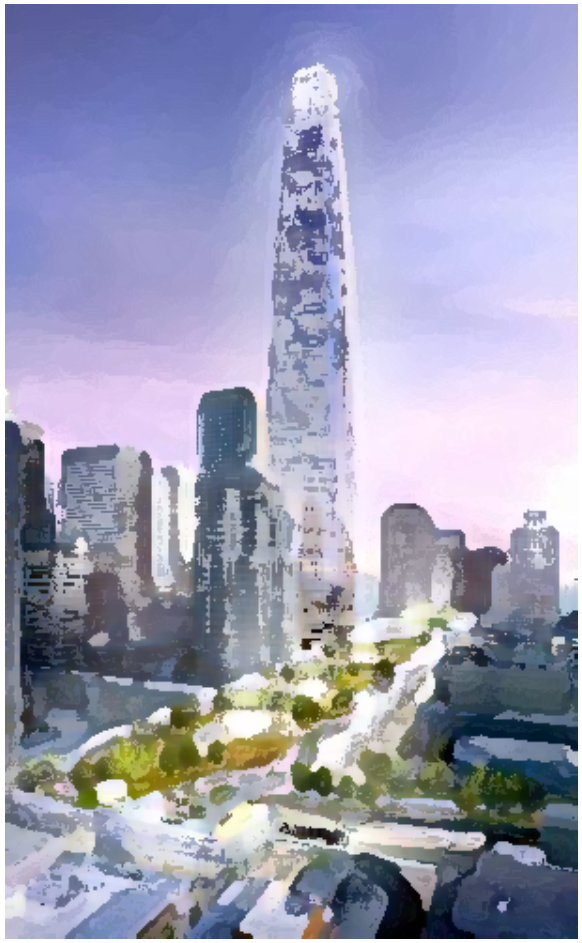
PEER Tall Building Seismic Design Guidelines



CB Crouse

Ron Hamburger

John Hooper

Jack Moehle

PEER

SEAW

November 30, 2010

Agenda

2:00 Jack Moehle will proved an overview of the PEER TBI project and the Guidelines that have been developed

2:30 C.B. Crouse will present the seismic hazard, ground motion, and SSFI aspects of the Guidelines

3:00 Break

3:15 Ron Hamburger will present the modeling, analysis, and acceptance criteria portions of the Guidelines

3:45 John Hooper will present the conceptual design recommendations and will present one of the design examples

4:15 Jack Moehle will present the cost implications for the design examples and will moderate the discussion

PEER

Purpose of this Meeting

- PEER Tall Buildings Initiative (TBI)
- TBI Guidelines
- Example designs
- Answer questions and solicit input
- Where to find the guidelines?
  - Go to PEER web site
  - Tall Buildings Initiative
  - Task 10

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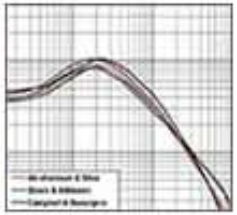
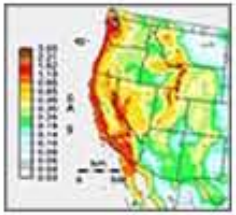
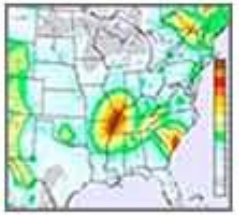
PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER

PEER Mega Research Programs





Latest News

More

- New publication posted: Modeling and Acceptance Criteria for Seismic Design and Analysis of Tall Buildings
- **Video now posted:** SEMM Seminar: Nanotechnology of Concrete: A Key Step in the Development of Sustainable Construction
- Testing for the Nonductile Concrete Grand Challenge Project gets media attention
- OpenSees Upgrades and launch on NEEShub
- Request for Proposals: PEER TSRP-2010-01
- Winners of PEER/NEES Concrete Column Blind Prediction Contest 2010

Upcoming Events

More

December 1, 2010

Imminent Danger: Earthquake Disaster and Risk Reduction in US Cities - Los Angeles, California

