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Revision of Chinese national standard GB 50118 - Code for design of sound insulation of civil buildings

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ABSTRACT

The national standard GB 50118 *Code for design of sound insulation of civil buildings*, issued by Ministry of Housing and Urban-Rural Development (MOHURD), is the basic code for indoor acoustical quality of civil buildings in China. It stipulates the limits for indoor noise levels and sound insulation performance of building elements, and specifies the design criteria of noise control. The current version was published in 2010, in which requirements had been raised compared to previous version. However, with the rapid development in China during the last decade, current regulations could not meet the growing needs for better sound environment. Traffic noise, HVAC noise and structure-borne noise from service equipment have become increasingly annoying, and inadequate sound insulation aggravates the situation. Therefore, MOHURD commissioned China Academy of Building Research to undertake the revision of current standard in 2018. Based on the correlation between field measurement results and occupants' perception, and referring to guidelines and regulations in developed regions, we'd like to put forward stricter requirements for indoor noise and sound insulation performance of building elements. Besides, limits for structure-borne noise caused by vibrations of building service equipment or any other noise sources will be introduced to assess the dominant low-frequency noise.

Keywords: Noise, Structure-borne, Insulation

1. INTRODUCTION

The national standard GB 50118-2010 *Code for design of sound insulation of civil buildings*, issued by Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), is the basic code for indoor acoustical quality of civil buildings in China, covering dwelling, school, hospital, hotel, office and commercial building. It stipulates the limits for indoor noise levels and requirements for sound insulation performance of building elements, and specifies the design criteria of noise and vibration control.

The original adoption of GB 50118, drafted by China Academy of Building Research (CABR), was first released in 1988. Twenty-two years later, the first replacement was published, which has been valid until now. Compared to the previous edition, the subjects of office and commercial building were incorporated, and stricter requirements for indoor noise and sound insulation were imposed as well.

However, with the rapid development and urbanization in China during the last decade, the current regulations could not meet the habitants' growing needs for better and healthier sound environment. Traffic noise, HVAC noise and structure-borne noise from service equipment have become more and more pervasive and annoying, and inadequate sound insulation aggravates this situation, which leads to increasing complaints or even lawsuits. Therefore, MOHURD commissioned CABR to undertake the revision of GB 50118 in 2018.

Based on the correlation between field measurement results and occupants' perception, and referring to guidelines and regulations in developed regions, we would like to put forward stricter requirements for indoor noise levels and sound insulation performance of building elements, especially for dwelling. Besides, limits for structure-borne noise caused by vibrations of building service equipment or any other noise sources will be introduced to assess the dominant low-frequency noise.

In view of space constraints, emphasis is placed on the modified requirements related to dwelling, which is also the main work of this revision.

2. REVISED REQUIREMENTS FOR DWELLING

2.1 Indoor Noise

The limit values of indoor noise for dwellings are shown in Table 1. The basic requirements in bold are compulsory provisions and should be strictly implemented, while the higher requirements are conditional recommendation for upscale housing.

Table 1 – Indoor noise requirements for dwelling

Rooms	$L_{A,eq}$ [dB]			
	Basic requirements		Higher requirements	
	Day-time	**Night-time**	Day-time	Night-time
Bedroom	**≤45**	**≤37→≤33**	≤40	≤30
Living room	**≤45**		≤40	
Note: Day-time is from 6:00 to 22:00. Night-time is from 22:00 to 6:00.				

Here, the limit value for night-time noise inside bedroom, which is underlined within the table, is the only modification to noise requirements, tightened up from 37dB to 33dB. This limitation is mainly based on the *Guidelines for Community Noise* published by WHO in 1999. In this document, noise level inside bedroom is supposed not to exceed 30dB at night. Though $L_{A,eq}$ is adopted by both the *Guidelines* and GB 50118 as the noise indicator, the integration time T, the measured time interval, is distinctly different from each other. T is over a long term of 8 hours during the night time according to the *Guidelines*, whereas the measurement should be taken during the noisiest period and T depends on the types of noise source prescribed in GB 50118, varying from 30 seconds for steady and continuous noise, to 20 minutes or even longer for unsteady and intermittent noise. Considering the noise is measured during the "peak hours" as per GB 50118, for example the service time of shopping mall or subway, it is supposed to get higher equivalent sound pressure level due to the exclusion of quiet hours at midnight. That is why we set 33dB as the updated basic requirement for night-time noise inside bedroom.

2.2 Structure-borne Noise

In the current version of GB 50118, there is only one indicator, $L_{A,eq}$, applied to assess the indoor noise environment. However, the structure-borne noise caused by the vibrations of service equipment generally includes a large proportion of low frequency components, and $L_{A,eq}$ could not adequately characterize the presence of low-frequency noise due to the suppression while A-weighted. It is not rare that $L_{A,eq}$ meets the noise requirements but still inhabitants feel uncomfortable with the humming.

In order to make up for the lack of requirements for low-frequency noise, limit values for $L_{f,eq}$ in octave bands, centered at 31.5Hz, 63Hz, 125Hz and 250Hz, are introduced to assess the structure-borne noise, which are presented in Table 2. The basic requirements in bold are compulsory provisions and should be strictly implemented, while the higher requirements are conditional recommendation for upscale housing.

Table 2 – Structure-borne noise requirements for dwelling

Rooms	Class	Time	$L_{f,eq}$ in octave bands [dB]			
			31.5Hz	63Hz	125Hz	250Hz
Bedroom	**Basic requirements**	**Day-time**	**≤79**	**≤63**	**≤52**	**≤44**
		Night-time	**≤74**	**≤57**	**≤45**	**≤37**
	Higher requirements	Day-time	≤76	≤59	≤48	≤39
		Night-time	≤69	≤51	≤39	≤30
Living room	**Basic requirements**	**All-day**	**≤79**	**≤63**	**≤52**	**≤44**
	Higher requirements	All-day	≤76	≤59	≤48	≤39

Note: Day-time is from 6:00 to 22:00. Night-time is from 22:00 to 6:00.

