

ECONOMIC BENEFITS OF EARTHQUAKE-RESISTANT BUILDINGS



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WHY BUSINESS AND GOVERNMENT SHOULD
INVEST NOW TO PROTECT CALIFORNIA
FROM DEVASTATING EARTHQUAKES



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EXECUTIVE SUMMARY

As this paper was being finalized, California received what Governor Gavin Newsom termed “a wake-up call” in the form of two major earthquakes in the Ridgecrest area. The double blow of a 6.4 quake followed by a 7.1 temblor, plus thousands of smaller quakes, the likes of which had not been felt by Californians in decades.

This timely paper presents important information from many sources to demonstrate that earthquake resistant buildings are a sound economic investment for business and government entities, particularly those that serve or employ large numbers of people or house vulnerable populations.

Building damage is the primary cause of death, injury and property loss suffered from earthquakes. Many building codes considered safe 25 years ago have now been proven to be ineffective in guarding against the violent ground movement experienced in a major quake. Scientists and engineers have pinpointed five main building types that present particular risk to building owners, tenants and the communities served by those structures.

The identification of these vulnerable building types has sparked considerable debate for property owners, businesses and governments. Some building owners and cities have chosen to pursue seismic retrofits to save lives, protect existing assets and ensure the economic and social well-being of the community-at-large. Others have opted to do nothing, taking a gamble that their buildings will stay standing without a retrofit after a major earthquake. Many others remain undecided: uncertain about the right path to follow.

Several independent studies show the money spent to retrofit existing building stock has significant benefits. These include: lower building repair and replacement costs, continuation of building function that reduces business interruption, preservation of revenue streams and, most importantly, improved life safety.

Other major economic risks to property owners and businesses when retrofit work is not done include owner’s liability for negligence due to death and injuries caused by failure of buildings, business relocation costs, destruction of equipment and inventory, displacement of key employees, loss of goodwill, and loss of business opportunities.

Governments across California also face serious economic and social risks from major earthquakes. The entire social and economic fabric of communities can be extensively impacted as businesses close, workers lose their employment, infrastructure networks and systems such as water, electricity and gas are compromised, housing becomes uninhabitable, public facilities are rendered inoperable, and public services are disrupted.

Unfortunately, there is a myth that the economics of retrofitting are not practical. In fact, retrofitting is a good business investment that protects businesses, property owners, residents, communities and government agencies in the event of earthquakes.

The reality is that Californians cannot hide from the type of major earthquakes projected by seismic experts. But we can and should take steps now in order to be as prepared as possible to survive the next major quake and preserve our quality of life in the Golden State.

WEIGHING THE RISKS

California Governor Gavin Newsom was 22 when the 1989 Loma Prieta earthquake struck San Francisco's Marina District, and he witnessed first-hand the devastating destruction: 64 deaths, nearly 4,000 injuries and the (equivalent to \$11.3–12.1 billion today) in damages. Fourteen years later, he was elected mayor of the city after running on a platform that included more stringent oversight of the city building department. Making his city safer was his priority and he pushed for a mandatory seismic retrofit law that was enacted after he left office.

“This becomes essential in terms of learning from the past and making sure that we don't make the mistakes of the past of being unprepared,” he announced in 2010 shortly after unveiling his plan.

Newsom's advocacy was the spark that launched successive measures in cities throughout California. But despite these efforts, there is much left to do, with thousands of buildings — 15,000 in Los Angeles alone — already identified as potential collapse hazards when the next major earthquake strikes.¹

Citizens care about the resilience of their communities. So do the owners of buildings that have been proven to be vulnerable to damage in a major earthquake. Why, then, are there so many communities left defenseless in our state?



Recovery efforts after the Loma Prieta Earthquake, (U.S. Geological Survey.)

There are many important variables to consider when weighing the decision to invest in a seismic retrofit of a potentially vulnerable building. They include:

Seismologic and geologic considerations such as the expected frequency and intensity of future earthquakes and whether the buildings are located on solid rock, firm soil, or poor soil sites;

Engineering factors such as the variations in building design and construction quality, expected seismic performance of the buildings, methods to rehabilitate the buildings, and the potential effectiveness of those methods to reduce casualties and damages from future earthquakes;



Social judgements on decisions, negative or positive, which put a value on potential human loss compared to the potential risk and costs involved in guarding against earthquake threats; and

Economic impacts in weighing potential risks of loss of cash flow, liability, reconstruction and environmental costs against the cost of a retrofit.

How much risk is deemed acceptable when considering the potential for death and injury, reductions in future economic damages, or in preserving the local economy, business operations, private investments, and critical functions such as hospital, fire and police services?

