SASSI Analytical Methods Compared with SHAKE Results

Structural Mechanics – SRS

October 4, 2011

Objective

This study presents a methodology for validating SASSI for use with a particular site profile, foundation size, and embedment depth.

Two case studies are presented:

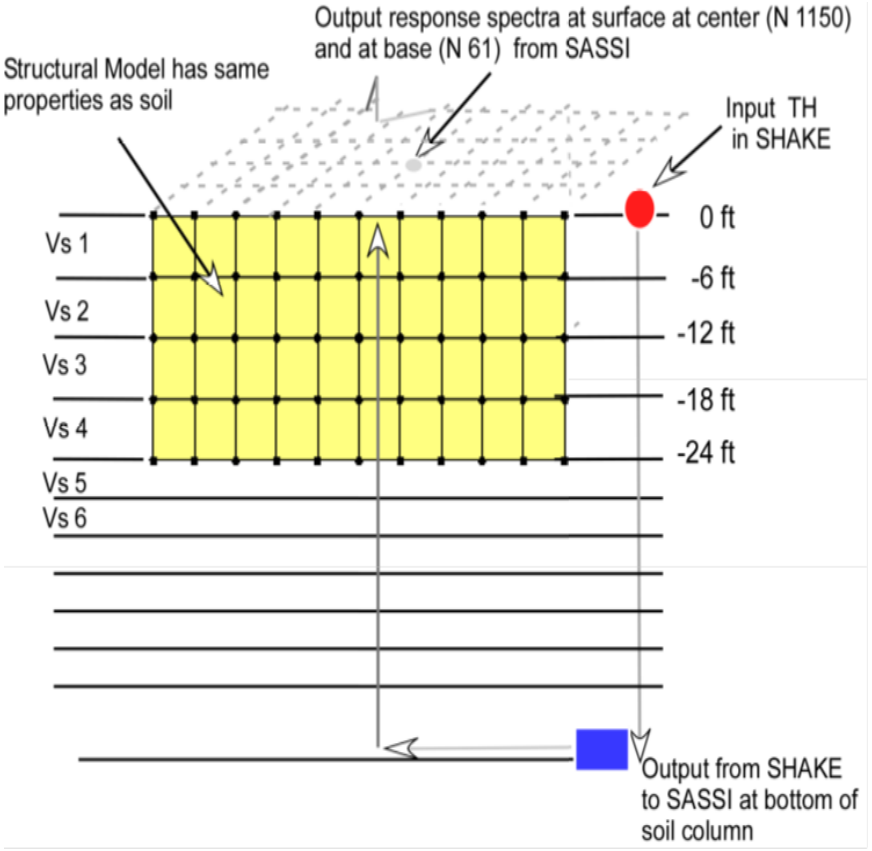
1) a deep soil site at the Savannah River Site (SRS)
2) a shallow stiff soil site at the Hanford Waste Treatment Plant (WTP).

Embedded box in SASSI is evaluated with Direct Method and (Modified) Subtraction method.

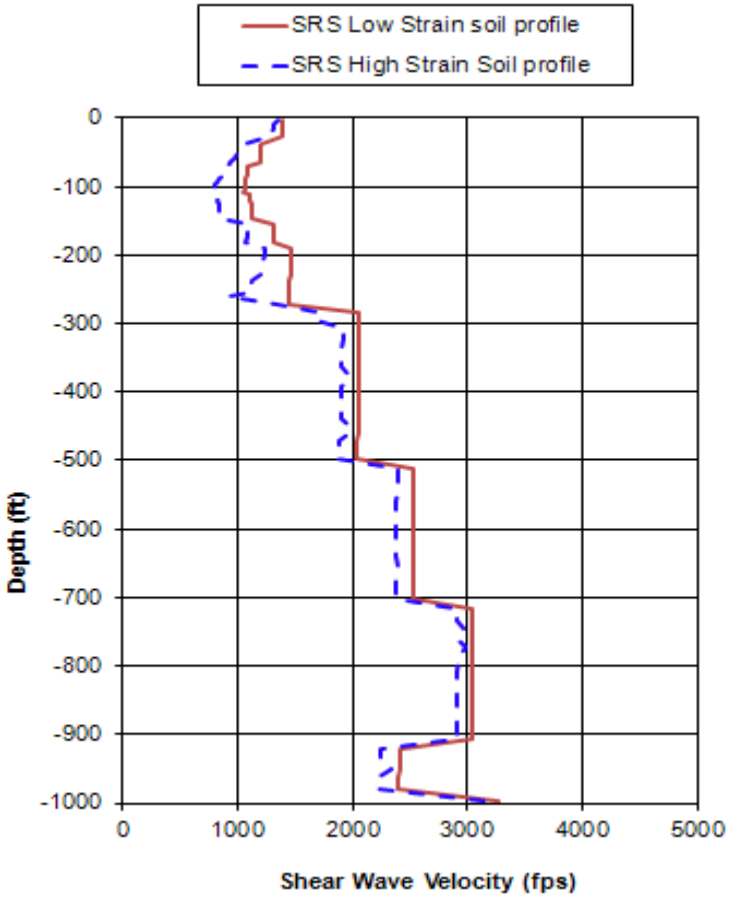
Methodology

- Ground motion at the surface is deconvolved in SHAKE to the bottom of the soil column and then brought back to the surface in a SASSI embedded box model.

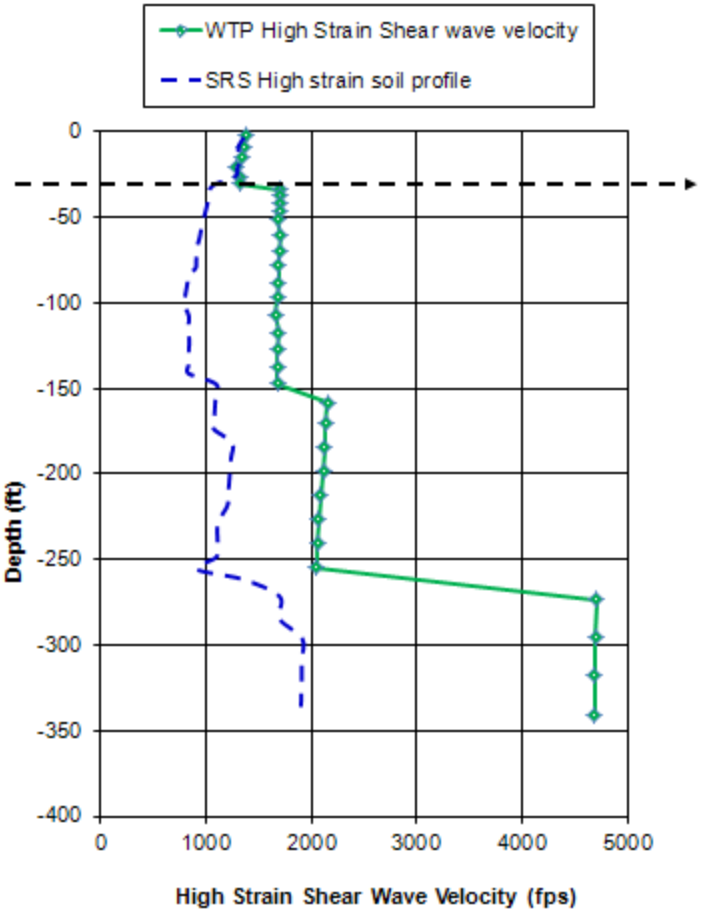
- SASSI response spectra at the ground and foundation levels are compared with spectra derived from SHAKE results to validate SASSI properly transmits motion through the soil profile.



