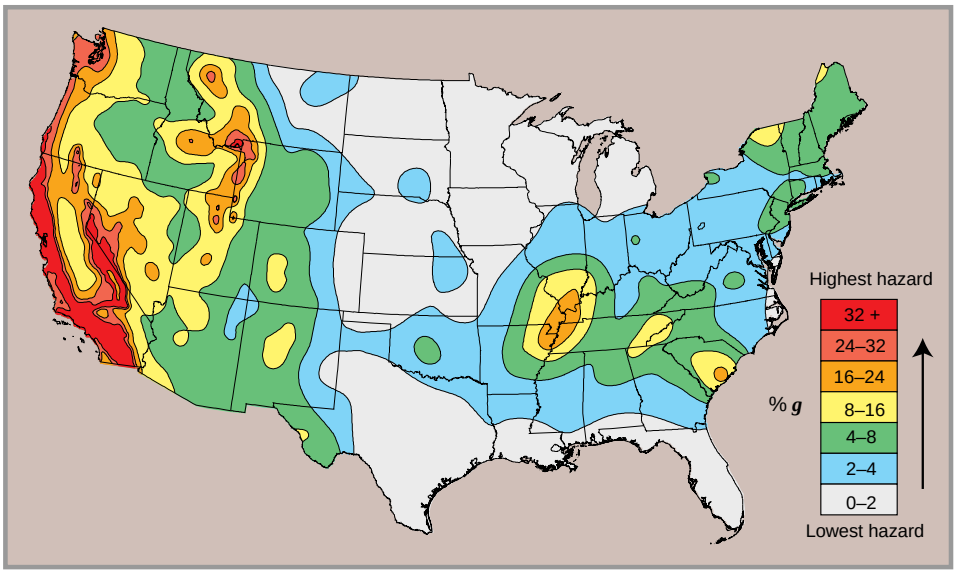
REDUCING EARTHQUAKE LOSSES THROUGHOUT THE UNITED STATES

Hazard Maps Help Save Lives and Property

National maps of earthquake shaking hazards provide information essential to creating and updating the seismic design provisions of building codes used in the United States. Scientists frequently revise these maps to reflect new knowledge. Buildings, bridges, highways, and utilities built to meet modern seismic design provisions are better able to withstand earthquakes, not only saving lives but also enabling critical activities to continue with less disruption.



*The 1996 U.S. Geological Survey shaking-hazard maps for the United States are based on current information about the rate at which earthquakes occur in different areas and on how far strong shaking extends from quake sources. Colors on this particular map show the levels of horizontal shaking that have a 1-in-10 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of **g** (**g** is the acceleration of a falling object due to gravity).*

America's first line of defense against earthquakes has historically been the construction of buildings that can withstand severe shaking. Cities and counties rely on the seismic design provisions in building codes to ensure that structures can resist earthquakes. The variations in the seismic threat across the country are depicted on maps in building codes as zones of different risk levels. These building-code maps are based on more detailed shaking-hazard maps prepared by U.S. Government scientists.

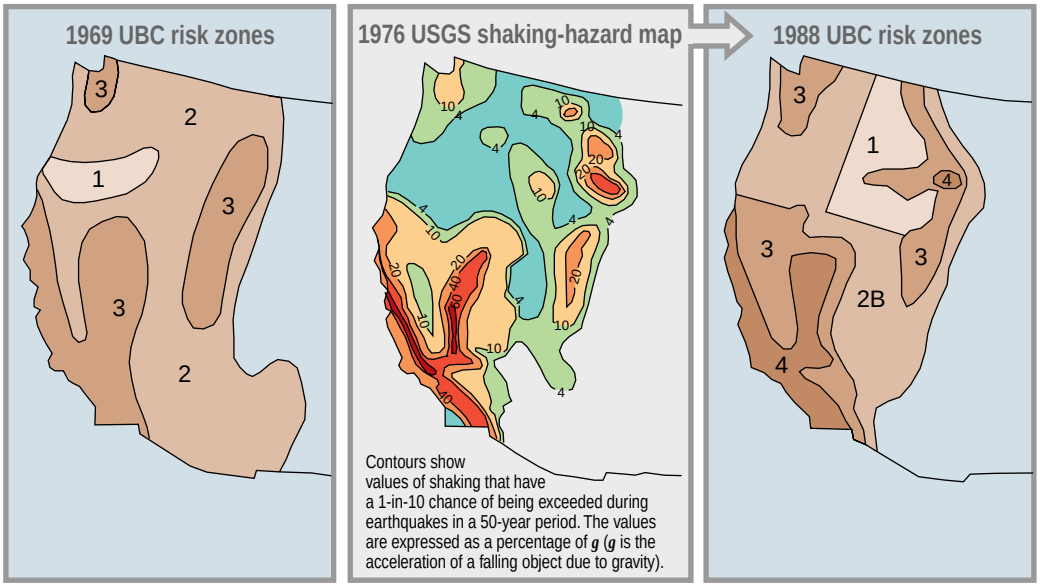
National maps of the earthquake shaking hazard in the United States have been produced since 1948. Scientists revise these maps as new earthquake studies improve their understanding of this hazard. After thorough review, professional organizations of engineers in turn update the seismic-risk maps and seismic design provisions contained in building codes. More than 20,000 cities, counties, and local government agencies use building codes, such as the Uniform Building Code, to help establish the construction requirements necessary to preserve public health and safety in earthquakes.

