ECONOMIC BENEFITS OF EARTHQUAKE RETROFITS AND RESILIENT DESIGN

By
Evan Reis, Executive Director,
U.S. Resiliency Council
Ali Sahabi, Chief Operating Officer,
Optimum Seismic, Inc.
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WHY BUSINESS AND GOVERNMENT SHOULD INVEST NOW TO PROTECT OUR COMMUNITIES AND ECONOMY FROM DISASTROUS EARTHQUAKES

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EXECUTIVE SUMMARY

Ghost town communities.

Shattered lives brought on by boarded-up businesses, record numbers of unemployed and economic collapse. A devastating death toll – and hospital, morgue and public safety services stretched beyond their limits.

This is what disaster looks like, and we are seeing it first-hand in 2020 with the deadly COVID-19 pandemic.

The world was not prepared for a global crisis such as this. We were seemingly too distracted, too busy, or too negligent to heed the warnings from epidemiologists.

The grim experience changed millions of lives as leaders cried out to make communities resilient against any disaster – be it disease, hurricane, fire, or earthquake.

Will that change really happen? How soon will we forget the lessons learned about the need for resilience?

This report presents important information demonstrating the effectiveness of earthquake-resistant buildings, and the sound economic investment they are to business and building owners, tenants, governments and the community-at-large.

The Risk is Real

FEMA estimates that $4.4 billion in earthquake losses occur each year in the United States. This figure includes only capital and business income losses, not the direct or indirect economic losses caused by damage to housing, schools, businesses, critical facilities, transportation, and utility lifelines. According to the study, 84% of the nation's annual losses are expected to occur in California, Oregon and Washington, with California alone accounting for $3.3 billion.[1]

The West Coast is at grave risk of a major earthquake, but the threat is relevant throughout the nation, in cities like Memphis, Charleston, SC, and Salt Lake City; and multiple disasters can strike simultaneously. Amid this year's novel coronavirus outbreak, Salt Lake City was hit by an earthquake that cut power to tens of thousands, temporarily closed the airport and suspended work at Utah's public health lab.

Nearly halfway around the world, the Croatian capital of Zagreb saw its largest earthquake in 140 years while in coronavirus lockdown. Extensive damage was reported to the Parliament building and cathedral. Hospitals were damaged and evacuated. Walls, rooftops and chimneys of many buildings collapsed.[2]

During the same period, a 6.5-magnitude quake struck Idaho – the strongest temblor in the state since 1983.

The U.S. Geologic Survey estimates a 99% chance in the next 30 years of another Northridge-size earthquake occurring in California. That 6.7-magnitude quake damaged or destroyed more than 82,000 structures, killed 60 people, and injured 9,000 in 1994.

Even more dramatic is the likelihood of a major quake of magnitude 7.5 or greater in the next 30 years: 46%. Recent estimates put damages caused by a magnitude-7 earthquake on the Puente Hills fault running through downtown Los Angeles at more than $252 billion with thousands killed and hundreds of thousands displaced.[3]

It could be much worse.

On September 7, 2017, a massive earthquake, estimated at Magnitude 8.1 by the U.S. Geological Survey, unleashed four times more energy on southern Mexico than the 1906 San Francisco Earthquake. A similar quake on the San Andreas fault would damage every community in Southern California from Palm Springs to San Luis Obispo, according to seismologist Lucy Jones.[4]

Earthquakes are Inevitable, But They Do Not Have to be Disasters

Much of society has embraced resilience, recognizing that the strength of the built environment affects the physical, economic, and social well-being of communities by preserving lives, property, business continuity, public services, and communities' fiscal stability.

Most notable are advances in the retrofitting of existing buildings, where – because of the numbers of vulnerable structures in our communities – the opportunity to make significant and positive change can reach deep into the heart of maintaining social well-being.

Major steps forward in earthquake safety were taken by California's two largest cities in the past decade.

Then-San Francisco Mayor Gavin Newsom signed an Executive Order in 2010 to launch an Earthquake Safety Implementation Program. The program mandates retrofits for vulnerable soft-story, wood-frame buildings of three or more stories with five or more residential dwelling units.[5] Retrofitting these buildings will improve safety for as many as 180,000 San Franciscans, while continuing to protect affordable housing stock, businesses and the local economy.

Similar action was taken by the City of Los Angeles in October 2015, when Mayor Eric Garcetti pushed for new laws mandating several measures, including seismic retrofits of nearly 14,000 pre-1978 soft-story wood -frame structures. Many of these buildings provide housing for the city's most vulnerable populations. In an ambitious report entitled, "Resilient by Design," Garcetti called for making Los Angeles "a nation-leading epicenter of seismic preparedness, resilience, and safety."[6]

As of April 1, 2020, plans had been submitted for 11,396 properties and 6,745 of these had pulled permits. Construction had been finished and Certificates of Completion issued for 4,142 properties with permits.[7]

We are at a tipping point. Today, the economics of retrofits and resilience work. Even the simple benefit of eliminating potential earthquake liability judgements can mean the difference between solvency and bankruptcy for building owners and businesses.

Over the past 40 years, structural engineers have developed innovative technologies to reduce building damage and injuries. Building science and materials have improved dramatically, and public awareness about the importance of seismic resiliency has grown significantly.

The costs of seismic retrofits are often affordable, resulting in a high return on investment. The National Institute of Building Sciences found that retrofitting existing residential building stock can produce up to $16 dollars in benefit for every dollar spent. Many smart building and business owners are taking the obvious next step: investing in resilience to stay in business after a major earthquake.

Everyone Benefits from Resilience

Our challenge as a society is to drive this momentum forward, ensuring that older buildings are safe, and that new construction makes the most of today's seismic engineering and technology advancements. Meeting this challenge begins with understanding that when our building stock becomes more resilient, everyone benefits.

- Safety: Lives are saved, injuries are prevented.
- Economic: Building owners preserve their equity, protect their income stream, safeguard important physical assets, and avoid costly liability claims. Businesses stay open, and insurers and lenders suffer fewer losses.
- Social: Governments maintain tax and other revenues to keep vital public services going when they are needed most, families are protected from job loss and displacement, and social networks remain intact.
- Environmental: Serious environmental damage is avoided with less debris being taken to landfills, and reduced hazardous waste exposure, greenhouse gas emissions and natural resource consumption associated with reconstruction efforts.

None of this will happen without significant behavioral transformation. Some of that has already happened, but there is much left to do.

Achieving greater public awareness and understanding of resilience will take time. However, this should not be a deterrent. Other important movements took time to gain support in our society: anti-smoking and drunk driving campaigns, seat belt safety, conservation, and the green movement. Each of these issues were addressed through some combination of public education, economic incentives or penalties, advocacy and legislation.

In the case of resilience, all these elements must come into play.

The United States Resiliency Council, in collaboration with building design professionals and contractors around the nation, has established a building performance rating system through which owners, businesses, institutions, and local, state, and federal governments can assess, specify and be rewarded for resilient design and retrofit.

The USRC framework relies on using state-of-the art research and science to produce objective, credible, and quantifiable metrics around the expected performance of buildings in natural hazard events.

These metrics form a sound basis for financial and other incentives to be offered by lenders, insurers, and government jurisdictions to building owners and developers for investments in resilient building design and retrofits. Since everyone benefits from resilient buildings, all parties have a role to play in sharing the costs, thus lightening the burden on any one group.

Enlightened leaders in business and government are increasingly joining the movement toward embracing earthquake-resistant buildings as a means of protecting businesses, investments, and enhancing public safety and well-being.

Imagine you are back in 2018, but with knowledge of the 2020 COVID-19 pandemic to come. What investments in readiness would you have made? Now, translate that same thought process to the opportunities you have available now to mitigate the seismic shocks that lay ahead.

INTRODUCTION: A TALE OF TWO CITIES

A San Francisco-based structural engineer was taking the subway in Tokyo, when his eye caught an ad for a downtown luxury apartment building. He did not understand the text, but the message was clear: an image of seismic base isolators in the basement proclaimed safety and resilience.