Soil Profile at SRS vs. WTP

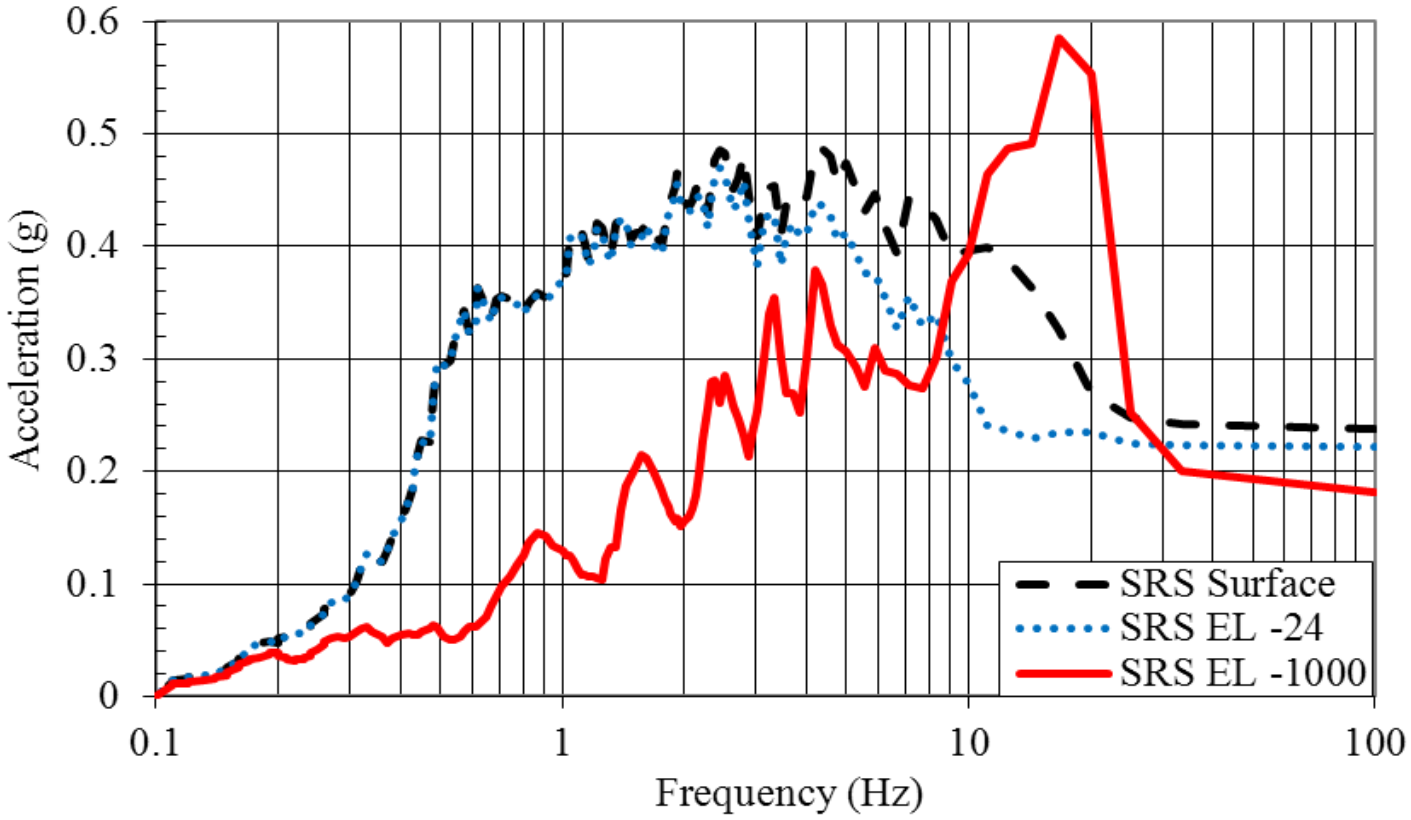


SRS Site 1000-ft best estimate soil
High strain vs. low strain
shear wave velocity (fps)



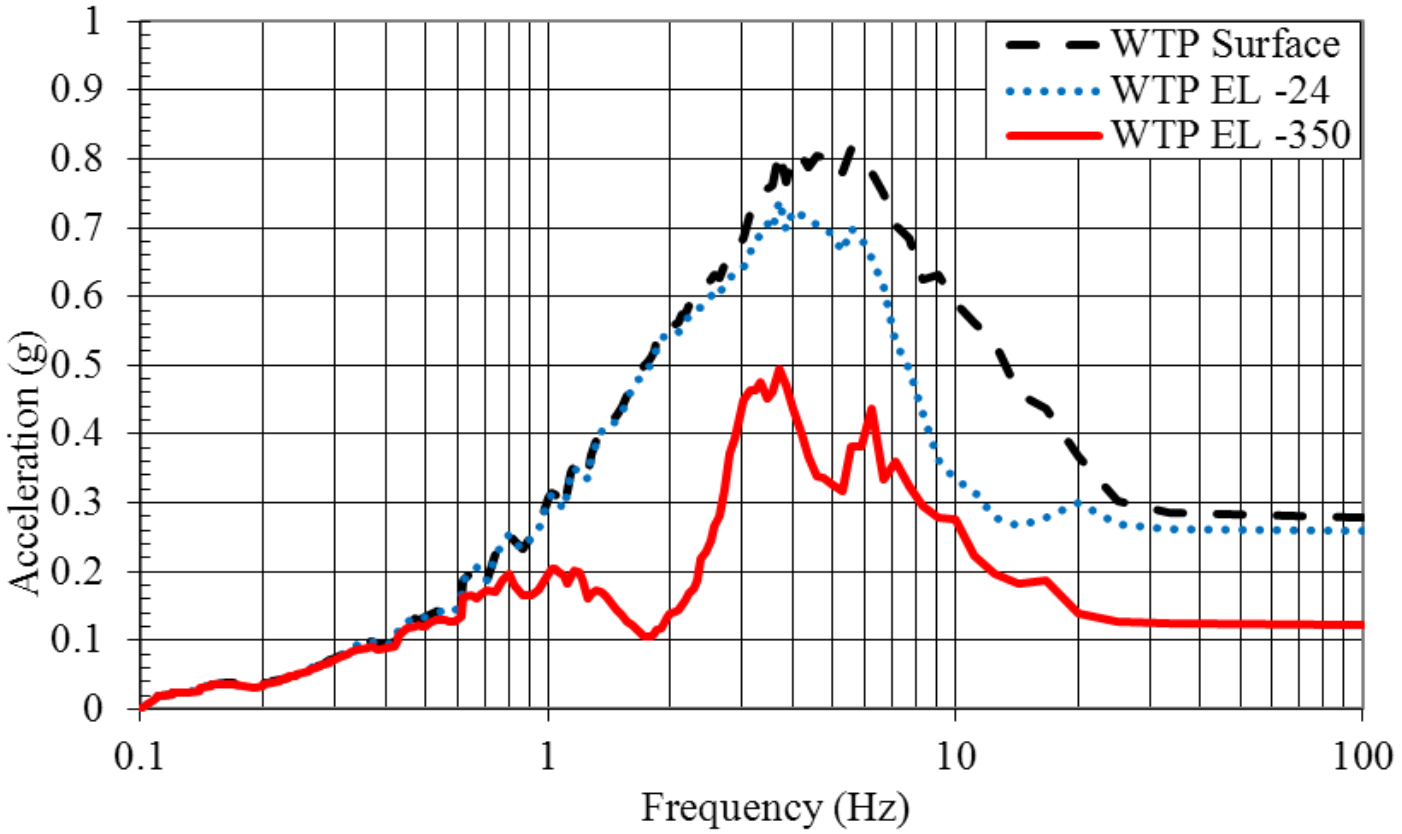
WTP high strain vs. SRS
high strain soil

