classifications, which are respectively: sensitive zones and mixed zones. Within the first ones there will be permissions for the existence of residential buildings, hospitals, and schools (and small shops or industries for local population support), and within the second ones could be possible the existence of sensitive zones uses and additionally the co-existence of commercial and bureau buildings. These two types of zoning are the core business of Portuguese Regulations. The zones have to be classified by the municipalities in terms of territory usage and consequently integrated on the land use planning procedures. The corresponding noise limits for land use zoning purposes are the following:

Table I – Noise limits for land use purposes

Zone \ L	L_{den}	L_n
Sensitive Zones	≤ 55 dB(A)	≤ 45 dB(A)
Mixed Zones	≤ 65 dB(A)	≤ 55 dB(A)

In the subsequent items it is presented the requirement set forth by the building acoustics code for housing buildings, in which there are no requirements for reverberation time:

- Sound insulation of façades
  Mixed zones: $D_{2m,nT,w} \geq 33$ dB
  Sensitive zones: $D_{2m,nT,w} \geq 28$ dB
- Airborne sound insulation
  Flat-flat: $D_{nT,w} \geq 50$ dB
  Common accesses-flats: $D_{nT,w} \geq 48$ dB
  Elevators-flats: $D_{nT,w} \geq 40$ dB
  Parking-flats: $D_{nT,w} \geq 40$ dB
  Comercial areas-flats: $D_{nT,w} \geq 58$ dB
- Impact sound insulation
  Flat-flat: $L'_{nT,w} \leq 60$ dB
  Comercial areas-flats: $L'_{nT,w} \leq 50$ dB
- Service equipment
  $L_{Ar,nT} \leq 32$ dB(A); [equipment operating intermittently]
  $L_{Ar,nT} \leq 27$ dB(A); [equipment operating continuously]

3 ASSESSMENT PROCEDURE

Under the provisions of paragraphs 6 and 7 of Article 3.º of Decree-Law 96/2008 (Building Acoustics Code), dated June 9th, which amends and republishes the Acoustic Requirements for Buildings (approved by Decree-Law 129/2002 of May, 11th), it is legally established by National Laboratory for Civil Engineering (LNEC), the general criteria of sampling for testing and noise measurements, in order to verify the buildings compliance with the legal provisions set in force, pursuant to Article 15.º of Ordinance 232/2008, of March 11th, and section 9 of Article 13.º of Decree-Law 26/2010, of March 30th.

Similarly, under the powers conferred by the provisions of paragraph 1 of Article 4.º of the same Regulation, the LNEC also defines the methodology for the compliance concerned.

For the purposes of these criteria, the following legal instruments are considered:

- Technical Opinion - A document certifying the regulatory compliance required, which should be prepared by a qualified technician in accordance with paragraph 2 of Article 3.º of Decree-Law 96/2008, of June 9th (this qualification is chartered by the respective professional association; engineers or architects).
- Test report - A document that contains the description and results of noise tests, carried out in accordance with the applicable standards, which should be made by an entity that meets the requirements set out in Articles 33.º And 34.º of Decree-Law 9/2007, of January 17th (let's say an accredited acoustics laboratory).

The process of the acoustic analysis, for verification of regulatory compliance, is made up of all the previous documents and must be accompanied by a statement of qualifications issued by the relevant technical professional.

The sampling adopted should cover all the proper construction solutions adopted in the building construction or rehabilitation works, as well as the criteria for acoustic performance of the various items that comprise the assessment of regulatory compliance requirements. The sampling in question shall be defined under the responsibility of the author of Technical Opinion.

The global procedure of assessment is presented as a flowchart in Figure 1.

