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NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
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Cowasjee Earthquake Study Centre NED NEWSLETTER

Japan rocked by two powerful Earthquakes

Japan is a seismically active region which accounts for about 20% of global earthquakes of magnitude 6.0 or greater. As a result, to protect its built environment and population, some of the best building construction practices are implemented in Japan. It has also established an early warning network which carries out analysis of the developing earthquake and establishes its location and strength.

Figure 1: Map of Kyushu island, locating 6.5 earthquake. (Source: AFP)

A powerful earthquake hit southern Japan, Kyushu region on 15 April 2016 at a depth of 10 km north of Kumamoto (**Figure 1**). Kumamoto lies at the southern end of the Japan Median Tectonic Line. The magnitude of this earthquake was recorded as 7.3 on Richter scale. The same region was hit on the previous day by a 6.5 magnitude earthquake. Both these earthquakes killed 32 people. Around 70,000 people were evacuated due to a forecasted storm and landslides in the devastated region. An area close to a dam is also thought to be at risk of collapse.

The people were rescued by digging through the rubble of collapsed buildings and mud and debris. The rescue efforts were hindered by the continued aftershocks. Nearly 165 aftershocks were felt causing extensive damage to buildings, splitting roads and triggering landslides (**Figure 2**). Some of these aftershocks had a magnitude of 5.3.

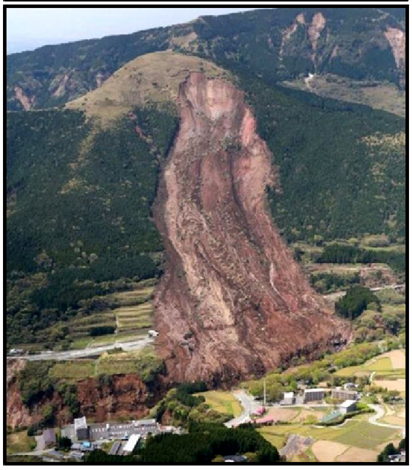

Figure 2: Aerial view of a landslide in Mimami-Aso. (Source: Jiji Press)

Isolated villages in the mountainous area of southern Kyushu Island, which were situated on the focus of the earthquake, were completely cut off by landslides and damages to the roads. Two historic Kumamoto Castle's turrets collapsed. The Aso Shrine was heavily damaged in the earthquake. The tower gate and worshiping hall of the shrine completely collapsed during the earthquake.

The transport network in the area also suffered considerable damage. One of the tunnels caved in. The historical (the Great Aso Bridge in Minamiaso) collapsed into the Kurokawa River. In addition, roads were blocked by landslips and the train services were stopped. A tsunami advisory was also issued by the authorities; this, however, was taken back later.

Powerful Earthquake Strikes Pakistan, India and Afghanistan

Pakistan is considered an area of high seismic activity and has been subjected to earthquakes regularly in recent years (**Figure 3**). A powerful 7.5 magnitude earthquake hit parts of Pakistan, India and Afghanistan on 3rd April 2016 and caused shaking of buildings and houses and panic in several cities. According to United States Geological Survey (USGS), the epicentre of this earthquake was 40 km west of Ashkasham in northeastern region of Afghanistan near its borders with Tajikistan and Pakistan. The depth of the earthquake was 210 km in the sparsely-populated Hindu Kush mountains.

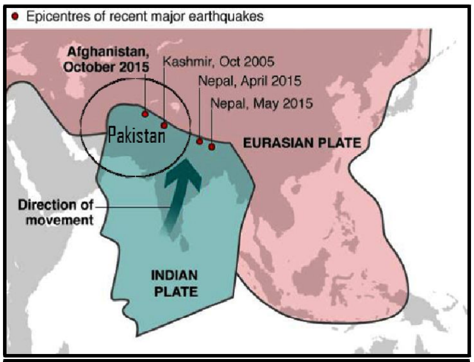

Figure 3: Epicenters of the recent major earthquakes (Source: BBC.com)

The tremors were felt in Kabul, Islamabad, Lahore and New Delhi, and forced the residents to leave their homes. There were no reports of any significant damage. Nevertheless, at least one person died in Swat, Pakistan and 30 people were injured. Pakistan's National Disaster Management Authority (NDMA) issued warning of a high risk of landslides. Pakistan Air Force was requested to conduct aerial photography to evaluate damage to infrastructure and to examine the slope stability of mountains in northern parts of the country.

