INVESTIGATION IN THE SENSITIVITY OF VELOCITY INTERPRETATION APPROACH FOR A SOFT ROCK SITE

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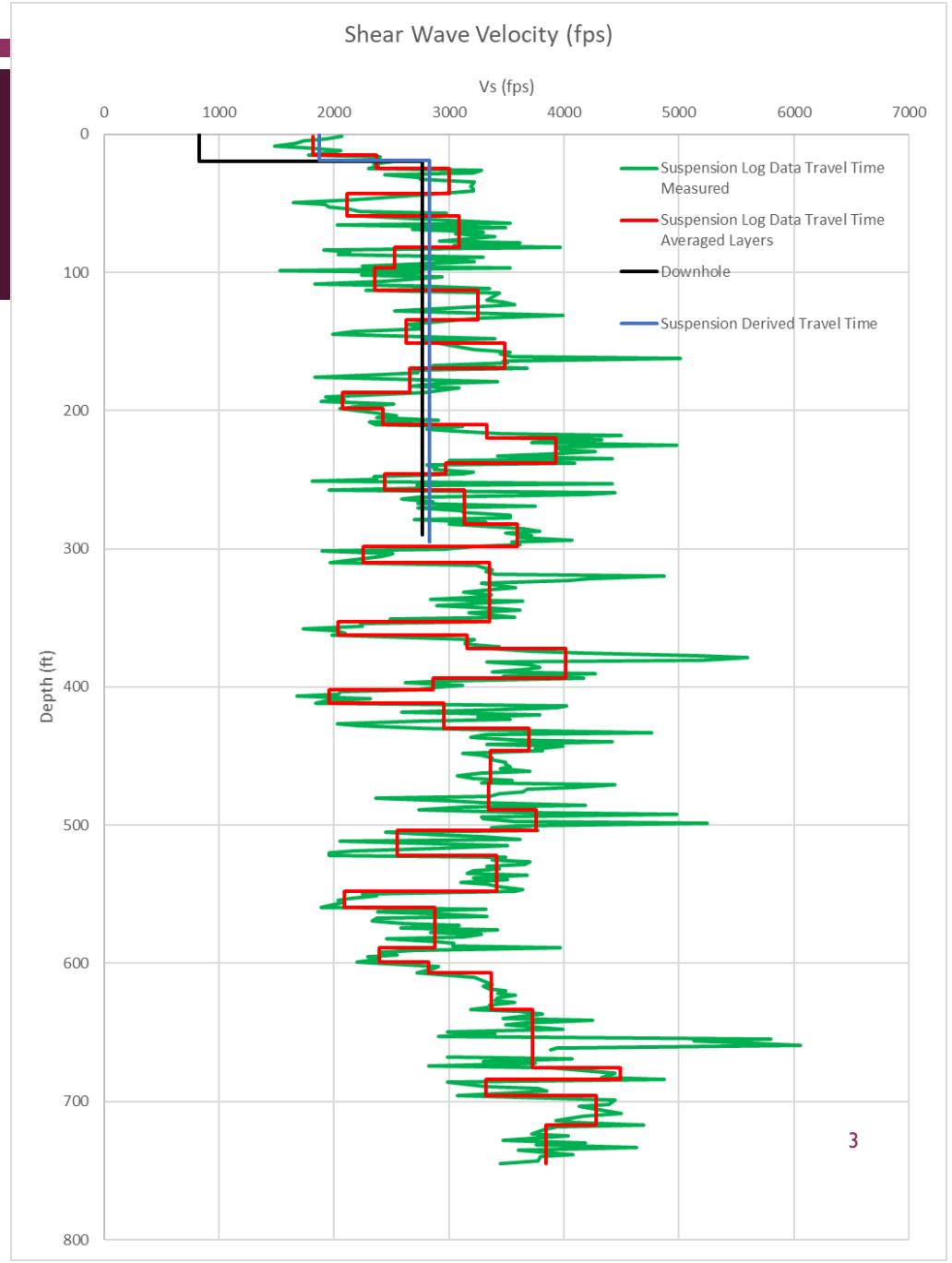
OVERVIEW

- Different interpretations of a soft rock column with variation in near surface layers are compared
  - Both from suspension logging data and downhole velocities
- Assessed by comparison:
  - Strain compatible soil properties
  - At-depth within acceleration response spectra
  - Surface outcrop acceleration response spectra

