

Extended Abstract

Earthquake Liquefaction exerts changes in ground water hydraulic heads, dismantle structures, sand boil conditions, and choke water wells

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When the ground liquefies in an earthquake, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged.

Earthquake liquefaction is a major contributor to urban seismic risk. The shaking causes increased pore water pressure which reduces the effective stress, and therefore reduces the shear strength of the sand. If there is a dry soil crust or impermeable cap, the excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils, colloquially called "sand volcanoes".

When the ground liquefies, sandy materials saturated with water can behave like a liquid, instead of like solid ground. The ground may sink or even pull apart. Sand boils, or sand "volcanoes," can appear.

Liquefaction can cause ground displacement and ground failure such as lateral spreads (essentially landslides on nearly flat ground next to rivers, harbors, and drainage channels) and flows.

Soil liquefaction describes the behavior of soils that, when loaded, suddenly suffer a transition from a solid state to a liquefied state, or having the consistency of a heavy liquid. Liquefaction is more likely to occur in loose to moderate saturated granular soils with poor drainage, such as silty sands or sands and gravels capped or containing seams of impermeable sediments. During loading, usually cyclic undrained loading, e.g. earthquake loading, loose sands tend to decrease in volume, which produces an increase in their porewater pressures and consequently a decrease in shear strength, i.e. reduction in effective stress.

Deposits most susceptible to liquefaction are young (Holocene-age, deposited within the last 10,000 years) sands and silts of similar grain size (well-sorted), in beds at least several feet thick, and saturated with water. Such deposits are often found along riverbeds, beaches, dunes, and areas where windblown silt (loess) and sand have accumulated. Some examples of liquefaction include quicksand, quick clay, turbidity currents, and earthquake liquefaction.

Depending on the initial void ratio, the soil material can respond to loading either *strain-softening* or *strain-hardening*. Strain-softened soils, e.g. loose sands, can be triggered to collapse, either monotonically or cyclically, if the static shear stress is greater than the

ultimate or steady-state shear strength of the soil. In this case *flow liquefaction* occurs, where the soil deforms at a low constant residual shear stress. If the soil strain-hardens, e.g. moderately dense to dense sand, flow liquefaction will generally not occur. However, *cyclic softening* can occur due to cyclic undrained loading, e.g. earthquake loading.

Earthquake liquefaction produce changes in hydraulic heads, porosity and permeability of the underlying aquifers especially in unconfined aquifers, and reduces the ultimate well yield, sand blowing, muddy water, and even abandonment of water wells. This phenomena of abundance changes in the hydrogeological features are much pronounced in the alluvial deposits conforming unconfined aquifers in the vicinity of floodplains of Punjab.

Studies of liquefaction features left by prehistoric earthquakes, called paleoliquefaction or paleoseismology, can reveal a great deal of information about earthquakes that occurred before records were kept or accurate measurements could be taken.

In alluvial deposits of Pakistan, soft muddy soils host liquefaction the maximum, sandy and gravelly formation the moderate, and the bedrocks remain on the minimum.

Some Photographs are shown to elaborate the phenomena of Earthquake liquefaction.

EARTHQUAKE LIQUEFACTION EXERTS CHANGES IN GROUND WATER HYDRAULIC HEADS, DISMANTLE STRUCTURES, AND SOIL BOIL CONDITIONS

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a) Some effects of liquefaction during the 1964 Niigata earthquake

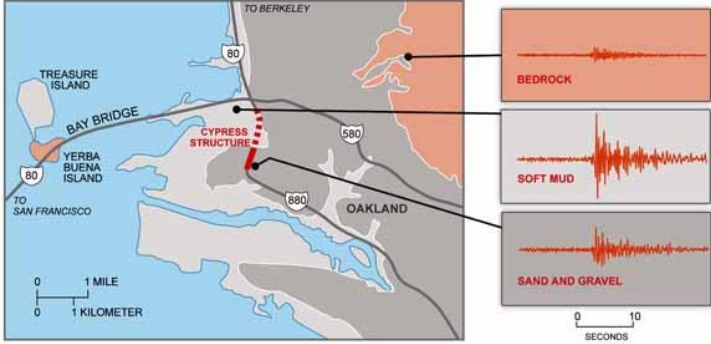
b) Sand Boil conditions

exhibit sinkhole



Source: http://commons.wikimedia.org/wiki/Image:Chuetsu_earthquake-earthquake_liquefaction1.jpg

c) Liquefaction allowed this sewer to float upward



d) Liquefaction in Formation