

Project 17

Development of Next-Generation Seismic Design Value Maps

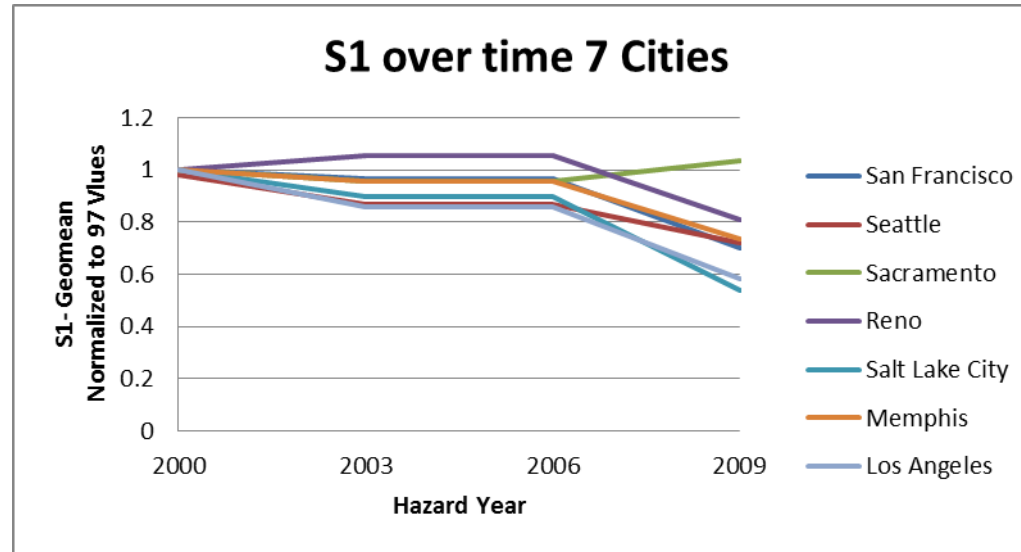
COSMOS Annual Meeting
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Project 17 Committee

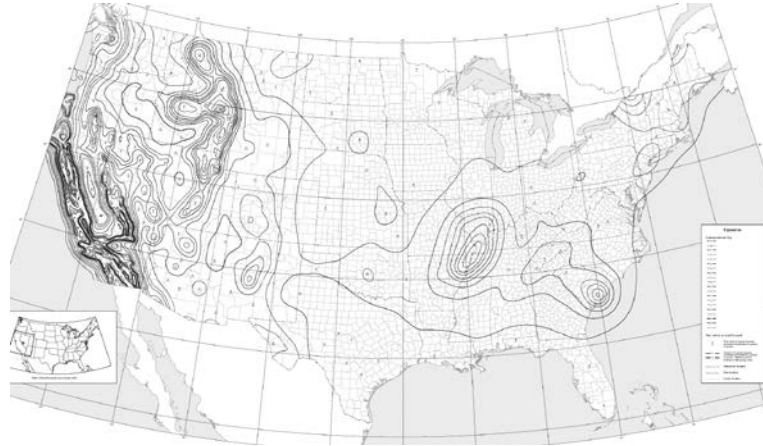
- Structural Engineering
 - David Bonneville
 - Dan Dolan
 - Julie Furr
 - Ronald Hamburger
 - James Harris
 - Jon Heintz
 - William Holmes
 - John Hooper
 - Charles Kircher
 - Robert Pekelnicky
 - Geotechnical and Seismology
 - C.B. Crouse
 - Nico Luco
 - Sanaz Rezaeian
 - Jonathan Stewart
 - Regulatory
 - John Siu
- Mai Tong - Robert Hanson - Phillip Schneider - Jiqu Yuan

Map Instability



- From edition to edition, mapped values first rise than fall, then rise again
- Creates lack of confidence in design community
- Results in vastly different code requirements from design edition to design edition

Maps in the Design Process



- Maps provide MCE_R acceleration values on reference Site Class
- Converted to site-adjusted design values S_{DS} , S_{D1}
- Site adjusted values used to determine:
 - Required strength
 - Seismic Design Category
 - Permissible structural systems
 - **Required detailing**
 - **Need for nonstructural mitigation measures**

