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Acoustics in nursery institutions focused on children - Practical methodologies observing sound environment from children's view -

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ABSTRACT

This study aims to create sound environment as educational surroundings for children, and we research methodology of sound environmental observing from children's viewpoint. We observed how children interacting with sound environment in the kindergarten, and measured sound field that surrounded children. The characteristic of kindergarten sound was 1~2kHz and low frequency range sound that accompanied with children's behavior, and almost noisy about over 70dB($L_{Aeq,10m}$). And, we classified their activities into three types and these models showed that the planning of sound environment design varied according to activity's aims. We also measured acoustical characteristics focusing on the height of children's ears. It was suggested that interior design influenced sound environment that surrounded children and these tended to be different from adult.

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1. INTRODUCTION

Early childhood is important time because children voluntarily begin to be interested in surroundings other than themselves for the first time and interact with surroundings, and develop the sensibility and the independency¹. And the environment that surrounds children greatly influences their development. Especially sound environment greatly affects motivation of playing, comfortable space of conversation and originality of activity, etc.

Though the recognition that mothers are assumed the role of taking care of their children in own family is traditionally deep-rooted, in recent Japan, the environment that surrounds preschool children has changed greatly as a mechanism of the society by the changing society named increasing of nuclear families and woman's advance into society.

On an administrative side so far, it has been divided by the main purpose: Nursery as living scene for children who cannot spend it in parental roof in daytime to the jurisdiction of the Ministry of Health, Labour and Welfare, and kindergarten as learning scene before compulsory education to the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology.

Under such now a frame, the nursery facilities are managed along the operating policy and the facility criterion of each place. But these range provided for by the standard is narrow compared with since the elementary school and a varied design made use of original concept has increased. In one side, the influence of deregulation that accompanies an increase rapidly in needs of the childcare is also large. Physical environment that surround children is essential, but actually not been keeping good. In recent Japan, we are now faced serious problem that only the equipment of the minimum requirement is prepared for in the nursery institutions. Along with such a background, the environment that surrounds children is greatly different according to commuting place, region, facilities, and management form. So to preserve the life space of children that matches various regional societies, it's important to work on the creating environment focusing on children's viewpoint. Sound environment for children influenced children's variegated learning activity learnt from environment in daily life through interaction with sound environment. So environmental factor of sound is very important for children especially in early childhood when basic act is learnt.

The research on the music activity is popular in the approach about the sound in nursery facilities. However, the research that focused on sound environment in daily life is a little. In Japan of recent years there are researches on acoustic design of nursery facilities by Sekizawa², the noise realities and the international comparison by Shimura and Fujii et al.³.

In this paper, we aim at the sound environment design for children in the Kindergarten and report on the result of examination of the observation methodologies focused on children.

2. ACTIVITY AND SOUND ENVIRONMENT IN THE KINDERGARTEN

A. Activity Style

In Japanese nursery facilities, teachers are practicing classes that are guided by teachers, and free nurse. A concrete curriculum has been entrusted to the educational concept of each facility. In this chapter, to understand interaction between children's learning activity and sound environment, we report on the result of the activity observation and the sound field analysis.

We researched the facility outline and observed activity situation in M kindergarten located in Tokyo. Table 1 shows institution outline and Fig.1 shows the floor plan. Usually, the outdoor space like playground is often used at free nurse. But the playground in M kindergarten is a state of the cliff, so it's a peculiar point that indoor space is mainly used at the free play. However,

nursery facilities where it cannot help doing similar operation are not few in the city part of Japan that cannot often take the lot area in facilities enough.

