SENATE FORUM

Volume XXIV, Number 1, Fall 2008 **A publication of the Academic Senate, California State University, Fullerton**

Staying Safe in Earthquake Country

David Bowman

On July 29 of this year, Mother Nature sent Cal State Fullerton a wake-up call in the form of the magnitude (M) 5.4 Chino Hills earthquake. Although this earthquake did not cause any serious damage to our campus, it has served as a reminder that we do indeed live in earthquake country.

Seismic hazards in California are sort of a good news/bad news deal. The bad news is that we live in earthquake country; not only do we have frequent earthquakes, but these quakes have the potential to be very powerful. The good news is that seismologists and engineers have a reasonably good understanding of the earthquake hazards we face and have made mitigation of the resulting risk a core focus of our work. With proper attention to earthquake preparedness we have no need to fear the next big quake!

The Bad News

When most southern Californians think of earthquakes, their minds leap immediately to the San Andreas Fault, the ~1200 km-long "crack" in the earth's crust that accommodates motion between two of the planet's great tectonic plates--the North American Plate and the Pacific Plate. This fault has produced two of the largest earthquakes in the history of the State of California, including the famous event that (together with the subsequent fire) led to the destruction of San Francisco in 1906. Seismologists worry about the San Andreas because it is not only the biggest fault in the state, but it also produces the most frequent large earthquakes. In southern California, the most recent earthquake on the San Andreas occurred in 1857 and broke a section of the fault that extends from the sleepy town of Parkfield in central California all the way south past the ski-resort of Wrightwood to the vicinity of the Cajon Pass, near the intersection of Interstate 15 and Interstate

In This Edition

215. Although there is debate in the seismological community about the frequency of earthquakes along this section of the San Andreas, most estimates suggest that events of approximately magnitude 7.9 (like the 1857 earthquake) have an average time between similar-sized earthquakes ("recurrence interval" in seismo-speak) of 132 years (Sieh, Stuiver & Brillinger, 1989). There is considerable scatter in this data; some of the intervals between geologically recorded earthquakes are as short as 30 years, while others are as long as 300 years. However, the fact remains that this segment of the San Andreas is "due" for a large earthquake.

Equally serious is the threat posed by the section of the San Andreas that extends from the Cajon Pass southwards to the border with Mexico. This stretch of the fault, which last had an earthquake sometime in about 1690 and has an average recurrence interval of approximately 150 years (Jones et al., 2008), could produce an earthquake in the M=7.8 range. By the way, that's not a typo – if it had followed its average behavior, the southernmost San Andreas should have had an earthquake somewhere around 1840. That portion of the fault is now about 160 years overdue. Ponder that for a moment...

Unfortunately, the news gets worse. The San Andreas represents only one potential earthquake source in southern California. In fact, the region is riddled with faults capable of producing earthquakes from inconsequential magnitude 2s all the way up to the monster M7+ events. On January 17, 1994, one of these small, less famous faults produced the M=6.7 Northridge earthquake that devastated Cal State Northridge. CSUN suffered approximately $321 million in damage and required nearly six years to complete rebuilding efforts.

When we consider the earthquake safety of our campus, we should look to the experience of our sister campus. Cal State Fullerton itself is built on a fault similar to the one that caused the 1994 Northridge earthquake. The nearby Coyote Hills that make such a pleasant backdrop for our city and university are the direct result of earthquakes on the eponymous Coyote Hills fault.

The Good News

Scared yet? Well, now comes the good news. As it turns out, earthquakes show a remarkable relationship between the size and frequency of events of any given magnitude. As it turns out, large earthquakes are relatively rare in the LA Metropolitan area (from a human perspective) – we only expect *on average* 1 earthquake of Northridge size or larger every 25 years or so within 100 miles of CSUF. And the odds of being killed in an earthquake are even more remote. A recent paper in *Nature* put the odds of an average American dying from an earthquake as 1 in 130,000. In contrast, the odds of dying from an airplane crash are 1 in 30,000 and the odds of dying from a motor vehicle accident are 1 in 90 (Harris, 2008).