December 1-3, 2010

7th International Bridge Engineering Conference - Improving Reliability and Safety - Restoration, Renewal and Replacement - San Antonio, Texas

December 18-20, 2010

ISSE-11 - The 11th International Symposium on Structural Engineering -

Videos now posted

Briefing on New Zealand Canterbury (Darfield) Earthquake

Quake Summit 2010
NEES & PEER
shakingresearchforward
October 8-9, 2010
San Francisco, CA

Concrete Column Blind Prediction Contest 2010

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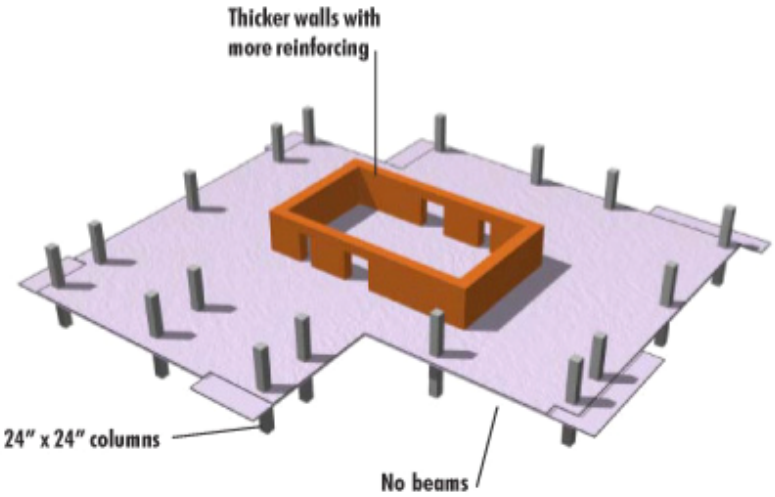
OpenSees

NISEE
NATIONAL INFORMATION SERVICE for EARTHQUAKE ENGINEERING

K-12 Education

Tall buildings circa 2005

- Surge in high-rise building construction
  - taller
  - new materials and systems
- Absent or inconsistent guidance
- Limited research



Tall Buildings Initiative (TBI)

- Purpose
  - Develop design criteria and guidance for the seismic design and review of tall buildings
- Tasks
  - Develop consensus on performance objectives
  - Ground motion selection and scaling
  - Soil-Foundation-Structure Interaction modeling
  - Modeling and acceptance criteria
  - Benchmark studies of building dynamic response
  - Guidelines development
  - Model building designs
  - Guidelines

TBI Partners

- Applied Technology Council
- California Geological Survey
- California Office of Emergency Services
- California Seismic Safety Commission
- FEMA
- Los Angeles Dept. of Buildings & Safety
- Los Angeles Tall Buildings Council
- National Science Foundation
- Pankow Foundation
- PEER
- San Francisco Building Department
- SCEC
- SEAoC
- USGS

TBI Guidelines

- Sponsor
  - Charles Pankow Foundation
- Development team
  - R. Hamburger, J. Moehle – Co-chairs
  - Y. Bozorgnia
  - C.B. Crouse
  - R. Klemencic
  - H. Krawinkler
  - J. Malley
  - F. Naeim
  - J. Stewart

TBI Guidelines Outline

1. Introduction
2. Performance objectives
3. Design process
4. Design criteria documentation
5. Seismic input
6. Preliminary design
7. Service level evaluation
8. MCE level evaluation
9. Presentation of results
10. Project review

1. Introduction

- Purpose
  - Recommended design criteria and procedures for individual tall buildings
  - Meet performance goals for Occupancy Category II Buildings
- Scope
  - Seismic structural design of tall buildings

1. Introduction

- Purpose
  - Recommended design criteria and procedures for individual tall buildings
  - Meet performance goals for Occupancy Category II Buildings
- Scope
  - Seismic structural design of tall buildings
  - Fundamental periods >> 1s
  - Significant mass participation and response in higher modes
  - Slender aspect ratio

1. Introduction

- Advantages
- Risks
- Qualifications
- Limitations

Danger –
Curves ahead!

