Technological development for the rationalization of fire safety and evacuation regulations

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1. Introduction

Local governments and private businesses engaging in town development are seeking to effectively use currently available buildings and historical buildings by changing their uses or renovating them to revitalize their regions and promote international tourism. To ensure the smooth use of currently available buildings, the NILIM is developing technologies for the rationalization and streamlining of fire safety and evacuation regulations under the Building Standards Act (hereinafter "the Act"). This article summarizes the outcomes of examinations conducted in FY 2018.

2. Outline of technological development

(1) Rationalization of standards concerning the evacuation safety of people inside buildings

From the perspective of ensuring the evacuation safety of people in buildings, special buildings, such as hotels and retail stores, with a certain size or larger are required to have fireproofed main structures. Since buildings up to three stories and 200 m^2 are small, the time required for evacuation is expected to be short. Therefore, as long as viable structural members found in common buildings are used, the same level of evacuation safety may be ensured as the current regulations even when a fireproof structure is not required in all the main structures if the evacuation time is short. Necessary measures for ensuring this assumption are examined so that alarm systems will be installed in buildings used for sleeping purposes where the start of evacuation may be delayed, and sections providing protection from fire and smoke will be installed in vertical columns, such as staircases, for people, such as elderly people who have difficulty evacuating by themselves (Figure 1).

Concerning fire safety facilities used to divide spaces, performances were checked using lightweight doors installed in conventional office buildings, and structural methods of fire walls that can block fire for ten minutes were clarified (Figure 2).

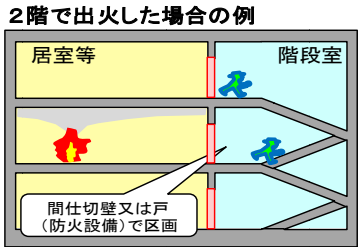


Figure 1 Image of vertical section in small buildings

Figure 2 Fire safety facility used in semi-vertical sections (blocks fire for ten minutes)

(2) Rationalization of standards for wooden buildings

In buildings in which wooden structural members are used, fire safety regulations on size (height and area) under the Act also become major restrictions. Especially, since the initial establishment of the Act, [1] restrictions on the height of wooden buildings and fire resistance performance of main structural parts (Article 21, Section 1) and [2] the installation of fire walls in wooden buildings (Article 26) have been stipulated as specifications based on past damage to large wooden buildings lost in fires and massive urban fires. Opinions have been raised claiming that these would restrict freedom of designs.

The freedom in the design of wooden buildings has been drastically expanded in regard to height restrictions since the performance standardization in 2000 when the use of wooden materials as fireproof structures became possible. Actually, however, realizing the use of wooden materials as fireproof structures faces a large burden, such as technological development and the acquisition of accreditation by the Minister of Land, Infrastructure and Transport. Thus, the NILIM conducted technological development with the goal of constructing technological standards that can enable the smooth use of new construction technologies and the flexible responses to changes in social situations by organizing the purposes of this regulation and functional requirements and setting

performance standards.

Real-scale fire extinguishing experiments supposing water discharging by firefighters during a fire were planned, and standard water discharging methods, temperature change within sections during water discharge, and carbonization of materials were examined (Figures 3 and 4). Based on the results, methods to evaluate the main structural parts of a building were constructed, and specifications that would satisfy the required performance were organized to ensure that buildings would not collapse during a fire by taking into account the effect of regular fire extinguishing measures (Figure 5).

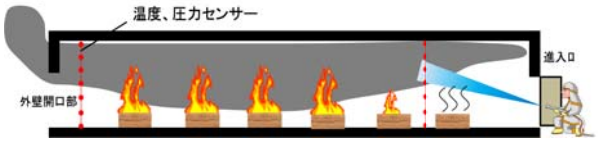


Figure 3 Conceptual diagram of the experiment

Figure 4 Actual measurement of fire extinguishing effect on main structural parts

