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Cowasjee Earthquake Study Centre

NED NEWSLETTER

Tohoku Earthquake Disaster

On March 11 at 2:46pm JST a massive 9.0-magnitude earthquake occurred near the northeastern coast of Japan, creating extremely destructive tsunami waves which hit Japan just minutes after the earthquake, and triggering evacuations and warnings across the Pacific Ocean. The earthquake and tsunami have caused extensive and severe damage in Northeastern Japan, leaving thousands of people confirmed dead, injured or missing, and millions more affected by lack of electricity, water and transportation The magnitude 9.0 Tohoku earthquake , which occurred near the northeast coast of Honshu, Japan, resulted from thrust faulting near the subduction zone plate boundary between the Pacific and North America plates. The March 11 earthquake was preceded by a series of large foreshocks over the previous two days, beginning on March 9th with a M 7.2 event approximately 40 km from the epicenter of the March 11 earthquake, and continuing with another three earthquakes greater than M 6 on the same day. The Japan Trench subduction zone has hosted nine events of magnitude 7 or greater since 1973. The largest of these, a M 7.8 earthquake approximately 260 km to the north of the March 11 epicenter, caused 3 fatalities and almost 700 injuries in December 1994. In June of 1978, a M 7.7 earthquake 35 km to the southwest of the March 11 epicenter caused 22 fatalities and over 400 injuries. Large offshore earthquakes have occurred in the same subduction zone in 1611, 1896 and 1933 that each produced devastating tsunami waves on the San-riku coast of Pacific NE Japan. That coastline is particularly vulnerable to tsunami waves because it has many deep coastal embayments that amplify tsunami waves and cause great wave inundations. The March 11, 2011 earthquake far surpassed other post-1900 plate-boundary thrust-fault earthquakes in the southern Japan Trench, none of which attained M8. A predecessor may have occurred on July 13, 869, when the Sendai area was swept by a large tsunami that Japanese scientists have identified from written records and a sand sheet. The Japanese National Police Agency has confirmed 14,133 deaths, 5,304 injured and 13,346 people missing across eighteen prefectures, as well as over 125,000 buildings damaged or destroyed. The earthquake and tsunami caused extensive and severe structural damage in Japan, including heavy damage to roads and railways as well as fires in many areas, and a dam collapse.

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Fig 2 : A map showing the epicenter of the earthquake

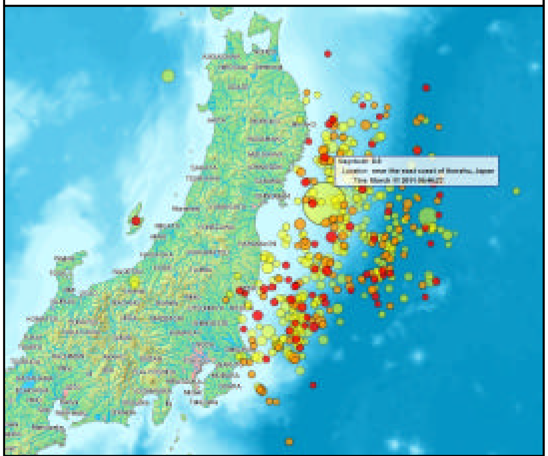

Fig 3: Map of the Tohoku earthquake and aftershocks March 11. - 14.

Fig 1: An office building burns in Tokyo after an earthquake

EDITORIAL

The first issue of volume 11of CESNED NEWS LETTER is once again an endeavor towards improving awareness of earthquake engineering in Pakistan.. Readers are encouraged to contribute in this newsletter.

