3-Days Training for Practical Application of ACS SASSI NQA V4 to Seismic SSI Analysis of Nuclear Facility Structures

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Part 3: User Guidance for ACS SASSI V4 Software w/ Demos

USNRC Office, Rockville, MD

June 25-27, 2019

Presentation Content

1. New ACS SASSI V4 Software Additional Capabilities

2. ACS SASSI Software Modular Configuration, Inputs and User Interface Pre/Post Inputs and Processing Capabilities

3. Building SSI Models Using ACS SASSI .Pre UI Commands

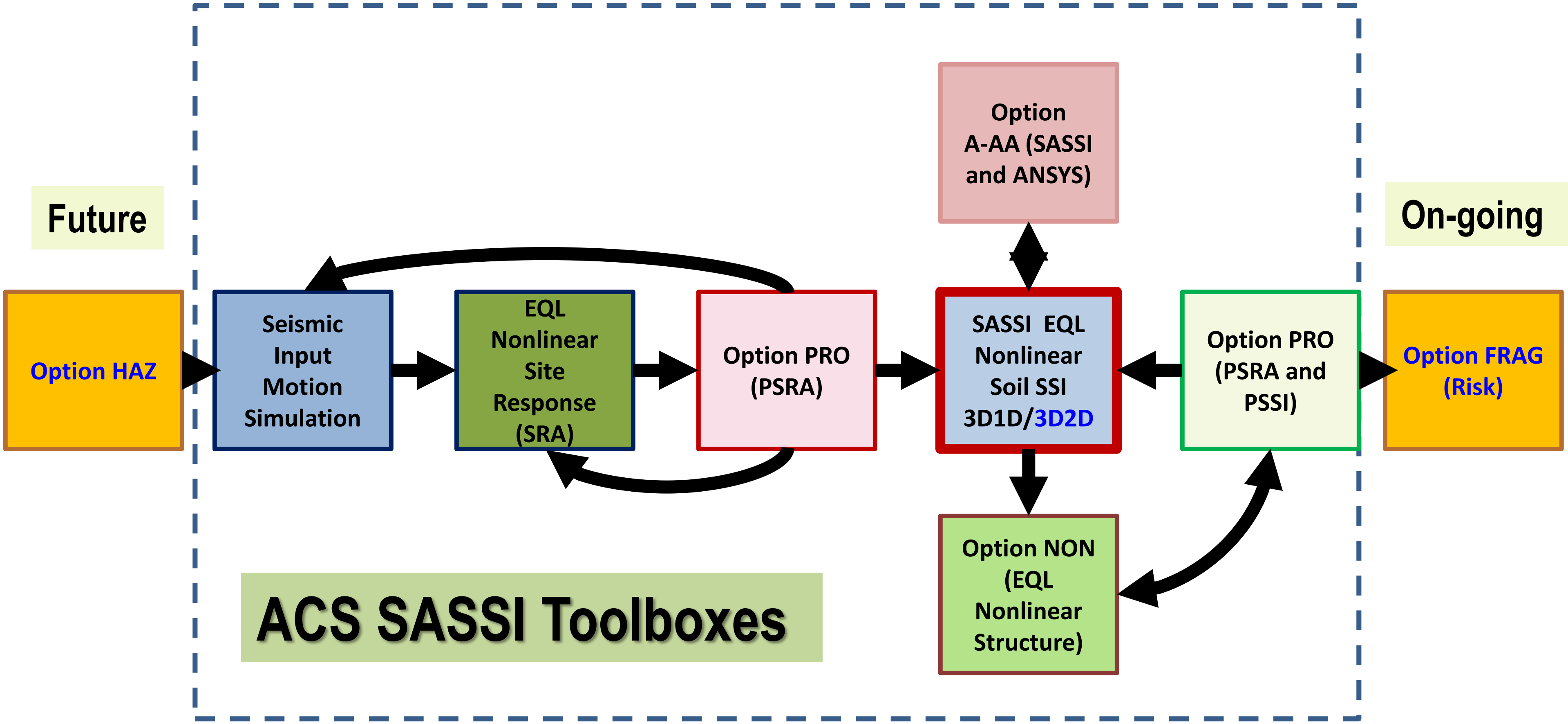
4. Run Demos and Describe Additional Example Problems Prepared for This Training

1. New ACS SASSI V4 Software. Additional Capabilities.

Release date planned for the July 8 Week

ACS SASSI V4 Development Framework

2019 Options A-AA, NON and PRO, and 2DSOIL
2020-2021 Options HAZ and FRAG



ACS SASSI V4 Software (IKTR0)

The new ACS SASSI NQA V4 software will be tentatively available by July 15, 2019. The SSI model size is limited to 100k nodes for the baseline version (IKTR0) and up to 1 million nodes for higher capability version (IKTR0_1M).

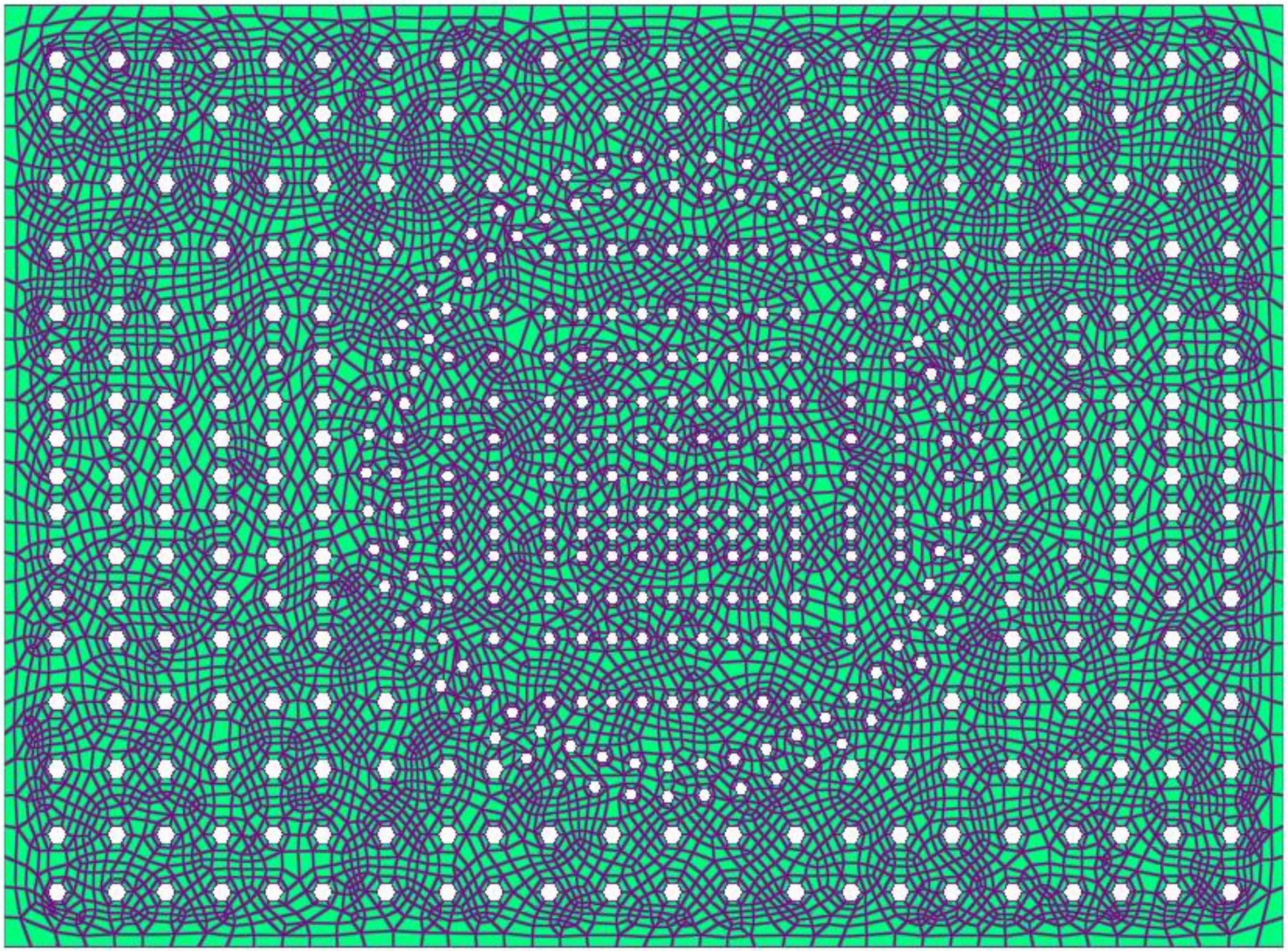
The ACS SASSI V4 (IKTR0) computational speed of the SSI analysis is about 2-3 times faster than the latest ACS SASSI NQA V3 (IKTR10) software.

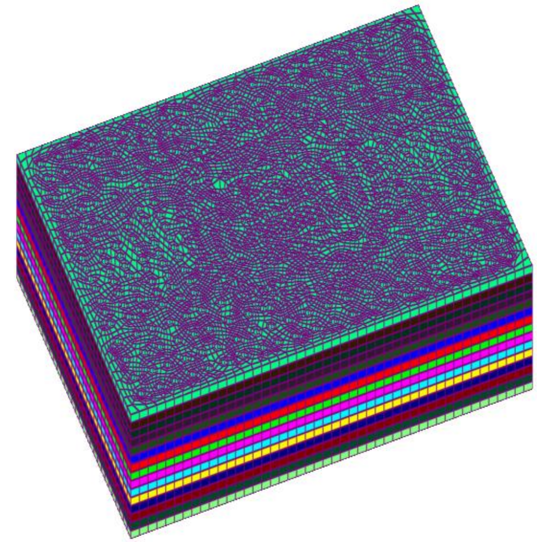
Depending on the SSI problem size and the MS Windows PC workstation resources, the SSI analysis runtime speed of the new V4 version can go up to 5 times faster than the current 2018 V3 version (for most of tests between 1.7 and 5 times)

ACS SASSI NQA V4 Runs on 512 GB RAM MS Windows 10 PC

Test No.	1	2	3
Problem Name	RB Complex Surface	NI Complex Embedded	Deeply Embedded Structure
Problem Type	Seismic SSI	Seismic SSI	Seismic SSI
Problem Size (nodes)	18743	88245	41661
Inter. Nodes	1389	9648	22707
Not included in the public version			
Runtime V3/Runtime V4	3.2	1.7	2.3
3 Parallel SSI Runtime/ Single SSI Runtime	1.05	1.11	1.32
Scalability Perfect is 0.33	0.35	0.37	0.44

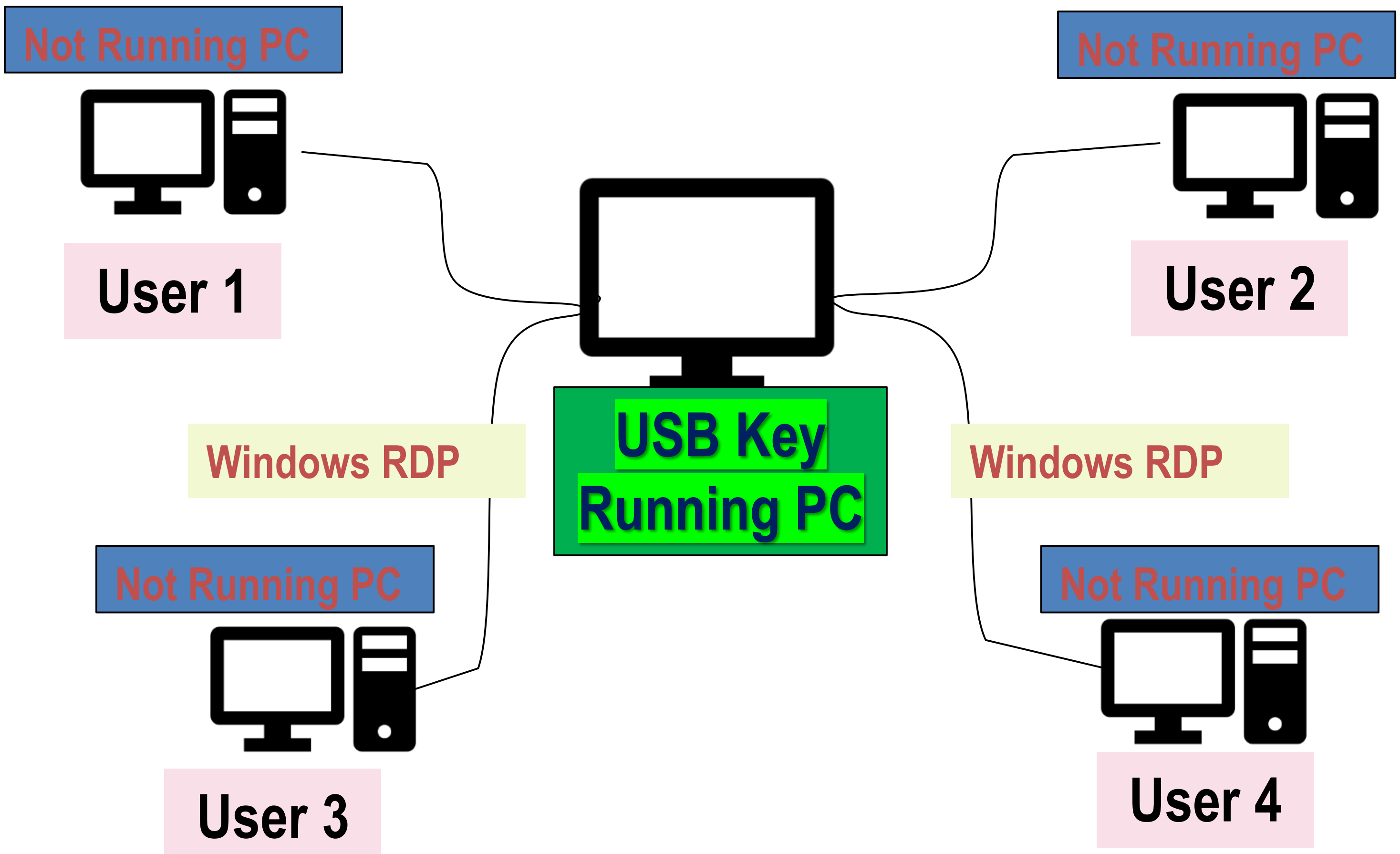
RB Complex on Piles Example Includes More Than 220,000 Nodes for Deep Pile Foundation Model



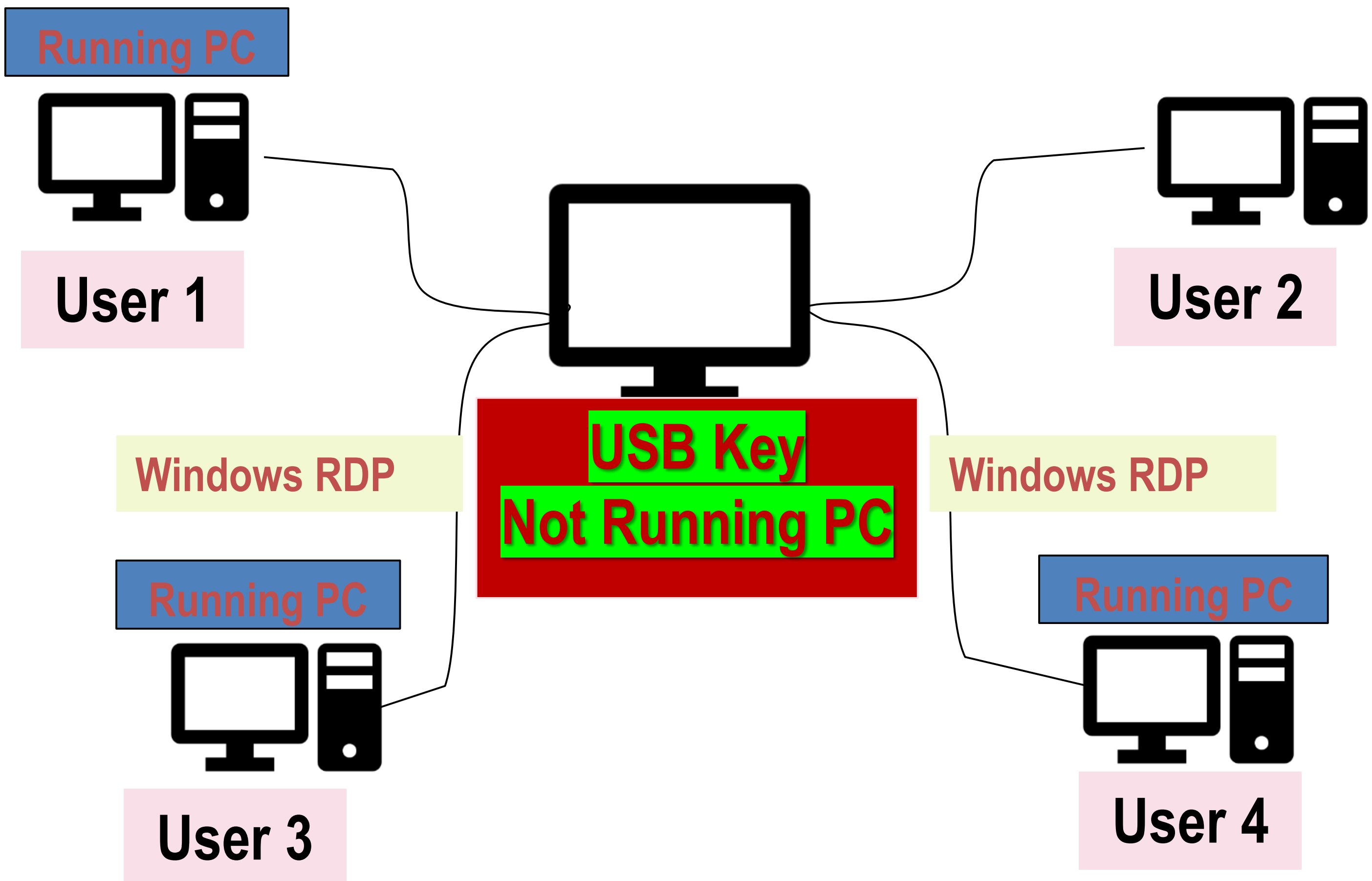


SSI runtime was about 2,800 sec. per frequency on a 128 GB RAM MS Windows PC

Single Workstation License USB *Green* Key
(Current, Non Floating License)



Multiple Workstation License USB *Red* Key
(New, Floating License in Testing)



2019 ACS SASSI V4 SSI Analysis Options

1) Main Software. Include advance pre-post processing, nonlinear soil modeling, motion incoherency, others. Plus, includes seismic motion simulation and site response capabilities.

2) Option A-AA. Integration with ANSYS. The ANSYS structure FE models can be used directly for the 1st step of the overall SSI analysis (Option AA), and/or in the 2nd step for the detailed stress analysis using the SSI responses as input BCs (Option A)

3) Option NON. Nonlinear structure, applicable to concrete structures and base-isolation (per ASCE 4-16 Sections 3 and 12)

4) Option PRO. Probabilistic SRA and SSI analyses (per ASCE 4-16 Sections 2 and 5.5, RG 1.208 E)

5) New Option 2DSOIL. Uses 3D2D SASSI model instead of 3D1D SASSI model (tentatively by August 31 2019).

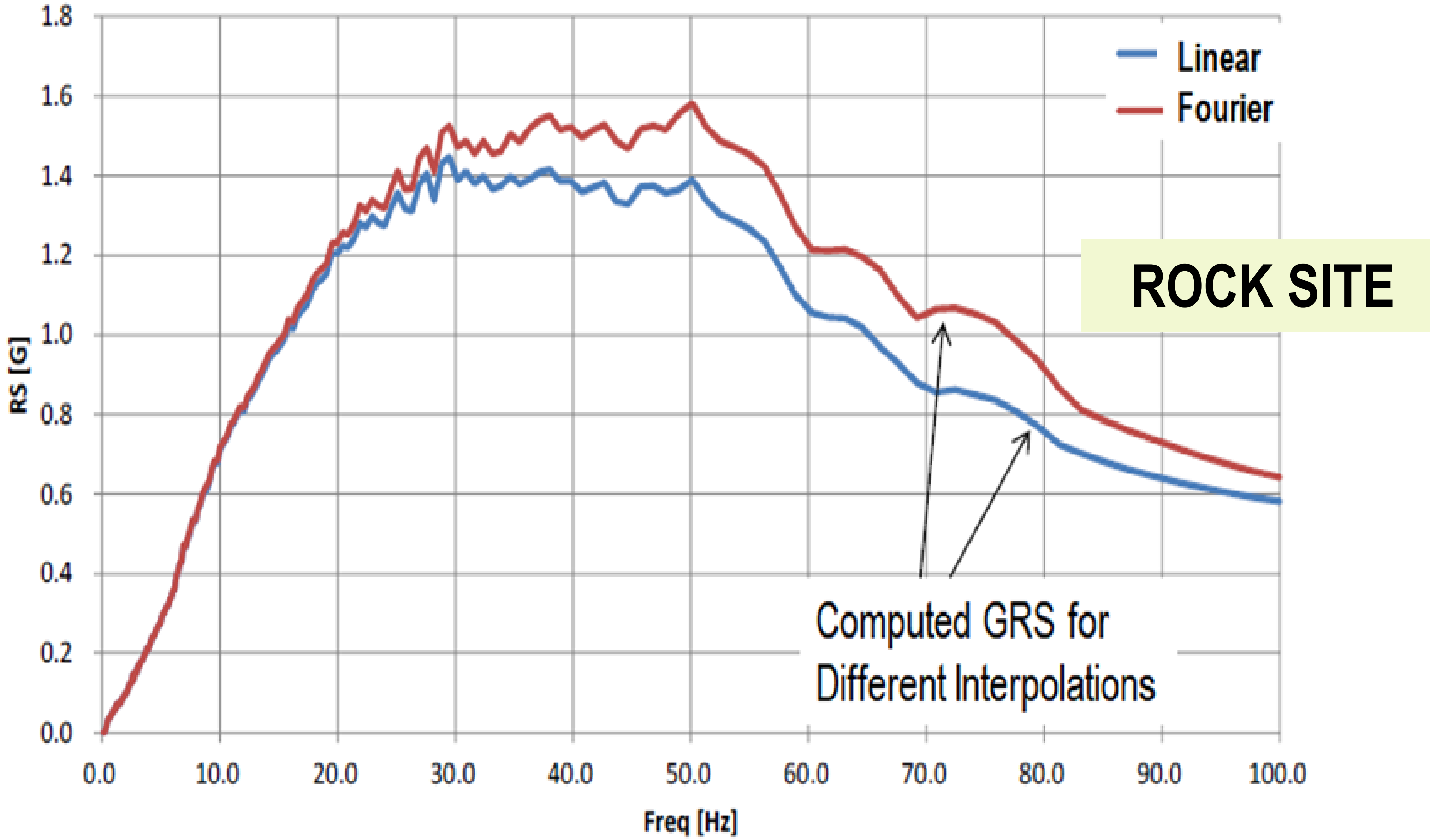
ACS SASSI V4 Software New Features

New features include:

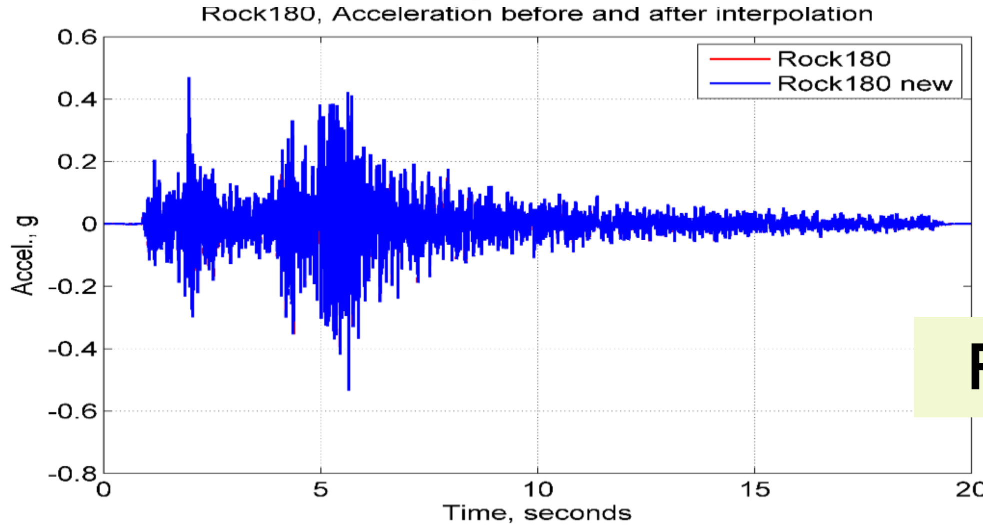
- New Fourier zero-padding (FZP) interpolation acceleration time histories. Required for high-frequency. Modification in EQUAKE.
- Improvements on the fast-post processing options. Modification in MOTION, RELDISP and STRESS.
- New FE type called HVD (3D High Viscous Damper) for seismic base-isolation problems. Modification in HOUSE.
- New Option 2DSOIL for nonhorizontal soil layering. Developed a new NST Module.
- New UI commands to support new functionalities; HVD, Binary Options for MOTION, RELDISP, STRESS, new 2DSOIL option

New Fourier ZP Interpolation for High-Frequency

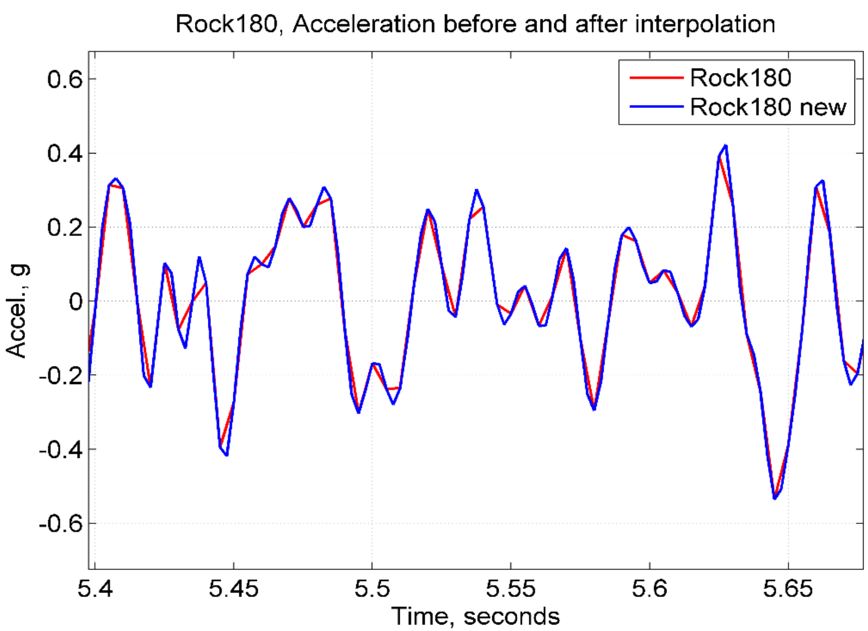
ACS SASSI V4 EQUAKE module includes the *Fourier zero-padding interpolation for acceleration histories* for computing the response spectra in the high-frequency range. ASCE 43-19 requirement.

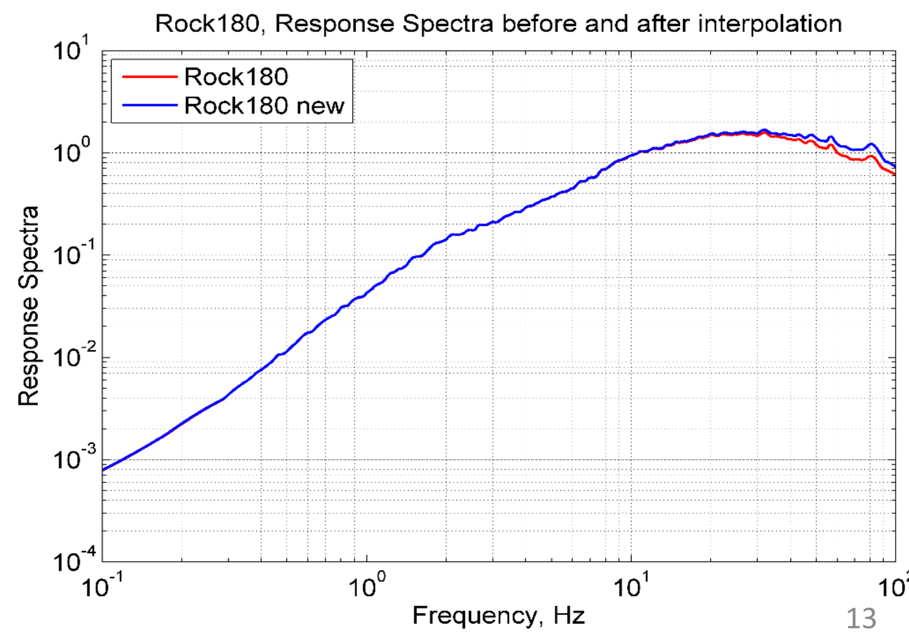


Computing High-Frequency RS Using EQUAKE Fourier Zero-Padding Interpolation Example

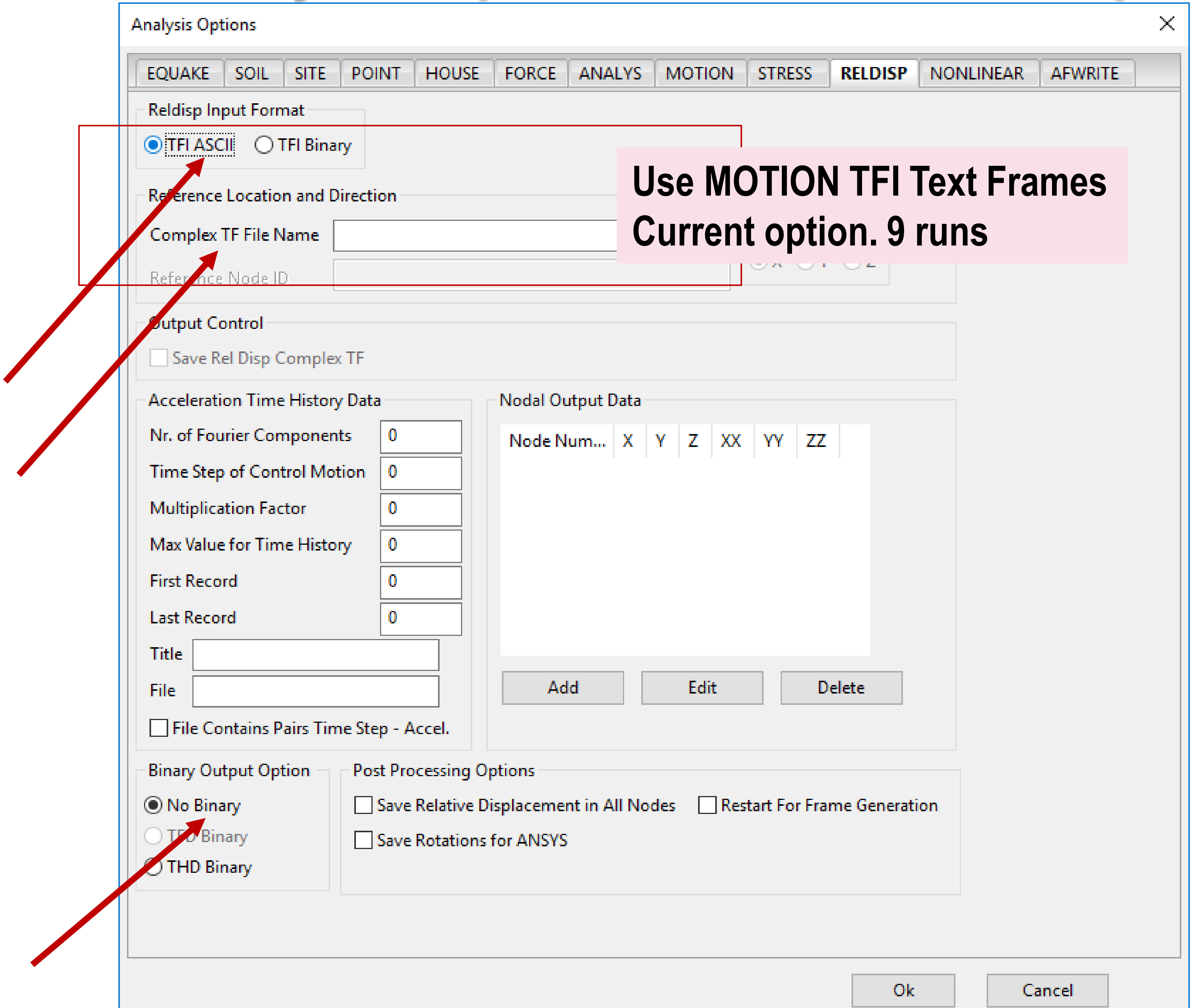


ROCK SITE



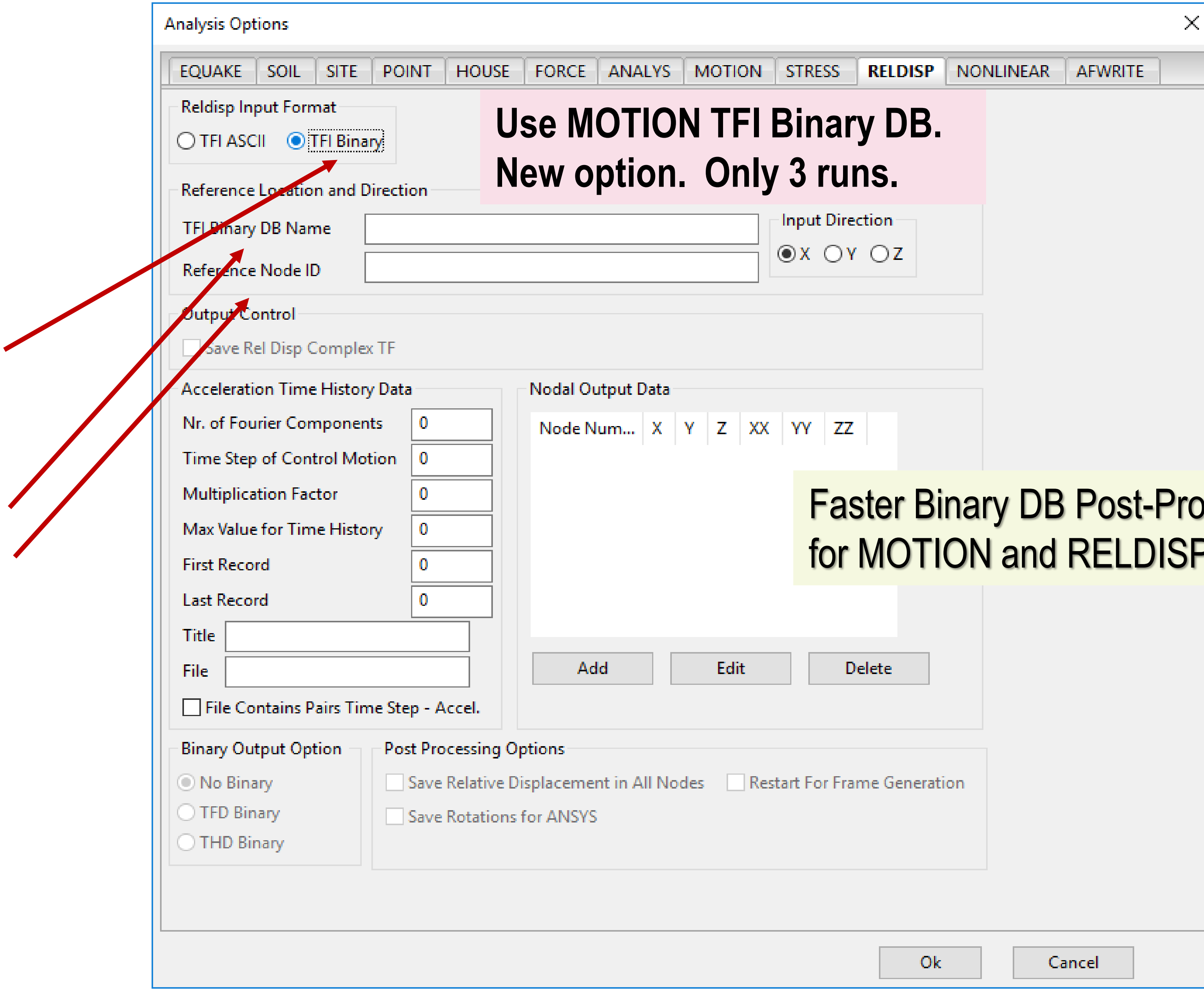


UI Analysis Options for RELDISP Input



Use MOTION TFI Text Frames
Current option. 9 runs

UI Analysis Options for RELDISP Input



Use MOTION TFI Binary DB.
New option. Only 3 runs.

