

A Basic Research on Size and Angle of Gradient of Light Shelf

Woori Chae^{1,1}, Heangwoo Lee^{2,1}, Yongseong Kim^{2,2}

The Graduate School of Techno Design, Kookmin University, Jeongneung-dong,
Seongbuk-gu, Seoul, 136-702, KOREA
woori1983@nate.com^{1,1}, moonup2001@nate.com^{2,1}, yongkim@kookmin.ac.kr^{2,2}

Abstract. The natural lighting technique in architecture has developed into a philosophical meaning on the strength of technological advancement on artificial light. However, with the emergence of energy reduction and eco-friendly alternative energy technology, natural lighting has gained momentum for secondary development from the two perspectives, i.e. the purpose of lighting energy reduction and indoor visual environment improvement. This study drew the performance assessment standard needed for usefulness of Light Shelf System through the preceding research and literature review of Light Shelf System which makes it possible for natural lighting to aggressively be introduced into architecture.

Keywords: Light Shelf System, Daylighting Performance, illuminance

1 Introduction

With the necessity of energy reduction becoming the topic of conversation among the public after the oil shock triggered by the rapid increase in energy consumption in the late 20th century the importance of environment preservation began to stand out. With the technological research on eco-friendly alternative energy actively in progress, the application cases of eco-friendly alternative energy technology have been increasing up to the present day. In addition, natural lighting technology using daylight also began to resume its development from the viewpoint of energy conservation.

The technological research on natural lighting has been done with the aim of conserving energy and enhancing the visual environment quality. The Light Shelf System among natural lighting technologies is excellent in economic feasibility in comparison with other active natural lighting technologies; hereupon, this study suggested the performance assessment standard needed for usefulness of the Light Shelf System through the preceding research and literature review of the Light Shelf System which can afford to aggressively introduce natural lighting into architecture.

2. Light Shelf system

2.1 Concept of Natural Lighting

Natural lighting is defined as a thing which doesn't cause a human's eyesight inconvenience as it uses natural light through the window. The reason why aggressively introducing natural light into a building interior other than simply the use of outside natural light through the window is considered as being important may lie in indoor occupants' visual environment improvement and lighting energy reduction in a state where indoor uniformity factor and glare problems are solved.

Daylight exists in the form of direct sunlight, scattered light and in the mixed form of the foregoing two; in case of direct sunlight, its illuminance value is extremely high, but in case it is directly flowed indoor, it rather becomes a factor in hindering one's visual environment due to the problem, such as glare or silhouette phenomenon, etc.¹ Such problems can be improved by inducing the inflow of sunlight indoors after scattering sunlight using a design technique of a structure or mechanical device.

2.2 Concept of Light Shelf system

The Light Shelf System is a kind of natural lighting system, which induces the influx of direct sunlight deep into every corner of the structure interiors by reflecting the direct sunlight flowing into the interiors. Light Shelf System plays a role as an awning blocking out the glare phenomenon due to the high illuminance at the window side, making it possible for natural light flowing into the interiors to get as far as the in-depth interior space by reflecting it. Accordingly, the Light Shelf System is the lighting system which serves to enhance the quality of the interior space and to reduce illuminance energy by equalizing the interior illuminance distribution and decreasing the excess of illuminance at the window surface part while augmenting the illuminance at the window posterior part.

Generally, the Light Shelf System is installed at the inner or outer side of the vertical window horizontally. At a time of installation, not only the Light Shelf System but also the window and ceiling become vital elements, and the installation work should be done by taking into account the architectural situation of a building where the Light Shelf System is to be installed.

2.3 Light Shelf System Angle Control

Generally, the Light Shelf System available for angle control is more expensive than the fixed Light Shelf System, but the Light Shelf System available for angle control is

¹ Kim, Tae-hyung, A Study on Performance Assessment of Light Shelf system of Scho of Building for Natural Lighting Use, Graduate Thesis at Hanbat National University, 2006

more flexible in using aspects. When the Light Shelf System angle is lowered, it covers the periphery of the window, reducing the amount of light reflected on the ceiling.

