Acoustic regulations for housing and schools in Europe and South America

A pilot study in 2016

Machimbarrena, Maria; Rasmussen, Birgit

Published in:
Meetings on Acoustics. Proceedings

DOI (link to publication from Publisher):
10.1121/2.0000459

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):
Acoustic regulations for housing and schools exist in most countries in Europe, the main reasons being protection of health of citizens in their homes and optimizing learning and work conditions in schools. Comparative studies in Europe have shown a high diversity of descriptors and limit values for acoustic requirements. Considering globalization and noise as a health issue, it is important to extend attention to other parts of the world and establish dialogue and cooperation. As a pilot study, acoustic regulations in three countries in South America, namely Argentina, Brazil and Chile, have been considered. The findings indicate weaker requirements than typical in Europe, although at both continents there is a joint challenge to review regulatory requirements in those countries needing improvement of acoustic conditions in housing and schools. It is concluded that one of the first steps is to create awareness among authorities and building industry and to exchange experience about construction solutions. The paper includes examples of specific acoustic requirements on airborne and impact sound insulation, noise from traffic and from service equipment for housing and schools and in addition on reverberation time for classrooms. Thus, the paper provides a basis for discussing future cooperation on optimizing acoustic regulations.
1. INTRODUCTION

In Europe, most countries have acoustic regulations for housing. Such regulations require that all new residential buildings meet certain requirements for sound insulation and noise. In several countries, there are also acoustic regulations for educational buildings. If the rest of the world is considered, there are many countries with acoustic regulations for buildings but there are many more that still lack it. This pilot study intends to provide a first impression of the extent and level of acoustic regulations for multi-family housing and for classrooms in schools and about standards and descriptors applied, based on the present regulations in a small group of selected countries in Europe and South America.

2. CHOOSING COUNTRIES IN SOUTH AMERICA AND EUROPE

As a starting point, based on previous studies, a number of countries in Europe were selected to represent different geographical parts, different descriptors, different level of requirements and different climates. The countries selected were Austria, Belgium, Czech Republic, Denmark and Spain. Aiming at increasing the size and interest of this study, and also due to the historical and cultural relations of South American countries to Southern Europe countries, this region was chosen as part of the comparative pilot study. Besides, the situation in South America is quite unknown which increased the interest of the study.

The three sample countries in South America (Argentina, Brazil and Chile) have been selected according to two main principles: a) existence of some regulations in building acoustics; b) interest and motivation to discuss such regulations and apply ISO standards. Besides, these three selected countries represent a high percentage of the population in South America. Adding the population and surface of these three countries it comes to approximately 64 % of the population and about 68 % of the surface of South America. Several other well populated countries like Peru, Colombia and Bolivia (7.5, 11.6 and 2.4% of the population in South America respectively) do not have any legislation concerning sound insulation in buildings and could not be included in this pilot study.

Table 1 summarizes relevant data considering population, dwellings and percentage of people living in urban spaces (urban population density) since it is mainly in urban environment where noise in housing is a major problem.
Table 1: Geographical data and population distribution in selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (millions)</th>
<th>Area ($10^3$ km$^2$)</th>
<th>Population density (inhabitants/km$^2$)</th>
<th>No. of dwellings (millions)</th>
<th>Urban population (millions)</th>
<th>Urban population density (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>43</td>
<td>2780</td>
<td>16</td>
<td>14</td>
<td>39.4</td>
<td>92</td>
</tr>
<tr>
<td>Brazil</td>
<td>206</td>
<td>8515</td>
<td>25</td>
<td>44.7</td>
<td>176</td>
<td>85</td>
</tr>
<tr>
<td>Chile</td>
<td>18</td>
<td>756</td>
<td>24</td>
<td>5.5</td>
<td>15.8</td>
<td>89</td>
</tr>
<tr>
<td>Austria</td>
<td>8.5</td>
<td>84</td>
<td>104</td>
<td>4.4</td>
<td>5.6</td>
<td>66</td>
</tr>
<tr>
<td>Belgium</td>
<td>11.2</td>
<td>31</td>
<td>371</td>
<td>5.3</td>
<td>10.9</td>
<td>98</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>10.5</td>
<td>79</td>
<td>136</td>
<td>4.7</td>
<td>7.6</td>
<td>73</td>
</tr>
<tr>
<td>Denmark</td>
<td>5.6</td>
<td>43</td>
<td>133</td>
<td>2.8</td>
<td>4.9</td>
<td>88</td>
</tr>
<tr>
<td>Spain</td>
<td>46.5</td>
<td>506</td>
<td>93</td>
<td>25.2</td>
<td>36.8</td>
<td>79</td>
</tr>
</tbody>
</table>

