



The Case for Earthquake Resilience

*Why Safer Structures
Protect and Promote
Social and Economic Vitality*

Feb. 23, 2018

EXECUTIVE SUMMARY

With a \$2.4 trillion gross domestic product, a population of nearly 40 million and a rich diversity of lucrative industries, California boasts the sixth largest economy on the planet. It is also a region famous for its earthquakes, with the risk of experiencing widespread economic and social devastation at any moment. The best way to guard against that threat is to prepare for it – making our cities safer by identifying and retrofitting our vulnerable structures.

Hurricane Katrina, so far, represents the nation’s most devastating natural disaster. Yet the U.S. Geological Survey estimates that an even bigger event – a 7.8-magnitude earthquake in Southern California – would result in more than 1,800 deaths, 50,000 injuries and \$200 billion in damage, with long-lasting social and economic impacts. According to the USGS, the odds are stacked against California in terms of a major earthquake striking within the next 30 years: 99 percent for a magnitude 6.7 temblor, and 46 percent for a magnitude 7.5 quake.

The displacement of potentially tens of thousands of residents can have a devastating impact on a society, its housing market and its broad economic stability. This situation is further complicated when the homes lost reflect a large proportion of a community’s affordable housing stock. People without homes have a harder time reporting for work and that can hamper business activity. The potential impacts on small business, which employs 56.8 million people representing 48 percent of the U.S. workforce, is particularly troublesome when considering that many of these enterprises occupy the very buildings that are at risk of failure during an earthquake.

Safety is of course the primary concern. However, there are real financial considerations affecting building owners. Legal precedent now places liability on building owners, as in the case of an unreinforced masonry building in Paso Robles where the courts found the owners liable for the deaths of two occupants (even though the building technically complied with the city’s retrofit ordinance). Other lawsuits stemming from the collapse of balconies and decks also show that building owners may be held responsible for a structure’s safety even if local jurisdictions have not passed specific ordinances requiring mitigation of unsafe conditions. The simple fact of knowing a building may be unsafe and not taking action may be grounds enough to assign blame through negligence.

The urgency to address these concerns has prompted a new movement called the Seismic Resilience Initiative, (SRI). This working group, led by the United States Resiliency Council, includes BizFed, Local California Building Department Leaders, the Structural Engineers Association of California and others, and is receiving technical assistance from the California Seismic Safety Commission, California Office of Emergency Services, the California Department of Insurance and the International Code Council. Its mission is to promote statewide regulations that will identify buildings that are known to present a heightened seismic risk of death, injury and damage based on their age, structural system, size and location.

Both the State of California Seismic Safety Commission and the Structural Engineers Association of California agree that California must improve the performance of our built environment through resilience-based design and seismic retrofits.

Researchers at Caltech recently determined that for every dollar spent in retrofitting soft-story structures, property owners could expect to save up to seven dollars, not including loss to contents, alternate living expenses or deaths and injuries – all of which would significantly increase cost-to-benefit ratios. FEMA found similar cost benefits in a two-year analysis of seismic retrofit scenarios applied to a variety of building types in locations throughout the United States.

Many West Coast cities, from San Diego to Seattle, recognize the economic value of preserving structures by retrofitting them in a manner that will safeguard them during an earthquake. Financial incentives such as density bonuses, reductions in development standards and relief from nonconforming provisions can incentivize building owners to perform upgrades that promote building safety and revitalize communities for greater economic impacts. Resilience isn't just good for society, it's good for business.

Los Angeles Mayor Eric Garcetti in 2015 pushed for the nation's most sweeping earthquake retrofit laws, requiring seismic fortification of pre-1978 wood-frame soft-story buildings and pre-1977 non-ductile concrete structures. This came on the heels of retrofit ordinances in San Francisco, Berkeley, and other cities. Since then, additional cities have adopted or are considering similar policies of their own.

The White House, in its National Security Strategy dated December 2017, listed the promotion of American resilience against natural disaster as one of the country's primary security issues for the coming year. The National Science and Technology Council, in characterizing the elements of disaster-resilient communities, identifies as the top priority to recognize and understand the impacts of relevant hazards.

Meanwhile, important legislation inspired by SRI and introduced Feb. 15, 2018 by California Assemblyman Adrin Nazarian, a longtime advocate for earthquake preparedness, aims to help cities identify buildings in their communities that could be at significant risk during a major quake, and to establish funding sources to help cover the costs to cities impacted by the law. AB 2681 will provide a "snapshot" of California's vulnerabilities and the potential impacts we face as a state; and it will spotlight communities where there is an urgency to address the matter. The legislation includes:

1. Developing criteria to identify seismically vulnerable building types.
2. Directing building departments to develop an initial list of potentially vulnerable buildings.
3. Notifying building owners that they may have potentially vulnerable buildings.
4. Directing noticed owners to assess the vulnerability of the structure.
5. Building and maintaining a statewide data repository of potentially vulnerable buildings.
6. Identifying possible funding mechanisms to offset costs to building departments.

For more information or to support the Seismic Resiliency Initiative, please visit www.usrc.org. Public participation is welcome.

