

Daylighting Environment of an Interior Space in Apartment Housing

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ABSTRACT: One of the most important factors in determining the quality of living environment is daylighting. Especially its influence on the psychological and biological life of human beings cannot be underestimated. Therefore, lots of researches have been done in order to develop a more efficient daylighting system. The sunlighting system, one of many developed systems, has been developed and applied in various ways. However, the high installation cost of sunlighting system has been the most difficult stumbling-block in making it commercial. However, as domestic apartment houses tend to be more luxury, life environment, in building apartment hose, becomes a very important factor more than cost. Therefore, it would be possible to adopt sunlighting system in the non-window areas such as a restroom in an apartment house. This research is a preliminary work in order to measure a possibility of applying sunlighting system in an apartment house. In order to do so, I measure Light Factor in various areas of apartment house. As a result, in case of a residential-commercial building, areas such as kitchen, restroom, and entrance are relatively weak-lighting areas. In case of a traditional apartment house, restroom and entrance are relatively weak-lighting areas. For that reason, a special lighting support is needed in these areas.

Keywords: Apartment House, Residential-Commercial Building, Daylighting, Sunlighting System

1. INTRODUCTION

One of the most important factors in determining the quality of living environment is daylighting. Especially its influence on the psychological and biological life of human beings cannot be underestimated. Therefore, lots of researches have been given to develop a more efficient daylighting system. The sunlighting system, one of many developed

systems, has been developed and applied in various ways. However, the high installation

cost of sunlighting system has been the most difficult stumbling-block in making it commercial.

However, as domestic apartment houses tend to be more luxury, life environment, in building apartment hoses, becomes a very important factor more than cost. Therefore, it would be possible to adopt sunlighting

system in the non-window areas such as a restroom in an apartment house.

This research is a preliminary work in order to measure a possibility of applying sunlighting system in an apartment house. In order to do so, I measure Light Factor in various areas of apartment house.

After the self-regulation of release price has been effective, the price of house has been increased and a competition of specializing an apartment house has begun. Thus, construction companies are looking for the new styles of luxury living. They also show a renewal of interest in a high-rise apartment building and pursue a variation of unit plan centering on residential-commercial building. This research differentiates apartment house between a general apartment house and a residential-commercial building. Also, this research analyzes the area and window-size of five apartment houses and of five residential-commercial buildings in order to determine objects of measurement. All of them had built within two years.

2. EXPERIMENTAL METHODOLOGY

2.1 AN ANALYSIS OF INNER SPACE OF APARTMENT HOUSES

Most apartment houses have advantages in sunlighting and ventilation because its front and back are open to outside. This research analyzes the mid-large sized(132 m² ~ 155 m²) apartment houses in measuring sunlighting. It examines areas and window-size of each space of apartment houses (table 1). Each apartment house has two bathrooms and living room is the largest in all of them.

Apartment houses have 3-4 rooms. As the area of room is wider, the space of room is bigger. The window-size-to-area ratio is high in the living room and room 1 which is planned to be master's bedroom. On the contrary, the window-size-to-area ratio of kitchen is very low. Especially, bathroom

and entrance are the weakest areas in sunlight because there are no windows.

Table I: Space Elements of Apartment house.

	A		B		C		D		E	
	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)
Total	132	-	135	-	145	-	155	-	155	-
Living Room	30.97	10.64	32.97	1.98	35.89	12.36	41.23	13.74	38.23	12.84
Room1	14.79	7.39	15.79	8.33	18.23	8.97	17.45	7.39	18.45	7.39
Room2	10.37	2.6	10.24	2.45	11	2.7	12	3.2	13	3.2
Room3	9.86	4.93	9.45	3	9.23	5	8.98	4.3	8.98	4.3
Room4	-	-	9.45	3	-	-	8.98	4.3	9.98	4.3
Bath Room1	2.91	-	3	-	2.84	-	3.2	-	3.2	-
Bath Room2	4.29	-	4.54	-	4.54	-	4.84	-	4.84	-
Kitchen	14.69	1.46	13.37	2	15.32	1.53	14.32	2.3	14.32	2.3
Entrance	3.77	-	3.77	-	4	-	4.2	-	4.2	-
Floor-to-Ceiling Height	2.3(m)		2.3(m)		2.3(m)		2.3(m)		2.3(m)	
Direction	South-East		South		South-West		South-East		South	