Faster Binary DB Post-Processing for MOTION and RELDISP

ACS SASSI V4 Finite Element Library

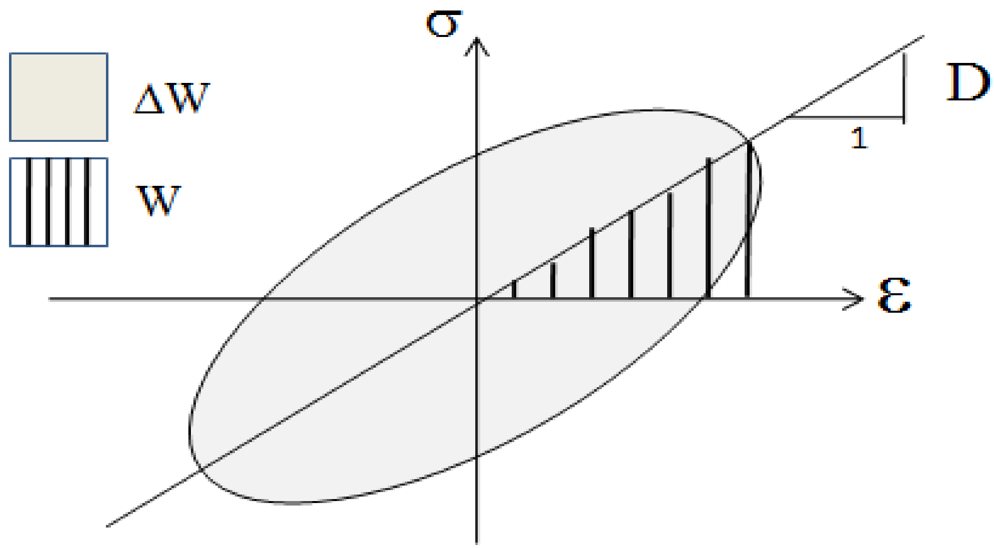
The FE library allows the use of the following linear element types:

3D solid elements	type SOLID
3D beam elements	type BEAMS
3D plate / thin shell elements	type SHELL
3D plate / thick shell elements	*type TSHELL*
2D plane strain elements	type PLANE
3D spring elements	type SPRING
3D stiffness/mass generalized elements	type GENERAL
3D highly viscous damper elements	***type HVD***

The excavated soil is modeled using the following element types:

SOLID for 3D FEM
PLANE for 2D FEM

Linearized Hysteretic and Viscous Models



Damping (Imaginary Part)

Hysteretic Model (Frequency-Independent); *LRB, FB/SB* for HORIZ (2D)

$$\tan\delta = \frac{\mathrm{Imag}(D^*)}{\mathrm{Real}(D^*)} = \frac{1}{2\pi}\frac{\Delta W}{W}$$

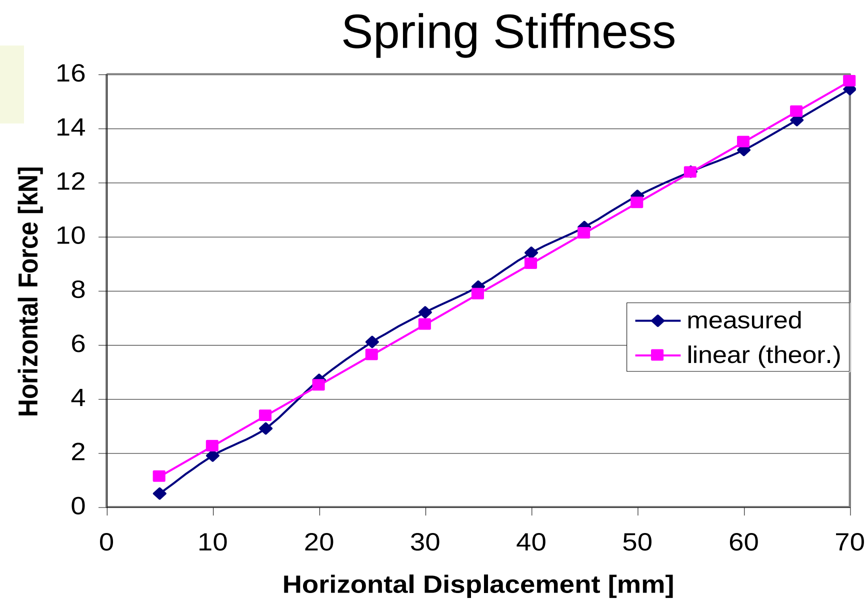
Viscous Model (Frequency-Dependent); *HVD* for HORIZ and VERT (3D)

$$\tan\delta = \frac{\mathrm{Imag}(D^*)}{\mathrm{Real}(D^*)} = \frac{c(\omega)\omega}{\mathrm{Real}(D^*)}$$

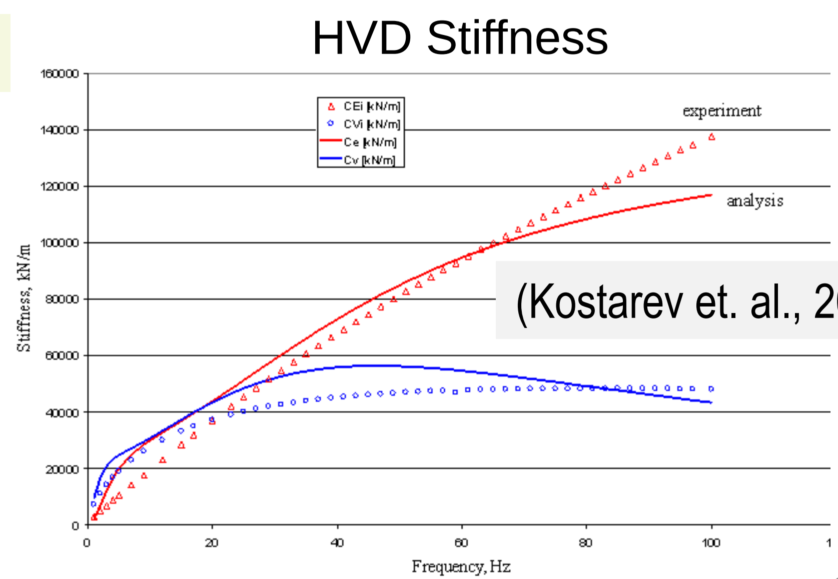
(Not mentioned in ASCE 4-16)

New 3D HVD Elements Simulate BCS Isolators

3D Springs

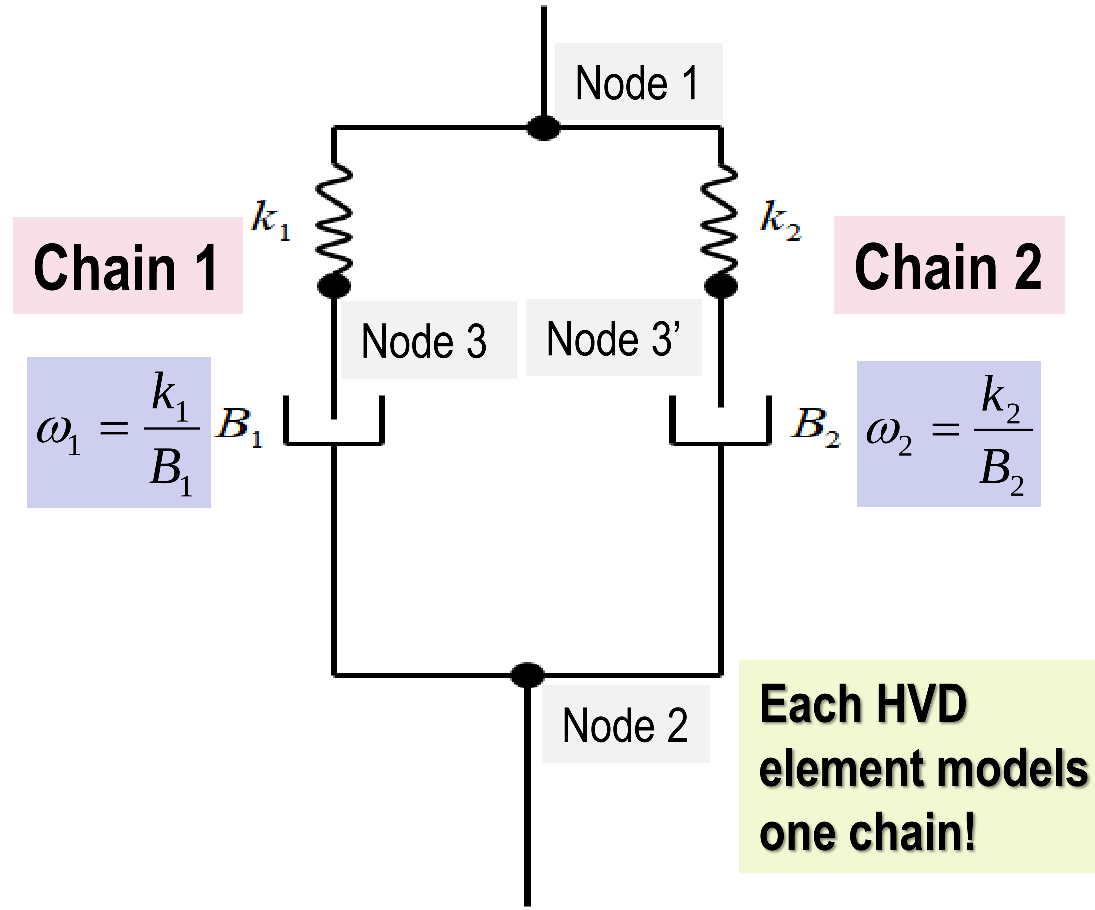


3D HV Dampers



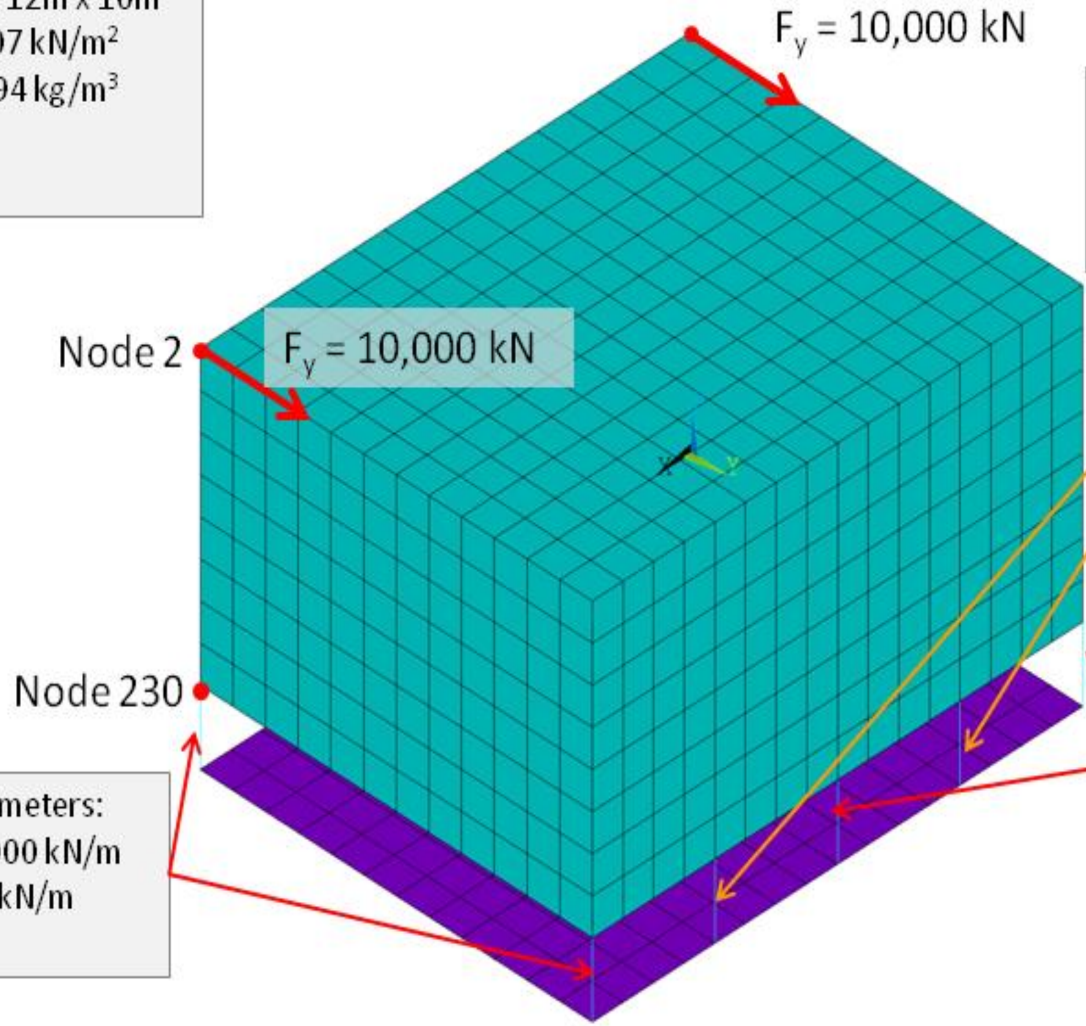
(Kostarev et. al., 2018)

3-Node HVD Element is Based on 4-Parameter Maxwell Model



Simple Validation Example for HVD Elements

Box Parameters:
Size: 15m x 12m x 10m
$E = 2.78E07\ kN/m^2$
$\rho = 8.15494\ kg/m^3$
$\eta = 0.17$
$\zeta = 0.04$

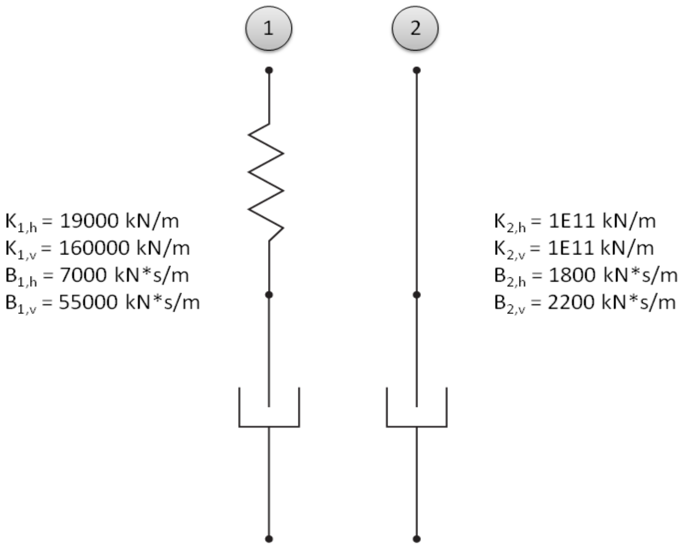


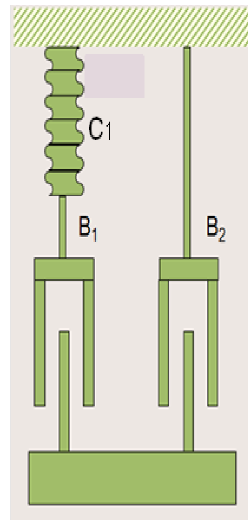
HVD Elements in ACS SASSI, and Equivalent MATRIX27 elements in ANSYS

Spring Parameters:
Kx = Ky = 9000 kN/m
Kz = 96000 kN/m
$\zeta = 0.01$

Spring Parameters:
Kx = Ky = 9000 kN/m
Kz = 96000 kN/m
Damping = 1%

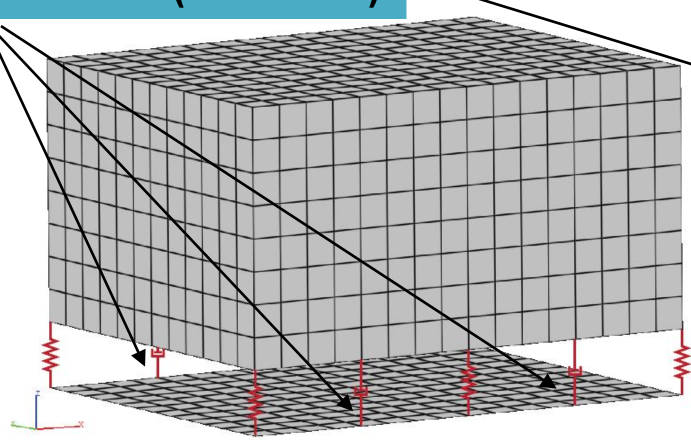
Validation of ACS SASSI V4 3-Node HVD Elements






```
* Spring Property Table
SC,1,9000,9000,96000,0,0,0,0.01
* HVD Equation Constants
HVDCEQ,1,19000,160000,7000,55000
HVDCEQ,2,1e+011,1e+011,1800,2200

GROUP,2,SPRING
E,1,836,222
E,2,883,238
E,3,864,230
E,4,835,366
E,5,856,374
E,6,848,358
RSET,1,6,1,1
GROUP,3,HVD
E,1,879,234,1056
E,2,887,242,1057
E,3,860,378,1058
E,4,852,370,1059
E,5,879,234,1060
E,6,887,242,1061
E,7,860,378,1062
E,8,852,370,1063
MSET,1,4,1,1
MSET,5,8,1,2
```

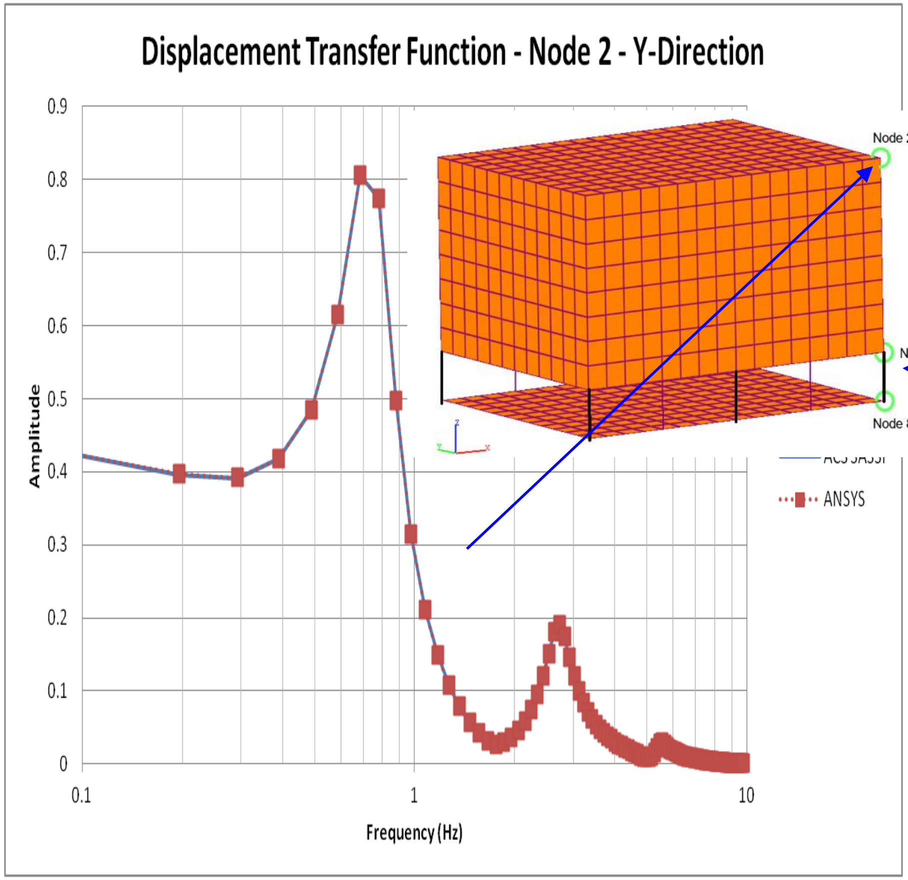
4 HVD Units (8 Chains)

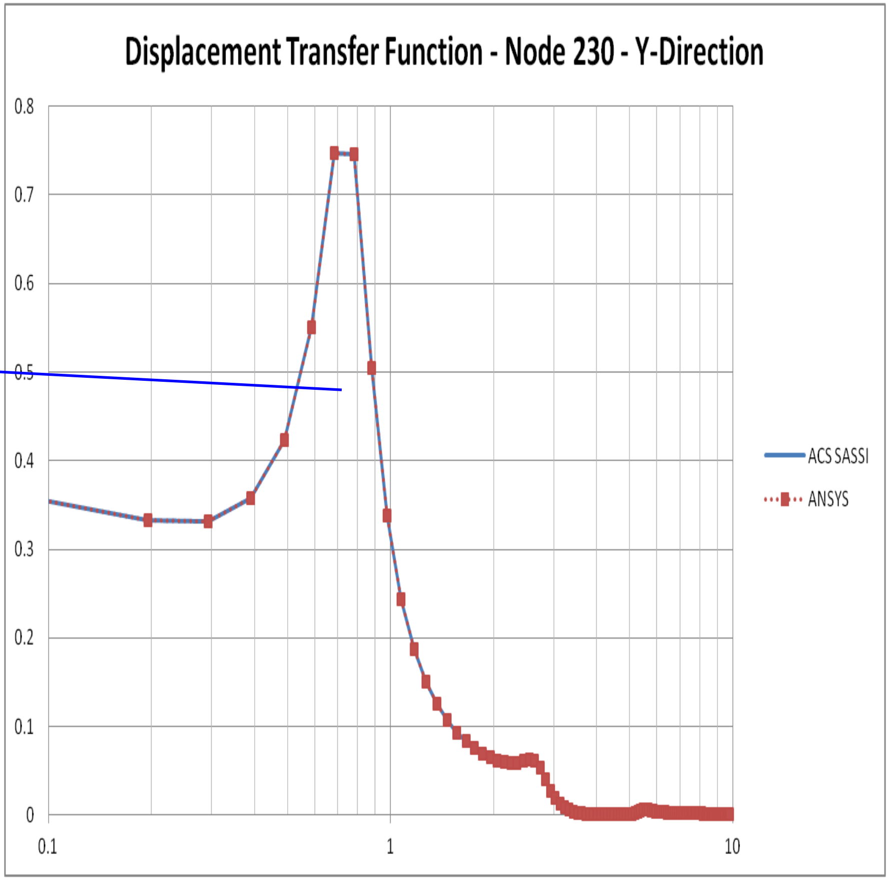


ACS SASSI vs. ANSYS (Using MATRIX27) Dynamic Displacement Harmonic Response Results

Top of Structure

Bottom of Structure





Seismic SSI Analysis per ASCE 4-16 Section 12 on Base-Isolation) Using Two-Step Approach

SSI Step:
Option NON

Validation Step
Option A for ANSYS Dynamic Nonlinear

- Seismic SSI Analysis for Nonlinear Hysteretic Base-Isolators:

  1) SSI step: *Nonlinear-isolator FD SSI using iterative equivalent linearization* based on the shear forces computed in isolators to get the SSI responses (including the bottom base motion)

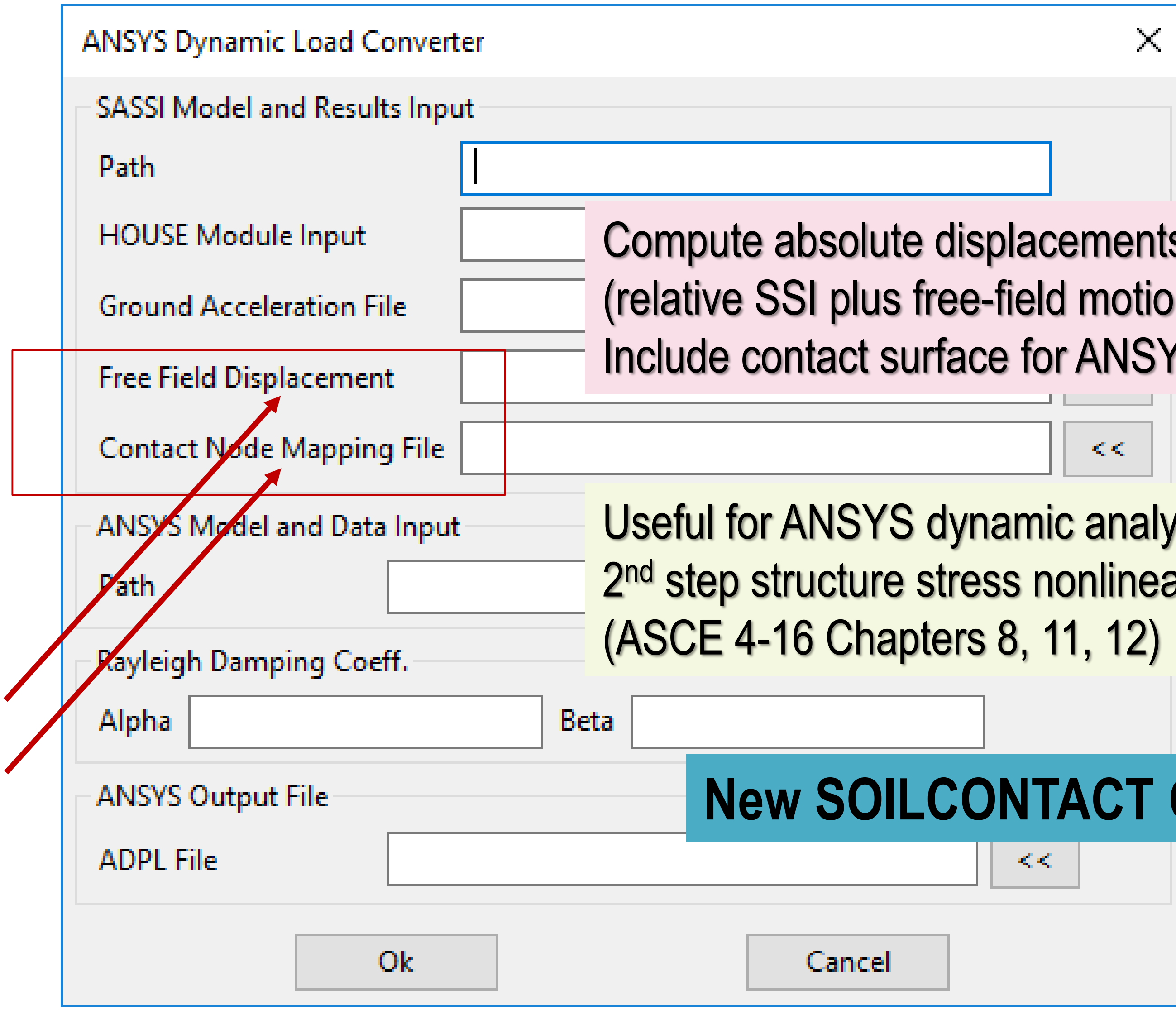
  2) Validation step: *Nonlinear-isolator TD SSI analysis for the basemat SSI motion computed at SSI Step* assumed as input (for flexible base or rigid, if acceptable)

  \- *Simplified*: Assume rigid base and use its SSI acceleration motion (3 translations&3 rotations). *Neglect the base deformation.*

  \- *Accurate:* Consider the flexible base as is and use its SSI acceleration and relative displacement motions, or its absolute displacement motions at bottom as input. *Recommended.*

REMARK: Validation step should be used to *validate/calibrate SSI* step; Use ACS SASSI NON for SSI step and then, ANSYS nonlinear dynamic based on time integration as validation step (Option A)

UI Input Windows for Option A Dynamic Option

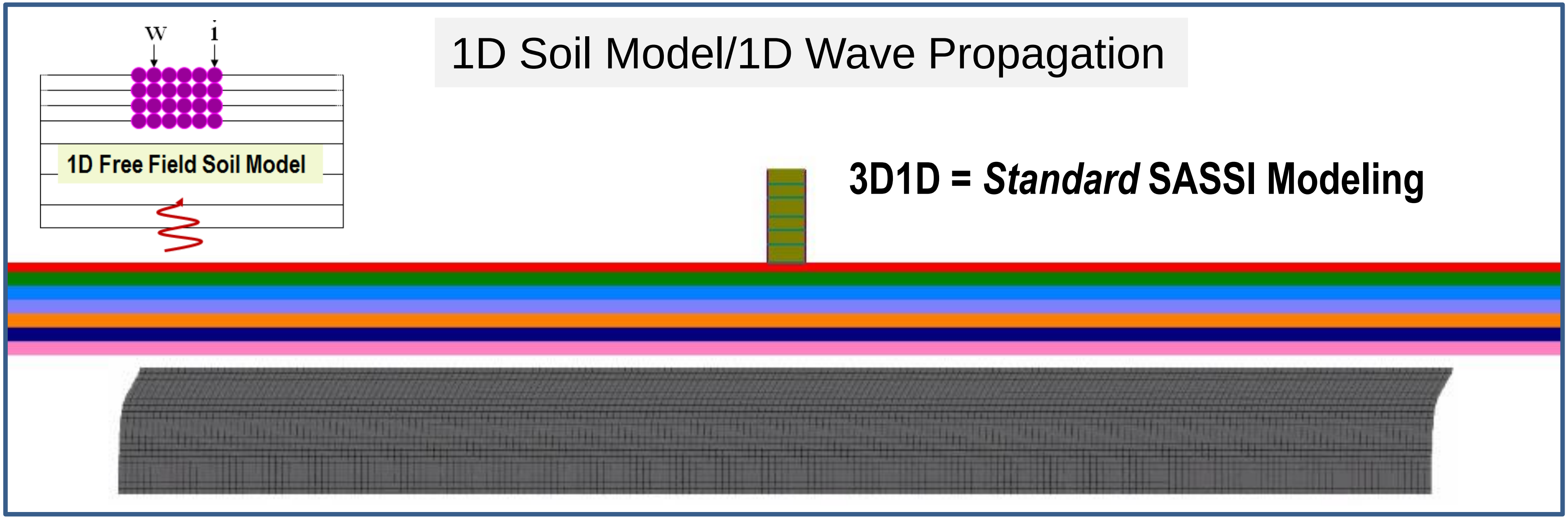


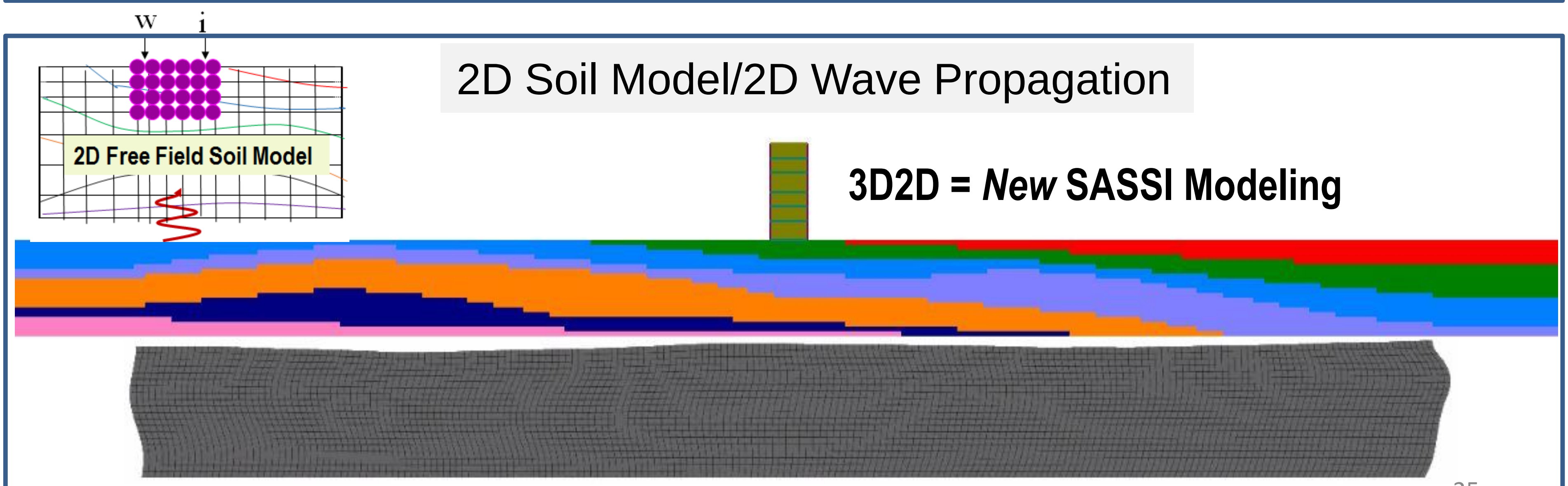
Compute absolute displacements (relative SSI plus free-field motion). Include contact surface for ANSYS.

Useful for ANSYS dynamic analysis option for 2nd step structure stress nonlinear analysis (ASCE 4-16 Chapters 8, 11, 12)

New SOILCONTACT Command

New Option 2DSOIL Uses 3D2D SASSI Modeling

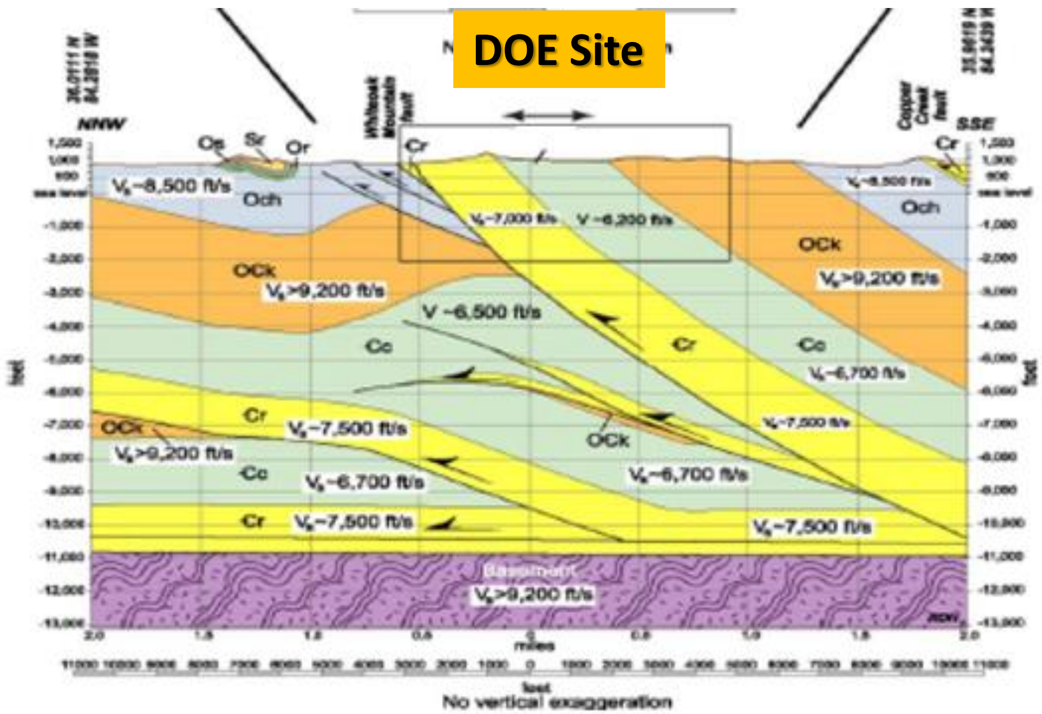


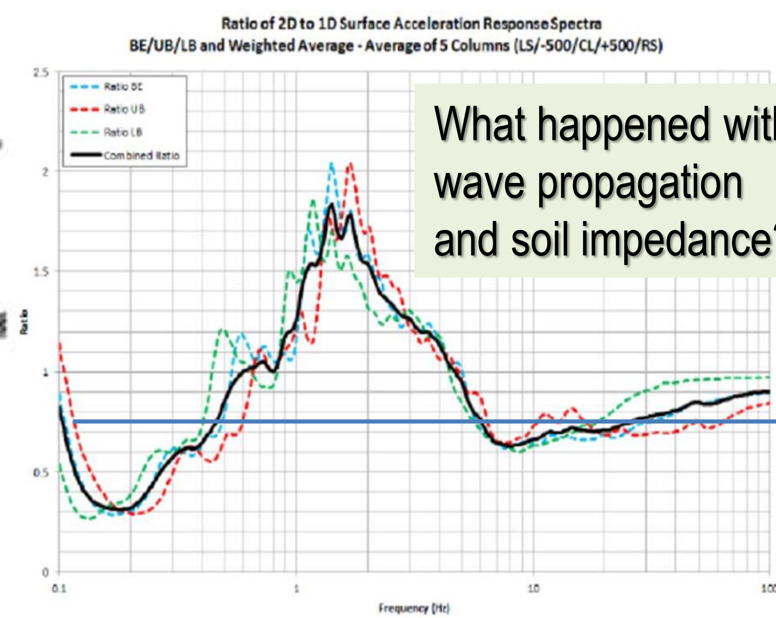


NPP Sites with Inclined Soil Layering

1-Dimensional SRA is commonly used for NPP projects as specified in the regulatory guidelines and design standards, e.g. RG1.208 and ASCE 4-16.

1-Dimensional SRA may not capture all aspects of wave propagation at a site, which may potentially result in a bias with respect to the true site amplification. This soil modelling uncertainty needs to be evaluated in site amplification estimates. *The 2-Dimensional soil models are useful for these situations.*

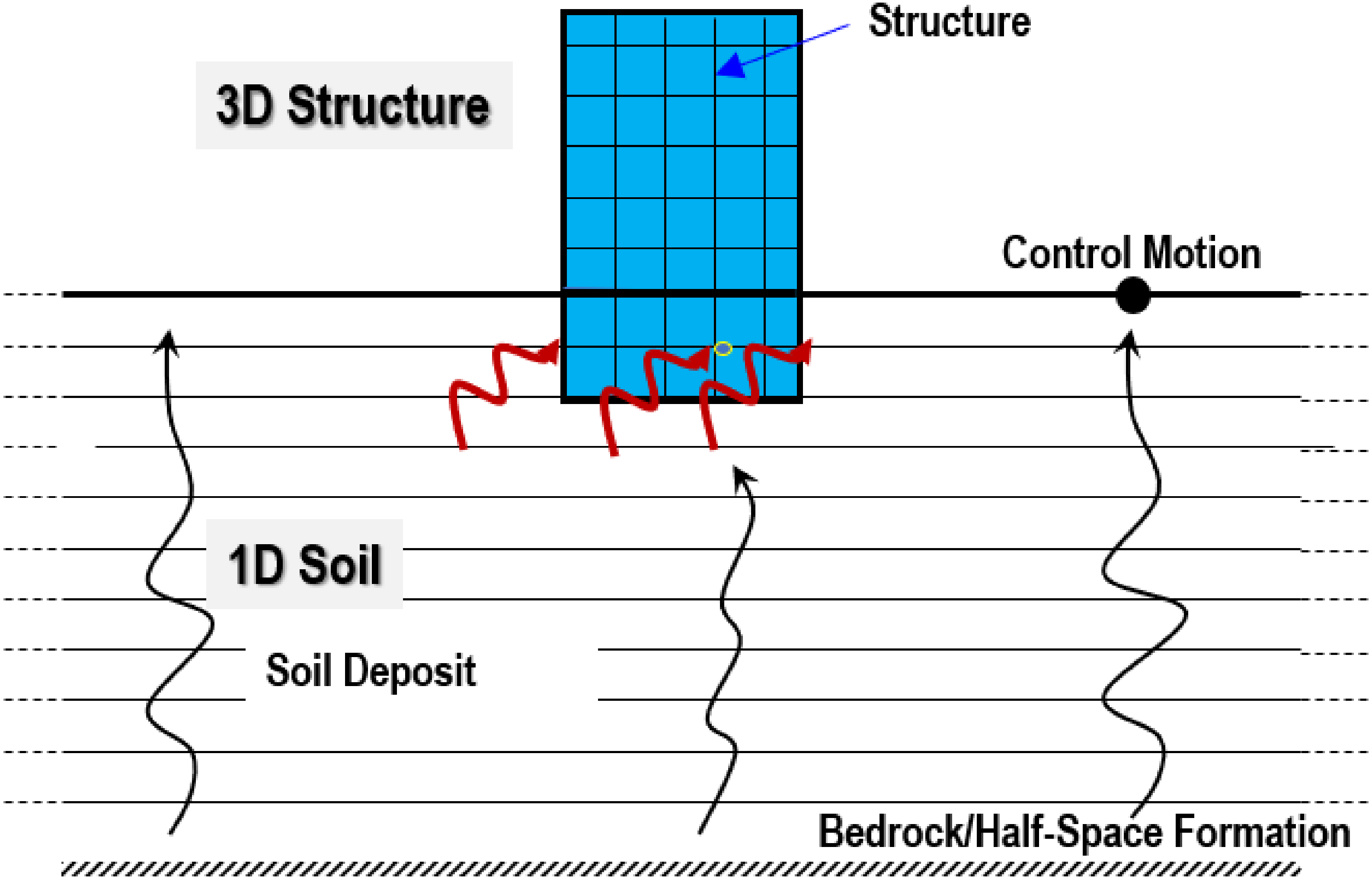




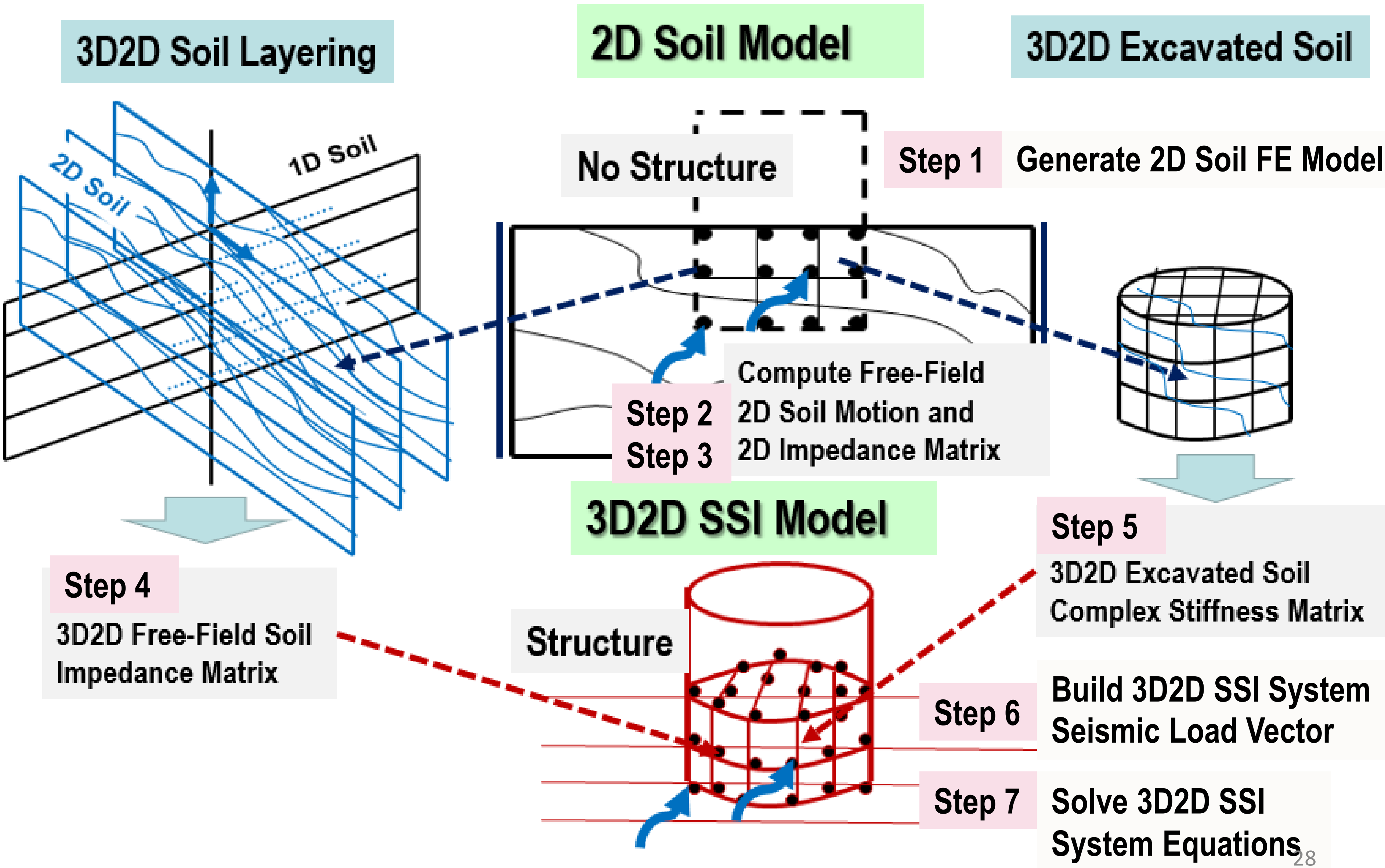
What happened with wave propagation and soil impedance?

