The Ravings of an Earthquake Engineer Acting as an Emergency Responder During the M6.5 San Simeon Earthquake

On December 22, 2003, I was sitting in my office, on the 12th floor of a building in the Civic Center area of Los Angeles, CA participating in a conference call with a number of other earthquake engineers and a seismologist. During that call, one of the other earthquake engineers that was calling from his home in Arroyo Grande, CA said, "speaking of earthquakes we are experiencing one here, and this is not a small one." From that moment on, I was able to simulate one of my roles as an emergency response coordinator, acting vicariously with the help of the California Integrated Seismic Network (CISN) Display earthquake monitor that has been running in a beta test version on my desktop continuously since the end of October 2003.

At first, I waited for the ground waves to travel from San Simeon, CA to Los Angeles, a distance of about 130 miles. I have learned that CISN Display is not the only earthquake monitor in my office. Our 1960s vintage, moment resisting, 15 story, steel frame building is also an earthquake monitor if the ground shaking is strong enough. For what seemed like the longest time, not much happened. The earthquake engineer in Arroyo Grande said that the power was out at his location and he might have to leave the call at any time. Then one of the other earthquake engineers on the conference call said, "We are beginning to rock and roll here on the 10th floor of an office building in Long Beach, CA." Within a few seconds, my building began to do its characteristic 3-second sway, exciting the floor to ceiling hanging curtains in my office. A quick look at CISN Display still did not provide any clue regarding the location and size of this event. Others started to report feeling the ground shaking, but I was still unable to report a location, so we began to resume our conference call.

Within another minute, the CISN Display monitor began to blink and a new earthquake symbol of considerable size appeared just Northeast of San Simeon, CA, with a description that identified it as a shallow magnitude 6.4 earthquake. I was euphoric, and blurted out in the middle of the conversation, "I have it!" and identified its location as NE of San Simeon at a distance of 11 km, as I zoomed down to a larger scale looking for possible causative faults and the names of communities that might be expected to have significant damage. Of course this initial, location of the epicenter was not accurate, but I was prepared when it made a jump of a couple of miles further to the Northeast from San Simeon and increased in magnitude to 6.5. I zoomed back out a little more and waited for the aftershock information to start reporting the general extent of the fault rupture, which would help me identify which communities had been hammered the hardest.

It was at this time, that I redirected my PC to our intranet web site to see if I could pick out the extent of the power outage that

the earthquake engineer from Arroyo Grande had reported. My immediate concern, and the concern of one of the others in the conference call was for a triggered shutdown of a Nuclear Power Plant located on the cost, near San Luis Obispo. I was not able to see anything but a tiny flicker of a disturbance in the power grid feeding Los Angeles. That tiny flicker was a good indication that this earthquake did not affect much of the power supply in the State of California. When I returned to CISN Display, I was rewarded with the first motion mechanism on the products button. I clicked on that button and brought up the first evidence that this was a reverse thrust fault, aligned with one of the nearby faults, shown on the CISN Display.

I again interrupted the conference call and shared the early fault rupture information with the other earthquake engineers. At the time, I remember thinking, this is odd, we are all in the earthquake business, some us have business interests in this area of California, yet I am the only one with access to this information. This kind of information needs to be available to a wider audience of informed individuals that can take it and make decisions based on what is being presented and who it might effect.

The fact that the first motion mechanism and initial aftershocks were now being reported at an increasing rate, gave me enough information to be concerned about the City of San Luis Obispo, a large population center in the region, and not concerned much about the Nuclear Power Plant. I began to empathize with the emergency responders that I knew from first hand experience, were beginning to pull together and open up Incident Command Posts (ICP) and Emergency Response Centers (EOC), just as most of us had learned at the California Specialized Training Institute, located a few miles West of San Luis Obispo, in Camp San Luis Obispo on State Highway 1. It was about this time that the conference call began to breakdown, with the other participants, beginning to think about their own concerns regarding the earthquake and bowing out of the conversation. We hung up at almost exactly 12:00 Noon, 45 minutes after the main shock.

I immediately turned on an AM radio news station in Los Angeles and started surfing the web for any more breaking news about the earthquake. During the next hour, the number of aftershocks being reported on CISN Display began to increase, with some additional information from the moment tensor solution that confirmed the reverse thrust type of fault mechanism and potential for directivity from the epicenter.

I began to imagine how I would organize and dispatch Damage Assessment Teams and develop staging areas for the additional resources that I new would be needed in the area. My knowledge of the communities in the area reinforced my concern for population centers along Highway 101. But, I was also concerned for the small and more remote population centers along State Highway 1. I reasoned, that if it were my responsibility, I would dispatch about 25% of the emergency resources from San Luis Obispo and surrounding area up State Highway 1, and about the same amount up Highway 101, with the balance in reserve at a staging area such as Camp San Luis Obispo.