Learning from the Past—The Northridge Example

The Northridge Earthquake in California presented some of history’s most widely publicized images of natural destruction: the flattened Northridge Meadows apartment buildings, collapsed freeway overpasses, grotesquely twisted reinforced concrete-framed parking structures and crumbling building facades.

These striking images, as horrifying as they may be, were but a fraction of the widespread devastation inflicted by the 6.7-magnitude quake.

All total, more than 6,000 commercial and industrial structures including municipal buildings, schools, universities and medical facilities were damaged on that pre-dawn morning of Jan. 17, 1994, according to the Public Policy Institute of California.ⁱⁱ

Those figures include 11 hospitals, an iconic music scene venue on the Sunset strip, and the entire Northridge Fashion Center shopping mall, which as a part of reconstruction also underwent extensive cleanup of asbestos that was shaken loose during the quake.ⁱⁱⁱ

In fact, 39% of all businesses surveyed in the Greater Los Angeles area reported suffering some sort of structural damage as a result of the quake, according to a University of Delaware study. About a third of those cases involved damage so severe that buildings were determined to be unsafe for occupancy.^{iv}

At the time that survey was conducted, (one-and-a-half years after the Northridge event), about a quarter of the businesses reporting structural damage from the quake said they had failed to recover from the experience. Smaller businesses were hardest hit.

“Firms that do business in a single location risk their entire investment should disaster strike,” the Disaster Research Center at the University of Delaware reported, adding that an overwhelming 80% of those reporting damage from the quake fell into that category.

Economic Impacts

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 in 2018 dollars:^v

\$132 billion in building damage

\$80 billion in business interruption

\$13 billion in related costs

Total Economic Impact: \$225 billion



Predictions for the Future

The Northridge Quake caused more than \$67 billion in damages,^{vi} yet it was a relative lightweight compared to the force of what will come.

Seismologists say the “Big One,” which could strike at any moment, could be of a magnitude of 7.5 or more. Such a quake would rip along the fault and displace it by an average of 9 feet.^{vii}

In Their Words

“California has more than a 99% chance of having a magnitude 6.7 or larger earthquake within the next 30 years.”

— U.S. GEOLOGICAL SURVEY

“Earthquakes present the most destructive source of hazards, risk and vulnerability for the state.”

— CALIFORNIA OFFICE OF EMERGENCY SERVICES

“Northridge was not a big quake,” Seismologist Lucy Jones told NBC News. A larger quake would decimate the local economy, she added. Businesses would close, people would not be able to get to work, and an exodus of residents would flee, leaving the City of Angels for others to rebuild.^{viii}

Researchers at the University of Southern California support that prediction, determining that the eight-county region of Southern California could suffer property damage of \$132 billion, with additional business-related impacts at \$80 billion or more (in 2018 dollars).^{ix}

The U.S. Geological Survey and other agencies support 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.^x

“California has more than a 99% chance of having a magnitude 6.7 or larger earthquake within the next 30 years,” the Geological Survey determined. “The likelihood of an earthquake greater than magnitude 7.5 occurring is 46% over the next 30 years.”^{xi}

Recognizing the prevalence and threat of seismic activity in this region, the California Office of Emergency Services has listed earthquakes as the “most destructive source of hazards, risk and vulnerability” for the state, based on history and the probability of future destruction larger than previously recorded.^{xii}

What Makes California so Vulnerable?

According to the agency, there are four major strikes against California that put it at risk for earthquake damage:^{xiii}

- ▶ Its geography and location along the infamous “Ring of Fire”
- ▶ A chronic and destructive earthquake history
- ▶ High-intensity earthquake zones located near populated areas
- ▶ The identification of earthquakes by nearly all local governments as being a primary threat to their communities

The proximity of active faults near densely populated areas underscores the fact that millions of people in California live at the very epicenter of risk. The convergence of tectonic plates that make up the beautiful Sierra Nevada and other mountain ranges is what makes the West Coast so vulnerable to the threat of a massive earthquake: one that can easily result in damage running into the billions of dollars.



Heavily urbanized areas with high concentrations of people are another reason why this region is so vulnerable to catastrophic devastation. The West Coast contains some of the nation’s most densely packed population areas, with millions of people living and working in buildings that were not constructed to withstand a major earthquake.