Project Purpose

- Develop consensus among the structural, geotechnical engineering and earth science communities
- Basis for next-generation seismic design value maps :
 - 2020 NEHRP Provisions
 - ASCE 7-22
 - IBC-2024

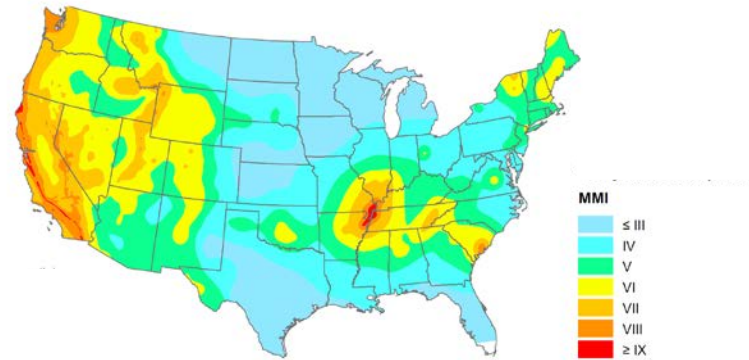
Major Goals

- Address issues of map “instability”
 - Map Precision v. Uncertainty
- Evaluate risk basis for maps
- Deal with “Characteristic Earthquake” definition for deterministic caps
- Fix problem with site coefficients on soft soil sites

Map Instability

- Use broad zones with fixed values
 - Enables more appropriate representation of precision
 - Results in stepped values from zone to zone
 - Zones would still shift as the science changes
- Average mapped values over several cycles
 - Would force changes in values to occur more slowly
 - If changes in science are well founded, maps will eventually pick up the increase or decrease
 - If science remains erratic, this will dampen out

Map Instability

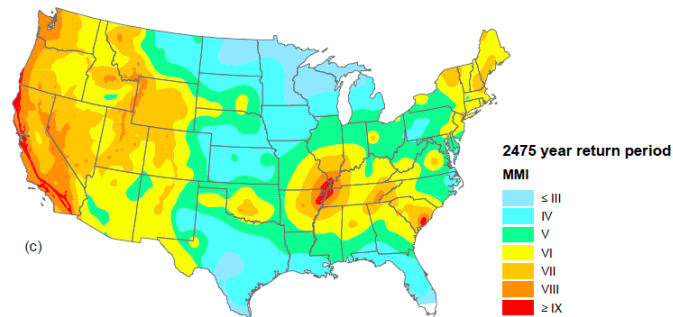
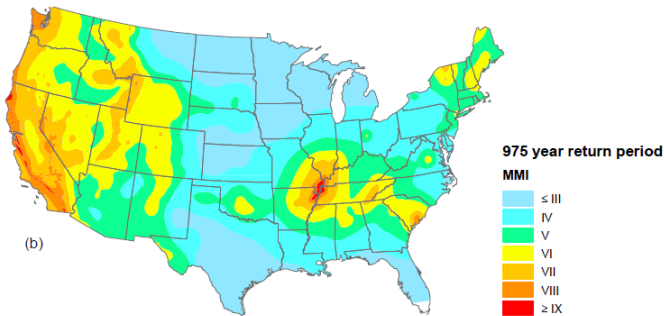
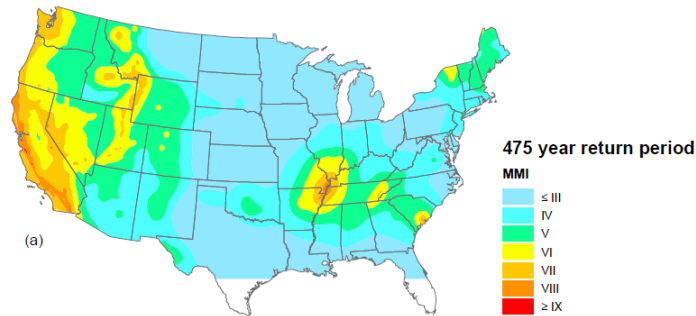