EDITORIAL

The First issue of volume 16 of CESNED NEWSLETTER re-affirms our promise to keep you well informed about earthquake happenings all around the globe along with researcch activities by the Department of Earthquake Engineering.

Despite very little response, CESNED believes in striving hard and reassures its commitment of continuing efforts to create safe built environment. — Editor

Inside this Issue:

Ecuador Shaken by 7.8 Magnitude Earthquake

A strong 7.8 magnitude earthquake struck off Ecuador's central coast on Saturday, 16 April 2016 (**Figure 4**) which is the deadliest earthquake to strike the South American country in decades. According to the United States Geological Survey, the epicentre of the earthquake was located at 27 km southeast of the coastal town of Muisne with a depth of 19 km.

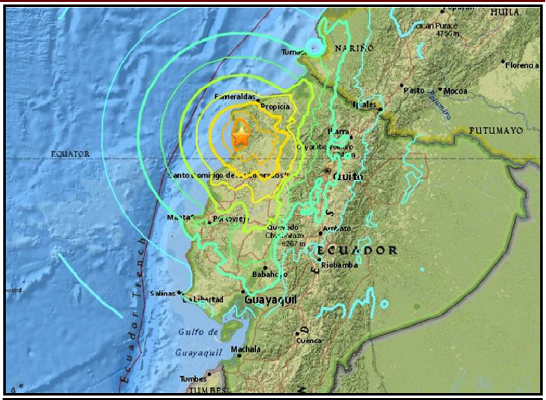

Figure 4: USGS map of the magnitude 7.8 earthquake in Ecuador (Source: USGS)

The earthquake caused destruction of buildings (**Figure 5**) and highways over hundreds of miles. Non-engineered low-quality buildings constructed with brick and concrete collapsed throughout the affected region. Much damage was reported in the cities of Manta, Portoviejo and Guayaquil which are several hundred kilometers from the epicenter of the earthquake. According to initial estimates, more than 90 percent of homes were damaged in the coastal town of Chamanga. At least more then 500 people are killed and 2,527 injured in the northwestern coastal area of Manabi. The effects of the earthquake were also felt in the capital (Quito) and into parts of Peru and Colombia. The main shock was followed by more than 135 aftershocks; one of these had a magnitude of 5.6.

Figure 5: A collapsed building in Portoviejo. (Source: CNN)

Ecuador is used to earthquakes due to its location on the so-called Ring of Fire which is the arc of high seismic activity that extends right around the Pacific basin (**Figure 6**). Ecuador fronts the boundary between the Nazca and South American tectonic plates. The Nazca plate (which makes up the Pacific Ocean floor in this region) is subducted under the South American coast. The convergence rate between the plates in Ecuador is 61 millimeters (2.4 in) per year. This process has created volcanoes in the Andes and Ecuador's, including the mighty Chimborazo.

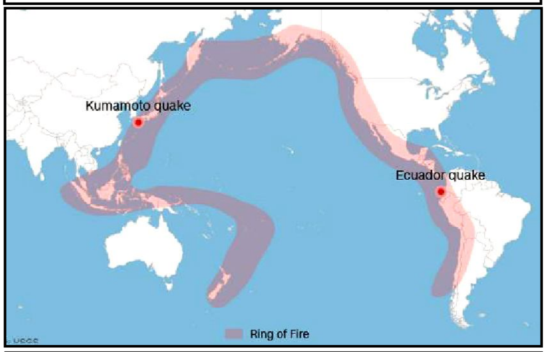

Figure 6: Deadly earthquake of Japan and Ecuador (Source: USGS)

The depth, location and focal mechanism of the earthquake are all consistent with rupture along the plate interface in the form of a megathrust earthquake. A major earthquake in 1906 ruptured the plate interface for at least 400 km immediately northeast of the current earthquake.

