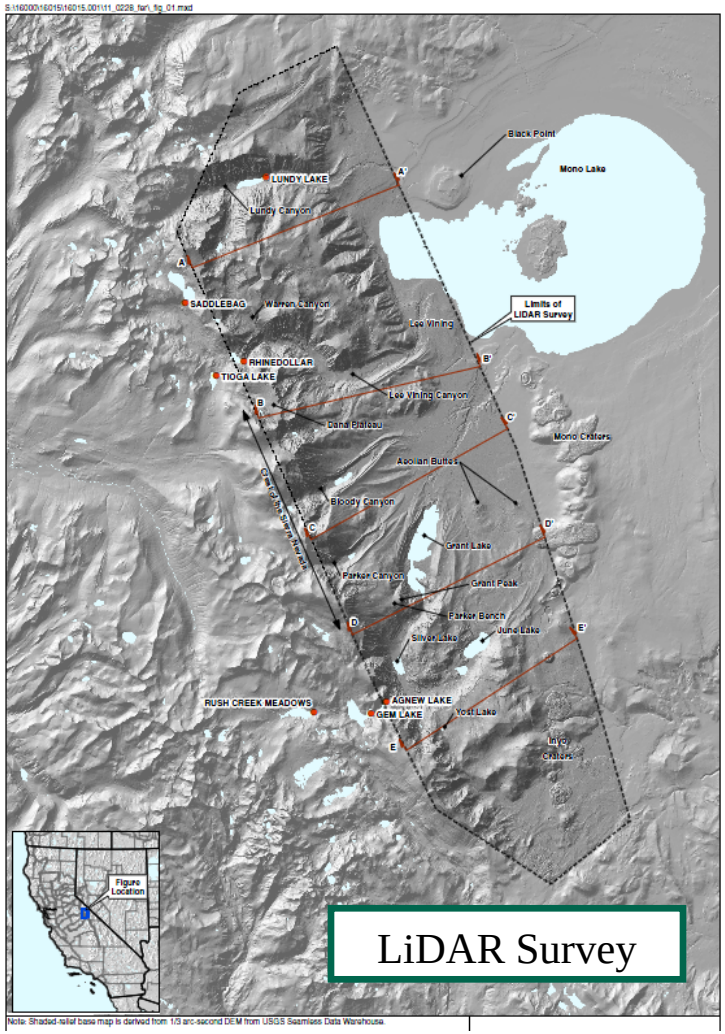
Seismic Fragility Studies of SCE Dams

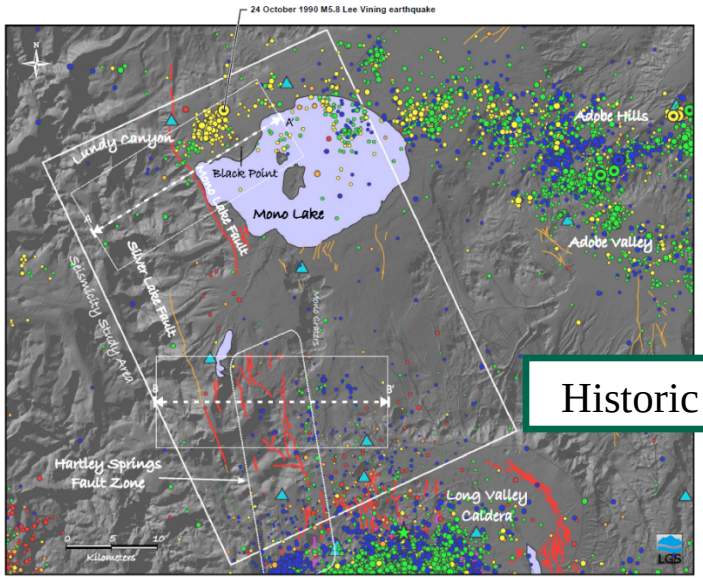
Dr. Matthew Muto
Nicolas von Gersdorff
Dam Safety Engineering
Southern California Edison

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

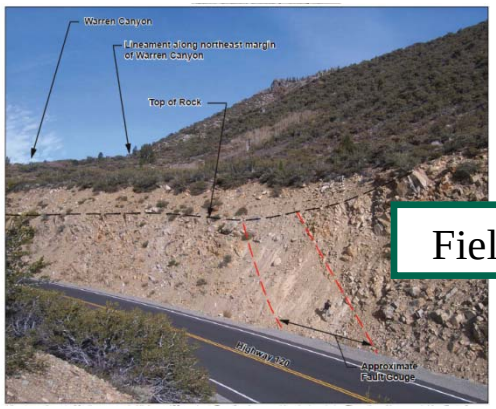
Understanding Our Seismic Setting



LiDAR Survey



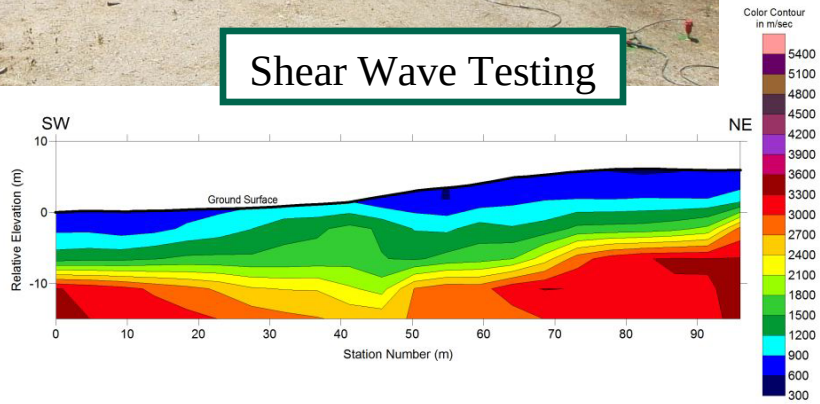
Historic Seismicity



Field Observations

Understanding Our Sites

Shear Wave Testing

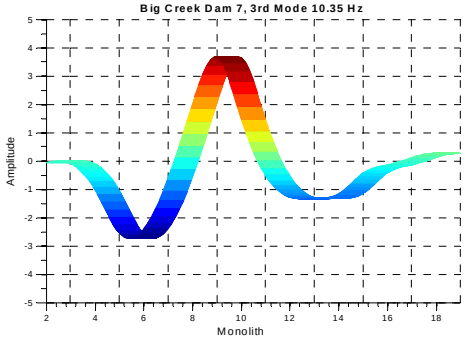


Boreholes

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

Understanding Our Structures

Forced and Ambient Vibration



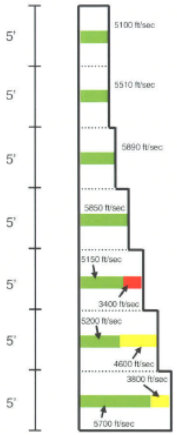


Figure D8: SASW Station #8

SASW and Acoustic Tomography

Coring

Deterministic – The MCE

- What is the shaking at the site of interest for a SPECIFIC earthquake on a SPECIFIC fault?