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THE CASE FOR EARTHQUAKE RESILIENCY

Why Safer Structures Protect and Promote Social and Economic Vitality

By Ali Sahabi, GEC¹; Evan Reis, S.E.²; David Khorram³, P.E., CBO

California is the Golden State of the nation. With a \$2.4 trillion gross domestic product, a population of nearly 40 million and a rich diversity of lucrative industries, it boasts the sixth largest economy on the planet and fuels much of the economic vitality of the nation, if not the world.

The state is an economic engine, a powerhouse for prosperity. But it is far from invincible.

California is also a region famous for its earthquakes: It's a global hotbed of seismic activity with the capacity to experience widespread economic and social devastation at any moment. The best way to guard against that threat is to prepare for it – making our cities safer by identifying and retrofitting our vulnerable structures.

Growing awareness of the threat of the “Big One” has sparked a statewide movement called the Seismic Resilience Initiative (SRI), a coalition of people in California who are concerned about the health and security of the state. A working group of stakeholders, led by the United States Resiliency Council, includes BizFed, California Building Officials, the Structural Engineers Association of California and others, and is receiving key technical assistance from the California Seismic Safety Commission, California Office of Emergency Services, the California Department of Insurance, and International Code Council.

Additionally, California Assemblyman Adrin Nazarian on Feb. 15, 2018 introduced legislation related to this initiative to identify buildings at risk of failure in a major quake and to provide funding assistance to help cover the costs to local governments. AB 2681 will require cities in seismically volatile regions to identify and evaluate classes of buildings that have been proven to be vulnerable in a major earthquake. This generally includes mid-1990s or older wood-framed, soft-story structures; unreinforced masonry; tilt-up; nonductile concrete; and steel moment frame buildings. Identifying these structures is the first step to assessing our state's vulnerabilities to earthquakes. Many owners or occupants may not know the risks associated with these buildings, which represent a large portion of California's affordable housing stock and hundreds, if not tens of thousands of businesses that help fuel local economies. To lose these structures would bring about serious economic and social turmoil.

This initiative is the first step in bringing about a more resilient California. It will save lives, guard against injury and protect the social and economic fabric of our state and nation. The following pages explain why such an action is needed, and why it makes good business and economic sense for building owners and society-at-large.

Albert Einstein famously stated, “Given one hour to save the world, I would spend 55 minutes defining the problem and five minutes on finding the solution.” California needs to identify and define its weaknesses to earthquakes to move forward toward a plan for resiliency now, and long into the future.

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ShakeOut Scenario

Researchers at the University of Southern California have determined that the economic impact of a projected 7.8-magnitude earthquake along the San Andreas Fault in Southern California would be the costliest disaster in U.S. history. Here are the numbers:

\$113 billion in building damage

\$68 billion in business interruption

\$11 billion in related costs

Total Economic Impact: \$192 billion

THE THREAT OF EARTHQUAKE DISASTER

We witnessed the state's potential for earthquake disaster in 1994. The Northridge earthquake jolted Southern California a mere 10 to 20 seconds, a 6.7-magnitude blind-reverse thrust event that struck with brutal force, causing more than \$67 billion in widespread damage.

Homes, businesses and apartment buildings splintered and collapsed. Aftershocks fueled the ferocity as large patches of the region were left heavily damaged: Nine hospitals were declared unstable.

Schools and universities were red-tagged; broken gas and water pipes, downed utility lines, fires, and flattened bridges and overpasses left many streets impassable. The temblor shook the earth with a power that produced the largest ground motion ever recorded in an urban environment in the United States. The scope of destruction ranks Northridge as one of the five costliest natural disasters in U.S. history.ⁱ

Yet the magnitude of that quake was relatively mild compared to what could be.

Seismologists say stress along the San Andreas fault has been building with little relief since the mid-1800s. The next "Big One" – which could come at any moment – could be of a magnitude of 7.5 or more, they say. Such a quake would rip along the fault and displace it by an average of 9 feet.ⁱⁱ

"Northridge was not a big quake," Seismologist Lucy Jones told NBC News. "... If we had the same quake on another fault, we'd have way more damage."ⁱⁱⁱ A larger quake would decimate the local economy, she said. Businesses would close, people would not be able to get to work, and an exodus of residents would flee, leaving the City of Angels behind for others to rebuild.

Predictions for the Future

Hurricane Katrina, so far, represents the nation's most devastating natural disaster. Yet experts say a 7.8-magnitude earthquake in Southern California would result in even more deaths and nearly twice the damage to area infrastructure, including buildings, critical transportation, power and water systems. This scenario, as depicted by the "Great ShakeOut," would "have devastating economic consequences for the eight-county region comprising Southern California," researchers at the University of Southern California determined.^{iv}

Building on estimates of property damage of \$113 billion and some estimates of direct business interruption by other members of the research team..., we estimate the total business interruption impacts at \$68 billion and related costs at nearly \$11 billion. This could make the ShakeOut Earthquake Scenario the costliest disaster in U.S. history. (Grossi 2009, Rose et al. 2009).^v

The U.S. Geological Survey and other agencies have confirmed USC’s numbers, estimating that a temblor of that size would kill more than 1,800 people, injure 50,000 and cause \$200 billion in damage with long-lasting social and economic impacts.^{vi} Those residual impacts – as witnessed from past hurricanes, earthquakes, tornadoes and other natural disasters – test the resiliency of individuals, families, businesses, neighborhoods, lending institutions, and local, state, even federal governments.