Anderson, 2018 DOE/NRC NPH Meeting

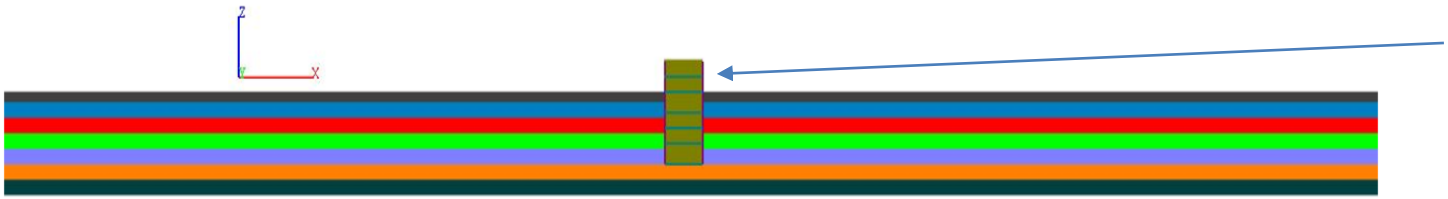
"Standard" 3D1D SASSI Modeling

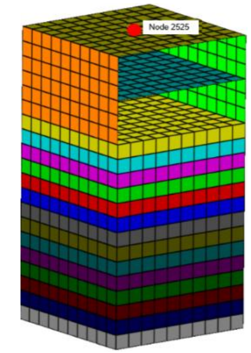


3D2D SASSI Modeling Concept Description

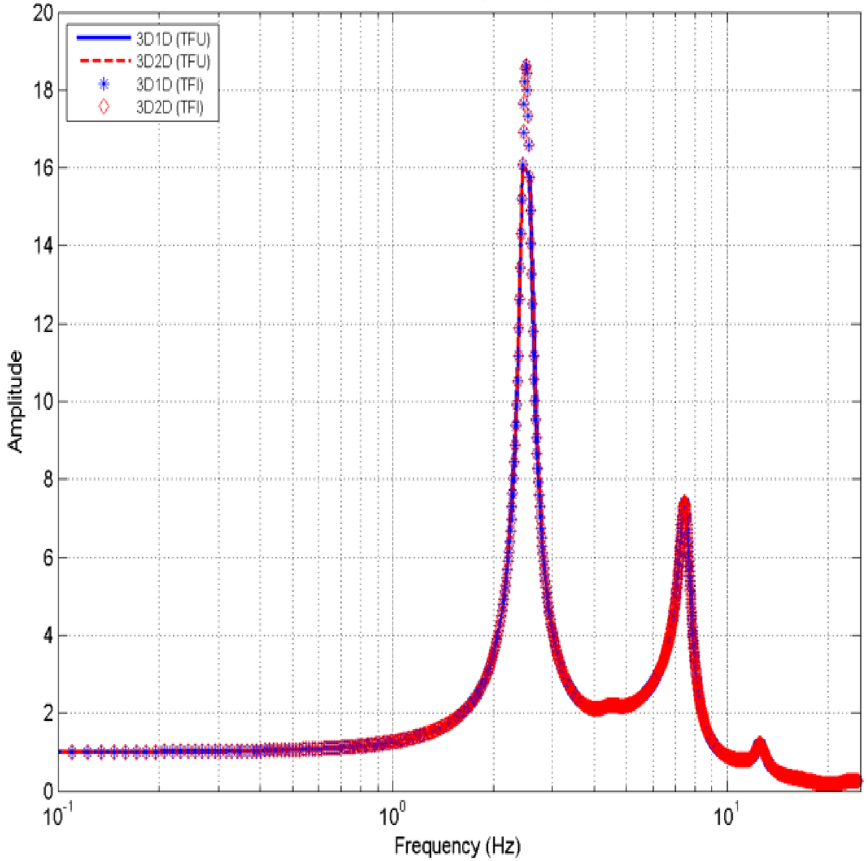


Simple Validation of 3D2D vs. 3D1D SASSI

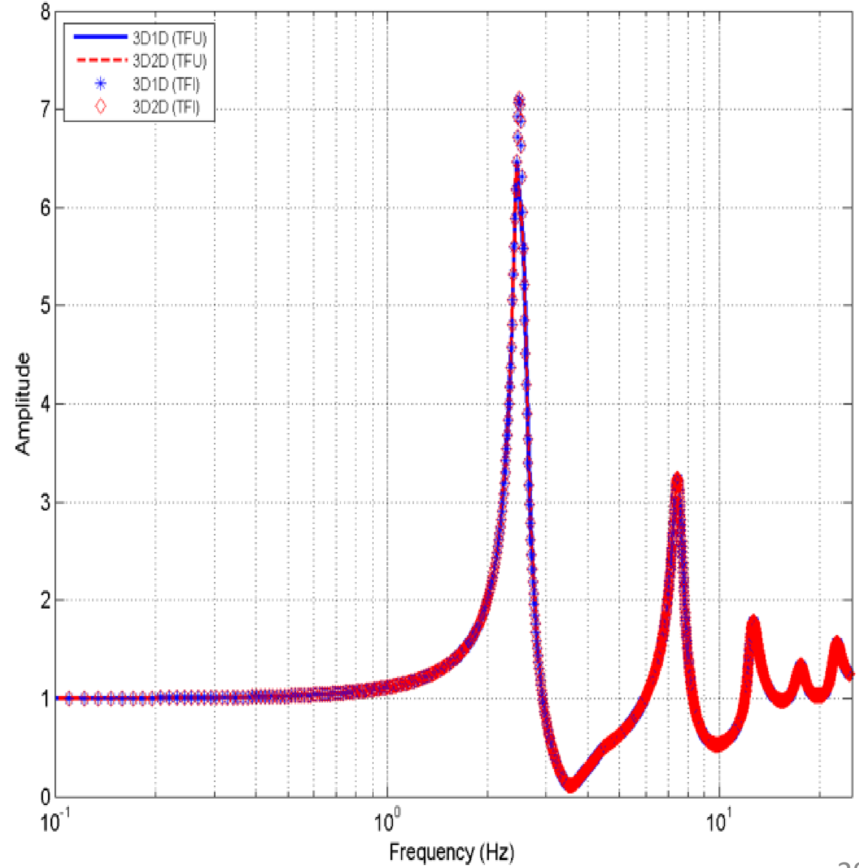




SMR Model (Node 2525)
Direction X at (0, 0, 60)



SMR Model (Node 61)
Direction X at (0, 0, -140)



2. ACS SASSI Software

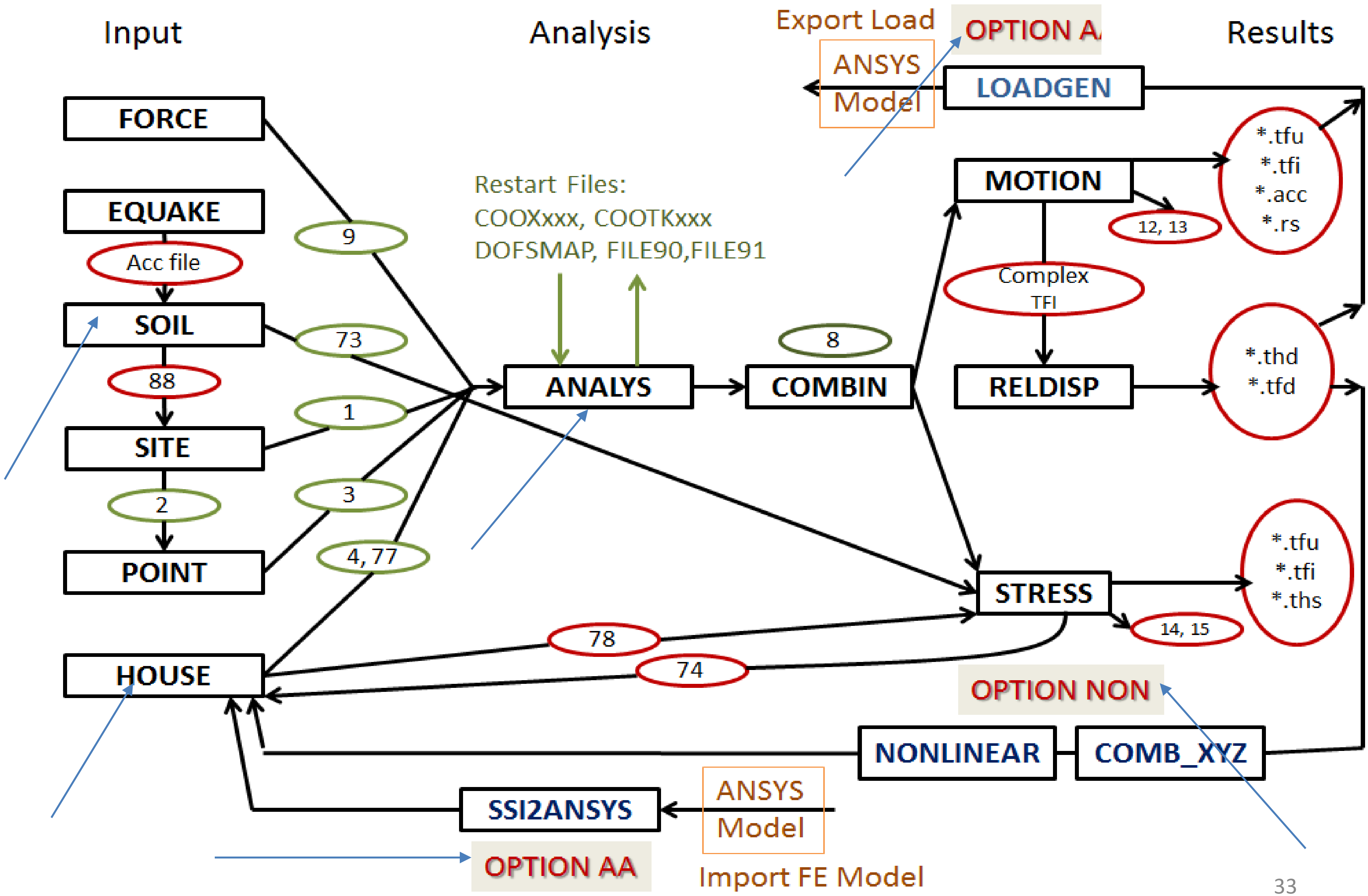
Modular Configuration, Inputs and User Interface Pre/Post Inputs and Processing Capabilities

Modular Configuration

ACS SASSI SSI Modules (Main Software)

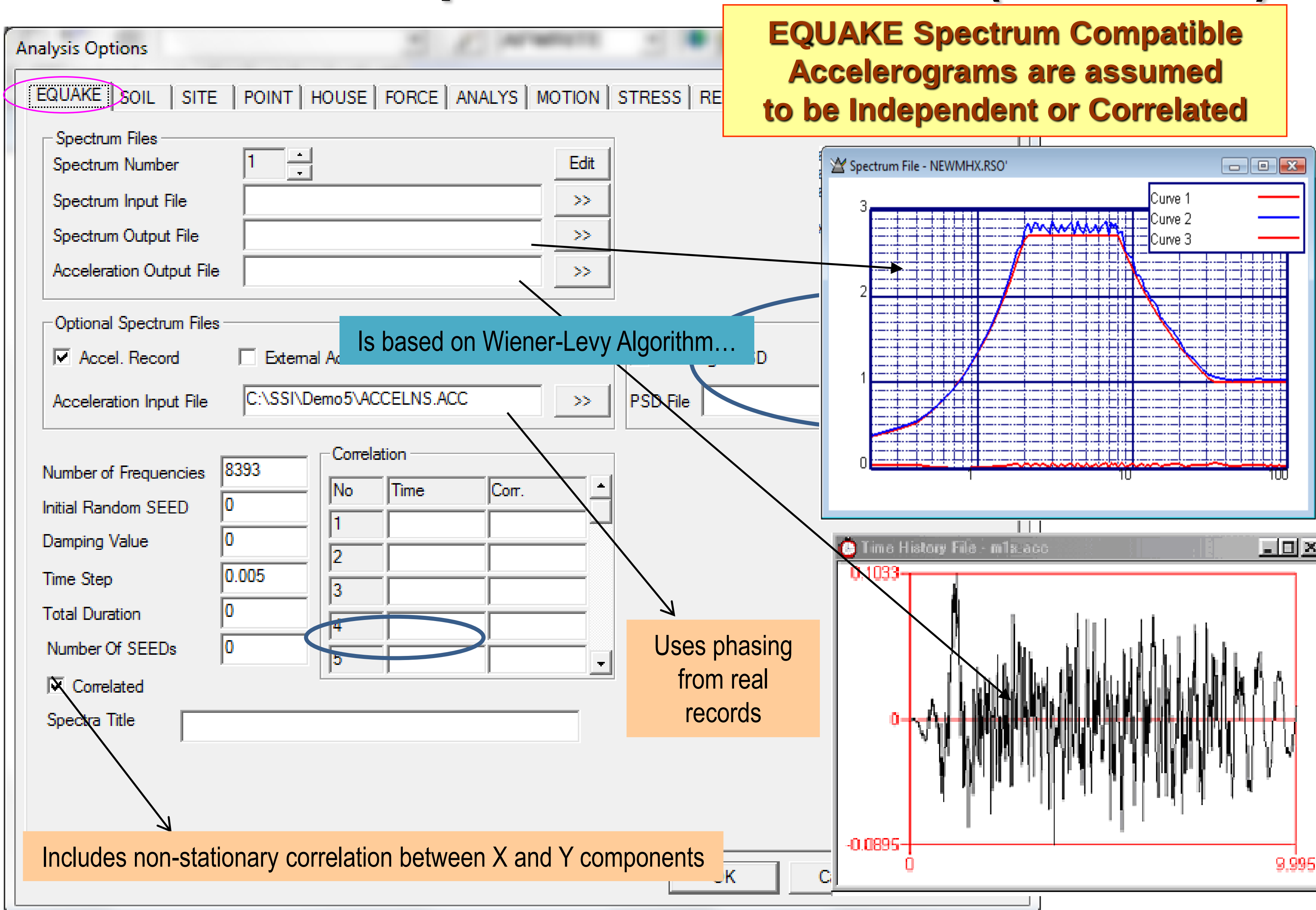
1. **EQUAKE** – Generates Control Motion
2. **SOIL** – Compute Equivalent Soil Properties and Free-Field Motions
3. **SITE** – Compute Site Layering Behavior Under Different Wave Types
4. **POINT** – Compute Soil Layering Flexibilities Under Point Loads
5. **HOUSE** – Defines the Structure and Near-Field Soil and Incoherence
6. **ANALYS** – Compute Impedances & Solves SSI Problem (ATF solution)
7. **MOTION** – Computes Accelerations, RS in Structure/Near-Soil
8. **RELDISP** - Computes Relative Displacements
9. **STRESS** – Computes Stresses/Strains in Structure and Near-Soil
10. **COMBIN** – Combine ANALYS Solutions with Different Frequencies

ACS SASSI Modular Configuration



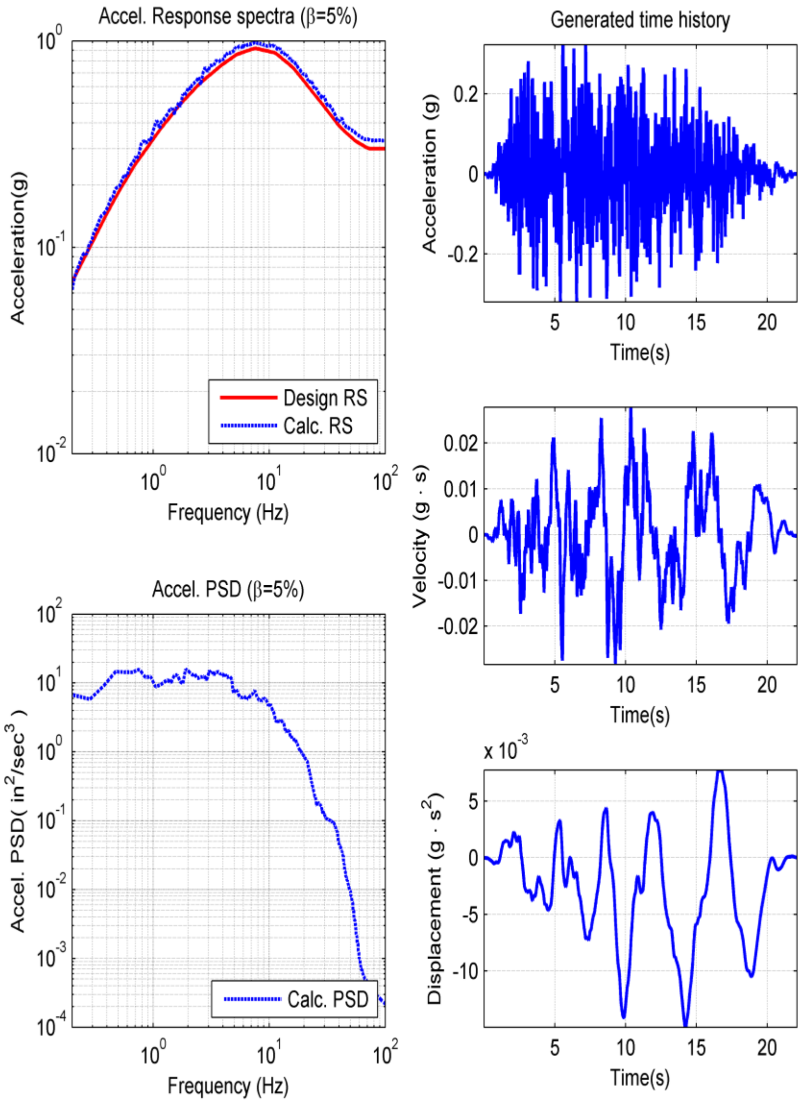
User Interface Inputs for SSI Modules

Simulation of Input Control Motion (EQUAKE)

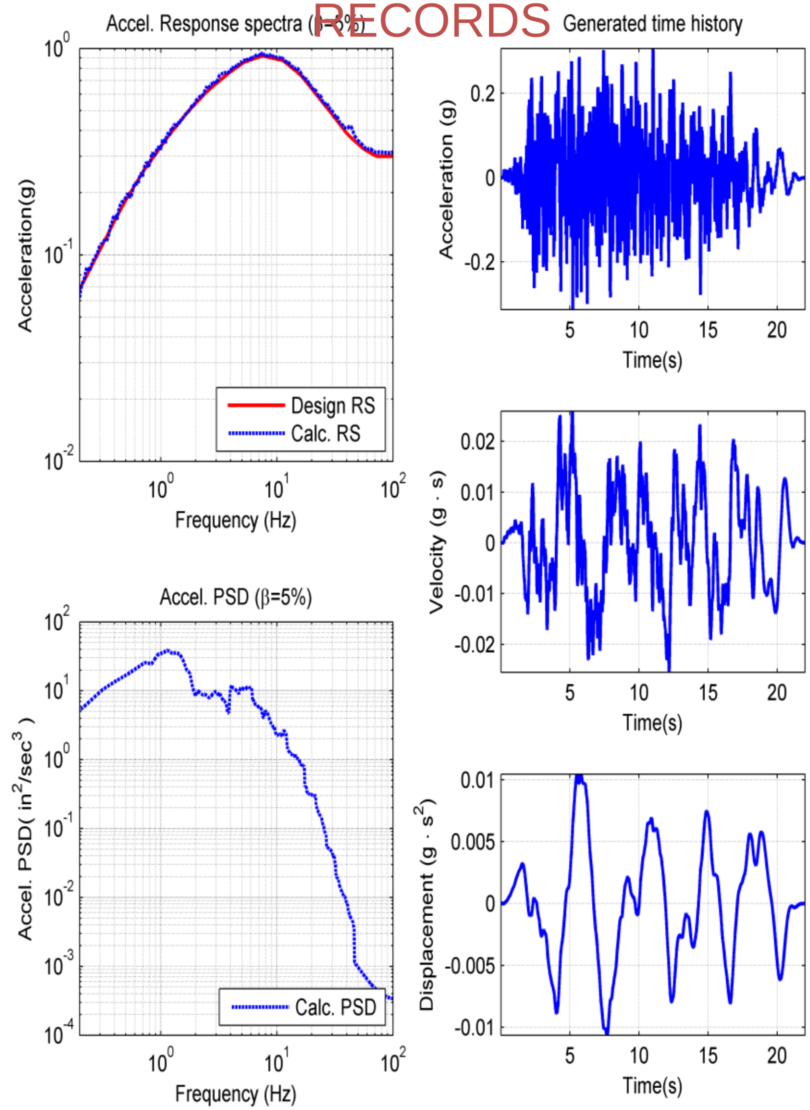


EQUAKE Module Capabilities – Firm Soil Site

WITHOUT SEED RECORDS

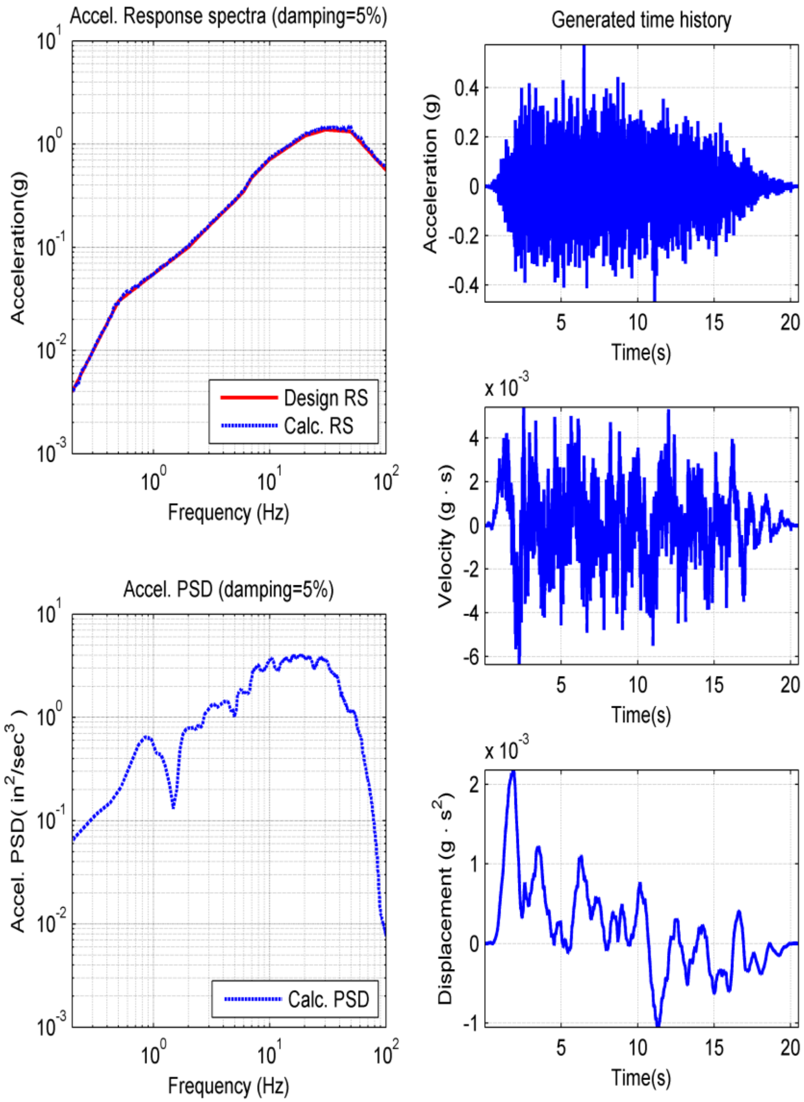


WITH SEED RECORDS

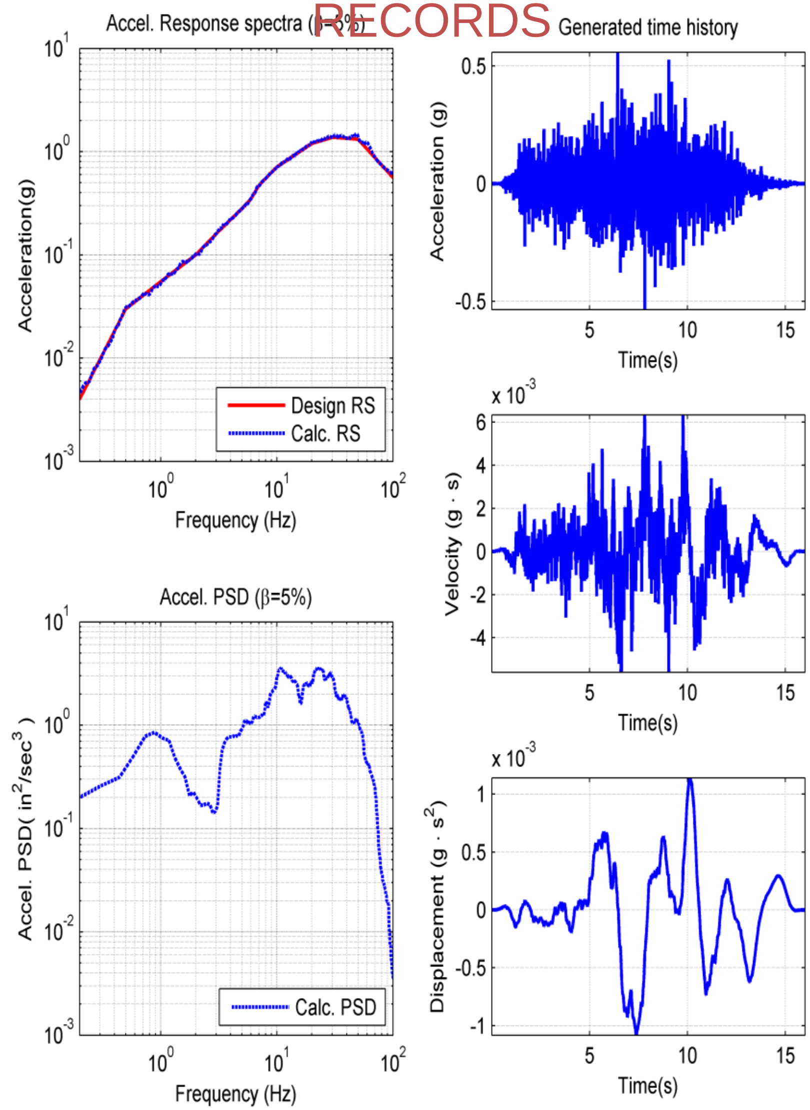


EQUAKE Module Capabilities – Rock Soil Site

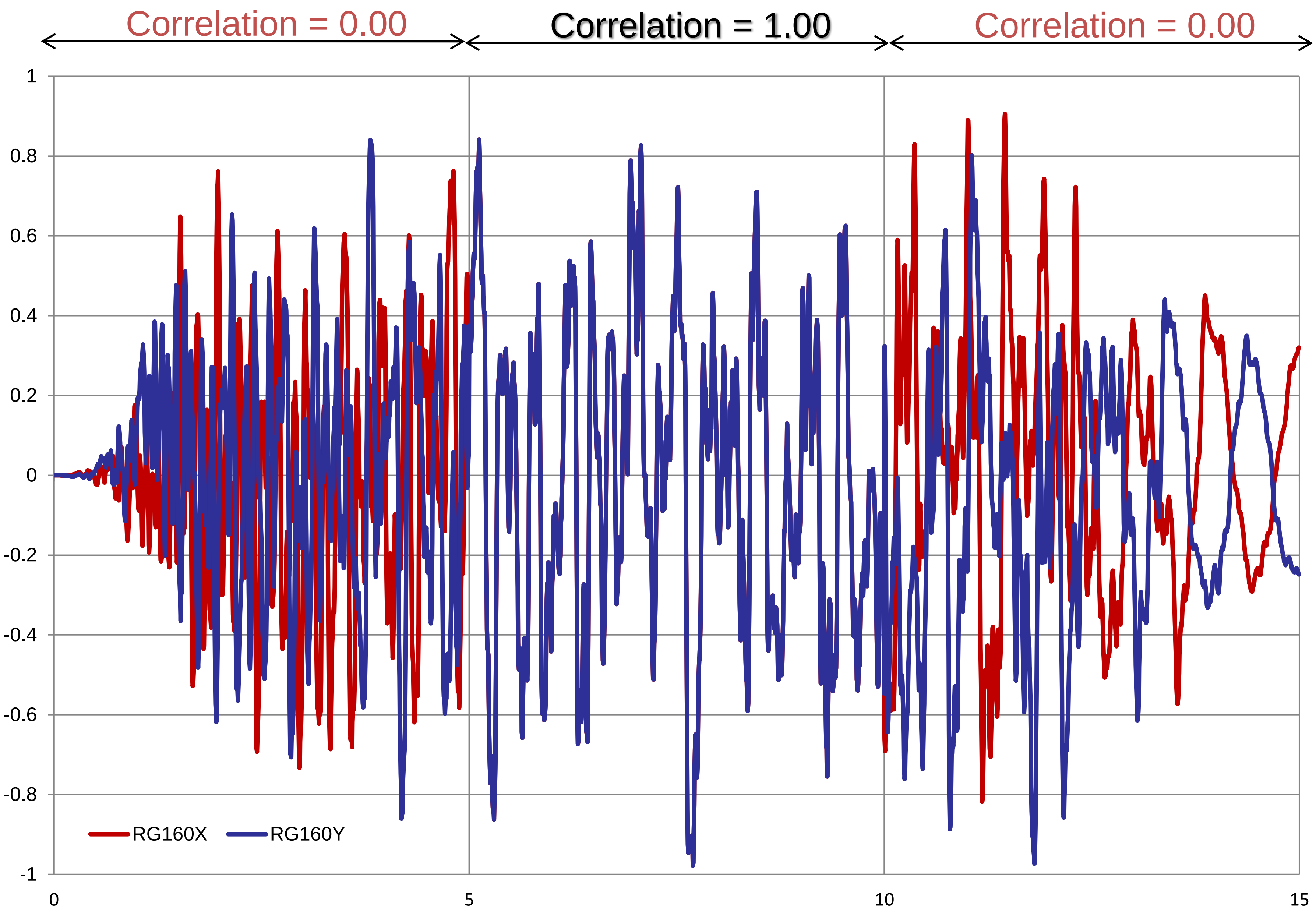
WITHOUT SEED RECORDS



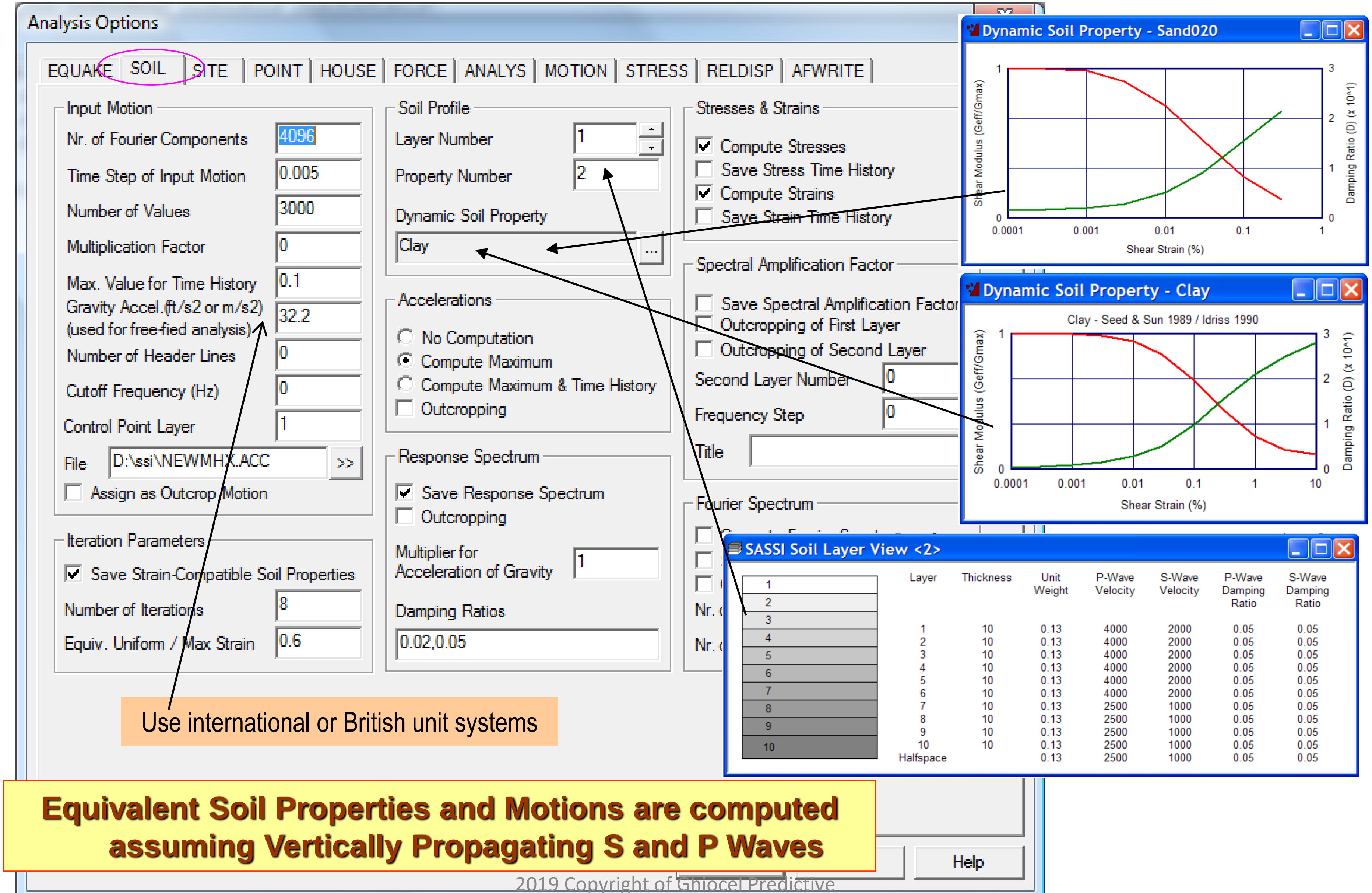
WITH SEED RECORDS



Spectrum Compatible Accelerograms with Nonstationary Correlation

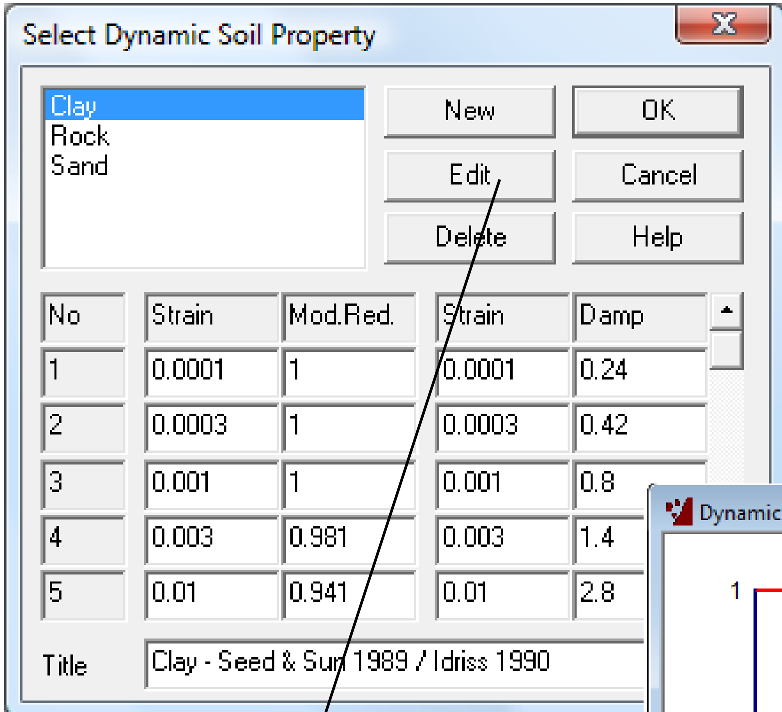


Site Response Via SHAKE Methodology (SOIL)

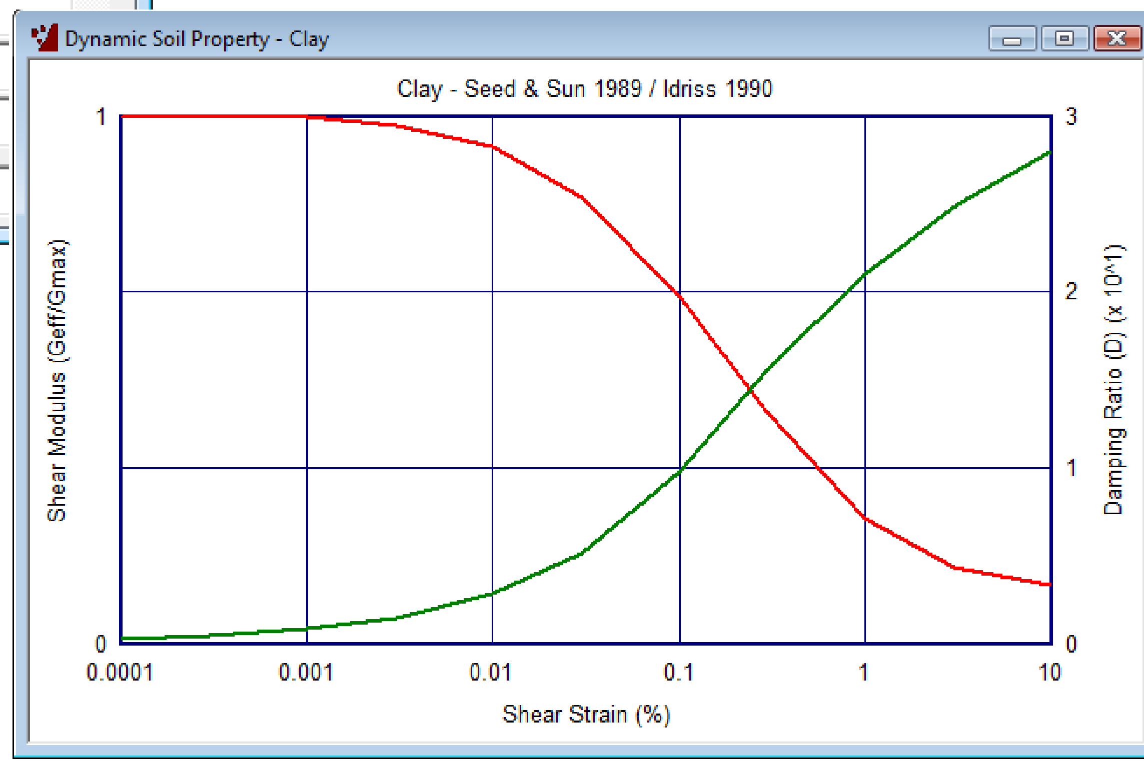


Layer	Thickness	Unit Weight	P-Wave Velocity	S-Wave Velocity	P-Wave Damping Ratio	S-Wave Damping Ratio
1	10	0.13	4000	2000	0.05	0.05
2	10	0.13	4000	2000	0.05	0.05
3	10	0.13	4000	2000	0.05	0.05
4	10	0.13	4000	2000	0.05	0.05
5	10	0.13	4000	2000	0.05	0.05
6	10	0.13	4000	2000	0.05	0.05
7	10	0.13	2500	1000	0.05	0.05
8	10	0.13	2500	1000	0.05	0.05
9	10	0.13	2500	1000	0.05	0.05
10	10	0.13	2500	1000	0.05	0.05
Halfspace		0.13	2500	1000	0.05	0.05

Equivalent Soil Properties and Motions are computed assuming Vertically Propagating S and P Waves



Nonlinear soil material curve database; Shear modulus and damping ration as functions of soil shear strain



User can add edit, delete, and included new curves

Computation of Equivalent Soil Properties

SOIL Module (based on SHAKE approach) Computes Equivalent Soil Properties Using Seed-Idriss Equivalent Linear Model

Input Acceleration Time History

```
MAXIMUM ACCELERATION =    .85600
AT TIME              =   4.37 SEC
THE VALUES WILL BE MULTIPLIED BY A FACTOR =    .350
TO GIVE NEW MAXIMUM ACCELERATION          =    .30000
MEAN SQUARE FREQUENCY =        6.87 C/SEC.
***  CONTROL MOTION LAYER ***
 **  MOTION OF LAYER NUMBER     1  OUTCROPPING

***  STRAIN COMPATIBLE SOIL PROPERTIES ***
 MAXIMUM NUMBER OF ITERATIONS    =     8
 STRAIN FACTOR IN TIME DOMAIN    =    .60

    EARTHQUAKE   -            C:\ACS_C\NEWMHX.ACC
```

Initial Soil Layering Properties

```
***  SOIL PROFILE DESCRIPTION ***
NEW SOIL PROFILE NO.    1      IDENTIFICATION
NUMBER OF LAYERS                   5          DEPTH TO BEDROCK         40.00
```

NO.	TYPE	THICKNESS (ft)	DEPTH (ft)	Tot. PRESS. (ksf)	MODULUS (ksf)	DAMPING	UNIT WT. (kcf)	SHEAR VEL (fps)
1	1	10.00	5.00	.65	4037.	.050	.130	1000.0
2	1	10.00	15.00	1.64	4037.	.050	.130	1000.0
3	1	10.00	25.00	2.31	4037.	.050	.130	1000.0
4	1	10.00	35.00	2.99	4037.	.050	.130	1000.0
5	BASE				4037.	.050	.130	1000.0

PERIOD =   .16 FOR AVERAGE SHEAR VELOCITY =   1000.

Final Soil Layering Properties

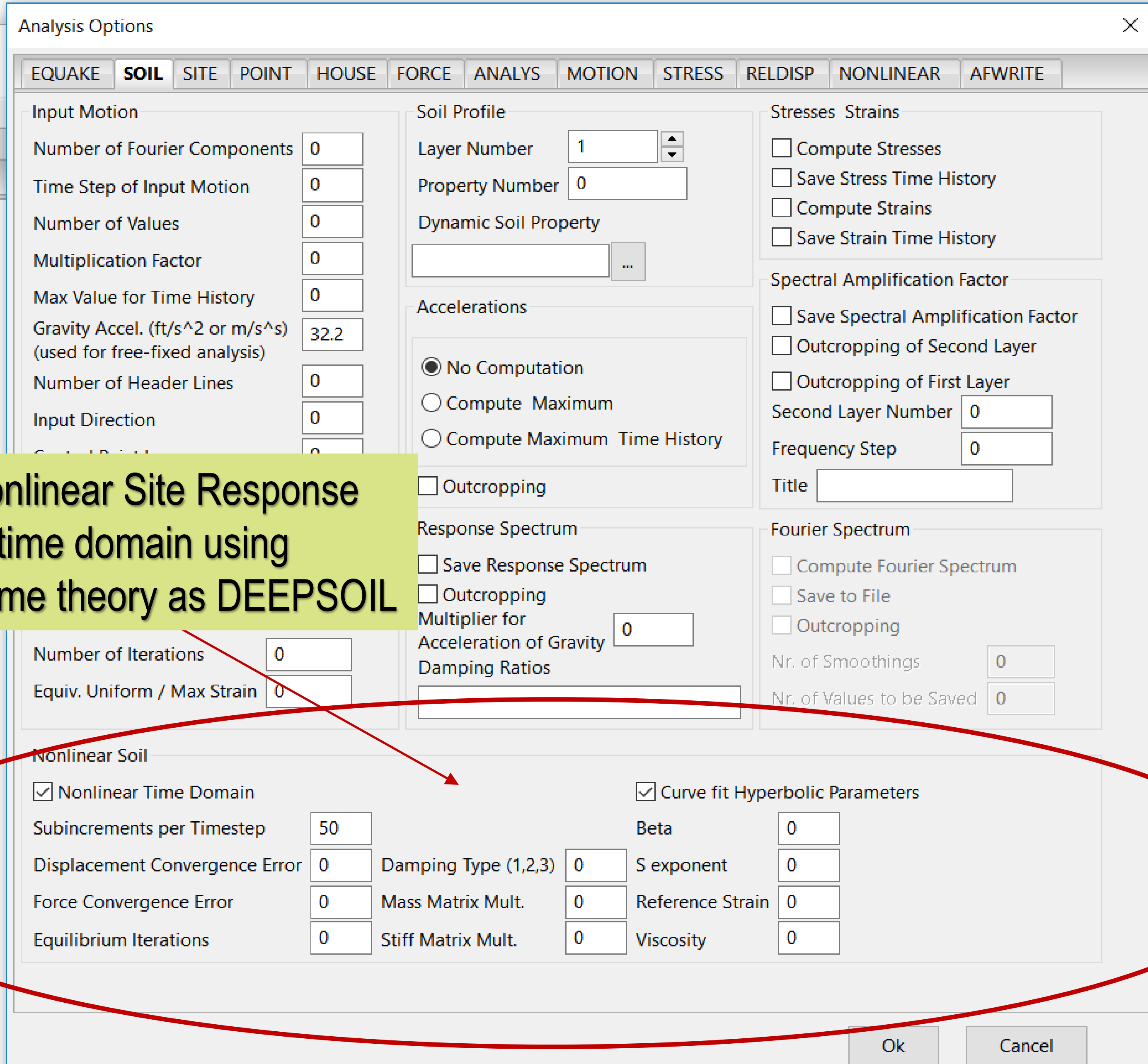
ITERATION NUMBER   8

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING NEW	USED	----> ERROR	<---- SHEAR MODULUS NEW	USED	-----> ERROR	G/Go RATIO
1	1	5.0	.00296	.014	.014	.0	3877.2	3877.2	.0	.960
2	1	15.0	.00909	.027	.027	0.0	3466.9	3466.9	.0	.859
3	1	25.0	.01629	.038	.038	0.0	3055.3	3055.3	0.0	.757
4	1	35.0	.02485	.047	.047	0.0	2729.1	2729.2	0.0	.676

PERIOD =   .18 FOR AVERAGE SHEAR VELOCITY =   900.