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

Deterministic – The MCE

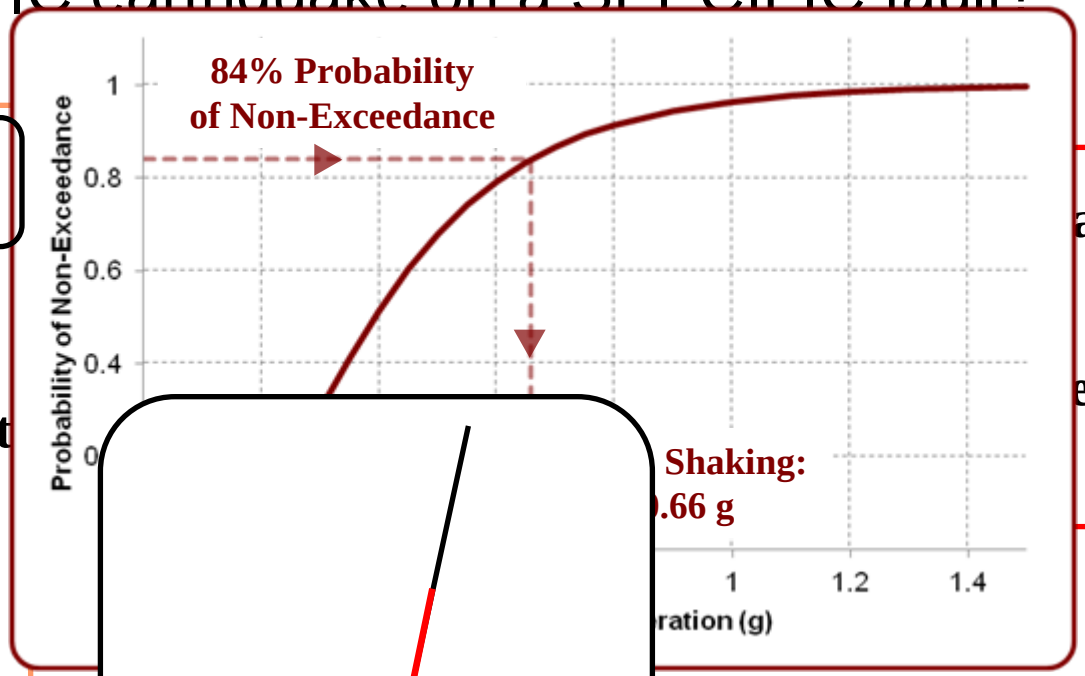
- What is the shaking at the site of interest for a SPECIFIC earthquake on a SPECIFIC fault?

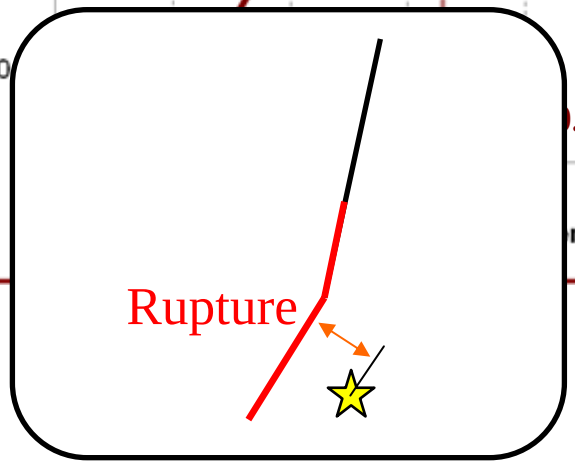
Magnitude
6.5

Distance
5 km

Type of Fault
Normal

Site Soil
Rock





an PGA (μ)
0.39 g

ertainty (σ)
0.52

Non-Exceedence Curve

Probabilistic – The Hazard Curve

- At the site of interest what is the PROBABILITY that a certain level of shaking is EXCEEDED due to a set of POTENTIAL seismic sources?

