Application of the Computer Program SASSI for Seismic SSI Analysis of WTP Facilities

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Background

- **SASSI computer code was developed in the early 1980's to solve Soil-Structure-Interaction (SSI) problems**
  - Original version of SASSI was based on the **direct solution method** for embedded structures
    - Requires that each soil node in the excavated soil volume be an interaction node
  - **Subtraction solution method** was introduced in 1998
    - Requires that only perimeter nodes in the excavated soil volume be considered interaction nodes
    - Significantly reduces computational effort

Background

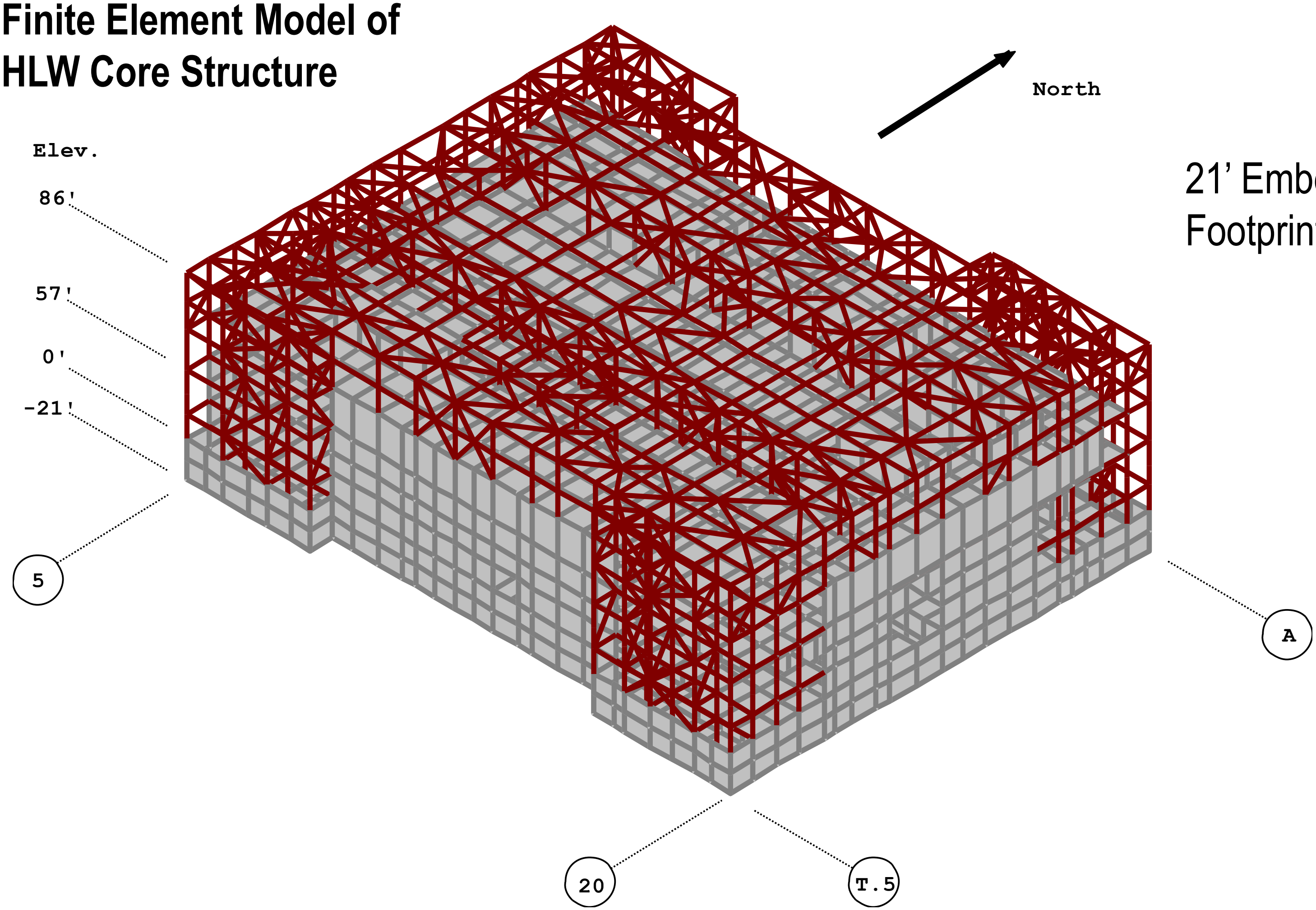
- **RPP-WTP facility includes two SC I (PC3) structures**
  - Pretreatment Facility
    - Surface structure
  - High-Level Waste Structure (HLW)
    - Shallowly embedded structure

Background

- **SSI analysis has been previously completed using the following:**
  - Extensive Finite Element Model
  - Simplified Stick Model
- **Correlation of dynamic properties has been demonstrated between the models**
  - Both models have been described in RPP-WTP structural summary report and reviewed by PRT and DFNSB

Background

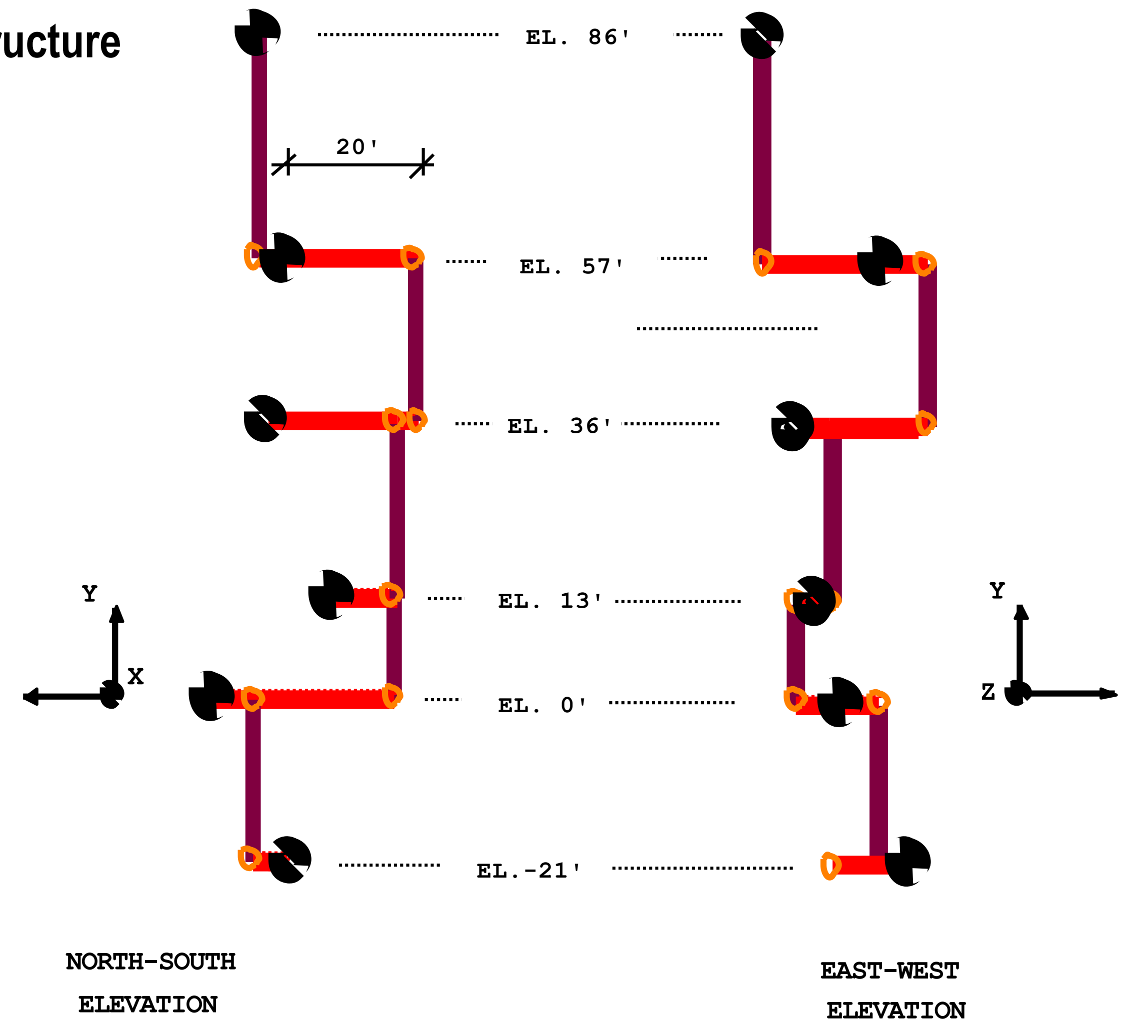
Finite Element Model of HLW Core Structure