CESNED is dedicating this issue to the effectives of March 2011 Japan Earthquake —— Editor

Inside this Issue:

TSUNAMI "*THE GREAT WAVES*"

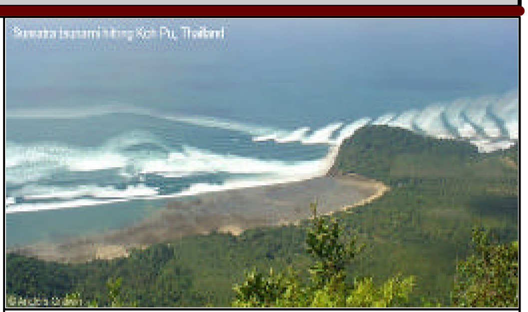

Fig 3: Sumatra Tsunami hitting Koh Pu, Thailand December 26, 2004
(Ref: http://nctr.pmel.noaa.gov/index.html)

."Tsunami" (soo-NAH-mee) is a series of travelling waves. They are generated by undersea earthquakes, landslides or even volcanic eruptions underwater. These "great waves" in deep open sea may propagate at speeds exceeding 800 km/hr with wavelengths often exceeding 100 km and wave heights of only a few tens of centimeters. The ruthlessness of these waves comes into play when they reach the shallow waters of the coast where the waves slow down and the water piles up into a wall of destruction tens of meters or more in height.

Fig 4: Tsunami wave Japan March 11, 2011

Recent events of Tsunamis such as that on December 26, 2004 in Sumatra, Indonesia and the one on March 11, 2011 in the North-East of Japan resulted in the tragic loss of life and extensive property damage in the coastal communities. Moreover, the coast of Pakistan is also prone to such events as is evident from the 1945 earthquake of the coast of Pasni that generate a Tsunami causing the destruction of the Pasni village. The devastation in the coastal areas has reminded the lack of adequate preparation for these infrequent but powerful events. Hence, detailed maps showing future tsunami flooding (inundation) are needed for delineation of evacuation routes and long-term planning in vulnerable coastal communities. Inundation maps are developed through computer models that require quality bathymetric and topographic data, which are then used for coastal community planning.

By: Dr Haider Hasan, Department of Civil Engineering , NEDUET, Karachi

Tohoku Earthquake Disaster

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Fig 5: Sendai Airport is flooded after a tsunami following an earthquake in Sendai, northeastern Japan, March 11, 2011.

Fig 6 : In the Miyagi port city Kesennuma , which has population of 74000, the waves smashed cars up against houses

Around 4.4 million households in northeastern Japan were left without electricity and 1.5 million without water. Many electrical generators were taken down, and at least three nuclear reactors suffered explosions due to hydrogen gas that had built up within their outer containment buildings after cooling system failure.

Estimates of the Tohoku earthquake's magnitude make it the most powerful known earthquake to have hit Japan, and one of the fivemost powerful earthquakes in the world overall since modern record-keeping began in 1900. Japanese Prime Minister Naoto Kan said, "In the 65 years after the end of World War II, this is the toughest and the most difficult crisis for Japan. The earthquake moved Honshu 2.4 m (7.9 ft) east and shifted the Earth on its axis by almost 10 cm (3.9 in). Early estimates placed insured losses from the earthquake alone at US$14.5 to $34.6 billion.

The Bank of Japan offered ¥15 trillion (US$183 billion) to the banking system on 14 March in an effort to normalize market conditions. On 21 March, the World Bank estimated damage between US$122 billion and $235 billion. Japan's government said the cost of the earthquake and tsunami that devastated the northeast could reach $309 billion, making it the most expensive natural disaster on record.

The earthquake which was caused by 5 to 8 meters upthrust on 180-km wide seabed at 60 km offshore from the east coast of Tohok resulted in a major tsunami which brought destruction along the Pacific coastline of Japan's northern islands and resulted in the loss of thousands of lives and devastated entire towns. The tsunami propagated across the Pacific, and warnings were issued and evacuations carried out. In many countries bordering the Pacific, including the entire Pacific coast of North and South America fromAlaska toChile; however, while the tsunami was felt in many of these places, it caused only relatively minor effects.

CESNED Activities

Fig 7: Dr Lodi , Dr Rafeeqi and Mr Ahmed during the award of city scenario contract

The First meeting regarding the WP4 of the EMME project was arranged in Istanbul on 25th and 26th Jan 2011. Mr Ahmed represented NEDUET. In this gathering the main focus was to discuss the project progress regarding the data compilation and risk assessment parameters.

