

San Simeon Earthquake

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Ronald O. Hamburger, Vice President of NCSEA and Principal at Simpson, Gumpertz and Heger, Inc. (SGH), along with Joshua M. Marrow, Senior Engineer at SGH, prepared the following report for NCSEA News on the San Simeon Earthquake of December 22, 2003.

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At approximately 11:15 am, December 22, 2003, the central coast region of California was struck by an M_w 6.5 earthquake. The epicenter was located approximately midway between San Francisco some 200 miles to the north and Los Angeles approximately 250 miles to the south. Although the earthquake was of large magnitude, comparable to the 1994 Northridge earthquake (M_w 6.7) and the same size as the devastating earthquake that struck Bam, Iran, four days later, it was located in a sparsely populated region, producing moderate effects. One building collapsed, resulting in two fatalities. A total of approximately 40 other injuries were reported and moderate damage occurred to buildings and contents throughout the region. Preliminary estimates of losses are approximately \$200 million. Primary industries in the affected area are vineyards and wine making, tourism and ranching. Population centers in the affected region include Paso Robles (population 26,000), 24 miles to the east; Templeton (population 5,000), 24 miles to the southeast and San Luis Obispo (population 45,000), 40 miles

to the south. Figure 1 is a location map for the region.

Seismicity of this region is dominated by the San Andreas Fault, a major tectonic plate boundary that trends southeast to northwest along the coast of California. The San Andreas Fault was the source of great earthquakes in Northern California in 1906 and Southern California in 1857. The earth's crust in the vicinity of the San Andreas Fault is highly fractured with many smaller faults present. The December 22 earthquake occurred along one of these smaller faults, the Oceana Fault, which underlies the coastal range of hills that separates California's coast from the central valley, along much of the state's length. The rupture mechanism was a type known as a thrust, with the rupture propagating from the northwest towards the southeast. It has been estimated that, locally, the coast range was uplifted approximately 12 inches by this event.

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Shaking from the earthquake was felt as far away as San Francisco and Los Angeles, though ground motion recordings in both regions indicate that actual accelerations were typically on the order of 1%g in these regions. The strongest ground motion recording was noted in Templeton, where a peak ground acceleration of nearly 50%g was obtained. Figure 2 compares acceleration response spectra obtained from the Templeton recording with the standard design spectrum specified by the Uniform Building Code for

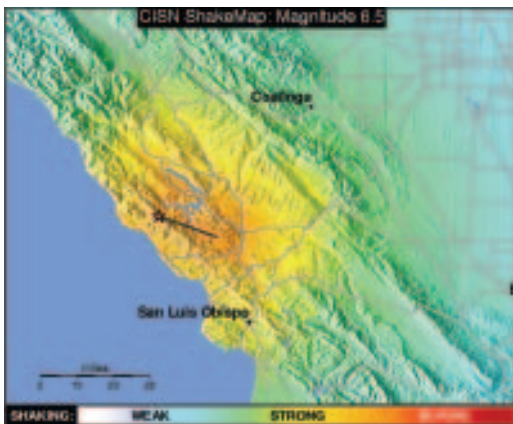


Figure 1 Location Map showing Epicenter and nearby communities

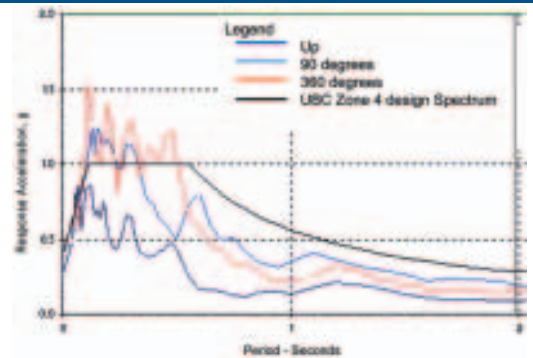


Figure 2 Response Spectra for Templeton (courtesy of California Department of Conservation)

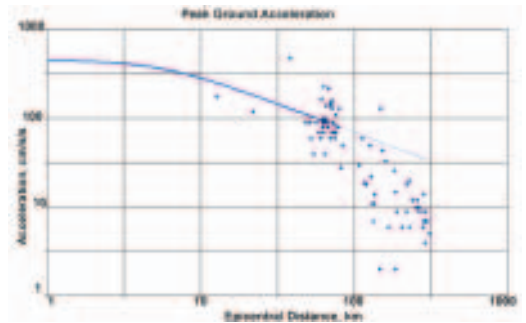


Figure 3 Approximate attenuation of shaking (courtesy of California Department of Conservation)