“When you have a big disaster, you lose a lot of money,” Jones told the Pasadena Star News. “There are things that are broken and wealth that is lost. But also the economic activity of the region stops. All of those businesses without water, without power and without transportation are no longer producing goods and the economic wealth that had been part of that business.”^{vii}



The San Francisco quake of 1906 left 300,000 people homeless. California has more than a 99 percent chance of another major quake happening in the next 30 years. Credit: USGS

The great San Francisco earthquake of 1906^{viii}, estimated at 7.8 on the Richter scale, killed about 3,000 and displaced as many as 300,000 people who were left homeless from the destruction. Thousands fled the city. Even more set up camps and shantytowns, where they lived for years during the city’s arduous reconstruction.

Today, because of improved building regulations and safer infrastructure, the damage caused from earthquakes is much less than what it was in the past. The United States Geological Services estimates that more than \$30 billion has been invested in the Bay Area alone to

retrofit buildings, replace bridges and other infrastructure to make it more resilient against earthquakes.^{ix}

But we also have not experienced an earthquake of the same or greater magnitude as that infamous San Francisco tragedy. Our most recent major seismic disasters – in Loma Prieta and Northridge – measured 6.9 and 6.7 respectively. Given the exponential nature of the ascending Richter scale and seismologists’ predictions that we are long overdue for an earthquake of epic proportions that rivals or exceeds the force of the San Francisco quake, an increasing number of cities are taking notice and hastening to action to be prepared.

According to the U.S. Geological Survey, “California has more than a 99 percent chance of having a magnitude 6.7 or larger earthquake within the next 30 years.” The likelihood of an earthquake greater than magnitude 7.5 occurring is 46 percent over the next 30 years.”^x

PROJECTED LOSS BY REGION

Recognizing this threat, the California Seismic Safety Commission noted that several laws have been enacted to protect public buildings and infrastructure in the event of an earthquake. “Notably absent

are laws and/or policies that are aimed at reducing damage to the private sector and accelerating post-earthquake economic recovery.” The commission added that:

It is imperative that appropriate policies be adopted and implemented so that California's businesses and industries ... can recover rapidly from any damage they may incur as a result of the next major earthquake. The failure to do so can result in California's economy taking a severe blow, both due to small businesses not being able to recover and reestablish themselves and by larger companies relocating to other states or even countries which are constantly attempting to lure them away.^{xi}

HAZUS Annualized Earthquake Loss (AEL) ¹		
Rank	Region	AEL in millions
1	Los Angeles	\$1,312.3
2	San Francisco	\$781.0
3	Riverside/San Bernardino	\$396.5
4	San Jose	\$276.7
5	Seattle	\$243.9
6	San Diego	\$155.2
7	Portland	\$137.1
8	Oxnard	\$111.0
9	Santa Rosa/Petaluma	\$68.6
10	St. Louis, MO	\$58.5

A lot has been learned from earthquake models since the Northridge quake. We now understand much more about seismicity, ground motion and engineering, and these advances in technology have allowed us to identify threats based not only on geography – i.e., proximity to fault lines and soil composition – but also by building characteristics.^{xii}

The Federal Emergency Management Agency has adopted Geographic Information System (GIS) technology to estimate physical, economic and social impacts of disasters such as earthquakes. This nationally applied

standard, called HAZUS, has put Los Angeles at the top of the list for annualized earthquake damage from an earthquake.^{xiii} These calculations are based on seismic hazard, the likelihood of damage to buildings and other structures and direct and indirect losses resulting from this damage.

Seismic retrofitting of vulnerable structures is critical to reducing risk, a Federal Emergency Management Agency study found.^{xiv}

“It’s important for protecting the lives and assets of building occupants and the continuity of their work,” FEMA reported. “On the whole, communities with more retrofitted structures can recover from earthquakes more rapidly.”

It’s not just a matter of saving lives, guarding against injury and preserving property. In instances where an earthquake of significant magnitude causes widespread damage to buildings, the federal agency found, retrofits can protect against economic devastation as well.

Macro- and Micro-Economic Impacts

Apart from the loss of life and limb, the impacts of a major earthquake can strike on many levels.

Macro-economic Impacts:

- Widespread destruction of neighborhoods and infrastructure
- Disruption of public services
- Business disruption and loss
- Widespread homelessness and unemployment
- Economic turmoil
- Reconstruction costs

Micro-economic Impacts:

- Damage/destruction to homes and businesses
- Loss of employment
- Homelessness
- Demolition and reconstruction costs
- Bankruptcy

“If you live or work in retrofitted structures,” FEMA determined, “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.”^{xv}

ECONOMIC IMPACTS OF DISASTER

The year 2011 experienced the highest economic losses due to earthquakes on record. According to the Center for Disaster Management and Risk Reduction, more than 20,000 people died and about a million people lost their homes due to earthquakes that year.

