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NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF EARTHQUAKE ENGINEERING

Cowasjee Earthquake Study Centre
NED
NEWSLETTER

Department of Earthquake Engineering enters the World Arena

The Department of Earthquake Engineering had entered in the open Blind Test Challenge at the 15th World Conference on Earthquake Engineering (15WCEE), held on 28th September 2012, in Lisbon, Portugal. The NED University team comprising of Prof. Sarosh H. Lodi, Dean, Faculty of Civil Engineering and Architecture, Prof. M. Masood Rafi, Chairman, Department of Earthquake Engineering, Dr. Mukesh Kumar, Associate Professor, Department of Earthquake Engineering and Mr. Adnan Rais Ahmed, Lecturer, Department of Civil Engineering has been declared 7th out of the 38 contested teams from reputed universities and consultants around the world, Figure 1.

Figure 1: Top ten teams of the Blind Test Challenge (15 WCEE)

The contest challenge was to predict the displacements with the help of numerical modeling, at the roof level of single story reinforced concrete frame that were tested to two-dimensional seismic excitation on a LNEC-3D shaking table. The single story consisted of one bay in each horizontal direction. The roof slab, having a thickness of 0.10 m, did not cover the entire span in one direction, Figure 2. A set of nine additional masses of around 1200 kg each were placed on the top of the roof slab. The shake table testing time history comprised of a time segment of two horizontal orthogonal components of a real strong motion signal registered during the Great East Japan (Tohoku) Earthquake and Tsunami (2011-3-11).

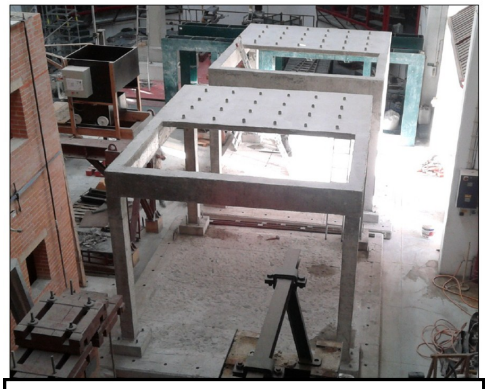

Figure 2: General view of reinforced concrete frames tested on a shake table for Blind Test Challenge.

In total, eight structures were tested on the shake table under two-dimensional earthquake excitation using accelerograms compatible with EC8 design acceleration spectrum. Four structures were designed for the low ductility class, whereas the other four were designed for the high ductility class, as per EC8 provisions. The required target motions at roof level were;

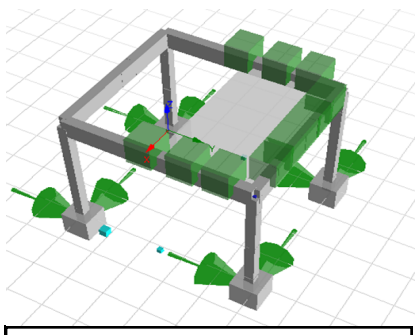

Figure 3: Numerical model of the RC frame

1. LOW, corresponding to 20% of the target intensity level.
2. MED, corresponding to 70% of the target intensity level.
3. REF, corresponding to 100% of the target intensity level.
4. HIGH, corresponding to 200% of the target intensity level.

SeismoStruct was used by the NED University team to generate and analyze the numerical model for prediction of displacements at roof level, Figure 3. SeismoStruct is a Finite Element package capable of predicting the large displacement behaviour of space frames under static or dynamic loading, taking into account both geometric nonlinearities and material inelasticity.

EDITORIAL

The second issue of volume 12 of CESNED NEWS LETTER is once again an endeavor towards improving awareness of earthquake engineering in Pakistan. All the published articles in this issue are taken from on-going research projects in the Department of Earthquake Engineering. Readers are encouraged to contribute towards this newsletter. — Editor

Inside this Issue:

Earthquake Hazard and Risk in Karachi

(A NORSAR Funded project)

A research project entitled ***"Earthquake Hazard and Risk in Karachi"*** was submitted to the Norwegian Ministry of Foreign Affairs/NORAD, through the Norwegian Embassy to Pakistan for funding. Department of Earthquake Engineering along with NORSAR have been awarded the 3 year research project, Figure 4, which is aimed at estimating earthquake hazard and risk in Karachi. The paradigm of this study is to carry out quantitative as well as qualitative analysis to attain the following objectives;

- Tectonics and Seismicity of the Region
- Geological and Geotechnical Considerations of the Region
- Ground Motion Prediction Models
- Probabilistic Earthquake Hazard
- Earthquake Scenarios
- Deterministic Earthquake Hazard
- Site Specific Seismic Hazard
- Ground Failures