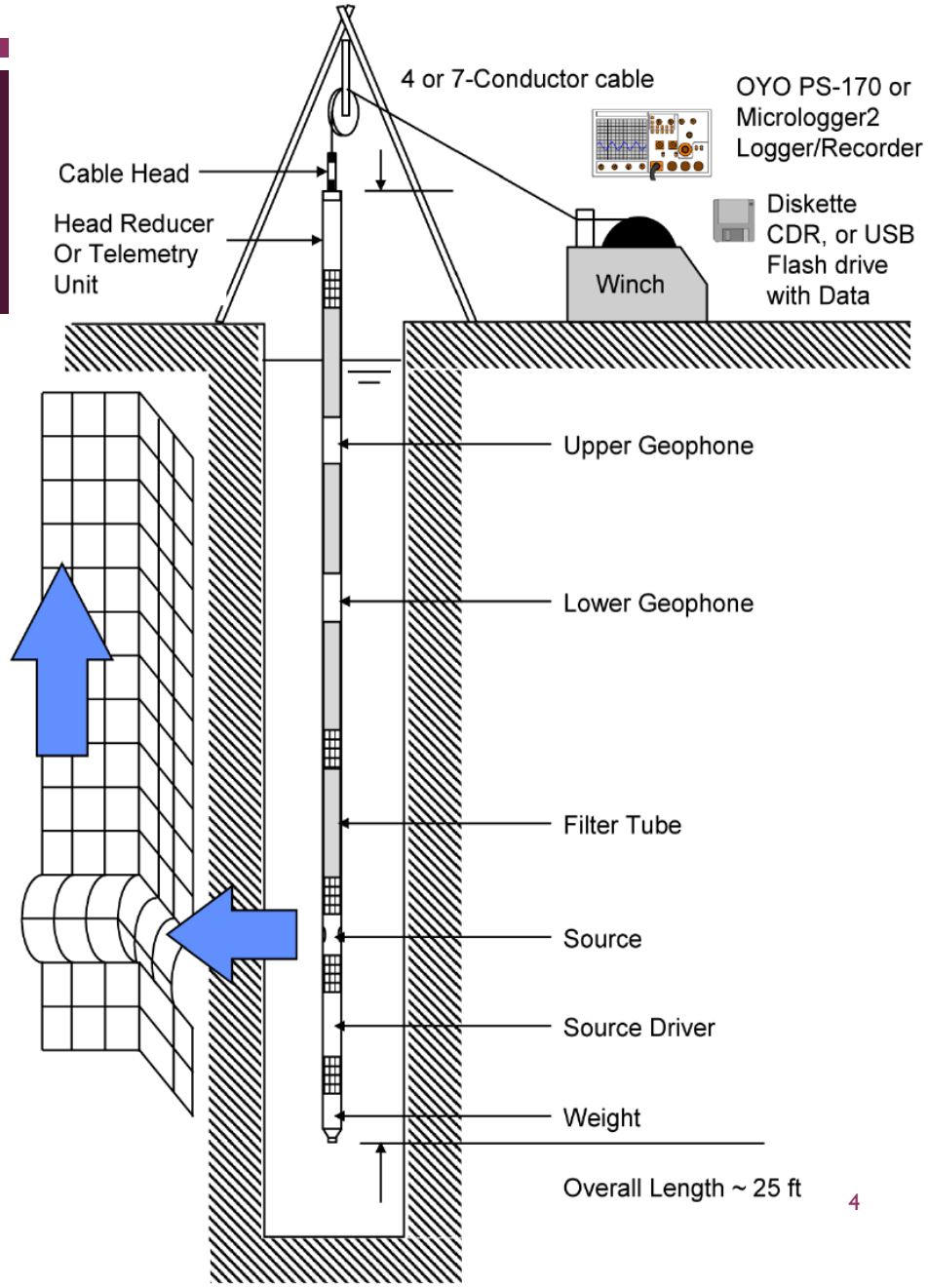
LOW STRAIN VS PROFILES

- Suspension Log Data Travel Time Measured (1.64 ft intervals) – GREEN
  - Depth ~740’
- Suspension Log Data Time Travel Average Layered – RED
- Downhole – BLACK
  - Softer top layer
- Suspension Derived Travel Time – BLUE
  - Different interpretation of surface layer



