

## Preparing Hospitals for Earthquakes Structural and Nonstructural Issues

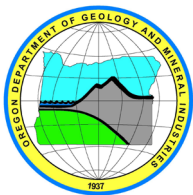
Photo: FEMA News Photo



Damage from earthquakes such as the M6.7 Northridge, CA, quake (above) can both endanger people and put a hospital out of action. Fortunately, hospitals can take steps now to prevent this.

### In this fact sheet:

- What past earthquakes reveal about hospitals' vulnerabilities
- How hospital leaders can make their buildings safer and functional after an earthquake
- Resources and tips to help improve your hospital's resilience



### How Vulnerable Are Hospital Buildings?

Every hospital should be professionally assessed to identify its unique vulnerabilities, although studies of past earthquakes reveal some common issues. Much depends on a building's age, as this indicates which codes were used to guide its design and construction. For example, Olive View Medical Center in California was severely damaged in the 1971 San Fernando quake. It was then rebuilt to a new, higher earthquake code. Structurally, the new hospital performed well in the 1994 Northridge earthquake, but nonstructural damage made it temporarily unusable. A similar pattern is evident in more recent earthquakes: Hospitals in Chile that were built to meet modern seismic codes withstood the magnitude 8.8 Maule quake in 2010; yet damage to nonstructural components—including medical, plumbing, mechanical, and electrical equipment—impaired hospital functions.

### Building Resilient Hospitals in Earthquake Country

For coastal and western areas of the Pacific Northwest, the greatest earthquake hazard is the Cascadia subduction zone, which is expected to cause a M9.0 quake and tsunami. Communities will need functioning hospitals after such an event. With this in view, Oregon Revised Statute 455.400 requires all existing hospitals to achieve a life-safety seismic performance level by 2022. New hospitals in at-risk areas should be built to exceed existing codes in order to function after an earthquake. California's Office of Statewide Health Planning and Development (OSHPD) offers useful criteria to help facilitate earthquake preparedness at hospitals ([www.oshpd.ca.gov/FDD/Pre-Approval/index.html](http://www.oshpd.ca.gov/FDD/Pre-Approval/index.html)). Hospital owners should work with a seismic design team to identify and achieve the right performance level.

### Nonstructural Components

When preparing your hospital to withstand shaking, give equal attention to nonstructural elements, such as fire-sprinkler and plumbing systems, ceilings, and decorative cladding, as well as medical equipment and contents. Unless properly designed, installed, and anchored, such elements can break or fall in an earthquake, injuring people, causing damage, blocking egresses, and putting the hospital out of action.



Earthquakes can topple and damage poorly anchored tanks (above) and medical gas cylinders.

Photo: DOGAMI

### Tips & Tools for Existing Buildings

- Arrange for subject experts to examine the hospital's site and buildings using the Hospital Seismic Evaluation Checklist in FEMA 577.
- Use FEMA P-767 to learn how to reduce seismic risks incrementally.
- Remember to assess mechanical equipment rooms and systems; include them in your mitigation plans.

## How Ready Is Your Hospital for the Next Earthquake?

Assess existing buildings and systems to identify vulnerabilities that must be mitigated to enable your hospital to withstand an earthquake and remain operational.

- Engage qualified, licensed structural engineers to use ASCE 41 to conduct seismic engineering evaluations of both structural and nonstructural features.
- Use FEMA P-1019 to evaluate the emergency power system; prepare to function on such power for three weeks (see CREW fact sheet #10).
- Use CDC guidelines to assess the hospital's water needs and plan for water outages; prepare the hospital to function on emergency water supplies for three weeks (see CREW fact sheet #11).

Develop and implement a resilience action plan based on your findings; be sure to consult your local partners, including emergency managers, water districts, electricity providers, school and elected officials, and other healthcare providers.

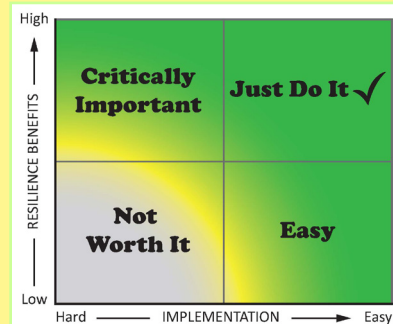
### ASCE 41: What to Expect

Ask the structural engineer who performs your ASCE 41 assessment to provide an executive summary for non-experts, along with a section called "Expected Building Performance" that specifies whether the existing building meets the hospital's immediate-occupancy performance level objective. If not, it should explain the key issues, compare the building to the performance of a new-code building, and describe:

- The building, structural systems, and renovations/retrofits completed since original construction.
- The documents reviewed, assumptions made during evaluation, and performance level for evaluation
- Structural and nonstructural deficiencies, what they mean in terms of expected seismic performance, the part(s) of the building that would experience the most damage, how the building can be retrofitted, and the impacts of completing retrofits.

### Upgrading Existing Hospitals

Upgrade incrementally to improve safety and achieve greater functionality after an earthquake by ranking and implementing proposed upgrades to achieve the greatest impact with available resources.



### Featured Resources

[ASCE 41-17](#): *Seismic Evaluation and Retrofit of Existing Buildings*. American Society of Civil Engineers (2017).

[FEMA E-74](#): *Reducing the Risks of Nonstructural Earthquake Damage* (2012b).

[FEMA 577](#): *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds* (2007), and [FEMA P-767](#): *Earthquake Mitigation for Hospitals* (2013).

*Emergency Power for Hospitals* (CREW Fact Sheet #10) and *Emergency Water for Hospitals* (CREW Fact Sheet #11).

Office of Statewide Health Planning and Development (OSHPD): [www.oshpd.ca.gov/FDD/Pre-Approval/index.html](http://www.oshpd.ca.gov/FDD/Pre-Approval/index.html)

#### Oregon

*Oregon Coastal Hospitals Preparing for Cascadia* (DOGAMI Open-File Report 0-18-03), [see especially Appendix A: Technical Resources List for Hospitals]. [www.oregongeology.org/pubs/ofr/O-18-03\\_report.pdf](http://www.oregongeology.org/pubs/ofr/O-18-03_report.pdf)

Oregon Health Authority (OHA) Prepare for Earthquakes website: <http://public.health.oregon.gov/Preparedness/Prepare/Pages/Prepare-ForEarthquake.aspx>

Oregon Revised Statute (ORS) 455.400: <https://www.oregonlaws.org/ors/455.400>

Hospitals in Oregon can apply to the Seismic Rehabilitation Grant Program for up to 2.5 million to support seismic upgrades: [www.oriinfrastructure.org/infrastructure-programs/seismic-rehab/](http://www.oriinfrastructure.org/infrastructure-programs/seismic-rehab/)

Learn more at [CREW.ORG](http://CREW.ORG)