ICUS NEWSLETTER

International Center for Urban Safety Engineering

Institute of Industrial Science
The University of Tokyo

VOLUME 4 NUMBER 2
JULY -SEPTEMBER 2004

EARTHQUAKES DO NOT WAIT
LET'S CONSTRUCT A BRIDGE BETWEEN THE RESEARCH OFFICES AND THE REAL SOCIETY

By

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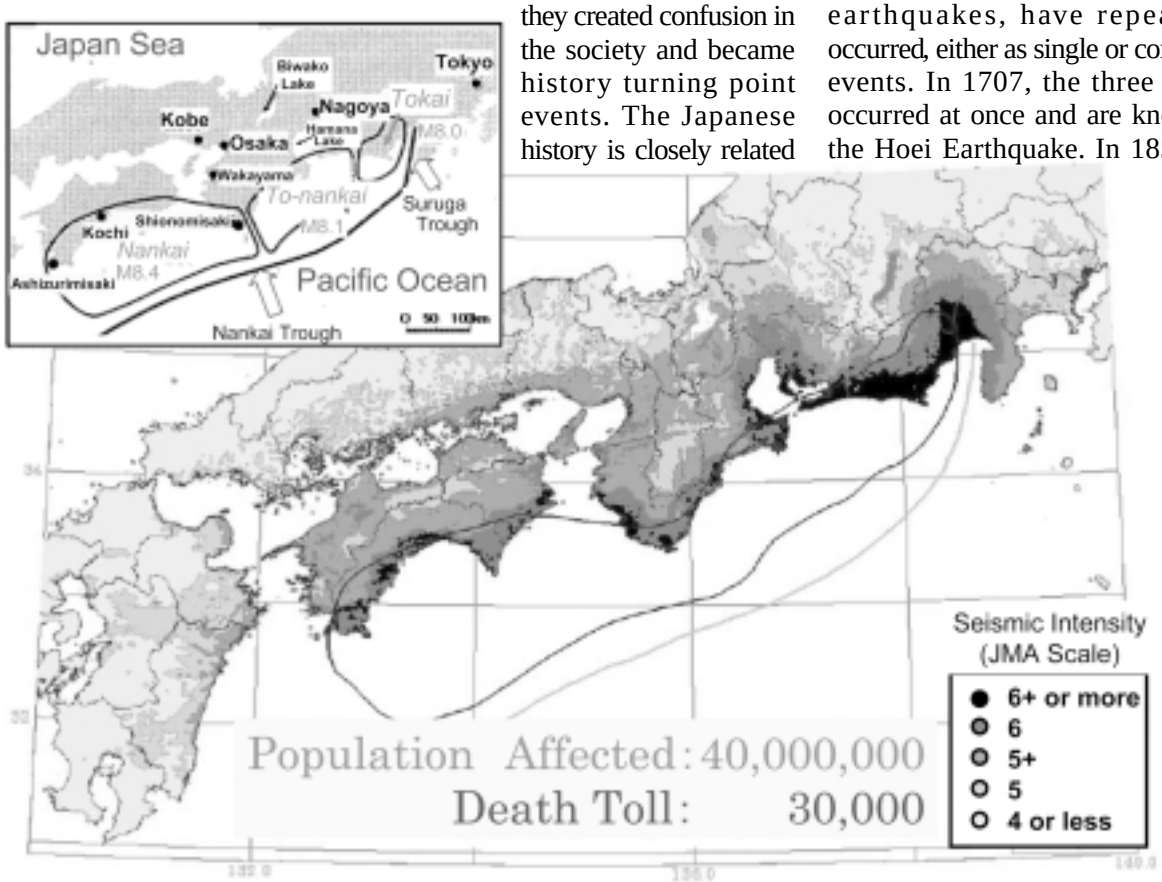
Earthquake engineering experts are greatly concerned about the occurrence of three huge earthquakes around the Nankai Trough, which is located along the western coast of Japan. These earthquakes are expected to shake vast regions with intensities over 6 in the Japanese Metrological Agency scale. When these earthquakes stroke in the past, they created confusion in the society and became history turning point events. The Japanese history is closely related with the occurrence of these events.