Seven magnitude 7 or greater earthquakes have occurred within 250 km of this event since 1900. On January 31st, 1906 a M 8.3 earthquake (reportedly as large as M 8.8 in some sources) nucleated on the subduction zone interface 90 km to the northeast of the April 2016 event, and ruptured over a length of approximately 400-500 km, resulting in a damaging tsunami that caused in the region of 500-1,500 fatalities. The April 2016 earthquake is at the southern end of the approximate rupture area of the 1906 event. A shallow, upper crustal M 7.2 earthquake 240 km east of the April 2016 event on March 6th, 1987 resulted in approximately 1,000 fatalities.

Inaugural Session of UNESCO Tehran Cluster

Afghanistan, Iran, Pakistan and Turkmenistan fall under the responsibility of the UNESCO Tehran Cluster Office. These countries are placed in the highly seismic active Alpian-Himalaya Orogenic belt and are, therefore, prone to earthquakes. The risks related to earthquakes have increased in urban areas of all these countries due to the growing trend of urbanization and densely populated cities.

Figure 7: Group photo of participating country members

A two-day meeting was held in Tehran from 29 November 2015 to 1 December 2015 (**Figure 7**) to discuss a project proposal. This project is aimed at assessing seismic vulnerability and risk in the main cities of these four cluster countries using the latest methodologies and technologies to carryout seismic hazard analysis and to develop seismic risk maps for the two selected cities in each of the four countries. The meeting was sponsored by International Institute of Earthquake Engineering and Seismology Iran and UNESCO Tehran Cluster. The main objectives of the project are as follows

- To improve understanding of scientific concepts and approaches in the area of natural disaster
- To identify and disseminate best practices, success stories, indigenous knowledge and local innovative approaches in resource management
- To build the capacities of local experts and decision makers
- To create thematic and intersectoral networks among scientists and policy makers
- To promote equal access to science and technology knowledge and benefits

Prof Sarosh Lodi represented Pakistan in the meeting and presented the details of the disaster mitigation framework and studies related to increasing disaster resilience conducted at NED University with local and international collaborators.

Commemorating 70 years of 1945 Markran Tsunami

Figure 8: Group photo of participants of Tsunami Inundation Modelling Workshop

NED University of Engineering and Technology, OXFAM Pakistan, and United Nations Educational Scientific and Cultural Organization (UNESCO) Islamabad and Jakarta joined hands together, to commemorate 70 years of 1945 Markran Tsunami. The aim of organizing the programme was to create awareness among people regarding natural disasters and preparedness, with specific reference to tsunami hazards. The timeliness of the event was endorsed by Pakistan Metrological Department, National Disaster Management Authority, United Nations ESCAP, UNDP, International Oceanographic Commission, and International Tsunami Information Center by participating in the programme. The commemoration event included a two-day workshop on Tsunami Inundation Modeling and an International Conference entitled Steps towards Tsunami Resilience. The workshop was held at NED University on 26-27 November 2015 (**Figure 8**), whereas the conference held on 28 November 2015 at Marriott Hotel, Karachi (**Figure 9**). An exhibition on tsunami awareness (supported by UNESCO Jakarta) was also part of the conference.

Figure 9: International Conference on Steps towards Tsunami Resilience at Marriot Hotel, Karachi

The workshop was delivered by Dr. Haider Hasan, Ms. Hira Ashfaq Lodhi, Mr. Mohammad Ahmed and Mr. Shoaib Ahmed. It was aimed at enhancing the tsunami inundation modelling techniques and risk analysis capacity. An open source code entitled Geoclaw developed by the University of Washington was used for hands-on training session using the 27 February 2010 Chile tsunami. The workshop trainers carried out probabilistic tsunami hazard analysis along the Makran coast. Inundation maps for Gwadar and Pasni were developed using worst case scenario with a 9-magnitude earthquake.

