Predicting Earthquake Damage in New Jersey

Damaging earthquakes are rare, but not unknown, in New Jersey (fig. 1). Earthquakes with an estimated magnitude of 5.2 on the Richter scale occurred in the New York City area in 1737 and 1884. In historic times, earthquakes with magnitudes between 6 and 7 have occurred in the Boston, Massachusetts and Charleston, South Carolina areas, and in the St. Lawrence Valley of Quebec. New Jersey is in a similar tectonic setting as these places and earthquakes of this magnitude are possible. The risk of a damaging quake, in combination with the density and value of the buildings, place New Jersey tenth among all states for potential economic loss from earthquakes.

Predicting the location and extent of damage is key to preparing for earthquakes. Damage depends on the location, depth, and magnitude of the earthquake, the thickness and composition of soil and bedrock beneath the area in question, and the types of building structures. A computer model commissioned by the Federal Emergency Management Agency (FEMA), now used as a nationwide standard, analyzes these factors to generate damage estimates.

Soils influence damage in two ways. Soft soils amplify the motion of earthquake waves, producing greater ground shaking and increasing the stresses on structures. Loose, wet, sandy soils may lose strength and flow as a fluid when shaken (a process known as liquefaction), causing foundations and underground structures to shift and break. Mapping the ground-shaking and liquefaction potential of soils is an essential component in predicting earth-

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**LEGEND**

- floodplain deposits
- stream-terrace deposits
- salt-marsh deposits
- swamp deposits
- glacial-lake sand and gravel
- glacial-lake silt and clay
- glacial-river sand and gravel
- thick till
- thin till
- moraine deposits
- bedrock outcrop
- wells and borings
- contours on bedrock surface

**Figure 1.** Surficial geology of the Newark area (from Stanford, 2002a, 2002b) and location of historic earthquake epicenters in and near New Jersey.
of swamp and salt-marsh peats that are now completely covered by fill. Engineering data from the many boring logs provide information on the density and compaction of the sediments.

This information was used to generate maps of liquefaction susceptibility and ground-shaking potential (fig. 2). Till, which underlies the western half of the city, is compact and has low liquefaction and ground-shaking potential. Peat, deposited in wetlands, and silt, clay, and fine sand deposited in floodplains and glacial lakes, are soft, saturated soils that are highly susceptible to shaking and liquefaction. These underlie much of the eastern half of the city. Sand and gravel deposited in glacial-lake deltas and river plains, which form a narrow belt through the center of the city, are of intermediate compaction and have medium shaking and liquefaction potential.

A 5.5 magnitude earthquake, centered about five miles northwest of the center of Newark, was simulated on a computer using the geologic data outlined above. In the simulation (fig. 3), less than 10% of the buildings underlain by till were significantly damaged, whereas between 20 and 30% of those buildings underlain by wetland and glacial-lake deposits were significantly damaged. Utility pipelines also suffer significantly increased damage on these soft, liquefiable soils. The vulnerable eastern section of the city contains within it vital transportation links, including Newark-Liberty International Airport, the New Jersey Turnpike, Interstate Route 78, the Amtrak Northeast Corridor rail line, and the Port Newark marine terminal. The mapping and simulations indicate that this is a priority area for strengthening vulnerable structures.

Similar soil mapping and earthquake simulations have been completed for Hudson, Bergen, Essex, and Union counties, and are planned for eight additional counties, in northern New Jersey.

References

