Preparedness Now

Available on YouTube

From SCEC - Southern California Earthquake Center
What’s at Stake?

Dr. Lucy Jones
Founder, Dr. Lucy Jones Center for Science and Society
Living on the plate boundary

Moving to San Francisco at 1 3/4 inches per year
Shaking Intensity ≠ Magnitude

Easter 2010 M7.2
El Mayor Cucaipa

January 1994 M6.7
Northridge
The other faults of southern California
ShakeOut Simulation of M7.8 on San Andreas
Our Urban Society Is At Risk

Urban Disaster Resilience is having a society that functions after the disaster.
A System of Systems
NECESSARY SYSTEMS

- Transportation
- Supply Chain
- Electricity
- Water
- Gas
- Internet
- Cell Towers
- Phone Systems
- Buildings
- Health and Safety
- Emotional Well-Being
- Business/Jobs
- Schools
- Banking/Finance
- Repair and Recovery
CRITICAL INFRASTRUCTURE

- WATER
- GAS
- ELECTRICITY
- INTERNET
- BUILDINGS
- CELL TOWERS
- PHONE SYSTEMS
Water and the San Andreas Fault

MAJOR WATER CONVEYANCE & EARTHQUAKE FAULTS
IN THE SCAG REGION

Los Angeles
Palmdale
Irvine
Lancaster
Riverside
Hesperia
Palm Springs
Victorville
Indio
Anaheim
Ontario
Apple Valley
Menifee
Adelanto
Fontana
Chino
Corona
Perris
Barstow
Long Beach
Hemet
Santa Clarita
Chino Hills
Simi Valley
Redlands
La Quinta
Temecula
Thousand Oaks
Orange
Murrieta
Yucaipa
Oxnard
Rialto
Moreno Valley
Twentynine Palms
Glendale
Jurupa Valley
Lake Elsinore
Yucaipa
Beaumont
Pomona
Banning
Santa Ana
Coachella
Riverside
Los Angeles
Ventura
Imperial
Orange
Colorado River Aqueduct
Coachella Canal
Second San Diego Canal
All American Canal
San Diego Canal
Sources: Esri, USGS, NOAA

Source: California Department of Water Resources, State of California Geoportal | Date: 10/10/2016 | P:\Feiyang Zhang\California Aqueduct\Map

° 0 5 10 20 Miles

WATER SYSTEMS
- Major Water Conveyance
- Nature Water Features

EARTHQUAKE FAULTS
- Historic
- Late Quaternary
- Holocene & Latest Pleistocene
Damaged Water Supply Network

- All aqueducts cross the San Andreas to get to southern California and will be broken.
  - 18 months to repair
- Widespread damage to pipes in the ground
  - 6 months to restore all service
Damaged Water Supply Network

**Causes:**
- Earthquake shaking
- Fault offset
- Chemical accidents

**Short-term Consequences:**
- Life loss
- Impaired medical response
- Loss of shelter

**Damaged Water Supply:**
- Damage to buildings and property
- Business closure

**Long repair time consequences:**
- Business disruption

**Needed for repairs:**
- Internet for water companies
- Transportation
- Purification systems

**Mass evacuation**

**Direct and indirect consequences:**
- Business closure
- Damage to buildings and property
- Life loss
- Impaired medical response
- Loss of shelter

**Short-term consequences:**
- Internet for water companies
- Business closure
- Damage to buildings and property

**Long-term consequences:**
- Business disruption
- Needed for repairs
Fire Following the Earthquake

- 1,600 ignitions requiring a fire engine
- 1,200 exceed capability of 1st engine
- 200 million square feet burnt
  \(\approx 133,000\) single family dwellings
- \(\approx 1.5\%\) of total building stock
- Property loss: $65 billion
Communication disruption

- Electricity could be out for weeks
- Cell tower backup power lasts 4 hours
- Two-thirds of Internet bandwidth in fiber cables across the San Andreas
Communication disruption

**Causes**
- Earthquake shaking
- Fault offset
- Fire

**Short-term consequences**
- Business disruption
- Emotional hardship
- Transportation
- Manpower
- Damaged cell towers
- Severed fiber optics
- Impaired emergency response
- Impaired medical response
- Impaired fire response
- Damage to communications networks
- Phone lines overloaded