The above values are determined by the following equation:

$$NR = L_{A,eq} - 10 \quad (1)$$

Here, $L_{A,eq}$ denotes the existing limit values for indoor noise, and NR is the Noise Rating values. For example, the maximum allowable $L_{A,eq}$ inside living room is 45dB, thus the associated limit values for structure-borne noise are determined by NR-35 curve. These values are harmonized with those in the Chinese national standard GB/T 50355-2018 *Standard for limits and measurement methods of vibration in the room of residential building*, which is newly issued by MOHURD in 2018.

2.3 Airborne Sound Insulation

Table 3 and Table 4 present the airborne sound insulation requirements for building elements and adjacent rooms, which are supposed to be derived from laboratory tests and field tests respectively. The basic requirements in bold are compulsory provisions and should be strictly implemented, while the higher requirements are conditional recommendation for upscale housing.

Table 3 – Airborne sound insulation requirements for building elements

Building elements	Indicators	Basic requirements [dB]	Higher requirements [dB]
Partition wall / Floor slab	R_w+C	**≥45→≥48**	≥50→≥53
Floor slab between dwelling and non-residential space(1)	R_w+C_{tr}	**>51**	—
Exterior wall	R_w+C_{tr}	**≥45**	—
Exterior window towards traffic artery(2)	R_w+C_{tr}	**≥30→≥35**	—
Other exterior window	R_w+C_{tr}	**≥25→≥30**	—
Entry door	R_w+C	≥25→≥30	—
Interior bedroom wall	R_w+C	≥35→≥40	—
Other interior wall	R_w+C	≥30→≥35	—
Notes: (1) Non-residential space denotes noisy areas such as underground garage or machine rooms. (2) For windows used for bedroom or living room.			

Table 4 – Requirements for airborne sound insulation between rooms

Rooms	Indicators	Basic requirements [dB]	Higher requirements [dB]
From outside to bedroom(1) (newly adopted)	$D_{2m,nT,w}+C_{tr}$	**≥35**	≥40
From adjacent unit to bedroom / living room(2)	$D_{nT,w}+C$	**≥45→≥48**	≥50→≥53
From non-residential space through floor slab to dwelling(3)	$D_{nT,w}+C_{tr}$	**≥51**	—
Adjacent bathrooms	$D_{nT,w}+C$	—	≥45

Notes:

(1) For exterior walls installed with window.

(2) Horizontally or vertically.

(3) Non-residential space denotes noisy areas such as underground garage or machine rooms.

In the past residential partition walls were generally built of solid bricks in China, characterized by massiveness and soundproofing. However, due to the requirements for energy efficiency, lightweight walls have become more and more popular, leading to deterioration in sound insulation. Based on the test results we gathered in the past few years, 200mm~250mm partition walls built of hollow blocks and plastered on both sides, which are common in high-rise buildings, can reach the $D_{nT,w}+C$ value above 45dB in compliance with present basic requirement. Inhabitants, nevertheless, feel dissatisfied with such performance and complain that it is easy to hear the talking or other activities from next door. Therefore, minimum allowable values for R_w+C of partition walls, as well as associated $D_{nT,w}+C$ between units, are both raised by 3dB, in order to better insulate against neighborhood noise.

Besides, the limit values for exterior windows are also raised by 5dB, with the aim of protecting against outdoor noise. Since there is no limitation for site test results of exterior walls or windows in present standard, and allowing for the difficulty in checking the wall and window separately, the combined sound insulation requirements for exterior walls installed with window are introduced to provide the criterion for quality acceptance.

2.4 Impact Sound Insulation

The impact sound insulation requirements for floor slab are presented in Table 5. The basic requirements in bold are compulsory provisions and should be strictly implemented, while the higher requirements are conditional recommendation for upscale housing.

Table 5 – Impact sound insulation requirements for floor slab

Building elements	Indicators	Basic requirements [dB]	Higher requirements [dB]
Floor slab	$L_{n,w}$ (laboratory test)	**<75→<70**	<65→<60
	$L'_{nT,w}$ (field test)	**≤75→≤70**	≤65→≤60
~~Note: In case of difficulty, limit values could be relaxed to 85dB only if there is room for further improvement in impact sound insulation.~~			

There are two main changes in the impact sound insulation requirements. Firstly, the note describing the conditional relaxation of limit values is now withdrawn. Considering that the $L_{n,w}$ of bare concrete floor is around 80dB, this note actually means that developers are allowed to take no acoustic treatment of the floor. Surely the room for maneuver was reserved on account of economic and technical reasons during the last revision. However, as soundproofing solution is progressing and becomes affordable nowadays, it is time to remove this non-binding provision. Meanwhile, all the limit values are now 5dB stricter than before, enforcing developers to improve the impact sound insulation of floor by necessary means.

3. CONCLUSIONS

Protecting against noise is a long campaign. Allowing for the national conditions, we haven't made radical revisions to the current GB 50118, and yet this is a step in the right direction. Critical requirements for noise and sound insulation have been tightened, for the purpose of enforcing developers and manufacturers to pay more attention to the noise and vibration control, and creating a healthier acoustic environment.

It should be noted that all the limit values presented in this paper are cited from the exposure draft. The final version is supposed to be officially issued in autumn, and further amendment might be adopted depending on the review comments.

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