ICUS Newsletter

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International Center for Urban Safety Engineering
Institute of Industrial Science, The University of Tokyo

Reconnaissance Survey Report of the 2015 Gurkha, Nepal, Earthquake

By K. Meguro
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Outline of Damage

At 11:56 local time on 25th April, 2015, an earthquake with magnitude 7.8 and focal depth of 15 km happened. Its epicenter was located 77km North-West from Kathmandu, the capital city of Nepal. Total death toll officially reported as of 15th May 2015 was 8,567 including 8,460 in Nepal, 78 in India, 25 in China, 4 in Bangladesh. Many old and low earthquake resistant structures including World Heritage buildings were damaged (Photo 1). However, considering the magnitude, focal depth and directivity effect, seismic intensity of the ground motion in Kathmandu was much lower than expected. It was surprising to see that there were many weak masonry structures still standing after the quake, many water tanks installed at the top of the buildings stayed undamaged (Photo 2, left) and many objects on narrow shelves such as photo stands, ornaments, and figures did not move or fall down (Photo 2, right). In affected areas, seismic capacity of structures varies based on main structural materials, such as stones (regularly-shaped or irregularly-shaped), adobe (unburned, just sun dried clay brick), and burned brick (with low and high temperature) and based on joint material, such as mud, mud and lime, poor cement, and cement mortar as shown in Figure 1.

Structural damage due to the earthquake was seen only in masonry buildings made with irregularly-shaped stones, adobe, and low temperature burned bricks using mud, mud and lime, poor cement mortar. For reinforced concrete (RC) structures, damage was observed to the structures that have poor beam column joints (Photo 3).

There were many damages to road facilities in mountainous areas due to landslides, but in urban areas, damage was limited to certain areas.

Photo 1: Damage to vulnerable masonry structures including World Heritage structures

Damage to bridge was also limited to only shear failure of RC stoppers for bridge girder (Photo 4).

Damage to non-engineered buildings and PP-band retrofit method

Based on the damage due to this earthquake, it was recognized that collapse of non-engineered buildings, which were constructed by the local people with no engineering background using locally available materials, without following seismic code of structure, was major cause of casualties. In developed countries like Japan, after many structures were damaged by earthquake, seismic code of structure was revised to improve the structural capacity based on the results obtained by survey and investigation of damage. However, in many developing countries, revision of the code cannot be a solution because there are many non-engineered structures constructed without following the code.

Photo 2: Undamaged weak water tanks installed at the top of the buildings (left) and unstable shaped photo stands, ornaments, and figures that didn't move and fall down from the narrow shelves (right)

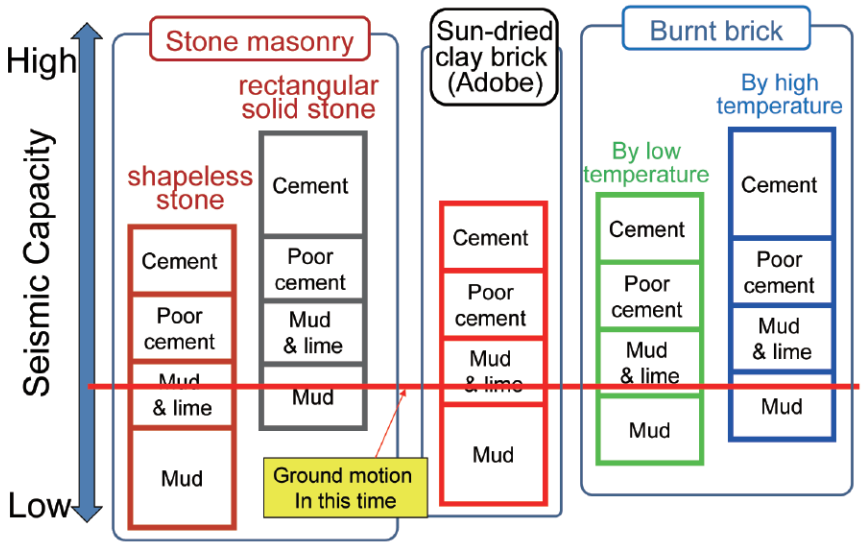


Figure 1: Seismic capacity of unreinforced masonry structures

Photo 3: Due to weak joint between column and beam, RC column and beam could not contribute seismic capacity of structure.