**Long repair time consequences**
- Needed for repairs
Damaged Transportation

Maule, Chile, M8.8
February 27, 2010
Damage to Transportation

Short-Term Consequences

- Impaired Emergency Response
- Impaired Medical Response
- Traffic Jams and Accidents
- No Debris Removal
- Loss of Food Supply

Causes

- Earthquake Shaking
- Landslides
- Fault Offset
- Damaged Power System
- Fire
- Water Pipe Breakage

Needed for Repairs

- Debris Removal
- Power
- Internet for CalTrans
- Manpower

Long Repair Time Consequences

- Supply Chain Disruption
- Impeded Reconstruction
ShakeOut Damage to Buildings

- Concrete buildings:
  - Commercial buildings from 1950s and 1960s
  - In highest shaking areas, 10% collapse
  - Biggest life loss in scenario
- Unreinforced masonry
  - Collapse of 300+ buildings
  - Complete financial loss for 90% within 30 km of fault
- Pre-1994 steel frame high rises could collapse
- 300,000 buildings with loss >10% of value
Building Damage and Destruction

**CAUSES**
- Earthquake shaking
- Fire
- Water pipe breakage

**SHORT-TERM CONSEQUENCES**
- Emotional hardship
- Long repair time
- Consequences

**NEEDED FOR REPAIRS**
- Debris removal
- Power
- Transportation
- Manpower

**LONG REPAIR TIME CONSEQUENCES**
- Damaged buildings
- Life loss
- Business closure
- Damage to adjacent building property $
Retrofitting URMs has saved lives

- In the Northridge earthquake:
  - No one died in a URM
  - Only 19% of inspected URMs needed repairs compared to 33% of buildings overall

- Statewide
  - Jurisdictions have retrofitted or demolished 88% of URMs with mandatory programs
  - Only 22% with voluntary programs
Buildings that Can Kill

- Unreinforced masonry (pre-1935)
- Soft-first-story (pre-1980)
- Non-ductile concrete (pre-1980)
- Steel moment frames (pre-1997)
Current building code

- In worst earthquake, 90% probability of not collapsing
- 10% probability of collapse = 10% of new buildings collapsing
Impaired buildings are economic loss
In California, many more buildings impaired

- Average of Loma Prieta & Northridge
- For each collapse
  + 13 red tags
- For each red tag,
  + 3.8 yellow tags
- = 63 impaired per collapse

Check: Napa 2014 had 57 impaired per collapse
CAN WE SURVIVE “THE “BIG ONE”? 

49% USABLE BUILDINGS AFTER EARTHQUAKE

1% COLLAPSED

10% UNSAFE

40% LIMITED USE
Christchurch 2015
Most people don’t know what the code provides

What is the building code’s objective?

Survey of 814 people by Dr. Keith Porter, U. Colorado:
Most people want more than the code provides

What should it ensure?

- Occupiable: 41%
- Functional: 18%
- Life safe: 22%
- Do not know: 17%
- Other: 2%
Social Repercussions

<table>
<thead>
<tr>
<th>Year</th>
<th>SF</th>
<th>LA</th>
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<tbody>
<tr>
<td>1890</td>
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<td>1900</td>
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<td>1910</td>
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<tr>
<td>1920</td>
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</table>

1906 earthquake

Population
Biggest Issues from San Andreas

- Life loss in old buildings
- Fire following earthquake
- Loss of housing
- Business disruption
  - Unusable commercial properties
  - Transportation disruption
  - Utility outages
- Region-wide disruption
## At-Risk Ranking

<table>
<thead>
<tr>
<th>Community Asset</th>
<th>Individual Rank</th>
<th>Your City Rank</th>
<th>Responsible Entity</th>
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</thead>
<tbody>
<tr>
<td>Water</td>
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<tr>
<td>Electricity</td>
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<td>Hospitals</td>
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<td>Schools</td>
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<tr>
<td>Parks and Cultural Venues</td>
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<tr>
<td>Transportation Infrastructure</td>
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<tr>
<td>Roads/Major Highways/Transit</td>
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<tr>
<td>Community Landmarks (official or unofficial)</td>
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<tr>
<td>Municipal Buildings</td>
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<tr>
<td>House of Worship/Faith</td>
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<tr>
<td>Community Non-Profit/Community Serving Organizations</td>
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<tr>
<td>Jobs Base</td>
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<tr>
<td>Business Base tax base</td>
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<tr>
<td>Economic Stability</td>
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<tr>
<td>Historical Character</td>
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<tr>
<td>Public Health</td>
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<tr>
<td>Housing stock - single family Homes</td>
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<tr>
<td>Housing Stock - Multi-family/Mental</td>
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<tr>
<td>Community Identity: Way of Life</td>
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<tr>
<td>Other:</td>
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</table>
What happened in New Orleans
What happened physically
Knowing risk ≠ planning ahead
Cascading failures
What happened politically
Economic consequences