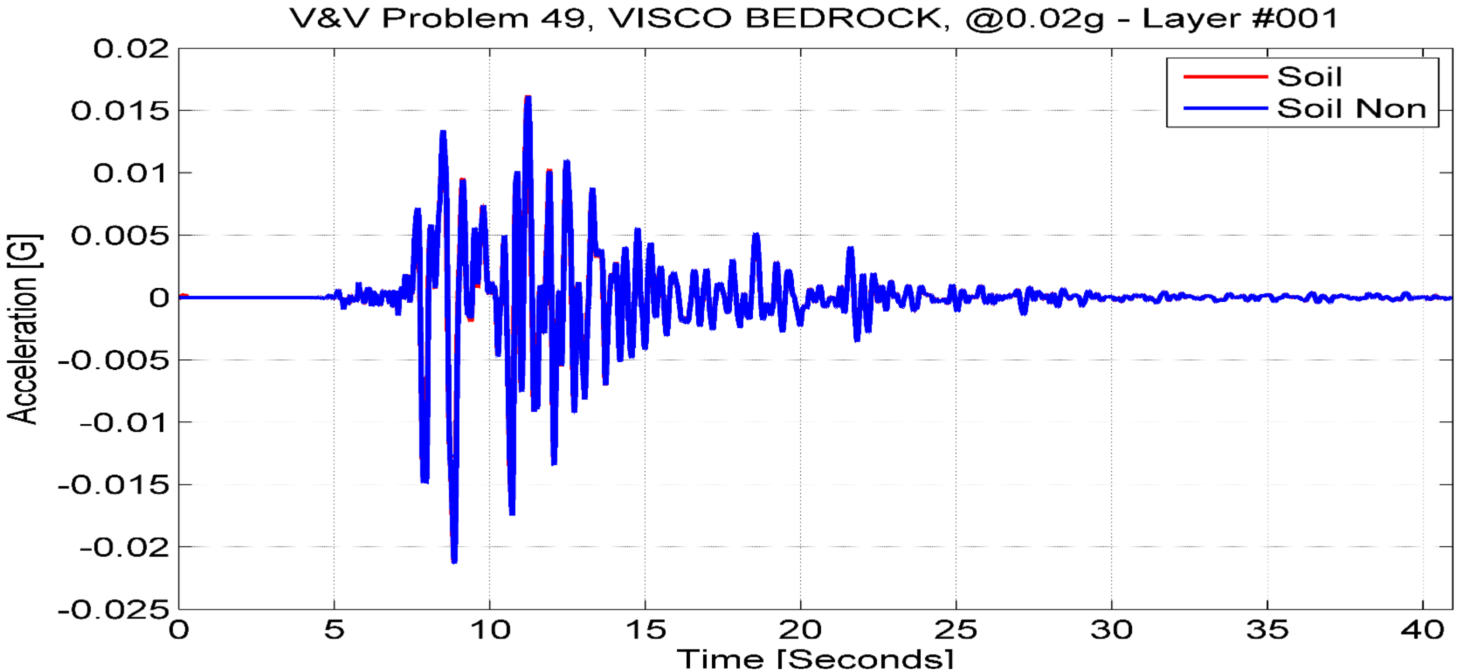
SOIL Module Including DEEPSOIL Option

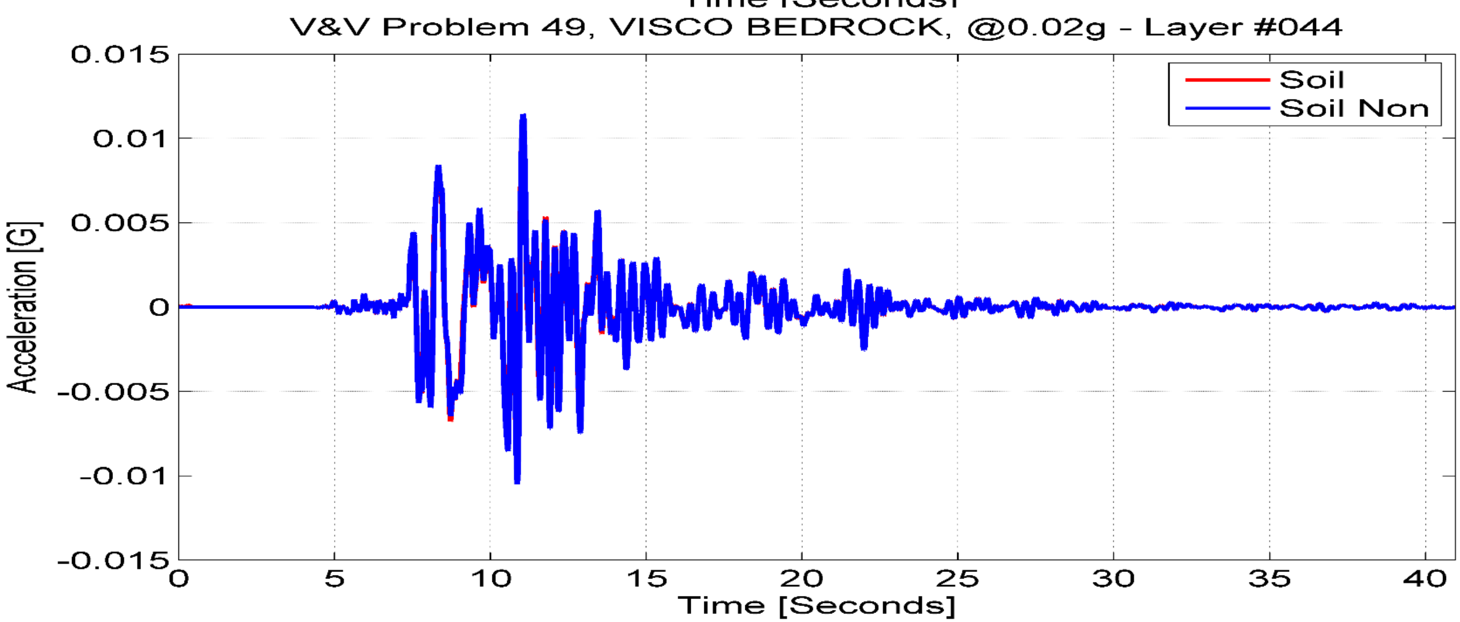


Nonlinear Site Response in time domain using same theory as DEEPSOIL

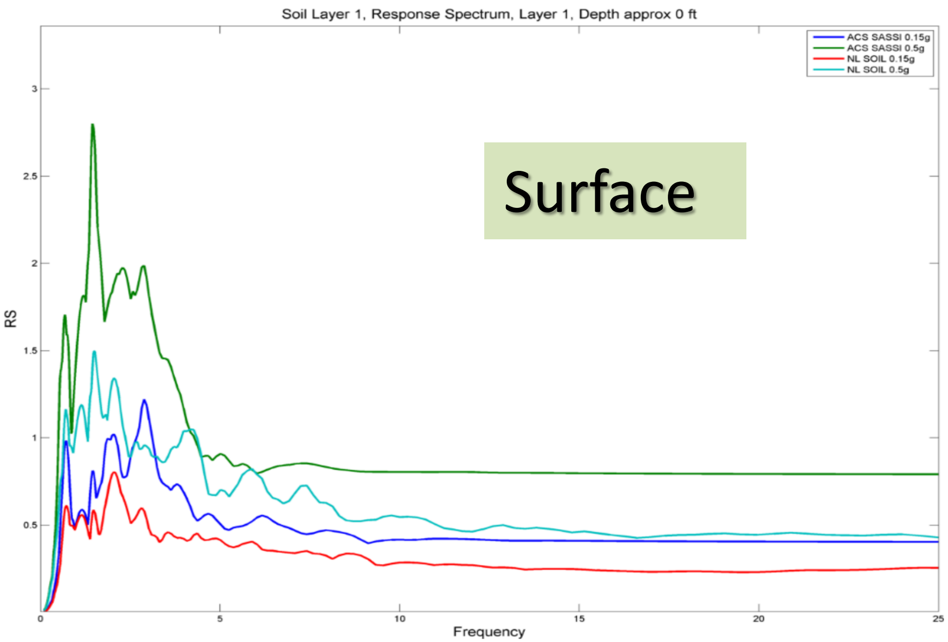
42

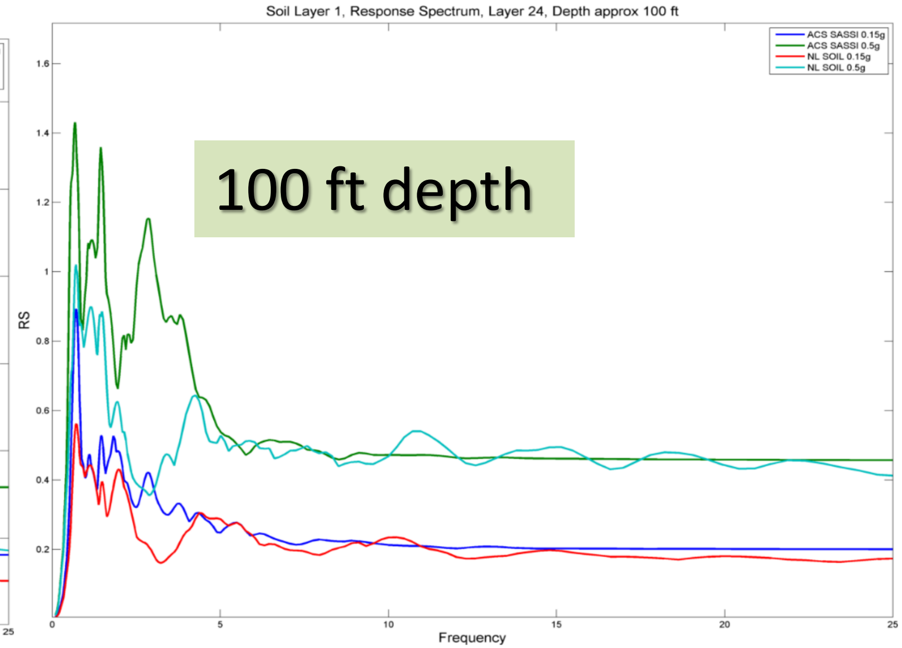
SOIL-NON DEEPSOIL vs. SOIL SHAKE Methods

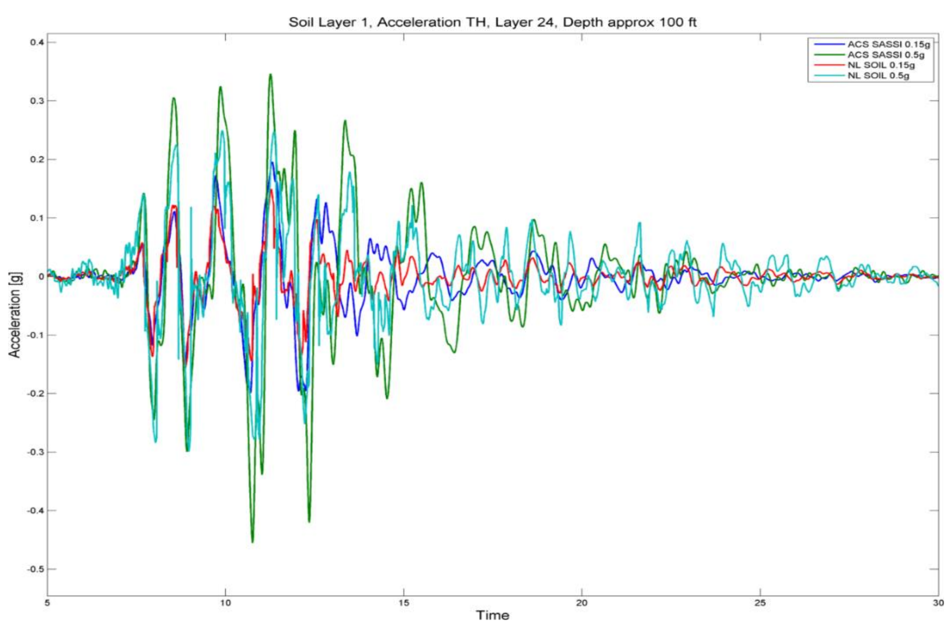


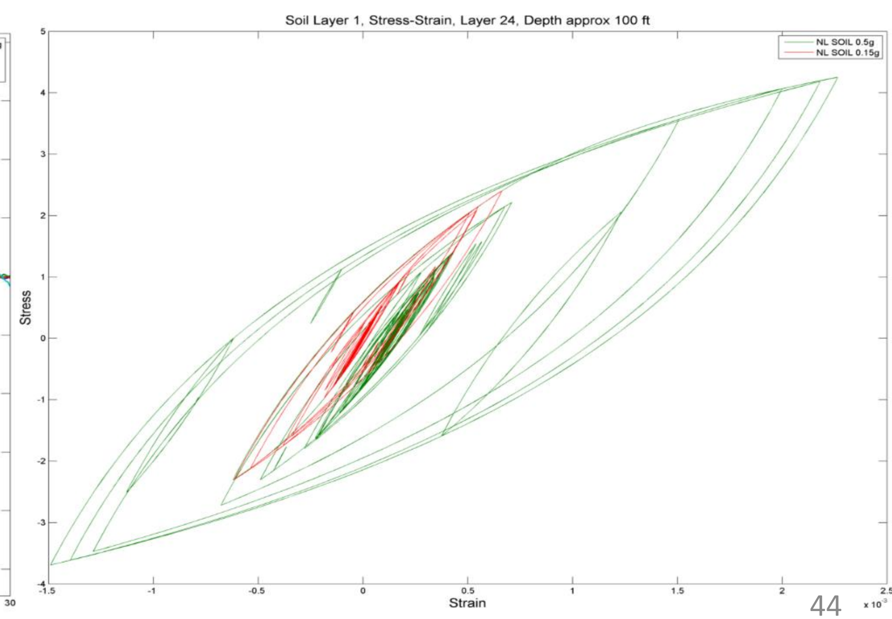


Equivalent-Linear vs. Nonlinear Site



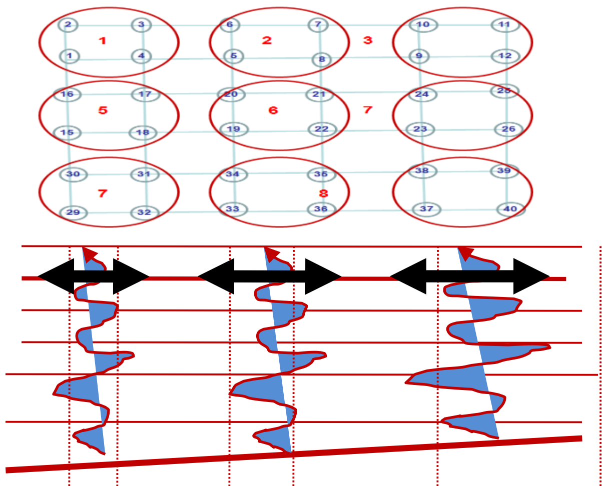




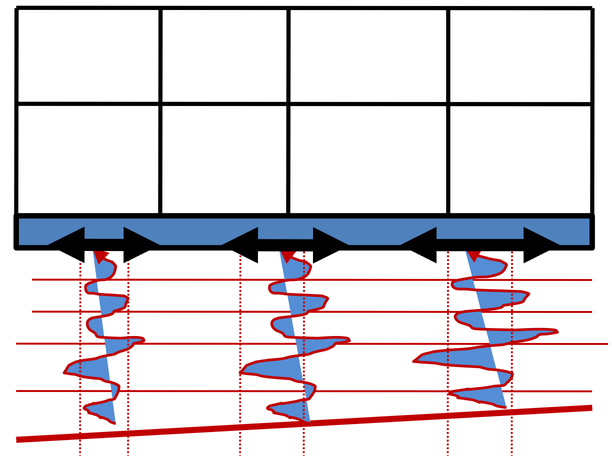


Nonuniform Seismic Input Motion in Horizontal Plane

Multiple Soil Column Response Analyses



Non-Uniform Excitation and Soil Stiffness

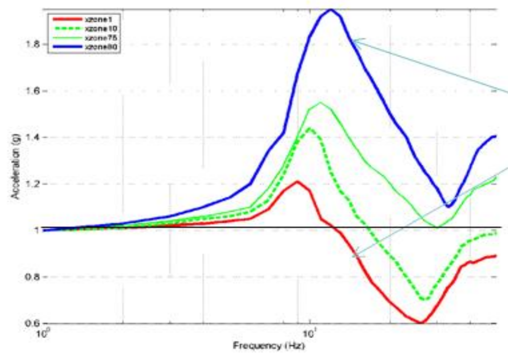


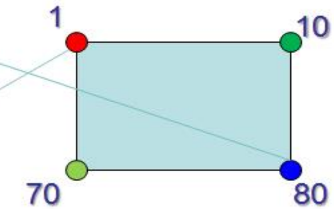
ACS SASSI Version 2.3.0 has the capability to consider deterministic spatial variation patterns for differential input motions in the horizontal plane.

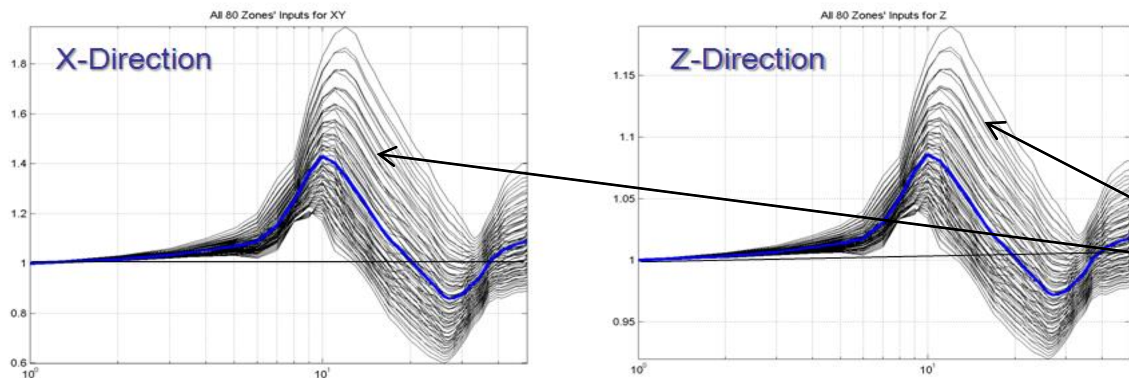
These deterministic spatial variation effects can be combined with the effects of motion incoherency and wave passage to create more realistic seismic inputs for SSI analysis of NPP structures, especially for those that have large foundation sizes.

Nonuniform Seismic Input Motion in Horizontal Plane

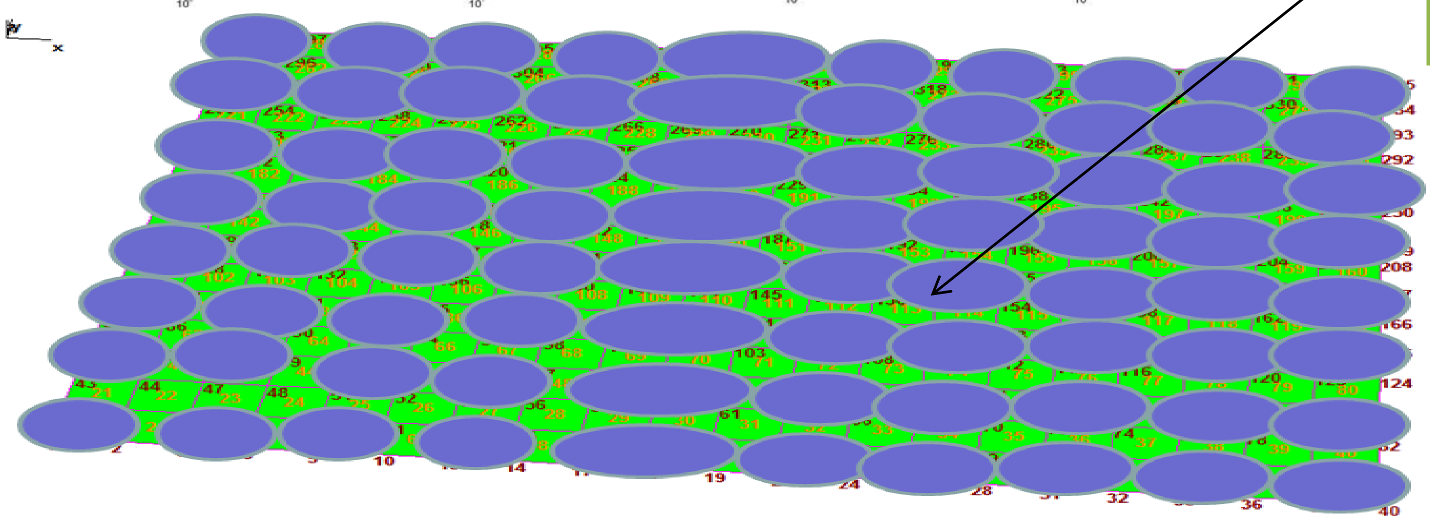
Multiple borehole soil column models



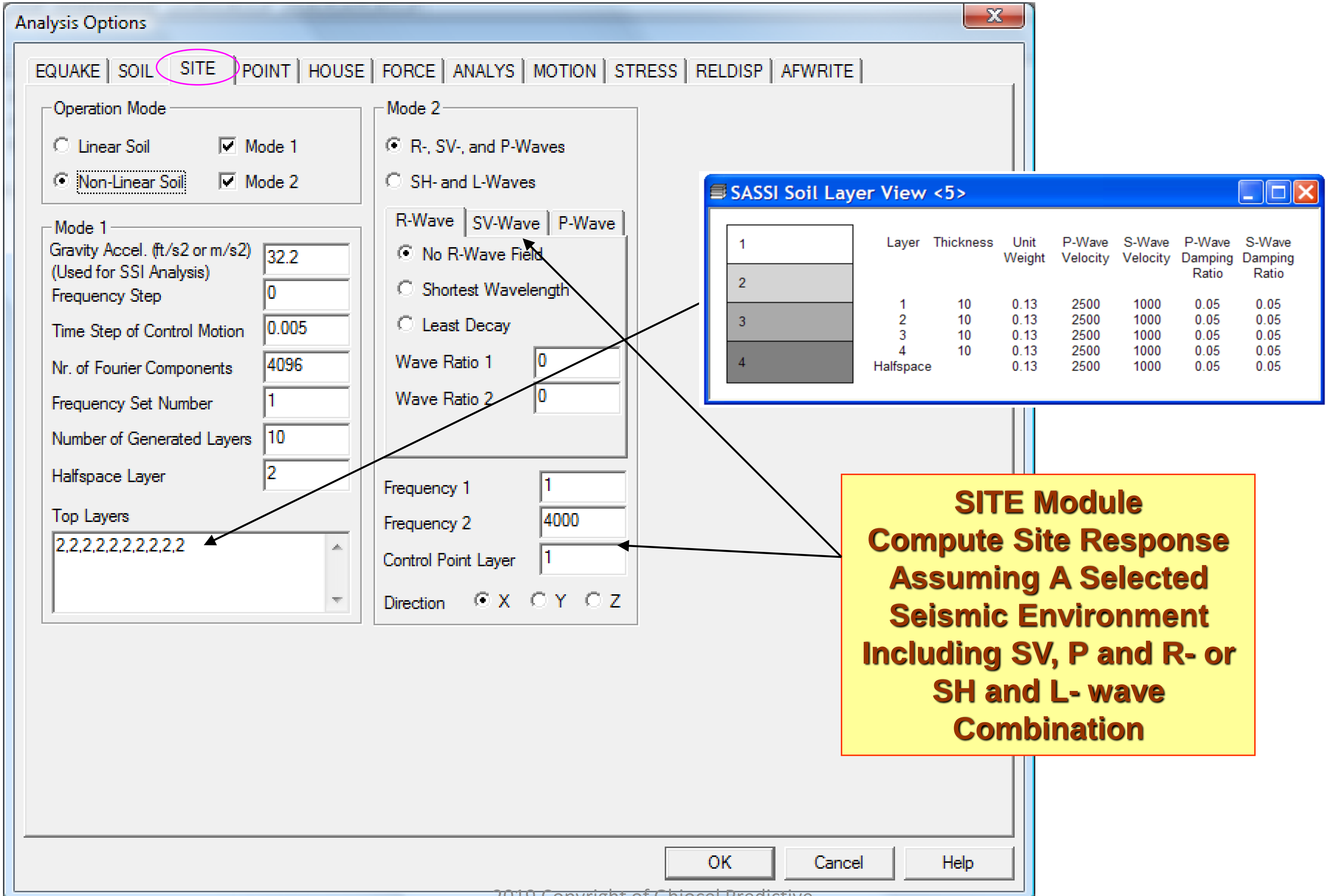




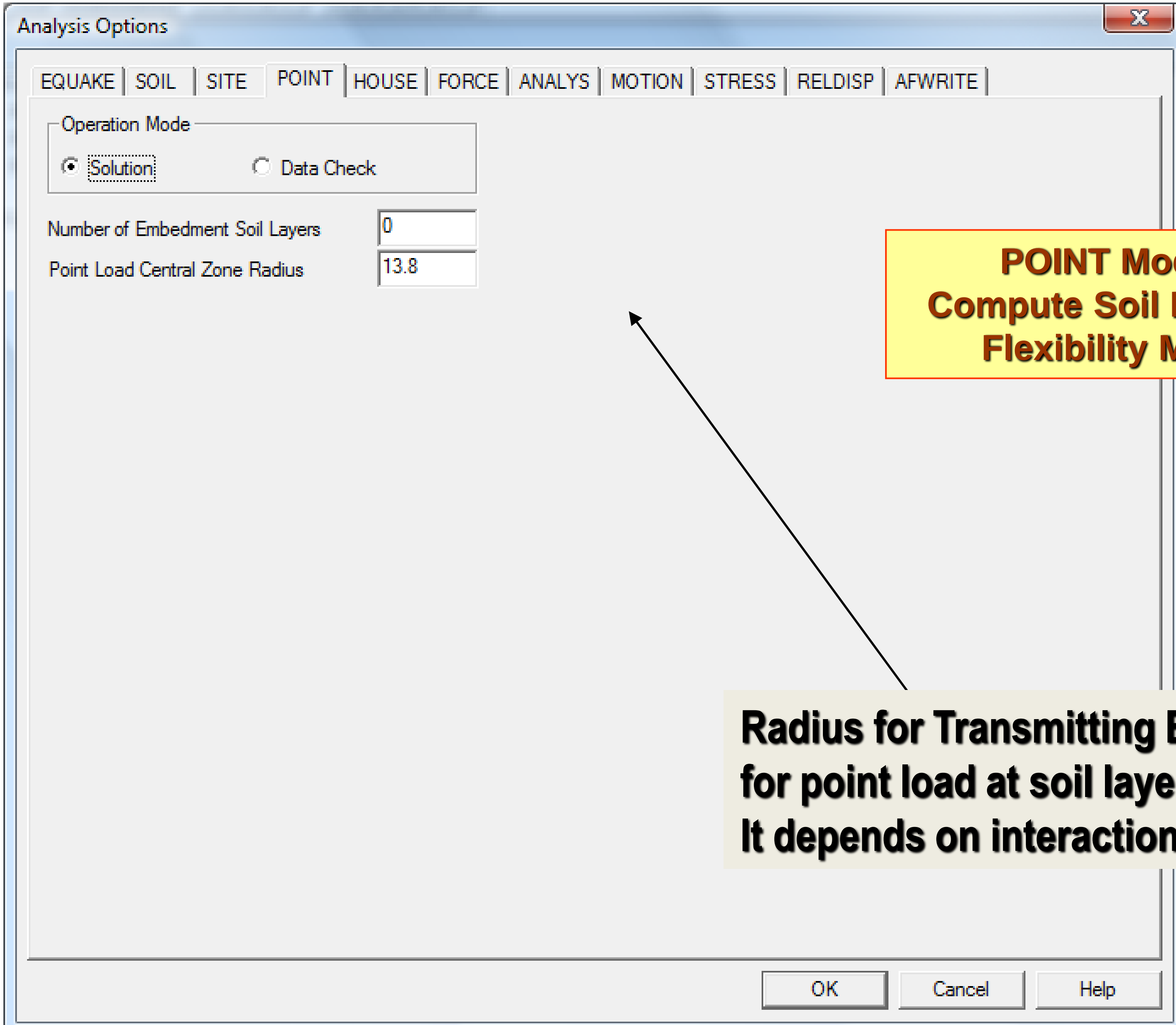
Each zone has different inputs that can be different for X, Y and Z directions



Selection of Seismic Wave Environment (SITE)



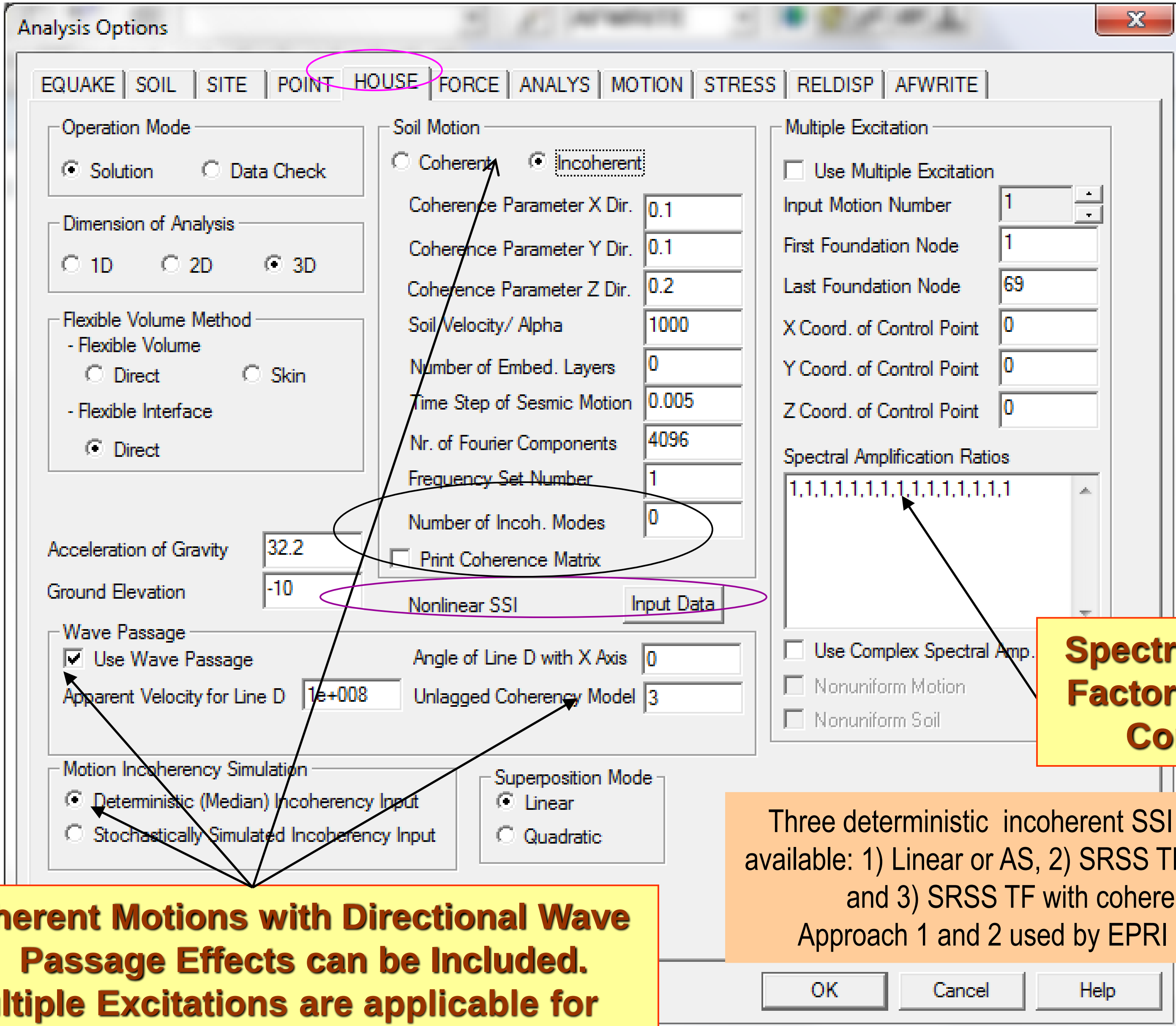
Input for Computing Soil Flexibility Matrix (POINT)



POINT Module
Compute Soil Layering
Flexibility Matrix

Radius for Transmitting Boundary for point load at soil layer interface. It depends on interaction node mesh.

Inputs for Coherent and Incoherent SSI (HOUSE)



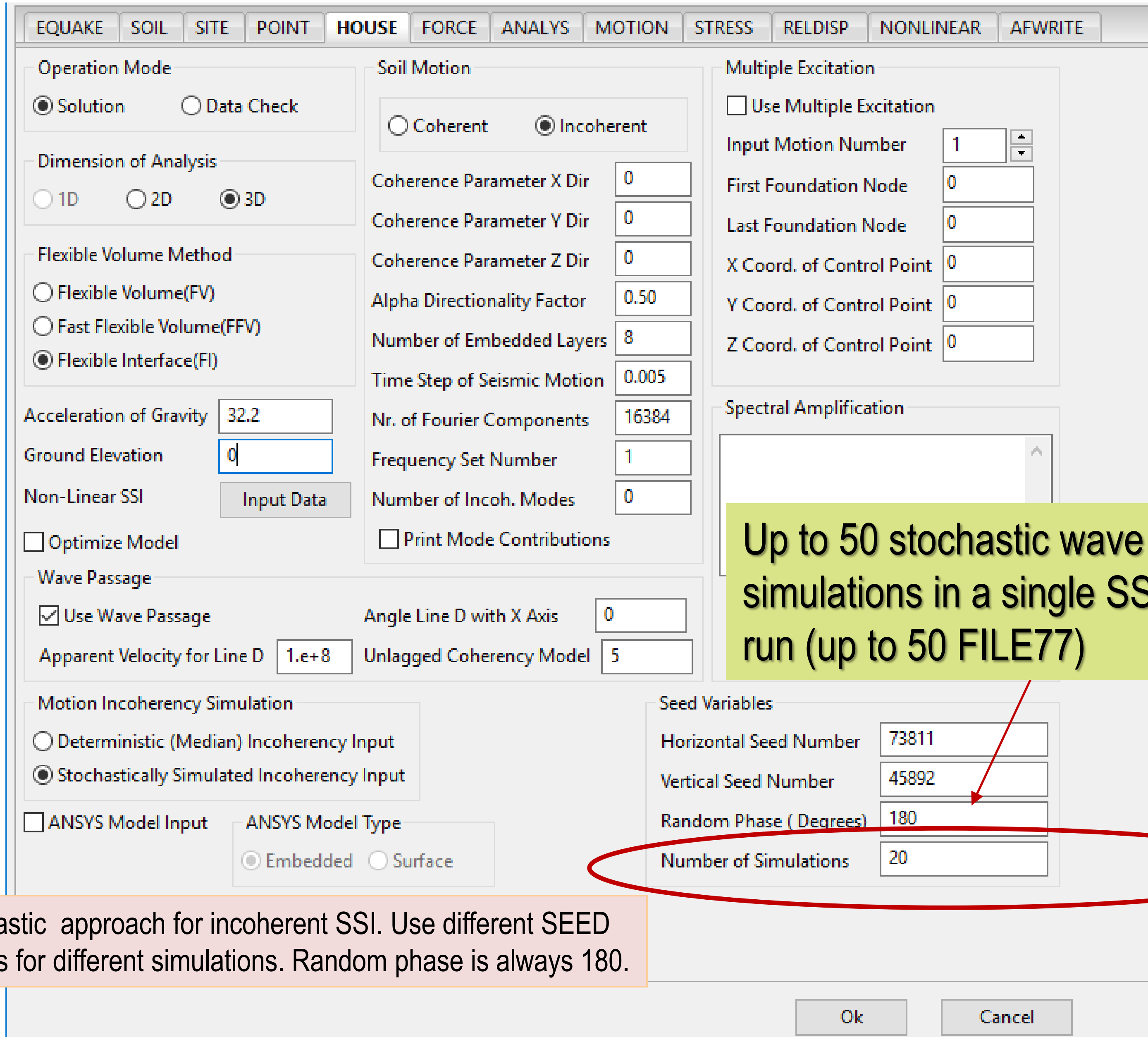
HOUSE include also a (hidden) node numbering optimization algorithm (1 in col 1 line of .hou)

Spectral Amplification Factors are applied to Control Motion

Three deterministic incoherent SSI approaches are available: 1) Linear or AS, 2) SRSS TF with zero phase, and 3) SRSS TF with coherent phase. Approach 1 and 2 used by EPRI (TR 1015111)

Incoherent Motions with Directional Wave Passage Effects can be Included. Multiple Excitations are applicable for Separate Isolated Foundations.

HOUSE Module for Incoherent SSI



Up to 50 stochastic wave field simulations in a single SSI analysis run (up to 50 FILE77)

Stochastic approach for incoherent SSI. Use different SEED numbers for different simulations. Random phase is always 180.

HOUSE Incoherent SSI Capabilities

There are several plane-wave incoherency models (with wave passage effects):

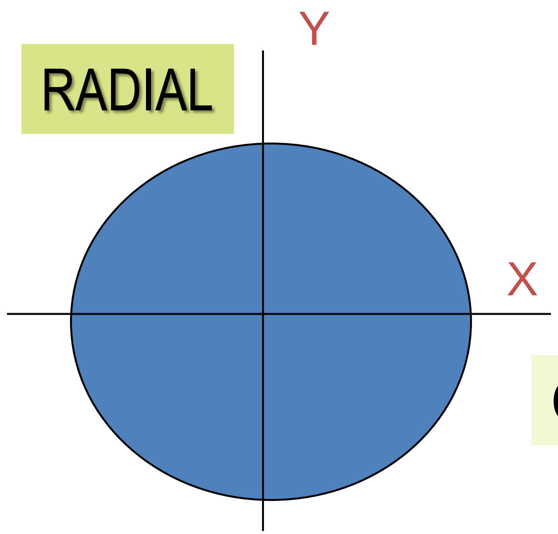
1) 1986 Luco-Wong model (theoretical, unvalidated, geom anisotropic)
2) 1993 Abrahamson model for all sites and surface foundations
3) 2005 Abrahamson model for all sites and surface foundations
4) 2006 Abrahamson model for all sites and embedded foundations
5) 2007 Abrahamson model for hard-rock sites and all foundations (NRC)
6) 2007 Abrahamson model for soil sites and surface foundations
7) *User-Defined Plane-Wave Coherency Functions for X, Y and Z.*

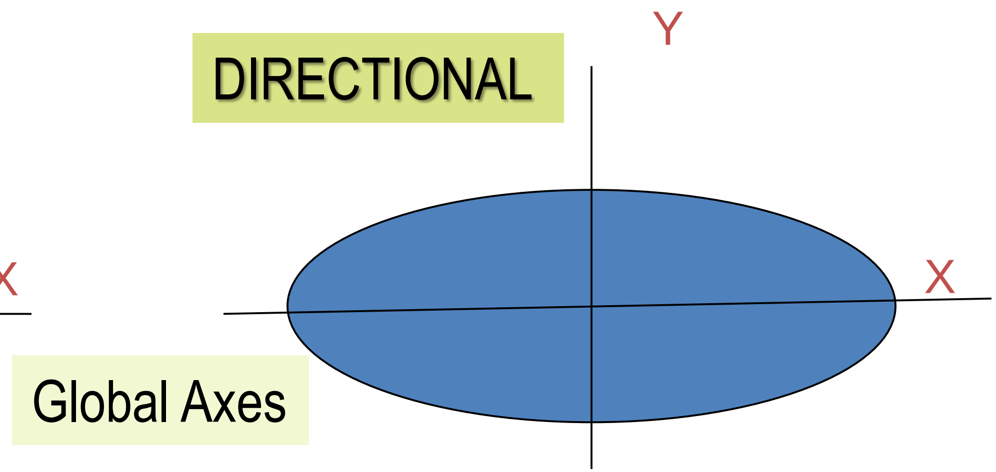
REMARKS:

1) Also includes *directional* Abrahamson or user-defined coherency models.
2) For general, more complex situations, can include *nonuniform motion in horizontal plane* by both amplitude and phase changes at different interaction nodes;
3) Analyst can include *different coherent functions at different depth levels* in the free-field using HOUSE create FILE77 for each node layers of interaction nodes, and append all FILE77 files together for all interaction nodes. CAREFULL OPTION.

NOTE: To include automatic checking for the mode shapes

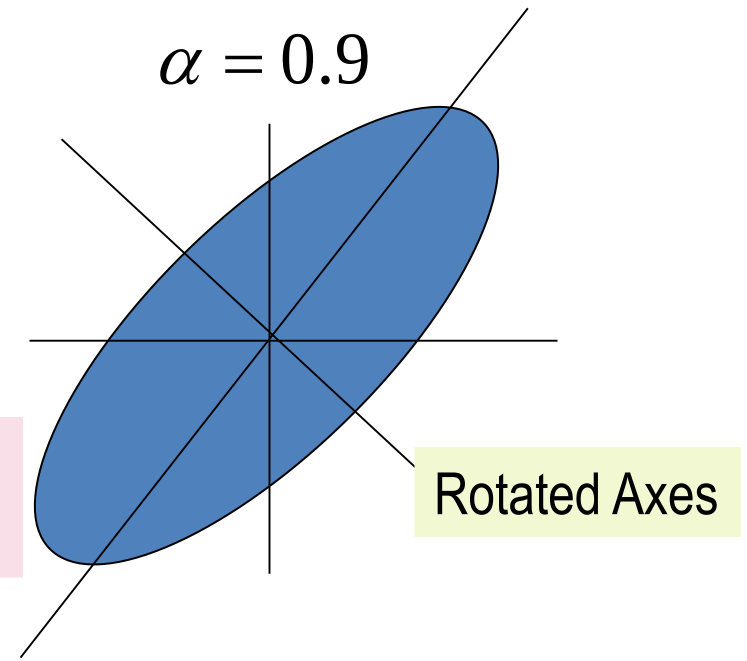
Radial vs. Directional Motion Coherency Models





$$\alpha = 0.5$$

$$\alpha = 0.9$$



$$D^2 = 2[(1-\alpha)Dx^2 + \alpha Dy^2]$$

Applicable to generic, Abrahamson models and user-defined, site-specific coherency models

Near-Field Soil Input for Nonlinear SSI

By clicking the “Nonlinear SSI” Input Data in HOUSE a text file is opened for editing.

This file has extension .pin and needs to input in a free-format:

1st line: Number of nonlinear soil element groups, effective strain factor, number of soil material curves defined in SOIL (soil constitutive model);

2nd line: Number of the nonlinear soil element group, number of materials (could be equal with the number of layers or not) in the group and number of solid elements in the group

3rd line and after define a loop over the number of soil materials, with each line including: The initial shear modulus reduction factor (1.00 indicates same shear modulus as in free-field), the initial damping ratio factor (1.00 indicates the same damping as in free-field) and the soil material curve order number.

