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NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING

Cowasjee Earthquake Study Centre NED

NEWSLETTER

CESNED ACTIVITIES

Building Capacity in Pakistan to Seismically Retrofit Essential Structures (Exchange Visit by members of Pakistan side Team to USA.)

A group of fifteen project participants from Pakistan visited the San Francisco Bay area October 25 – November 1, 2008. Participants began the week with a visit to the Stanford University campus. Stanford is located very close to the San Andreas fault, and the 1906 San Francisco earthquake badly damaged the campus. The university is conducting an ongoing, extensive campus seismic retrofit program. After hearing a presentation from Evan Reis, an excellent structural engineer and retrofit expert structural engineer, the participants visited several structure retrofits with in the campus designed by Evan Reis . In the second half of the day the participants presented the results of their case study investigations for open discussion. The following day, Professors Greg Deierlein of Stanford University and Khalid Mosalam of University of California, Berkeley opened the first day of an intensive two-day course on nonlinear analysis and modeling. Practicing structural engineers David Mar and Mike Korolyk led the second day of the course, using a sample building from Karachi to demonstrate modeling and analysis techniques. As the course for the nonlinear analysis was purely for engineers, so some of the team members visited the state building department responsible for earthquake-resistant school construction while Dr Asif Khan visited colleagues at the geology departments at Stanford and UC Berkeley. Following the two-day nonlinear analysis intensive course, participants visited a number of seismically retrofitted buildings in Berkeley and San Francisco, UC Berkeley's structural engineering laboratory facilities, an engineering design office in San Francisco, a retrofit construction site, and the Golden Gate Bridge (which is in the midst of a multi-phase seismic retrofit). At UC Berkeley, participants were briefed about the Pacific Earthquake Engineering Research Center from Associate Director Youssef Bozorgnia, and an introduction to UC Berkeley's earthquake risk reduction efforts by Christine Shaff of UC Facilities and Sarah Nathe of the Disaster Resistant Universities initiative. After the presentations, the participants took a walking tour of retrofitted buildings on the UC Berkeley campus. On the final day of the visit, participants visited the offices of Rutherford & Chekene, a leading structural engineering firm in San Francisco. William Holmes, one of the principal of the firm, gave participants a presentation on the history of seismic retrofit in California and on the design of some specific retrofit projects. He then led participants on a walking tour of seismically retrofitted buildings in the vicinity his office. The participants also visited an ongoing retrofit project designed by Holmes Culley Engineers.

Fig 1: Pakistan & USA side Participants at Stanford University USA

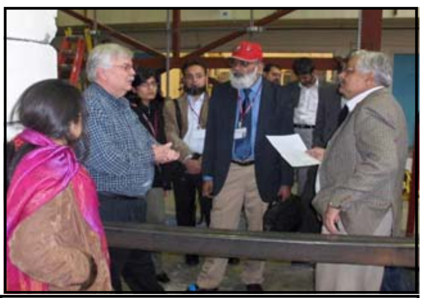

Fig. 2: Prof. Stephen Mahin of University of California, Berkeley explains his current shaking table experiment.

Fig 3: participants tour a retrofit construction site with Holmes Culley Engineers.

Inside this Issue:

EDITORIAL

The First issue of volume 9 of CESNED NEWS LETTER re-affirm our promise to keep you well informed about earthquake happenings all around the globe along with latest development in earthquake engineering . CESNED still believes in striving hard , despite very little response, which we hope will increase by each passing day .

Editor

Baluchistan Earthquake 29th October 2008

(Mountain Range Between Towns of Ziarat and Pishin)

Before dawn, early Wednesday on 29 October 2008 two earthquakes shook various parts of southwest Baluchistan Pakistan, killing at least 200 people, destroying mud houses and sending survivors screaming into the streets in panic. A 5.2 magnitude foreshock at 04:33 am local time was followed by the major earthquake at 05:09 local time with magnitude of 6.4 in the Chiltan Hills, Baluchistan at a distance of about 59.3km NE of Quetta, 195km NE of Kalat, 51.4km NW of Ziarat,87.2km ESE of Chaman . The epicenter was located at 4.3km SW of Jalak (Balochistan), at ***30.656°N and 67.361°E*** with the depth of ***15km***. Almost 12-hours after the first earthquake, another earthquake of magnitude 6.4 struck the region at 17:32 PM local time on same day, it was also centered in the Chiltan Hills and was felt throughout the region including Chaman, Loralai, Naseerabad, Noshki, Pishin, Qila Abdullah and Quetta. It was also felt in Sindh including Dadu, Ghari Khairu, Jacobabad, Kambhar, Larkana, Qambar, Qubo Saeed Khan and Shahdadkot.