2. Performance Objectives

- PEER 2008/101
  - Stakeholders for residential buildings
    - Concern about losing their investment and homes
    - Profess to be willing to pay for better performance
- Regardless…
  - Guidelines written to attain code objectives except:
    - control of residual drift limits
    - limited risk of cladding failure at MCE
    - discussion on how to achieve superior performance

2. Performance Objectives

- Primary Objectives
  - MCE - Low probability of collapse
  - DE – Low probability of life loss
  - Service level – Low probability of loss of use

SEAOC Vision 2000		Earthquake Performance Level			
		Fully Operational	**Operational**	**Life Safe**	**Near Collapse**
Earthquake Design Level	**Frequent** (43 years)	Basic Objective	Unacceptable	Unacceptable	Unacceptable
	Occasional (72 years)	Essential/Hazardous Objective	Basic Objective	Unacceptable	Unacceptable
	Rare (475 years)	Safety Critical Objective	Essential/Hazardous Objective	Basic Objective	Unacceptable
	Very Rare (~~975 years~~)MCE	Not Feasible	Safety Critical Objective	Essential/Hazardous Objective	Basic Objective

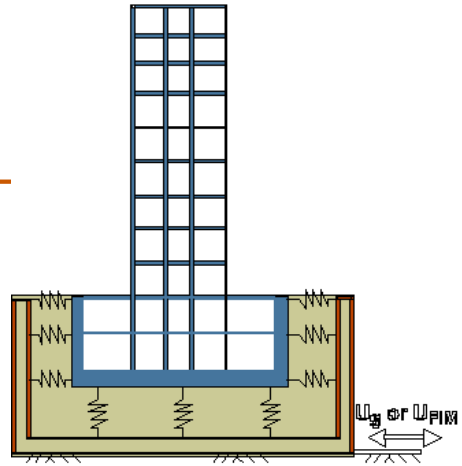
3. Design Process

1. Confirm approach acceptable
   - Building official
   - Development team
2. Establish performance objectives
3. Seismic input
4. Conceptual design
5. Design criteria document
6. Service level design
7. MCE level design
8. Final design
9. Peer review