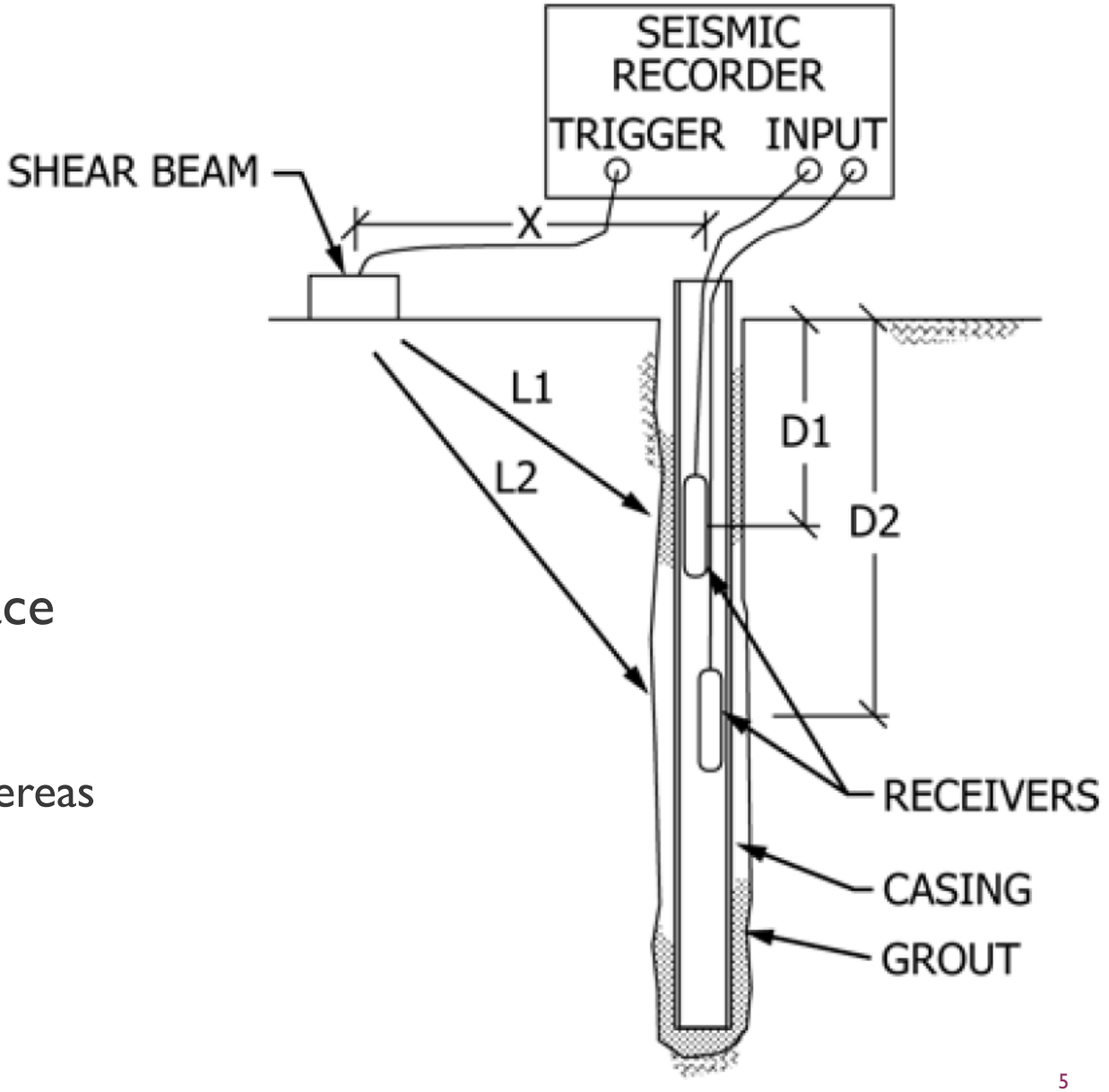
OYO SUSPENSION LOGGER

- Bore hole filled with fluid
- Device not fixed at base like downhole
- Two sources at depth and surface
- Travel time is read by two geophones near surface



DOWNHOLE LOGGING

- Device grouted to field at base
- Source at mid depth and read at surface
- Specific to reading at site
  - May have considered top layers of soil whereas suspension logging did not