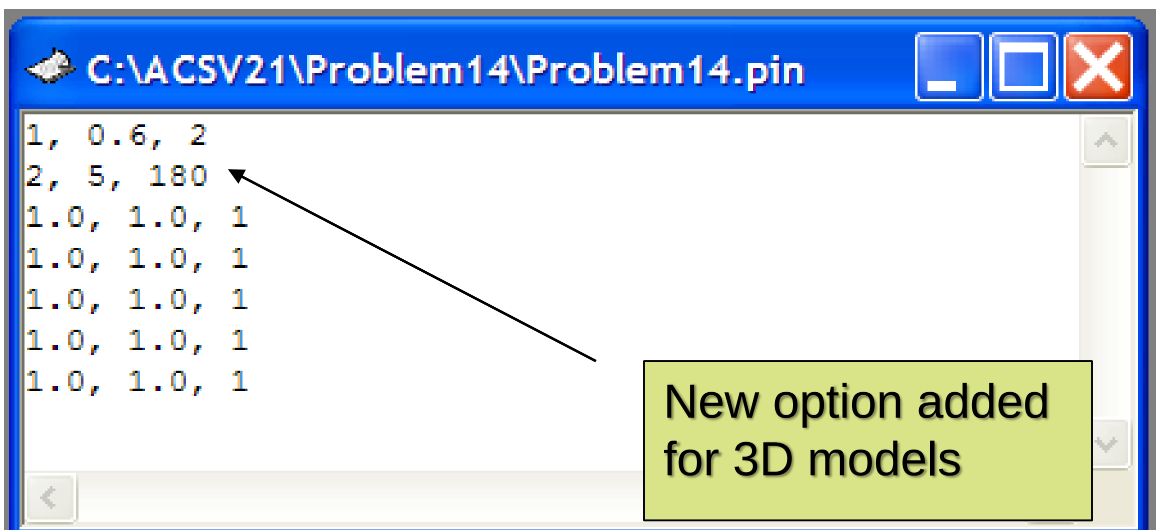
The block of lines after 1st line, needs to be input for all nonlinear soil element groups.

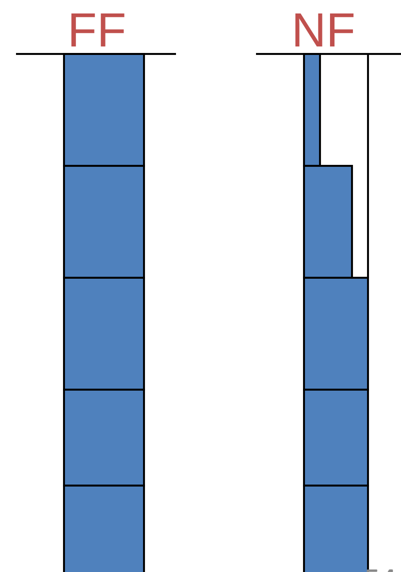
Near-Field Soil Input for Nonlinear SSI (cont.)

Example with a single group of nonlinear soil elements, an effective strain factor of 0.60 and 2 soil material curves.

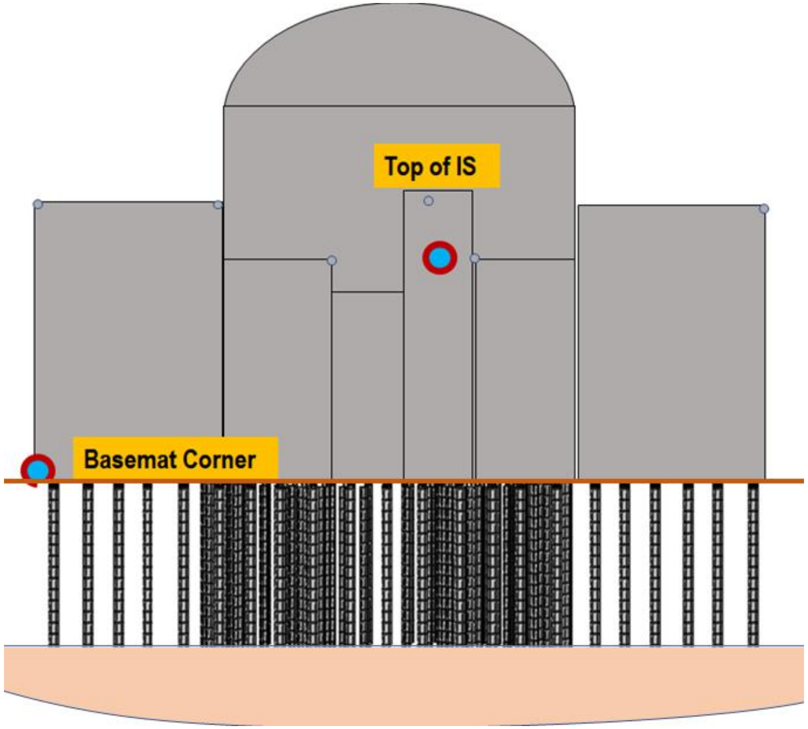
The order number of the nonlinear soil group is 2, the number of soil materials in the group is 5, and total number of elements in the group is 180.

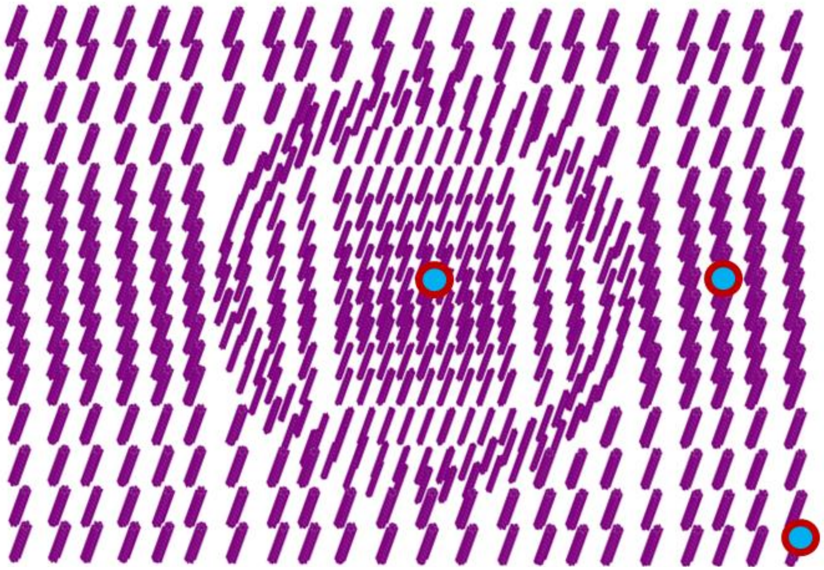
For each the 5 soil material lines, we input 1.0 for the scale factor of G, 1.0 for the scale factor of D, and 1 for material curve (curve number are defined in SOIL).

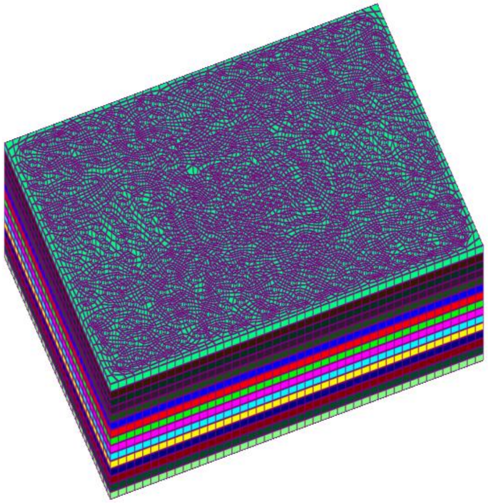


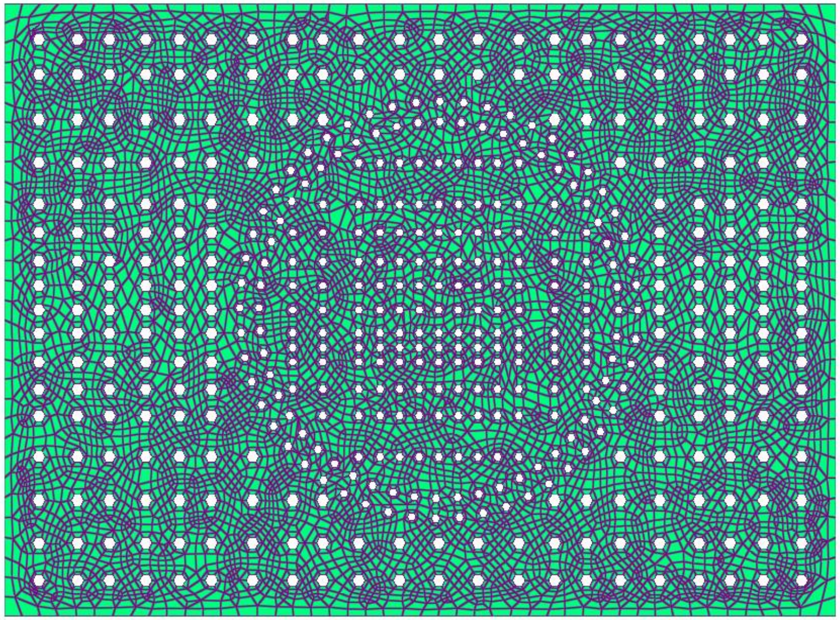


RB on Piles Example for Nonlinear Soil Effects

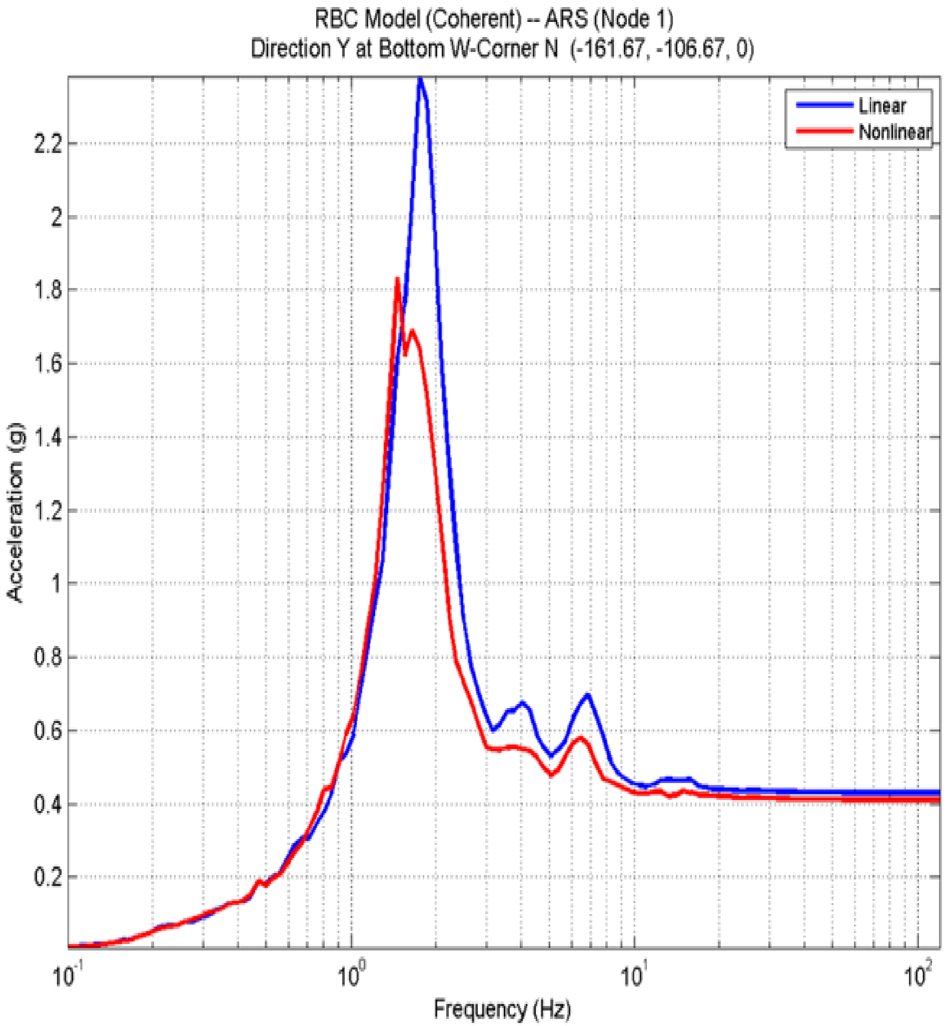


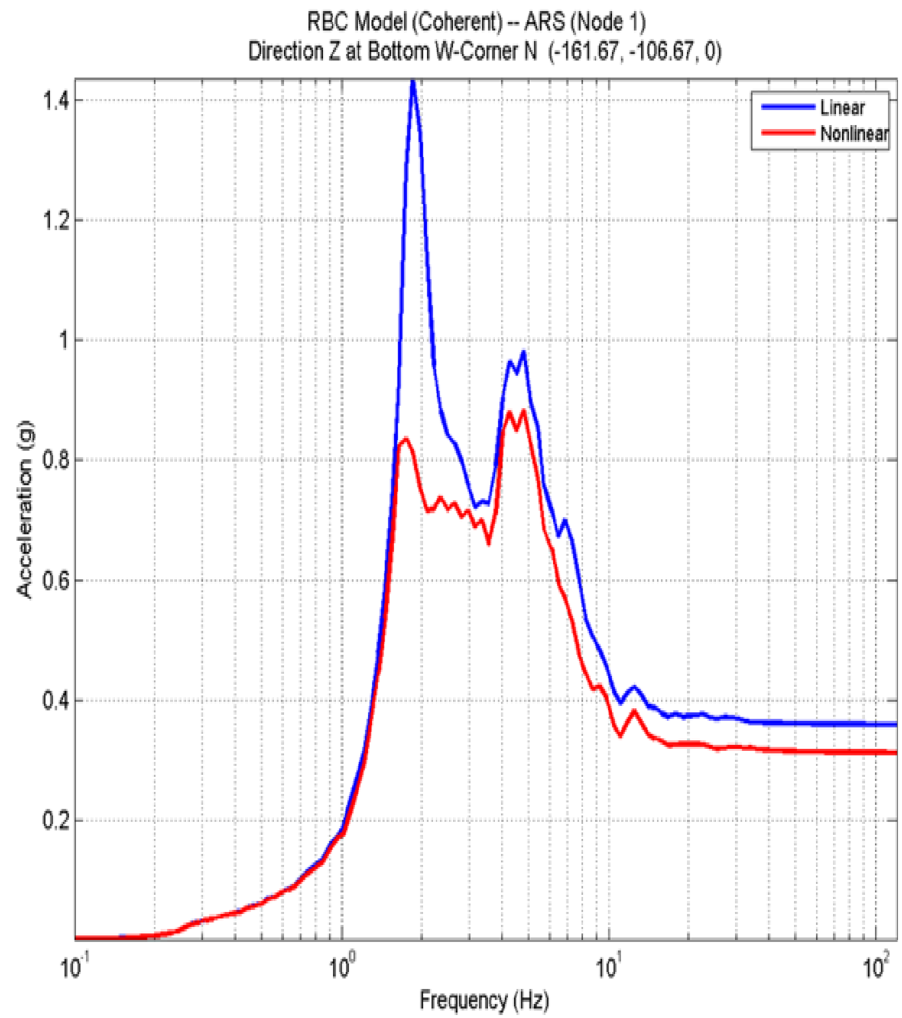




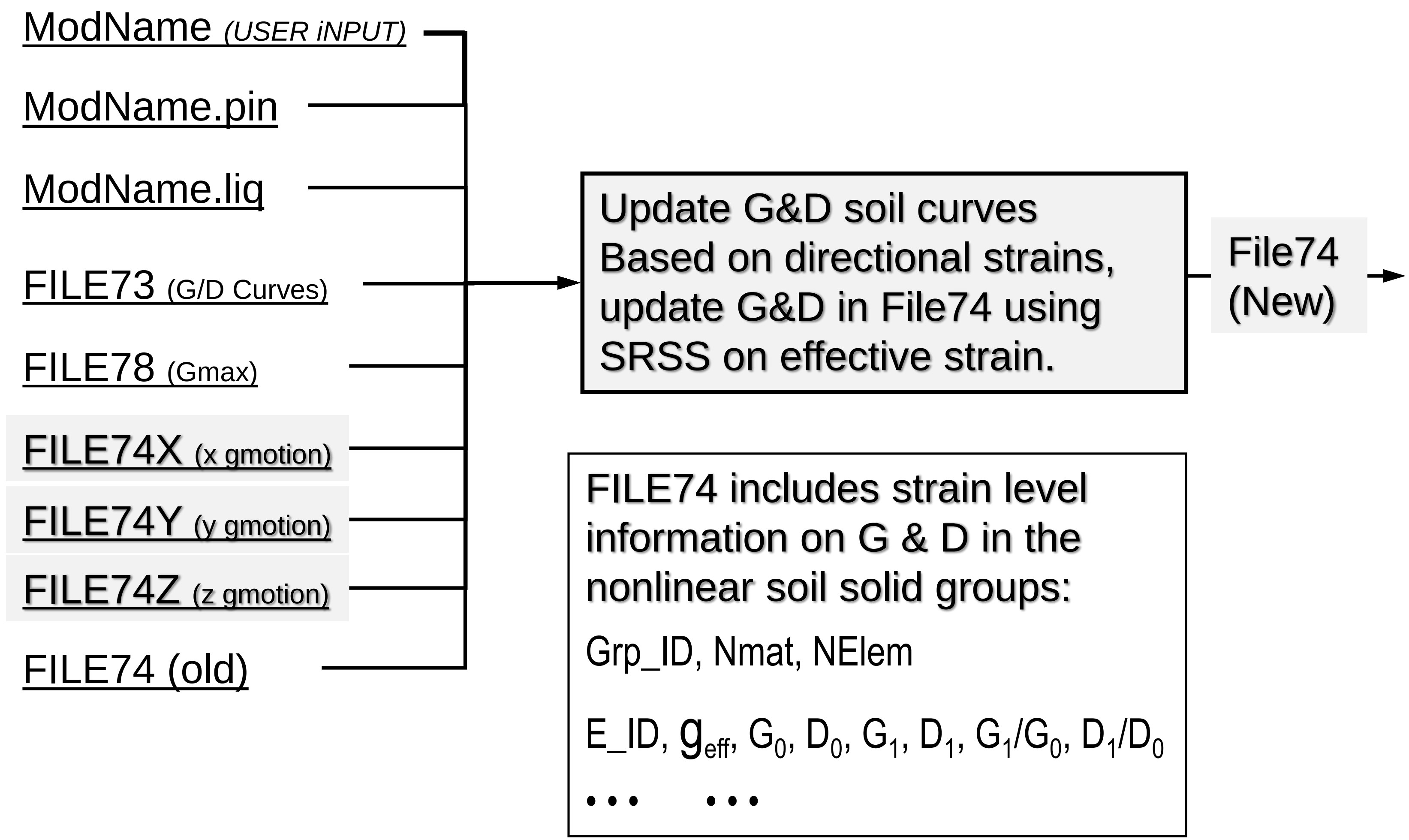


Effects of Nonlinear vs. Linear Soil Behavior In Vicinity of Piles on ISRS



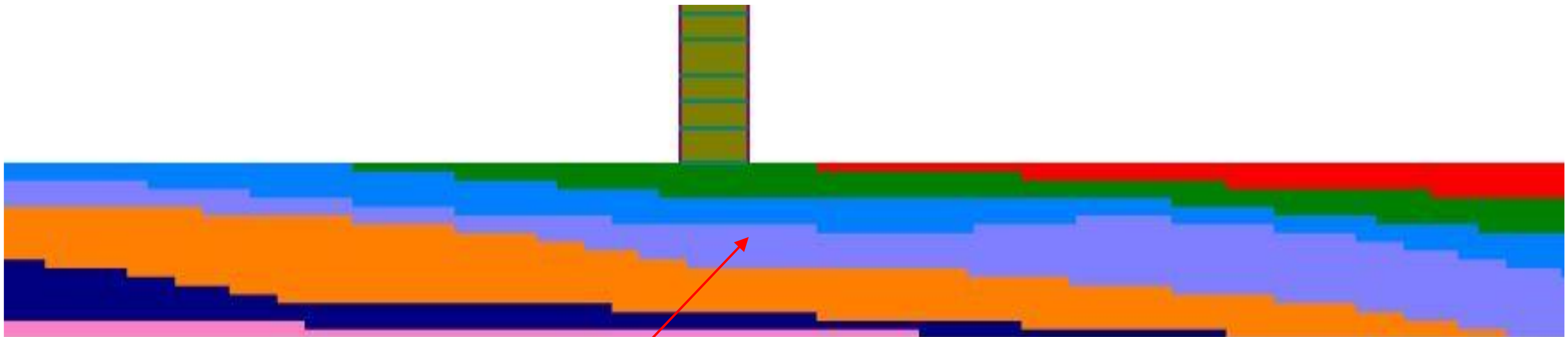


Auxiliary Program COMB_XYZ_STRAIN for Combining SSI Soil Shear Strains in 3D Space



2D/3D Soil Nonlinear Soil for Site or SSI Response

Use of nonlinear 2D PLANE elements similar to the use of nonlinear 3D SOLID elements for 3D SSI analysis

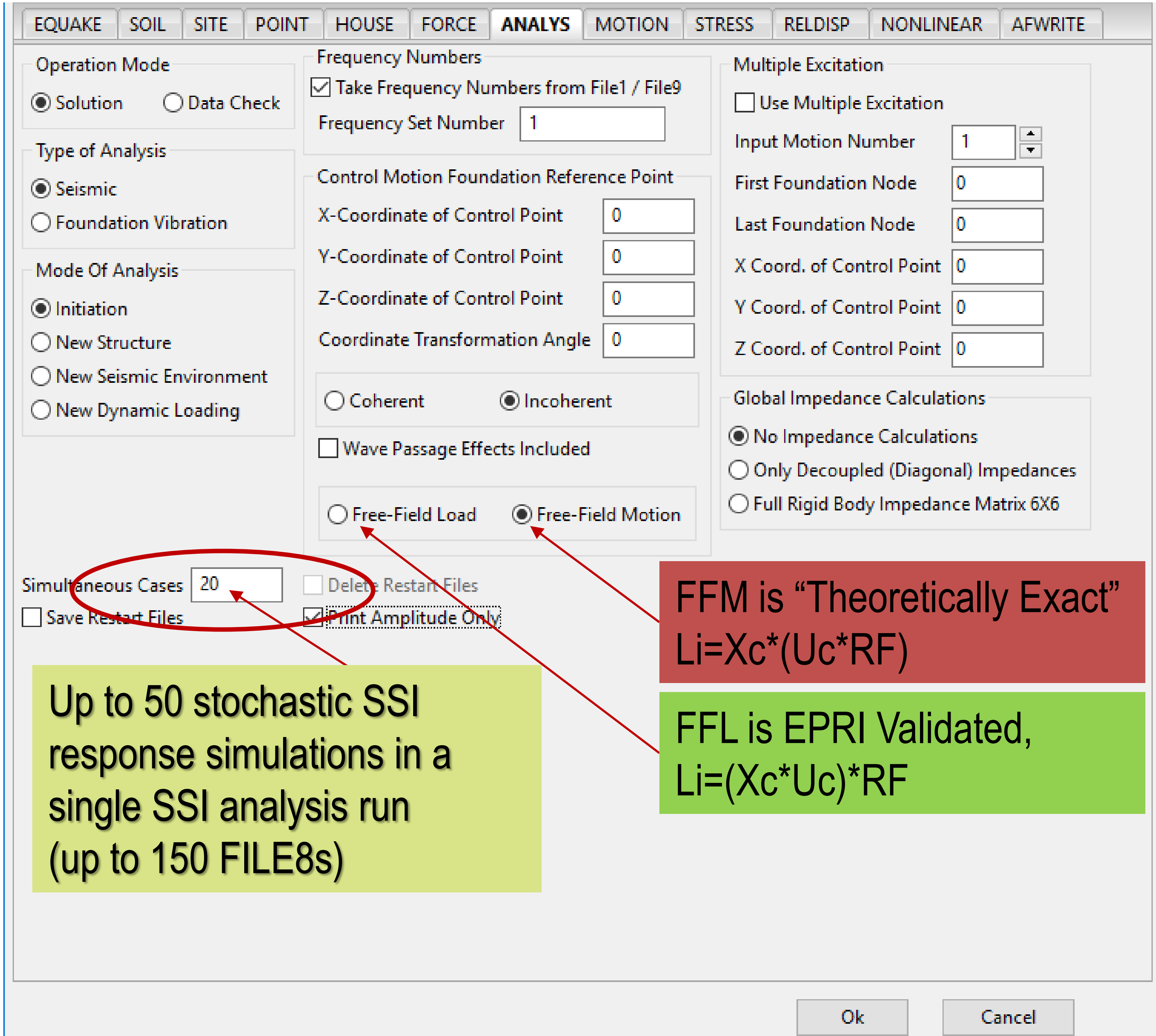


COMB_XYZ_STRAIN Module for 3D SSI Models

Constitutive Model Criteria based on:

1) Maximum Component Shear Strain (X)
2) Maximum Shear Plane Criterion
   (Maximum Octahedral Strain for 3D SSI

ANALYS Module Coherent & Incoherent SSI



FFM is "Theoretically Exact"
Li=Xc*(Uc*RF)

FFL is EPRI Validated,
Li=(Xc*Uc)*RF

Up to 50 stochastic SSI response simulations in a single SSI analysis run (up to 150 FILE8s)

This optional input is only for the fast-solver HOUSE module. To save significant SSI runtime for batch runs, the ANALYSFS can solve simultaneously all three X, Y and Z input directions for seismic analysis (seismic option), or to up to 500 load cases of external forcing function (vibration option).

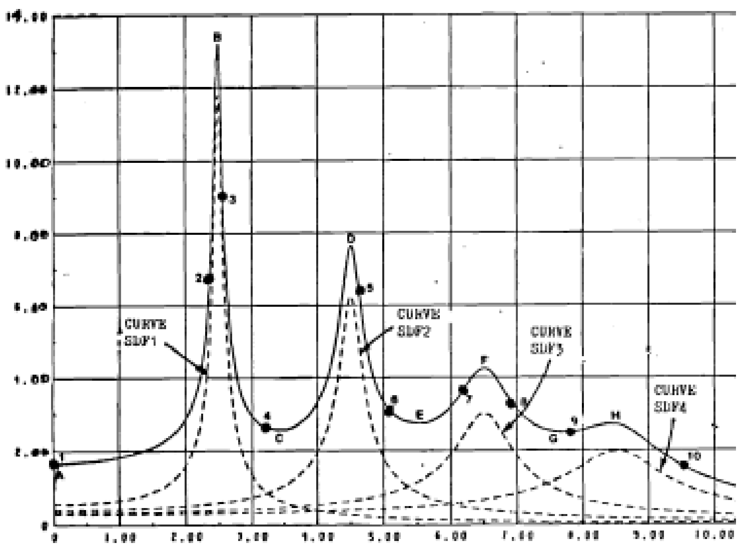
For seismic analysis the user should type 1 to get all three X,Y and Z direction results in a single run. The ANALYS run results will be saved in three FILE8 files computed for X,Y and Z inputs named FILE8X, FILE8Y and FILE8Z.The ANALYS output will include ATF computed for all three directions. To use this option for seismic analysis, the SITE module should be run before ANALYS run for X, Y and Z direction inputs and generate the FILE1X, FILE1Y and FILE1Z files. The user should select the SV waves for the X-direction by selecting x' direction and 0 angle in the .sit SITE input file, the SH waves for the Y-direction by selecting y' direction and 0 degree angle and the P waves in the Z-direction by selecting z direction and 0 angle.The coordinate transformation angle in the .anl ANALYS input file should be 0.

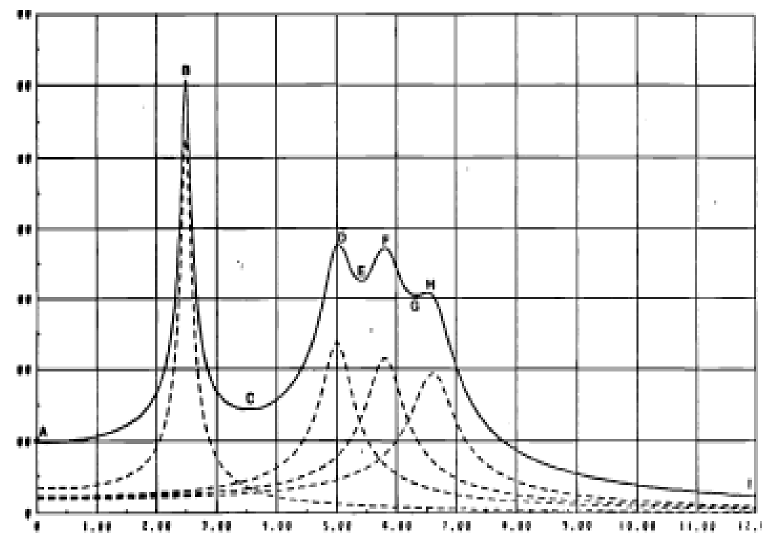
It should be noted that if the “Simultaneous Cases” is selected for incoherent SSI analysis, then, up 50 simulations can be solved in a single run. The FILE77 produced by HOUSE should be also replicated in the FILE7001, FILE77002, up to FILE77050 before the ANALYS module is run.

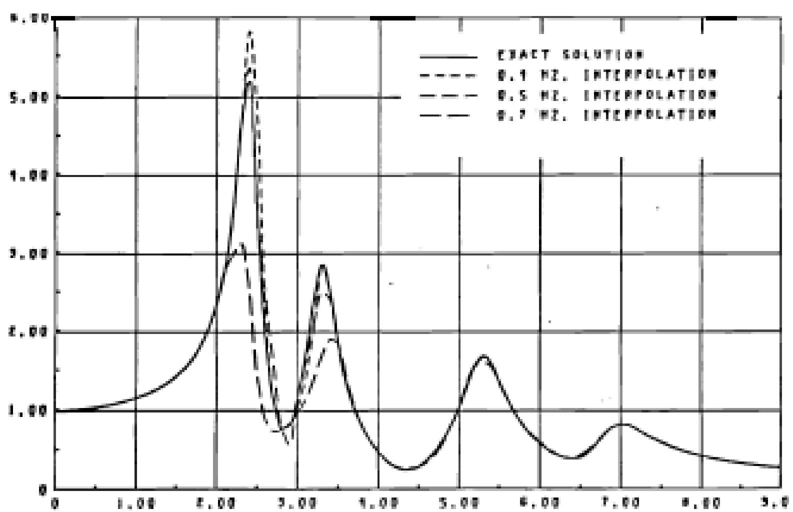
For external force/vibration analysis the user should type an three-digit number to input multiple load cases, up to 500 load external force cases. To use multiple external force cases up to 500 load cases in a single ANALYS run, the FORCE module should be run before ANALYS for all considered load cases and generate the FILE9001, FILE9002, FILE9003...up to FILE500.

For the 50 load cases, ANALYSFS produces the 150 FILE8 files named FILE8001, FILE8002, FILE8003,...up to FILE8150 depending on the number of load cases.

Transfer Function Interpolation Technique







(after Tajirian, 1983)

Transfer Function Interpolation Technique

- The frequency interpolation technique used to interpolate the response for frequencies in between the calculated and to obtain the response for all FFT frequencies is based on the frequency response function of a two-degree-of-freedom system.

- The total response of a two-degree-of-freedom system subjected to harmonic base excitation for each degree-of-freedom has the following general from

$$U^{i}(\omega)=\frac{C_1^i\omega^4+C_2^i\omega^2+C_3^i}{\omega^4+C_4^i\omega^2+C_5^i}$$

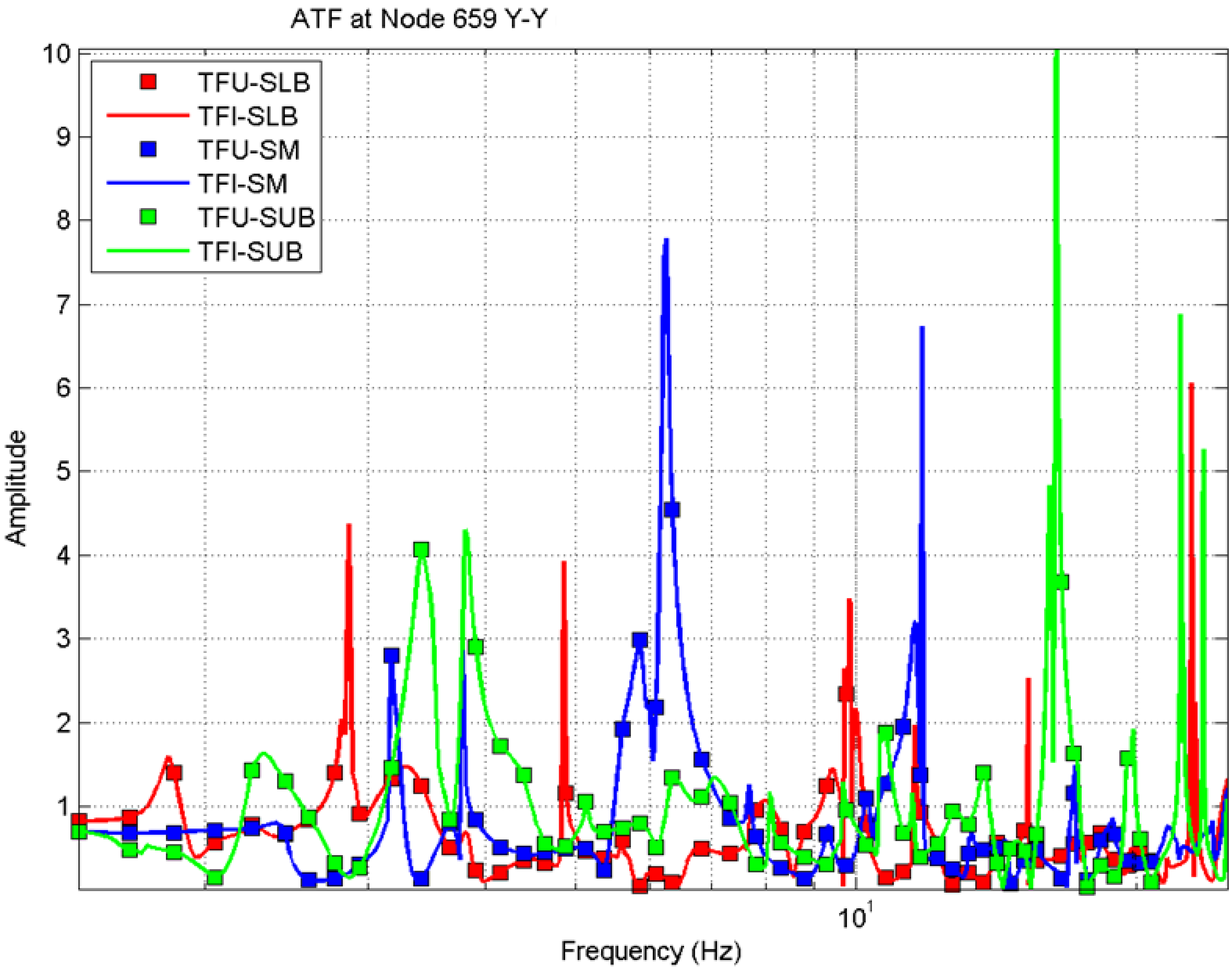
To compute the complex coefficients a five equation system needs to be solved

$$\begin{bmatrix} \omega_1^4 & \omega_1^2 & 1 & -\omega_1^2 U_1 & U_1 \\ \omega_2^4 & \omega_2^2 & 1 & -\omega_2^2 U_2 & U_2 \\ \omega_3^4 & \omega_3^2 & 1 & -\omega_3^2 U_3 & U_3 \\ \omega_4^4 & \omega_4^2 & 1 & -\omega_4^2 U_4 & U_4 \\ \omega_5^4 & \omega_5^2 & 1 & -\omega_5^2 U_5 & U_5 \end{bmatrix} \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \end{bmatrix} = \begin{bmatrix} \omega_1^4 U_1 \\ \omega_2^4 U_2 \\ \omega_3^4 U_3 \\ \omega_4^4 U_4 \\ \omega_5^4 U_5 \end{bmatrix}$$

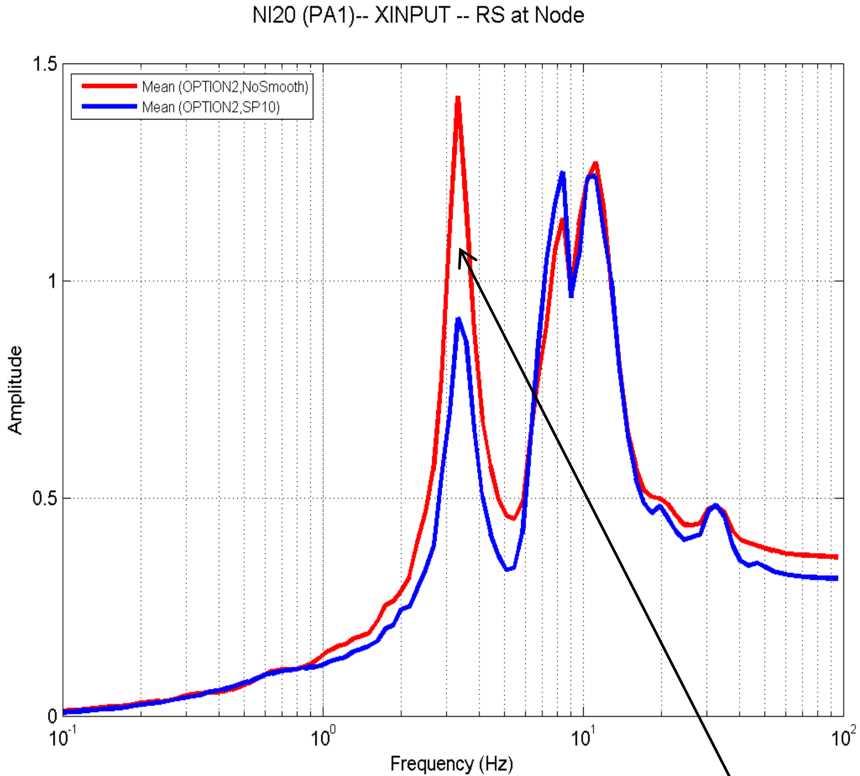
Note:
Based on our experience that the two-degree-of-freedom-system interpolation technique may sometimes introduce some spurious spectral peaks and valleys. Thus, it is recommended when significant spectral peaks are identified between the frequency solution points to add new frequency points in that range.

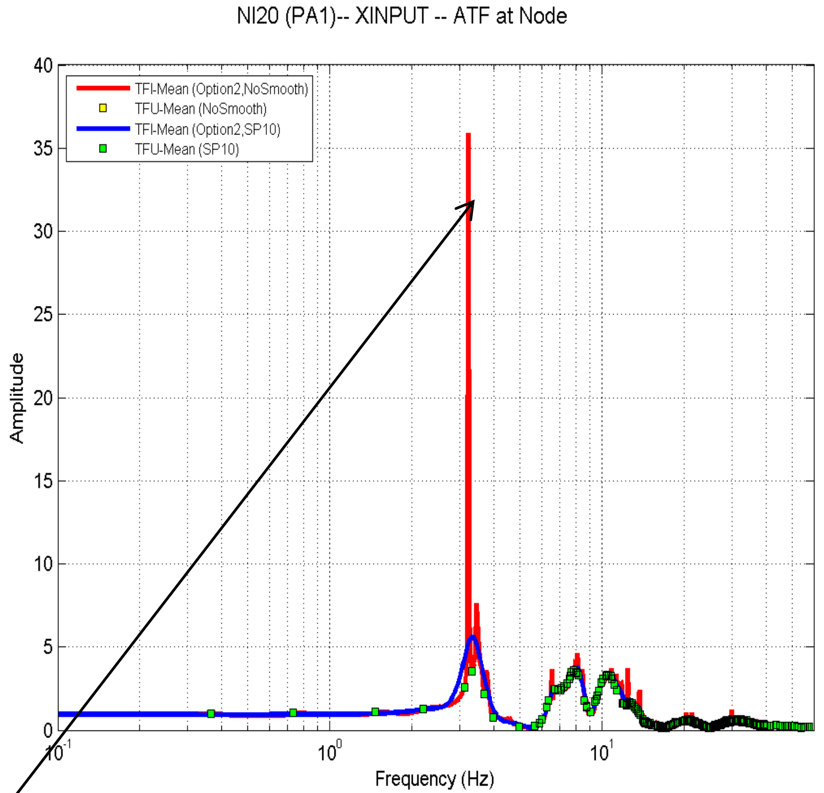
Criteria for Selecting Frequency Solution Points

- Depend on the number of peaks in the transfer function at the specific response location and how close these peaks are located relative to each other.
- The frequencies of analysis can be selected by recognizing that the SSI effects usually shift the frequencies to the lower frequency range and tend to flatten the sharp peaks or sometimes even eliminate the fixed-base response peaks.
- Most of the practical problems are sufficient to solve SSI solution for a limited number of frequencies; about 40-50 frequencies for stick SSI models and about 50-200 frequencies for 3D SSI models. A larger number of frequencies needed for rock sites than soil sites.
- If no information on natural frequencies of the system are is available, it is necessary to selected adequate number of frequencies with an uniform increment throughout the frequency range of interest. Then, after revising the results, more frequencies are added to reconstruct the missing spectral peaks.


