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COWASJEE EARTHQUAKE STUDY CENTRE NED NEWSLETTER

Inside this issue:

EDITORIAL

First India, then Afghanistan and now Iran has faced the devastations made by violent earthquakes in the last two years. It is, therefore, evident that our region is under constant threat of this natural hazard. This is an alarming sign for us as well, as no one knows what will be the next target. This once again emphasizes the need of collective efforts towards preparedness and mitigation of earthquake, before its arrival, to save innocent lives. CESNED is making its all out efforts to achieve its aims regarding mitigation but unfortunately is yet to receive cooperation, of any type, from other agencies. A request once again of your personal attention and patronage, therefore, will not be out of place, as this is a matter of our survival also.

There is no change in the theme of Newsletter in hand and you will find all our regular features in this issue as well. We look forward and always welcome your comments, suggestions and cooperation.

Editor

CESNED participates in Seminar on "Atmospheric and Ionospheric Physics".

A one day seminar was organized by Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) on "Atmospheric and Ionospheric Physics" on August 19, 2002. Theme of the Seminar covered earthquakes as well, beside others. A large number of participants and experts attended the Seminar. Engr. Abul Kalam, vice chancellor NED University of Engineering and Technology Karachi attended the Seminar as a special guest. Cowasjee Earthquake Study Center NED (CESNED) participated in the Seminar by presenting a paper titled "Earthquake Mitigation - An objective approach" by one of its members, Miss Farnaz Batool. The presentation highlighted the various aspects of mitigation, its effectiveness verses prediction and the model, for earthquake mitigation, CESNED is working on. The presentation was very much appreciated and was well taken. Chairman SUPARCO expressed desire for further strengthening of cooperation and ties between the two organizations. The proceedings of the Seminar will soon be available.

Left: Miss Farnaz Batool presenting her paper.
Right: From left to right Gen. Raza Hussain,Chairman SUPARCO, Engr. Abul Kalam, Vice Chancellor NED.

Strong Quake hits Western Iran.

A strong earthquake occurred in western Iran, about 65 miles (105 km) north-northeast of Hamadan or about 140 miles (225 km) west of Tehran at 8:58 PM MDT on Saturday, June 21, 2002 (June 22 at 7:28 AM local time in Iran). The earthquake was measured 6.1 on the Richter scale. It flattened nearly 100 remote mountain villages in north-western Iran. United States Geological Survey reported the killing of at least 500 people with more than 1300 injured and thousands homeless. However, State-run media this described death toll to 245 people and 1600 injured. According to Iran's official Islamic Republic News Agency most of the known deaths occurred in the town of Bou'inZahra in Qazvin province, which was the epicenter of the earthquake. Desert and hills mark the terrain around Qazvin. The area, inhabited by tens of thousands of people, is one of Iran's industrial centres, home to many small industries, producing goods ranging from plastics to medicine and food.

Source: *www.usgs.org*

The quake struck at a time, when most people were still in their homes made up of bricks, stones and mud. These structures are prone to collapse in the region's frequent earthquakes, often burying occupants in the rubble. Among places hit worst was the tiny village of Abdareh, about 225km (140 miles) west of the capital, Tehran. The quake toppled Abdareh's mosque, demolished 40 homes and left at least 20 people dead. In nearby Changooreh, only two of the village's 100 houses were intact.

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Deaths from Earthquakes in 2002

Date UTC	Region	Magnitude	Number Killed *
2002/01/09	Tajikistan	5.2	3
2002/01/10	Near N Coast of New Guinea	6.7	1
2002/01/20	Democratic Republic of the Congo	4.7	Several
2002/01/22	Crete, Greece	6.3	1
2002/02/03	Turkey	6.5	44
2002/02/17	Southern Iran	5.4	1
2002/03/03	Hindu Kush Region, Afghanistan	7.4	166
2002/03/05	Mindanao, Philippines	7.5	15
2002/03/25	Hindu Kush Region, Afghanistan	6.1	1000
2002/03/31	Taiwan Region	7.1	5
2002/04/01	Eastern New Guinea Region, P.N.G.	5.9	36
2002/04/12	Hindu Kush Region, Afghanistan	5.9	50
2002/04/22	Near Coast of Peru	4.4	1
2002/04/24	Northwestern Balkan Region	5.7	1
2002/04/24	Western Iran	4.9	2
2002/04/25	Northwestern Caucasus	4.7	5
2002/05/15	Taiwan	6.2	1
2002/05/18	Lake Victoria Region	5.5	2
2002/06/22	Western Iran	6.5	261
Total			1595

* Includes "missing and presumed dead." Source: *www.usgs.org*

Recorded Earthquakes of Magnitude 7.0 and Greater in 2002 (May-August)

	Year	Month	Day	Time UTC	Latitude	Longitude	Depth (km)	Magnitude	Region
1	2002	6	28	17:19:30.2	43.752	130.666	566	7.3	E. Russia - N.E. China Border Region
2	2002	8	19	11:01:01	-21.697	-179.505	580	7.6	Fiji Islands Region
3	2002	8	19	11:08:25	-23.876	178.411	693	7.7	South of Fiji Islands
4	2002	9	8	18:44:26	-3.240	-142.895	33	7.6	Near North Coast of New Guinea, PNG

Source: *www.usgs.org*

Strong Quake hits Iran….