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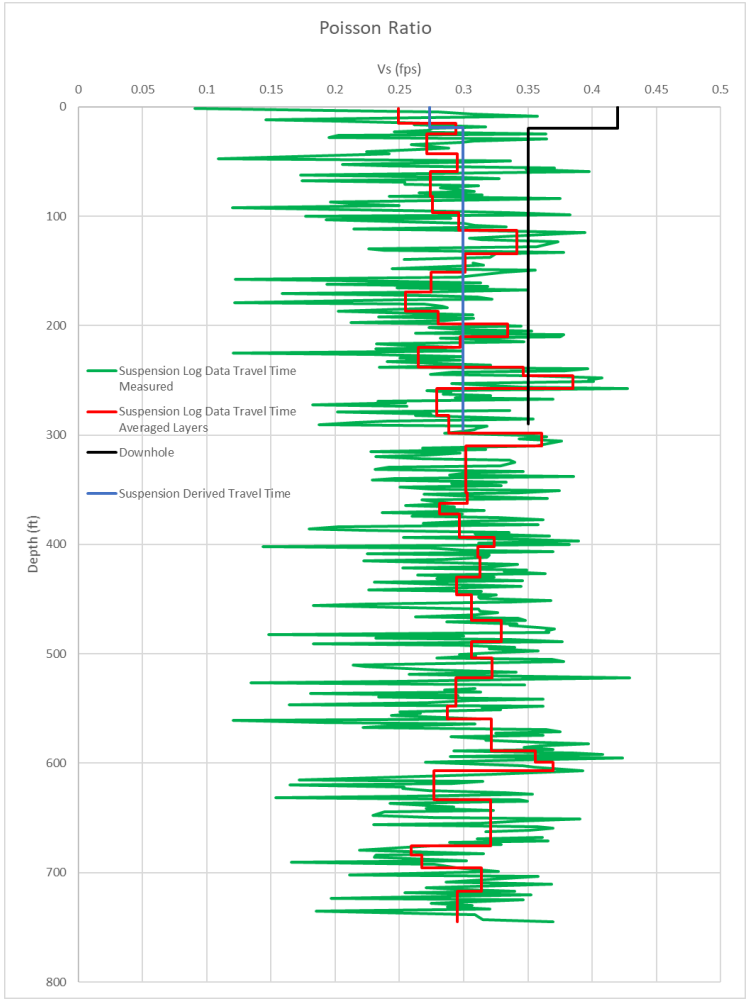