You can make those already-remote odds even smaller by being aware of the basics of earthquake preparedness. Pop culture has created an image of earthquakes that has the damage, injuries, and fatalities in earthquakes coming from collapsed buildings. While this may be sadly true in many third-world countries, it is not the case in California.

All buildings in the state of California are required by law to be built with consideration for earthquake safety. Without going into the details of building codes, structures in California– including the buildings on our campus–are designed to be "life-safe." This means that, in the event of a severe earthquake, our buildings should retain sufficient structural integrity to allow occupants to be evacuated, even if the building is a total loss. However, tragedies such as the collapse of the Northridge Meadows apartment complex in the 1994 earthquake demonstrate that enforcement of building codes remains a critical issue even in California. Nonetheless, the overall quality of building design and construction in California is such that the odds of building collapse from an earthquake are very small.

What to Do During an Earthquake

What then is the hazard in an earthquake? Most earthquake-related injuries are the result of

building contents being tossed about during the event. The strongest motion in an earthquake generally occurs as sharp side-to-side motion in a nearly horizontal plane. Therefore, the greatest hazard in most rooms is from heavy objects being flung off walls, shelves, or desks. Unsecured computers and monitors may be flung off desks. Bookshelves that are not properly anchored to the wall may topple. Pictures may be knocked off walls.

This is the reason why *all* earthquake experts recommend that you should **Duck, Cover, and Hold On** in the event of a major earthquake. What does this mean? If you are near a desk or table when an earthquake begins, you should drop to the floor and take cover under the desk. This will protect you from the greatest hazard in an earthquake – objects being flung off desks and shelves. Once you have **Ducked** and **Covered**, you should **Hold On** to the desk under which you are sheltering. Why? Because a sufficiently strong earthquake may cause the table under which you are sheltering to shimmy away from you during the shaking. You can prevent such a dangerous (although admittedly comical) eventuality by **Holding On** to the table's leg once you've taken shelter.

If you are not near a desk or table in an earthquake, then try to shelter yourself as best as you can. In a theater, you could shelter between the rows of seats, taking care to cover your head with your arms. If you are in a large open room, such as a gymnasium, try to shelter against an *interior* wall, again taking care to cover your head. Avoid exterior walls, windows, hanging objects, mirrors, tall furniture, large appliances, and kitchen cabinets with heavy objects or glass.

Note that you should *not* stand in a doorway during an earthquake. This is an enduring myth that is sadly incorrect. It has its origins in a photograph of an adobe building that completely collapsed in an earthquake, leaving nothing standing but the wooden doorframe. Adobe is one of the worst building materials in earthquake country; the mud and straw bricks that typically make up adobe construction crumble under even minor earthquake shaking. In this case, the doorway may be the strongest part of the building. However, in modern buildings, whether steel high-rise or wood-frame house, the door is no stronger than any other part of the building. Indeed, the doorway may be *more* dangerous in an earthquake, as it may slam shut in your face!

Also, do *not* run outside during an earthquake. Strong shaking may cause non-structural exterior elements of the building, including plasterwork, chimneys, or facades, to fall off the building. Falling debris such as this pose serious hazards to people exiting buildings. A tragic example of this occurred during the 2003 M=6.5 Paso Robles earthquake when two women were crushed by falling masonry when fleeing a building in downtown Paso Robles. The women would likely have survived the event if they had stayed indoors and Ducked, Covered, and Held On.

Finally, in recent years a viral email about the "triangle of life" has been circulating through the Internet. If you receive this information, *disregard it*. An excellent discussion of the importance of **Drop, Cover, and Hold On** (and why triangle-of-life is a deadly fallacy) can be found at http://www.earthquakecountry.info/dropcoverholdon/.