Probabilistic – The Hazard Curve

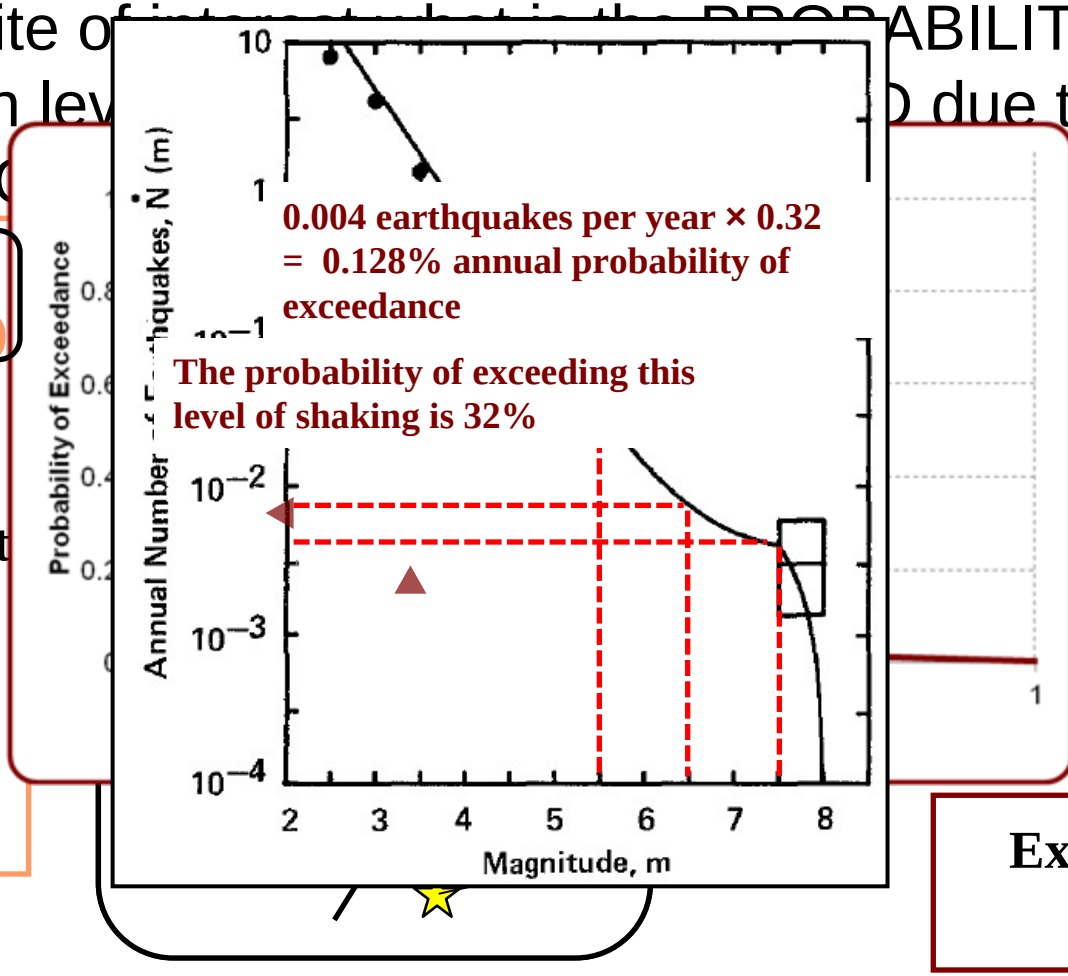
- At the site of ... ABILITY that a certain lev... due to a set of PG...

Magnitude
7.5 (0.006/yr)

Distance
10 km

Type of Fault
Normal

Site Soil
Rock



...an PGA (μ)
0.25 g

...ertainty (σ)
0.5

Exceedence Curve

Probabilistic – The Hazard Curve

- At the site of interest what is the PROBABILITY that a certain level of shaking is EXCEEDED due to a set of POTENTIAL seismic sources?

Magnitude
7.5 (0.004/yr)
Distance
10 km
Type of Fault
Normal
Site Soil
Rock

→

Ground Motion Prediction Equation
Boore and Atkinson (2008)

→

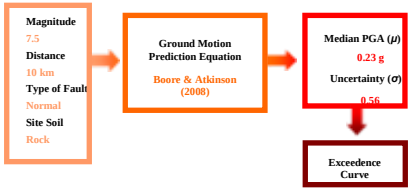
Median PGA (μ)
0.23 g
Uncertainty (σ)
0.56

↓

Exceedence Curve

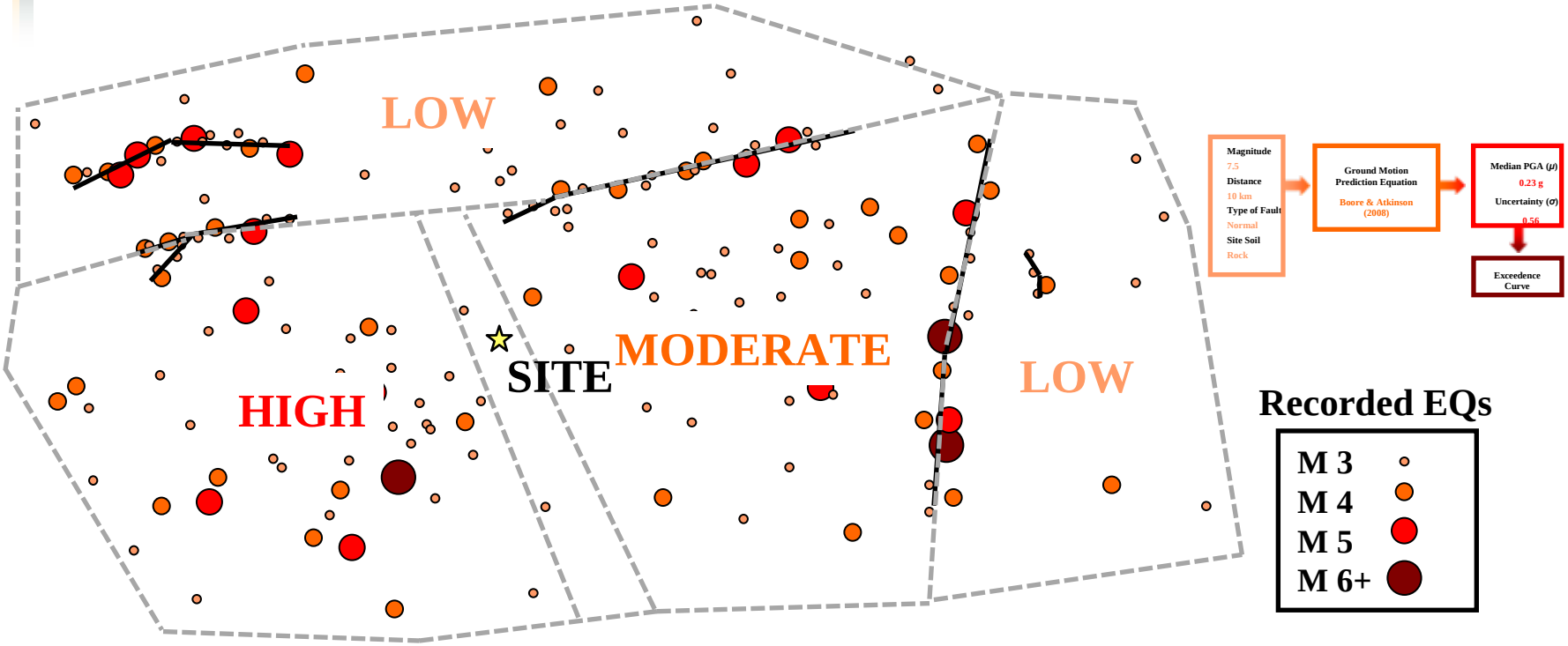
Probabilistic – The Hazard Curve

- At the site of interest what is the PROBABILITY that a certain level of shaking is EXCEEDED due to a set of POTENTIAL seismic sources?