Along the Nankai Trough, three 100-year return period events, the Tokai, To-Nankai and Nankai earthquakes, have repeatedly occurred, either as single or combined events. In 1707, the three events occurred at once and are known as the Hoei Earthquake. In 1854, the



JMA Seismic Intensity Distribution due to Tokai+To-Nankai+Nankai Earthquakes (by The Central Bureau of Earthquake Disaster Reduction, Japan)

Tokai and To-Nankai Earthquakes stroke simultaneously and the Nankai Earthquake followed after 32 hours. This event is known as the Ansei Earthquake. The last series of combined events occurred in 1944 and 1946 when the To-Nankai and Nankai Earthquakes occurred, respectively. Because at that time no Tokai Earthquake occurred, this event is highly expected and 25 years ago, a short term prediction system was started to be prepared.

The Japanese earthquake research committee of the National Government has reported on March 2004 that the probabilities of occurrence of the Tokai, To-Nankai, and Nankai earthquakes in the coming 30 years are 84%, 56%, and 46%, respectively. The Central Bureau of Earthquake Disaster Reduction estimated the damage expected in case these three earthquakes occurred and reported its results in 2003 as shown in the figure in the front page. In the worst case scenario, the estimated death toll was approximately 30,000, the number of collapsed and heavily damaged houses, 1,000,000 and the economic loss, 100 trillion yen. Compared with the damage caused by the 1995 Kobe Earthquake, the estimated death toll and the structural damage/economic loss are five and ten times larger, respectively. Japanese total tax revenue in 2004 is estimated as 41.7 trillion yen. Therefore, it can be said that Japan has a great probability of losing the equivalent of more than two-year tax revenue in the first half of this century. Japan should recognize this situation.

The main cause of earthquake damage is the existing low resistant structures. In Japan, when a new building design code is enacted, it is not retroactive, i.e. existing buildings do not need to comply with the new code. Because of this, there are approximately 13 million low earthquake resistant houses in Japan. Retrofitting these structures is the key issue to reduce the earthquake damage level. A huge damaging earthquake in Japan may have a worldwide impact.

It has been recognized that it is very important to promote earthquake disaster counter measures in the areas that will face the Tokai, To-Nankai and Nankai Earthquakes. These regions are wide and located in western Japan. Approximately 40 million people live there in 10 million houses. If a huge earthquake strikes, one third of the total Japanese population will be affected and self defense forces and firefighters are needed to cope with in this situation, however, the numbers of these two organizations are both 150,000. It is clear that there will be a shortage of human resources to respond well against such a disaster. In this situation, all the population should engage in activities of rescue, first aid, fire fighting, and life protection as well as on mutual assistance inside the community. There is no other possible way to deal with this disaster situation. In the case that three earthquakes strike at once, the damaged area will extend from Kanto to Kyushu. Against such a huge disaster, cooperation among prefectures is fundamental. In order to be able to help each other, the damage in each region should be minimized, thus increasing the capability of each of them to respond independently against the disaster.

What shall we, earthquake disaster field researchers responsible of human lives, do against this imminent situation? Of course, research on highly developed technologies such as base isolation systems, health monitoring, vibration control, and others are very important. I myself am convinced that it is much more important to spread the use of earthquake retrofitting methods which have the minimum requirements to safeguard the human life. Even if these methods are not perfect but manage to save lives, they are very meaningful. It is necessary to retrofit all structures by minimum requirement low cost methods which can be readily implemented. Earthquake disaster research has no meaning if it can not help protect human lives.