3. PURPOSE AND TYPICAL MAIN CONTENTS OF ACOUSTIC REGULATIONS

The main purpose of implementing acoustic regulations is in general the protection of the health of the citizens whether at work, in the urban environment, in leisure spaces, in their homes or in a learning situation. The impact of noise on health has been evidenced by many researchers and recognized by WHO and other similar organizations in different publications; see e.g. [1], [2], [3].

Acoustic regulations aim at protecting citizens from noise, and for schools a secondary objective is optimization of listening conditions, thus improving learning and work conditions in educational environments.

Typical acoustic regulations include limit values for airborne and impact sound insulation, façade sound insulation and/or maximum sound levels indoors, noise limits for traffic and service equipment as well as limits for reverberation time and/or absorption area.

Previously, comparative studies of sound insulation requirements and descriptors in more than 30 countries in Europe have been carried out; see [4], [5], [6]. Most regulations refer to international ISO measurement and rating methods, which are also implemented as European standards and as national standards as well. These studies revealed a wide variety of sound insulation descriptors and requirements. Further considerations on the evolution of the international regulatory framework within building acoustics is found in [7].

Traditionally, sound insulation measurements were made according to the ISO 140 series, although over the last 6 years the series has been replaced by new standards. Some countries have updated their regulations accordingly while most countries are on the way of doing it. The final restructuring of the standards directly related to acoustic regulations is shown in Tables 2 and 3. ISO 140-2 is about precision and has been replaced by ISO 12999.

---

2. Instituto Brasileiro de Geografia e Estatística
3. Informe final Comisión Externa Revisora del CENSO 2012- Instituto Nacional de Estadística de Chile -
http://www.ine.cl/canales/chile_estadistico/familias/censos.php
4. Eurostat http://ec.europa.eu/eurostat
Table 2: Measurement standards for laboratory sound insulation measurements

<table>
<thead>
<tr>
<th>LABORATORY MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawn</td>
</tr>
<tr>
<td>Replaced by</td>
</tr>
</tbody>
</table>

Table 3: Measurement standards for field sound insulation measurements

<table>
<thead>
<tr>
<th>FIELD MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawn</td>
</tr>
<tr>
<td>Replaced by</td>
</tr>
</tbody>
</table>

Other field testing and rating standards commonly used are ISO 3382-2, ISO 10052, ISO 16032 and ISO 717. Table 4 summarizes present building acoustic regulations and sound insulation measurement methods for the selected countries.

