

EARTHQUAKE DAMAGE TO SCHOOLS



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National Oceanic and Atmospheric Administration
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Boulder, Colorado 80303, USA**

Earthquake Damage to Schools

These unusual slides show earthquake damage to school and university buildings around the world. They graphically illustrate the potential danger to our schools, and to the welfare of our children, that results from major earthquakes. The slides range from Algeria, where a collapsed school roof is held up only by students' desks; to Anchorage, Alaska, where an elementary school structure has split in half; to California and other areas, where school buildings have sustained damage to walls, roofs, and chimneys.

Interestingly, all the United States earthquakes depicted in this set of slides occurred either on a holiday or before or after school hours, except the 1935 tremor in Helena, Montana, which occurred at 11:35 a.m. It undoubtedly would have caused casualties had the schools not been closed days earlier by Helena city officials because of a damaging foreshock. Students in Algeria, the People's Republic of China, Armenia, and other stricken countries were not so fortunate.

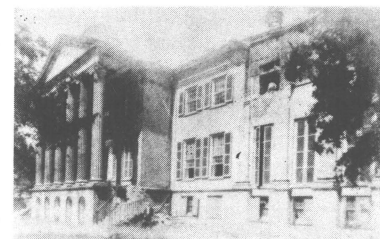
This set of slides represents 17 destructive earthquakes that occurred in 9 countries, and covers more than a century--from 1886 to 1988. Two of the tremors, both of which occurred in the United States, were magnitude 8+ on the Richter Scale, and four were magnitude 7-7.9. The events represented by the slides (see table below) claimed more than a quarter of a million lives.

LIST OF EARTHQUAKES REPRESENTED IN SLIDE SET

EVENT	DATE	RICHTER MAGNITUDE	NO. OF DEATHS
ALGERIA:			
El Asnam	OCT. 10, 1980	7.4	5,000
ARMENIAN SSR:			
Spitak	DEC. 7, 1988	6.9	25,000
AUSTRALIA:			
Cadoux	JUNE 2, 1979	6.4	0
ECUADOR:			
Esmeraldas	APR. 9, 1976	6.7	8
MEXICO:			
Veracruz	AUG. 28, 1973	7.2	600
PEOPLE'S REP. OF CHINA:			
Tangshan	JULY 27, 1976	7.9	240,000
PERU:			
Lima	OCT. 3, 1974	7.6	78
TURKEY:			
Lice	SEPT. 6, 1975	6.7	2,300
UNITED STATES:			
Alaska:			
Anchorage	MAR. 27, 1964	8.3	131
California:			
San Francisco	APR. 18, 1906	8.3	700
Long Beach	MAR. 10, 1933	6.3	115
Kern County	JULY 21, 1952	7.7	14
Coalinga	MAY 2, 1983	6.7	0
Montana:			
Hebgen Lake	AUG. 18, 1959	7.1	28
Helena	JUNE 27, 1925	6.7	0
Helena	OCT. 31, 1935	6.0	2
South Carolina:			
Charleston	AUG. 31, 1886	unknown	60

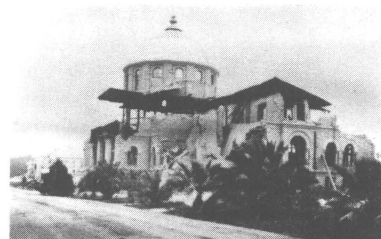
In the following descriptions of earthquakes the location is only approximate. The damage is in millions of U.S. dollars.

Earthquake of August 31, 1886, Charleston, South Carolina, USA. Location: fifteen miles northwest of Charleston; Affected Area: 5.2 million km²; Damage: \$5 million. The first shock was followed by a second shock eight minutes later. At least 10 severe aftershocks drove most of the residents into the streets. Most of the houses were damaged and debris filled the streets. Much of Charleston was built on manmade land, some of it over former creek beds. This fill amplified the ground motion. The masonry structures were severely damaged although the damage varied according to the type of brick and mortar. Wooden houses usually survived although many were thrown out of plumb. Chimneys on at least 14,000 houses were destroyed.



1 This photo shows the damage at Charleston College. Photo Credit: South Carolina Art Association.

Earthquake of April 18, 1906, San Francisco, California, USA. Location: northwest of San Francisco; Affected Area: 971,000 km²; Damage: \$400 million. The earthquake was associated with the largest known length of slip along a fault plane in the contiguous United States (430 km). Pipelines crossing the fault line were broken. This lack of water supply allowed raging fires to destroy the city.