I know that it is not easy to promote retrofitting or to make the general public understand its importance. Therefore, the government should improve its system to promote retrofitting. In this sense, I believe that the most important point is to educate the people and show them the situation that they would be facing if an earthquake strikes and they have not retrofit their houses. I am convinced that it is necessary to increase the public awareness by organizing activities to let the people understand the importance of retrofitting. It is also important to bring up a generation of people who can carry out these activities. We, earthquake researchers, are the people called to reduce the earthquake damage in the region, and therefore should go from our research offices to the society by carrying out awareness campaigns for the general public, especially in the areas where the number of specialists is insufficient.

Because the number of earthquake experts is limited, we should collaborate and get support from the media to help us create a bridge between the specialists and the general public. The key issues are the education of elementary, junior and high school teachers, voluntaries in the disaster mitigation field, and mass media people. The author and other supporting members started establishing various cooperation systems among the public as shown in the figure below, as well as human resource education system, colleges for the training of disaster mitigation leaders, and development of disaster

Cooperative activities at a regional level

Educational activities using portable equipments to demonstrate the public the dynamic behavior of structures and the benefits of retrofitting.

mitigation education at elementary school. Useful tools for this purpose are education materials such as portable dynamic structure behavior simulators. The figure above shows three models produced by the author. These equipments are manually or electrically motored and have a great impact on the public.

The university, where earthquake disaster experts are working, may be regarded as a very important regional base for proper preparation and response in case of an earthquake. In a disaster situation, the university can gather information related to ground motion observations and building damage. An appropriate disaster information system is therefore required. The figure below shows the earthquake disaster information system recently developed at Nagoya University, where the author works. Cameras and seismometers are installed at various locations in the Nagoya University campus and national universities around it. Through this system, photographs and strong ground motion records can widely be sent in real time. This information is displayed in multiple screens and many researchers can analyze it. We have established satelite information networks and TV conference systems by which we can communicate with different municipalities. With this system, the university can play a key role as a regional disaster response organization. I am currently developing a very economic seismometer, with a cost of less than 100,000 yen/unit, and am aiming at installing it in all elementary school and business buildings in order to observe the vibration of these structures.

If the general public is given the opportunity to seriously consider an earthquake and a disaster situation, it may become possible to guide them to take proper disaster reduction countermeasures. We, earthquake disaster researchers, have many things to do now. We are expected to take initiatives beyond our conventional action boundaries.

**Professor, Environmental and Safety Management, Graduate School of Environmental Studies, Nagoya University*

Earthquake disaster information system at Nagoya University. This system combines cameras and seismometers to monitor the disaster situation in real-time at Nagoya University and surroundings.

Reports Published by the Research Committee RC-39 "Research on Sustainable Engineering for Urban Safety"(2)

The Research Committee on Sustainable Engineering for Urban Safety (RC-39) established by the ICUS, has been working since April, 2002. Besides the members of the faculty of the Center, the committee comprises of 16 private companies and research organizations.Reports written by the 5 working groups(WG) were published in March, 2004 in Japanese. Research topic and the name of secretary of each WG are listed below. Following the last volume, ICUS Newsletter vol.4-1, brief explanation of WG4 and WG5 are given in this volume.

WG1: Methods to handle aging infrastructure (Secretary: Mr. Kenji SHIBA, Shimizu Corporation)
WG2: Global environment (Secretary: Mr. Hidenobu NAKAI, The Tokyo Electric Power Co., Inc.)
WG3: Study on heat islands in urban environments (Secretary: Mr.Haruhido TSUBAKI, Kajima Corporation)
WG4: Disaster prevention and response (Secretary: Mr. Seiichiro FUKUSHIMA, Tokyo Electric Power Services Co., Ltd.)
WG5: Developments in sensing technology and its applications (Secretary: Mr. Yukio AKAMATSU, Kokusai Kogyo Co., Ltd.)

WG4: Disaster prevention and response

Among the various risks we are exposed to, those of the current concern are natural hazard disaster and terrorism. Since these two risks are categorized into pure risk and unavoidable risk, it is very important to accept these risks adequately and to construct countermeasures in the manner of disaster mitigation. In this research, two model risks; one is the terrorist attack to SHINKANSEN, the Japanese bullet train, and the other is the earthquake, were examined.

