Post-Earthquake Damage Screening of Structures

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In earthquake-prone regions, the primary measure for the performance of buildings and civil infrastructure has been strength and deformation capacity of structures under strong ground motions induced by major seismological events. Real-life effectiveness of seismic protection system in reducing overall damage of the structures have been verified through past large earthquakes, and through a series of recent full-scale tests at the world's largest shaking table in Japan.

Nevertheless, since the seismic design of building structures conceptually allows some level of damage for large and rare earthquakes in part due to uncertainties in strong ground motion predictions and economic constraints, the affected buildings require inspection for making decision on whether they are operational or not. Such downtime as consequences of damage in large and important structures (*e.g.*, bridges, schools, and high-rise buildings) can result in long-term economic losses and impact to social activities that hinder the rapid recovery of earthquake-affected communities. However, the current visual inspection approach in investigating safety risks in earthquake-damaged buildings involves intensive labor and the required time for completing damage screening after a large earthquake in the Tokyo metropolitan area is estimated to be more than a month.

A stand-alone sensor network deployed to a structure for monitoring its response, commonly called as a Structural Health Monitoring (SHM) system, has a strong potential for increasing the speed in the damage screening process and for providing objective information based on data. However, the real-life application of the SHM system for the damage assessment of structures is still limited to important infrastructures for two major reasons: 1) the large cost and amount of labor of sensor installation as well as issues associated with long-term maintenance of sensors; 2) the unknown impact on decision making process and management of structures in natural hazards and fatigue-related deteriorations.

An on-going project on the enhancement of sensor installation is the application of emerging wireless sensing technology in SHM system as an alternative to conventional tethered sensors. A wireless configuration can also enhance scalability and modality in designing a SHM system. The long-term performance of the developed wireless sensor network has been evaluated through the deployment to a large-scale suspension bridge in California. In response to the second issue, another research effort focuses on the development of the damage diagnosis system for steel buildings using testbed specimens at DPRI, Kyoto University. The key objectives of the project are what responses are truly important to measure and how to translate data in a meaningful format to decision makers.

In summary, the presentation will first introduce major achievements in seismic protection systems, which continue to be a primary area of research in the structural engineering community, and will then discuss the need and the latest achievements in damage screening technologies for enhancing disaster resiliency of urban areas. Finally, the presenter will give his own views on what can be done over the next 5-10 years to promote major research achievements to be standard technologies installed to seismically vulnerable structures.