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TWO-DIMENSIONAL SEISMIC SITE RESPONSE ANALYSIS FOR SMITH RIVER BRIDGE REPLACEMENT

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September 9 – 11, 2015
Reno, Nevada

Acknowledgments

- Xing Zheng, Caltrans
- Anoosh Shamsabadi, Caltrans
- James Gingery, Kleinfelder
- John Liao, Kleinfelder

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Smith River (Dr. Fine) Bridge Replacement

- Introduction
- Seismic Setting and Field Investigation
- Seismic Hazard Analysis
- Time Histories
- Site Response Analysis
  - 1D
  - 2D
- Results

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Smith River (Dr. Fine) Bridge Replacement

- Located in Del Norte County
- 1,000 feet long existing bridge with 2 abutments and 17 piers
- Replaced with 1,000 feet long 4-span box girder continuous deck bridge
- Deck will be isolated by triple frictional pendulum (TFP) bearing

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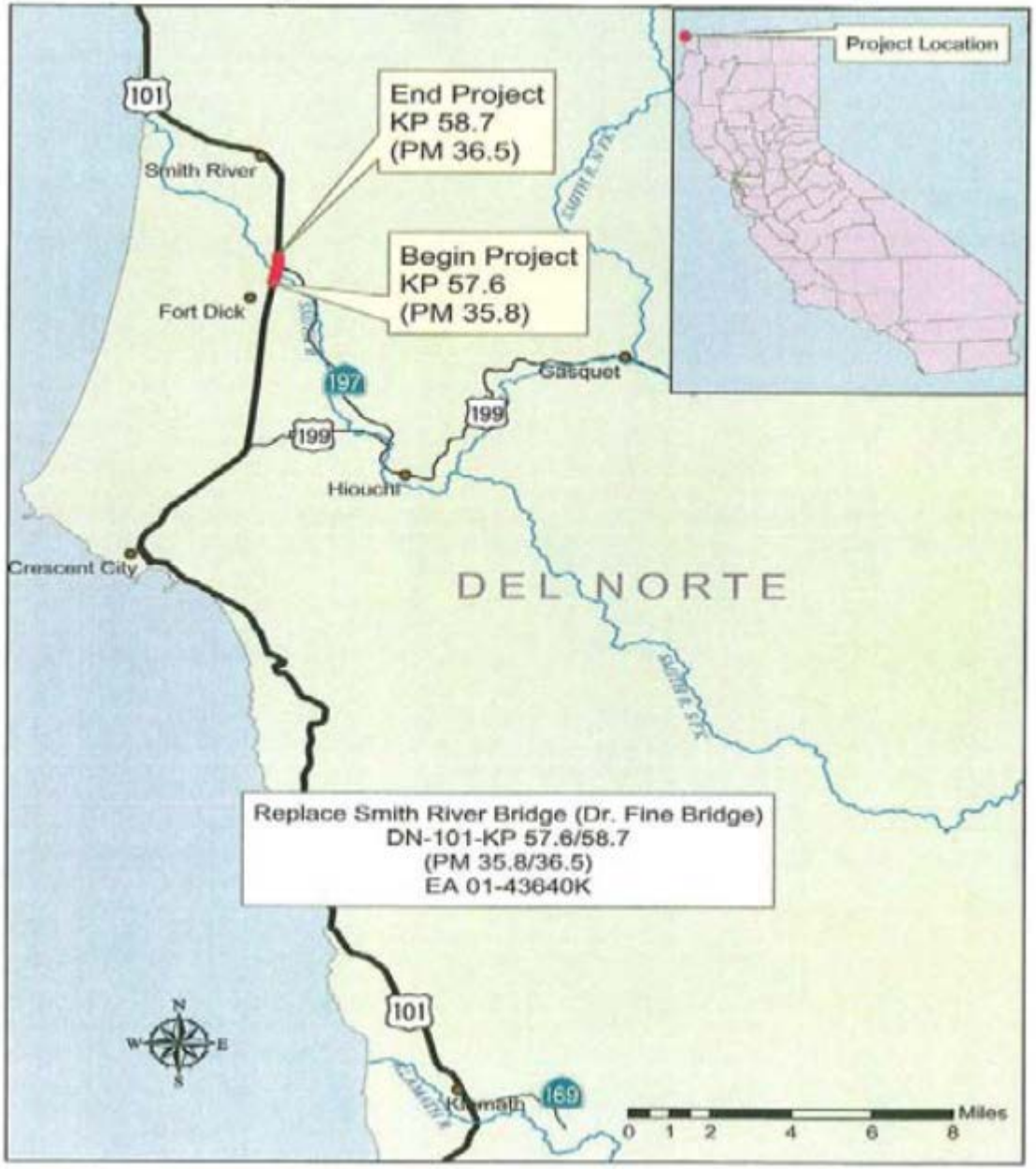
Project Location Map



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Existing Bridge

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Existing Bridge

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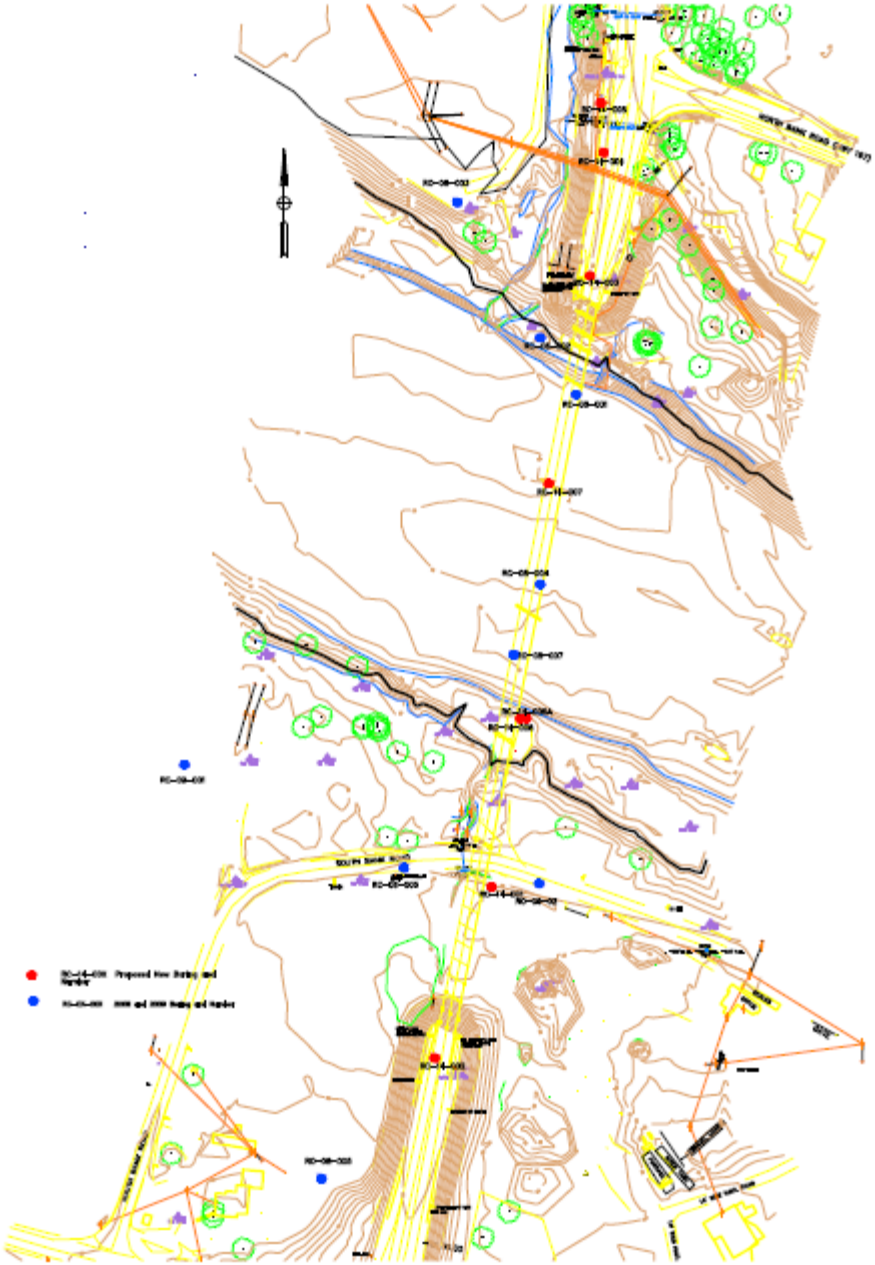
Rendering of the New Bridge

Boring Locations

- New Borings
- Old Borings



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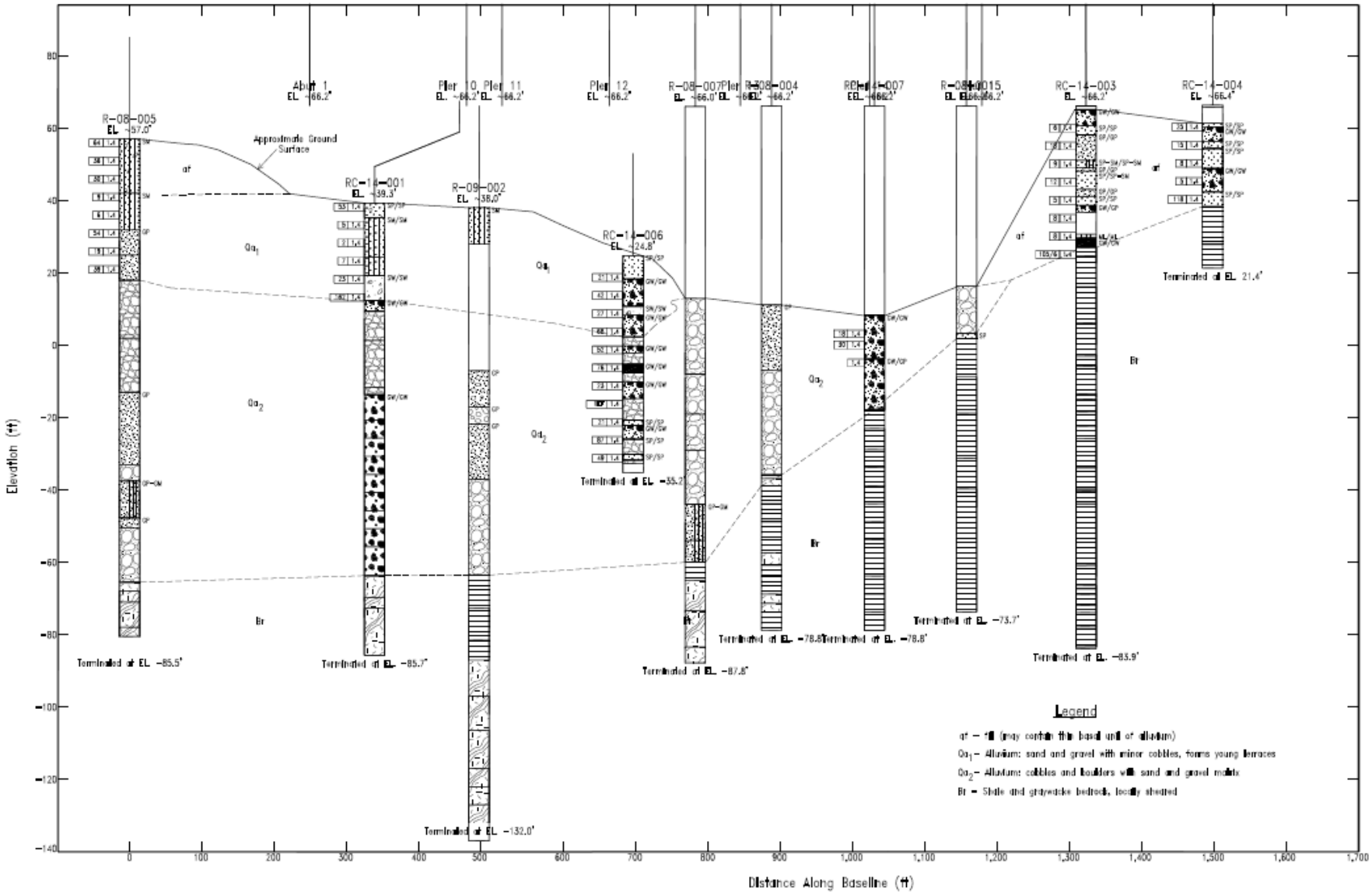
Profile