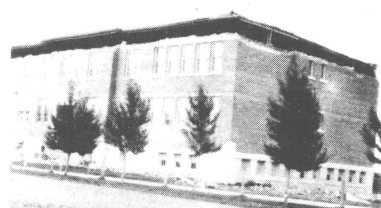
2 The library at Stanford University, Palo Alto sustained severe damage. Photo Credit: U.S. Geological Survey (W.C. Mendenhall).

3 The chapel at Stanford University, Palo Alto, was damaged. Photo Credit: U.S. Geological Survey (W.C. Mendenhall).

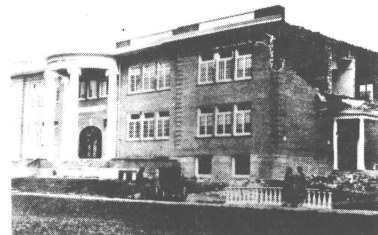


Earthquake of June 27, 1925, Helena, Montana, USA. Location: east of Helena; Affected Area: 803,000 km²; Damage: \$0.3 million. Chimneys fell in every direction from the shaking. In addition, brick and mortar structures were damaged. Cracks appeared in roads, and railroad tracks were bent.

4 The high school at Three Forks, Montana, with brick walls in lime mortar was badly damaged and the walls bulged on all sides. Photo Credit: U.S. Geological Survey (J.T. Pardee).



5 At Manhattan, Montana, partition walls of the school house separated from the outside wall owing to lack of ties. Photo Credit: U.S. Geological Survey (J.T. Pardee).



Earthquake of March 10, 1933, Long Beach, California, USA. Location: 5 km southwest of Newport Beach; Seriously Affected Area: 1,200 km²; Damage: \$40 million. Schools were among the buildings most severely damaged because they were not designed to resist shaking. In addition to the damage to the schools at Long Beach, the schools at Buena Park were badly damaged, there was considerable damage to schools at Lomita, and two schools were damaged at Redondo Beach. Great loss of life would have occurred if the shock had taken place during school hours. Unlike the 1906 San Francisco earthquake the loss due to fire in the 1933 earthquake was almost negligible.

6 Collapse of John Muir School on Pacific Avenue from the 1933 Long Beach earthquake. Photo Credit: W.L. Huber.

7 Walls crumbled at Alexander Hamilton Jr. High School on State Street. Photo Credit: W.L. Huber.

Earthquake of October 31, 1935, Helena, Montana, USA.

Location: almost directly beneath Helena; Affected Area: 363,000 km²; Damage: \$4 million. A series of earthquakes beginning on October 3, 1935, shook the area. The strongest of the shocks was on October 18. Several shocks of lesser intensity were followed by a second strong earthquake on October 31 that destroyed many buildings that had been previously damaged. The shocks continued with additional strong shocks on November 21 and November 28.

8 The photo shows the west wing of Helena High School that collapsed in the October 31 earthquake. The collapsed part of the school had reinforced concrete frame, floors, and roof, and the tile floors were faced with brick. The greatest amount of damage to a single structure was incurred by this building although it had just been completed only two months prior to the earthquake at a cost of approximately \$500,000. Photo Credit: NOAA/NGDC.

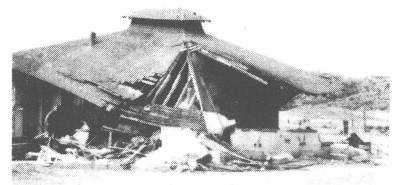
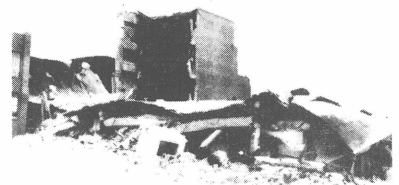
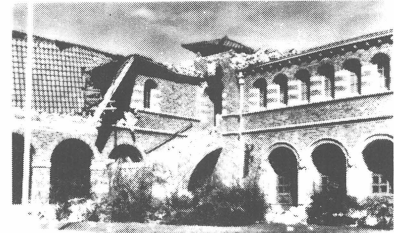
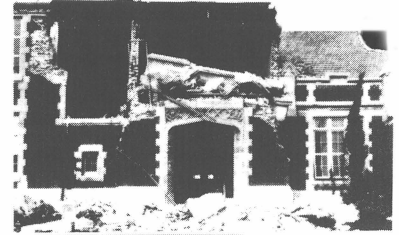
Earthquake of July 21, 1952, Kern County, California, USA.