San Francisco and Tokyo have a lot in common. Both are wealthy metropolitan jewels located along the "Ring of Fire" – the most seismically active region on our planet – which circumscribes the Pacific Ocean.

A Japanese ad touts an apartment building's safety over luxury.

Credit: Troy Morgan

Both cities have suffered devastating earthquakes, but their attitudes about seismic risk divide them.

Like California, Japan is no stranger to deadly earthquakes: The Great Kanto quake of 1923, an 8.3-magnitude event, killed more than 100,000 people with another 40,000 presumed dead because their bodies were never found. In 2011, a colossal 9.1-magnitude earthquake – one of the world's five largest earthquakes ever recorded – triggered a tsunami with waves as high as 33 feet. The disaster killed thousands, destroyed infrastructure, and led to significant accidents at four major nuclear power stations, prompting radiation scares as far away as California.[8]

After the Kobe earthquake in 1995, which killed about 6,000 people and injured 26,000, Japan put enormous resources into new research on protecting structures, as well as retrofitting the country's older and more vulnerable structures. Japan has spent billions of dollars developing the most advanced technology against earthquakes and tsunamis.[9] Hidden inside the skeletons of high-rise towers, extra steel bracing, giant rubber pads and embedded hydraulic shock absorbers make modern Japanese buildings among the sturdiest in the world during a major earthquake.

Tokyo's demand for earthquake safety makes base isolators a better selling point for real estate than rooftop patios with a view, and this shows in the advertising targeted to each respective population.

New apartment and office developments in Japan flaunt their seismic resistance as a marketing technique, a fact that has accelerated the use of the latest technologies, said Ronald O. Hamburger, a structural engineer in the civil engineering society and Simpson Gumpertz & Heger, a San Francisco engineering firm.

"You can increase the rents by providing a sort of warranty — 'If you locate here, you'll be safe,'" he told the New York Times.[10]

California's Erratic Record of Resilience

One of California's first forms of earthquake legislation, The Field Act, mandated strict guidelines for schools following a 6.4-magnitude quake in Long Beach in 1933 that killed 120 and injured 500 others. Because 120 schools were destroyed or severely damaged in that quake, many more deaths would have occurred had the quake happened when school was in session.[11]

The Garrison Act of 1939, also stemming from that quake, required reviews of existing schools built prior to the Long Beach Quake. The third law resulting from this quake was the Riley Act, which institutionalized building safety regulation.

Many years later, the Sylmar quake of 1971 prompted a handful of laws, including safety acts for dams and hospitals, and changes in concrete construction codes.

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With each major earthquake comes a new understanding of the ways in which buildings respond to them. Advances in the technology associated with testing systems, design and seismic modeling software, structural materials, connections and seismic force resisting systems have accelerated dramatically over time.

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 of $164 million in damage. 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. As noted earlier in the Executive Summary, making his city safer was a 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.

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.

WHAT IS RESILIENCE?

Our first white paper titled, "Economic Benefits of Earthquake-Resistant Buildings," laid out the likelihood of a major earthquake striking California, and the devastation it would leave in terms of deaths, injuries, damaged infrastructure, loss of housing, employment, and quality of life.

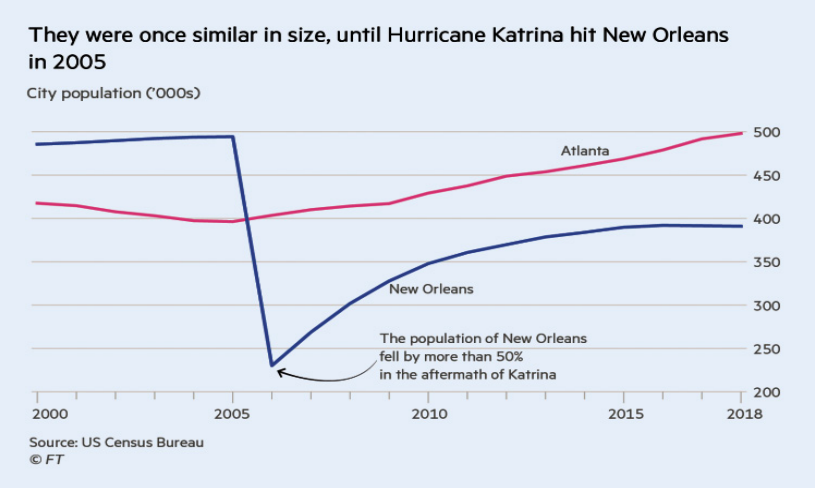
This study takes a deeper look into what is resilient design, and why is it a good strategy for business, property owners and government entities.

Resilience is the ability of a nation, a community, a building, a business, or an individual to withstand and recover from adversity, be it physical, social, emotional or economic.

Nearly all social functions depend on physical infrastructure. The ability of a community to restore these functions quickly after a natural disaster is in part dependent on the damage our infrastructure sustains and how quickly it can be repaired to a state of basic functionality.

The Hurricane Katrina experience in New Orleans illustrates this concept well, particularly when you compare that Louisiana city to its Southern rival, Atlanta.

As indicated in this graph, the population of New Orleans fell by more than 50% following Katrina, and the city never caught up to Atlanta.



The population of New Orleans and Atlanta, before and after Hurricane Katrina.

Today, Atlanta is the fifth most populous city in the southern Sun Belt, having grown to 500,000 people to 400,000 for New Orleans, a complete reversal from their populations before Katrina, according to the Financial Times.[12]

Hurricane Katrina began as a natural phenomenon but became a national tragedy as it illuminated the vulnerabilities of a city sitting below sea level, and of residents without the means to safely weather the storm. When the levees broke, floodwaters rushed into the city's lowest-lying and poorest neighborhoods, displacing predominantly poor and single-household populations.[13]

A New Push for Resilient Design

Unlike the COVID-19 disaster – which left public infrastructure and buildings intact – earthquakes can take a calamitous physical toll on communities as buildings and infrastructure crumble, businesses are closed, and people are left homeless.

Recovery requires years of rebuilding. Sometimes with little success.

When buildings can still be used after an earthquake, benefits accrue not only to the owner, but to the broader community as well.

Even as late as 2009, four years after Hurricane Katrina struck New Orleans, many homes and homeowners had not yet recovered from the disaster.[14]

We have seen these tragic results many times when buildings and infrastructure fail in natural disasters.

- The Camp Fire, 2018: 85 people died, more than 150,000 acres were burned, and 18,800 structures were destroyed, wiping out the city of Paradise, perhaps permanently.
- Hurricane Michael, 2018: The category 5 storm damaged or destroyed 1,584 of 1,692 buildings in Mexico Beach, Florida, essentially wiping out the resort community,
- Hurricane Katrina, 2005: In addition to the 1,836 deaths caused by the storm, more than 600,000 households were displaced, the region suffered more than $80 billion dollars in immediate losses, with possibly $250 billion in additional economic losses due to slow recovery.[15]

Beyond the physical assets and business value that a building represents to its owner, the social and economic stability of a community are directly dependent on how buildings perform in natural disasters.

Code vs. Resilient Design?

Code-Based Design, according to the Federal Emergency Management Agency, "[is] intended to ensure the health, safety, and well-being of people in buildings by establishing minimum requirements to address structural strength, adequate means of egress, sanitary equipment, light and ventilation, and fire safety." [16]

Building codes try to balance the cost of construction with achieving a minimum performance goal of life safety. But saving lives does not protect the financial security of the building owner. Code-based measures do not ensure that a building will be usable, or even salvageable following a major disaster.

When two major earthquakes hit Christchurch, New Zealand in 2011, just two buildings collapsed killing 133 people.[17] Most modern downtown structures performed as expected and avoided dramatic failure. Yet in the earthquakes' aftermath, more than 50% of these modern buildings were demolished due to extensive damage.

Credit: Seattle Times

Had the city implemented retrofit ordinances for its older buildings, or required resilience-based design for newer construction, it would have reduced the need to demolish many of these downtown area structures.