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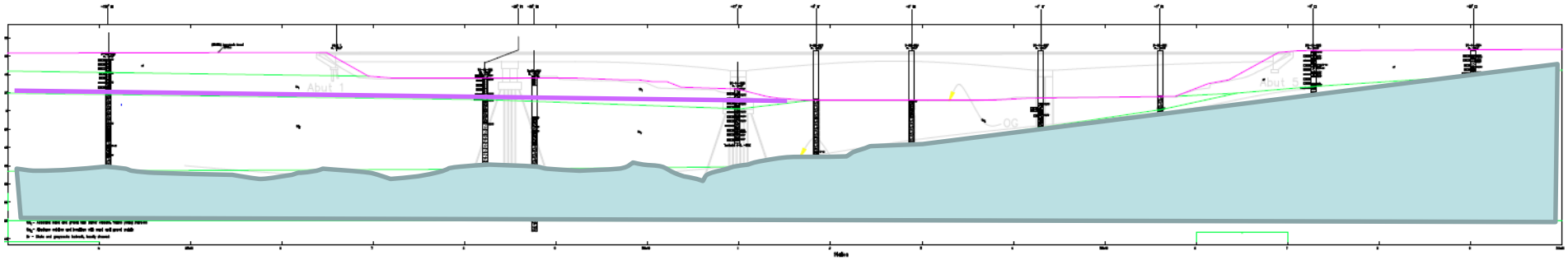
Profile



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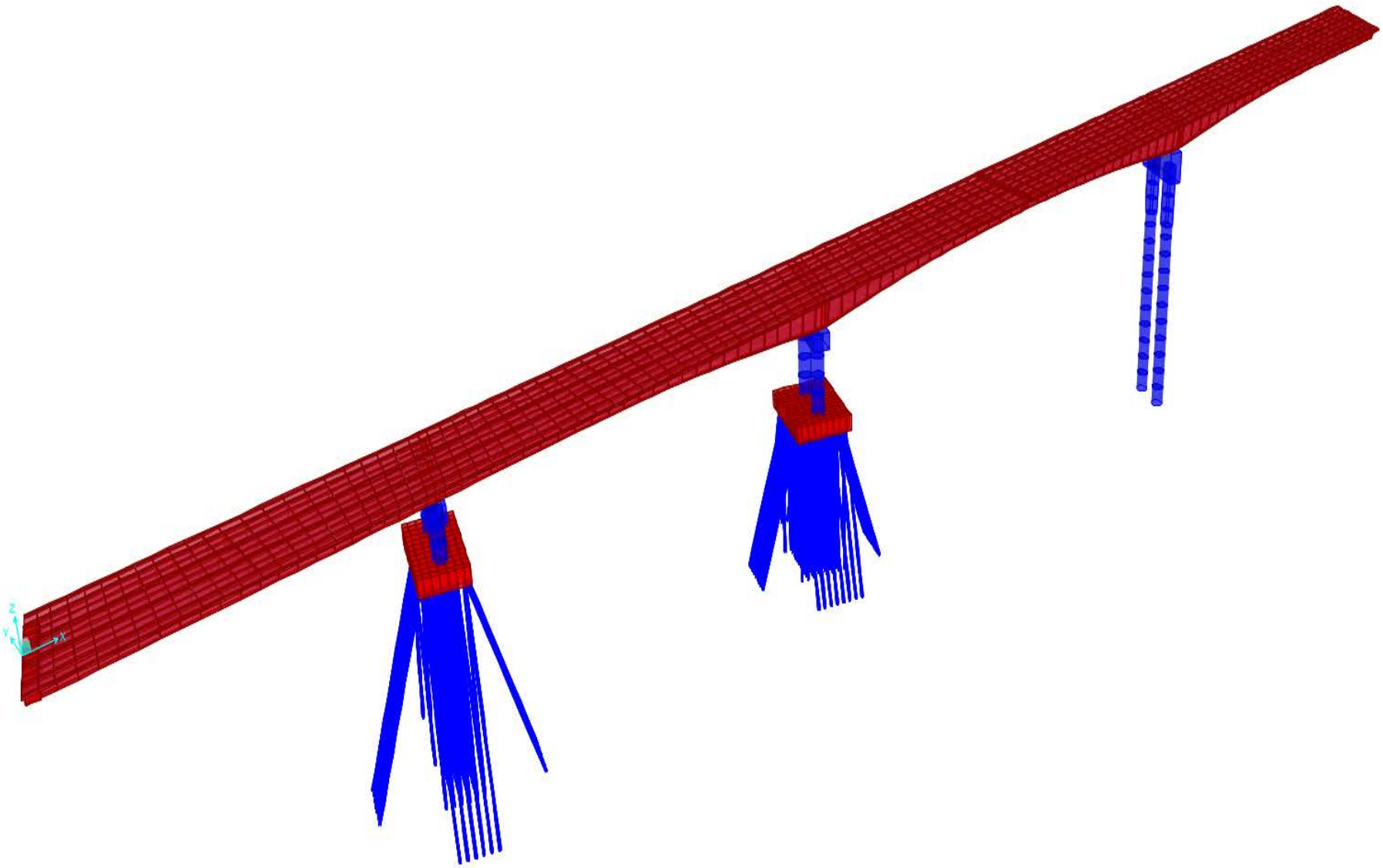
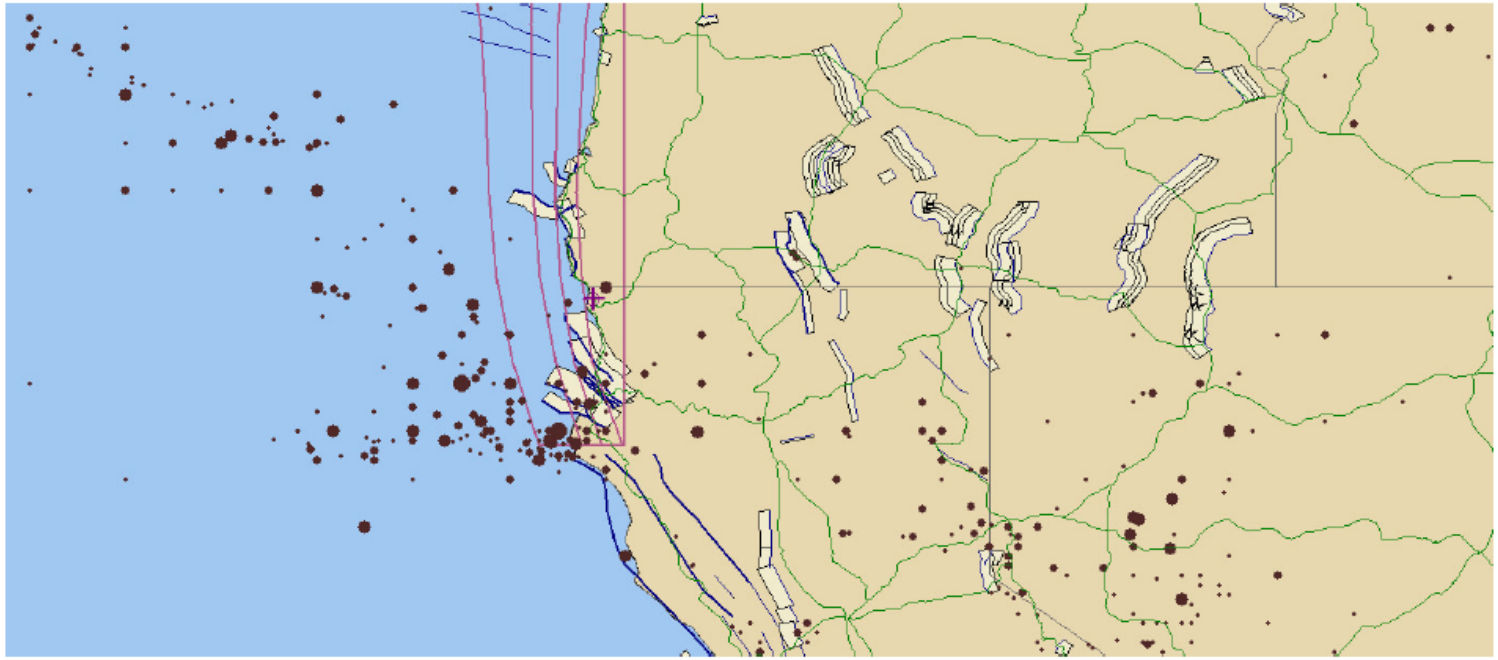
Structural Model



Fault and Seismicity Map



MAP LEGEND

- Site
- Highways

Faults

- Included
- Not included

Subduction Interface

- Included
- Not included

Historical Seismicity

- Greater than 8.5
- 7.5 to 8.5
- 6.5 to 7.5
- 5.5 to 6.5
- Less than 5.5
- Unknown Magnitude

