

Building Science Branch Brochure

Earthquake

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Building Science Branch



Every year, natural disasters and man-made hazard events cause fatalities and injuries, and cost billions of dollars in property damage throughout the United States. Mitigation creates real value for the American people by reducing loss of life, injuries and property damage for communities who are faced with these hazards as well as by minimizing disruption and enabling faster recovery.

The Federal Emergency Management Agency (FEMA) Building Science Branch studies these hazards and provides technical services within FEMA, to the rest of the federal government and to our private sector partners. With a focus on earthquake, wind, flood and other natural and man-made hazards, the Building Science Branch takes a lead role in developing state-of-the-art publications, guidance materials, tools, training, technical bulletins and recovery advisories that incorporate the most up-to-date building codes, seismic design guidelines, flood damage resistant requirements and wind design criteria for new and existing buildings.

For more information on the Building Science Branch, visit: fema.gov/building-science.

Front cover photo: Damage to buildings in downtown Napa, California, prompted the city to fence off streets and close down businesses after a 6.0 earthquake rocked the city on August 24th, 2014. Source: FEMA

Earthquake Overview

Earthquakes are one of the most destructive natural phenomena and, if they occur in a populated area, can cause many deaths, injuries and extensive property damage. More than 143 million Americans living in the 48 contiguous states are exposed to potential damage from ground shaking earthquakes. When the people living in the earthquake-prone areas of Alaska, Hawaii and the U.S. territories are added, this number rises to nearly half of all Americans (<u>Reference</u>).

An earthquake is the sudden, rapid shaking of the earth, caused by the breaking and shifting of subterranean rock as it releases strain that has accumulated over a long time. Initial mild shaking may strengthen and become extremely violent within seconds. Additional earthquakes, called aftershocks, may occur for days, months or even years. Most aftershocks are usually one magnitude less than the main shock.

Several thousand shocks of varying sizes occur annually in the United States and 70 to 75 damaging earthquakes occur throughout the world each year. All 50 states and all U.S. territories are vulnerable to earthquakes. Where earthquakes have occurred in the past, they will happen again. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes—most located in uninhabited areas.



The map above represents the foretasted frequency of earthquake shaking capable of causing damage within the United States. Source: HSIP, ESRI, USGS

Impacts from Earthquakes

Larger earthquakes may cause deaths, injuries, and extensive property damage. Most casualties and injuries experienced during an earthquake occur when: people fall while trying to walk or run during the shaking; when they are hit by falling, flying, or sliding household items or debris; and/or when they are struck or trapped by collapsing walls or other parts of a building.

Transportation, power, water, gas, and other services may be disrupted. In some areas, shaking can cause liquefaction— when the ground acts more like a liquid. When this happens the ground can no longer support the weight of a building. In coastal areas, earthquakes under the sea floor can cause tsunamis.



This video was developed to target first responders to help them prepare for and respond to earthquakes. All 50 states and 5 U.S. territories are at some risk for earthquakes and it is impossible to predict when or where an earthquake with occur. Our first responders need to be ready.

<< Watch Video

Napa, CA, August 24, 2014 – No longer sitting on its foundation, and deemed unsafe to enter by building inspectors, this home was severely damaged by a 6.0 magnitude earthquake. Source: FEMA

Building Codes



Make sure your home and other buildings you spend time in are safer during earthquakes and more resistant to earthquake damage. If your home is more than 30 years old, get professional help to assess the building's structure. Take steps to better protect your home, including foundation bolting, cripple wall bracing, and replacing your masonry chimney with a light weight metal flue chimney. If you live in a mobile home, consider installing an earthquake resistant bracing system. These measures can help reduce major damage to a structure.

Structures that may be more vulnerable in an earthquake are those not anchored to their foundations or having weak crawl space walls, unbraced pier-and post foundations, or unreinforced masonry walls or foundations. Check with your local office of emergency management to ask if there are volunteer teams in your community to help with assessments.

<u>FEMA 232, Homebuilders' Guide to Earthquake-Resistant Design and Construction (2006)</u> and <u>FEMA P-593,</u> <u>Seismic Rehabilitation Training For One- and Two-Family Dwellings</u> are two resources available to assist you in preparing your home to be seismically resistant.

Visit <u>fema.gov/earthquake-safety-home</u> for guidance on nonstructural ways to reduce damage and increase earthquake resistance through structural design or retrofit.

The <u>Seven Design and Construction Features Important to Seismic</u> <u>Performance</u> animation provides property and business owners with an overview of the importance of understanding seismic risk as well as the adoption and implementation of building codes with appropriate seismic design and construction standards.