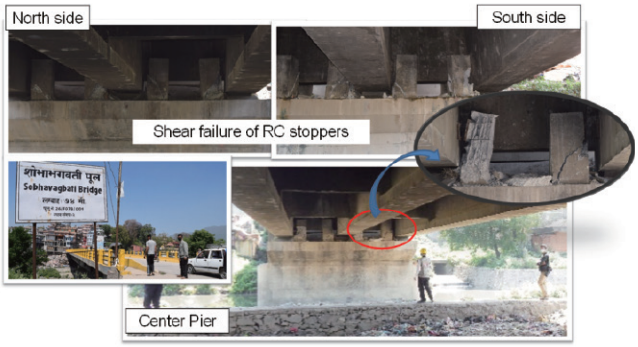


Photo 4: Danage to bridge: RC stoppers for bridge girder were failed.

Photo 5: Adobe with mud mortar masonry house retrofitted by PP-band method in 2009 (top) could stand against earthquake (bottom) in spite that surrounding stronger brick masonry houses are damaged.

Understanding this actual situation, I have been developing many retrofit methods and their promotion systems that local people can apply with locally available materials without changing their life style. PP-band retrofit method is one of such methods. With this method, polypropylene band (PP-band), normally used for packing, is used as reinforcing material. PP-band meshes are installed on the both sides of masonry wall and they are connected with each other by PP-strings set in holes made with some intervals on the masonry wall. After installation of PP-band meshes, cement mortar or mud mortar are pasted on the surface of the wall to prevent Ultra Violet ray attack.

In the affected area by the Gurkha earthquake this time, there is a two-story adobe masonry house with mud mortar which was retrofitted by PP-band method in 2009 (upper one in Photo 5). Due to lack of electric power and welding machine, PP-band mesh was prepared by wave form without welding at cross points of PP-bands. However, the retrofitted house had much less damage compared to other much stronger masonry houses built nearby, such as burned brick masonry with cement mortar houses that were damaged severely. The cost for retrofitting the house was about 50 USD and it was proved by the Gurkha earthquake that PP-band method could increase seismic capacity of weak masonry structures (bottom one in Photo 5).

Characteristics of strong ground motion recorded

At the location of 60 km from the epicenter, US Geological Survey (USGS) has installed one seismometer in Kathmandu valley and it recorded time history of the acceleration of ground motions in three directions. The duration of the ground motion was more than two minutes, maximum acceleration of horizontal two directions were about 160 gals, and vertical was 190 gals as shown in the Figure 2. These values were smaller compared to those by similar earthquake. But velocity and displacement were very large. Peak ground velocity (PGV) were 107, 86 and 60 kine in EW, NS and UD directions, respectively. And peak ground displacement (PGD) were 117, 140 and 59 cm in EW, NS and UD directions, respectively. As for the characteristics of frequency, the ground motion did not have power in short period of time range less than 1 sec comparing with past well known earthquake ground motions. However, long period components with more than 4 sec, it has very strong power.

According to velocity and displacement response spectrum (damping coefficient: 2 and 5 %), the maximum velocity response spectrum

