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IIS.The University of Tokyo

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[Disaster Management with Structural and Non-structural Approaches]

Department of Human and Social Systems

Urban Earthquake Disaster Mitigation Engineering・International Disaster Management Strategy

Civil Engineering/Interfaculty Initiative in Information Studies　　　http://risk-mg.iis.u-tokyo.ac.jp/

Japan has entered a period of high seismic activity. Within next 30 to 50 years, magnitude 8 (M8) class earthquakes may happen 4, 5 times and M7 class earthquakes may strike Japan 40 to 50 times. Typical one with magnitude 7 is Tokyo Metropolitan inland earthquake and those with magnitude 8 are great earthquakes along the Nankai-Trough. The Central Disaster Prevention Council of Japanese Government estimated that the damage by the linked gigantic earthquake (M9 class) along the Nankai Trough is about 220 trillion yen, and that by Tokyo Metropolitan inland earthquake is about 95 trillion yen. The number of damaged buildings (only totally collapsed, burned out, and washed away) becomes more than 3 million, and that of fatalities is about 350,000. However, they are the damages only caused by shaking, fires, and tsunami just after the quake. In June 2018, the Japan Society of Civil Engineers reported their estimated long-term (20 years) economic loss due to these disasters that approximately 1,410 trillion yen by the Nankai Trough gigantic earthquake and about 778 trillion yen by Tokyo Metropolitan inland earthquake.

There are three types of efforts for disaster management: "self-help effort, mutual assistance, and public support." Considering current issues of Japan, such as aging and depopulation society and financial limitation, it is expected that contribution ratio of "public support" will decrease in the future, therefore securing and continuing the activities of "self-help effort" and "mutual assistance" are important. However, it is no longer possible to maintain conventional "disaster preparation that appeals to the conscience" of individuals, corporations, NPOs, and NGOs who are responsible for "self-help effort" and "mutual assistance." It is essential to improve the environment to bring about economical and mental benefits to them.

The important keywords are "from cost to value" and "phase-free." The conventional disaster management measures, which are considered cost, do not have continuity once being done, and the effect can be found only when disaster occurs. However, value-type disaster management measures are evaluated to be the ones that bring additional value and brand power to the organization and/or the region in normal period, and this situation will be maintained regardless of the occurrence of a disaster. "Phase-free" type disaster management measures, which contribute both improving the quality of life in normal period and decreasing negative impact during disaster, can bring additional new value.

Together with the new coronavirus problem that has spread all over the world, the above-mentioned way of thinking is becoming more important. Based on this recognition, our laboratory has been conducting strategic researches to realize a disaster-resistant society with both hardware (mainly structural measures) and soft measures (systems, education, various systems, etc.) approaches.

Hardware [Structural Measures]

■ Retrofitting of masonry structures
Proposal of a simple and low-cost seismic retrofitting method for masonry in earthquake-prone areas

■ Building collapse analysis
Simulate the failure behavior of structures using the Applied Element Method (AEM). The AEM can simulate total collapse behavior of structures from continuum to discontinuity with high accuracy.
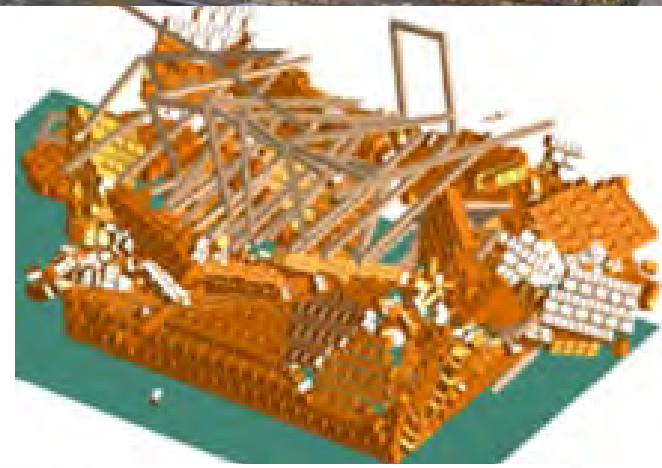
■ Self-floating evacuation facility
Development of a new Tsunami evacuation facility which can protect disaster prone people. The facility floats when Tsunami comes. Feasibility study has been carried out by experiment and numerical approaches.
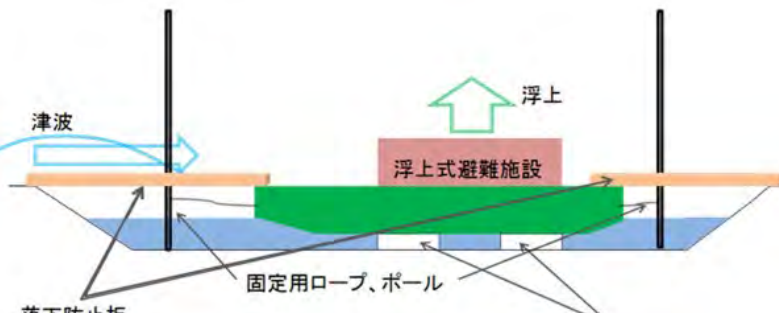
■ Development and verification of a overturning protection device for furniture
Conduct shake table tests using ground motions with various predominant periods and intensity to verify the effect of the developed furniture overturning protection device.