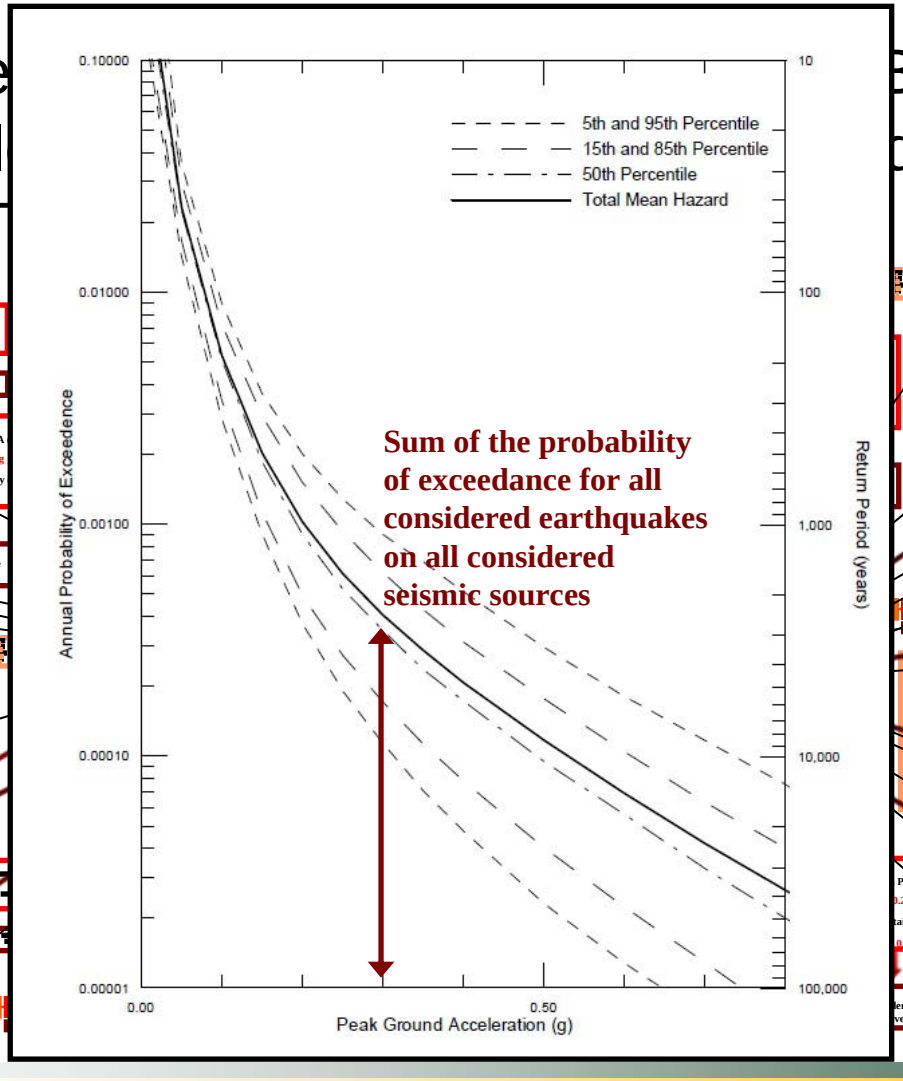
Probabilistic – The Hazard Curve

- At the site of interest what is the PROBABILITY that a certain level of shaking is EXCEEDED due to a set of POTENTIAL seismic sources?