ATF at Node 659 Y-Y
TFU-SLB
TFI-SLB
TFU-SM
TFI-SM
TFU-SUB
TFI-SUB
Amplitude
Frequency (Hz)
10
9
8
7
6
5
4
3
2
1
10^1

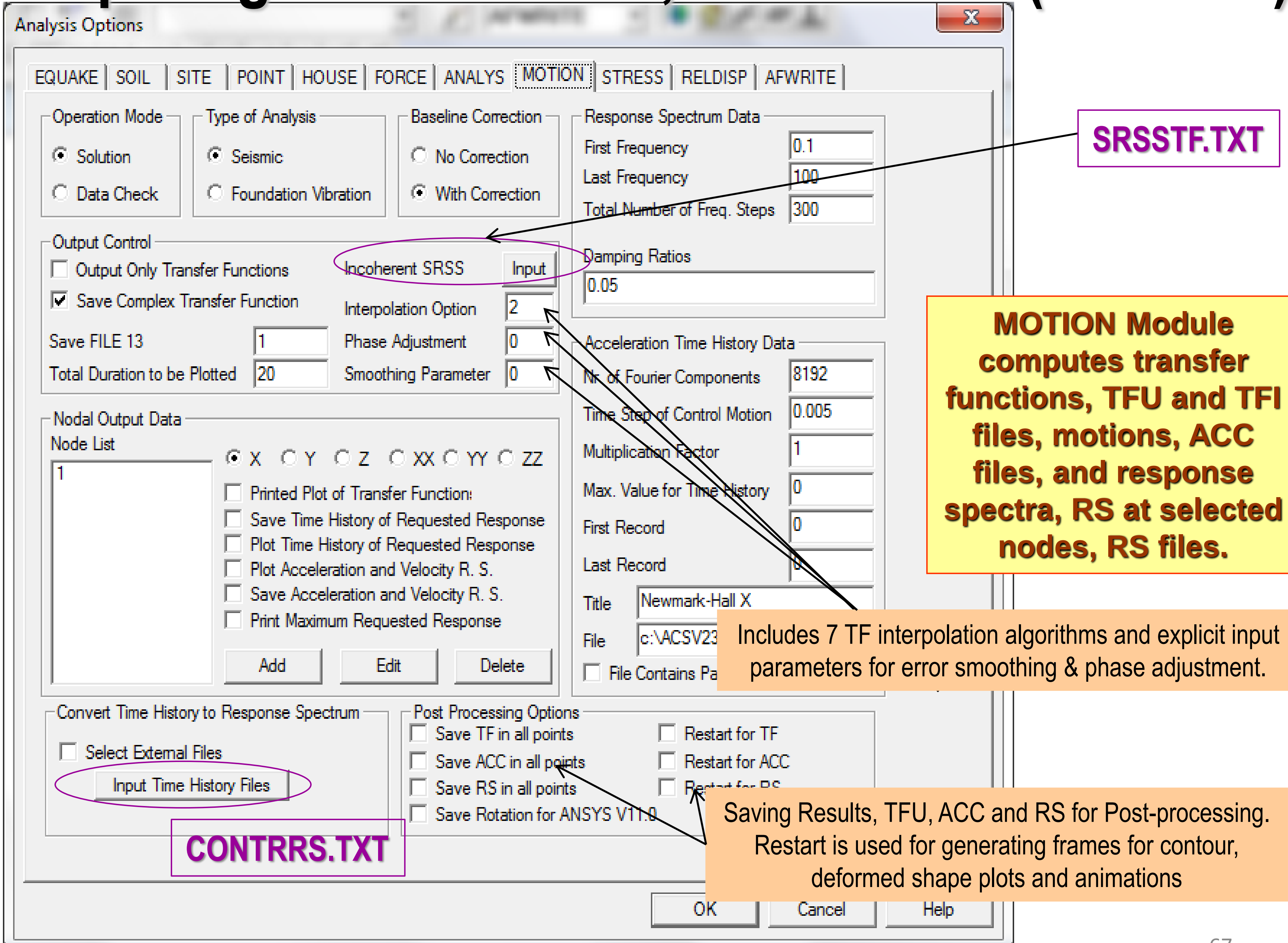
ATF Interpolation Error Smoothing Results; No Smoothing vs. Smoothing For Interpolated ATF. Need to Correlate RS and ATF Results



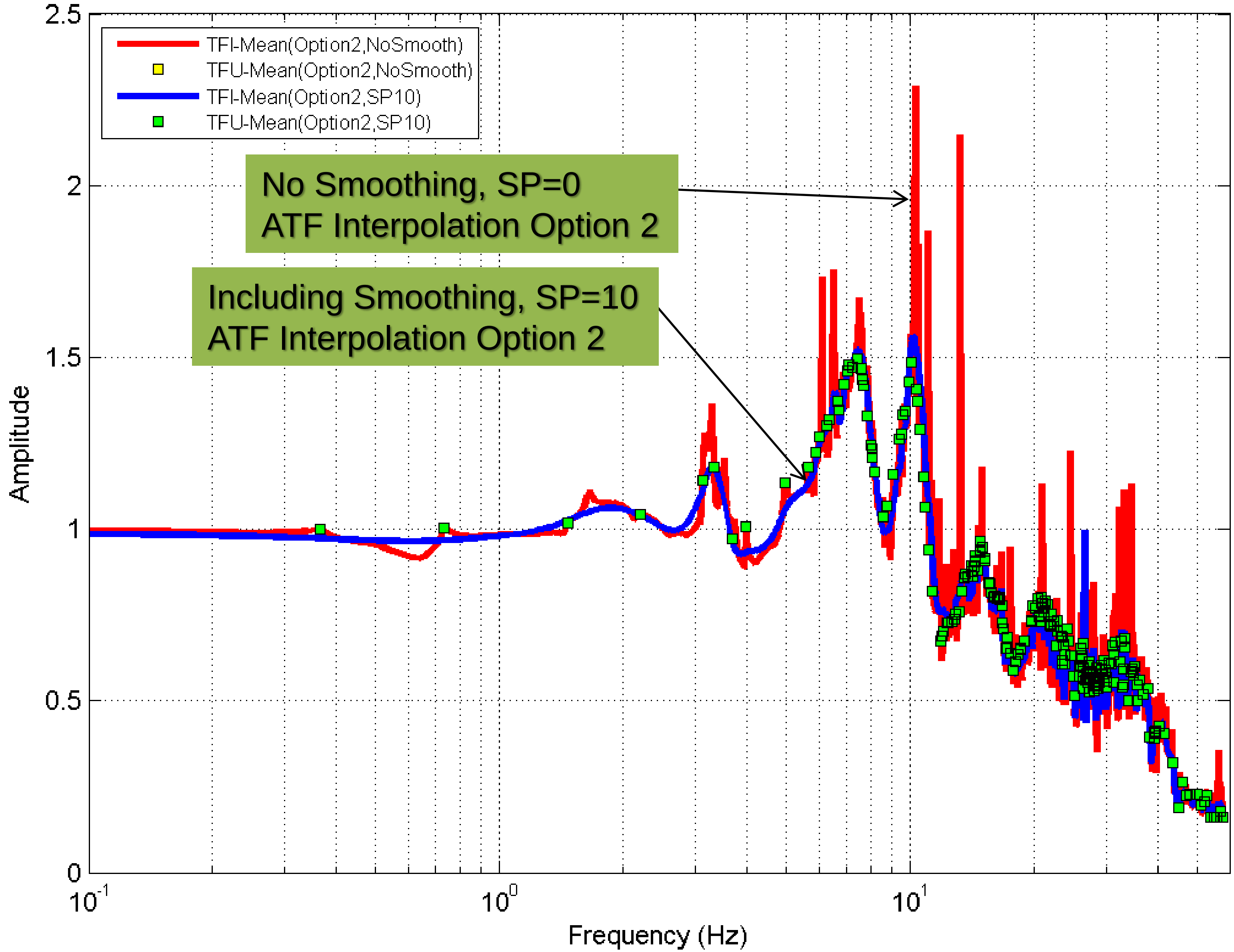


"Spurious" ATF Peak Produced by the Interpolation Function

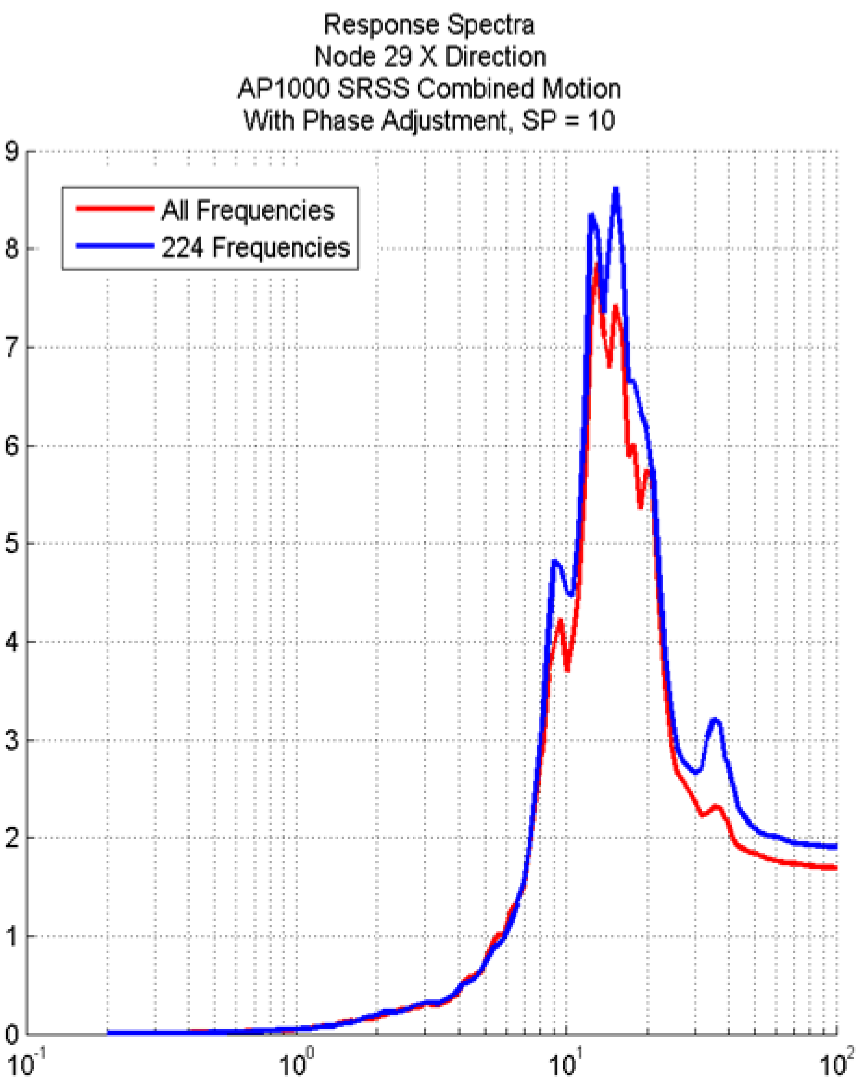
Computing Accelerations, ATF and RS (MOTION)

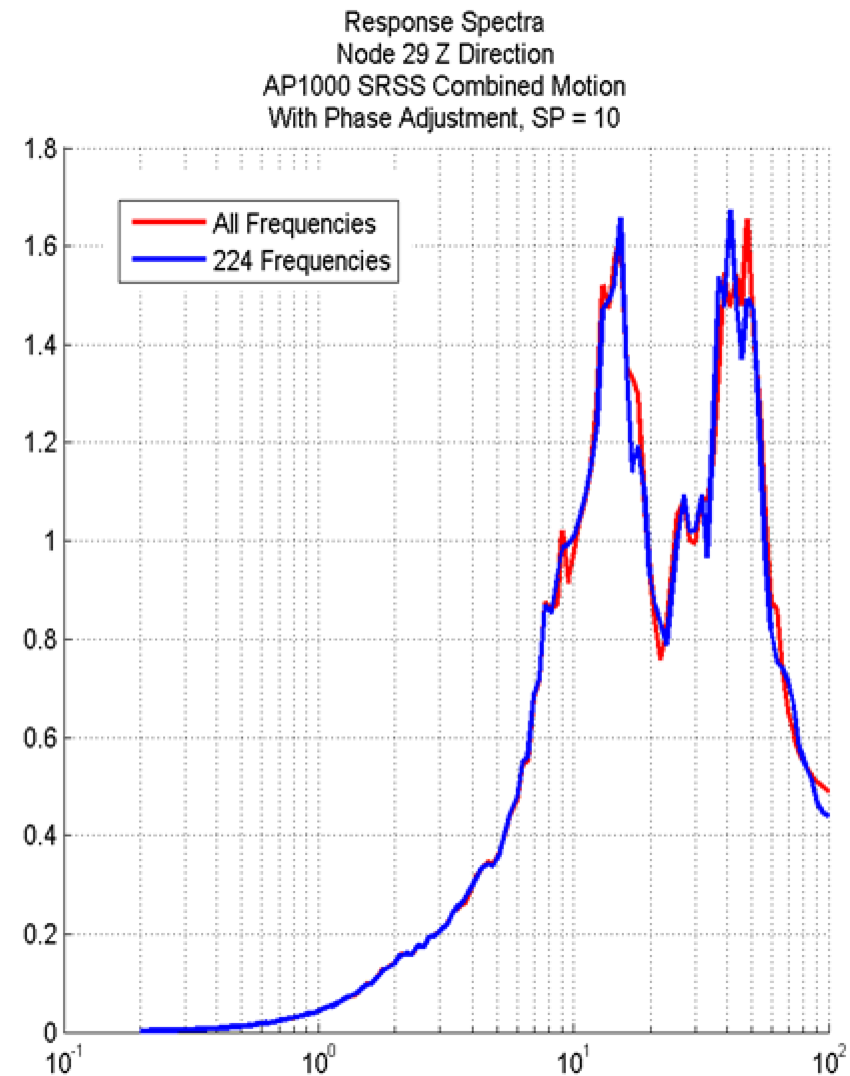


Including ATF Interpolation Error Smoothing. Results Using New Option 2. With Overlapping Moving Windows, A=(A1+A2+A3+A4+A5)/5)

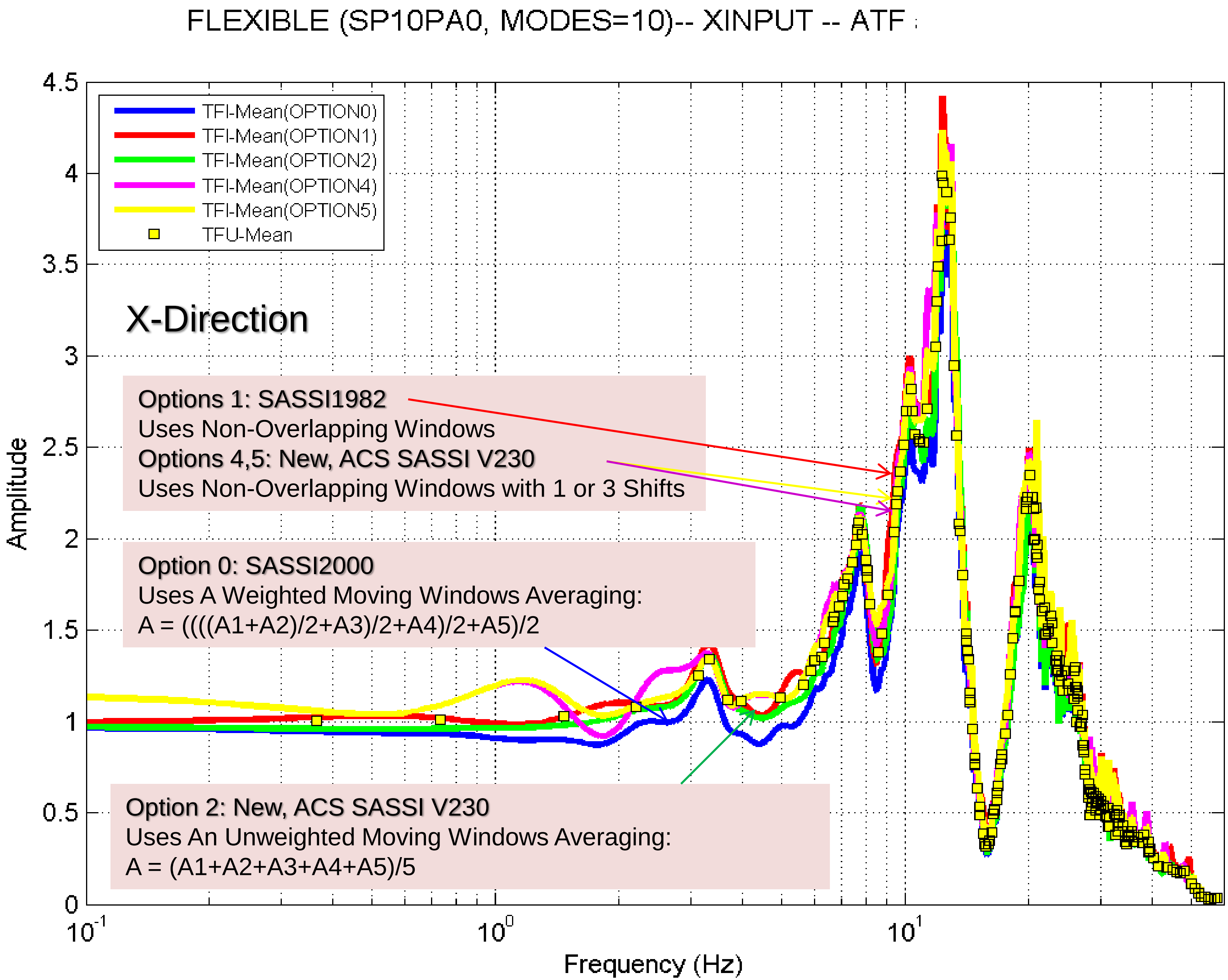


ATF Interpolation Error Smoothing Results for EPRI AP1000 Stick Model. Comparisons for 224 SSI Frequencies vs. 2048 Fourier Frequencies

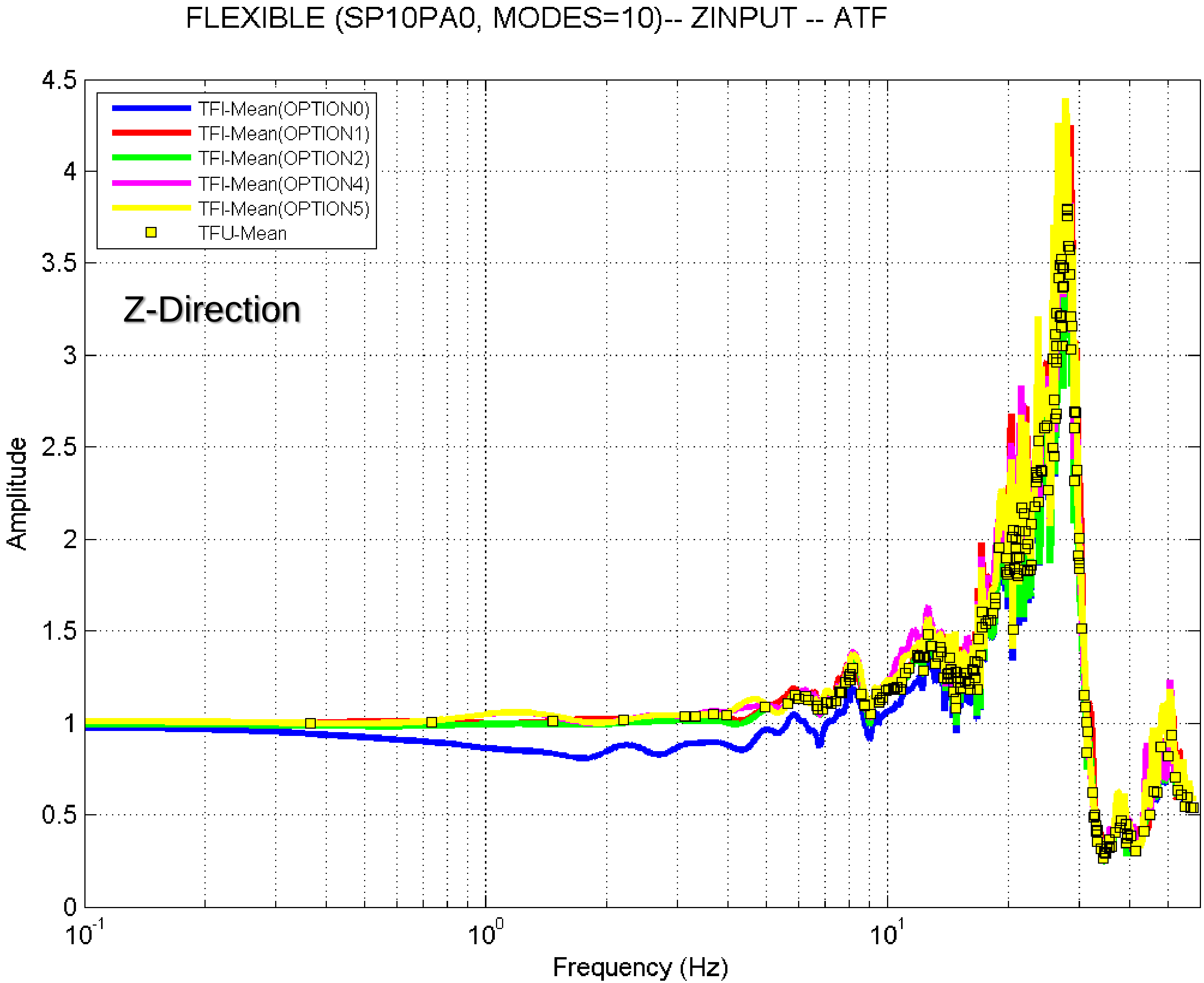




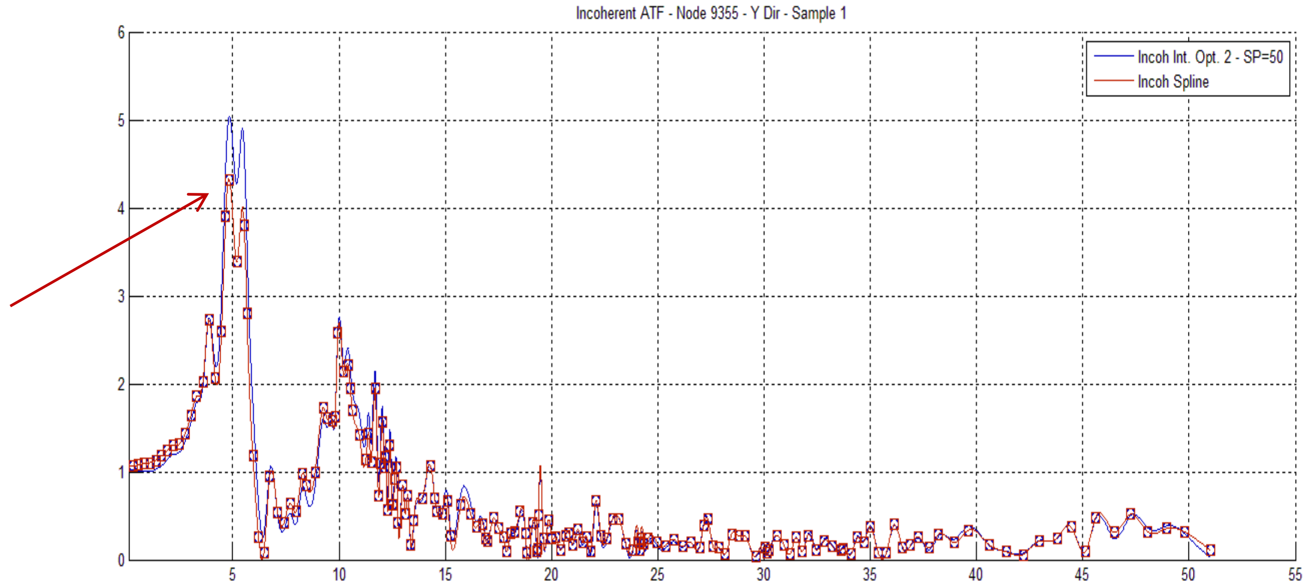
(Mean) Incoherent Interpolated ATF Using Different Interpolation Schemes

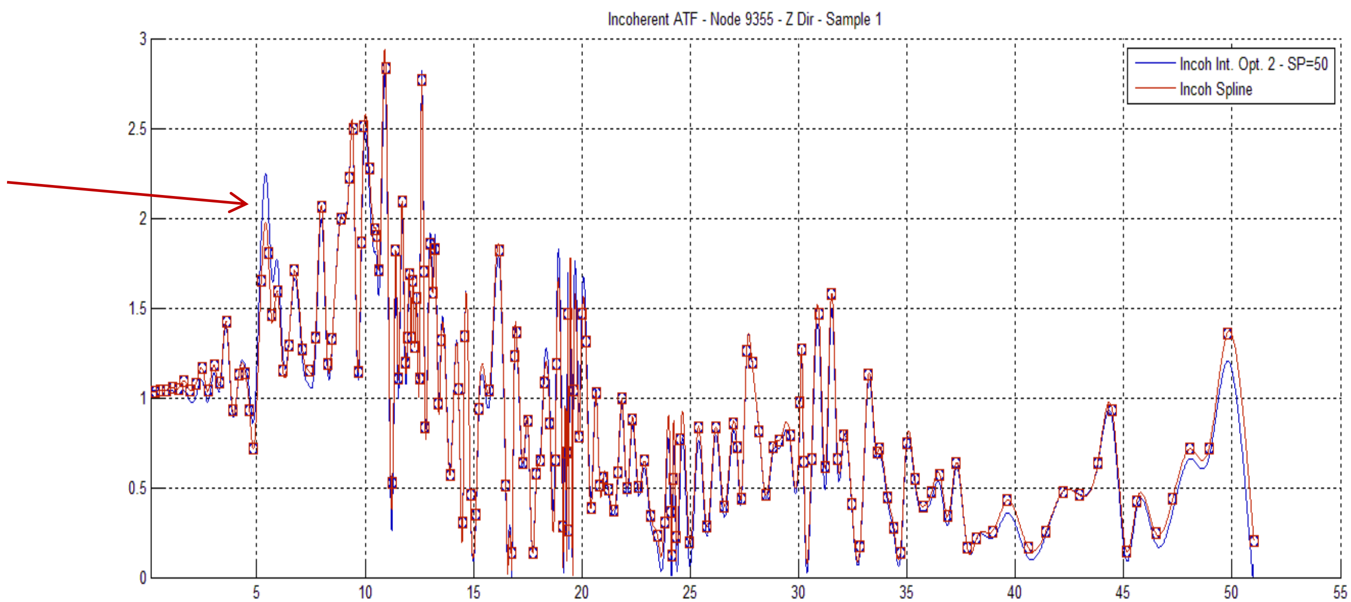


(Mean) Incoherent Interpolated ATF Using Different Interpolation Schemes

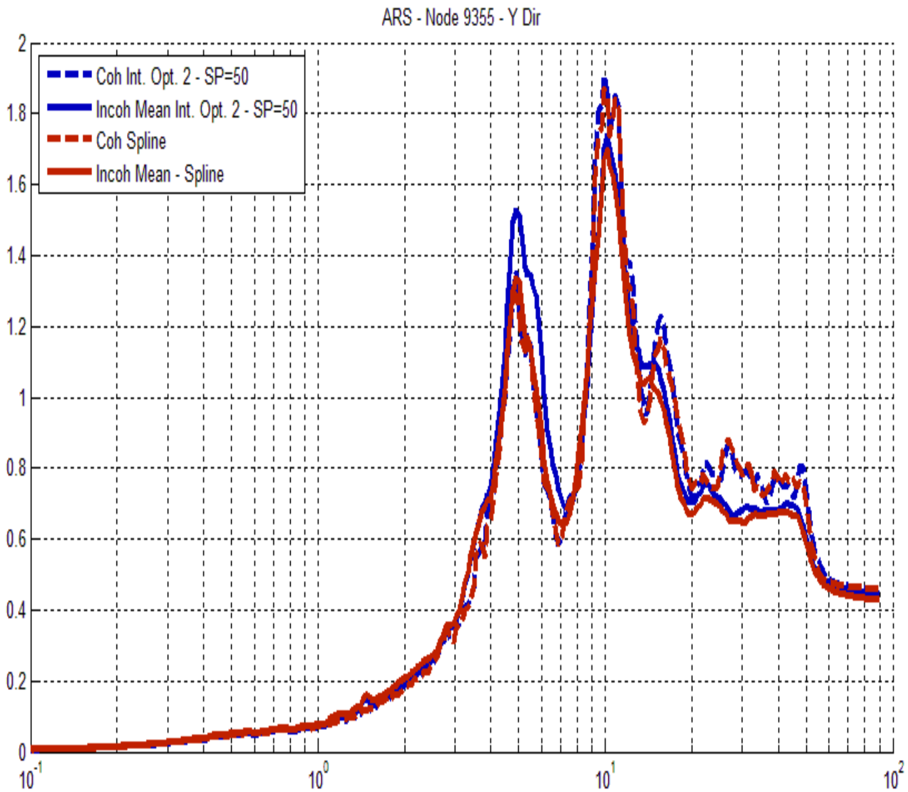


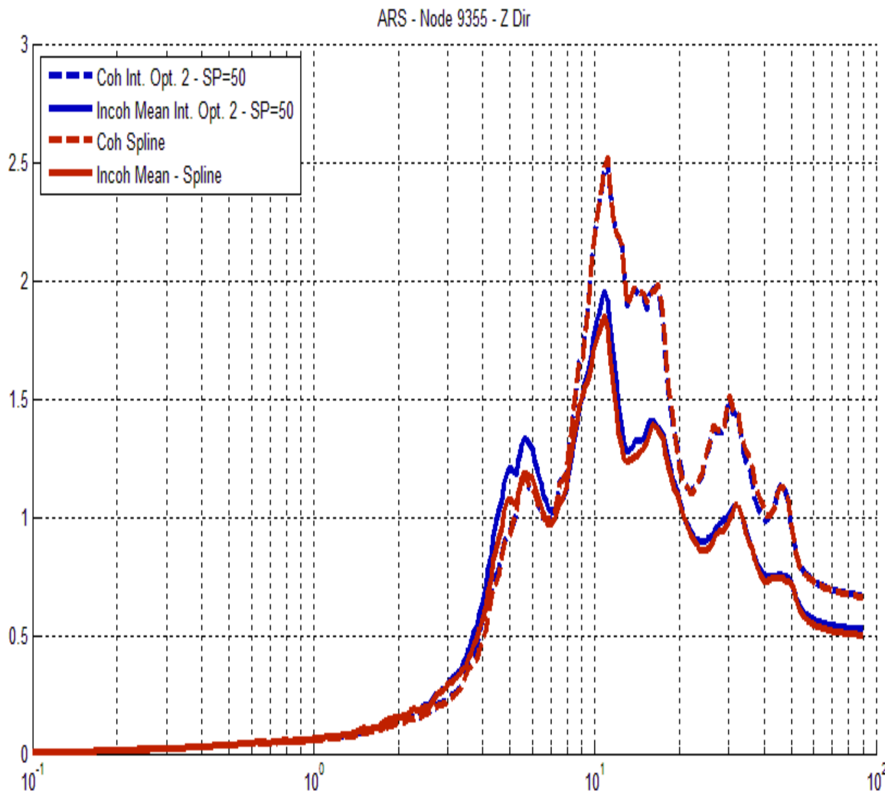
Spline Interpolation Applied to SSI Simulations



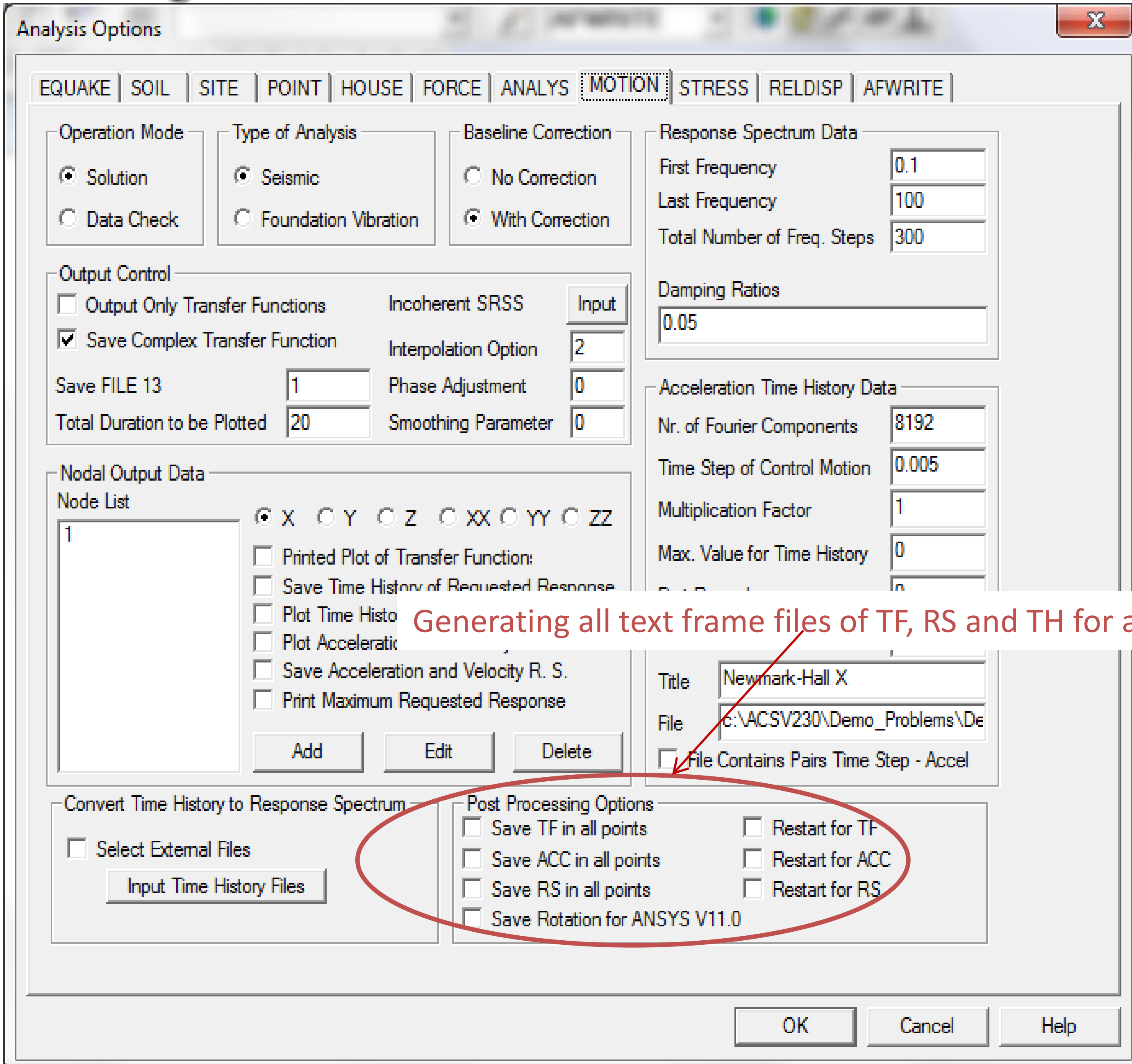


Spline Interpolation Applied to Incoherent SSI Simulation Approach



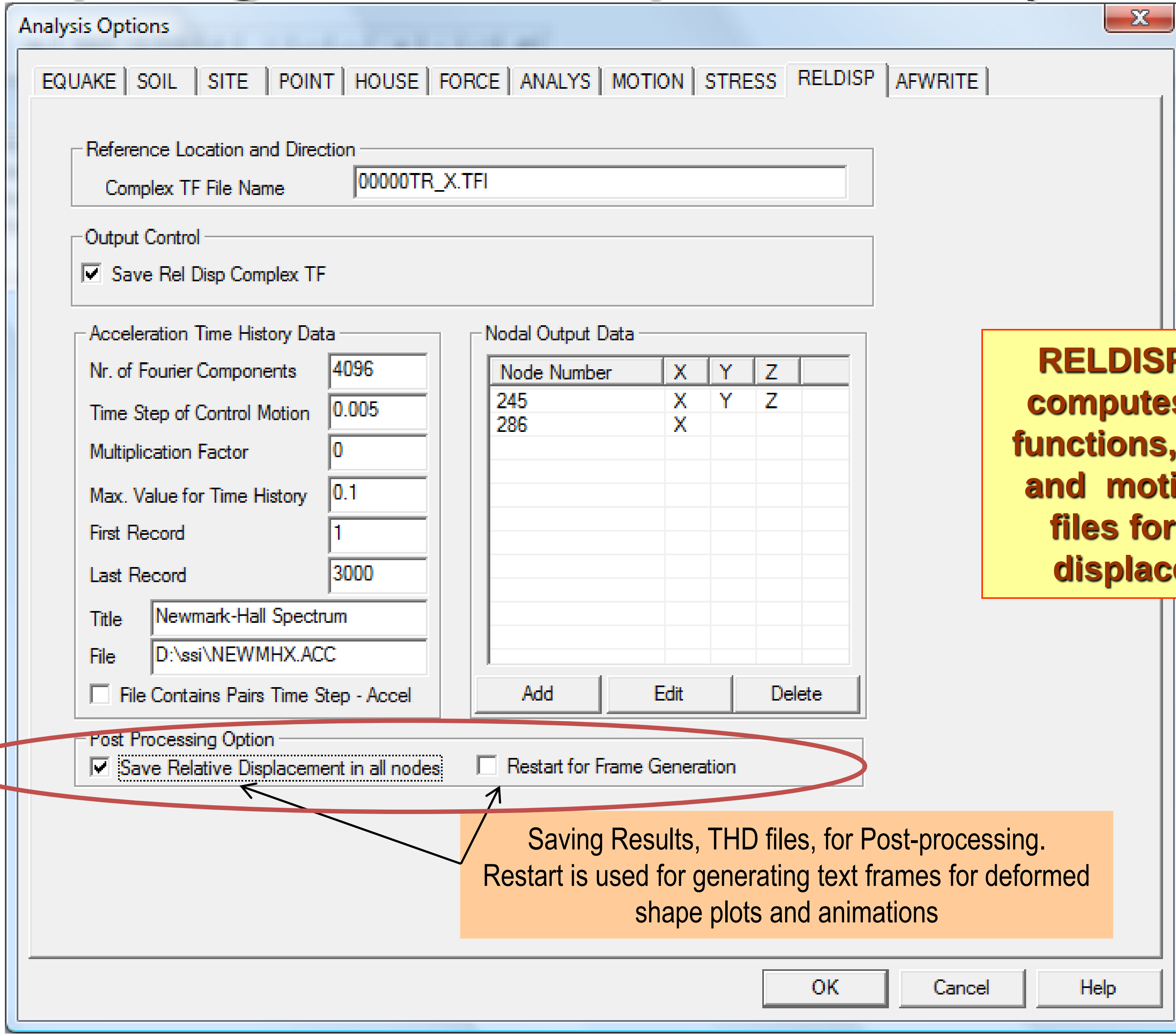


Generating ACC, TFU and RS Restart Frames



Generating all text frame files of TF, RS and TH for all nodes

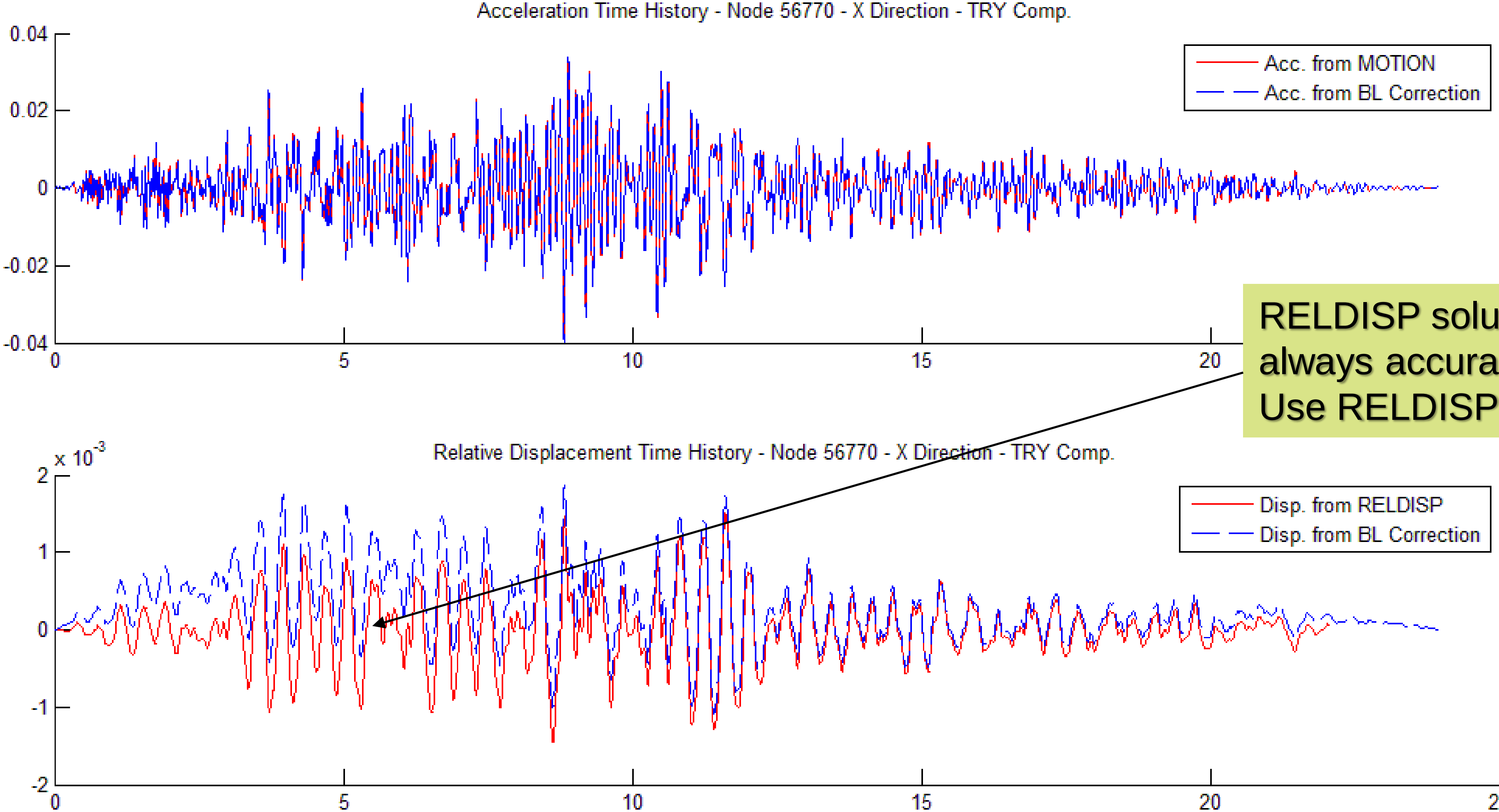
Computing Relative Displacements (RELDISP)



RELDISP Module computes transfer functions, TFD files, and motions, THD files for relative displacements.

