RECONNAISSANCE REPORT: YOUNTVILLE/NAPA, CALIFORNIA EARTHQUAKE

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The Yountville/Napa Earthquake occurred on September 3, 2000 at 1:36 a.m. Pacific Standard Time. The epicenter (38°22.6'N; 122°24.8'W) was about 2.5 miles west of Yountville, 7 miles northwest of Napa, and 17 miles east of Santa Rosa at a focal depth of approximately 6 miles. The local Richter magnitude was M_L= 5.2 and the local moment magnitude was M_w = 5.0. Loss estimates range from 15 to 70 million dollars. The earthquake is reported to have occurred on a previously unknown fault with a right-lateral strike-slip mechanism. The majority of strong shaking was felt south of the epicenter with most significant ground motion reported in the city of Napa. Reports of shaking ranged as far east as Sacramento with no reports of shaking further north than St. Helena, indicating a possible directivity to the south of the epicenter. Figure 1 shows the earthquake and aftershock intensity data collected by USGS.

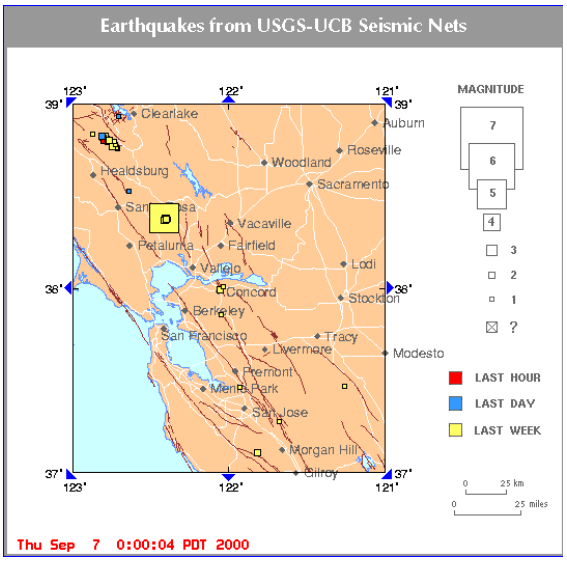

Figure 1 - Map of the Bay Area and the Yountville/Napa Earthquake, and aftershocks [1]

Division of Mines and Geology Strong Motion Instrumentation Program (CSMIP) are within 30 miles of the epicenter. One instrument, located in a maintenance shed on the Napa Valley College campus (approximately 8 miles south of the epicenter), recorded the most intense record as shown in Figures 2a and 2b. The instrument site is located in an area of soft soil, which explains the high peak ground acceleration.

The maintenance shed housing the accelerometer and other adjacent structures showed no signs of strong shaking. Reports from maintenance personnel indicated that very few items fell from shelves in the immediate vicinity of the accelerometer. No broken or cracked glass windows were observed in any of the structures on the Napa Valley College campus. These observations support the notion that spectral acceleration and duration play a large role in earthquake damage. This theory correlates well with other damage observed throughout the Napa area.

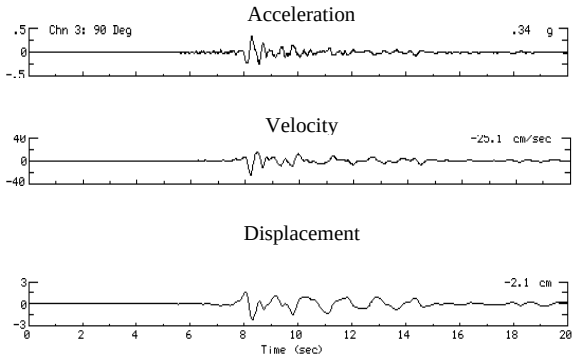

Figure 2a - Strong motion records measured at Napa Valley College Instrument Station (E-W)

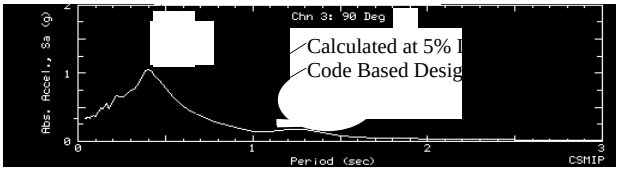

Figure 2b - Acceleration Response Spectrum at Napa Valley College Instrument Station (E-W)

Building Observations

The reconnaissance effort was focused on the Napa Valley College campus, Napa State Hospital campus (1/2 mile northeast of Napa Valley College), Downtown Napa, the west end of Trancas Street (north end of Napa), and the Yountville Veterans Home of California (2.5 miles from the epicenter).

