

SEISMIC SHAKING, TSUNAMIS, AND GROUND RESPONSE (14)

I Main Topics

A Recognition of direct effects of shaking as a seismic hazard

B Recognition of tsunamis and seiches as seismic hazards

C Recognition of types of shaking-induced hazards

<http://earthquake.usgs.gov/faq//effects.html>

II Recognition of direct effects of shaking as a seismic hazard

A Shaking (and tsunamis) the most widespread seismic hazards

B Shaking generally causes the most damage and loss of life

C Unlike ground rupture, shaking is very difficult to avoid

D Shaking can be engineered against to a large extent

E Key factors controlling response of near-surface materials:

1 Thickness of Holocene/Quaternary deposits

2 Degree of consolidation (void ratio)

3 Degree of cementation

4 Depth to water table (some dispute here)

III Tsunamis and seiches

A Tsunamis: seismic sea waves generated by sharp vertical displacement of the ocean floor

1 Can reflect dip-slip faulting or landsliding

2 Long-wavelength ("shallow-water") waves

3 Examples: Hilo, Hawaii, 1946; Lituya Bay, Alaska, 1958 (518m!)

<http://www.tsunami.org/>

<http://www.geocities.com/CapeCanaveral/Lab/1029/Tsunami1958LituyaB.html>

B Seiches: Shaking-induced oscillations of enclosed water bodies, Most destructive when strong shaking is at resonant frequency.

IV Types of shaking-induced ground failures

A Settlement of cohesionless (sandy) alluvial materials

- 1 Vertical contraction resulting from loss of void space
- 2 Example: Homer, Alaska, 1964

B Liquefaction of cohesionless (sandy) alluvial materials

<http://www.ce.washington.edu/~liquefaction/html/content.html>

- 1 Loss of shear strength due to shaking; liquids have essentially no shear strength
- 2 Sands and silty sands most susceptible to liquefaction are:
 - a Well-sorted
 - b Very young (<100 years)
 - c Have a high water table (< 3 meters below surface)
 - d River deposits susceptible
- 3 Examples: Niigata, Japan, 1964

C Ground oscillation

- a Occurrence of large surface waves, without permanent lateral translation, as a surficial layer that overlies a liquefied layer fractures and blocks bob up and down. Sandblows form.

<http://www.gi.alaska.edu/ScienceForum/ASF3/323.html>

- b San Francisco, California, 1906

D Lateral spreading (slopes <math><3^\circ</math>)

<http://geohazards.cr.usgs.gov/wa/uwmeeting2.html>

- a Horizontal translation of surficial blocks in response to liquefaction of underlying subhorizontal layers
- b Example: Anchorage, Alaska, 1964

E Flow failure (slopes >math>>3^\circ</math>)

- a Translation of surficial blocks in response to liquefaction of underlying inclined layers (Same mechanism as lateral spreading)
- b Examples: Valdez, Alaska, 1964; Kansu Province, China, 1920

F Failure of quick clays

- a Collapse of open clay structure and loss of shear strength
- b Example: Turnagin Heights, Anchorage, Alaska, 1964

<http://www.iris.washington.edu/EandO/slidescans/alaska/slideshow/>

G Triggering of deep-seated slides

- a Mechanism not understood
- b Example: Santa Cruz Mtns, California, 1989