Table 1: Institution Outline

Location	Tokyo
Surrounding area	Commercial district
Construction	RC construction
Floor construction	3F: 1,2F area
Ceiling height	3m
Number of kindergarteners	340 people
3 years old	4 classes (110 people)
Number of classes 4 years old	4 classes (120 people)
5 years old	4 classes (110 people)
Management form	A day Half a day
Activity space	Class style Nursery room, Open space Free nurse Open space, Nursery room, Garden

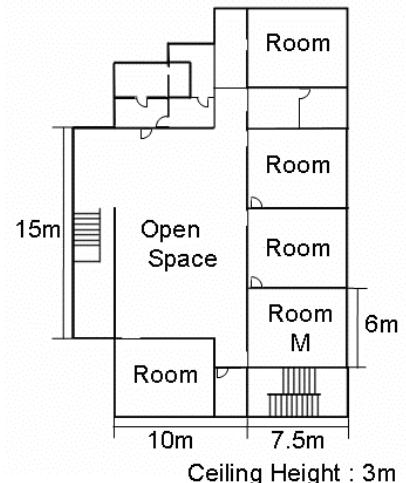


Figure 1: Floor Plan

B. Sound Environment Observing

We analyzed the activity observation and the sound for the nursery room. We used the digital video camera and the sound level meter (RION NL-32) for recording. Figure 2 shows equivalent continuous sound pressure level every ten minutes.

It is a feature on the whole that the activity in the kindergarten will change in a short time, and this is different from that in the school. We observed that kindergartners were often lying and sitting on floor and guessed that they tended to act by a very low space.

The feature of the sound environment is described as follows. First, it is pointed out that 1~2 kHz band and low frequency sound is extremely large when kindergartners in the room. This tendency is especially remarkable at free play and sound characteristic is different depending on the activity and teacher's instructional method at class. At the class, there are various activities such as static one like reading and dynamic one like singing or dancing. This result shows that sound pressure level at static activity is about 65~70dB($L_{Aeq,10m}$) but its level in other time is over 70dB($L_{Aeq,10m}$) so it is difficult to say that people can communicate smoothly in this space. In spite of such a situation, teachers try to quiet kindergartners before and behind lunch by playing back music, turning the lights off and letting kindergartners keep asleep. The quieted space is important for the calm of children, and we think that it is necessary to ensure the silent space in the kindergarten.

The place which kindergartners act is almost 70dB or more. And even when they voluntarily act, it is difficult for them to select the quiet surrounding. So we think that it is essential to consider how to use kindergarten from planning stage.