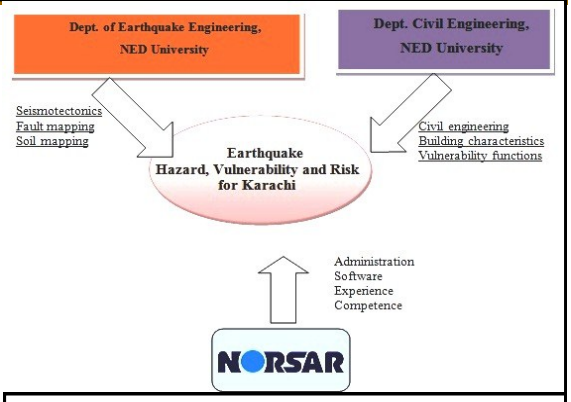

Figure 4 : Summary of constellation and contributions of each participating institution

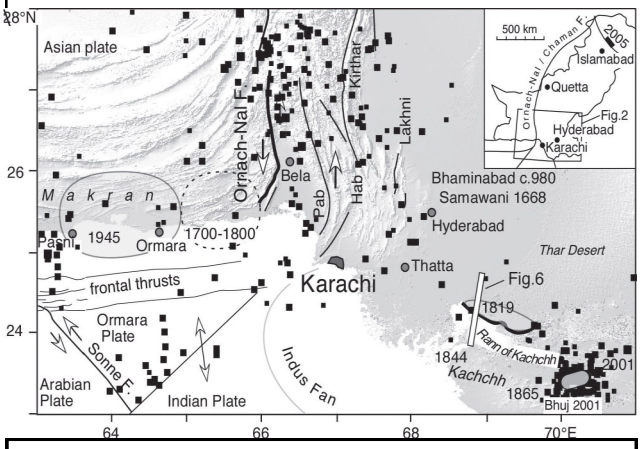

Figure 5 : Earthquakes and Potential Seismic threat to Karachi
(Source: Bilham et. al, Seismological Research Letter, USA Vol. 78, Number 6)

Karachi is the hub of economic and commercial activity of Pakistan and is known to lie in a region of seismic hazards, Figure 5, but due to the result of unplanned urban growth, negligence of construction standards, localized concentration of population and infrastructure, and the lack of awareness at the public and the institutional levels, it becomes vital to analyze expected Earthquake hazard and accurately examine the extent of risk associated with such a location. This research will propose an integrated approach which will develop investigation process and to provide an accurate assessment of seismic risk assessment and loss estimations. Consequently, detailed seismological, geophysical, geological and geotechnical investigations will be assembled, quality controlled and/or conducted if needed.

The earthquake hazard assessment for the city of Karachi will be conducted with risk analysis using deterministic computations of seismic risk relevant to worst-case earthquake scenarios. Additionally, deterministic assessments will also be conducted in a Monte Carlo approach using the synthetic earthquake catalogues, results of which are of importance in the insurance sector. Results, where appropriate ground motion prediction models are selected, will be applied after a careful comparison and calibration to have them commensurate with the earthquake source conditions and regional geological conditions. Earthquake hazard data will be aggregated in geo-cells with predefined dimensions and the same geo-cells will also be used for aggregation of the geotechnical data and the building inventories.

The research results: hazard, vulnerability and risk will be presented in easy understandable terms and will be presented both to the National Disaster Management Authority (NMDA) and to the Karachi City authorities.

NORSAR is the seismological institution in Norway responsible for monitoring the Comprehensive Test Ban Treaty on Nuclear testing. It has since 1968 been the driving research institution in the development of new array based technologies in seismic monitoring and surveillance. NORSAR has over the last 20 years been a leader in probabilistic and semi-probabilistic seismic hazard investigations and had, among others, a key role in the development of the new anti-seismic building code in Norway effective from 2005. The earthquake risk evaluation code SELENA, is developed and maintained by NORSAR, and this will be an important tool within the planned cooperation.

Research Project Awarded by Aga Khan Development Network

(Funded under Disaster Risk Management Initiative, AKDN)

Natural disasters have direct impact on built environment, where damages are largely dependent on construction types, practices, material, traditional and social system, and institutional policies. Large number of buildings in Pakistan are non-engineered and need technical and policy support to improve the overall built environment standards. A six month research project is signed between NED University and AKDN aimed at the following deliverables;

⇒ Develop inventory of predominant traditional construction types in earthquake hazard prone areas of Pakistan
⇒ Analytical and experimental study of predominant construction material and their seismic performance
⇒ Dynamic testing of construction typologies and evolve the cost effective seismic resistant construction techniques
⇒ Documentation, promotion and training on earthquake resistant construction.

