California’s Earthquake Legislation
California’s Earthquake Legislation

- Generally follows every earthquake
- Attempts to alleviate problem observed
Legislation, Paso Robles Earthquake

- Associated with M6 and M5 eqs in late September
- Paso Robles, 2003-$250,000 in damage
- Unreinforced brick bldgs must post signs
- Encourages the retrofitting of unreinforced brick by not requiring other non-seismic improvements
1933 Long Beach Earthquake

- Collapse of URM
- Schools collapsed
- Recognition that lateral forces caused building collapse
Collapse of Unreinforced Masonry School

- 5 teachers killed
- Field Act passed
- Gave the state authority to supervise structures built for schools
Earthquake Codes

• $F = CW$
• $F$ = force
• $C$ = constant depending on building material, earth material, and number of building stories
• $W$ = weight of building
• Recognition of lateral forces: acceleration
1933 Long Beach Earthquake

- Building response
  - Un-reinforced masonry
- Field Act: legislation
- Seismic Element Code (F=CW)
- First acceleration records
- Expertise and classification of “structural engineer” developed
1971 San Fernando earthquake

- “Hidden thrust”
- Hospital structure response
- Alquist-Priolo Act-ground rupture
- Dam safety act
- Ground accelerations > 1g
- Performance of hydraulic fill structures
- Infra-structure: roads, power, water supply
Alquist-Priolo Act

- Prohibits building structures for human occupancy on active faults
1989, Loma Prieta Earthquake
This act addresses the fact that areas tend to respond the same during an earthquake.
Maps indicate areas that are most likely to experience ground shaking, liquefaction and landslides.
Maps are used by cities and counties for guidance.
Education

American Red Cross, Bay Area Chapter
Association of Bay Area Governments
California Earthquake Authority
California Geological Survey
Earthquake Engineering Research Institute
Governor’s Office of Emergency Services
San Francisco Office of Emergency Services and Homeland Security
Southern California Earthquake Center
Structural Engineers Association of Northern California
University of California Berkeley
U.S. Geological Survey
The Northridge Earthquake
The mountains are the surface expression of the fault. This fault was unknown before this earthquake.
California Earthquake Authority

- 1994, Northridge, 12.5 billion dollars damage
- 1995-private companies restrict or refuse to write earthquake insurance
- 1996-California Earthquake Authority
California Earthquake Authority

- privately financed, publicly managed
- sell to homeowners, mobile home owners, condominium owners, and renters
Post-Northridge Earthquake- Chuck Quakenbush, the California Insurance Commissioner

- Refused to punish insurance companies who mishandled claims associated with the Northridge earthquake
- Currently lives in Hawaii
<table>
<thead>
<tr>
<th>California Earthquake Insurance</th>
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<tbody>
<tr>
<td>• Instead of forcing insurance companies to pay large sums of money to earthquake victims whose claims were mishandled</td>
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<tr>
<td>• Collected 11.6 million dollars in donation to grants and non-profit corporations created by Quakenbush</td>
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<tr>
<td>• Some of the funds were used in his campaign</td>
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</tbody>
</table>
Rates are developed depending on

1.
2.
3.
4.
5.
Rates are developed depending on:
1. proximity to active fault
2. earth material
3. special study zones
4. building materials
5. age of structure
6. ?
California Earthquake Insurance

- Coverage shall be in accordance to the rules of insurer
- up to the current building code
  - bolted to foundation
  - bracing for cripple wall
  - strapping of water heaters
California Earthquake Insurance

• Rates vary from $1.10 to $5.25 per 1000 dollars
California Earthquake Insurance

- 60 days of renewal or issuance of insurance
- authorized insurer (by the state)
- disclosure of discounts or surcharges
- dwelling not including:
  - outbuildings,
  - swimming pools
  - masonry fences and walls
  - masonry chimneys
## California Earthquake Insurance

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Base-limits earthquake coverage</strong></td>
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<tr>
<td><strong>Coverage A</strong> - Dwelling: the structure is equal to the amount of homeowners policy</td>
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<td><strong>Coverage B</strong> - Deductible, 10-15%</td>
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<td><strong>Coverage C</strong> - Contents: $5,000 - 100,000</td>
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<tr>
<td><strong>Coverage D</strong> - Loss of use: $1,500 - 15,000</td>
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<tr>
<td><strong>Coverage E</strong> - Limited building upgrade: $20,000 limit</td>
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</tbody>
</table>
Bay Area Earthquake

- Hayward Fault: M 6.8
- $112-122$ billion in economic loss
- < 15% covered by insurance
Hayward Fault
Hayward Fault Earthquake, 20??
Geological Cross-section
1868 earthquake
Hayward fault
Damage is equated to the Modified Mercalli Scale, then a Richtor Magnitude is assigned
County Court House
Cripple wall damage
Have we fixed this problem?
Scenario for a M 7 earthquake on the Hayward Fault

- Moves at about 9mm per year
- 12-13KM at depth
- Extends from Fremont, Hayward, San Leandro, Berkeley to El Cerrito
- At the surface and below 12 KM it is creeping
- The intermediate portion is locked since 1868
Quake 2003 Scenario
Hayward fault earthquake

- Water and sewer delivery will be halted
- Liquefaction and ground shaking
- Breaking of pipes
- 60% of customers out of service
- 75% will not have service if reservoirs run dry
Dam Failure

HAZARD MAP
DAM FAILURE
INUNDATION AREAS
- San Lorenzo Creek
- Cull/San Lorenzo
- Upper San Leandro
- Upper San Lean/Chabot
- Dunsmuir
- Duns/Upper SL/Chabot

Source: ABAG, 1995
This hazard map is generalized from maps dam owners are required to prepare and file with the State Office of Emergency Services. The map is intended for planning only. Current version of this map is available on Internet at http://www.abag.ca.gov
Bay Area Roads
Transportation

1989-300 feet of runway lost at Oakland airport

• Damages to bridges- 0.05-.1g of lateral force

• San Mateo Bridge-retrofitted

• New Antioch bridge
• **BART** crosses the Hayward fault-Orinda Tunnel
• 238
• crosses 580
Structures

- Industrial and light commercial buildings - 500 red-tagged in Alameda and Contra Costa Counties
- Unreinforced masonry buildings - 500
- Residential buildings - 7000
Housing

- 370,000 people displaced
- 95% in Alameda and San Francisco Counties
- 16% in Bay Area - loss of multi-family housing
- Unreinforced masonry
  - 92% loss in Alameda County
  - 55% in Bay Area
Hospitals

- 20% of the beds are in good location
- 50% in marginal buildings
- 30% in bad buildings
- 2008-retrofit poorly designed structures
- 2030- all structures should be to code
Shelter Population

HOUSING IMPACTS
Northern Hayward Earthquake
Magnitude 7.1

Peak Shelter Population by Census Tract

- Less Than 100
- 101 to 200
- 201 to 300
- 301 to 400
- Over 400

Source: Shaken Awake!
ABAG – 1996

Key Map
Bay Area Earthquake (1906 magnitude)

- 122-150 billion dollars in direct loss
- Fire, transportation, water, housing
- Up to 1800 fatalities; 8,000 injured (night)
- 3400 fatalities; 10,000 injured (day)
- Commercial buildings: 40%-SF; 79% SCC
  - 15% overall