

Seismic Vulnerability of California's Housing Stock: How bad is it?

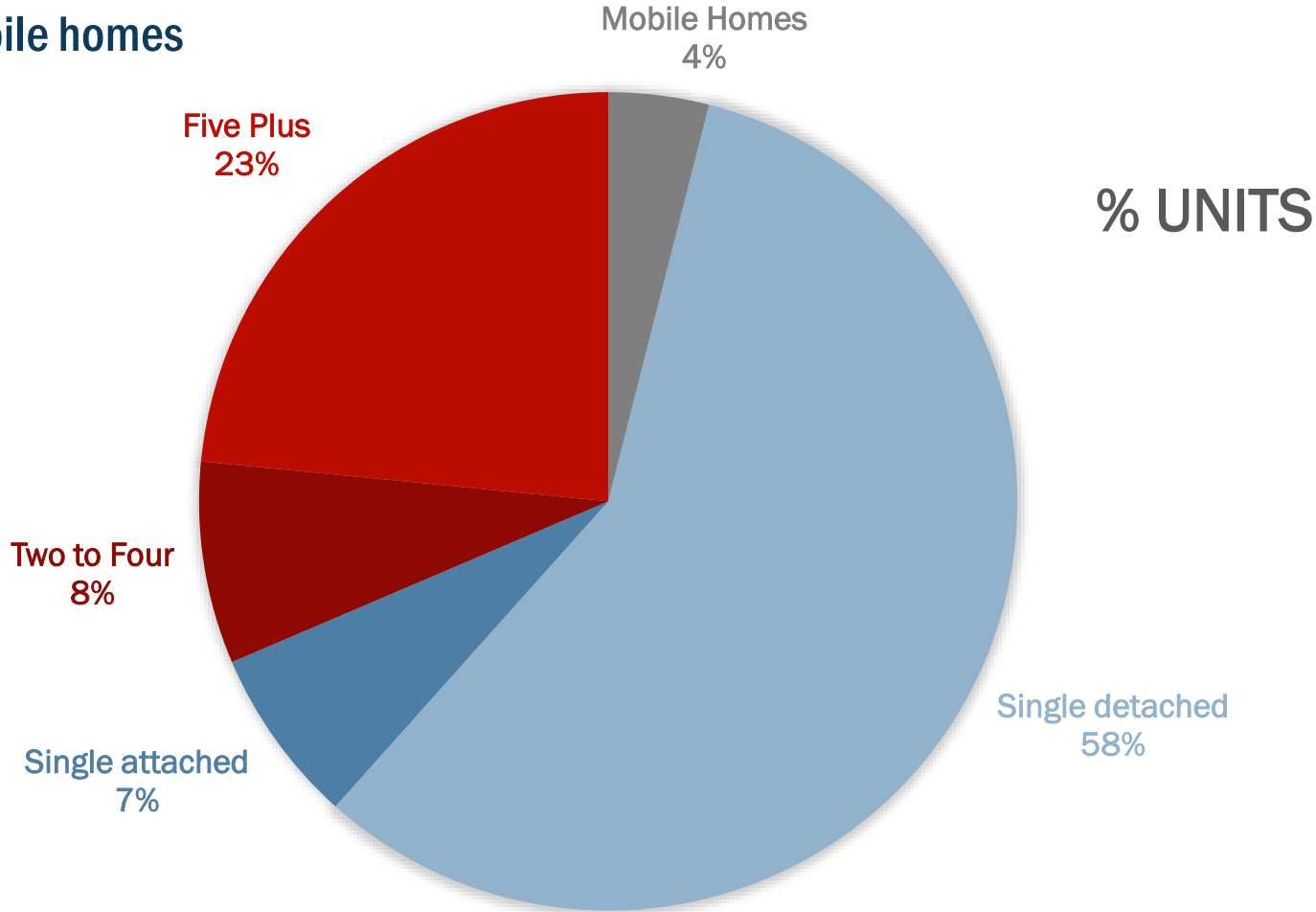
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THERE ARE 14.1 MILLION HOMES IN CALIFORNIA

- 9 mn single-family (detached and attached)
- 3.3 mn multifamily (5+ units)
- 1.1 mn multifamily (2 to 4 units)
- 500k mobile homes

