

Guidelines on acoustic treatments for school buildings proposed by the Architectural Institute of Japan

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Abstract

In order to realize effective educational activities in school buildings, acoustic conditions for verbal communication and calm atmosphere are essentially important. The Architectural Institute of Japan set up a working group to investigate acoustical criteria for schoolrooms and to publish a new guideline to improve the acoustic conditions in school buildings. In this paper, the activities being made in the working group and the outline of the new criteria are introduced.

1. Introduction

In Japan, the “side-corridor type” arrangement of schoolrooms is most popular as the stereotype design for a long time. Since the 1970s, however, educational policy has gradually changed and new architectural ideas to realize the new educational policies are being adopted. As an example, “open-type” classroom, which is clearly disadvantageous from acoustical viewpoint, is becoming popular for elementary schools [1]. Besides, the way of school building design is now diversifying and various acoustic problems such that the spaces with different functions are connected and large rooms have excessive reverberation are often seen.

At present, the Architectural Institute of Japan (AIJ) shows the guideline for acoustical properties of schoolrooms regarding sound insulation and ambient noise level [2]. However, the importance of acoustical quality in school buildings has not been fully recognized in architectural design. Besides, there is a movement in the AIJ to reconsider the existing guidelines of various building performance to suit the recent situation.

From these background conditions, a working group for the preparation of new acoustical guidelines for school buildings has been set up in the AIJ in April 2003 and the new criteria are being discussed. In this paper, these activities and present draft of the guidelines are introduced.

2. Scheme of the guidelines

The work to draft the new acoustic guidelines is being made by referring the existing criteria [2] and those in

foreign countries [3]. The main points are ambient noise level in schoolrooms, sound insulation between rooms and reverberation in rooms. The draft of the requirements for these points is as follows. The values set for each requirement are recommendations as the desirable acoustic conditions for school. They will be discussed furthermore as the acoustic guideline for construction and renovation of school buildings and the final version will be published in March 2005 as an AIJ Environmental Standard.

2.1. Ambient noise level in schoolrooms

By considering the condition that the school activities are not disturbed, the criteria of the ambient noise level in classrooms are set as shown in Table 1. The criterion value depends on the type and purpose of the rooms. The noise levels shown in the table are the values measured under the condition that the room is unoccupied, the doors/windows are closed and HVAC system is working. According to these criteria, the sound insulation of building facade has to be designed properly by considering the environmental noise condition and noises generated by such building equipment as HVAC system have to be controlled.

Table 1: Criteria for ambient noise level in classrooms

Room type	L_{Aeq}
R1: Rooms where quiet condition is especially required (music room, auditorium, school infirmary)	35
R2: Rooms where the quiet condition is desirable (classroom, teachers' room)	40
R3: Rooms for active works (craftwork room, gymnasium)	45

2.2. Sound insulation

In order to prevent the acoustic interference between spaces during school activities, partition walls should have sufficient sound insulation properties both for air-borne sound and floor impact sound. By considering these points, the criteria for sound insulation are tentatively decided as shown in Table 2 for air-borne sound insulation and in Table 3 for floor impact sound insulation. They are given by considering the required

ambient noise level and supposed noise level generated in each type of the rooms.

Regarding the air-borne sound insulation, the criteria are shown in two kinds of indices: one is the arithmetic mean value of the sound pressure level difference in octave bands from 125 Hz to 2k Hz, and the other is “*D*-value” (in parentheses) which has been uniquely used in Japan for a long time [4].

Regarding the floor impact sound insulation, the criteria are also shown in two kinds of indices: one is *A*-weighted sound pressure level L_A and the other is “*L*-value” (in parentheses) which has been used in Japan [5]. For the measurement of these indices, the standard light impact source (tapping machine) and the standard heavy impact source (tire) specified in JIS A 1418-1 and -2 are used and L_{Aeq} and Fast-maximum value of L_A are measured for the tapping machine method and the tire method, respectively.

Table 2: Criteria for air-borne sound insulation

Receiving room		Room type	
Source room		$R1^{*1}$	$R2^{*1}$
Room type		Ambient noise limits	
	L_{Aeq}^{*2}	35[dB]	40[dB]
Rooms mainly for speech communication (classroom etc.)	80 [dB]	45 (D-45)	40 (D-40)
Rooms for active works (gymnasium, music room, auditorium, etc.)	95 [dB]	60 (D-60)	55 (D-55)

*1: Room types defined in Table 1

*2: Supposed level generated in the source room

Table 3: Criteria for floor-impact sound insulation

Receiving room		Room type	
Source room		$R1^{*1}$	$R2^{*1}$
Room type		Ambient noise limits	
		35[dB]	40[dB]
Rooms where speech communication is mainly conducted (classroom etc.)		50 (L-50)	55 (L-55)
Rooms where the higher impact sound is generated (gymnasium, etc.)		40 (L-40)	45 (L-45)

*1: Room types defined in Table 1

2.3. Reverberation in schoolrooms

To realize high speech intelligibility and sound insulation, excess reverberation must be prevented for various kinds of spaces in school buildings. For this aim, the desirable sound absorption treatment is specified in reverberation time *RT* and in average sound absorption coefficient \bar{a} as shown in Table 3. These values are for the mean values in 2-octave bands including 500 Hz and 1k Hz frequency bands under furnished and unoccupied condition. For such special rooms as music rooms, the

frequency characteristic of reverberation time should be carefully considered. In addition, it is recommended that the reverberation in such spaces in school buildings as corridors and entrance halls should be carefully controlled to realize quiet acoustic environment.

Table 4: Recommended reverberation time

Room type	<i>RT</i>	\bar{a}
Classrooms ($V \approx 200$)	0.6	0.2
Classrooms ($V \approx 300$)	0.7	0.2
Rooms where shorter reverberation is suitable (audio visual rooms, etc.)	0.4	0.3
Rooms where longer reverberation is suitable (music practice rooms, etc.)	0.8	0.15
Large spaces (gymnasiums, etc., $V \approx 5000$)	1.5	0.2

3. Further works

In order to realize the acoustically well treated school buildings, it is very important not only to show the recommendation value but also to make architects understand the necessity of the acoustic treatment and the ways to realize the performances. It should be also noted that the criteria will be only for the most ordinal buildings whereas acoustic treatment is even more important for such cases as open-type classrooms, combined facilities, classrooms for hearing impaired children, room with high-quality electro-acoustic equipment, and so on. To instruct the solution in these cases, a guidebook for architectural design is also preparing, in which practical examples of acoustic treatment for school rooms, information of acoustic environment in school buildings, results of the questionnaire surveys for teachers and children and typical acoustical problems in schools will be included.

4. References

- [1] H. Tachibana and K. Ueno, “Study on acoustical conditions in elementary schools of open-plan type in Japan,” *Internoise 2002*, N323, 324.
- [2] Edited by Architectural Institute of Japan, *Standard of sound insulation performance and planning guide for architecture (second edition)*, 1997.
- [3] Z. Karabiber and M. Vallet, “Classroom acoustics policies – An overview”, *Euronoise Naples 2003* Paper ID: 048-OL, 2003.
- [4] JIS A 1419-1, “Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation”, 2000.
- [5] JIS A 1419-2, “Rating of sound insulation in buildings and of building elements – Part 2: Floor impact sound insulation”, 2000.