21' Embedment Depth
Footprint: 438' x 236'

Background

Stick Model of HLW Core Structure



Objective

- **Compare results of HLW SSI analysis using two methods**
  - SASSI Direct Method
  - SASSI Subtraction Method
- **Confirm adequacy of the SASSI Subtraction Method analysis of the HLW structure using the SASSI Direct Method as a benchmark**

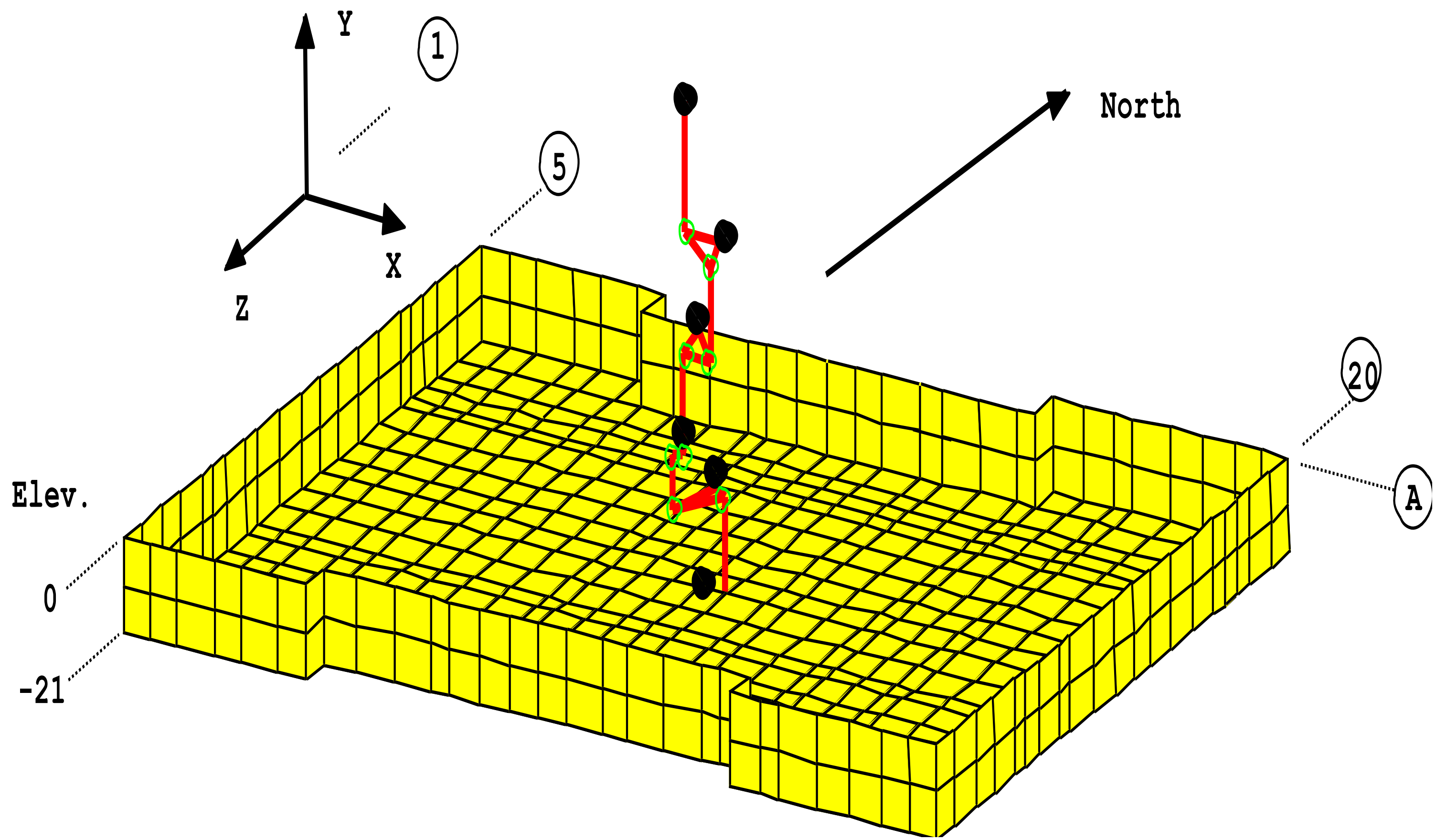
Methodology

- A Hybrid Finite Element Model and Stick Model representing the HLW Structure Core Structure is created
- Dynamic characteristics of all three models are correlated

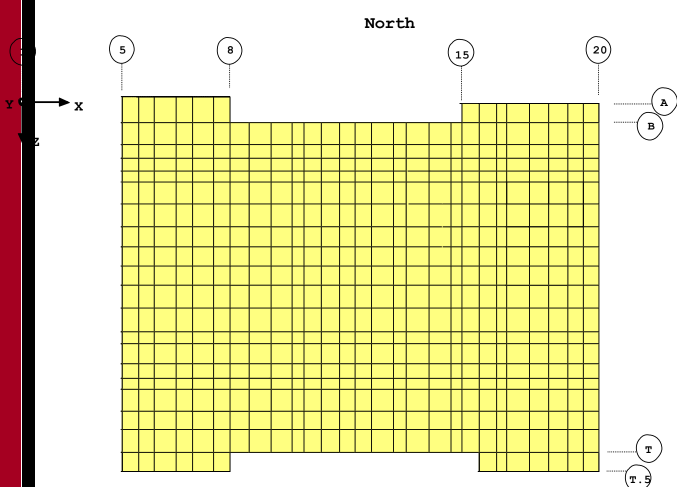
	X-Direction (EW)			Z-Direction (Vertical)		
Model	**Mode**	**Frequency (Hz)**	**Mass Participation**	**Mode**	**Frequency (Hz)**	**Mass Participation**
Finite Element	67	12.1	61.7%	80	13.0	20.1%
Stick	3	12.2	67.5%	4	13.0	77.6%
Hybrid	3	12.3	69.3%	4	12.9	78.5%