NEW ORLEANS VS NASHVILLE
ECONOMIC GROWTH

REAL GROSS DOMESTIC PRODUCT
(in Billions of Dollars)

YEAR

NEW ORLEANS

NASHVILLE


$80 BILLION

$105 BILLION
SOCIAL REPERCUSSIONS

NEW ORLEANS
POPULATION GROWTH

YEAR


POPULATION

180,000 260,000 340,000 420,000 500,000
## Pitfalls

When tackling a complicated issue like seismic safety, city officials can face unique challenges. There are some common pitfalls that have occurred when addressing this issue and still others that may be unique to your specific jurisdiction. Below, first list the potential pitfalls you may face, and then, suggest ways you can mitigate those challenges:

<table>
<thead>
<tr>
<th>Pitfalls</th>
<th>Ways to Address Them</th>
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Prepared by the Dr. Lucy Jones Center for Science and Society
Unlikely Supporters

For the groups or organizations below, determine whether they will potential be supportive or be an obstacle in advance your seismic safety goals. Put an “S” (supporter) “O” (obstacle), “?” (unsure) or “N/A” (not applicable in your role) in the status column. For the supporters, explain what their role might be; for potential opponents, explain how could they be turned to supporters?

<table>
<thead>
<tr>
<th>Organization or Group</th>
<th>Status</th>
<th>Potential Role</th>
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<tbody>
<tr>
<td>Homeowners Associations</td>
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<tr>
<td>Renters Rights Advocates</td>
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<tr>
<td>Housing Advocates</td>
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<td>Developers</td>
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<td>Apartment Owners</td>
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<td>Utility Operators</td>
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<td>Transit Advocates</td>
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<td>Transit Riders</td>
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<tr>
<td>Older Adults</td>
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<td>Youth Advocates</td>
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<tr>
<td>Animal Advocates</td>
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<tr>
<td>Chambers of Commerce</td>
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<tr>
<td>Large Business Owners</td>
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<tr>
<td>Trade Associations</td>
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<tr>
<td>College Students</td>
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<tr>
<td>Renters</td>
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<tr>
<td>Homeowners</td>
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<td>Social service nonprofits</td>
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<tr>
<td>Disability Advocates</td>
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<tr>
<td>Building Owners</td>
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<tr>
<td>Structural Engineers Assn.</td>
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<tr>
<td>American Institute of Architects (AIA)</td>
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<td>American Planning Assn. (APA)</td>
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Prepared by
the Dr. Lucy Jones Center
for Science and Society
Your Seismic Safety Priorities

List the top three issues/items that you have discussed that you could focus on to increase seismic safety in your jurisdiction.

- 
- 
- 

After listing the priorities, rank them 1, 2, and 3 in the box.

For each priority listed above, what are the main tasks that would need to be completed to increase seismic safety in this area in the short-, mid-, and long-term? Estimate duration it would take to complete them.

**Priority 1:**

<table>
<thead>
<tr>
<th>Short-Term Tasks (less than 6 months)</th>
<th>Duration In Weeks Or Months</th>
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<tbody>
<tr>
<td>Task</td>
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<table>
<thead>
<tr>
<th>Mid-Term Tasks (6-12 months)</th>
<th>Duration In Weeks Or Months</th>
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<tbody>
<tr>
<td>Task</td>
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<table>
<thead>
<tr>
<th>Long-Term Tasks (more than 12 months)</th>
<th>Duration In Weeks Or Months</th>
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<tbody>
<tr>
<td>Task</td>
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Earthquake Glossary

To understand earthquakes, here is a short primer on some of the terms scientists use and what they mean:

**Earthquake** is the sudden slip of one block of the earth's crust past another that produces shaking as one of its effects. Just like the slip of one finger past another when snapping your fingers produces a sound wave, the slip along a fault produces waves that are perceived as earthquake shaking.

