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New Finnish building acoustic regulation

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ABSTRACT

New building acoustic regulation and related guidelines took effect in Finland recently. The statutes include provisions concerning sound insulation, noise and vibration abatement and acoustic conditions necessary for the construction of a new building, repair and alteration of a building and the changing of the intended use of a building. The essential technical characteristics enacted concern health and wellbeing in the manner required by the intended use of the building. The purpose of the guidelines is to clarify and facilitate compliance with the requirements as the statute directs. The guidelines provide instructions on the procedures for design and verification. The statutes apply to buildings with dwellings or accommodation or patient rooms, facilities for teaching, meeting, eating, treatment, recreation or physical exercise, or office spaces.

Keywords: sound insulation, noise control, room acoustics

1. INTRODUCTION

In Finland, guidelines and recommendations for acoustics of different buildings has existed since the year 1955. The first guidelines revised in 1960 and 1967 were not official, even though building inspectors usually required them to be followed. Regulation came into effect when The National Building Code of Finland was first published in 1975. One part of the Building Code concerned acoustics of buildings. This part was the revised in 1985 and 1998 (1).

New building acoustic regulation and related guidelines took effect in Finland recently. In the end of the year 2017, the regulation was revised as the Decree of the Ministry of the Environment on the Acoustic Environment of Buildings was given (2). The decree came into force in the beginning of the year 2018. The purpose of this paper is to describe the main revisions of the new regulation.

The revision of the regulation was preceded by extensive scientific research and evaluation of the cost and other effects of suggested changes in the regulation (3–4). The scientific studies were carried out as a research project “User-oriented development of sound insulation in buildings ÄKK” (2012–2014). The project was funded by Tekes – the Funding Agency for Technology and Innovation, Ministry of Environment and eight companies of building industry. This paper also describes the scientific background for the revisions as well as the evaluation of the effects of the revised regulation.

2. PURVIEW OF THE REGULATION

The structure of the Finnish regulation is shown in Figure 1. There are three levels: first level is formed by the decree which is mandatory. The revised decree includes (2) provisions concerning sound insulation, noise and vibration abatement and acoustic conditions necessary for the construction of a new building, repair and alteration of a building and the changing of the intended use of a building. The essential technical characteristics enacted concern health and wellbeing in the manner required by the intended use of the building. The statutes apply to buildings with dwellings or accommodation or patient rooms, facilities for teaching, meeting, eating, treatment, recreation or physical exercise, or office spaces.

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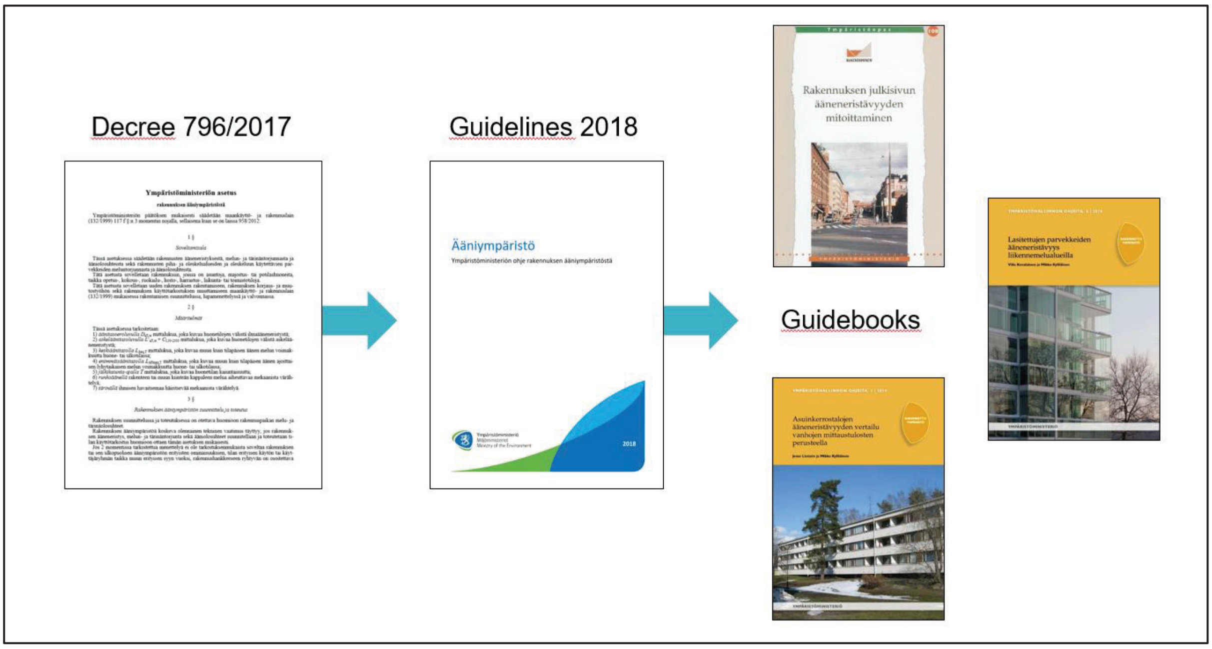