What to Do After an Earthquake

After the shaking stops, your first action should be to check yourself for injuries. You should do this before anything else – although there may be a temptation to immediately rush to the aid of people around you, if you yourself are injured you could do harm to both yourself and the person you are trying to assist. If you or somebody near you is bleeding, make sure to keep pressure on the wound. Do not try to move seriously wounded people unless they are in imminent danger of further injury. For more information on First Aid procedures, I encourage all faculty and staff to take a First Aid training course from either the Office of Environmental Health and Instructional Safety (EH&IS) (http://ehis.fullerton.edu/) or directly from the Orange County Chapter of the American Red Cross (http://www.oc-redcross.org).

Once you have checked yourself and the people around you for injuries, you should assess your situation. If you see damage or feel that the building you are in might be unsafe, then evacuate the building in an orderly fashion. Try to maintain order – the greatest hazard at this point is being trampled by people rushing for the exits. You should also be aware of falling debris, be they ceiling tiles, light fixtures, or masonry from the building's facade. Once you evacuate the building, you should move at least **150 feet** away from any other structures.

Faculty and staff should also be aware that according to the California Government Code, Sections 3100 and 3101, all state employees, including faculty and staff, are designated as disaster service workers. You should be prepared to report to designated emergency personnel – meaning your supervisor (Department Chair or Dean) – to receive further instructions. The EH&IS website includes a list of faculty responsibilities in the event of a disaster that requires a building evacuation. Faculty should:

- Direct students to evacuate using the stairways only. Elevators may not be operable.
- Instruct students to take all personal possessions with them.
- Ensure that all students in class have evacuated safely before leaving the building.
- Assist students who are not able to use the stairs. Direct/lead them to the stairwell landing. If possible, leave a volunteer to wait with them. Report the location to designated emergency personnel. [5] (http://ehis.fullerton.edu/AcademicSafety/)

Wherever you find yourself in the aftermath of an earthquake, you should be prepared to be self-sufficient. If possible, you should put out small fires immediately. Call for help, but don't necessarily wait for the fire department to arrive. This is potentially more dangerous in a science laboratory environment, because adding water to a chemical fire may make the situation much worse. If you are in a laboratory environment and do not know what is burning, then do *not* try to put the fire out by yourself. Notify the fire department or a building marshal and evacuate the building immediately.

If you are at home after a quake, you should **only** turn off your main gas valve if you have some indication that there is actually a leak, including broken pipes or the odor or sound of leaking gas. After an earthquake you should never turn the gas back on by yourself, because there may be leaks of which you are unaware; call the gas company to have your service restored. You should also be careful to unplug any broken lights or electrical appliances because they may start a fire when electricity is restored. Do not use electrical appliances (including lights) until you are sure there are no gas leaks because a spark could cause a fire to break out. Flashlights are the best light source after an earthquake.

Should the unthinkable happen and you find yourself trapped by debris, do not panic! If the shaking is severe enough that there is significant structural damage to buildings, then rescue crews will soon be on the scene looking for you. Don't start screaming – if you are trapped in a severely damaged building, it could take several hours to rescue you, and you'll need to conserve your strength. If you have an emergency whistle, use it to signal for help. Otherwise, knock loudly on a nearby piece of metal or a solid piece of the building. Try to knock three times every few minutes – these are the sorts of signals that rescuers zero-in on. Remember, this is a worst-case scenario. It is extremely unlikely that you will ever find yourself trapped in a collapsed building after an earthquake.

You should also be aware that telephone service (including cell phones) might not be available after even moderate earthquakes. Whenever a quake rumbles through the southland, local telephone lines get jammed as people call their friends and family to say, "Did you feel that?" However, long-distance circuits frequently will remain open after an earthquake. For that reason, you and your family should agree on a friend or family member outside southern California to serve as a contact in case of emergency.

