



## **just in case arizona**

### **Soils & Earthquakes**

#### **What is Soil?**

A surficial material formed by chemical, physical, and biological weathering.

#### **What Variables Control the Soil in an Area?**

- Climate and weather
- Topography
- Time
- Parent material
- Vegetation (dependent on the climate, weather and water)
- Biological and chemical agents

#### **How Do Soils Vary?**

- Grain size and hardness (There are 3 basic particle sizes that create the 3 basic soil types: sand, silt, and clay.)
- Color
- Grain size and shape
- Chemical composition
- Amount of pore spaces - open spaces filled with air
- Amount of moisture
- Permeability

#### **Why is Soil Important to Consider in an Earthquake?**

Although structures are supported on soil, most of us rarely consider soil, its differences, and its subsequent effect on structures in an earthquake. Some soil is hard, like rock, and can support over 40 tons per square foot (Levy & Salvadori, 1992), while other soil is weak, like loose sand.

Different soil properties can affect seismic waves as they pass through a soil layer. In some areas, there may be many different types of soils layered one upon another before

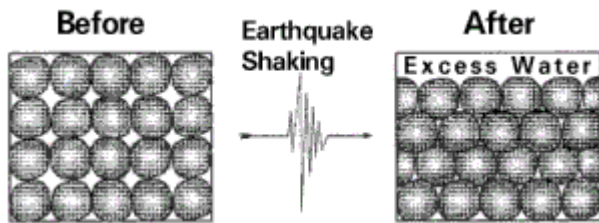
hard rock is encountered. Sometimes, ground shaking will be amplified. This will influence what needs to be done to structures to help them fare better in an earthquake. Also, a phenomenon known as liquefaction or ground failure can occur in moderate to major earthquakes.

### **What is Liquefaction?**

When there is ground water less than 30 feet from the surface in soils that contain layers of sand, the pressures generated by repetitive squeezing of the earth by several seconds of seismic wave vibrations will cause the ground water to flow up and out.

When this occurs, the sand grains, which have no strength except when touching each other, are forced apart. The ground then takes on the properties of a semi-solid. When it happens over a large area, houses and buildings with inadequate foundations may actually sink slightly.

When liquefaction happens in a small area, liquefied sand can be ejected to the surface through fissures in the overlying layers. Soil failure, as described earlier, will have a larger impact on pipelines and pile foundations, and other structures below the surface of the earth.



### **Does Liquefaction Always Occur During an Earthquake?**

No. Liquefaction occurs only under ideal conditions as a result of an earthshaking event and is controlled by the following variables:

- Grain size of the soil
- Duration of the earthquake and amplitude and frequency of shaking
- Distance from the epicenter
- Location of the water table
- Cohesiveness of the soil
- Permeability of the layer

### **Where Do I Begin?**

Investigation of the soil is a good place to start. Get a sample from your yard or the yard next door. Examine it with a magnifying glass. Draw a picture of how the soil looks under the magnifying glass. Start a soil collection.

- What color(s) are the grains?
- What general color is the soil?
- What size(s) are the particles?
- Do the particles have rounded or sharp edges?
- Is there anything living in the soil?
- Is it moist or dry?

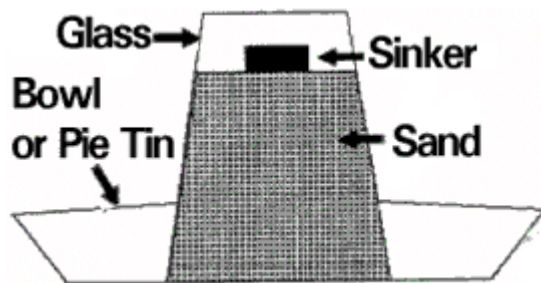
### Soil Profile:

- A soil profile is a cross section of soil layers with different characteristics. You can make one with a clear plastic tube.
- Carefully dig a hole as deep as the tube is long.
- Put a bit of soil from the bottom of the hole into the bottom of the tube.
- Take soil a few inches from the bottom and place it in the tube.
- Continue this procedure until the tube is full of soil.

### Evaluate and note the soil profile characteristics with the following questions:

- Do the colors of layers vary?
- Where is the darkest soil? The lightest?
- Where are the most stones?
- What can you learn by looking at the different layers?
- Is the soil further down in a hole always the same as it is at the top?

### Liquefaction in a Pie Plate



### Materials:

- fine, well sorted sand (i.e., most grains the same size)
- flexible plastic cup
- 8-12" pie pan
- 1 oz. or larger sinker
- beaker, 125 ml water

### Procedure:

- Carefully cut off the bottom portion of the plastic cup (within 1 1/2 cm from the bottom).
- Invert cup and place in the middle of the pie pan.

- Pressing down on the cup, slowly pour the sand into the inverted cup to a level approximately 12 cm from the top. Make sure the sand is level, but do not try to compact it.
- Gently place a sinker or comparable object on the surface of the sand.
- Holding onto the cup, slowly pour 125 ml of water outside the cup into the pan. Record the time it takes for the water to migrate or move upward to saturate the sand (permeability).
- Firmly holding the cup in place, tap forcibly on the side of the cup. What happens to the sinker?
- What did you learn from this experiment?

#### **Additional Resources:**

- Earthquake Engineering Research Institute. (January 1994). Earthquake basics: Liquefaction what it is and what to do about it.
- Hilston, P., & Hilston, C. R. (1993). A field guide to planet earth: Projects for reading rocks, rivers, mountains, and the forces that shape them. Chicago, IL: Chicago Review Press.
- Jennings, T. (1989). The young scientist investigates: Rocks and soil. Chicago: Chicago Children's Press.
- Levy, M., & Salvadori, M. (1992). Why buildings fall down: How structures fail. NY: W. W. Norton.

*Model developed by: Len Sharp, Robert Allers, Borys Browar, Daniel Parke, John Rice, Richard Thomas.*

(Source: Multidisciplinary Center for Earthquake Engineering Research (MCEER), <http://mceer.buffalo.edu>)

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