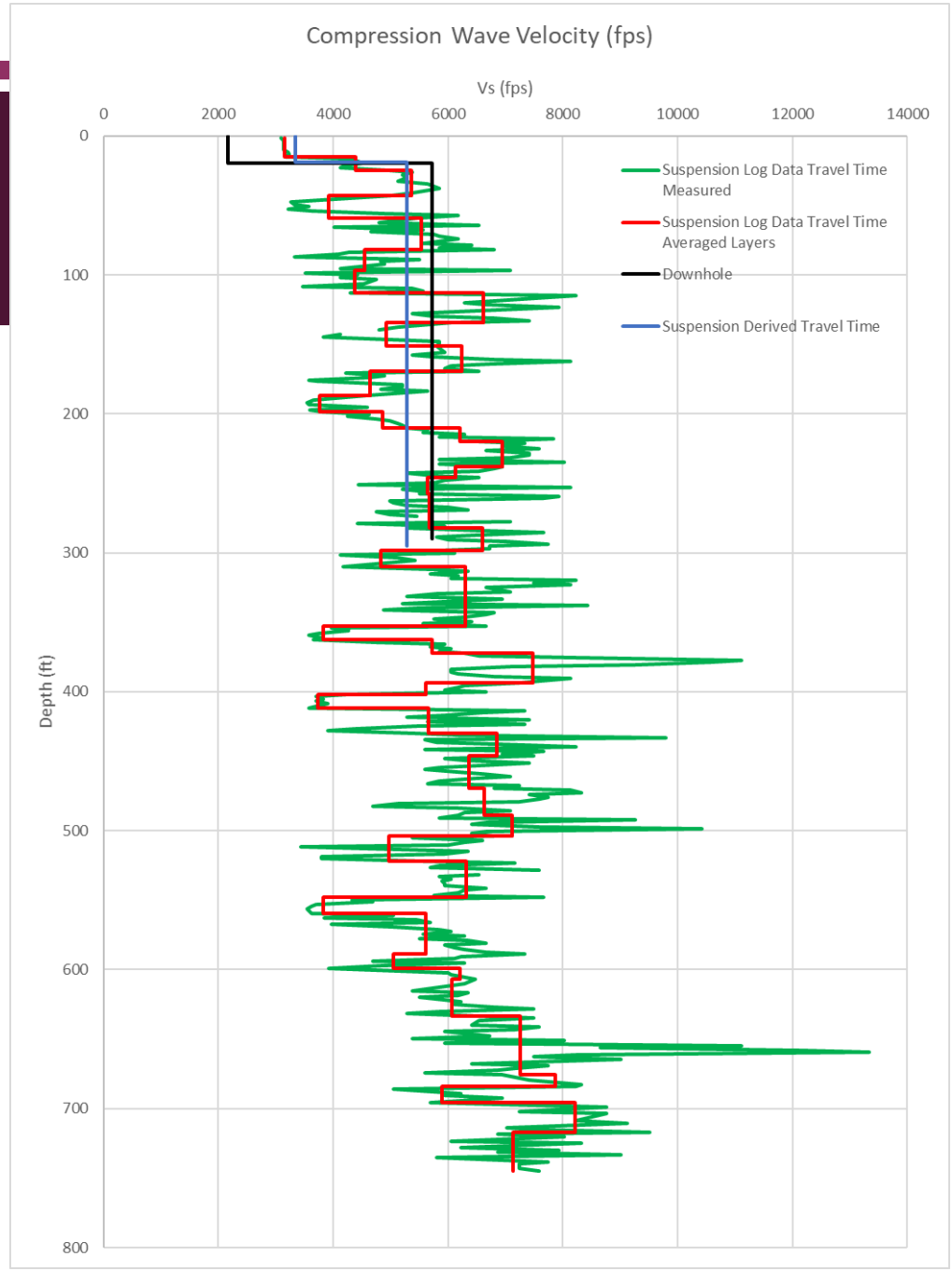
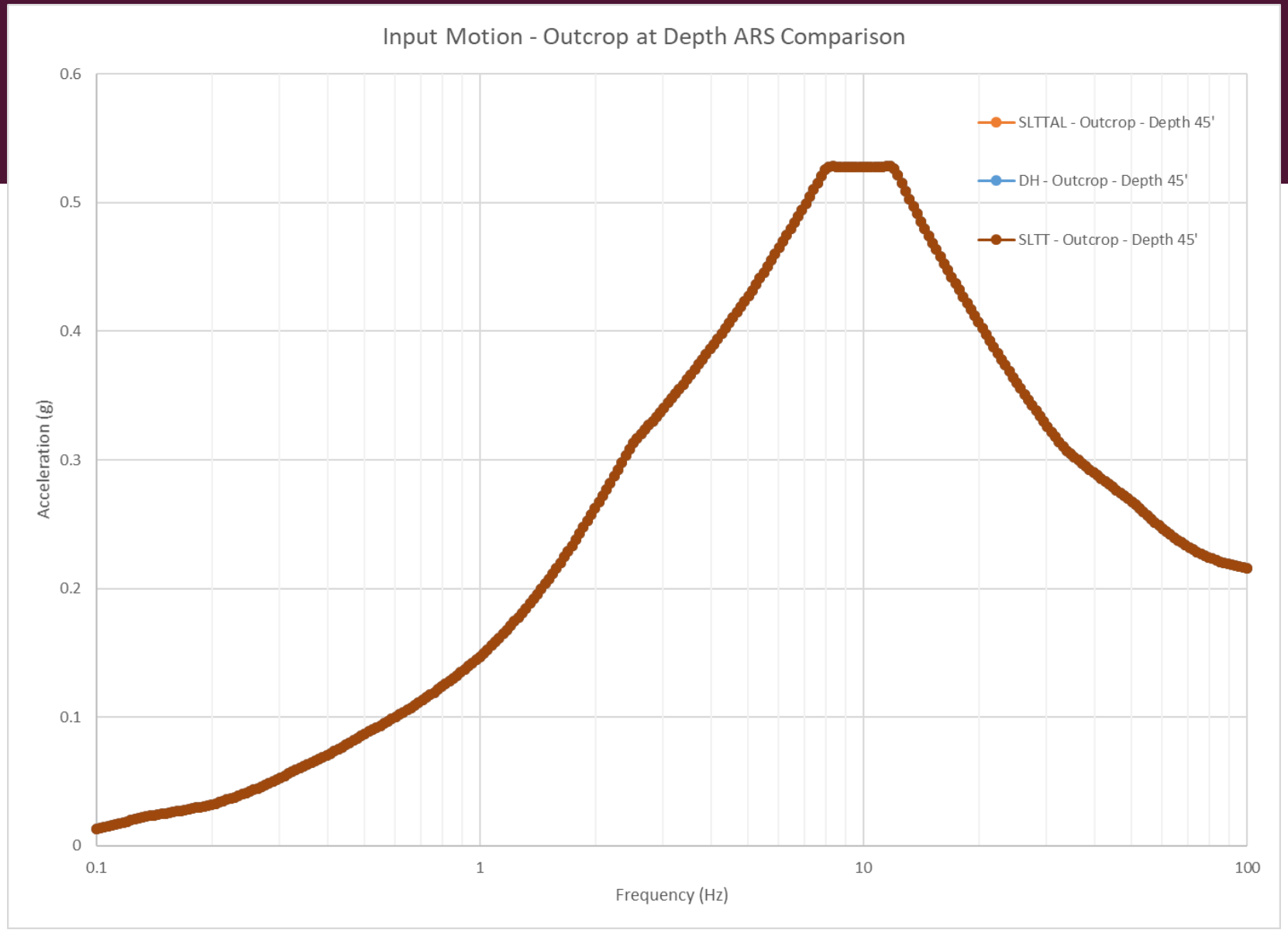




