



Earthquake

An earthquake is a sudden release of energy that creates a movement in the earth's crust. Most earthquake-related property damage and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the extent and duration of the shaking. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (in mountain regions and along hillsides), and liquefaction.

Local Planning and Regulations

EQ-1 Adopt and Enforce Building Codes

FEMA Resources/Publications
FEMA 83, 224, 232, 254, 266, 313, 349, P-749, P-750

EQ-2 Incorporate Earthquake Mitigation into Local Planning

FEMA Resources/Publications
FEMA 83, 224, 254, 266, 313, 349

EQ-3 Map and Assess Community Vulnerability to Seismic Hazards

FEMA Resources/Publications
FEMA 83, 154, 366, ROVER

Building codes reduce earthquake damage to structures. Consider actions such as:

- Adopting and enforcing updated building code provisions to reduce earthquake damage risk.
- Adopting the International Building Code (IBC) and International Residential Code (IRC).

Earthquake risk can be reduced through local planning, codes, and ordinances, including:

- Creating a seismic safety committee to provide policy recommendations, evaluate and recommend changes in seismic safety standards, and give an annual assessment of local and statewide implementation of seismic safety improvements.
- Developing and distributing guidelines or passing ordinances that require developers and building owners to locate lifelines, buildings, critical facilities, and hazardous materials out of areas subject to significant seismic hazards.
- Incorporating structural and non-structural seismic strengthening actions into ongoing building plans and activities in the capital improvement plan to ensure that facilities remain operational for years to come.
- Supporting financial incentives, such as low interest loans or tax breaks, for home and business owners who seismically retrofit their structures.

To better understand and assess local vulnerability to earthquakes, consider actions such as:

- Developing an inventory of public and commercial buildings that may be particularly vulnerable to earthquake damage, including pre-1940s homes and homes with cripple wall foundations.
- Collecting geologic information on seismic sources, soil conditions, and related potential hazards.
- Creating an earthquake scenario to estimate potential loss of life and injuries, the types of potential damage, and existing vulnerabilities within a community to develop earthquake mitigation priorities.
- Using Hazus to quantitatively estimate potential losses from an earthquake.
- Maintaining a database to track community vulnerability to earthquake risk.
- Using GIS to map hazard areas, at-risk structures, and associated hazards (e.g., liquefaction and landslides) to assess high-risk areas.

EQ-4 Conduct Inspections of Building Safety

FEMA Resources/Publications

FEMA 154, 155, 202, 221, 224, 225, 226, 233, 306, 307, 395, ROVER

Inspections can be used to assess earthquake risk, such as:

- Establishing a school survey procedure and guidance document to inventory structural and non-structural hazards in and around school buildings.
- Using rapid visual screening to quickly inspect a building and identify disaster damage or potential seismic structural and non-structural weaknesses to prioritize retrofit efforts, inventory high-risk structures and critical facilities, or assess post-disaster risk to determine if buildings are safe to re-occupy.
- Consulting industry standard publications such as American Society of Civil Engineers (ASCE) 31 - *Seismic Evaluation of Existing Buildings*, ASCE 41 - *Seismic Rehabilitation of Existing Buildings*, and Applied Technology Council (ATC) 20 - *Procedures for Postearthquake Safety Evaluation of Buildings*.



Structure and Infrastructure Projects

EQ-5 Protect Critical Facilities and Infrastructure

Reduce potential damage to critical facilities and infrastructure from future seismic events through actions such as:

- Conducting seismic retrofitting for critical public facilities most at risk to earthquakes.
- Requiring bracing of generators, elevators, and other vital equipment in hospitals.
- Identifying and hardening critical lifeline systems (i.e., critical public services such as utilities and roads) to meet “Seismic Design Guidelines and Standards for Lifelines” or equivalent standards such as American Lifelines Alliance (ALA) guidance. This may distinguish a manageable earthquake from a social and economic catastrophe.
- Reviewing construction plans for all bridges to determine their susceptibility to collapse and retrofitting problem bridges.
- Using flexible piping when extending water, sewer, or natural gas service.
- Installing shutoff valves and emergency connector hoses where water mains cross fault lines.

EQ-6 Implement Structural Mitigation Techniques

FEMA Resources/Publications
FEMA 307, 320, 345, 356, 361,
395, 396, 412, 453, 547, P-774

Use structural mitigation measures to reduce damage from future seismic events, such as:

- Strengthening and retrofitting non-reinforced masonry buildings and non-ductile concrete facilities that are particularly vulnerable to ground shaking.
- Retrofitting building veneers to prevent failure.
- Building a safe room to provide protection during an earthquake.
- Installing window film to prevent injuries from shattered glass.
- Anchoring rooftop-mounted equipment (i.e., HVAC units, satellite dishes, etc).
- Constructing masonry chimneys greater than 6 feet above a roof with continuous reinforced steel bracing.



Education and Awareness Programs

EQ-7 Increase Earthquake Risk Awareness

FEMA Resources/Publications
FEMA E-74, 474, 526, 527, 528, 529, 530, P-811; EMI IS-22

There are many ways to increase awareness of earthquake risk, including:

- Working with insurance industry representatives to increase public awareness of the importance of earthquake insurance. Residential structural improvements can be factored into the process of obtaining insurance coverage or reduced deductibles.
- Developing an outreach program about earthquake risk and mitigation activities in homes, schools, and businesses.
- Educating homeowners on safety techniques to follow during and after an earthquake.
- Offering GIS hazard mapping online for residents and design professionals.

EQ-8 Conduct Outreach to Builders, Architects, Engineers, and Inspectors

FEMA Resources/Publications
FEMA 232, 313, 389, P-420, 454

Building susceptibility to earthquake damage can be improved if design professionals are made aware of proper design and building requirements. Outreach activities include:

- Conducting information sessions or other forms of outreach on seismic code provisions for new and existing buildings to enhance code use and enforcement by local architects, engineers, contractors, and code enforcement personnel.
- Training building department staff and officials on Form ATC-20 for post-earthquake building evaluation. The ATC-20 report and addendum, prepared by the Applied Technology Council, provide procedures and guidelines for making on-the-spot evaluations and decisions regarding continued use and occupancy of earthquake-damaged buildings.



EQ-9 Provide Information on Structural and Non-Structural Retrofitting

FEMA Resources/Publications

FEMA E-74, 412, 413, 414, 530, 547

Property owners can retrofit existing structures to reduce damage from seismic events. Potential actions include the following:

- Educating homeowners about structural and non-structural retrofitting of vulnerable homes and encouraging retrofit.
- Developing a technical assistance information program for homeowners. Teaching them how to seismically strengthen their houses can be an effective mitigation activity. The program can include providing local government building departments with copies of existing strengthening and repair information for distribution.
- Developing an outreach program to encourage homeowners to secure furnishings, storage cabinets, and utilities to prevent injuries and damage. Examples include anchoring tall bookcases and file cabinets, installing latches on drawers and cabinet doors, restraining desktop computers and appliances, using flexible connections on gas and water lines, mounting framed pictures and mirrors securely, and anchoring and bracing propane tanks and gas cylinders.
- Establishing a library of technical documents on structural and non-structural mitigation options as well as model ordinances and procedures that have been used by other jurisdictions to reduce earthquake risk.

Other earthquake-related mitigation actions may also apply to other hazards. See the section entitled “Multiple Hazards” for other possible ideas.