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RECENT DEVELOPMENT OF POST-TENSIONED SELF-CENTERING STRUCTURES FOR EARTHQUAKE RESISTANCE

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A post-tensioned (PT) self-centering (SC) structure that uses post-tensioning steel to compress beams against columns or bridge column segments against a footing has been developed as an alternative to a traditional earthquake-resisting system. The approach in seismic design, developed under the U.S. PRESSS program for precast concrete buildings with the SC connections, was verified from a 3/5 scale five-story SC concrete test-building (Priestley 1991, Pampanin et al. 2000). The SC behavior of the test-building was extremely satisfactory without significant strength loss up to drift levels of 4.5%. This posttensioning technology was successfully extended to steel moment-resisting frames (MRFs) by several connection tests (Ricles et al. 2002, Christopoulos et al. 2002). The lateral deformation of the PT frame leads to the opening of the gap at beam-to-column interfaces, so the compression force in the PT beam is affected by the column and slab restraints that oppose the frame expansion. These two issues become sources to hinder the SC behavior expected for this system.

Various conceptual proposals have been made along this line. Recently, Chou et al. (2008) experimentally showed that the PT connection with a continuous composite slab self-centers with low residual deformations as long as the metal deck separates along the column lines and negative connection moments provided by the slab reinforcements are considered in design. Chou et al. (2009) also demonstrated similar cyclic responses between a bare PT connection and a composite PT connection with a fully discontinuous composite slab, which opens freely along the beam-to-column interface. By adopting a concept of the rigid bay to transfer floor inertia forces to the PT frame and accommodate PT frame expansion (Garlock et al. 2006), shake table tests of a 3-dimensional PT frame with a sliding slab demonstrated the SC seismic response and small residual drift of the specimen frame in earthquake loadings (Chou and Chen 2009).

Kim and Christopoulos (2008) outlined the column restraining effect and suggested a pinned boundary condition for upper story columns to estimate column bending stiffness. The assumption of pinned boundary conditions represents a simplified estimate that represents an upper bound of this restraining effect and was suggested to account for the worst case scenario where a structure responds with a high drift at one floor while the drifts in the floors above and below are almost zero. Note that when the structure responds in its first mode shape (common seismic response for regular low-to-medium rise buildings) where all stories have comparable drifts, the restraining effect might be greatly reduced because the columns are pushed out at all floors simultaneously. Therefore, the previously approximate approach is overly conservative in cases where the structure responds in its first mode. Chou and Chen (2009) presented an alternative method for evaluating bending stiffness of the columns and compression forces in

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the beams based on a deformed column shape that matches the gap-opening at each beam-to-column interface. This method was verified analytically and experimentally through a full-scale one-story PT test-frame (Chou and Chen 2010).

It is easier to apply the posttensioning technology to bridge columns than buildings due to lack of restraints from the superstructure. In the past few years, research activities on the seismic responses of concrete segmental columns have been carried out in the U.S. and in other countries (Billington et al. 1999, Chang et a. 2002, Hewes and Priestley 2002, Chou and Chen 2006, Chou and Hsu 2008, Ou et al. 2007). Several test and analytical results of the PT segmental columns demonstrated the SC capability and good energy dissipation, but the application of this system in high seismic areas is still limited.

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DEBRIS FLOW HAZARD ASSESSMENTS WITH NUMERICAL MODELING

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Debris flow disasters are usually accompanied by serious loss of lives and properties. However, debris flows are also part of earth's natural phenomenon, what is the reasonable budget to be spent on mitigation measures becomes an important issue for the budget allocation processes. This paper utilizes economic concepts to propose a reasonable estimation of the hazard damage and the cost of proposed mitigation measures. The proposed method is composed of four steps, namely, delineating the area of the disaster with different return periods, itemizing the land use within those area, calculating the hazard lose using official values and computing the expected probable maximum loss with a probability distribution. The comparison between the assessment of hazard and the economic gains of any proposed mitigation measures can be used as a reference for future decision making process.