The upper wall of this unreinforced masonry building in Fillmore, California, collapsed and destroyed a parked vehicle during the 1994 Northridge earthquake. Unreinforced masonry buildings are especially susceptible to collapse or severe damage during strong earthquake shaking. Shaking-hazard maps can be used to determine if such buildings in a particular area need to be reinforced to make them safe in earthquakes.

Shaking-hazard maps have many other applications. For example, the 1976 U.S. Geological Survey (USGS) shaking-hazard map for the United States was used for many years as the basis of design requirements for highway bridges nationwide. Such maps are also used by:

- insurance companies to set insurance rates for properties in various areas of the country,
- civil engineers to estimate the stability and landslide potential of hillsides,
- the Environmental Protection Agency to set construction standards that help ensure the safety of waste-disposal facilities, and
- the Federal Emergency Management Agency (FEMA) to plan the allocation of assistance funds for earthquake education and preparedness.

A new series of national shaking-hazard maps has recently been prepared by the USGS. Each of these maps shows the severity of expected earthquake shaking



Detailed shaking-hazard maps prepared by U.S. Government scientists are used by professional organizations of engineers to improve the maps of seismic-risk zones published in building codes, such as the Uniform Building Code (UBC). The 1976 U.S. Geological Survey (USGS) shaking-hazard map represented a substantially improved understanding of the earthquake hazard nationwide. That map, as well as other information, was used to update seismic-risk maps, such as the 1969 UBC map. The 1988 UBC map reflects these updates, including the addition of zone 4 to represent a newly recognized higher level of risk.

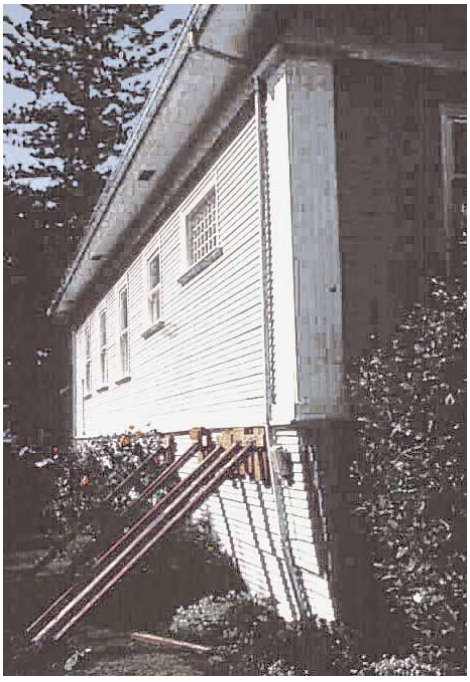
for a particular level of probability. For example, the map at the top of this page shows levels of earthquake shaking that have a 1-in-10 chance of being exceeded in a 50-year period. This new series of maps also depicts shaking using a number of different measures that engineers can readily apply to designing earthquake-resistant buildings of different heights.

Shaking-hazard maps can be combined with data about the strength of existing buildings to estimate expected earthquake damage in an area over a given period of time. Although strong earthquakes are less frequent in the Central and Eastern United States than in California, damage in those regions could be catastrophic in a powerful temblor. This is because most buildings and other structures there have not been constructed to withstand severe earthquake shaking. For example, the shaking hazard in Boston is far lower than that in Los Angeles, but the damage to structures throughout the Boston area would be much greater if a strong earthquake struck today. A single earthquake in the Central or Eastern United States could cause as many casualties and as much damage as several earthquakes of similar magnitude in California.

To familiarize design engineers, local public officials, emergency-services personnel, and other users with shaking-hazard maps and earthquake risk issues, the USGS conducts workshops throughout the country. These seminars have been held in New York, Memphis, Salt Lake City, San Francisco, and Seattle, and more will be held elsewhere in the near future. The latest shaking-hazard maps are also available for examination and comment on the Internet.

The USGS is now working with the Building Seismic Safety Council (BSSC), funded by FEMA, to produce new seismic-risk maps for the United States from the 1996 versions of USGS shaking-hazard maps. These new maps will be published by the BSSC in its 1997 recommended provisions for seismic regulations in building codes.

Through the continuing process of refining estimates of the shaking hazard across the Nation and observing successes and failures in building design, scientists and engineers are laying the groundwork for future urban environments that will be safer in earthquakes. By improving the resistance of homes, office buildings, hospitals, highways, dams, and utilities to earthquake shaking, scientists and engineers also help to ensure that communities are able to recover rapidly following a major temblor.



This home in Santa Cruz, California, damaged in the 1989 Loma Prieta earthquake, shows the effects of a weak "cripple-wall" connection between the upper part of the house and its foundation. Houses without adequate connections to foundations can easily shift during even moderate earthquake shaking, causing extensive damage. For example, pipes and wires may be broken by a slight cripple-wall shift, resulting in fires, water damage, or other problems. Much damage of this type can be avoided by using inexpensive bracing techniques, such as those recommended in the seismic design provisions of building codes.

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