SSI Model

Hybrid Finite Element Model and Stick Model of HLW Core Structure

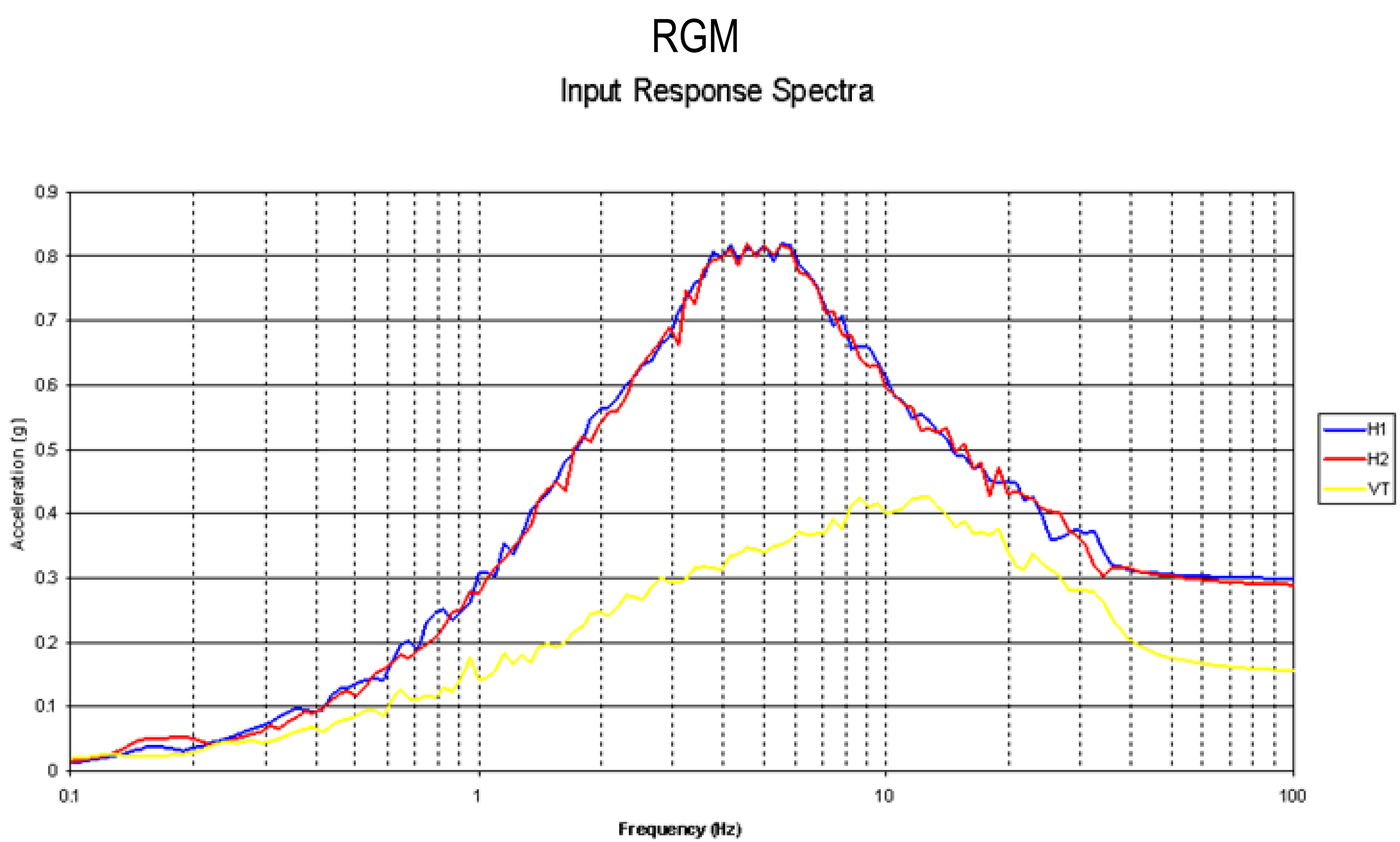


Element Size in Excavated Soil



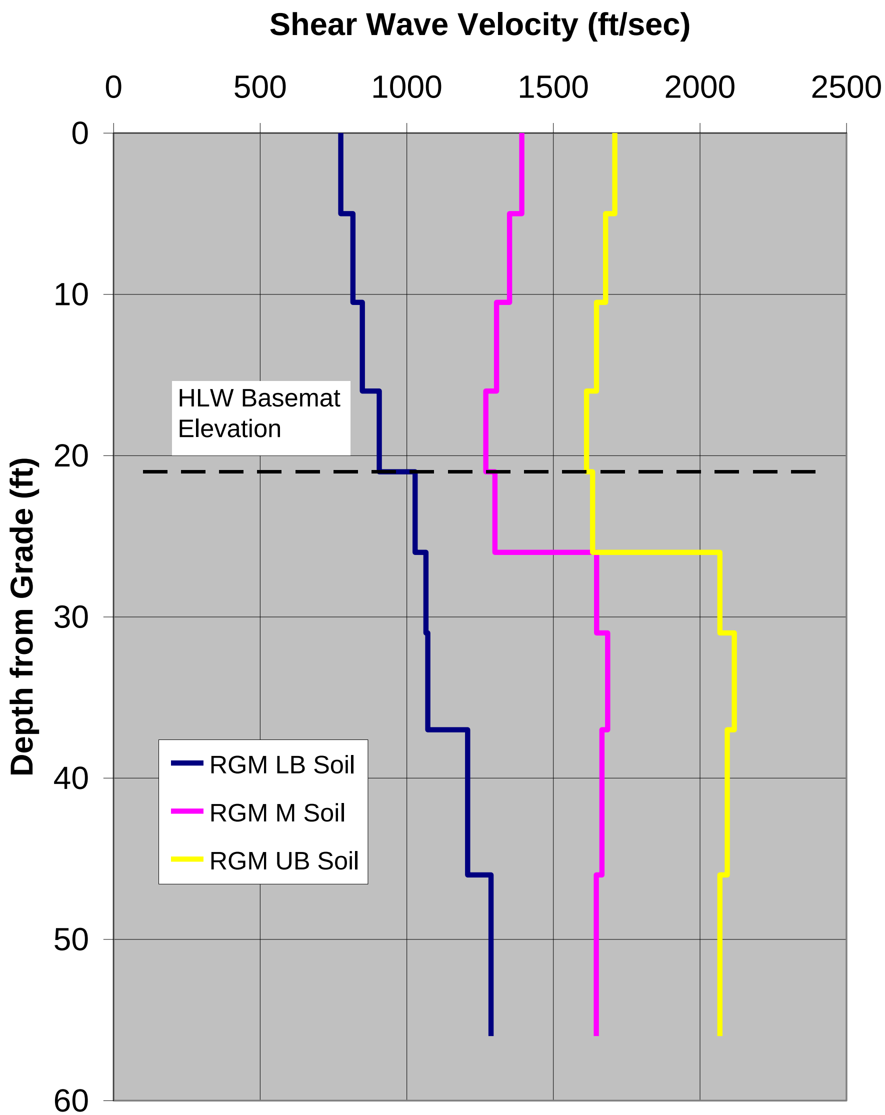
	Min (ft)	Max (ft)
X-Dir: (EW)	7	15
Y-Dir: (NS)	7	17
Z-Dir: (Vert)	10.50	