As the California Office of Emergency Services explains, “Most of the state—everything east of the San Andreas Fault—is on the North American Plate. The cities of Monterey, Santa Barbara, Los Angeles, and San Diego are on the Pacific Plate, which is constantly moving northwest past the North American Plate. The relative rate of movement is about 2 inches (50 millimeters) per year.”^{xiv}

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,” the commission said, “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.”^{xv}

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

“Today, businesses of all types and sizes serve as the backbone of every community and the nation’s economic strength,” FEMA officials wrote in the agency’s “Quake Smart Tool Kit for Business.” “Small businesses alone account for more than 99 percent of all companies with employees, employ 50 percent of all private sector workers, and provide nearly 45 percent of the nation’s payroll. If businesses are unable to continue operations after an earthquake event, this could impact effective flow of critical products and services (i.e. food, medicine, utilities, financial, etc.), limit individual and community livelihood, and significantly delay disaster recovery.”^{xvii}

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.^{xviii}



The collapsed Northridge Meadows apartment buildings were a striking example of how soft-story structures can fail in an earthquake. (USGS)

New data released by Caltech researchers revealed that California has experienced 10 times more earthquakes than previously known — more than 1.8 million compared to the 180,000 previously on record, the Los Angeles Times recently reported.^{xix}

These small events are expected to provide scientists with a broader understanding of the process of fault rupture that leads to major earthquakes. Structures generally considered at-risk for damage or failure in a major earthquake include:

Five Most Vulnerable Buildings

- ▶ **Soft-story:** These wood-framed buildings have 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 mid-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, using large welded steel beams and columns, was most commonly used from 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.



IMPACTS OF QUAKES ON GOVERNMENT, COMMUNITIES, BUSINESS

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. 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. Much of this damage would be the result of disruptions in local economics: the projected inability of local businesses to function, and for employees to work.^{xx}

HAZUS Annualized Earthquake Loss (AEL)		
Rank	Region	AEL in Millions
1	Los Angeles	\$1,312
2	San Francisco	\$781
3	Riverside/San Bernardino	\$397
4	San Jose	\$278
5	Seattle	\$244
6	San Diego	\$155
7	Portland	\$137
8	Oxnard	\$111
9	Santa Rosa/Petaluma	\$69
10	St. Louis, MO	\$59



Concrete structures, like this Kaiser Permanente building, collapsed when exposed to the ground movements experienced in the 1994 Northridge earthquake. (USGS)

The Association of Bay Area Governments, concerned with these threats to the communities it serves, developed a business case study of a downtown Napa coffee shop to illustrate the problems typical of businesses that suffer through a quake. It's important to note that in this case study, the business did not suffer any direct earthquake damage, but was negatively impacted by damage experienced by other nearby businesses and infrastructure.

In the study, the unnamed business had opened five years prior to the 2014 Napa earthquake and its customer base was split between local residents and tourists. It employed fewer than 10 people, and its annual revenues were less than \$500,000. Prior to the earthquake, the business was breaking even and growing rapidly. After suffering no structural damage in the quake, the shop's operations were devastated by surrounding damage, loss of utilities and more.

Napa Business Case Study

The business rents the building housing the coffee shop. During the earthquake, it experienced some non-structural damage including ceiling cracks and overhead duct failure according to the ATC survey results. No structural damage was reported. It was a brand new building, with steel moment frames in one direction and reinforced masonry in the other. However, the building was located adjacent to other buildings which experienced significant damage. For that reason, the building was posted as a "yellow" placard. It took approximately one to three months for business operations to resume. It took approximately three to six months for the placard to be changed to "green"

because danger from adjacent building damage was removed. It is not clear if business was being conducted while the "yellow" tag was still in place. The street was closed for 16 months and access is still limited (including no parking availability). The respondent indicated it would be another two years until all repairs to surrounding areas will be completed. They also indicated that the inability of customers to access the business was a major impact. Since the earthquake, the customer base has shifted such that 70% are now

local (which indicates that less tourists are visiting the area). The business is currently operating at 50% reduced capacity (e.g. fewer hours and closed on some days). Aside from the major impact of site access restrictions, utility disruption at this site seemed particularly impactful. While electricity and water were restored within 24 hours, natural gas took 6 to 12 months to restore. The business also suffered cash flow issues and decreased revenues. Prior to the earthquake, the owner had property insurance (including for contents), business interruption insurance, and business liability insurance. A few days after the earthquake, the owner made insurance claims which were rejected. The owner also submitted requests for other funding from the Small Business Administration, corporate assistance, and local, state, or federal assistance, and was rejected on all counts. The owner indicated that the reason they were not eligible for FEMA or other grant money is because they had re-opened. To fund recovery, 70% came from personal savings, 20% from business revenues, and the remainder from debt.^{xxi}

Businesses Impacted in Northridge Quake

More than 559 firms (36% of all businesses surveyed), said the quake caused them to lose an average of \$85,026.

— U.C. BERKELEY SURVEY



Multiply this impact by the thousands of small businesses affected by the Napa quake and the magnitude of devastation becomes much clearer.

Then, factor in the added impact on larger businesses, which have a much larger effect on local economies. A larger factory, for instance, may employ a hundred people or more and be served by multiple vendors who collectively employ hundreds or thousands more. If the larger business shuts down, even temporarily, that presents a significant ripple effect in the economy.