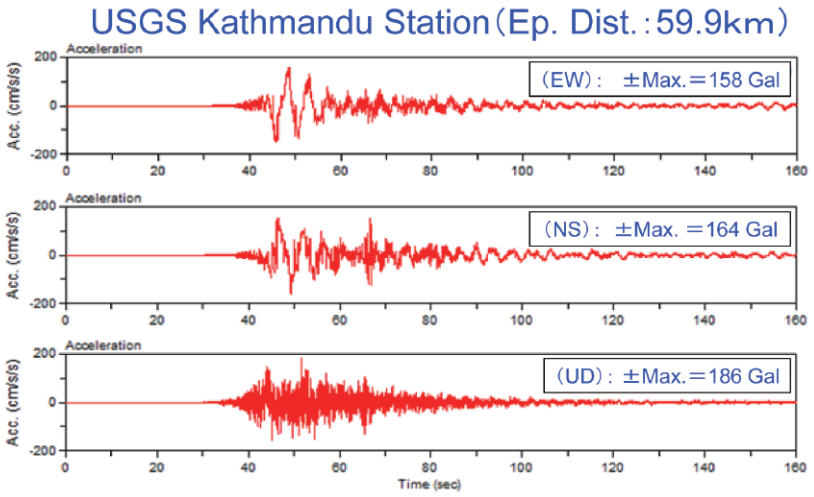


Figure 2: Time history of the ground motion (acceleration) recorded at USGS Kathmandu station

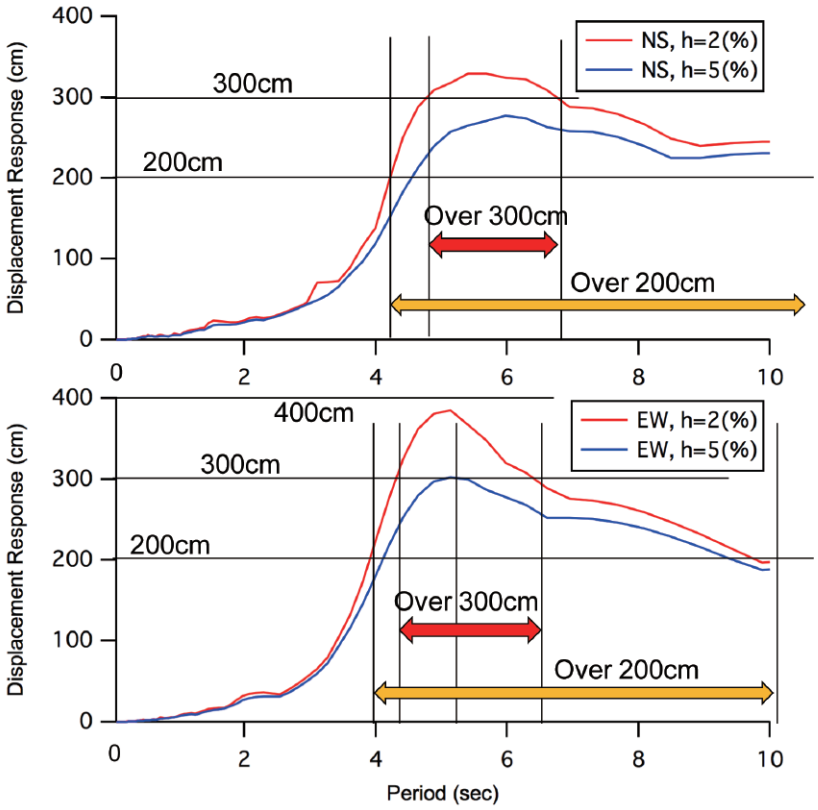


Figure 3: Displacement response spectrum

in case of damping coefficient of 2 % was 500 kine with around 5 sec and over 400 kine from 4 to 6 sec in EW direction. In NS direction, it was about 400 kine with 5 sec and over 300 kine from 4 to 7 sec in case that damping coefficient was assumed 2 %. Moreover, about displacement response spectrum, it was 400 cm with 5 sec and over 300 cm from 4 to 7 secin EW direction. Also in NS direction, it was over 300 cm from 5 to 7 sec as shown in Figure 3.

Fortunately, there was no problem in Kathmandu valley since there was no facility and structure with natural period of over 4 sec. But in Japan where there are many structures with long natural period, such as super high rise buildings, long span bridges, and large capacity storage tanks, there will be severe damage if a strong ground motion like Gurkha earthquake motion attacks them.

School earthquake safety project by NSET

NSET (National Society for Earthquake Technology-Nepal) is one of the major organizations that have been playing important roles for promotion of preparation of earthquake disaster. The NSET is an NGO established in 1994 as a result of activities by WSSI (World Seismic Safety Initiative) that was established by Dr. K. Katayama, Professor Emeritus of The University of Tokyo and Dr. Haresh C. Shah, Professor Emeritus of Stanford University, etc. WSSI was established for the purpose of promotion of earthquake disaster preparation in developing countries in terms of earthquake engineering and I have been supporting it since its establishment. Among the countries with which WSSI has been working together, Nepal is one of the good examples that WSSI activity can be well implemented. I have received some students from NSET and trained them to understand the locally applicable disaster reduction technologies and social systems including Dr. Ramesh GURAGAIN, deputy director general of NSET.