Measurement

2.2 AN ANALYSIS OF INNER SPACE OF RESIDENTIAL-COMMERCIAL BUILDING

Residential-commercial building is built in tower-type. The meaning of tower-type, in a general sense, the long side and the short side is more than 4 to 1. The meaning of tower-type, in a legal sense, is a building which not less than 16 stories building that the access to inside from an elevator or stair is possible.

This research analyzes the mid-large sized(132 m² ~ 155 m²) residential-commercial building in measuring sunlighting. It examines areas and window-size of each space of residential-commercial building (table 2).

In case of residential-commercial building, they have two bathrooms and living room is the largest area. They also have 3-4 bedrooms. As the area of room is wider, the space of room is bigger. The window-size-to-area ratio is high in the living room and room 1 which is planned to be master's bedroom.

However, again, bathrooms and entrance are the weakest areas in sunlight because

there are no windows. Moreover, different from apartment house, some kitchens in residential-commercial building do not have window. Therefore, a supplement for this is needed.

In comparing apartment house to residential-commercial building in terms of window-size-to-area ratio, residential-commercial building shows high sunlighting effectiveness in the living room. In case of other rooms, they show similar effectiveness. Kitchen shows the most difference following the existence of window.

Also, this study compared apartment house and residential-commercial building by floor area to window-size ratio. Residential-commercial building shows high sunlighting effectiveness in the living room due to its high floor area to window-size ratio. In case of other rooms, they show similar effectiveness. Kitchen shows the most difference following the existence of window.

Table 2: Space Elements of Residential-Commercial Building

	F		G		H		I		J	
	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)	area (m ²)	Window Size (m ²)
Total	132	-	135	-	145	-	135	-	135	-
Living Room	28.97	9.64	30.97	10.32	33.21	18.98	35.22	20.02	34.22	25.2
Room1	12.79	9.39	14.79	8.01	15.32	6.11	14.3	5.33	14.3	5.3
Room2	12.37	2.6	11.24	3.4	12.22	4.5	12.22	5.2	12.22	5.2
Room3	10.86	4.93	10.45	4.5	11.3	3.4	11.3	3.4	11.3	3.4
Room4	-	-	-	-	-	-	8.4	3.4	11.3	3.4
Bath Room1	2.91	-	2.84	-	3.01	-	3.1	-	3.1	-
Bath Room2	3.25	-	3.23	-	3.28	-	4.5	-	5.8	-
Kitchen	14.69	-	15.21	1.46	16.22	-	16.28	-	15.23	-
Entrance	3.77	-	3.77	-	4	-	4.3	-	4.3	-
Floor-to-Ceiling Height	2.3(m)		2.3(m)		2.3(m)		2.3(m)		2.3(m)	
Direction	South-East		South		South-West		North-East		South-West	

Measurement

2.3 MEASUREMENT

In measuring Light Factor of each spaces of apartment house, I use Topcon IM-5 luxmeter. The measurement is done three time in the center of the room at the height

of 80±5 cm from the ground following the rule of KS Illuminance. The measurement is done during 11AM-1PM which Sun shines is in zenith. I express both the result of outdoor illuminance and indoor illuminance (Light Factor).



Figure 1: IM-5

Table 3 is house illuminance code following rule of KS illuminance. For comparing apartment house and residential-commercial building, I measure identically measurement's location, unit plan, floor area, and sky condition. Table 4 is basic conditions for the measuring houses.