The Mid term General Assembly of the Project was held in Jordan (31st March - 2nd April 2011). The aim of the assembly was to follow up the advancement of the different work packages and to award the City scenario contracts to different courtiers. Dr. S.F.A Rafeeqi , Dr Sarosh H. Lodi and Mr Muhammad Ahmed attended the meeting on the behalf of NEDUET. The city scenario for Karachi was awarded to NEDUET Karachi and Dr. Sarosh H. Lodi signed the contract on the behalf of the University.

CORSET: Competition Of Retrofitting Seismically Essential sTructures (Jan 2011—March 2011)

The competition of retrofitting seismically essential structures was arranged by the Department of Civil Engineering , NEDUET Karachi. It was among the capacity building exercises under the HED-USAID project " Building capacity in Pakistan to Seismically Retrofit Essential Structures". CORSET was intended to provide an opportunity to the professionals to address one of the most challenging issues of considering the masonry infill behaviour in the analysis and design of reinforced concrete (RC) structures and develop retrofit solutions appropriate for the Pakistani context. CORSET was arranged primarily to strengthen the already existing academic-industry relations by bringing them together on a common platform. The participants from the industry admitted the fact that this competition significantly improved their understanding of the seismic behaviour of buildings which will help improving the design methodology of new structures.

Fig 8: Participants during the presentation

Training " Shake Table Testing on Large scale 7-11 April 2011"

Fig 9: Team visiting Shake table in EU Center

A team comprising of the Chairman Department of Civil Engineering Prof. Dr. Asad-ur-Rehman Khan, Mr. Fawwad Masood (lecturer), Mr.Amir Nizam (lab engineer), Mr. Hasan Mansoor (lecturer) went to EU Center, Pavia, Italy for a training session about Large Shake Table Testing. The purpose of training was to introduce the theory and practice of laboratory operations to be performed when dealing with shake table testing. several aspects and issues will be revised, including:

- Test instrumentation and acquisition systems
- Basics of signal processing
- signal processing lab: examples illustrating basic concepts.
- Test systems (shake table, actuation, pumping, accumulators):

Participation in "3rd Asian Conference on Earthquake Engineering , 1st—4th December 2010. Thailand"

Aslam Faqeer Mohammad Assistant Professor of Civil Engineering Department visited Thailand for the 3rd Asian Conference on Earthquake Engineering and presented the paper "Comparative Evaluation of Non-Ductile Reinforced Concrete Frame with and without Infill".

The paper presented in the conference focuses on the performance based evaluation of non-ductile two dimensional frame with and without infill, retrofitted by adding struts of variable strengths in two different ways: Retrofitting soft storey and retrofitting only single interior bay gradually converting into a spine for relevant regional seismic hazard, through performance based analysis with indigenous cost effective retrofitting techniques. Results showed that the presence of infill significantly alters the collapse mechanism of bare frame as compare to retrofitted infill frame.

Fig 10: Aslam during the presentation

Tohoku Earthquake Disaster - *The Fukushima I nuclear Accident*

The Fukushima I nuclear accidents are a series of ongoing equipment failures and releases of radioactive materials at the Fukushima I Nuclear Power Plant, following the 9.0 magnitude Tohoku earthquake and tsunami on 11 March 2011. The plant comprises six separate boiling water reactors maintained by the Tokyo Electric Power Company (TEPCO). Experts consider it to be the second largest nuclear accident after the Chernobyl disaster, but more complex as all reactors are involved.