Before examining the terrorist attack, the differences in the mechanisms of terrorism risk and earthquake risk were identified, in order to make the characteristics of the former clear in some aspects, such as a definition of risk, background of occurrence, consequences, methodology for quantifying risk, countermeasures, and so on. It was found that the largest difference is the possibility to control the risk. Based on the knowledge obtained, the scenario of terrorist attack to SHINKANSEN was constructed. Through this examination, vulnerable area and parts were illustrated, followed by the concrete countermeasures for them.

For earthquake disaster reduction, although the most important and effective measure is the retrofitting of existing low earthquake-resistant buildings, the progress of retrofitting program is still very slow. In this study, the business model for promoting the retrofitting was proposed to overcome this situation. Employing the model case with realistic retrofitting cost, insurance fee, effect of retrofitting on seismic risk and so on, the effectiveness and feasibility of the proposed business model were demonstrated from the view point of total cost within the business period.

A forum for the terrorism risk was held and a technical paper titled "business model for promotion of retrofitting existing low earthquake-resistant structures" was published during the period of this research.

WG5: Developments in sensing technology and its applications

It is necessary to monitor the present status and change of urban infrastructure in order to maintain a sustainable urban development.

However, there is yet to have any systematic methodology for urban infrastructure has not been systematized enough yet, as the concept of monitoring methodology for a sustainable urban development is new and the monitoring methodologies are not well examined.

The WG5, consisted of specialists in the fields of monitoring and application, has made a set of guidelines of monitoring methodologies for sustainable urban development through examination and organization of materials in order of importance for sustainability.

The guidelines consist of six topics for monitoring methodology in four major application fields, such as, aged infrastructure, disaster, global environment, and urban environment. The themes of six topics are as follows;

- interior damage to an aged infrastructure
- reduction of man-made disaster
- assessment of low-seismic resistant building
- assessment of heat island
- extraction of 3D urban structures towards reduction of CO_2 emission
- dream-inspiring monitoring methodology for future

These guidelines consider not only practically methodologies for a sustainable urban development but also new techniques and concepts such as network with ultra small sensr devices, monitoring methodology from the sky and counterterrorism. It is a challenging task to develop useful guidelines for sustainable urban development that are multi-dimensional and multi-disciplinary in nature. Although, our exercise for the guideline development is yet to achieve the final goal, we believe the concept and the monitoring methodology that are proposed by this group will be useful for a sustainable urban development in the future.

Computational System for Evaluating the Oil Tank Sloshing Risk due to Earthquake

Dr. Naoto Ohbo, Kajima Corporation, was invited by Prof. Amano to give a lecture to ICUS members on computational system for evaluating the oil tank sloshing risk due to earthquake on September 21, 2004.

The natural period of a liquid retaining tank depends on the tank diameter and the liquid depth. Sloshing excitation is determined by the power of the seismic ground motion in this period.

The sloshing evaluation system, which is installed in the oil tank base, uses real-time earthquake information, such as the event location and magnitude determined using the ground motions recorded at stations close to the source, and the local site conditions at the tank site to quickly estimate the expected ground motion at the tank. With this information, the tank diameter and the liquid depth, the sloshing wave height is rapidly estimated. This initial estimation is recalculated and updated when the "real" earthquake motion reaches the tank base. The figure on the right shows one example of the system output for a particular earthquake ground motion and liquid level.

Sloshing wave height in all tanks estimated by the proposed system

In addition, the system evaluates the damage probability based on the relation between the heights of the sloshing wave and tank, and delivers this information to the manager.

The 7th ICUS Open Lecture

The 7th ICUS Open Lecture was performed at IIS in the afternoon of September 29,2004. The title of the open lecture was "Prediction and Countermeasures of Global Disaster in Asia". About 200 audiences attended the meeting and interacted with the presenters.