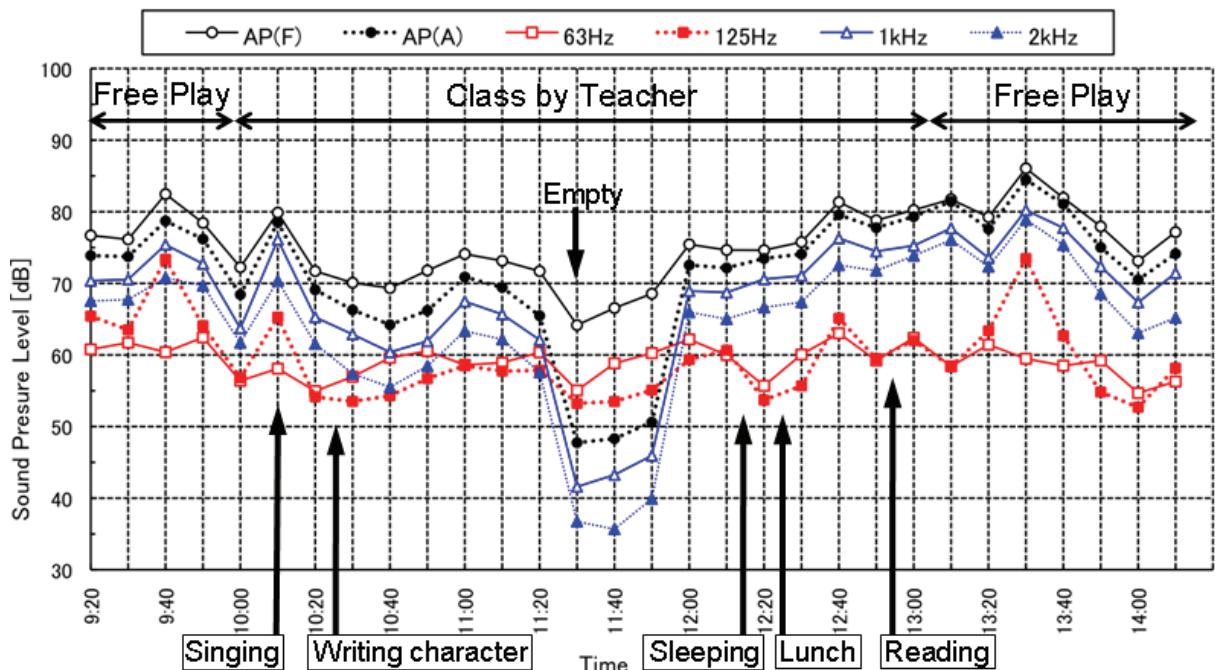


Figure 2: Sound Pressure Level



Figure 3: Activity Observing during a Day

C. Sound Communication Models

The observed activity was classified according to how interacted with sound environment. Table 2 shows concrete activity and Fig.4 shows sound communication models in the kindergarten. This model shows how human and the sound are interactive and create of sound environment. And this classification is along the object that the kindergartners chiefly hear. They mainly hear "teachers (others)" in *Lesson*, "oneself and others" at *Playing* and "The entire environment" at *Free*. Kindergartner's "hearing activity" lead them to acquire sociality. For instance, this model means the acquisition process of social ability: "listening to others (*Lesson*)", "collaborating with others (*Playing*)", and "relating to surroundings voluntarily (*Free*)".

Table 2: Activity's Classification in the Kindergarten by Sound Communication

Classification	Activities
Lesson	Reading, Gathering, Lecture, etc
Playing	Music activity (Singing, Playing sound), Dynamic activity (Dancing, Gesture game), etc.
Free	Sports (Running, Skipping rope), Play of words, Toy (Natural or artificially toy), etc

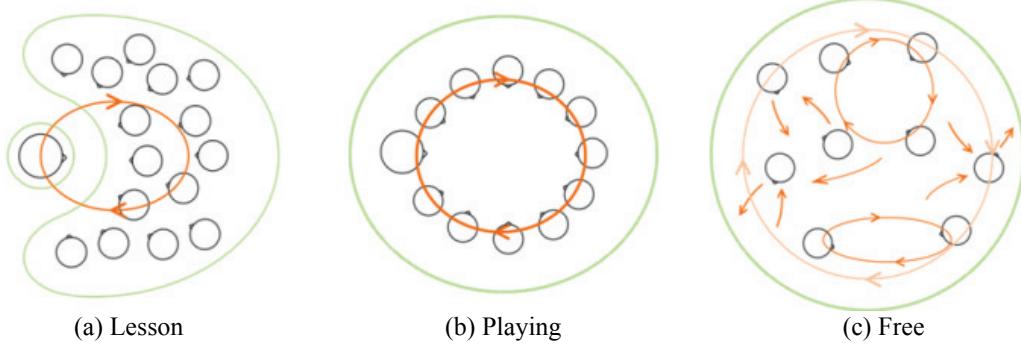


Figure 4: Sound Communication Models in the Kindergarten

3. ACOUSTIC MEASUREMENT FOCUSED ON CHILDREN

A. Measurement

In this chapter, we report the result that we measured acoustical characteristics focused on children's listening height. We measured reverberation time, impulse response and sound pressure distribution in nursery room.

Traditional ways of acoustic measurement provided that microphones height is 120cm or 150cm by Japanese Industrial Standard. But we considered kindergartners hearing height in accordance with feature of body and kindergartner's behavioral pattern and set microphones 3cm/5cm (lying height of kindergartner), 60cm (sitting height of kindergartner), 120cm (sitting height of adult) and 150cm (standing height of adult). And I investigated the difference of the acoustical performance according to hearing height. Figure 5 shows the measurement position.

