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DAYLIGHTING PERFORMANCE ON VENETIAN BLIND FOR HEALTHY APARTMENT HOUSING

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ABSTRACT:

The balcony expansion of apartment houses has been legalized recently in Korea and causes lots of environmental problems. Enlarging living area by balcony expansion, the unshaded window area is exposed to the direct sunlight. Blind system can be used in all orientations and all latitudes and it may obstruct, absorb, reflect and transmit solar radiation to building by proper adjusting slat angle and blind height. However, blind system can produce discomfort in occupant and less energyefficiency, if it has not been controlled optimally. The purpose of this study was to estimate the occupant preferred position method for daylight control and recommended the operation of venetian blinds. The main variables related to ratio of shading height to window area and blind's slat angle to seasonal variation and solar positions. The room dimensions based on unit module of apartments are 6.0m(width) X 6.9m(depth) X 2.7m(height) with 4.5m X 2.43m window opening. The blind system was simulated at five slat angles (horizontal, 30°, 45° upward and downward tilted) and the four ratio of shading height to window (fully closed, partly opened, non-blind) using the Desktop RADIANCE 2.0 program. The simulation results show as two indicators: daylight illuminance and uniformity.

Conference Topic: The Earth/Desert/Green and Sustainable Buildings
Keywords: Venetian blind, Solar control, RADIANCE program, Daylighting performance

1. INTRODUCTION:

In Korea, floor-to-ceiling window walls of living spaces are used widely in apartment buildings since the Korean government has legally allowed elimination of the balcony area. A balcony as a buffer space plays an important role in overhang sturucture, climate–filter, and indoor noise environment. Eliminating the balcony, the larger glass area of window in living space have produced excessive penetration of direct sunbeams and uncomfortable glare. In addition, occupants might be exposed to unwanted UV ray which cause a critical risk to their health. Thus, using a proper controlled daylighting strategy is a key factor for creates a high quality indoor environment and control energy demands. As a common sunlight controlling device, venetian blind system is essential to not only excluding intense daylight and reflecting light to rear wall zone but also improving uniformity in illuminance. In the preliminary stage of the study, parametric analysis on daylighting control strategy of venetian blind system was performed as a function of ratio of shading height to window and slat angles. A series of simulation produced illuminance data for the internal lighting level.

2. RESEARCH DESIGN AND METHOD:

2.1 Simulation Model

For the comparative study of daylight conditions, the CIE Clear sky applied to simulation model that considered as direct sunlight and installed on the south-facing window in general apartment building in Korea. In this study, conventional type of a horizontal blind was used to produce the Table 2. Korean standards A 3011: recommended level of illuminance in apartment basic performance data by Radiance program. The parametrical case studies of three cases of shading height to window area and five tiled slat angles were simulated to seasonal variation (equinox, summer, winter).

Table.1 Radiance simulation parameters

Parameters	Contents	
Building Type	Typical apartment house	
Simulation Model	6.0m(W) X 6.9m(D) X 2.7m(H)	
Window	4.50m(W) X 2.43m(H)	
Sky Condition	CIE clear sky	
Orientation	South	
Simulation Period	March, June, December, 21 (noon)	
Glazing Transmittance	78.2% (Clear LBNL)	
Reflectance	Floor	30.0% (grey LESO91)
	Ceiling	71.0% (beige paint LBNL)
	Wall	59.5% (beige LESO91)
	Frame	58.7% (light blue LES091)
	Blind	71.0% (beige paint LBNL)
Blind Control	Shading Height	0%(no-blind), 30%, 60%, 100%(fully-closed)
	Slat Angles	-30。-45。0。+30。+45。
	Slat Width	40mm

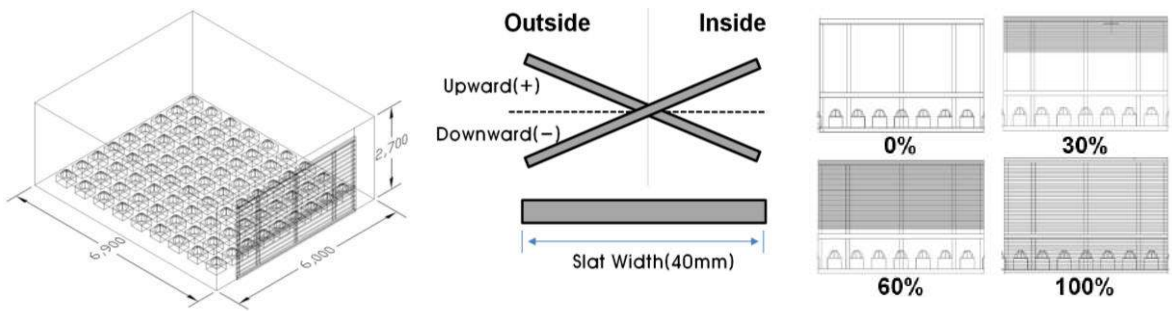


Fig 1. Model configuration **Fig 2. Blind control (slat angle and shading height)**

The room dimension was 6m X 6.9m (width by depth) and a floor to ceiling height of 2.5m(Fig. 1). Typical apartment building in Korea has a prototype of a window system with pair glass with a 78% transmittance. The internal walls are covered with a beige wall paper with a reflectance of 59.5%. The ceiling consists of a beige paper with a reflectance of 71% and the floor is covered with a gray carpet with a reflectance of 30%. Table 1 and Figure 2 show the simulation conditions and control method of blind system applied to Radiance analysis.