Magnitude is a number that represents the total energy released during an earthquake. The smallest earthquake ever recorded is about magnitude -2 (yes, like temperature magnitudes can be negative, and the largest historical event was magnitude 9.5. Although there is no theoretical limit to magnitude, it is unlikely that an earthquake much larger than 9.5 will occur. Each unit of magnitude represents a 32 times increase in the energy released by the fault. So a magnitude 7 earthquake has 32 times more energy than a magnitude 6 earthquake, and more than thousand times (!) more energy than a magnitude 5.0 earthquake and a million times more energy than a magnitude 3.0 earthquake. These are no "points on the scale". When seismologists say "point 7" is to express the Decimal point - magnitude 6 point 5 means magnitude 6.5.

**Intensity** is a number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures. Several scales exist, but the one most commonly used in the United States is the Modified Mercalli Intensity scale sometimes written "MMI". Unlike the magnitude, which has one value for each earthquake, the intensity depends on your distance from the earthquake and decreases with distance from the event.

The fault is the surface across which two blocks of crust slip in an earthquake. This planet surface may intersect the earth's surface as an identifiable fault trace. Faults vary in size from centimeters to thousands of kilometers long. A fault zone may be a complicated set of fractures up to hundreds of kilometers wide. The magnitude of an earthquake is proportional to the area of the fault that slips and how much it slips. A magnitude 5.0 happens over a fault surface of 1-10 square kilometers. A magnitude 5.0 requires slip on a fault a few kilometers across, while a magnitude 8.0 needs a fault several hundreds of kilometers long. Big earthquakes occur only on big faults, but a small earthquake could occur on a big fault if only part of it slips. Small quakes may also happen on a little "secondary" fault near a big fault or on a tiny fault.

The slip is the amount of movement that occurs between the two sides of the fault surface during an earthquake. The amount of slip can range from a few centimeters for a magnitude 4.0 up to 10 meters or more for a magnitude 9.0. For smaller quakes this slip may all occur miles deep in the earth and not reach the surface.

The epicenter is the point on the earth's surface above the hypocenter, which is the point at depth on the fault where the earthquake begins. When an earthquake occurs the slip doesn't happen all at once. The earthquake begins at a point and ruptures across the fault. The rupture moves at about 3 kilometers per second, so a bigger earthquake lasts for a longer time.

An earthquake cluster, or earthquake sequence, is a group of earthquakes that are close in time and space. Every earthquake changes stress in the surrounding rock and increases the probability that another earthquake will occur nearby. This probability dies off quickly with both time and distance, so mostly they are near the fault surface that has been moving. A big earthquake is on a big fault and therefore produces more aftershocks.
Earthquake FAQs

1. When do fault locations matter?

All earthquakes occur on faults but often the faults are too small to be recognized at the surface — or even to extend to the surface at all. But even a small earthquake can create a big fault. So when an earthquake occurs near a big fault, it could trigger a bigger earthquake on that nearby big fault. The first earthquake need not be on the big fault to trigger another earthquake.

2. How are earthquakes assigned to faults?

The only way to be certain an earthquake occurred on a particular fault is to see actual surface slip on that fault, usually as cracks at the surface. Surface slip is almost never seen in a small earthquake smaller than magnitude 5.0 and sometimes not for even larger earthquakes. If no surface slip is observed near a fault, a focal mechanism can still allow scientists to estimate the orientation and direction of slip on the fault. If that is parallel to a mapped fault and the location is very near that fault, it might be on the fault — or it might be a secondary fault that runs parallel to the main fault. Without surface slip, it may take quite a bit of research to make the assignment.

**The USGS usually doesn’t try to assign a fault for earthquakes below magnitude 5.1.**

3. How do you determine the depth of an earthquake?

When an earthquake happens, the seismic waves (ground shaking) travel from the earthquake and arrive at seismic stations distributed across southern California. By measuring the time these waves reach each station, we triangulate the location of the earthquake including the depth. Because all our stations are on the surface, we cannot determine the depth as accurately as the horizontal location. To determine the depth accurately, we need to have at least one station close to the horizontal location as the earthquake is deep. So for very shallow earthquakes, it can be quite difficult to know exactly how deep they are.

4. What’s the difference between an earthquake and an aftershock?

Nothing. An aftershock is as earthquake.

5. Can aftershocks trigger another earthquake?

Absolutely. An aftershock is an earthquake and every earthquake makes another one more likely.