Seven years after those earthquakes in Christchurch, officials said it would still take another 20 years to get the city's quake-damaged roads to the same standards of other cities.[18]

Resilience-based design strives for quick recovery of infrastructure systems within the communities they serve, reducing damage costs and recovery time so that families, businesses, institutions and communities can get back to normal quickly after a quake or other natural disaster.

The Earthquake Engineering Research Institute defines functional recovery as "a post-earthquake state in which capacity is sufficiently maintained or restored to support pre-earthquake functionality." [19]

Older concrete structures are at risk of collapse, like this medical building did during the Northridge quake of 1994.
Credit: USGS

- For housing, resilience might mean the ability of a homeowner to shelter in place with basic utilities. On a community level, it also means that enough people can remain in their homes so that existing shelter space is not overwhelmed.
- For a retailer, resilience may mean that it can repair damage and restore operations within two months in order to avoid financial ruin, and therefore continue to provide its employees a safe place to work. A city may consider its businesses resilient if enough retailers recover within six months to avoid heavy loss of sales tax dollars and flight of labor to other communities.
- For schools, resilience is the ability to continue to provide classroom space for students. Schools often also provide an essential service during the response and recovery phases after a disaster by serving as community emergency shelters.
- For hospitals, resilience has to be measured in terms of being able to function immediately after an event, to treat the injured from the surrounding area.

The Imperative for More Resilient Design

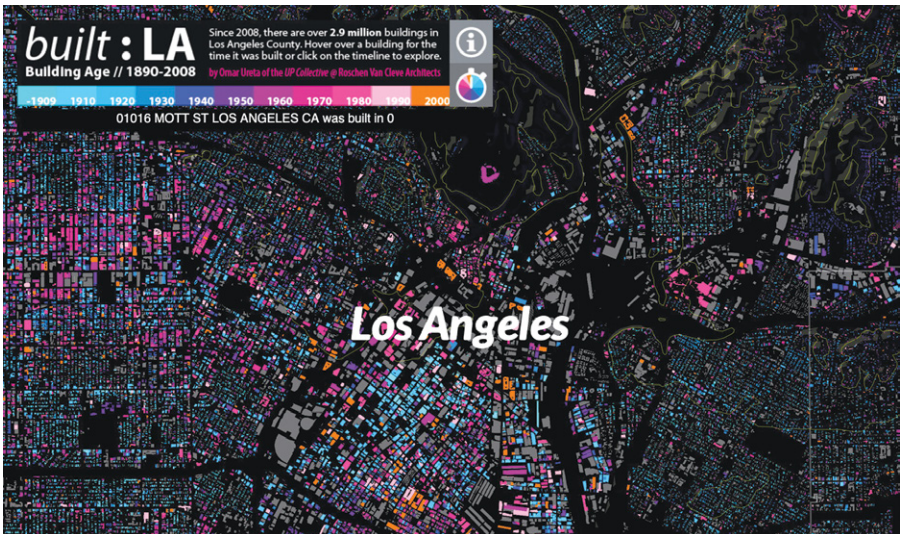
Widespread resilience can be best achieved with a focus on the thousands of buildings in many major cities that are at risk of collapse in a major earthquake.

Each of these buildings represents hundreds, if not thousands of lives and livelihoods: tenants, employees, customers, students, health care workers and patients, and the list goes on.

The average age of a commercial building in the United States is about 50 years. Mixed-use development is about 75 years old on average.[20] These structures were constructed in the 1950s to 1970s, and most of them are vulnerable to damage if in an earthquake prone region.

Mitigating these structures can provide a high return on investment because of the potential to save lives and, when coupled with other upgrades, it can add to the life of a building and increase its value. The National Institute of Building Sciences found that retrofitting existing soft-story residential building stock can produce up to $16 dollars in benefit for every dollar spent.[21]

A recent Stanford University study found that older buildings that predate modern codes are "by far the dominant source of natural-hazard risk today...These results show that society can cost-effectively protect itself from natural hazard risk in multiple ways, both by mitigating past problems and by preventing future ones." [22]



An interactive map by City Hub L.A. illustrates the ages of buildings in the city. https://bit.ly/3cySN3V

Structural engineers consider modern seismic building codes, which adequately address life safety at a minimum, to be those in force from about the 1990s forward.[23] City Hub L.A. has compiled an interactive map showing the ages of Los Angeles buildings from 1909 to 2000 – the vast majority of which were constructed in the 1970s or earlier. [24]

What types of existing buildings are most at risk of failure in a major earthquake?

> **Soft-Story:** a design commonly found among apartment buildings, soft-story buildings are characterized by open parking on the ground floor and dwelling units built above. In some instances, the ground floor may be used as retail space and enclosed by windows that do not provide structural support. These wood-framed structures, when constructed prior to 1978, are considered extremely vulnerable to collapse in a major earthquake.

Non-ductile Concrete: Non-ductile concrete buildings built before 1978 are characterized as having concrete floors and/or roofs supported by concrete walls, columns and/or frames. Due to their rigid construction and limited capacity to absorb the energy of strong ground-shaking, these structures are at risk of collapse. In fact, non-ductile concrete buildings make up most earthquake losses around the world. Because they are frequently used for office and retail uses that draw large numbers of people, the potential for death and injury with these structures is of grave concern.

Tilt-up Concrete: This type of construction became popular in the post-World War II construction boom. This cost-effective technique of pouring a building's walls directly at the jobsite and then raising or "tilting" the panels into position was and continues to be a popular way to meet California's demand for new commercial buildings. The walls of a concrete tilt-up building can weigh between 100,000 and 300,000 pounds. Many tilt-up structures built prior to the late 1970s were constructed with limited or weak connections between individual wall panels or from the walls to wood or metal deck roofs. Several dramatic collapses of these type of structures led to significant code changes in the 1980s and later.

> Every dollar spent on natural disaster mitigation returns $4 to $7 in in reduced economic impacts.
>
> —National Institute of Building Sciences

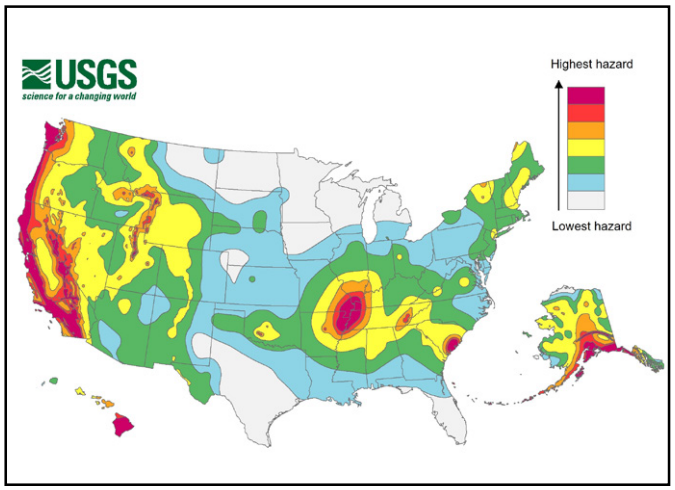
Steel Moment Frame: Steel moment frame construction dates back to the 1880s with the very first skyscraper, the Home Insurance Building in Chicago, but this building technique was most commonly used in the 1960s to 1990s. Steel moment frame construction is characterized by the use of a rigid steel frame of beams connected to columns to support the many floors of the structure. Those that were designed and built prior to the mid-1990s can sustain brittle fracturing of the steel frames at the welded joints between the beams and the columns. In fact, many moment frame buildings in Southern California, which have been through major seismic events may today contain cracks and fissures in these frames and be susceptible to collapse in a future, large earthquake.