The University will communicate emergency information to faculty, staff, and students in

several ways. The University website will serve as a central clearinghouse for information. As most of you discovered this summer, emergency information will also be sent out by email and by voice messages to your office phone. CSUF also has a new system that will send a text message to your cell phone with emergency information. However, this text-message communication system does require you to actively "opt-in". You can do so by going to https://myweb.fullerton.edu/PhoneUpdate/ and entering the requested information.

The best way to ensure your safety in an earthquake is to take steps now to safeguard your home and working environment. Many excellent resources on earthquake preparedness are available online. I personally recommend the outstanding guide "Putting Down Roots in Earthquake Country" created by the Southern California Earthquake Center. This guide can be accessed online in both English and Spanish at http://www.earthquakecountry.info/. Versions of this guide in other languages are in development and should be available soon.

Get Ready to Shake Out

The final step in any earthquake preparedness plan is to practice what you would do in a real earthquake. To that end, the State of California, Southern California Earthquake Center, the U.S. Geological Survey, and the Federal Emergency Management Agency have taken the lead in organizing a statewide earthquake drill this year. The drill, dubbed "ShakeOut," will involve emergency responders, utility companies, government agencies, schools, and businesses from across southern California responding to a hypothetical M=7.8 earthquake on the southern San Andreas fault. The purpose of the drill is both to raise earthquake awareness throughout southern California and to test the emergency management systems that are in place in the state. If hurricane Katrina has taught us anything, it is that only preparedness can prevent a disaster from becoming a catastrophe. The ShakeOut drill was designed to meet this challenge. You can read a narrative version of the scenario written specifically for laypeople at http://pubs.usgs.gov/circ/1324/.

The earthquake awareness e-mails that you have been receiving throughout the semester are part of Cal State Fullerton's effort to build on the ShakeOut exercise. In addition to our e-mail information campaign and articles such as this one, we are planning a "Get Ready Rally" on Monday, November 10. This rally will include information on earthquake safety, a noontime earthquake safety Q & A session, and a special earthquake simulator that you can sit in to experience the shaking from a magnitude 7.8 earthquake. There will also be an opportunity to buy earthquake supplies from the Geology Club as well as commercial vendors.

Our preparedness activities for the semester will culminate on Thursday, November 13 with the ShakeOut drill itself. Between 9:30 am and 10:30 am the campus loudspeakers will announce the beginning of the drill. When the drill begins everyone should Drop, Cover and Hold On for the duration of the "earthquake."

Our preparedness activities for the semester will culminate on Thursday, November 13 with the ShakeOut drill itself. Between 9:30 am and 10:30 am the campus loudspeakers will announce the beginning of the drill. When the drill begins, everyone should Drop, Cover and Hold On for the duration of the "earthquake." The duration of the drop-cover-hold drill will be based on the actual duration of shaking expected in Fullerton for an earthquake on the San Andreas fault. The loudspeakers will again notify you when that phase of the drill is done. Immediately after the "shaking" is over, we will have an all-campus mandatory building evacuation. The total drill, including the building evacuation, should be completed in less than half an hour. Throughout the drill, students from selected Geology classes will be circulating through campus to assess the performance of the

faculty, staff, and students. Once classes resume, emergency officials from the university will continue to drill their response to various potential earthquake-related emergencies.

In organizing CSUF's earthquake drill, we have made every effort to minimize the disruption to classes. However, the University has the safety of our students, faculty, and staff as its highest priority. I am convinced that the exercise will provide a valuable opportunity to make our institution more resilient to natural disasters; the simple act of preparing for the ShakeOut has already made our university a safer place. By taking such a proactive stance towards the ShakeOut drill, Cal State Fullerton has also gained significant respect from the earthquake community. Our plans have been highlighted on the ShakeOut website (http://www.shakeout.org), and we have been recognized by the Southern California Earthquake Center for our leadership in earthquake preparedness among regional universities. I challenge each of you to make a similar commitment to your own preparedness. Be safe. Be prepared.

References

Sieh , K., Stuiver, M., & Brillinger, D. (1989). A more precise chronology of earthquakes produced by the San Andreas fault in southern California. *Journal of Geophysical Research, 94*, 603-623.