Location: south of Bakersfield; Affected Area: 414,000 km²; Damage: \$50 million. This was the main shock of the series of earthquakes that struck this area. It was the largest earthquake in the United States since 1906. Several hundred people were injured. Nine of the deaths resulted from the collapse of a brick wall in Tehachapi. About 20 schools were damaged or destroyed by this earthquake. Many of the schools that collapsed were built prior to 1933. Schools built after 1933 were constructed to resist lateral forces and incurred only minor damage. These included Caliente, Tehachapi, El Tejon, Lakeside Union, and Santa Barbara city schools. Older schools that were destroyed or had to be abandoned included Shafter, Cummings Valley (slide 9), Buttonwillow, Di Giorgio, Fairfax, and Elk Hills schools. Porterville Union High School auditorium and several other older schools incurred moderate damage.

9 The Cummings Valley School completely collapsed. The school building was reportedly constructed in 1910 of concrete walls and a wood roof. The building was a total loss. Photo Credit: NOAA/NGDC.

Earthquake of August 18, 1959, Hebgen Lake, Montana, USA.

Location: near Hebgen Lake in southwestern Montana; Affected Area: 1,554,000 km²; Damage: \$11 million. In addition to the damage to the elementary school at West Yellowstone, bricks were dislodged from chimneys and window ledges at Montana State College in Bozeman. There was some damage to the brick school at Busby. At Butte, the Franklin School incurred the greatest amount of damage. The chimney fell and the walls were badly cracked. The cost of repairs was estimated at \$5,000 to \$10,000. A large block fell from the top entrance of the Emerson School and the front steps were destroyed. Bricks in the chimney at Harrison school were cracked, and the cement columns fell from under the windows at the Longfellow School. The first floor on the south wing of Butte Public High School was damaged, and walls cracked.

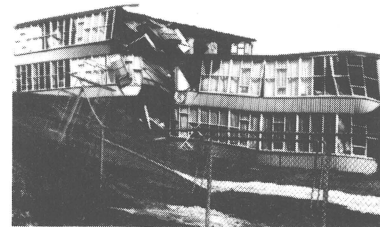


10 The decorative stone entryway at the West Yellowstone Elementary School fell into a heap of rubble during the 1959 Hegben Lake earthquake. The back wall of the school garage had severe diagonal cracks and later was torn down. The west parapet leaned on a tree. Photo Credit: U.S. Geological Survey (R.W. Bayley).



Earthquake of March 27, 1964, Prince William Sound, Alaska, USA. Location: Prince William Sound, southern Alaska; Affected Area: 1,813,000 km²; Damage: \$538 million. The earthquake was one of the most violent ever recorded. In addition to the Government Hill School which was destroyed, the Denali School incurred considerable structural damage. The entire second floor of West High School classroom wing was a total loss. Chugiak and Eagle River elementary schools incurred some damage. Despite widespread destruction, ten of Anchorage's 20 schools reopened on April 6, ten days after the earthquake.

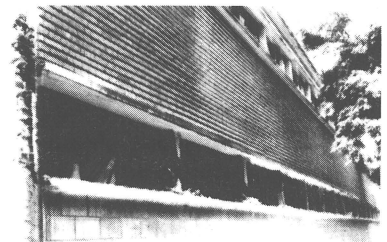
11 Government Hill Elementary School split in two and was virtually destroyed when the ground beneath it slumped down. Fortunately, the earthquake occurred on Good Friday, a school holiday. Photo Credit: NOAA/NGDC.



Earthquake of August 28, 1973, Veracruz, Mexico.

Location: south of Veracruz, southeastern Mexico; Damage: Severe. The earthquake caused heavy damage in the states of Morelos, Puebla, and Veracruz. Thousands were left homeless.

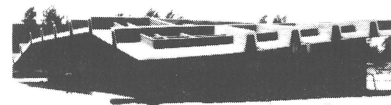
12 This two-story wooden school building at Ciudad Serdan sustained heavy damage, largely in the longitudinal direction of the building wings. Photo Credit: State of California Dept. of Architecture and Construction (J.F. Meehan).



Earthquake of October 3, 1974, Lima, Peru.

Location: Near coast of central Peru; Damage: Extensive. Over 2,000 were injured, and extensive damage occurred.