Most significant were the earthquakes in Christchurch, New Zealand; and Tohoku, Japan; with more than 1 million buildings damaged in Japan alone.^{xvi}

Protecting life and limb is the primary objective in any threatening situation. But once the shaking and damage is over, what happens then? Some of the most challenging aspects of recovery are the displacement of residents and businesses, the loss of affordable housing stock, widespread business disruption, unemployment and damage to uninsured homes and other structures.

Widespread Business Disruption

Apart from the social chaos that can come from any disaster, one major issue is the disruption of jobs and economic activity following a major earthquake. People without homes have a harder time reporting for work and that can hamper business activity. Deliveries from vendors may be shut off for weeks or even longer as a result of damaged buildings and infrastructure. All this has the potential to lead to a distressed workforce, reluctant consumer climate and a downward spiraling economic cycle.

The potential impacts on small business is particularly troublesome, when considering that many of these enterprises occupy the very buildings that are at risk of failure during an earthquake.

Small businesses employ 56.8 million people representing 48 percent of the U.S. workforce, the Small Business Administration reported in 2016.^{xvii} In short, they constitute much of the economic health of local communities, states and the nation. A disruption in the ability to do business – even for a short while – can quickly lead to serious financial consequences, even bankruptcy. This in turn, exacerbates the problem with an increase in unemployment and residual impacts on other businesses and vendors.

In Their Words

“These earthquakes provide inescapable evidence that California must continue to prepare for major seismic events to strike.”

**State of California
Seismic Safety Commission**

“Improved performance of our community’s and region’s built environment is critically important to saving lives as well as important to protecting its economy, character and fabric.”

**Structural Engineers Association of
Southern California**

“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.”

**Federal Emergency Management Agency
(FEMA)**

It’s not just small businesses that are at risk. Following the 1995 earthquake in Kobe, Japan, several automobile manufacturers had to cease production. Toyota lost its supplier of brake parts and radios, resulting in the loss of production of some 20,000 vehicles.

The Malaysian automobile manufacturer Proton had to halt operations for some time because the parts the company was receiving from Mitsubishi Motors could not be shipped from the damaged Kobe Port. In the United States, Chrysler Motors came very close to having to suspend operations.^{xviii}

Recovery of the greater Kobe region since then was devastatingly slow. Thirteen years later, shoe production – a major industry in the region – was at just 78.8 percent of what it was prior to the earthquake.

Likewise, Japan’s robust industry for sake plummeted. Shipping figures in 2008 for the country’s popular rice brew were just 40 percent of what they once were. Damage to the port facilities resulted in shipping traffic being diverted to other ports in the region.^{xix}

Loss of Local and Affordable Housing Stock

The bulk of our vulnerable buildings are represented by older structures that make up a disproportionately broad swath of our state’s more affordable housing stock. Housing affordability today is a critical problem in California, which ranks as the second most expensive state in the nation, behind Hawaii. Rents in Orange County represent 54 percent of the average tenant’s income, meaning that a single renter would need almost two full-time jobs to afford a typical two-bedroom apartment.^{xx} Elsewhere in urban areas of the state, the situation is virtually the same.

The Journal of Public Economics found that major earthquakes have a disproportionate impact on people of lower-economic demographics.^{xxi} Researchers Nejat Anbarci, Monica Escaleras and Charles Register found strong correlations between wealth and resiliency, citing the discrepancy as a matter of social justice. The researchers called on government to help ensure a more even application of building safety codes and retrofits: “The ultimate lesson therefore is that building and development is simply not a physical process – government institutions and social processes must develop in parallel, to keep up

with the physical demands and assure minimum acceptable standards of construction and public safety.”^{xxii}

The displacement of hundreds if not thousands of residents can have a devastating impact on a society. Quite often, when large numbers of people are forced out of their homes, the housing market responds erratically. This situation is further complicated when the homes lost reflect a large proportion of a community’s affordable housing stock.

Refugees from the 2017 fires in Napa and Sonoma counties were faced with an out-right housing crisis.

Those who were displaced, whether they owned their homes or rented, faced an expensive real estate market that was already seriously squeezed by a limited housing stock – particularly for affordable housing. Following the fires, many of those who lost their homes fell victim to rent-gouging.^{xxiii} Families with children doubled-up with neighbors hoping to keep their kids in the same school district. Those with pets faced added burdens.^{xxiv}

This dire housing situation will become an even more serious concern following a major quake in California, the Association of Bay Area Governments proclaimed. If many of a region’s affordable housing units are lost in an earthquake, “a constrained market may drive up the cost of housing even further. Loss or damage of housing that results in increased costs... will likely increase the number of permanently displaced Bay Area residents.”^{xxv}

Liability Through Negligence

What legal risks do property owners face if they don’t retrofit their vulnerable buildings?