SRS spectra at different level (SHAKE)



SRS response spectra at surface, -24 ft and -1000 ft

WTP spectra at different level (SHAKE)



WTP response spectra at surface, -24 ft and -350 ft

Model Statistics

Using the maximum element size and 1/5 λ_s criteria:

The elements horizontal and vertical distance is 6 feet. Soil layer below foundation V_s =1276 ft/sec / (5*6 ft) = 32 Hz,

cut-off frequency used is

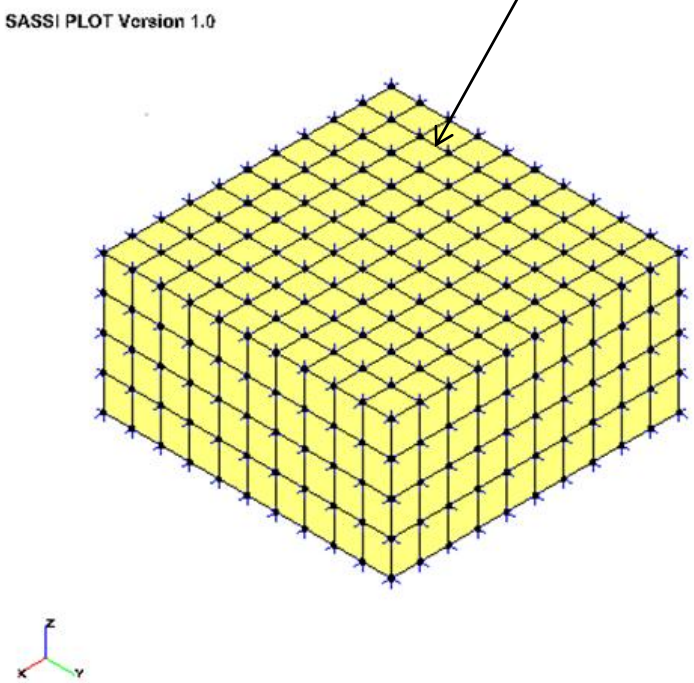
	Critical V_s. (Hz)	Mesh Limiting Freq (Hz)	Cut-Off Freq (Hz)
SRS BE :	1276 ft/s	32	20

Total number of nodes 3D FEM BOX (50-ft x 50-ft x 24 feet deep)

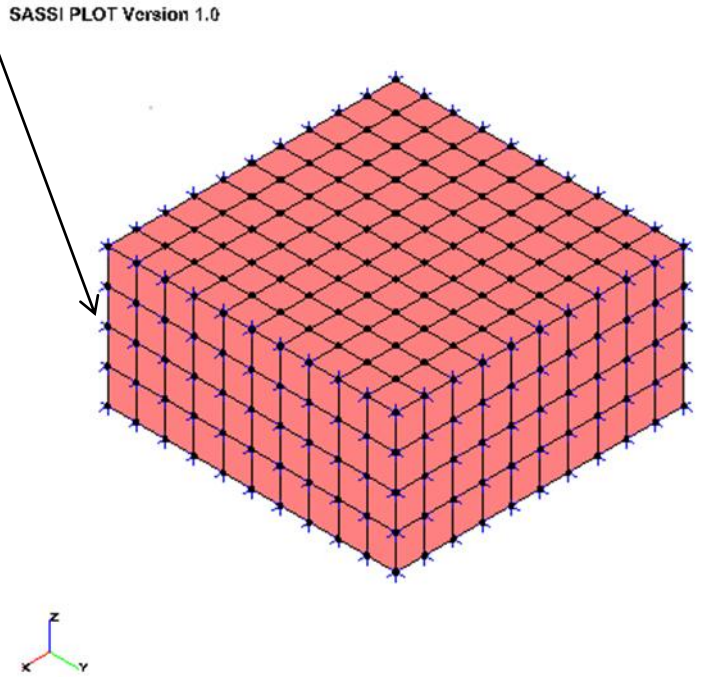
SASSI	Total nodes	Interaction nodes	8 Node Brick & soil elem
Subtraction	1210	281	400
Modified subtraction	1210	362	400
Direct Method	1210	605	400

