From: Don Holden [mailto:info@inlaw.co.nz]
Sent: Tuesday, 22 November 2011 7:03 p.m.
To: canterbury
Subject: Rating System for Buildings Earthquake Resilience

TO: The Canterbury Earthquakes Royal Commission.

Greetings.
Following extensive discussions with a wide range of potential stakeholders, we are now researching, with the assistance of the Structural Engineers Association of Northern California,(SEAONC) the establishment of a buildings resilience rating scheme for both new and existing buildings, both commercial and residential.

SEAONC have been researching a "star" based rating system since 2006, and are now launching the project, as a part of the Obama Administration's call for Buildings Resilience - building better buildings. While this system may not easily translate to New Zealand conditions and practices, the background research, at least, is exceptionally useful. My contact has been with Drs Kate Stillwell and Dr Ron Mayes, of SEAONC, Kate having practiced recently briefly, in Wellington with Holmes Consulting, and Dr Mayes being a New Zealander, with extensive US experience, helping out engineering colleagues in February of this year as he was visiting this country at the time.

The system will offer to owners, developers, tenants, visitors and insurers an easily-understood rating system, in terms understood by the market, which empowers stakeholders to make building, tenanting and visiting decisions based on a rating system. A Power Point presentation of their proposal is attached.

We see such a rating system as at least initially being voluntary, market-led, and controlled and implemented by a Council with internationally respected integrity and credence, possibly formally linked to the USA body so as to achieve an international standard capable of recognition globally, particularly by the offshore insurance industry.
The Green Building Council in New Zealand is an excellent business and legal model, also being an industry-led initiative, which has been successful in achieving its goals, and with strong international affiliations.

We have been communicating with members of the NZ Society of Earthquake Engineers notably Dr Richard Sharpe, and Dr David Hopkins (the latter giving evidence to the Commission recently) and they are keen to participate or contribute, as are a wide range of industry associations, the NZ Insurance Council, NZ Property Council, CERA, Department of Building and Housing, major construction manufacturing entities, Insurance companies, Banks, and many other potential stakeholders.

We are writing to the Commission on this simply to inform the Commission of this industry-led initiative, following questions being asked by His Honour The Chair of the Commission, of Dr

Hopkins, whether “it was his evidence that a rating system was needed….” – to which the answer was positive.

We see the establishment of this body as being a priority, enabling better understanding particularly by the insurance community, of the resilience of buildings, thus hopefully speeding up the Canterbury Rebuilding process and offering a much better understanding by builders, developers, owners, and tenants, of the issues involved in constructing and repairing of buildings.

The Council which may be formed as a result of the research may also develop a knowledge bank, being a repository for the best and latest expertise and research, making the best use of the experiences learnt from the Canterbury Quakes, acting as a potential international focus for earthquake studies.

The Rating System, and any Knowledge Repository, could be a fitting legacy for , and as a dedication to, those who lost their lives in the Canterbury Quakes, as suggested by Dr Hopkins.

If there is any information that the Commission may require in respect to this initiative, I would be pleased to assist.

With Regards,
Don Holden.

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SEAONC Rating System for the Expected Performance of Buildings

Presented by: Doug Hohbach, on behalf of:

SEAONC Existing Buildings Committee,
Building Ratings Subcommittee

SEAONC Building Ratings Subcommittee Members

Marguerite Bello, Mathew Bittleston, Stephen Bono, David Bonowitz, Craig Cole, David McCormick, Evan Reis, Kate Stillwell

Co-Chairs: Ron Mayes, Doug Hohbach

Seismic Ratings Goal: Reducing Seismic Risk

- Intent is to provide reliable seismic risk information in accessible form to general public
- Utilize existing evaluation methodologies

Introduction

- SEAONC Existing Buildings Committee – tasked by SEAONC Board August 2006
- Phase 1 – Feasibility – October 2006 to June 2008
- Phase 2 – Development – July 2008 to September 2011
- ATC stakeholder workshop – March 2011

The Problem: Tenant: Office Lease

Information Provided:

- “Designed to Code”
- Level 1 PML: 18%
- Class A office space

Information for Decisions:

- Will employees be injured?
- Will our data be secure?
- How long until we can serve our clients?
- Might the landlord breach contract?

