Volume 4, Issue 2

OCTOBER 2004 BI-ANNUAL

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING

Cowasjee Earthquake Study Centre NED
NEWSLETTER

Iran, Pakistan and Afghanistan face continuous seismic threat.

During last six months, Iran, Pakistan and Afghanistan were severely hit by series of earthquakes. Although, no large scale destruction, has been reported, however, these small earthquakes may transform into lethal earthquake .

Pakistan and Afghanistan

After the earthquake of February 14, 2004 (reported in the previous issue of the newsletter), a series of earthquakes of moderate to low intensity hit northern and north-western parts of Pakistan and western parts of Afghanistan. Following is the detailed description of these earthquakes.

On May 8, 2004, a light earthquake having a magnitude of 4.4 on the Richter scale struck north-eastern parts of Pakistan. The epicenter was located at a distance of 25 km north-east of Quetta in Baluchistan province, with no deaths or injuries reported.

Another earthquake of moderate intensity hit south of Quetta on May 13, 2004. The magnitude was measured 5.0 on the Richter scale and epicenter was located 145 km south of Quetta.

Fig. 1 Locations of earthquakes in Pakistan and Afghanistan.

The northern areas, which have been hit by severe earthquakes in the past, were struck by a moderate earthquake of 5.2 magnitude on July 15, 2004. The epicenter was located 130 km west of Chitral in the Hindu Kush Mountain region in Afghanistan. The tremors were felt in Islamabad, Peshawar and Kabul.

On July 18, 2004, central Afghanistan was hit by a moderate earthquake of 5.1 magnitude. The epicenter was located 132 km south-east of Kabul and 197 km south-west of Peshawar in Pakistan.

Baluchistan province in Pakistan was again hit by a moderate earthquake of 5.1 magnitude on July 22, 2004. The epicenter was located 235 km south-west of Quetta.

Iran

Iran which remains highly seismic active zone most recently experienced earthquake in southeastern Iran, measuring 6.6 on Richter scale, which resulted in more than 26000 casualties and severe damages to land and would remembered as Bam earthquake in history books.

More recently, on May 28, 2004 a strong earthquake measuring 6.2 shook central and northern Iran. Its epicenter was in the village of Baladeh, 43 miles north-east of Tehran, near the Caspian sea. At least 23 peoples were killed 100 injured and 80 villages were seriously damaged.

Villages near Alamout, about 80 miles west of Tehran were severely damaged, altogether eight provinces in central and northern Iran were affected by the tremor. The quake unleashed landslides and falling boulders that killed 16 people and injured 70 others by burying them in their cars along the mountainous Tehran-Chalous road. Twelve aftershocks, one with 4.4 magnitude were also recorded.

On July 22, 2004 another earthquake measuring 4.2 on the Richter scale shook the area of Bam in southeastern Iran but no casualties were reported.

Inside this issue:

EDITORIAL

The second issue of volume 4 of CESNED NEWSLETTER in hand once again contains similar features except the get up which was changed after completion of 3 years of publication. For almost all these three years we have been requesting readers to contribute through writing so that we may think of bringing some changes from routine. Aspects of mitigation which shall remain the main features of this Newsletter can always take a new look if professionals working in earthquake prone areas start contributing through write up regarding their experiences in seismic retrofitting, and pre and post earthquake mitigation efforts through planning ,designing and detailing. The four page newsletter could be extended to eight pages if readers start contributing. Once again it is emphasized that this modest effort needs a joint effort of planners, constructors, civic agencies and civil society to mitigate earthquake hazards.

Editor

Development of Response Spectra for the Southern Coastal Region of Sindh

Cowasjee Earthquake Study centre is carrying out a research project titled "Development of Response Spectra for the Southern Coastal Region of Sindh" under the supervision of Dr. Sarosh.H.Lodi, Mukesh Kumar is the research student who is working on this title The main purpose of the project is briefly explained below.

Seismic design code currently employed by the practicing structural engineers in Pakistan is Uniform Building Code (UBC), designed for the geological and seismological environment of United States. The seismological and geological environment of this country is entirely different from that of United States, which proves that there exists no scientific and logical basis for adopting the UBC for Pakistan. The existing state of conditions necessitates the research pursuit towards the development of design response spectra for our region.

The ongoing research work serves as the initiative effort towards the design code for the region. The research endeavour aims at the development of generic response spectra for the southern coastal region of Sindh, a region that is lacking strong motion accelerogram.The undertaken research mainly concentrates at the understanding of philosophy and behaviour of strong motion attenuation models, developed by various researchers for regions lacking ground motion ensemble of an earthquake event. It also focuses at study of point source stochastic simulation procedures to generate the synthetic accelerogram that will be used to achieve the response spectra for the simulated earthquake events.

