

## **A building code on indoor noise environment for the hearing impaired senior's aging at home**

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### **ABSTRACT**

Hearing weakness is part of the natural aging process of humans just as wrinkles occur. In order to improve the quality of life in the old age, it is necessary to provide a living environment that can lead a universal life despite the problem of hearing impairment. Life inconvenience of old age hearing loss is more prominent in noise environment and reverberant environment than normal person. In this study, we have studied the housing acoustics design guideline that considers the hearing loss of old age as a natural process of life.

### **NEED FOR A BUILDING CODE ON INDOOR NOISE ENVIRONMENT**

The residential space for the elderly needs careful attention to the mental and physical health of the elderly, so more care is needed than other facilities. It is planned, designed and managed to provide the environment for the elderly to live bright and pleasant life. As a result of various studies, it is necessary to keep the background noise level of the elderly residents low because the influence of the ambient noise on the accurate listening gets bigger in the hearing situation of the elderly. It is necessary to create a proper reverberant environment in order to improve problems in listening life indoors such as watching TV or listening to a notification sound, and it is also necessary to improve the inter-household and inter-floor sound insulation performance to prevent disputes between neighbors due to high TV viewing levels. There is also a need to build a more reliable guidance system that can be prepared for unexpected accidents or fires(1).

### **CASE STUDY**

#### **Australian Building Code**

The Building Code of Australia provides building codes for elderly residences in three categories(2). . These criteria provide greater flexibility in the design of housing for the elderly and provide a reasonable range of protection for the elderly at home. BCA Class 3 is the standard for long-term residences (Hostel), class 9a refers to the Nursing Home, and Class 9c

refers to the building standard for the aging-in-place. BCA Class 9c is most similar category to Korea's elderly housing situation, except that the personnel should be placed for 24-hour emergency evacuation considering that the behavior may be inconvenient.

### **Design Guidelines for the Elderly with Dementia**

In a study on acoustic environment design guidelines of elderly people with dementia in particular, Hayne et al., insisted that the two principles of design should minimize the influence of internal and external noises and control the reverberant time.(3) Under this principle, first, the main noise sources (Table 4) are defined and provided a comprehensive design guideline that suggested the recommended sound level (Leq) and sound insulation degree (Rw / STC) for the layout of the house, the bedroom, the social space such as the dining room, toilets, kitchens, exterior spaces, etc. (Table 5 and Table 6). The sound insulation performance of the wall is generally above Rw 50 and is somewhat higher than the BCA standard in Australia. The recommended standard value of indoor noise is about 40dBA, which requires a somewhat quieter environment than the general house of Korea which has the recommended standard value of 43dB.

### **US Architectural Code**

The International Building Code (Uniform Building Code), which has been issued by the International Council of Building Officials since 1927 and revised every three years, describes minimum performance standard on sound insulation performance standards in apartment house.(4) Unlike the Australian building code, it does not have a separate subclass considering the inconvenience of the elderly. The 12th section of this code covers the overall standard for the indoor environment, and the 7th section is the minimum standard for the sound insulation performance of the apartment house. The majority of countries use the ISO evaluation unit, Rw, while US architectural codes are based on ASTM STC and IIC, the national standards of the United States.

## **CURRENT STANDARDS ON INDOOR NOISE ENVIRONMENT**

In Korea, the standard, consideration, and policy for aging in place have not yet been established, and many elderly people live in general apartment houses, especially old apartments for low income class. Therefore, it is possible to roughly grasp the acoustic environment of the elderly's residence by examining the acoustic environment standards and performance status of the general apartment house. The acoustic environment standards of apartment house are presented as regulatory standards in the "Housing Act", the "Regulations on Housing Construction Standards, etc.", the Presidential Decree, and the "Regulations on Housing Construction Standards, etc." Ordinance of the Minister of Land, Infrastructure and Transport, and the detailed rules are determined by standards of the Ministry of Land, Infrastructure and Transport in each field.

### **Standard on Noise from Outside**

Article 9 Paragraph 1 of the "Regulations on Housing Construction Standards, etc." stipulates that the external noise level of apartment house should be less than 65dB.(5) However, because it is not possible to reduce the external noise of high-rise buildings in an architectural way, there are exception rule that the indoor noise level should be less than 45dB when the window is closed for the part more than 6 stories in the urban area apartment house.