- Instead of tying Seismic Design Category to S_{DS} , S_{D1} , link to MCE MMI on reference site
- Consider reducing number of SDCs and making requirements more uniform
- Reduced precision will result in excessive criteria for some structures

Acceptable Risk

- Goal: Avoid future U.S. urban disasters (like the 1988 Leninakan, Armenia event) for scenarios that can reasonably be expected to occur
 - Originally 475 year hazard was used
 - Not capable of accomplishing the goal
 - In 2000, shift to 2,475 year hazard to capture New Madrid events (based on 1990s opinions)
 - Incorporated deterministic caps based on “Characteristic earthquake”
 - In 2007, shift to “uniform collapse risk” of 1%-50 years
 - Maintained “Characteristic earthquake”

Acceptable Risk



- Definition of acceptable risk significantly effects design requirements
- MCE Return periods on order of 1,000 to 1,500 years could avoid need for deterministic caps while allowing more uniform representation of risk across the U.S.

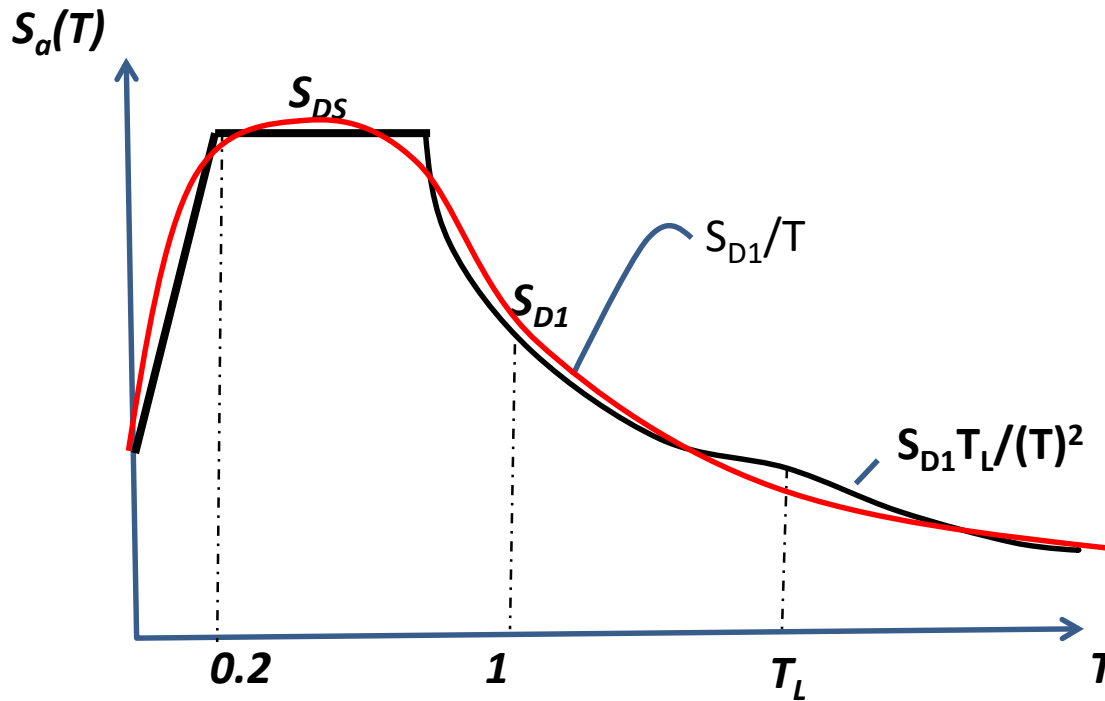
Deterministic Earthquakes

- Follow on to UCERF3
 - Removed concept of “characteristic” earthquakes
- Task is dependent on definition of acceptable risk, and whether it is necessary to “cap” probabilistic motions
- Will likely involve disaggregation of hazard to evaluate dominant sources, and reducing ϵ to comfortable levels

