Application of the Refurbished Daylighting Window System based on its Orientations

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ABSTRACT

The urban areas in Asian capital cities including Seoul should acquire international competitiveness, but overpopulation of the regions increases all costs there and thus makes it difficult to enhance the quality of life. As a residential solution, apartment buildings are flourishing along with a boom due to their economic benefit in terms of land use and maintenance. One of the major flaws of the apartment is that it is not environment-oriented but the key post of apartment design in Korea has dramatically shifted to environment-friendly planning since 2000. Fortunately, the apartment will be much more convenient than the other one in the application of green technologies, providing the merits by mass production. For example, pre-manufactured building materials can be effectively adapted to the formation of buildings. Recently, the refurbished version of conventional windows has been developed for the purposed of minimizing energy loss occurred around windows. A various types of glass can be applied to the window system and it plays a critical role in the determination of inner visual environment. On the other, the building might be set in various orientations, resulting unexpected visual performance of the window. In this paper, a series of computer simulation provides basic daylight performance data with a variety of orientation for the issued window. It is a matter of course that its optical performance might depend on the sun’s geometry. In particular, the controls to take advantage of using sunlight as a light source must be stressed for daylighting application.

KEYWORDS: Daylighting, Window, Lighting energy, Light distribution, Orientation

1. INTRODUCTION

Now a day, the shape of apartment houses has shifted from liner types toward the towers. Though they have advantages in terms of aesthetic in modern architecture, however, rectangular-shaped towers have a serious drawbacks since these plans produce relatively small amount of houses with a southern exposure. It also causes being short of natural light due to deep interior space. In addition, people give priority to view and thus, whole-glass window walls have been dominated, which produce complicated visual problems due to fenestration of severe direct sunlight.

There are compromised attempts to take advantages of each building shape selectively. As a result, we now witness the advent of Y-shaped, T-shaped, V-shaped and ↖-shaped buildings on the market. The mutative type of apartment houses usually faces southwest or southeast, which has lot of daylighting availability but anyhow, the proportion of the apartment houses which have a full south aspect. The need to verify the potential of daylighting in new building-block shapes exists. At the same time, the expansion of balcony area was legalized and thus, a visual buffer area does not exist any more. Most windowed area in perimeters of glass buildings may get too much light, creating excessive glare, and thus, light entering the building should be carefully controlled. All-glass window
wall on apartment houses without a balcony produces pretty harmful area with direct sunbeam. This paper initialized a series of research to deal with almost all on window wall for apartment houses. First of all, huge amount of already-designed examples of apartment houses have been analyzed in terms of floor plan, elevation, orientation and glazing materials. Recently, the refurbished version of conventional windows has been developed for the purpose of minimizing energy loss occurred around windows. In terms of natural lighting, the easiest way to get plenty of daylight into a space is to use very large clear glass windows.

2. REFUBISHED GLASS FENESTRATION-WALL

A deep-rooted preference for full view without any obstruction has been a critical momentum for architects to design the full-height glass window wall in apartment houses. In case of expansion the balcony areas an additional consideration for fire protection on the lower part of window wall. Compromising these constraints might be the use of two different windows; a view glazing with high visible transmission and lower window with fire-prevention glass. In terms of light transmission, a fire-prevention glass has not a significant different from clear glasses. Base on these design criteria, K Company has refurbished a new window wall system consisted of two pane of pair glasses, which formulates a differentiated glazing area (Figure 1). For the upper view window, a variety of functional glasses developed recently might be applied and their optical characteristics are shown on Table 1.

This research surveyed 1,286 apartment building blocks that have been planned recently in Korea in order to extract the information on the direction and orientation in their site plans. A orientation of 45° Southeast is 17% and 45° Southwest is 11%, while south-facing (0°) plan is only 22%. Three angles of 45°, 20° and 0° are selected as representative orientation for further research.

<table>
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<th>Case</th>
<th>Description</th>
<th>UV transmission (%)</th>
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<th>Reflectance (%)</th>
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<td>64</td>
<td>11</td>
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</table>
3. DAYLIGHTING PERFORMANCE

For the purpose of projecting the performance of the refurbished window, a prototype plan of an apartment house has been established (Figure 2). The daylighting performance of the space is analyzed for each zone since they have entirely different visual needs and potentials. A series of daylighting simulation by Radiance program for the conventional apartment house plan was performed to determine how variable transmitted glazing materials modify the intensity and distribution of daylight from the refurbished window-wall. The daylighting system promises good potentials of natural lighting owing to relatively bigger area of glazing than the conventional.

Under clear skies, the tinted, transparent glasses and plastics are probably the most common types of selectively transmitting materials in use now. They allow a view out but restrict the amount of daylight and sun that comes in. Figure 3 exemplifies the impact of glazing materials on light levels under clear skies dated on March 21 (Noon). Under clear skies, same as expected, the light levels have been changed proportionally dependent on the transmittance of the glass. The planned use of direct sunlight with tinted glasses is another concept for daylighting in fat buildings, while lessening the brightness of view windows. The light level of rear space does not significantly deteriorated, considering the amount of light attenuation within front areas. That tells the treated glazing is good for better distribution of daylight, still holding the amount of daylight for the rear to some degree.

4. SUNLIGHTING CONTROL

Controlling or avoiding direct sun beam to keep it out of the interior is a key criterion in most architectural designs. This treatment is mainly intended to attenuate the adverse glare and contrast associated with direct sun light and to lessen the negative contribution of direct sunlight on the cooling load. One of the most effective sunlighting controls are Venetian blinds. They play a role in excluding direct sunlight but reflecting its light to rear interior, while still allowing a view to exterior. By adapting Venetian blinds, Figure 4 exemplifies the combined impact of orientation and
blinds on the illuminance. The blinds go far toward improving uniformity in illuminance. The illuminance within rear space is likely to remain intact by different azimuth angles of the window. It might be due to that basically not direct sun penetrates into the deep rear and blinds tend to increase reflected light like lightshelves.

5. CONCLUSION

Clear and overcast skies, however, provide totally different lighting patterns and should be considered separately when designing large glazing windows. The refurbished large clear window in this research promises sufficient and deeper penetration of soft daylight into the rear interior under overcast sky but direct sun in the vicinity of window areas and a direct view of the sky from these areas will expose occupants to excessive brightness differences that will result in poor visibility and discomfort. In addition, the flux of dangerous U-V light is another concern of the interest. It seems logical to use an optical control such as tinted glazing medium with low transmittance. Using lower transmitted glass such as the tinted plays a role in decreasing light level at perimeter adjacent the window, still holding same amount of daylight in the rear space. Under clear skies, same as expected, the light levels have been changed proportionally dependent on the transmittance of the glass.

Under severe hot summer, adaptation of coloured glasses may not the best to deal with intense sunlight and thus, a physical shading device such as Venetian blinds should be issued. A simulation of Radiance program verifies that horizontal blinds alone would effectively prevent sun penetration where a building faces the south. However, where the faces of the apartment houses are to be oriented to the southeast or southwest, neither horizontal nor vertical blinds alone would effectively prevent sun penetration. In next stage of the research, more dense and tilted blinds will be issued for a solution, sandwiched between the two panes of glass within the refurbished window walls.

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REFERENCES