In the year following the 1994 Northridge Earthquake, a group of U.C. Berkeley researchers sent out surveys to Southern California businesses, asking them to gauge the impact of the quake on operations.

More than a third of the 559 firms responding to the survey said the quake caused them to lose money – an average of \$85,026.^{xxii} The results included companies located in Orange County, nearly 50 miles from the epicenter of the quake.

Examples like these are important to consider because the threat of an earthquake is not unique to any one structure. Vulnerability to earthquakes impacts entire blocks of businesses and homes. This bears a significant concern to the following groups:

- ▶ Businesses (both tenants and owner-occupied)
- ▶ Commercial property owners
- ▶ Government and communities
- ▶ Public institutions

Government and Communities

There are social and economic reasons why government and communities should make resilience against earthquakes one of their primary concerns. Assessing earthquake risk and guarding against it saves lives, protects public infrastructure and services, keeps people in their homes and businesses and allows the wheels of the local economy to continue to function with minimal disruption.

Without this protection, revenues slow or stop and quality of life erodes. This could pose social and economic problems on a national or even global scale, with California representing the fifth largest economy in the world.


The Structural Engineers Association of Southern California came to this conclusion, 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.”^{xxii}

Apart from the social chaos that can come from any disaster, one major issue surrounding major earthquakes revolves around the disruption of businesses, loss of jobs, and decreased economic activity following a major earthquake. Businesses closed due

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 | Alameda |
| Berkeley | Santa Clara County |
| Richmond | Los Angeles County |
| Freemont | Los Angeles |
| San Jose | Beverly Hills |
| Oakland | Santa Monica |



to building failures cannot put employees back to work. 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 are particularly troublesome, considering many of these enterprises occupy the very buildings that are most at risk of failure during an earthquake.

Small businesses employ 56.8 million people representing 48% of the U.S. workforce, the Small Business Administration reported in 2016. In short, they constitute much of the economic health of local communities, states and the nation.^{xxiii}

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 the ripple effects on other businesses and vendors.

“As a city, we have a responsibility to put measures in place that will prevent injury and loss of life, and reduce displacement and recovery time in the aftermath of a major quake.”

— OAKLAND MAYOR LIBBY SCHAAF^{xxiv}



One of the biggest responsibilities of government is to spark and protect economic development that will bring jobs, support public services and enhance the quality of life for communities.



Business

Making sure the building stock of a community is prepared to survive a major earthquake and sustain its businesses should be a fundamental aspect of any city's economic development plan because it helps to maintain the economic health and well-being of the community.

Businesses are extremely vulnerable to the risks presented by earthquakes — and this in turn threatens the life, livelihood and well-being of the communities those businesses serve. This is true for businesses that lease space in a commercial building, as well as those that own and occupy their buildings. In either case, businesses may experience the following:

- ▶ **Loss of cash flow:** A disruption in business can mean a loss of revenue, putting a heavy strain on a business owner's ability to pay ongoing expenses.
- ▶ **Loss of equipment/inventory:** Damage to equipment and inventory can stifle or halt production. This adds another burden to the initial costs of replacing what was lost.
- ▶ **Loss of workforce:** Operational delays caused by earthquake damage may result in employees resigning to take jobs elsewhere. This may lead to lowered production once operations resume.
- ▶ **Liability:** Business owners may be held liable for losses incurred by employees or customers caused by failure of buildings vulnerable to earthquakes.
- ▶ **Environmental concerns:** Many businesses manage toxic substances that may pose hazards if exposed to the environment during an earthquake. Businesses are liable for cleanup costs associated with spills.
- ▶ **Loss of market share to competitors:** If business operations are slowed down or halted after an earthquake, it's likely that competitors will absorb the difference — temporarily or permanently, depending on the situation. Conversely, businesses that come out of a major earthquake unscathed may be better positioned to fill voids left by less fortunate competitors.

How does earthquake damage impact these constituencies? It's mostly a matter of economics. Whenever a building is damaged, revenue stops. Inventory is destroyed and virtually all aspects of a business are at risk.

That includes a business's most valuable asset: its employees. If a business cannot reopen after an earthquake, even for a couple of days, employees may not have the means to wait for the business to get back on its feet. By the same token, many employees may find themselves having to take care of their own needs in the event their homes or those of family members were damaged.

Long-term impacts can be equally as devastating. A major earthquake could lead to deep and extensive bankruptcies that could further impact the local economy.

"Most businesses have not conducted earthquake mitigation measures to protect their assets, staff and business operations."

—CALIFORNIA OFFICE OF EMERGENCY SERVICES



SMART STRATEGIES FOR BUSINESS: PREPARE FOR THE WORST

Business owners should consider the value of their company, factoring in all assets including equipment, inventory, revenue and expenses. In many instances the value of the business is more than the worth of the building it operates out of. That said, it's important that the business be located in a structure that will protect it in an earthquake so that it can remain viable.