Table 4: Acoustic regulations and sound insulation measurement methods in selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>BUILDING ACOUSTIC REGULATIONS(1)</th>
<th>MEASUREMENT METHODS(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>IRAM 4044:2015 (R) [8]</td>
<td>ISO 140 series both for lab and situ</td>
</tr>
<tr>
<td>Brazil</td>
<td>In NBR 15573 (N) [9]</td>
<td>ISO 140-4, -5, -7 (Engineering)</td>
</tr>
<tr>
<td>Chile</td>
<td>OGUC: Título 4 - Capítulo 1, Artículos 4.1.5 y 4.1.6 (N) [10], [11]</td>
<td>ISO 140 series both for lab and situ</td>
</tr>
<tr>
<td>Austria</td>
<td>[12], [13]</td>
<td>ISO 140-4, -5, -7</td>
</tr>
<tr>
<td>Belgium</td>
<td>[14], [15]</td>
<td>ISO 140-4, -5, -7</td>
</tr>
<tr>
<td>Czech Rep</td>
<td>[16]</td>
<td>ISO 140-4, -5, -7</td>
</tr>
<tr>
<td>Denmark</td>
<td>[17]</td>
<td>ISO 140-4, -5, -7</td>
</tr>
<tr>
<td>Spain</td>
<td>CTE-DB HR (N) [18]</td>
<td>ISO 140-4, -5, -7</td>
</tr>
</tbody>
</table>

(1) R = Recommended; N = Normative
(2) The field standards ISO 140-4, -5, -7 have now been replaced by the ISO 16283 series, the last part being published spring 2016, and implementation is expected in many countries soon.

4. ACOUSTIC REGULATIONS FOR HOUSING

Tables 5 and 6 summarize the sound insulation requirements found in the existing regulations in the eight selected countries. Table 5 relates to protection against neighbouring noise, whereas Table 6 is focused on other sound sources in a dwelling such as outdoor noise or service equipment, among other things. The values included in these tables are the basic limit values, not considering special cases like higher quality spaces or especially noisy spaces.

Concerning neighbour noise and airborne sound insulation, there is a significant wide spread both considering requirements and descriptors: there are four different descriptors (R’w, RA/R’A, DnT,w, DnT,A) and requirements varying from 55 to 45 dB. The frequency range is not homogeneous either, since at least in Spain the upper frequency range reaches 5000 Hz instead of 3150 Hz found in ISO 717-1. For impact sound insulation there are only two different descriptors (L’n,w, L’nT,w), but the requirements range from 48 to 80 dB. In this case these extreme requirements are set for the same impact sound insulation descriptor, L’nT,w, which allows making a direct comparison and concluding that in Brazil the impact sound insulation requirement is 32 dB weaker than in Austria. Although it is not possible to make a direct comparison of requirements when different descriptors are applied, it is nevertheless clear that
there are significant differences between countries as far as requirements are concerned. The background and details for these requirements should be investigated further.

### Table 5 – Sound insulation requirements for multi-family housing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>$R'_w \geq 50$</td>
<td>$L'_n,w \leq 53$</td>
<td>Not mandatory. Approved November 2015</td>
</tr>
<tr>
<td>Brazil</td>
<td>$D_{nT, w} \geq 45$</td>
<td>$L'_{nT, w} \leq 80$</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Chile</td>
<td>$R_A / R'_A \geq 45$</td>
<td>$L_{n,w} \leq 75$</td>
<td>Mandatory. Under revision. Proposal 2014: $R'<em>w + C \geq 50$ dB; $L'</em>{n,w} \leq 65$ dB.</td>
</tr>
<tr>
<td>Austria</td>
<td>$D_{nT,w} \geq 55$</td>
<td>$L'_{nT, w} \leq 48$</td>
<td>Stricter requirements for row housing</td>
</tr>
<tr>
<td>Belgium</td>
<td>$D_{nT,w} \geq 54$</td>
<td>$L'_{nT, w} \leq 58$</td>
<td>From &quot;non-bedrooms&quot; outside the dwelling to a bedroom ≤ 54 dB is required.</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>$R'_w \geq 53$</td>
<td>$L'_n,w \leq 55$</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>$R'_w \geq 55$</td>
<td>$L'_n,w \leq 53$</td>
<td></td>
</tr>
<tr>
<td>España (Spain)</td>
<td>$D_{nT, A*} \approx D_{nT, w} + C \geq 50$</td>
<td>$L'_{nT, w} \leq 65$</td>
<td>* $D_{nT, A}$ from 100 Hz to 5000 Hz</td>
</tr>
</tbody>
</table>

**Notes - General**

1. Overview information only. Detailed requirements and conditions are found in the building codes.
2. No generally applicable conversion between the different descriptors exists, as the relations depend on characteristics of rooms and constructions. Exact conversion can only be made in specific cases.
3. Main requirements only. Typically, there are stricter requirements towards e.g. noisy premises.

