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ACOUSTIC REGULATIONS IN EUROPEAN UNION COUNTRIES

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ABSTRACT:

This paper represents a first approach to the acoustical regulations in some European Union countries. It is only considered the case of dwellings in Residential Buildings.

The analysis is limited to the comparison of the different indexes used in the several countries. Some examples illustrate the enormous differences in philosophy and requirements of the different Regulations that were analysed.

The conclusions emphasize the need to begin the preparation of a common code that could be used as a European Union Regulation in the field of Building Acoustics.

1. INTRODUCTION

Acoustical Regulations deal with a lot of areas of the human activities. To illustrate this thought one can refer that, in Portugal, Acoustic Regulations deal with at least the following different fields:

- Health: noise power limitations to equipments in several areas of work;
- Building acoustics: minimum performance levels for insulation in many types of buildings (Hotels, Schools, Residential Buildings, Industry, Commerce and Services);
- Urban acoustics: definition of quiet and noisy places;
- Traffic: limitations to noise produced by vehicles;
- Environment: limitation of noise levels produced by "noisy activities".

It is, therefore, a huge task to evaluate and compare the Acoustic Regulations of the 15 European Union countries in all those fields.

The purpose of this paper is to present data on some Regulations and only on the areas of Building Acoustics. The analysis is limited to dwellings and even in such a small field of analysis it was not possible to gather all the needed information.

The comparison between the different regulations is difficult to perform as the several countries use different ways of evaluating the user's demands:

– the insulation index used is not the same and can not be directly compared;
– the insulation criteria are also different (some use the maximum values of the sound index in the spaces, other use acoustical performance requirements for the partitions, walls and floors);
– the specifications used to evaluate the insulation index are not the same in all countries.

It was also very difficult to find accurate and updated information on the different regulations and therefore this paper includes poor detailed information on the various countries.

This paper has the following chapters: after this short presentation, it includes a chapter on definitions and then one that presents the insulation indexes used in the different European Union countries. Then, the paper includes four chapters that present tables of index values on some countries in what concerns respectively "Airborne Sound Insulation", "Impact Sound Insulation", "Noise from services and appliances" and "Noise insulation of external walls". Finally the paper presents some conclusions.

2. DEFINITIONS

2.1 Standard insulation indexes (D_n, D_{nA}, D_{nT})

The index D_n gives the difference (for each one-third octave band or for each octave band) between the sound pressure value in the emission room and the sound pressure value in the receiving room. It is used for "in situ" measurements.

If a standard absorption area of 10 m^2 for the receiving room is used to change the D_n index to a standard value a D_{nA} value is obtained.

If a standard reverberation time for the receiving room is used to change the D_n index measured for any room a D_{nT} value is obtained.

The D_{nA}, D_{nT} and D_n values are measured or calculated for each band of frequencies normally between 100 Hz and 5000 Hz. It is not a single-value number. It changes with frequency.

2.2 Insulation indexes (R_r, R')

The insulation index R is defined for construction elements which divide two different spaces (walls, partitions, floors). It is evaluated in laboratory and defines the insulation properties of a specific construction product.

When the index is evaluated "in situ", the R' value is used which is different from R because it considers the flanking transmissions which are insignificant in laboratory measurements.

D_n and R can be related by the following formula:

$$Dn = R + 10 \log (0.16\ V/TA) \quad \text{where} \qquad (1)$$

V – total volume of the receiving room (m^3);
T – reverberation time of the receiving room (seconds);
A – total area of the separating wall between the emission and the receiving rooms (m^2).

2.3 Standard impact sound insulation indexes (L_n, L'_n)

The value L_n is the sound pressure index measured in a room when the above floor is tapped by the standard tapping machine. This index is evaluated in laboratory.

Similarly to the index R, if the measurements are performed "in situ" the index L'_n is used.

If a standard absorption area for the receiving room is used to correct the L_n value a L_{nA} (or L'_{nA}) value is obtained. Similarly, if a standard reverberation time is used a L_{nT} (or L'_{nT}) is obtained.

In conclusion for impact sound insulation the following indexes may be used: L_n, L_{nA}, L_{nT}, L'_n, L'_{nA} or L'_{nT}.

2.4 The EN-ISO Index

The EN-ISO index is a single value number that is obtained using the rules defined in EN-ISO 717. The index results from the adjustment of the values obtained in the test to a reference curve defined in EN-ISO 717.1, EN-ISO 717.2 and ISO 717.3 (respectively for airborne sound insulation, impact sound and for facades). The EN-ISO indexes use the notation R_w, R'_w, $D_{nT,w}$, $D_{nA,w}$, $L'_{nT,w}$, $L'_{nA,\,w}$, $L_{nA,\,w}$, $L_{nT,\,w}$, $L_{n,\,w}$ and $L'_{n,\,w}$.