Class D sites. As can be seen, for the short period structures that predominate in this region, the record matches the code spectrum well. However, energy from this event appears to have been strongly focused in the direction of this instrument, which was located almost directly along the fault rupture path. Other instruments recorded much less intense shaking. An instrument in San Luis Obispo, for example, recorded a peak ground acceleration of 0.17g. Based on observational estimates of intensity, it would appear that Paso Robles experienced MMI VII to VIII ground shaking, with probable accelerations in the range of 0.2g to 0.25g. Figure 3 is a preliminary attenuation diagram for the earthquake, plotting the recorded peak ground acceleration at various instruments vs. distance to the plane of fault rupture and an approximate statistical fit to this data. In the figure, peak acceleration is shown in units of cm/sec² where 980 cm/sec² is equal to 100% g.

The most severe damage to buildings occurred in Paso Robles, where one historic unreinforced masonry structure experienced a complete collapse of its second story (Figure 4) resulting in the two fatalities. It was reported that a seismic upgrade of the building had been



planned and that the building's owners were attempting to obtain funding for this project, the cost of which had been considerably increased by requirements to add a passenger elevator for disabled access to the second floor. In the past, California structural engineers had argued for legislation that would exempt seismic upgrade projects from mandated collateral disabled access and fire/life safety upgrades. However, these efforts have not been successful. As a result, seismic upgrade of many buildings remains outside the financial resources of building owners.

Many of the other unreinforced masonry buildings in Paso Robles had previously been upgraded and performed much better. Still, potentially life-threatening failure of masonry veneers did occur in a few cases (Figure 5). In addition, several homes experienced severe damage or collapse of their brick chimneys. Concrete roof tiles were loosened and in some cases fell off buildings. Fortunately, these additional failures did not result in further human loss. Buildings throughout the region experienced cracking of stucco and dry wall. One school building, originally

constructed in the 1920s and upgraded in the 1940s, was reported as having sustained structural damage.

The central coast is an active vineyard region with many wineries present. Several of these wineries reported significant losses to their inventory, with ageing barrels toppling over and in some cases spilling contents (Figure 6). Several million dollars of losses are reported.



Figure 6 Toppling of wine ageing barrels

"...the outflow of several hundred gallons per minute of hot, sulfurous water in the middle of the City of Paso Robles."

Perhaps one of the most interesting and, ultimately, costly effects caused by the earthquake was the emergence of a geothermal spring in the center of the parking lot adjacent to Paso Robles City Hall. Earthquake ground shaking has affected underground water flows in past earthquakes. For example, geyser activity at Yellowstone National Park has been altered following earthquakes in that region. Following an earthquake in Northern Mexico in the late 1890s, ground water flowed into mines near Tombstone, Arizona, ending mining in the region. The current event resulted in the outflow of several hundred gallons per minute of hot, sulfurous water in the middle of the City of Paso Robles. A week later, efforts were still underway to cap the flow, including the excavation of a 40-foot deep pit around the source. In the mean time, the muddy water is being pumped from the pit and flowing along City streets into the local storm sewer system.

For many years, the State of California, Office of Emergency Services, and the Structural Engineers Association of California have operated a joint post-earthquake safety assessment program. Under this program, which is similar to the SEERP recently developed by NCSEA,

volunteer structural engineers are deputized as building inspectors to assist local building officials in identifying hazardous buildings. Despite the fact that this earthquake occurred Christmas week, more than 50 structural engineers from around the state volunteered to assist with this effort, often spending Christmas away from their homes and families. The local communities and merchants generously provided lodging and food for these many volunteers.

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Earthquakes the size of the San Simeon event can be expected to strike California approximately one time every five to ten years. As a result, California's building codes and practices have evolved around this hazard, resulting in a building stock that is generally able to protect life when such earthquakes occur. Tragically, two lives were lost in this event due to failure of an old unreinforced masonry building that had not been seismically upgraded. Many other buildings of this type, and of other types of vulnerable construction, remain unreinforced due to a lack of concern on the part of building owners and legislated impediments to improving buildings, such as the requirement to perform disabled access upgrades when performing seismic reinforcement. An event of this size, located within the densely populated San Francisco or Los Angeles metropolitan areas would undoubtedly cause billions of dollars of economic loss and the loss of many lives. Similar size events could occur in many other states as well.



Figure 4 Collapse of the Acorn Building in Paso Robles



Figure 5 Masonry veneer peeled off the parapet of this building in Paso Robles