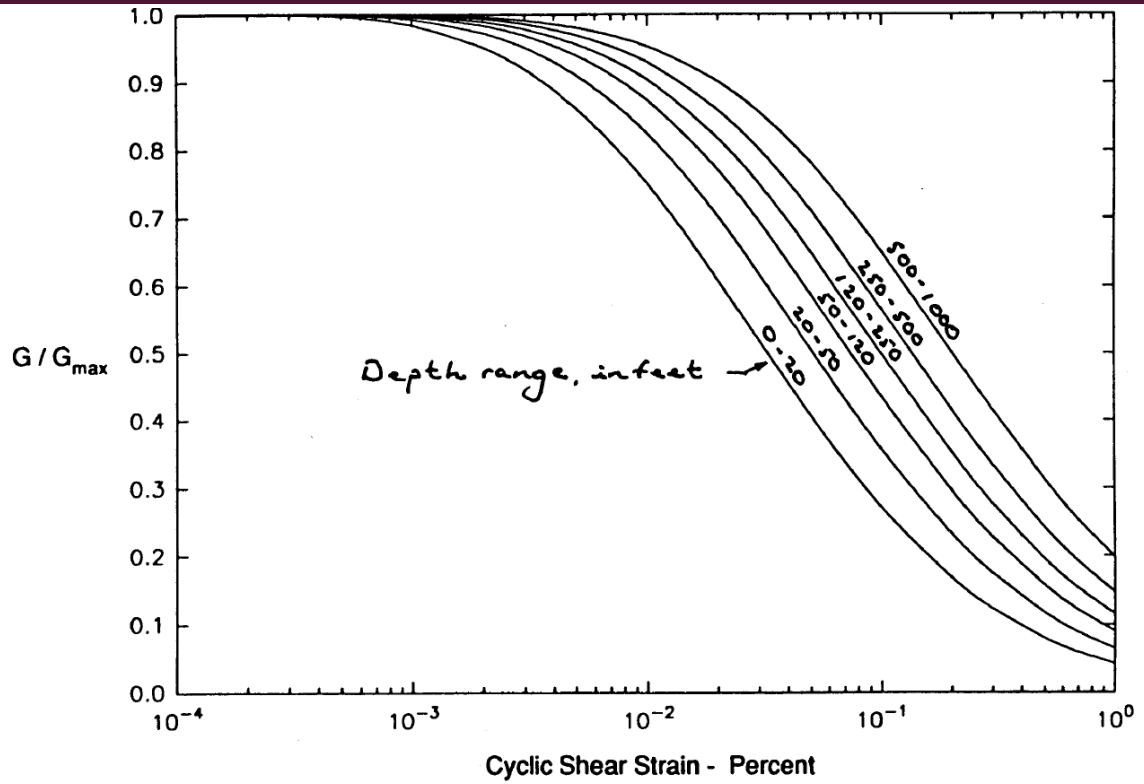
INPUT MOTION

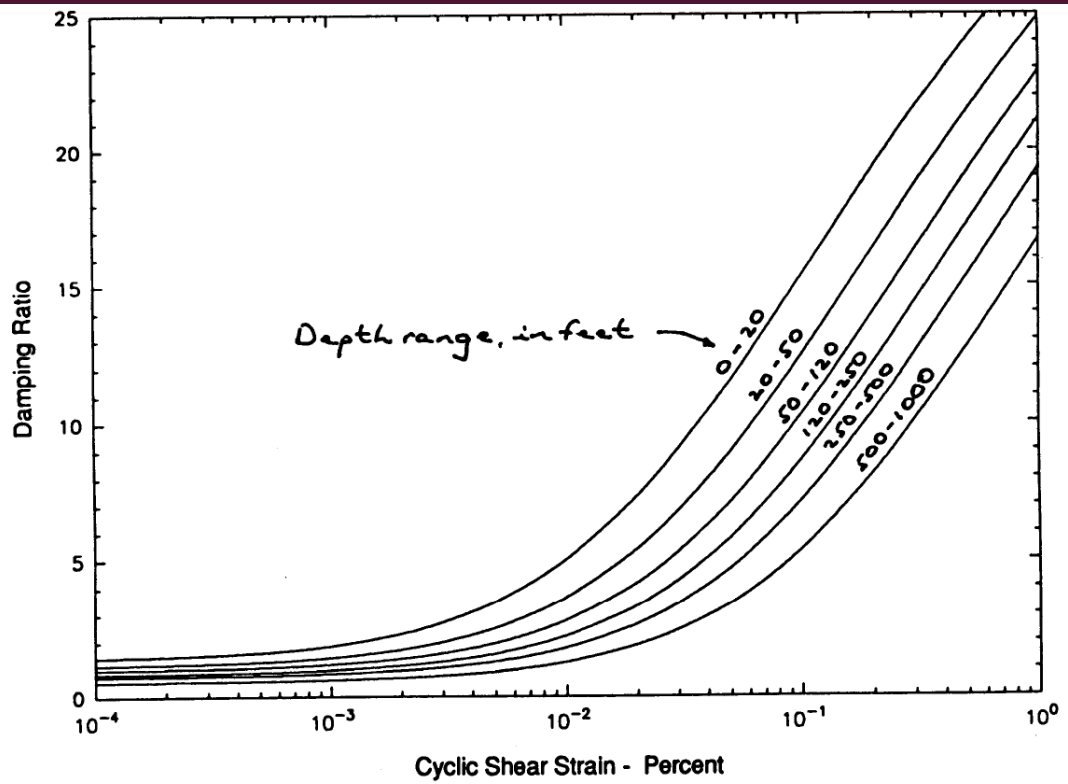


ANALYSIS

- PSHAKE Soil Column Analysis
  - Random Vibration Theory with ARS input
- Input at approximately 45’ depth
  - Main foundation depth
- Consistent 0.152 kcf unit weight and 1.5% damping are used
- All layers are considered linear except the top 20’ of the column which is assigned the EPRI degradation/damping curve
  - Source for EPRI curve? EPRI TR-102293 Guidelines for Determining Design Basis Ground Motions Vo. 2, November 1993

