Is My Building Earthquake-Safe?

Obstacles to a Practical Earthquake Rating System

David Bonowitz, S.E.

NIBS Multihazard Mitigation Council Webinar Series
September 25, 2014

What clients ask

- Is it safe?
- Should I buy it?
- Am I making a bad decision?
What clients ask

With regards to our interest in the space, I have two more requests before I can give an final answer:

1). Can you please confirm if the building is retrofitted?
2) May we schedule a time early next week for my staff to visit?

I'm assuming by retrofitted, you are referring to an Earthquake retrofit.

The building is an Unreinforced Masonry Building, meaning it has not been retrofitted. However, the frame and structure of the building is made of steel and concrete, making the retrofit process unnecessary.

From my understanding of earthquake retrofitting, the process essentially adds metal supports for buildings, which would make "retrofitting" redundant for a steel and concrete building. After the 1989 earthquake, the inspectors came through and did not require us to retrofit the building.

Hope this information helps!*

What clients need

- Common shorthands
  - BOMA Class A
  - ASCE 31 Structural LS
  - Built to 1991 UBC
  - PML = 19%
  - SSC Commercial Checklist

- A way to compare them
- A decision-making tool
OUTLINE

- Why earthquake rating of buildings is hard
- Some existing systems and their shortcomings
- What a good rating system should do
  - SEAONC EPRS
- Implementation issues
  - USRC

USEFUL MODELS?

- EQ performance rating
- Consumer Reports
- Yelp, movie reviews
- Nutrition, Drug Facts
- Election forecasts
- NCAA football ranking
- Sports booking
- SAT scores
- Probable maximum loss
- LEED certification
- BOMA classes
- Restaurant grades
- Weather forecasts
- Tornado warnings
- UL approvals
- Building permits
- Stock picks
- Bond ratings
### Buildings: Custom Designs

<table>
<thead>
<tr>
<th>EQ performance rating</th>
<th>LEED certification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumer Reports</strong></td>
<td></td>
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### Earthquakes: Rare Events

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**Prediction, not review**

- EQ performance rating
- Consumer Reports
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- Election forecasts
- NCAA football ranking
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- LEED certification
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**High, indirect consequences**

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**David Bokowitz, P.E.**
GENERAL AUDIENCE

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- Bond ratings

5 REASONS THIS IS HARD

- Buildings are custom designs with long lives
- Earthquakes are rare and unique
- Prediction differs from review
- Ratings predict indirect consequences
  - Casualties, financial loss, business interruption
- The audience is non-expert
  - Building rating is as much about communication as it is about engineering
3 RATING SYSTEMS & PROGRAMS

- California DGS Risk Levels
- "PML" practice
- ASCE 41

CALIFORNIA DGS RISK LEVELS

- For state-owned buildings

<table>
<thead>
<tr>
<th>Level</th>
<th>Building</th>
<th>Risk to Life</th>
<th>Systems</th>
<th>Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Negligible structural damage: repairable. Minor non-structural damage: repairable.</td>
<td>Negligible.</td>
<td>Minor disruptions for hours to days.</td>
<td>Minor disruptions, return within hours.</td>
</tr>
<tr>
<td>III</td>
<td>Minor structural damage: repairable. Moderate non-structural damage: extensive repair.</td>
<td>Minor</td>
<td>Disruption of systems for days to months.</td>
<td>Return within weeks, with minor disruptions.</td>
</tr>
</tbody>
</table>
CALIFORNIA DGS RISK LEVELS

- For state-owned buildings
- Seismic Risk Levels I – VII
- Considers multiple aspects of performance: Safety, repairability, downtime
- Combines into single SRL
- Vague terminology: “Minor,” “Moderate,” “Extensive.”
- Requires separate evaluation

“PML” PRACTICE

- Scenario Expected Loss
  - Cost of damage/repair as % of replacement cost
  - A number used as a rating
- Used by lenders, insurers
  - Typical industry limit: 20%
- Focuses on dollar loss
  - Ignores downtime
  - Sometimes ignores safety
- Quality control issues
ASCE 41

- National standard
- A full evaluation methodology
- Considers a range of performance levels

Operational

Immediate Occupancy

Life Safety

Collapse Prevention

David J. Schowitz, P.E.
**Performance & Recovery Time**

- Immediate Occupancy: Hours
- Most social services: Days, Weeks
- Most private businesses: Months
- Life Safety: Eventually
- Collapse Prevention: Never