The simulation results will be validated by the comparing with the originally recorded accelerogram and generated response spectra for the earthquake event of 26th Jan 2001 Bhuj. The ground acceleration record of earthquake event was captured at two different stations viz. Ahmedabad and Bhuj at the epicentral distance of 237 km and 97 km respectively. Best model will be chosen for modelling of source, wave path and wave amplification phenomenon. Parametric study will be carried out further to study the effect of all the factors affecting the simulated ground motion.

Research extends towards application of Component Attenuation Modelling (CAM) technique, for the generation of response spectra for direct engineering applications. Results obtained from the two different methodologies will be compared to acquire the most suitable methodology.

The second phase of research involves the study of one dimensional response analysis using nonlinear models of soils. Software is also under development for the generation of synthetic accelerogram using wave attenuation models and performing ground response analysis for the overlying soil depositions.

The undertaken Research also aims to develop generalized Geographic Information System (GIS) model that will not only serve as a database of different geological and geotechnical properties of various sites, but also serve as a complete model to understand the behaviour of seismic waves at various distances with different geotechnical conditions for the simulated events of interest.

Recorded Earthquakes of Magnitude 7.0 and Greater in 2004

S. No	Year	Month	Day	Time UTC	Latitude	Longitude	Depth (km)	Magnitude	Region
1	2004	01	03	16:23:21.0	-22.253	169.683	22	7.1	Southeast of the Loyalty Islands
2	2004	02	05	21:05:02.8	-3.615	135.538	17	7.0	Papua, Indonesia
3	2004	02	07	02:42:35.2	-4.003	135.023	10	7.3	Near the South Coast of Papua, Indonesia
4	2004	07	15	04:27:14.7	-17.656	-178.760	566	7.1	Fiji Region
5	2004	07	25	14:35:19.0	-2.427	103.981	582	7.3	Southern Sumatra, Indonesia
6	2004	09	05	10:07:07.8	33.060	136.619	14	7.2	Near the South Coast of Western Honshu, Japan
7	2004	09	05	14:57:18.6	33.217	137.060	10	7.4	Near the South Coast of Honshu, Japan

(Source*: www.usgs.org)*

Aspects of Mitigation

Having discussed some of the features of rural construction it seems to be worthwhile to discuss some planning and detailing aspects of masonry buildings.

While ductility is the most desirable quality for better earthquake performance and may be incorporated to much extent by introduction of steel reinforcement at critical junctions as would be discussed later on, however, since tensile and shear strength are important for seismic resistance of masonry wall, use mud and very lean mortars will always be unsuitable materials, and mortar mix with cement to sand equal to 1:6 by volume or equivalent in strength should be the minimum specified.

Opening in walls are one of the features that adds to hazard if not properly planned and detailed (refer to volume 3, issue 1 of newsletter published in March 2003, for behaviors and response). The opening should possibly be small in size and preferably located in centre, such that there should ample separation of openings if required in series.

Some of the guidelines regarding size and position of openings are given as under and should be read in conjunction with fig.1(A Manual of Earthquake Resistant Non-Engineered construction, published by National Centre for Earthquake Engineering.)

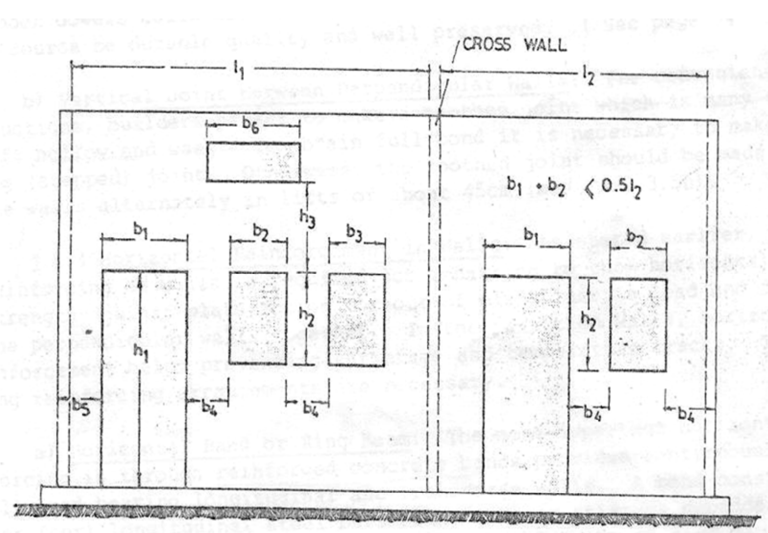
1) Openings should be located at least by a clear distance of one fourth(1/4) of the height of the opening from a corner.

2) For series of opening the sum of the width of openings should not exceed half(1/2) the length of wall in which they are located.

3) Pier width formed between two openings should not be kept less than half(1/2) of the height of the smaller opening of the two.

