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Optimization of Apartment-House Design Factors in View of Sunlight and Outdoor Thermal Environment in South Korea

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Extended Abstract

Economic growths lead to population increases in large cities. This has brought about the growing necessity for apartment housing which has resulted in higher density populations living in high-rise apartment complexes. Therefore, the urban microclimate is aggravated due to the increasing ratio of artificial coverage and substandard daylight availability [1]. To achieve a comfortable living environment and improve urban microclimates, a process considering the daylight availability and the outdoor thermal environment is required when designing apartment housing complexes. This study selected a total of 27 valid cases using an orthogonal array, L27(313) design of experiments (DOE).

Case studies were conducted on the sunlight and numerical simulations of the entire three dimensional surface temperature, focusing on the layout planning factors of the apartment housing complex. In doing so, the design factors that influence the outdoor thermal environment and the daylight availability were selected, and the optimal integrative layout planning was drawn out. As to numerical simulation methodology, this has already been established in several papers published in international journals [2][3].

Using an orthogonal layout of L27(313), 27 valid cases in total were selected. After this, the outdoor thermal environment and the daylight availability of each case were analyzed. The results showed that the layout planning factor has a strong effect on the outdoor thermal environment and the daylight availability, particularly in the MRT and the HIP results. Establishing a comfortable living space is possible by arranging environment-friendly design factors appropriately to satisfy the outdoor conditions (e.g., thermal environment and daylight availability).

Design factors that influence the outdoor thermal environment and the daylight availability are the building coverage ratio (0.013), pitch of building (0.050) and azimuth (0.000). The rank of influence of the design factors on the outdoor thermal environment and the daylight availability appeared in the following order azimuth (D) > building coverage ratio (B) > distance between buildings (C) > floor area ratio (A) > w/d ratio (E).

The change in the outdoor thermal environment was also examined by applying a greenery coverage ratio of 30% and 60% for each case. By applying green space to the ground surface, the entire building surface temperature was decreased by 0.3 °C on average. Furthermore, the MRT average value declined by approximately 1.5 °C. When applying a 30% greenery coverage ratio, an average decreased of 0.6 °C was noted; and when applying a 60% greenery coverage ratio, the temperature decreased by an average of 1.5 °C. This shows that HIP decreases as the greenery coverage ratio increases. Each case at 12:00 showed the highest decline of HIP (5.4 °C on the average), and there was a decrease of 4.6 °C on average at 20:00.

Greenery plans should be implemented in accordance with application of building density, and it is thought that mitigation of thermal island effects can be achieved through earth surface and building afforestation plans, with these also contributing to the creation of pleasant outdoor environments.

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