The study on the computer analysis of solar daylighting system in the schoolroom

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1. Introduction

Daylighting is the efficient use of natural light in order to minimize the need for artificial light in buildings. A well thought out building designed with daylighting can have a number of significant benefits for building owners and occupants. Increasing levels of daylight within rooms can reduce electrical lighting loads by up to 70% in some cases.

In this study, the daylighting system using mini dish and optical fiber was analyzed for application to the schoolroom by the simulation of ECOTECT and RADIANCE.

2. Daylighting System and Computer Modeling

2.1 Daylighting System

The daylighting system we selected for simulation consists of a solar tracker, mini dish module which has a 30cm-parabolic concentrator and second reflector, an optic fibre and diffuser. Figure 1 shows the dayliging system using mini dish module.

Unlike other daylighting system, this system offers many obvious advantages as they do not require strong foundation or structure for installation and thus, reduce start-up costs. Even when subject to high wind velocities on occasions of strong winds from the ambient in certain times of the year, the mini dish concentrators experience relatively low wind drag requiring less inexpensive structures to hold them when they are placed on roofs of buildings.

Fig. 1. The daylighting system using mini dish module.

2.2 Modeling of Schoolroom

The classroom was modeled by using ECOTECT and exported to RADIANCE for the daylighting simulation.

In order to analyze the efficiency of daylighting system, a classroom of Jeju National University in Korea which has north & south-oriented windows was selected.

Figure 2 shows the dimensions of the classroom facing north.

The size of the classroom is 740cm×967.5cm, and its height 270cm. There are 10 desks in two rows and 1 white board on the west-side wall.

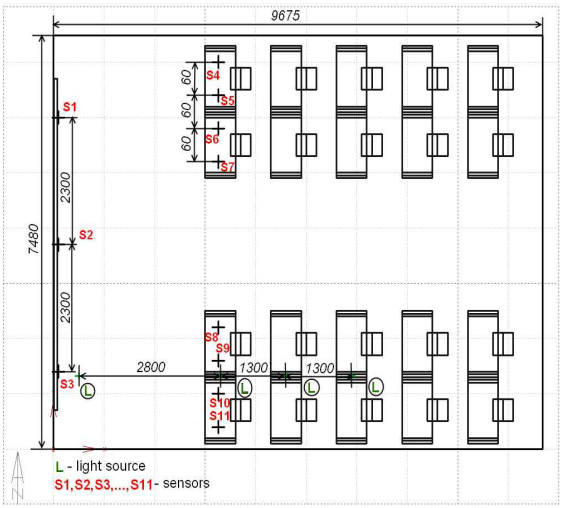


Fig. 2. Overall dimensions and sensors' location

The letter '+' indicates the diffuser of daylighting system in Figure 2. It was assumed that five daylighting system was installed in the classroom.

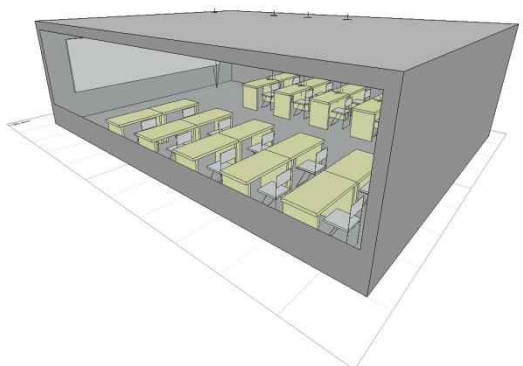


Fig. 3. The modeling of classroom by ECOTECT.

3. Results

As a result of the simulation, illuminance and luminance values in case of the room with daylighting system boosted up to 862.7 lux and 148.6 cd/m^2 at the center of opposite wall in the north-oriented classroom(Table Ⅰ, Ⅲ).

Table Ⅰ: A north-oriented classroom's luminance distribution (cd/m^2) in December 22, 2009 at 12:00 pm [(a),(b)]

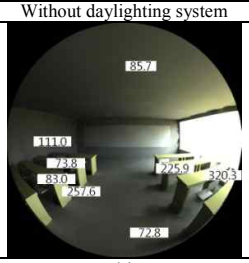
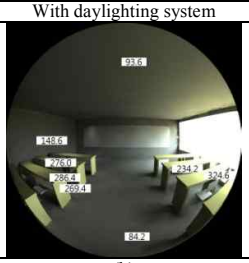
Without daylighting system	With daylighting system
	
(a)	(b)

Table Ⅱ: A north-oriented classroom's illuminance distribution (lux) in December 22, 2009 at 12:00 pm [(a),(b)]

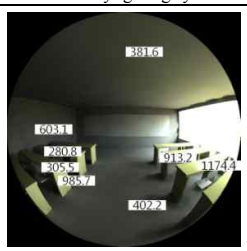
Without daylighting system	With daylighting system
	
(a)	(b)

Table Ⅲ: A south-oriented classroom's luminance distribution (cd/m^2) in December 23, 2009 at 12:00 pm [(a),(b)]

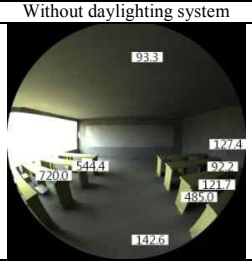
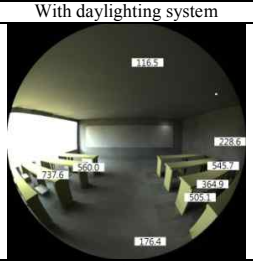
Without daylighting system	With daylighting system
	
(a)	(b)

Table Ⅳ: A south-oriented classroom's illuminance distribution (lux) in December 23, 2009 at 12:00 pm [(a),(b)]

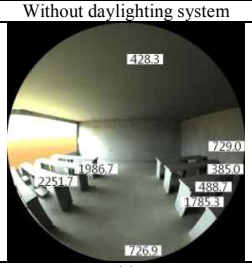
Without daylighting system	With daylighting system
	
(a)	(b)

Table Ⅲ and Ⅳ show 1296.4 lux and 228.6 cd/m^2 at the center of nearby wall in the south-oriented classroom.

3. Conclusions

As a result, illuminance and luminance values boosted up to 862.7 lux and 148.6 cd/m^2 at the center of opposite wall in the north-oriented classroom, 1296.4 lux and 228.6 cd/m^2 at the center of nearby wall in the south-oriented classroom from their lowest original values (i.e. the cases without daylighting systems) of 603.1 lux and 111.0 cd/m^2, 729 lux and 127.4 cd/m^2 respectively.

The present experimentation shows the schoolroom with daylighting system is brighter than without daylighting system. Especially, our daylighting system will be efficient in dark-space such as the north-oriented room, basement and so on.

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