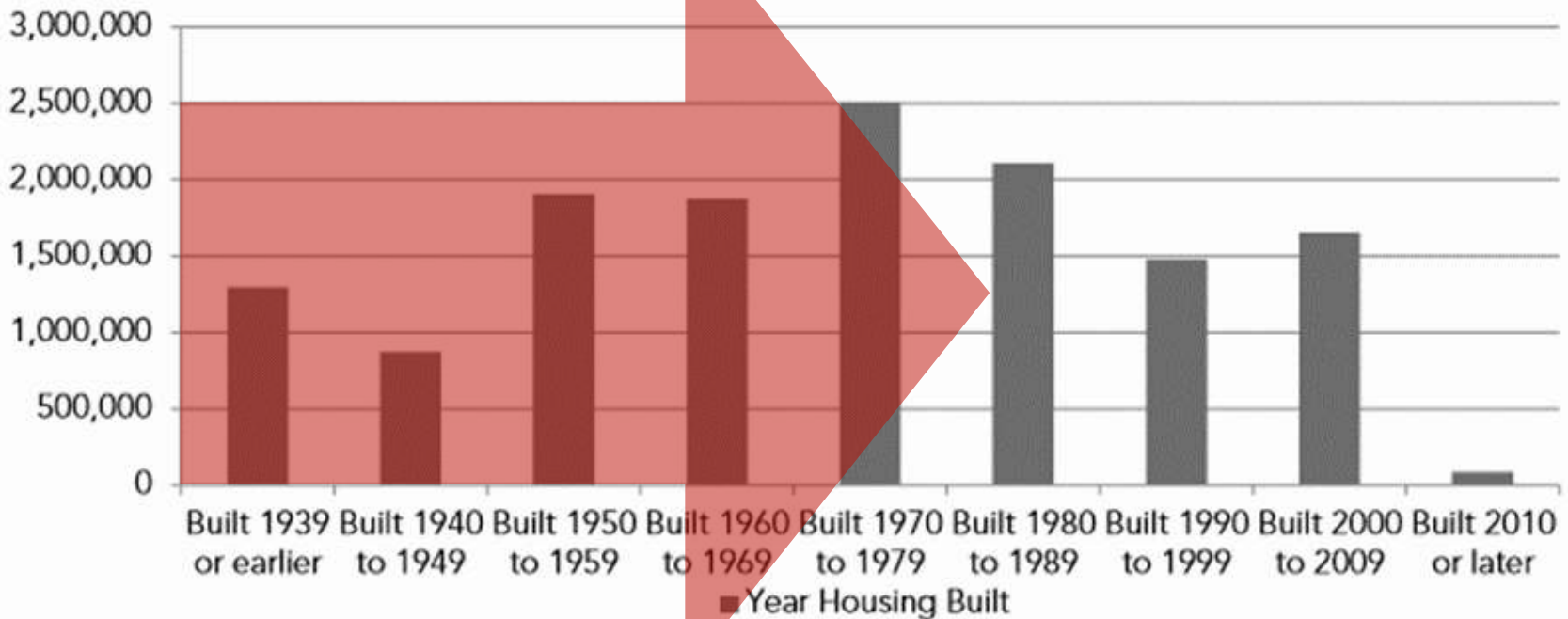


AGE IS A MAJOR DETERMINANT OF SEISMIC VULNERABILITY

Majority of homes across the state were built before 1980 and lack adequate seismic strength



Figure 1.11
Majority of California Housing More than 35 Years Old
Age of Housing in California 2010-2014 Average

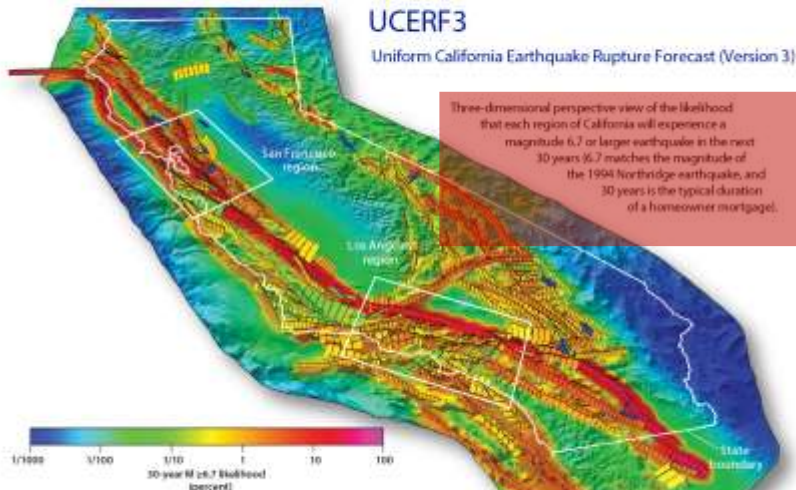


29 COUNTIES HAVE THE HIGHEST SEISMIC RISK

Earthquake Probability Forecast for next 30 years

M6.7 and greater >99%

M8 and greater >7%



UCERF3
Uniform California Earthquake Rupture Forecast (Version 3)

Three-dimensional perspective view of the likelihood that each region of California will experience a magnitude 6.7 or larger earthquake in the next 30 years (6.7 matches the magnitude of the 1994 Northridge earthquake, and 30 years is the typical duration of a homeowner mortgage).