In the open lecture, very interesting and informative lectures were given from the four famous researchers, Profs. Kimoto, Takara, and Mrs. awatsu and Kawamura. The titles and lecturers were as follows:

1) Prof. Masahide Kimoto, Professor, Center for Climate System Research, University of Tokyo:
"Global Climate Variability and Its Prediction"

2) Prof. Kaoru Takara, Professor, Division of Fluvial and Marine Disasters, Disaster Prevention Research Institute, Kyoto University:
"Global Monitoring and Countermeasures Against Storms and Water-Related Disasters"

3) Mr. Takuyuki Kawazu, Senior Assistant for Disaster Prevention, Planning Division Administration Department, Japan Meteorological Agency:
"International Network for Monitoring the Seismic and Volcanic Activities"

4) Mr. Hiroshi Kawamura, Director, Department of Social Rehabilitation Research Institute, National Rehabilitation Center for Persons with Disabilities:
"Persons with Disabilities and Old People as Active Players of Disaster Preparedness"

Finally, Prof. Taketo Uomoto of ICUS made the concluding remarks on this Open Lecture and expresses gratitude to the participants. Details of this Open Lecture will be reported in the next ICUS News Letter.

Open Lecture lively discussion

Lecture by Prof. M. Kimoto

ICUS New Staff

During this Newsletter Volume period, ICUS welcomes two new staff, Mr.Shogo HAYASHI and Dr. Jun-ichi Susaki as a visiting Professor and an Assistant Professor, respectively. Mr.HAYASHI joined ICUS in July and Dr.Susaki did in August. Here we present their self-introduction for our network members and readers.

Mr. Shogo HAYASHI

I joined the ICUS as a Visiting Professor on July 1, 2004. I graduated from the Faculty of Law, the University of Tokyo in 1970 and entered the Ministry of Internal Affairs and Communications, former Ministry of Home Affairs. Since then, I have been working as a specialist of law system for taxation and public finance. I am currently the Head of the Fire and Disaster Management Agency of the above mentioned ministry of the Japanese Government.

I believe that in both the academic and administrative fields, we have a strong specialization and work independently in each field. This causes a low efficiency and generates various problems. It is time to change our current style to integrate isolated fields of expertise in order to effectively contribute to achieve our final goal of "human happiness, safety and security".

As an ICUS member, I would like to share experiences and exchange information with ICUS network members in the world. I am looking forward to getting new ideas and developing a human network.

Dr. Jun-ichi SUSAKI

I received the Dr. Eng. degree in civil engineering in 2000 from the University of Tokyo. I worked as an Assistant Professor at the Department of Environmental Information, Faculty of Informatics, Tokyo University of Information Science, till joining ICUS. My current major research interests include development of large-scale vegetation monitoring systems using satellite data based on data fusion techniques.

In recent years, there have been concentrated efforts towards conservation of global environment and importance of global monitoring has been widely recognized for that purpose. Meaningful global monitoring requires stability and continuity in order to analyze from the long-term view point. The Institute of Industrial Science (IIS) of the University of Tokyo, a leading institute of remote sensing in Japan, has been playing active role in receiving, processing and distributing remotely sensed data. On the other hand, urban safety is one of the most pressing issues in Japan, and the techniques and strategies to prevent and control disasters are highly expected. As a member of IIS and ICUS, I shall put efforts to contribute to such urban safety issues as an expert of remote sensing.

ICUS Activity Records

- *Prof. Uomoto attended the "4th International Conference on Advanced Composite Materials in Bridges and Structures", at Calgary, Canada (July20-24) and the "3rd Civil Engineering Conference in the Asian Region" at Seoul, Korea (Aug.16-20), and "the International Conference on ISO/TC71- Concrete, Reinforced Concrete and Pre-stressed Concrete" at Istanbul, Turkey (Sep. 19-24) .*
- *Prof. Yasuoka attended the "XXth International Society for Photogrammetry and Remote Sensing" at Turkey, Istanbul (July16-23).*
- *Prof. Meguro and Ms. Yoshimura attended the "13th World Conference on Earthquake Engineering" at Vancouver, Canada (Aug. 1-8).*
- *Prof. Ooka attended the "5th Conference on the Urban Environment" at Nashville, Vancouver, Canada (Aug. 21-28).*
- *Prof. Dutta visited AIT, Thailand for collaborative research at RNUS (June 15-Aug 31).*
- *Dr. Kato visited AIT, Thailand for collaborative research at RNUS (July 2- 23).*
- *Dr. Susaki participated in the "Meeting on Operation of MODIS Receiving Station and Research using MODIS data" at Bangkok, Thailand (Aug15-17).*