Unreinforced Masonry: Unreinforced masonry buildings make up many of the older structures typical in downtown communities. They are characterized by walls of brick, cinderblock, or other masonry materials not reinforced with steel. URM structures are vulnerable to collapse in an earthquake because the walls are brittle and have low strength, and because they are generally poorly anchored to floors and roofs. Unreinforced or poorly anchored brick parapets can also peel from the building façade and fall onto the sidewalk below. Most of these structures were identified as part of a 1986 California mandate. During the late 1980s and 1990s, many cities enacted mandatory ordinances to require mitigation of these buildings, but there are still thousands of these buildings yet to be retrofitted.

Some states and several local jurisdictions have taken steps to require or encourage building owners to seismically retrofit their older buildings in order to reduce the risk to the millions of people that inhabit them, but there still is a lot to be done if we are to become resilient.

Risk and Resilience

Risk is be assessed by considering three factors: hazard, vulnerability, and consequences.



Hazard is the probability over some defined timeframe that a large natural disaster will strike a building. In California, there is a 99% chance over the next 30 years that a magnitude 6.7 or greater earthquake will occur in the state, according to the USGS. The magnitude 6.7 event that struck Northridge in 1994 resulted in more than $50 billion dollars in damage, displaced over 50,000 people, and left 60 dead.

But as noted above, there are many regions of the country where seismic hazards are present, and where buildings may be particularly vulnerable to them.

Exposure and proximity to hazards also matters. The 7.1 earthquake that struck the high desert area of Ridgecrest in 2019 did comparatively little damage because it was far from more densely populated urban areas.

Vulnerability measures how buildings are impacted by these severe hazards.

A building's vulnerability depends on its structural system and the type of building code under which it was designed. If you were to relocate a hospital built in Houston, where earthquake risk is not a consideration, to San Francisco, or consider a 100-year-old historic Bay Area building constructed before modern building codes existed, those buildings would be much more vulnerable than those designed today under California's seismic codes.

Alterations, deterioration, and the effects of past earthquakes can also increase the vulnerability of a building, as can the soil conditions under it.

Students at Cal Poly San Luis Obispo simulate the effects of an earthquake on a model skyscraper placed on a "shake table" at an international competition involving some 50 universities from around the globe.

The structural engineering profession's ability to design safe and resilient buildings continues to grow as it studies the effects of past earthquakes on buildings, performs laboratory testing of materials and structural systems, and uses advances in computing capabilities to model building performance when subjected to realistic event scenarios.

The ability to assess a structure's vulnerability has prompted interest by the financial lending, insurance, and real estate industries to require parties interested in obtaining financing or insurance on properties or transferring ownership to identify, disclose and mitigate earthquake vulnerabilities. These actions will help to ensure businesses and buildings survive future earthquakes. State and local government agencies are also finding it beneficial to identify vulnerable structures to aid in planning disaster response, protecting their economies and safeguarding the public.

Consequence is a measure of the impact resulting from building damage. Impacts can be economic and social. They can affect an owner's investments, their ability to stay in their home or in business, their reputation, and liability. Consequences can be felt on a city or regional level if a major employer is shut down. If a hospital collapses in an earthquake, the consequences can be profound: loss of life, inability to care for people injured in the event, loss of revenue for the owner, and loss of employment in the community. Some of the key questions that owners and their design professionals should ask are:

- If a building suffers a total loss, what will be the impact? Do I have insurance or other funding sources to cover these losses?
- How much revenue do I stand to lose per day until a building can regain basic functionality? What will it cost me to relocate operations elsewhere?
- If my building is damaged, am I properly indemnified against liability for deaths, injuries and losses due to my possible negligence in maintaining a hazardous condition?

Putting it All Together

Stanford University calculated that a 7.2-magnitude earthquake along the Hayward fault in the Bay Area would be disastrous. "Direct [building and infrastructure] losses from simulations are U.S. $115 billion," the report found. More than $60 billion of that would occur in the housing sector. Infrastructure damage would result in ripples through the economy causing an additional $35 a billion in losses. The study estimates that it may take more than two years for the regional economy to recover. [25]

A 6.9-magnitude earthquake along the Rose Canyon fault in San Diego would devastate the seaside city, according to the Earthquake Engineering Research Institute. In a study EERI unveiled at the 2020 National Earthquake Conference in San Diego, the institute projected extensive losses from such a quake: [26]

- 45% of all residential buildings damaged
- 23,000 residential units severely or completely damaged
- 6,000 households displaced
- 40% of commercial and industrial buildings damaged, (20% extensively or beyond repair)
- $38 billion in damage
- $5.2 billion in lost income

"(Earthquake) damage to buildings is expected to be severe and widespread, particularly in the heavily populated coastal areas and in the older urban areas," the study found. "While most newer buildings, particularly single-family residences, can be expected to survive the scenario earthquake with repairable damage, many larger and older buildings can be expected to be more severely damaged and potentially unsalvageable." [27]

USRC RATING SYSTEM

The nonprofit U.S. Resiliency Council was founded in 2011 to establish a credible and consistent means of quantifying the performance of buildings in earthquakes and other natural disasters. Its mission is to improve community resilience, one building at a time, by educating stakeholders about the vulnerability of our built environment, implementing a building performance rating system, and advocating for incentives to raise demand for resilient design.

The first earthquake rating was awarded by the USRC in 2016. To date, more than 60 buildings have been rated, with several more in progress. The rating system is being used by cities, states, and private owners in their design criteria. Cities and states are considering establishing USRC ratings criteria for new public projects in the same way many require LEED® (Leadership in Energy and Environmental Design) ratings. Private owners have used their USRC ratings to raise demand for properties that they lease.

Los Angeles Mayor Eric Garcetti, in his "Resilience by Design" plan, calls for a seismic safety rating system that would help our city not only survive a large earthquake, but better protect our residents and their property. He said USRC's system answers that call.[28]

The USRC is also partnering with Fannie Mae to develop meaningful financial incentives for buildings that achieve high USRC performance ratings. Sorrel Hanson of FM Global Insurance said the rating system sheds light on the vulnerability of not only structures, but communities. "I believe that consistent and credible ratings like the USRC's are critical to dispel myths about building performance and support effective resilience efforts," Hanson said.

Understand Building Performance

The USRC Platinum Rating represents the highest level of building performance and is intended to exceed modern code standards in terms of safety, by protecting occupants against major injury and egress restrictions. Platinum-rated buildings are expected to suffer negligible damage: less than 5% of replacement cost, and allow functional recovery within a few days of a major seismic event.

The USRC Gold Rating represents a very high level of performance that is intended to exceed modern code standards in terms of safety, by protecting occupants against major injury. Gold-rated buildings are expected to suffer only minor damage: less than 10% of replacement cost, allowing functional recovery within several weeks of a major seismic event.

The USRC Silver Rating is for buildings that in addition to meeting the certified standards are expected to suffer significantly reduced damage: less than 20% of replacement cost, allowing functional recovery within a few months of a major seismic event.

The USRC Certified Rating is for buildings evaluated by the U.S. Resiliency Council that comply with modern codes for performance in earthquakes. Certified buildings are expected to perform in a manner that will preserve life safety of occupants, limit damage to repairable levels, and allow functional recovery in less than a year after a major seismic event.

The USRC Safe-at-Home Initiative designates multifamily residential properties that meet USRC requirements as Safe-at-Home Facilities. This designation provides building owners, residents and cities with information on existing residential space that is expected to be able to house people after a damaging earthquake. USRC expects designated buildings to have a higher value and contribute meaningfully to the overall post-disaster resilience of a city.

Who Uses the USRC Rating System?

Building owners, brokers, buyers, lenders, insurers and tenants all benefit from the USRC rating system.

- **Owners** with properties that receive high USRC ratings may benefit from an increase in perceived value, potentially increasing leasing rates and transaction efficiency — the same benefits associated with LEED® accredited properties.
- **Lenders and Insurers** use USRC ratings to inform real estate transactions and define insurance products.
- **Tenants** value the USRC rating as it relates to both safety and recovery time following a major event.

The Society Hotel in Portland was awarded the USRC's Silver rating as a result of its retrofit work.

RETROFIT BENEFITS REVEALED: CASE STUDIES

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 preferable loan and insurance rates, 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 is not simply good for society, it's good for business.