WTP Ground Motion



Soil Profile at HLW Site

Consider the Upper Bound Site-Specific soil case

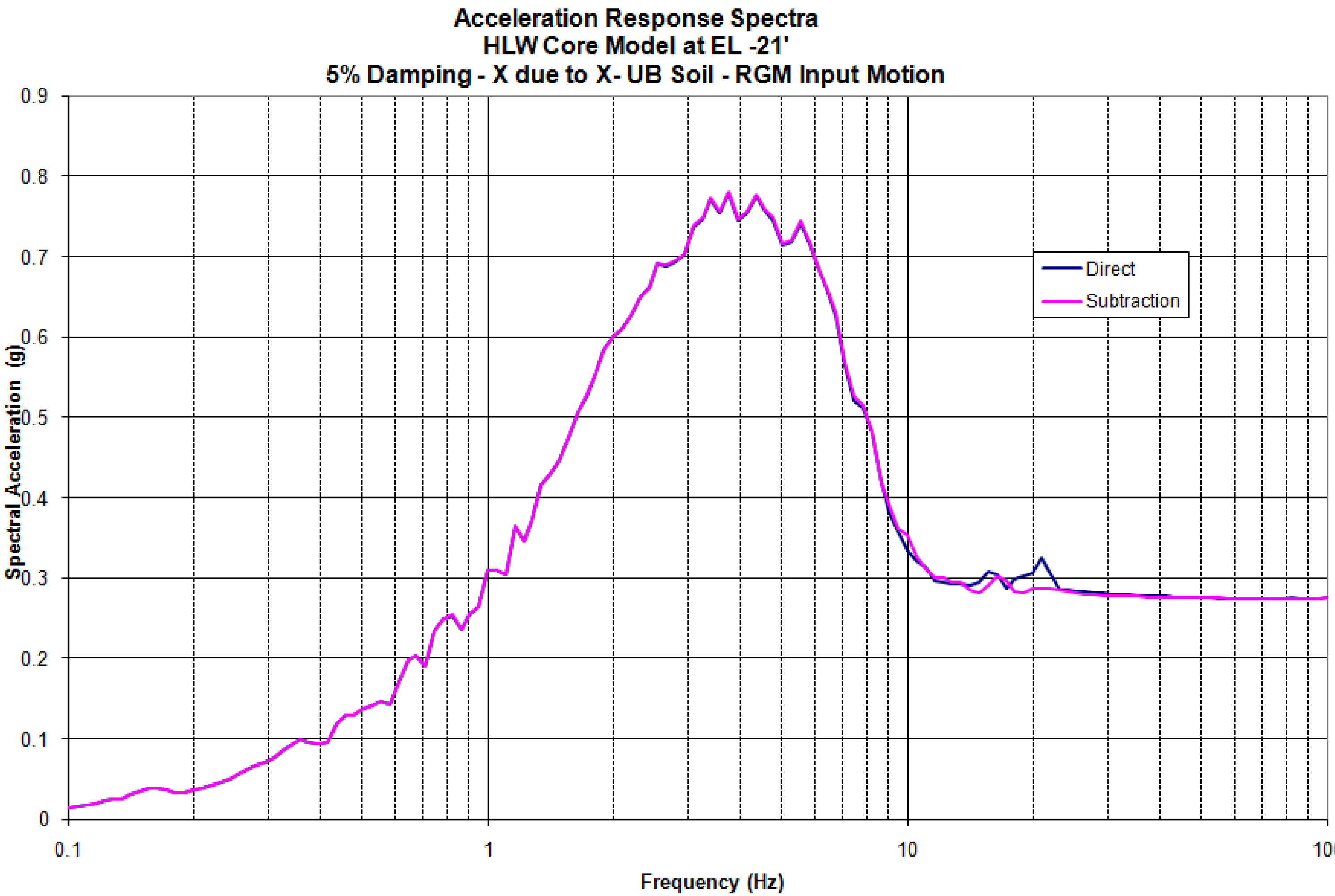


Mesh Limiting & Cut-off Frequencies

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

	Critical Shear Wave Velocity	Mesh Limiting Freq (Hz)	Cut-Off Freq (Hz)
LB:	775 fps	9.1	10.5
M:	1269 fps	14.9	17.5
UB:	1613 fps	19.0	22.0

Comparison of SSI Results



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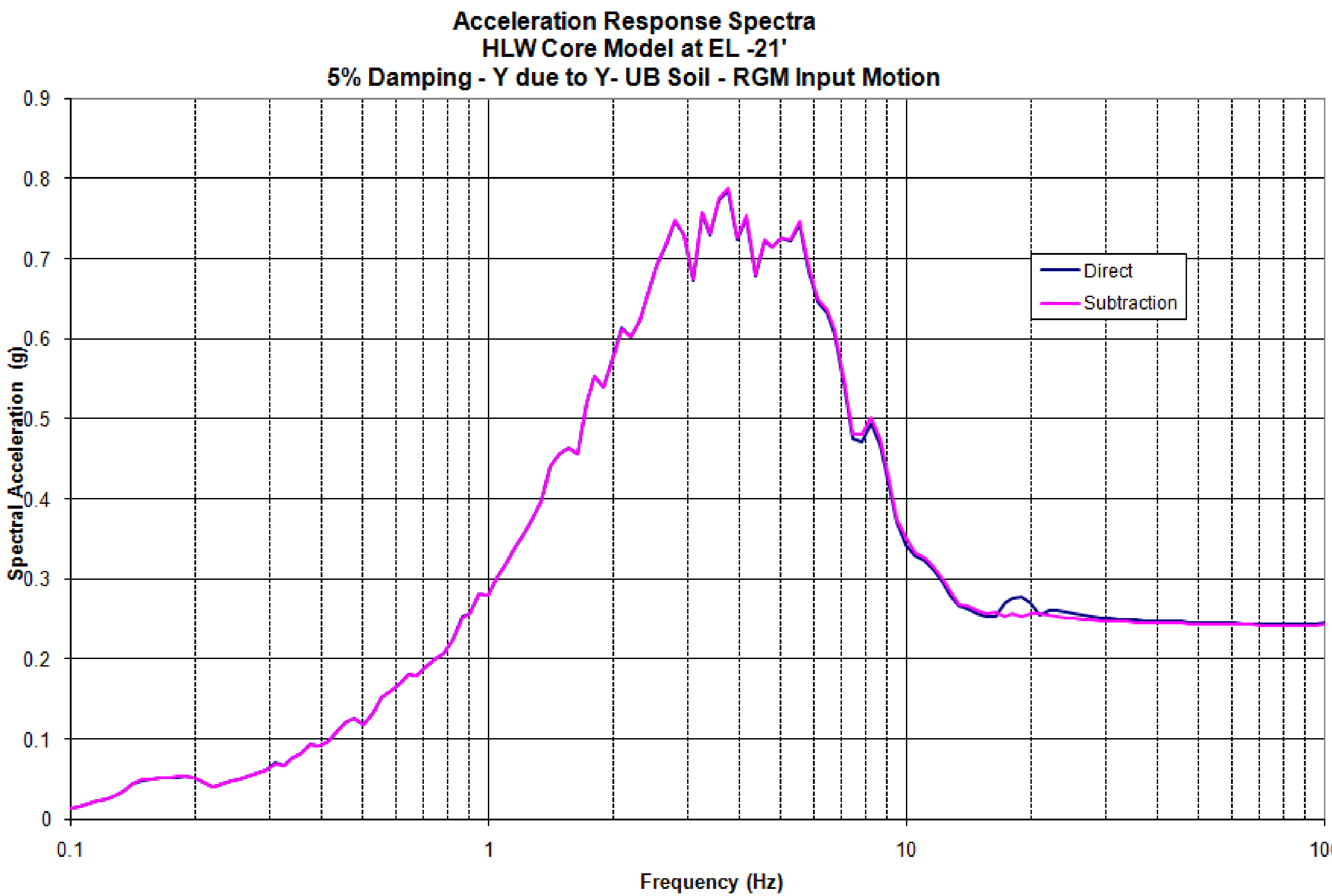

