

ASCE 4/43 – Integration of ASCE-4 Seismic Analysis Requirements with ASCE 43 Performance Based Design

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The Earthquake Resilience of Nuclear Facilities**

ASCE 43

Performance Based Design

- Objective:
 - Probability of exceeding limit state \leq Target Performance Goal
 - Limit States:



- Performance Goals, Annual Probability of Exceedance

$$\begin{array}{c} \text{SDC-3} \\ P_F \leq 1 \times 10^{-4} \end{array}$$

$$\begin{array}{c} \text{SDC-4} \\ P_F \leq 4 \times 10^{-4} \end{array}$$

$$\begin{array}{c} \text{SDC-5} \\ P_F \leq 1 \times 10^{-5} \end{array}$$

ASCE 43

Performance Based Design

$$C \geq D_{NS} + \frac{E}{F_{\mu}}$$

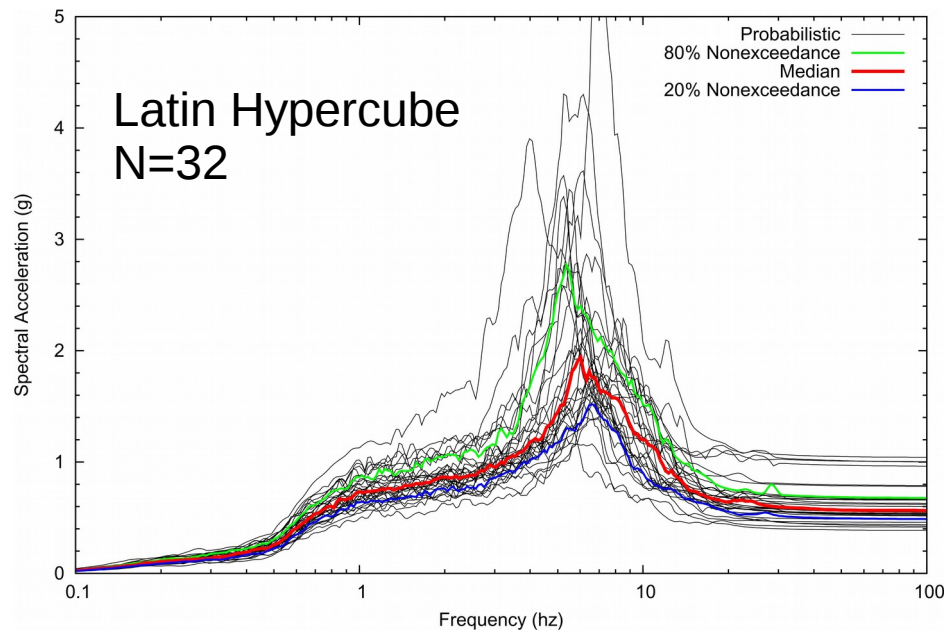
- C 98% EP capacity
- D_{NS} Median non-seismic demand
- E 80% NEP seismic demand
 - Median seismic input \times SF
- F_{μ} 95% EP inelastic factor
 - Limit state dependent

ASCE 4-2016

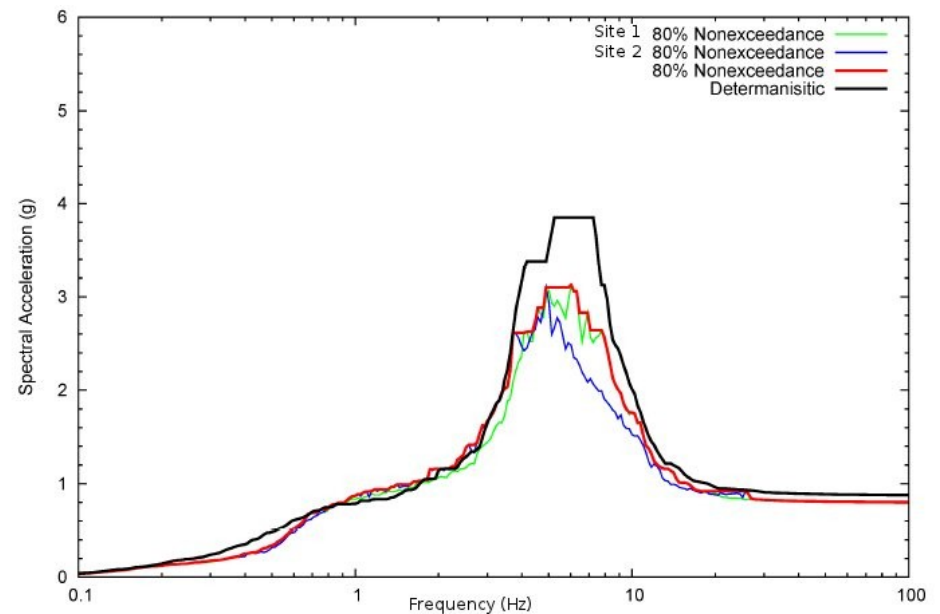
- Probabilistic SSI Analysis
 - Explicitly account for uncertainty
 - Stiffness and damping
 - Soil properties
 - Input motion
 - Analysis
 - Monte Carlo, $N \geq 200$
 - Latin Hypercube, $N \geq 30$
 - Extract results at the 80% NEP

Probabilistic SSI Example

- Probabilistic Spectra for one node



- Envelop Roof Spectra



Observations:

- 80% EP Probabilistic spectra generally > Deterministic spectra for elevated slabs
- Basemat spectra can be slightly unconservative

ASCE 4 Deterministic SSI

- Median Centered SSI Analysis
 - Add conservatism thru treatment of uncertainties
 - Envelop LB, BE and UB Soil Cases
 - Broaden Spectra
- Generally provides 80% NEP demands
 - Basemat spectra can be slightly unconservative
- Supports ASCE 43 target performance goals