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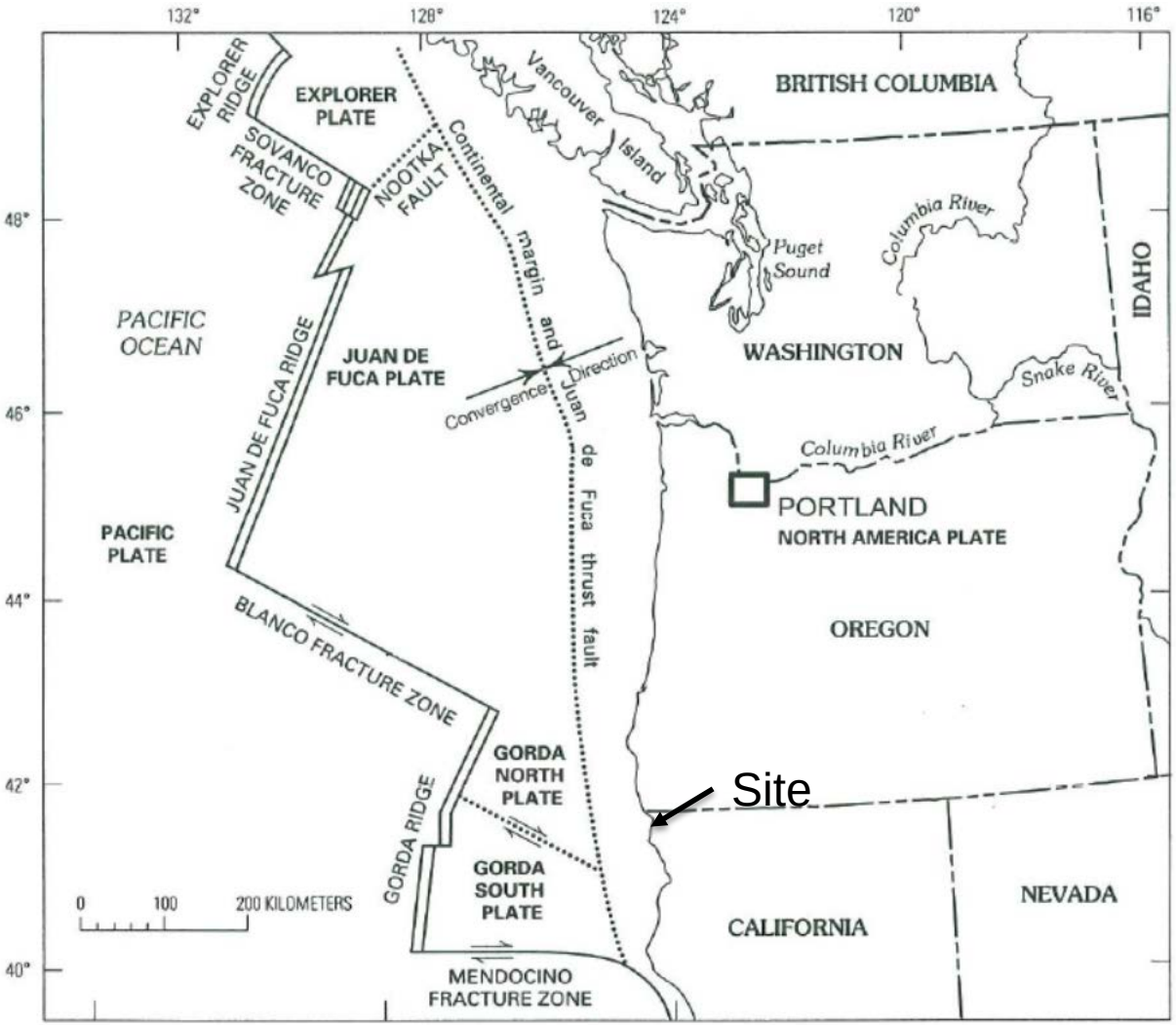
Cascadia Subduction Zone



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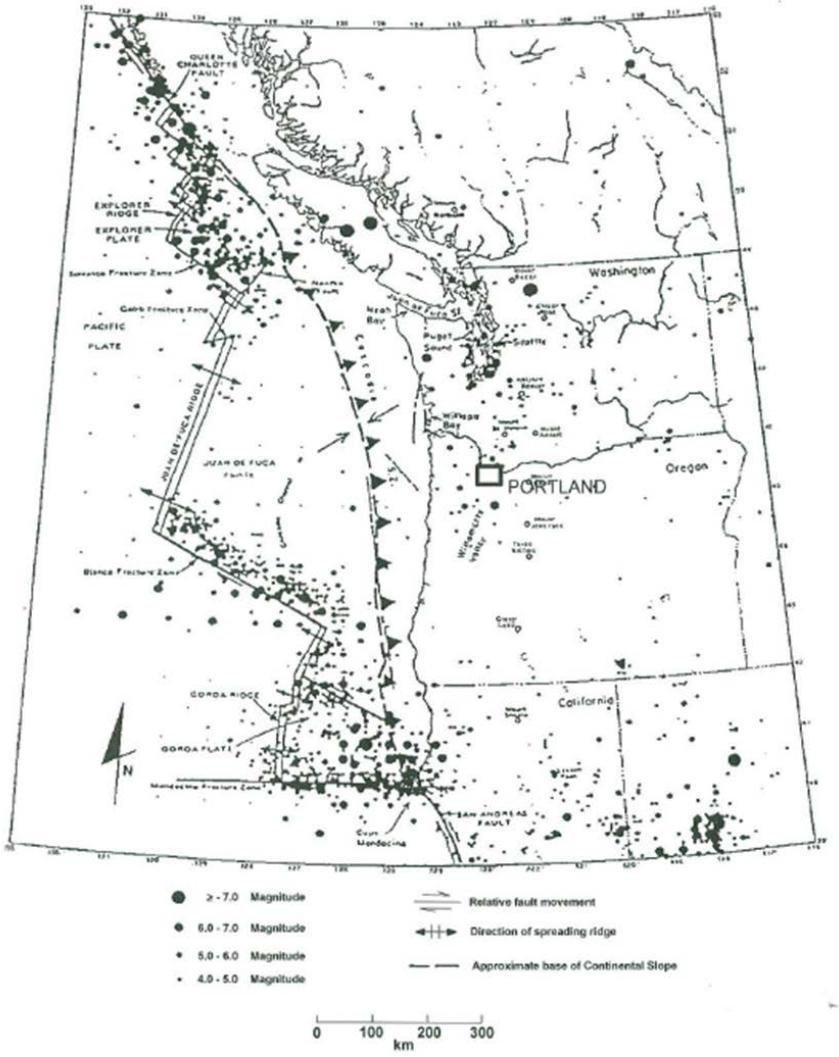
Pacific Northwest Seismicity



SOURCE: Heaton and Hartzell (1987)

NOTE: Features shown are for illustrative purposes only and are approximate

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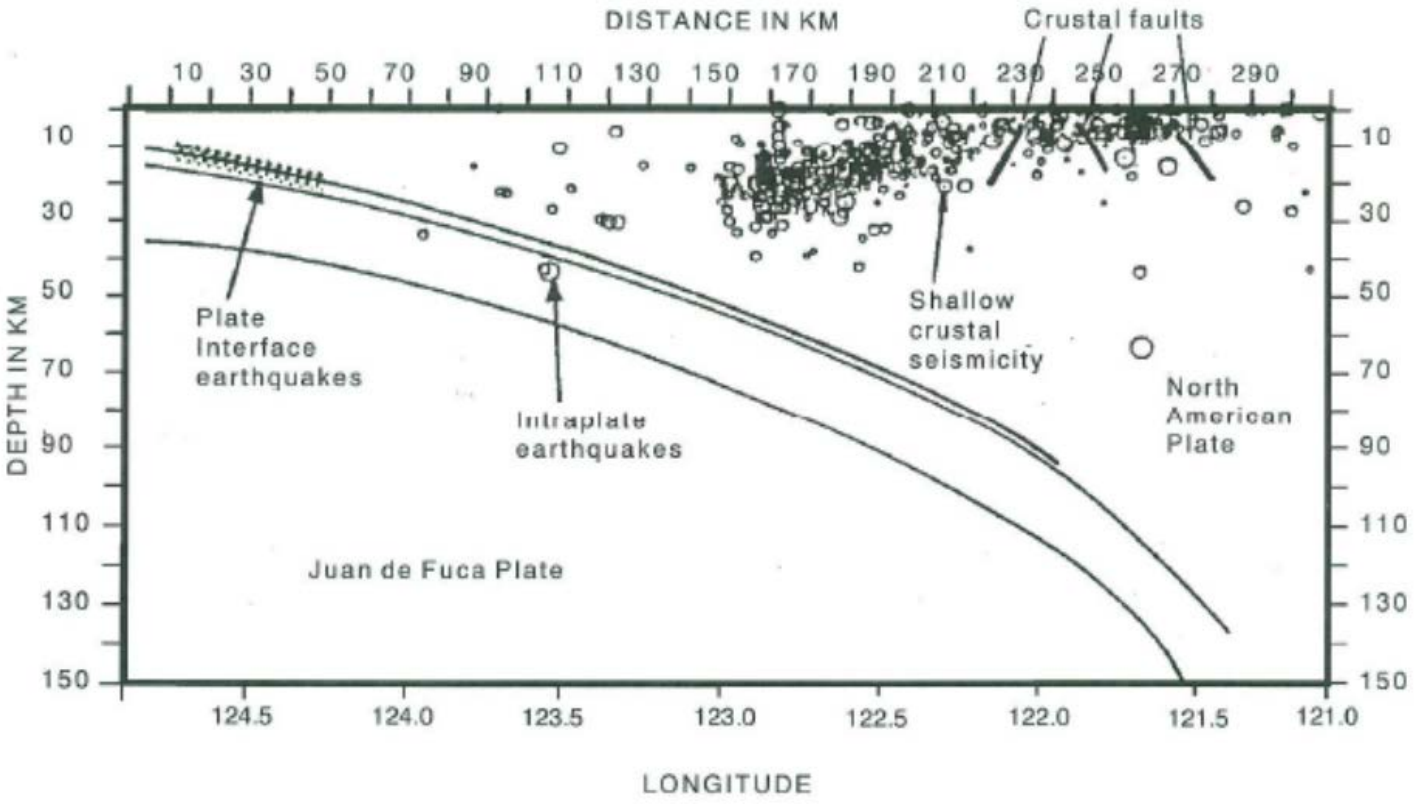
Seismicity Sources



SOURCE: Modified from Geomatrix Consultants (1995)

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Seismic Sources

- Primarily seismic source is the Cascadia Subduction Zone (CSZ), with rupture distance of about 35 km
- Additional local shallow crustal faults
  - Big Lagoon – Bald Mountain fault, rupture distance of about 15 km
  - Trinidad fault, about 45 km

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Seismic Hazards

- Use USGS seismic source model
- Perform probabilistic seismic hazard analysis for 5% probability of exceedance in 50 years (return period of 975 years)
- Develop rock outcrop horizontal and vertical spectra
- Since CSZ controls, near-source and directivity effects were not needed