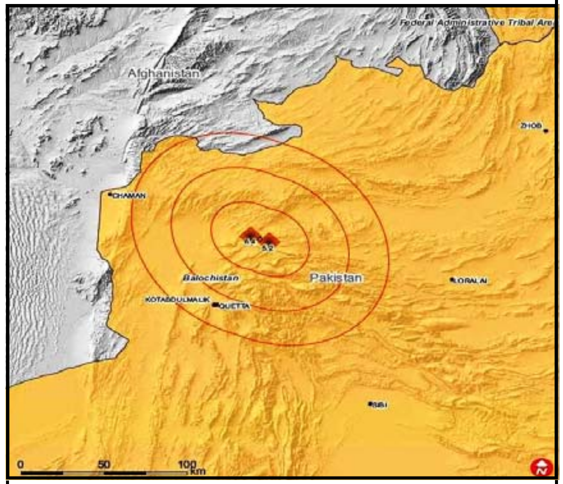

Fig 1: Showing the epicenter of Earthquake. IFRC


Fig2: Destruction due to the earthquake.

The part of Baluchistan effected by this earthquake lies in north-eastern Pakistan near the famous Chaman Fault. Population is scant in small villages and hut communities due to topography . These settlements do not have proper motorable access. Last Major Earthquake experienced by this area was in 1935 of 7.5 Magnitude taking about 30,000 lives with it. All the residential structures were of thick mud walls and rubble masonry with mud roof supported on horizontal bamboo or wooden log rafters offering no resistance to strong ground motion. There were a few stone masonry structures with wooden trusses which survived the complete collapse. Incongruity of devastation was glaring by the fact that adjacent British Colonial military cantonment structures meticulously built with brick or ashlars stone masonry and steel or wooden truss roofs with-stood the collapse and suffered wide cracks. During the 20th Century City grew in population nearing over a million, and sprawling with engineered brick masonry structures and reinforced concrete columns and roofs. However city regulations limited the height of structures to only three stories. The City has been visited by quite a few +6 Magnitude jolts, but damages could not be described as major devastations. In the Oct 2008 earthquake according to figures released by the NDMA (Islamabad) on 3 November 2008 almost 166 people were killed and 357 injured . Media reports put the figure higher at over 400 people killed and 1,000 injured. At least 2,000 buildings were reported to be destroyed and at least 8,000 people were displaced by this earthquake. Most of the damage occurred in the districts of Pishin and Ziarat ,casualties were also reported in Chaman, Dera Murad Jamali and Sani Shoorn. The villages of Ahmadoon, Gogi Kawas, Kan Depot, Lori, Sarkhizai, Wam and Warchun were almost completed destroyed. Damage was also reported from the Kalazai area in Ziarat district. Several people were got injured at Kalat and Pishin while 50 were reported to be hurt at Quetta. Power supply was disrupted in the epicentral region and the villages of Killi Kant, Killi Shadi Khan and Warchum near Ziarat were struck by landslides. The road between Quetta and Ziarat also suffered damaged due to "large cracks". Damage to mud-walled buildings has been reported from Chaman, Kalat, Killa Abdullah, Pishin, Ziarat and from Quetta including Nawakilli and Pashtunabad on the outskirts of the city. Many people spend the rest of the morning outdoors in fear of further tremors. Tremors were strongly felt at Bolan, Jaffarabad, Loralai, Mach, Mastung, Muslimbagh, Naseerabad, Qalat, Qila Saifullah and Quetta as well as parts of northern and central Balochistan. It was also felt at Kandahar, Afghanistan.

Description of Structural Damages:

School Buildings: As per the records, damages caused by the last (Oct 29/08) earthquake and its after -shocks, indicate at least 85 public schools affected. Some showing collapse of rooms, majority showing wide cracks. These schools were apparently not limited to Ziarat city, but spread out in the villages and towns in the vicinity as well. Most of the schools built by government agencies were with brick masonry or reinforced concrete. Here the lack of quality control of the bricks or non provision of Code required reinforcement in the brick walls may be the causes of failure.