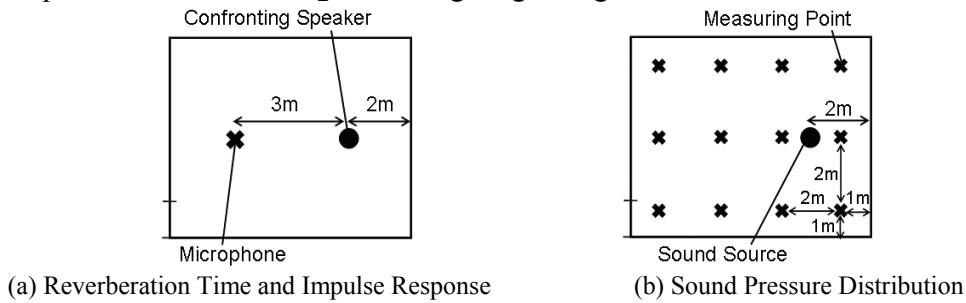


Figure 5: Measurement Chart in Horizontal Plane

B. Reverberation Time

Figure 6 shows the reverberation time in nursery room.

In Japanese elementary school, junior high school and high school, the reverberation time in various spaces is recommended as academic standard⁴. This time in the classroom, in those averaging of middle frequency band (500Hz and 1kHz) is recommended 0.6 second for sound awareness. Nursery room is designed a little smaller than the classroom at the school, so this space not to follow the word easily a little. And there are a few differences in the low frequency range between at the height of 15cm and that of 60, 120cm. The reverberation time at the height of 15cm is shorter than others.

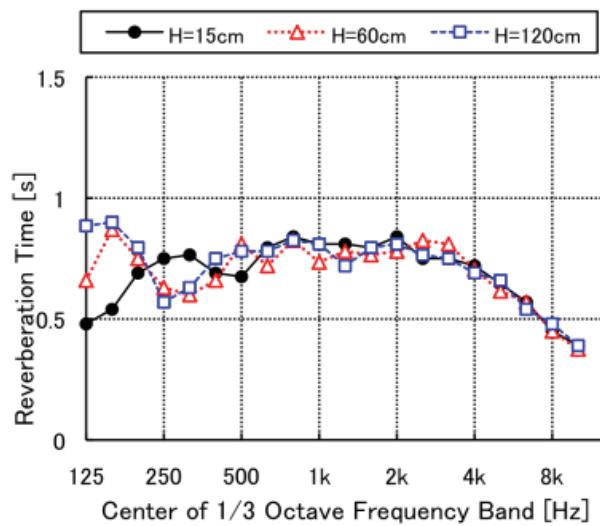


Figure 6: Reverberation Time

C. Impulse Response

Impulse responses of 1/1 octave frequency band are shown in Fig.7. The amplitude of 250Hz band is 8 times that of 1kHz band and 4kHz band.

Especially, the difference according to height is large in 250Hz band. The early sound pressure level is large at the height of 15cm. At the height of 60cm, the late sound is larger than early one, and those levels are large as the same at that of 120cm. The amplitude of 1kHz band is similar at all height but the density of reflected sound is different. And direct sound is remarkable at the height of 60cm and 120cm at the 4kHz band.

D. Sound Pressure Distribution

We measured sound pressure distribution using white noise source. The results of vertical plane on the middle are shown in Fig.8. The attenuation of a low frequency range is smaller than that of a high frequency range at a receiving sound position near the floor. This result is guessed according to the influence of the reflected sound on the floor. The floor in this room is linoleum finish. The material of the floor greatly influences the result. The influence of the floor material is large for kindergartners who always acted by height near the floor surface that was the reflection side.