Faults are shown by the rectangles outlined in black. The entire colored area represents greater California, and the white line across the middle defines northern versus southern California. Results do not include earthquakes on the Cascadia Subduction Zone, a 750-mile offshore fault that extends about 150 miles into California from Oregon and Washington to the north.



California Counties with High Seismic Risk

■ "High Seismic Risk" Counties
■ Other Counties

29 HIGH SEISMIC RISK COUNTIES

Potentially Earthquake-Vulnerable Residential Buildings and Units

	Building Count	Housing Units
Single-family	4,756,380	4,756,380
Multifamily (<20 units)	300,230	1,524,660
Multifamily (>20 units)	18,800	921,760
Mobile Homes	275,080	275,080
Total	5,350,490	7,477,880



This data was extracted from Hazus, a geographic information system-based natural hazard analysis tool, publicly available and developed by the Federal Emergency Management Agency. These potentially vulnerable housing estimates were derived from Hazus default residential building inventory data categorized by Occupancy Class (single family, multi-family or mobile home/manufactured) and seismic Design Level (built to moderate code or below). "Moderate Code" design level or below are buildings likely constructed prior to the adoption of modern seismic code provisions, defined as written prior to 1980. A subset of pre-1980 houses designed to moderate code or below may have architectural and structural characteristics that make them more resilient to earthquake damage.

LOS ANGELES COUNTY

Potentially Earthquake-Vulnerable Residential Buildings and Units

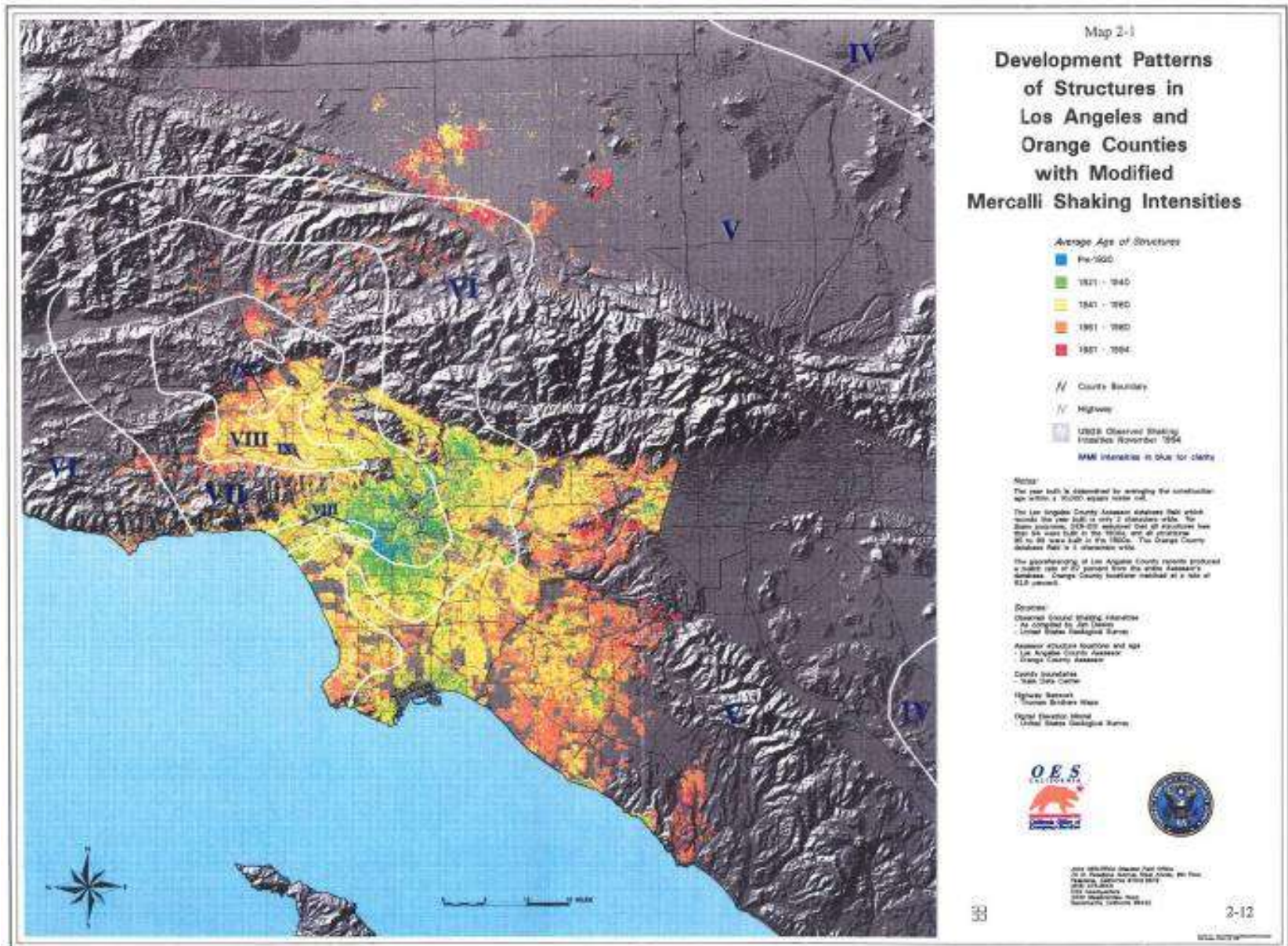
	Building Count	Housing Units
Single-family	1,290,860	1,290,860
Multifamily (<20 units)	98,440	543,400
Multifamily (>20 units)	8,630	403,840
Mobile Homes	36,380	36,380
Total	1,434,310	2,274,480