  (repair costs > liquid funds)

The Problem: Condo Buyer

Information Provided:

- “Not a landslide zone”
- “Not a liquefaction zone”
- “Not a fault zone”

Information for Decisions:

- Will I be safe?
- Will I be able to keep living here?
- Will I be able to retrieve my possessions? My car?
- Should I buy EQ insurance?

The Problem: Owner: Emergency Plan

Information Provided:

- ASCE 31: “Meets LS”

Information for Decisions:

- What will happen to systems?
- How much required cash after the event?
- How much operational downtime?

Objective of an Earthquake Performance Rating System

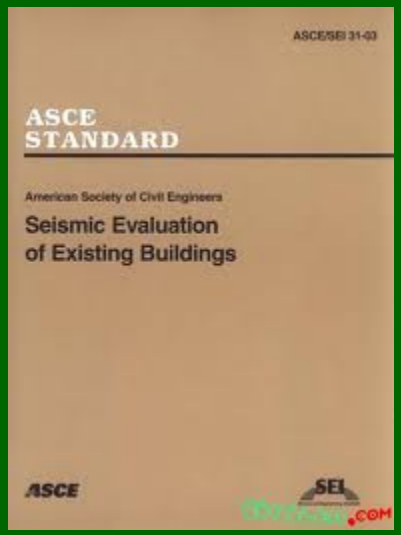
- Communicate seismic risk to non-engineers
  - Intended audience: anyone who makes decisions about buildings
- Ultimate objective: spur action to reduce seismic risk in building stock

Definition of an Earthquake Performance Rating System

- Set of definitions, rules, and procedures that lead to a concise characterization of earthquake performance

Existing Earthquake Performance Rating Systems

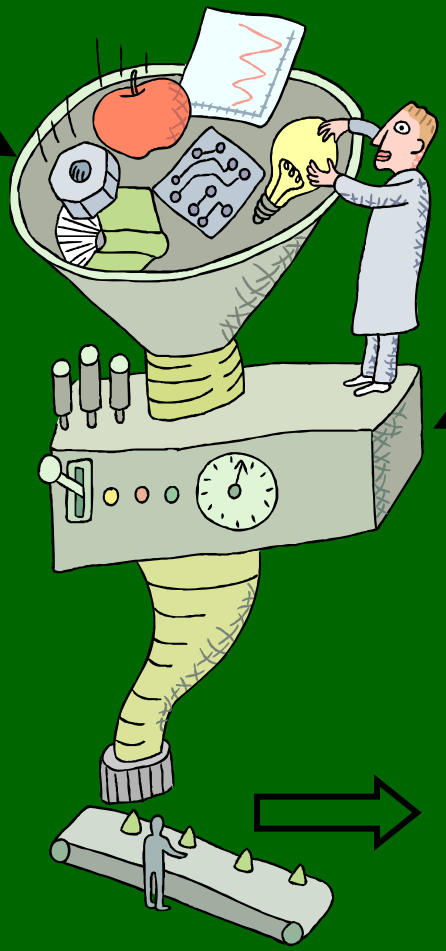
- ASCE 31
  - Output not straightforward to interpret by general public
  - Does not readily allow comparisons between buildings
  - Not generally adopted by private sector



Existing Earthquake Performance Rating Systems

- Probable Maximum Loss Analyses (PMLs)
  - Life safety not directly addressed
  - Lower level of understanding and effort can result in higher rating
  - Misleading degree of precision implied