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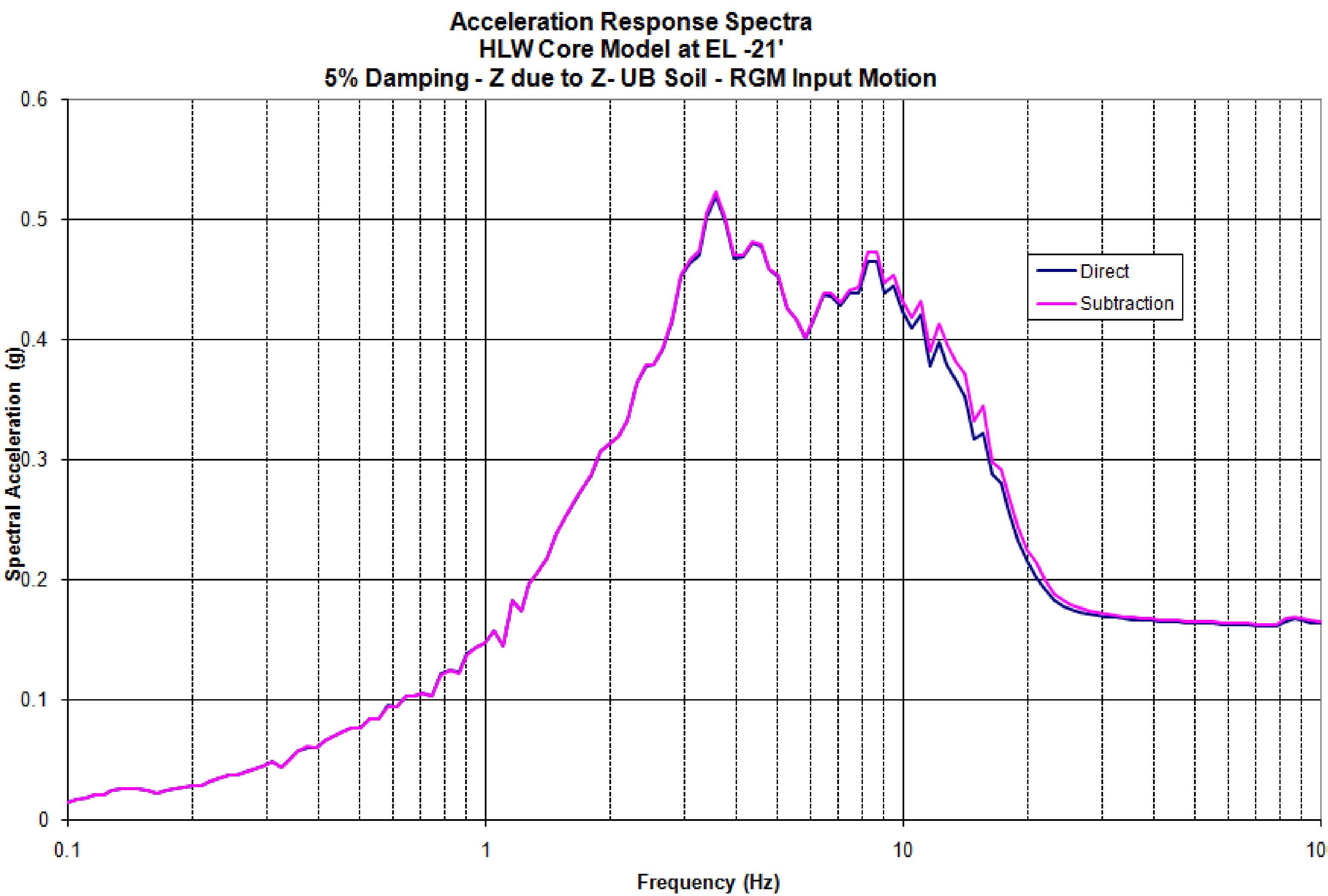

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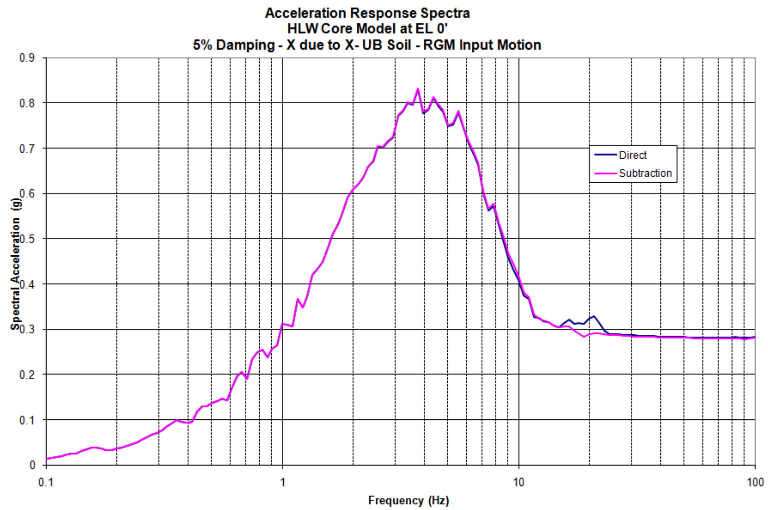