4) If an opening is needed upon an other opening, then the vertical distance between the top of bottom opening and the soffit of upper opening should not be kept less than 12 inches nor less than half (1/2) the width of the smaller opening.

5.) When the opening for any reason do not comply with requirements as given in 1 to 4 above, they should either be boxed in reinforced concrete all round or reinforcing bars provided at the jambs through the masonry as shown in fig.2 (After A Manual of Earthquake Resistant Non-Engineered Construction, published by National Centre for Earthquake Engineering.) for achieving full strength of masonry the usual bonds specified for masonry should be followed so that the vertical joints are broken properly from course to course. Points necking special attention shall be dealt in volume 5, Issue 1 the best practice in preserving the integrity and stability of masonry building is by way of providing RC bonds at critical locations as shown in fig 3(After A Manual of Earthquake Resistant Non-Engineered Construction, published by National Centre for Earthquake Engineering.) Further elaboration on these bonds shall also be taken up in next issue of this newsletter.



Notes: b1, b2, b3 < 0.5L1

b4 > 0.5 h2

b5 > 0.25 h1

h3 > 60 cm or 0.5 (b2 or b6 whichever is more)

Fig 1 Recommendation regarding opening s in bearing walls

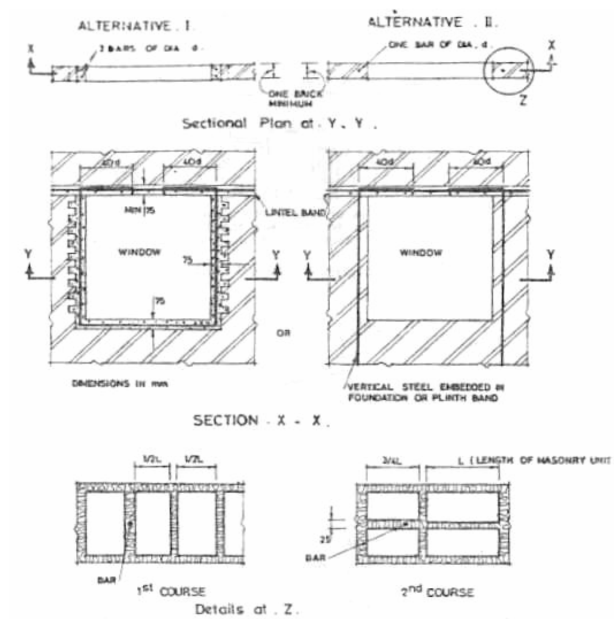


Fig 2 Strengthening of masonry around openings

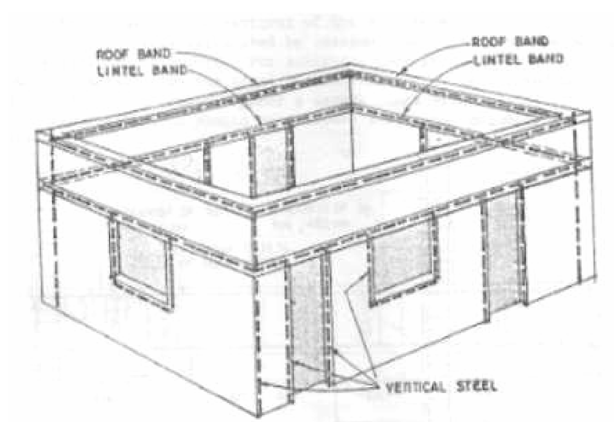


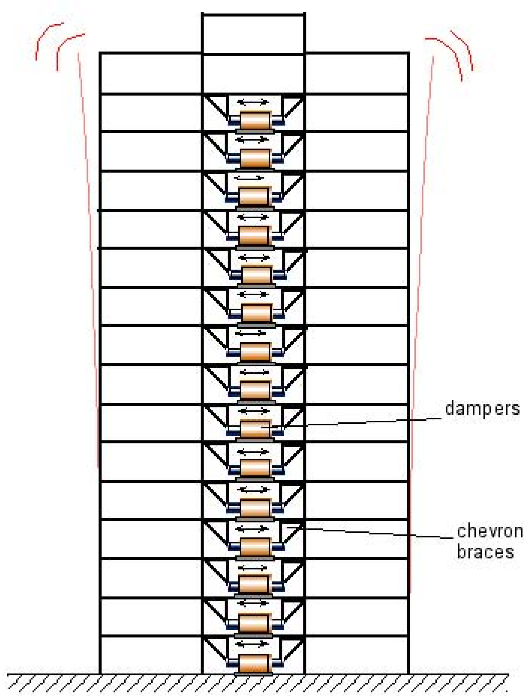
Fig 3 Overall arrangement of reinforcing masonry buildings

Emerging Technologies — How Smart Structures Work?