3D FEM Box Embedded Box Model

Interaction Nodes

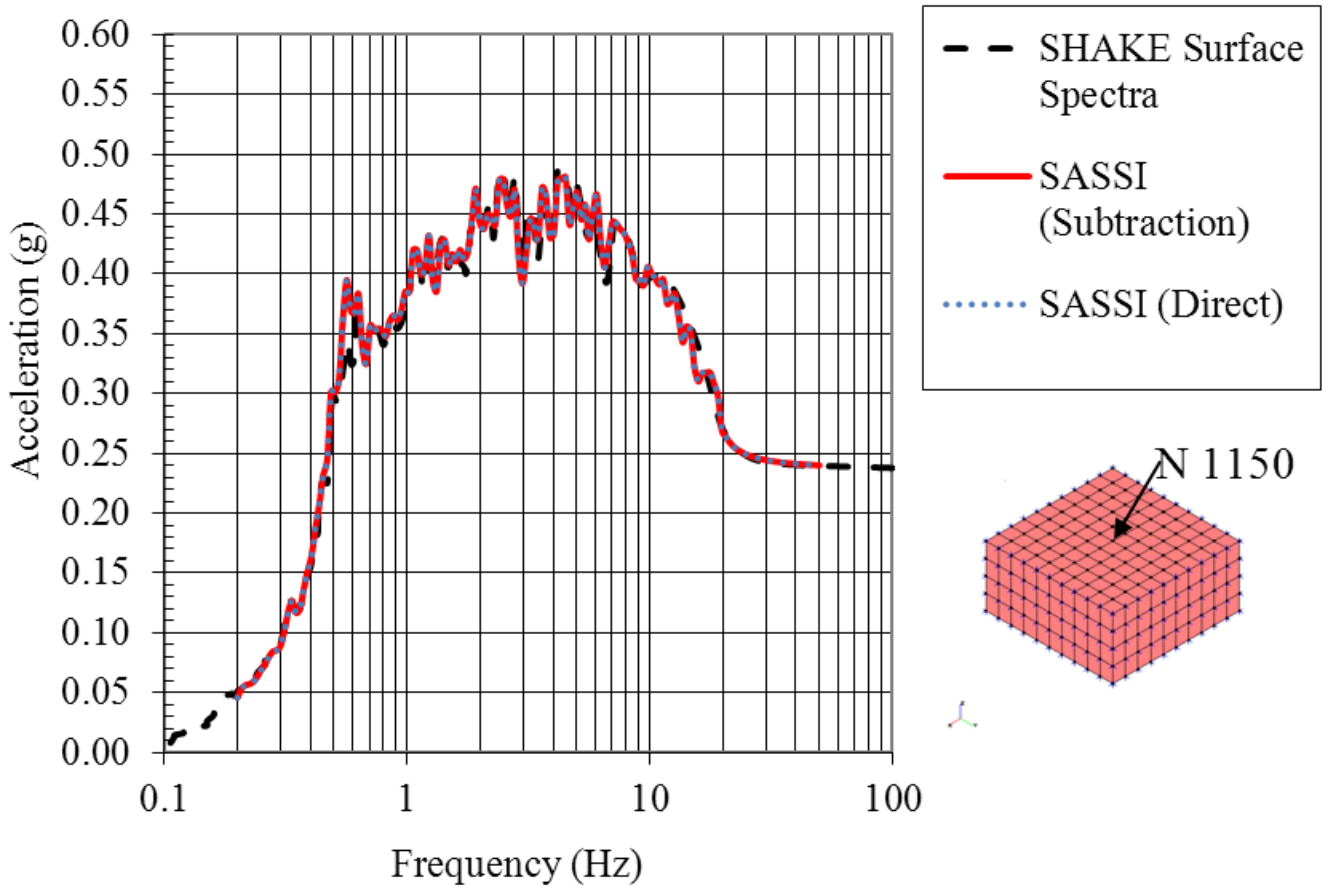


Direct Method Model

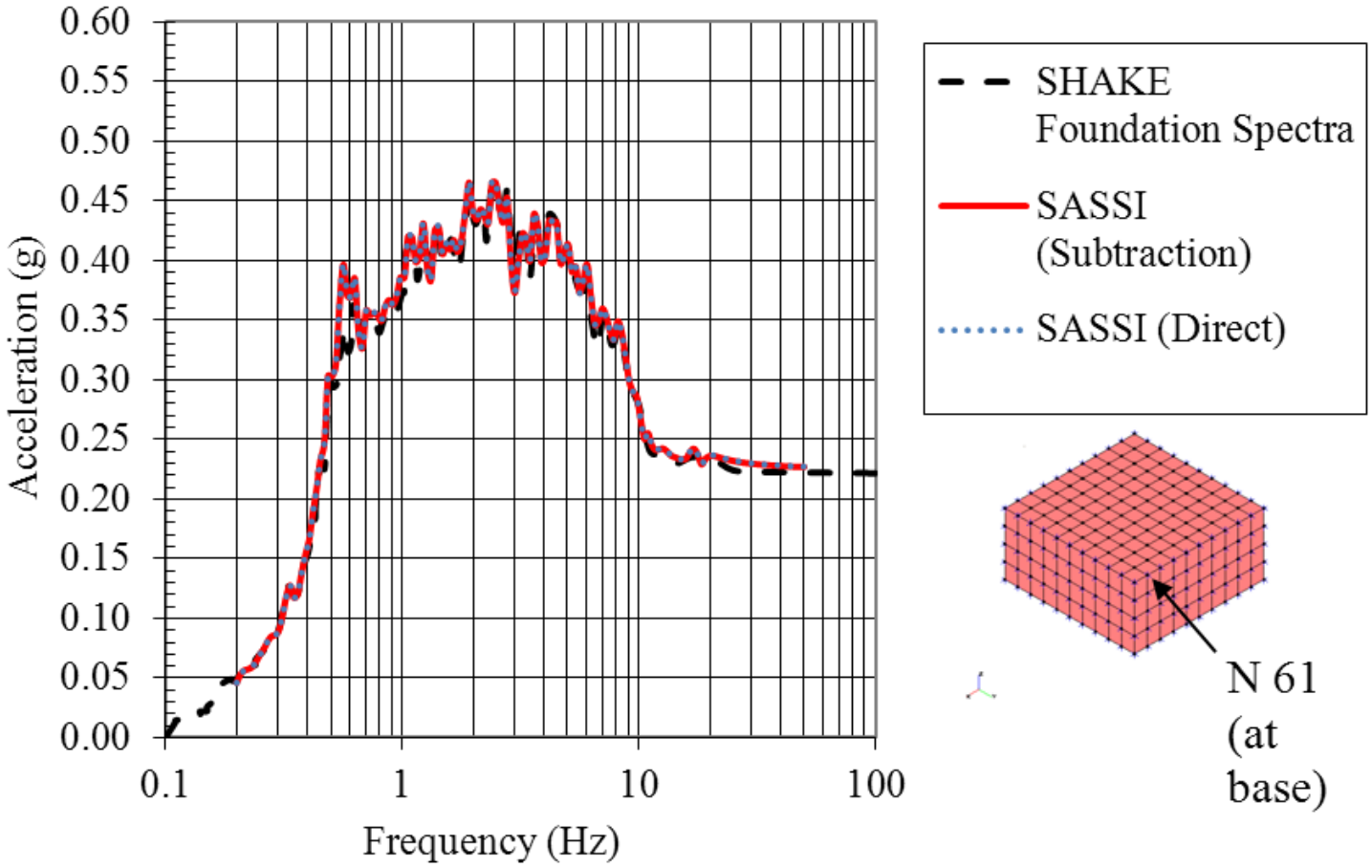


Subtraction Method
(top layers are not interaction nodes)