6. Are we overdue for a big earthquake?

Earthquakes are not regular enough to talk about “overdue.” On the central section of the San Andreas fault, there are intervals as short as 40 years and as long as 400 years between individual events at the same spot.

7. When smaller earthquakes happen, do they release more energy as big ones are less likely?

No. Seismologists have observed that for every magnitude 6.0 earthquake there are 10 of magnitude 5.0, 100 of magnitude 4.3, 1,000 of magnitude 3.0, and so forth as the events get smaller and smaller. This seems like a lot of small earthquakes, but there are never enough small ones to eliminate the occasional large event. It would take 32 magnitude 5.0’s, 1,000 magnitude 4.0’s, 32,000 magnitude 3.0’s to release the same energy as one magnitude 6.0 event. So even though there are more small events than large ones, there are never enough to release all the stress in the earth’s crust and eliminate the need for the occasional large earthquake.

Prepared by
the Dr. Lucy Jones Center
for Science and Society
Realities for Southern California

UNIFORM CALIFORNIA EARTHQUAKE RUPTURE FORECAST

This model describes where large earthquakes at least M6.7 are most likely to originate in California. Each of the little black boxes is a segment of a fault of the right size to produce a M6.7 earthquake. To be a larger earthquake, multiple segments need to move together. The areas with the highest likelihood are dark red where the chance of being part of a big earthquake is better than 50-50 for a 30-year period. This very high probability only occurs on the San Andreas Fault which is the fastest moving fault in California.

Scientific Consensus

This model was developed by a large team of scientists working with the U.S. Geological Survey, Southern California Earthquake Center and the California Geological Survey and published in 2013. It compiles all the work scientists have done about faults, where they are, and how fast they move, and has been extensively peer reviewed. It is the best estimate of where earthquakes are likely to originate. It does not tell you the chance of getting damaging earthquake shaking.

Prepared by the Dr. Lucy Jones Center for Science and Society
Impacts for Southern California

SHAKEOUT SCENARIO: IMPACT OF A SAN ANDREAS EARTHQUAKE

The U.S. Geological Survey led a large team of experts to model what was likely to happen when a big San Andreas earthquake finally breaks through the southern part of the fault. This map shows the prediction of what the shaking will be. The black line is the part of the fault modeled to break in this earthquake. Very near the fault, you receive very strong shaking (red). As you move away from the fault, the level of shaking mostly decreases. But in valleys that have a thick layer of soil, the shaking is amplified and we see strong shaking tens of miles distant from the fault.

Bottom line: The San Andreas earthquake will give all of southern California the type of strong shaking that only the northwest San Fernando Valley got in the 1994 Northridge earthquake. Map A shows the shaking from 1994 on the same scale and same colors as the San Andreas map (Map B).

Source: U.S. Geological Survey

Prepared by the Dr. Lucy Jones Center for Science and Society
15 Common Earthquake Myths

1. It's Hot and Dry - Earthquake Weather!
   Many people believe that earthquakes are more common in certain kinds of weather. In fact, no correlation with weather has been found. Earthquakes begin many miles below the region affected by surface weather. People tend to notice earthquakes that fit the pattern and forget the ones that don't. Also, every region of the world has a story about earthquake weather, but the type of weather is whatever they had for their most memorable earthquake.

2. Big Earthquakes Always Happen in the Early Morning
   This myth may be so common because we want it to be true. Several recent damaging earthquakes have been in the early morning, so many people believe that all big earthquakes happen then. In fact, earthquakes occur at all times of day. The 1995 Long Beach earthquake was at 5:44 pm and the 1940 Imperial Valley event was at 9:37 pm. More recently, the 1992 Joshua Tree earthquake was at 9:00 pm and the 2003 San Simeon event was at 11:15 am. It is easy to notice the earthquakes that fit the pattern and forget the ones that don't.

3. Beachfront Property in Arizona
   The idea of California falling into the ocean has had an enduring appeal to those envying its life in the Golden State. Of course, the ocean is not a great hole into which California can fall, but it is itselffund at a somewhat lower elevation with water above it. The motion of plates will not make California sink - California is moving horizontally along the San Andreas fault and up around the Transverse Ranges.

4. And the Earth Opened...
   A popular literary device is a fault that opens during an earthquake to swallow up an inconvenience character. But, unfortunately for reincidized writers, gaping faults exist only in novels. The ground moves across a fault during an earthquake, not away from it. If the fault could open, there would be no friction. Without friction, there would be no earthquake.

