A Study on the Simulation Result of Horizontal Shading Installation for Passive Cooling of Building South KOREA

Seok-Hyun Kim¹, Soo Cho^{1,*}, and Young-Hum Cho²

¹Energy ICT·ESS Laboratory, Korea Institute of Energy Research, 34129 Daejeon, Republic of KOREA ²School of Architecture, Yeungnam University, 38541 Gyeongbuk, Republic of KOREA

Abstract. In South Korea, the evaluation criteria for the shading devices installation are defined by regulations, but the standards of design methods are not clearly established. The installation of shading device is used to solar control in building. It has become mandatory for some public buildings due to revised regulations. Generally this device mean is horizontal shading at upper window. Therefore, a design of horizontal shading device which takes into account the energy consumption of the building is required, and indoor environmental problems which may occur due to the installation of them should also be taken into consideration. This research studied to propose a design which takes into account the energy consumption which may occur if the horizontal shading device is installed, and suggest an improved design method of horizontal shading devices on the basis of the analysis of the problems that may occur when they are installed. Consequently, it was confirmed that as the length of the horizontal shading device becomes longer, the incoming daylight is reduced and the indoor intensity of illumination becomes lower, and thus, more lighting energy may be consumption was calculated by applying the lighting control and it was found that the total energy consumption decreased as a result of the reduction in energy consumption for air conditioning and fans and further decrease in lighting energy consumption.

Introduce

In South Korea, Recently, the insulation performance of windows has become more important because the area of the window at the building envelope was increased. So, it has lower performance than the insulation. Most efforts to improve this performance have been based on thermal insulation and air tightness, when actually the cooling load is affected by the solar radiation transmitted through windows in buildings. For energy saving, solar radiation should be blocked by a shading device in the summer season. But the heat gain through the window from solar radiation is required for heating energy saving in the winter season. Therefore, the consideration of control device of solar radiation is required by regulations and designers.

This study analysed and compared the indoor energy consumption according to the performance of windows installed on the outer walls of office buildings and analysed the indoor energy consumption concerning the installation of the horizontal shading device, one of the shading devices which are currently installed mandatorily. Taking various window-to-wall ratios and window performance differences into consideration, the unit space was set, and the energy consumption of the unit space according to the window to wall ratio(WWR) was calculated using simulation. In addition, the calculated figure of the protruding length of each horizontal shading device was applied, the indoor energy consumption was calculated by means of simulation, and the results were analysed. By these results of analysis, this paper proposed an elementary chart of design of horizontal shading device installation.

Energy analysis of the effectiveness of horizontal shading device installation

The solar block effect by the shading device at the large size window was more important than in the case of small window. For confirmation of the effectiveness of energy saving, this study performed the energy simulation and analysed the simulation results. So the authors simulated the non-shading device effectiveness and the shading device effectiveness about the regulation level. This is the length requirement of horizontal shading devices for recognition about energy saving building device. Because the purpose of this study is to satisfy building permission, the shading devices must meet the minimum protrusion length of horizontal shading devices. A comparison of the performance of windows and shading devices was conducted using COMFEN 4.1, which is a window and daylighting simulation software program provided by Lawrence Berkeley National Laboratory. BASE case refers to the situation where the horizontal shading device is not

Corresponding author: scho@kier.re.kr

installed and simulations were conducted by applying the four types of windows to each window-to-wall ratio. Simulations were performed in this manner considering the fact that all buildings do not use identical windows, and four types of windows were selected by referring to the window design guidelines. Applying the four types of windows to each window-to-wall ratio, the annual energy consumption of heating and cooling was calculated, and then the averaged figure of energy consumption for each window-to-wall ratio was calculated, and these figures were compared. As a result of simulations, it was confirmed that the higher the the greater window-to-wall ratio, the energy consumption. Especially in case of 80% WWR, the difference of energy consumption between east facade and west façade was confirmed as 27.91MJ/m²·a(about 4%). And the case of south facade and north facade was different, 113 MJ/ m² ·a (about 18%). This was a phenomenon that occurred in all orientations, and the fact that as the window-to-wall ratio gets higher the energy consumption for cooling increases may indicate that as the window becomes larger, the indoor heat gain is increased, increasing cooling loads, and the cooling energy consumption is increased.

Variation of energy consumption by installation of horizontal shading device

Installation of the shading device for energy saving is done by various methods. But the regulation of South Korea is to only limit the minimum length of horizontal shading. So, the designer should keep the regulation and guideline of South Korea for advantage of approval. Therefore, the authors were considered the regulation of installation of shading devices in an office building. So the authors calculated the length of horizontal shading through keeping regulation of South Korea. In order to meet the legal criteria, it is necessary to install the horizontal shading device whose solar heat gain coefficient is 0.6 (the value calculated using the formula and table presented in the Energy Performance Index) over south facing and west facing windows. So the author simulated the energy consumption by various WWR in office building.

As a result of the simulation, it was confirmed that the higher the window-to-wall ratio, the greater the energy consumption. The same results were obtained for west and south windows, and the installation of the horizontal shading device blocked the incoming solar radiation which increased the cooling load of the room and made it possible to get the Energy Performance Index scores. For west façade, the energy-saving ratio was shown to be

 $2 \sim 16\%$ by increasing WWR. However, due to the excessive protruding length of the shading devices, insufficient daylight enters the room, and thereby the use of indoor lighting seems necessary and structural problems may occur. In case of south window, the energy-saving ratio was increasing by $1 \sim 13\%$.

Conclusion

Based on modelling building, by each window-to-wall ratio, energy consumption was analysed. The higher the window-to-wall ratio was, the larger the energy consumption has. However, it was confirmed that the energy consumption increase caused by the use of fans and air-conditioning resulted in the increase of the total energy consumption for heating and cooling. Energy consumption was calculated both for the room without the horizontal shading device and with the horizontal shading device. This is after the protrusion length which can get scores of the Energy Performance Index was calculated and applied. Since the application of the horizontal shading device resulted in blocking incoming solar radiation, the amount of the decrease of energy consumption for fans and cooling was higher than the amount of the increase of energy consumption for heating, and the total energy consumption was reduced. In addition, it was found that the higher the window-towall ratio was, the greater the amount of energy consumption reduction was.

By this study, author confirmed that the effectiveness of horizontal shading at window is important for suitable design for energy saving of solar heat gain by designer.

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