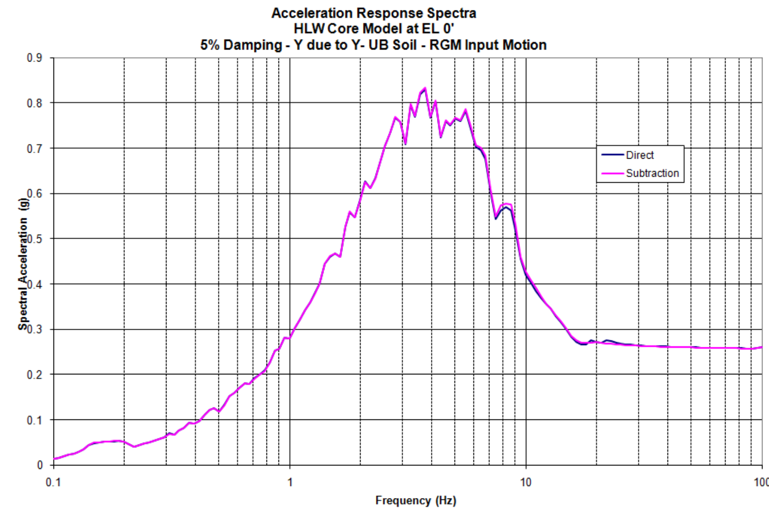

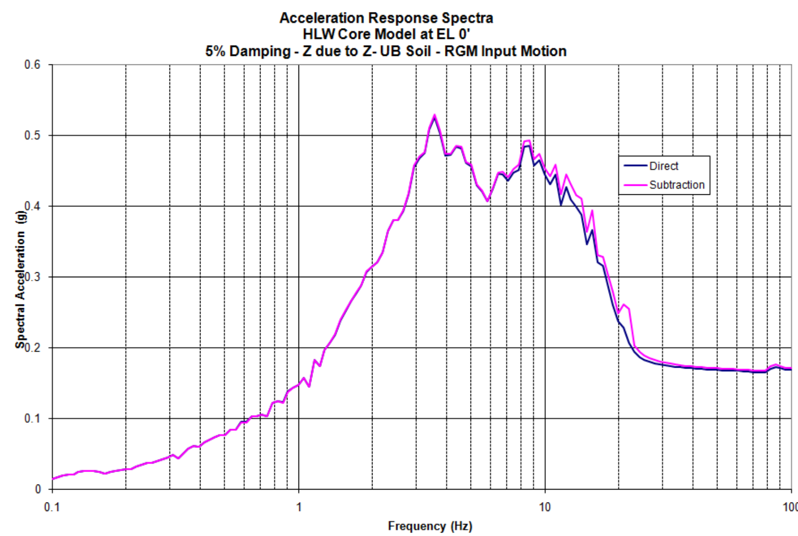

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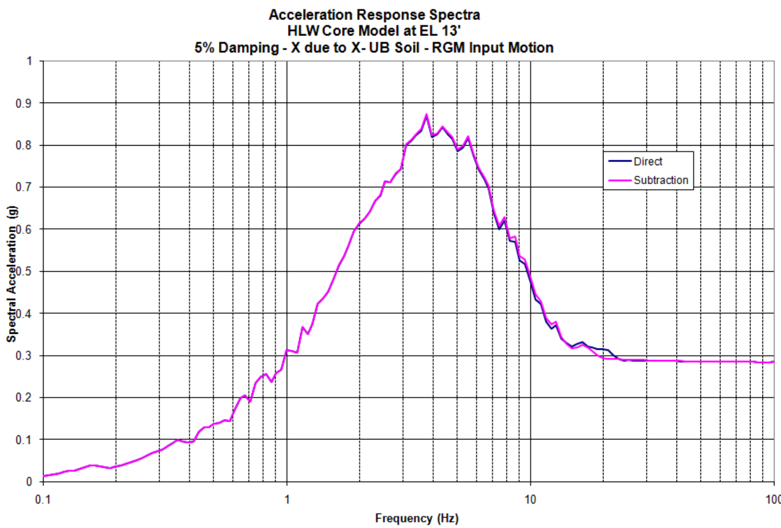