In case the Light Shelf System angle is adjusted upward, the penetration of the reflected sunlight is improved, but the light-shielding effect of the window periphery is reduced. The fixed Light Shelf System outside can block out much more direct light coming in through the lower viewing opening, making it possible for the interior cooling load to be reduced. In case of the internal fixed Light Shelf System, its upper side doesn't get shady, which causes the radian heat of the light transmitted through the fan light to increase.²

3 Proposal of Light Shelf System Performance Assessment

A reasonable proposal of the internal Light Shelf System can be drawn through the process of conducting the performance assessment of the angle and size of the internal Light Shelf System at the Summer Solstice point, Winter Solstice point, Vernal Equinox point and Autumnal Equinox point using artificial sunlight which is available for setting the external illuminance by each season as a setup variable at an actual size of the test bed, and analyzing the correlation of the interior daylight inflow. The progression stage is proposed as follows:

1) Consideration of the Light Shelf System

Analyzing the definition of the Light Shelf System and its application cases through consideration of the preceding research and drawing the insufficient part of the performance assessment of the Light Shelf System which has been under research progress up to the present day.

2) Light Shelf System Experimental Set-up Variable

An experiment by setting up the height, angle, size and external variable element of the Light Shelf System while applying the meridian transit altitude by season and illuminance value of clear sky conditions on the basis of the preceding research is done.

3) Light Shelf System Performance Assessment

* Implementation of Performance Assessment in order to verify the effectiveness of the Light Shelf System.

* Implementation of the performance assessment by each season consequent on solar altitude of the internal Light Shelf System.

* Verification of correlation & utility of variables by analyzing the interior illuminance distribution through daylight inflow in relation to angle and size of the Light Shelf System.

² Kim, Tae-hyung, A Study on Performance Assessment of Light Shelf System of School Building for Natural Lighting Use, Graduate Thesis at Hanbat National University, 2006

4 Conclusion

This study drew the performance assessment standard needed for usefulness of the Light Shelf system through consideration of the preceding research.

1. In case the angle of the Light Shelf System is adjusted downward, the periphery of the window is covered, reducing the amount of light reflected on the ceiling while adjusting the Light Shelf System angle upward improves the penetration of the reflected sunlight, but reduces the light-shielding effect of the window periphery.

2. In case of overcast sky conditions or the window on the north side, it's advantageous to give the angle of the gradient of the internal Light Shelf system & external Light Shelf System.

The performance assessment standard needed for usefulness of the Light Shelf System is as follows:

1. A reasonable proposal of the internal Light Shelf System can be drawn through the process of conducting the performance assessment of the angle and size of the internal Light Shelf System at the Summer Solstice point, Winter Solstice point, Vernal Equinox point and Autumnal Equinox point using artificial sunlight which is available for setting the external illuminance by each season as a setup variable at an actual size of the test bed, and analyzing the correlation of the interior daylight inflow.

2. Analysis of the definition of the Light Shelf System and its application cases through consideration of the preceding research and drawing the insufficient part of the performance assessment of the Light Shelf System which has been under research progress up to the present.

3. Doing an experiment by setting up the height, angle, size and external variable element of the Light Shelf System while applying the meridian transit altitude by season and illuminance value of clear sky conditions on the basis of the preceding research.

References

1. Kim Jeong tai, Kim Ki cheol, Kim Gon, Development and Performance Evaluation of a Sloped Lightshelf Daylighting System
2. Kim, Tae-hyung, A Study on Performance Assessment of Light Shelf system of School Building for Natural Lighting Use, Graduate Thesis at Hanbat National University, 2006
3. Lee, Jong-su., A Study on Lighting and Energy Performance Assessment of Polycarbonate Light Shelf, Graduate Thesis at Kyunghee University, 2013
4. Seo, Tae-won, A Basic Study on User-recognition-Technology-applied illuminance Energy Reduction Light Shelf System in Residential Space, Master's Thesis at Techno-Design Graduate School of Kookmin University, 2013
5. Seo Tae-won, Lee Heang-woo, Kim yong-seong, A Study on Light-Shelf System using Context Awareness Technology for Energy Saving in Housing Space