MEGURO LAB.

Disaster Prevention with Hardware and Software Approaches

Department of Human and Social Systems

Urban Earthquake Disaster Mitigation Engineering, International Strategy for Disaster Management
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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 Nankai-Trough. The Central Disaster Prevention Council estimated the worst damage by the gigantic earthquake along the Nankai Trough to be about 220 trillion yen, and that by Tokyo Metropolitan inland earthquake to be about 95 trillion yen, and the number of damaged buildings (totally collapsed or burned) to be more than 3 million buildings, and the number of deaths to be about 350,000. However, these damage, besides by strong ground motion, cover only the damage caused by the fire spread and the tsunami that may happen within a couple of days after the earthquake. In June 2018, the Japan Society of Civil Engineers estimated and announced the long-term (20 years) economic loss from these disasters that it is about 1,541 trillion yen due to the Nankai Trough earthquake and about 855 trillion yen by Tokyo Metropolitan earthquake.

There are three roles for disaster management: "Self-help Effort (SE), Mutual Assistance (MA), Public Support (PS)". It is expected that the ratio of "PS" will decrease in the future, therefore, in order to cover the decrease of PS, securing and continuing the activities of “SE” and “MA” is necessary. For its implementation, it is essential to improve the environment to bring physical and mental benefits to the stakeholders of “SE” and “MA.” The important keywords here are “from cost to value” and “phase-free”. Conventionally, disaster countermeasures are considered to be costs therefore they are the ones that ends once being done and do not have continuity, and also the effect cannot be found unless a disaster occurs. However, disaster countermeasures which increase value become the ones that can be maintained continuously regardless of the occurrence of a disaster as they bring always reliability and brand power to the organization and the region in both normal and disaster time. "Phase-free" disaster countermeasures are services, products, and ways of life, that improve the quality of life in normal period and also their functions can be continuously used even in a condition of disaster, bring new additional value.

Based on the recognition above, our group conducts strategic research to realize a disaster-resilient society from both "hardware and software," and "international and domestic" viewpoints.

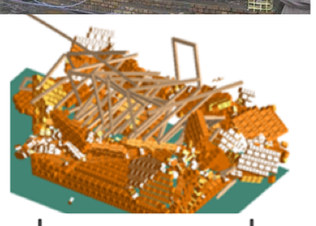
Hardware [Investigation of physical phenomena and realization of disaster-resilient structures]

■ Retrofitting of masonry structures

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

■ Building collapse analysis

Simulate the collapse behavior of structures using the Applied Element Method (AEM) and/or the Extended Discrete Element Method (EDEM) that can simulate the total behavior of structures from continuum to discrete state with high accuracy



■ Self-floating evacuation facility

Development of an evacuation facility that can save disaster-prone people from Tsunami attack by self-floating of the facility
Feasibility study by experiment and numerical analysis are being carried out.

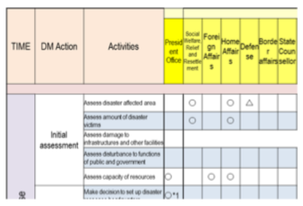
■ Development and verification of a device for the prevention of furniture overturning

Conduct shake table tests using ground motions of various predominant periods and intensity to verify the effect of the developed furniture overturning prevention device

Software [Investigation of social phenomena and realization of a disaster-resilient society]

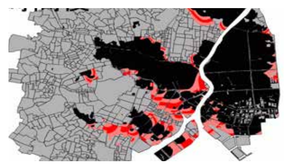
■ Social promotion system for masonry retrofitting

Study on promotion systems of seismic retrofitting for unreinforced masonry houses



■ Analysis of disaster management plan in developing countries

Clarification of problems of disaster management plans for revisions based on literature reviews and interview surveys



■ Analysis on fire spreading

Investigation of the damage caused by the fire spread (relation between structural damage and the fire spread)
The left figure shows a fire spread 12 hours after the 1923 Great Kanto earthquake.

■ Design of disaster related laws

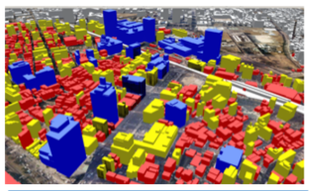
Study on the method of introducing incentives for promotion of retrofitting vulnerable buildings
The left figure shows the results of an evaluation of the effect of the "Seismic retrofit incentive system based on guarantees by local governments" for Shizuoka Prefecture.

Comprehensive disaster prevention strategies

Disaster information archive

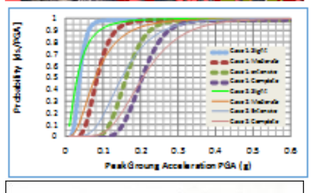
■ Development of effective hazard map and its management

Systemize, accumulate, and suggest the risk map to contribute to countermeasure in-advance, disaster response activity, recovery, and reconstruction.



■ Estimation of intensity distribution based on actual damage in earthquake area

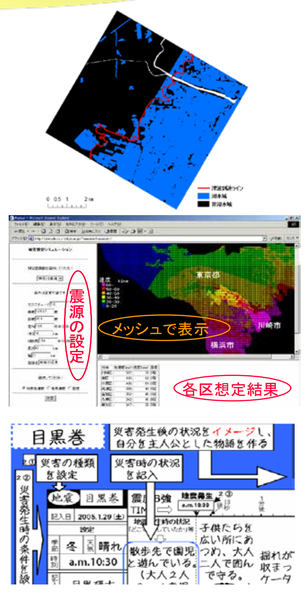
Estimate the intensity distribution in the earthquake area with few observation points by using the damage recognizing result by satellite image and the fragility function of structures.



■ Database and learning system of lessons learned from past disasters

Archive survey reports, disaster experiences, and lessons learned from the past disasters, and organize them well to accumulate

Reception/distribution of disaster information



■ Application of remote sensing (RS) for disaster management

Develop a system to utilize disaster information obtained by RS to assist disaster management

■ Next generation disaster management manual

Build a system for supporting implementation of disaster countermeasures and responses in all phases from before to after the hazard attack
Evaluate the effects of proactive measures, and navigate the disaster response timing and staffing management according tc the damage

■ Disaster imagination tool development

Improve ability to imagine situations that occur around you in a disaster and the damage that you will suffer (disaster imagination) by setting yourself as a player and setting certain scenes in daily life