Additionally, the Los Angeles Economic Development Corporation suggests businesses also guard against earthquake loss by taking the following steps. (1) Prepare a business operations flow chart to identify your most critical operations and employees. (2) Prepare a list of vendors and consider how supply chain and operational deficiencies will be affected by an earthquake. (3) Define crisis management strategies and responsibilities in advance. (4) Establish a disaster communications plan with employees. (5) Update your employee phone list with home/cell phone numbers. (6) Test your plans. (7) Take other precautions such as storing emergency supplies.^{xxv}

For income property owners, there are additional economic factors to consider when weighing the cost benefits of a seismic retrofit.

These include potential loss of income, which can occur when property is damaged to the point it is no longer habitable. This can create severe financial hardship for property owners who not only lose their monthly rental income, but are simultaneously faced with the costs of recovery coupled with ongoing monthly payments associated with their original mortgage.

LIABILITY

What risks do building owners face if they do not have their buildings retrofitted? Apart from the possible destruction of the building and the loss of all equity in it, there are significant liability issues to consider.

Owners can be found liable for negligence due to death and injuries caused by failure of buildings that are vulnerable to earthquakes.

When it comes to the law, a two-year study funded by the National Science Foundation's Earthquake Hazard Reduction Program determined that liability is in the hands of a jury to decide. In a precedent-setting case in Paso Robles, two employees of a clothing store were crushed to death by falling bricks during an earthquake in 2003. The building had been ordered by the city to be seismically retrofitted, but the deadline to do it had not yet passed.

A jury in the case found the building owner negligent based on the fact that he had received a retrofit order, knew the building was potentially dangerous, but had not taken action to correct the problem. The judgment was for \$2 million.

It could have been for much more, had the business been a commercial center or big-box retailer, a manufacturing plant, office building or multi-family complex. Liability grows with every person that occupies a structure.

The late Joel B. Castro, a construction defect attorney with Castro and Associates was working in Los Angeles at the time of the Northridge Quake. "The time I've been involved in these types of cases has given me what I think is a rare insight into the human psyche, which is, 'Let's wait until something happens before we do something,'" he said. ^{xxvi}

In these times, no business can afford to take that wait-and-see attitude.



A jury found owners of this building in Paso Robles liable for the deaths of two employees who were killed when the structure collapsed in a 2003 earthquake. The courts upheld that finding. (USGS)

THE CASE FOR RETROFITS


Earthquake resilience is not just about safety. It's smart, responsible and good business, according to Elizabeth Tulasi, chief operating officer of BizFed Los Angeles County. "It's not just the personal toll," she explained. "It's about how quickly businesses can get back on their feet."^{xxvii}

Researchers at Caltech have 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 benefit-to-cost ratios. In a separate study, the university determined that seismic retrofits are cost-effective when projected annualized loss can be reduced by 50% or more at a cost that would equal no more than 10% of the replacement cost of a building.^{xxviii}

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."^{xxix} That return on investment was even higher for tilt-ups with a higher occupancy, such as light industry, the study found. A typical cost-benefit analysis would look like this:

- ▶ Apartment Building Value: \$250,000 per unit
- ▶ 10-Unit Apartment Building: \$2.5 million
- ▶ Retrofit Cost (10 units): \$75,000
- ▶ Percentage of Value: 3%



Retrofits make good business sense, according to these figures. 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 six dollars or more.^{xxx}

As stated earlier, 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 is destroyed or red-tagged to restrict occupancy
- ▶ Ongoing financial obligations tied to the original mortgage loan
- ▶ Demolition costs including abatement of asbestos and lead contaminants
- ▶ Reconstruction and code upgrade costs, as well as cost overruns

“Everyone knows that major earthquakes are inevitable,” said Earle Vaughan, a longtime apartment owner and longtime director of the Apartment Association of Greater Los Angeles. “I have already completed a retrofit on my property because I know it will not only be needed down the road, but it protects my residents and investment from anything that may happen in the near future.”^{xxxi}

Indeed, seismic retrofits are the best option an apartment owner can take to protect his or her investment.

The University of California at San Diego, home to the world’s largest outdoor shake table, has repeatedly replicated the effects of quakes on a variety of structures.^{xxxi}

Recently conducted experiments on the performance of soft-story structures — buildings constructed over ground-level parking — found retrofits are quite effective in helping to control or even prevent damage.