Activities by NSET are notable when we discuss the damage due to the Gurkha earthquake. NSET has been actively carrying out many activities for earthquake disaster reduction, such as retrofitting weak structures, training technicians in order to construct earthquake resistant structures, setting up national earthquake safety day and week, a series of events and regular TV programs for promotion of preparedness for earthquake disaster, lectures for high-level governmental officials and the general public, and so on. I have been working together with them for over twenty years and visited Nepal every year in recent years. School earthquake safety program (SESP) is one of their such activities. SESP is a disaster warning activity through retrofitting weak school buildings and education of students as well as the general public living around the school. Dr. Ramesh GURAGAIN is one of the key persons who have carried out SESP. About 200 weakest school buildings were retrofitted before the earthquake by SESP, some of which were retrofitted by full jacketing method and some were by splint and bandage method. Among all these retrofitted school buildings by SESP, only four buildings have minor cracks but all structures can be used after the quake as evacuation centers holding over 300, while about 6,000 un-retrofitted school buildings were severely damaged or collapsed within Kathmandu valley and in all affected areas.

Summary

Because of the frequency characteristics of ground motion by the earthquake, seismic intensity in affected areas were relatively mild considering the magnitude, focal depth, and directivity effect of the earthquake. But, many vulnerable (masonry) structures including World Heritage structures were severely damaged and over 8,500 people were killed. It is very difficult to save the people trapped under the damaged structures by search and rescue activities. Based on the damage, it is recognized that retrofit of vulnerable structures before an earthquake is an essential countermeasures for earthquake disaster reduction.

When the JICA seminar was held in Kathmandu City one month after the quake, I was invited to give a speech and I explained that earthquake disaster was an unfortunate event, but it should be used as a important opportunity to change the affected society. This is 'Build Back Better (BBB)' and BBB is a way not to waste valuable lives of victims and social loss.

As tourism is a major industry in Nepal, it is important to reconstruct affected areas to become attractive areas from the tourists' viewpoints. Key words are 'Clean and Safe'. Kathmandu City should be reconstructed as 'Clean and Safe City (CSC).' For implementation of CSC Kathmandu, followings are important.

1) Recovery and reconstruction plan considering long term development and changes of the city and country
2) Establishment of functional garbage treatment system
3) Stable power supply system
4) Comprehensive disaster management system in seven phases of disaster life cycle by each player, self-help effort, mutual assistance, and public support
5) Quality control system of retrofit and new construction for both engineered and non-engineered structures
6) Change the mind for disaster counter measures 'from Cost to Value'

External evaluation of ICUS conducted in June 2015

By K. Meguro

An external evaluation for new-born ICUS (International Center for Urban Safety Engineering) was conducted on June 10th 2015 as it is reaching its five-year term since April 2011 when it started its activities as a new-born research center. ICUS was established with an objective to find issues and come up with solutions in order to realize safe and rich urban environment for the people in our country with characteristics, such as decreasing and aging population, financial strain, high–tech society, environmental load reduction, decentralization of power and balanced contraction. These activities are also important for the international community as Japan is considered to be an "advanced country on issues" and is facing issues that many other developing and developed countries will face in the future. Based on previous activities, with three newly defined research fields of Social Infrastructure Management Division, Urban Safety & Disaster Mitigation Division and Environmental Informatics Division as its core, a new-born ICUS conducted research activities that would achieve above-mentioned objectives through promotion of leading-edge researches, establishment of network, and collection and dissemination of information.