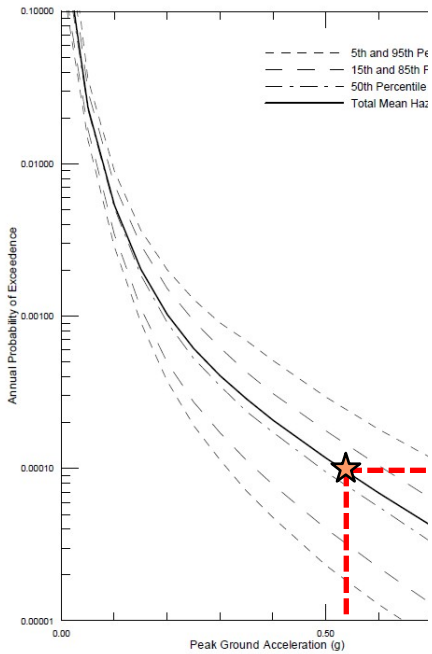
Probabilistic – The Hazard Curve

- At the site BILITY that a certain l due to a set of PO

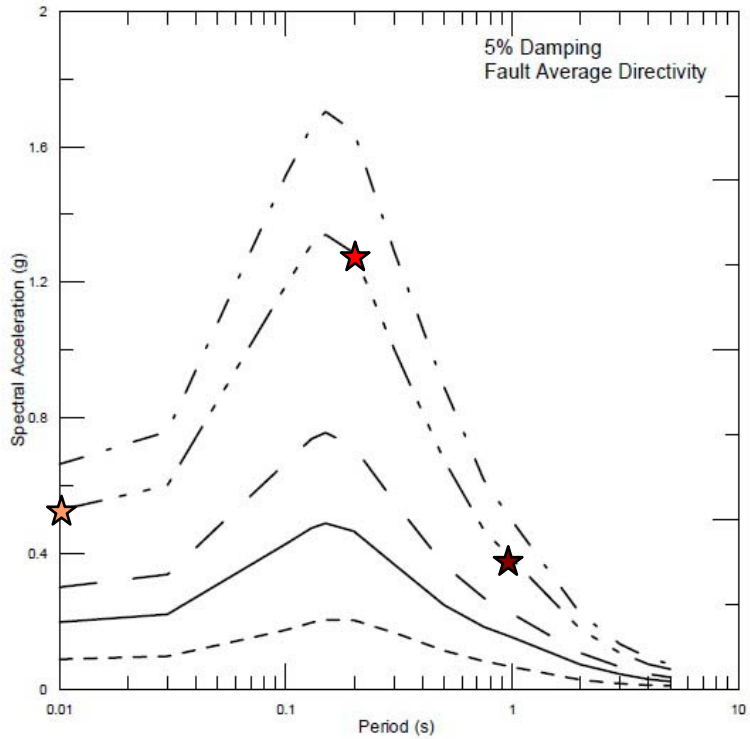


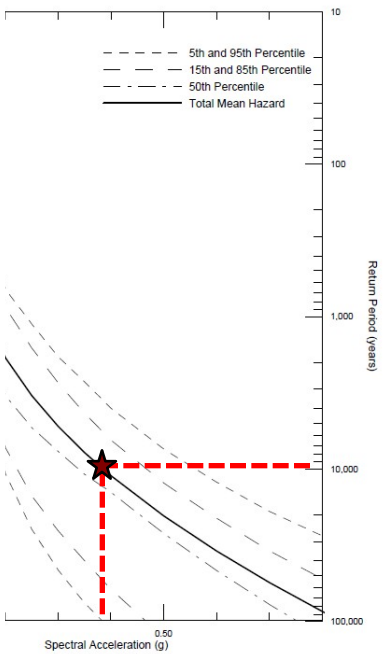
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