Generating a Rating



Context

Outputs of (E) Evaluations

Development: Phase 2

Assignment Procedure

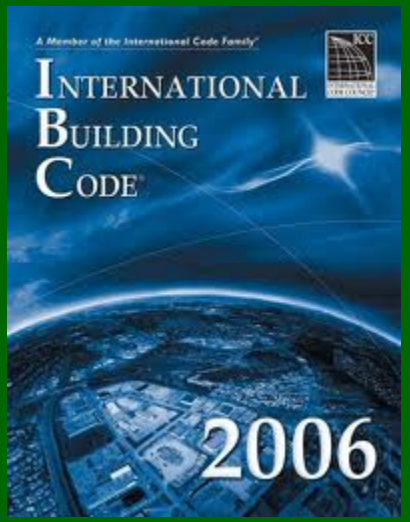
Rating

Context - ATC 71-2 Workshop

- Workshop on a Rating System for the Earthquake Performance of Buildings
- Feedback from building owners, investors, policy-makers regarding utility of an EPRS
- Funded by FEMA

ATC 71-2 Workshop Consensus: *Hazard Level*

- Make analogous to current seismic codes



ATC 71-2 Workshop Consensus: *Mandatory vs. Voluntary*

- Consensus: rating system should begin as voluntary

  not mandatory

ATC 71-2 Workshop Consensus: *Rating Symbols*

- Symbolic system preferred to point scale
- Avoid misperception of undue precision

ATC 71-2 Workshop Consensus: *Scope and Cost of a Rating*

- Use separate system for small scale residential buildings and commercial buildings

STRUCTURAL ENGINEERS ASSOCIATION SEA CALIFORNIA

ATC 71-2 Workshop Consensus: *Qualifications / Quality Control*

- Who should produce ratings?
  - Certified and *licensed* engineer for commercial buildings
  - Certified and *credentialed* individual acceptable for small scale residential buildings
- Independent oversight necessary

ATC 71-2 Workshop Consensus: *Rating Dimensions*

- Report 3 Dimensions
  - Safety
  - Repair Cost
  - Time to Regain Function
- Potentially combine into one rating for presentation

ATC 71-2 Workshop

- Workshop on a Rating System for the Earthquake Performance of Buildings
- Feedback from building owners, investors, policy-makers regarding utility of an EPRS
- Funded by FEMA
- Proceedings of ATC 71-2 available now at ATC booth here at the convention

Context Summary: *Private Transactions*

Impetus: Voluntary, Mandatory, or Triggered?

Generated by: Owner (or agent) or 3rd Party?

Results: Private or Public?

Verification: Self-enforcing or 3rd party?

Overall criteria: Feasible and Achievable

Earthquake Performance Rating System Development

- Two main steps
  - Defining each rating value
  - Establishing a procedure by which to derive the rating value

EPRS Development

- Design rating system for use in California
  - Also could be applicable to other areas of high and moderate seismicity

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Attributes of a SEAONC Rating

- Three Independent Dimensions

Safety	★ ★ ★ ★ ★
Repair Cost	★ ★ ★ ★ ★
Time to Regain Function	★ ★ ★ ★ ★

- Clear and concise for a general audience
- Basis of comparison: no predictions
- No new tools
- Contents excluded (if movable)

SEAONC Definitions for ★ Rating Values: Safety

Rating	Safety
★★★★★	Building performance would not lead to conditions commonly associated with earthquake-related *entrapment*.
★★★★	Building performance would not lead to conditions commonly associated with earthquake-related *injuries*.
★★★	Building performance would not lead to conditions commonly associated with earthquake-related *death*.
★★	Building performance in select locations within or adjacent to the building leads to conditions known to be associated with earthquake-related *death*.
★	Performance of the building as a whole leads to conditions known to be associated with earthquake-related *death*.