Beyond the direct benefits a retrofit has on a building's value, (as a structure likely to withstand external threats for many years), 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

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.[29]

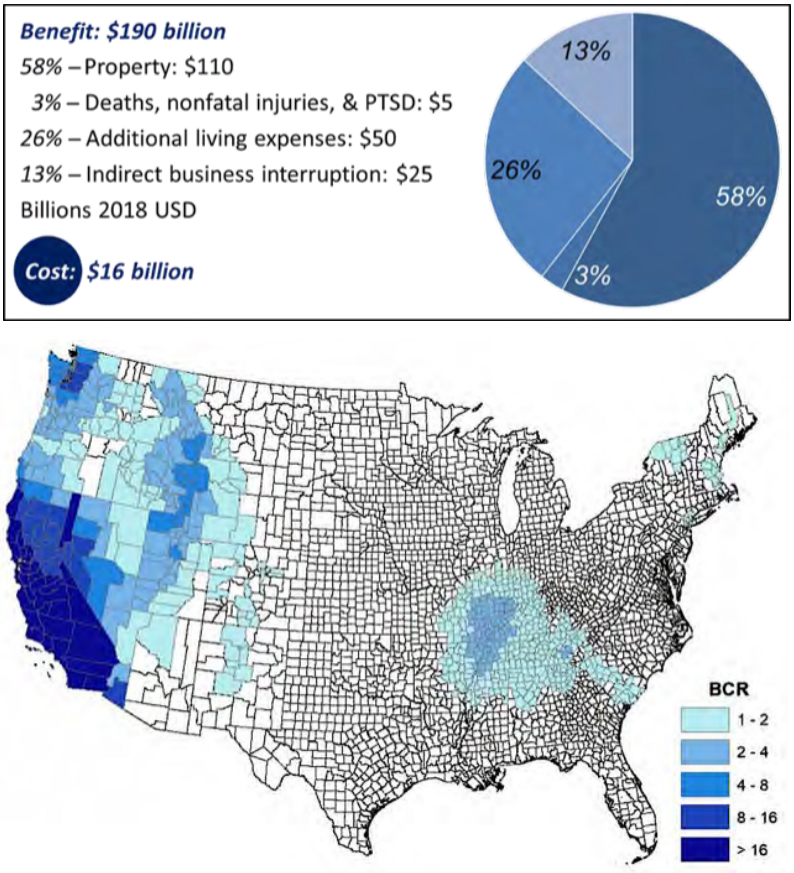
The National Institute of Building Sciences, in its 2019 report, Mitigation Saves, found that retrofitting approximately 1.8 billions square feet of soft story buildings at earthquake risk throughout the United States would cost about $16 billion – an average of $8.60 per square foot – but would avoid $190 billion in future losses, producing a Benefit to Cost ratio of 12:1. In many California counties the BCR exceeds 16:1.

A typical benefit-cost analysis for a 10-unit 1960s era soft story apartment building in Los Angeles, might look like this:

- Apartment Building Value: 10 units at $250,000 per unit = $2.5 million
- Building Retrofit Cost: $75,000
- Avoided losses at 16:1 BCR in California: $1.2 million

The Federal Emergency Management Agency 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.

In a 2014 study, FEMA cited many benefits to having a vulnerable building retrofitted.



Benefits of retrofitting soft story building. Credit National Institute of Building Sciences

"If you live or work in retrofitted structures," FEMA determined, "you're less likely to be injured during an earthquake. After the earthquake, you are 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."

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 it. The benefit/cost analysis suggests that retrofit is strongly justified economically."[30] That return on investment was even higher for tilt-ups with industrial occupancies, the study found.

The types of benefits described above were all factors considered in the following case study examples:

Disaster Averted for the Anheuser Busch Brewery:
In the 6.5 San Fernando earthquake in 1971, Anheuser-Busch's Van Nuys brewery was damaged, interrupting beer production and costing the company significant losses in market share. To avoid a similar business impact in a future earthquake, Anheuser-Busch performed a detailed risk assessment and $11 million in seismic retrofits and new construction on their $1.3 billion brewery facility. The goal was to limit property damage, business interruption and market share losses following future severe earthquakes.

The Anheuser Busch Brewery in Van Nuys, CA

The facility was seriously tested during the 6.7 Northridge earthquake in 1994, but none of the retrofitted structures or equipment sustained significant damage. Buildings not retrofitted were damaged and needed $17 million in repairs. Yet because all essential structures were retrofitted, the brewery was able to return to operations in a week, with no loss of market share. Anheuser-Busch estimated direct and business interruption losses had there been no strengthening could have exceeded $750 million, over 60 times the cost of the retrofit program.[31]

Economic Development of Historic Neighborhoods:
The cities of San Diego, Santa Monica and Fullerton, California, have experienced transformational change as a result of programs that included efforts to make historic unreinforced masonry buildings safer. Fullerton, in 1992, set up a seismic loan program that metamorphosized the downtown core from a mishmash of pawnshops and tattoo parlors to a vibrant destination of trendy restaurants, nightclubs and storefronts.[32]

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.[33]

San Diego's world-renown Gaslamp District is the result of efforts to preserve the historic structures of downtown through retrofits and other improvements. Today, the once-blighted 16-block quarter contributes significantly to the region's tourism industry, drawing 35 million people a year, $10.4 billion in spending and $289 million in Tourism Occupancy Tax.[34]

Protecting Precious California Housing with Soft-story Apartment Retrofits:
The collapse of the Northridge Meadows apartment complex in 1994 sent a jarring alarm to owners and residents of these types of structures. But retrofitting them is a relatively easy process that makes good business sense.

Retrofits of these structures, said U.S. Geological Survey geophysicist Ken Hudnut, are highly effective at protecting a building from damage in a quake.

"It's not that hard, it's not that expensive, and it can even be done while people are living in the structure," he told the Los Angeles Times.[35]

City-County Building in Salt Lake City: Civic buildings have also enjoyed the benefits of investments in resilience. When Salt Lake City, Utah was struck by its strongest earthquake in 28 years in March 2020, the 130-year old City-County Building, which had been seismically retrofitted with base isolation in 1989, suffered only minimal damage. One city official commented, "Had the city not invested in the isolator system, there would certainly have been a lot more damage."

On April 9, 2020, the Desert News reported that inspectors in Salt Lake County found 107 government buildings, including dozens of school buildings, to be damaged by the earthquake. Preliminary damage estimates were $48.5 million, according to Clint Mecham, County Emergency Management Division Chief. Those figures did not include businesses or homes.[36]

Wineman Building Renovstion-- San Luis Obispo: This building near the central coast of California is one of many once faded landmarks that has been renovated by Optimum Seismic at the same time extensive earthquake retrofits were installed.

Renovation of the historic Wineman Building in San Luis Obispo by Optimum Seismic was awarded the 2010 Honor Award by the AIACCC. Located on the major intersection in Downtown San Luis Obispo, the renovation project brought a renewed sense of vitality to the Downtown.

Wineman Building renovation in San Luis Obispo:

RESILIENT NEW CONSTRUCTION RECOGNIZED WITH USRC EARTHQUAKE PERFORMANCE RATINGS

The materials that contribute to a building's ability to resist earthquake shaking and remain safe often make up less than 10% of the total building cost. Making a building resilient so that it is not only safe, but repairable and occupiable after a major event may result in perhaps a 1% to 3% increase over minimum code-based design costs, according to U.S. Resiliency Council calculations.

Environmentally conscious owners across the West Coast are deciding that it is not enough to incorporate green design into their new construction projects. In order to protect their investments, their businesses and the lives and livelihoods of their employees, they must also consider the long-term, lifecycle costs of their buildings' performance in natural disasters.

True sustainability requires not only that we have a low impact on the environment, but that the environment has a low impact on us.

Edificio Mirador, a luxury apartment building in Santiago, Chile, obtained a USRC Platinum rating for its resilient design using base isolation.