5. We Have Good Building Codes: So We Must Have Good Buildings
   The best building codes in the world do nothing for buildings built before that code was enacted. While the rules have been updated, the older buildings are still in place. Fixing problems in older buildings - retrofitting - is the choice of the building owner, unless ordinances specifically requiring retrofitting has been passed.

6. Head for the Doorway
   An enduring earthquake image of California is a collapsed adobe home with the door frame as the only standing part. From this came our belief that a doorway is the safest place to be during an earthquake. True - if you live in an old, unimproved adobe house. In modern houses, doorways are no stronger than any other part of the house and usually have doors that will swing and can injure you. You are safer under a table.

7. Everyone Will Panic During the Big One
   A common belief is that people always panic and run around madly during and after earthquakes, creating more danger for themselves and others. Actually, research shows that people usually take protective actions and help others both during and after the shaking. Most people don't get too shaken up about being shaken up!
Resource Organizations

American Institute of Architects/National Institute of Building Sciences: https://www.brikbase.org/

AIA provides technical support via reports on the Building Research Information Knowledgebase (BRIK), an online information portal where you will find current, professionally-reviewed research on all facets of the built environment, from building performance and materials to large-scale infrastructure and systems. BRIK is a collaborative effort of AIA and the National Institute of Building Sciences.

Contact Person: Will Wright, will@aisia.socal.org (ccally)

Earthquake Country Alliance: www.earthquakemcountry.org

The Earthquake Country Alliance (ECA) is a public-private partnership of people, organizations, and regional alliances that work together to improve preparedness, mitigation, and resiliency.

ECA provides information and resources to help everyone who lives, works, or travels in earthquake country get prepared to survive and recover quickly.

Contact Person: Mark Bentheim, bentheim@usc.edu

Southern California Earthquake Center: www.scec.org

Southern California Earthquake Center’s community engages earthquake science through three basic activities: (a) gathering information from seismology and geodetic sensors, geologic field observations, and laboratory experiments; (b) synthesizing knowledge of earthquake phenomena through modeling; and (c) communicating this information of seismic hazards to reduce earthquake risk and promote community resilience.

Contact Person: Mark Bentheim, bentheim@usc.edu

Structural Engineers Association of Southern California: http://www.seaosc.org/Safer-Cities-Advisory-Program

The Safer Cities Advisory Program provides pro bono technical insights and creative minds from their membership to have an independent, qualified review of a jurisdiction’s draft ordinances and programs and provide expert advice from their qualified and vetted members.

Contact Person: Binnie Ochoa, seaosc@seaosc.org

Thriving Earth Exchange: tvearthexchange.org

Thriving Earth Exchange (TEX) helps communities leverage Earth and space science to build a better future for themselves and the planet. TEX does this by bringing together Earth and space scientists and community leaders and helping them combine science and local knowledge to solve on-the-ground challenges related to natural hazards, natural resources, and climate change.

Contact Person: Natasha Udod-ganai, nudogana@ags.org

Urban Land Institute: http://uli.org/research/certers-initiatives/urban-resilience-program/

The Urban Land Institute provides leadership in the responsible use of land and in creating and sustaining thriving communities. As a nonpartisan organization, the Institute has long been recognized as one of America’s most respected and widely quoted sources of objective information on urban planning, growth, and development.

Contact Person: Jonathan Nettler, jonathan.nettler@uli.org
# Sample Seismic Ordinances

