Technological development for the rationalization of fire control and evacuation regulations

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1. Introduction

Local governments and private businesses engaging in regional development are demanding the effective use of available buildings by changing their uses or renovating them to make them more useful in promoting regional economies and international tourism. The NILIM is engaging in the necessary technological developments to rationalize fire management and evacuation regulations and streamline the use of the regulations to effectively promote activities to utilize the available buildings. This paper introduces an outline of such technological developments.

2. Rationalization of standards concerning the evacuation safety of people in buildings

To ensure the evacuation safety of people in a building, the main structural parts of a building, such as columns and walls, are required to be fireproof structures, except for cases when evacuation can be relatively quickly completed. The maximum size for which such structures are not required is two-story buildings with 300 m^2 of floor area on the second floor, which becomes applicable when people sleep in the building. The rationalization of building regulations may be possible if the same or higher level of evacuation safety is secured for three-story buildings. The researchers are calculating the evacuation time targeting welfare facilities in which special care becomes especially important during evacuation to specify the areas to regulate (Fig. 1).

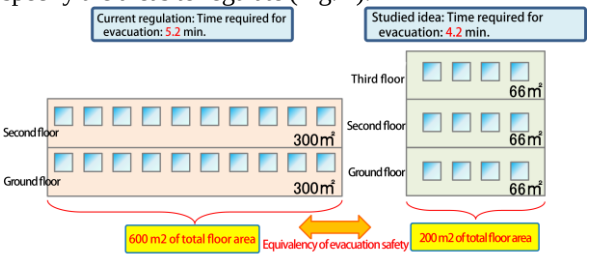


Figure 1 Example of examining sizes with which evacuation safety is secured

All rooms in buildings of certain sizes used for certain purposes are restricted in terms of interior materials and required to be equipped with smoke extraction facilities. In terms of the evacuation from individual rooms into the corridors, the installation of sprinklers and smoke leakage prevention doors and walls is expected to prevent the smoke from spreading within each room and from leaking from the rooms into the corridors. The researchers are exploring rational methods to replace current regulations that are applicable to all rooms, including interior materials and smoke extraction, while ensuring safety with new methods (Fig. 2).

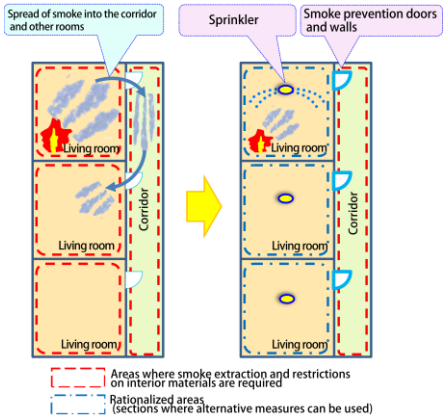


Figure 2 The rationalization of regulations on smoke extraction and interior materials

3. Rationalization of standards for wooden buildings

Regulations applicable to sizes (height and area) of buildings mainly constructed with wooden materials would become major restrictions when renovating available buildings and changing their uses.

Specific restrictions in the flexibility of design include the following: 1) the provision in the Article 21-1 of the Building Standards Act (hereinafter “the Act”) regulating the height of large wooden structures (13 m or higher or 9 m or higher for the eaves height) and fireproof functions of the main structural parts, and 2) the provision in Article 26 of the Act regulating the structural method of fireproof walls to divide areas in wooden structures (vertical walls every 1000 m^2).

The restrictions on the height of wooden buildings are based on regulations from the Urban Buildings Act, the law preceding the Building Standards Act. They practically prohibit the use of wooden materials for the main structural parts. Although some regulations have been relaxed, these regulations are one of the factors that prevent the use of wooden materials. The researchers are

conducting technological developments to organize objectives and functional requirements realized through these standards-based regulations and to modify the applicable regulations to govern performance. Specifically, the prevention of the collapse of a wooden building of a certain height from damaging nearby buildings is organized as the objective of this regulation. Instead, a framework is constructed to evaluate the rationally required duration of fire resistance and fire resistance performance by assuming the use of fire extinguishing measures (e.g. fire control using sprinklers and firefighting activities by firefighters), which are not evaluated under the current regulations (Table 1). These developments are expected to enable optimal wooden buildings based on the effect of fire control measures.