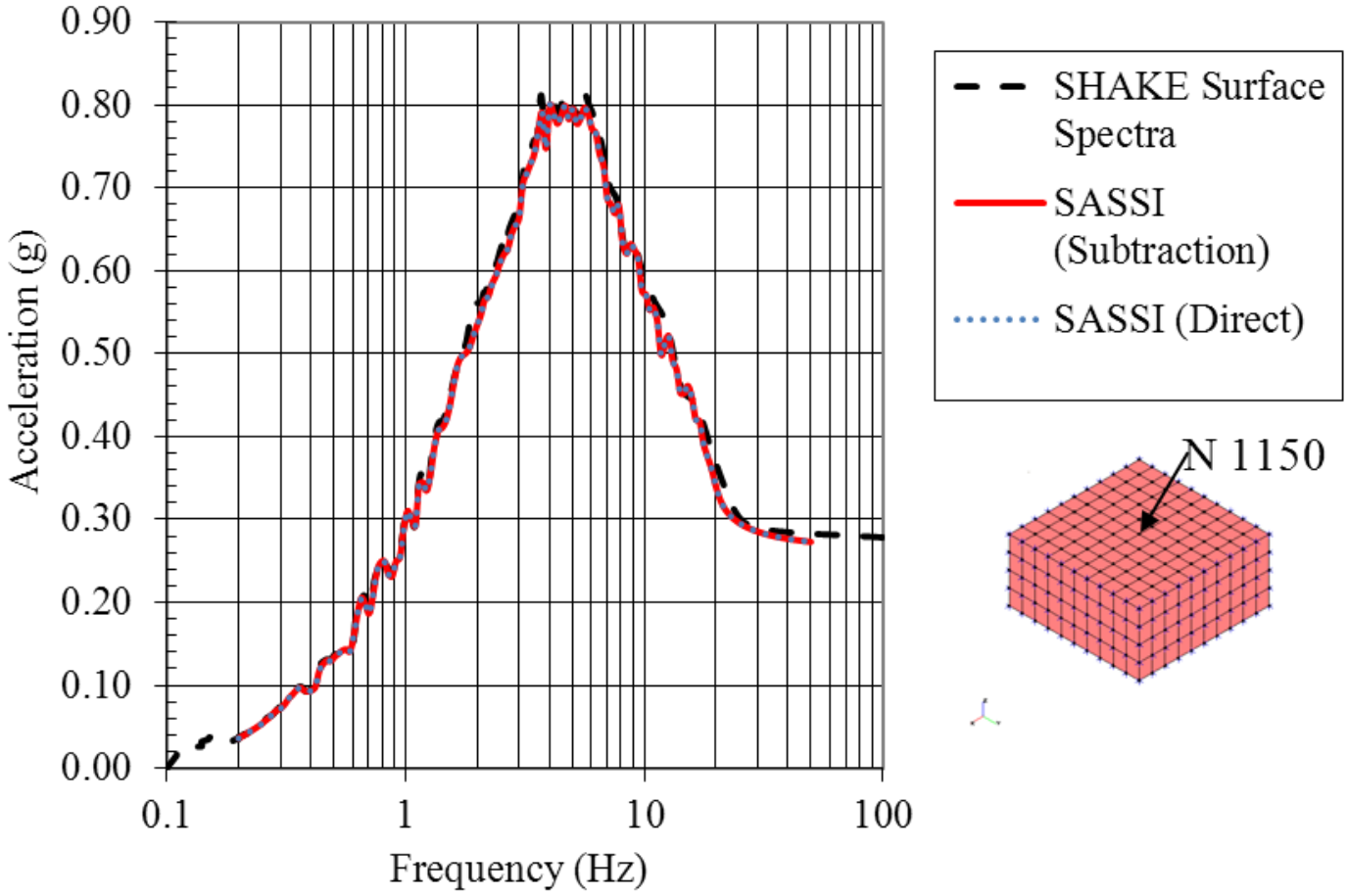
Comparison of Response Spectra from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at Top of Box (1000 feet SRS soil depth)



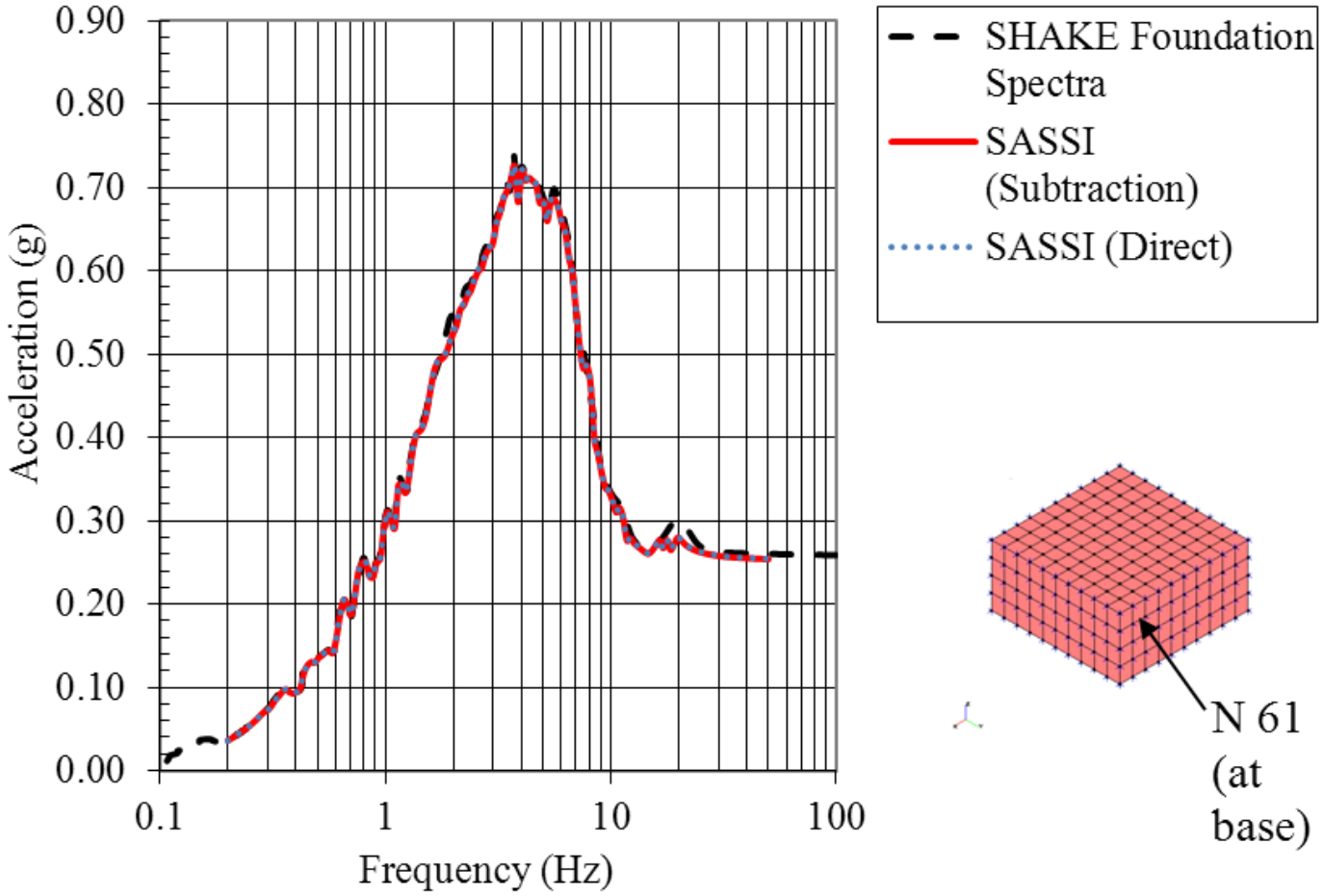
Comparison of Response Spectra from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at foundation level (1000 feet SRS soil depth)