Keywords: Debris flow, Hazard assessment, Risk analysis, Numerical Simulation, GIS, econometric model

Shaw Chen Liu

Global data (GPCP) covering the period 1979-2007 are examined for changes of precipitation extremes as a function of global mean temperature by using a new method which focuses on interannual differences rather than time series. This work finds that globally the very heavy precipitation (top 10% bin of precipitation intensity) increases by about 95% for each degree Kelvin (K) increase in global mean temperature, while 30%-60% bins decrease by about 20% K^{-1}. The global average precipitation intensity increases by about 23% K^{-1}, substantially greater than the increase of about 7% K^{-1} in atmospheric water-holding capacity estimated by the Clausius-Clapeyron equation. The large increase of precipitation intensity is qualitatively consistent with the hypothesis that the precipitation intensity should increase more than 7% K^{-1} because of the positive feedback from additional latent heat released. However an ensemble of 17 latest generation climate models estimates an increase of only about 2% K^{-1} in precipitation intensity, about one order of magnitude smaller than our value, suggesting that the risk of extreme precipitation events due to global warming is severely underestimated by the IPCC2007 climate models.

The increase in precipitation intensity is found about twice a large at low latitudes (30S – 30N) than higher latitudes. For example, the top 10% bin of precipitation intensity at low latitudes increases by about 130%K^{-1}, but only about 70% K^{-1} at latitudes above 30 degrees. Increases in heavy precipitation can lead to more floods. On the other hand, chronic decreases of moderate precipitation pose a serious threat to droughts because moderate precipitation is a critical source of water for soil moisture. Given the fact that there has been about 0.8 K global temperature increase since the industrial revolution, our results imply that floods caused by the top 10% heavy precipitation have increased by about 100% at low latitudes, and similar increases have occurred in the risk of droughts due to the decrease of moderate precipitation. Thus low latitude nations are suffering and will continue to suffer the bulk of increasing risk of floods, mudslides and droughts due to global warming. Since mitigation of the greenhouse warming by reducing CO_2 emissions will take decades to be effective (because the CO_2 residence time in the atmosphere is about 80 years), it is imperative that adaptation strategies such as flood control, water resource policy and alternative land use plans are implemented quickly.

TECHNOLOGIES REQUIRED FOR THE MITIGATION AND MANAGEMENT OF MEGA-DISASTERS

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Reducing vulnerability to natural hazards is a critical concern for natural hazard prone area. However, hazards vary by location, and society has scarce resources to devote to mitigation. Decision makers need methods for integrating realistic predictions of disaster effects with information about community assets and the costs of possible mitigation options so that these options can be effectively prioritized. For example, information on the likely locations and extent of potential ground failures from a specific earthquake source is required for prioritizing earthquake mitigation efforts before an earthquake occurs. Hazard management framework contains three major issues: Hazard risk assessment (science & engineering knowledge), emergency management (planning and mitigation tool), and emergency services (lifelines and social services). To provide community resilience to natural physical hazards research agencies, government, and community must collaborate and communicate to each other under this hazard management framework. Development of knowledge-based emergency and risk management support system can provide excellent support system for hazard management. Missions of emergency management in national level covers: a) promote sustainable management of hazards, b) enable communities to achieve acceptable levels of risk, c) require local authorities to coordinate EM planning and activities through regional Groups, d) provide for integration of national and local emergency management planning, e) encourage coordination across agencies, f) Defines roles and responsibilities of national agencies and international assistance. Effective emergency hazard management included emergency preparedness, response, and recovery result from the coordinated and collaborative efforts of multiple organizations, both governmental and commercial. These organizations must not only coordinate their preparations for and initial response to all types of emergencies, but must remain coordinated and collaborative in highly dynamic and volatile situations.

One of the important elements for reducing the MC/MD hazard is to develop a close relationship among local government, emergency services, welfare sector, community and lifelines. The local government needs to provide commitment to work together, to develop and coordinate planning and activities, and do the work on readiness, response and recovery. The emergency services need to plan and exercise jointly with emergency management group members and carry out emergency management group plan functions. The welfare sector and community need to plan and exercise jointly, and service meet emergency. Due to the change of infrastructure and the environmental situation, enhancement of both typhoon and earthquake disaster emergency response capabilities must be conducted, such as to assemble hazard warning information from all related agencies and to provide all the assessment information sources and coordination among all related agencies (government and private) to assemble hazard information for hazard management.

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Finally, to develop MC/MD hazard mitigation the following future works need to be strengthened.