However, since the noise reduction measures can be established by installing soundproof wall for the part of 5 stories or less of the apartment house, the above-mentioned indoor noise exception rule is not applied. Detailed measurement methods by this rule are prescribed by Ordinance of the Minister of Land, Infrastructure and Transport.

### Standard on Floor Impact Noise

The standards for the light and heavy floor impact sound of the apartment house are presented in Article 14-2 of the "Regulations on Housing Construction Standards, etc." The minimum slab thickness of the ramen structure and the wall structure is specified, and the lightweight impact sound should meet 58dB and heavyweight impact sound, of 50dB or less. Detailed rules of implementation including standard impact source, measurement method and certification procedure.(6) The standard of impact source, the method of measurement and the certification procedure, and the type and application of the standard floor structure each is prescribed by Ordinance of the Ministry of Land, Infrastructure and Transport.

### Standard on Room to Room Sound Insulation Performance

The inter-household boundary walls of apartment house should satisfy the standard of sound insulation performance. Generally, in case of concrete walls installed in apartment house, Sound insulation performance is superior to other materials of the same thickness, because it's heavy and tight if there are not any gaps nor construction defects. Therefore, the sound insulation performance is defined by the thickness of the wall in the case of the reinforced concrete or non-reinforced concrete (including concrete block, brick, stone, etc. and the prefabricated concrete plate.

## A BUILDING CODE ON INDOOR NOISE ENVIRONMENT OF HOUSES FOR HEARING IMPAIRED SENIORS

The housing sound design guidelines for the elderly proposed in this study are not intended as mandatory standards. However, in the inevitable aging society in the future, it is absolutely necessary to consider to minimize the inconvenience caused by hearing loss of the elderly, and it should be regarded as an essential performance of the housing field to realize this.

**Table 1:** Proposed building code on noise environment of houses for hearing impaired seniors

Noise criteria		Guideline	Measurement
Floor impact noise		53	Molit 2013-611
Heavy weight floor impact noise		50	Molit 2013-611
Room to room sound insulation performance		$D_{n,TW} \geq 48$	KS F 2809 / 2862
Indoor background noise level	Plumbing noise	$Leq \leq 40$	Molit 2014-608
	Noise from outdoor	$Leq \leq 40$	Molit 2014-608
	Noise from next door	$Leq \leq 40$	Molit 2014-608
	Indoor service noise	$Leq \leq 40$	Molit 2014-608
	Total background noise	$Leq \leq 43$	Molit 2014-608 / 2014-446

## **Floor Impact Sound Isolation Performance**

It is necessary to strengthen the floor impact sound performance in consideration of the decline of the used frequency band of the elderly (the minimum audible level rise) while accepting 50 dB of the heavy floor impact sound insulation performance as the current legal standard. To do this, we intend to propose the performance of light floor impact sound isolation of 53 decibels, which is 5 decibels higher than the legal standard of 58 decibels equivalent to grade 3 of the green building certification standard as housing acoustics design guidelines for the elderly. This is also due to the tendency of listening to the elderly who need smaller background noise environment for accurate listening.

## **Room to Room Sound Insulation Performance**

For the inter-household noise insulation design guideline that considers the hearing loss of the elderly at present time, it is necessary to utilize the sound insulation performance evaluation tool considering all variable factors such as wall joints, porches, staircase, and fire evacuation exit as well as the sound insulation performance of inter-household wall members of apartment houses. For this purpose, as housing acoustics design guidelines for the elderly, we intend to propose inter-household air transmission sound insulation performance 48 decibels by actual inter-household sound insulation performance evaluation criteria Dntw value, not by sound insulation performance evaluation criterion of a simple wall members

## **Background Noise Level**

As the housing acoustics design guideline considering the hearing loss of the elderly, it is suggested that the noise level of each internal noise factor is limited to 40dBA, and the background noise level inside the house, which is the sum of them, is kept within 43dBA. In other words, if the various internal noise sources such as the noise of the water supply and drainage system, traffic noise, etc. is kept within 40 dBA each, the background noise level inside the house, the ultimate goal, will be kept within 43dBA.

## **Acknowledgements**

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(2016R1D1A1B03932172) and a grant(16AUDP-B068892-04) from Architecture & Urban Development Research Program funded by the Ministry of Land, Infrastructure and Transport of the Korea government.

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