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1994 NORTHRIDGE EARTHQUAKE

Ground Shaking Levels and Building Age



1994 NORTHRIDGE EARTHQUAKE

Residential Impacts



- \$20 billion in residential damage
- 93,000 residential structures, containing 450,000 housing units, were inspected
- >100,000 housing units needed repair
 - 49,000 multifamily units
 - 4,400 mobile homes
- City of Los Angeles sustained 95% of region's total residential damage
 - 14,600 dwelling units deemed uninhabitable by the City of Los Angeles, 77% were multifamily units and 23% were single-family residences

1994 NORTHRIDGE EARTHQUAKE

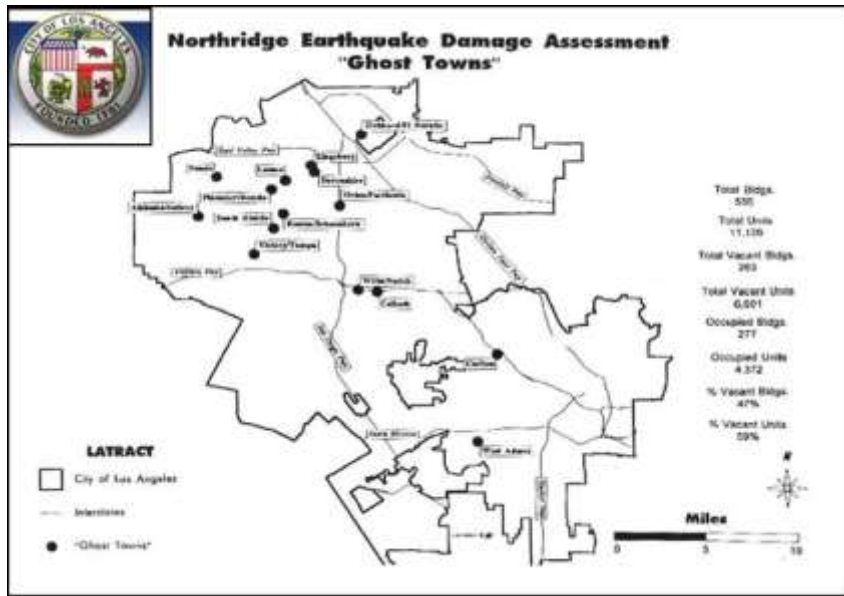
Housing with Extensive or Complete Damage (typically yellow- or red-tagged)



- 11.4% residential structures and 13.7% residential units damaged
- Many fatalities occurred in multifamily buildings
- Also vulnerable to fires (>half of 466 fires in housing damaged by ground shaking)
- Repair costs 3 to 12 times higher than buildings with minor repairs
- More likely to be uninhabitable until repaired; Impairment times of months to years for red- and yellow-tagged buildings, versus a few days to few months for green-tagged buildings

