

EARTHQUAKE CASE HISTORIES (07)

- I Main Topics for next two lectures
 - A Recognition of earthquake hazards from case histories
 - B Consistent lessons
 - C Key questions regarding characterization of earthquakes and faulting
- II Recognition of earthquake hazard: a broad perspective
 - A Magnitude of problem (see handout)
 - B Concentration of earthquakes worldwide near plate boundaries, with a small but significant number of intra-plate quakes
- IV Case Histories (The historic record)
 - http://wwwneic.cr.usgs.gov/neis/eqlists/USA/1872_03_26.html
 - A Owens Valley, 1872 (2:30 AM March 26, 1872; M="8.3+", **M**=7.8)
 - 1 Epicenter at Lone Pine at base of Mt. Whitney. Second great historical California earthquake. Rupture length of 100+ km.
 - 2 Earthquake felt from Oregon to Mexico to Salt Lake City
 - 3 Damage to Bidwell mansion in Chico, 300 miles from epicenter
 - 4 Resilience of wood-frame construction and flaws of unreinforced masonry highlighted. In Lone Pine (population 250-300), 23 killed, 50+ injured, most in the collapse of unreinforced masonry. 52 of 59 buildings wholly or partly destroyed, including every adobe, brick, or stone building.
 - 5 Deciding factor in G.K. Gilbert (1884) recognizing faulting hazard in Basin and Range, including Salt Lake City
 - B San Francisco, 1906 (5:12 AM April 18, 1906; M=8.25, now **M**=7.7)
 - http://wwwneic.cr.usgs.gov/neis/eqlists/USA/1906_04_18.html
 - 1 Epicenter: Pt. Reyes. Rupture length of ~270 miles (430 km).
 - 2 Report of the State Earthquake Investigation Commission
 - a Establishment of elastic rebound theory as earthquake mechanism (vol. 2, p. 27)
 - b Recognition that rupture was along a fault that could have been identified in hindsight
 - c Recognition and documentation of association between shaking intensity and surficial geology; beginning of characterization (vol. 2, p. 49-56)
 - d Resilience of wood-frame construction and flaws of unreinforced masonry

- e Significance of Hayward fault
 - f Estimation of ~100 year recurrence interval (vol. 2, p. 18-19)
 - g Difference in attenuation characteristics vs. East coast quakes (i.e. Charleston 1886)
 - h Calculation of energy release (vol. 2, p. 22)
 - i Estimate of regional principal stress field (vol. 2, p. 22-28)
 - j Documentation of effect on ground water
- 3 700 people killed, \$500 million damage
- C San Fernando, 1971 (6 AM February 9, 1971; $M_L=6.4$, $M=6.6$)
- 1 Rupture length of ~15 km
 - 2 Quake occurred near the center of the largest concentration of strong-motion instruments in U.S
 - 3 First instrumental recording of vertical accelerations $>1g$
 - 4 "Shattered ridge tops" recognized as potential evidence of vertical accelerations $>1g$
 - 5 Numerous houses damaged by ground rupture. Whether fault could have been recognized in advance is controversial.
 - 6 Initiated Alquist-Priolo Act
 - 7 Near failure of Van Norman dam
 - 8 Gave major boost to review of safety of dams in U.S.
 - 9 Graphic evidence of potential for freeway disruption
 - 10 Graphic evidence of inadequacy of "flexible first story" design. Other buildings built to code generally did well
 - 11 Resilience of wood-frame construction highlighted again. Casualties in personal residences less than 1 in a million.
 - 12 \$500 million damage, or \$71 per person in the L.A. area
 - 13 58 deaths out of 7 million people in affected area. We were lucky.

Earthquakes since 1268 that have caused at least 50,000 deaths*

Place	Year	Estimated Deaths
Silicia, Turkey	1268	60,000
Chihli, China	1290	100,000
Shaanxi, China	1556	830,000
Shemska, "USSR"	1667	80,000
Naples, Italy	1693	93,000
Catania, Italy	1693	60,000
Beijing, China	1731	100,000
Calcutta, India	1737	300,000
Lisbon, Portugal	1755	60,000
Calabria, Italy	1783	50,000
Messina, Italy	1908	160,000
Gansu, China	1932	70,000
Tokyo/Yokohama, Japan	1923	143,000
Gansu, China	1932	70,000
Quetta, Pakistan	1935	60,000
Tangshan, China	1976	240,000
Iran	1990	52,000

Earthquake distributions for the entire Earth

Magnitude	Number per year	Maximum Modified Mercalli Intensity	Effects on populated areas
<3.4	800,000	I	Recorded by seismographs only
3.5-4.2	30,000	II and III	Felt by some people indoors
4.3-4.8	4,800	IV	Felt by many, windows rattle
4.9-5.4	1,400	V	Felt by all, dishes break
5.5-6.1	500	VI and VII	Slight building damage, plaster cracks, bricks fall
6.2-6.9	100	VIII and IX	Houses move on foundations, chimneys fall
7.0-7.3	15	X	Bridges twisted, many masonry buildings collapse
7.4-7.9	4	XI	Most buildings collapse
>8.0	1/5 -/10	XII	Total damage, Waves on ground, objects thrown into air

(Modified from Skinner and Porter, 1992)