Advanced Science and Technology Letters
Vol.89 (Architecture and Civil Engineering 2015), pp.128-132
http://dx.doi.org/10.14257/astl.2015.89.26

# Basic Study on Performance Evaluation according to Separation Distance of Internal Double Light-Shelf Reflector

Yuchang Choi[1.1], Heangwoo Lee[1.2], Yongseong Kim[1.3]

[1]The Graduate School of Techno Design, Kookmin University, Jeongneung-dong, Seongbuk-gu, Seoul, 136-702, KOREA
uchangaa@hanmail.net1.1, moonup2001@nate.com1.2, yongkim@kookmin.ac.kr1.3

**Abstract.** As lighting energy consumption increases, various studies are carried out to solve such a problem. As a solution to the problem, a variety of studies are conducted since the performance of light-shelf using external natural light is excellent. The light-shelf is divided into external, internal and mixed type light shelves, and also it is divided into single light shelf and double light-shelf according to reflector's installation type. Preceding studies on light shelves are mostly simulation studies. In this regard, this study aimed to conduct an experiment research of double light-shelf, and the study results are as follows: 1) When a double light-shelf is applied, average illuminance increases compared with a single light-shelf. 2) When an internal double light-shelf is applied, uniformity factor declines compared with a single light-shelf, and this is a factor to consider in installing a light-shelf. 3) In case of the internal double light-shelf selected in this study, when separation distance diminishes, uniformity factor improves. Also, when separation distance is 100mm, indoor illuminance distribution is high, which is advantageous to lighting energy reduction. Therefore, proper separation distance of an internal double light-shelf is 100mm on the summer solstice.

**Keywords:** Double Light-Shelf, Ceiling Height, Performance Evaluation

## 1 Introduction

The need for energy reduction emerges due to the increase of lighting energy consumption out of total building energy consumption. As a solution to this, various studies are being carried out since the efficiency of a natural daylighting system using external natural light is outstanding [1]. The type of a light shelf is divided into external, internal and mixed type light shelves. According to reflection installation type, a light-shelf is also divided into a general single light-shelf with a single reflector, and a double light-shelf with double reflector. Especially, the double light-shelf can reduce the width of light-shelf by applying two reflectors. It can reduce damage by external factors including wind pressure, and can maximize daylighting performance improvement. However, studies on double light shelf design are greatly insufficient and a study on basic data is urgently necessary. The purpose of this study

ISSN: 2287-1233 ASTL

is to conduct performance evaluation depending on the separation distance of double light-shelf's reflectors and conclude proper separation distance of the double light shelf's reflectors.

## 2 Concept of Double Light-Shelf and performance evaluation of an internal-type light-Shelf

### 2.1 Concept of Double Light-Shelf

As shown in Fig.1, the effect of a double light shelf is equal to existing light shelves. However, the reflector type of the light shelf is double and external natural light is introduced directly. To solve the problem caused by imbalanced illuminance, the indoor illuminance distribution need to be even by preventing natural light coming to indoor space directly and introducing the light deeply through reflection. Through this process, natural light system is operated to reduce lightening energy while improving the quality of indoor space.

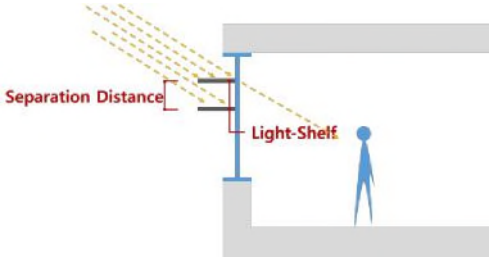


**Fig. 1.** Concept of Double Light Shelf

### 2.2 Setting Double Light Shelf for Performance Evaluation

Table 1 shows the setting of the width, height, separation distance and angle of single and double light shelves. Table 2 reveals the setting of the size, quality of material, reflectivity, window size and the quality of material of test-bed.