<u>Watch Video >></u>

Non-Structural Mitigation

Non-structural seismic hazard mitigation projects improve, strengthen, or brace non-structural building elements to reduce damage, economic losses and casualties in earthquakes. Since nonstructural failures have accounted for the majority of earthquake damage in several recent U.S. earthquakes, it is critical to raise awareness of potential nonstructural risks, the costly consequences of nonstructural failures, and the opportunities that exist to limit future losses.

To prevent potential injuries, take the time to secure your space. Secure items that might fall, fly, or slide in an earthquake. Periodically review the locations where you spend time—your home, workplace, or school—to look for potential hazards and secure them.



The <u>Earthquake Home Hazard Hunt</u> provides visuals and descriptions so that homeowners can identify and fix at-risk areas of their homes to reduce future earthquake damage and disruption.

A few examples of items that need to be secured during an earthquake include cabinet doors, mirrors, electronics, bookcases, water heaters and refrigerators, as well as everyday objects like lamps and photos.

For methods to reduce potential risk, visit fema.gov/earthquake-publications-private-sector-small-businesses.

Napa, CA, August 24, 2014 – Books scatter the floor of the historic Romanesque Goodman Library building in the City of Napa, California, which was struck by a 6.0 earthquake at 3:20 a.m. Source: Eilis Maynard/FEMA

NEHRP

National Earthquake Hazards Reduction Program (NEHRP)

The role of NEHRP is to provide the public and private sectors with the scientific and engineering information, knowledge, and technologies needed to prepare for earthquakes and reduce the costs of losses and recovery. To fulfill this role, NEHRP works in partnership with the community of earthquake professionals in academia and in business, government, technical, professional, and codes-and-standards organizations involved in the earthquake risk reduction process.

Focusing on building code standards, technical guidance, and education, NEHRP is a collaborative effort among FEMA, the National Institute of Standards and Technology (NIST), the NEHRP lead agency, the National Science Foundation (NSF), and the United States Geological Survey (USGS).

To learn more about NEHRP, visit <u>NEHRP.gov</u>.



The three main goals of NEHRP are to:

- 1. Improve understanding of earthquake processes and impacts.
- 2. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society at large.
- 3. Improve the earthquake resilience of communities nationwide.



QuakeSmart

QuakeSmart is a FEMA NEHRP initiative to help businesses in atrisk earthquake communities implement earthquake mitigation actions. The QuakeSmart program encourages business leaders and owners in areas of the U. S. that are at risk from earthquakes to take actions that will mitigate damage to their businesses, provide greater safety for customers and employees, and speed recovery in the event of an earthquake.

The <u>QuakeSmart Toolkit</u> provides actionable and scalable basic guidance and tools to the private sector, its owners, managers, and employees about the importance of earthquake mitigation and the simple things that they can do to reduce the potential of earthquake damages, injuries, and financial losses.

To learn more about QuakeSmart, visit fema.gov/quakesmart.

ShakeOut

Great ShakeOut Earthquake Drills are an annual opportunity for people in homes, schools, and organizations to practice what to do during earthquakes, and to improve preparedness. In addition to creating your family emergency plan and getting an emergency kit, encourage your family, office, and community to participate in a ShakeOut earthquake drill.

The ShakeOut provides a tangible way to participate in preparedness by focusing on the potentially life-saving actions of "Drop, Cover, and Hold On" during and immediately after an earthquake. Earthquakes can happen practically anytime, anywhere, so participate even if you don't live in high risk area.



To learn more about the Great ShakeOut drill, visit ShakeOut.org.



During America's PrepareAthon, The Great ShakeOut conducted an earthquake drill encouraging participants to Drop, Cover, and Hold On during an earthquake. Source: FEMA

Building Science Branch Library

Communities can strengthen their ability to reduce the loss of life, injuries and property damage by taking advantage of the vast resources available in the FEMA Building Science Library. The information in the library can help communities and interested citizens understand impacts from hazards, determine the appropriate standards for new construction, determine how best to retrofit existing structures to mitigate the risk of damage, and understand the benefits of enhancing or updating building codes to reduce the community's risk.

For more information about FEMA Building Science publications, please contact the FEMA Building Science Helpline by email at <u>FEMA-BuildingScienceHelp@fema.dhs.gov</u> or by phone at (866) 927-2104 (toll free).

To subscribe to FEMA Building Science e-mail updates, visit <u>https://service.govdelivery.</u> com/accounts/USDHSFEMA/subscriber/new?topic_id=USDHSFEMA_193.

To learn more about earthquake hazards and preparedness, visit the FEMA Earthquake Program page at <u>fema.gov/earthquake</u>.



Catalog of FEMA Earthquake Resources

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Napa, CA, August 24, 2014 – Unable to withstand the 6.0 magnitude earthquake the shook the city, this carport in a Napa neighborhood nearly collapsed Source: Eilis Maynard/FEMA.