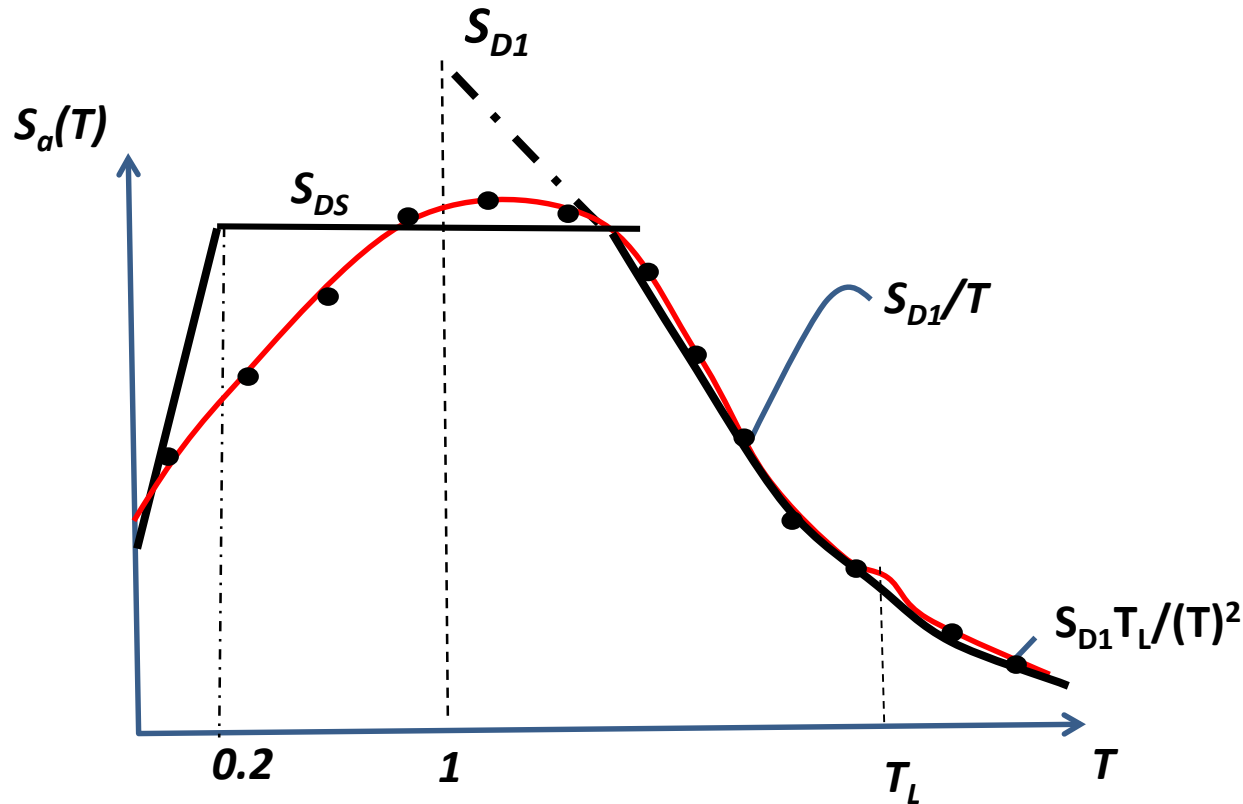
Multi-Point Spectra

- Follow on to 2015 NERHP Provisions
 - Inability of three parameter (SDS, SD1, TL) generated spectrum to capture true spectral shape for softer sites and large magnitude events

Classical Spectrum



Multi-point Spectrum



- F_a and F_v no longer used, soil class used directly in hazard analysis
- S_{DS} taken as 90% of max spectral response
- S_{D1} selected, so as to fit the spectral shape

Some Big Questions

- Do we have the courage to make major changes, if this seems appropriate or are we going to “buff up” the existing hazard?
- Since we don’t believe risk is as high as the commentary indicates (1%-50 years) how do we admit this without losing credibility?
- Can / should we separate Seismic Design Category & Detailing from the design values?

Your Questions?



FEMA

