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Policies and status of window design for energy efficient buildings

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Abstract

Windows are known to be responsible for considerable portion of heating and cooling energy use in modern buildings. Many countries have tightened minimum requirements for window performance and design in building energy conservation codes and regulations. We analyzed and compared these requirements of window performance and design in building energy policies of many countries. We also investigated the status of window design of office buildings in Korea in terms of WWR, glazing types, window frames, and air-tightness, etc. Finally, some suggestions were proposed to improve Korean building energy conservation code, such as the necessity of more strengthened requirements on window air-tightness and shading devices.

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Keywords: Window; Fenestration; Shading; Design Criteria; Building Energy Policy

1. Introduction

Windows are known to be responsible for considerable portion of heating and cooling energy use in modern buildings. Appropriate window design is significantly important to improve building energy efficiency. Energy performance of windows are influenced by variety of design parameters such as WWR(window-to-wall ratio), SHGC, U-value, VT, shadings, daylighting control, etc. These parameters affect occupants' thermal and visual comfort as well. Therefore, many countries have tightened minimum requirements for window performance and design in building energy conservation codes and regulations. We analyzed and compared building energy policies of many countries and investigated the status of window design of office buildings in Korea.

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2. Analysis of building energy polices for window design

In many countries, various foreign regulations on window design parameters were prescribed in consideration of complicated and interrelated influences of orientation, WWR, glass types(U-value, SHGC, and VT), and shading devices(types and projection factor) with different climate conditions.

For example, International Energy Conservation Code specifies the criteria for SHGC considering climate zone, orientation, and projection factor of solar shadings. For commercial buildings, vertical fenestration area shall not be greater than 30% of the gross above-grade wall area. It also includes criteria for dynamic glazing which has not been widely used in the market up to date but is expected to come into wide use in the near future (ICC 2014). ANSI/ASHRAE/IES Standard 90.1-2013 also specifies prescriptive criteria for maximum vertical fenestration area, SHGC and VT/SHGC ratio considering climate zone and building types as well as performance criteria for west-oriented and east-oriented vertical fenestration area (ASHRAE 2013).

U.K. Building Regulation Part L2A (DCLG 2013) limits the effects of solar gain in summer by specifying the criteria for the solar gain through the glazing compared to that through the reference glazing. Building Code of Australia specifies the criteria for the aggregate air-conditioning energy value with regard to SHGC, U-value, glazing area, energy constant for the specific orientation, and heating and cooling shading multiplier. The concept of overall thermal transfer value (OTTV) is also widely used in various countries such as Singapore, Hong Kong, and India, to control the heat gain through the building through its envelope.

On the while, minimum requirements for U-value were only provided for different climate condition in Korean code. Also, minimum window to floor area ratio was defined to ensure daylighting performance in buildings. Since May 2015, criteria for solar heat gain are included in order to reduce cooling energy consumption, but there is still much room for improvement.

3. Status of window design

To suggest the improvement strategies for the Korea code, we investigated and compared the status of window design for 82 office buildings constructed between 2007 and 2010 and 323 office buildings constructed between 2011 and 2014. Figure 1 shows that most buildings below 10,000 m^2 total floor area are designed with a window-to-wall ratio of less than 50%, but buildings above 10,000 m^2 were designed with broad variations in their window-to-wall ratios. As office buildings often have different average window-to-wall ratios that correspond to their respective building sizes, this result can be used as a reference for criteria when considering a deviation from the average U-value and number of shading devices according to the building size. Most of the buildings selected windows with high air-tightness (under 2 m^3/hm^2 at 100Pa), but about 13% of the buildings used window with low air-tightness between 8 and 10 m^3/hm^2 at 10Pa. Relations between glazing types and WWR, orientations and WWR, and building sizes and window frames were also analyzed in this study.

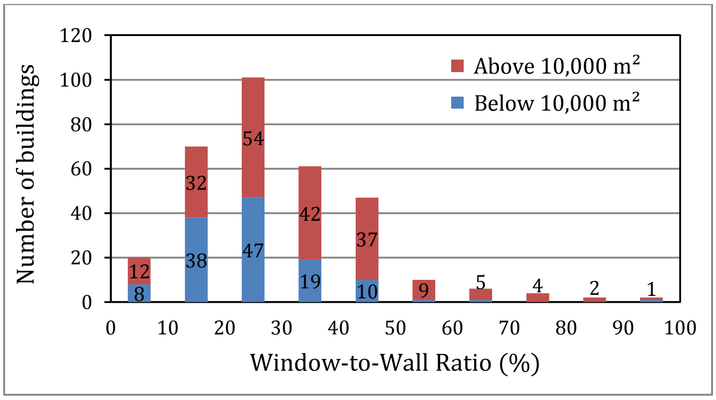

Fig. 1. Number of office buildings by window-to-wall ratio

4. Conclusion

We analyzed and compared these requirements of window performance and design in building energy policies of many countries. We also investigated the status of window design of office buildings in Korea in terms of WWR, glazing types, window frames, and air-tightness, etc. Some suggestions were proposed to improve Korean building energy conservation code, such as the necessity of more strengthened requirements on window performance.

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