A two-year study funded by the National Science Foundation’s Earthquake Hazard Reduction Program determined that case law has put the question in the hands of a jury to decide based on how much the owner knew about the building defects, how much he or she knew about retrofits that could correct structural weaknesses, and the cost-to-benefit analysis of having a retrofit done. The Association of Bay Area Governments prepared a document for businesses, warning of potential liability issues from earthquake damage.^{xxvi}

Building owners can be found liable, according to a precedent-setting case in Paso Robles, where, during an earthquake in 2003, two employees of a clothing store were crushed to death by falling bricks and plaster as they ran out of a building that had been ordered by the city to be seismically retrofitted but the deadline for completion had not yet passed. The families of the women sued the property owners and won. A jury awarded them \$2 million, finding that the property owners were negligent because they knew the building had the potential of being unsafe in an earthquake but did nothing about it. A state appeals court upheld the verdict in 2010.^{xxvii} The precedent was set: It didn’t matter whether the quake was an “act of God” or that the building technically complied with the city retrofit ordinance because the deadline to have the work done had not yet passed. The jury determined that the simple fact of knowing a building may be unsafe and not taking action is grounds enough to assign blame through negligence.



Workers inspect damage from a fallen balcony that resulted in the deaths of eight Irish tourists. Negligence in this case can apply to virtually everyone involved with the building, the San Francisco Examiner determined. Credit SF Examiner.

Many property owners believe that ignorance is a good defense against liability, and that the identification of vulnerable buildings may secure their legal responsibility if their building is on the list. Knowledge that a building is potentially unsafe doesn't have to come from a city notice. Risk can also be officially conveyed in documents prepared by banks and lending institutions, insurance companies and any other industry that does building assessments as a part of doing business.

In truth, many structures have already undergone evaluations of some kind. It is common to assess the structural integrity of a building as a part of the sale, purchase, refinance and application for liability insurance of most properties. In the majority of these

cases, a physical inspection is required, which includes a structural inspection of the building. These documents will identify seismic vulnerabilities if they exist, and they can be accessed as a part of discovery during litigation.

In addition, similar negligence issues have recently been tested with other construction-related failures. The *San Francisco Examiner*, in explaining liability issues in a case involving the fatal collapse of a balcony in Berkeley in 2015, wrote that wrongful death actions could potentially be brought against the building's architects, structural engineers, developers, general contractors, sub-contractors, product manufacturers, distributors and retailers, building owners and building managers.^{xxviii}

"Negligence is the failure to use reasonable care to prevent harm to oneself or to others," the article stated. "A person can be negligent by acting or by failing to act. A person is negligent if he or she does something that a reasonably careful person would not do in the same situation or fails to do something that a reasonably careful person would do in the same situation. This would result in a civil action brought by private parties (in contrast to a criminal action potentially brought by the D.A.) for monetary damages for wrongful death and/or personal injuries. The wrongful death actions would be brought by the families of the six who died and the personal injury actions would be brought by those who suffered physical and/or emotional injuries."^{xxix}

Insurance Alone is Not the Answer

It's no secret that earthquake insurance in California is expensive and that most property owners – 81.2 percent, to be exact – are reluctant to buy it.^{xxx} That's one reason why the state in 1996 established the California Earthquake Authority, a nonprofit designed to help individual homeowners gain access to more affordable insurance options to protect themselves and their families against the threat of a major earthquake.

Regrettably, earthquake insurance options for commercial building owners remain limited, costly and in many ways inadequate – putting an added burden on the potential for economic hardship, should a structure become damaged when the Big One strikes. Owners that do carry insurance on their buildings

face burdensome deductibles of as much as 15 percent of the value of the structure. Policies that provide coverage for loss of income, alternative housing and other ancillary costs are frequently considered to be prohibitively expensive. While earthquake insurance does not guard against death, injury or property damage – only retrofits can do that – it can help during the recovery process and should be made more affordable to protect the state’s ability to spring back from a major quake.

THE GOOD NEWS: RETROFITS PROTECT SOCIAL, ECONOMIC STABILITY

Typical L.A. Soft-Story Retrofit Case Study

Apartment Building Value:
\$250,000 per unit

Retrofit Cost: \$7,500 per Unit

Cost/Value Ratio: .03

The State of California Seismic Safety Commission in 2000 prepared a report on lessons learned from major quakes striking Turkey, Greece and Taiwan in 1999. Damage from the Turkey quake was shocking: with more than 211,000 people displaced and forced to live in tent cities for more than a year. “Each of these events provides a reminder that major earthquakes can strike urban areas without notice and with devastating impacts,” the report said. “These earthquakes provide inescapable evidence that California must continue to prepare for major seismic events to strike.”

The Structural Engineers Association of Southern California agreed, stating, “Improved performance of our community’s and region’s built environment is critically important to saving lives as well as important to protecting its economy, character and fabric.”^{xxxix} Yet to date, there has been no broad-reaching private-sector policy enacted to enhance the resiliency of California communities to withstand a major earthquake.

“Too many countries are playing Russian roulette when it comes to seismic risk,” Claire Berlinski wrote in a Manhattan Institute commentary. “Seismic risk mitigation is the greatest urban policy challenge the world confronts today. If you consider that too strong a claim, try to imagine another way in which bad urban policy could kill a million people in 30 seconds.”^{xxxix}

Cost Benefits to Building Owners

Researchers at Caltech recently determined that for every dollar spent in retrofitting soft-story structures, property owners could expect to save up to seven dollars, and that study didn’t factor in loss to contents, alternate living expenses or deaths and injuries – all of which would have significantly increased the cost-to-benefit ratios.^{xxxix}

FEMA found similar cost benefits in a two-year analysis of seismic retrofit scenarios applied to a variety of building types in locations throughout the United States. The study found high benefit-to-cost ratios for California, including a scenario of a tilt-up warehouse building in Hayward. “In this example,” the study found, “the benefit/cost ratio is about 10 without the value of life and about 12 with the value of life. The benefit/cost analysis suggests that retrofit is strongly justified economically, even without including the value of life.”^{xxxix} That return on investment was even higher for tilt-ups with a higher occupancy, such as light industry, the study found.

