The development of visible sky area as an alternative daylight assessment method for high-rise buildings in high-density urban environments

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This research aims to develop a new daylight assessment method for high-rise residential buildings located in high-density urban environments. The new visible sky area (VSA) method was developed based on data gathered from an extensive survey of high-rise residential building plans and layouts in Hong Kong and followed by a large number of daylight simulation experiments. The results of simulations showed a very small daylight quantity arriving at windowpane of lower floor level of high-rise residential buildings due to high-obstruction from nearby buildings and also self-obstruction. The new method would guarantee the availability of sky area seen from windowpane in order to provide a good vertical daylight factor (VDF), which has been adopted as a performance-based daylight indicator in Hong Kong. A minimum VSA of 12% and 6% for habitable rooms and kitchens, respectively, is proposed for this situation.

Keywords: daylight assessment method; high-rise buildings; high-density environments; visible sky area; vertical daylight factor

Introduction

Hong Kong context

As a vertical city, residential buildings in Hong Kong are mostly high-rise with typically 40–60 storeys, with the complexity of building envelope, and situated in high-density urban environments. This condition might have occurred because of population growth and economic expansion in the 1970s that generated great demands for housing and the limitation of buildable land. Due to land shortage, the average number of stories for apartment towers has risen from 4 to 6 stories during the post-war period of the 1950s to over 60 stories in the 2000s. As the consequences of this built form, living spaces at the lower parts of high-rise residential buildings are often disadvantaged of daylight, natural ventilation, and views.

Most of residential building designs consist of an 8-unit plan, which is about 61% of 147 private residential buildings completed in 2000 (Lau et al. 2006). This 8-unit plan made of mainly six types of plan: (a) cruciform, (b) pinwheel, (c) hybrid, (d) diamond, (e) X-shaped, and (f) Y-shaped. In addition to those, two other types exist: (g) 6-unit plan and (h) 10-unit plan (Figure 1). Developers prefer the 8-unit to maximize profit from land. To attract buyers, bedrooms were placed outwards with the best views leaving kitchen and bathroom to be inward facing. To resolve ventilation problems, a gap called a “re-entrant” was allowed between the units. The re-entrant is an equivalent of a light well that resulted from the grouping of windows for kitchens, toilets, and other spaces of homes in an apartment building.

Building regulation for the provision of natural light

Prescribed window regulation

In Hong Kong, the provision of natural light has been controlled by the Building (Planning) Regulations B(P)Reg. 30, 31, and 32 (HKSAR 1997). Basically, this regulation controls the minimum window glazing area and the distance between buildings. It is stipulated that the minimum window glazing area is 10% of floor area. This window is referred as a prescribed window (see Figure 2).

According to these regulations (HKSAR 1997), no prescribed window shall be deemed facing into external air unless it faces into a street which is not less than 4.5 m wide; or it faces into space uncovered and unobstructed above the area defined by the rectangular horizontal plane (RHP). The RHP required that the minimum distance between building blocks is determined by a minimum inclined angle of 71.5° and 76° above the RHP for habitable rooms and kitchen, respectively. For window facing site boundary, these angles shall be 81° and 83° for habitable rooms and kitchens, respectively. It is also stipulated that the RHP should have a minimum width of not less than 2.3 m, with area not less than 21 m².

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