These symbols have the same meanings mentioned in (§ 2.2) and (§ 2.3). The letter "w" means weighted and at the same time indicates single-value number.

2.5 The dB(A) index

The dB(A) index is another single-value number. It results from the measured values by one-third octave bands or octave bands using correction values for each band. The index is calculated based on the corrected values for each band using a logarithmic sum. A single-value index is obtained.

To represent the dB(A) index the letter A is included in the index defined in (§ 2.2) and (§ 2.3).

The index D_{nAT}, D_{nAA}, R_A, R'_A, L_{nAA}, L_{nAT}, L'_{nAT} and L'_{nAA} are obtained.

It is not possible to find an easy correlation between the EN-ISO index and the dB(A) index.

2.6 Noises produced by services and appliances

To evaluate the annoyance caused by installations and equipments the dB(A) index is used to obtain single values to define each source of noise. The sound pressure values for one-third octave bands or octave bands are used.

Some regulations define maximum values for the single-value ratings measured instantaneously (Lp) and others use mean values for a representative period of time (Leq).

In the case of equipments it is not common to evaluate the difference between the sound pressure index measured "in situ" and in the laboratory.

Some regulations use indexes that consider a standard reverberation time (T) or a equivalent absorption area (A) for the room where the equipment is installed.

Nevertheless, in all cases the parameters Lp and Leq are used.

2.7 Exterior walls insulation

The majority of the countries use a ISO index measured "in situ" according to standards ISO 140.5 and ISO 717.3 ($R_{\theta,\,w}$ or $R_{tr,\,w}$). Some countries define the requirements indirectly limiting the Lp and/or Leq index values measured inside the buildings. In this cases, the $R_{\theta,\,w}$ or $R_{tr,\,w}$ are not evaluated directly but must be specified in the projects so that the building is able to respect the regulations for a certain urban area.

2.8 Sources of noise

For an airborne sound insulation of interior walls the ISO 140 standards define as a source of noise in the emission room the noise produced by one or more loudspeakers according to the different situations.

Some regulations use pink noise sources (same sound pressure levels for all octave bands).

For exterior walls some countries (France, U.K., Sweden) use specific "traffic noise sources". Others use any noise source produced by loudspeakers. Also at this level the differences between the regulations are very large and difficult to find.

3. PARAMETERS USED IN EUROPEAN UNION COUNTRIES

Table 1 presents the indexes used in 11 European Union countries. Information was obtained from references [1], [2], [3], [4], [5] and [6].

Country	Airborne Sound Insulation		Impact Sound Insulation		Equipments Noise		Exterior Walls Insulation	
Austria	R'w	dB	$L'_{nA,\,w}$	dB	Lp	dB(A)	$R_{\theta,\,w}$	dB
Belgium [(1)]	$R + D_n$ + Belgium Graphs	dB(A)	L'_{nA} + Belgium Graphs	dB(A)	Leq	dB(A)	$R'/D_n/Leq$ + Belgium Graphs	dB(A)
Denmark	R'w	dB	$L'_{nA,\,w}$	dB	Leq	dB(A)	Leq	dB(A)
Finland	R'w	dB	$L'_{n,\,w}$	dB	Lp	dB(A)	Lp	dB
France	$D_{nAT\,(pink)}$	dB(A)	L'_{nAT}	dB(A)	Leq	dB(A)	$D_{nAT\,(traffic)}$	dB(A)
Germany	R'w	dB	$L'_{nA,\,w}$	dB	Lp	dB(A)	$R_{\theta,\,w}$	dB
Greece	R'w	dB	$L'_{nA,\,w}$	dB	Lp	dB(A)	$R_{\theta,\,w}$	dB
Netherlands	R'w	dB	$L'_{nA,\,w}$	dB	Lp	dB(A)	$R_{\theta,\,w}$	dB
Portugal	R'w	dB	$L'_{nA,\,w}$	dB	-		$R_{\theta,\,w}$	dB
Spain	R_A	dB(A)	L'_{nAA}	dB(A)	-		$R_{A\,(pink)}$	dB(A)
Sweden	R'w	dB	$L'_{n,\,w}$	dB	Leq	dB(A)	Lp/Leq	dB
United Kingdom	$D_{nT,\,w}$	dB	$L'_{nT,\,w}$	dB(A)	Lp	dB(A)	$R_{tr,\,w}$	dB

(1) Information based on 1992 data

Table 1 Index used in European Union countries

4. AIRBORNE SOUND INSULATION

A large majority of the European Union countries use the EN-ISO index and "in situ" measurements (R'w) to evaluate the airborne sound insulation between interior spaces.