“Government institutions and social processes must develop in parallel, to keep up with the physical demands and assure minimum acceptable standards of construction and public safety.”

Journal of Public Economics

Researchers at Caltech determined that seismic retrofits are cost-effective when expected annualized loss would be reduced by 50 percent or more at a cost that would equal no more than 10 percent of the replacement cost of a building.^{xxxv}

These figures show that retrofits make good business sense. In fact, the National Institute of Building Sciences in its seminal report, *Mitigation Saves*, estimates that for every dollar spent on mitigation, society sees a resilience benefit of four dollars or more.^{xxxvi}

There are other strong economic factors for building owners to consider when weighing the cost benefits of a seismic retrofit. These include:

- Liability associated with damage, death and injury
- Loss of income when a building gets red-tagged
- Financial obligations tied to the original mortgage loan
- Demolition costs including abatement of asbestos and lead
- Reconstruction costs and cost overruns

Seismic Retrofits and Economic Development

Many West Coast cities, from Los Angeles to Seattle, have recognized the economic value of preserving structures with retrofits that will safeguard them during an earthquake.

This has proven to be especially true for earthquake retrofits of unreinforced masonry (URM) buildings, which add a historic character and charm to communities and can bring social, environmental and economic benefits to a community. In many instances, the retrofitting of these buildings in downtown areas has helped to spark additional investment in revitalizing neighborhoods. One need only think about the Gaslamp Quarter in San Diego, Santa Monica’s Third Street Promenade, and other revitalized historic downtown neighborhoods to realize that preserving the character of a community can lend itself to a renaissance of renewal and economic growth. The city of Medford, Oregon is one of the latest in a long line of communities that is pursuing economic benefits from the retrofitting of its buildings. The city has recently pursued a funding program to help downtown building owners finance retrofits, which officials believe would spark a revitalization effort – given that many of the buildings were already vacant due to a variety of problems, including blight and inhabitability problems.

“If we can bolster our restaurants and nightlife and downtown residences, I think it will just have a snowball effect and people will come to downtown Medford to find some niche foods,” explained City Councilman Clay Bearson.^{xxxvii}



Economic Engine: Seattle saw the retrofitting of its unreinforced masonry buildings as a win-win for the community. It protected lives and property and inspired façade upgrades that enhanced the character and charm of the city’s popular downtown neighborhoods. Credit: City of Seattle.

California State Polytechnic University, San Luis Obispo, recently prepared an analysis of the cities of Paso Robles and Santa Barbara and their methods for revitalizing downtown areas through seismic retrofitting of older buildings, particularly unreinforced masonry structures.

Typically, structures in need of seismic retrofitting are older in nature and frequently located within neighborhoods that are in decline, the study said: “By implementing (seismic retrofits) before an earthquake or similar disaster happens, a city can also take concurrent steps to foster the financing of necessary public infrastructure improvement. Consequently, these improvements will make the economics of retrofitting a building much more viable and achievable for the private property owner.”^{xxxviii}

Overall, the study found, public/private efforts to retrofit these historic buildings are fostering a strong economic climate in a central business district. “These partnerships are also critical in preserving the architectural history and heritage of a community. Without this sort of positive economic climate and these funding sources, the economic temptation to simply demolish (as opposed to retrofitting and preserving) an older building that needs seismic work is almost overwhelming. If this occurs, we will be in danger of losing the bulk of California’s 19th century architectural and historical heritage.”^{xxxix}

Historically, many cities have offered financial incentives that not only help to improve the safety of buildings through retrofits, but can enhance the aesthetics of a structure through façade improvements and other upgrades. Zoning incentives such as density bonuses, reductions in development standards and relief from nonconforming provisions can also incentivize building owners to perform seismic retrofits and upgrades that promote building safety and revitalize communities for greater economic impacts.^{xl}

Fullerton, in 1992, set up a seismic loan program through its redevelopment agency for the unreinforced masonry buildings that lined its downtown area. The retrofit program was part of a larger downtown revitalization effort called “Fullerton 2000 and Beyond,” which received a 1997-98 Achievement Award from the California Downtown Association. Evidence of the success of that revitalization can be seen in the transformation of the historic downtown core from a mishmash of pawnshops, tattoo parlors and vintage clothing stores to a vibrant destination of trendy restaurants, nightclubs and storefronts.^{xli} “The Redevelopment Agency’s seismic retrofitting, commercial rehabilitation, and tenant improvement loan programs were clearly a crucial component of the downtown’s rebirth,” the Southern California Association of Governments determined in an analysis of the city’s downtown transformation.^{xlii}

Striving for Resiliency

The following California cities and counties are among those that have adopted or are considering ordinances requiring seismic retrofits of buildings proven to be vulnerable to damage in a quake.