Table 3: Illuminance Code (KS)

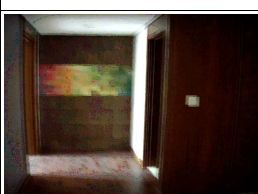
Space	illuminance[Lx]
Hall	30-40-60
Entrance Hall	60-100-150
Hall way	150-200-300
Kitchen	60-100-150
Operation room	300-400-600
Living Room	30-40-60
Bath Room	60-100-150

Table 4: Profile of Measurement

Element	Condition
Area	145 m ²
Unit plan Elements	Living room, Room(3), Bath Room(2), Kitchen
Direction	South-west

Floor	4
Sky condition	clear sky

Table 5: Room Condition of Measuring Object

	Residence- Commercial Building	Apartment House
Living Room①		
Room1 ②		
Bath Room2 ③		
Kitchen④		
Entrance⑤& Hall Way⑥		

3. RESULTS AND ANALYSIS

3.1 AN EVALUATION OF SUNLIGHT OF EACH SPACE OF RESIDENTIAL-COMMERCAIL BUILDING

Following picture is master plan of measuring residential-commercial building. The measured house belongs to the red-

marked building in the left-down of the picture.

The measured residential-commercial building consists of 6 house-holds. The direction of the measured house is south-west located in 4th floor.

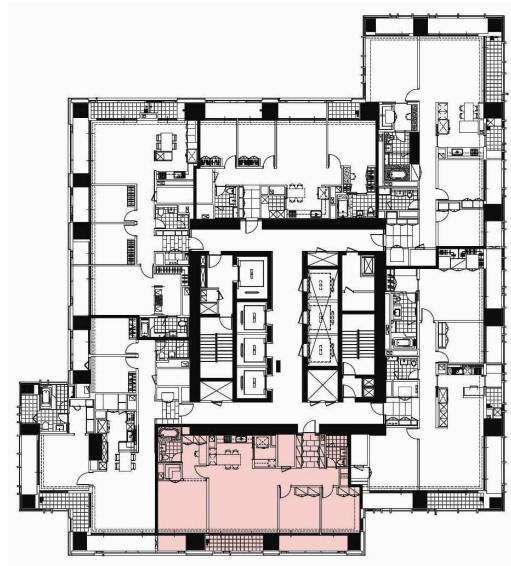


Figure 2: Unit plan of Target Measurement

Figure 3 is a ground plan of measured house and numbers signify measurement point. A measured result (Light Factor and illuminance) is expressed in the table 6. Bold-marked areas are weak lighting areas.

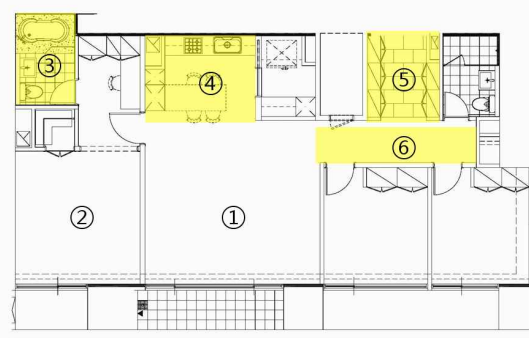


Figure 3: Measurement Point of Residential-Commercial Building

In case of residential-commercial building average illuminance is 185[Lx]. It is better than maximum illuminance of KS,

60[Lx]. However, its entrance (4.3[Lx] ~5.7 [Lx]), kitchen (36[Lx] ~58 [Lx]), bathroom (0[Lx]) has insufficient lighting, even in the best time for lighting. Thus, the supplement of artificial light is needed in these areas.

Table 6: Light Factor and Illuminance of Residential-Commercial Building (Outdoor illuminance: 50,500 Lx)

item	Luxmeter location						average
	1 Living Room	2 Room1	3 Bath Room	4 Kit -chen	5 Ent- rance	6 Hall way	
Indoor Illuminance	628	417	0	36	4.3	26	185
Light Factor	1.2	0.8	0	0.07	0.009	0.05	0.35

Light Factor is 1.2~0.8% in the living room and master's bedroom those have openings. However, bathroom, kitchen, entrance, and pathway shows 0.11~0% of light factor.