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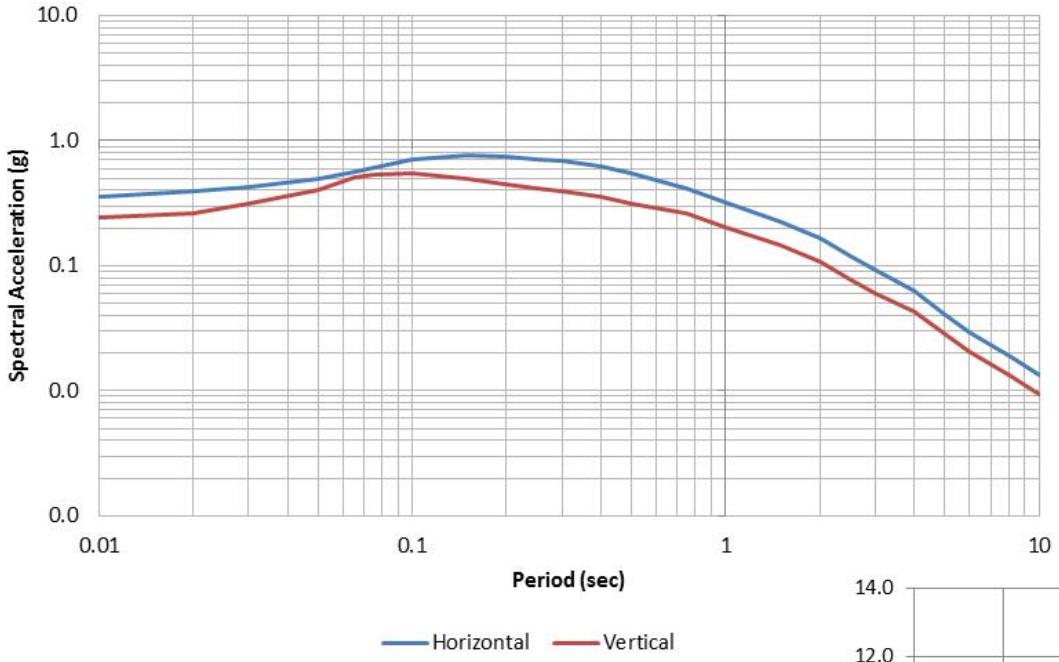
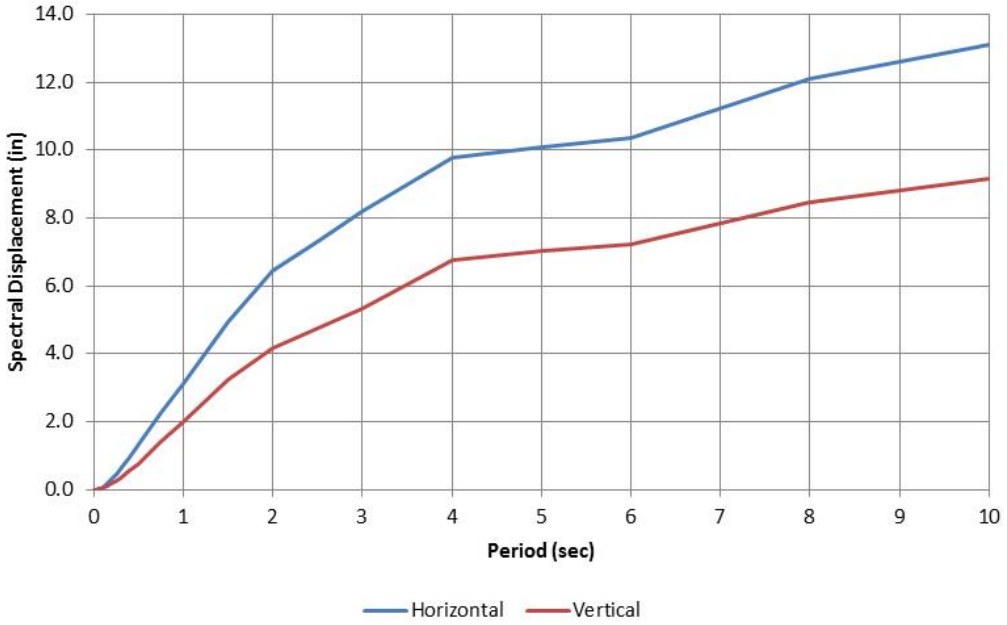
Outcrop Spectra





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Time Histories

- Seven sets (each set having two orthogonal horizontal motions) of time histories
- Time histories were selected from historical records based on spectral shape, frequency content, source mechanism, and site conditions
- Earthquakes from Japan, Chile, and Taiwan up to 300-sec long were selected
- Spectrally matched to outcrop horizontal spectrum

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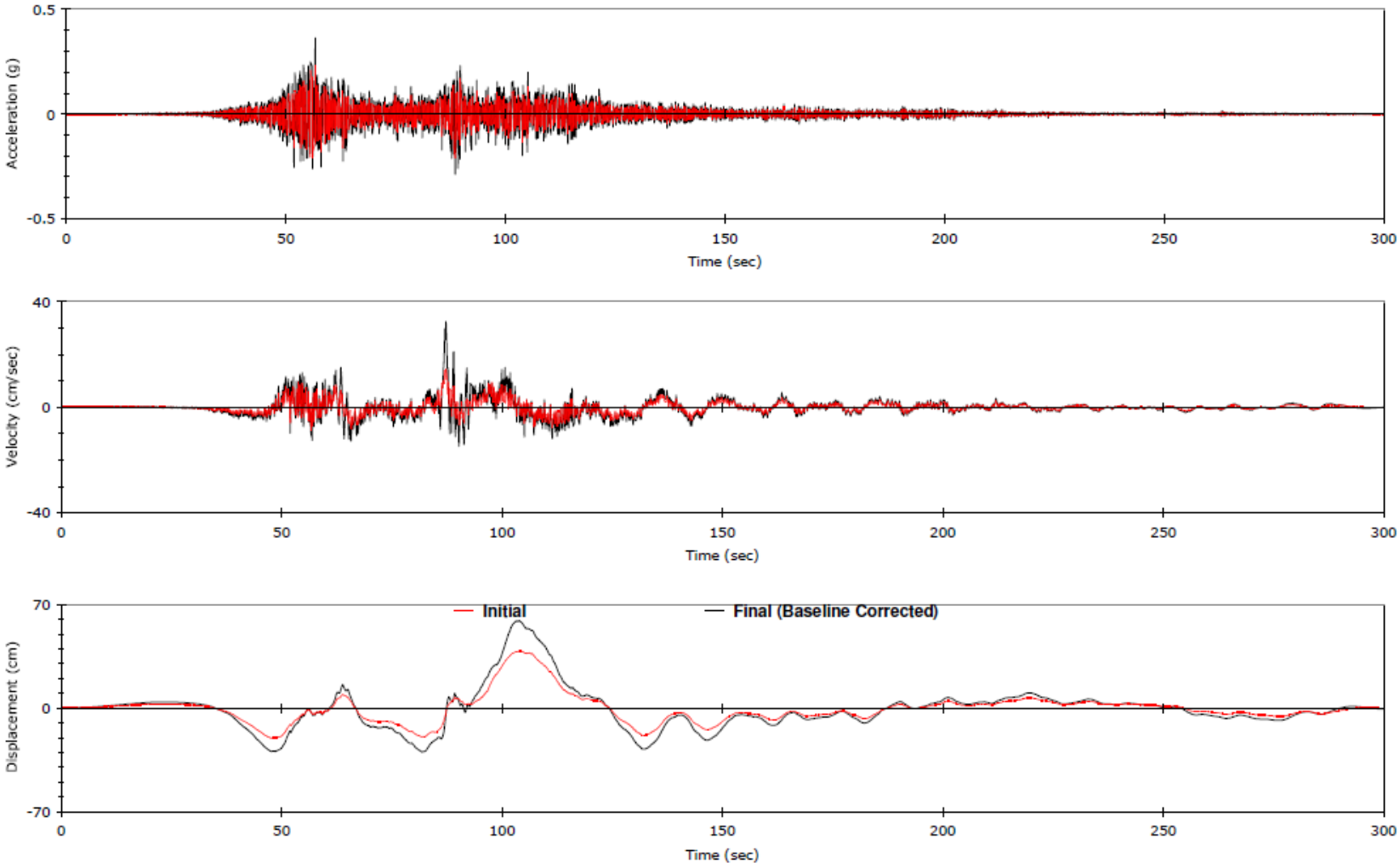
Spectrally Matched Time History



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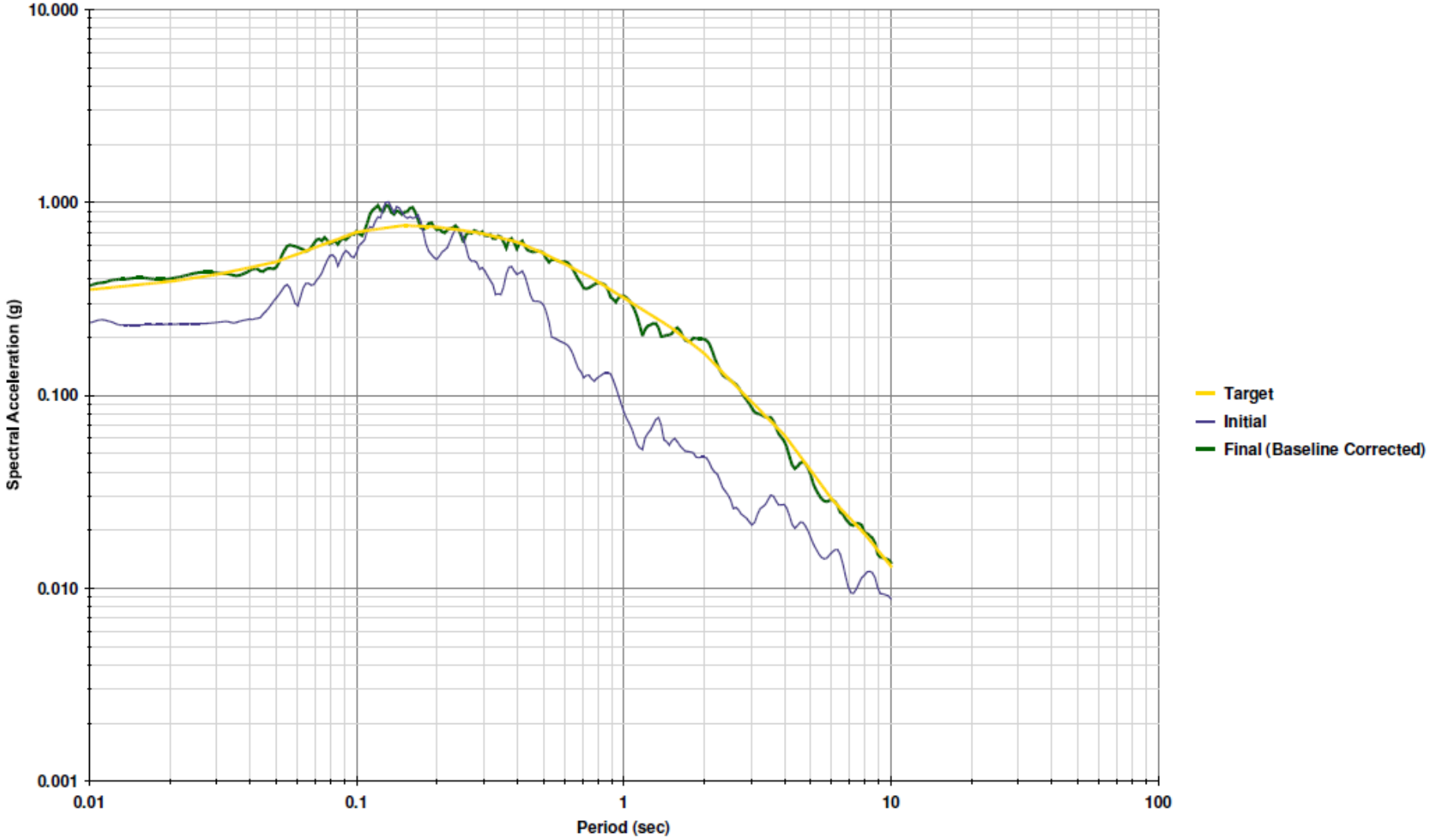
Spectrally Matched Time History