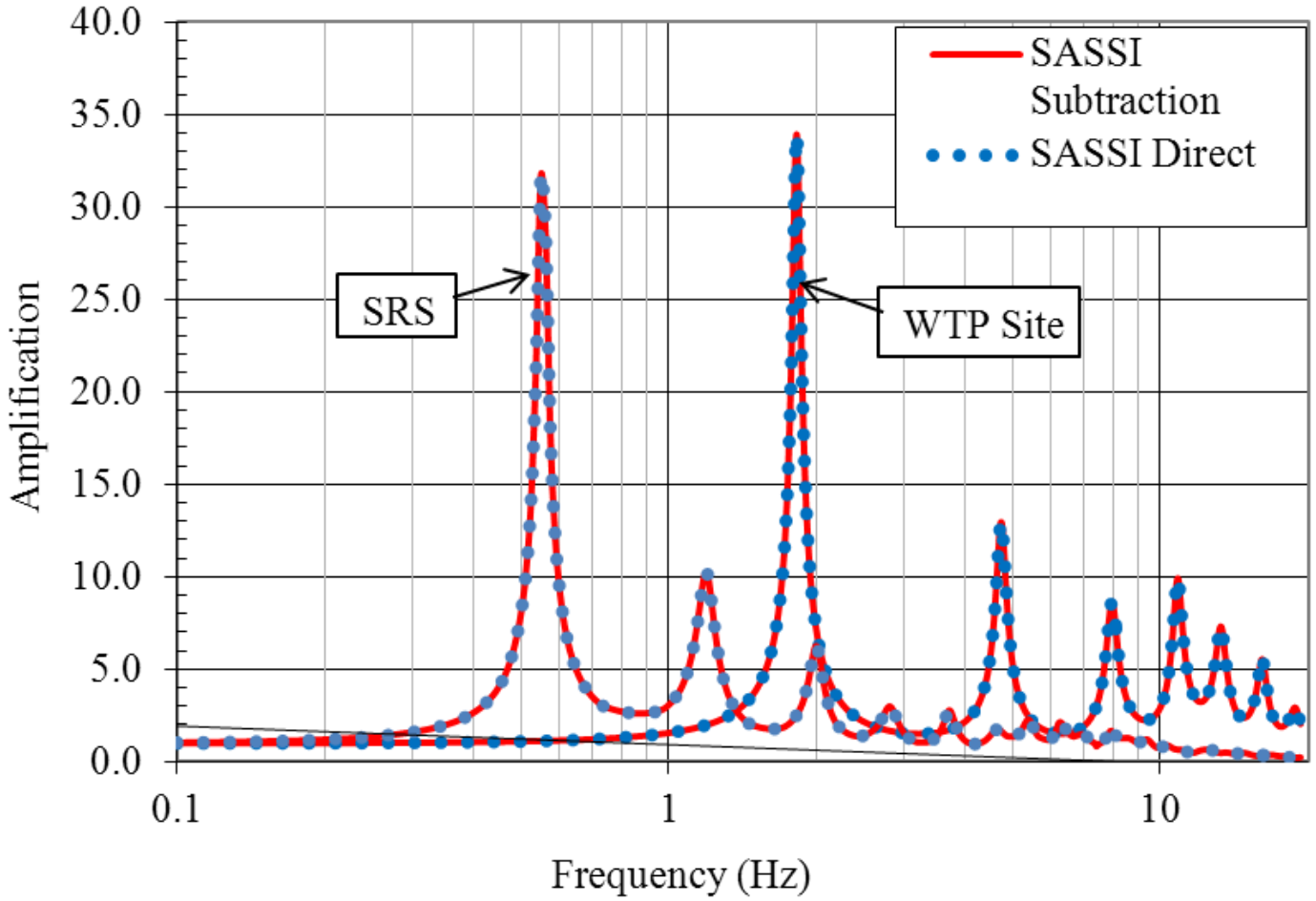
Comparison of Response Spectra from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at surface level of Box (350 feet WTP soil depth)



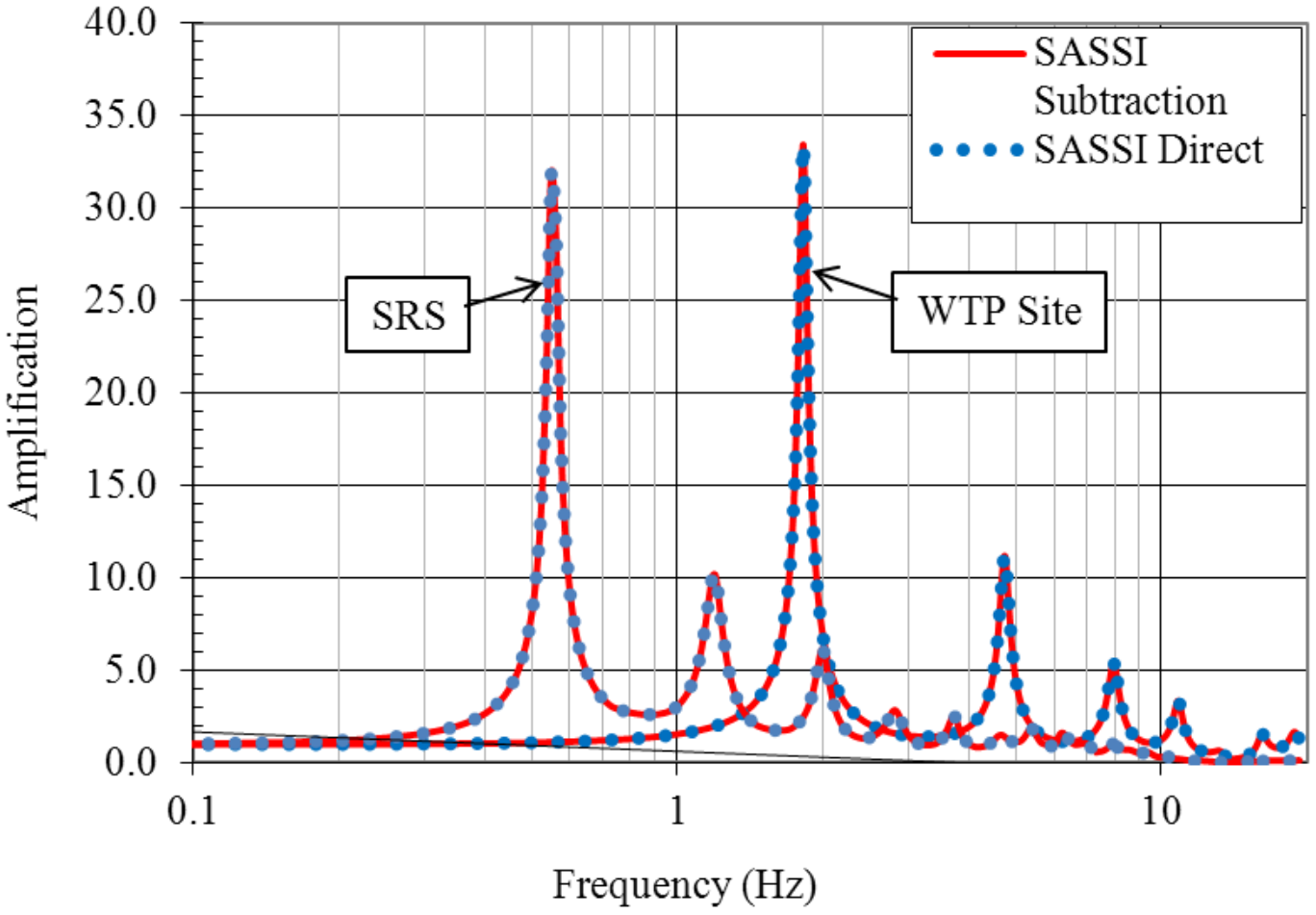
Comparison of Response Spectra from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at foundation of Box (350 feet WTP soil depth)