Continued on Page 3

Baluchistan Earthquake 29th October 2008

(Mountain Range Between Towns of Ziarat and Pishin)

Continued from page 2

Quality of Brick Masonry Reinforcement in Brick Masonary Walls: During the earthquake tremors the inferior quality bricks gave way and displayed wide cracks. The absence of supervision by qualified engineers or experienced foreman may have resulted in low quality construction in some recent collapse of the brick masonry structures. Especially for public schools the perceptible damage pattern in Ziarat District, this seems to be the main cause .UBC-97 Code (as adopted by Pakistan Building Code 2007) puts a stringent requirement of providing ½" dia bars placed at 4 ft centers vertically and horizontally in brick walls in Earthquake regions and bars to be tucked in peripheral beam or columns. Except in a few properly engineered and supervised structures in Quetta or Ziarat, no such provisions seem to have been made. This may be one of the main reasons of collapse of masonry walls during last earthquake in Ziarat area, and development of wide diagonal cracks generally i n the infill brick masonry walls in Quetta also.

Fig3: Structural Damages

Destruction of Mud Structures: Most of mud village houses and even ground plus one shops and ware houses were constructed by age old traditional method rubble boulders covered with earth mud thick walls because of extreme variation in winter-summer temperature . Such structures do not have tensile capacity and ductility while the roof do not contribute as stiff diaphragm to resist lateral forces of earthquake and are more vulnerable to collapse. Such mud houses and structures were the immediate casualty of October 29, 08 Strong Earthquake. In all typical instances roof buckled under horizontal vibration, depriving the heavy mud wall of lateral props at top. The stand alone heavy and thick mud and rubble stone walls bent inwards crumbled and collapsed.

***Old Stone/Brick Structures*:** Ziarat is among the most popular place for the tourists in summer resorts has continued to attract tourists, resulted in upscale bungalows and villas. One of such old time historic villa has carried the grace and honor of being last residence of Mr. Mohammed Ali Jinnah. Most of these structures were constructed of thick ashlars stone masonry walls on the outer periphery. Interior walls were either of stone masonry or thick walls of rubble stones embedded in mud mass covered with thick lime mortar plasters with thick wooden log pieces horizontally embedded in within the body of the walls at intervals, to resist in-plane shear. In case of such major seismic events such as of October 29-2008 major wide cracks developed in the walls and floors. No total collapse of the old structures has been reported but some are reported to have shown precarious damage and spalling of plaster or lumps of lime mortar and wide cracks.

Tied Brick Masonry Buildings & RCC Buildings: In Quetta as well as in Ziarat and adjacent towns different revolutionary methods were evolved for earthquake resistant structures for the safety of the occupants after 1935 great one.

(i) RCC Tie-Straps or bend: This was introduced by old British Engineers after the 1935 Earthquake. It was named Quetta Building Code which was in force till ACI 318 in early 1980's, and US Uniform Building Code 97 as adopted by Pakistan Building Code 2007. Quetta Code had offered a simplistic solution. It required to providing RCC or even CC 150mm (6 in) thick strap laid in situ over the brick masonry at plinth, at lintel levels of doors and windows and at the top roof eave level before laying the roof truss This system worked efficiently for decades in Quetta and its surrounding regions. But due to the quality issues of the masonry bricks, some perceptible wide cracks have been observed in the walls during October 29 2008 Earthquake and during earlier tremors to which the region is under continuous distress. Nevertheless very few buildings and structures build on 1935 cc strap/bend tradition have been reported having suffered total collapse during October 29, 2008 earthquake.

(ii) Reinforced concrete structures: Once 1965-1970 Quetta has adopted reinforced concrete technology for their low rise structures as well as high rise buildings (Max. 3 Story). These structures are mainly Column Beam, Slab frames with infill brick masonry walls. However for single story or higher (Max 3 Story) structures the Building Code being used is ACI 318 and the Seismic Hazard according to UBC-97 as adopted recently by Building Code of Pakistan 2007, which has place this region of Balochistan in seismic Hazard Zone-3 (UBC) – (PGA 0.36g IBC). Some seismologists have placed Quetta City on active faults and have suggested to design the structure for UBC-97- Zone 4. . During the past 30 years Quetta has suffered minor to major earthquakes but no collapse of the reinforced concrete building or properly engineered bridges has been reported in Quetta or Ziarat. Similar system of reinforced concrete structures and cc strap masonry wall for low rises are spreading out throughout Balochistan towns including Ziarat and it has been observed that such structures have proved successful to withstand the collapse, except developing cracks in the masonry walls.