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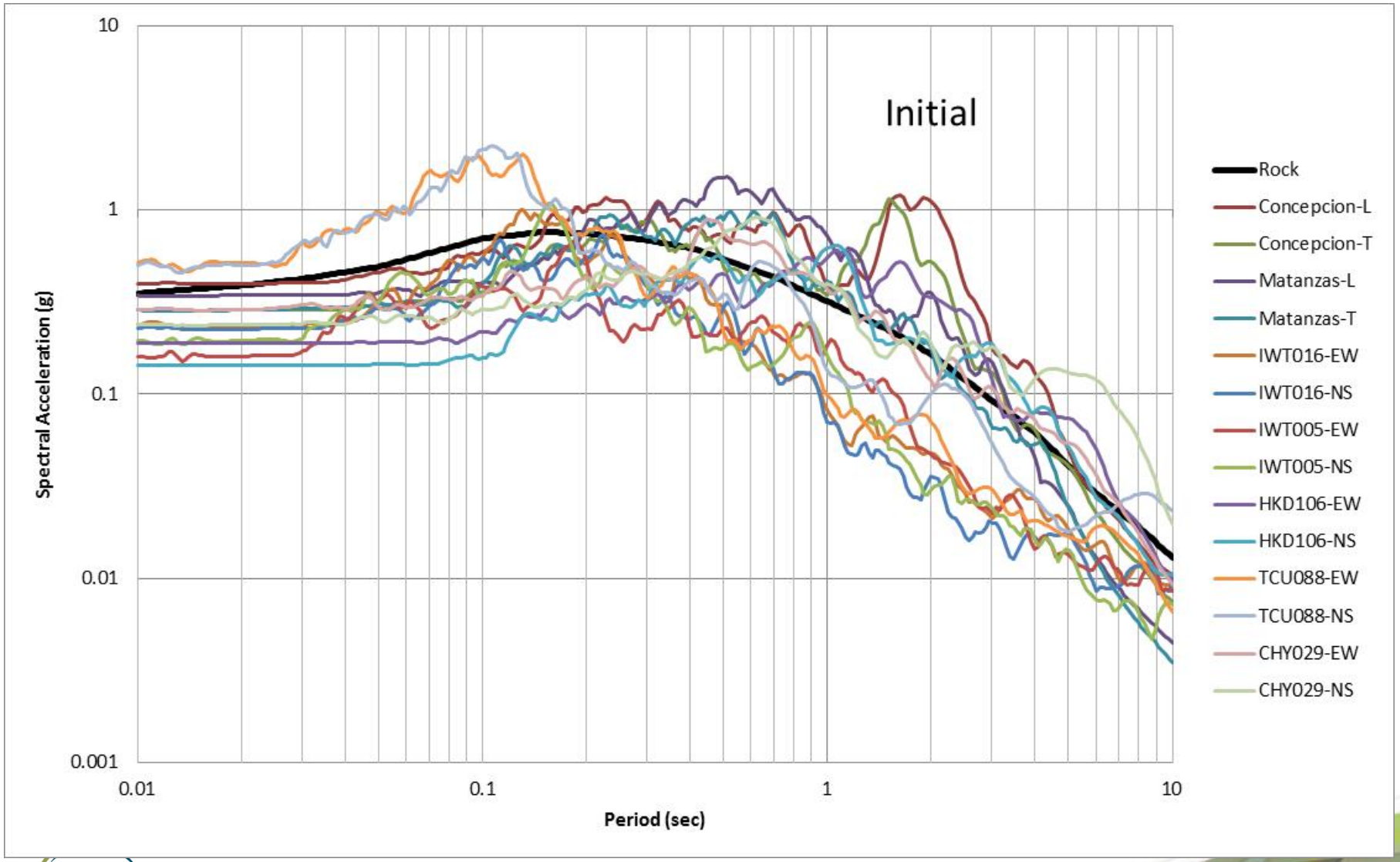
Original Time Histories



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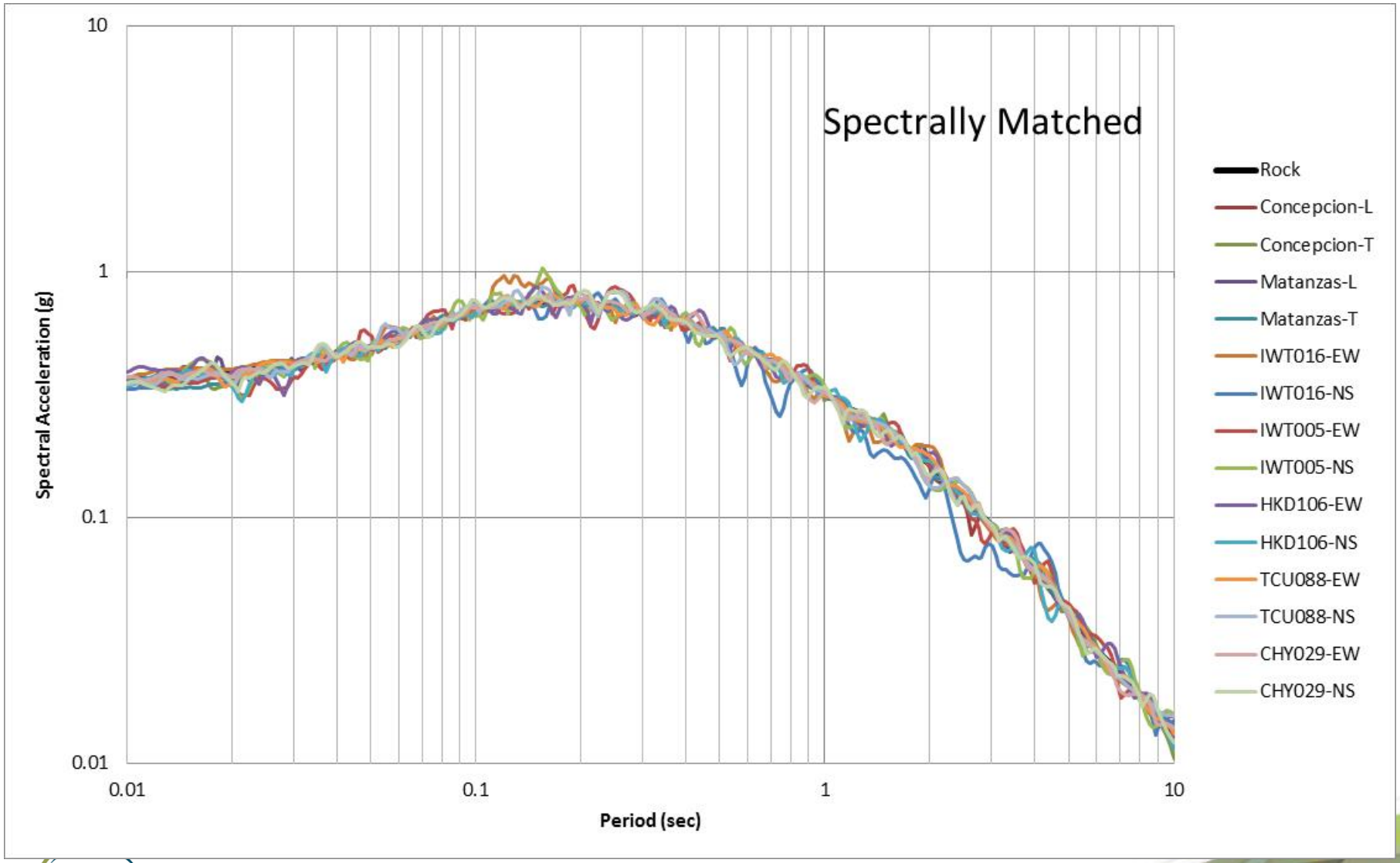
Spectrally Matched Time Histories