2.1 Criteria of Dayligting Performance

To providing daylighting parametric data related to shading height and slat angles, illuminance(lux) and uniformity value were calculated. A total of 81 illuminance sensors were located at 0.45m above the floor and spaced at a 0.5m interval starting from the surface of the interior wall as shown in Figure 1. The uniformity(U) can be defined as the ratio of the minimum to average illuminance.

By providing enough daylight for the perimeter zone, not only electric lighting but also cooling demand can be reduced. The threshold value of illuminance can vary according to the task category. Table 2 is a list of a Korean Standards illuminance recommendation that intended to guide an appropriate illuminanace for apartment.

Table 2. Korean standards A 3011: recommended level of illuminance in apartment

Type	Illuminance(lux)	Task category
Ambient	60-100-150	general activities, bathroom
	30-40-60	living room (general)
Task	300-400-600	reading, dining, cooking

3. DAYLIGHTING PERFORMANCE:

3.1 Daylighting Simulation

Daylighting simulation cases are made for the three key seasonal days (March 21st, June 21st and December 21st at noon) and on each day the CIE clear sky condition was selected. 436 daylighting simulations were performed for location of Seoul Korea (latitude 37.5° N; longitude 126.34° E). The slat angles were changed in ±30°, ±45°, 0° according to shading height to window area (0%, 30%, 60%, 100%).

3.2 Illuminance

Figure 3 shows the daylighting illuminance of a prototype blind system incorporating control slat angles and shading height to window area. The preliminary performance data were analysed based on the depth of the space in the window, intermediate and rear wall zone.

In equinox season, window zone showed identical daylight performance according to blind height with all slat angles but the degree of upward 45°. The case of 100% shading height with +45° tilted slat provided 6.5~15.5 times higher illuminance than other slats.

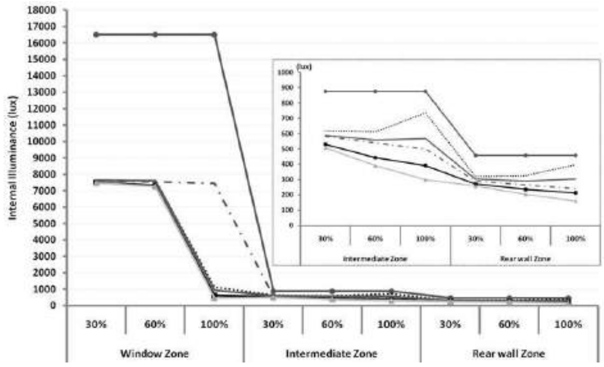
In the illuminance of intermediate and rear wall zone, 30° upward degree showed the most significant performance in 100% shading height for up to 146% light level.

In summer, average illuminance was relatively 2 times lower than other seasons due to the higher solar altitude. Shading height of 60% and 100% and +30°, +45°, 0° tilted slats showed nearly identical daylight performance in middle and rear space with 18~37%, 23~48% higher light level than downward slat angles.

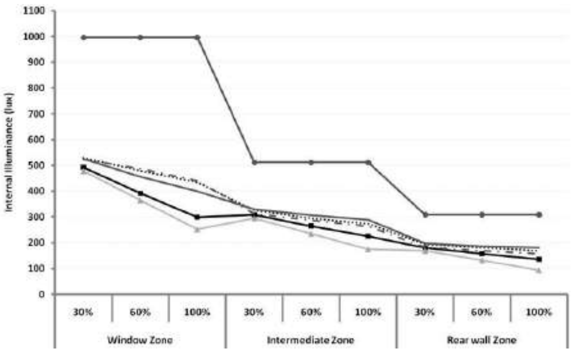
According to the change of shading height, upward and horizontal slat angles provided 16%, 13% of low illuminance differences for middle zone while downward tilted angles have showed 50% illuminance differences.

In winter season, window zone showed that the high identical light level according to 60% and 100% shading height with upward 30° and 45° tilted slats.