1994 NORTHRIDGE EARTHQUAKE

“Ghost Towns” and Multifamily Repair Program

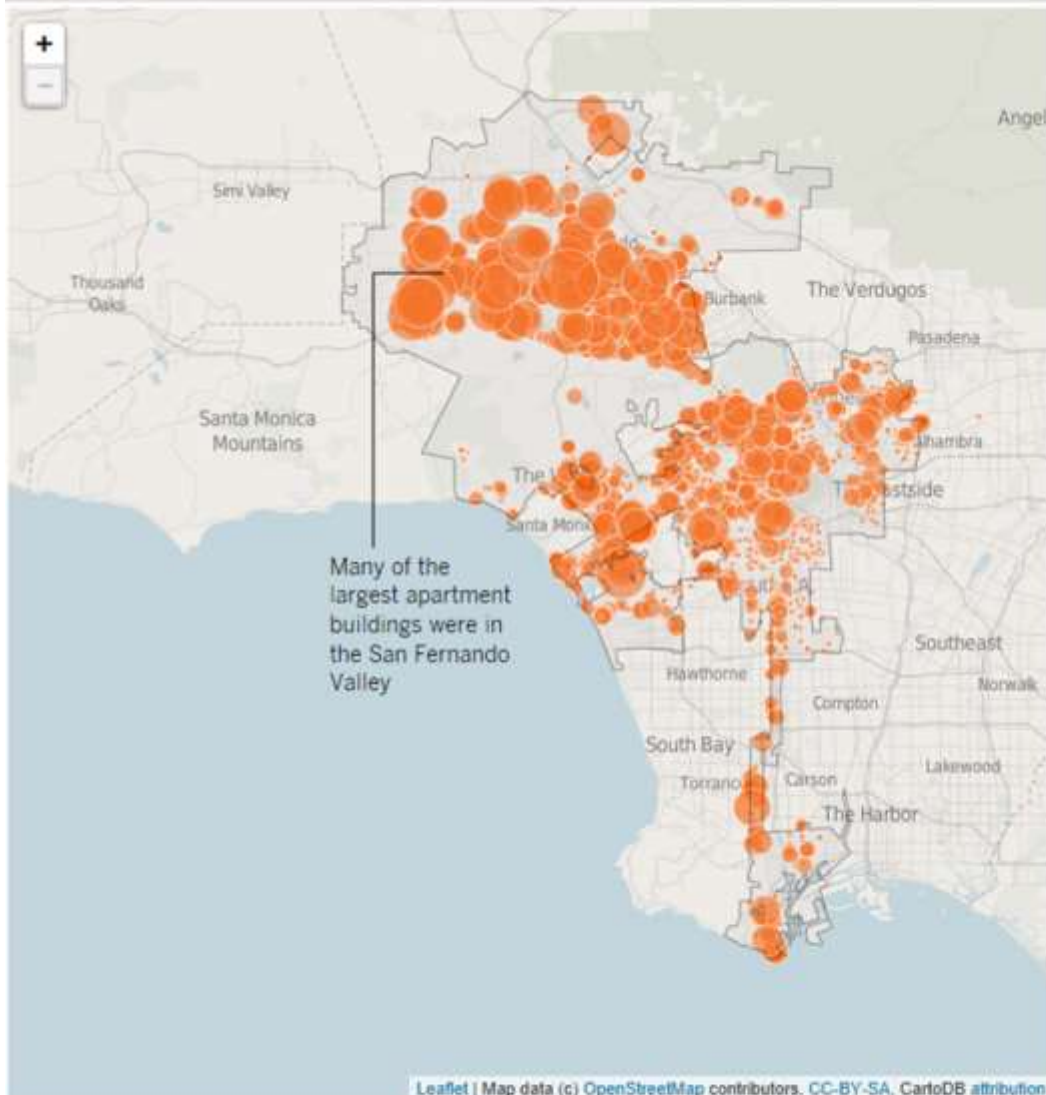


- LA Housing Department identified 17 “Ghost-towns” with 17,000 multi-family residential units (including 7,400 vacant units)
- \$320 million loan repair program for mostly wood-frame apartments (age 1950-1975) with “soft story” failures
 - Max. loan \$35,000/unit (costs averaged \$43,000/ unit)
 - 0% interest rate
 - Payments deferred for 5 years
 - 20% of rental units had to be affordable”
- By 1999, nearly all units repaired, and loan payments began



LOS ANGELES “SOFT-STORY” RETROFIT ORDINANCE (Adopted 2016)