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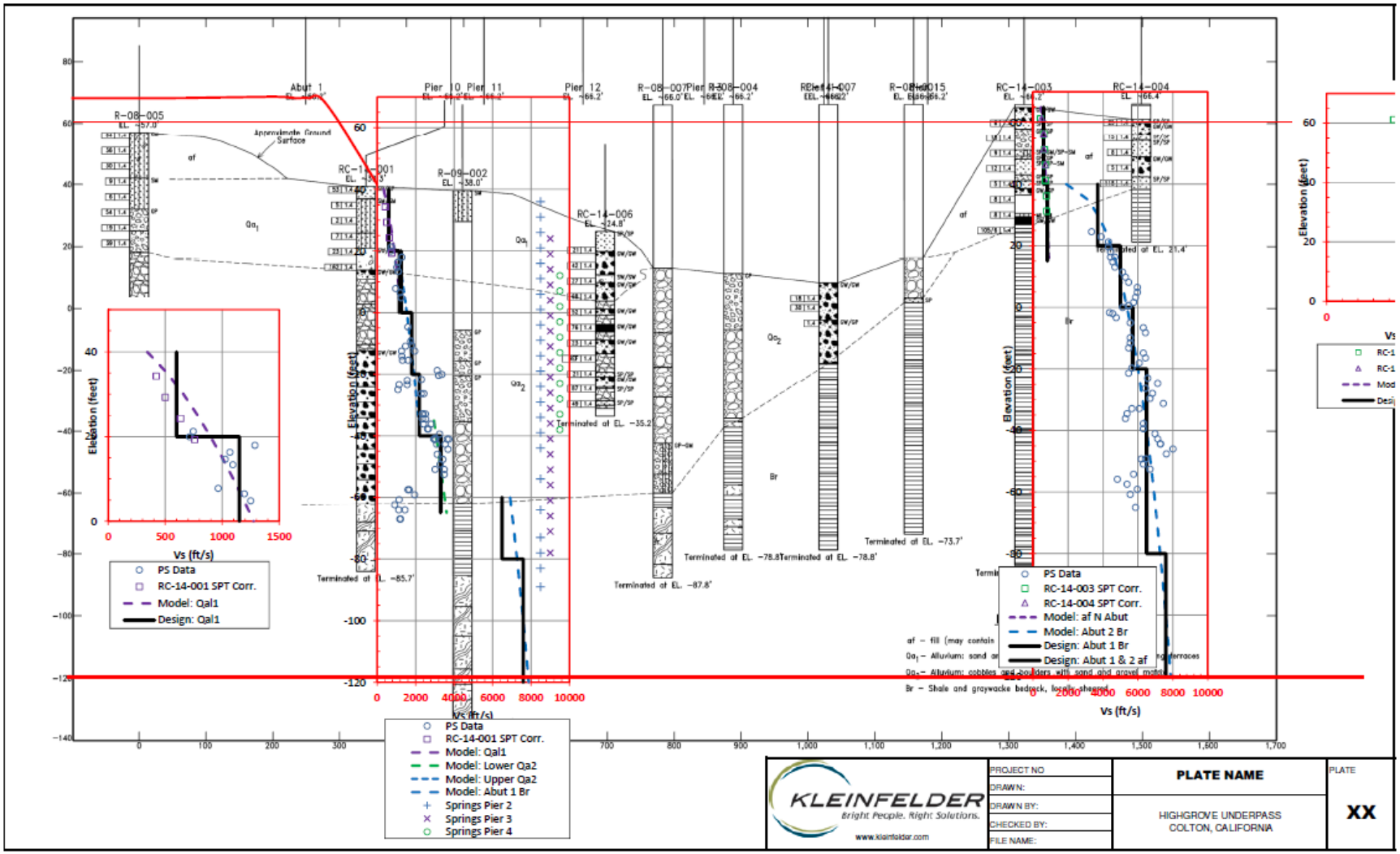
Shear Wave Velocity



Site Response Analysis

- Seven sets (14) of time histories
- 1D analysis in transverse direction using DEEPSOIL at each abutment and bent location
- 2D analysis in longitudinal direction using QUAD4M
- Free-field response at the surface at each abutment and bent location

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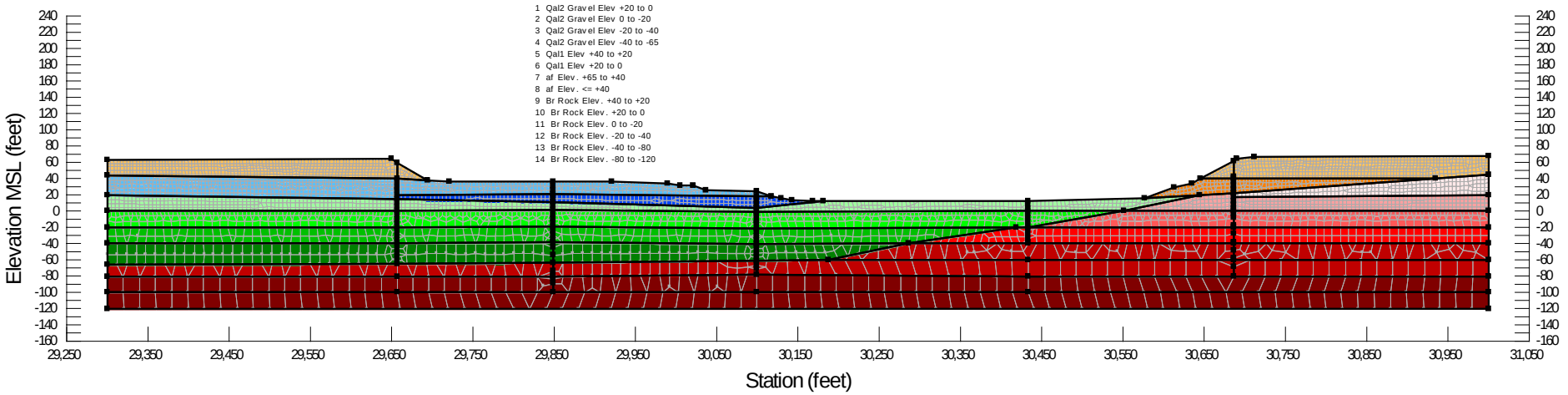
2D Model



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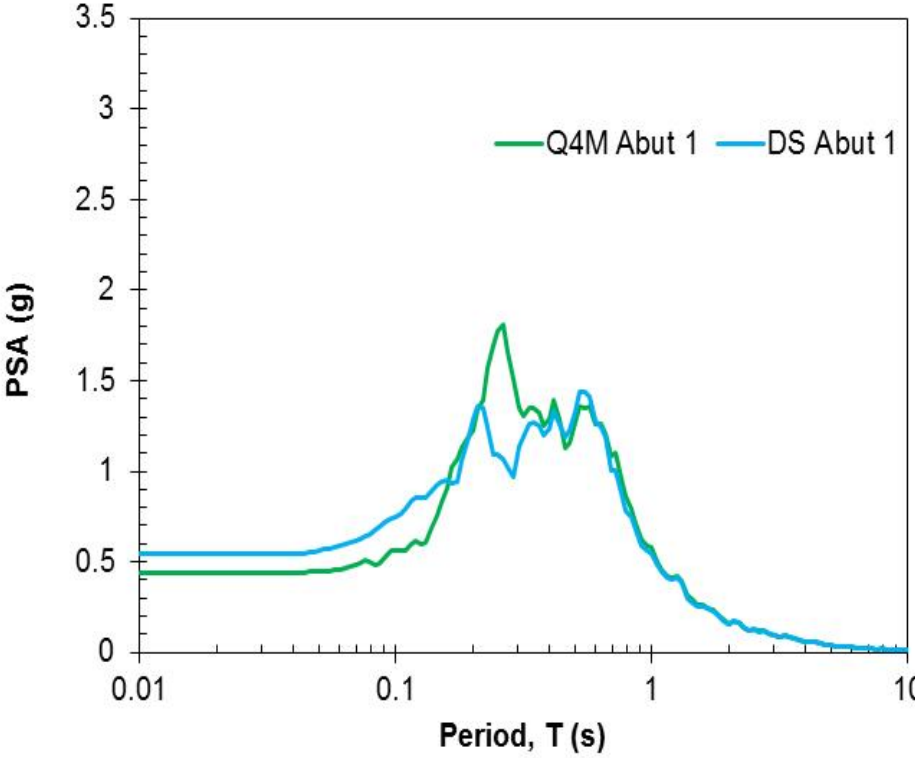
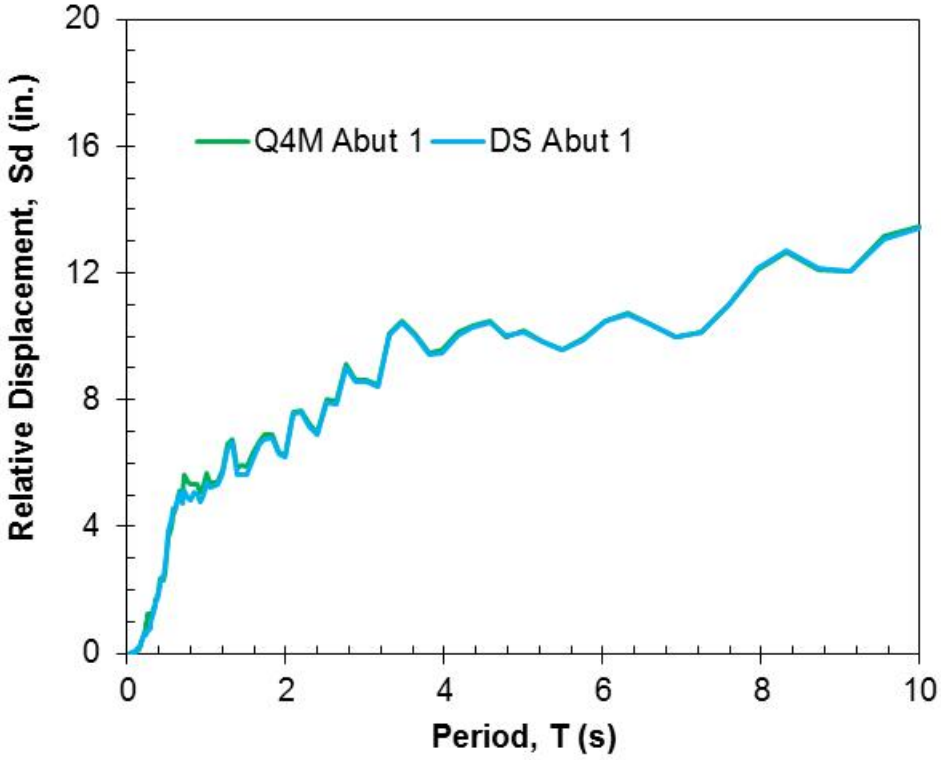
Verification – QUAD4M and DEEPSOIL Comparison in Transverse