**ASCE 41**

- National standard
- A full evaluation methodology
- Considers a range of performance levels
  - Meaningful terminology
  - Not a typical “rating” hierarchy
- Does not consider full range of recovery times
- Does not consider financial losses
- Thorough → time consuming, expensive
  - Typically used by sophisticated clients
A RANGE OF RATING SYSTEMS

- Some multi-dimensional
  - More than safety
- Some comprehensive
  - All building types
  - Structural and nonstructural
- Some associated with evaluation methodologies

SEAONC INSIGHT #1

- We don’t need a new evaluation tool for safety

INSIGHT #1B: We probably do for recovery.
A RANGE OF RATING SYSTEMS

- Some multi-dimensional
  - More than safety
- Some comprehensive
  - All building types
  - Structural and nonstructural
- Some associated with evaluation methodologies
  - More complete → more reliable
  - More complete → more expensive
- Some associated with specific programs

SEAONC INSIGHT #2

- One rating system cannot serve every rating program.
- Rating programs
  - Mandatory or voluntary?
  - By authority or by parties?
  - Rating is public or private?
OUTLINE

- Why earthquake rating of buildings is hard
- Some existing systems and their shortcomings
  - Rating systems
  - Rating programs
  - Evaluation methodologies
- What a good rating system should do
  - SEAONC EPRS

WHAT CLIENTS NEED

- A useful shorthand
- A decision-making tool
- Clear terminology
- Clear presentation
- A system that suits their program
### THE SEAONC 4-PART EPRS

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<td>3 ★ No death</td>
<td>3 ★ Industry SEL standard (&lt;20%)</td>
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<td>3 ★ Within weeks</td>
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<td>2 ★ Death in isolated locations</td>
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### SYMBOL, SHORTHAND, DEFINITION

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<tbody>
<tr>
<td>★★★★★ No entrapment.</td>
</tr>
<tr>
<td>Performance would not lead to conditions commonly associated with earthquake-related entrapment.</td>
</tr>
<tr>
<td>★★★★★ No injuries.</td>
</tr>
<tr>
<td>Performance would not lead to conditions commonly associated with earthquake-related injuries requiring more than first aid.</td>
</tr>
<tr>
<td>★★★ No death.</td>
</tr>
<tr>
<td>Performance would not lead to conditions commonly associated with earthquake-related death.</td>
</tr>
<tr>
<td>★★ Death in isolated locations.</td>
</tr>
<tr>
<td>Performance in certain locations within or adjacent to the building would lead to conditions known to be associated with earthquake-related death.</td>
</tr>
<tr>
<td>★ Death in multiple or widespread locations.</td>
</tr>
<tr>
<td>Performance as a whole would lead to multiple or widespread conditions known to be associated with earthquake-related death.</td>
</tr>
<tr>
<td>NR No rating.</td>
</tr>
<tr>
<td>The rating methodology does not justify or support a Safety Rating, or no Safety Rating was requested.</td>
</tr>
</tbody>
</table>
Essential Features

- The seismic hazard: “Design basis”
  - Not the maximum event
  - Not a frequent event
- Rating scope
  - What’s considered, and what isn’t

Rating Scope

- In
  - Structure, Nonstructure, Geologic
  - Some fixed equipment
  - Associated non-building structures
- Out
  - Most contents
  - Utilities, other externalities
EXTERNALITIES

ESSENTIAL FEATURES

- The seismic hazard: “Design basis”
- Rating scope
- Four essential features
  - Multiple dimensions
  - 5 rating levels per dimension
  - A “No Rating” option
  - Pragmatic levels and definitions
### 5 Rating Levels per Dimension

- **Safety**
  - 5 ★: No entrapment
  - 4 ★: No injuries
  - 3 ★: No death
  - 2 ★: Death in isolated locations
  - 1 ★: Death in multiple locations
  - NR: No rating

- **Comprehensive**
- **Not quintiles**
- **Broad bins; useful distinctions**

### A “No Rating” Option

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<tr>
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<td></td>
<td>NR</td>
<td>NR</td>
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</table>

**NR** No rating.

The rating methodology does not justify or support a Safety Rating, or no Safety Rating was requested.
A “No Rating” Option