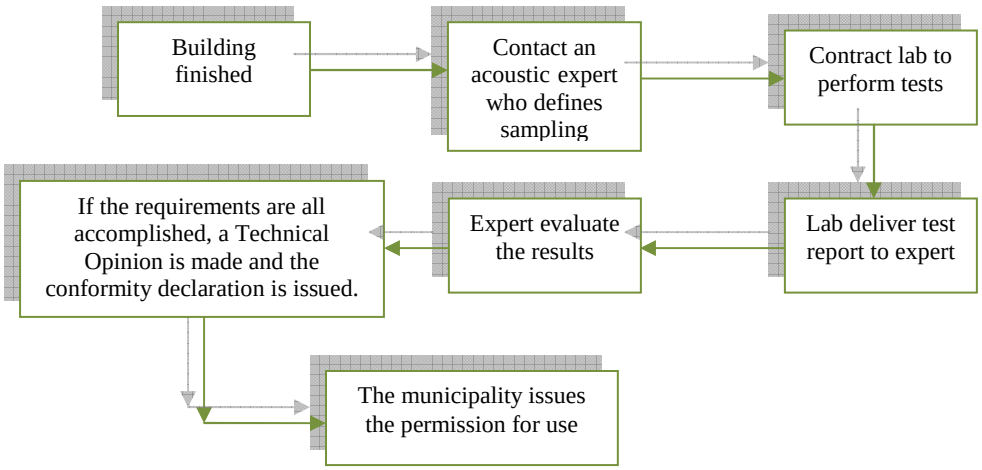

Fig. 1 - Shcematic flow chart of the assessment procedure

This procedure can be applied to the overall building or just to a simple apartment. Whenever the acoustic expert, who has to be chartered by their professional association on the basis of the corresponding CV and ability, is not confident about the sampling proposed, he/she can impose a more detailed or additional sampling.

4 SAMPLING OPTIONS FOR DIFFERENT TYPE OF BUILDINGS

In order to avoid testing all possibilities in terms of partitions, service equipment, volumes and surfaces, a simplified sampling is adopted. This sampling takes into account all the overall building and not just a selected apartment for the purpose. Thus:

Airborne and impact sound insulation

- single-family residential buildings - the parameter ($D_{2m,nT,w}$) should be checked for the most unfavorable constructive solutions.

- single-family isolated residential buildings which are part of a specific urbanization - the parameter ($D_{2m,nT,w}$) should be checked for constructive solutions that:
  a) have different constitution;
  b) have different composition.

- single-family equal residential buildings, twin or in a row - the parameters ($D_{2m,nT,w}$ and $D_{nT,w}$, if applicable, $L'_{nT,w}$), should be checked for constructive solutions that:
  a) have different constitution;
  b) have different composition.

- multifamily buildings - all parameters ($D_{2m,nT,w}$, $D_{nT,w}$ and $L'_{nT,w}$), should be checked for constructive solutions that:
  a) have different constitution;
  b) have different composition;

Service equipment

In relation to service equipment, considering the most worse exposure conditions in living spaces, it must be rated the noise level ($L_{Ar,nT}$) of all collective equipment installed in the building.

The different constitution and different compositions are defined as such: it is understood as different constitution the existence of different materials and / or thickness of constructive solutions (e.g. one leaf of masonry wall with different thicknesses, different floor coverings of floors), and as different composition the constructive solutions that have different geometries (e.g. walls with different areas, façades with different windows in terms of area or type of glazing).

5 CONCLUSIONS

As an overall conclusion it can be stated that Portugal has very good and updated noise legislation on building acoustics. However, in terms of its implementation it can be considered that, despite the delays that normally occur on the issuing of housing permissions by local authorities (municipalities), or any other public department, noise control is a reality, and the suitable conditions for acoustic comfort in buildings undergoes a process on continuous improvement.

In fact, all of these aspects have been internalized into the current concerns of the citizens, and have raised a strong awareness of populations with regard to noise and its effects, as well as the compliance of their commercial rights when acquiring a building or a flat**.**

6 REFERENCES

1. Decree-Law 09/2007, *Portuguese Noise Pollution Act (in Portuguese).* RGR 2007, January, 17th, Lisbon, Portugal, 2007.

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