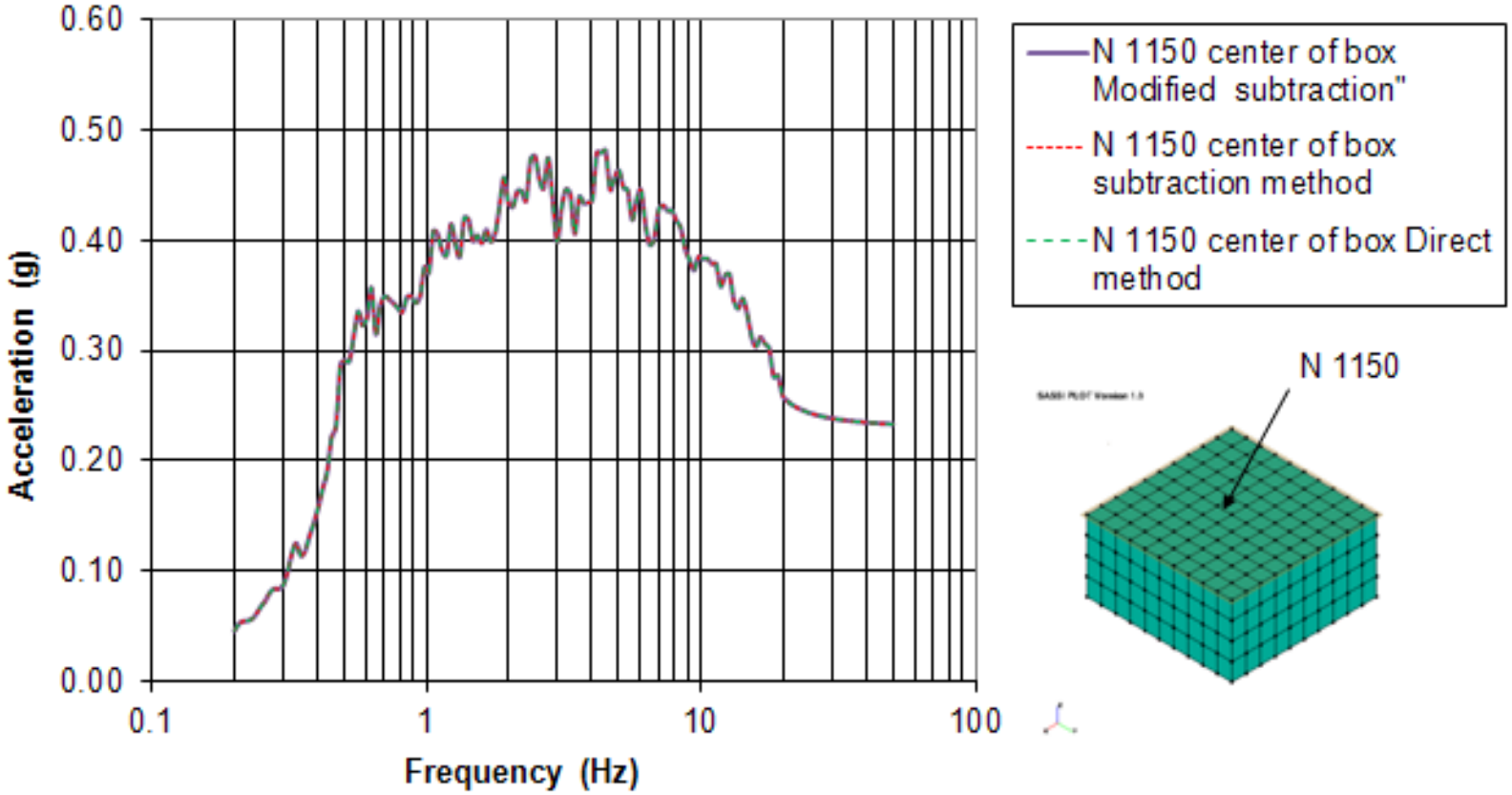
Comparison of Transfer functions from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at foundation level of box (SRS 1000 ft, WTP 350 ft soil depth)



