Analysis of the Indoor Environmental Characteristics of Educational Facilities

Kim, Jin-Kil) Cho, Min-Kwan1) Cho, Chang-Geun2) Baik, Yong-Kyu2) Seo, Boong-Kyo3)

1) Dept. of Urban & Architectural Eng., Kangnam University
San 6-2, Kugal-Ri, Kihung-Up, Yongin-Shi, Kyounggi-Do, 449-702, Korea
Tel)+82-31-2803-803 E-mail)JKIM95@chollian.net, cho803@kangnam.ac.kr
2) Dept. of Architecture, Seoil College
#49-3, Myounmog 8-Dong, Junglang-Gu, Seoul, 131-208 Korea
Tel)+82-2-4907-427 E-mail)hbamange@hitel.net, ykbaik@hanimail.com
3) Dept. of Architecture, Kyungwon University
San 65, Bokjung-Dong, Soojung-Ku, Seongnam-Shi, Kyounggi-Do, 461-701, Korea
Tel)+82-017-345-2246 E-mail)bkseo@mail.kyungwon.ac.kr

ABSTRACT: This study is to understand the actual conditions of indoor environment of timeworn educational facilities by standard architectural plan and modernized model school through field measurement of environmental factors. In order of it, the performance of indoor environment was investigated in 2 elementary schools located in Seoul.

As the result of this study, the temperature in general classroom distributes broader than that in opened classroom in a modernized model school due to the larger space volume. The vertical temperature distributions in general and opened classroom show to be 11.2℃ and 12.1℃ respectively, which gives occupants much dissatisfaction of thermal sensation. And, the indoor temperature variation of special classroom leads to entirely higher value than that of opened classroom because of the different heat flux of walls. The sound insulation performance of partition of cement bricks between classrooms in two schools are satisfied with the criteria of the AIJ(Architectural Institute of Japan), but that of folding accordion partition wall in opened school is so low as to be influenced on class.

1. INTRODUCTION

As the educational facilities become wornout, the cost of their maintenance increase, and the important problems of their building structures may occur.

Many problems of each building components, materials and construction method in school buildings which constructed by standard architectural plan before their modernization gives the educational environment relatively poor and threatens to occupants' safety.

As in the above, though newly construction or renovation of elementary schools becomes issue, but hardly accomplishes actively due to recent economical and environmental restriction.

In these circumstances, remodeling saves construction cost and shortens period more than newly construction or reconstruction, and henceforth saves cost of maintenance. Furthermore, it rises to be an alternative proposal which can solve the problem of existing building's rearrangement according to the 7th curriculum.

However, even though timeworn educational facilities will greatly demands remodeling sooner or later, international research trend about remodeling shows most of establishment of political or metaphysical concept.

Because researches about judgement of some building components to be timeworn approach in the same point of view as the conventional reconstruction, it is some difficult that the conventional results of researches directly apply to this research.

Consequently, in order to make reasonable remodeling plan of timeworn educational facilities, first of all, facility manager should clearly judge the compatibility of remodeling in the viewpoint of durability, economy, residential safety, and other performance. In addition to it, it is thought that selection system of adequate materials for highly increasing effect of performance improvement by remodeling should have been established.

This study shows the actual conditions of timeworn school and modernized model school through field measurement of their environmental factors.

Indoor environmental characteristics is analyzed by investigating the indoor environmental criteria and measuring environmental performance of a timeworn school and a modernized model school located in Seoul.

2. INDOOR ENVIRONMENTAL CRITERIA of EDUCATIONAL FACILITIES

Indoor environmental criteria of school buildings are regulated in educational facility code of Department of Education as over 300lx(desk illumination), below 55dB(noise level), and over 18℃(temperature).

But, it is not yet classified to grades of indoor environmental performance considering the purposes and characteristics of rooms in order of comfortable indoor environment.

3. MEASUREMENT

3.1 MEASURING OBJECTS AND PERIOD

Field measurement of indoor environmental performance were carried out in 2 elementary schools located in Seoul, that is, Y school (timeworn school building by standard architectural plan) and J school (modernized model school building), for 12 days from 17th until 31st on March in 2001.

Outside wall of Y school building is finished by RC(reinforced concrete) and interior wall of it between classrooms is partitioned by cement bricks.

Outside wall of J school building is constructed by RC(reinforced concrete) and interior wall between classrooms is partitioned by light weight dry wall panel.

Wall between general classroom and opened classroom is furnished by openable accordion folding wall.

3.2 MEASURING ITEMS AND EQUIPMENT

Table 1 shows measuring items and equipment for field measurement of indoor environmental performance.

Photo 1 and Photo 2 show the front view of measured buildings. Fig. 1 and Fig.2 are floor plans of their classrooms.

