ABSTRACT

Lighting Designs and Controls for Energy Conservation in Office Buildings

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Most contemporary commercial buildings depend upon artificial lighting, even in the daytime, to maintain a proper task illuminance. The electric energy for the artificial lighting in commercial buildings takes almost 30 to 50 percent of the total electric energy consumption. In order to save electric lighting energy while maintaining a sufficient indoor illuminance, it is necessary to quantitatively assess the illuminances of daylighting and artificial lighting.

In this study, a computer simulation model to evaluate the performances of various lighting control algorithms was developed based on Monte Carlo method and ray-tracing technique. Then, the accuracy of the computer simulation model was validated through a series of measurements with physical scale models. In addition, a case study was performed for an office room in order to demonstrate the energy saving effects of a lighting control algorithm with the consideration of daylighting.

This thesis comprises a total of six chapters and the content of each chapter is as follows:

In Chapter 1, the background, purpose, contents, scope and procedure of the study

were described.

In Chapter 2, theories related to the electric lighting design methods and control schemes to save energy were reviewed.

In Chapter 3, theories related to Monte Carlo method, ray-tracing technique, and Perez sky model were reviewed. A computer simulation model which was developed in this study to determine the illuminances on the work plane and at the locations of photocells for lighting controls was described.

In Chapter 4, the procedure and the results of the physical scale model measurements to validate the accuracy of the computer simulation model were described. The results showed that the accuracy of the computer model was about 94 percent.

In Chapter 5, a series of computer simulations was performed to estimate the extinction rate of the electric lighting which were determined from the daylighting illuminances.

In Chapter 6, the conclusions of the study were described.

The results of this study can be summarized as follows:

1) The computer model developed based on Monte Carlo method and ray-tracing technique could accurately calculate the illuminances on the work plane and at the locations of photocells for lighting controls.

2) The validation results from the physical scale model measurements showed that the average error ratio of the computer model in determining the illuminances on the work plane was 6.24 percent and that in determining the illuiminance ratio of the work plane illuminance to photocell illuminance was 5.28 percent.

3) A series of computer simulation study with an office room demonstrate the energy conservation effects of daylighting.

4) The computer simulation model developed in this study could be used to develop energy conservative lighting control algorithms.