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NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF EARTHQUAKE ENGINEERING

# Cowasjee Earthquake Study Centre NED NEWSLETTER

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## Reconnaissance Team visits Mashkel

A reconnaissance team from the Department of Earthquake Engineering at NED University of Engineering and Technology visited Mashkel which was affected by the16 April 2013 Iran earthquake (Figure 1). Mashkel is a tehsil of Washuk district in Baluchistan. It lies at 467 km South-West of Quetta. The city area of this tehsil is also named as Mashkel. The visit was carried out from 20 April 2013 to 22 April 2013. Owing to the remoteness, security concerns and sparse development in the region, the team concentrated on the areas in the close proximity of the epicentre. The team installed a strong motion instrument to record possible after-shocks. A reasonably large sample of the populated area of Mashkel was surveyed by the team and the information was recorded using two different questionnaires. The damages to infrastructure and buildings were studied based on the observations and these were documented. Significant damages to adobe buildings were found in different areas (Figure 2) whereas reinforced concrete and block masonry buildings performed better (Figure 3). In addition, geotechnical and seismological aspects of the earthquake in the affected region were also investigated.

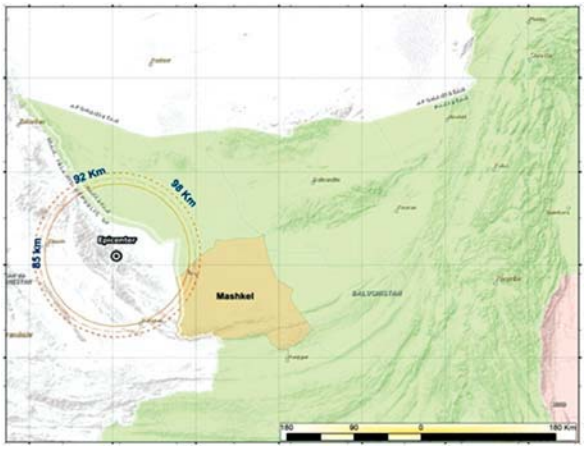


Figure 1: Earthquake affected region of Mashkel

Figure 2: Damages to adobe buildings

Figure 3: Undamaged block masonry house in Mashkel

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

Presence of masonry infill walls in RC frames results in a significantly different response from that assumed in the seismic design of a structure. Realising the importance of this study the Department of Earthquake Engineering has started a project to investigate the characteristics of concrete infill masonry walls and their influence on the behaviour of RC frame subjected to lateral loading. An experimental scheme has been designed which shall help to develop simple FE modelling techniques, and the design and assessment procedures for infill masonry walls. The mechanical tests have been conducted both on block and mortar samples to determine their properties in accordance with relevant ASTM standards. Masonry specimens have been tested to determine their (Continued on page 3)

Figure 4: Failure mode of specimen in Direct Shear without Confinement.

### EDITORIAL

*This issue of CESNED Newsletter provides the readers information about various research activities the Department of Earthquake Engineering is involved in. These activates are aimed at improving the built environment of Pakistan by increased level of understanding of the behaviour of indigenous structural forms to make the existing and future built environment more resilient to the earthquake hazard. — Editor*

### Inside this Issue:

## Seismic Vulnerability Assessment for Bridges in Pakistan

Bridges are lifeline structures and represent potentially the most vulnerable component in highway transportation network under seismicity. Failure of bridges during a seismic event can seriously hamper the relief and rehabilitation work. It is therefore necessary to adequately design new bridges and assess the capacity of existing bridges which are located in areas of earthquake hazard. Many international transportation authorities are incorporating seismic risk assessment in their Bridge Management Systems (BMS).

Current seismic performance assessment methods are tending towards fragility curves (Figure 7) as a means of describing the vulnerability of structures (such as highway bridges) under uncertain input. In the context of evaluating the seismic performance of bridges in a specified hazard environment, fragility curves provide a rational and consistent probabilistic treatment of damage or loss.