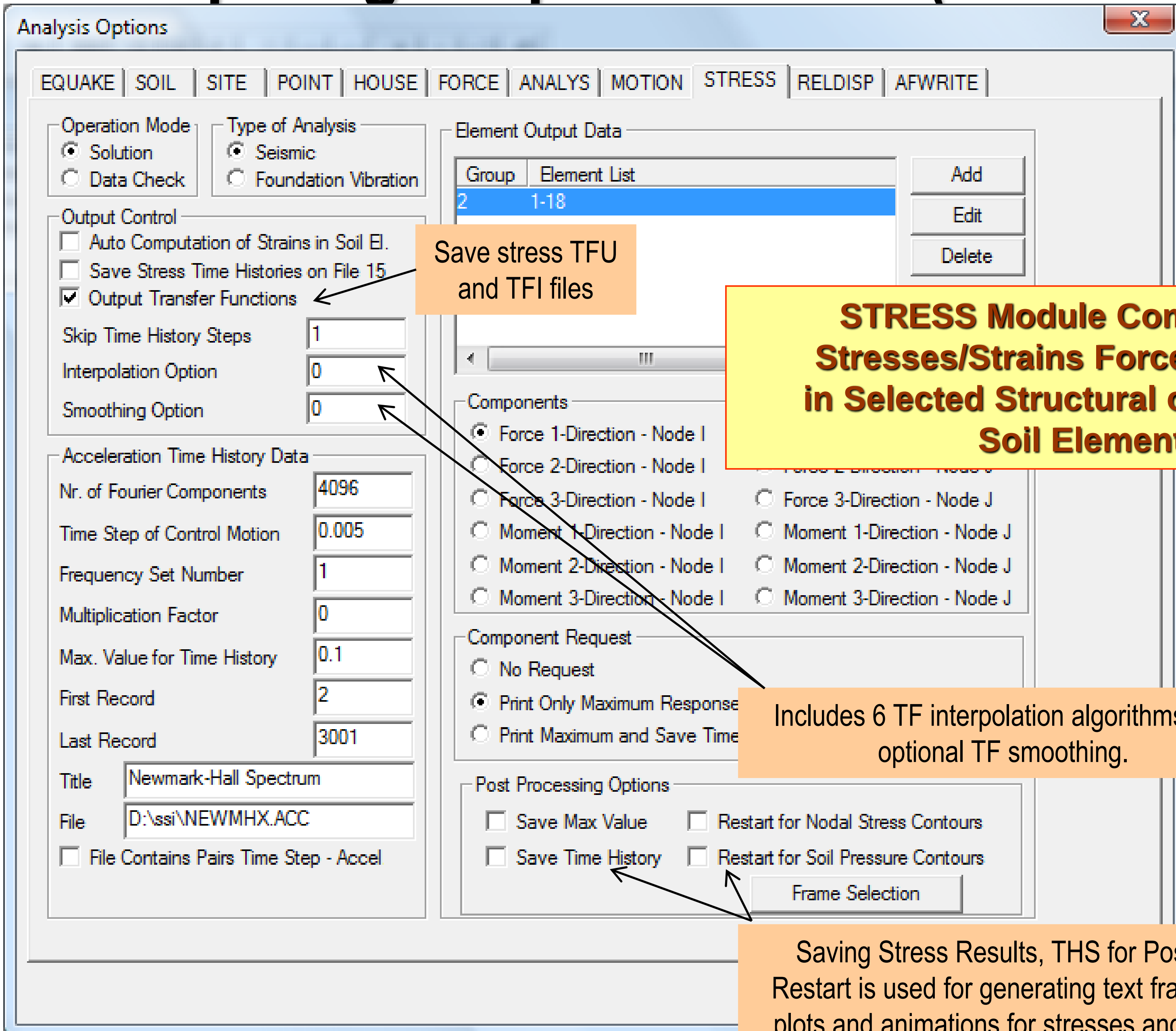
Saving Results, THD files, for Post-processing. Restart is used for generating text frames for deformed shape plots and animations

Relative Displacements Computed By Baseline Correction ("Approximate") and RELDISP ("Exact")



RELDISP solu
always accura
Use RELDISP

Computing Output Stresses (STRESS)



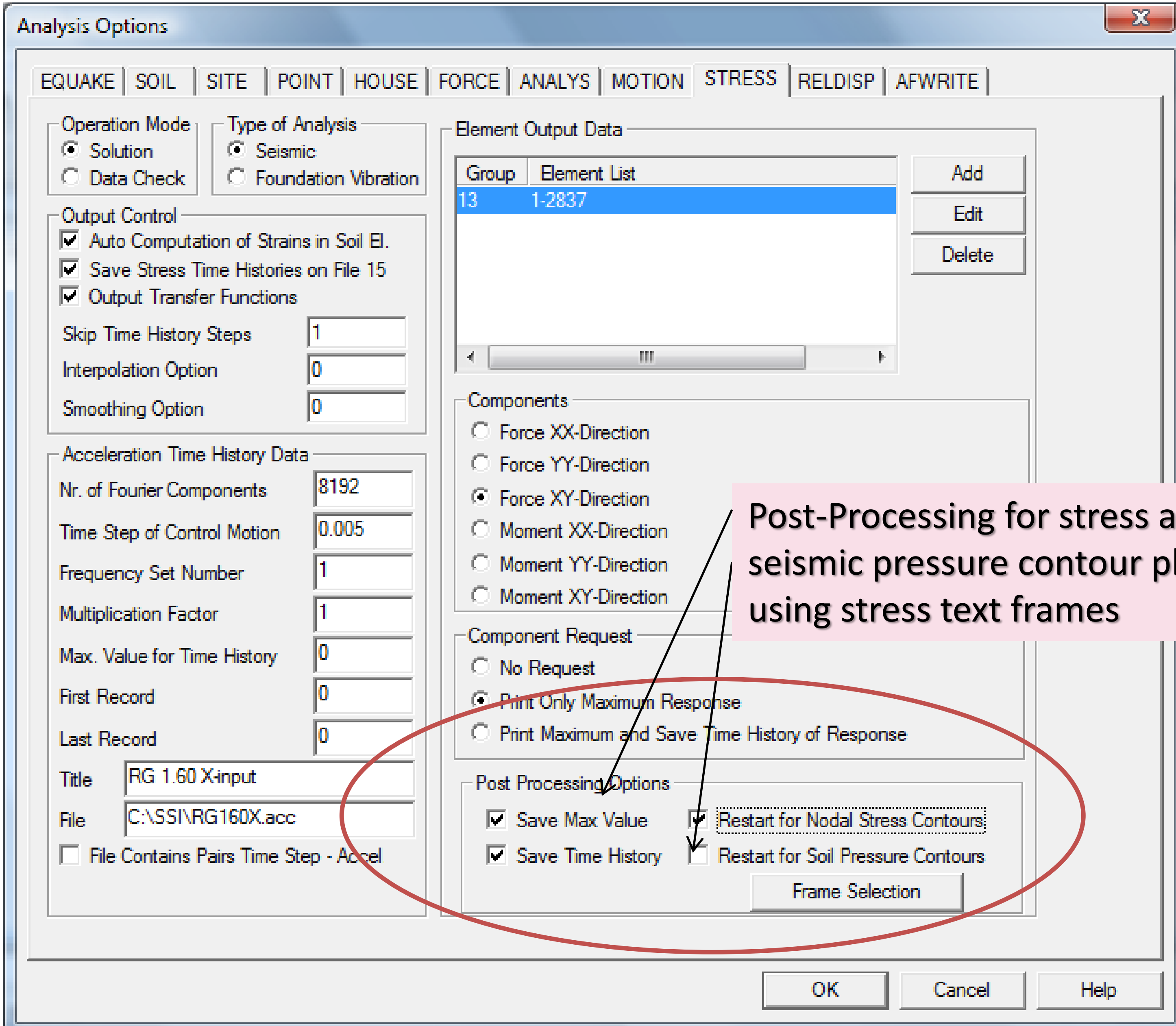
Save stress TFU and TFI files

STRESS Module Computes Stresses/Strains Forces/Moments in Selected Structural or Near-Field Soil Elements

Includes 6 TF interpolation algorithms and optional TF smoothing.

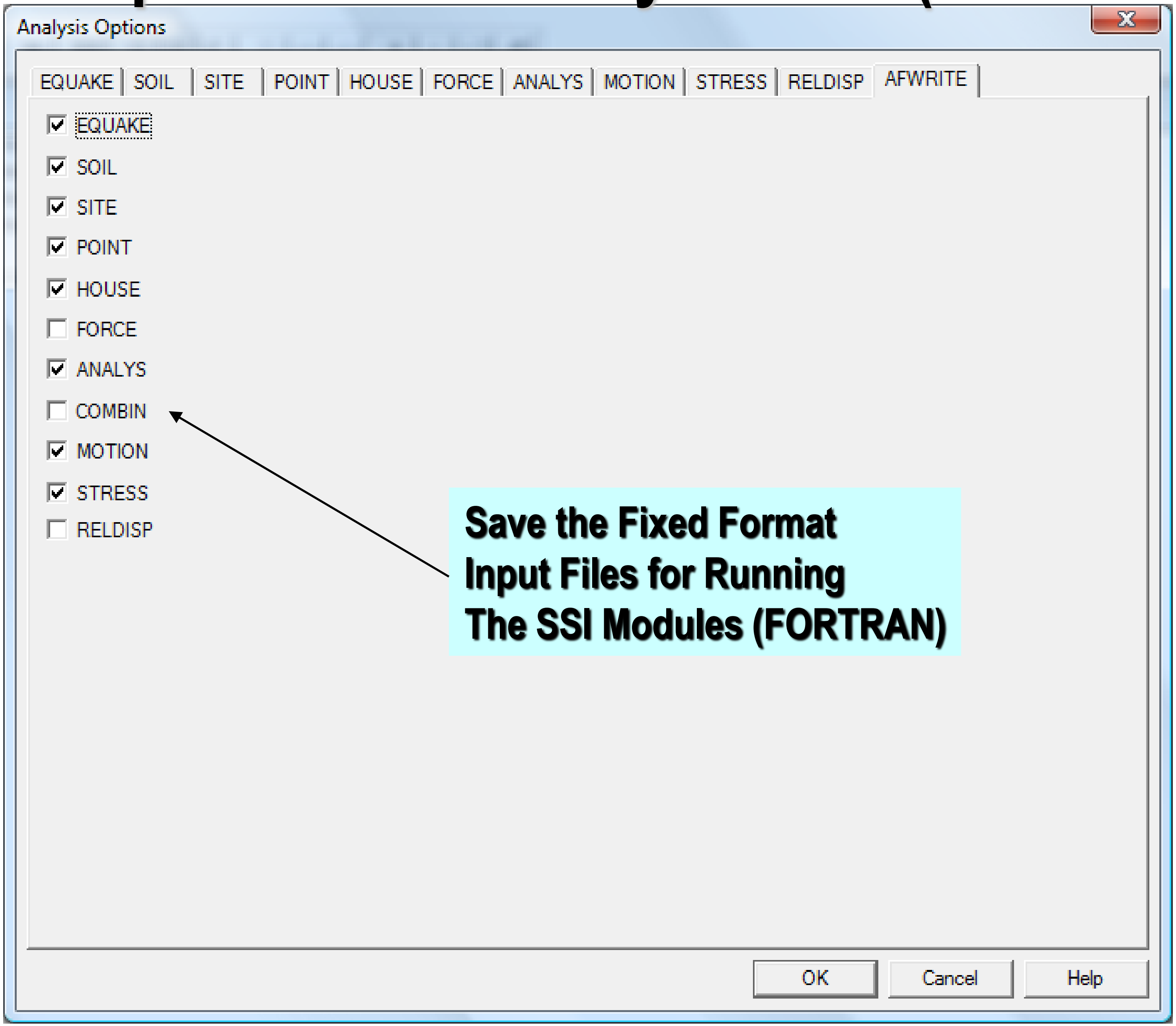
Saving Stress Results, THS for Post-processing. Restart is used for generating text frames for contour plots and animations for stresses and soil pressures.

New Stress Computation and Plotting Options



Post-Processing for stress and seismic pressure contour plots using stress text frames

Save Inputs for SSI Analysis Run (AFWRITE)



Description of Text Files and Frames

Transfer Function (TF), Response Spectra (RS) and Time History (TH) Text Files for Post-Processing

RS	Response spectra data files generated by the motion module		
	Naming Scheme for TFU, TFI, TFD, ACC Files		
	Characters 1-5	Node Number	
	Characters 6-9	Translation (TR) or Rotational (R) degree of freedom	
	Characters 10-11	Damping ratio number	
TFU	Uninterpolated acceleration transfer functions written by the motion module and stress transfer functions		
TFI	Interpolated acceleration transfer functions written by the motion module and stress transfer functions written by the stress module		
TFD	Displacement transfer functions generated by the reldisp module		
THD	Displacement time history written by reldisp module		
ACC	Acceleration time history written by motion module		
	Naming Scheme for Acceleration TFU, Acceleration TFI, TFD, THD, and ACC Files		
	Characters 1-5	Node Number	
	Characters 6-9	Translation (TR) or Rotational (R) degree of freedom	
TH	Soil time history for layers		
	Naming Scheme		
	ACC***	Acceleration time history for soil layer ***	i.e. ACC001.TH is the acceleration time history for soil layer 1
	SN***	Strain time history for soil layer ***	i.e. SN001.TH is the strain time history for soil layer 2
	SS***	Stress time history for soil layer ***	i.e. SS001.TH is the stress time history for soil layer 3
THS	Stress time history written by stress module		
	Naming Scheme for THS, stress TFU, and Stress TFI		
	etype_gnum_enum_comp		e.g. BEAMS_012_00001_FXI.THS
	etype =	element type	
	gnum =	group number	
	enum =	element number	
	comp =	stress component	
Frames.txt	Post processing frames for stress and motion		
ELEMENT_CENTER_ABS_MAX_STRESSES.TXT	List of maximum stresses for each element		
STATIC_SOIL_PRESSURES.TXT	Defines additional soil pressure (geological pressure) to be included in soil pressure frames		
SRSSTF.txt	SRSS option in motion		

Frame Files for Post-Processing

RS Frames Naming Scheme			
RS##_freq_filenum			e.g. \RS\RS01_000.10_00001
	## =	Damping number	
	freq =	frequency	
	fnum =	Frame number	
TFU Frames Naming Scheme			
TFU_freq_filenum			e.g. \TFU\TFU_000.02_00001
	freq =	frequency	
	fnum =	Frame number	
ACC Frames Naming Scheme			e.g. \ACC\ACC_00.000_00001
ACC_time_filenum			
	time =	time	
	fnum =	Frame number	
THD Frames Naming Scheme			e.g. \THD\THD_00.000_00001
THD_time_filenum			
	time =	time	
	fnum =	Frame number	
Stress Frame Naming Scheme			
stress_time_fnum_comp			e.g. \NTRESS\stress_00.000_00001_sig
	time =	time	
	fnum =	Frame number	
	comp =	Stress Component	
		sig	Solids — Normal Stress
			Shells — Membrane Stress
		tau	Solids — Shear Stress
			Shells — Membrane Shear
		bdsig	Bending Stress (shell elements only)
		bdtau	Bending Shear (shell elements only)
Soil Pressure Frame Naming Scheme			
press_time_fnum_type			e.g. \SOILPRES\pres_00.000_00001_nod
	time =	time	
	fnum =	Frame number	
	type =	Element Values or Nodal Values	
		ele	Element Values
		nod	Nodal Values

Frame Files for Post-Processing (cont')

Maximum Value Frames				
Stress				
stress_ABS_MAX_comp			e.g. \NSTRESS\stress_ABS_MAX_sig	
	comp =	Stress Component		
		sig	Solids	Normal Stress
			Shells	Membrane Stress
		tau	Solids	Shear Stress
			Shells	Membrane Shear
		bdsig	Bending Stress (shell elements only)	
		bdtau	Bending Shear (shell elements only)	
Soil Pressure				
press_ABS_MAX_type			e.g. \SOILPRES\pres_ABS_MAX_nod	
	type =	Element Values or Nodal Values		
		ele	Element Values	
		nod	Nodal Values	

SSI Response Post-Processing Options

User Interface:

Binary Databases:

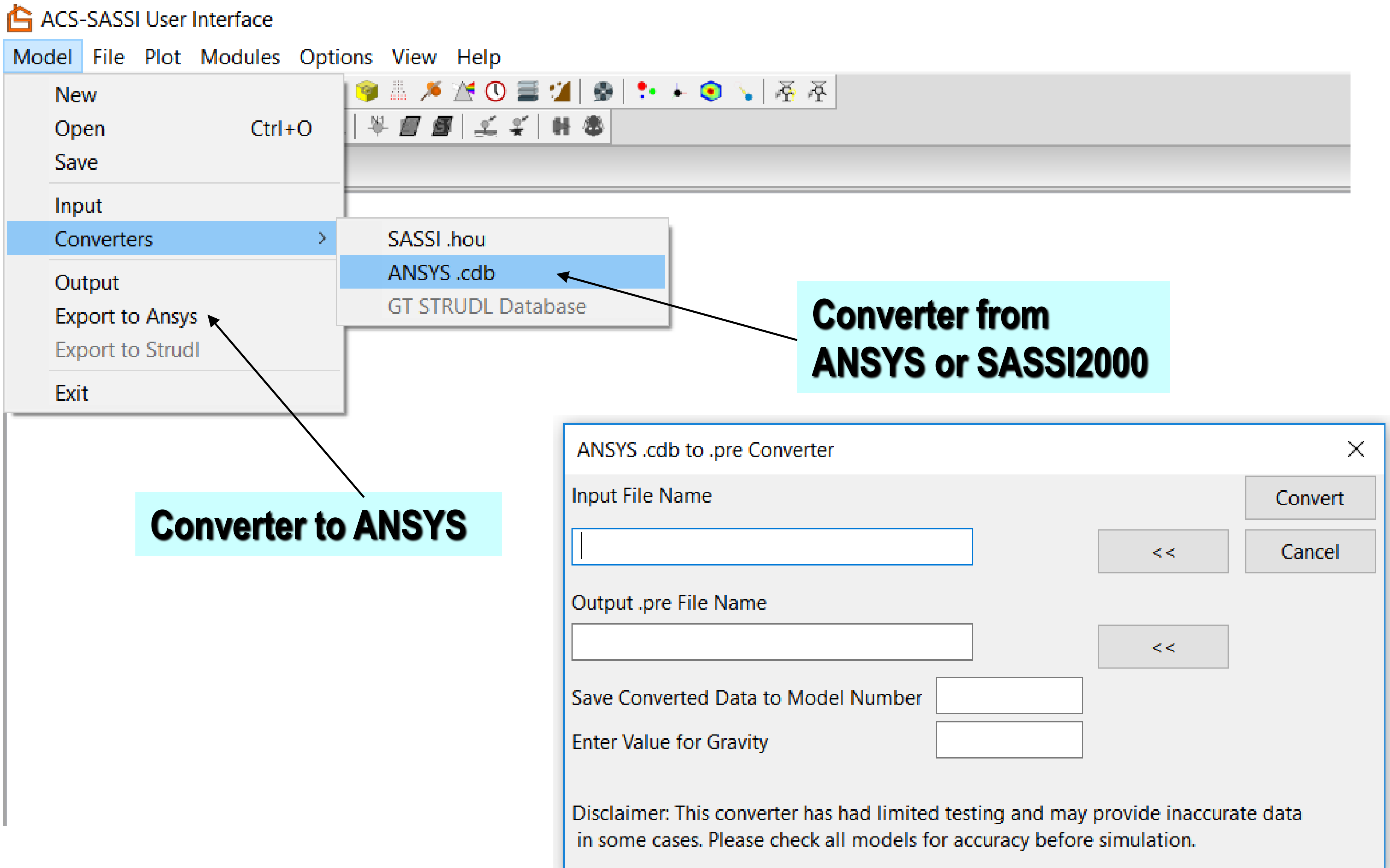
- Generate BDBs for each input direction; select flag for BDB
- Combine BDBs for three input direction using UI commands
- Use the XYZ combined BDB to extract frames at selected time steps or maximum values (text frame tables)
- A new UI command is designed for extracting selected time histories from BDB – *included in the V3 January 2018 upgrade*

Text Files (.acc or .thd files):

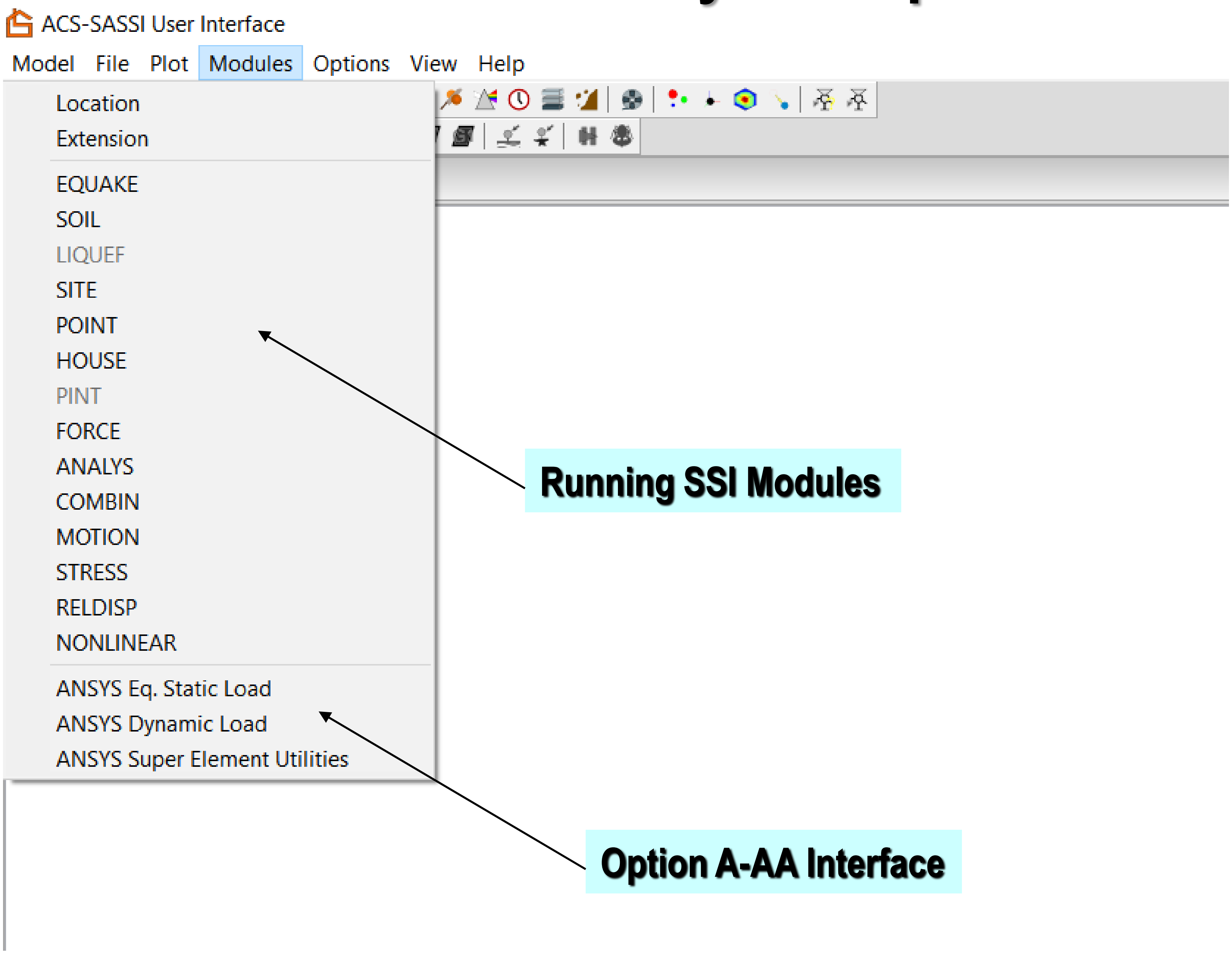
- Combine .acc or .thd node/dof history files using the ADDITION command, such as *ADDITION,4,1,2,3 ; combine histories 1,2,3 for X, Y and Z inputs in the response combined history 4.*

User Interface Menus for Input for Model, Analysis Run and Plotting

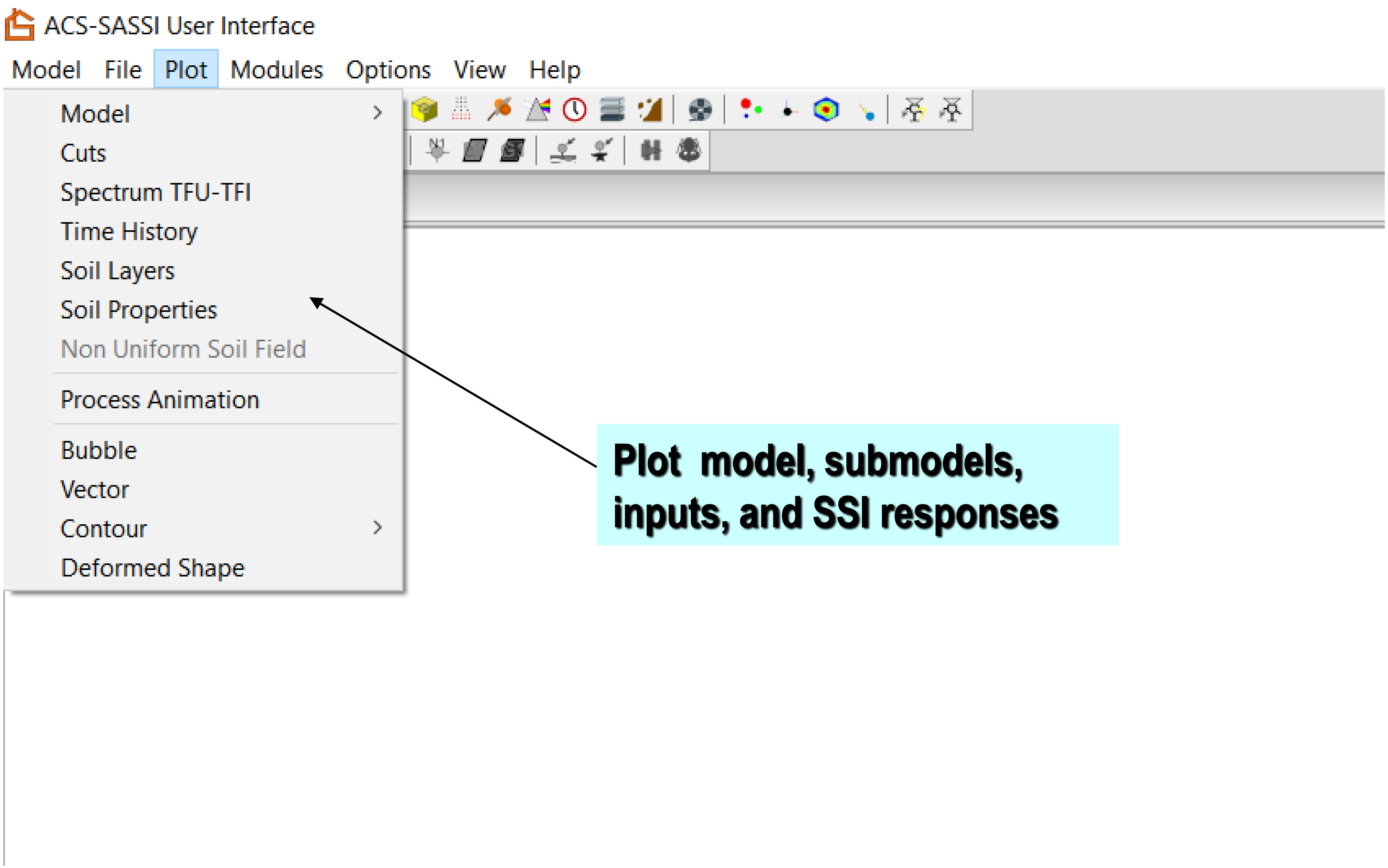
ACS SASSI Model Input File Capabilities



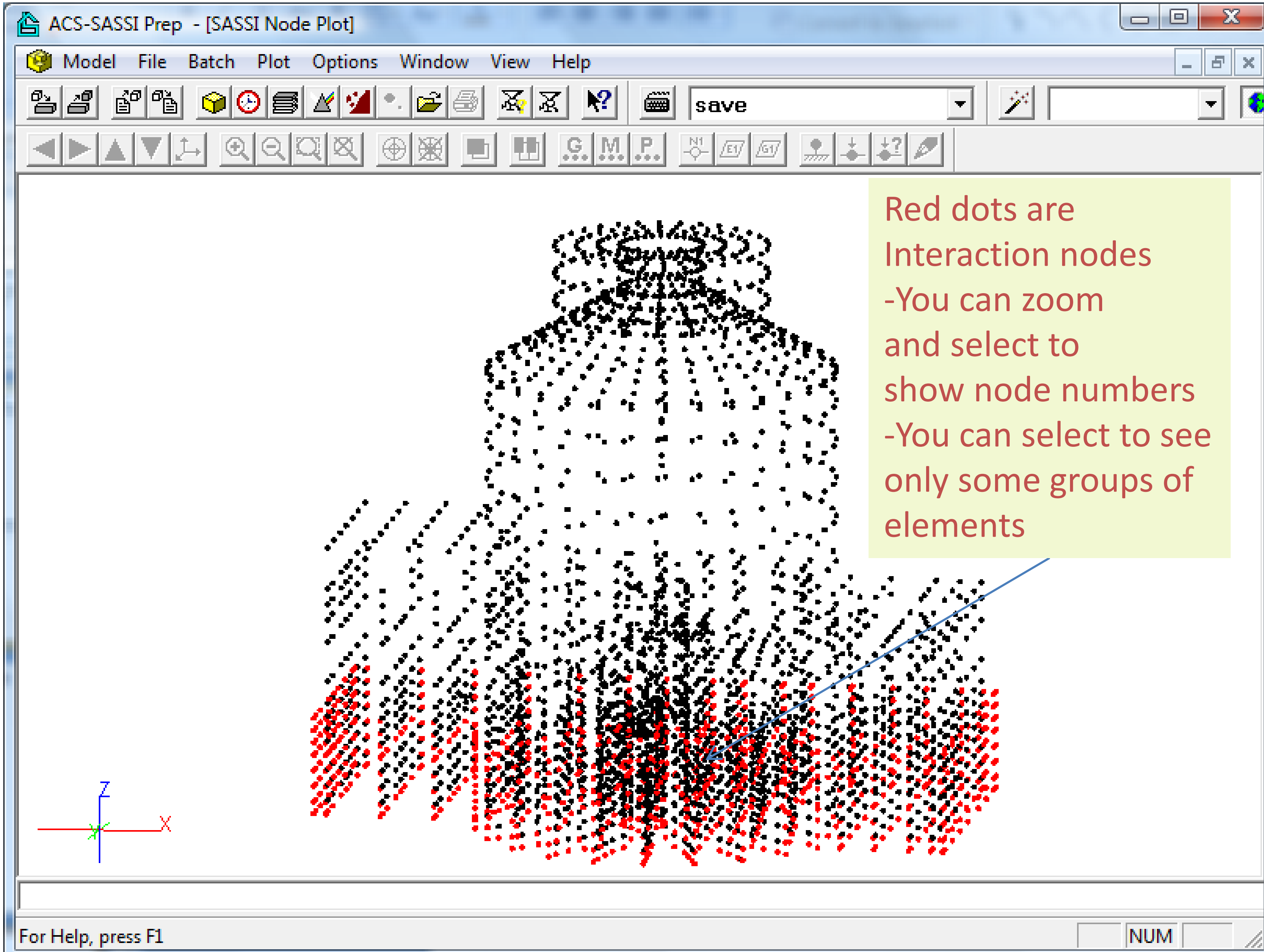
ACS SASSI SSI Analysis Capabilities



ACS SASSI Graphical Processing Capabilities

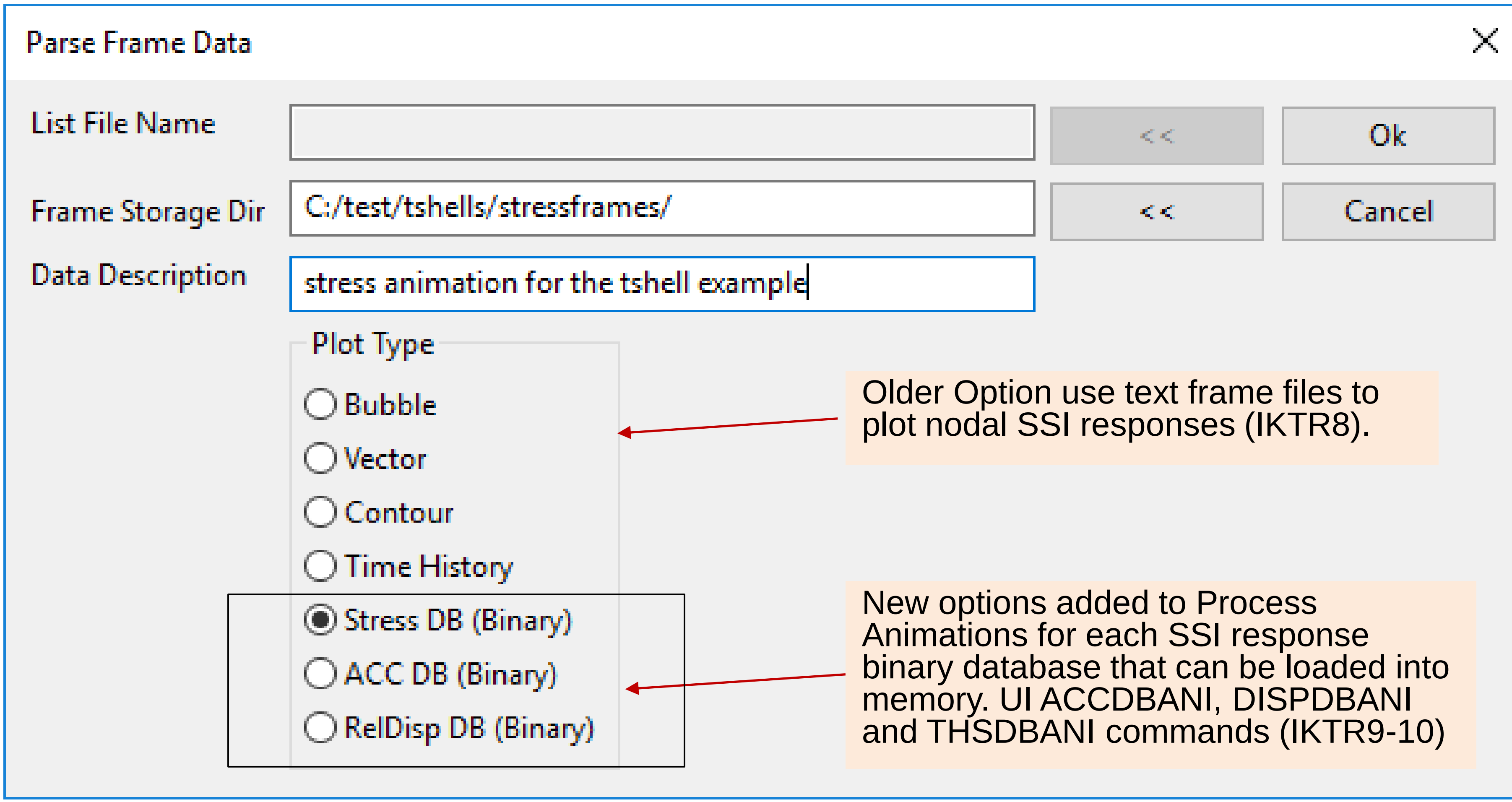


Checking SSI Interaction Nodes



Red dots are Interaction nodes
-You can zoom and select to show node numbers
-You can select to see only some groups of elements

UI Processing for Node or Element Animation Using Text Frames or Binary Databases



Selected UI Commands for SSI Analysis, Modeling and Post-Processing

SETENV Command

SETENV,<mem>

<mem> - The Memory size limit that the fast solver is allowed to use in megabytes. It is suggested that user set the size limit at 90 - 95% of physical RAM on the system. If the user attempts to allocate more than 100% of physical memory the fast solver has shown sometime to return incorrect results.

This command shall be used after software installation when the UI is launched for the first time. Sets the environment variables for the fast solver modules. The command sets three environment variables in the users registry. The environment variables are local to each user account and are persistent once they have been set. This command should be run by each user account.

GETENV Command

GETENV

This command shows the environment variables for the fast solver and the values of those environment variables.

AFWRBAT Command

AFWRBAT,<splits>
<splits> - number of sections the frequency set will be split into.

The AFWRBAT command allows the user split a simulation across multiple systems by frequency set into multiple models each with a separate frequency subset in separate folders. The folders can then be transferred to different systems and batch files created by this command run the necessary modules, then the data from each model can be combined by another batch file created by this command.

The command uses model data defined by MDL command to determine the name and location of the new folders that are created.

CRITFREQ Command

CRITFREQ,<tol>,<minfilter>,<TF>,<Var>

<tol> - percentage difference between the TFU and TFI that will cause the frequency to be added to the result.

<minfilter> - percentage below the global maximum where differences between the TFU and TFI should be ignored.

<TF> - name of the transfer function file for which the .TFI peak and .TFU values are compared.

<Var> - Variable name that includes the results of the critical frequency command application.

This command allows the user to identify automatically the frequencies where the interpolated ATF peaks are significantly different from the computed ATF values in the vicinity of the frequency of the interpolated ATF peak. These are identified frequencies should be added to the SSI input analysis. The user controls the results of this command with the <tol> and the <minfitler> argument. The full path name of the .TFU or .TFI files without these extensions should be included in the TF argument. The identified frequencies will be stored in the variable named in the last argument.

FRAMECOMBIN Command

FRAMECOMBIN,<op>,<num>,<InFile1>, …,<InFileX>,<Outfile>

<op> - operation code controls the way frames are to be combine.
= 0 - SRSS
= 1 - sum
= 2 - average
<num> - number of input frames to be combine.
<Infile> - full path of the input frame files.
<Outfile> - full path of output frame files.

Combine ASCII text frame files generated by MOTION, RELDISP or STRESS modules and combine them to make animations. This command requires the header of frame files to specify the number of rows columns in the frame file. This is written by default in the current ACS SASSI .

FRAMESEL Command

FRAMESEL,<tol>,<TimeHist>,<Var>

<tol> - Percentage of the global maximum below which local maximums will be ignored as critical frames
<TimeHist> - Acceleration file to be processed
<Var> - Variable Name to store the list of critical frames

This command allows the users to find local maximums/minimums in a time history and store these in a variable. Based on the list in the variable, the user can determine the critical frames or time steps.

Useful UI Commands for Checking FE Models and Improving Numerical Condition, Section-Cuts

Commands for building SSI and SSSI models:
MERGESOIL, EXCAV, EXTRACTEXCAV, INTGEN, FIXEDINT, HINGED, EXCSTRCHK

Improving the FEA model numerical condition and speed/storage:
FIXROT, FIXSHELL, FIXSOLID, FIXSPRING

Section-Cut Commands:
CUTVOL, SLICE, CSECT, CALCPAR, CALCSECTHIST, etc. (see Demo 8)

Create Nonlinear Models, PANELIZE, PANELGEN, SHEAR, BBCGEN,…

SSI Model Checking UI Commands

Command	Action
EXCSTRCHK	Checks excavation nodes for potential errors
FIXEDINT	Find Fixed Interaction Nodes
FREESPRING	Find Free Spring Nodes
HINGED	Check model for possible hinged connections
KINT	Find K node that are interaction nodes
USED	Check and fix Unused nodes

EXCSTRCHK Commands

EXCSTRCHK

This command checks if the Excavation interior nodes are common with the Structure basement nodes. This will be incorrect from a SASSI modeling point of view. A list detailing the shared nodes will be printed to the command history. The number of entries in the list is controlled by the Check Options break message number.

This command does not change the active model in any way.

EXCAV command creates an excavation model for a structural model that doesn't have an excavation

Example code to create an excavation model for a structural model (.pre).

```
Actm,1
INP, Example_model.pre
EXCAV,2
ACTM,2
* Write .pre file for the excavation model 2
Write, Example_Excavation.pre
```

FIXROT to automatically add the needed soft rotational springs to improve numerical conditioning for detailed flat SHELL models (for the Kirckhoff plate element the drilling degree of freedom has no stiffness associated with it, and therefore could produce poorly conditioned or unstable numerical models). Not required for the TSHELL elements.

FIXROT,<Stiff>.

Example code for fixing free shell drilling rotations in a FEA model.

Actm,1
Inp, Example_Model.pre
** Add soft springs with overall stiffness 10 at the oblique SHELL nodes;*
FixRot,10

HINGED checks model to find all hinged connections between solids and shell and beams and beams and shells. Write warnings for hinged nodes.

These hinged connections could be potentially indicate incorrect FE modelling, since the node rotations from beams and shells are not transmitted to solids at the common nodes, and the node rotations from beams are not transmitted the in-plane shell rotations at the common nodes (the drilling dof equations have no stiffness terms by default)

***FIXEDINT** checks if there are interaction nodes that are fixed by mistake*

Useful UI Commands for SSI and SSSI Model Building and Combination

Command	Action
EXCAV	Create an Excavation volume for a model
MERGE	Merge 2 models
MERGEGROUP	Merge 2 groups together
MERGEPANEL	Merge a Panel Model to the Solids and beams of the original model
MERGESOIL	Merge a Structural Model With a Matching Soil
ROTATE	Rotate the model around a point
SOILMESH	Create a soil mesh for the active model
TRANSLATE	Translate all nodes a specified distance
WELD	Combine nodes that share the same location

MERGESOIL,
<Struct>,<Soil>,[Mode],[StiffStiff],[StiffSoft],[SepLevel],[Mapping]

This command is used to merge the structural and the excavation volume models together in a new
active SSI FEA model.

<Struct> - Model Number of the Structure

<Soil> - Model Number of the Excavation volume

[Mode] - Merging nodes on the structure excavation interface

= 0 Unbonded lateral foundation-soil interface with side solid

= 1 Bonded lateral foundation-soil interface (default)

= 2 Bonded foundation-soil interface using duplicate nodes connected by stiff springs

= 3 Unbonded foundation soil-interface using duplicate nodes connected by soft springs

[StiffStiff] - Stiff spring stiffness for Modes 2 and 4. (Default = 10^7)

[StiffSoft] - Soft spring stiffness for Modes 3. (Default = 10)

[SepLevel] - Global z-coordinate level for depth where soil separation occurs

[Mapping] - This is mapping filename for the duplicate node merging

INTGEN to generate automatically interaction nodes for different substructuring approaches FV, FI-FSIN (SM), FI-EVBN (MSM) and Fast FV.

INTGEN,<type>,<skip> to generate the interaction nodes based on the selected SSI substructuringapproach. The excavation volume must be explicitly defined by the ETYPE command for options 1-3.
If the ETYPE is left to default values, this command will not work.