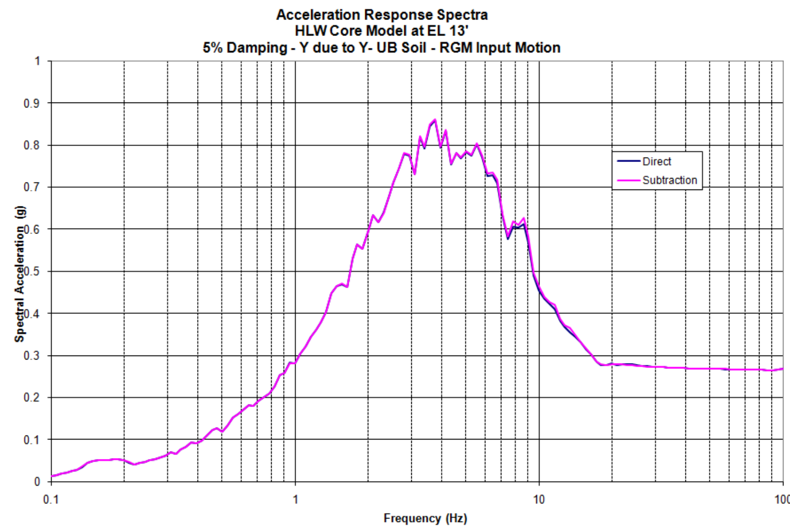

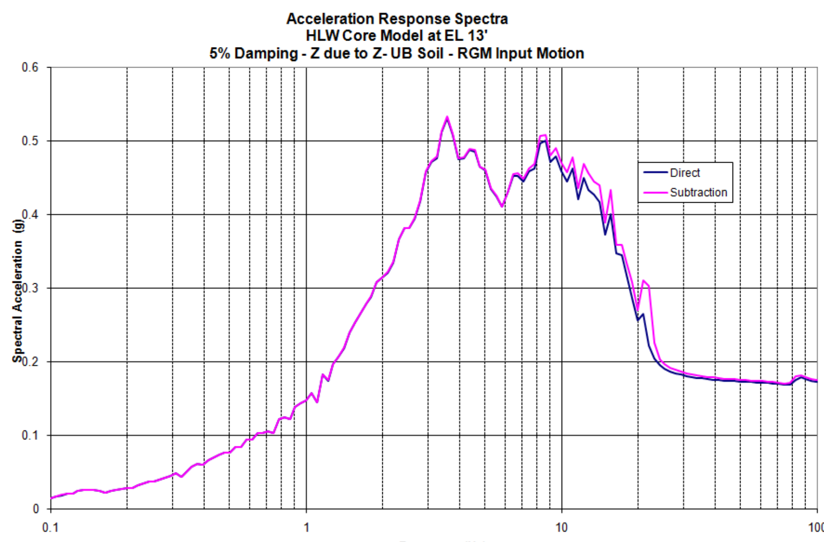

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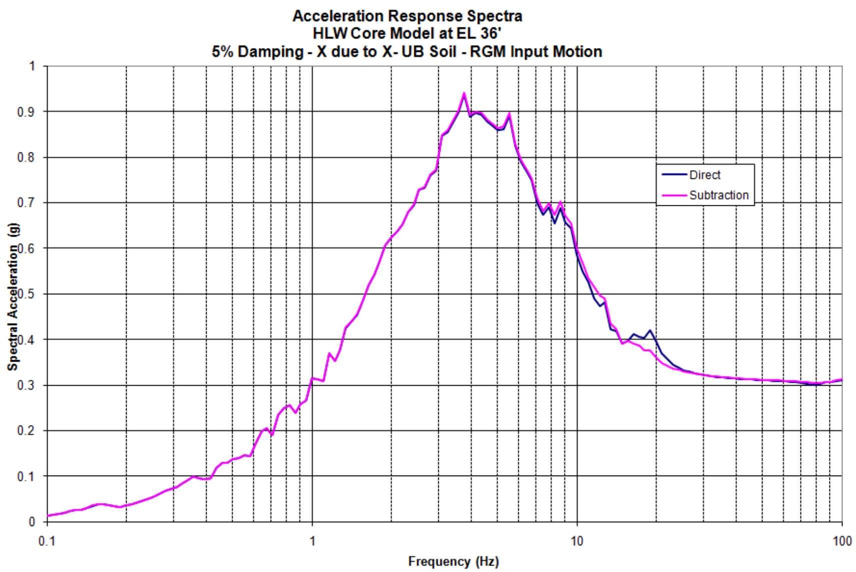

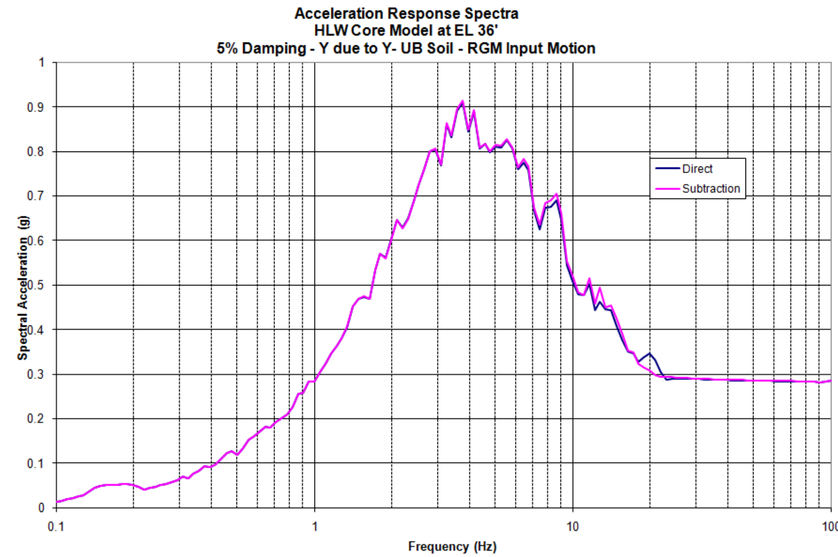

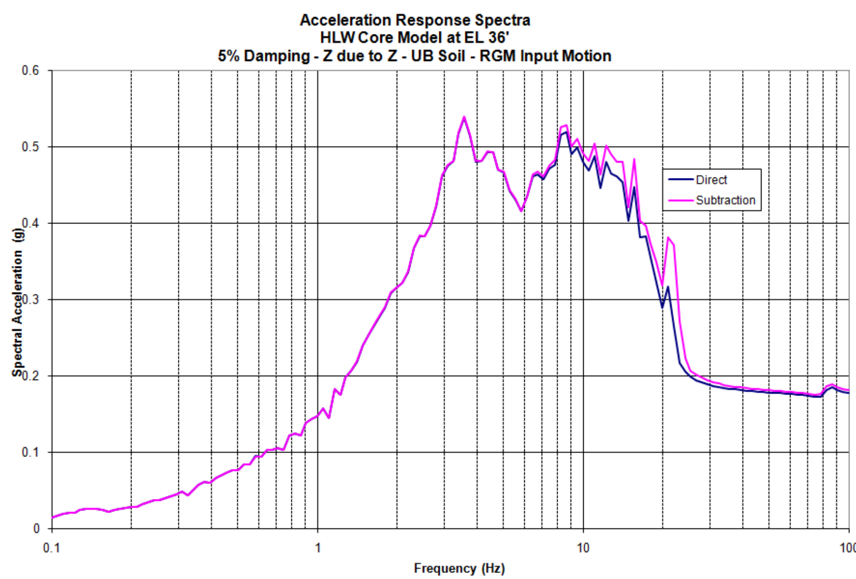

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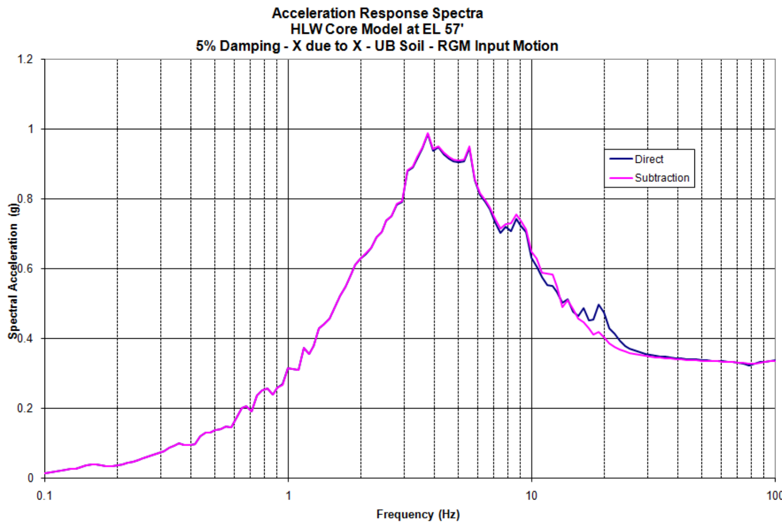