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Topic</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Burbank</td>
<td>Single Family Wood Frame Retrofit</td>
<td>Amendment requires following Chapter A4 on their voluntary program for retrofit of existing wood frame residential buildings with soft, weak, or open front walls</td>
<td>Ordinance 9-1-7-A400</td>
</tr>
<tr>
<td></td>
<td>Non-ductile concrete buildings</td>
<td>Amendment requires following Chapter A3 on their voluntary program for retrofit of existing non-ductile concrete residential buildings</td>
<td>Ordinance 9-1-7-A500</td>
</tr>
<tr>
<td>City of Berkeley</td>
<td>Single Family Wood Frame Retrofit</td>
<td>Property transfer tax to use up to 8% toward seismic retrofit</td>
<td>Chapter 7.22.060</td>
</tr>
<tr>
<td></td>
<td>Soft Story Inventory and Retrofit</td>
<td>Establishing an inventory of potentially hazardous building containing soft, weak or open front walls and adopting Chapter A4 of the International Existing Building Code with amendments</td>
<td>Chapter 19.39</td>
</tr>
<tr>
<td>City of Fremont</td>
<td>Soft Story Inventory and Retrofit</td>
<td>An ordinance amending city code regarding the retrofit of soft or open front walls in wood frame, residential, soft-story buildings</td>
<td>Ordinance 10-2007</td>
</tr>
<tr>
<td></td>
<td>Unreinforced Masonry Retrofit</td>
<td>Ordinance amending city code regarding fit-up and masonry building exceeding exception and modifying timetable</td>
<td>Ordinance 2449</td>
</tr>
<tr>
<td>City of Los Angeles</td>
<td>Soft story buildings</td>
<td>Mandatory retrofit of soft story buildings was passed and signed into law on October 9, 2015 and requires that approximately 18,500 soft story buildings with 4 or more residential units be retrofitted in 7 years or receiving an order</td>
<td>Ordinance 185893</td>
</tr>
<tr>
<td></td>
<td>Non-ductile reinforced concrete buildings</td>
<td>Mandatory retrofit of non-ductile reinforced concrete buildings was passed and signed into law on October 9, 2015 and requires that approximately 1,500 concrete buildings be retrofitted in 15 years or receiving an order</td>
<td>Ordinance 185893</td>
</tr>
<tr>
<td>City of Los Angeles</td>
<td>Fortify cellular towers</td>
<td>Stronger telecommunications standards were passed and signed into law in the summer of 2015 that require new cell towers to be built to more than a life safety standard, consistent with other critical infrastructures</td>
<td>Ordinance 185580</td>
</tr>
</tbody>
</table>

Prepared by
The Dr. Lucy Jones Center for Science and Society
Prototype Ordinance for Soft First Story Retrofit
From the City of Los Angeles

MANDATORY EARTHQUAKE HAZARD REDUCTION IN EXISTING WOOD FRAME BUILDINGS WITH SOFT, WEAK OR OPEN WALLS

Ordinance No. __________ Effective: __________

I. PURPOSE
The purpose of this Ordinance is to promote the public welfare and safety by reducing the risk of death or injury that may result from the effects of earthquakes on existing wood-frame buildings with soft, weak or open walls. In the Northridge Earthquake, many multi-story wood-frame buildings with back-to-back parking performed poorly and collapsed. These types of buildings were shown to be vulnerable to loss of human life, personal injury and property damage during past earthquakes. Common deficiencies of this building type have been identified as soft, weak or open walls. This Ordinance creates minimum standards to mitigate hazards from these deficiencies. When fully followed, these minimum standards will improve the performance of these buildings but will not necessarily prevent all earthquake-related damage.

II. SCOPE
The provisions of this Ordinance shall apply to all existing commercial and residential buildings of wood frame construction, except residential buildings with 3 units or less, having all the following:

1. Two or more stories,
2. Determined by the Department to have been built and issued a Certificate of Occupancy before January 1, 1980, and
3. Ground floor portion of the wood frame structure contains parking or other similar open floor space that causes soft, weak or open wall lines.

III. DEFINITIONS
The following definitions shall apply for the purposes of this Ordinance:

CRESCRETE WAIL is a wood-framed stud wall extending from the top of the foundation wall to the underside of the lowest floor framing of the building.

GROUND FLOOR is any floor within the wood frame portion of a building whose elevation is immediately accessible from an adjacent grade by vehicles or pedestrians. The ground floor portion of the structure does not include any level that is completely below adjacent grades.

OPEN WALL LINE is an exterior wall line with vertical elements of the lateral force resisting system which requires tributary seismic forces to be resisted by diaphragm rotation or excessive cantilever beyond parallel lines of shear walls. Diaphragms that cantilever more than twenty-five percent of the distance between lines of lateral force resisting elements from which the diaphragm cantilevers shall be considered excessive. Exterior wall balconies of six feet or less in width shall not be considered excessive cantilevers.

RETRICETT is an improvement of the lateral force resisting system by alteration of existing structural elements or addition of new structural elements.

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What You Can Do In Your City

Complete this questionnaire as specifically as possible keeping in mind your jurisdiction.

1. Based on the previous worksheets, what seismic issue are you planning to address?

2. What are the mitigation actions you plan to take (implementing a policy or program, a directive to staff, etc.)? Be specific.
   a. 
   b. 
   c. 