Table 1 The duration of fire based on fire control measures

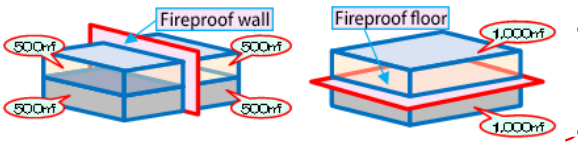
Duration of fire (time when water spray is started + duration of firefighting activities)	
(1) Main factors that affect the time when water spray is started	(2) Main factors that affect the duration of firefighting activities
・ Time required for firefighting teams to arrive at the scene of fire ・ Time required for preparation ・ Time required to move to the source of fire	・ Area of combustion ・ Fire control using sprinklers ・ The amount of water spray

The installation of fireproof walls every 1,000 m^2 is required in wooden buildings. The division of areas using fireproof walls is only applicable to a structure that vertically divides areas inside a wooden building. It does not include the effect of dividing sections using horizontal members such as floors (called fireproof floors) (Fig. 3). The establishment of methods to evaluate the fire spread prevention performance and independency of fireproof floors will enable designs that rationally use wooden materials while reducing the spread of a fire with dividing members. A fireproof floor is expected to increase the possibility of realizing buildings with a mixed structure in which the ground floor is based on a RC structure and the second floor is a wooden structure.

a) Fireproof wall (vertical) b) fireproof floor (horizontal)

Figure 3 Fireproof walls and fireproof floors

4. Rationalization of standards related to the prevention of urban fire



When fire safety zones and semi-fire safety zones are designated, buildings within such areas must be fireproof buildings or semi-fireproof buildings depending on their floor areas and the number of floors. In addition, gates and walls within the premises of the buildings must be made with nonflammable materials when they are more than two meters in height. The current situation is that the use of wooden materials is largely restricted while urban fire prevention measures are being strengthened. The researchers are currently constructing methods to evaluate whether urban buildings have fire spread prevention functions or not. For example, flexible designs that abundantly use wooden materials within a building are enabled if the same level or better fireproof performance can be realized by improving the performance of the outer walls and openings.

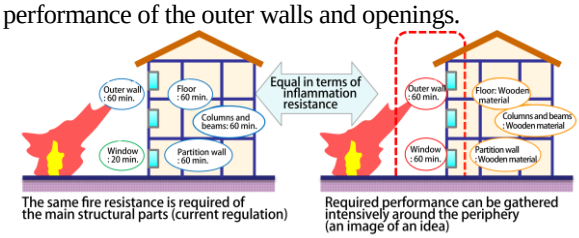
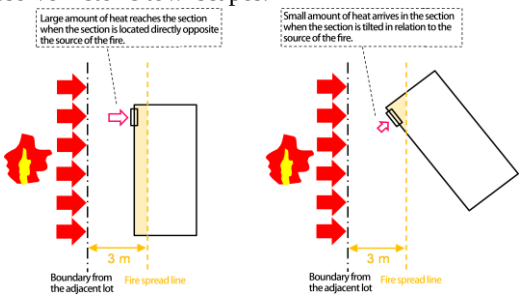


Figure 4 The reevaluation of fire control regulations within fire safety zones

The design of the facade is often regarded as an important factor when preserving and utilizing the historic townscape. Current regulations regard the section of the ground level of a building and the second level or higher section of a building within three meters and five meters, respectively, from the center line of a road or the boundary of an adjacent lot as sections to which the fire may spread. Fire control measures are required for such sections, such as the installation of fireproof windows. Depending on the position (e.g. distance, angle, and height) in relation to the building located at or near the boundary of an adjacent lot that may become the source of a fire, however, some sections are known to be less affected by heat (Fig. 5). The researchers are thus conducting empirical examinations to remove such sections from the sections to which the fire may spread. The rationalized standards are expected to increase the sections where the use of metal window sashes or wired glasses is exempted, which would make it easier to preserve historic townscapes.



A) oppositely located b) located in angle

Figure 5 The effect of heat depending on the relationship of the location of the source of the fire and building

5. Future perspectives

The researchers are going to maintain the cooperative relationship with the relevant bureaus of the Ministry of Land, Infrastructure and Transport, local government organizations, Building Research Institute, and intellectuals to continue technological development for the establishment of a draft of the technological standards and guidelines.