Software [Non-structural Measures]

■ Social promotion system for retrofitting of masonry structures
Study on promotion systems of seismic retrofitting for unreinforced masonry houses

■ Analysis of disaster management plan in developing countries
Analysis of contents and clarification of problems for revision of disaster management plans through literature reviews and interview surveys

■ Analysis on fire spreading
Investigation of the damage caused by the fire spread. Left figure shows a fire spread 12 hours after the 1923 Kanto earthquake.

■ Design of disaster related laws
Study on the incentive system for promoting retrofitting of vulnerable buildings. Left figure shows the effect of the "Seismic retrofit incentive system based on guarantees by local governments" for Shizuoka Prefecture.
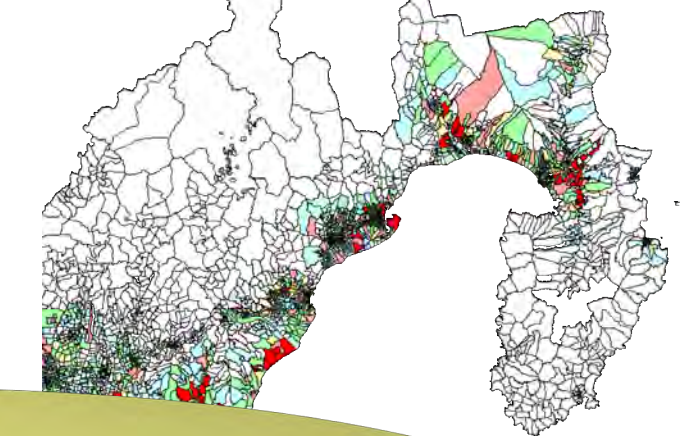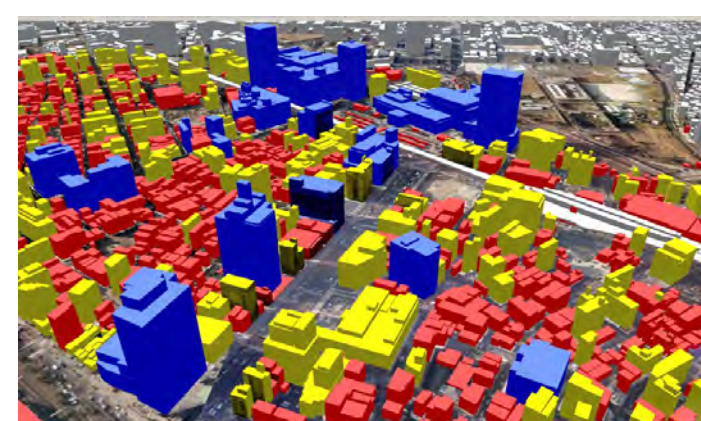
### Comprehensive disaster management strategies

Disaster information archive

■ Development of effective hazard map and its management
Development of effective hazard map for improving countermeasures for pre-disaster, disaster response activity, and recovery/reconstruction.

■ Estimation of intensity distribution based on actual damage in affected area
Estimate the seismic intensity distribution of the area with limited observation points using damage recognizing by satellite image and earthquake damage function
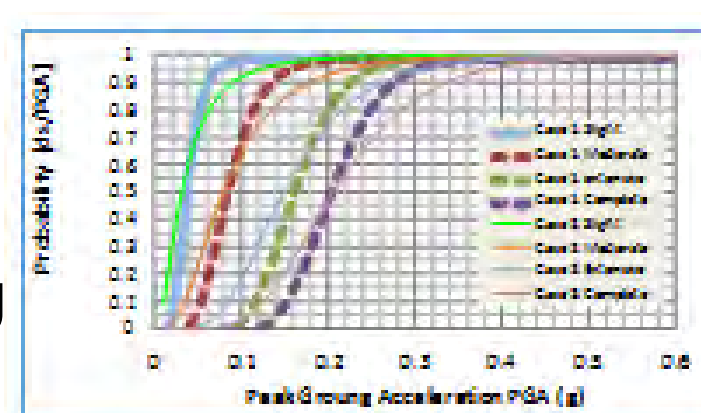
**■ Database and learning system of lessons learned from past disasters**
Archive survey reports, disaster experiences, and lessons learned from the past disasters to organize knowledge, accumulate and utilize.

Disaster information collection and dissemination

■ Application of remote sensing
Develop a system to utilize disaster information obtained by remote sensing for disaster response.
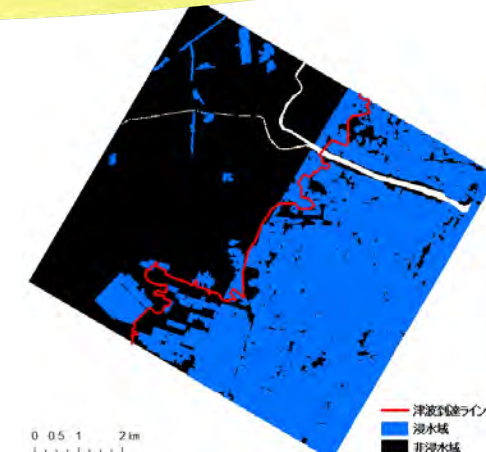
■ Next generation disaster management manual
Build a system to contribute all-phases countermeasures. Evaluate the effects of pre-disaster measures, and navigate the disaster response period and staffing management according to the damage.

■ Development of disaster imagination tool
Improve disaster imagination that is essential for establishing proper disaster countermeasures. Disaster imagination is an ability to image what will happen around you as time goes since hazard happens based on the regional characteristics and occurrence condition.

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