Probabilistic Hazard Spectra



PGA

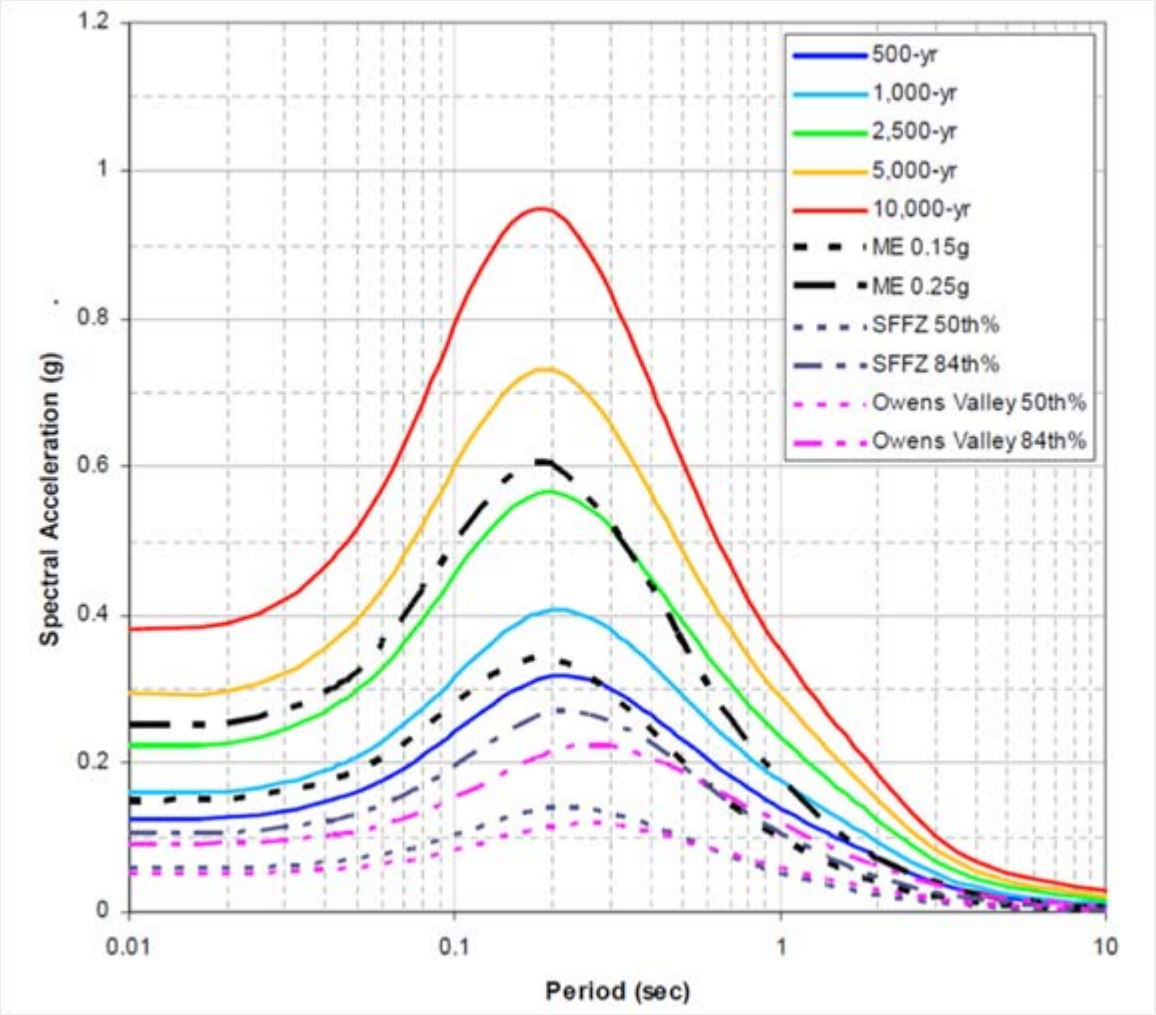




S_a T=1 s

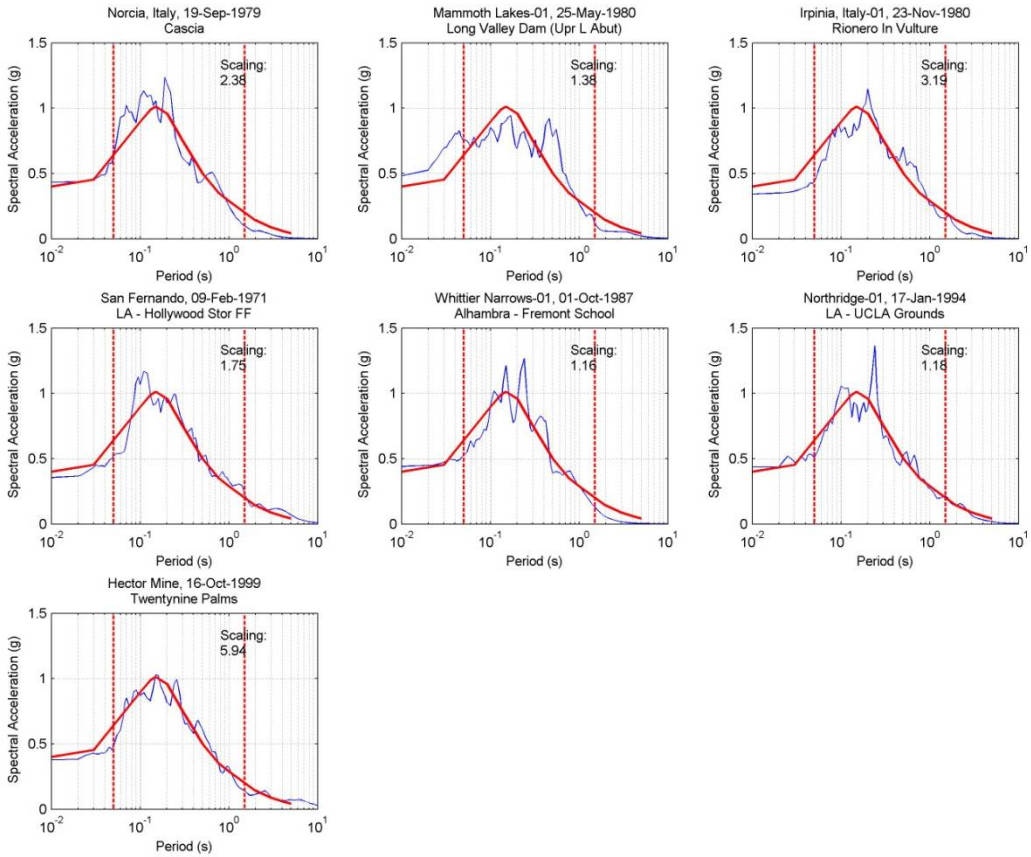
144-YEAR RETURN PERIOD
950-YEAR RETURN PERIOD
2,475-YEAR RETURN PERIOD
10,000-YEAR RETURN PERIOD
50,000-YEAR RETURN PERIOD

Probabilistic Hazard Spectra



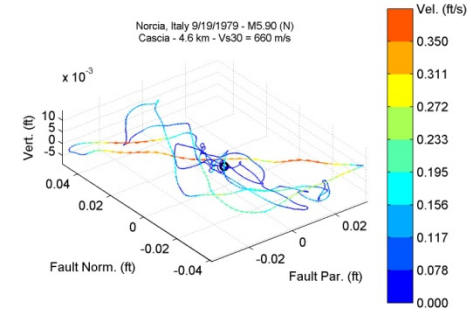
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

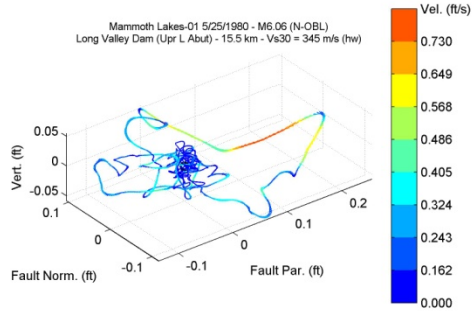
Time History Selection

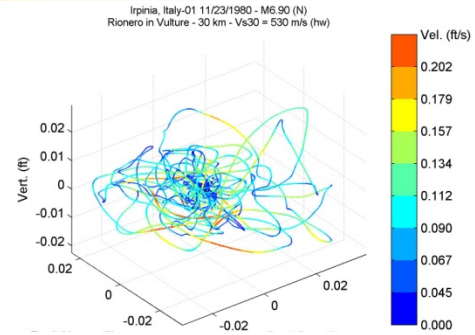


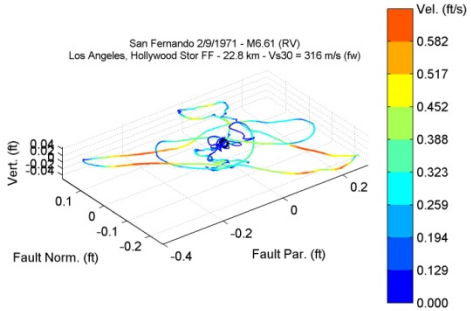
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL℠ Company