Courtesy** :A. RAZZAK LOYA** Managing Partner, For Loya Associates, **USGS** *and* **ASC**

CESNED ACTICITIES

Another Landmark - Another Achievement - Shake Table at NED .

(Installation & Training)

Shake table is now fully installed in the Department of Civil Engineering at NED University. This landmark achievement will go a long way in achieving the objectives of CESNED. The installed Shake Table has a linear hydraulic actuator with a fatigue rating of 110 kip (500 kN). The actuator is attached to a 3 M x 3 M table which is guided by linear bearings. The stroke capability of the unit is ± 300 mm (± 12 inch) with a nominal peak velocity of 1 meter/sec (40 inches/sec) and average velocity of ½ meter/sec (20 in/sec). The linear guide bearing are sized to test a 20 MT payload with a CG 3 M off the table surface, with 60 MT-M over turning moment at 1g. The entire table assembly is attached to the mass via the post tensioned steel plates on the mass top surface. The actuator is attached to the moving table. The table surface includes a mounting grid pattern to simplify specimen attachment. The assembly has a servo valve 900 l pm (240 gpm) and position transducer to allow displacement to be used as the feedback for loop closure. An accelerometer is used to control or monitor the table motion in an external loop as well. The control system accepts a signal from the control system. The hydraulic power is provided via a 156 gpm, 3000 psi HPS. The Siesmic Table Assembly is attached to a reaction mass in order to develop full force performance. A mass to maximum load ratio is 20:1.The systems include control software with all standard features. The System has four (4), 32 bit input A/D channels with 16 bit programmable attenuators, one, 64-bit output D/A channel with 16-bit D/A, one, high speed signal processing module, classical shock vibration and a 2.93 GHz PC based computer. Hydraulic Linear Actuator, 500 kN (110 kip), is a double ended fatigue rated, with hydrostatic and replaceable non-metallic back up bearings, one-piece 133.4 mm (5.25 inch) heat treated alloy piston rod, and internal, concentrically mounted LVDT. Hydrostatic bearing provide a low friction high side load bearing to assure low harmonic distortion during high velocity tests. The Training has also been conducted in March 2009 for the Faculty members so that the table can be used effectively in undergraduate and post graduate studies.

Fig1: Participants in Training Session

Fig2: Shake table installation

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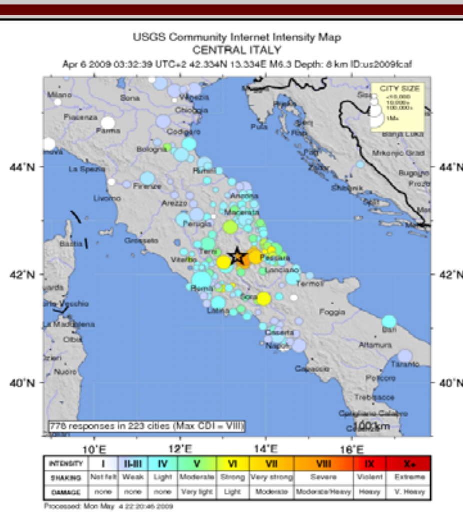
CESNED NEWS : L'Aquila Italy Earthquake, April 6, 2009



On April 6, 2009, a powerful earthquake of Magnitude 6.3 struck central Italy, near the medieval town of L'Aquila, about 75 miles northeast of Rome. It caused the deaths of nearly 300 people and substantial damage to buildings in L'Aquila and surrounding towns. The Italian government estimates that 28,000 are homeless as a result of the quake. The location of the epicenter of the earthquake was at 42.334˚N and 13.334E˚ with the depth of 8.8km. The earthquake occurred at the distances of 75 km (45 miles) W of Pescara, 85 km (55 miles) NE of ROME, 115 km (75 miles) SE of Perugia, 145 km (90 miles) S of Ancona, Italy.

Courtesy *:***USGS**

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