One reason for the differences observed in Table 5 could be that countries with a longer history/experience on sound insulation regulations have developed stronger requirements as well as building techniques to comply with such requirements, whereas countries “younger” in this field have less strong requirements. On the other hand, there might also be other cultural and/or climatological reasons. Examples of corresponding sound insulation requirements for other countries in Europe are found in [4], [5], [6].

As previously mentioned, Table 6 gathers other aspects related to protection against noise, not directly related to neighbour noise, but to outdoor noise, service equipment noise and reverberation time in common areas. When considering protection against outdoor noise, regulations often include requirements either for the façade sound insulation or for maximum noise levels indoors. For the selected countries, the descriptors and limit values vary considerably. For example in Argentina, the requirements are for the façade parts, independently of the type/level of noise source outdoors, in Spain the requirement is also for the façade but dependent on $L_{den}$ outdoors (defined in [19]), in Denmark the requirement is set to the $L_{den}$ indoors and in Belgium and Czech Republic the requirement is set for $L_{A, eq}$. For service equipment in most cases the regulations include a limit for stationary sources and another for maximum or peak values, but again, the wide spread of descriptors and how they shall be measured is considerable and needs further investigation. Concerning the reverberation time in common areas, among the selected countries, there are only two (Denmark and Belgium) which include a requirement for reverberation time in stairwells. These requirements intend to reduce the noise in such common areas and thus protect from noise in the spaces adjacent to them, although the two countries have chosen a different approach for the requirement: Denmark has set an upper limit for the reverberation time, whereas in Belgium the requirement is expressed as minimum sound absorption depending on the walkable areas.
### Table 6 – Other acoustic requirements for multi-family housing – Examples for typical rooms

<table>
<thead>
<tr>
<th>Country</th>
<th>Façade sound insulation or indoor level Req. [dB]</th>
<th>Service equipment noise Req. [dB]</th>
<th>Reverberation time in stairwells Req. [s]</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>$D_{2m,n,T,w} \geq 53^*$</td>
<td>Recommendations on mounting</td>
<td>None</td>
<td>* For &quot;blind&quot; walls ** For glass areas (max 20% of façade)</td>
</tr>
<tr>
<td>Brazil</td>
<td>$D_{2m,n,T,w} \geq 20-30^*$</td>
<td>$L_{Aeq, N_T} \leq 37^*$</td>
<td>None</td>
<td>* Depending on surrounding noise **Recommendations for water supply devices, not mandatory</td>
</tr>
<tr>
<td>Chile</td>
<td>$D_{nT,w} + C_{tr} \geq X^*$</td>
<td>$L_{A,max} &lt; 40$ inside dwelling</td>
<td>None</td>
<td>Proposal 2014 (not yet approved) * X depending on outdoor noise For $Leq (h) &lt; 60$ $dB(A) \Rightarrow X= 20$</td>
</tr>
<tr>
<td>Austria</td>
<td>$R'_{res,w} \geq X^*$</td>
<td>Stationary sources: $L_{ANmax,nT} \leq 25$</td>
<td>None</td>
<td>* X depends on outdoor level For $61 &lt; L_d &lt; 65$ and $51 &lt; L_n &lt; 55$ $dB \Rightarrow X= 43$</td>
</tr>
<tr>
<td>Belgium</td>
<td>Goal indoor level during peak hours: $L_{Aeq} \leq 34$ $dB$ Always: $D_{2a,fr} \geq 26$</td>
<td>Stationary sources: $L_{ANmax,nT} \leq 30$</td>
<td>$A_w \geq 0.3 \times S_H^{**}$</td>
<td>27 for bedrooms and 35 for kitchen, bathrooms and toilets ** $S_H$ = Surface of horizontal projection of walkable areas</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>Indoor level: $L_{Aeq} \leq 40$ (day) $L_{Aeq} \leq 30$ (night)</td>
<td>$L_{A,max} \leq 40$ (living rooms)</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>$L_{den} \leq 33$</td>
<td>$T \leq 1.3$ $s^*$</td>
<td>None</td>
<td>* 500 Hz, 1 kHz, 2 kHz</td>
</tr>
<tr>
<td>España (Spain)</td>
<td>$D_{2m,n,T,Air (100 to 5000)}^* = D_{2m,n,T,w} + C_p \geq X^*$</td>
<td>Recommendations on mounting</td>
<td>None</td>
<td>* X depending on $L_{den}$ For $L_{den} &lt; 60$ $dB (A) \Rightarrow X= 30$</td>
</tr>
</tbody>
</table>

