The Relation between Block Size and Building Shape

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Block restructuring has been strongly emphasized in Japan for renovating cities. However, little is known about the relation between block size and building shape. Moreover, the shape of buildings designed on a block after restructuring is unclear. In this study, the relation between block size and building shape is analyzed quantitatively, and a three-dimensional building shape is estimated by a model using an urban planning GIS data set of Tokyo. Results show the quantitative relation between block size and building shape, and the building shape image on the blocks. Higher buildings and buildings with a basement tend to be built in larger blocks, leading to efficient use of the maximum volume permitted in the block. In addition, the region composed by larger blocks can be spacious, because the range of building setback will be long in larger blocks. Designation of a high floor area ratio may induce integration and enlargement of blocks. Blocks are less likely to be partitioned in zones when a high floor area ratio is designated.

Key Words : *Block, estimation, floor area ratio, GIS*

1. INTRODUCTION

Recently, urban policies in Japan have shifted from the development of new cities to the renovation of existing cities. Particularly in Tokyo, the importance of block (land surrounded by road) restructuring has been strongly emphasized. Three reasons can be identified. First, in a small block, large buildings cannot be constructed because of urban planning regulations, which may fail to motivate developers to renovate. Second, large offices cannot be located in a small block. Therefore, the city may lose the opportunity to attract investment from global industries. Third, the existence of roads that are too narrow is an obstacle to disaster preparedness. For all these reasons, block restructuring has become necessary.

In this study, the relation between block size and building shape is analysed quantitatively, and the three-dimensional building shape is estimated by using an urban planning GIS data set of Tokyo (March 2013). Finally, the effect of block restructuring is discussed.

2. METHODS

In this study, an urban planning GIS data set of Tokyo (March 2013) is used. This data set contains building types, the number of floors, land-use zones, the designated FAR, and the designated BCR (overview on urban planning regulations in Japan is shown in online Appendix 1, Table A2). The relation between block size and building shape is first analyzed quantitatively. For analyzing the relation, we aggregate the number of blocks, lots, and buildings. Moreover, we calculate the area of blocks, lots, and building floors. The study area encompasses the special wards of Tokyo (626.70km2). The population (9,256,625 people) and many functions are dense in this area (Tokyo Metropolitan Government, 2016). Moreover, urban renewal and block restructuring are strongly emphasized in this area.

All buildings, lots (parcel of land), and blocks in the special wards of Tokyo are used for analysis. When the relation between block size and building shape is analyzed, samples are distinguished by designated FAR, because the block size and building shape are expected to be much different in each designated FAR.

Next, the building shape is estimated using a model. The accuracy of the estimation will be higher when sample blocks with only similar conditions are used, such as land use and building type. Therefore, blocks in urgent urban renewal areas of commercial zones are chosen for analysis because the areas are designated for the most urgent block restructuring in Tokyo, where the government finances and promotes the renewal projects. In this estimation, office buildings are used in this area, because office supply is promoted in this area and several studies have focused on office shape (Grierson and Khajehpour, 2002; Kooijman, 2000; Ouarghi and Krarti, 2006; Shpuza and Peponis, 2008; Wang et al., 2006). For our analysis, two typical designated FARs are selected, namely 600% (termed group A: 27 blocks) and 700% (termed group B: 36 blocks). The FAR of 600% and 700% is found to be the mode value and the second mode value of all the blocks in the urgent urban renewal area, respectively. These blocks are used as reference blocks for estimation of building shape.

3. CONCLUSION

In this study, the relation between block size and building shape is analyzed quantitatively. In addition, blocks used for offices are chosen, and the building shape is estimated by a developed BSE model.

Results show that the number of floors above the ground and underground of the higher designated FAR blocks increases as the block becomes larger. On the other hand, the floors do not increase in low designated FAR blocks as the block becomes large. Moreover, there is a strong positive correlation between the number of floors above ground and those underground.

The VSR increases gradually as the block becomes large, excepting blocks of a low designated FAR. However, in blocks that are too large− more than 100,000m2− the VSR is low. In the low designated FAR block, the VSR decreases as the block becomes larger.

On the upper floors, the estimated BAR is higher in large blocks. Moreover, the larger the blocks, the farther the buildings are set back from the roads. Therefore, the significance of enlarging blocks throughout the block restructuring can be discussed by these results. In large blocks, high buildings can be built, and the volume in the block can be used efficiently. In addition, in the area composed of large blocks, many open spaces will be created because the buildings are set back from the surrounding roads. It is possible that large blocks create a spacious city. But it is necessary to designate high FAR of more than 600% on the blocks.