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The death toll there was at least 120.

The quake, the state news agency stated, hit the provinces of Gilan, Tehran, Kurdestan, Qazvin, Zanjan and Hamedan, and was followed by several aftershocks. It was also felt in Tehran, but there were no reports of damage in the capital. About 40 of the 280 inhabitants of the Garm Darreh village, in western Hamadan province, were killed.

Major earthquakes are not uncommon in Iran, which lies on a major seismic line. Moderate tremors are reported in various parts of the country almost daily. Since 1990, more than 41,000 people have been killed in three major earthquakes.

This recent Iranian earthquake occurred in the Zagros fold-and-thrust belt. This highly seismic region forms the boundary between the Arabian and Eurasian plates. The Arabian Plate is a small plate split from the African Plate by rifting along the Red Sea. As it collides with the massive Eurasian Plate it causes uplift of the Zagros mountains and numerous damaging earthquakes. Several severe earthquakes have occurred near this recent Iranian event. The most deadly was a magnitude 7.4 earthquake that struck on June 20, 1990, located about 150 km to the north of this recent event. This earthquake killed an estimated 40,000 to 50,000 people, injured more than 60,000, and left 400,000 or more homeless. There was extensive damage and landslides in the Rasht-Qazvin-Zanjan area and nearly all buildings in the Rudbar-Manjil area were destroyed. Another nearby devastating quake struck on September 1, 1962. This magnitude 7.3 quake killed about 12,000 people.

More distant recent events include a February 28, 1997 magnitude 6.1 earthquake occurring about 300 km to the north (near the Armenia-Azerbaijan-Iran border), and a May 10, 1997 magnitude 7.3 event occurring about 1000 km to the east. The February 28th earthquake killed at least 1,100 people, injured 2,600, and left 36,000 homeless. The May 10th earthquake killed at least 1,567 people, injured 2,300, and left about 50,000

Aspects of Mitigation...

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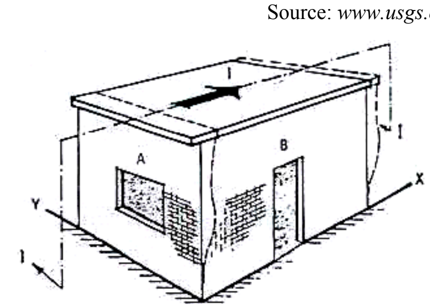
greater than the walls A in X direction. In this case, the plate action of walls A will be restrained by the roof at the top and horizontal bending of wall A will be reduced. On the other hand, if the roof is flexible the roof inertia will go to the wall on which it is supported and the support provided to plate action of walls A will also be little or zero. Again the enclosure will act as a box for resisting the lateral loads, this action decreasing in value as the plan dimensions of the enclosures increase.



1- Earthquake force, A- Wall A, B- Wall B

Figure 4: Roof on wall enclosure

The roofs and floors, which are rigid and flat and are bonded or tied to the masonry, have a positive effect on the wall, such as the slab or slab and beam construction be directly cast over the walls or jack arch floors or roofs provided with horizontal ties and laid over the masonry walls through good quality mortar. Others that simply rest on the masonry walls will offer resistance to relative motion only through friction, which may or may not be adequate depending on the earthquake intensity. In the case of a floor consisting

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Aspect of Mitigation

The principle concern in structural design for earthquake forces is for the laterally resistive system of the building. In most buildings this system consists of some combination of horizontally distributing elements (usually roof and floor diaphragms) and vertical bracing elements (shear walls, rigid frames, etc.). Failure of any part of this system, or of connections between the parts can result in major damage to the building, including the possibility of total collapse.

An earthquake shakes the whole building and if the building is to remain completely intact, the potential movement of all its parts must be considered. A major design consideration is tying the building together so that it is quite literally not shaken apart. This means that the various separate elements must be positively secured to one another.

Consider the free standing masonry walls shown in Fig.1. In Fig.1(a), the ground motion is acting transverse to a free standing wall A. The force acting on the mass of the wall tends to overturn it. The seismic resistance of the wall is by virtue of its weight and tensile strength of mortar and it is obviously very small. This wall will collapse by overturning under the ground motion.