3.2 AN EVALUATION OF SUNLIGHT OF EACH SPACE OF APARTMENT HOUSE

A measured result of sunlighting in apartment house is expressed in the table 7. Figure 4 is the ground plan of measured house and bold-marked building is the measured building. Numbers in figure 5 signify measurement point. Bold-marked areas are weak lighting areas.

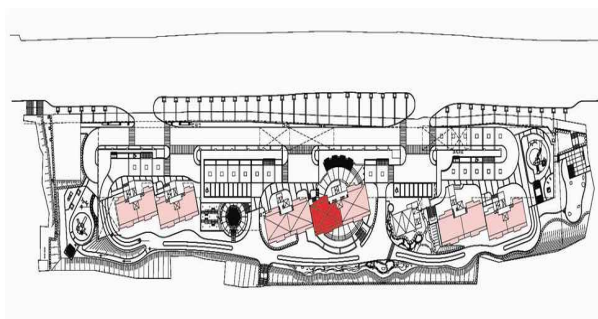


Figure 4: The Ground Plan of Measured Apartment House

In case of apartment house average illuminance is 218[Lx]. It is much better than maximum illuminance of KS, 60[Lx]. However, entrance (4.3[Lx] ~5 [Lx]) and bathroom (0[Lx]) have insufficient lighting. Therefore, the supplement of artificial light is needed in these areas.

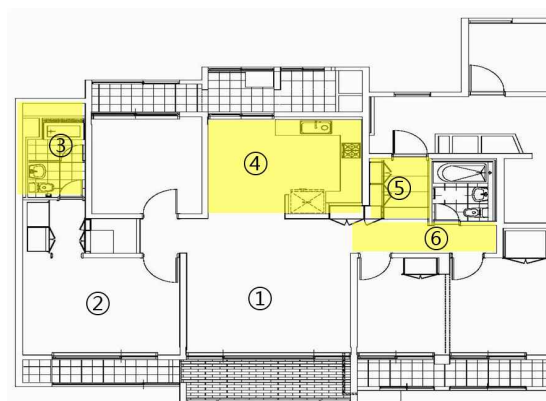


Figure 5: Measurement Point of Apartment House

Light Factor is 0.09~0.07% in the living room and master's bedroom, and kitchen those have openings. However, bathroom, entrance, and pathway shows 0.08~0% of light factor.

Table 7: Light Factor and Illuminance of Apartment House (Outdoor illuminance: 79,300 Lx)

item	Luxmeter location						average
	1 Living Room	2 Room1	3 Bath Room	4 Kit -chen	5 Ent- rance	6 Hall way	
indoor Illuminance	728	487	0	63	4.3	26	218
Light Factor	0.9	0.6	0	0.07	0.005	0.03	0.26

4. CONCLUSION

This research is a preliminary work in order to measure a possibility of applying sunlighting system in an apartment house those were built within 2 years. The result is as followed.

(1) A daylighting is needed in an additional bathroom (bathroom 2) as its function is emphasized.

(2) The window-size-to-area ratio is highest in the living room. And the window-size of the living room in residential-commercial building is wider than that of apartment house.

(3) In case of residential-commercial building, entrance, kitchen, and bathroom have insufficient light less than 60[Lx] even in the best time for lighting.

(4) In case of apartment house, entrance and bathroom have insufficient light, even in the best time for lighting.

As a result, in case of a residential-commercial building, areas such as kitchen, restroom, and entrance are relatively weak-lighting areas. In case of a traditional apartment house, restroom and entrance are relatively weak-lighting areas. For that reason, a special lighting support is needed in these areas.

Therefore, I examine the possible sunlighting system for areas mentioned above, its efficiency, and application methods in next research.

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