There were three members of evaluation committee, namely Dr. S. Nishikawa, a board member of Japan Water Agency, an Incorporated Administrative Agency, Dr. M. Kanatani, a director of Civil Engineering Research Laboratory of Central Research Institute of Electric Power Industry and Dr. H. Shimoda, a Professor of Tokai University Research & Information Center. During the evaluation, Prof. Meguro, the director of ICUS gave a presentation about the purpose of the evaluation and activities and future vision of ICUS, followed by presentations by the representatives of three divisions about their activities and overall discussion as shown in the Photo.

Overall discussion during the external evaluation committee

Evaluation points include I. activities of ICUS from its establishment to present, 1) outcomes of leading-edge researches on urban safety engineering, 2) activities related to networking including international relationships, 3) activities related to the collection and dissemination of information; II. whether ICUS is achieving its objective of establishing a research center; and III. Opinions about future vision.

As a result of the evaluation, a new-born ICUS was highly evaluated for its active development. During the last external evaluation conducted in 2009, an individual research activity was highly evaluated while strengthening of collaboration among academia and governmental organizations as well as active participation in the governmental activities were indicated as needed and this time it was evaluated as greatly improved since the start of new-born ICUS in April 2011. It is important to continue having a dialogue with members of the society and the accumulation of human network and amount of research conducted in the last fifteen years since the establishment of ICUS are highly valuable assets considering international development of this field of study in Japan. It is a great outcome that ICUS has established a relationship that allows those researchers that once belonged to ICUS or participants of USMCA (anunal International Symposium on Urban Saflty of Megocities in Asia held by ICUS) to consider ICUS as their teacher in case they face a big problem in their own country.

Following opinions were expressed in regard to the situation that ICUS is no longer able to continue as a research center according to a current rule of the Institute of Industrial Science, The University of Tokyo (UTokyo). In urban mega-cities in Asia, there are a number of issues such as rapid urban development without safety countermeasures, the needs for appropriate urban planning with a long-term vision, maintenance of aging infrastructure and issues as a host country to carry out 2020 Tokyo Olympic and Paralympic Games, and ICUS has been conducting researches on these topics.

Therefore, it is too good to give up the brand name of ICUS which was established based on various activities in the past fifteen years for both UTokyo as well as for our nation. It will be greatly encouraged if its mission supports a long-term research topic, ICUS would be acknowledged for its continuing activities as a research center with a different operational style that is not a short-term focused on accomplishing objective and contribute actively to the society.

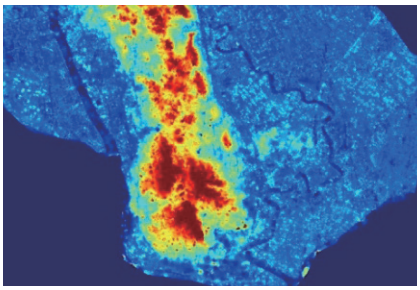
In addition to the results of evaluation by the external evaluation committee members, ICUS members consider it is not appropriate to close the center considering a number of reasons, such as the importance of relationship among the emerging issues of our nation and neighboring countries and the objective of establishment of ICUS, continuation of relationship of mutual trust with international research institutes and the responsibility for pursuing on-going research projects. Since April 1st 2016, ICUS plans to continue its activity as a research center using competitive funds from big research projects such as SIP (cross-minisrerial Strategic Inoveation Promotion Program) and SATREPS (See page 6) and not depend on special assistance from IIS. Kind understanding and cooperation is sincerely appreciated.

SATREPS: Progress report

By A.Kodaka

We are pleased to announce that Record of Discussion (R/D) was singed as of April 9, 2015, between Myanmar and Japan: Myanmar signers were U Kyaw Zwa Soe, Director General, Department of Technology Promotion and Coordination, Ministry of Science and Technology, and Prof. Dr. Aye Myint, Rector, Yangon Technological University (YTU), and Japan signer was Mr. Masahiko Tanaka, Chief Representative, Myanmar Office, Japan International Cooperation Agency (JICA). R/D is a contract which signals the official start of the project based on mutual agreement on governments of both countries. The project will be operated and managed under the framework of Project Design Matrix (PDM) and Plan of Operation (PO) with 6 research groups: 1) Water-related disaster, 2) Earthquake-related Disaster, 3) Geospatial Technology, 4) Infrastructure Management, 5) Transport and Mobility, 6) Disaster Management. We will keep you updated with our project activities through the TCUS Newsletter. In this volume, following 3 groups' activities are presented.