13,000 potentially vulnerable apartments and condominiums



23,059 addresses

Addresses are listed the way the city provided them to the Times

< 1 / 1,538 >

2174 E 103RD ST Los Angeles, CA 90002

446 W 106TH ST Los Angeles, CA 90003

1926 S 10TH AVE Los Angeles, CA 90018

6015 S 10TH AVE Los Angeles, CA 90043

6200 S 10TH AVE Los Angeles, CA 90043

6210 S 10TH AVE Los Angeles, CA 90043

6329 S 10TH AVE Los Angeles, CA 90043

6407 S 10TH AVE Los Angeles, CA 90043

6416 S 10TH AVE Los Angeles, CA 90043

6419 S 10TH AVE Los Angeles, CA 90043

6429 S 10TH AVE Los Angeles, CA 90043

6809 S 10TH AVE Los Angeles, CA 90043

6821 S 10TH AVE Los Angeles, CA 90043

7211 S 10TH AVE Los Angeles, CA 90043

604 W 10TH ST Los Angeles, CA 90731

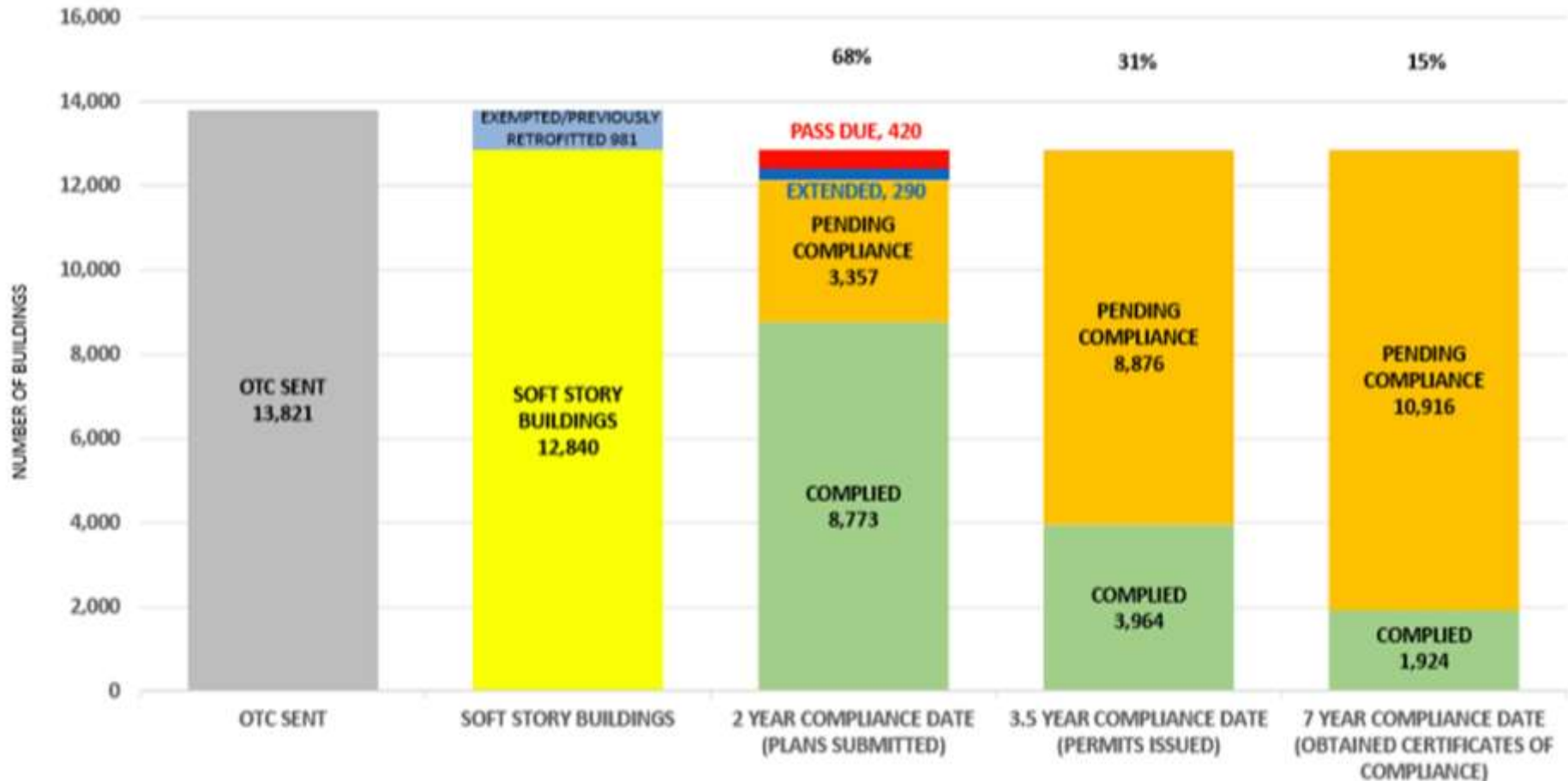
Leaflet | Map data (c) OpenStreetMap contributors, CC-BY-SA, CartoDB attribution

Note: Locations and unit sizes are based on L.A. County assessor parcel records.

