

# EXPECTED EARTHQUAKE PERFORMANCE OF BUILDINGS DESIGNED TO THE CALIFORNIA BUILDING CODE

Earthquakes don't happen everyday but when they do, there are consequences to families, businesses, and communities!

What is your risk?  
How are you impacted after a quake?  
How do you want to live after an earthquake?  
What can you do to achieve that goal?





# EXPECTED CODE PERFORMANCE

The California Building Code is a *minimum requirement* intended to protect *life safety* and *prevent collapse*. It *allows damage*, which means buildings may not be habitable or functional after a moderate or large earthquake.

## THE BUILDING CODE...

### HAS LIFE SAFETY INTENT

the building may remain standing so you can evacuate

### ALLOWS DAMAGE

you might not be allowed to re-enter a damaged building

### IS A MINIMUM REQUIREMENT

you can choose to have your building designed or retrofitted for less damage

## EARTHQUAKES & CODE IMPROVEMENTS

1971

### SAN FERNANDO

Magnitude 6.5: 64 died, 2543 injured, \$553M damage  
Code improvement: Concrete detailing

1989

### LOMA PRIETA

Magnitude 6.9: 63 died, 3757 injured, \$5.6-\$6B damage  
Code improvements: Wood frame soft story issues

1994

### NORTHRIDGE

Magnitude 6.7: 57 died, 8700 injured, \$13B-\$40B damage  
Code improvement: Welded steel frame detailing

## EXPECTED PERFORMANCE OF CODE-DESIGNED NEW BUILDINGS IN EARTHQUAKES

### ESSENTIAL BUILDINGS



Examples: Hospitals, Fire Stations

**Extreme Shaking**  
Maximum Considered Earthquake



**Strong Shaking**  
Design Level Earthquake



### ORDINARY BUILDINGS



Examples: Houses, Apartments, Stores, Offices, Schools

**Extreme Shaking**  
Maximum Considered Earthquake



**Strong Shaking**  
Design Level Earthquake



**Collapse Prevention**

**Life Safety**

**Immediate Occupancy**

**Operational**

Likely

Likely

Unlikely

Unlikely

Likely

Likely

Possibly

Unlikely

Likely

Possibly

Unlikely

Unlikely

Likely

Likely

Unlikely

Unlikely

# POSSIBLE CONSEQUENCES AND YOUR RISK

## MYTHS

I occupy a new building, so I will be fine.

## REALITY & RISKS

The California Building Code establishes a minimum standard intended to protect life safety. Even a new building, following an earthquake, may have damage and be unusable.

My building was retrofitted last year, so I will be fine.

Most retrofitted buildings are not required to be fully compliant with the current California Building Code. Even a retrofitted building may have damage and be unusable after an earthquake.

Only buildings that are compliant to current code can be occupied or sold.

Even as the California Building Code develops and improves, communities may not be able to require existing buildings to comply with current code.

My home and workplace are not located next to a fault, so I will be fine.

Different soil and site conditions can result in strong shaking far from faults. In 1989, severe damage and collapses occurred in San Francisco and Oakland, 60 miles away from the epicenter of the Loma Prieta Earthquake.

I am located in a lower hazard area, so I will be fine.

In lower hazard areas, infrequent earthquakes can still cause strong shaking.

Damage to the building's structure is the most costly type of damage in earthquakes.

Most costs are typically from non-structural repairs, replacement of high-value components, and lost revenue from business disruption.

I cannot afford to mitigate and prepare now.

Bracing and anchoring building contents can be part of regular maintenance tasks. There are programs designed to partially subsidize home mitigation efforts. Taking action now can reduce damage and disruption later.

## EARTHQUAKE HAZARD IN CALIFORNIA



Higher Hazard →



## CONSEQUENCES



### FAMILY

- injury from falling items
- expensive repairs
- isolation and stress
- displacement



### BUSINESS

- loss of inventory
- supply chain broken
- loss of income
- relocation



### COMMUNITY

- limited supplies & services
- emergency services overloaded
- fragmentation



*Life Safety Level of Damage for an Ordinary Building after a Large Earthquake*

# THINGS YOU CAN DO

Preparedness will determine the quality of life in the weeks and months that follow a major earthquake.



## FAMILY

- Secure your space: brace and restrain heavy and important items such as water heaters and bookcases.
- In addition to a short-term emergency and communication plan, develop a longer-term recovery plan that includes personal and financial security.
- Assess age and earthquake safety of home. Consider retrofitting measures including chimney bracing.

## RESOURCES

### California Earthquake Authority – Residential Earthquake Insurance and Mitigation

<https://www.earthquakeauthority.com>

#### “Homeowner’s Guide to Earthquake Safety”

[https://ssc.ca.gov/forms\\_pubs/hog.html](https://ssc.ca.gov/forms_pubs/hog.html)

#### “Staying Safe Where the Earth Shakes”

<https://www.earthquakecountry.org/stayingsafe/>

#### “MyHazards” Online Tool: Risks and Recommended Actions

<http://myhazards.caloes.ca.gov/>



## BUSINESS

- Develop a short-term emergency plan as well as a longer-term continuity and recovery plan that includes employees, inventory, and financial security.
- Incorporate equipment and inventory restraint with operational maintenance plans.
- Confer with experts to identify risks and how to maintain operational functions by designing beyond the minimum code level.

## RESOURCES

### California Resilient Business Challenge

<https://outsmartdisaster.com/be-resilient-at-work/resilient-business-challenge/>

#### “Commercial Property Owner’s Guide to Earthquake Safety”

[https://ssc.ca.gov/forms\\_pubs/cog.html](https://ssc.ca.gov/forms_pubs/cog.html)

#### “7 Steps to an Earthquake Resilient Business”

<https://www.earthquakecountry.org/library/7StepsBusiness2008.pdf>



## COMMUNITY

- Engage, inform, and train neighborhoods about mitigating the consequences of major earthquakes, including short-term emergency response and longer-term recovery measures.
- Determine which facilities are at risk and their impact on the public.
- For each public building, define its post-earthquake role in the community, complete a structural and non-structural assessment, and implement needed upgrades.

## RESOURCES

### Federal Emergency Management Agency (FEMA) Earthquake Publications

<https://www.fema.gov/earthquake-publications>

#### “Natural Hazard Mitigation Saves - 2018 Interim Report” and Fact Sheets

<https://www.nibs.org/page/mitigationsaves>

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