Whereas, Mr. Murad Ali Shah Syed, Senior Minister, Finance Department, Government of Sindh inaugurated the conference. Prof. Sarosh Hashmat Lodi, Dean Faculty of Civil Engineering and Architecture, NED University, welcomed the participants of the conference. Ms. Vibeke Jensen, Representative/Director UNESCO, Islamabad, emphasized the need of more efforts required for tsunami resilience in the coastal areas of Pakistan. Mr. Tony Elliott, Head of ICG/IOTWMS Secretariat, IOC/UNESCO, presented keynote speech entitled Global Tsunami Early Warning Systems, 10 years after the 2004 Indian Ocean Tsunami. Mr. Arif Jabbar Khan, Country director OXFAM Pakistan presented vote of thanks at the end of the inaugural session.

Technical papers were presented by Dr. Haider Hasan, Ms. Hira Ashfaq Lodhi and Mr. Din Muhammad Kakar. A documentary on the devastations made by the 1945 tsunami was screened first time in the conference. The documentary was prepared jointly by UNESCO Islamabad and Jakarta. An exhibit on the work done by partners was also organized with the support of UNESCO Indian Ocean Tsunami Information Centre (IOTIC).

Lecture on Modelling of Post-earthquake Fire Spread

Figure 10: Prof Rafi presenting his lecture

Commercial, industrial and residential buildings typically constitute a significant proportion of the overall construction in a built environment. Fire is considered as one of the inevitable threats to buildings. Although incidents of large fires and conflagrations are rare, they may happen after a catastrophe such as earthquakes, war, accidental fires, wild-land fire and arson. A prompt response to an early fire in terms of its detection and suppression reduces the chances of fire spread to other parts of a building and to the adjacent buildings. This type of response becomes difficult in the immediate aftermath of an earthquake owing to the chaos these incidents usually cause. Delays in fighting the initial fire in a proper manner and/or absence of right extinguishing agents/equipment allow the fire to get out of control. As a result, post-earthquake fire may spread to a larger area. Some of the recent examples of post-earthquake fire include 1989 Loma Prieta earthquake, 1994 Northridge earthquake, 1995 Kobe earthquake, 1999 Marmara earthquake and 2011 Great East Japan earthquake. Nearly every major city in United States of America has suffered from a significant conflagration, often in its early history. Building fire incidents result in significant life and economic losses.

The Department of Earthquake Engineering is carrying out studies to develop a reliable model for the simulation of mass fire spread in an urban area. These studies are part of the project entitled Capacity Building for Pakistan in Fire Risk Management. The project is financially supported by Higher Education Commission, Pakistan and USAID. Prof Muhammad Masood Rafi was invited to present the work in the Third Mini-Symposium and Workshop on Design for Fire Safety in Buildings and Built Infrastructure (**Figure 10**). The programme was organised by the American University of Sharjah, Sharjah on 13-14 March 2016. Prof Rafi shared the details of the model which considers fire spread both within a building and building to building. A fire safety design approach has been employed to model compartment fire. The effects of type of building material, building floor area, number of storeys of a building, direct flame impingement, heat transfer by convection and radiation, direction and velocity of wind, environmental conditions and fire spread by flaming brands have been included in the model. The model construction is based on a cellular automata scheme and a free-source computer programming framework was employed for the implementation of model. A close correlation of the predictions was found with the fire spread after 1995 Kobe Earthquake and 1916 Paris, Texas Conflagration.