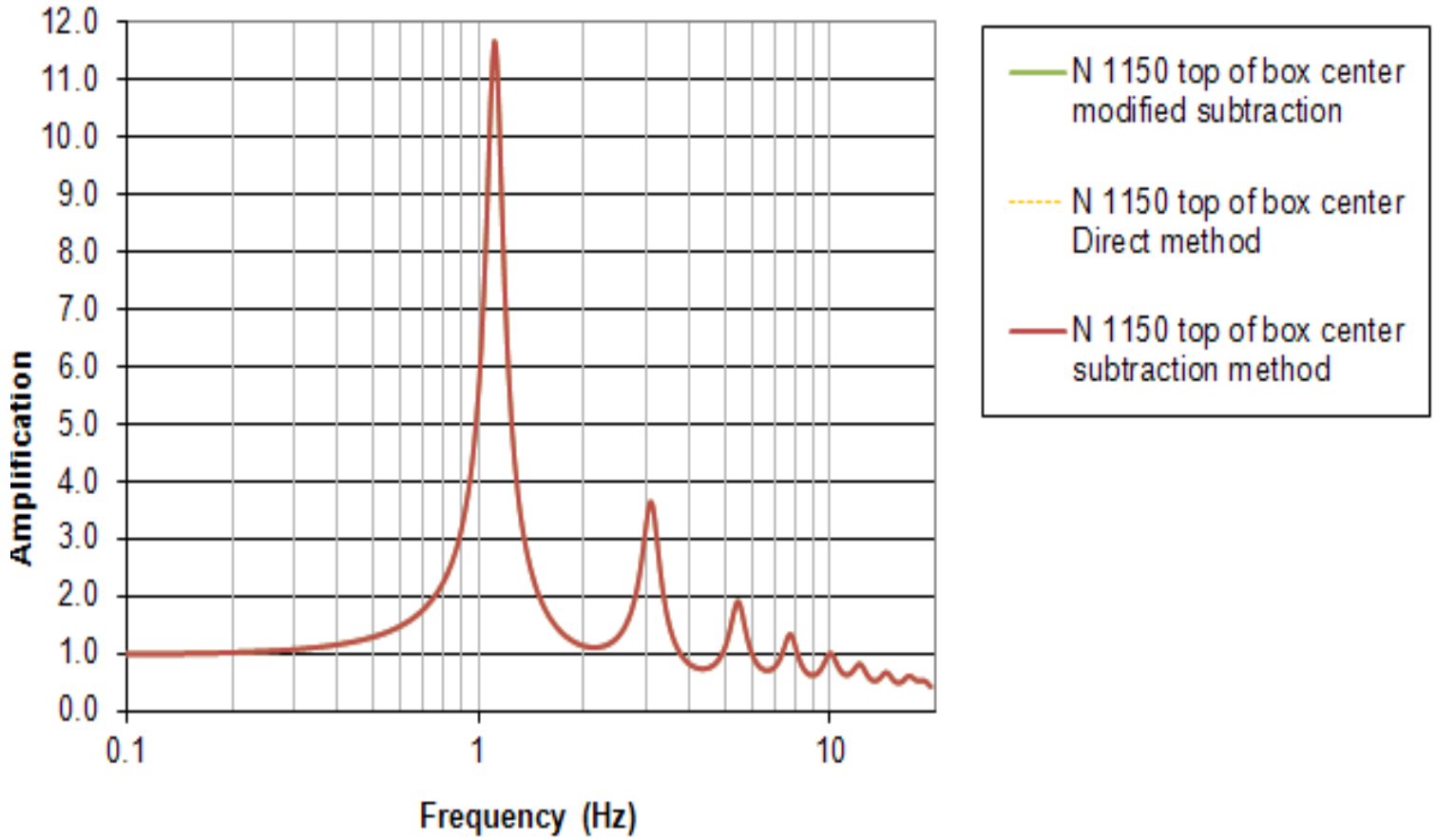
Comparison of Transfer functions from SASSI Direct vs. Subtraction (surface nodes interaction nodes) at surface level of box (SRS 1000 ft, WTP 350 ft soil depth)



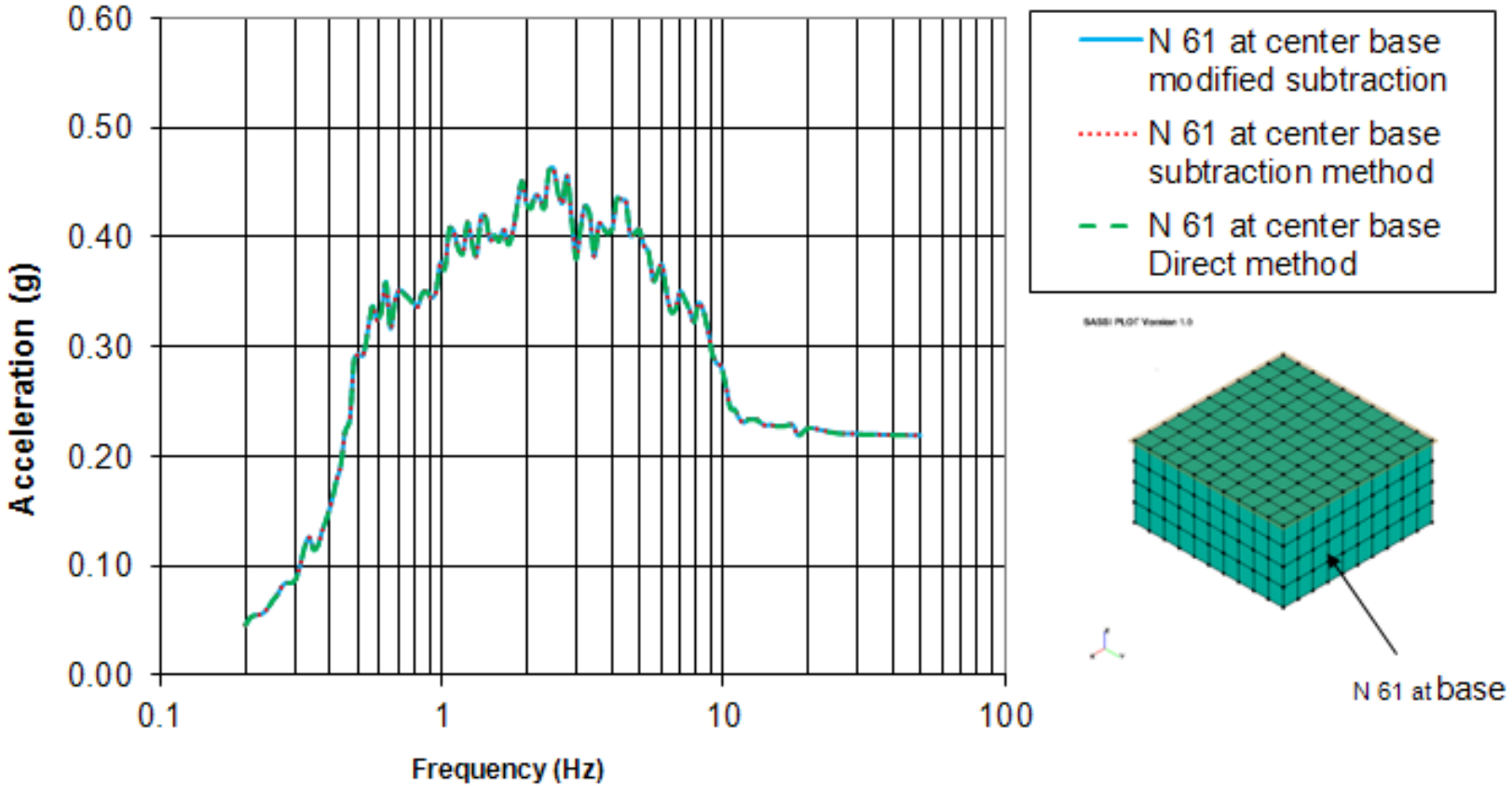
Comparison of Response Spectra from SASSI Direct vs. Subtraction vs. Modified subtraction Method at Top of Box (250 feet SRS soil depth)



Comparison of transfer function from SASSI Direct vs. Subtraction vs. Modified subtraction Method at Top of Box (250 feet SRS soil depth)



Comparison of Response Spectra from SASSI Direct vs. Subtraction vs. Modified subtraction Method at Foundation of Box (250 feet SRS soil depth)



Conclusions

The methodology presented in this paper provides a framework for validating that SASSI properly transmits ground motion through a given site by modeling an embedded box with structural properties equal to that of the surrounding soil.

Two cases studies are presented:

1) a deep soil site at SRS and
2) a shallow stiff soil site at WTP.

Conclusions

For both sites, the response spectra obtained at both the surface and the foundation levels from SASSI analysis of the embedded structure matches the response spectra derived from SHAKE.

The direct and (modified) subtraction method of SASSI produce nearly identical results for response spectra and transfer functions for these examples.

The methodology presented can be adapted for any soil site condition, foundation size, and structural embedment depth.