SEAONC Definitions: Safety

Rating	Safety Rating Definition
★★★★★	*No entrapment*
★★★★	*No injuries*
★★★	*No death*
★★	*Death in isolated locations*
★	*Death in multiple or widespread locations*

Definitions and Commentary for Each Rating Value: *Safety*

- Direct language utilized for clear communication
- To exceed ★★★ safety rating, knowledge of additional factors (falling hazards, factors affecting egress) is necessary - typically excluded from a conventional structural evaluation

SEAONC Definitions for ★ Rating Values: Repair Cost

Rating	Repair Cost
★★★★★	Building performance would lead to conditions requiring earthquake-related repairs commonly costing less than 5% of building replacement value.
★★★★	Building performance would lead to conditions requiring earthquake-related repairs commonly costing less than 10% of building replacement value.
★★★	Building performance would lead to conditions requiring earthquake-related repairs commonly costing less than 20% of building replacement value.
★★	Building performance would lead to conditions requiring earthquake-related repairs commonly costing less than 50% of building replacement value.
★	Building performance would lead to conditions requiring earthquake-related repairs costing more than 50% of building replacement value.

SEAONC Definitions: Repair Cost

Rating	Repair Cost
★★★★★	**Within Typical Operating Budget** Building performance would lead to conditions requiring earthquake-related repairs costing less than 5% of building replacement value.
★★★★	**Within Typical Insurance Deductible** <10% of building replacement value
★★★	**Within Industry SEL Limit** <20% of building replacement value
★★	**Repairable Damage** <50% of building replacement value
★	**Substantial Damage** >50% of building replacement value

SEAONC Definitions for ★ Rating Values: Time to Regain Function

Rating	Time to Regain Function
★★★★★	Building performance would support the building's basic intended functions within *hours* following the earthquake.
★★★★	Building performance would support the building's basic intended functions within *days* following the earthquake.
★★★	Building performance would support the building's basic intended functions within *weeks* following the earthquake.
★★	Building performance would support the building's basic intended functions within *months* following the earthquake.
★	Building performance would support the building's basic intended functions within *years* following the earthquake.

SEAONC Definitions: Time to Regain Function

Rating	Time to Regain Function
★★★★★	Within hours
★★★★	Within days
★★★	Within weeks
★★	Within months
★	Within years

Definitions and Commentary for Each Rating Value: *Time to Regain Function*

- Since impractical to set precise boundaries to categories, categories are purposefully approximate
- Corresponds to time it takes before building is substantially functional, excluding externalities that may affect a building's functionality

Definitions and Commentary for Each Rating Value

- Ratings are quantitative (to degree that methodology allows) and predictive (try to convey real world meaning)
  - Safety: akin to using performance-based terminology
  - Repair Cost: aligns rating categories with industry-standard decision points
  - Time to Regain Function: no strong precedents exist, approximate categories are defined
- Ratings include nonstructural features, but exclude performance of typical contents

Rating Determination

- EPRS not an evaluation tool
  - Translates evaluation results into consistent and pragmatic terms
- EPRS does *not* introduce new evaluation criteria, but relies on the criteria of underlying methodology

ASCE 31 Evaluation

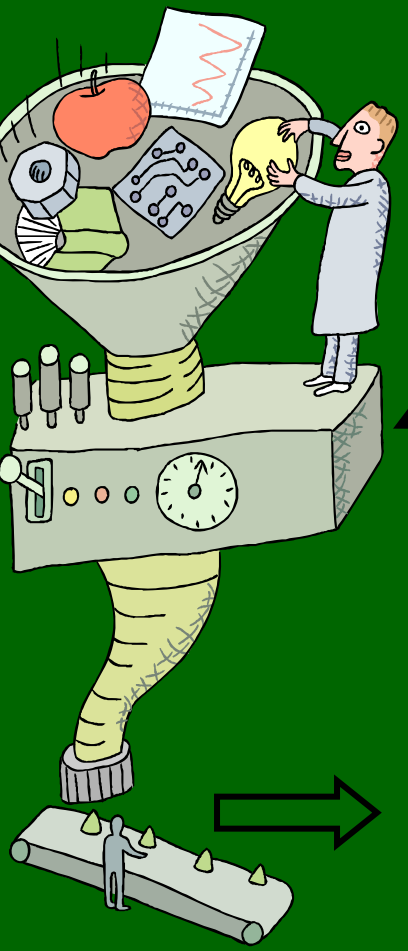
- Rating system provides a procedure for producing a rating from ASCE 31 (structural, non-structural, geotechnical evaluation statements)
- Ratings for Safety, Repair Cost, Time to Regain Function can be derived from ASCE 31 evaluation
  - Tier 1, Tier 2, or Tier 3 evaluation may be performed
  - Rating may change as more analysis is performed

