Engineering
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From Research to Practice

Advances in the practices in engineering are made with honesty. However, even in the field of engineering rational thought can be misdirected. Although difficult at times because of a community of short-sighted individuals, the most effective solution to a problem is when it is most objectively viewed.

In fact, when conclusions are reached based on skewed data because of short-sighted repercussions to the individual, organization, or specific industry, the problem is not accurately visualized. It then follows that the most effective solution is not found. The persistence and severity of the problem continues for how long and to what degree it is not confronted. Near-sighted thought compounds the long term expense and effort. Skewed data can occur in the form of falsifying, changing, or not reporting facts, as well as quelching investigations of the problem. This in its most calloused and overt form occurs in legal proceedings.

Further, the solution to one problem will lead to the start of successive solutions to problems which formerly could not be solved. Near-sighted thought does not allow the potential realization of these more distant solutions.

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RESPONSE OF HOUSE FOUNDATIONS DURING THE LOMA PRIETA EARTHQUAKE

The Loma Prieta Earthquake occurred in the Santa Cruz Mountains about 60 miles south of San Francisco on October 17, 1989 at 5:04 pm. The quake registered 7.1 on the Richter Scale and was located between the towns of Boulder Creek to the northwest and Watsonville to the southeast (see Figure 1).

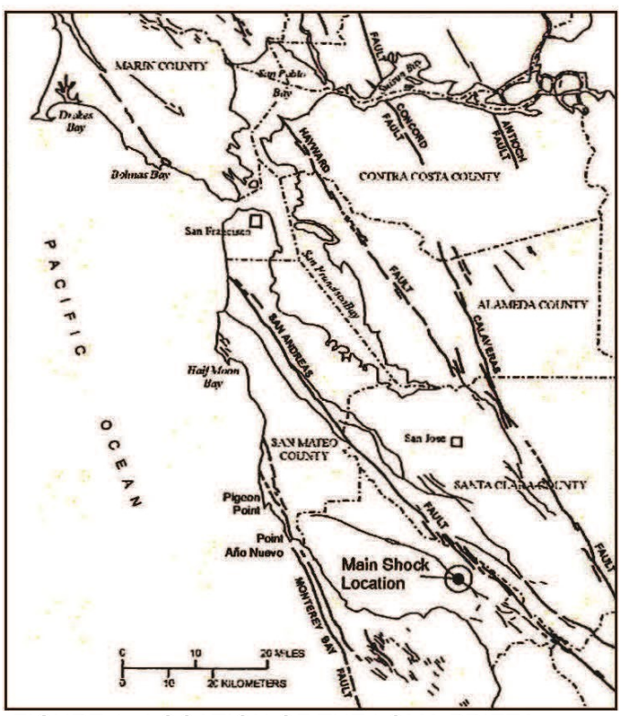

FIGURE 1 LOCATION OF THE LOMA PRIETA EARTHQUAKE AND THE REGIONAL FAULTING CHARACTERISTCS

Presented here are overall observations on the response of residential foundations to the Loma Prieta earthquake. These observations are based on field inspections across the entire damage area affected by the quake, review of numerous engineering investigations and repair recommendations, and many detailed interviews conducted with geotechnical and structural engineers with extensive experience in the EQ damage to the residential structures.

The basic types of foundations more common to the San Francisco area include perimeter footings, post-and-pier foundations, pole foundations, and pier and grade beam foundations (see Figure 2).