San Francisco
Berkeley
Richmond
Freemont
San Jose
Alameda
Santa Clara County
Los Angeles County
Los Angeles
Beverly Hills
Santa Monica
West Hollywood

Likewise, several of the historic structures lining Santa Monica’s Third Street Promenade and downtown area were revitalized in conjunction with seismic retrofits to make them safer, including the 1875 Rapp Saloon, the 1891 Whitworth Block building, and the 1893 Keller Block, which underwent a retrofit and restoration in 1987 that helped kick off the Third Street Promenade revitalization.^{xliii}

Resilience isn’t just good for society, it’s good for business, the U.S. Green Building Council aptly stated.

“Those who incorporate resilience into their buildings, business processes and communities stand to fare better in a disaster, responding more quickly and recovering more fully,” the organization found. “They are also able to leverage disaster into positive change, using the disruption as a springboard into a brighter future.”^{xliv}

Cities Take Action

Driven by a concern about the desolation that could come from a major quake, Los Angeles Mayor Eric Garcetti in 2015 pushed for the nation’s most sweeping earthquake retrofit laws, requiring seismic fortification of pre-1978

wood-frame soft-story buildings and pre-1977 non-ductile concrete structures, which – without proper strengthening – would be vulnerable to collapse during and/or after an earthquake. This came on the heels of retrofit ordinances in San Francisco, Berkeley, and other cities.

Since then, several municipalities throughout California have followed suit with retrofit ordinances of their own, including Santa Monica, which in 2017 adopted the nation’s most comprehensive ordinance for not only soft-story and non-ductile concrete buildings, but unreinforced masonry and steel moment frame structures as well.^{xlv}

The City of Long Beach, like many other major California municipalities, is considering commencing a Seismic Resilience Initiative study and has completed a yearlong RFP process to bring on board a consulting engineering firm to complete the first phase of the Long Beach Building Resiliency Program which is tasked with identifying the city’s seismically vulnerable buildings. Since the 1933 Long Beach earthquake, the city has been in the forefront of seismic legislation in California, beginning with the inception of the Field Act (requiring retrofits of vulnerable school buildings), and Riley Act (requiring all cities and counties to establish departments to regulate building construction).^{xlvi}

Structures generally considered at-risk for damage or failure in a major earthquake include:

Soft-story: Wood-framed buildings with an open ground level typically used for tuck-under parking, with one or more stories of dwelling units above. Extremely popular as a means of conserving lot space, buildings of this type constructed prior to 1978 have been proven vulnerable to collapse from seismic activity.

Unreinforced Masonry: These structures are characterized by walls and other building components made of brick or other masonry materials not braced with rebar or another reinforcing material. These facades can collapse during an earthquake. Most of these buildings were identified as part of an earlier state mandate, but there are still thousands that have yet to be retrofitted.

Tilt-up: Tilt-up construction is a cost-effective technique of pouring a building's walls directly at the jobsite and then raising or "tilting" the panels into position. Many of these structures built prior to the 1970s were constructed with limited or weak roof connections and diaphragms that can fail during an earthquake.

Non-ductile Concrete: These buildings are characterized as having concrete floors and/or roofs supported by concrete walls and/or frames. Their rigid construction and limited capacity of structures built prior to 1978 to absorb the energy of ground shaking makes them at risk for collapse.

Steel Moment Frame: This building technique, used in the first skyscraper, was most commonly used in the 1960s to 1990s. Those constructed prior to 1994 can sustain brittle fracturing of the steel frames at welded points between the beams and columns.

When Mayor Garcetti signed L.A.'s ordinance into law, he said he did it not only for life and safety issues, but to protect the city's ability to function after that long-anticipated monster of an earthquake strikes. Public response to the new law has been much better than expected, particularly among building owners, who have recognized that it makes good business sense to retrofit their properties.



To date, more than 15 percent of the city's 13,500 structures tagged for retrofits have begun the process with engineering studies and/or construction.

"That means property saved, and more importantly, people saved," Garcetti told the Los Angeles Times in 2017. "We just pray the earthquake doesn't come before we finish this work. And when it does come, we're all going to be better off."^{xlvii}

A Matter of National Concern

The White House, in its National Security Strategy dated December 2017, listed the promotion of American resilience against natural disaster as one of the country's primary security issues for the coming year.

This included a call to “Build a culture of preparedness – taking steps to promote preparedness and to empower communities and individuals to take action to be more resilient against the threats and hazards Americans face.”^{xlviii}

“Reducing risk and building more resilient communities are the best ways to protect people, property and taxpayer dollars from loss and disruption,” the White House stated. “Through risk-informed investments, we will build resilient communities and infrastructure to protect and benefit future generations.”^{lix}

The White House report goes on to say that while government will be responsive to communities that suffer from natural disaster, much of the responsibility for recovery must take place at the local level.