Awards

- *Mr. Atsushi ONEZAWA and Mr. Naoki TAKESHITA, students of Dr. Kato, won the excellent presentation awards at the Annual Conference of Japan Society of Civil Engineers in September.*
- *Mr. Shinya Kondo, student of Prof. Meguro, won the excellent presentation awards at the Annual Conference of Japan Society of Civil Engineers in September.*

- RNUS Activities -

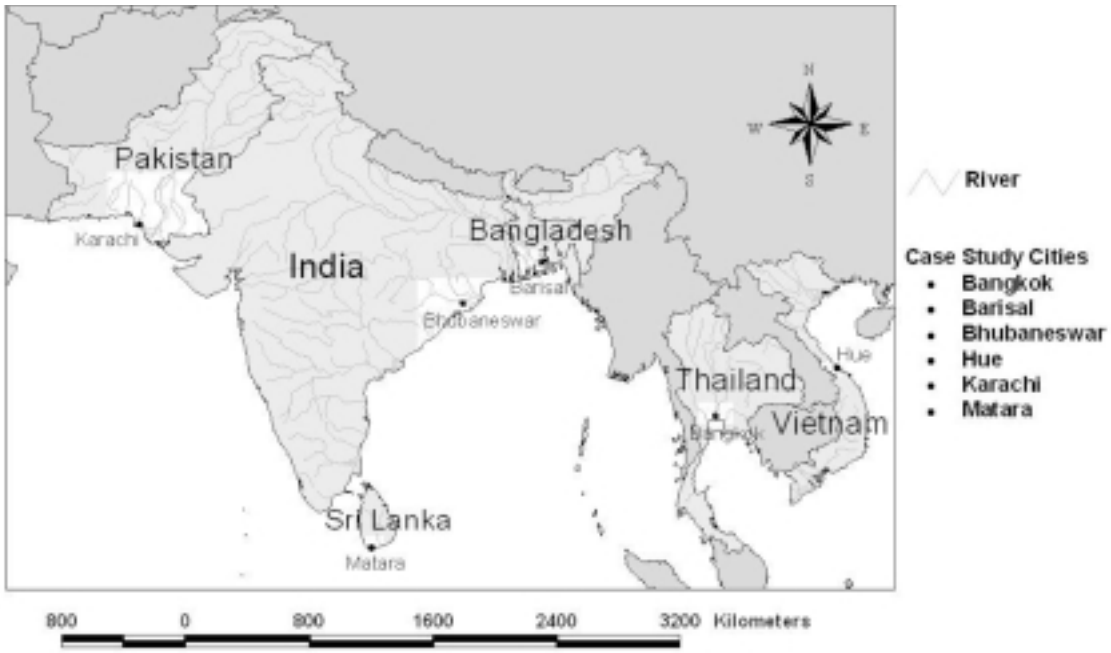
RNUS proposal was selected for APN funding

The Regional Network Office for Urban Safety (RNUS) of ICUS/AIT receives an award from the Asian Pacific Network on Global Change (APN) to conduct a research project titled "An Assessment of the Socio-economic Impacts of Floods under Climate Change Conditions in Large Coastal Cities in South and South-east Asia". The APN was established as a regional research network that would focus on broadening global change research, providing support for multi-disciplinary research and education and encouraging the development of sound science that underpins national and international policy-making needs in the Asia-Pacific region. The award received by RNUS is under the CAPaBLE programme of APN, which is a concrete initiative to realize parts 110 to 114 of the Johannesburg Plan of Implementation for the World Summit on Sustainable Development (WSSD) and has been registered as a WSSD Type II Partnership Initiative to develop and enhance scientific capacity in developing countries to improve their decision-making in climate change and water and food security.