Stanford Biomedical Innovations Building, Palo Alto:
This new university laboratory is an excellent example of how institutions are considering the long-term, lifecycle costs of owning a building, which includes the potential for having to withstand a major natural hazard event. According to the University, "the Biomedical Innovations Building will be both a proving ground and a springboard for scientific discovery." The building's USRC Gold Rating emphasizes its long-term importance to the University's mission.

Casa Adelante, San Francisco:
The U.S. Resiliency Council has awarded a Gold rating for high performance earthquake design to this nine-story, 94-unit apartment complex in San Francisco that is fully dedicated to serving low-income seniors.

"We designed the building to rock back and forth, cushioned by the concrete in the mat and slabs, essentially re-centering itself," said engineer of record David Mar. Ultimately, his higher performance earthquake design added only $100,000, less than 0.25%, to the $41.2 million total project cost. After an earthquake that could rival the 1906 Great San Francisco Earthquake, residents of Casa Adelante are expected to be able to remain safely in their homes. The example of Casa Adelante shows that resilience can be available to everyone.

Clifford B Allenby Building, Sacramento:
This new office building for the State of California Department of General Services has achieved a USRC Platinum rating and was the first state-owned building in California to do so. Platinum-rated buildings are expected to suffer negligible damage, less than 5% of replacement cost, and allow functional recovery within a few days of a major seismic event. The USRC Platinum rating is sought by owners who demand the highest level of asset protection and virtually uninterrupted functionality of their operations.

iMod Structures:
Roughly 90% of existing metropolitan buildings, including many schools, were not built to modern codes. iMod Structures, makers of 'Future Proof' modular classrooms, received the U.S. Resiliency Council's Platinum Earthquake Rating, making them the first educational facilities in the country to achieve USRC's highest resiliency status. "There is no question of whether or not there will be another major earthquake in California," said Craig Severance, co-founder of iMod Structures. "The only questions are when, where, and how big? Given that inevitability, schools and universities need to ask themselves whether they have adequately factored resiliency into their facility plans." The expected cost of iMod classrooms is the same as traditional code-based designs.

85 Bluxome Street, San Francisco: Scientists predict a 72% chance[38] of a major earthquake striking the Bay Area in the next 30 years, and the city has taken action to address earthquake resilience on multiple fronts, most recently releasing a report recommending that the City Department of Building Inspection consider establishing design standards for new buildings so that they can recover and become habitable after a major earthquake. 85 Bluxome Street, a five-story steel frame office building, shows that this standard can be met now, without significant impacts on cost and schedule. In 2019, the USRC awarded a Gold Rating to the new office building in San Francisco's South of Market (SOMA) neighborhood. A notable financial benefit to the property's owners was that the building, sandwiched between two adjacent structures, was strengthened with heavier steel beams to achieve the USRC Gold Rating. This resulted in a stiffer structure that allowed for a smaller gap between the building and its neighbors, increasing the amount of rentable square footage in the building, essentially paying for the added steel material costs, according to the builder.

Achieving resilient design typically adds less than 3% to the costs of a new building.

THE ALTERNATIVE TO RESILIENT DESIGN: INCREASED LIABILITY RISKS

Paso Robles Case Sets Precedent for Liability Due to Negligence in Maintaining an Unsafe Condition

By Madison S. Spach, Jr., Partner at Spach, Capaldi and Waggaman

No owner of older residential or commercial real estate, particularly in California, could reasonably deny that a major seismic event might potentially impact the property.

Owners are generally aware that, when it comes to their exposure for all potential dangers of their property, they have a duty to act reasonably not to cause harm to their tenants or the general public.

For potential liability exposure arising from seismic events, owners often key their conduct to the deadlines set by the applicable ordinances.

In other words, they believe that because the legislators have gone through a considered deliberative process to define the last date by which to complete the required retrofit, it would certainly be unreasonable to hold an owner liable for failing to complete the required retrofitting before that deadline has run.

Such was the unsuccessful contention made by the owner of a 111-year-old unreinforced masonry building in Paso Robles, California, known as the "Acorn Building," in a rare reported decision by a California appellate court on whether a building owner could be found liable in negligence for failing to complete retrofitting work before the city-mandated deadline.

In Myrick v. Mastagni (2010) 184 Cal. App.4th 1082, the appellate court settled the point of whether being in a state of retrofitting compliance amounts to a complete defense.

The starting point of the case cannot be disputed: in the moments before the San Simeon earthquake hit on December 22, 2003, the owner of the Acorn Building was following its local retrofitting ordinances. In fact, the deadline for completing the work mandated by that ordinance was still 15 years away as the compliance deadline had been extended in 1998 to 2018.

The Acorn Building's owner received a notice on November 5, 1993, but didn't do anything about it until nearly five years later on October 28, 1998, when a structural engineer was hired to prepare a structural design study of the building to bring it into compliance with the Paso Robles ordinance. The engineer delivered a report, which identified the seismic deficiencies of the building and specified the work to achieve compliance, to the owner and to the city.

Nearly five years after that, on the day of the deadly quake, construction for that work had not yet begun, much less been completed.

One of the businesses located in the Acorn Building was a dress shop on the second floor. When the earthquake struck, two of the shop's employees were at work. Jennifer Lynn Myrick was a 20-year-old who had recently become engaged; Marilyn Frost-Zafuto was a 50-year-old who, having just got her daughter situated at college, began working in the dress shop because she thought doing so would be the perfect way to re-acquaint herself with her community. Both women fled the building after the earthquake hit.

Tragically, they were killed when a portion of the collapsing building crushed them both.

After the trial court entered judgment on the jury's award of damages for the loss of the two women, the owner appealed on the basis of the rule that any liability was precluded because the city council, by setting an outside compliance date, determined when it would be reasonable to do the required work.

The Myrick verdict is the alarm clock telling owners that the time has come when they can no longer defer either the decisions or costs of shoring up their buildings.

The California Court of Appeal recognized that the basic rule of liability governing the case was that "an owner must use ordinary care in the management of his or her property to prevent injury to another." (Myrick, 184 Cal. App.4th at 1087.) The test applicable in this case was whether the owner "acted as a reasonable person in view of the probability of injury." (Id.) Arguing that the city council had already performed this balancing test and thereby determined that it would not be unreasonable to fail to complete compliance before the end of 2018, the owner denied liability as a matter of law because that date had not yet passed.

The Court rejected the owner's argument that statutory compliance amounts to a complete defense:

Certainly, the city considered the interests of building owners in setting the deadline for compliance. But the overriding policy behind the seismic retrofit ordinance, taken as a whole, is not the promotion of the interests of building owners. Instead, the overriding policy is public safety.... To hold that as a matter of law that a building owner has no duty until after the compliance date of the ordinance would frustrate the very policy that the ordinance was designed to promote. (Myrick, 184 Cal. App.4th at 1090.)

In other words, the compliance deadline is no safe harbor.

The general rule governing negligence applies and is tested by the circumstances of the case. And therefore, the jury decides whether the owner is liable even though the deadline for completing the required work was still years away.

In the Myrick case, the jury found the owner should have shored up the building long before the compliance deadline. A factor that undoubtedly influenced the jury was that the owner had the funds to pay for an elevator to accommodate increased traffic to the second floor. The cost of that improvement was more than the cost of the retrofitting.

Myrick's decision sets the legal standard by which an owner's conduct will be assessed looking backwards after a seismic event has occurred. It is the alarm clock telling owners that the time has come when they can longer defer either the decisions or costs of shoring up their buildings.

The lesson to be learned from the case is that owners can no longer bury their heads in the sand any more than they can claim protection from liability based on the schedule set by their city or the county.

After Myrick, owners must prioritize not only assessing retrofitting needs, but implementing their retrofitting plan.

Because no California owner could reasonably deny that a severe earthquake may hit close to their locale in the near future, no reasonable owner can look past assessing the seismic risk of every structure having an indicia of risk – and moving with reasonable speed to solve the problem.