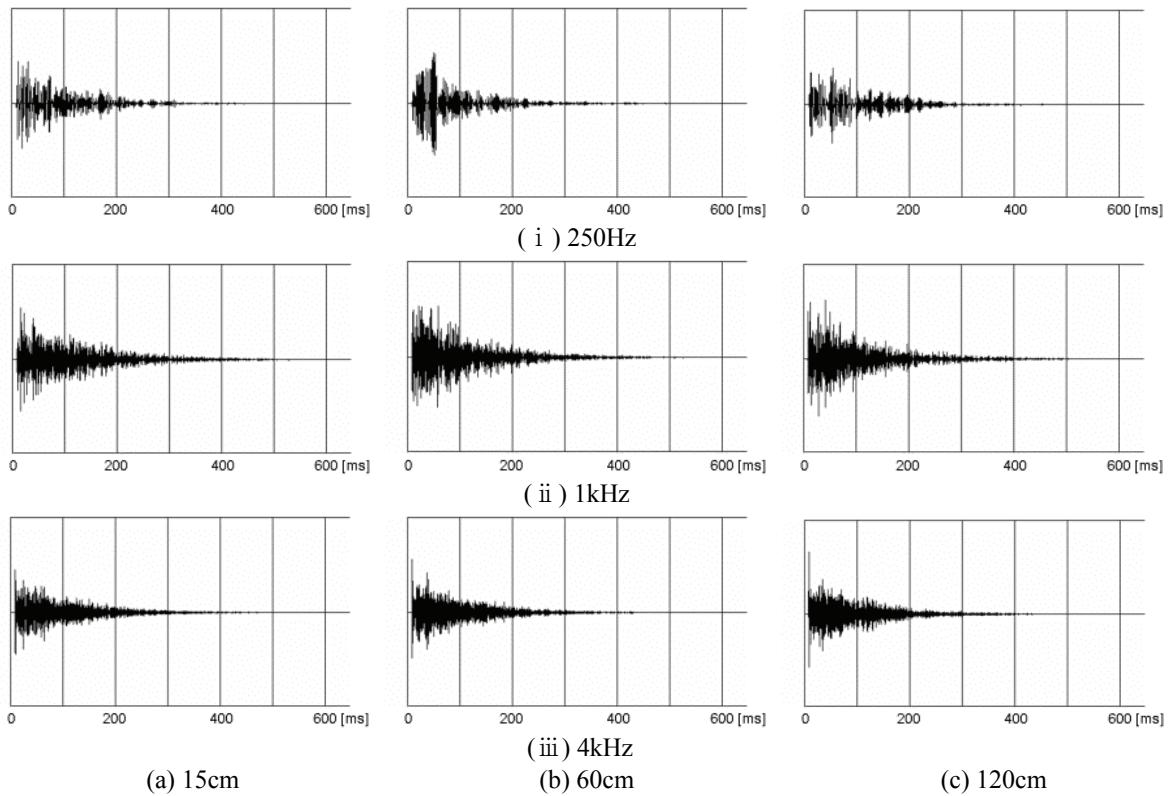


Figure 7: Impulse Response

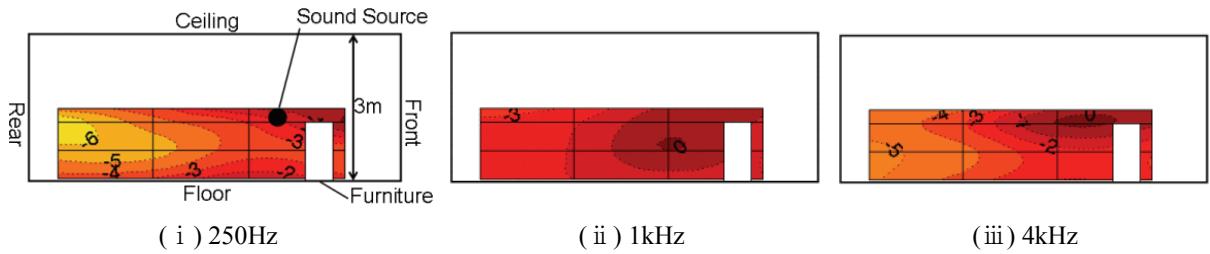


Figure 8: Sound Pressure Distribution in Vertical Plane

4. CONCLUSIONS

In this paper, we tried various observing of sound environment from children's viewpoint. As a result, the sound accompanied with kindergartners behavior such as 1~2kHz and low frequency range sound pressure level was characteristic, sound environment inside a room of the kindergarten tended to be noisy and the influence of the reflected sound with a floor face and familiar furniture is greatly received from the viewpoint of kindergartners.

Understanding viewpoint of children who doesn't assert themselves by using a physical parameter can become an important clue that we can understand their sound environment that cannot be experienced by adult. In future, we try to propose that many-sided observing methodologies of sound environment from children's learning activity and these applications, and work on the construction of the index to feed back to architects and teachers.

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