Evaluating the Influence of Concrete Block Infill Walls on Seismic Performance of RC Frames

RC structures with infill walls are very common in Pakistan, Figure 6. The presence of infill walls has shown to resist the lateral loads by increasing the stiffness and strength of the RC frame building. However, in most cases, the contribution of stiffness and strength due to presence of infill walls is not incorporated in the analytical design process. Moreover, it is noted that the influence of infill walls on RC frames may vary significantly due to different types of infill material used in different parts of the world. In addition, many of the developing countries do not specify the modeling, design and assessment procedures of such infill walls in their codes. In US and Europe, a significant amount of work has been conducted to evaluate the lateral stiffness of RC frame with masonry infill walls. However, there is a lack of work in this area of research in Pakistan. In the absence of code requirements, there is a need to develop a realistic approach towards performance of concrete infill walls against the lateral loads. Therefore a research project has been initiated by the Department of Earthquake Engineering, to evaluate the influence of concrete block infill walls on seismic performance of RC frame.

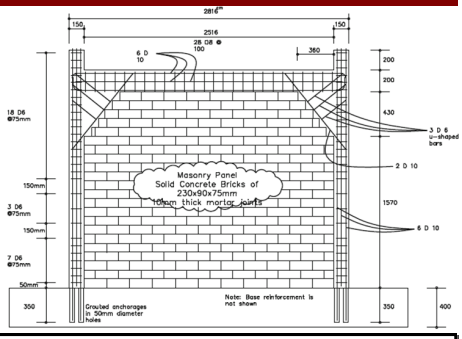

Figure 6: Typical concrete block infills in RC frames

Mr. Muhammad Haider, supervised by Prof. Sarosh Lodi, Dr. Mukesh Kumar and Prof. Masood Rafi, will investigate the characteristics of concrete infill walls and their influence on the behavior of RC frame subjected to lateral loading so that simple analytical techniques can be developed for structural engineers in Pakistan. To this end, various experimental tests shall be performed to obtain mechanical properties of the concrete infill walls using direct compression test, direct shear test and diagonal compression test. Subsequently, a full scale RC frame with concrete block infill walls will be tested under lateral loading to simulate seismic behaviour. Finally, analytical models will be developed and compared with the experimental results.

Development of V_s30 Maps for Karachi

The objective of the research is to develop Vs30 (shear wave velocity at a depth of 30m) maps for Karachi, Figure 7, by conducting geophysical (MASW- Multichannel Analysis of Surface Waves) and geotechnical (using empirical relations through SPT-N value) surveys. These maps will be utilized to conduct soil amplification study for Karachi by two different methods and the data obtained would also help to recommend any one method for future studies on the basis of its accuracy.

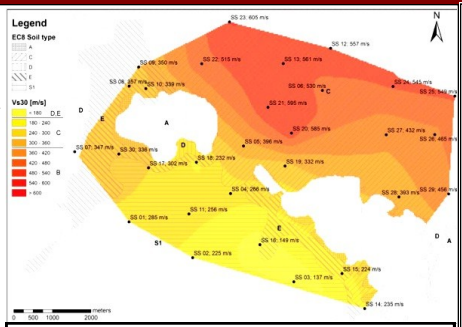

Figure 7: Typical Vs30 distribution Map and Soil classification (Gosar 2010)

The project methodology includes of collecting borehole information and subsequent computation of V_s30. In addition a cross check will be applied while experimentation is performed on same locations as that of boreholes by conducting MASW survey to obtain shear wave velocity profile and Vs30. The future perspective of the research would facilitate deterministic and probabilistic seismic hazard assessment. Furthermore, it will help engineers to carry out assessment and design of existing and new structures respectively.

The study is being conducted by Ms. Maria Ansari and supervised by, Dr. Mukesh Kumar, Associate Professor, Department of Earthquake Engineering and Prof. Sarosh H. Lodi, Dean, Faculty of Civil Engineering and Architecture.

WP5 – City Scenarios
Seismic Risk Study for the City of Karachi

After a bidding process NED University of Engineering and Technology (NEDUET) has won the WP5-City Scenario for Pakistan. Work Package-5 (WP5) is a part of Earthquake Model of the Middle East Region project that is being funded by Japan Tobacco International. The two year project, having started in July 2012, aims to develop a GIS database of building topologies, population and lifeline systems for the city of Karachi towards the development of tools for seismic risk assessment and loss estimations.