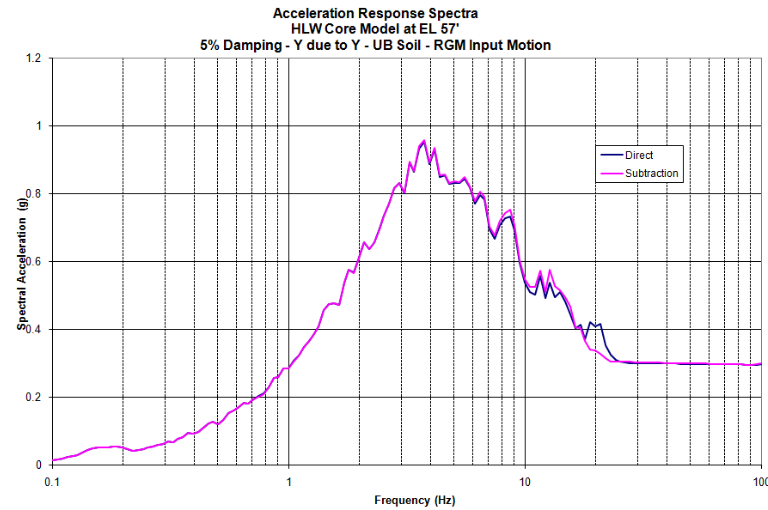

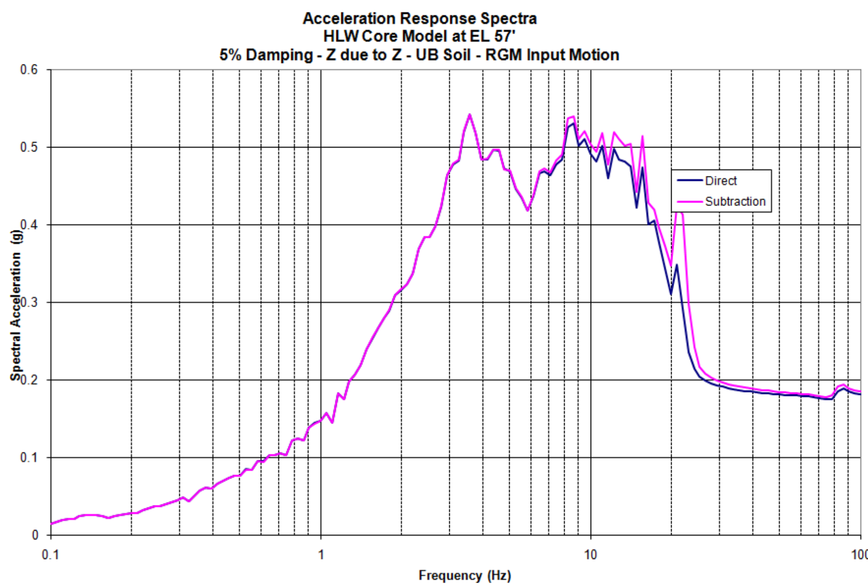

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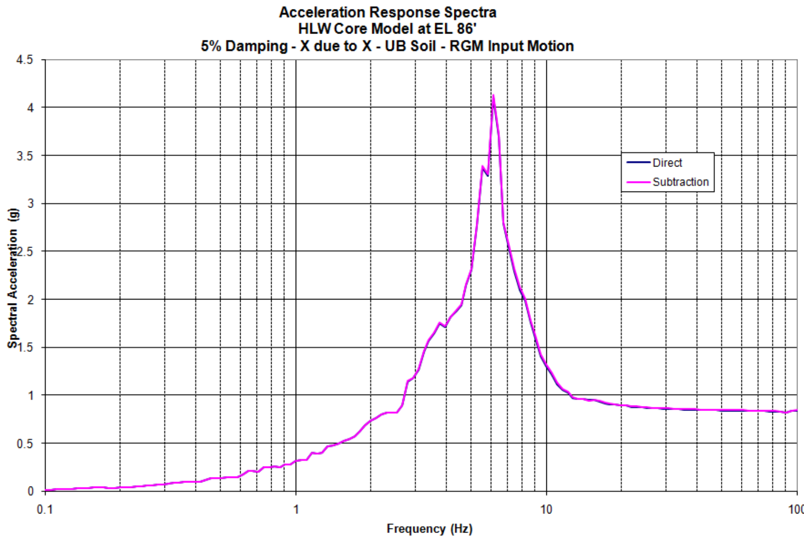

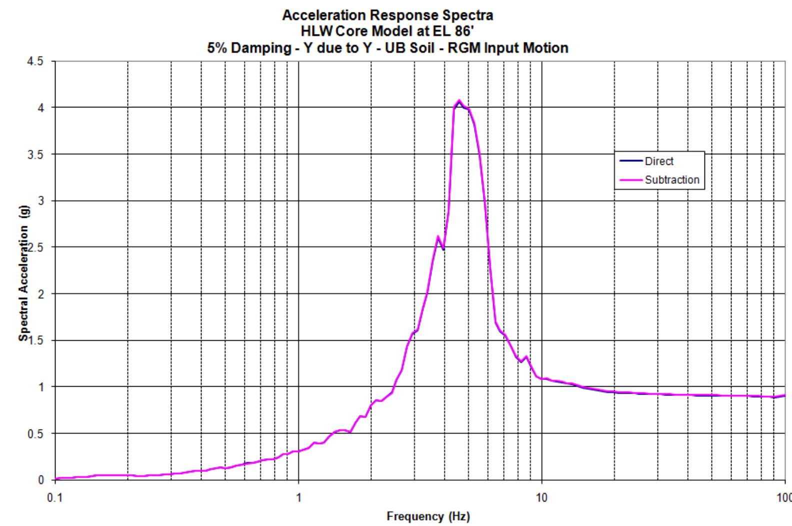

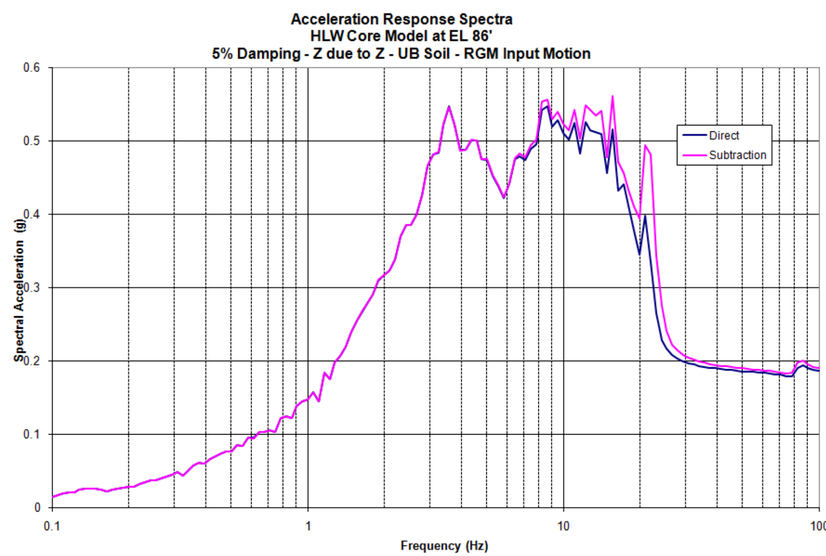

Observations

- **Horizontal response:**
  - Subtraction method results are essentially the same as those of direct method
- **Vertical response:**
  - Subtraction method results are slightly higher than those of direct method in the higher frequency range
    - Results in a slightly higher ISRS

Conclusions

- Use of subtraction method for SSI Analysis of the RPP-WTP HLW (a shallowly embedded structure) is considered to be adequate and slightly conservative

Conclusions

- **SASSI is a complex program**
  - Before use in any critical facility, the user must develop experience in modeling, analysis, and interpretation of results
  - It is our observation that lack of experience and knowledge, as well as, overconfidence have caused issues with respect to use of SASSI

Conclusions

- **Verification is critical**
  - It is very important that SASSI program, as installed on the production computer, is fully verified particularly for the options utilized
  - BNI SASSI verification examples include many solutions that compare the results with reliable published papers, several SSI-related doctoral dissertations, as well as experimental data

Conclusions

- **Verification is critical**
  - Some users modify the program SASSI and develop additional features
  - Any developments must be carefully reviewed by the expert to ensure compatibility with SASSI formulations and methodology and proper verification before use in design
  - Simple verification examples may not be sufficient when the new features are used for complex modeling conditions

Conclusions

- **Independent checking is recommended**
  - When in doubt, perform SSI analysis by other simple methods (soil spring, dashpot) and verify the overall global responses obtained from SASSI