Buildings and Communities

Lessons and New Approaches since Loma Prieta

David Bonowitz, S.E.

Loma Prieta Earthquake Commemorative Symposium
October 17, 2009
Lessons?

David Bonowitz, S.E.
Unreinforced Masonry

1989

1933
Unreinforced masonry

1989
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1983
Unreinforced masonry

1994

2003
Unbraced Cripple Walls

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Unbraced Cripple Walls

1933

1989

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Unbraced Cripple Walls

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Nonstructural components
VULNERABLE STRUCTURE TYPES

- Unreinforced masonry
- Unbraced cripple walls
- Soft story wood frame
- Non-ductile concrete frames
- Tilt-ups
- Hillside houses
- Parking structures (precast concrete)
- Pre-Northridge steel frames
- Thin-wall steel braced frames
Applying old lessons: URM

- 1933 Long Beach earthquake
  - Field Act, 1933
  - Riley Act, 1933
- SB 547, 1986
- 1989 Loma Prieta earthquake
  - San Francisco, 1992
    - 90% complete
    - Risk reduction
  - Other cities
Applying old lessons: Hospitals

- 1971 San Fernando earthquake
  - Alquist Hospital Safety Act, 1973
- 1994 Northridge earthquake
  - SB 1953, 1994
Gauging Performance

Functionality → Damage

New buildings → Safety

Risk reduction → Collapse

SB 1953

URM retrofit

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SETTING GOALS

Damage

Functionality

New buildings ➔ Safety

Risk reduction ➔ Collapse

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WHERE DO WE START?
# Recovery Targets

<table>
<thead>
<tr>
<th>Service</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals operational</td>
<td>0 hrs</td>
</tr>
<tr>
<td>95% housing habitable</td>
<td>24 hrs</td>
</tr>
<tr>
<td>Emergency shelters open</td>
<td>24 hrs</td>
</tr>
<tr>
<td>Essential City services restored</td>
<td>1 mo</td>
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<tr>
<td>Schools reopened</td>
<td>1 mo</td>
</tr>
<tr>
<td>Social services reopened</td>
<td>1 mo</td>
</tr>
<tr>
<td>Community retail reopened</td>
<td>1 mo</td>
</tr>
<tr>
<td>All businesses reopened</td>
<td>4 mo</td>
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<tr>
<td></td>
<td>URM</td>
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<td>----------------</td>
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<tr>
<td><strong>Hospitals</strong></td>
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<tr>
<td><strong>SF Res’l</strong></td>
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<tr>
<td><strong>MF Res’l</strong></td>
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<tr>
<td><strong>Shelters</strong></td>
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<tr>
<td><strong>City svcs</strong></td>
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<tr>
<td><strong>Schools</strong></td>
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<tr>
<td><strong>Social svcs</strong></td>
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<tr>
<td><strong>Retail/Office</strong></td>
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</tbody>
</table>
Soft story residential

1989

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Soft story residential

1989

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Soft story residential

1989

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Soft story residential

- 1971 San Fernando earthquake
- 1989 Loma Prieta earthquake
- 1994 Northridge earthquake
- Bay Area programs
  - Fremont
  - Berkeley
  - Alameda
  - Oakland
  - San Francisco
1. Mandate: Soft story multi-unit
2. Mandate: Shelters
3. Recovery-phase services
4. Non-ductile concrete
5. GAS LINES & EQUIPMENT
6. Unreinforced Masonry