Figure 1 – Levels of the Finnish regulation.

The second level is the guidelines (5) concerning the decree. The purpose of the guidelines (3) is to clarify and facilitate compliance with the requirements as the statute directs. The guidelines provide instructions on the procedures for design and verification. The guidelines are not mandatory. However, they describe the good way of building. The decree nevertheless defines that there is a possibility to design and construct using structures and methods not prescribed in the decree or in the guidelines, if the building still fulfills the essential technical requirements defined in the Land Use and Building Act from the year 2000 (6).

The third level is formed by different guidebooks which give either design methods for different engineering problems or guidance for acoustical engineering of certain building types. For example, one of the guidelines concerns interpretation of single-number quantities for sound insulation defined in the earlier regulation as well as repair and alteration of a building and the changing of the intended use of a building (7).

3. MAIN REVISIONS AND THEIR BACKGROUND

3.1 Standardized single-number quantities for rating the sound insulation

In Finland, the single-number quantity for rating the airborne sound insulation has been the weighted apparent sound reduction index R'_{w} since the year 1967. The impact sound insulation has been rated by the weighted normalized impact sound pressure level $L'_{n,w}$. Earlier, the single-number quantities standardized to a reference reverberation time of 0,5 s were used. The revision of the regulation has returned the standardized values. Table 1 shows the requirements for the sound insulation of a new building given in the decree (2). The guidelines (5) give also requirements for schools, office buildings, hospitals etc.

Table 1 – Requirements for the sound insulation of a new building (2).

Room	Permitted $D_{nT,w}$	Permitted $L'_{nT,w} + C_{I,50\text{-}2500}$
Between dwellings or accommodation or patient rooms	≥ 55 dB	≤ 53 dB
From the exit route to a residential, accommodation or patient room	≥ 39 dB	≤ 63 dB

The change of definition of the single-number quantities is justified on the bases of the references (8) and (9). In the reference (8), a study on the agreement between the transmission of living sounds from a neighboring dwelling expressed as the A-weighted equivalent sound level $L_{A,eq}$ and different single-number quantities like R'_{w} and $D_{nT,w}$ is described. Measurement results of airborne sound insulation was collected from 100 field measurements. Six sound types were studied: guitar playing, two kinds of music, baby cry, loud speech and dog bark. In all cases, the single-number quantity $D_{nT,w}$ resulted in a better correlation with the transmitted sound than R'_{w}. Figure 2 describes the situation when the transmitted sound is loud speech. Similar results concerning the rating of impact sound insulation have been reported in the reference (9).