Sources: Los Angeles Department of Building and Safety, L.A. County Assessor
[Download the addresses](#)

LOS ANGELES “SOFT-STORY” RETROFIT ORDINANCE

Compliance Status (April 1, 2019)



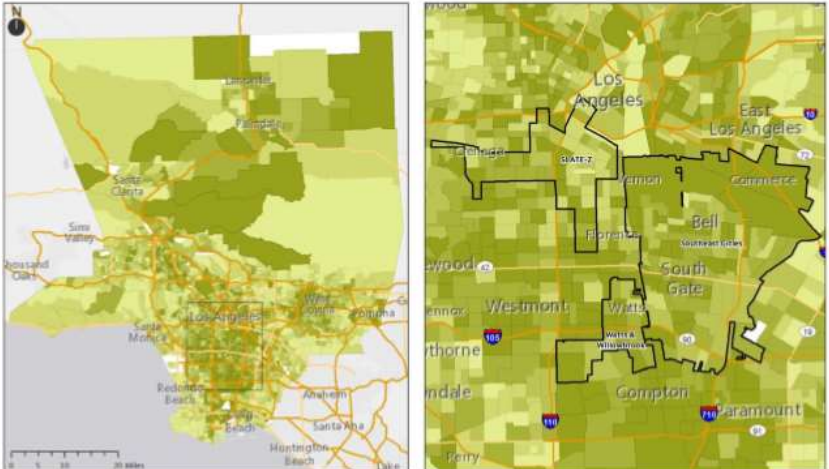
From the receipt of the Order to Comply:

- 2 years: Submit proof of previous retrofit, or plans to retrofit or demolish
- 3.5 years: Obtain permit to start construction or demolition
- 7 years: Complete construction

VULNERABLE POPULATIONS STRONGLY CORRELATE WITH VULNERABLE BUILDINGS

Unemployment Rate by Census Tract, 2014

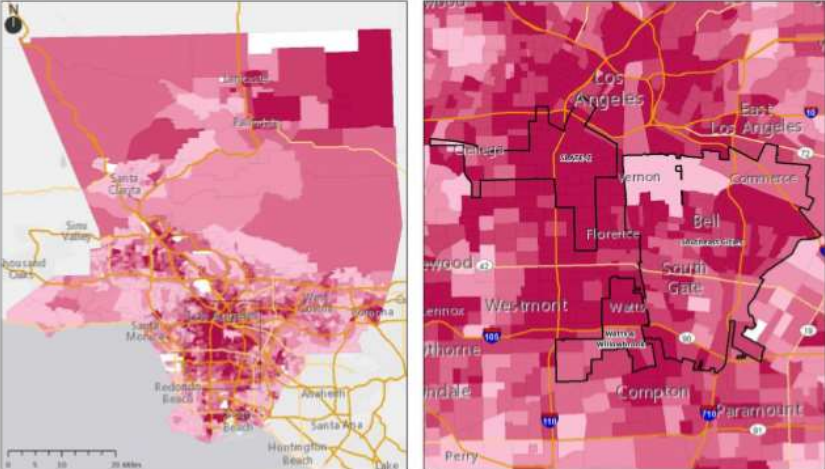
- Los Angeles County 11%
- Watts and Willowbrook 16%
- Southeast cities 14%
- SLATE-Z area 13%



Source: U.S. Census Bureau; TomTom, ESRI, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Universe includes the civilian noninstitutional population ages 16 and older. Note: Data represent a 2010 through 2014 average. Areas in white have missing data.

