Towards the Creation of Safe and Secure Cities

—Urban Disaster Prevention Research: Its Past and Future—

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1. Introduction

A long time has passed since we recognized just how susceptible Japan's cities are to earthquakes, to urban fires in particular. According to a damage estimate by the Expert Panel on Measures to Prepare for an Earthquake Directly Under Tokyo of the Central Disaster Management Council, in the worst case, of approximately 850,000 homes which would be damaged, about 80% would be burned down, and of the 12,000 anticipated fatalities, more than half would be killed by fire.

To plan urban disaster prevention, it is, of course, essential to consider disasters of many kinds, including flooding caused by torrential concentrated rainfall which has increased in recent years, storm surges, strong winds, tornadoes, etc., but the Urban Planning Department has conducted a series of research projects concerning urban fires. This report summarizes past initiatives and considers the future direction regarding research on urban disaster prevention, including the perspective of densely populated urban areas where the risk of fire is extremely high.

2. Evaluating the disaster prevention performance of urban areas focused on urban fire simulations

A General Technology Development Project implemented from 1998 to 2002, Development of Disaster Prevention Assessment and Countermeasure Technologies for City Planning, was a study of a damage prediction simulation concerning 1) the danger of fire spreading and the 2) difficulty of activities (evacuation, rescue, first-aid, and fire-fighting activities) as a result of road closures.

Specifically, regarding 1), to perform urban fire simulations, a program which visually represents the way fires spread by elapsed time in the process, outbreak of fire → spread of the fire → damage to surroundings → ignition of nearby buildings, has been developed based on data concerning the state of individual buildings in urban areas, positional relationships of buildings, and shielding. Concerning 2), activity simulations, a study was performed to evaluate the degree of difficulty of evacuation, fire-fighting, rescue, and first-aid activities according to the state of the area's facilities, parks, city streets, etc., under conditions where roads have been closed following an earthquake.

These studies incorporated knowledge concerning the situation when many fires broke out simultaneously in densely populated urban areas and the effectiveness of fire break belts (wide streets, parks, rows of noncombustible buildings) during the 1995 Hanshin-Awaji Earthquake Disaster.

Urban area fire simulations are performed to develop 1) advanced urban area fire simulation technology, 2) urban area fire imaging technologies, and 3) urban area data and building data control technologies as part of Development of Support Tools for Comprehensive Urban Area Fire Measures (2007 to 2009), in order to continue to improve the precision of simulations and visualization technologies.

3. Disaster prevention performance evaluations for densely populated urban areas

The 2002 Urban Recovery Project (Third decision) stipulated that during the next 10 years, priority improvement of approximately 8,000 hectares at particularly high risk of major fires during earthquakes from among a total of 25,000 hectares of densely populated urban areas nationwide would be undertaken. And the 2007 Urban Recovery Project (Twelfth decision) stipulated that because, in densely populated urban areas, there are many bottlenecks, including numerous lots which cannot be used effectively under building regulations, and houses difficult to reconstruct, it is necessary to accelerate improvements of such areas.

In response, we tackled disaster prevention problems in densely urban areas based on the results of the General Technology Development Project referred to above as part of Research on Human Suffering During Earthquake Fires Based on the Improvement of Area Facilities in Densely Populated Urban Areas (2006 to 2008). Specifically, the theme of the study was 1) evacuation simulation technologies performed to predict the state of evacuation by area residents incorporating residents' evacuation site and evacuation route selection actions and obstruction of roads caused by the collapse of buildings and by fire. The study also included 2) methods of evaluating the effectiveness of providing small empty spaces (pocket parks, etc.) to prevent the spread of fire by performing urban area fire simulations. Based on 1) and 2), a

technique to clarify methods of effectively improving area facilities etc. comprehensively considering the characteristics of the area was studied and, for example, a method of clarifying a road project site to effectively prevent the spread of fire was presented.

And concerning evacuation simulations, Research on Smoothing Wide Area Evacuation During an Earthquake Fire began in 2009 in order to develop a wide-area evacuation multi-agent program which can be used to deal with a variety of problems encountered during wide area evacuation, including the analysis of locations of evacuation problems and obstructive factors.

4. Densely populated urban area improvement promotion policies

And regarding research on improvement promotion policies for densely populated urban areas, as part of Study and Survey of Early Safety Assurance Promotion Policies for Densely Populated Urban Areas (2004 2005), studies from the perspective of reconstructing deteriorated housing etc., were carried out focused on the use of Special Methods of Cooperative Reconstruction such as special exceptions to building form restrictions under the Building Code of Japan, for example, cityscape inducement type area plans, special approvals of building coverage ratios, and the special design method for group buildings etc.

The term, Special Methods of Cooperative Reconstruction used above means effectively linking individual building plans to reconstruction, by applying special methods under the Building Standard Law as reinforcement measures of so-called bean jam buildings inside urban blocks.

And beginning in 2010, the Development of Cooperative Reconstruction Rule Enactment Support Technologies for Densely Populated Urban Areas was started in order to construct guidelines to the enactment of cooperative reconstruction rules to promote the improvement of densely populated urban areas. And in order to discover reconstruction needs based on the application of Special Methods of Cooperative Reconstruction, plans call for the development of area performance prediction and assessment tools which local governments and consultants can use easily, including environmental performance items such as access to sunlight and ventilation in addition to disaster prevention performance. (see following figure)

5. Conclusions

Disaster prevention research has advanced under the methodology—considering future measures taking past disasters which have actually occurred as lessons—but severe disasters which actually occur usually trigger damage greater than that anticipated and greatly exceeding past knowledge. In response, we considered that it might be possible to go beyond conventional methodology to use simulation technologies to clarify new forms of disaster damage. It is assumed that from the macroscopic perspective, damage hypotheses of earthquakes bear this role to a certain degree, but it might be possible to search for forms of damage which apparently cannot be imagined applying past knowledge, that related to evacuation after earthquake fires in particular, according to the specific conditions in various urban areas.

Resources:

Guidebook to the Operation of Group Regulations to Improve Densely Populated Urban Areas, Technical Note of the NILIM January 2007.
(http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0368.htm)