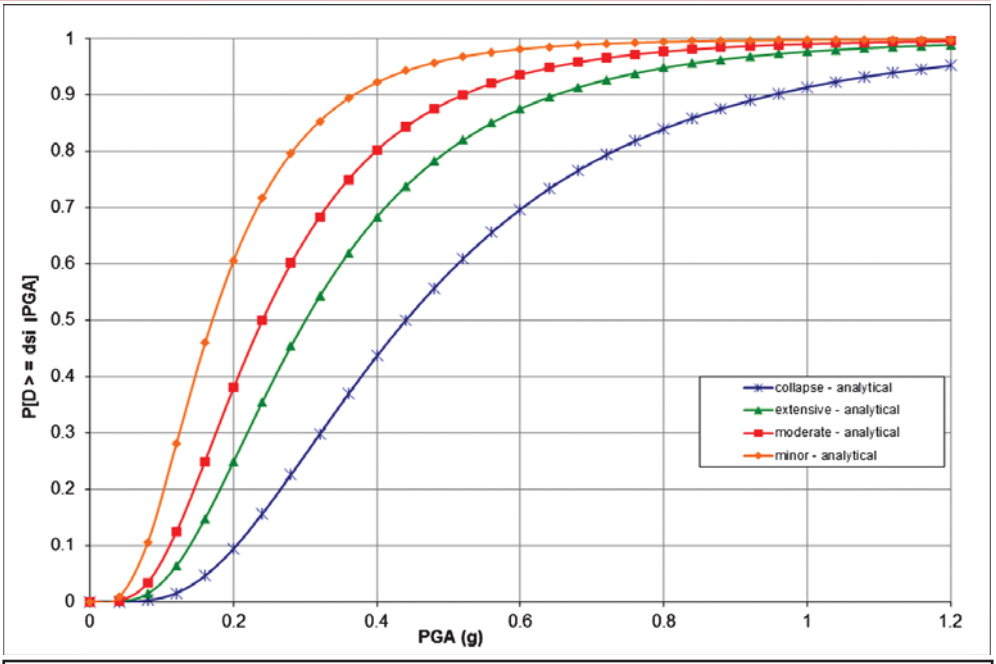


Figure 7: Fragility Curves for the Bridges with Multiple Column Bents and Prestressed Concrete Simply Supported Girders (HAZUS)

HAZUS is one of the seismic risk tool for developing fragility curves which requires only the following three types of data for seismic vulnerability analysis: (1) bridge inventory records that contain the bridge attributes and geographical location; (2) soil profile maps from which soil types and hence S-factors can be inferred and (3) peak ground acceleration (PGA).

For Pakistan, future threats of earthquake vulnerability to the numerous existing bridges is inevitable and therefore it becomes necessary to adequately design new bridges and assess the capacity of existing bridges. Therefore, the Department of Earthquake Engineering is working on a study to determine seismic vulnerability of bridges in Karachi. In this regard, an existing BMS model will be modified as a seismic risk analysis tool using GIS platform. The modified model will provide useful information to disaster management agencies of the country and bridge owners regarding evacuation maps, seismic retrofitting decisions, disaster response planning, estimation of direct monetary losses and loss of functionality of highway systems.

## Workshop on Safe and Sustainable Building Design Guidelines for Mountainous Region

A one-day workshop entitled Safe and Sustainable Building Design Guidelines for Mountainous Region was organised by Aga Khan Planning and Building Services, Pakistan (AKPBS,P) in collaboration with Pakistan Engineering Council (PEC) on 29 January 2013 (Figure 8). Prof. Sarosh Lodi presented a lecture on promoting the methods of providing seismic resistant features in the non-engineered construction in Gilgit-Baltistan and Chitral region of Pakistan; this construction very common in these areas of the Country. The lecture was based on the guidelines prepared by AKPBS,P for mountainous region of Pakistan. The objective of the workshop was to create awareness among local construction workers and community of the safe construction practices to reduce the seismic vulnerability of built environment in the region. In addition, methods of improving thermal efficiency of the buildings were also presented by other speaker. The focus area of the workshop was northern Pakistan which is not only a seismically active region but also comprises of large number of vulnerable non-engineered buildings.


Figure 8: Group photo of workshop participants.

## Inventory Development for Building Data in Pakistan

Pakistan has a varied built landscape. Rapidly urbanizing cities like Karachi contain a mix of large scale concrete masses in the form of commercial and office complexes, and contemporary concrete frame constructions in the form of residential buildings. Outlying villages contain crude construction ranging from temporary shacks, bamboo and grass houses to sturdy load bearing brick buildings.

Since Pakistan lies in an earthquake prone region, it is essential that the vulnerability of the country's built environment is determined. This would help prepare an accurate assessment of the actual risk faced by the country in the case of a natural disaster. This would in turn indicate the resilience of the country to hazards such as earthquakes and floods. As a precursor to estimating losses resulting from natural disasters, a reliable, comprehensive and reproducible building database needs to be developed. The aim of this study therefore is to develop a multipurpose database of the various attributes of Pakistan's built environment. The information which will be gathered includes physical parameters such as building footprint, height, location, age, structural systems, material of construction, as well as socio-economic factors, such as zoning, land use, occupancy type, and population density. Owing to very large size of these data a sampling technique will be employed to select representative samples of different types of buildings.

The resulting building inventory would be of interest to a variety of local institutions and agencies in addition to researchers and disaster managers. Some of the potential domains for the application of this database include:

1. Hazard Mitigation/Disaster Management – extrapolating data to predict the impacts of catastrophic events in the future
2. Urban Planning – a database for regional and national bodies for future planning and allotment of resources
3. Census baseline or verification – a credible information source for agencies such as the National Housing Census and Pakistan Bureau of Statistics.
4. Demographics Study – geographic distribution of housing, population, densities, and other socio-economic factors, for use in studying phenomena such as urban sprawl, migration, and social paradigm shifts.