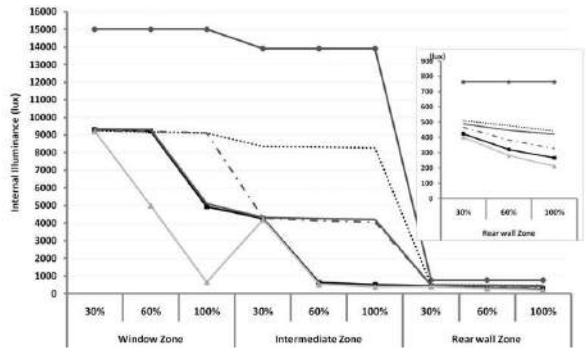
An upward 30° slat provided the significantly higher performance in the intermidiate zone regaldless of shading height. In the case of downward slat angles, illuminance of rear wall zone showed 45~90% reduction as shading heights were increased.



a) Equinox (Mar. 21st)



b) Summer (June. 21st)



c) Winter (Dec. 21st)

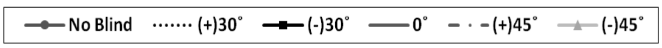


Figure 3. Daylighting illuminacne in seasonal days (south orientation at noon)

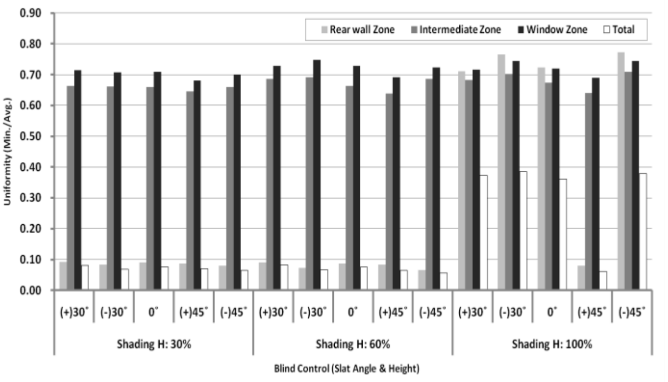
3.3 Uniformity

Figure 4 showed the illuminance uniformity on seasonal days. In equinox, the internal uniformity of 100% shading height with upward 30° and 0°slat angles provided 4.6times increase compare to other slat height. The reason is that the rear zone illuminance was lit by reflective light.

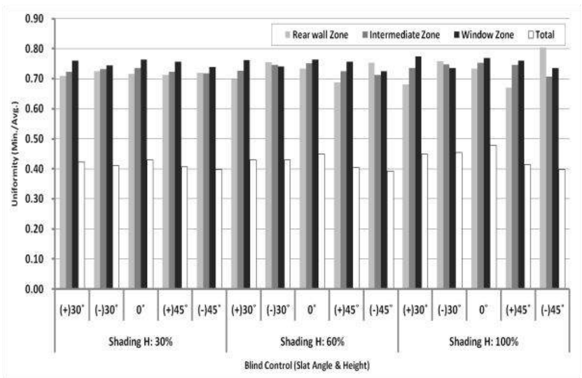
In summer (June. 21st), illuminance uniformity provided significant high performance in all kinds of blind controls in comparison with other seasons (i.e., Mar. 21st, Dec. 21st).

In the uniformity on Dec. 21st at intermediate zone provided 5.6times decreased due to the high illuminance differences resulted from penetrating direct beam light of low solar position.

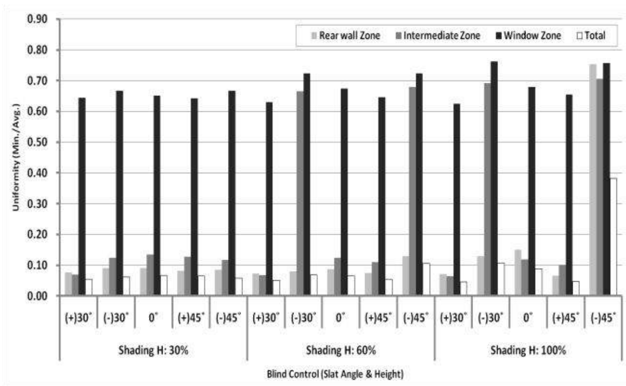
The shading height of 60% and 100% with downward slat angles has the greatest uniform illuminance of intermediate zone.



a) Equinox (Mar. 21st)



b) Summer (June. 21st)



c) Winter (Dec. 21st)

Figure 4. Illuminacne uniformity in seasonal days (south orientation at noon)

4. CONCLUSION

For optimal control of venetian blinds, parametric simulations with RADIANCE program have been conducted. The venetian blind with optimal heights and tilted slats could be applied to get more daylight, higher uniformity and more outside view.

1. In equinox, the venetian blind with all shading height and upward slat angles penetrate high daylight performance and fully-closed blind provided high uniformity with slat angle control due to rear wall zone uniformity was rapidly increased.
2. In summer, the venetian blind with all shading height with upward slat angles provided desirable illumination and uniformity as the shading height has not impact on daylight performance.
3. In winter, the venetian blind with shading-height of 60% and 100% and downward slat angles in middle zone provided low illuminance and improves uniformity. Whereas, proper control of shading heights and slat angles for window zone and middle zone should be considered to control direct sunbeam from low angle sunlight.

This study is a preliminary simulation-based daylighting performance on the venetian blind systems. Studies on energy demands (i.e., heating, cooling and lighting load) with various parameters (i.e., solar position, shading control, light dimming control) might be considered for further outcomes.

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