Population Below Poverty Level Income by Census Tract, 2014

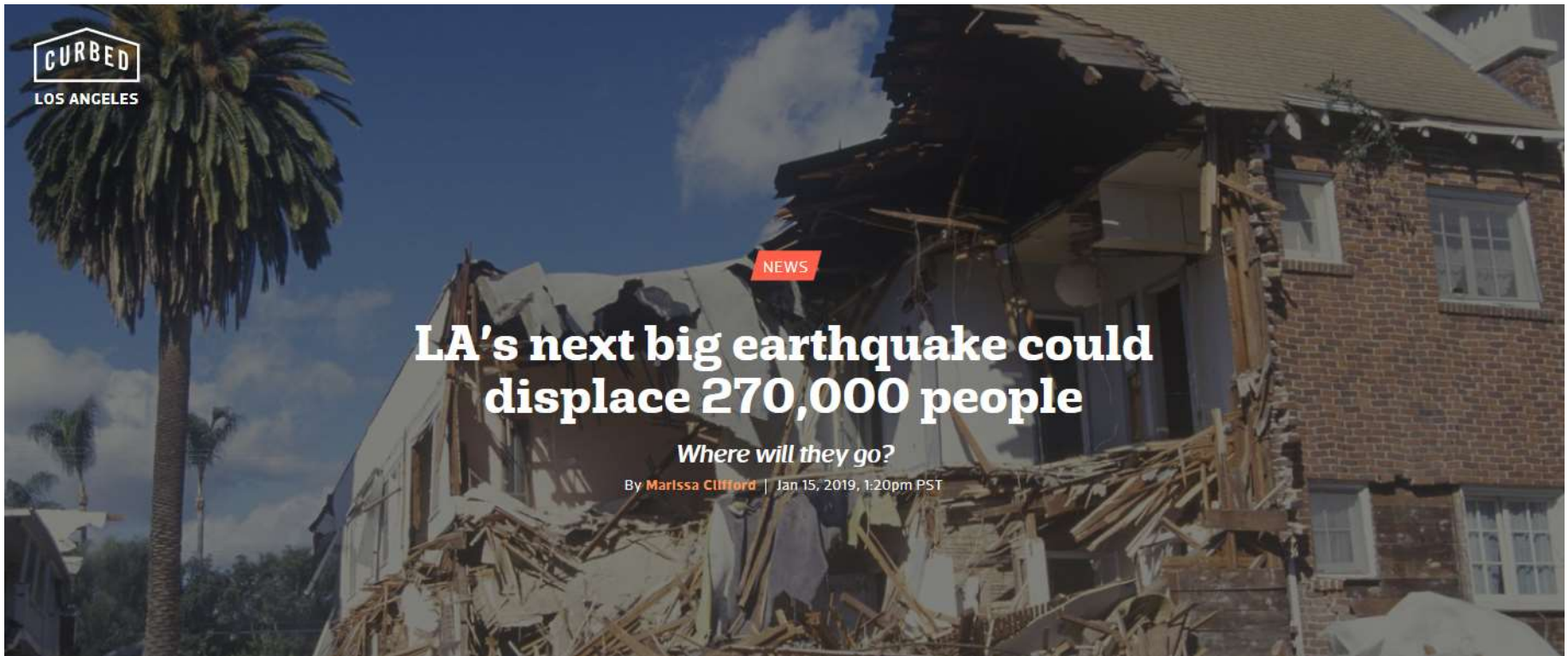
- Los Angeles County 18%
- Watts and Willowbrook 36%
- Southeast cities 26%
- SLATE-Z area 41%



Source: U.S. Census Bureau; TomTom, ESRI, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Universe includes all persons not in group quarters. Note: Data represent a 2010 through 2014 average. Areas in white have missing data.

EARTHQUAKE SCENARIOS FOR CALIFORNIA

How bad it could be



Region	Last Major Earthquake	Mean Recurrence Interval (yr)	Economic Losses	Insured Losses
Southern California	1690 – South San Andreas	300 ¹	>\$200 bn ¹	\$30 bn ²
	1857 – Central-South San Andreas	140 ¹	>\$150 bn ³	\$40 bn ³
Northern California	1868 – Hayward	140 ⁴	>\$102 bn ⁴	\$30 bn ⁵
	1906 – North San Andreas	>200 ⁶	>\$150 bn ⁶	>\$50 bn ⁷

1. "Shakeout Scenario" USGS, 2008
 2. "CatUpdate for 'Shakeout' Earthquake Scenario Mw7.8" RMS, 2008

3. "1857 Fort Tejon Earthquake: 150-Year Retrospective" RMS, 2007
 4. "HayWired Scenario", USGS, 2018

5. CoreLogic, 2018
 6. "Repeat of the 1906 Earthquake," EERI 2006
 7. AIR Worldwide, 2006, RMS, 2006