3. Who is affected by these actions?
   a. 
   b. 
   c. 

4. Who would be supportive? Who would be opposed?
   Supportive
   
   Opposed:

5. What’s at risk by not acting?
How to Build Your City-Wide Resilience Team

GOAL: To build a cross-discipline team, also known as a public-private partnership, consisting of representatives at all levels of the community that will work together with you on resilience initiatives.

You may be a veteran or new to seismic safety, but it is important to understand you are not alone. There are others within and outside of your agency, including outside of your city boundaries, that would not only be great partners but are also willing to participate in creating solutions to make the community safer. Government alone cannot solve these issues, as they are too great. Collectively and collaboratively the approach to address your city’s risk are at your fingertips. Partners just need to be invited to join your initiative. Together you can choose areas of focus and how to solve them.

Who are your local partners?

The only way to not be successful here is to not cast a wide enough net. Be open to why and how individuals, or organizations, want to join your team. Do not allow your perceptions or beliefs about potential partners limit what they can really do to help make your community safer. Invite motivated representatives who are interested in working collaboratively and willing to “roll up their sleeves” especially as some of what you are trying to address will take some time to accomplish. Partners should also be representative of the full fabric of your community.

Potential Partners: (Consider what resources each of these representatives, or their organizations, would bring to the table)

- Government: local, regional, state, regional, federal
- Businesses
- Chambers, associations and trade groups
- Scientists, subject matter and technical experts
- Non-profit organizations
- Universities and colleges
- Community/Civic groups
- Faith-based organizations
- Neighborhoods
- Academicians
- Researchers
- Educators and trainers
- Media
- Others

How can your team members/partners help your seismic safety effort?

These people, and/or their organizations, are the “worker bees” to establish and accomplish significant elements of your seismic safety initiative. Under your leadership, and the guidance of a chair to focus on the step-by-step tasks, your team of motivated subject matter experts and interested stakeholders will enable you and your city to create tangible measurable results in areas not yet addressed. You will work together and engage critical community members that will be key programmatic areas. For example, a building official on your team may engage engineers and architects in a sub-committee to develop prescriptive plan sets for residential retrofit in order to streamline quality control and ease compliance - this may not have been an initial goal of your efforts but becomes a key element to address one that was. If established well, your team and all your partners, will be the stepping stones to achieving your community’s overall resilience.
How to Engage Your City-Wide Resilience Team

In order to address seismic safety issues in your community, it is recommended to engage a city-wide resilience team to facilitate the process and achieve results. This public-private partnership needs to represent the full fabric of the community, at all levels, and include individuals and organizations interested in developing solutions to address the earthquake hazard.

The way to engage committed people is to develop an initiative that they can: 1) be inspired to be a part of, 2) have their time and contributions be respected and appreciated, 3) make a difference, save lives, and 4) also meet at least one need of their own organization.

As public sector officials for your city, how do you engage members to join your team? Here are a few steps to get you started:

1. First, decide that you want to accomplish the goal of making your city more resilient.
2. Create a small leadership team of those to form your group who are interested in the subject, have cross-sector connections, and who can help identify stakeholders in the community. Don't limit invitees to only those in your jurisdiction or some expertise, interest, and resources can come from outside.
3. Meet with your leadership team to accomplish two items:
   - Share your high-level approach or vision and get their buy-in and feedback.
   - Develop a list of types of partners (e.g., business, non-profit) and list names of potential people. If you do not know names yet, then list the organizations that make the most sense or would be good strategic partners. Have more than one name per type of partner, especially where you plan to have more than one organization represented, such as businesses.
4. Set a date to hold your first city-wide resilience team meeting.
5. Have your leadership team begin inviting potential members to the 1st meeting:
   - Share the high-level approach or vision.
   - Gage their interest.
   - Get them to agree to attend the meeting or send a representative if they are unavailable.
6. Plan meeting agenda and logistics:
   - Meeting should be set up with everyone around a central table, facing each other, and foster interaction between attendees.
   - Agenda should begin with introductions of each attendee, cover the hazard, any necessary history, your high-level approach, and program scope. Discuss. Have a scientist or technical expert available to answer specific hazard questions so partners fully understand why this is so important.
   - Share some basic goals and objectives (you'd like your team to accomplish, discuss with attendees to refine, but not necessarily finalize yet).

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