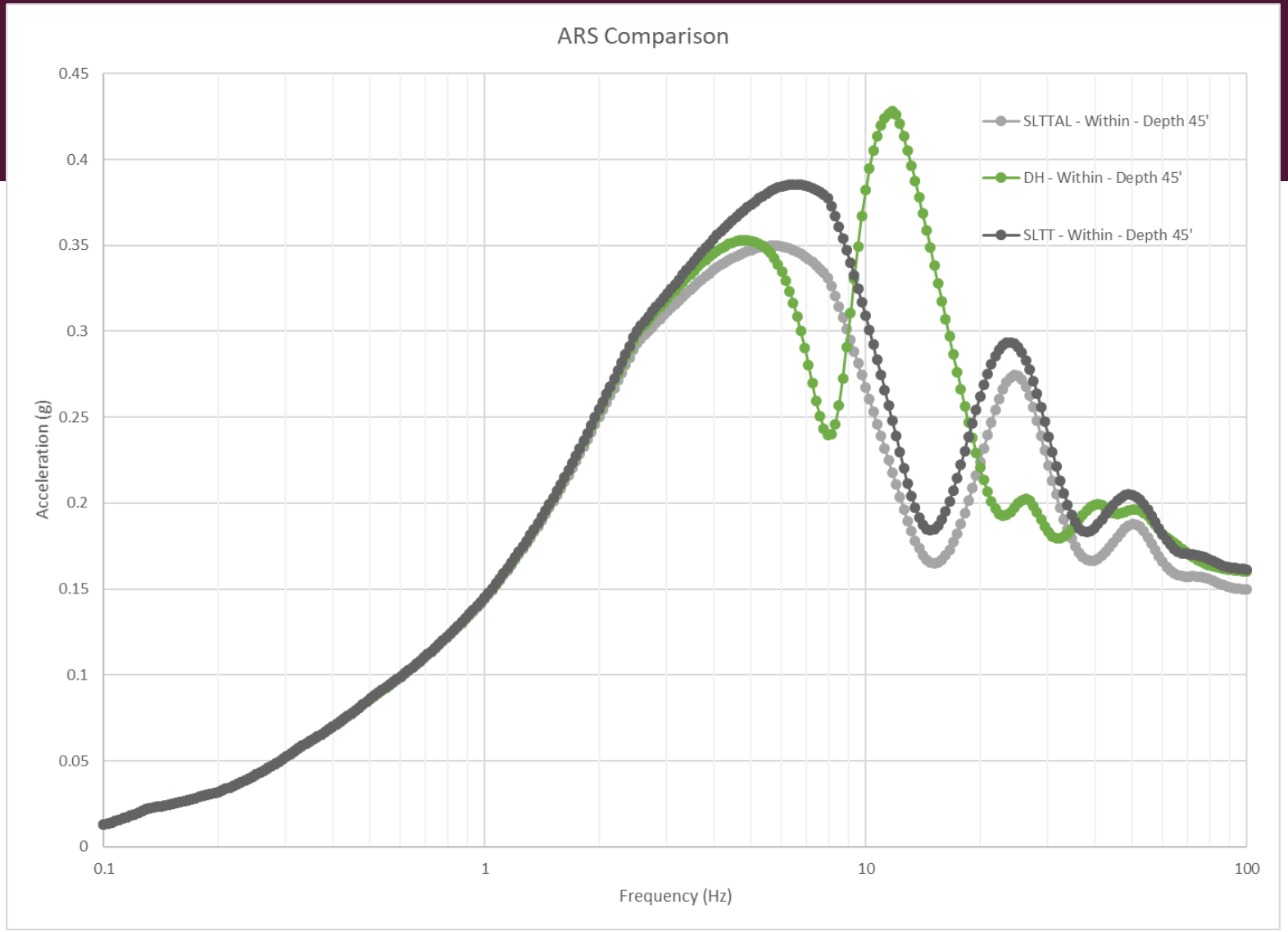
EPRI 1993 CURVES





AT DEPTH WITHIN

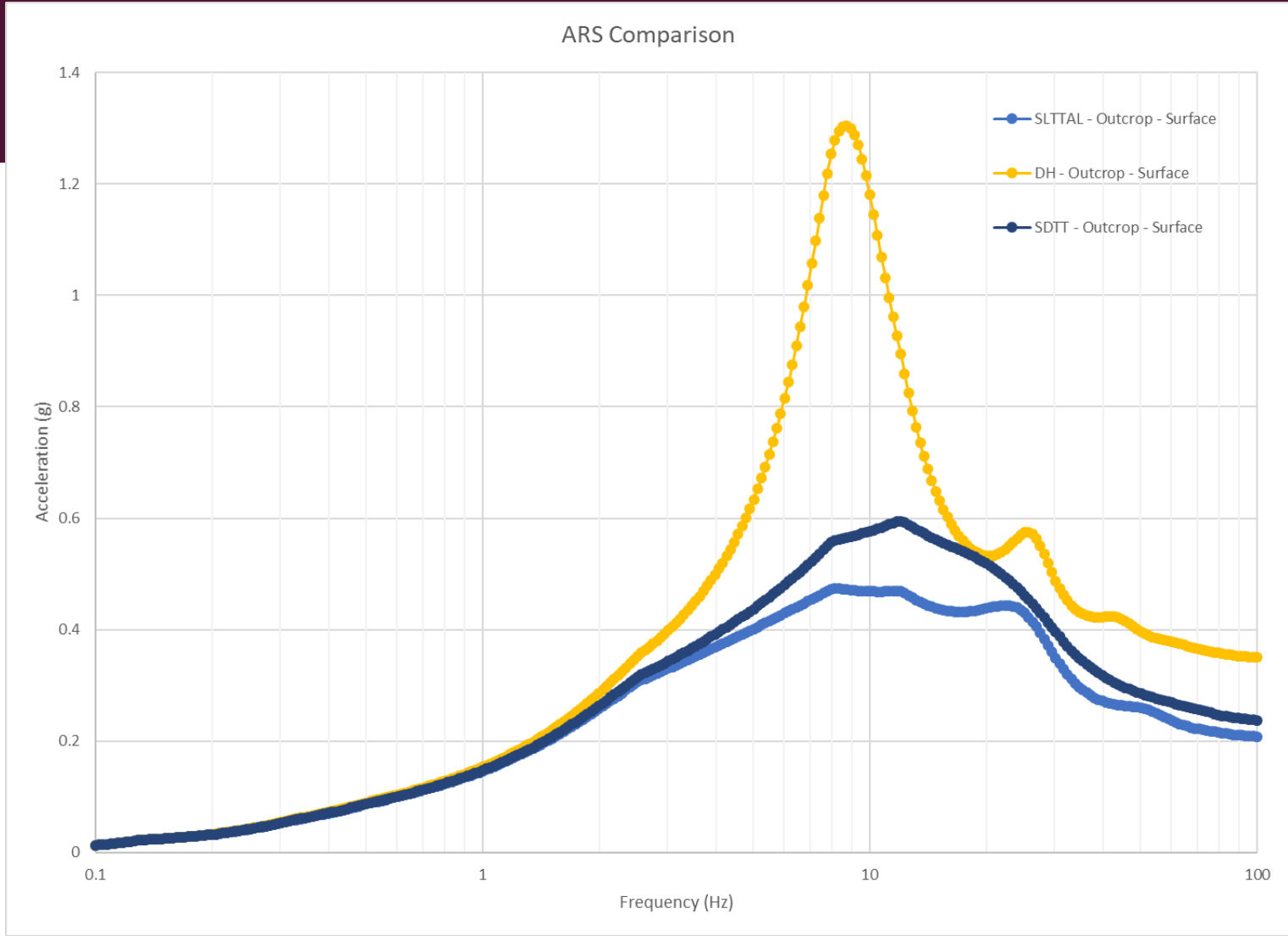
- Downhole (DH) profile has top layer with significantly lower Vs
- Suspension Logger Travel Time Averaged Layers (SLTTAL) has velocity reversals throughout depth
- Suspension Derived Travel Time (SDTT) has a smoother Vs profile