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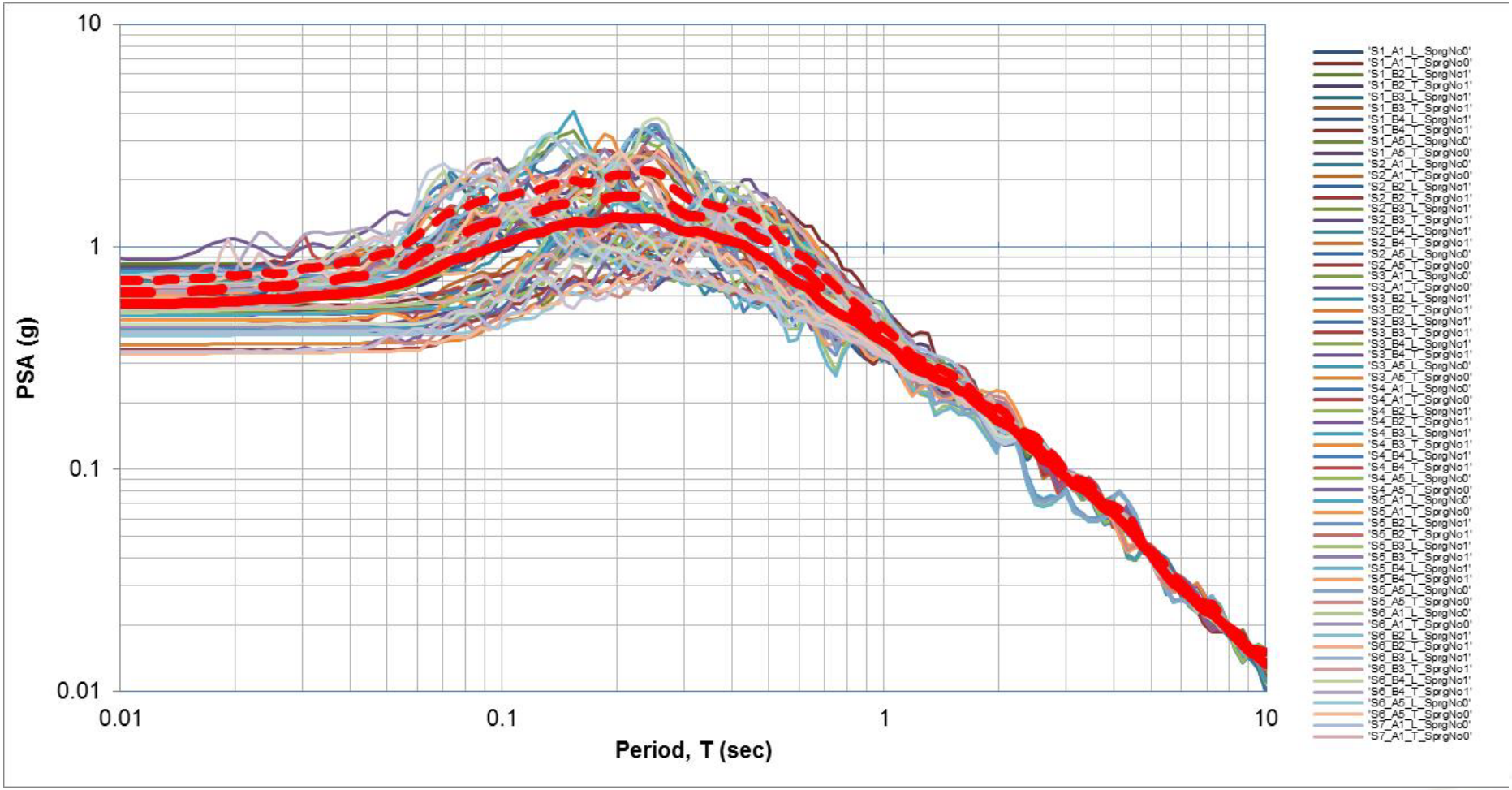
Results – Surface Spectra



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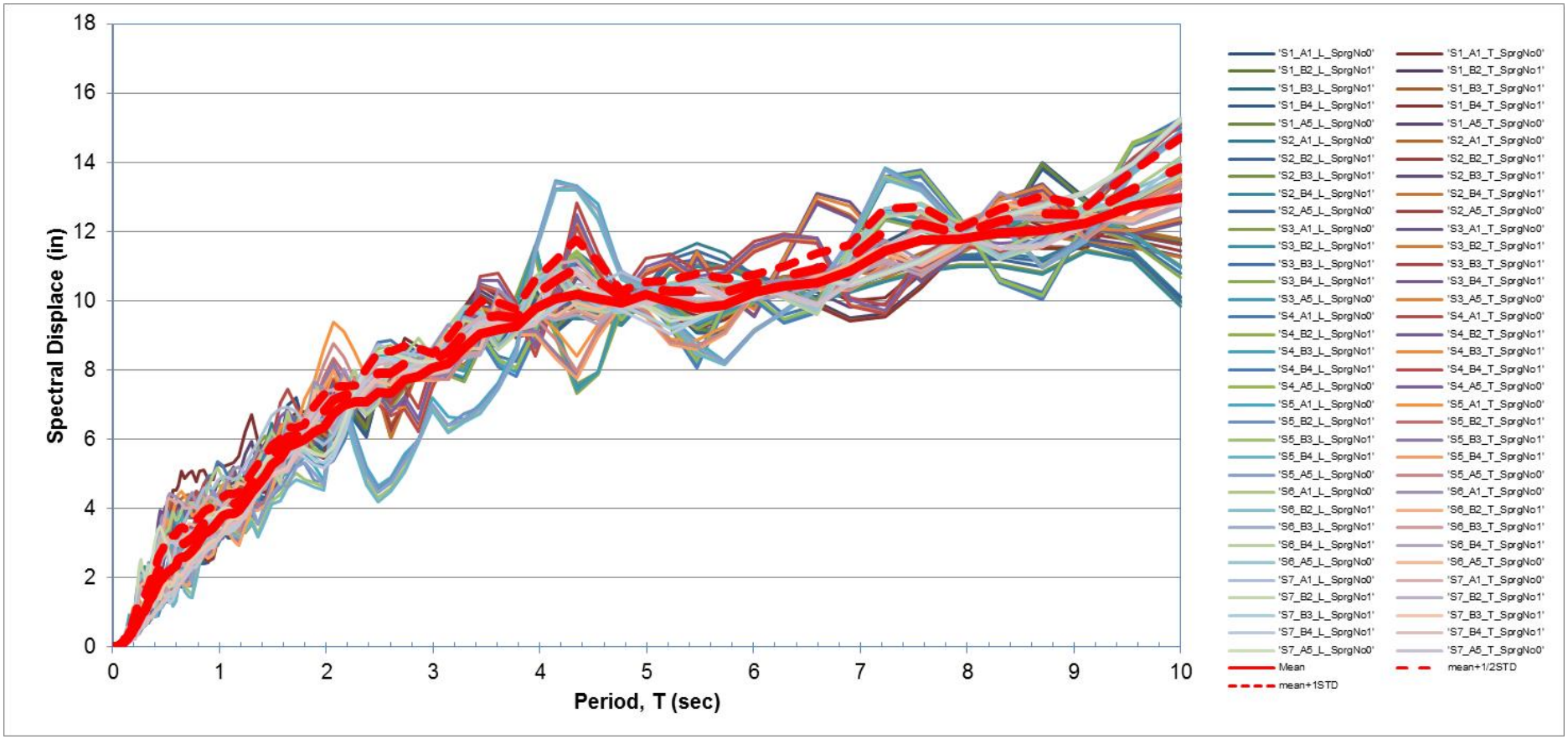
Results – Surface Spectra



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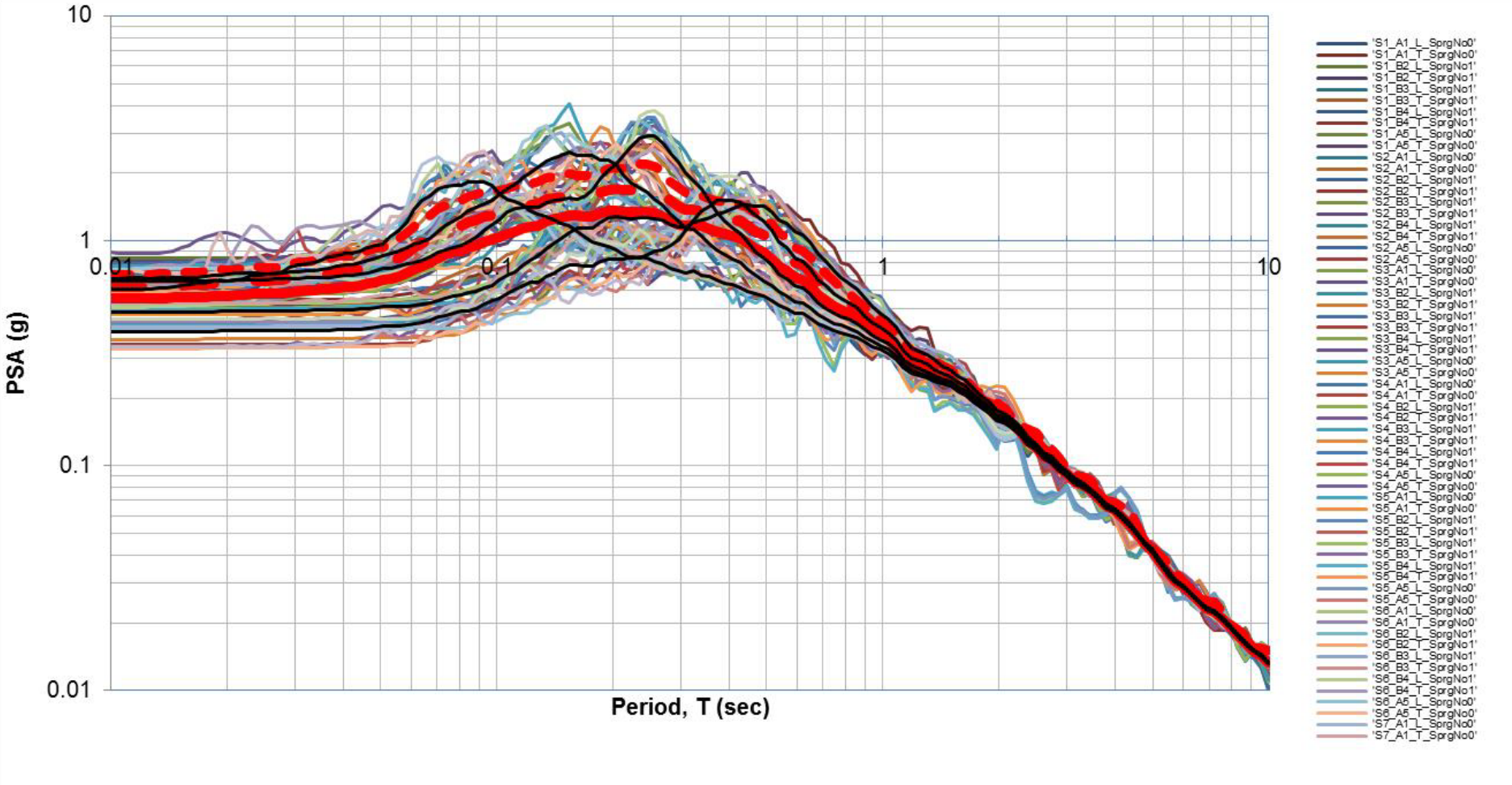