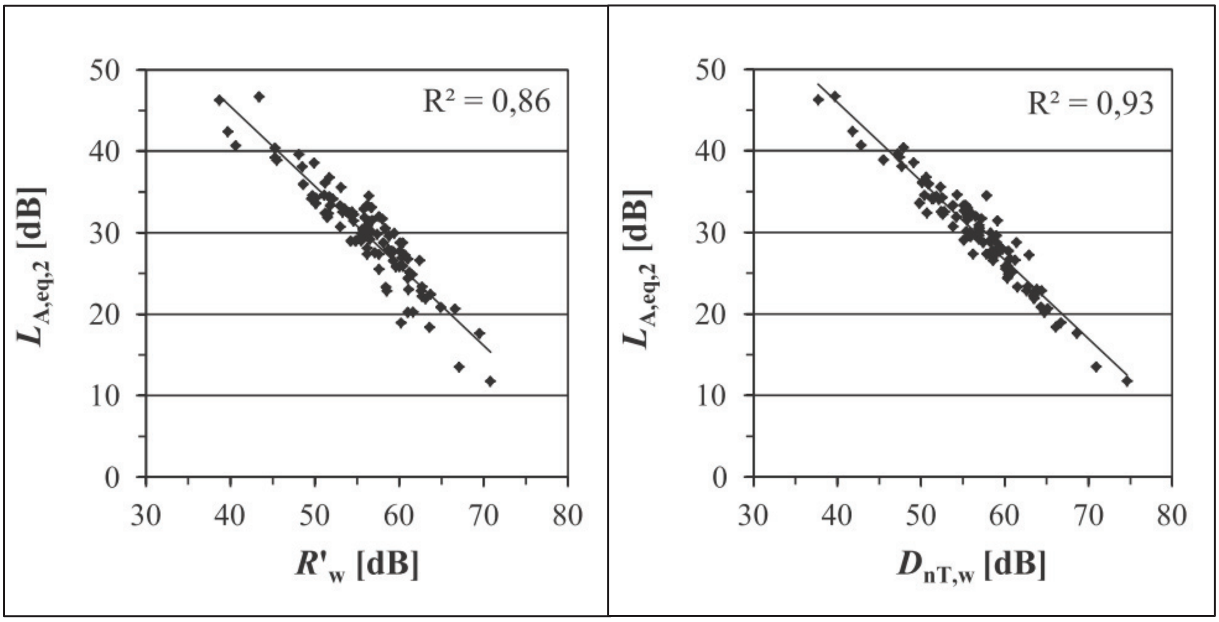

Figure 2 – Sound levels $L_{A,eq}$ of transmitted loud speech in receiving room as function of the R'_{w} (left) and $D_{nT,w}$.

In the referred study (8), it was also shown that the reverberation times of Finnish furnished rooms are typically 0,5 s which agrees with the reference absorption area used in the definition of the single-number quantities $D_{nT,w}$ and $L'_{nT,w}$. The absorption areas of the Finnish rooms do not correspond to the reference absorption area of 10 m^2. This indicates that the revision concerning the single-number quantities defined in the regulation has been justified.

3.2 Rating the impact sound insulation

The measured frequency range for rating airborne and impact sound insulation has been 100–3150 Hz in the Finnish regulation earlier. The airborne sound insulation is also in the revised regulation defined to be measured at this frequency range. This is because the measurement uncertainty is considered to become too large in the widened frequency range reaching to 50 Hz (10). In the Finnish research prescribed in the introduction, no significant benefit was not found in rating of airborne sound insulation if the rated frequency range was enlarged down to 50 Hz (11).

In rating the impact sound insulation, the revised regulation enlarges the measured frequency range down to 50 Hz as was already shown on chapter 3.1. In the reference (12), it was found that enlarging the frequency range slightly improves the correlation between the subjective rating and the single-number quantity. In the case of impact sound insulation, the measurement uncertainty does not raise unacceptably large (13). However, it can be stated that present single-number quantities for rating the impact sound insulation are not the possible as the correlation between them and the subjective rating by the people is relatively low. There are also possibilities to find new better rating methods (14).

An interesting question is the effect of the revision on the structural types of the floors. In the reference (3), a study on a sample of 214 field measurement results on impact sound insulation was carried out. From the measurement results, both the weighted normalized impact sound pressure level

$L'_{n,w}$ and weighted standardized impact sound pressure level $L'_{nT,w} + C_{I,50\text{-}2500}$ were calculated. The calculated values were compared to the largest permitted value given in the previous and present regulation. The result was that 7 % of the results fulfilling the requirements of the previous regulation would not fulfill the revised requirements. This amount can be considered small, but the 7 % of the measurement results are from such situations where people have expressed their unsatisfaction towards the impact sound insulation. The results have been shown in Table 2.

Table 2 – Amount of measurement results fulfilling the previous requirement but not fulfilling the present requirements (3).

Material of the bearing structure	Amount	Proportion (%)
Concrete	13	6,7 %
Lightweight	1	7,7 %
Other	1	11,1 %
In total	15	7,0 %

3.3 Room acoustics

The requirements for room acoustics for different roomtypes and spaces are given in the guidelines (5). Examples of the room acoustical requirements are shown in Table 3. In addition to the traditional reverberation time, the requirement has been given also as speech transmission index STI for some of the room and space types. This is done in order to ensure the acoustic quality for the rooms. For example, the reverberation time is not a sufficient measure for rating the room acoustics in an open-plan office.