Sweden has in the case of residential buildings five quality classes (A, B, C, D and E) being "A" the most demanding.

Portugal defines minimum values for airborne sound insulation in several situations and has no quality classes.

The differences between the values and the spaces that are specified in the various regulations are enormous and cannot be easily presented in common tables.

In table 2 the "Airborne Sound Insulation" between dwellings minimum values for several European countries are presented.

Country	R'w	Observ.
Austria	54 – 57	
Denmark	52 – 53	
Finland	55	
France	51 – 54	D_{nAT} (pink)
Germany	53 – 54	
Netherlands	55	
Portugal	48	
Sweden	48 – 60	Classes A, B, C, D, E
United Kingdom	51 – 54	$D_{nT, w}$

(adapted from [2])

Table 2 Airborne sound insulation between dwellings
Minimum R'w (dB)

5. IMPACT SOUND INSULATION

The use of a tapping machine is consensual in all European Union countries.

The majority of the countries use the standard "in situ" index $L'_{nA,w}$ evaluated according to EN-ISO 717-2 and using different standard equivalent absorption areas for the receiving room.

Table 3 presents the impact sound insulation index between dwellings for several European Union countries.

Country	$L'_{nA, w}$	Observ.
Austria	43 – 50	
Denmark	58	
Finland	58	$L'_{n, w}$
France	61 – 65	L'_{nAT} (dB(A))
Germany	53	
Netherlands	54 – 61	
Portugal	70	
Sweden	50 – 66	$L'_{n, w}$
United Kingdom	57 – 64	$L'_{nT, w}$

(adapted from [2])

Table 3 Impact sound insulation between dwellings
Maximum $L'_{n, w}$ (dB)

6. NOISE FROM SERVICES AND APPLIANCES

Generally the European Union countries Regulations define the maximum total sound level due to services and appliances that could be measured in the different spaces of the dwelling.

In Sweden [2], values range from 20 to 30 dB(A) in bedrooms, 25 to 35 dB(A) in living rooms, 30 to 40 dB(A) in kitchens and 35 to 45 dB(A) in other spaces. These values indicate the maximum total sound level produced by all the services and appliances, which generate noise of long duration. For noise of short duration, these values could be increased by 5 dB(A).

In France [5], only ventilation units and hot water boilers are mentioned in the regulations. The measured values (L_{nAT} in the French regulation which means Lp adapted to a standard reverberation time of 0.5 seconds) must not be higher than between 30 dB(A) to 45 dB(A) in the living room and between 35 dB(A) and 50 dB(A) in the kitchen.

Portugal has no regulation demands in what concerns noises from services and appliances.

7. NOISE INSULATION OF EXTERNAL SOUNDS

In what concerns insulation from external sounds, which is related, with external facades insulation the regulations are also very different.

The Portuguese regulations define the minimum airborne sound insulation of facades when noise source is applied in the exterior part of the wall at a certain distance and at a 45º angle with the façade. The test is performed according to ISO 140.5.

The minimum values of the measured $R_{\theta, w}$ range from 25 dB to 35 dB depending on the type of building and on the classification of the neighbourhood (ranges from quiet to very noisy).

The French regulations demand between 30 to 40 dB(A) for the insulation of the facades using a D_{nAT} index and a standard French traffic noise source.

Sweden uses Lp and Leq indexes which represent the maximum instantaneous and equivalent levels measured inside the building in dB(A) due to all normal traffic outside the building. Values range between 25 to 40 dB(A) for Leq and between 40 to 50 dB(A) for Lp.

8. CONCLUSIONS

The message of this paper is the following: “Building Acoustics Regulations are a good example of the enormous differences that exist between the Regulations of the several European Union countries”.

From the analysis of the present situation many conclusions and suggestions arise naturally:

- many countries have new acoustic regulations that are more demanding and imply increasing costs for construction;
- it is very difficult to compare results and solutions between countries because the different regulations are not comparable;
- the standards EN-ISO 140 and EN-ISO 717 are the major factor of proximity between the different countries;
- in this moment, specially because of the language barriers and also due to some technical differences, each European Union country has a different approach to the Building Acoustics Regulations.
- it is consensual that the acoustical performance of Buildings in European Union countries would very largely benefit of the existence of a common European Regulation;

- therefore it seems also obvious that it would be of great interest to include in CEN TC 126 a new work group that would try to establish new consensual Building Acoustics Regulations. They should use as a basis the new CEN standards and have quality classes that could solve the different in quality demands of the several countries;
- the documents to be prepared could have a format similar to Eurocodes;
- the problem with Acoustics is that, however the existence of some CEN harmonised standards, it has not been possible to convince the difference countries to adopt new regulations exclusively based on these standards.

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