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Basic Research on Performance Evaluation of Light Shelf Applying Curvature

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Abstract. Recently, buildings take up 39% of total energy consumption in Korea, 28% of which is consumed as lighting energy. Therefore, various studies are conducted in order to reduce indoor artificial lighting energy consumption. Natural lighting systems can efficiently save lighting energy, among which the light shelf is a system with excellent lighting performance and economic feasibility using the inflow of natural lights. The performance of light shelves is determined by the form of reflector in terms of reflection, and rays that apply curvature are excellent due to the diffusion of light. Therefore, this study focused on testing the performance of light shelf applying curvature, and conducted seasonal research using a real-scale test bed for the lighting performance of light shelf applying curvature that can be implemented round-the-clock and year-round. Moreover, this study aimed to verify the energy saving efficiency by applying change by the curvature value of light shelf reflector based on the width of light shelf and the meridian altitude of the sun.

Keyword: Light-Shelf System, Curvature, performance evaluation

1 Introduction

1.2 Purpose of research

With the rapid increase in global energy consumption, various studies are conducted to reduce lighting energy. Among them, many researches are carried out with regard to the light shelf, which is a natural lighting system with excellent economic feasibility and lighting performance. Previous researches on light shelf applied flat-type reflectors, but flat surface allows less inflow of light than a curve, which acts as a disadvantage in terms of lighting performance. Therefore, applying curvature on light shelf will lead to more natural lighting flowing indoors and save lighting energy by bringing light more deeply into space than a flat light shelf and producing large-area diffusion. This study aims to verify the performance by comparatively analyzing the flat light shelf and light shelf applying curvature.

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1.2 Methods and procedures of the study

First, this study set up the external illumination value that may influence the environment per residential space and conducted a performance evaluation on meridian altitude and curvature value of light shelf reflector. The angle is set up to be right-angled, and a test bed reproducing the actual residential environment is established for performance evaluation.

2 Light shelf system

2.1 Concept of shelf system of light

The light shelf system is a system that blocks natural light flowing indoors and bringing light deep inside by reflecting light in order to prevent problems such as severe illumination imbalance and glares in the process of inflow due to external direct lights. Moreover, the light shelf is a natural lighting system that equalizes the indoor illumination to save lighting energy and improve the quality of space at the same time. It is desirable to install the light shelf at a low position for natural light flowing in, but generally it is installed above the eye level of a standing person in order to prevent glares and secure the prospect right of the occupants. The light shelf system is categorized into external type, internal type, and mixed type

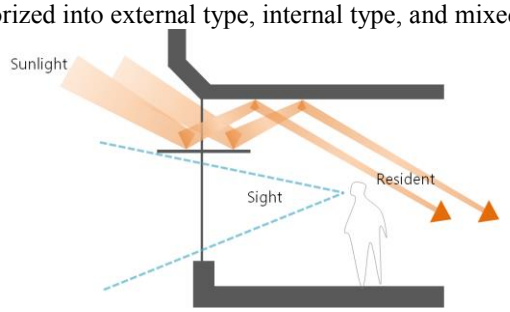

Fig. 1. The principle of the shelf system of light [1]

3 Performance Evaluation of the Application of Light Shelves of Curvature

Independent variables included the meridian altitude of summer, spring and fall and winter, width and curvature value. The height was 1800mm so that it does not cause inconvenience to the visibility of people, and surface reflectance of the light shelf system used the 85% reflective sheet. The angle was set as the right angle in proposing the performance evaluation.

Table1. Experiment Henin also set man Used and application of light shelf curvature

Light shelf width	400mm	
Light shelf height	1800mm	
Light shelf reflectivity	specular reflection film (reflexibility 85%)	
Season	summer	76.5°
Type	External fixed type	

The test bed can be implemented round-the-clock and year-round, and it included the solar altitude and external environment of four seasons ----- spring and fall, winter and summer ----- using an artificial sunray irradiation facility similar to the brightness of the actual sun. Moreover, the illumination sensor module was arranged in four sections at 2,200mm intervals, and the lighting was installed near the sensor.

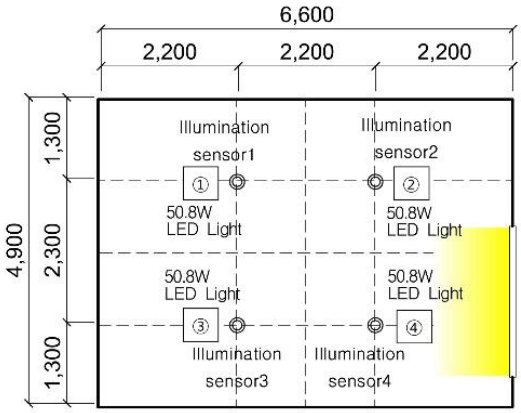

Fig. 2. Height of the illuminance sensor and the cross section of the test bed

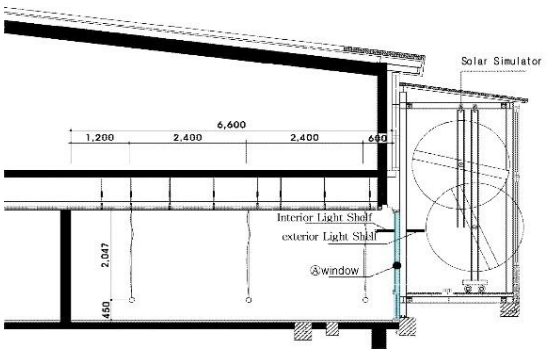

Fig. 3. Position of the illuminance sensor Ceiling

Table 2. Application performance analysis result of the curvature

Season	Time	Light shelf		Ceiling illuminance(lx)			
		width	Curvature	1	2	3	4
Summer	12H~2H	400	0	212.90	473.28	182.37	1039.49
			20	223.54	505.00	193.38	1095.11

4 Conclusions

This study controlled the variables by setting up the light shelf width as 400mm, time between 12 and 2 p.m., and the angle as the right angle. The independent variable was set as the curvature of 20°, comparing the basic illumination of a flat light shelf, illumination of installing a flat light shelf, and applying the curvature of 20°. In summer when there is abundant sunlight, the curvature will be used more efficiently and thereby be more beneficial than the flat surface. This study proposed an efficient inflow of natural lighting into indoor space by applying curvature, and there will be continuous research in the future to improve light shelf lighting performance.

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