**Notes - General**

(1) Overview information only. Detailed requirements and conditions are found in the building codes

(2) No generally applicable conversion between the different descriptors exists, as the relations depend on characteristics of the situation, e.g. rooms, constructions or sources.

The differences found in acoustic regulations for housing both within the same continent and between continents point at the need for creating common discussion forums which in turn will support the optimal development and update of building acoustics regulations according to the specificity and needs in each country, but aiming at harmonizing the “language” used in this field. The effect of cultural and climatological aspects on building sound insulation requirements would nevertheless be part of a different study.

### 5. ACOUSTIC REGULATIONS FOR SCHOOLS

In educational buildings, it is of high importance that the hearing/listening conditions are optimized to facilitate the learning process. Since the most common room type in schools is ordinary classrooms, the examples of acoustic regulations are for such rooms.

For the same selected countries as before, airborne and impact sound insulation requirements for classrooms are summarized in Table 7. All countries, except Brazil and Chile, have included in regulations airborne and impact sound insulation requirements for classrooms and the situation of finding different descriptors and requirements is similar to the one described in Section 4 for housing. Looking at the data in Table 7, there are three countries (Argentina, Czech Republic and Denmark) which have chosen similar airborne sound insulation descriptor and requirement: $R'_w \geq 47/48$ $dB$ for walls. On the other hand, if $D_{2nT,w} + C_p$ is considered, there are differences of about 6 $dB$ between countries. For impact sound insulation, the higher divergences are found for
example between Spain ($L'_{nT,w} \leq 65$) and Austria ($L'_{nT,w} \leq 48$), with 17 dB difference for the same type of requirement.

The differences found concerning airborne and impact sound insulation in classrooms indicate the need of research and discussion on the subject. It is interesting to notice that when comparing Tables 7 and 5, some regulations consider the classrooms just like a protected space in a dwelling whereas others have slightly lower requirements than for dwellings. The different approaches found in the regulations motivate the following questions: Are the sound insulation needs in a classroom the same as in a private space in a dwelling or not? Do needs for schools differ between countries? Do needs for housing differ between countries?

<table>
<thead>
<tr>
<th>Country</th>
<th>Airborne Req. [dB]</th>
<th>Impact Req. [dB]</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>$R'_w \geq 47$</td>
<td>$L'_{n,w} \leq 53$</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>$D_{nT,w} \geq 55$</td>
<td>$L'_{nT,w} \leq 48$</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>$D_{nT,w} + C \geq 44$</td>
<td>$L'_{nT,w} + C_I \leq 60$</td>
<td></td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>$R'_w$ $H: \geq 47$; $V: \geq 52$</td>
<td>$L'_{n,w} \leq 58$</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>$R'_w$ $H: \geq 48$; $V: \geq 51$</td>
<td>$L'_{n,w} \leq 58$</td>
<td></td>
</tr>
<tr>
<td>España (Spain)</td>
<td>$D_{nT,A}^* \approx D_{nT,w} + C \geq 50$</td>
<td>$L'_{nT,w} \leq 65$</td>
<td>$D_{nT,A}$ from 100 to 5000 Hz</td>
</tr>
</tbody>
</table>

Notes - General

(1) Overview information only. Detailed requirements and conditions are found in the building codes.