The CISN Display was providing more information when the first Shake Maps began to appear. Shake Maps are extremely useful to provide information

about where Damage Assessment Teams might be needed by color coding the areas of highest ground shaking intensity and providing contours of estimated maximum ground accelerations. The colors on the map indicated strong to very strong ground motions only in the uninhabited mountains between State Highway 1 and Highway 101. The areas to the East of the epicenter were moderate to strong shaking, while the areas to the West were shaken at a little higher level. The area that contained San Luis Obispo was moderately shaken. It appears my initial judgment of holding a large reserve in San Luis Obispo was not warranted. Better to send more up State Highway 1 because of the potential for more damage from higher ground shaking and send more up Highway 101 because of the larger population along that important North/South transportation corridor. A smaller contingency of perhaps 20% of available resources might be able to take care of damage assessment in San Luis Obispo because the ground shaking was quantified by the Shake Map acceleration measurements was only 17% g. This small ground shaking can be a problem for older, un-reinforced masonry buildings that might be present in the downtown area, but not much of problem for residential and commercial structures that have been built in the last 50 years.

One of the major concerns that I was feeling about the initial Shake Map is that it only had three stations reporting ground motions in the area of this earthquake shown on it. This concern is based in part, because earthquake damage in Paso Robles is being reported on the news, with the only station located some distance to the East at 3%g. It is quite clear that Paso Robles has either experienced much higher ground shaking than indicated by Shake Map, or the structures located in Paso Robles are much more vulnerable than I would have expected. But, I am confident in my decisions based on the technology that I know goes into the development of Shake Map, and I imagine that I would have assigned about equal resources to go up State Highway 1 and Highway 101.

It is now 2½ hours after the earthquake and damage assessment teams should have been assembled, assigned, briefed and dispatched with only 3½ hours of sun light left. Reports are beginning to come in from Atascadero and Paso Robles that confirm significant damage, but reports from Morro Bay, Cayucos, Cambria and San Simeon are sparse and not indicating much damage. Perhaps the news media has not recognized the potential for damage on the West side as being high enough, or they just find it easier to get to the East side because of the main transportation corridor that Highway 101 represents. Whatever the problem, my imaginary damage assessment teams have been deployed and won't be back until well after dark.

The CISN Display is now beginning to show an aftershock pattern that is beginning to be disturbing, in that they are becoming quite dense near Highway 101, South of Paso Robles. This is not a good sign, but they are deeper in that area, perhaps the ground shaking is still as indicated on the initial Shake Map. Then late in the afternoon, the Shake Map changed to show higher ground shaking in the earthquake area, close to Highway 101 and South of Paso Robles. Pictures on the news networks now make much more sense. I imagine that the damage assessment teams are reporting similar findings on Highway 101 and the teams dispatched to Highway 1 are not.

I begin to plan what to do tonight to get ready for tomorrow. Already, a significant number of extra resources are beginning to show up in the area around San Luis Obispo. The incidents that will remain working tonight involve life/safety concerns, centered in Paso Robles. But, tomorrow, will require much more detailed information about the extent of damage for recovery in addition to the location of the damaged areas.

Early in the evening, a Shake Map becomes available that shows a peak ground acceleration of 46% g in Templeton, CA located on Highway 101, just South of Paso Robles. The ground shaking intensity is now classified as severe in this area and the expected damage begins to match the observed damage. It would have been much better to have this information before I deployed my imaginary damage assessment teams when resources were scarce and time was limited to make these kinds of decisions.

My name is Ron Tognazzini. I am the Seismic Manager, in charge of Natural Hazard Management for the Power System at the City of Los Angeles Department of Water and Power. I have a Bachelors Degree in Civil Engineering and Masters Degree Structural Engineering. I have had over 30 years of experience in earthquake engineering, with experience in near real time reporting of earthquake information systems, damage assessment and emergency response for nearly 20 years. I am currently the Vice Chair of the Advisory Committee for the California Integrated Seismic Network (CISN).

This article has some truth, in that I actually experienced this event. It also has much fiction in that the emergency response effort imagined here, is not based on any actions that were actually performed by emergency responders in the area. They performed much better than I imagined, without a seismic network system reporting ground motion information. But, the scenario spun in this article is based on the use of CISN Display and Shake Map products during a real earthquake. You can draw your own conclusions, but my point with this article is that more stations reporting data faster would have enhanced an emergency response effort tremendously if it could have been made available through modified procedures and existing technology.