Unlike many of nature's deadly forces, earthquakes almost always strike without warning. These destructive and devastating forces can topple cities in seconds, leaving behind rubble and tragedy in their wakes. Earthquakes are not limited to any one area of the world or any one season of the year. Although most earthquakes are just small tremors, it only takes one to cause millions of dollars in property damage and thousands of deaths. For this reason, scientists continue to pursue new technologies to limit the destruction that earthquakes can dish out.

This pursuit has led to the development of new materials and products, which the researchers believe can reduce the damage caused by earthquakes. One such unique substance is called **Magnetorheological Fluid** (MR fluid), which is being used inside large dampers to stabilized buildings during earthquakes. MR fluid is a liquid that changes to a near-solid when exposed to a magnetic force, then back to liquid once the magnetic force is removed.

During an earthquake, MR fluid inside the dampers will change from solid to liquid and back as tremors activate a magnetic force inside the damper. Using these dampers in buildings and on bridges will create **smart structures** that automatically react to seismic activity. This will limit the amount of damage caused by earthquakes.



In the future, buildings might be built with hundreds of large dampers filled with MR fluid to stabilize the structures during earthquakes. This diagram shows how the dampers would work during an earthquake.

Application of MR Fluid in Buildings and Bridges:

High-rise buildings and long bridges are susceptible to resonance created by high winds and seismic activity. In order to mitigate the resonance effect, it is important to build large dampers into their design to interrupt the resonant waves. If these devices are not in place, buildings and bridges can be shaken to the ground, as is witnessed anytime an earthquake happens.

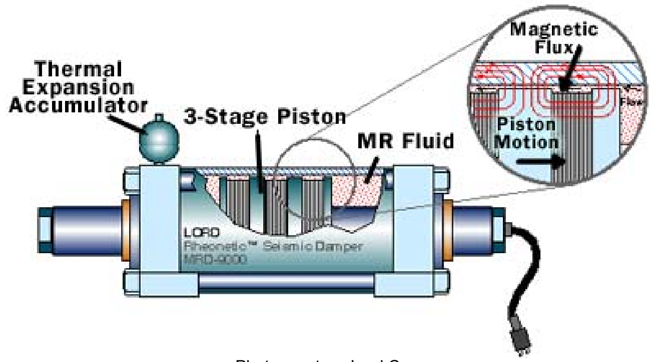


Photo courtesy Lord Corp.

A full-scale MR fluid damper that is 1-meter long and weighs 250 kilograms. This one damper can exert 20 tons (200,000 N) of force on a building.

A damping system in a building is designed to absorb the violent shocks of an earthquake. The size of the dampers depend on the size of the building. There are three classifications for dampening systems:

Passive -- This is an uncontrolled damper, which requires no input power to operate. They are simple and generally low in cost but unable to adapt to changing needs.

Active -- Active dampers are force generators that actively push on the structure to counteract a disturbance. They are fully controllable and require a great deal of power.

Semi-Active -- Combines features of passive and active damping. Rather than push on the structure they counteract motion with a controlled resistive force to reduce motion. They are fully controllable yet require little input power. Unlike active devices they do not have the potential to go out of control and destabilize the structure. MR fluid dampers are semi-active devices that change their damping level by varying the amount of current supplied to an internal electromagnet that controls the flow of MR fluid.

Inside the MR fluid damper, an **electromagnetic coil** is wrapped around three sections of the **piston**. Approximately 5 liters of MR fluid is used to fill the damper's main chamber. During an earthquake, sensors attached to the building will signal the computer to supply the dampers with an electrical charge. This electrical charge then magnetizes the coil, turning the MR fluid from a liquid to a near-solid. Now, the electromagnet will likely pulse as the vibrations ripple through the building. This vibration will cause the MR fluid to change from liquid to solid thousands of times per second, and may cause the temperature of the fluid to rise. A **thermal expansion accumulator** is fixed to the top of the damper housing to allow for the expansion of the fluid as it heats up. This accumulator prevents a dangerous rise in pressure as the fluid expands. Depending on the size of the building, there could be an array of possibly hundreds of dampers. Each damper would sit on the floor and be attached to the chevron braces that are welded into a steel cross beam. As the building begins to shake, the dampers would move back and forth to compensate for the vibration of the shock.

When it's magnetized, the MR fluid increases the amount of force that the dampers can exert.

(*Source: www.howstuffworks.com*)

RESOURCE PERSONS:

- Prof. Dr. S. F. A. Rafeeqi
- Prof. S. H. Lodi

Mail: Cowasjee Earthquake Study Centre NED,
Department of Civil Engineering,
NED University of Engg. and Tech., Karachi-75270, Pakistan.
Phone: +92-21-924 3262-68
Ext. 2205 & 2223
Fax: +92-21-924 3255
Email: cesned@neduet.edu.pk
Web page: www.neduet.edu.pk

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