BUSINESS: BACKBONE OF A COMMUNITY

Today, businesses of all types and sizes serve as the foundation of every community and the nation’s economic strength. Small businesses alone account for more than 99% of all companies with employees, employ 50% of all private sector workers and provide nearly 45% of the nation’s payroll. If businesses are unable to continue operations after an earthquake event, this could impact effective flow of critical products and services such as food, medicine, utilities, and financial services, limit individual and community livelihood, and significantly delay disaster recovery.^{xxxiii}

In general, many businesses have invested in emergency management and continuity of operations planning. However, according to FEMA, most businesses have not conducted earthquake mitigation measures to protect their assets, staff and business operations. During an earthquake, buildings—or their components or contents—can be collapsed, toppled, broken apart, tossed around or rendered inoperable or unusable.



The same can happen to lifeline infrastructure systems and their components, including those related to transportation, such as roads, bridges, railways, ports and airports, and those related to utilities, such as distribution lines for water, wastewater, electric power, telecommunications, natural gas and liquid fuels. ^{xxxiv}

Damage from these hazards, such as broken gas or water pipes, can be very hazardous, and generate further damage by igniting fires or flooding buildings, FEMA reported. ^{xxxv}

THE SOCIALLY RESPONSIBLE THING TO DO

When Los Angeles Mayor Eric Garcetti in 2015 signed into law what was at the time the nation’s most sweeping mandatory building retrofit ordinance, he did so to ensure L.A.’s most vulnerable buildings are strengthened to prevent loss of life in the event of a major earthquake.

Key to ensuring life preservation and economic resilience in the event of a major earthquake, the ordinance requires mandatory seismic retrofitting for two of L.A.’s most vulnerable types of buildings: non-ductile reinforced concrete, and soft first-story buildings built before 1980. Soft first-story buildings are wood frame buildings that have a large opening on the first floor for things like tuck-under parking, garage doors, and retail display windows. ^{xxxvi}

Under the new ordinance, building owners are required to accomplish the following seismic safety measures:


- ▶ For soft-first story buildings built before 1980, building owners were permitted one year to submit to the city documentation establishing that an acceptable retrofit had already been conducted or that a retrofit is required, and an additional year to acquire necessary permits. Property owners received seven years total to retrofit their buildings upon receipt of notice. The seven years is inclusive of the two years granted to the property owner to conduct an assessment and obtain permits.
- ▶ For non-ductile reinforced concrete, building owners received three years to submit documentation to the city to begin the inspection process, and 10 years to establish whether an acceptable retrofit has already been conducted or that a retrofit is required. Property owners were given 25 years total to complete the retrofit work, inclusive of the first 13.

“We’re leading the nation in requiring this level of building safety before, not after, the big quake we know is coming. It’s not just the lives lost, but the lasting social and economic effects that we can avoid by ... protecting our communities.” ^{xxxvii}

—LOS ANGELES MAYOR ERIC GARCETTI

It was a monumental step in establishing seismic resilience for our nation’s cities. Since then, many other municipalities have established ordinances of their own. Why?

Societies throughout the world depend on seismic resiliency to protect their economies, businesses and populations.



Every building protected from earthquake damage enhances its capacity to spring back quickly from hardship– for tenants, employers, hospitals, government services and the building owners themselves. Every building saved means businesses continue to operate, families can remain in their homes, and employees can go to work. It’s another step away from the chaos and crime that can result from a community’s economy shutting down due to earthquake damage. The first step toward achieving resiliency is to identify buildings that are vulnerable to damage in an earthquake.

Resilience is essential to a functioning society. It ensures:

Social well-being: People have a right to be informed about the buildings in which they live and work based on the best information available. Knowing a structure is at risk of failure in an earthquake is a first step toward mitigating vulnerable buildings’ deficiencies and avoiding widespread destruction of much of the state’s affordable housing and business stock and the increased homelessness and business impacts that may result from a major quake.

Economic stability: Studies indicate that widespread homelessness and resulting joblessness from an earthquake disaster in California would trigger billions of dollars of economic loss to communities and the state. Untold numbers of businesses would go bankrupt. Reconstruction costs alone after a major Southern California earthquake are estimated at up to \$113 billion.^{xxviii}

Environmental health: Many seismically vulnerable buildings contain asbestos and lead, which, when released into the air and groundwater from crumbled rubble, will pose a public health problem of potentially overwhelming impacts. Preventing these structures from being damaged averts widespread exposure which can impact humans and nature. It also avoids the overburdening of landfills should the state need to dispose of the ruins of a major quake.

Here in California, governments are working to build resilience through legislation. Scientists and engineers are working to develop a better understanding of the nature of quakes and their impacts on our built environment. And technology experts are finding ways to warn against earthquakes before they strike.

These efforts need to be continued and accelerated. In addition, businesses and property owners need to expand their investments in building retrofits in order to make Californians safer and more resilient.



CONCLUSION

The force of a major quake is more than most of us could imagine. Richard Goodis, a victim of the Northridge quake, described the experience saying his home was moving “like a jackhammer was going at it.”