4. Design Criteria Documentation

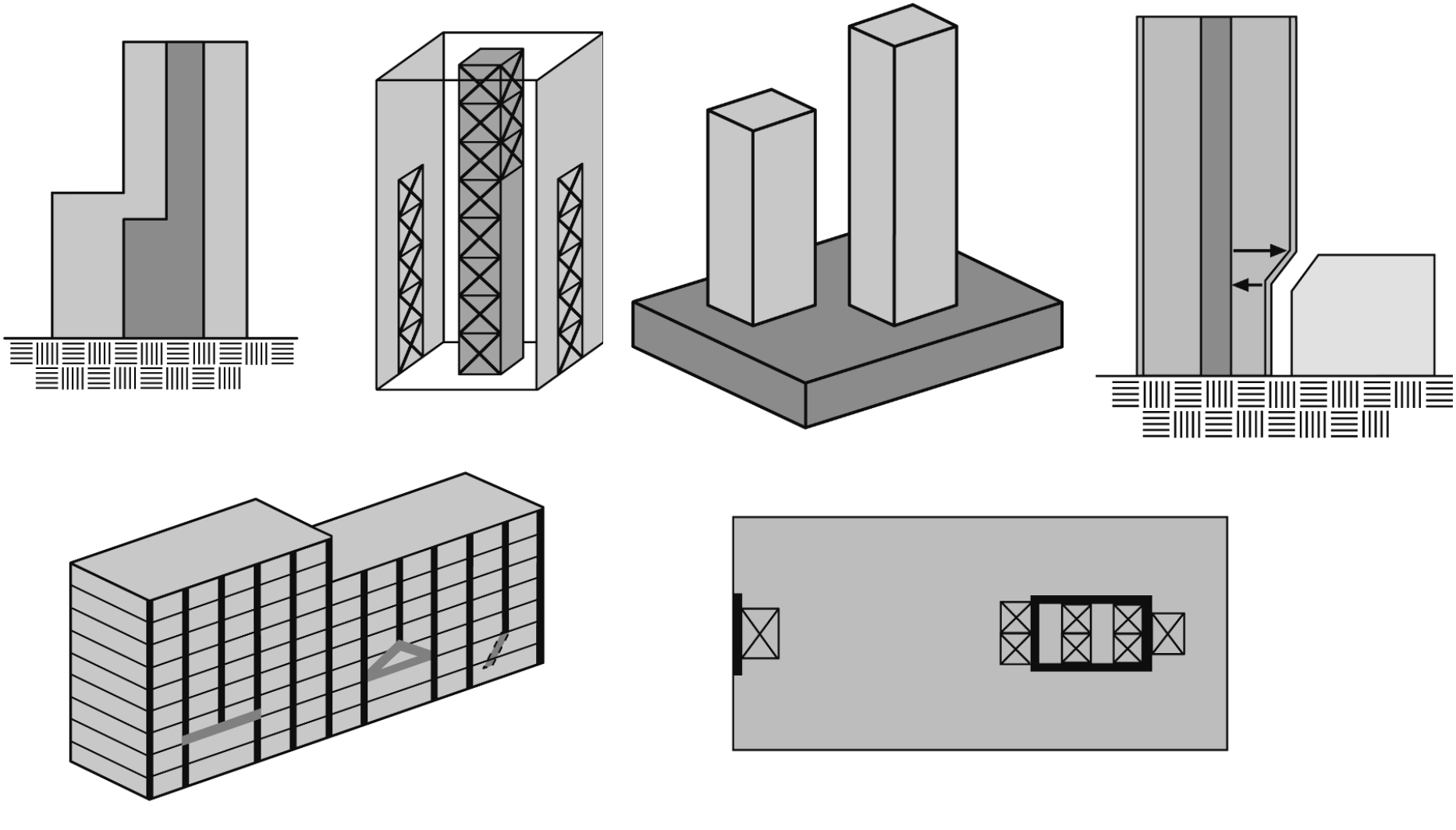
- Building & site description
- Performance Objectives
- Gravity Loading Criteria
- Seismic Hazards
- Wind Design
- Load Combinations
- Materials
- Analysis
  - Procedures
  - Modeling assumptions
  - Software
- Acceptance Criteria
- Test Data
- Appendices