Inaugural meeting of North Western Indian Ocean Working Group in Oman

Figure 11: Group photo of participating members

An inaugural meeting of Sub-Regional Working Group of North Western Indian Ocean (WG-NWIO) was held in Muscat, Oman on 14-15 October 2015. The meeting was hosted by the Directorate General of Meteorology of the Public Authority for Civil Aviation, Government of Oman under the Intergovernmental Coordination Group (ICG) for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS). This group was established by the Assembly of UNESCO's Intergovernmental Oceanographic Commission (IOC) in 2005 (**Figure 11**). The terms of reference for the WG-NWIO are as follows

1. To evaluate capabilities and ascertain requirements of countries in the northwest Indian Ocean region for providing end-to-end tsunami warning and mitigation services within a multi-hazard framework and within the framework of the ICG/IOTWMS
2. To promote and facilitate tsunami hazard and risk studies and research in the region
3. To facilitate cooperation in the establishment and upgrading of seismic, sea level and GNSS stations and networks and communication systems in the region
4. To facilitate improvement of the education programmes on tsunami mitigation in the region
5. To facilitate capacity building and the sharing of tsunami-related data and information in the region

Members are nominated for the group by the member states which include India, Iran, Oman, Pakistan, Yemen, other member states in the North West Indian Ocean region. Observers are also invited to attend the meeting.

Prof Sarosh Lodi led the delegates from Pakistan which reported the efforts carried out on tsunami risk assessment and reduction in Pakistan. The probabilistic tsunami hazard analysis carried out by the Department of Earthquake Engineering indicates that 17.5% probability in 50 years for the tsunami wave height to exceed 5 m along the Makran coast. The team also presented tsunami inundation maps for Gwadar and Pasni which were developed using worst case scenario considering a 9 magnitude earthquake.

Mr Ameer Hyder, a scientist Pakistan Meteorological Department (PMD) described the details of a seismic network which has been developed in Pakistan by PMD in collaboration with the Chinese Earthquake Administration (CEA). The network contains twenty stations developed by PMD and CEA in equal numbers. The tsunami scenario simulation is carried out using the processing system Seiscomp3 with the GUITAR application. In addition, tsunami messages from the IOTWMS Tsunami Service Providers are received by PMD through GTS and are disseminated to the stakeholders.

Lecture and Seminar on
Recent Advancements in Strengthening & Retrofitting of Structures using FRP and TRM


Figure 12: (Top) Participants at Zaffar Razzak Memorial Lecture Series,
(Bottom) Prof Thanasis Triantafillou (Right) with Dr. SFA Rafeeqi, Chairman, IEP Council Karachi

Prof Thanasis Triantafillou, Professor, Department of Civil Engineering at University of Patras, Greece was invited to deliver a lecture as part of Zafar Razzak Memorial Lecture Series in the Department of Civil Engineering. The lecture was held on 28 March 2016 (**Figure 12**). Renowned international and local experts are invited bi-annually for this lecture series to share the advancements and cutting edge research in the field of Structural Engineering.

The lecture was attended by a large number of students and faculty. Prof Triantafillou presented the recent developments in the field of strengthening and seismic retrofitting of reinforced concrete and masonry structures using fibre reinforced polymers (FRP) to increase flexural, shear and axial resistance of these structures. He mentioned that the issues related to the polymeric resins used in FRP have led to the development of a new class of composite materials which are termed as textile reinforced mortars (TRM). These provide effective alternative solutions in a number of strengthening/retrofitting applications.

Along with technical details and case studies, Prof Triantafillou also discussed key aspects on materials, concepts, design, behavioural aspects with a critical comparison of their effectiveness in the field of strengthening and seismic retrofitting of reinforced concrete and masonry structures.

A half-day seminar was also organised on 29 March 2016 by Institution of Engineers Pakistan for the professional engineers taking advantage of the presence of Prof Triantafillou (**Figure 12**). The seminar was aimed at making the industry aware of the benefits TRM offers for them and to acquaint them with the design process for retrofitting and re-strengthening of infrastructures.

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