Earthquake Resistant and Resilient Hospitals

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The role of Hospitals in the Community

- Source of state-of-the-art healthcare
- Economic engine for the region
- Vital source of aid and hope following an earthquake
- Hospitals that survive relatively intact can shorten recovery time as a key element in resilience of the community
Hospital Seismic Safety Act

- Enacted following the 1971 San Fernando Earthquake
Hospital Seismic Safety Act

- Identified deficiencies in building codes, plan review, and construction quality
- Established new seismic safety standards
- Addressed only new construction
Northridge Earthquake
catalyst for change
1994 Norhridge Earthquake

- Significant damage to pre-HSSA buildings
- Nonstructural damage to pre- and post HSSA buildings
# Northridge Performance

Performance of all Buildings at 23 Hospital Sites with One or More Yellow or Red Tagged Buildings

<table>
<thead>
<tr>
<th>Type of Damage</th>
<th>Number (%) of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Act</td>
</tr>
<tr>
<td>Structural Damage</td>
<td></td>
</tr>
<tr>
<td>Red tagged</td>
<td>12 (24%)</td>
</tr>
<tr>
<td>Yellow tagged</td>
<td>17 (33%)</td>
</tr>
<tr>
<td>Green tagged</td>
<td>22 (43%)</td>
</tr>
<tr>
<td>Nonstructural Damage</td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td>31 (61%)</td>
</tr>
<tr>
<td>Minor</td>
<td>20 (39%)</td>
</tr>
<tr>
<td><strong>Total Buildings</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>
SB 1953 Hospital Seismic Retrofit Program

- Evaluation
- Database of Hospital Building Stock
- Retrofit to prevent collapse and loss of life
- Retrofit to provide continued operation after an earthquake
SB 1953 Major Milestones

1994

Seismic evaluations and plans for compliance submitted to OSHPD

2001

Northridge EQ

Improvements to allow evacuation 1.1.2002 (NPC-2)

2002

2001

2008

2013

2001

Possible Extension to 2008 Deadline

2008

2008

Prevent collapse and loss of life 1.1.2008 (SPC-3/NPC-3)

2030

2030

Possible Extension to 2008 Deadline

All buildings capable of continued operation By 1.1.2030 (SPC-5/NPC-5)
Hospital Building Inventory
Age of Facilities

Seismic Safety Act

NUMBER OF BUILDINGS

0 100 200 300 400 500 600 700

YEAR BUILT

00-15 16-25 26-33 34-39 40-49 50-59 60-69 70-73 74-79 80-90

14 39 70 35 87 413 626 348 430 551
### Reported Seismic Performance Ratings

<table>
<thead>
<tr>
<th>Number of Buildings in Each Category</th>
<th>SPC-1 = 1,023</th>
<th>NPC-1 = 2,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-2 = 193</td>
<td></td>
<td>NPC-2 = 412</td>
</tr>
<tr>
<td>SPC-3 = 345</td>
<td></td>
<td>NPC-3 = 50</td>
</tr>
<tr>
<td>SPC-4 = 739</td>
<td></td>
<td>NPC-4 = 150</td>
</tr>
<tr>
<td>SPC-5 = 336</td>
<td></td>
<td>NPC-5 = 4</td>
</tr>
<tr>
<td>SPC-0 = 73</td>
<td></td>
<td>NPC-0 = 93</td>
</tr>
<tr>
<td>Total = 2,709</td>
<td></td>
<td>Total = 2,709</td>
</tr>
</tbody>
</table>

SPC-1 = significant risk of collapse  
SPC-2 = pre-HSSA, no collapse  
SPC-3 to 5 = post-HSSA
Urgent Need for Retrofit Strategies

• Making decisions today that…
  • Influence retrofit approach
  • Influence use of the buildings for the next 30 years
• In the absence of science we must rely on intuition and judgment
• Work being done at MCEER can help OSHPD make informed decisions
Critical Research Needs

• Likely performance and retrofit of nonstructural systems
• Innovative, cost-effective retrofit solutions that are useable by designers
Architectural Systems
Medical Equipment
Building Contents
Mechanical and Electrical Systems
Seismic Resistance for Hospital Buildings

- Conventional Systems
  - Steel Plate Shear walls
- Advanced Technologies
- Geohazard Issues
  - Liquefaction Mitigation measures for (E) Hospital buildings
The Need for Innovative Solutions is Critical

- Seismic retrofit is costly, but the cost of doing nothing is greater
  - Ten years after the Northridge EQ some facilities have still not reopened
- Resilience of communities in the aftermath of a disaster is critical
- Understanding what drives that resilience can drive policy decisions
Questions?