5. Seismic Input



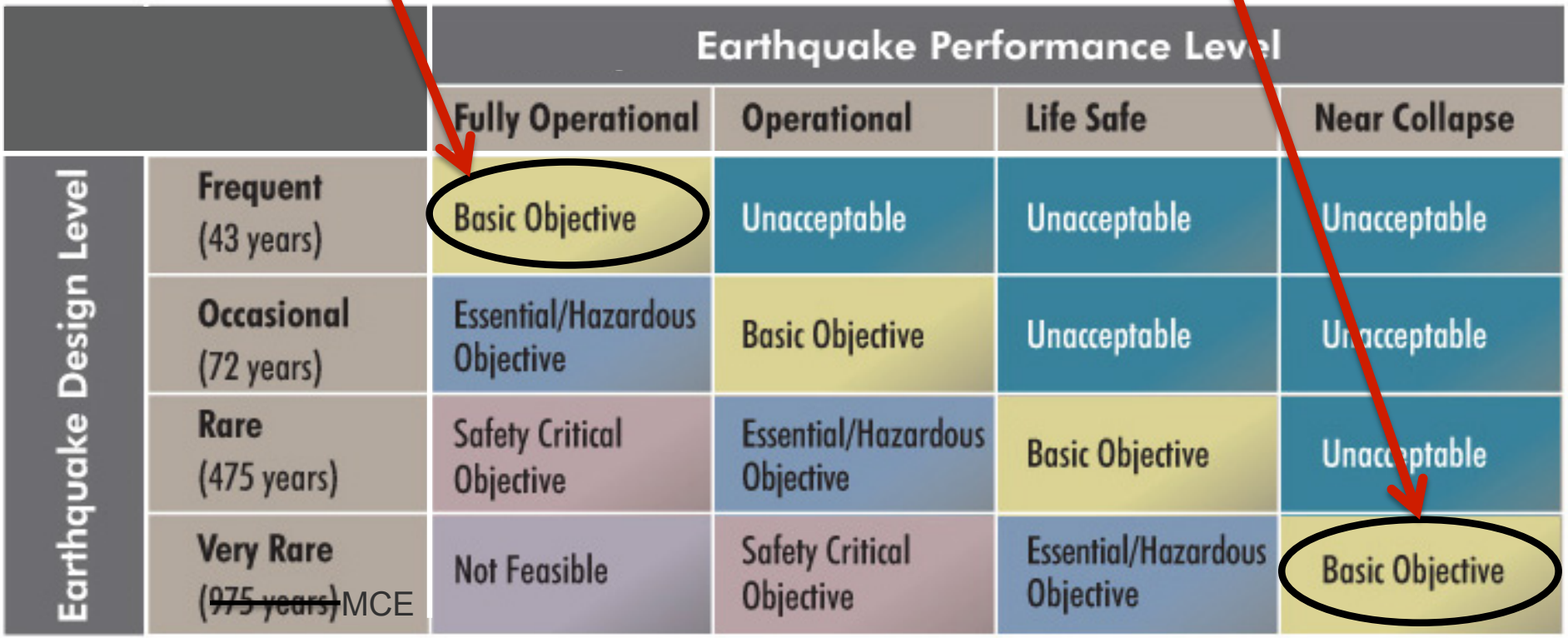
- Seismic Hazard Analysis
  - Probabilistic
  - Deterministic
  - Site-response analysis
- Selection and Scaling of Accelerograms
  - Identification of controlling seismic sources
  - Accelerogram selection guidelines
  - Accelerogram modifications
- Soil-Foundation-Structure Interaction
  - Kinematic
  - Inertial
  - Input motion