SURFACE OUTCROP

DH surface outcrop is significantly higher as the secondary response of the soil column is shifted to the right near the peak of the input ARS

SDTT is slightly higher than the SLTTAL response consistent with the within at-depth responses

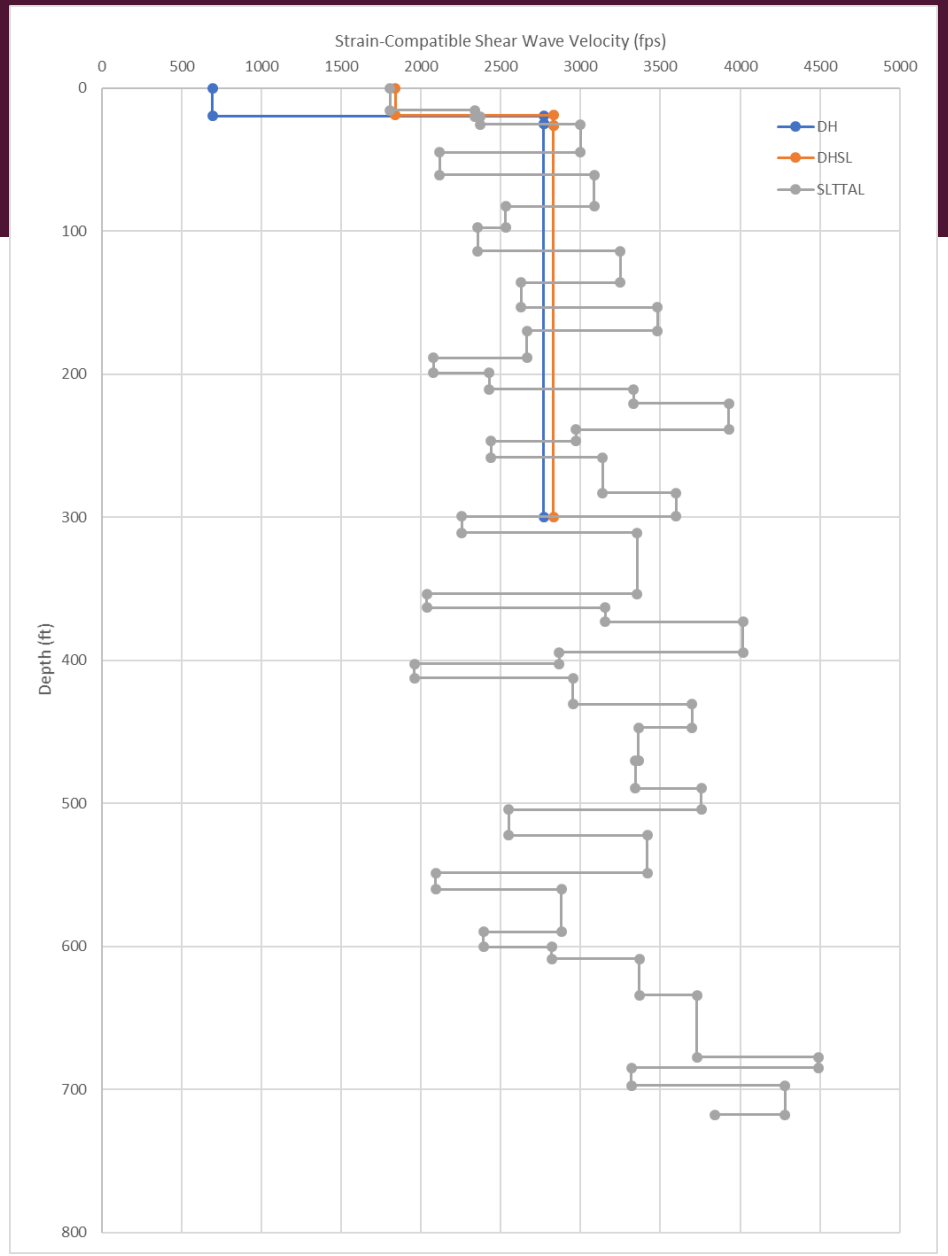


STRAIN COMPATIBLE Vs

Lower VS low strain downhole column is more affected by the soil column analysis

Highlights the need to understand uncertainties in the input

- Important to do sensitivity studies with different sources
- May lead to enveloping of different cases



OBSERVATIONS

- Lower velocity top layer amplifies the surface response, likely can be attributed to resonance with the input motion
  - The soil column analysis results in significantly lower modulus for this case
- Column with velocity reversals matching the measured suspension logging data results in a lower seismic response compared to the consistent averaged column

CONCLUSIONS

- More studies are needed to assess impact of the deep portion of the column and depth of the input motion
- Not surprisingly, softer surface layers have significant affect on seismic response throughout the column
- Columns with velocity reversals may impart a damping effect on the overall column response

QUESTIONS?