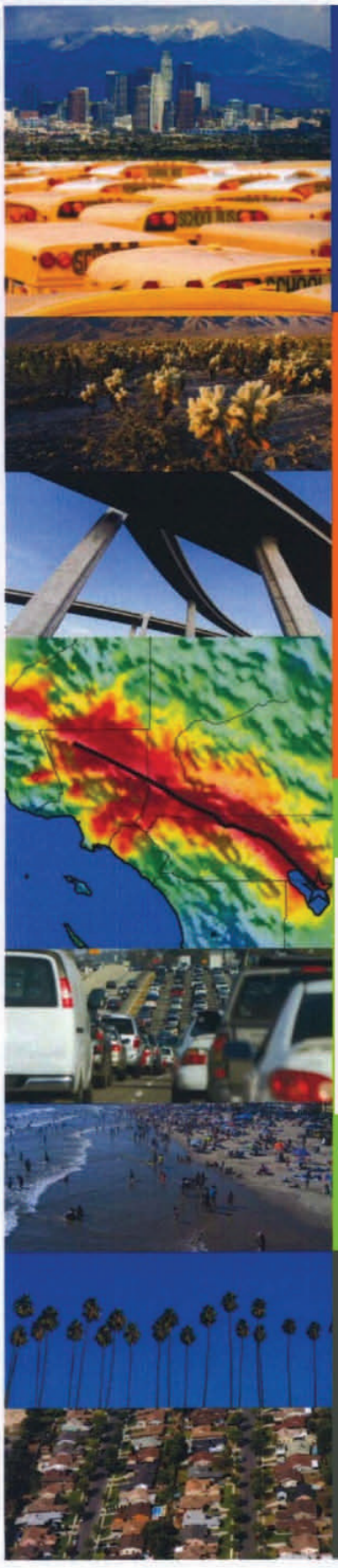
Jones, L. M., Bernknopf, R. Cox, D. Goltz, J. Hudnut, K. Mileti, D. Perry, S. Ponti, D. Porter, K. Reichle, M. Seligson, H. Shoaf, K. Treiman, J., & Wein, A. (2008). The ShakeOut Scenario, *USGS Open File Report 2008-1150* and *California Geological Survey Preliminary Report 25. Available at* http://pubs.usgs.gov/of/2008/1150/

University grows into powerhouse. LA Daily News, November 12, 2004. Available at http://www.calstate.edu/pa/clips2004/november/15nov/powerhouse.shtml

Harris, A. (2008). What Spaceguard did. *Nature, 453*, 1178-1179.

Dr. David Bowman attended the University of Southern California for both undergraduate and graduate school, receiving a B.S. in Geology in 1993 and a Ph.D. in Geology in 1999. After completing his doctorate, he was a postdoctoral fellow in the Tectonics Lab of the Institute for Earth Physics at the University of Paris. He has been a member of the faculty of the Department of Geological Sciences at Cal State Fullerton since May 2001, and has been Chair of the Department since July 2007.

Dr. Bowman is a member of the American Geophysical Union and the Seismological Society of America, and sits on the Board of Directors of the Southern California Earthquake Center. His specialties are Earthquake Seismology and Tectonophysics. He has done fieldwork in exotic locales such as northern Tibet, central Greece, and the San Fernando Valley. His current research interests are earthquake stress interactions, regional seismicity associated with large earthquakes, and the formation and evolution of fault systems.



Get Ready Rally

Monday November 10, 2008

A special event, featuring an earthquake simulator, organized to inspire CSUF to get ready for big earthquakes and to prevent disasters from becoming catastrophes

10 Monday	11 Tuesday	12 Wednesday	13 Thursday
GET READY RALLY! Central Quad 10am-3pm			ShakeOut Drill

Get Ready to ShakeOut.

On CSUF Campus

University Police
Environmental Health & Instructional Safety
Department of Geological Sciences

We're all in this together.