**Table 1.** internal type Double Light-Shelf variable

| | | |
|---|---|---|
| Light-Shelf | Single Light-Shelf Width | 600mm |
| | Double Light-Shelf Width | lower: 300mm, upper: 300mm |
| | Height | 1800mm |
| | Separation distance | By 100mm at 2300mm |
| | reflectance | Reflective film (85%) |
| | angle | Fixed-type (0°) |
| Meridian transit altitude | | Summer Solstice (29.5˚) |

**Table 2.** Installation of Internal Double Light Shelf and Location of Illuminance Sensor within Test-Bed

| | | |
|---|---|---|
| Room Size | 4.9m(W)×6.6m(D)×2.5m(H) |  |
| reflectance | Wall: reflectance 46%, Ceiling: reflectance 86% | |
| Windows Size | 1.76m(W) × 1.76m(H) | |

### 2.3 Setting Distance of Double Light Shelf for Performance Evaluation

An internal double light shelf is shown on the left of Fig. 2, and the plane of test-bed is shown on the right, and the location of an illuminance sensor is indicated. In consideration of working surface, the illuminance sensor was located at 750mm above the working surface.


**Fig 2.** Performance evaluation result according to the separation distance of internal double light shelf's reflector on the summer solstic

## 3 Performance Evaluation Method and Result of double Light Shelf

According to the separation distance of double light shelf's reflector on the summer solstice, the performance evaluation method is as follows: First, solar altitude at meridian passage on performance evaluation was limited to the situation depending on the summer solstice. Second, the width of a single light shelf was set to be 600mm, and the width of a double light shelf was set to be 300mm, equally both for the upper and lower light shelves. Third, the separation distance of the double light shelf was increased up to 500mm by rising 100mm, respectively, based on the lower light shelf's height, 1800mm.

**Table 3.** Performance evaluation result according to the separation distance of internal double light shelf's reflector on the summer solstice

| | | Sensor 1 | Sensor 2 | Sensor 3 | Sensor 4 | Average Illumination | Uniformity Illumination |
|---|---|---|---|---|---|---|---|
| Single Light Shelf | | 183.44 | 179.98 | 56.94 | 99.86 | 130.06 | 0.44 |
| Separation | 100mm | 207.4 | 272.08 | 85.36 | 492.72 | 264.39 | 0.32 |
| | 200mm | 202.08 | 247.38 | 69.56 | 454.54 | 243.39 | 0.29 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| distance | 300mm | 201.02 | 248.30 | 69.18 | 440.22 | 239.68 | 0.29 |
| | 400mm | 205.02 | 255.32 | 61.22 | 503.12 | 256.17 | 0.24 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 500mm | 198.52 | 268.90 | 55.46 | 573.44 | 274.08 | 0.20 |

According to the separation distance of double light shelf's reflector on the summer solstice, the performance evaluation is identified as follows: 1) When a double light shelf is applied, average illuminance increases compared with a single light shelf. It is judged to be derived from the intensity of radiation introduced by the light shelf. 2) When an internal double light shelf is applied, uniformity factor is reduced compared with a single light shelf. It is a factor to be considered in installing s light shelf. 3) As for the internal double light shelf selected in this study, when separation distance is reduced, uniformity factor improves. Also, when separation distance is 100mm, indoor illuminance distribution is high. It is favorable to lighting energy reduction. The proper separation distance of internal double lighting shelf is 100mm on the summer solstice.

## 4 Conclusion

This study aims to offer basic data upon design through performance evaluation according to the separation distance of a double light shelf's reflector. The study results are presented below: Firstly, when a double light shelf is applied, average illuminance increases compared with a single light shelf. It is judged to be derived from the increase of the intensity of radiation by the light shelf. Secondly, when an internal double light shelf is applied, uniformity factor is reduced compared with a single light shelf. It is a factor to be considered in installing a light shelf. Thirdly, as for the internal double light shelf selected in this study, when separation distance diminishes, uniformity factor improves. Also, when separation distance is 100mm, illuminance distribution is high. It is favorable to lighting energy reduction. Therefore, the proper separation distance of an internal double light shelf's reflector is 100mm on the summer solstice.

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