Lecture on LULC



Outcomes: Digital terrain map

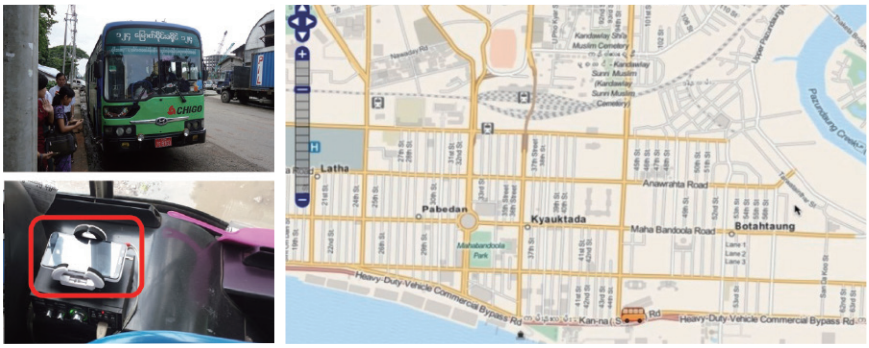
Activities of Geospatial Technology group

Geospatial Technology

Geospatial technology group will carry out two activities: 1) Collect land use, population, buildings, infrastructures, and geotechnical information in Yangon area, 2) Analyze collected geo-spatial data and develop urban expansion simulation by cellular automaton model. For a capacity development of YTU graduate students in the research field of the group to facilitate the activities, the group conducted a special lecture at YTU campus from June 9 to 11, 2015. The lecture provided a basic knowledge of the science and technology of remote sensing (RS), how to generate land-use and land-cover (LULC) map, and field data collection to validate LULC map. A total of 35 students took the lecture and they have gotten a certificate when they submitted an assignment report as a completion of the lecture. The special lecture will be continued as a series so that YTU graduate students can strengthen their knowledge and gain further understanding in the field of geospatial technology, especially in RS, and contribute the project's activities with us.

Transport and Mobility

Transport and mobility group will conduct an activity that collects and accumulates aggregated mobile phone base station usage data and probe vehicle GPS data to project people movement with people activity model in Yangon area. On July 16, 2015, 5 group members will visit Myanmar Posts and Telecommunications (MPT), and have a discussion with a staffs of MPT and KDDI to gather a mobile phone base station data; KDDI is current joint venture partner of MPT. Although the group obtained a sample data from MPT, it will keep having a close discussion with them to obtain a series of data needed for the project. On the same day, the group will also conduct about 1.5 hours lecture to 17 students from Transportation department of YTU to introduce the contents of the group's research activities. In addition, on July 17, the group will visit Ma Hta Tha, Yangon Region's public transport regulatory and supervisory committee, with 5 YTU research members (3 faculty members and 2 students), and 3 Japanese members, to conduct an experiment of bus location service system installing a smartphone as a GPS sensor. The experiment will be conducted with three buses from different service lines from July 18 to 19, 2015.



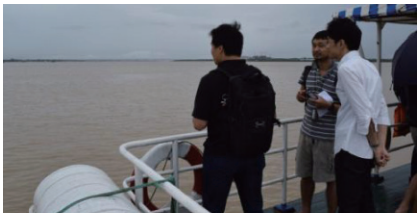
Experiment on trial of bus location service system
(red square shows the smartphone and trial screen of the system is shown in right)

Activities of Transport and Mobility group

Water-related disaster

Water reated disaster group will conduct two activities:1) Gathers information and data in the Bago river and water resource management, and builds integrated database in the Bago river basin to develop seamlessly integrated river- and coastal hydraulic- models, 2) analyzes disaster management plan of central and local governments and investigates needs on the integrated water-related disaster response system. The group conducted field

survey from 28 June to 2nd July, 2015 to understand characteristic of natural environment and river structures, and socio-economic characteristics of residents located in frequently inundated areas in Bago river basin. The survey was jointly perforwed by Myanmar and Japan teams with 35 participants in total; they are from the University of Tokyo, Keio University, YTU, Myanmar Maritime University, Myanmar Port Authority, Irrigation Department Ministry of Agriculture and Irrigation.