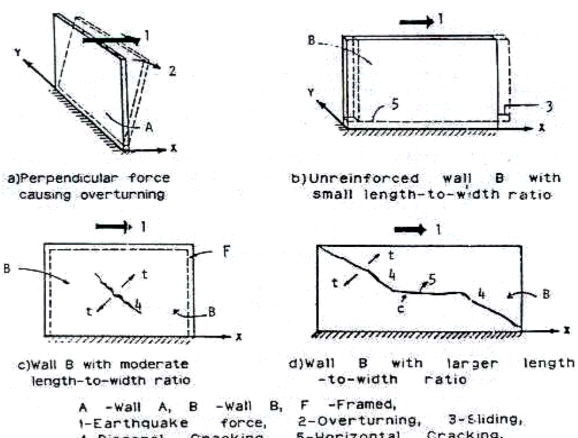
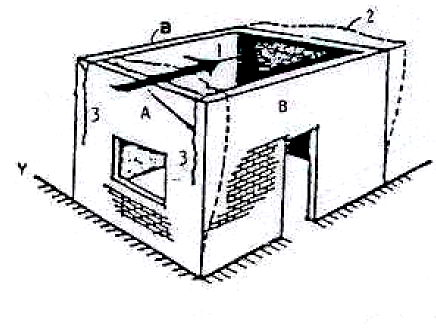


Figure 1: Failure mechanism of free standing walls.
(*After "Manual of International Association for Earthquake Engineering (IAEE)"*)

The free standing wall B fixed on the ground in Fig.1(b) is subjected to ground motion in its own plane. In this case, the wall will offer much greater resistance because of its large depth in the plane of bending. Such a wall is termed a shear wall. The damage modes of an unreinforced shear wall depend on the length-to-width ratio of the wall. A wall with small length-to-depth ratio will generally develop a horizontal crack due to bending tension and then slide due to shearing as shown in Fig. 1(b). A wall with moderate length-to-width ratio and bounding frame diagonally cracks due to shearing as shown in Fig.1(c).

A wall with large length-to-width ratio, on the other hand, may develop diagonal tension cracks at both sides and horizontal cracks at the middle as shown in Fig.1(d).



1 -Earthquake force, 2 -Bending of Wall A, 3 -Bending cracks at ends of Wall A.

Figure 2: Failure mechanism of wall enclosure without roof

Now consider the combination of walls A and B as an enclosure shown in Fig.2. For the X direction of force as shown, walls B act as shear walls and, besides taking their own inertia, they offer resistance against the collapse of wall A as well. As a result walls A now act as vertical slabs supported on two vertical sides and the bottom plinth. The walls A are subjected to the inertia force of their own mass. Near the vertical edges cracking and separation of the walls may occur due to reversible bending moment in the horizontal plane of wall A.

If the connection between walls A and B is not lost due to their bonding action as plates, the building will tend to act as a box and its resistance to horizontal loads will be much larger than that of walls B acting separately. Most unreinforced masonry enclosures, however, have very weak vertical joints between walls meeting at right angles due to the construction procedure involving toothed joint that is generally not properly filled with mortar. Consequently the corners fail and lead to collapse of the walls. It may also be easily imagined that the longer the walls in plan, the smaller will be the support to them from the cross walls and the lesser will be the box effect.In Fig.3 a roof slab is shown to be resting on two parallel walls B and the earthquake force is acting in the plane of the walls. To be able to transfer its inertia force to the two end walls, the slab must have enough strength in bending in the horizontal plane. This action of slab is known as diaphragm action. Reinforced concrete or reinforced brick slabs have such strength inherently and act as rigid diaphragms. However, other types of roofs or floors such as timber or reinforced concrete joists with brick tile covering will be very flexible. The joists will have to be connected together and fixed to the walls suitably so that they are able to transfer their inertia force to the walls. At the same time, the walls B must have enough strength as shear walls to withstand the force from the roof and their own inertia forces. Obviously, the structure shown in Fig.3, when subjected to ground motion perpendicular to its plane, will collapse very easily because walls B have little bending resistance in the plane perpendicular to it.

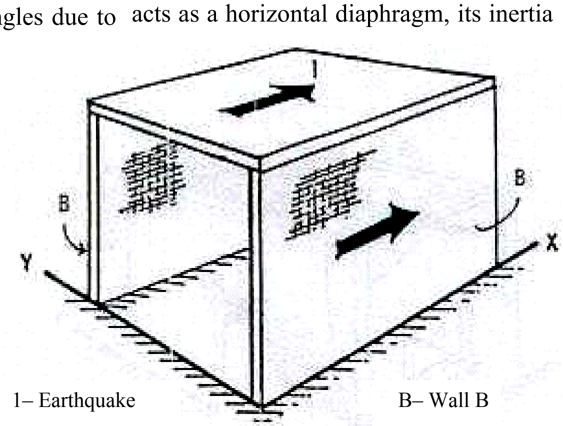


Figure 3: Roof on two walls

Now consider a complete wall enclosure with a roof on the top subjected to earthquake force acting along X-axis as shown in Fig.4. If the roof is rigid and acts as a horizontal diaphragm, its inertia will be distributed to the four walls in proportion to their stiffness. The inertia of roof will almost entirely go to walls B since the stiffness of the walls B is much