(2) No generally applicable conversion between the different descriptors exists, as the relations depend on characteristics of rooms and constructions. Exact conversion can only be made in specific cases.

(3) Typically stricter requirements apply in case of rooms for music, singing, woodwork.

As for housing, there are other acoustic requirements to be considered, when protecting students from noise: façade sound insulation, service equipment and reverberation time in the classroom. The reverberation time is of high importance since it has been shown that there is a strong correlation between the reverberation time and speech intelligibility in a classroom. - Table 8 summarizes these requirements for the selected countries. Concerning protection against outdoor noise, the requirements for classrooms are similar to those for dwellings (cf. Tables 6 and 8). Concerning reverberation time and service equipment noise, the selected countries in Europe have a requirement for classrooms, except equipment noise in Spain. In South America, only Chile has a requirement for equipment noise, and Brazil has a recommendation for reverberation time.
### Table 8 – Other acoustic requirements for schools than sound insulation – Examples for classrooms

<table>
<thead>
<tr>
<th>Country</th>
<th>Façade sound insulation or indoor level Req. [dB]</th>
<th>Service equipment noise Req. [dB]</th>
<th>Reverberation time (furnished, unoccupied)</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Argentina     | $D_{2m,n,T,w} \geq 53^*$                         | None                             | None                                        | * For “blind” walls  
** For glass (max 20% of façade) |
| Brazil        | None                                             | None                             | 0.6 s*                                      | * FDE recommendations. Not normative. |
| Chile         | $D_{nT,w} + C_T \geq X^*$                        | $L_{A,\text{max}} \leq 40$ inside classroom | None                                        | * X depending on outdoor noise $L_{\text{eq}}(h)$ and type of building |
| Austria       | $R_{\text{res},w} \geq X^*$                     | Stationary sources:  
$L_{\text{AF,max,nT}} \leq 25$  
Short-term: $L_{\text{AF,max,nT}} \leq 30$  
$T_{\text{max}} = 0.32 \log V - 0.17$ for occupied rooms **  
e.g. for $V = 150 \text{ m}^3$: $T \leq 0.5$ s  
* X depends on outdoor level  
For $61 < L_d < 65$ and $51 < L_n < 55$ dB $\Rightarrow X=43$  
** $T_{\text{max}}$ depends on room volume |
| Belgium       | Depends on outdoor level. Always: $D_{nA,T} \geq 26$ | Stationary sources:  
$L_{\text{AEq,nT,stat}} \leq 35$  
Example $V = 150 \text{ m}^3$: $T \leq 0.8$ s* (unfurnished and unoccupied room)  
* $T_{\text{max}}$ depends on room volume  
Avg. of 500, 1000, 2000 Hz. If the classroom is furnished, the limit is 10 % lower. – For use of absorption area instead of $T$, see the standard. |
| Czech Rep.    | $L_{A,\text{eq}} \leq 45$                       | $L_{A,\text{max}} \leq 45$      | $T = 0.7$ s*  
(125 Hz - 4 kHz) | * Target value. For 250-2000 Hz, lower/upper limits are 80/120 %. |
| Denmark       | $L_{\text{den}} \leq 33$                        | $L_{A,\text{eq}} \leq 30$       | $T \leq 0.6$ s*  
$125 - 4000$ Hz | * 125 - 4000 Hz |
| España (Spain)| $D_{2m,n,T,Ar} \approx D_{2m,n,T,w} + C_{P} \geq X^*$ | None                             | $T \leq 0.5$ s furnished  
$T \leq 0.7$ s unfurnished | * X depending on $L_{\text{den}}$  
$D_{2m,n,T,Ar}$ from 100 to 5000 Hz |

### Notes - General

1. Overview information only. Detailed requirements and conditions are found in the building codes.
2. No generally applicable conversion between the different descriptors exists, as the relations depend on characteristics of the situation, e.g. rooms, constructions or sources.