6. Preliminary Design



Chapter 7. Service-Level Evaluation

Chapter 8. Maximum Considered Shaking Evaluation



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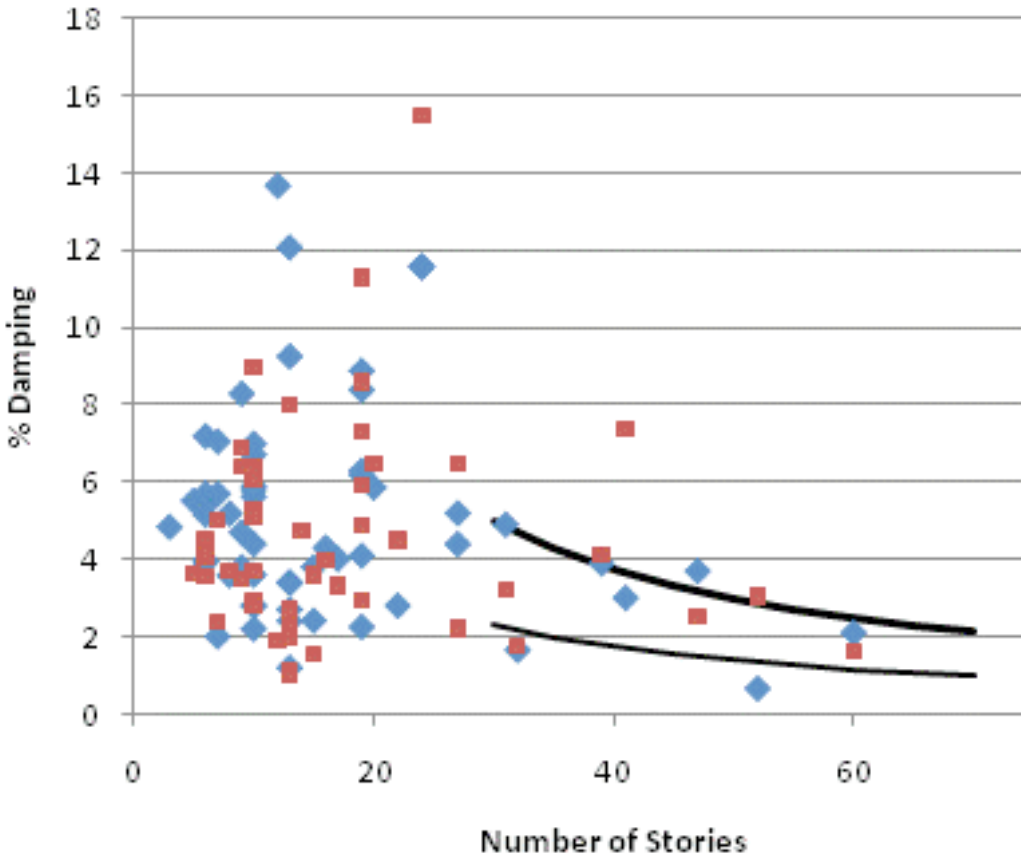
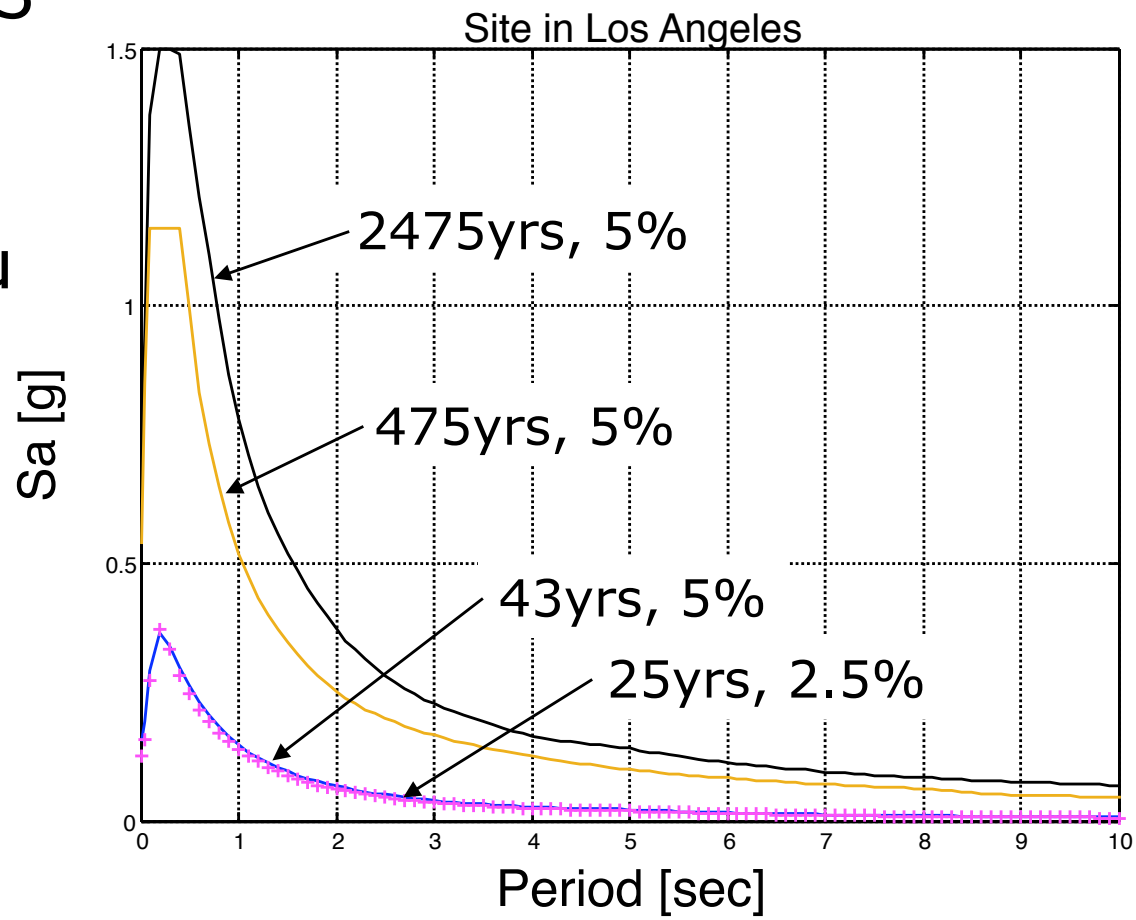
7. Service level evaluation