- Incomplete question: “Is it safe?”
- Complete answer

Pragmatic Levels

<table>
<thead>
<tr>
<th>Repair Cost</th>
<th>Description</th>
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<tbody>
<tr>
<td>5★</td>
<td>Within operating budget (&lt;5%)</td>
</tr>
<tr>
<td>4★</td>
<td>Under deductible (&lt;10%)</td>
</tr>
<tr>
<td>3★</td>
<td>Industry SEL standard (&lt;20%)</td>
</tr>
<tr>
<td>2★</td>
<td>Repairable (&lt;50%)</td>
</tr>
<tr>
<td>1★</td>
<td>Substantial (50%+)</td>
</tr>
<tr>
<td>NR</td>
<td>No rating</td>
</tr>
</tbody>
</table>

- Not vague descriptors
- Not arbitrary values or scores
- Bright lines where needed to support industry standards
- Fuzzy boundaries elsewhere
WHAT CLIENTS NEED

- A useful shorthand
- A decision-making tool
- Clear terminology
- Clear presentation

- A system that suits their program
  
  Insight #2: Different programs need different systems

LOS ANGELES

Mayor Eric Garcetti seeks rating system for buildings’ seismic safety

Garcetti proposes seismic ratings of office buildings and apartments and posting the information publicly. He also wants a mandatory retrofit program.

April 11, 2014 | By Rong-Gong Lin II, Rosanna Xia, Doug Smith

Mayor Eric Garcetti wants buildings across Los Angeles to be graded for their seismic safety as part of an ambitious plan to help residents understand the earthquake risks of their office buildings and apartments.

Garcetti announced what would be the nation’s first seismic safety grading system for buildings during his State of the City address Thursday, when he also for the first time said he supports some type of mandatory retrofitting of older buildings that have a risk of collapse in a major earthquake.
**Preconceived Ideas**

- About PML
- About safety
- Voluntary
- Conservative
- High tech
- Easy to use & read

**A Clearer Vision**

<table>
<thead>
<tr>
<th>Specialized Ratings</th>
<th>REDi</th>
<th>UC</th>
<th>DGS</th>
<th>ATC-20</th>
<th>SPUR</th>
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<tbody>
<tr>
<td>Platinum</td>
<td>I-II</td>
<td>A</td>
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<td></td>
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</tr>
<tr>
<td>Gold</td>
<td>Good</td>
<td>III</td>
<td>Green</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>Fair</td>
<td>IV</td>
<td>Yellow</td>
<td>C</td>
<td></td>
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<tr>
<td>Poor</td>
<td>VI-VII</td>
<td>Red</td>
<td></td>
<td>D</td>
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**EPRS**
Multi-dimensional, Comprehensive

<table>
<thead>
<tr>
<th>Methodologies</th>
<th>ASCE</th>
<th>FEMA</th>
<th>IBC</th>
<th>IEBG</th>
<th>SSC</th>
<th>ATC 5B</th>
<th>P-807</th>
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<tr>
<td>IO</td>
<td>S &gt; 3</td>
<td>RC IV</td>
<td>Appx A</td>
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<tr>
<td>LS</td>
<td>S = 3</td>
<td>RC III</td>
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<tr>
<td>S = 2</td>
<td>RC II</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>CP</td>
<td>S &lt; 2</td>
<td>RC I</td>
<td></td>
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</table>
Specialized Ratings

- REDi Gold
  - Immediate reoccupancy
  - Functional recovery < 1 month
  - SEL < 5%
  - Injury “unlikely”

Specialized Ratings

- SPUR C
  - Safe
    - “Significant structural damage”
  - Usable after repairs
    - Yellow tag likely
    - 4 month to 3 year repair time likely
## Specialized Ratings

### REDI Gold

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### Specialized Targets

### PML Standard

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### S.F. "Soft Story"

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David Borowitz P.E.
**SEAONC Insight #2**

- One rating system cannot serve every rating program.
- Rating programs
  - Mandatory or voluntary?
  - By authority or by parties?
  - Rating is public or private?

**Insight #2B:** A comprehensive system is more adaptable to diverse perspectives.
- Focus on stakeholder needs, not building types.

---

**Stakeholders, not buildings**

- Schools
- Houses
- Soft story apts
- Pre-80 concrete
- New buildings
- Existing buildings

*David Schoritz, P.E.*
Simple presentation?

- Disclaimer
- Seismic hazard level
- Rating definitions
- Methodologies used
- Link to User's Guide
- Supporting documents

Implementation

- The PML Problem
  - Quality control
  - Credentials and enforcement
- The US Resiliency Council
  - Accreditation
  - Review
  - Third party verification
  - Technical development & maintenance
Thank you

David Bonowitz, S.E.
dbonowitz@att.net