Of the observed areas, Downtown Napa appeared to have the highest concentration of damage. The concentration of damage is most likely due to two factors. First, the soil in downtown Napa is characterized as soft and susceptible to liquefaction (the area is part of an ancient riverbed with varying depths of alluvial deposits). Second, many of the older structures in the downtown region are constructed of unreinforced masonry.

No structural damage was observed at the Napa Valley College campus, the Napa State Hospital campus or the Yountville Veterans Home of California. Nonstructural damage observed in these locations consisted of a limited amount of cracked plaster and broken window glass. The following damage was observed in the downtown Napa area: minor cracking in unreinforced brick walls (Figure 3), glass breakage, veneer and plaster damage and nonstructural damage. Most damage appeared to be concentrated in low-rise structures constructed of nonductile materials with inadequate detailing of nonstructural components to accommodate drift (e.g. glass damage). Reports from occupants indicated that more significant amounts nonstructural damage occurred in upper stories of multi-story structures. Unreinforced brick fireplace and chimney damage, plaster damage, falling lights and glass damage was observed in select areas of residential and commercial buildings throughout Napa (Figure 4). The Napa area experienced an MMI of VI to VII.

The local building department, along with volunteers from the Office of Emergency Services, have inspected almost 17,000 buildings (as of September 28) and have posted most buildings with green tags, about 2000 buildings (12%) with yellow tags and less than 39 buildings (.23%) with red tags. Based on observed conditions, red tags were placed because of hazards other than structural damage.

Figure 3 – Cracking in Unreinforced Brick Wall Building

Figure 4 – Chimney Damage

During the reconnaissance, two structures were studied extensively; a two-story unreinforced stone building constructed in 1901 (Figure 5) and a two-story unreinforced stone building constructed in the late 1880's. Both buildings sustained minor structural damage and very limited nonstructural damage. Out-of-plane wall anchors in both structures showed signs of working and each structure showed minor cracking and stone loosening at the parapets. Based on the observed damage, the ground shaking at both locations appears to be aligned in the north-south direction (contrary to the predominant direction of shaking recorded by the strong motion instrument at Napa Valley College).

Figure 5 – 1901 Unreinforced Stone Building

The 1901 building sustained damage consisting of a loose stone falling from the north-facing parapet and other stones in the same area of the parapet appear to have cracked and bulged outward. Small (1/8") vertical cracks were observed running through some spandrels located on the west elevation. The structure was evaluated and strengthened in the 1970's.

The evaluation report, developed during the 70's, indicated the presence of cracking and delaminating (bulging) in some areas of the stone walls. The 1970's damage (attributable to the 1969 M 5+ Santa Rosa earthquakes) correlates well with the observed damage for this event. The strengthening for the 1901 building consisted of the addition of wall anchors and parapet bracing, both strengthening elements showed signs of distress following this earthquake.

Conclusions

Observed structural and nonstructural damage do not appear to correlate well with the near design level recorded ground motions. In general, highly susceptible structural systems (unreinforced masonry) exhibited the most observed damage. Most reports indicated that the majority of damage to multi-story structures occurred in the upper story.

Most of the buildings that sustained damage were located on soils having moderate to high susceptibility to liquefaction. Based on the recorded ground motions and observed damage, it appears that areas of poor soil, like below the Napa Valley College accelerometer, were subjected to a PGA of over 0.3g, while other areas with stiff soil profiles, like the those located under the Napa State Hospital campus, may have been subjected to a much lower PGA. In addition, observed damage was not coupled with distance to the epicenter as Yountville (2.5 miles) had little damage to its community of unreinforced masonry buildings, compared to Napa (7 miles).

References

[1] http://quake.wr.usgs.gov/recenteqs/Maps/