A. Enhancement database and decision-support system

Many databases for disaster reduction have been built by government units, but most of them are scattered in different agencies, and difficult to integrate. Therefore, they can only provide limited information for decision-support systems. To establish information system for disaster decision-support system, special attention will be given to the following points:

- Standardizing classification, format, quality of data and procedure for data updating,
- Adopting an open type of GIS technology to integrate the spatial geographical information scattered in different units and NGOs,
- Establishing a common platform for the disaster reduction database,

B. Application of remote sensing technology

Remote sensing technology can provide effectively observed information for different types of disaster. They can be used to monitor field situation of disaster and thereby to assess losses in a large area. The effort to promote application of remote sensing will be concentrated on the following:

- Upgrading capability for disaster monitoring and investigation by well-developed high technology, such as airborne radar,
- Establishing a multi-functional telemetric data integration center for integration of data from different time and sources,
- Developing and implementing a comprehensive land use monitoring program,

C. Establish Sustainable land use management

In recent years, the risk of large-area landslide, debris flow and flood disasters have drastically increased. The fundamental way to reduce the risk of these disasters is to avoid improper land exploitation. The development of technology for land use management will be focused on the following:

- Establishing a disaster risk assessment system for land use planning,
- Intensifying research on land use development and ecological engineering related to disaster reduction,
- Integrating effectively the land use management mechanism with the disaster reduction operations system,

D. Establish inter-ministerial collaboration mechanism

Because the subject areas for research and development in disaster reduction technology are of highly interdisciplinary and inter-ministerial natural, it is learned that consolidated planning, coordination and management are critically important. Methodology and system development for mega-city and mega-disaster hazard mitigation need an integration of a lot of assessment tools and policies.

LANDSLIDE-INDUCED DISASTERS IN THE CNETRAL TAIWAN

Ming-Der Yang[3]

The geological formation of Taiwan, where is located at an active tectonic plate, is so young and unsteady to be prone to sloping and landsliding. The occurrence probability of landslide is comparably high in the central Taiwan, especially after the Chi-Chi earthquake in 1999. Besides, climate change increasing the rainfall intensity and human cultivation changing the landuse exacerbate the damage of the landslide catastrophe. In the past decade, hundreds of hillsides and landslides were identified in the central Taiwan due to the fragile geological environment and heavy rainfalls. During Mindulle and Morakot typhoons, which are the most serious rainfall events in the last decade, the catastrophic investigation of the disaster scene, including field survey, outcrop investigation, and remote sensing investigation was executed to reveal the inundation for disaster response. Applying GIS and GPS, field survey was carried out for prime investigation immediate in the end of the flood. SPOT and FORSAT-II satellite and airborne images provided temporal and spatial information for inundation investigation and scenario simulations. Not limited to hill slope sliding, the landside-induced disasters are complex and include debris flows, river bed lift-up, levee failure caused by hyper-concentrated sediment flow, and landslide dam. The river bed has been significantly rose up by sediments originating from landslides in the watershed that threatens the structures and property in the downstream, such as levees, bridges, farms, and houses. The landslides nearby the river bank stock the stream and detour flow, and even generate a landslide dam threatening the downstream areas. Considering the detriment of landslides, a basin management strategy for the rivers in the mountainous area should have revolutionary thoughts beside traditional water-only concern.

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EMERGENCY SHELTER DESIG AND MANAGENET FOR A FRIENDLY ENVIRONMENT

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During the Morako flooding, one of the problems discovered is that although government issued warning signals for the imminent danger of mud flow and land slide but quite a few residents refused to move out of their home to the emergency shelters. Some of them suffered serious consequences and the government was blamed for not doing enough to protect her citizen. If natural disasters are going to be frequent in the future, what can be done to reduce these problems except using public authority to a forced evacuation by law.

After site survey to a couple of emergency shelters and conduct questionnaires on refugee in the shelters, some conclusions are drawn:

1. Emergency shelters are not safe. Because it was an ad-hoc stay, a lot of people were thrown into a large space, such as a school auditorium or community center, to spend several days together. These places are not designed to accommodate people to their individual needs. Refugees may lose their property, can not get enough sleep, and some times sexually harassed.
2. Pets are not allowed in the shelters. In many families, pets are like members in the house. In an emergency shelters, animals are not allowed inside. Therefore, people would rather gamble to stay at home to accompany their pets than moving into a shelter. There are incidences that people died because of this reason.
3. Social support at the shelter is inadequate. When people moved into a shelter, they need to start making plans for the aftermath. But refugees generally come to a shelter with nothing. Therefore adequate social support from the government and volunteer groups is extremely important. Otherwise, refugees may not want to leave their home next time when an emergency happens.
4. Location of shelter should be close to home. After the imminent danger is over, refugees want to check back on their house and plan for the recovery. A long distance travel from shelter back home may discourage people to go to the shelters.

<u>Recommendations for improvement</u>

1. Adequate pre-disaster planning and design on the shelter space is important for a more friendly shelter environment.
2. Reorganization of disaster management for a more efficient administration is important.
3. Pet issue need further research.

US experience may be a starting point for Taiwan to improve.

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