Downstream of the Yangon river

Weir at upper Bago river

Investigation of the Bago river by a boat

Interview to a monk who leads evacuation in flood prone area

Activities of Water-related disaster group

Report on Guided Tour in IIS Open Campus

By T. Kato

Annual IIS Open Campus was held on June 5th, and 6th in 2015. ICUS provided "Guided Tour" for experts, which started as a pre-event since the last year. The theme was "Technology for Social Resilience and It's Implementation". Over 10 experts selected from many fields related to social infrastructure attended the tour. After introduction of recent research activities of each division of ICUS by Prof. Meguro, Dr. Matsumoto, and Prof. Oki, demonstration of experiment by Prof. Kuwano and exhibition of social or urban simulation related to urban safety, such as evacuation simulation by Dr. Kato, Dr. Iryo, and Dr. Honma, were conducted. Dr. Kato coordinated discussion perspective of technologies for Social Disaster Resilience with participants as the final session and importance of cooperation between business sectors and universities and inter and transdisciplinary discussion were shared. Over 90 persons in total visited ICUS room to exchange information in the period of Open Campus. We are looking forward to discussing new topic with more people next year.

Photo of guided tour

ICUS welcomes

By Prof. K. Meguro

Drs. Yosuke Nakaso and Hideomi Gokon have joined ICUS from 1st April 2015 as Assistant Professor and Ms. Tomoko Matsushita has became a project researcher from 16th April 2015.

Dr. Nakaso received his Doctor al Degree from UTokyo in 2015. His major is architectural structural engineering, especially the safety against ceiling collapse.

Dr. Gokon received his Doctoral Degree from Tohoku University in 2015. He has studied tsunami and remote sensing for 5 years at Tohoku University, including a collaborative research with the German Aerospace Center (DLR). He contributed to develop a method for estimating tsunami-induced damage by integrating tsunami numerical modeling and remote sensing technology.

Ms. Matsushita received Master Degree of Civil Engineering from of UTokyo in 2010 and Bachelor degree in Architecture from the University of Washington in 1999. She is a registered architect and an active member of an NGO working in disaster field since 2004. Her main field of study is post-disaster housing reconstruction. She will be working mainly on the SATREPS project in Myanmar.

We expect new members to contribute to ICUS activities.

Editor's note...

The main mission of ICUS is to create safe urban societies from international newpoint through the incorporation of advanced technologies. This newsletter includes our damage survey of the 2015 Gurka earthquake and the launching of the SATREPS project in Myanmar.

The 2015 Gurka earthquake hit on 25th April, 2015 causing over 8,500 death toll. We visited the affected sites to investigate damage and discuss how the affected areas can be assisted for their recovery and reconstruction. The damaged structures were mainly unreinforced masonry stratures, most of which were designed and constructed without adequate engineering consideration of potential earthquakes. Observed ground motions during the Gurka earthquake revealed a displacement response spectrum of 400 cm at 5 sec and over 300 cm from 5 to 7 sec. These strong ground motions should be considered as a warning to Japan, especially long natural period facilities, such as super high rise buildings in urban areas. Details are available in the main article of this volume entitled "Reconnaissance Survey Report of the 2015 Gurka, Nepal, Earthquake".

The SATREPS project, "Development of a Comprehensive Disaster Resilience and Collaboration Platform in Myanmar", started in April 2015 with six research groups. This newsletter introduces the activities of the three groups, Geospatial Technology, Transport and Mobility, and Water-related Disasters. We are looking forward to conducting research that will ultimately contribute to solve international problems related to urban safety and to provide ideas for creating a new and vibrant society in Myanmar.

by M.Numada

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The International Center for Urban Safety Engineering (ICUS) is a research center located at the Institute of Industrial Science, The University of Tokyo.

The purpose of ICUS is to identify, investigate, and resolve issues towards the realization of sustainable urban systems for the prosperity and safety of society considering challenging socio-economic problems.