Evaluation of urban fire control performance in inclined built-up areas

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1. Introduction

Various fire control measures have been implemented in Japan. In recent years, Local governments are especially focusing on organizing dense urban areas that are high-risk areas of fire. Methods to evaluate fire control performances of cities have also been developed, but these activities have not examined effects of terrains.

Thus, the National Institute for Land and Infrastructure Management (NILIM) has been developing methods to evaluate fire and fire evacuation safety while taking into account the terrains and road conditions on hills. This paper introduces the progress of the examination of how slopes affect how fast fire spreads

2. Characteristics of hilly urban areas

Buildings are constructed along terrains features of hilly urban areas. Thus, characteristics of such areas include buildings constructed in step-like arrangements, retaining walls, not many roads where cars can drive on, many roads in step-like arrangements, and narrow roads. Thus, fire is expected to spread differently, and people evacuate from fire differently from flat terrain. Yet, actual differences are not clearly known.

Photo 1. Hilly urban areas

3. Characteristics of the speed of spreading fire on hills

To clarify differences in the speed of spreading fire based on inclination, the study arranged five eight-by-eight-meter buildings side by side with three-meter intervals between them and 13 of them on the vertical direction (direction of the slope). The study also set up hypothetical cities on 0 to 30% grades to estimate how fire spreads in simulated urban fire.

The simulation with a scenario that fire started from the center of the hypothetical city on 0% grade with no wind (Fig. 1) indicated that the fire arrived at the buildings at the top and the bottom of the slope 157 minutes after the start of the fire. Meanwhile, when the grade was 20% (Fig. 2), the fire arrived at buildings at the top of the slope 163 minutes after the start of fire. Based on this simulation, the fire tends to spread more slowly when there is a slope compared to when the terrain is flat. In terms of the spread of fire toward the bottom, the fire has not arrived at the two rows of buildings at the bottom. Thus, the speed of the spread of fire tends to be slower with a slope.

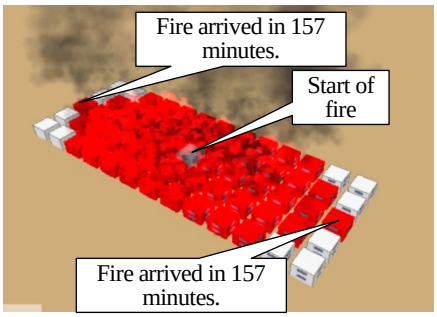

Figure 1. Spread of fire when buildings at the fire arrives at buildings at the top of the slope (0% grade)

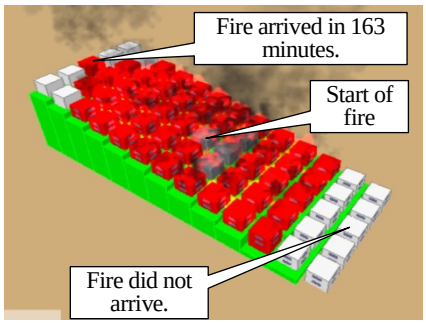

Figure 2. Spread of fire when buildings at the fire arrives at buildings at the top of the slope (20% grade)

4. Conclusion

The team is going to explore how fire spreads and the conditions of fire evacuation depending on the slopes using larger hypothetical cities to conduct case studies using actual cities.