MOTIVATING PEOPLE TOWARD RESILIENCE

Market forces, direct financial incentivization and government mandates are three useful ways to motivate action towards resilience-based design.

Market forces: As we described in the introduction of this white paper, market demand for better seismic performance in the United States lags well behind other countries like Japan. Over the past 20 years, we have seen a significant increase in demand for LEED certified buildings, and an associated increase in property and rental values for these buildings.

But the process of raising market demand for resilient structures requires educating the public to better understand the value of resilient design and the importance of long-term thinking about high consequence events.

Financial incentives: Direct financial incentives are what we focus on in this section. Incentives seek to translate the long-term benefits to a society of resilience-based design into tangible short- and medium-term offsets to the cost of investing in better performing buildings.

Government involvement: When it comes to resilience-based design and building retrofits, most of the efforts over the past 50 years have relied on government mandates. It has primarily been through the building code that government has dictated the level of performance our building stock should meet during major natural disasters.

Protecting Business Investments

The benefits of resilient design in reducing injuries and deaths, property losses and financial catastrophe are well documented. In addition, the National Institute of Building Sciences report demonstrates there is a very high net positive return on such investments over the long-term.

Some building owners, buyers and occupants may be full of regret when faced with extraordinary financial losses — including potential bankruptcy and liability exposure —because they did not embrace earthquake retrofits and resilient design today. They may also be surprised that these losses could have been avoided at a reasonable cost.

Consider a $100,000 investment in a $10 million retail property that would, in the event of a major earthquake, reduce damage from $5 million to $1 million and recovery time from one year to one week. This investment would likely spell the difference between bankruptcy and the ability to weather the disaster. Some 40% of businesses that close for more than two weeks after a disaster never re-open.[39] On the surface, this seems like an obvious

investment. Some owners may not think that even given the clear benefits, they should make the investment of a retrofit. There are many indicators they are wrong, especially since earthquake risk is so widespread.

While owners of individual buildings often find it hard to justify trading off certain short-term costs against uncertain long-term benefits, others do this regularly:

Insurers : The entire concept behind insurance is that when you aggregate the risks of large numbers of buildings over timeframes measured in decades, these risks go from hypothetical and uncertain to practical and definitive. However, insurers are increasingly unwilling to provide earthquake insurance due to high potential losses.

Lenders: Lenders, like insurers, manage risk by spreading debt financing over many properties and amortizing loans over long periods like 10, 15 or 30 years. Their bottom lines depend on the number and amount of loans they make, and keeping the chances low that borrowers will default on their loans, in particular if the value of the property drops below the borrower's equity, a situation that may occur if the building is heavily damaged in a natural disaster. Lenders have begun asking for structural assessments and requiring retrofitting prior to providing financing.

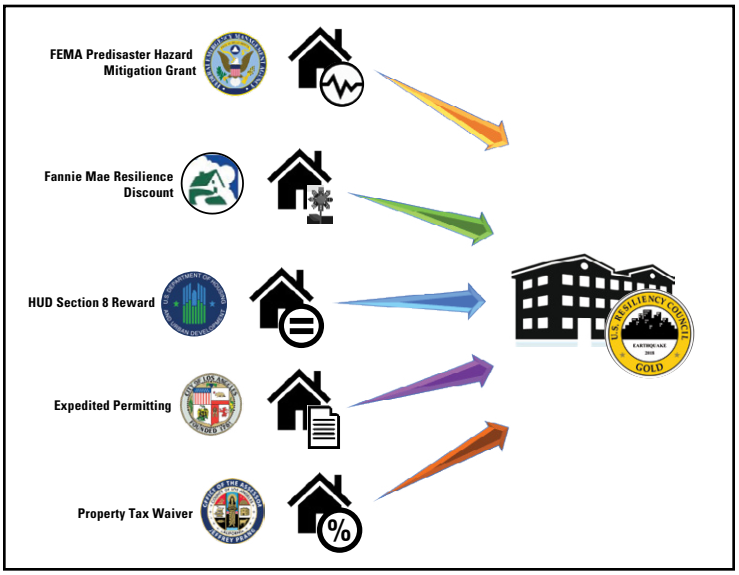
Governments: Local, regional state and federal governments obviously have a long-term outlook on resilience as they are planning to be around for the next 100 years plus. This does not always lead to long-term thinking of course since political decisions are often guided by election cycles. But when buildings in a community perform better after a natural disaster there are many quantifiable benefits, including maintaining tax revenues, residents, jobs, and a community's social and economic fabric.

Incentives

Absent regulations and mandates that require resilient design and retrofit, and until the marketplace naturally rewards more resilient properties with higher values, we must look to financial incentives to promote resilience.

We should look toward long-term, large-scale entities like banks, insurers, and governments to translate the clear benefits they receive into meaningful financial incentives for owners and developers to invest up front in resilience.

Below we consider how such incentives are being established already by these three groups: banks, insurers, and governments.



Incentives can motivate owners to invest in resilience

The Case for a Resilience Mortgage

A popular Fannie Mae loan product is its Green Rewards[40] program, which offers lower interest rates and other discounts for properties certified to meet energy efficiency benchmarks.

Designing and constructing more resilient multifamily housing results in multiple social and economic benefits:

- Lower property damage and repair costs
- Reduced recovery time before tenants can return to their homes
- Reduced risk of borrower default on a loan where the damage exceeds its equity
- Avoided red-tags, and reduced emergency shelter needs
- Reduced displacement, and Increased retention of the labor force

A Resilience Mortgage could provide the necessary incentive for building owners, builders, and borrowers to invest in seismic retrofits or resilient design.

Buildings that achieve a USRC Gold or Platinum rating are expected to suffer significantly less damage and require less repair than buildings designed to minimum building code requirements. These metrics are extremely meaningful to a lender because when repair costs exceed a borrower's equity, the risk of default rises dramatically.

Beyond default risk is the probability that a building designed to minimum code requirements will be red tagged. The property may be left in disrepair until the lender assumes control, resulting in additional damage and a below market foreclosure sale that results in a substantially deeper loss to the lender. In addition, these losses may be in concentrated areas that place additional pressures on lenders, particularly smaller, local lenders.

As noted earlier, the added cost to retrofit an existing building or achieve resilience ratings for new construction is typically between 1% to 3% of code minimum cost. A reduced mortgage rate of 25 to 50 basis points, (0.25% to 0.5%) or the ability to obtain a larger loan amount at lower rates would cover all or most of this cost amortized over the life of the loan, so that the tenants themselves need not shoulder the burden with higher rents.

Insurance

It is a misconception that insurers prefer high-risk properties because they can just charge higher premiums. In fact, with lower risk generally comes lower uncertainty, meaning that they can more accurately price policies and be more confident of the profit margin they are receiving. Insurance companies also typically insure themselves through reinsurance, and the greater the risk they carry, the larger their own premiums will be. Therefore, it is in the best interests of underwriters to encourage owners to make their buildings more resilient.

Most home insurers offer discounts if homeowners have smoke detectors or replace older wood shake roofs with composite shingles, because houses with these features are at substantially lower risk of being consumed in a fire.

The U.S. Resiliency Council is working with catastrophe modeling companies for some of the world's largest insurers to modify their actuarial models for natural hazard insurance to reflect the reduced risk of buildings identified as more resilient through the USRC rating system.

Thanks to the decades of scientific research being done on quantifying building performance in extreme events, the same types of credible risk models have been developed and are being used by insurers today to reward earthquake resilience.

The U.S. Resiliency Council is currently working with catastrophe modeling companies for some of the world's largest insurers to include in the actuarial models they use to price natural hazard insurance, the reduced risk of buildings identified as more resilient through the USRC rating system. This is already being done for residential properties by a handful of states in the nation.