The RNUS project focuses on understanding the flooding characteristics under projected climatic and socio-economic scenarios. It will integrate and analyze existing data, information and results and use existing tools for simulating the flood behavior and impacts. The project scope is limited to selected low-lying large cities of the participating countries: Bangladesh, India, Pakistan, Sri Lanka, Thailand and Vietnam. One city from each country is identified based on their representativeness for the study. The research also focuses on identifying critical gaps in information and policy and a set of recommendations will be made for better decision making to improve the livelihood of the local people. The figure shows the locations of the six cities of South and South-east Asia selected for conducting case studies in the project.

Participation of RNUS in GISIDEAS 2004 in Vietnam

RNUS joined the list of the supporters of the International Symposium on GeoInformatics for Spatial-Infrastructure Development in Earth & Allied Sciences (GISIDEAS 2004), which was held in Hanoi, Vietnam during 16-18 September 2004. The symposium was organized by the Japan-Vietnam Geoinformatics Consortium and the main theme was Geoinformatics applications for monitoring, predicting, managing and mitigation of natural disasters. RNUS Coordinator Dr. D. Dutta was a member of the Steering Committee of the Symposium and he participated in the symposium to present two technical papers titled "Development of Urban Building Inventory for Bangkok using Very High-Resolution Remote Sensing Data for Disaster Risk Analysis" and "Impact of Urbanization in Flow Characteristics in an Urban River Basin in Japan using a GIS Based Distributed Hydrological Model", which were the outcomes of research works conducted at RNUS. For further information about GISIDEAS 2004, please visit the following website; http://gisws.media.osaka-cu.ac.jp/gisideas04/.



The cities of South and South-east Asia selected for case studies

Editor's Note

Japan has been facing a very seismically active period. As presented by Prof. Fukuwa, in the main article of this volume, we will have the Tokai, To-nankai, and Nankai earthquakes with M8 or more, along the Nankai-Trough within 30 to 40 years. In northern Japan, a M7.5 to 8 event, the Miyagi-ken-Oki earthquake, will attack with very high probability, 85% and 99% within 20 and 30 years, respectively. Besides these huge earthquakes, the number of the events of M7 class, same as the 1995 Kobe earthquake, which will occur before and after huge earthquakes, is several times larger than that of M8 events. The total damage due to the 1923 Kanto earthquake was over 40% of total GDP of Japan at that time. The total damage due to above mentioned events will be larger than that. The number of collapsed/heavily damaged and moderately damaged structures will be over one million and approximately two million, respectively.

The most important issue for earthquake damage reduction is retrofitting the existing low earthquake resistant structures. There are three measures for total disaster management, Mitigation, Preparedness and Disaster Response, and Recovery and Reconstruction Strategy. Although we can improve our disaster reduction capacity by well balancing these three measures, the most important measure among them is Mitigation which makes an effort to prevent the Hazard, a physical phenomenon, to become a disaster, a negative impact to the society, by taking optimal measures beforehand. Even with a very good disaster response system and optimum recovery and reconstruction strategy, if your structures are not strong enough, you can reduce neither the number of damaged structures nor the casualties that their collapse will cause.

Based on this understanding point, we have been studying technical methods and social systems to increase the seismic capacity of existing low earthquake resistant structures in developed and developing countries. For developed countries, incentive systems for promotion of retrofitting and for developing countries, very low cost and efficient retrofitting methods, are proposed. By our proposed new incentive system, the total damage can be drastically decreased and thus, the cost burden to both government and citizens, reduced. By our economical and efficient retrofitting method, typical adobe and/or masonry houses can be retrofitted by approximately US$100. I hope that using these study results, an earthquake safer environment can be realized.

(K. Meguro)

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