Figure 9: Mules Mansion, en route from Native Jetty Bridge to Keamari Docks - load bearing stone construction from the British Era (Source: www.flickr.com)

Figure 10: Brick house in village near Larkana

The methodology of work includes documentation of building typology in one urban, one peri-urban, and one rural area within Sindh. A variety of building types exist in the selected regions such as load-bearing stone masonry buildings (Figure 9), wood-reinforced buildings, baked brick buildings (Figure 10), etc. This study will employ a three-tier approach. The first phase is to extractplot footprints and rooftop data from satellite imagery and preparing cadastral maps as starting cues. The second stage consists of street-level video capturing from a vehicle-mounted camera to rapidly populate a standard database of neighbourhood buildings by visual inspection. The third stage consists of plot-level physical field surveys to verify the data obtained through the first two processes. Software such as ArcGIS and Erdas IMAGINE are used to extract spectral data which gives the built-up area from high resolution satellite imagery.

Figure 5: Tested Specimen in Direct Shear with Confinement.

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

*(Continued from page 1)*

compressive and shear strengths with and without confinement (Figures 4 and 5). In addition, diagonal compression tests were performed on diamond shaped specimens (Figure 6). These data are being analysed and will be shared with the interested groups in due course of time.

Figure 6: Diagonal Compression test specimen.

## Study on Properties of Steel Rebars Produced in Pakistan

The Department of Earthquake Engineering is carrying out a study to investigate the chemical and mechanical properties of steel rebars available in the local market and design implications of using these rebars in earthquake resistant structures in relation to ACI code provisions. The study team comprises of Prof. Sarosh Lodi, Prof. Muhammad Masood Rafi and Mr. Amir Nizam. The bars include cold-twisted ribbed and hot-rolled deformed bars. The data of tensile and bend tests of the bars has been employed to study the bar mechanical properties in accordance with ASTM 615-05 or BS 4449:1197. Spectrographic analysis have been carried out to determine the proportion of carbon and other alloying additives such as manganese, sulphur and phosphorous used in the bars. The data of more than 2,000 bars of each of the aforementioned types have been analysed for the study. Figure 11 illustrates the data of yield strength of cold-twisted bars. The study will help in providing guidelines for the design of structures using deficient bars available in Pakistan. A reliability analysis will also be conducted to determine the strength reduction factors to be employed in strength design method of reinforced concrete structures.

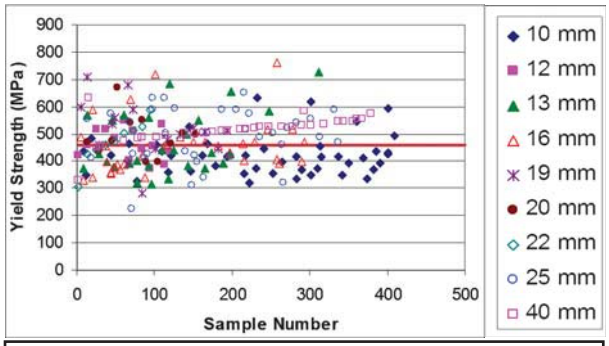


Figure 11: Data of yield strength of cold-twisted ribbed bars

## Two-day Course on Building Fire Safety

A two-day course entitled Building Fire Safety was organized by the Department of Earthquake Engineering along with Centre for Continuing Engineering Education, NED University for professionals working in the industry. The course focused on discussing different aspects of fire dynamics and fire phenomenon in the context of building fire. Prof. Muhammad Masood Rafi conducted this course which was designed to create awareness of this important hazard in the urban environment. The course was attended by a significant number of participants from different industries. This course was a part of disaster mitigation efforts of the Department of Earthquake Engineering in order to increase resilience of the society against natural and man-made hazards. The course covered different aspects of fire process and controlling its spread, and production and movement of smoke.

## Workshop on Quantification of Seismic Hazards in the Indo/Asian Collision Zone

A workshop organized by Dr. Abdulkrim Aoudia of The Abdus Salam International Centre for Theoretical Physics (ICTP) and co-sponsored by International Union of Geodesy and Geophysics (IUGG), National Science Foundation (NSF), UNAVCO, UNESCO, IAEA and Tribhuvan University, was held from 15 to 21 November 2012 in Kathmandu, Nepal.

The workshop aimed to build capacity in the theory and application of modern seismological and geodetic methods as well as to facilitate new initiatives for cooperation in the Himalayan region and develop networks for exchange of ideas and expertise. The workshop included invited lectures, panel discussions and training sessions in paleseismology, seismology, GPS geodesy, InSAR, seismic hazard and risk assessment.

Figure 12: Group photo of the workshop participants

In all, thirty eight delegates participated from different countries, such as Pakistan, India, Nepal, Bangladesh, Italy, China and USA (Figure 12). Prof. SH lodi, Dr. Mukesh Kumar and Ms. Maria Ansari, represented Pakistan, while the other major presenters from USA included Prof. Roger Bilham, Dr. Keith Porter, Dr. Tom Herring and Prof. Steve Wesnousky, with contributions from Dr. Vinod K. Gaur, India, and Dr. Bishal Upreti, from Nepal.

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