ASCE 31 Evaluation

- Tier 1 - Screening Phase (Checklists)
- Tier 2 – Evaluation Phase (Full Building or Deficiency Only)
- Tier 3 – Detailed Evaluation (ASCE 41)

Generating a Rating

Outputs of ASCE 31 Evaluations



Assignment Procedure

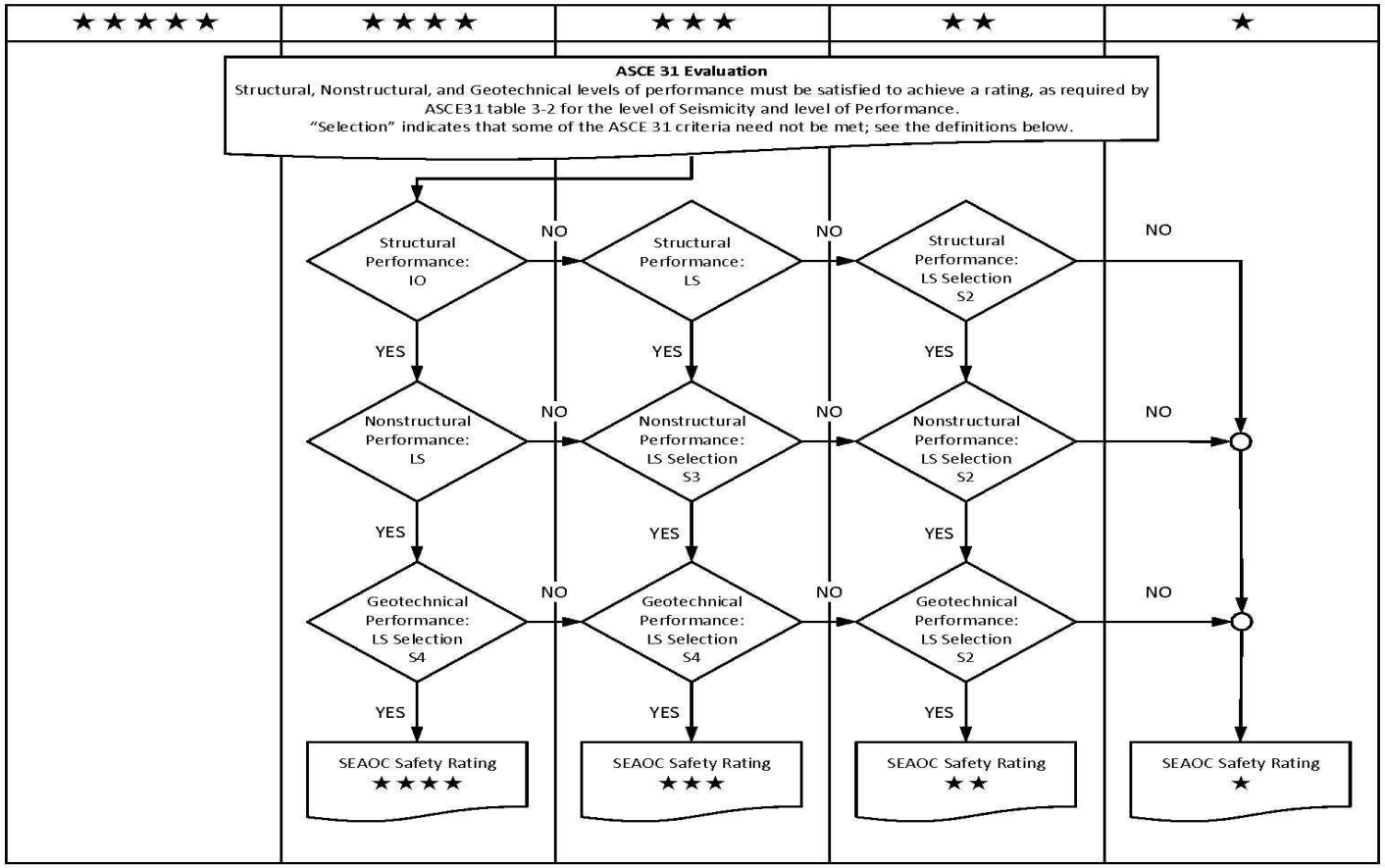
Rating

Mapping ASCE 31 Evaluation to a Safety Rating

Structural Performance[2]	Nonstructural Performance	Geotechnical Performance[3]	Safety Rating Definition	Rating
Rating Not Achievable	IO selection	IO	**No entrapment.**	★★★★★
IO	LS	LS[4]	**No injuries.**	★★★★
LS	LS selection S3	LS[4]	**No death.**	★★★
LS selection S2	LS selection S2	LS selection S2	**Death in isolated locations.**	★★
Less than LS selection S2			**Death in multiple or widespread locations.**	★

1 Structural, Nonstructural, and Geotechnical levels of performance must be satisfied to achieve rating. "Selection" indicates that some of the ASCE 31 criteria need not be met; the selection will be defined in the SEAONC rating instructions. Selection "S3," for example, indicates the particular selection of ASCE 31 issues required for a 3-star safety rating.
2 Includes performance of foundations
3 Refers to items from the Geologic Site Hazards Checklist (i.e. liquefaction, slope failure, and surface fault rupture)
4 Need not comply with liquefaction evaluation statement

ASCE 31-03 Translation: SAFETY



Definitions:

Structural Performance: Refers to items from the Basic Structural and Supplemental Structural checklists, including performance of foundation from the Geologic Site Hazard and Foundation checklist, as applicable. See ASCE 31 table 3-2.

Nonstructural Performance: Refers to items from the Basic Nonstructural, Intermediate Nonstructural and Supplemental Nonstructural checklists, as applicable. See ASCE 31

Geotechnical Performance: Refers to non-foundation items from the Geologic Site Hazard checklist. See ASCE 31 table 3-2.

Selection S2: Need not comply with: ….

Selection S3: Need not comply with: ….

Selection S4: Need not comply with: Liquefaction evaluation statement.

Mapping ASCE 31 Evaluation to a Repair Cost Rating

Structural Performance[2]	Nonstructural Performance	Geotechnical Performance[3]	Repair Cost Rating Definition	Rating
Rating Not Achievable			**Within Typical Operating Budget.**	★★★★★
Rating Not Achievable	IO	Rating Not Achievable	**Within Typical Insurance Deductible.**	★★★★
IO	IO	IO	**Within Industry SEL limit.**	★★★
LS	LS	LS	**Repairable Damage.**	★★
Less than LS			**Substantial Damage.**	★

1 Structural, Nonstructural, and Geotechnical levels of performance must be satisfied to achieve rating.
2 Includes performance of foundations
3 Refers to items from the Geologic Site Hazards Checklist (i.e. liquefaction, slope failure, and surface fault rupture)