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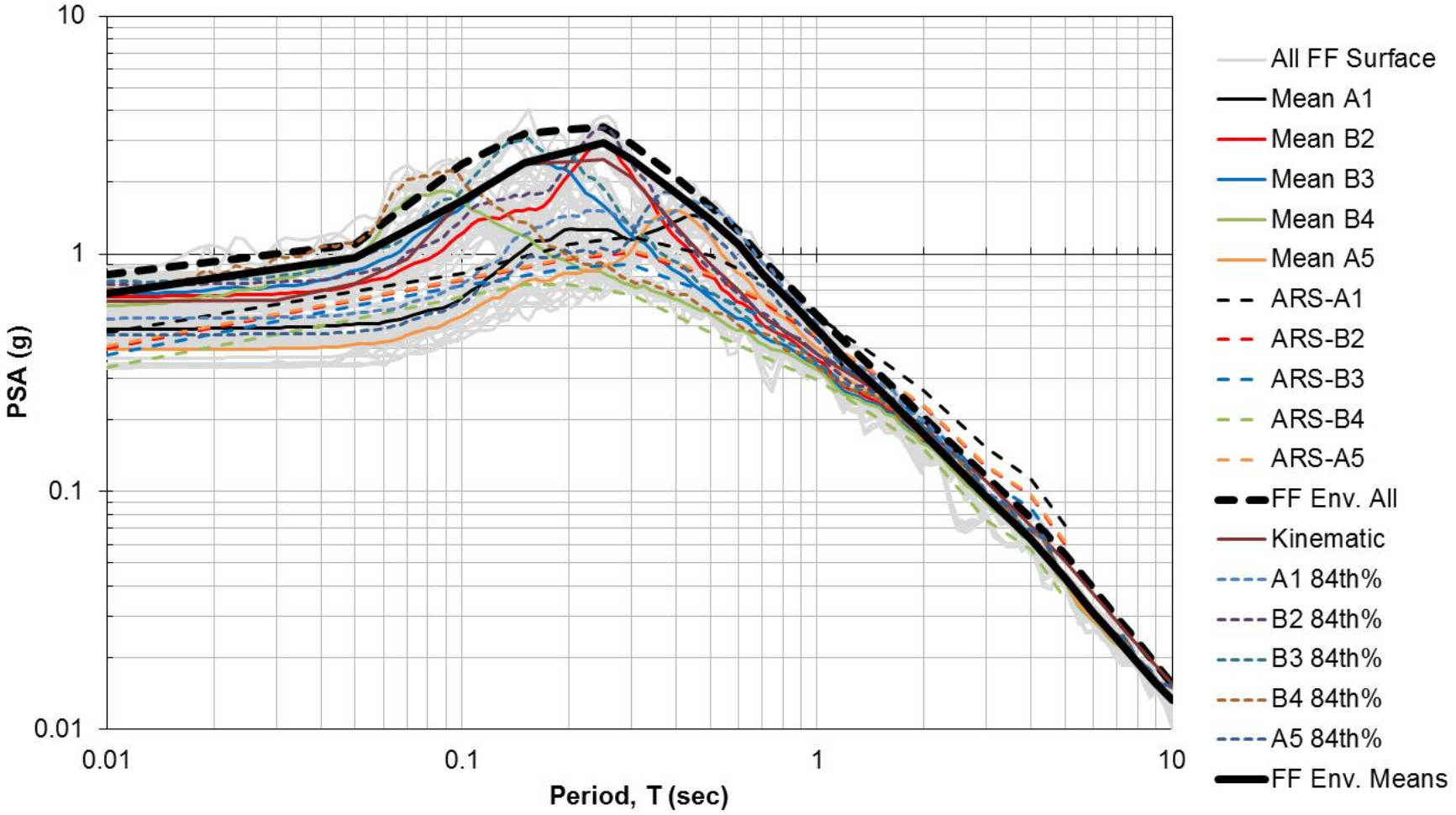
Results – Surface Spectra



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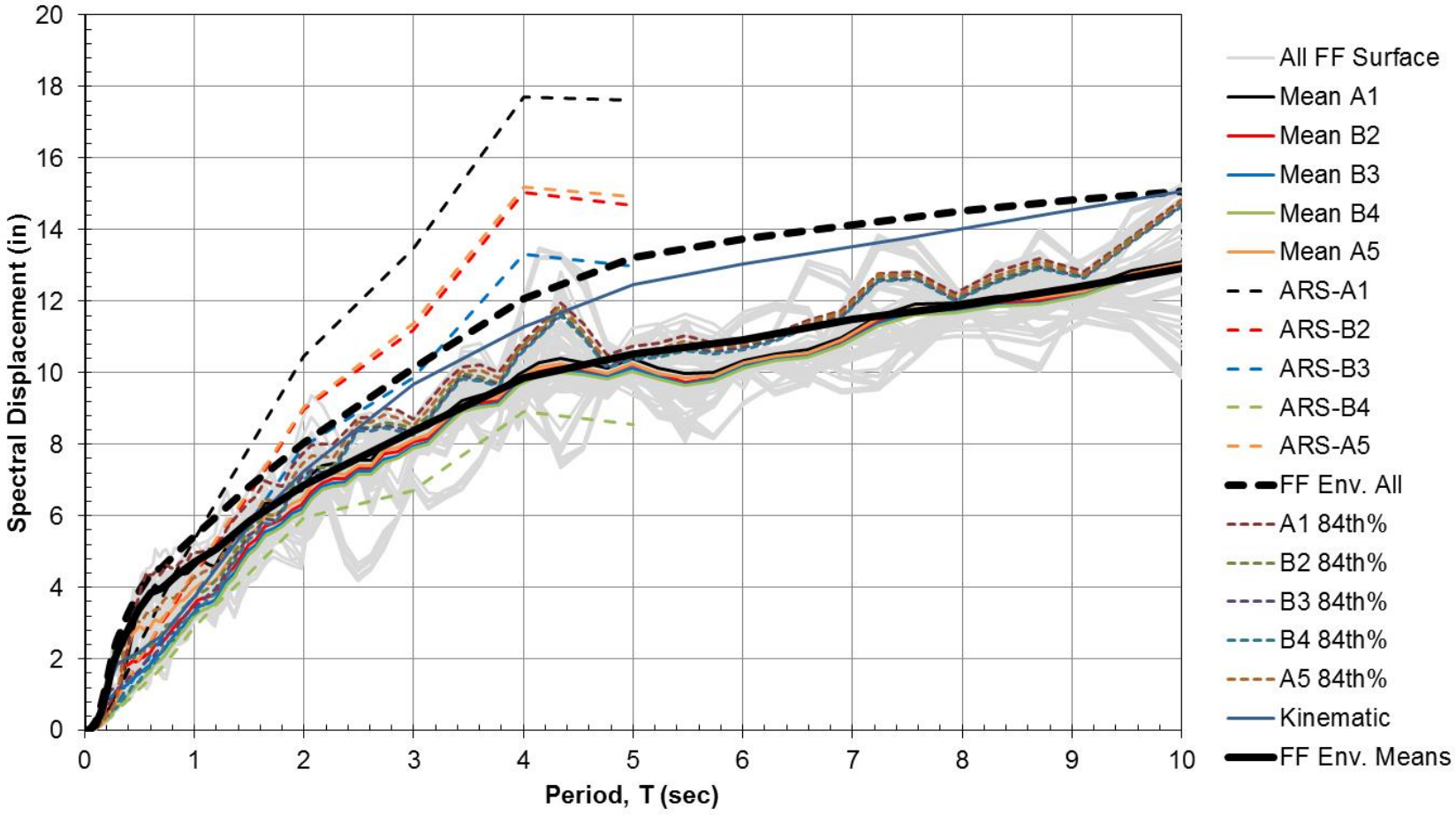
Results – Surface Spectra



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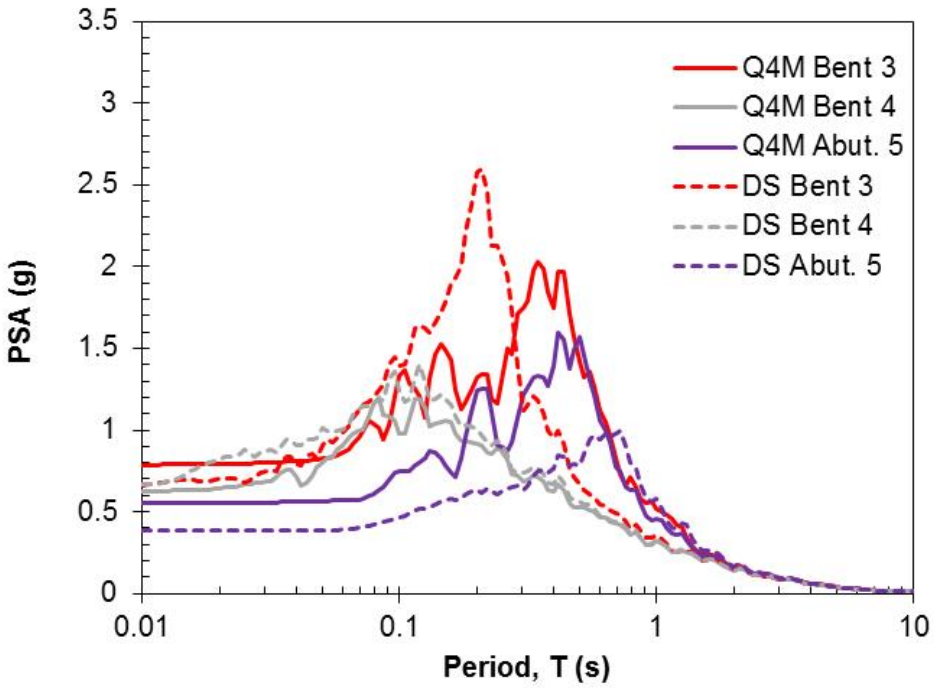
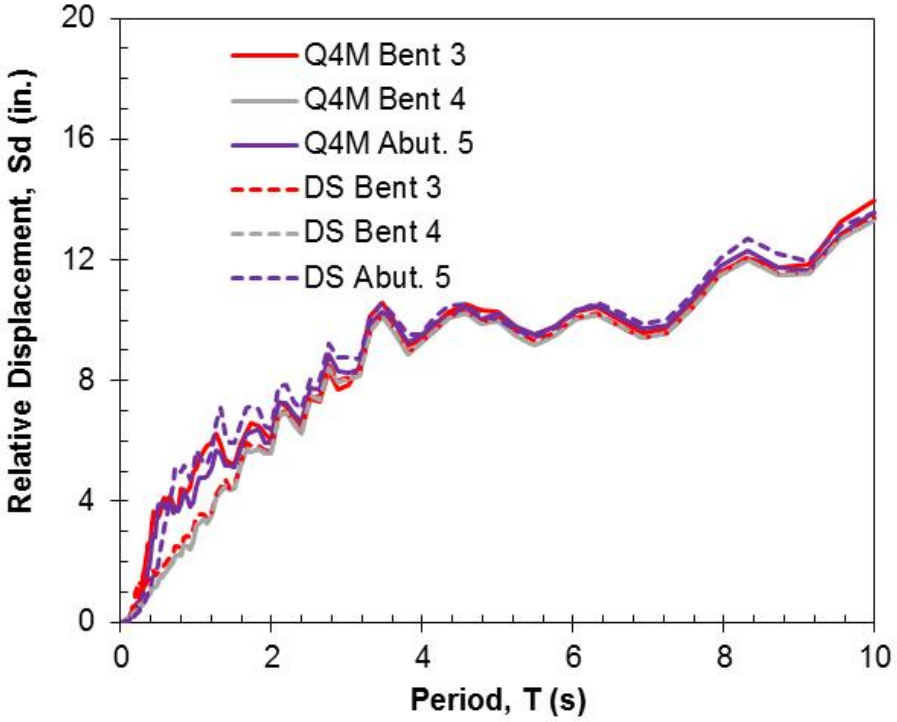
QUAD4M and DEEPSOIL Comparison in Longitudinal





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Questions?

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