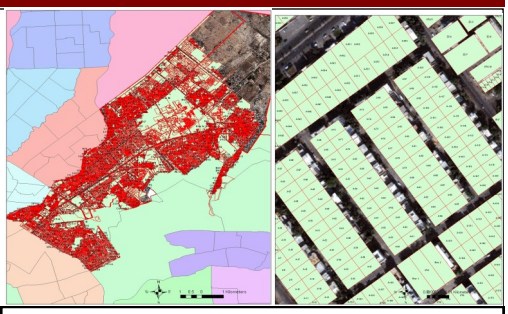

Figure 8: 0.6 m spatial resolution plot level map of Gulshan-e-Iqbal

To study the earthquake risk scenario of Karachi city, a detailed vulnerability assessment of buildings in Gulshan-e-Iqbal has been completed by students of NED University. The gathered information of the existing buildings topologies is being used to develop a GIS mapping system, Figure 8, and to develop fragility curves of all the building topologies and lifelines.

City District Government Karachi (CDGK) is collaborating with the NED University of Engineering and Technology. While Provincial Disaster Management Authority (PDMA), Sindh and National Disaster Management Authority (NDMA), Pakistan are the additional partners and beneficiary of the project.

Major Earthquakes around the World in 2012
(Source: U.S. Geological Survey Website)

Date	Location	Magnitude
October 12, 2012	NEAR THE SOUTH COAST OF PAPUA, INDONESIA	6.7
September 07, 2012	SICHUAN-YUNNAN-GUIZHOU REGION, CHINA	5.6
September 05, 2012	COSTA RICA	7.6
August 27, 2012	OFFSHORE EL SALVADOR	7.3
August 18, 2012	SULAWESI, INDONESIA	6.3
August 11, 2012	NORTHWESTERN IRAN	6.4
June 11, 2012	HINDU KUSH REGION, AFGHANISTAN	5.7
May 28, 2012	SANTIAGO DEL ESTERO, ARGENTINA	6.7
April 17, 2012	EASTERN NEW GUINEA REG, PAPUA NEW GUINEA	6.8
April 17, 2012	OFFSHORE VALPARAISO, CHILE	6.7
April 11, 2012	OFF THE WEST COAST OF NORTHERN SUMATRA	8.6
March 25, 2012	MAULE, CHILE	7.1
March 21, 2012	NEW GUINEA, PAPUA NEW GUINEA	6.6
March 20, 2012	OAXACA, MEXICO	7.4
March 14, 2012	OFF THE EAST COAST OF HONSHU, JAPAN	6.9
February 26, 2012	SOUTHWESTERN SIBERIA, RUSSIA	6.7
January 10, 2012	OFF THE WEST COAST OF NORTHERN SUMATRA	7.2
January 01, 2012	IZU ISLANDS, JAPAN REGION	6.8

Building Vulnerability Assessment Survey and Development of GIS Inventory for Gulshan-e-Iqbal and Gulberg Town, Karachi

Figure 9: Students with the supervisors involved in programme.

A 30 day internship programme was offered through May to June 2012, to the third year students of Civil Engineering, Urban and Infrastructure Engineering and Architecture and Planning Department. Forty five (45) students participated in the programme. The involved students were required to conduct field surveys, in-order to gather building typology data for the two towns of Karachi, Figure 9. The exercise was performed in relation to the project entitled Earthquake Model for Middle East (see details on Page 3). The data was subsequently employed in carrying out seismic vulnerability analysis of buildings.

During the internship programme, the students were also trained to carry out hands-on exercises related to the digitization of the collected building typology information and to develop GIS based building inventories and building maps for vulnerability assessment.

15th World Conference on Earthquake Engineering (15WCEE)

8 research papers from authors belonging to different disciplines of the Faculty of Civil Engineering and Architecture have been published in the conference proceedings of the 15th World Conference on Earthquake Engineering held in Lisbon, Portugal, on September 2012. Research areas included, application of earthquake engineering in various fields, performance of infill & adobe structures, nonlinear behavior of frames and risk assessment methodologies for various earthquake scenarios for Pakistan.

NATO Sponsored Workshop for Disaster Forecast and Prevention Projects in Partner Countries

Prof. Sarosh H. Lodi, Dean, Faculty of Civil Engineering and Architecture, was invited as a speaker in a two-day Seismic Workshop, funded by the Science for Peace and Security (SPS) Programme, was organised by the Kandilli Observatory and Earthquake Research Institute in Istanbul, Turkey on 21-22 May 2012. 65 academic experts from NATO and partner countries held discussions focused on the threat posed by earthquakes and the available responses for securing nations through technology, mutual assistance and cooperation. It provided a platform for participants to discuss current structures and practices, as well as advanced technologies, in order to identify areas of improvement at national and international level.

RESOURCE PERSONS:

- Prof. Dr. Sahibzada F A. Rafeeqi
- Prof. Sarosh H. Lodi
- Prof. Muhammad Masood Rafi

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