### 6. CONCLUSIONS

Based on the research done within this pilot study, it has been found that there are significant differences concerning acoustic regulations between Europe and South America and even within each of these regions.

On one hand it is important to point out that in South America, there are still many countries not having acoustic regulations. On the other hand, the existing regulations, both in Europe and South America, are not easily comparable since they are quite inhomogeneous in contents. Some countries in South America have regulations for dwellings only; others include schools. In general, different descriptors and requirement levels are found. On top of the aforementioned differences, there are other discrepancies not included in this paper, e.g. in procedures verifying compliance with the requirements.

Concerning dwellings, apart from the previously mentioned different descriptors and different levels of requirements, it has been observed that some countries include regulations for service equipment and reverberation time in stairwells, while others don’t. In general, the requirements are lower in Southern Europe (cf. also [6]) and South America than in Central and Northern Europe. The reasons for these differences are beyond the scope of this paper, but could partially be related to cultural, historical and even geographical and climatic aspects.

When it comes to acoustic regulations in schools, the most important finding is that not all existing regulations include requirements for schools and, when they do, the inhomogeneity is
very significant. None of the countries in South America have a requirement for reverberation
time in classrooms, although very important for speech intelligibility and the learning process,
especially for children. However, Brazil has a recommendation, which is a step in the right
direction.

Having observed the existing differences between acoustic regulations in the selected
countries and between Europe and South America in general, it is important to react and promote
discussion at both ends. The future challenges both in Europe and South America are similar:
aiming at harmonizing sound insulation descriptors, aiming at reviewing and improving acoustic
performance of buildings, aiming at developing basic acoustic regulations, where needed, and
finally, aiming at enforcing the compliance with the regulations. Considering this set of
challenges, an ultimate step would be creating awareness among authorities and building
industry and developing a common acoustic classification scheme for dwellings and other
buildings that could be used not only for new-build, but also to quantify acoustic performance of
existing and retrofitted buildings.

This is especially interesting now, when still many countries both in Europe and South
America are in the process of developing or updating their respective acoustic regulations. It is
not often that collaboration between experts at an early stage is possible. The findings of the pilot
study should be looked upon as an incentive for discussing and understanding acoustic
regulations and for initiating collaboration about reviewing, revising and harmonizing
requirements, aiming at in the long run to improve acoustic quality of new and retrofitted buildings.

ACKNOWLEDGMENTS

The authors would like to thank all the acoustic colleagues who have assisted collecting
updated information concerning building acoustics regulations in their country. Without their
collaboration this study would not be possible. For all countries, comments, corrections and
updated information will be highly appreciated.

REFERENCES

health/noise/publications/2009/night-noise-guidelines-for-europe]
Europe. [www.euro.who.int/data/assets/pdf_file/0010/157969/e96194.pdf]
[6] Rasmussen, B., Machimbarrena, M., Existing sound insulation performance requirements and classification
schemes for housing across Europe, Ch. 2 in COST Action TU0901 – Building acoustics throughout Europe.
Volume 1: Towards a common framework in building acoustics throughout Europe. DiScript Preimpresion, S. L.,
2014. p. 31-54.
acústica de la edificación (Evolution of the international regulatory framework in building acoustics). I.J. P.
Arenas (red.), FIA2014 IX Congreso Iberoamericano de Acústica, Valdivia, Chile 1-3, Diciembre: Actas del
Congreso. (s. 51-70). [1705] Valdivia: Instituto de Acústica, Universidad Austral de Chile.


Note: Refers in general to other documents with specific limit values.
Note: All current and previous building regulations are found at http://bygningsreglementet.dk.
