Committee Report

Research Committee Report on “Optimum Facade Type Considering Light and Visual Environment”

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ABSTRACT

This report summarizes the works of the Research Committee on “Optimum Facade Type Considering Light and Visual Environment” (from October, 2000 to March, 2003).

The use of daylight to replace or supplement electric lighting in commercial buildings can result in significant reductions in energy and demand. Façade design is one of the determinants for use of daylight. In order to assist designers who intend to use daylight in buildings, the committee provides a brochure showing the effects of window conditions on light and heat introduced in buildings visually and plainly. Also, the committee reviewed the level of technology of the techniques for utilizing daylight.

KEYWORDS: facade, simulation, solar gain, Expanded AmeDAS weather data

1. Introduction

Daylight must be used as interior lighting to reduce energy used for electric lighting. Recent buildings adopt new technologies / products to efficiently introduce daylight into rooms. However, it is not easy to use daylight since solar radiation emits not only light but also heat which increases load for air-conditioning.

The purpose of this committee is to provide a brochure which can help building designers decide basic facade plans for a building.

This research committee started on October 17, 2000 and the final report (36 pages of the main text and 24 pages of appendix) was published in March, 2004.

2. Contents of the report

The report consists of three chapters as follows,

1. Simulation for daylight and solar heat through windows

1.1 Introduction

1.2 Outline of simulation method

1.3 What the results of simulation show

1.4 Discussion

2. Problems in introducing daylight in buildings

2.1 Basic idea of utilizing daylight

2.2 Heat gain through windows

3. Existing techniques for utilizing daylight

3.1 Specification of window

3.2 Variety of control method

3.3 Practical use of systems

3. Simulation for daylight and solar heat through windows

In this chapter, the concept and the method of the simulation is described. In order to assist designers who intend to use daylight in buildings, the effects of window conditions on light and heat introduced in buildings should be indicated visually and plainly, at an early stage of planning. Therefore, we made the output of this simulation intuitively understandable.

For the visual environment, the output includes;

- (1) horizontal illuminance (average, maximum and minimum)
- (2) ratio of vertical illuminance from the window and reflected from the opposite wall (at a point 1m from the façade and at the center of the room.)

Table 1 Daylight conditions

Place	Tokyo
Date	Equinox, winter solstice and summer solstice
Time	9:00, 12:00, 15:00
Sky condition	Clear sky, Intermediate sky and overcast sky
Window orientation	East, west, north and south

(3) color contour showing distribution of horizontal illuminance

For thermal environment, the average heat gain per hour every month for a year is indicated.

Table 1 shows daylight conditions for the simulation.

Table 2 shows window conditions which were examined.

The simulations were made under a total of 108 conditions by using INSPIRER (ver.5.72).

Table 2 Window conditions

Window shape	Glass type	shade
Continuous	Clear	without
Low window		
Separated		
Deep-set		
Floor to ceiling		
With a balcony	translucent	
Continuous	clear	louver
		eaves
		Outer light shelf
		Inner light shelf
		Inner blind

4. Problems in introducing daylight in buildings

In this chapter, the advantages and disadvantages of using daylight is discussed from the viewpoint of light and heat.

The first section describes the effects of daylight on energy savings and on the regulation of biological rhythms. Table 3 shows a source efficacy comparison which demonstrates that using daylight can reduce air-conditioning loads.

The second section outlines the methods for calculating thermal impact of windows. Solar heat gain, as well as thermal transmittance (U-factor), is the most important energy considerations for windows. The fundamentals of solar heat gain is explained as shown in Figure 1.

To measure solar heat gain, factors such as Shading

Table 3 Source efficacy

Source	Efficacy [lm/W]
Direct-beam solar radiation	60-120
Diffused sky radiation	100-130
Fluorescent lamp	60-80
Incandescent lamp	10-20
Candle	1-5
LED	80-

Figure 1 Solar energy stream

Coefficient (*SC*) or Solar Heat Gain Coefficient (*SHGC*) are generally used. The concepts of *SC* and *SHGC* are described.

5. Existing techniques for utilizing daylight

In this chapter, advanced fenestration systems including new types of glass and blinds are introduced. Regarding lighting control systems, the concept, the elements and algorithm are described. In addition, recent practical operation systems are mentioned.

APPENDIX

The results of this simulation are added as an appendix. The results of 12 types of windows (see Table 2) are recorded, visually. Figure 2 shows an example.

Figure 2 A sample of the results

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