The average block area is large in low designated FAR zones and high designated FAR zones. Accordingly, high designated FAR may lead to enlarging blocks by promoting block restructuring. By high designated FAR, the blocks are less likely to be split by lots, even in large blocks. The BSE model, which estimates the building shape and location, was developed. The estimated results are shown as targeting offices. This technique can be applied to other buildings and cities.

If software to estimate building shape by block shape and other conditions was developed, it would be useful for determining urban planning, as well as population estimation and land-use estimation. In the future, it is possible to estimate the urban image by using this method, particularly in the city, where development and urban restructuring are active. By the estimation, planners can understand the building shapes and locations of the future and use the results for planning, and citizens can easily understand the future image of the block. They can judge whether the urban renewal plan is better. In addition, the estimation of building location and shape can be applied to many fields. Many studies have been conducted related to the building location and shape, the relation between the building shape and energy efficiency of office buildings (AlAnzi et al., 2009), the energy consumption and buildings (Ko and Radke, 2014; Mortimer et al., 2000; O’Brien et al., 2010; Ourghi et al., 2007; Rode et al., 2014), and the wind-induced response of buildings in a block (Kuang et al., 2011; Kwok, 1988; Merrick and Bitsuamlak, 2009). Combined with this knowledge, it is possible that the estimation of wind, energy efficiency, and consumption can be done using the estimation of buildings.

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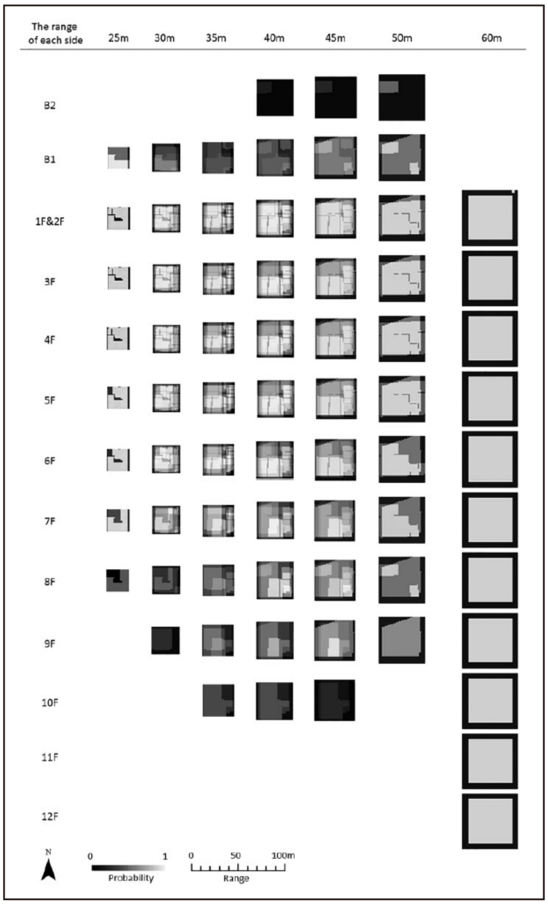

Figure 1. Visualization of building existing probability in 600% designated FAR zones. FAR: floor area ratio.

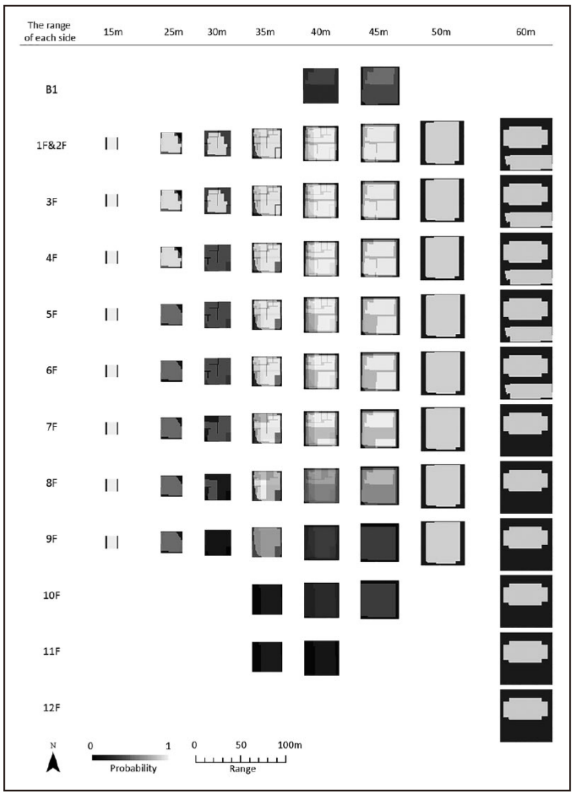

Figure 2. Visualization of building existing probability in 700% designated FAR zones. FAR: floor area ratio.