**“Our bedroom wall tore away,” he told the Associated Press at the time.
“I was looking at the ceiling one moment, then I was looking at the sky.
I thought we were dead.”^{xxxix}**

The probability of another Northridge earthquake, with a similar or greater scale of losses, is high, the Association of Bay Area Governments reported.

Yet federal and state governments are keen to shift the responsibility for disaster relief, and funding is unlikely to be adequate to rebuild based solely on government aid. Insurers have also grown wary—as the increased premium rates and reduced coverage offered by the the private market indicate—and earthquake insurance is no longer as widely carried by the public as before.

For many decades, the Federal government has provided financial assistance to state and local governments following earthquake, fire, flood and wind disasters.

In the months following California’s deadliest wild fire season in 2018, FEMA informed state leaders that it would withhold millions of dollars in reimbursements, which state fire agencies contend they are owed for battling wildfires on federal lands. The Los Angeles Times reported the dispute marked a sudden change in a partnership that existed between federal and local authorities since 1961. ^{xi}

As California prepares for another challenging fire season in 2019, officials are concerned this dispute portends the administration’s plans to cut back further on fire assistance. Worse yet, the potential economic losses that could result from a major earthquake disaster are much higher. Will the model of inter-agency cooperation that was forged between California and Washington D.C. over generations continue to function in the future when it is needed most?

Who will bear the costs of the next Northridge earthquake? Will it be the federal government? The state government? The private insurers? Or the disaster victims?


The likelihood is that it will be the latter, the association study found. This shift in responsibility for economic losses will have significant political, economic and social costs.

Berkeley’s retrofit grants program allows owners of seismically vulnerable buildings to receive up to \$50,000, depending on building type and cost of construction to retrofit their commercial buildings

—CITY OF BERKELEY WEBSITE, ^{xii}

What Can Government, Businesses and Property Owners Do?

Local businesses and property owners should work with their state, tribal, and local governments on the development and adoption of local hazard mitigation plans. FEMA requires these plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. Jurisdictions must update and resubmit their plans for FEMA approval every five years to maintain eligibility.



Through FEMA's Hazard Mitigation Assistance (HMA) grant programs (Hazard Mitigation Grant Program, Pre-Disaster Mitigation, and Flood Mitigation Assistance), planning grants are offered to assist state, local and tribal governments with developing and updating mitigation plans.^{xlii}

The Hazard Mitigation Grants Program (HMGP) helps individuals and state, local, and tribal government representatives with the information and resources they need to implement hazard mitigation measures in their communities.

FEMA's vision is to serve as a catalyst that drives increased understanding and proactive action to help people in communities reduce their losses from natural hazards. To support this vision, FEMA funds three Hazard Mitigation Assistance (HMA) grant programs.

Hazard mitigation measures are sustainable actions that can be taken to reduce or eliminate long-term risk to people and property from future disasters.

- ▶ The HMGP supports cost-effective post-disaster projects and is the longest running mitigation program among FEMA's three grant programs. Studies have shown that every \$1 spent equals \$6 of future damages mitigated.
- ▶ FEMA provides up to 75% of the funds for mitigation projects. The remaining 25% can come from a variety of sources, including cash payments from the state, local government or in some cases directly from the building owners.
- ▶ Other sources may include donated resources, such as construction labor; Increased Cost of Compliance (ICC) funds from an insurance policy; or loans from other government agencies, such as the Small Business Administration.
- ▶ Pre-Disaster Mitigation Grants (PDM) assist states, local communities and other areas with implementing a sustained, pre-disaster natural hazard mitigation program. The goal is to reduce risks to people and structures from future hazard events, while also reducing reliance on Federal funding in future disasters.
- ▶ This program awards planning and project grants, and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Mitigation planning is key to breaking the cycle of disaster damage, reconstruction, and repeated damage. PDM grants are funded annually by Congressional appropriations, and are awarded on a nationally competitive basis.
- ▶ For information on the mitigation plan requirement, visit the FEMA Hazard Mitigation Plan Requirement web page at fema.gov/hazard-mitigation-planning or refer to the current HMA Guidance for detailed information.



Strategies for Resilience

Resilience is a transformational process—the product of change, born of a combination of education and action.

State and community leaders need to educate themselves and their communities about the unique threats faced in our neighborhoods. We have seen this in the past as people rallied to push for retrofits of school buildings after several were destroyed in the 1933 Long Beach earthquake.

Seatbelt laws were passed and their usage became commonplace when the public carnage caused by not wearing them seemed to no longer be an acceptable risk.

And the truth remains, that our nation's most resilient communities are those that have done their due diligence to identify the risks they face, and to take action to guard against them.