Foundation damage from the Loma Prieta Earthquake was observed as the result of induced ground movement as well as from literally shaking. EQ-induced ground movements which most commonly resulted in residential foundation damage were mainly the result of landsliding, soil densification, and

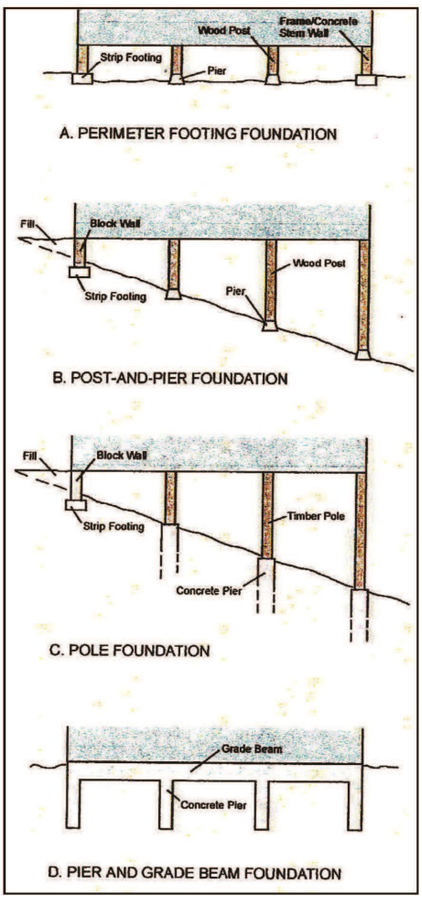

FIGURE 2 TYPICAL RESIDENTIAL FOUNDATION TYPES

liquefaction. The occurrence of these different phenomena mainly depended on geologic setting, geotechnical properties of the ground, and the magnitude of the shake. Overall, perimeter foundation systems were found to be the most sensitive to damage.

Although the shaking damage was less significant than the ground induced damage, there were certain more prominent damage scenarios including tensile cracking of concrete stem walls and footings, floor sliding on foundation, racking of cripple walls, and racking post-and-pier foundations. In the Loma Prieta earthquake some houses were knocked completely off the foundation (see Figure 3).

Hillside homes resting on post-and-pier foundations present a structural situation where shaking is accentuated. This condition results because the entire residential structure is top heavy, likened to a heavy weight on a stick that is shook at its base. Consequently, because the posts are typically not sufficiently braced nor fixed into the ground, they become significantly racked and displaced as the house shook. Figure 4 is a photograph of this type of racking damage.

FIGURE 3 HOUSE THAT WAS NOT BOLTED DOWN WAS KNOCKED OFF ITS FOUNDATION DURING THE LOMA PRIETA EARTHQUAKE

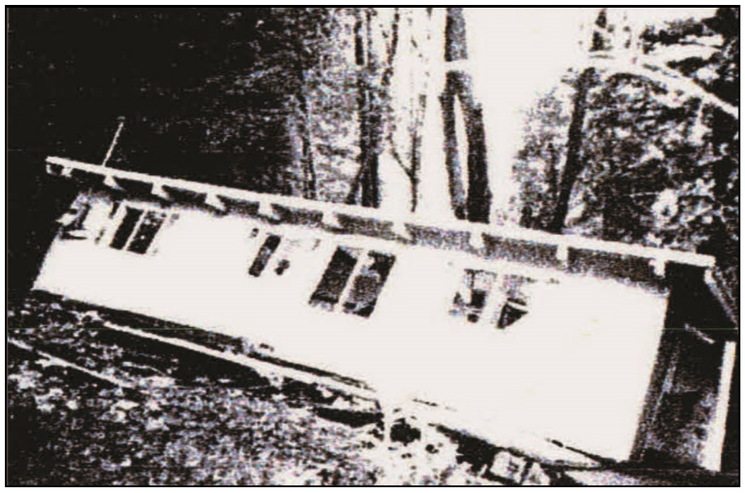

FIGURE 4 RACKING OF POST-AND-PIER FOUNDATION ON MOUNTAIN SIDE FROM SHAKING

Other Engineering UPDATES of Interest:

UPDATE 9: Hard Excavation Dispute

UPDATE 11: Frozen Fill Causes Building Damage

UPDATE 13: Foundation Recommendations Result in Unnecessary Large Cost

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 24 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact Dr. Marino at the address listed below.

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