Table 1. Measuring items and equipment

Items		No. of measuring points	Equipment
Sound transmission loss		40	Sound level meter & Signal analyzer(NA-27, Rion), Sound source(B&K)
Solar radiation		1	Solar Radiation Meter (OTA, NO 44)
Temperature	Outdoor air	1	Data Logger (GRANT SQ 1601)
	Outside surface of envelope	2	
	Inside surface of envelope	6	
	Floor surface of classroom	4	
	Ceiling surface of classroom	4	
	Vertical distribution of classroom	20	
	Surface of partition wall in classroom	4	
	Surface of cement brick partition wall	7	
	Surface of light weight partition wall		
	Surface of window glass		

Photo 1. Front view of J school building

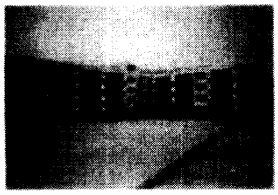

Photo 2. Front view of Y school building

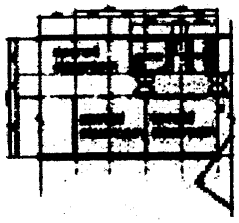

Fig. 1. Floor plan of J school building

Fig. 2. Floor plan of Y school building

Photo 3. View of measurement in J school

Photo 4. View of measurement in Y school

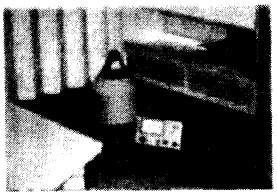

Photo 5. Sound source

Photo 6. Sound receiver

Measured data, outdoor air temperature, solar radiation, and so on, were collected every 10 minutes in 49 measuring points.

4. RESULT OF MEASUREMENT

4.1 Thermal environmental performance

Fig. 3 shows indoor temperature variation of classroom with outdoor air temperature in J school building for 5 days. Outdoor temperature distributes 4.4℃ · 26.8℃ in average 13.5℃. Indoor temperature of general classroom shows the range of 15.7·23. 8℃ in average 17.8℃, and that of opened classroom distributes 14.6 · 2 2.2 ℃ in average 16.7 ℃ respectively. Indoor temperature of general classroom shows slightly higher than that of opened classroom due to the difference of their space volumes.

On the other hand, the lowest air temperature over 100mm from the floor shows 15.2 ℃ in general classroom in a day, and the highest air temperature under 100mm from the ceiling is 26.4℃. The difference of them is 11.2℃, and that in opened classroom is 12.1℃. It is thought that occupants would much dissatisfy with thermal sensation. Accordingly, improvement of indoor environment and collection of its data are greatly needed.

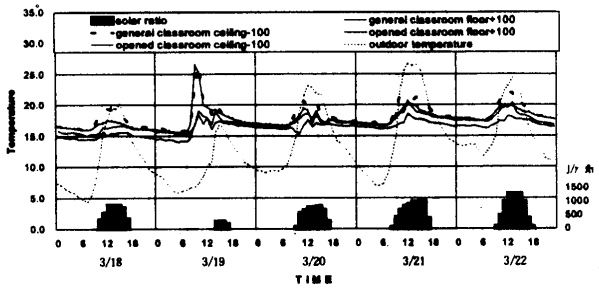

Fig. 3. Indoor temperature variation of classroom in J school building-1

Fig. 4 shows the indoor temperature variation both general classroom and special classroom in J school building. It tends to be similarly to Fig. 3, but the temperature of special classroom is wholely higher than that of general classroom.

It is thought that heat frequently would flow in general classroom which use light weight openable partition wall adjacent to neighbored classroom other than in special classroom which uses cement brick partition wall.

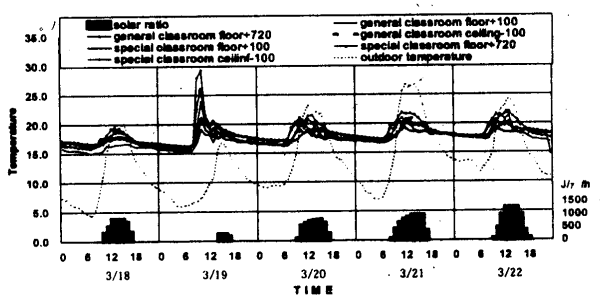

Fig. 4. Indoor temperature variation of classroom in J school building-2

Outdoor air shows the highest temperature to be 26.8℃ at noon of 21st on March during measuring period, but the indoor temperature doesn't go high so much. It may be under influenced of weather condition.

So to speak, it is thought that indoor temperature slightly goes high so much as solar radiation stored in building structure on 21st day because the RC structure had gotten much cool due to cloudy days 19th and 20th day that of cumulative solar radiation was 1100J/m^2·h and 5700J/m^2·h as well.

4.2 SOUND INSULATION PERFORMANCE OF WALLS

Sound insulation of wall is regulated to be evaluated on the basis of evaluation method and criteria because it is the important factor of performance evaluation of building. However, criteria of its purpose and part of educational facilities are not established yet.

In Japan, JIS standard(JIS A 1419) and criteria of AIJ(Architectural Institute of Japan) are used in actual building design.

Table 2 shows the criteria of average sound pressure level difference between two rooms of school building of AIJ.