Table 3 – Examples of requirements for room acoustics (2).

Room	Reverberation time T	Speech transmission index STI
Classroom or meeting room	0,5–0,7 s	≥ 0,7
Canteen, sports hall (≤1500 m^3)	≤ 1,2 s	≥ 0,6
Patient room	≤ 0,8 s	≥ 0,6
Open-plan office	≤ 0,6 s	≤ 0,5
Office room	≤ 0,8 s	–
Day care centre	≤ 0,6 s	–
Exit route to a residential building	≤ 1,3 s	–

Concerning room acoustics, cost effects were studied. These calculations concerned both building costs and costs which usually are not considered at all, i.e. costs for the user of the space depending on insufficient acoustic conditions (4). An example of this is classroom where poor acoustic may cause problems in voice formation of the teachers, which often results in a long rehabilitation period and sick leave. Another example is open-plan office studied in the reference (4).

In an open-plan office, the loss of working time is known to be connected with speech transmission index STI as speech is considered a source of disturbance (15). In the study reported in the reference (4), an open-plan office with 170 workstations was studied in two cases; when it was planned to be acoustically functional and when it was planned to meet only the minimum requirements. For both cases the building costs resulting from the acoustic design were determined as well as the costs resulting from the loss of working time. Assuming there was constantly at least one speaker somewhere in the space, STI value and a model presented in the reference (15) was used to calculate the resulted costs. To determine the loss of working time it was assumed that 90 % of office work time is work that can be charged and price of one hour of work is 60 €/h (VAT 0 %). Figure 3 shows the cumulative costs of both versions of the open-plan office during a period of five years. On the bases of the results it was obviously justified and profitable to set room acoustical criteria for open-plan offices in the revised regulation.

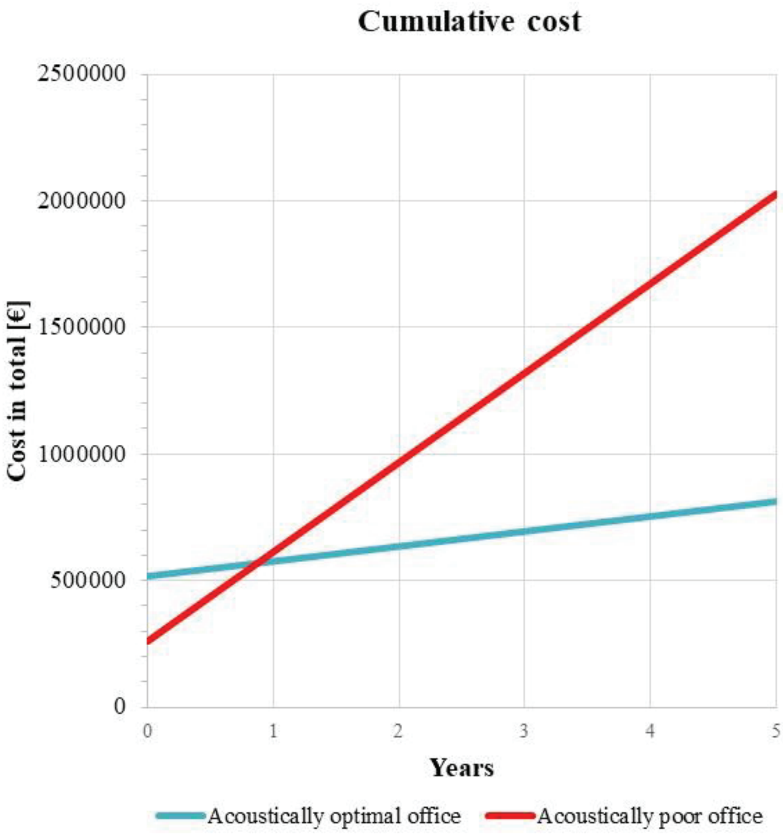

Figure 3 – Sound levels $L_{A,eq}$ of loud speech in receiving room as function of the R'_w (left) and $D_{nT,w}$.

4. CONCLUSIONS

This paper presents the main revisions of the new Finnish regulation on acoustical environment of buildings as well as the scientific background of the regulation. The Finnish regulation is based on a thorough national research project and utilizing the international scientific literature. The requirements given in the regulation are scientifically justified. The cost effects of the regulations have also been studied beforehand which also supported the revisions made by the Ministry of the Environment.

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