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A Preliminary Study on the Lighting Performance of Internal Light-Shelf according to the Shape of Curvature

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Abstract. The energy consumption in buildings accounts for 39% of total energy consumption in our country, and 28% of energy consumption in buildings is consumed for lighting energy, so various studies for reducing the consumption of indoor artificial lighting energy have been carried out. The light-shelf system among natural lighting systems is the system with excellent lighting performance and economic feasibility. The performance of light-shelf id determined by the side of reflection, and the light-shelf applied with the curvature is especially excellent due to the diffusion of light. Therefore, this study focuses on the verification of performance through the comparison between concave curvature and convex curvature applied to the light-shelf, and the energy saving efficiency of light-shelf is verified in this study by applying different curvature values on the reflective surface of light-shelf and light-shelf angles based on the solar altitude at meridian passage and shape of light-shelf.

Keyword: Internal Light-Shelf System, Curvature, Lighting Performance

1 Introduction

1.1 Purpose of study

Due to rapid energy consumption increase around the world, various studies for reducing the consumption of lighting energy are being carried out, and various studies on the light-shelf are being carried out since the light-shelf among various natural lighting systems has excellent lighting performance and economic feasibility. Studies on the light-shelf have been carried out mainly for the light-shelf with flat reflective surface. The curved light-shelf is more advantageous than the flat light-shelf due to the diffusion of incoming and reflected light. Also, the internal light-shelf has lower performance than the external light-shelf, so studies regarding the improvement of its performance are necessary. Therefore, the performance evaluation is carried out in this study by applying curvature to the internal light-shelf, and this study aims at the establishment of preliminary performance evaluation data according to the application of curvature. And, another purpose of this study is to verify the energy saving efficiency of light-shelf by applying different curvature values on the reflective

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surface of light-shelf and light-shelf angles based on the solar altitude at meridian passage and shape of light-shelf.

1.2 Methods and Procedures of the study

In this study, the test bed which reproduced the actual residential environments is established and the external illumination value is set in order to carry out the performance evaluation of internal light-shelf according to the shape of curvature, and the performance evaluation for the curvature angle of reflective surface on the light-shelf is carried out[1].

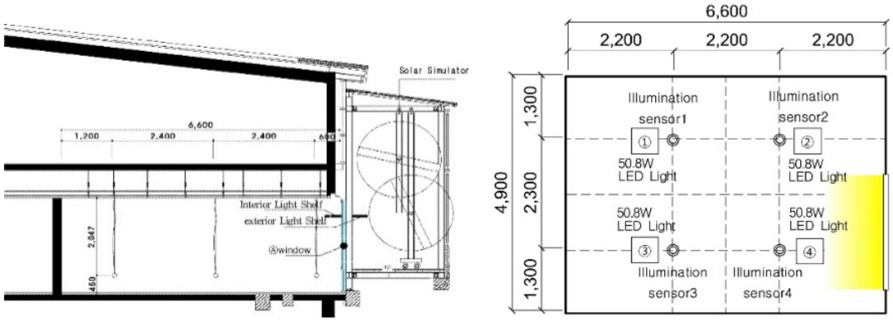

Fig. 1. View of Test Bed and Position of the illuminance sensor Ceiling

2 Light Shelf System

The light shelf system is to simultaneously interrupt introduced natural light to prevent extreme illuminance imbalance and glaring in the process of light introduction, due to solar direct light from outside, and let solar light come into indoor deep by reflecting light.

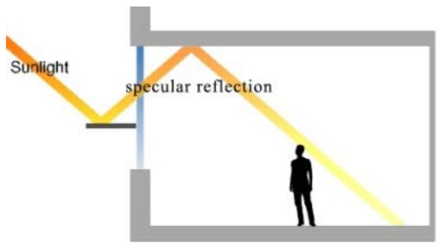

Fig. 2. The principle of the shelf system of light[1]

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3 Performance evaluation of the application of light shelves of curvature

Independent variables are set for season, width and curvature as shown in Table 1 and the right angle is set for the angle of light-shelf in order to carry out the performance evaluation of internal light-shelf according to the shape of curvature[1].

Table 1. Setting of test-bed

Light shelf width	Internal fixed type	400 mm
Light shelf style	concave, convex	
Light shelf Curvature	0°, 40°, 80°	
Light shelf height	1800 mm	
Light shelf reflectivity	specular reflection film (reflexibility 85%)	
Season	Summer	76.5°

The variable is controlled to 12 PM to 2 PM on the summer solstice when altitude is the highest along with the solar altitude at meridian passage to establish the external illumination as the basic illumination and it is measured as shown in Table 2.

Table 2. External Environment of Experiment

Seasons	External illumination	Basic illumination(lx)			
		1	2	3	4
Summer	80000lx	183.72	279.42	176.36	789.21

Table 3. Analysis result of lighting performance of light-shelf applied with curvature

Seasons	Times	Light shelf			Ceiling illumination(lx)			
		Width (mm)	Shape of reflector	Curvature	1	2	3	4
Summer	12H~ 2H	400	concave	0	212.90	473.28	182.37	1039.49
				40	219.88	513.21	197.32	1092.08
				80	240.97	521.37	251.43	1171.71
			convex	0	207.62	468.51	179.53	1027.55
				40	167.29	307.32	156.21	889.51
				80	140.11	298.81	142.65	715.46

As shown in Table 3, summer solstice is set for season, 12 PM to 2 PM is set for time and 400 mm is set for the width of light-shelf in order to analyze the lighting performance. The comparative analysis is carried out by applying concave and convex light-shelves for the shape of light-shelf and 0°, 40° and 80° for the angle of curvature, and it is confirmed in this study that as the angle of curvature increases, illumination also increases proportionally when the concave light-shelf is installed, and when the convex light-shelf is installed, as the angle of curvature increases, illumination decreases inverse-proportionally.

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4 Conclusion

In this study, variables including the width of convex light-shelf, time and angle are controlled to 400 mm, 12 PM to 2 PM and the right angle respectively and summer solstice and 0°, 40° and, 80° are set for independent variables including season and curvature. The illuminations in case of installing concave light-shelf, convex light-shelf and in case of applying 0°, 40° and 80° for curvature are compared. During the summer solstice with high external illumination, the curvature is used efficiently so that as the angle of curvature increases, illumination also increases proportionally when the concave light-shelf is installed, and when the convex light-shelf is installed, as the angle of curvature increases, illumination decreases inverse-proportionally. In this study, suggestion and comparative analysis regarding bringing natural lighting into indoor space efficiently by applying curvature according to the shape of light-shelf, and it is expected that studies for improving the lighting performance of light-shelf will be carried out continuously in future.

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