- ATC-72
  - Modeling Considerations
    - …
    - Damping
    - …

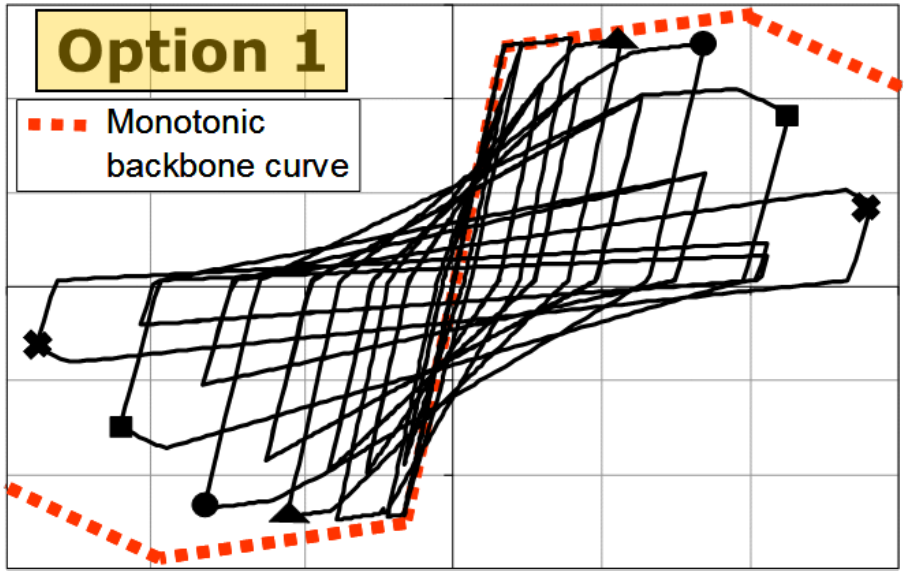


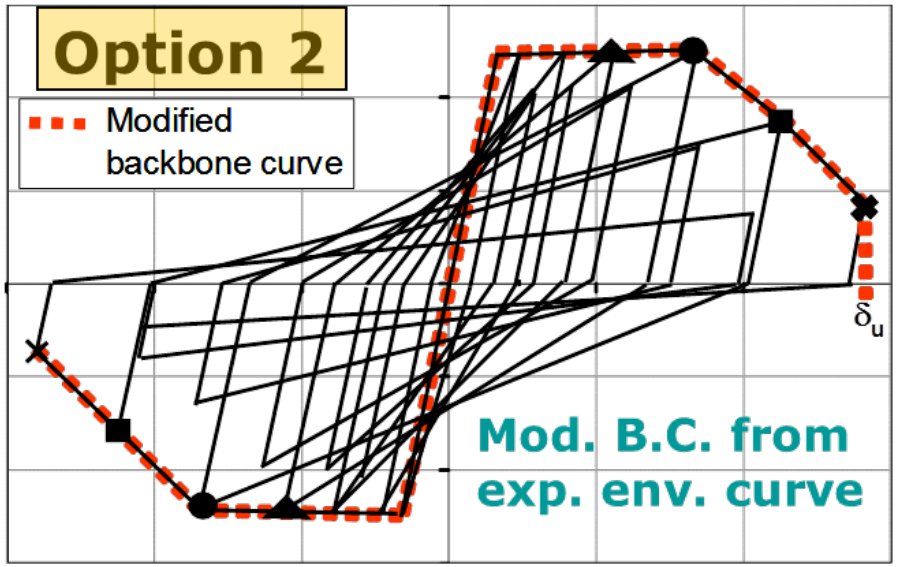
Service-level Earthquake Shaking

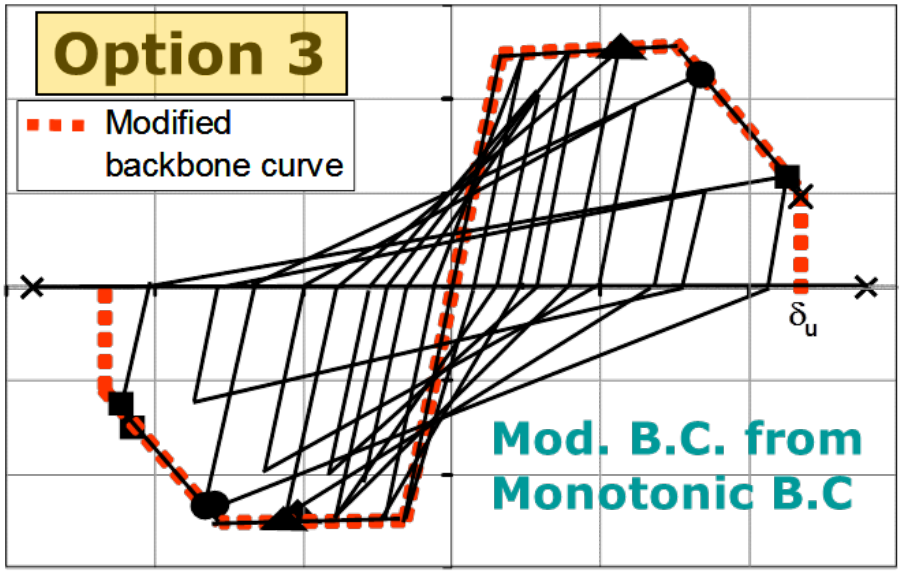
- Return period = 43 years