At the time of the quake, reactor 4 had been de-fuelled while 5 and 6 were in cold shutdown for planned maintenance. The remaining reactors shut down automatically after the earthquake, and emergency generators started up to run the control electronics and water pumps needed to cool them. The plant was protected by a seawall designed to withstand a 5.7 metres (19 ft) tsunami, but not the 14-metre (46 ft) wave which arrived 15 minutes after the earthquake. The entire plant was flooded; including low-lying generators and electrical switchgear in reactor basements, and its connection to the electrical grid was broken. All power for cooling was lost and reactors started to overheat, despite shutdown, due to natural decay of the fission products created before shutdown. The flooding and earthquake damage hindered external assistance. Evidence soon arose of partial core meltdown in reactors 1, 2, and 3; hydrogen explosions destroyed the upper cladding of the buildings housing reactors 1, 3, and 4; an explosion damaged the containment inside reactor 2; and multiple fires broke out at reactor 4. In addition, spent fuel rods stored in spent fuel pools of units 1–4 began to overheat as water levels in the pools dropped. Fears of radiation leaks led to a 20-kilometre (12 mi) radius evacuation around the plant while workers suffered radiation exposure and were temporarily evacuated at various times. One generator at unit 6 was restarted on 17 March allowing some cooling at units 5 and 6 which were least damaged. Grid power was restored to parts of the plant from 20 March, but machinery for reactors 1–4 damaged by floods, fires and explosions remained inoperable. Japanese officials initially assessed the accident as level 4 on the International Nuclear Event Scale (INES) despite the views of other international agencies that it should be higher. The INES level was raised successively to 5 and then the maximum 7. Measurements taken by the Japanese science ministry and education ministry in areas of northern Japan 30–50 km from the plant showed radioactive caesium levels high enough to cause concern. Food grown in the area was banned from sale. It was suggested that worldwide measurements of iodine-131 and caesium-137 indicate that the releases from Fukushima are of the same order of magnitude as the releases of those isotopes from the Chernobyl disaster in 1986; Tokyo officials temporarily recommended that tap water should not be used to prepare food for infants. Plutonium contamination has been detected in the soil at two sites in the plant. The International Atomic Energy Agency (IAEA) announced on 27 March that workers hospitalized as a precaution on 25 March had been exposed to between 2 and 6 Sv of radiation at their ankles when standing in water in unit 3. The international reaction to the accidents was also concerned. The Japanese government and TEPCO have been criticized for poor communication with the public and improvised cleanup efforts. Experts have said that a workforce in the hundreds or even thousands would take years or decades to clean up the area. On 20 March, the Chief Cabinet Secretary Yukio Edano announced that the plant would be decommissioned once the crisis was over. The earthquake that hit Japan was several times more powerful than the worst earthquake the nuclear power plant was built for (the Richter scale works logarithmically; for example the difference between an 8.2 and the 8.9 that happened is 5 times, not 0.7). When the earthquake hit, the nuclear reactors all automatically shutdown. Within seconds after the earthquake started, the control rods had been inserted into the core and the nuclear chain reaction stopped. At this point, the cooling system has to carry away the residual heat, about 7% of the full power heat load under normal operating conditions. The earthquake destroyed the external power supply of the nuclear reactor. This is a challenging accident for a nuclear power plant, and is referred to as a "loss of offsite power." The reactor and its backup systems are designed to handle this type of accident by including backup power systems to keep the coolant pumps working. Furthermore, since the power plant had been shut down, it cannot produce any electricity by itself. For the first hour, the first set of multiple emergency diesel power generators started and provided the electricity that was needed. However, when the tsunami arrived (a very rare and larger than anticipated tsunami) it flooded the diesel generators, causing them to fail. One of the fundamental tenets of nuclear power plant design is "Defense in Depth." This approach leads engineers to design a plant that can withstand severe catastrophes, even when several systems fail. A large tsunami that disables all the diesel generators at once is such a scenario, but the tsunami of March 11th was beyond all expectations. To mitigate such an event, engineers designed an extra line of defense by putting everything into the containment structure , that is designed to contain everything inside the structure.

Fig 11: Satellite image on 16 March of the four damaged reactor build-

Fig 12: Fukushima Daiichi Nuclear Station showing damaged reactors #1 , #3, and #4.Exterior of #2 appears intact although smoke and/or steam has streamed from hole in upper east wall. From (http://shineyourlight-shineyourlight.blogspot.com/2011/03/japan-one-week-after-

RESOURCE PERSONS:

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Information, news items, short notes on research findings are invited from across the globe.