California’s Hospital Seismic Retrofit Program

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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 Northridge 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>
<th>Pre Act</th>
<th>Post Act</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Damage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red tagged</td>
<td></td>
<td>12 (24%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Yellow tagged</td>
<td></td>
<td>17 (33%)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>Green tagged</td>
<td></td>
<td>22 (43%)</td>
<td>30 (97%)</td>
</tr>
<tr>
<td><strong>Nonstructural Damage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td>31 (61%)</td>
<td>7 (23%)</td>
</tr>
<tr>
<td>Minor</td>
<td></td>
<td>20 (39%)</td>
<td>24 (77%)</td>
</tr>
<tr>
<td><strong>Total Buildings</strong></td>
<td></td>
<td>51</td>
<td>31</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

Seismic evaluations and plans for compliance submitted to OSHPD

- 1994
- Northridge EQ
- Improvements to allow evacuation 1.1.2002 (NPC-2)

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

- 2001
- 2002
- 2008
- Possible Extension to 2008 Deadline

All buildings capable of continued operation By 1.1.2030 (SPC-5/NPC-5)

- 2030

Possible Extension to 2008 Deadline

- 2013

Possible Extension to 2008 Deadline
Hospital Building Inventory - Age of Facilities

Seismic Safety Act

YEAR BUILT

NUMBER OF BUILDINGS

0-15 16-25 26-33 34-39 40-49 50-59 60-69 70-79 80-90

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

Structural Performance Ratings
Total No. of Hospital Buildings Reported = 2662
Reported Hospital Building Seismic Performance Ratings

Non-Structural Performance Ratings

Total No. of Hospital Buildings Reported = 2662
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 for Hospital Components & Operations

- 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
The Need for Innovative Solutions is Critical

• Seismic retrofit is costly, but the cost of doing nothing is greater
  – Thirteen 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
Available Mitigation Strategies for NCS

• Seismic retrofit of NCS
  – 2001 CBC
  – 2007 CBC
    • 2006 IBC
      – ASCE -7
    • ASCE 41
  – ...

• Replacement of NCS
  – 2007 CBC
  – ...

• 2006 IBC
  – ASCE -7
  • ASCE 41
2007 California Building Code (CBC) Requirements for NCS

- Components in or attached to Occupancy Category IV Structures
  - Needed for Continuous Operation of the Facility or
  - Failure Could Impair the Continuous Operation of the Facility
    - “Seismic Qualification” of Mechanical and Electrical Equipment
    - Manufacturer’s “Seismic Certification” for Architectural, Mechanical, and Electrical Components, Supports, and Attachments
“Seismic Qualification” Requirements

• Mechanical and Electrical Equipment (CBC 2007, Section 1708A.5)

• “Seismic Qualification” for Designated Seismic System
  – All Mechanical & Electrical Equipment Designed per Chapter 13 of ASCE 7 with Importance Factor, $I_p > 1.0$
“Seismic Qualification” Requirements

• Test on a Shake Table by 3D shock …

• Analytical Method using Dynamic Characteristics and Forces.

• Experience Data (i.e. Historical Data Demonstrating Acceptable Seismic Performance)

• More Rigorous Analysis Providing for Equivalent Safety
“Seismic Qualification” Requirements

• Engineer shall state the applicable requirements for the designated seismic system on construction documents

• Manufacturer shall provide certificate of compliance.

• Calif. Structural Engineer shall review & accept certification.

• Approval by Building Official is required.
“Special Certification” Requirements

- “Special Certification” for Equipment
  - (ASCE 7, Section 13.2.2.a)

- Active mechanical and electrical equipment that must remain operational following design earthquake shall be certified by the supplier
  - Based on Approved Shake Table Testing per ASCE 7, Section 13.2.5
    - ICC-ES AC 156
    - Experience Data per ASCE 7, Section 13.2.6
    - Analysis

- Require approval by Engineer & AHJ.
Acceptance by Experience Data

• No Procedure Provided in the Code or Reference Standards

• 1999 SEAOC Blue Book
  – Rugged Equipment
    • Qualified by Experience Data
    • Ampleness of Construction that gives such Equipment the Ability to Survive Strong Motions without Significant Loss of Function
Questions?