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The possibility of a warning system for earthquakes

Earthquakes have proved the worst enemies of mankind and the destructions caused by them have been legendary. But earthquakes themselves are only energy releases. An earthquake becomes a disaster only if it strikes a populated area. One of the approaches for the reduction of this loss of life is via general public awareness of the safety issues involved in the type of houses they live in and of earthquake considerations inside the home and workplace. The other method, though not very successful yet to avoid the loss of life, would be to predict the earthquake and evacuate the occupants of the buildings, just before its arrival. This short-term prediction cannot reduce the damage to property but, if successful, it can be helpful in reducing human injury and some of the secondary effects of earthquakes like fires. Efforts for earthquake prediction have been made since 1950s. However, sooner it was realized that the phenomenon of the occurrence of earthquake is far more complex to predict than it was thought. This made the scientists and experts, especially after Kobe earthquake in 1995, to divert their efforts towards the mitigation of earthquake effects. However, there are still some who are involved in the development of warning systems.

In a number of specialized cases the danger from earthquakes come from the shock waves arriving from an earthquake with its epicenter some distance away. These earthquakes occur some 20 to 30 seconds before their shock waves hit the town inland. Japanese railways have pioneered an alarm system to register the occurrence of a large costal earthquake and signal an automatic braking system for the speed *shinkansen* bullet trains operating in the vicinity inland. The 20 seconds or so gained from advance warning allows the trains to be slowed to a much safer speed by the time the ground starts to shake.

Similar warning system have been tested in other areas, for example in several US West Coast communities, as well as in Mexico, and may be useful in locations a long distance from likely earthquake epicenter for many factories, power stations and other mechanical operations that would be safer if shut down by the time the ground starts to shake.

Taiwan's seismic station network is now one of the most comprehensive earthquake monitoring systems in the world. According to news from San Francisco by Andrew Quinn, scientists working with a new network of seismic monitoring stations in Taiwan claim the possibility of a 30 seconds warning before some major earthquakes to allow shutting off gas lines, stop public transit and take other precautions to limit damage.

Researcher Leon Teng of the Southern California Earthquake Center at the University of Southern California said. "When you have this kind of information coming in, you really can prepare." By allowing computers to isolate "subnetworks" of closely placed monitoring stations, scientisits were able to identify the early stages of specific earthquakes, calculating estimates of epicenter and magnitude rapidly enough to alert communities further away that a shake-up is coming.

During the test period, the "subnetwork" system correctly detected and reported 54 earthquakes measuring between 3.5 and 6.3 on the Richter scale, and that further tests have shown it close to 100% accurate.

The quake information is then relayed to emergency response agencies in areas likely to be affected as the quake's shock-waves move through the earth's surface. While in some cases the earthquake occurs too close for warning, communities that are further away can get 20 to 30 seconds to prepare

While these earthquake alert systems have proven to be effective in sensing some of the "compression waves" or "p-waves" that signal the onset of an earthquake, they are often too small or localized to provide much in the way of a useful warning.

"In the most likely circumstances you would get less than ten seconds," Heaton said. "The demand for such systems is not really there until we have a capability to deliver and use the information quickly."

According to Teng the Taiwan prototype for earthquake alerts could be replicated in other seismically active areas, allowing the automated shutdown of key utility, transit and computer systems and giving officials time to prepare emergency medical and rescue teams.

But he said that in most cases--including California--earthquake agencies have not set up enough seismic monitoring stations to form the "subnetworks" crucial to determining when and where an earthquake will hit.

Taiwan, which experiences numerous earthquakes, has spent a total of $60 million on its seismic monitoring system. To equip California with a comparable network could cost as much as $200 million, he said.

"Taiwan is about 20 percent the size of California, but it has as many instruments as California. There is high density, quick transmission and good software."

Unfortunately, this short-term prediction is of limited use in evacuating people, as the warning period is much shorter than the time needed to recognize the warning, react and evacuate buildings. However, in conjunction with a well-considered earthquake drill, such a warning may become worth-while to let people carry out rapid preparation measures and brace themselves in a safe position.

Aspects of Mitigation...

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of timber joists placed at center to center spacing of 20 to 25cm with brick tiles placed in directly over the joists and covered with clayey earth, the brick tiles have no binding effect on the joists. Therefore, relative displacement of the joists is quite likely to occur during an earthquake, which could easily bring down the tiles, damaging property and causing injury to people. Similar behaviour may be visualized with the floor consisting of precast reinforced concrete elements not adequately tied together. In this case, relative displacement of the supporting walls

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