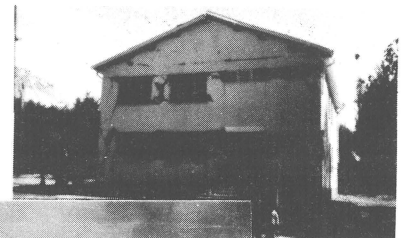
13 Column failure caused the roof to sag on a one-story classroom at Agricultural University. Note heavy roof structure on the concrete-frame building. Photo Credit: L.A. Wylie, Jr.



Earthquake of September 6, 1975, Lice, Turkey.

Location: eastern Turkey; Damage: \$17 million.

14 All lateral resisting elements were shattered in the west wall of the high school building. Photo Credit: URS/John A. Blume and Associates (Peter I. Yanev).



Earthquake of April 9, 1976, Esmeraldas, Ecuador.

Location: Northwestern Ecuador; Damage: Severe.

15 Severe damage to exterior of Juan Montalvo School. Photo Credit: Jorge Road-Silva.



Earthquake of July 27, 1976 Tangshan, People's Republic of China. Location: Northeastern China; Damage: \$5,600 million. The death toll (240,000) was one of largest in recorded history from an earthquake. In addition, around 800,000 were injured. Extensive damage occurred over a wide area.

16 Collapse of a classroom and laboratory building at the College Mining Institute. The school was closed when the earthquake occurred, but more than 2,000 students were killed in their dormitories. Photo Credit: Stanford University (J.M. Gere).

Earthquake of June 2, 1979, Cadoux, Australia.
Location: Western Australia; Damage: \$1.5 million.

17 Brick chimneys have fallen through the sheet metal roof of a school building. Photo Credit: Bureau of Mineral Resources, Geology, and Geophysics, Canberra.

Earthquake of October 10, 1980, El Asnam, Algeria.
Location: northern Algeria; Damage: \$3,000 million. About 9,000 were injured. Extensive damage occurred in the El Asnam area.

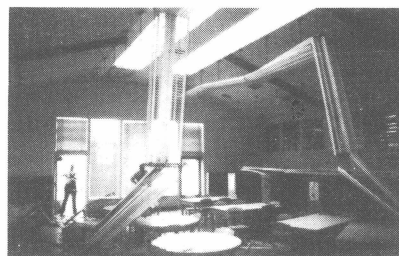
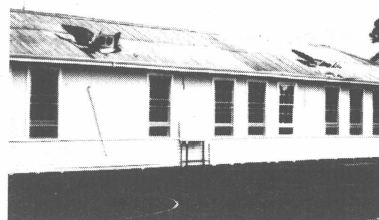
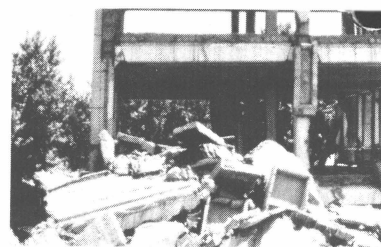
18 This modern school building collapsed at El Asnam. This school is one of 85 that collapsed during the earthquake. The earthquake occurred after school hours, and so no loss of life was sustained at this school. Photo Credit: Stanford University (H.C. Shah).

Earthquake of May 2, 1983, Coalinga, California, USA.
Location: Central California, 20.8 km from Coalinga; Affected Area: 205,000 km²; Damage: \$31 million. The most serious damage occurred in the eight-block downtown commercial district, but residents were also heavily damaged. More than 800 single-family houses were destroyed or incurred major damage. The majority of the 94 injuries occurred in residential sections of the city.

19 Failure of pendant light fixtures in the Dawson Elementary School library would have caused many injuries if the library had been occupied. The light fixtures were hung end to end. Photo Credit: Earthquake Engineering Research Institute.

Earthquake of December 7, 1988, Spitak, Armenian SSR.
Location: Northwestern Armenian SSR, 18 km north northwest of Spitak; Damage: \$14.2 billion. Fifteen thousand were injured and 517,000 people were made homeless. The death toll (25,000) could have been much worse had it not been for the heroic rescue of 15,000 who were pulled from the rubble.

20 Four hundred children were killed at this elementary school in Dzhrashen southeast of Spitak, Armenian SSR. The precast concrete floors in the building collapsed due to poor ties with the walls. Photo Credit: U.S. Geological Survey (C.J. Langer).



Additional natural hazards slide sets are available from:

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