Mapping ASCE 31 Evaluation to a Time to Regain Function Rating

Structural Performance[2]	Nonstructural Performance	Geotechnical Performance[3]	Time to Regain Function Rating Definition	Rating
Rating Not Achievable			**Within Hours.** .	★★★★★
IO	IO selection F4	IO	**Within Days.**	★★★★
IO selection F3	IO selection F3	LS	**Within Weeks.**	★★★
LS selection F2	LS	LS	**Within Months.** .	★★
Less than LS selection F2	Less than LS	Less than LS	**Within Years.**	★

1 Structural, Nonstructural, and Geotechnical levels of performance must be satisfied to achieve rating. "Selection" indicates that some of the ASCE 31 criteria need not be met; the selection will be defined in the SEAONC rating instructions. Selection "F3," for example, indicates the particular selection of ASCE 31 is required for a 3-star functionality rating.
2 Includes performance of foundations.
3 Refers to items from the Geologic Site Hazards Checklist (i.e. liquefaction, slope failure, and surface fau rupture).

ASCE 31 Evaluation

- Most effective approach to mapping ASCE 31 evaluation statements is to consider the damage and performance they generally suggest (not the worst or extreme case)
  - Duty of engineer/qualified person to understand interaction of non-compliant evaluation items and resolve them into a rating

Demand for Seismic Ratings

Top End Ratings	**Developers:** Owners of new buildings should want a rating for marketing purposes. They have spent money to meet current seismic standards and they are leasing against older buildings that do not measure up. **Major Tenants:** Major tenants want information on down-time as well as risks to life and contents. **Governments and Institutions:** Use ratings to reassure the electorate that funds are being well spent and employees that buildings are safe.

Demand for Seismic Ratings

Mid Range Ratings	**Lenders and Tenants:** Lenders and tenants will welcome this information as they make go/no go decisions

Demand for Seismic Ratings

Low End Ratings	**Cities and States:** Governing bodies could mandate ratings be obtained and disclosed for known classes of vulnerable or dangerous buildings. (A rating system designed for voluntary private use might need to be modified for application in these mandatory public contexts.)

Rating Validation

- Critically important to maintain high level of technical credibility
- Vision: independent non-profit organizations established by others to provide peer review and technical consistency
  - Accredit engineers to market and apply the SEAONC rating system
  - Example: LEED and its adoption by USGBC

Rating Validation

- SEAONC not expected to directly participate in review or accreditation
  - May review an application developed by non-profit to ensure that it follows SEAONC intent
  - Assures that independent organization claiming to use SEAONC rating system adheres to the established process
- In the future, may establish accreditation requirements for engineers and develop minimum peer review standards

Example Application:
Steel Braced Frame Office Building

<u>ASCE 31 Analysis</u>

- Structural - LS (some queries required Tier 2 analysis)
- Non-structural - LS with limited exceptions
- Geotechnical - LS

<u>Rating:</u>

Safety	★ ★ ★
Repair Cost	★ ★
Time to Re-Occupy	★★

Performance Level Mapping:

ASCE-31 Performance Level	*Rating Values:*	
Life Safety	Safety	★ ★ ★
	Repair Cost	★ ★
	Time to Regain Function	★ ★
Immediate Occupancy	Safety	★ ★ ★ ★
	Repair Cost	★ ★ ★
	Time to Regain Function	★ ★ ★ ★

Earthquake Performance Rating

- SEAONC Earthquake Performance Rating System
  - Safety
  - Repair Cost
  - Time to Regain Function

SEAONC EPRS – Ready to Reduce Seismic Risk

- Multiple dimensions
- Clear differentiations between ratings
- Utilizes existing evaluation methodology
- Higher ratings require more understanding – ignorance not rewarded
- Ratings readily comparable

Status

- Methodology to obtain earthquake performance ratings utilizing ASCE 31 has been completed
- Next step: publication of evaluation statements for ratings, along with application examples “Beta testing”
- Longer term: include mapping of other existing or new evaluation standards to ratings

Thanks

SEAONC Existing Buildings Committee – Building Ratings Subcommittee