Quantifying the Social and Economic Value of Citywide Seismic Retrofit Ordinances

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Past Seismic Retrofit Ordinances

Mandatory Ordinances
- Unreinforced Masonry Buildings
- Precast Concrete Tilt-up Ordinances (Fullerton, L.A. City, etc.)
- Soft-story Multi-family (S.F., L.A., Santa Monica, Oakland, Berkeley, Fremont, etc.)
- Non-ductile Reinforced Concrete Buildings (L.A., Santa Monica, etc.)
- Pre-Northridge Welded Steel Moment-Frames (Santa Monica)

Non-mandatory Ordinances (e.g. residential cripple-wall bracing programs)

Adaptive Re-use / Change of Occupancy (various cities)

Public School Seismic Retrofit Programs (AB300)

Hospitals (SB1953)
Life-safety concerns following earthquakes (Loma Prieta, Northridge, etc.)
FEMA Hazard Mitigation Grants (government buildings, public agencies)
Presidential Executive Orders
State Programs (California Courts, CalTrans, schools, hospitals, etc.)
Prudent-owner actions
Regional loss studies (e.g., ShakeOut, Haywired, etc.)
Lender requirements (due-diligence studies – “PML” reports)
Seismic Resilience Ratings (e.g., USRC)
Los Angeles at Risk

built : LA
Building Age // 1890-2008

Since 2008, there are over 2.9 million buildings in Los Angeles County. Hover over a building for the time it was built or click on the timeline to explore.

by Omar Ureta of the UP Collective @ Roschen Van Cleve Architects

00526 6TH ST LOS ANGELES CA was built in 1912
Macro and Micro Level Impacts

1. **Housing**
   - Severe loss of affordable units
   - Most vulnerable buildings old and occupied
   - Loss of these structures could result in broader rent controls
   - Increased homelessness / family disruption

2. **Economy**
   - Displaced Workforce
   - Breakdown of Infrastructure
   - Vendor and Production Delays
   - Closure of Small Businesses
   - Bankruptcy
   - Financial Burdens to Consumer Market
   - California Exports / Logistics Halted
San Francisco Soft-Story Buildings

• 4,901 properties
• ~160,000 residents
• 4,386 permits (6/18)
• Avg $74K per bldg.
Nonlinear Modeling

Suite of ground motions

Material cyclic behavior

Computer modeling

Performance evaluation

Keith Palmer, Ph.D., P.E. Senior Staff II, SGH
Retrofit significantly improves seismic strength

<table>
<thead>
<tr>
<th>Case</th>
<th>Collapse probability in 500-yr shaking</th>
<th>Damage (% replacement cost)</th>
<th>Recovery (repair time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing building</td>
<td>15%</td>
<td>75%</td>
<td>&gt;2 years</td>
</tr>
<tr>
<td>Retrofitted building</td>
<td>&lt;1%</td>
<td>19%</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

Average SF Shaking Intensity (M 6.5+ event)

Benefit / Cost > 1.0

Life-safety retrofit

Keith Palmer, Ph.D., P.E. Senior Staff II, SGH
Building Ratings:

• Beyond Life-Safety
• Towards Resilience
US Resiliency Council Performance Metrics

USRC BUILDING RATING SYSTEM

<table>
<thead>
<tr>
<th>SAFETY</th>
<th>DAMAGE</th>
<th>RECOVERY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocking exit paths unlikely</td>
<td>Minimal Damage (&lt;5%)</td>
<td>Immediate to Days</td>
</tr>
<tr>
<td>Serious injuries unlikely</td>
<td>Moderate Damage (&lt;10%)</td>
<td>Within days to weeks</td>
</tr>
<tr>
<td>Loss of life unlikely</td>
<td>Significant Damage (&lt;20%)</td>
<td>Within weeks to months</td>
</tr>
<tr>
<td>Isolated loss of life</td>
<td>Substantial Damage (&lt;40%)</td>
<td>Within months to a year</td>
</tr>
<tr>
<td>Loss of life likely</td>
<td>Severe Damage (40%+)</td>
<td>More than a year</td>
</tr>
</tbody>
</table>

CODE BASED DESIGN

RESILIENCE BASED DESIGN

+0-5% Cost

Modern Codes
AB2681 – Seismically Vulnerable Buildings

High Seismic Areas ~ 28 million residents – AB 2681

Cities with seismic ordinances ~ 7 million residents

- San Francisco
- Oakland
- Berkeley
- Alameda
- Fremont
- Palo Alto

- Los Angeles
- Long Beach
- Burbank
- Santa Monica
- West Hollywood
- Beverley Hills

- Unreinforced Masonry
- Soft-Story
- Nonductile Concrete and Steel
- Tilt-up Reinf. Masonry
Measurable Benefits of Retrofit Ordinances

If soft story retrofits complied with USRC Certified Rating
Developing Community Resilience Programs
Portfolio Analysis & City Resilience Data

- Ratings for new buildings
- Performance criteria for new critical infrastructure
- Evaluation of existing buildings
- Ratings provided in real estate disclosures