- Damping 2.5% of critical unless you can prove otherwise
- Acceptance

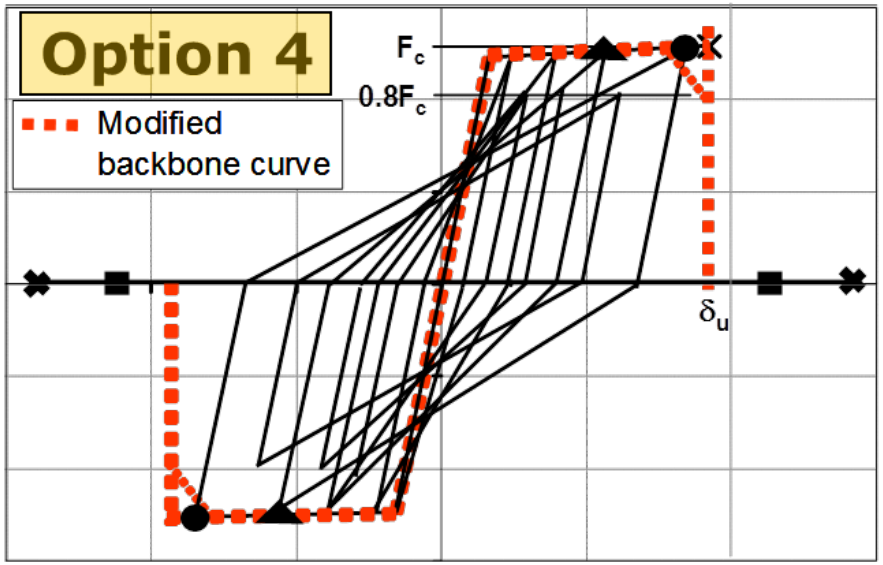


8. MCE-Level Evaluation









9. Presentation of Results

- Facilitate review
- Suggested items to include
- Level of detail left to individual designer and reviewers

10. Project Review