Development of method to evaluate annual lighting energy saving effect using daylight in offices

(Research period: FY 2015)

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Keywords: Use of daylight in offices, annual lighting energy saving effect, evaluation method, energy conservation standard

1. Introduction

Non-residential buildings are expected to further improve their energy conservation performances, such as through the gradual requirement for new buildings to comply with energy conservation standards by 2020. Non-residential buildings are expected to improve the lighting energy saving effect using daylight as natural energy to realize net zero energy buildings (ZEB) while the use of high-efficient LED lights is now a common practice. Still, the reduction of lighting energy using daylight fundamentally requires annual simulations that take into account the weather conditions, the shape of openings and indoors, and specifications and setups of lighting devices. It is difficult to require designers to run such simulations and reflect them in the energy conservation standards. Therefore, the authors developed a method to simply and precisely evaluate the annual lighting energy saving effect in offices by running a systematic annual daylight simulation and calculating the energy saving effect based on indexes, such as the ratio of openings and the availability of automatically controlled blinds. The developed method was then reflected in the energy conservation standards.

2. The outline of the use of daylight in offices and outcomes of examinations

The use of daylight is a method to reduce lighting energy consumption while maintaining the necessary brightness within the entire office space by detecting brightness on a desktop using brightness sensors placed on the ceiling and controlling lighting devices based on the level of daylight entering through windows. Blind control is a system to automatically control the angle of blind slats. Its lighting energy saving effect was higher than non-controlled blinds (figure 1). This case was examined using Radiance, high-precision daylight simulation software, using standard setups to be reflected in energy conservation standards (no adjacent building on the outside, ratio of opening: 10%, setup illuminance: 750 lx, lower limit of the lighting control of a lighting device: 25%, fixed blind angle: 45°, no blind on the north side), and by systematically combining the directions of windows, number of surfaces, surface areas, and shapes of rooms. As a result, the standard office where blinds were installed had about 10% of an annual lighting energy saving effect with the use of daylight when the ratio of opening

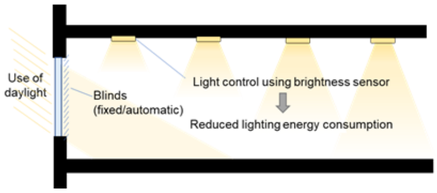

Figure 1: Method to reduce lighting energy using daylight

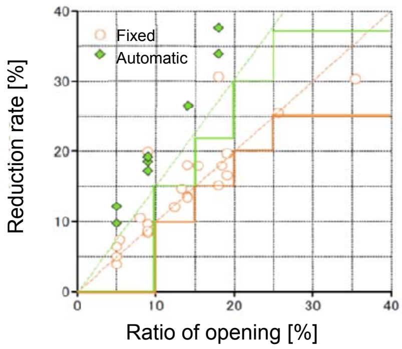

Figure 2: Relationship between the ratio of opening (open area/floor area of a room) and annual lighting energy saving rate

was 10%. The energy saving effect was greater when the blinds were being controlled compared to fixed-angle blinds. The angle of the regression line of the lighting energy saving rate for the ratio of opening was two times greater with controlled blinds. The study indicated that the energy saving effect could be easily identified with high precision (figure 2).

3. Reflection to energy conservation standards

The effects of reducing lighting energy using daylight based on the ratio of opening and the availability of automatically controlled blinds were reflected in the online program for the standard input method in the non-residential energy conservation standards in October 2017.

☞For more detailed information

1) National Institute for Land and Infrastructure Management Reference No. 973 2016 Energy Conservation Standards Technical References: Energy Consumption Performance Calculation Program (non-residential version) Ver. 2.4 (October 2017)