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Preparation of criteria suitable for universal design in Norwegian sound quality classification standard NS 8175

Iiris Turunen-Rindel
Standards Norway, P.O. Box 242, 1326 Oslo, Norway, itr@standard.no

Norwegian standard for sound classification of buildings, NS 8175 [1], is closely connected to technical regulations for buildings. Latest edition was published in 2008. The standard contains noise and sound insulation criteria for indoor conditions in buildings, and for outdoor noise nearby buildings and at outdoor areas around the building. There are four sound quality classes. Present focus in technical regulations and laws in Norway is on universal design and accessibility for all in public and work buildings. The suitability of the present limit values and relevant types of criteria for hearing and visual disabled people are reconsidered in NS 8175. The classification today concerns dwellings, hospitals, schools, kindergartens, offices, work places and similar. Updates have been made for open plan teaching environments and open plan offices. Other types of buildings that do not have specified criteria in the present standard, e.g. cultural buildings, museums, lobbies, assembly halls etc., are evaluated concerning accessibility to all. A questionnaire study is planned in order to survey these other types of buildings, spaces and rooms that are problematic for hearing and visual disabled. Types of problems in these spaces are to be registered and used for evaluation the criteria that are relevant to give in NS 8175.

1 Introduction

Present focus in technical regulations [2] and revised acts in Norway [3, 4] is on universal design and accessibility for all in public and work buildings so that the buildings are accessible for all. The limit values for acoustic classification are examined for suitability for universal design. Acoustics is one of the main criteria [5] to be considered for sound perception, orientation in the room and for communication, in addition to access criteria (e.g. by wheelchair) and illumination. The political interest in making changes is high. Qualified literature and experience from practise are being studied. Acoustic conditions adapted to various types of disabilities are regarded advantageous for all inhabitants.

The present acoustic classification in NS 8175 [1] concerns dwellings, hospitals, schools and premises for education, kindergartens, offices, noisy work places and similar. In accordance with the new laws, some types of buildings that do not have specified acoustic criteria today, e.g. cultural buildings, museums, court rooms, lobbies, assembly halls, political premises, restaurants, cafes etc., shall be accessible to all. Most architectural designers of schools and offices in Norway focus on open plan teaching environments and offices. These have been especially criticized for unsuitability for many users, especially disabled people, and for various applications.

For outdoor conditions, the national guidelines, T-1442 [6], for handling of noise in land-use planning, is also under revision due to the changes in accordance with revised Planning and Building Act [4]. The accessibility in the physical surroundings and interests of people with disabilities are to be safeguarded and promoted. This Act defines the requirements regarding the usability of buildings. The specific requirements pertaining to access to buildings are defined in the regulations concerning requirements for construction works and products for construction works [2]. Standards considering various physical outdoor conditions for disabled people, including acoustics, are published [7, 8].

2 New references for regulations

Until now, the basis for acoustic criteria in technical regulations and classification has been the degree of satisfaction of about 80 % of the normal hearing population, e.g. as in acoustic quality class C in NS 8175 (see Chapter 3.1). Since the new regulations shall in principle be valid for all users of buildings, the frame of reference has to be redefined. Limits in preparation for illumination are under development and are based on the ability of an 80 year old person having normal vision, degree of perception of light and information. A comparable model has also been established for accessibility for wheelchair users. This is a new way of thinking and preparing limits in relation to the technical regulations in Norway.

As much as about 90 % of people above 80 years age may be defined as hearing disabled. Acoustic conditions are considered to be the most important factor for functioning of visual and hearing disabled people in dwellings [5]. A model that could be utilized in selecting acoustic criteria, has been discussed for acoustic criteria suitable for visual and hearing disabled people. The perception of speech varies a lot between children of different ages, immigrants not using their mother tongue, elderly people with age-reduced hearing abilities etc. Establishing some common reference or basis has been found difficult in this revision work. In so far, other means of evaluation have been considered as more relevant. Such an acoustic reference needs more research which is not possible within the time frame of this work. A literature review is in preparation at the time of writing. Also, a questionnaire study on how different building types and rooms or areas are functioning for hearing and visual disabled (orientation, communication, speech intelligibility etc.), is in preparation.

3 Acoustic classification

3.1 Classification systems

Various Nordic and European classification systems have been compared and studied by B. Rasmussen [9]. Nine European countries have acoustic classification for dwellings. Three more countries are preparing acoustic classifications of dwellings. Some countries, like Norway and Sweden, have acoustic classification for other types of buildings, too. The Nordic classification standards have many similarities and some minor differences. The differences are mainly based on national building tradition, number of classes, level difference between the limit values and types of noise quantities used.

The Norwegian classification system is based on four sound quality classes (A, B, C and D), originally decided in Nordic INSTA committee [10]. Class C is based on former national building regulations and is closely connected to these [2]. The tight connection between the classification standard and the national legislation means that the acoustic classification may not be considered independently from the regulation needs. The Norwegian limits are given as weighted sound reduction index for airborne sound insulation (R'_w or $R'_{w + C50\text{-}5000}$), weighted normalised impact sound pressure level for impact sound insulation ($L'_{n,w}$ or $L'_{n,w} + C_{I,50\text{-}2500}$), reverberation time T (or acoustic absorption) and weighted time-averaged or maximum sound pressure levels.

