The Importance of Building Codes in Earthquake-Prone Communities

There is an often-repeated saying, "Earthquakes don't kill people, buildings do." Although you can't control the seismic hazard in the community where you live or work, you can influence the most important factor in saving lives and reducing losses from an earthquake: *the adoption and enforcement of up-to-date building codes.*

What are Building Codes?

Building codes are sets of regulations governing the design, construction, alteration, and maintenance of structures. They specify the minimum requirements to adequately safeguard the health, safety, and welfare of building occupants.

First story of an apartment building in San Francisco, California, leaning to the side after the 1989 Loma Prieta earthquake. U.S. Geological Survey Image.

Rather than create and maintain their own codes, most States and local jurisdictions adopt the model building codes maintained by the International Code Council (ICC). The ICC's family of International Codes includes:

- **International Building Code (IBC):** Applies to almost all types of new buildings.
- **International Residential Code (IRC):** Applies to new one- and two-family dwellings and townhouses of not more than three stories in height.
- **International Existing Building Code (IEBC):** Applies to the alteration, repair, addition, or change in occupancy of existing structures.

The ICC publishes new editions of the International Codes every 3 years, and many States and localities have adopted them since the first editions were issued in 2000. Before 2000, the three regionally-based legacy model code organizations (BOCA National Code, SBCCI Standard Code, and ICBO Uniform Code) combined together to form the ICC.

What are Seismic Codes?

Some provisions within the IBC, IRC, and IEBC are intended to ensure that structures can adequately resist seismic forces during earthquakes. These seismic provisions represent the best available guidance on how structures should be designed and constructed to limit seismic risk.

Changes or additions to the seismic provisions come from many different sources, including new research results and documentation of performance in past earthquakes. A primary resource is the NEHRP Recommended Seismic Provisions for New Buildings and Other Structures (FEMA P-750). FEMA's companion document Earthquake Resistant Design Concepts (FEMA P-749) provides a non-technical background explanation.

Adoption of the model codes is uneven across and within States, even in areas with high levels of seismic hazard. Some States and local jurisdictions have adopted the codes but have made amendments or exclusions relating to the seismic provisions.

FEMA Mitigation Specialist Marshall Marik inspects for structural damage to the Hilo, Hawaii Fire Station with U.S. Army Corps structural engineer Peter Lam after a recent series of earthquakes. November 13, 2006. FEMA Image.

Other jurisdictions have been slow to adopt the latest code editions. Unless your community has adopted the latest model building code, including its seismic provisions, new structures in your community may not provide the current minimum level of protection from earthquake hazards to you and others who use them.

How are the Codes Enforced?

Adopting the latest building codes is only part of the solution. Codes must also be effectively enforced to ensure that buildings and their occupants benefit from advances in seismic provisions in the model codes. For the most part, code enforcement is the responsibility of local government building officials who review design plans, inspect construction work, and issue building and occupancy permits.

What about Older Buildings?

Except in certain circumstances, such as when a building is significantly renovated or altered or there is a change in its use that triggers the IBC or IEBC, the code requirements for existing buildings are those that were in effect when the structure was designed and constructed. Your community probably has many older structures that are not protected against earthquakes. This is because buildings are often used for decades before being replaced or substantially altered.

These existing buildings are the single biggest contributor to seismic risk in the United States today.

Damage to older, reinforced concrete building in the 1994 Northridge Earthquake. ©1994 by Peter W. Clark and Regents of the University of California.

Can We Make These Buildings Safe?

It's possible to make these buildings more resistant to earthquakes through *seismic retrofitting.* When dealing with a population of buildings, the first step is to perform a quick survey using Rapid Visual Screening of Buildings for Potential Seismic Hazards (FEMA 154), or the electronic version, FEMA 154 ROVER. The next step is to evaluate the building using Seismic Evaluation of Existing Buildings (ASCE/SEI 31-03). If the evaluation shows that retrofitting is needed, this should be done using Seismic Rehabilitation of Existing Buildings (ASCE/SEI 41-06). ASCE/SEI 31-03 and 41-06 were recently updated and combined together into ASCE/SEI 41-15. The FEMA publication Techniques for the Seismic Rehabilitation of Existing Buildings (FEMA 547) provides an extensive description of retrofit techniques for strengthening the structural elements of buildings.

Seismic retrofitting of a building must also include steps to better protect non-structural components (suspended ceilings, non-load-bearing walls, and utility systems) and building contents (furnishings, supplies, inventory, and equipment). Reducing the Risks of Non-Structural Earthquake Damage (FEMA E-74) is an excellent resource for information on mitigating risk to non-structural components and contents.

Non-structural damage to the basement of the Olive View Medical Treatment Building caused by the 1971 San Fernando earthquake. ©1971 by Earthquake Engineering Research Center and Regents of the University of California.

Certain types of buildings, such as unreinforced masonry structures, have performed poorly in past earthquakes and are known to be particularly hazardous. Some local governments in high-hazard areas have enacted ordinances mandating that owners evaluate and retrofit these buildings. In most jurisdictions, however, seismic retrofitting remains voluntary.

How Important Is Seismic Retrofitting?

Seismic retrofitting of vulnerable structures is critical to reducing risk. It is important for protecting the lives and assets of building occupants and the continuity of their work. On the whole, communities with more retrofitted structures can recover from earthquakes more rapidly.

If you live or work in retrofitted structures, you're less likely to be injured during an earthquake. After the earthquake, you're also more likely to have a home and a job to which you can quickly return. Businesses that use retrofitted buildings are more likely to survive damaging earthquakes and to sustain shorter business interruptions and fewer inventory losses. FEMA's QuakeSmart program helps businesses identify and address their seismic risks through retrofitting and other earthquake mitigation activities.

Conclusions

There is no more important factor in reducing a community's risk from an earthquake than the adoption and enforcement of up-to-date building codes. Evaluating older buildings and retrofitting structural and non-structural components also are critical steps. To survive and remain resilient, communities should also strengthen their core infrastructure and critical facilities so that these can withstand an earthquake or other disaster and continue to provide essential services.

Whatcom Middle School in Bellingham, Washington, reopened in September 2011 after undergoing a seismic retrofit. ©2011 The Bellingham Herald.

For More Information

For many years, FEMA has supported seismic code development processes and promoted the adoption and enforcement of seismic codes through its participation in the National Earthquake Hazards Reduction Program (NEHRP).

FEMA has produced many publications for a variety of audiences to identify and correct building vulnerabilities through seismic rehabilitation. Visit Earthquake Publications: Building Codes and Seismic Rehabilitation to review these resources.