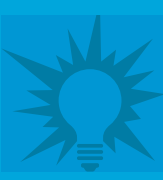
Here are some steps to get communities started on the path to resiliency:

- ▶ Identify local buildings that are most at risk of earthquake damage.
- ▶ Study whether it makes sense to require retrofits of your community's most vulnerable structures, or at least to identify buildings needing retrofits to improve the overall safety of the people they serve.
- ▶ Consider measures allowing property owners to pass through to tenants some portion of the costs of retrofitting their buildings. This will help to incentivize structural improvements that could save lives.
- ▶ Consider allowing affordable housing funds to be used to do seismic retrofits that will protect and preserve the community's existing affordable housing stock.
- ▶ Consider providing incentives of various types to assist businesses with the cost of seismic retrofits.
- ▶ Conduct community meetings to educate property owners and business leaders on the importance and economic benefits of installing earthquake retrofits to enhance safety, protect lives and property investments.

The forecasts of the potential for deaths, massive casualties, building and infrastructure collapse, and the social, economic and financial impacts of that destruction can be overwhelming. But each of us is capable of preparing for a major quake as it affects our lives, families, homes and places of business. There are steps you can take now in advance of an earthquake to protect your assets and the lives of your loved ones. Don't delay.

There is too much at risk.

Coming soon: Part 2, addressing specifics of retrofits, risk assessment and financial incentives to pay for building fortification.



ABOUT THE AUTHORS



Evan Reis, SE

**Executive Director
U.S. Resiliency Council**

Evan Reis is a Registered Structural Engineer in California, Hawaii and Texas. He graduated from Stanford University in 1988 with bachelor's and master's degrees in structural engineering. The following year, he was helping the university recover from the Loma Prieta Earthquake and playing an integral part in its long-term seismic program, a relationship that continues today. He was the structural engineer for the seismic retrofit of several of Stanford's most historic buildings, including the Memorial Church and Stanford Art Museum, each of which won national awards for their technical excellence and creative design.

Evan co-founded the U.S. Resiliency Council (www.usrc.org) in 2011 as a way to educate building stakeholders and the public about the gap between the growing sustainability movement and true resilient design. The country was made painfully aware of this gap little more than a year later, in the aftermath of Superstorm Sandy. Evan noted that even though there were more LEED certified buildings in the New York area than anywhere in the world, these buildings were built to have a low impact on the environment, not for the environment to have a low impact on them.

The mission of the USRC is to educate, advocate and promote resilience-based design that considers the impacts of natural disasters as an essential component of long-term sustainability. Its earthquake building performance rating system is being used by public and private owners and communities, and is forming the basis of economic and financial incentives being developed by lenders and insurers to reward high performing buildings.

Evan is a member of the Earthquake Engineering Research Institute, The Federal Alliance for Safe Homes, BizFed, the California Polytechnic University San Luis Obispo Architectural Engineering Advisory Board, and the National Institute of Building Sciences. He is Chairman of the Alliance for National and Community Resilience and the Ravenswood Youth Athletic Association.

Evan lives in the San Francisco Bay Area with his wife, Kristine, and their three sons.



Ali Sahabi, GEC, MRED

**Real Estate Developer, General Engineering Contractor,
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Ali Sahabi, a lifelong advocate for resilient and sustainable communities, has spent his career promoting the safety, economy and quality of life of communities throughout California. His work has been honored with the California Governor's Environmental and Economic Leadership Award for taking a sustainable approach toward community development and environmental restoration in the Dos Lagos mixed-use development in the City of Corona.

As Chief Operating Officer of Optimum Seismic, Inc., one of California's leading seismic retrofit companies, he leads an experienced team that has been making cities safer since 1984 by performing earthquake engineering to achieve earthquake resistant buildings. His company performs full-service seismic retrofit engineering and construction services on multifamily, residential, commercial and industrial buildings throughout the state. Sahabi also serves as President of Optimum Group, LLC.

Sahabi earned a Master of Real Estate Development degree from the School of Urban Planning and Development at the University of Southern California, and a Bachelor of Science degree in Management from Pepperdine University.

Widely known for his philanthropic efforts, he supports a broad range of causes. He generously endowed the University of California, Riverside's Center for Sustainable Suburban Development, and continues to support numerous other causes to help people and communities.

The immediate past president of the Building Industry Association, Baldy View Chapter, Sahabi has extensive involvement in multiple professional, civic and nonprofit organizations including the California Apartment Association, California Building Officials, California Manufacturers & Technology Association, Los Angeles Area Chamber of Commerce, Los Angeles County Business Federation, and U.S. Resiliency Council. He is also involved in numerous local Apartment Associations, Chambers of Commerce, and Realtors Associations. He and his wife, Aida, live in the Los Angeles area with their two children, Leila and Edward.

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