“Should tragedy strike, the U.S. Government will help communities recover and rebuild,” the report states. “Citizens must be confident in our government, but also recognize that response and recovery begin with individuals and local communities.”^l

What does an earthquake-resilient community look like? The National Science and Technology Council identified four key characteristics of disaster-resilient communities:^{li}

1. Relevant hazards are recognized and understood
2. Communities at risk know when a hazard event is imminent
3. Individuals at risk are safe from hazards in their homes and places of work, and
4. Disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed

CONCLUSION

A scene in the movie “L.A. Story” shows Steve Martin dining with friends when a massive earthquake starts shaking wildly. Glasses rattle, tables scoot across the floor. An ice sculpture swan takes a nose dive into a platter of fruit. Yet everyone continues their conversation unfazed – as if nothing is happening. It’s all business as usual.

Clearly, Californians live in earthquake denial. We laugh it off, ignore its ever-present threat to our lives and our livelihood. But this is an issue that should be in the forefront of everyone’s minds. Are we prepared at home, in our place of business, in our hospitals, schools and community? How quickly could we recover from that looming 7.8-magnitude earthquake, and how severely would economic disaster in California ripple throughout the rest of the nation?

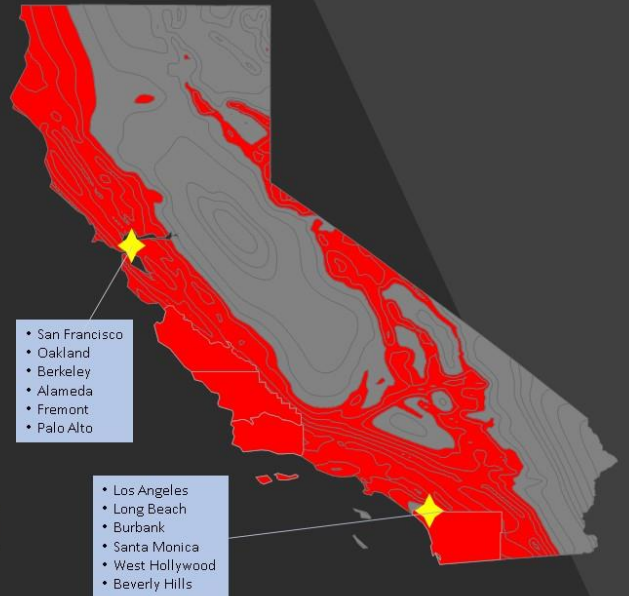
Every building protected from an earthquake represents resilience – the capacity to spring back quickly from hardship – for tenants, their employers, hospitals, government services and the building owners themselves. Every building saved means families can remain in their homes, and employees can go to work. It’s another step away from the chaos and crime that can come when a community shuts down. The first step to resilience is to identify buildings that are vulnerable to damage in an earthquake.

Scope of AB 2681 Legislation

Approximately 26% of the state's population to be affected by Assemblyman Nazarian's legislation are already under some sort of mandatory identification and retrofit program.

Included in Scope of Legislation:
28 Million Residents

Cities with Retrofit Ordinances: 7 Million Residents



Legislation and the Seismic Resilience Initiative

Assemblyman Adrin Nazarian, a longtime advocate for earthquake preparedness, an early warning system to alert residents before a quake strikes, and funding assistance to building owners to help finance much-needed retrofits, has introduced legislation that will help to address the situation.

Inspired by the Seismic Resilience Initiative, the focus of AB 2681 is to help cities identify buildings in their communities that could crumble or collapse during a major quake, and to identify funding sources to help cover the costs to cities impacted by the law.

This snapshot of California's vulnerabilities will assess the potential risks we face as a state, and spotlight communities where there is an urgency to address the matter.

AB 2681, introduced in February 2018, would require local jurisdictions in California's areas of highest seismic activity to identify and evaluate potentially vulnerable occupied buildings, including multi-family structures of five units or more. The fiscal impact would be minimal for local agencies to administer the program, and for owners to gather seismic performance data on their buildings. This information will give the state and its communities key metrics on California's overall risks and potential for resilience.

The specific steps would include:

1. Developing criteria to identify seismically vulnerable building types considering age, structural system and other characteristics known to negatively affect seismic performance.
2. Directing building departments in local agencies to develop an initial list of potentially vulnerable buildings, based on age and other publicly available information, using Tax Assessors Record surveys and online searches.
3. Notifying building owners by mail that they may have potentially vulnerable buildings.
4. Directing noticed owners to assess the vulnerability of the structure.

5. Building and maintaining a statewide data repository of potentially vulnerable buildings, which will be updated as structures are retrofitted or replaced.
6. Identifying possible funding mechanisms to offset costs to building departments.

The widespread impacts of a catastrophic earthquake affect us all. It's a cause of the utmost social and economic concern, and ultimately, seismic retrofits of our vulnerable buildings will help keep the economic engine of society moving forward. They help ensure public services are available for others in need, and building owners and financial institutions are able to continue doing business as usual – keeping the wheels in motion for a local market economy to thrive.

Scientists agree that the “Big One” is coming. The time has come for California to join forces and face up to the dangers posed by earthquakes in our communities. Please support the Seismic Resilience Initiative in the following ways:

- Participate/Volunteer your time in the SRI working group.
- [Contribute financially](#) to USRC's SRI Special Fund.
- [Sign petition](#) to be distributed to political and civic leaders.

For more information on the Seismic Resilience Initiative, please visit www.usrc.org/SRI.

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