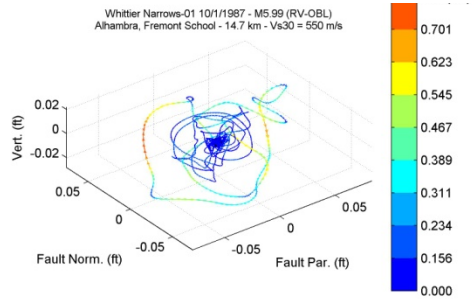
Time History Selection

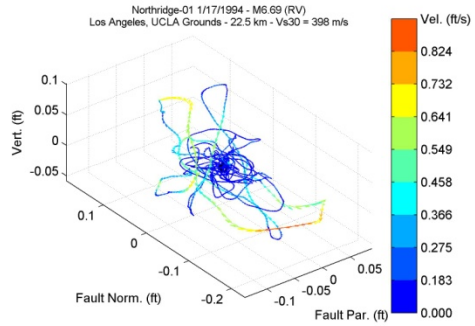


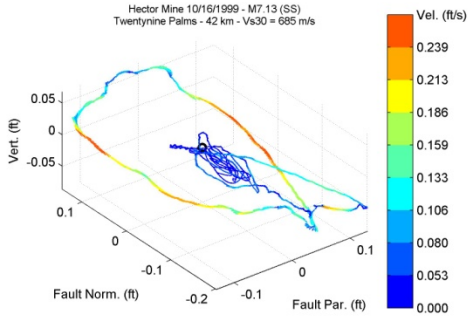












Structural Analysis

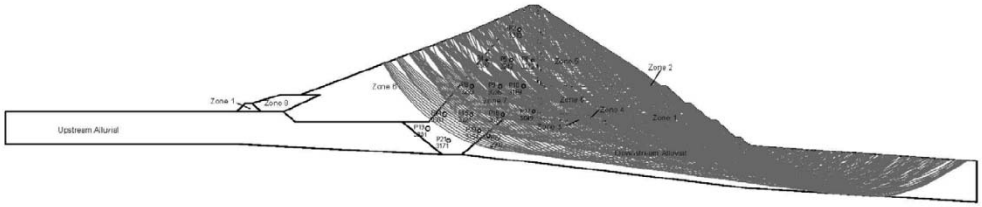
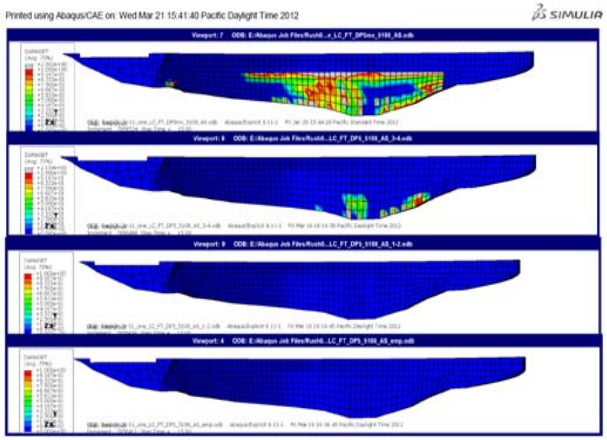
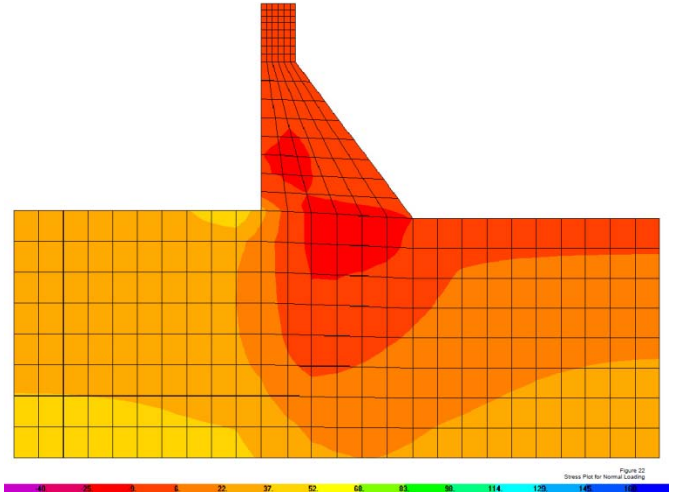
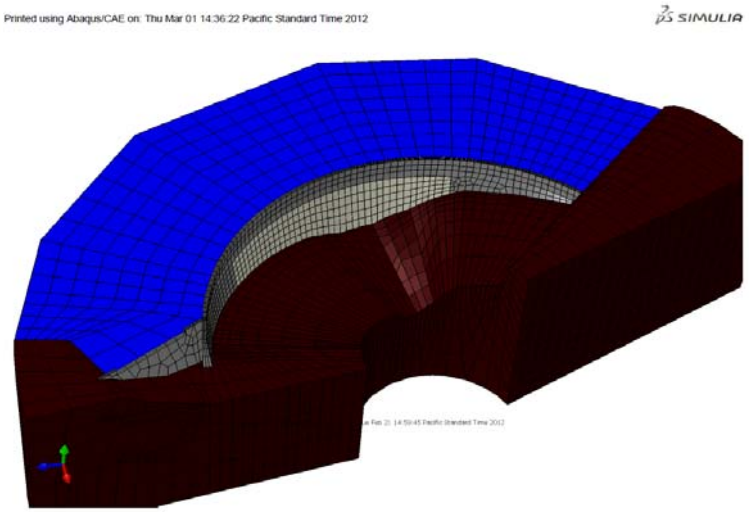