The changes planned due to universal design are primarily applied for room acoustics and noise levels from service equipment. As an example, the present limits for reverberation time in buildings used for teaching are shown in Table 1. The reverberation values in Table 1 are now reconsidered and may be changed in classes B and C to 0,4 s for classrooms, conference rooms etc. and to 0,6 s for corridors and staircases etc.. For larger rooms additional requirements related to the height of the room are discussed. For open plan spaces, additional limits given as STI or other relevant measures are in consideration. Studies show that for hearing disabled people, reverberation times around 0,3 s to 0,4 s are more suitable [5, 11]. Similar changes are planned for other types of buildings.

Reverberation time alone is considered not to be a sufficiently descriptive factor. Noise conditions are to be evaluated, especially in schools and in other work premises. Acoustic regulation of such spaces is necessary in order to achieve satisfactory acoustic conditions for all users. In the present standard, e.g. for large classrooms, auditoria and open plan teaching environments, special acoustic regulation is required in order to achieve sufficient speech intelligibility or other desired characteristics, without giving specific limits.

Table 1: Sound quality classes for teaching spaces. Upper limit values for reverberation time T

Type of space	Class A T (s)	Class B T (s)	Class C T (s)	Class D T (s)s
In classrooms[1], conference rooms	0,6	0,6	0,8	0,9
In woodwork rooms and other rooms where noisy activities are performed	0,4	0,5	0,6	0,8
In classrooms for people with visual and hearing impairments	0,3	0,5	0,6	0,6
In common areas and corridors	0,8	0,8	0,9	1,3
In stairwells	0,8	1,0	1,3	1,3
In large classrooms / auditoria and other teaching and staff rooms (see Note 3)	Set individually	Set individually	Set individually	Set individually
In open plan teaching environments[2]	0,3	0,3	0,4	0,5
Gymnasiums[3] with volume $V < 3000$ m^3	1,0	1,2	1,5	2,0
Indoor swimming pools[4] with volume $V < 2000$ m^3	1,5	1,8	2,0	2,5

[1] Slightly longer reverberation time may be appropriate in classrooms for singing and music.

[2] The acoustic conditions in open plan teaching environments for people with visual and hearing impairments should meet internationally recommended guidelines [11].

[3] For gymnasiums and other sports halls that are larger than the given volume, and that are used for teaching, can the reverberation time increase by 0,05 s per 1000 m^3 up to $T = 2,5$ s that is the upper limit.

[4] For swimming pools that are larger than the given volume, and that are used for teaching, can the reverberation time increase by 0,05 s per 1000 m^3.

3.2 Room acoustics and sound transmission devices

The draft regulations [2] have new requirements of satisfactory room acoustic conditions and use of sound transmission devices, whenever relevant. The present acoustic quantities that are used in the Norwegian classification are based on the common standards for airborne and impact sound insulation (see Chapter 3.1), i.e. EN ISO 140-series for sound reduction index and impact sound pressure level [12], EN ISO 16032 for noise levels [13], EN ISO 3382 for reverberation time [14, 15] etc. The limits for noise levels are reconsidered together with those of reverberation time. Application of the additional acoustic measures to be discussed, are e.g. limits for reverberation time in combination with room height or volume, speech transmission index (STI) [17], distraction distance (r_D) [15, 16], spatial decay rate of speech or A-weighted SPL of speech at a distance of 4 m, or other quantities [14, 15].

Sound transmission devices may be necessary for improving acoustic conditions of some spaces or buildings for the visual and hearing disabled people, children, etc., e.g. using induction loops or wireless sound transmission devices in addition to the acoustic measures. In some cases, more specific measures have to be taken.

Types of rooms or spaces in buildings that need improvement of acoustic conditions, are to be studied by a questionnaire survey. Preliminary consideration of relevant spaces has been made. Such spaces may be reception areas, waiting rooms and spaces, restrooms, cafeterias, common corridors, entrances, staircases, etc. Studies of sound conditions for kindergartens and open plan schools [18] imply that additional acoustic measures have to be applied.

The common basis for classification will also be studied in detail in a COST Action on Integrating and harmonizing sound insulation aspects in sustainable urban housing constructions (TU0901) [19]. At the moment, the changes in the Norwegian standard are planned to comply with the needs for visual and hearing disabled people.

4 Summary

Acoustic classification is to be applied for all inhabitants, not only for the majority of normal hearing population as it has been until now. Criteria for acoustic quality of buildings and classification limits for accessibility to all, are to be defined. Basic references covering the majority of the population are discussed for setting limits.

Present overall legal requirements on acoustic quality suitable for all users may lead to other measures than those applied traditionally in Nordic regulations. Such measures may be given as speech transmission index (STI), more strict requirements for reverberation time and noise levels, or by means other relevant measures e.g. for open plan spaces.

The renewal of existing building traditions and way of thinking is expected to lead to more satisfactory acoustic quality for all users. The common basis for classification will also be closely studied in the COST Action on Integrating and harmonizing sound insulation aspects in sustainable urban housing constructions (TU0901) [19].

References

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