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A Preliminary Study on the Drawing of Proper Distance between the Window and Internal Light-Shelf for Improving the Lighting Performance

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Abstract. The energy consumption in buildings accounts for approximately 40% of total energy consumption in the world. The light-shelf system is suggested as a measure to reduce energy consumption in buildings, and the test bed is used for evaluating the performance of suggested light-shelf system. The result of this study can be used as the preliminary data for design to install the internal light-shelf by improving the efficiency of light-shelf through the proper location and angle of light-shelf indoors.

Keywords: Light-Shelf System, Distance, Performance Evaluation

1 Introduction

1.1 Purpose of study

Recently increased energy consumption has caused various problems such as exhaustion of energy resource, depletion of the ozone layer, global warming and climate changes. Especially, the energy consumption in buildings accounts for approximately 40% of total energy consumption in the world. Efforts to reduce use of lighting energy have been made in order to reduce energy consumption in buildings. Among those efforts, the efficiency of light-shelf system has been recognized so that various studies regarding the light-shelf system have been carried out, but still there is lack of studies regarding actual application of light-shelf. The performance of internal light-shelf which is a type of light-shelf system is somewhat lower than the performance of external light-shelf so that studies for improving its performance are necessary.

Therefore, the purpose of this study is to suggest the light-shelf system for improving lighting and reducing the consumption of lighting energy and draw proper location and angle of light-shelf through the distance between the window and light-shelf.

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1.2 Method and procedure of study

In this study, the light-shelf system for saving energy through solar altitude, external illumination which are external environment factors, width of light-shelf and distance between the window and light-shelf is suggested in order to determine the proper location and angle of internal light-shelf. In order to find the illumination according to the proper location and angle of suggested light-shelf system, the evaluation of energy performance for each season is carried out through actual scale test bed which can reduce actual environments for 24 hours a day and 365 days a year and the possibility and efficiency of internal light-shelf system to be introduced into residence are verified.

2 Light-shelf system

The light-shelf system is the natural lighting system which reflects incident sunlight from the window through the indoor ceiling surface and brings in light into indoors, and this system can block natural light incoming to indoors and distribute interior illumination evenly in order to prevent problems such as dazzling from direct sunlight and illumination imbalance, improving the quality of indoor space and reducing the consumption of lighting energy through natural light.

3 Suggestion of light-shelf system according to the distance between the window and internal light-shelf

The purpose of light-shelf system according to the distance between the window and internal light-shelf is to find proper location and angle of internal light-shelf installed indoors through the fixed height of light-shelf and distance between the window and light-shelf in order to adjust the amount of natural light incoming to indoors and find proper illumination. For the suggested system, fix the width of light-shelf first at the fixed height, change the distance between the window and light-shelf, measure the illumination through each illumination sensor, change the angle of light-shelf second, measure the illumination through each illumination sensor, change the width of light-shelf gradually and measure the illumination through changes in the distance between the window and light-shelf and angle of light-shelf. Carry out this process repeatedly in consecutive order and compare and analyze the illumination.

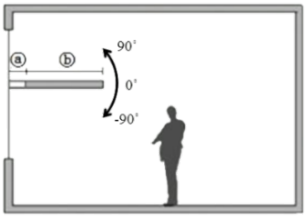

Fig. 2. Configuration of Light Shelf System

4 Result of performance evaluation

The configuration of test bed to verify the performance of light-shelf system according to the distance between the window and reflective surface of light-shelf in this study is as shown in Fig. 4.

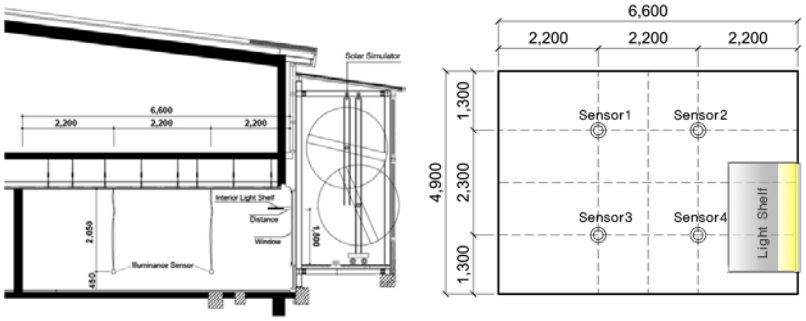

Fig. 3. Cross Sectional Diagram of the Test Bed and Height of the Luminance Sensor

The variables of light-shelf system for evaluation of performance according to the distance between the internal light-shelf and window are as shown in Table 1, and the angle of light-shelf, vernal equinox and autumnal equinox, summer solstice, winter solstice and solar altitude at meridian passage are set as the experiment variables and the experiment result is drawn. 100mm~400mm is set as the width of light-shelf, 0mm~400mm is set as the distance between the window and light-shelf, and 600mm is set as sum of width of light-shelf and the distance between the window and light-shelf. The result of performance evaluation according to the distance between the internal light-shelf and window can be used as preliminary data in the actual light-shelf design, and different performance evaluation results were shown depending on the distance, so it is necessary to consider such results for designing.

Table 1. Setting of Factors of a Light Shelf

Distance	ⓐ	0mm ~ 500mm
Width	ⓑ : 100mm ~ 400mm / ⓐ + ⓑ : 600mm	
Light Shelf Reflectivity	specular reflection film (reflexibility 85%)	
Meridian transit altitude	Summer Solstice 76.5° / Spring and Autumnal equinoxes 53° / Winter Solstice29.5°	
Angle	-90° ~ 90° (10° Unit)	

5 Conclusion

The light-shelf system can respond to energy issues all over the world as well as the lighting performance directly. In case of the light-shelf system according to the

distance between the window and light-shelf suggested in this study, the proper location of internal light-shelf and the proper distance between the window and light-shelf can be drawn by changing the width, position and angle of internal light-shelf in order to bring natural light into indoors effectively so that the indoor lighting environment and light performance can be improved, and the consumption of indoor lighting energy can be reduced and the result of this study can be used as the preliminary data for design to install the internal light-shelf.

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