FIGURE 13
POTENTIAL SLIP SURFACES SEARCHED IN NEWMARK SLIDING BLOCK ANALYSIS







Fragility Curve

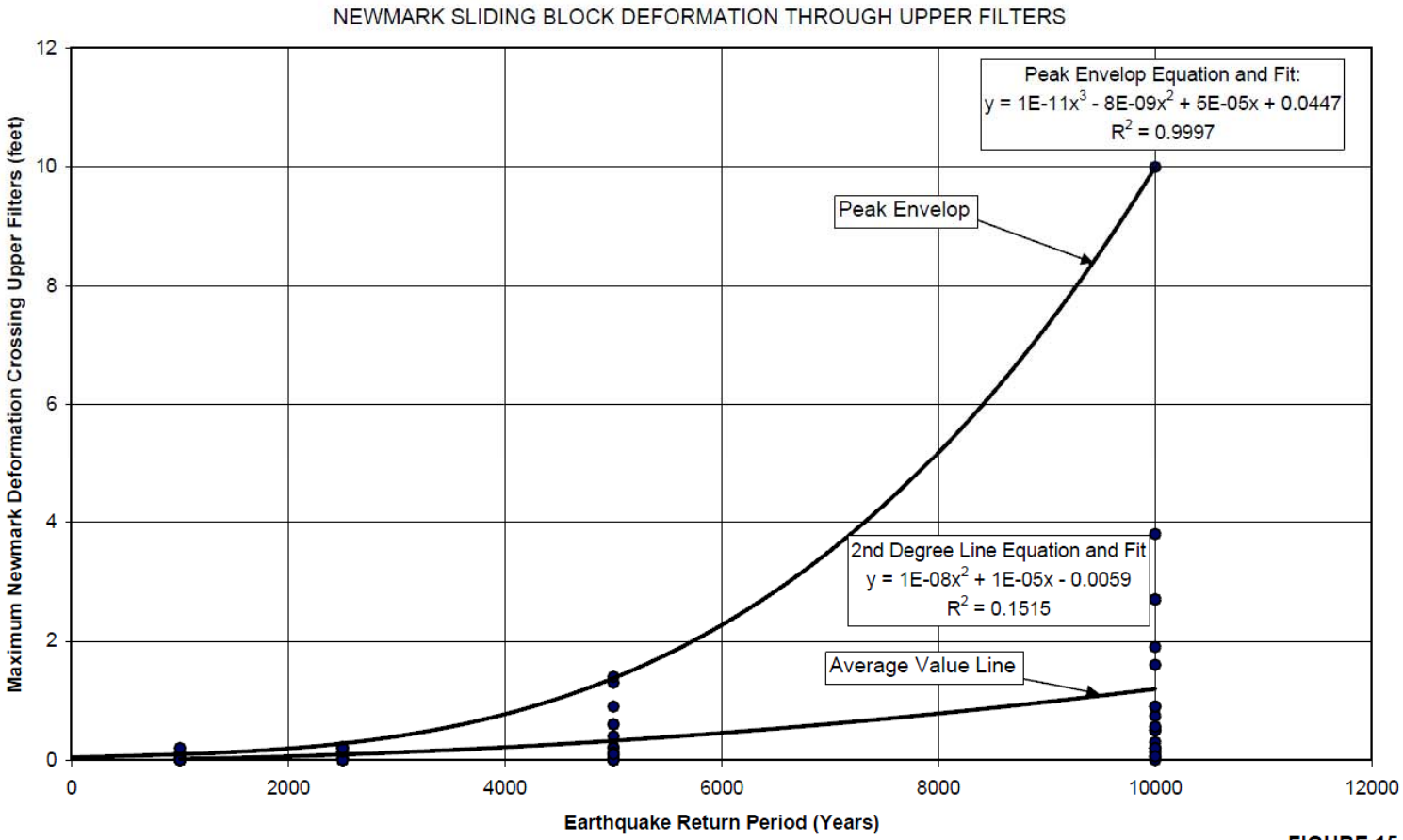
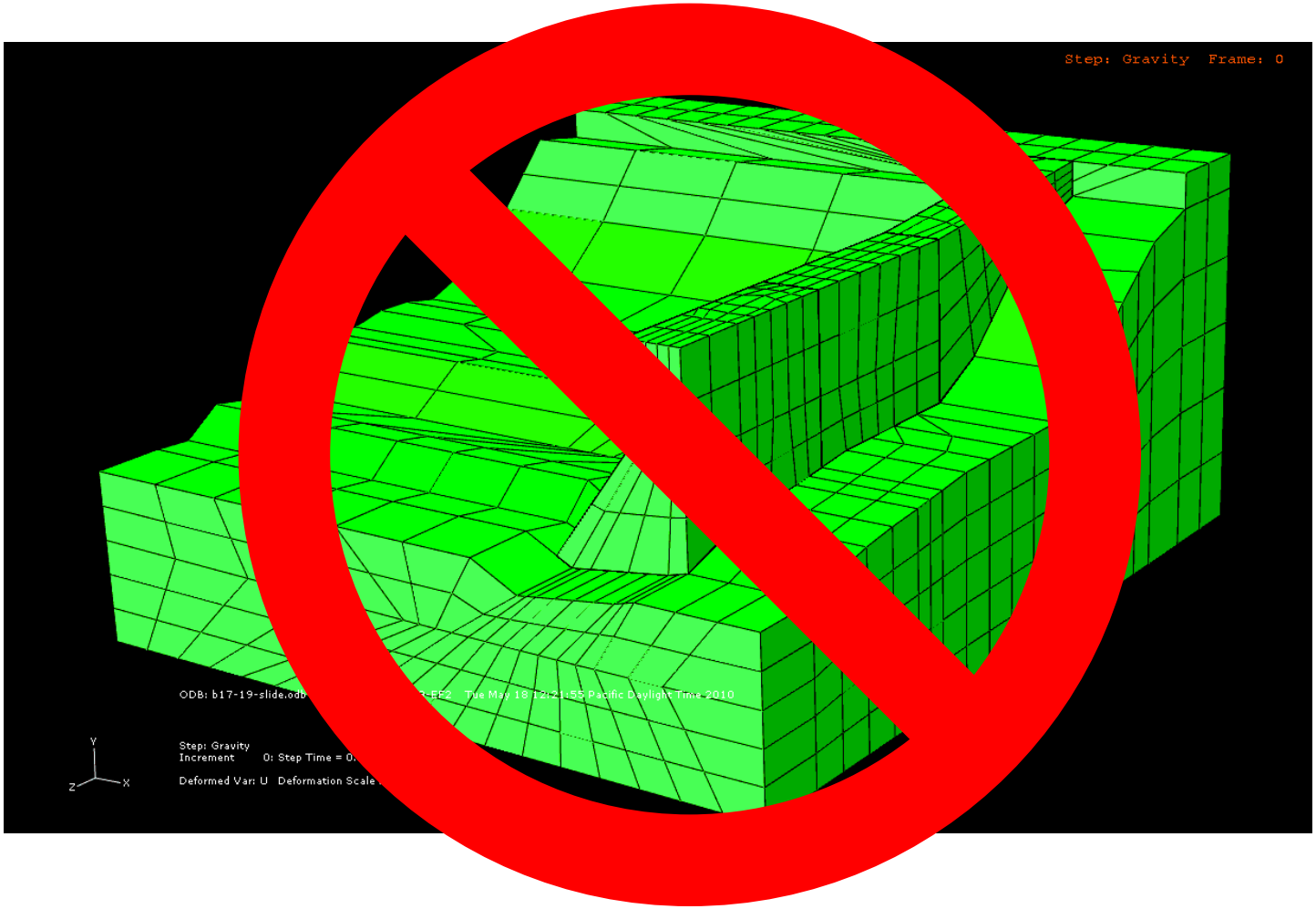


FIGURE 15
CROSS CREST DEFORMATION VERSUS RETURN PERIOD FROM ALL NEWMARK ANALYSES

From Numerical Models to Failure?



Contact Information

- Dr. Matthew Muto
  - Matthew.muto@sce.com
- Nicolas von Gersdorff
  - Nicolas.von@sce.com