Acceptable Risk
Overview

This issue focuses on:

• 10% probability of “collapse” in the MCE\textsubscript{R}

• Absolute risk target of 1% “collapse” risk in 50 years where the probabilistic, risk targeted hazard parameters govern

• In regions where the deterministic hazard governs over the probabilistic, the absolute risk of collapse is greater than 1%
1976 UBC and previous

- Deliberate omission of “return period” or seismic hazard parameters
- SEAOC Blue Book explicitly points out desire to not specify a specific earthquake, but rather uses descriptors of moderate, major and most severe
- Based on Algermissen Maps
- Provide minimum design force of around 10% for “ductile” moment frame
ATC-3

- Provide equal probability throughout the country of design ground motion being exceeded
- If ground motion occurred “…there might be life threatening damage in 1 to 2 percent of buildings…”
- Did not explicitly specify a uniform hazard return period for design parameters
USGS Project 97 / 1997 NEHRP

- Uniform Risk MCE set at 2% probability of exceedance in 50 years
- 5% probability of exceedance in 50 years discussed, but not considered (previously used in Blue Book & CBC/UBC)
- Design Earthquake set at 2/3*MCE
- Intent clarified to prevent collapse in MCE, but some viewed as a change
SAC Project

• 90% confidence of a 10% Probability of Collapse given MCE shaking
• Recognition of uncertainty in component response, analytical procedures, and ground motion
FEMA P695

• Validate R-factors for 10% Probability of Collapse in MCE
Project 07 / 2009 NEHRP

• Change MCE from uniform risk of 2% in 50 year probability of exceedance (Project 97) to absolute risk of collapse 1% in 50 years

• MCE$_R$ return period now varies from 1,000 year to 3,000 year

• Deterministic caps still present, but increase mean plus 1-sigma from 1.5 to 1.8
Probabilistic Hazard
Collapse Risk w/ Uniform Hazard

Probability of Collapse in 50yrs

City Sequence #

Southern California
San Bernardino
Northridge
Riverside
Concord
San Mateo
San Jose
San Francisco
Santa Cruz
Vallejo
Santa Rosa
Seattle
Memphis

2%-50yr

0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
Collapse Risk of $\text{MCE}_R$

- City Sequence #
- Probability of Collapse in 50yrs
- Southern California
- Northridge
- Riverside
- San Bernardino
- Concord
- San Mateo
- Santa Cruz
- San Francisco
- Vallejo
- Oakland
- San Jose
- San Francisco
- San Jose
- Santa Cruz
- Sacramento
- Vallejo
- Concord
- San Mateo
- Northern California
- Intermountain
- Pacific NW
- CEUS
- Seattle
- Memphis
- Southern California
- Northridge
- Riverside
- San Bernardino
- Concord
- San Mateo
- Santa Cruz
- San Francisco
- Vallejo
- Oakland
- San Jose
- San Francisco
- San Jose
- Santa Cruz
- Sacramento
- Vallejo
- Concord
- San Mateo
- Northern California
- Intermountain
- Pacific NW
- CEUS
- Seattle
- Memphis

Building Seismic Safety Council

FEMA

USGS

National Institute of Building Sciences

An Authoritative Source of Innovative Solutions for the Built Environment
Deterministic Hazard
Map showing selected Southern California city sites used to compare MCE_R ground motions (and high slip rate WUS faults)

San Andreas Fault System

San Jacinto Fault System
De-aggregation of 2,475-year mean annual return period seismic hazard at the SCEC Riverside site - 1s response (USGS)
Comparison of Probabilistic and Deterministic MCE_R Response Spectra - SCEC Riverside Site

SCEC Riverside Site Response Spectra - Vs,30 = 1,200 fps (CD) - RotD100

- MCE Probabilistic - 2%-50yr Uniform Hazard
- MCEr Probabilistic - 1%-50yr Uniform Collapse Risk
- MCEr Deterministic - 'Lower-Limit' Ground Motions
- MCEr Deterministic - M7.8 84th %ile Ground Motions
- Median M7.8 Earthquake Ground Motions at Rx = 18 km

Probabilistic MCE_R ≈ 3 x median response of an M7.8 earthquake

Likely ground motions due to the next M7.8 earthquake on the San Jacinto Fault
Working Group Topics
• Should the Provisions stay with a uniform risk of collapse approach to defining maximum considered ground motions for design?

• Examine the difference between the risk provided by the probabilistic definition of MCE and the deterministic cap. Should the deterministic caps should be maintained?
• Is the conditional target of 10% probability of collapse given the MCE (however it is defined) appropriate?

• Do design provisions, such as maximum direction, skew the 90% conditional probability of collapse?
• If the committee agrees to recommend staying with a uniform risk of collapse to define the MCE, what should that global risk target be? Is 1% appropriate?

• If the group does not recommend staying with uniform risk, then what? Return to Uniform Hazard?

• Is 2/3 appropriate for design level?
Working Group Studies
• Evaluate 10% probability of collapse in MCE
• Determine absolute risk of “collapse” for 2,500 year; 1,500 year; 1,000 year; deterministic caps only; ‘94 UBC deterministic lower bound
• Evaluate effect changing 10% conditional probability in MCE changes absolute risk of collapse for aforementioned hazards
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Questions