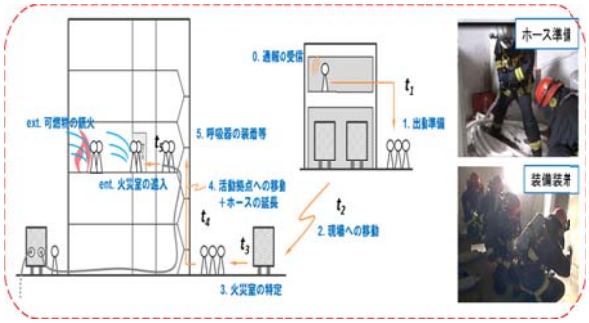


Figure 5 Production of the model of fire extinguishing measures

(3) Rationalization of standards concerning fire prevention in urban areas

When fire safety zones or quasi-fire safety zones are set, buildings within such areas must be fire-resistant buildings or semi-fire-resistant buildings depending on the floor areas and the number of floors. Attached gates and fences with the height exceeding two meters must also be constructed with incombustible materials. Since this greatly restricts the use of wooden materials while preventing urban fires, the NILIM is examining methods to evaluate the fire spread prevention performance of buildings in urban areas. Flexible use of wooden materials inside buildings can be enabled if the same or higher performance than required under current regulations is confirmed by improving the performance of the outer walls and openings, for example (Figure 6). In addition, freedom in the design of gates and fences that make up of townscapes can also be expanded, which will consequently result in the preservation of historical landscapes, by establishing structures and evaluation methods of gates and fences that would not accelerate the spread of fire to nearby buildings (Figure 7).

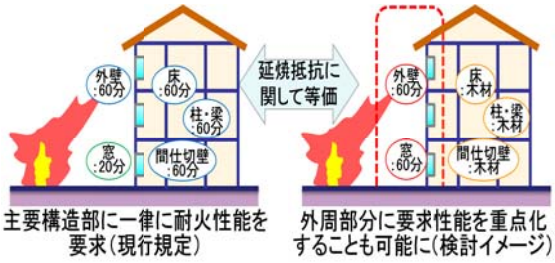


Figure 6 Image of reevaluating fire safety regulations within fire safety zones

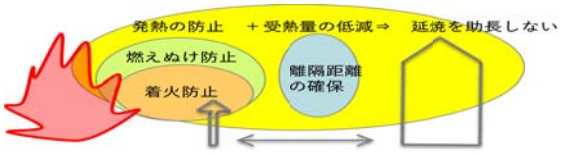
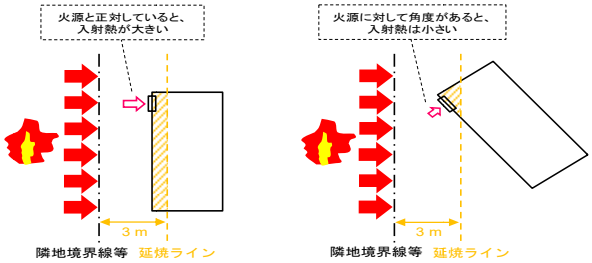


Figure 7 Image of fire safety performance required in gates and fences

The design of the facade is often regarded as important when preserving and utilizing historical townscapes. Current regulations regard areas within three meters from the centerline of a road or the boundary with an adjacent lot for the ground floor and within five meters for the second floor and up as the section with the risk of spreading fires. Measures, such as the installation of fire safety windows, are required in such sections. Still, buildings become less affected by heat depending on the spatial relationship (such as distance, angle, and height) with buildings on fire at the boundary of an adjacent lot (Figure 8). Thus, the NILIM empirically reevaluated the concept of the section with the risk of spreading fires.



a) When opposing b) with an angle

Figure 8 Effect of heat based on the spatial relationship between the source of fire and buildings

3. Future plans

The NILIM will continue cooperating with the relevant bureaus of Ministry of Land, Infrastructure and Tourism, Building Research Institute, and intellectuals and experts and continue technological development to propose technical standards and establish guidelines, such as notices. Fire extinguishing experiments were conducted with the cooperation and advice of the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, Fire Chief's Association of Japan, and Tsukuba City Fire Headquarters.