Table 2. Criteria of average sound pressure level difference between two rooms of school building(AIJ)

Building		School
Use		Classroom
Part		Partition wall between two rooms
Criteria	Special(Special specification)	D-45
	1st(standard)	D-40
	2nd(Admissible)	D-35
	3rd(At least)	D-30

Table 3 shows measured results of sound insulation performance of partition wall between classrooms. Fig. 5 is comparison of sound insulation performance of partition wall between classrooms with the D-curves of AIJ. Y school building, timeworn school by standard architectural plan, is older than J school building as modernized model school. Partition wall between classroom and corridor of J school building, opened school, was not air-tight structure as folding accordion partition wall made from PVC. Sound insulation performance of partition wall between classrooms of newly constructed J school building shows up to be STC-17(D-20), and that of timeworn Y school building is STC-23(D-25) and that of brick wall is STC-33(D-30).

The formers are evaluated to be below D-30, at least criteria of AIJ, and the last are proved to be satisfied with D-30.

Therefore, increase of sound insulation performance through improving building design are demanded, because transmitted sound through folding accordion partition wall between classroom and corridor rather than partition wall between classrooms is thought to be interfered with each other.

Table 3. Sound transmission loss of walls

Frequency(Hz)	J school	Y school	
	Light Weight Partition wall	Light Weight Partition wall	Cement Brick Partition wall
125	15	4	24
160	14	17	22
200	13	18	23
250	14	19	26
315	13	19	26
400	14	16	29
500	13	21	31
630	11	25	33
800	15	25	35
1000	19	25	34
1250	20	28	36
1600	24	23	35
2000	23	21	33
2500	18	24	32
3150	17	25	33
4000	21	25	36
STC	STC-17	STC-23	STC-33
D rate	D-20	S-25	D-30

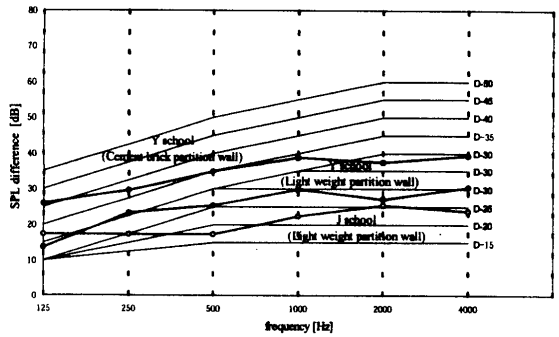

Fig. 5. Comparison of sound insulation performance among partition walls

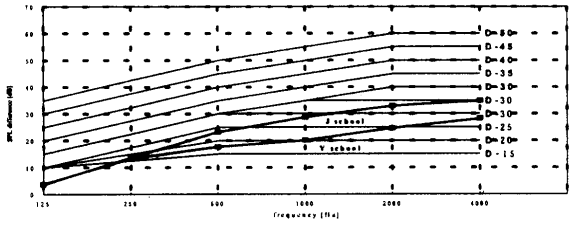

Fig. 6. Comparison of sound insulation performance between windows of classrooms

Fig. 6 compares the sound insulation performance of window of classroom with D-curves. Window of Y school classroom consists of double glasses in 5mm thick with Al. sash, and that of J school classroom is furnished with pair glass in 12mm+double glasses in 5mm with Al. sash and plastic sash as well. Sound insulation performance of window are resulted in D-15 in 2 schools, that of Y school(timeworn school by standard architectural plan) are lower than that of J school(modernized model school). Increase of sound insulation performance is thought to be necessary through improving building design.

5. CONCLUSION

Measurement and analysis of indoor environmental performance and investigation of its criteria are carried out in timeworn school by standard architectural plan and modernized model school.

The results of this study are as follows;

1) Criteria of indoor environmental physical factors of educational facilities are regulated on the code of facilities of Depart of Education, but aren't classified in grades of them considering use and characteristics for comfortable indoor environment.

2) Indoor temperature distribution of general classroom tends to be higher than that of opened classroom in J school building. It may be caused by the difference of space volume between them.

3) Vertical air temperature differences between in general classroom and opened classroom are 11.2℃ and 12.1℃ as well. Accordingly, occupants would much dissatisfy with thermal sensation. Also, indoor air temperature variation in special classroom shows wholely higher than that in opened classroom, because the amount of heat flow of wall are differ from each other.

4) Sound insulation performance of partition wall made of cement bricks between classrooms are satisfied with 3rd grade(at least criteria) in J and Y school buildings. That is to say, transmitted sound through folding accordion partition wall between classroom and corridor rather than partition wall between classrooms is thought to be interfered with each other.

6. REFERENCES

1) Feasibility Study on Basic Design and Construction of KIER Green Building, Korea Institute of Energy Research, 1996.4.
2) A Study on Planning for Development of Efficient Building Energy Management Techniques, Korea Institute of Energy Research, 1997.6.
3) The Development of Optimal Maintenance Model for Buildings, Korea Institute of Construction Technology, 1994.12.
4) Evaluation Method of Deterioration Degree of Structural Material for Remodeling Old Educational Facilities.(I)-On the Repairing Records of Elementary Facilities-, The Korean Institute of Educational Facilities, 2001.7.

This work was supported by grant No.2000-1-31000-006-3 from the Basic Research Program of the Korea Science & Engineering Foundation.