The California Earthquake Authority offers a 10% to 25% earthquake insurance premium discount to owners who undertake seismic retrofit of their homes by bracing and bolting their crawl spaces.[41]

The state of Alabama recently passed a law requiring that insurers offer homeowners wind insurance discounts of 20% to 60% if they receive a "Fortified" rating from the Insurance Institute for Building and Home Safety.[42]

Permitting

Governments can help to incentivize safer buildings with discounts and expedited processes for projects associated with seismic retrofits or resilient-design buildings.

The time it takes to receive a permit for construction directly affects the project's bottom line. Time to market, whether for a restaurant, apartment, or retail store determines when an owner can start recouping the cost of his or her investment through sales or rental revenue. The same is true for offices, manufacturing plants and hospitals. Reducing permitting time also benefits cities and counties, through sales and property tax revenues, which can be received sooner.

Many cities in California[43] and other states, in order to promote green design, have adopted ordinances to provide for expedited permits when a building is submitted with LEED certification. A partial list includes:

- Big Bear Lake
- Burbank
- Corona
- Livermore
- Long Beach
- Los Altos Hills
- Los Angeles
- Rancho Palos Verdes
- San Diego
- San Mateo County
- Santa Monica
- Tiburon
- Ventura
- Seattle, WA
- Salt Lake City, UT

It is important to note that every city in this list that offers expedited permitting for green design is in an area of high seismicity, where the performance of a building after a major earthquake will have a direct impact on the city's ability to recover. Therefore, it would directly benefit these cities and others to provide a similar expedited permitting process for buildings that met resilient design standards like those recognized by the U.S. Resiliency Council.

Tax breaks

Federal, state, and local governments can also offer many tax incentives for owners and builders who invest in green and resilient design practices.

This concept is already in practice with property and sales tax breaks for installing solar panels or other energy and water saving appliances.

California and several cities and counties within the state offer incentives to owners who seismically retrofit their properties. These often include exclusions from property tax assessments of the cost of construction to seismically strengthen buildings with retrofits or waivers of transfer taxes, etc.

Several examples include:

- San Francisco's Earthquake Retrofit Exclusion [44]
- Santa Clara County's Seismic Safety Construction Exclusion [45]
- Berkeley's Transfer Tax Reductions for Seismic Retrofit Work [46]

One of the more interesting nationwide tax incentive programs is Property Assessed Clean Energy (PACE). Established originally for the installation of solar panels, PACE programs allow the installation cost to be financed through property tax assessments rather than a traditional loan. The original owner does not have to shoulder the entire cost of the installation. Rather, subsequent owners who receive the advantage of the solar power share in the cost.

California and other states have made PACE funding available for property owners who invest in earthquake retrofits.[47]

Benefits to city, county, state, and federal governments of promoting resilience-based design include:

- Maintaining provision of vital goods and services for residents
- Reducing potential loss of residents and labor and associated sales and other tax revenues
- Preserving property and sales tax revenue after a disaster when it may be needed most
- Preserving existing housing stock
- Reducing the amount of space needed to shelter displaced residents
- Reducing the amounts of state and federal disaster aid needed

CONCLUSION AND NEXT STEPS

Earthquakes are Inevitable, but They Do Not Have to be Disasters.

Attorney Madison S. Spach, Jr. put it well when he wrote "no owner of older residential or commercial real estate, particularly in California, could reasonably deny that a major seismic event might potentially impact the property."

The risk is real, and the consequences could be catastrophic to everyone.

Fortunately, we have the technology and the financial means to reduce these impacts, and to protect the lives and livelihoods of ourselves, our children and grandchildren, when the earthquake does strike. This whitepaper describes some of the important things that building stakeholders need to understand about our built environment:

Economics

- The United States sees $4.4 billion in earthquake losses each year, $3.3 billion of that in California, according to FEMA.
- Retrofits of existing buildings and resilient design of new construction make good business sense.
- A study by the National Institute of Building Sciences determined that every dollar spent on natural disaster mitigation returns $4 to $7 in reduced economic impacts.[48]
- Building owners and occupants can be found liable for damage from an earthquake, if they knew their structure was unsafe and did not act reasonably to protect the public.
- Seismic retrofits of existing vulnerable buildings are often cost-effective and have the broader impact on protecting communities and local economies.

Social Well-being

- Modern building codes are designed to protect life safety and reduce the risk of building collapse, but not to ensure a building can be re-occupied.
- True resilience is measured by how well we ensure safety and how quickly individuals, families, businesses, and communities recover.

Apple Park headquarters, Cupertino:
This new, base-isolated structure is an excellent example of how businesses are considering the long-term, lifecycle costs of owning a building, that includes the potential for having to withstand a major natural hazard event.
The building has four stories above ground and three below. Opened in 2017, the structure houses 12,000 employees and rests upon 700 base isolators customized for low friction, according to lead structural engineer John Worley of Arup.[37]

- A new building can be designed to be safe, repairable, and quickly restored to functionality with an increase typically of between 1% to 3% in the construction cost.
- Seismic risks exist in the Midwest, South and Northeast portions of the country. Earthquakes are not just a California problem.

All stakeholders in the built environment benefit from resilient buildings. Financial incentives for buildings that meet resilience standards such as those defined by the USRC are being developed or are currently available that can reduce or eliminate the additional cost of designing new or retrofitting existing buildings so that they are resilient following major earthquakes:

- Lenders benefit when borrowers continue to pay off their loans.
- Insurers benefit when their portfolio contains less risk.
- Cities and counties benefit when they have more confidence that buildings which are essential to their recovery are less likely to suffer damage.
- States and federal agencies benefit when communities are more resilient because there is less need for post disaster recovery.

Working Together: What Can You Do?

Resilient design must become the norm if property owners, businesses, investors and communities are to adequately face the ever-growing risk of natural hazards.

Society depends on building codes to set standards that will protect life safety. But these are the minimum we should expect. Higher standards should also be used to ensure resilience – meaning the structure can recover quickly from a major disaster, and protect our livelihoods as well.

Members of the building stakeholder community have roles to play in making these incentives happen.

- The design community must educate the public about the value of resilient design, and their clients, builders, and owners about the modest cost to achieve resilience.
- Tenants need to demand more resilient buildings in the marketplace, recognizing that a small investment by them will help enable owners to invest in safer, higher performance structures.

- Business owners and occupants of at-risk buildings should act now to avoid potential business interruption, loss of life, earthquake liability exposure and bankruptcy.
- Building ratings, like those developed by the U.S. Resiliency Council, should become the objective and credible standard to measure building performance in natural hazards, forming the basis for incentives the way LEED® ratings do for green design.
- Chambers of commerce and other leading business organizations should work with cities to promote expedited permitting, tax relief and other incentives for their members.
- Building owner groups should lobby their state and federal representatives to provide grants, loans, subsidies, and tax breaks through targeted resiliency policy.
- Leaders in financial, insurance, real estate and other key industries should work towards identifying and mitigating earthquake risks in the most vulnerable buildings.
- Policymakers should work with insurers and both public and private lenders to provide resilience insurance and loan discounts. The engineering community should work with these industries to demonstrate the actuarial justification for such discounts.
- Public officials should expand efforts to educate the public on steps that can be taken to identify the most vulnerable buildings in their communities and mitigate these risks to public safety.

Together, all of those who have a stake in the resilience of our communities can share in its benefits, if they are willing to share in the investment to make resilience happen.

We owe it to ourselves and to generations that follow to avert disaster when the next Big One comes.

ABOUT THE AUTHOR

Evan Reis, SE

Executive Director
U.S. Resiliency Council

Evan Reis is 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.

Evan 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 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.

ABOUT THE AUTHOR

Ali Sahabi, GEC, MRED

**Real Estate Developer, General Engineering Contractor,
Sustainability & Seismic Resilience Leader**

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. In conjunction with seismic retrofits, he has performed numerous renovations on older, historic buildings to give them new life and restore profitability. 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. He provides scholarships and professional organization memberships for the next generation of structural engineers, supports women and minorities in business and is an advocate for community resilience and sustainability.

The immediate past president of the Building Industry Association, Baldy View Chapter, Sahabi received that organization's Lifetime Achievement Award. He 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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