<type> :Type of iteration node generation
= 1 for Embedded Foundation - Flexible Volume (FV)
= 2 for Embedded Foundation - Flexible Interface with Excavation Volume Boundary Nodes, denoted FI-EVBN or Modified Subtraction Method (MSM)
= 3 for Embedded Foundation - Flexible Interface with Foundation-Soil Interface Nodes, denoted FI-FSIN or Subtraction Method (SM)
= 4 for Surface Foundation (interaction nodes are only at the ground surface level)
= 5 for FFV with repeated internal interaction node layers based on <skip>

Building SSI Model Example to Merge Structure and Excavation FE Models for SSI Analysis (also in Option AA)

It is assumed that the ground surface is at Z=0. and the FV method will be used

**Convert ANSYS Structure.cdb in Model 1*

Actm,1

Convert,ansys,struct.cdb,32.2

Etypegen,1

Actm,2

Convert, ansys,Soil.cdb,32.2

** Define excavation elements of type 2*

Etypegen,2

** Create SSI model by combining Models 1 and 2 in Model 3*

Actm,3

MergeSoil,1,2,1,,,,mappingfile.txt

Groundelev, 0

Intgen, 1

Using ACS SASSI User Interface (UI) Macros. Few Examples…See also Demo 3

- Perform fast repeated UI operations easily
- Post-Process SSI results (SRSS, averaging, time superposition by algebraic summation, etc.)
- Identify missing frequencies based on ATF or STF results, and build list of new frequencies to be added
- Generate Backbone Curves for Nonlinear SSI Analysis (Option NON)
- Automate the running of SSI Analysis

Macro Basic Functions

- Macros are loaded into the UI with the LOADMACRO command
- Macros are called with the MACRO command
- Input arguments for a macro are written in the form n, where n is the number of the argument, i.e. 1 is the first input argument, 2 is the second, etc.
  - In the example below, the macro call would look like **macro,srss,.\XDIR\00001TR_X01.rs,.\YDIR\00001TR_X01.rs,.\ZDIR\00001TR_X01.rs,.\SRSS\00001TR_X01_SRSS.rs**
  - From this example, the first argument is the X-Direction .rs file, the second is the Y-Direction .rs file, the third is the Z-Direction .rs file, and the last argument is the file to save the computed SRSS to.

```
* Compute SRSS
READSPEC,$1$,1,1
READSPEC,$2$,1,2
READSPEC,$3$,1,3
SRSS,4,1,2,3
WRITESPEC,$4$,4
```

Defining Variables for Efficient Post-Processing

- Defined in the ACS SASSI UI using the VAR and LOADVAR commands
- Can be viewed with VARLIST and SHOWVAR commands
- Reference in the ACS SASSI UI by the defined name preceded by @, i.e. *@variablename[1]*
  - *The number within the brackets identifies the index number to use to access the values stored in a variable i.e. @name[1] for the first value, @name[2] for the second, etc.*

FOREACH Command for Building Variable Loops

- The FOREACH command is extremely useful for post-processing SSI results for many nodes or elements
- Command syntax: FOREACH, *variable,*<*command to be executed*>
- The looped variable should appear in the command to be executed in the form of *variable[#]*
  - The [#] indicates that the specified variable is to be looped on
  - Only one variable can be looped on in a single FOREACH command
- When used with the MACRO command, the execution of operations such as computing SRSS for spectra or summation of time histories can be looped through for a list of nodes or elements

Nested Macros for Efficient Post-Processing

Macros can be nested to easily perform repeated operations. This example calls the nesting macro to pass file name information to the macro performing the SRSS operation. The nesting macro is passed file name information from the top level .pre file, looping through nodes to build file names to pass to the nesting macro with the FOREACH command.

Top Level .pre File Calling Nesting Macro

```
* Define Variables
mdl,temp,<work folder>\Coherent\Post-Processing
var,path,.
loadvar,nodes,@Path[1]\Nodes.txt

* Load Macros
loadmacro,srss,SRSS-macro.pre
loadmacro,nestSRSS,Nested-SRSS.pre

* Combine Results
foreach,nodes,macro,nestSRSS,@nodes[#],01,X,@path[1]
```

Macro Calling SRSS Macro (Nested-SRSS.pre)

```
* NEST SRSS
macro,srss,$4$\XDIR\$1$TR_$3$$2$.rs,$4$\YDIR\$1$TR_$3$$2$.rs,
$4$\ZDIR\$1$TR_$3$$2$.rs,$4$\Combined\ISRS\$1$TR_$3$$2$.RS
```

Macro to Perform SRSS Calculation (SRSS-macro.pre)

```
* SRSS MACRO
READSPEC,$1$,1,1
READSPEC,$2$,1,2
READSPEC,$3$,1,3
SRSS,4,1,2,3
WRITESPEC,$4$,4
```

Example of UI Macros for Adding Acceleration Histories

Macros can be nested to easily perform repeated operations. This example calls the nesting macro to pass file name information to the macro performing the ADDITION operation.
The nesting macro is passed file name information from the top level .pre file, looping through nodes to build file names to pass to the nesting macro with the FOREACH command.

Top Level .pre File Calling Nesting Macro

```
* Define Variables
mdl,temp,<work folder>\Coherent\Post-Processing
var,path,.
loadvar,nodes,@Path[1]\Nodes.txt

* Load Macros
loadmacro,ADD,ADD-Macro.pre
loadmacro,NESTADD,Nested-ADD.pre

* Combine Results
foreach,nodes,macro,nestADD,@nodes[#],X,@path[1]
```

NESTADD Macro Calling ADD Macro (Nested-ADD.pre)

```
* NESTADD Macro
macro,ADD,$3$\XDIR\$1$TR_$2$.acc,$3$\YDIR\$1$TR_$2$.rs,$3$\ZDIR\$1$TR_$2$.acc,$4$\Combined\ISRS\$1$TR_$2$.acc
```

ADD Macro for ADDITION Calculations (ADD-Macro.pre)

```
* ADD Macro
READTH,$1$,0,1
READTH,$2$,0,2
READTH,$3$,0,3
ADDITION,4,1,2,3
WRITETH,$4$,4
```

Nodes.txt

```
09201
09202
09203
09204
09205
09206
09207
09208
09209
09210
09211
09212
09213
09214
09215
09233
09960
```

Combination of ISRS, ACC, and THD Files for Incoherent SSI Analysis (Combine_Results.pre)

```
* Combine_Results.pre
* Macro to run SRSS and Average for ISRS, and time history
combination for * THD, ACC, and THS files

* Define Variables
mdl,temp,<work directory>\Incoherent\Post-Processing
var,path,.
loadvar,xnodes,@Path[1]\XDIR_Nodes.txt
loadvar,ynodes,@Path[1]\YDIR_Nodes.txt
loadvar,znodes,@Path[1]\ZDIR_Nodes.txt
loadvar,samples,@Path[1]\Samples.txt

* Load Macros
loadmacro,srss,SRSS-macro.pre
loadmacro,add,Addition-macro.pre
loadmacro,mean,Average-macro.pre

loadmacro,xnestsrssfor,Nested-SRSS-foreach-X.pre
loadmacro,ynestsrssfor,Nested-SRSS-foreach-Y.pre
loadmacro,znestsrssfor,Nested-SRSS-foreach-Z.pre

loadmacro,xnestaddaccfor,Nested-Add-ACC-foreach-X.pre
loadmacro,ynestaddaccfor,Nested-Add-ACC-foreach-Y.pre
loadmacro,znestaddaccfor,Nested-Add-ACC-foreach-Z.pre
loadmacro,xnestaddthdfor,Nested-Add-THD-foreach-X.pre
loadmacro,ynestaddthdfor,Nested-Add-THD-foreach-Y.pre
loadmacro,znestaddthdfor,Nested-Add-THD-foreach-Z.pre

loadmacro,nestSRSS,Nested-SRSS.pre
loadmacro,nestAddACC,Nested-Add-ACC.pre
loadmacro,nestAddTHD,Nested-Add-THD.pre

* Macro continued
* Create Combined Folders for Each Sample
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined\ISRS
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined\THD
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined\ACC

* Calculate SRSS for ISRS for Each Sample
foreach,samples,macro,xnestsrssfor,@samples[#]
foreach,samples,macro,ynestsrssfor,@samples[#]
foreach,samples,macro,znestsrssfor,@samples[#]

* Calculate Sum for ACC for Each Sample
foreach,samples,macro,xnestaddaccfor,@samples[#]
foreach,samples,macro,ynestaddaccfor,@samples[#]
foreach,samples,macro,znestaddaccfor,@samples[#]
```

Combination of ISRS, ACC, and THD Files for Incoherent SSI Analysis (Combine_Results.pre)

```
* Calculate Sum for THD for Each Sample
foreach,samples,macro,xnestaddthdfor,@samples[#]
foreach,samples,macro,ynestaddthdfor,@samples[#]
foreach,samples,macro,znestaddthdfor,@samples[#]

* Calculate Mean for Each Node
mkdir,.\Mean
foreach,xnodes,macro,mean,@path[1],@xnodes[#],X,01
foreach,ynodes,macro,mean,@path[1],@ynodes[#],Y,01
foreach,znodes,macro,mean,@path[1],@znodes[#],Z,01
```

Macros Loaded in .pre From Previous Slide

```
* Addition-Macro.pre for Add
Time History for 3 Directions
READTH,$1$,0,1
READTH,$2$,0,2
READTH,$3$,0,3
ADDITION,4,1,2,3
WRITETH,$4$,4
```

```
* SRSS-Macro.pre for SRSS
READSPEC,$1$,1,1
READSPEC,$2$,1,2
READSPEC,$3$,1,3
SRSS,4,1,2,3
WRITESPEC,$4$,4
```

```
* Nested-SRSS.pre
macro,srss,$4$\XDIR\$1$TR_$3$$2$.rs,$4$\YDIR\$1$TR_$3$$2$.rs,$4$\
ZDIR\$1$TR_$3$$2$.rs,$4$\Combined\ISRS\$1$TR_$3$$2$.RS
```

```
* Nested-SRSS-foreach-X.pre
foreach,xnodes,macro,nestSRSS,@xnodes[#],01,X,@path[1]\Sample_$1$
```

```
* Nested-Add-ACC-foreach-X.pre
foreach,xnodes,macro,nestAddACC,@xnodes[#],X,@path[1]\Sample_$1$
```

```
* Average-Macro.pre for Average for 20 Samples
READSPEC,$1$\Sample_1\Combined\ISRS\$2$TR_$3$$4$.RS,1,1
READSPEC,$1$\Sample_2\Combined\ISRS\$2$TR_$3$$4$.RS,1,2
READSPEC,$1$\Sample_3\Combined\ISRS\$2$TR_$3$$4$.RS,1,3
READSPEC,$1$\Sample_4\Combined\ISRS\$2$TR_$3$$4$.RS,1,4
READSPEC,$1$\Sample_5\Combined\ISRS\$2$TR_$3$$4$.RS,1,5
READSPEC,$1$\Sample_6\Combined\ISRS\$2$TR_$3$$4$.RS,1,6
READSPEC,$1$\Sample_7\Combined\ISRS\$2$TR_$3$$4$.RS,1,7
READSPEC,$1$\Sample_8\Combined\ISRS\$2$TR_$3$$4$.RS,1,8
READSPEC,$1$\Sample_9\Combined\ISRS\$2$TR_$3$$4$.RS,1,9
READSPEC,$1$\Sample_10\Combined\ISRS\$2$TR_$3$$4$.RS,1,10
READSPEC,$1$\Sample_11\Combined\ISRS\$2$TR_$3$$4$.RS,1,11
READSPEC,$1$\Sample_12\Combined\ISRS\$2$TR_$3$$4$.RS,1,12
READSPEC,$1$\Sample_13\Combined\ISRS\$2$TR_$3$$4$.RS,1,13
READSPEC,$1$\Sample_14\Combined\ISRS\$2$TR_$3$$4$.RS,1,14
READSPEC,$1$\Sample_15\Combined\ISRS\$2$TR_$3$$4$.RS,1,15
READSPEC,$1$\Sample_16\Combined\ISRS\$2$TR_$3$$4$.RS,1,16
READSPEC,$1$\Sample_17\Combined\ISRS\$2$TR_$3$$4$.RS,1,17
READSPEC,$1$\Sample_18\Combined\ISRS\$2$TR_$3$$4$.RS,1,18
READSPEC,$1$\Sample_19\Combined\ISRS\$2$TR_$3$$4$.RS,1,19
READSPEC,$1$\Sample_20\Combined\ISRS\$2$TR_$3$$4$.RS,1,20
AVERAGE,21,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20
WRITESPEC,$1$\Mean\$2$TR_$3$$4$.RS,21
```

The THS, THD, and ACC addition nested macros follow a similar structure to the Nested-SRSS.pre and Nested-SRSS-foreach-X.pre

Combination of THS Files for Incoherent Analysis

```
* Define Variables
mdl,temp,<work directory>\Post-Processing
var,path,.
loadvar,thslist,@path[1]\ths_list.txt
loadvar,samples,@Path[1]\Samples.txt

* Load Macros
loadmacro,add,Addition-macro.pre
loadmacro,nestaddthsfor,Nested-Add-THS-foreach.pre
loadmacro,nestAddTHS,Nested-Add-THS.pre

* Create Combined Folders for Each Sample
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined
foreach,samples,mkdir,@Path[1]\Sample_@samples[#]\Combined\THS

* Calculate Sum for THS for Each Sample
foreach,samples,macro,nestaddthsfor,@samples[#]
```

```
* Addition-Macro.pre for Add Time History for 3 Directions
READTH,$1$,0,1
READTH,$2$,0,2
READTH,$3$,0,3
ADDITION,4,1,2,3
WRITETH,$4$,4
```

```
* Nested-Add-THS-foreach.pre
foreach,thslist,macro,nestAddTHS,@path[1]\Sample_$1$,@thslist[#]
```

```
* Nested-Add-THS.pre
macro,add,$1$\XDIR\$2$,$1$\YDIR\$2$,$1$\ZDIR\$2$,$1$\Combined\THS\$2$
```

```
* Nested-Add-THS.pre
macro,add,$1$\XDIR\$2$,$1$\YDIR\$2$,$1$\ZDIR\$2$,$1$\Combined\THS\$2$
```

THS_list.txt

```
BEAMS_002_00001_FXI.THS
BEAMS_002_00001_FXJ.THS
BEAMS_002_00001_FYI.THS
BEAMS_002_00001_FYJ.THS
BEAMS_002_00001_FZI.THS
BEAMS_002_00001_FZJ.THS
BEAMS_002_00001_MXI.THS
BEAMS_002_00001_MXJ.THS
BEAMS_002_00001_MYI.THS
BEAMS_002_00001_MYJ.THS
BEAMS_002_00001_MZI.THS
BEAMS_002_00001_MZJ.THS
.
.
.
BEAMS_011_00095_FXI.THS
BEAMS_011_00095_FXJ.THS
BEAMS_011_00095_FYI.THS
BEAMS_011_00095_FYJ.THS
BEAMS_011_00095_FZI.THS
BEAMS_011_00095_FZJ.THS
BEAMS_011_00095_MXI.THS
BEAMS_011_00095_MXJ.THS
BEAMS_011_00095_MYI.THS
BEAMS_011_00095_MYJ.THS
BEAMS_011_00095_MZI.THS
BEAMS_011_00095_MZJ.THS
```

Variables Loaded in Combine_Results.pre

XDIR_Nodes.txt

```
09201
09202
09203
09204
09205
09206
09207
09208
09209
09210
09211
09212
09213
09214
09215
09233
09960
```

YDIR_Nodes.txt

```
09201
09202
09203
09204
09205
09206
09207
09208
09209
09210
09211
09212
09213
09214
09215
09233
09960
```

ZDIR_Nodes.txt

```
09201
09202
09203
09204
09205
09206
09207
09208
09209
09210
09211
09212
09213
09214
09215
09233
09301
09302
09303
09304
09305
09306
09307
09308
09309
09310
09311
09312
09313
09314
09315
09316
09960
```

Samples.txt

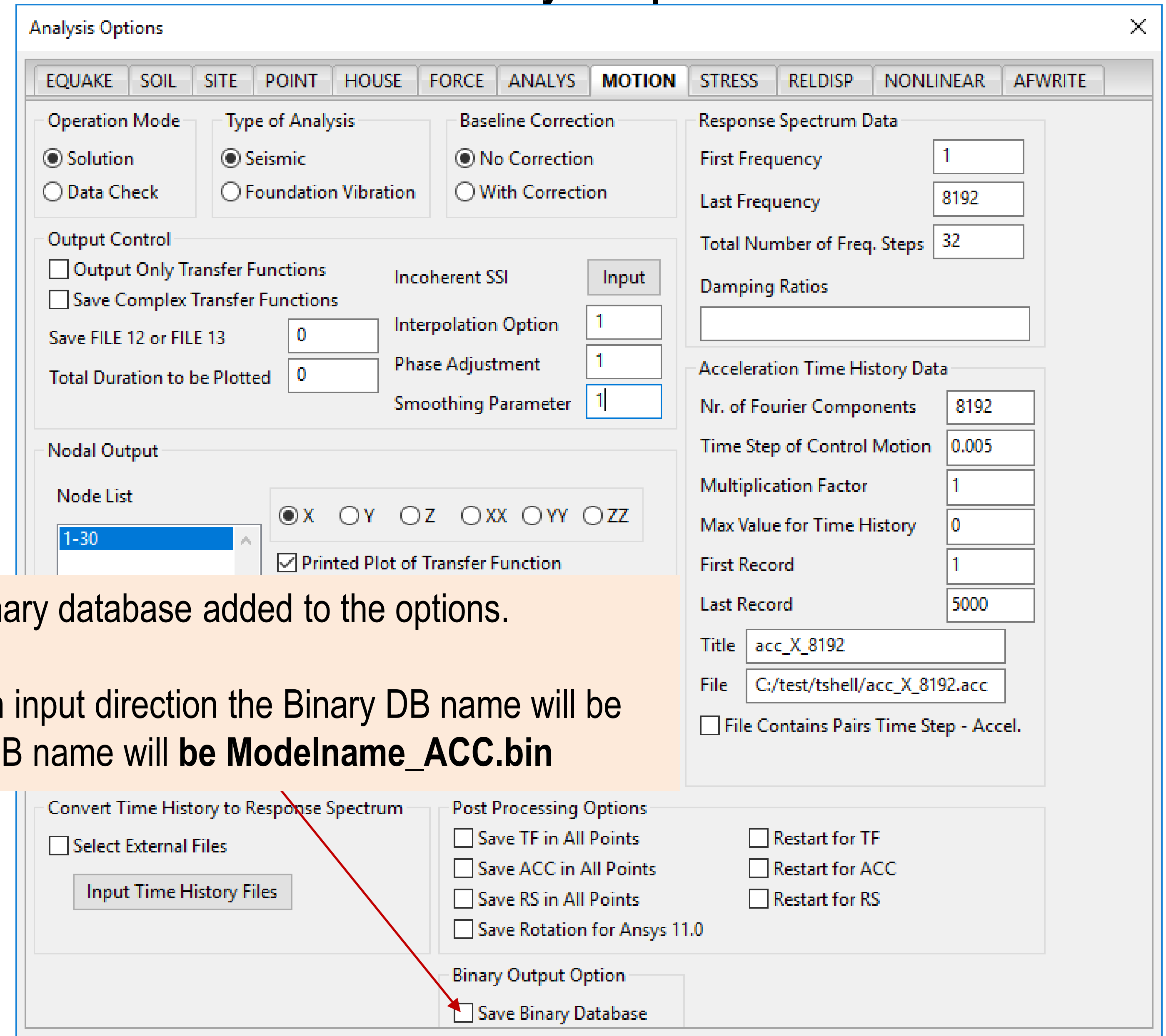
```
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
```

Macro for Finding Additional Frequencies for Improving ATF and STF Interpolation Errors

```
* Modify path var to location of the demo directory
var,path,C:ACSV300\Demo_Problems\demo3\
var,dirs,@path[1]\TFU-TFI
mdl,,@path[1]
loadvar,TF,tflist.txt
mdl,,@dirs[1]
var,FREQ
foreach,TF,CRITFREQ,90,50,@TF[#],FREQ
reduceset,FREQ,FLOAT
showvar,FREQ
```

Fast Post-Processing of SSI Response Time Histories Using UI Commands for Binary Databases

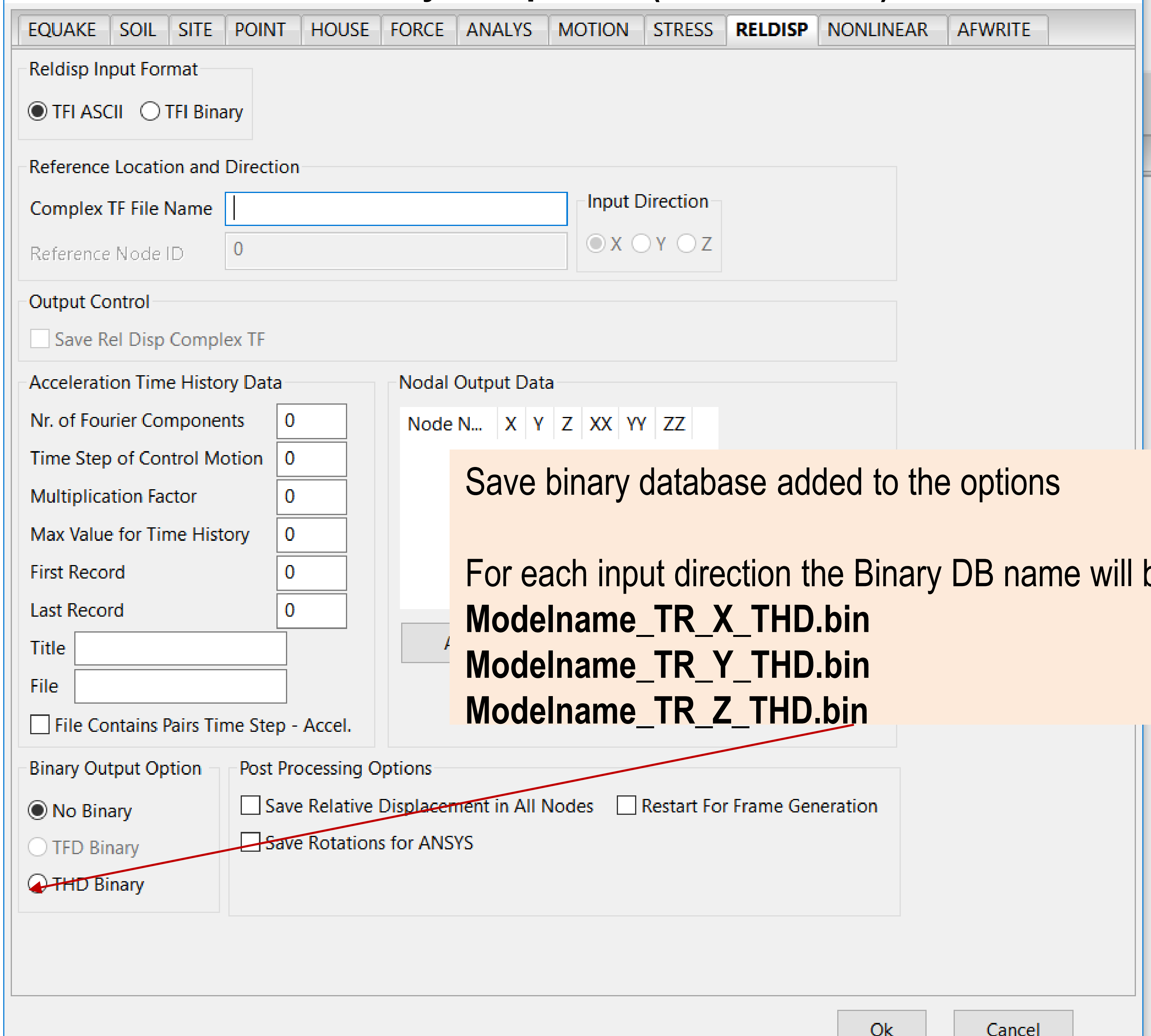
MOTION Analysis Options



Save binary database added to the options.

For each input direction the Binary DB name will be Binary DB name will **be Modelname_ACC.bin**

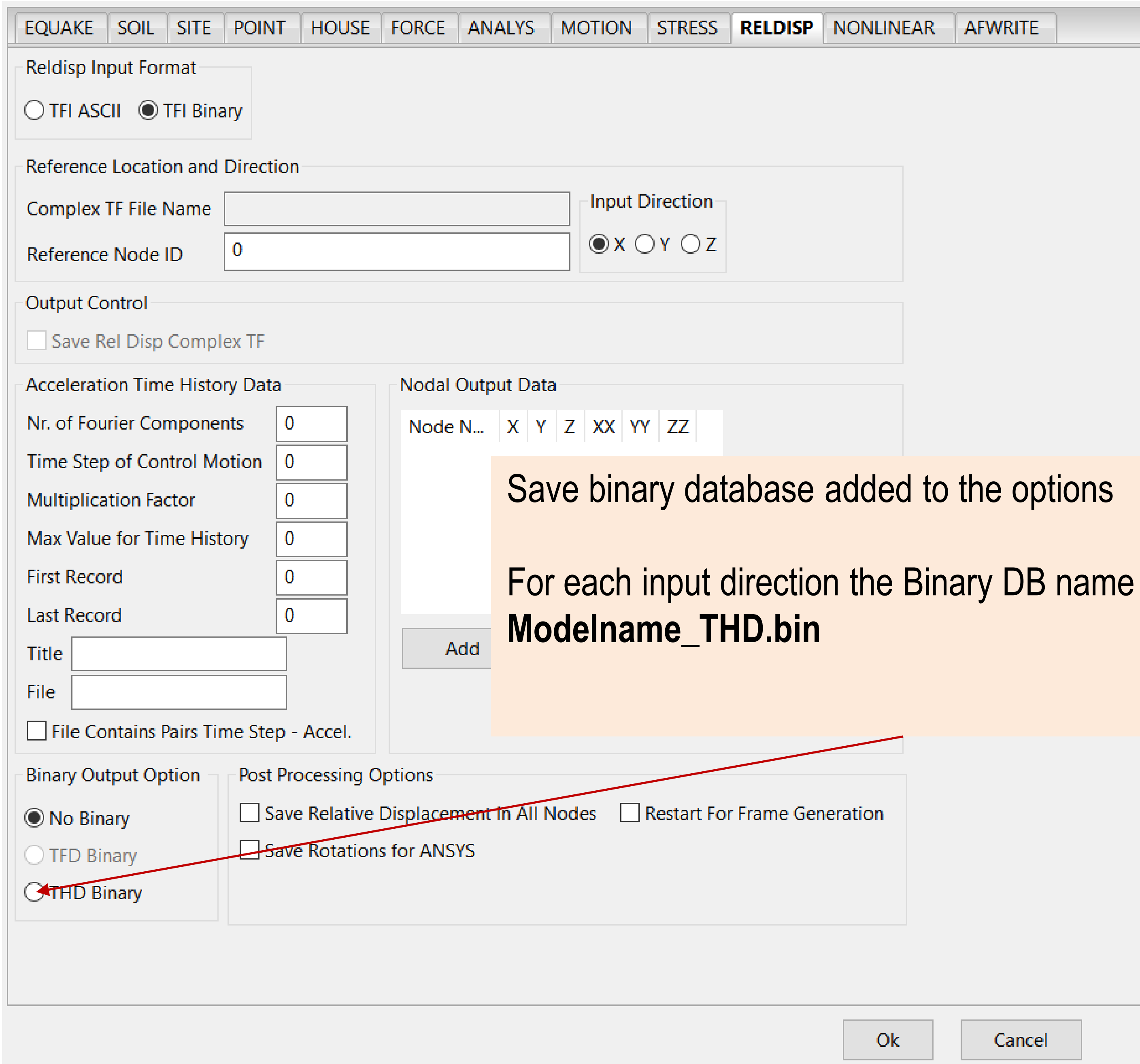
RELDISP Analysis Options (TFI Text Files)



Save binary database added to the options

For each input direction the Binary DB name will be
Modelname_TR_X_THD.bin
Modelname_TR_Y_THD.bin
Modelname_TR_Z_THD.bin

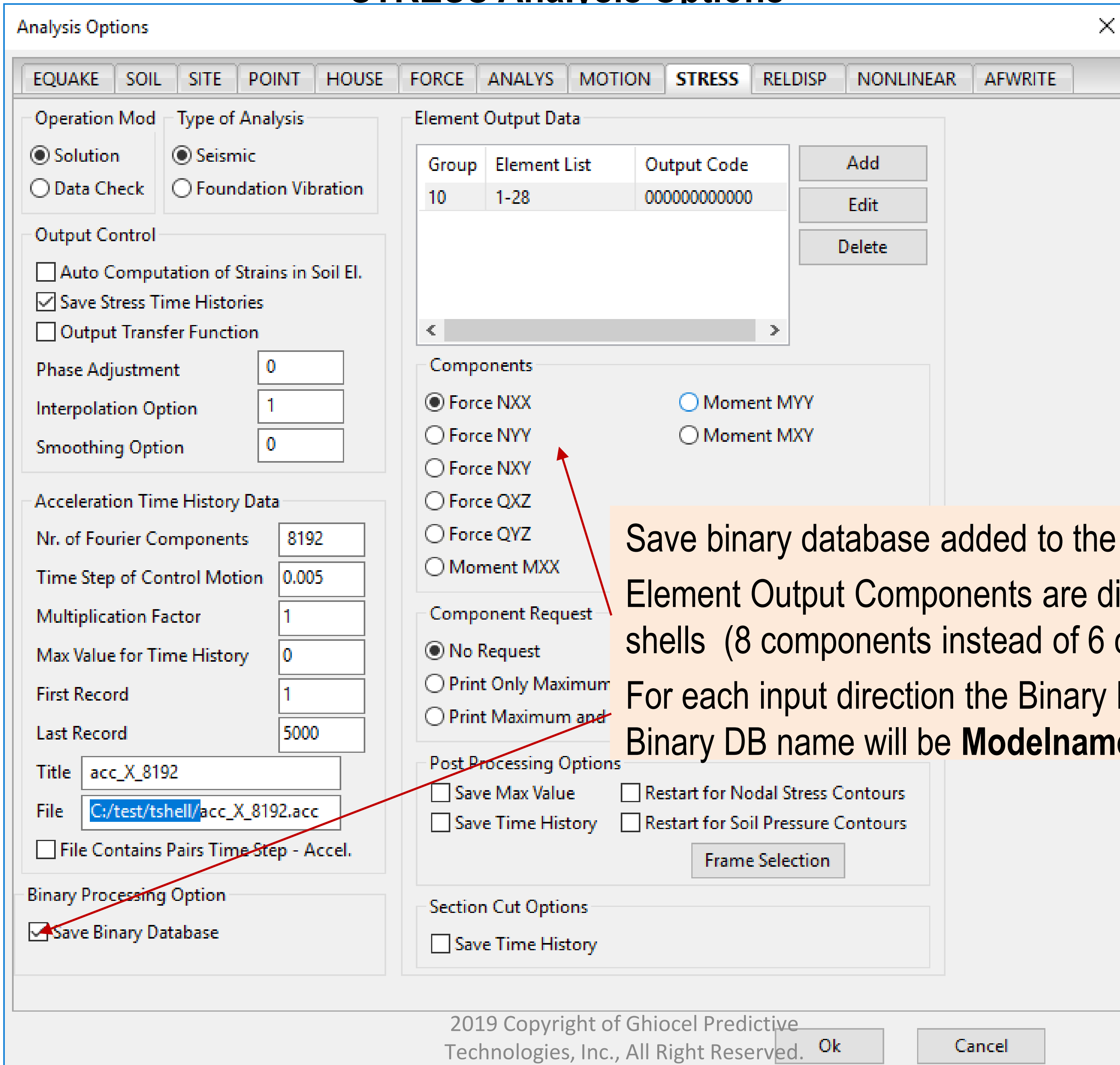
RELDISP Analysis Options (TFI Binary Files)



Save binary database added to the options

For each input direction the Binary DB name will be **Modelname_THD.bin**

STRESS Analysis Options



Save binary database added to the options

Element Output Components are different for thick shells (8 components instead of 6 components)

For each input direction the Binary DB name will be Binary DB name will be **Modelname_STRESS.bin**

BINOUT Command

BINOUT,[mot],[str],[reldisp]

BINOUT command sets the binary options for the inputs of the SSI modules such as MOTION, RELDISP and STRESS. If an argument is left blank the value of the associated flag remains unchanged

- MOTION nodal acceleration history binary database
    - 0 - Do not write database
    - 1 - Write binary database
- STRESS the element stress/force/moment history binary database
    - 0 - Do not write database
    - 1 - Write binary database
- RELDISP nodal displacement history binary database
    - 0 - Do not write database
    - 1 - Not used in this version
    - 2 - Write binary database

COMBACCDB Command

COMBACCDB,<Xfile>,<Yfile>,<Zfile>,<Comb>

Combine *three acceleration history binary databases* for X, Y and Z seismic input into a single database.

- Xfile - full path name of the x direction binary database
- Yfile - full path name of the y direction binary database
- Zfile - full path name of the z direction binary database
- Comb - full path name of combined direction binary database

COMBDISPDB Command

three displacement history binary databases

COMBTHSDB Command

Three element stress history binary databases

LOADACCDB Command

LOADACCDB,<file>

Load the MOTION created acceleration history binary database into the UI memory. Only a single acceleration binary database can be loaded into the UI memory at a time

•file - full path name of binary acceleration database

LOADDISPDB Command

Load the RELDISP created displacement history binary database

LOADTHSDB Command

Load the STRESS created element stress history binary database

ACCDBANI Command

ACCDBANI,<dir>,[label]

Create the SSI model animation from the nodal acceleration binary database that is loaded in the UI memory

- dir – work directory for the animation files.
- label – description label of the animation data. This label is stored in the animation database under Process Animation, and is used to identify the selected animation file when the animation data is loaded/reloaded

DISPDBANI Command

Create the SSI model animation from the nodal displacement binary database

THSDBANI Command

Create the SSI model animation from the element stress binary database

MAXDBFRAME Command

MAXDBFRAME,<Type>,[dir]

This command will find the maximum component values of for a binary database loaded into UI memory. The data will be written in a binary database file located in either the working directory or an user defined directory.

- Type - Database used to make the frame
  - THS - Stress
  - DISP - Displacement
  - ACC - Acceleration
- dir - directory where the frame file will be written. (default: current working directory)

BINSTRTBL Command

BINSTRTBL,<group>,<EVar>,<file>,[step]

Create a text table format for selected stresses.

Gr.	Elem.	SXX	SYY	TXY	MXX	MYY	MXY
34	1	0.0619	1.3769	1.7051	0.2896	0.2343	0.3228
34	2	0.0092	1.6048	2.6930	0.2101	0.8928	0.1681
34	3	0.1953	1.0696	2.6461	0.5233	0.8652	0.1771
34	4	0.1861	0.7625	2.1855	0.2927	1.1031	0.1119
34	5	0.0589	0.8005	4.2785	0.5619	1.8940	0.0472
34	6	0.0849	0.7012	4.9323	0.8285	1.8190	0.1373
34	7	0.0262	0.6604	3.4275	0.6116	0.2215	0.4655
34	8	0.0329	0.4823	1.7195	0.2640	1.7506	0.5377
34	9	0.0498	0.7906	1.7139	0.7083	1.3001	0.2326
34	10	0.0864	0.5886	2.4700	0.5667	0.5384	0.1734

The 1st line of the file will be column labels for each column. Each subsequent line will be the Group and element number then each component stress for that element.

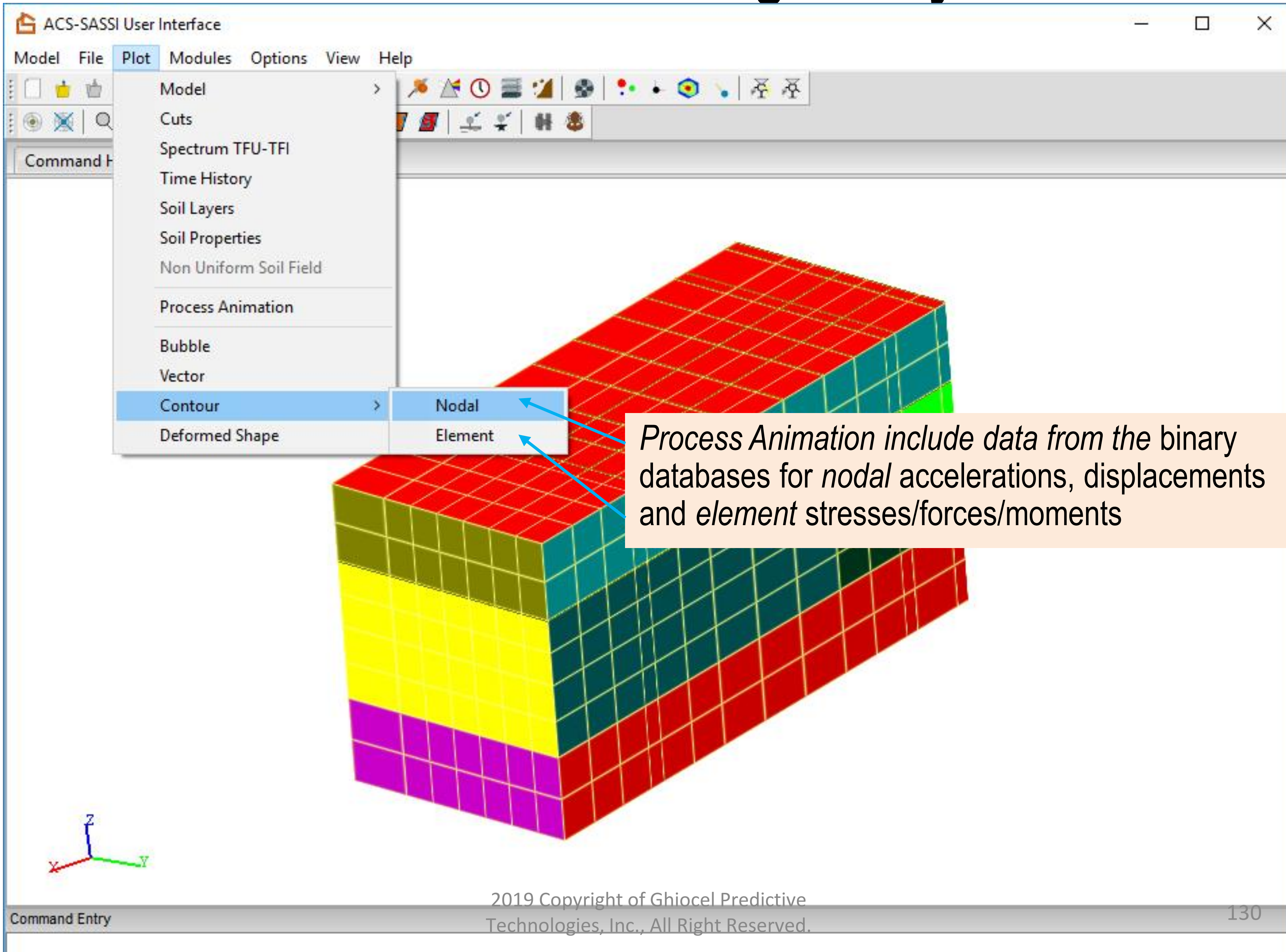
If the step argument is left blank or set to -1 the Maximum values of each component will be written to the table. This Maximum is the absolute maximum for the component.

UI Extracting STRESS Maximum Element Outputs

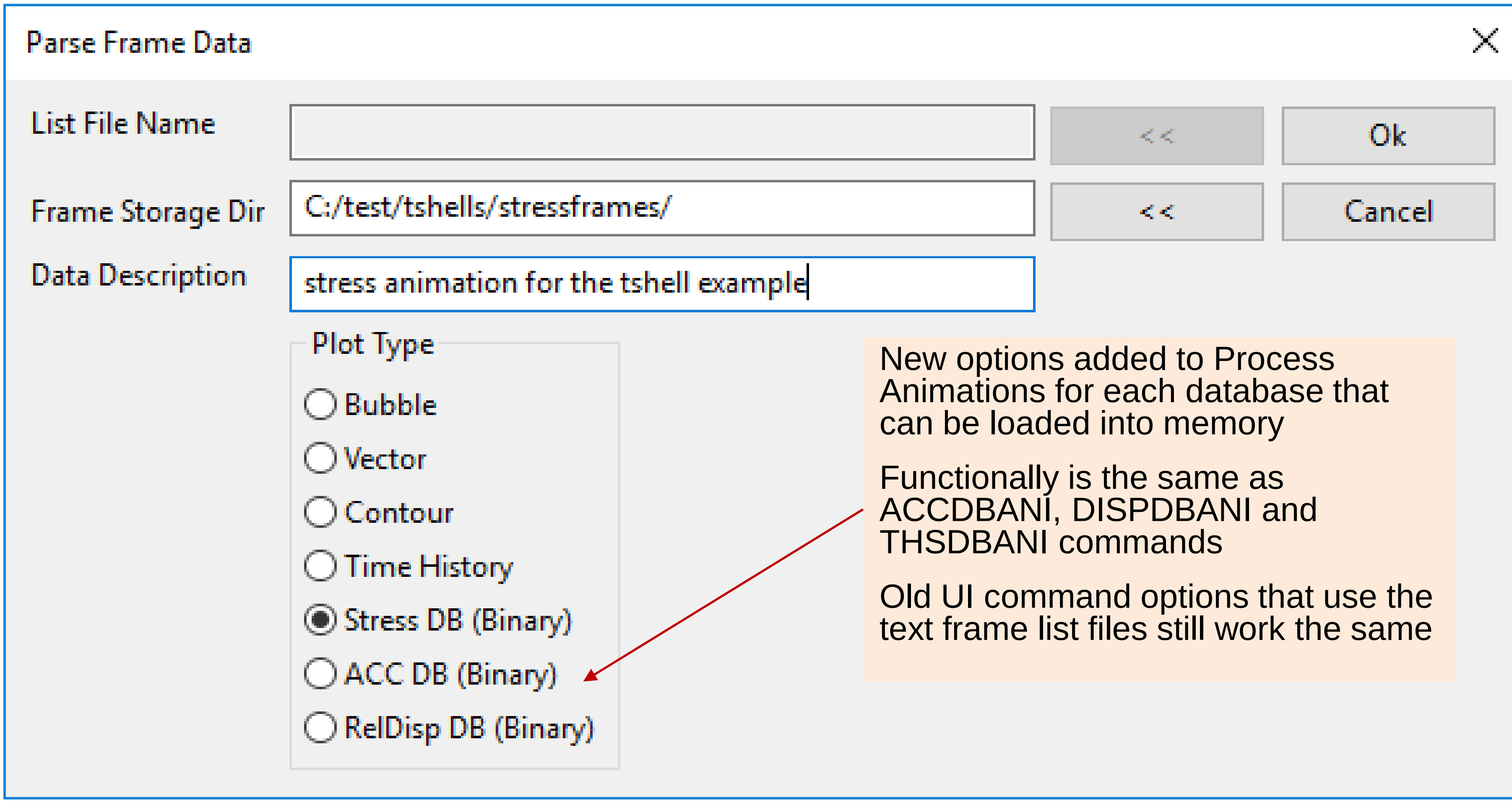
```
LOADTHSDB,C:\ACSV300\DEMO_PROBLEMS\DEMO9\XYZ_Analysis\STRESS\Combined\THS\AB_SHEAR_NL_STRESS.BIN
Database read took 3.906000 Seconds
LOADVAR,elist,C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\element_output_list.txt
Variable Loaded Sucessfully from file
BINSTRTBL,34,elist,1,C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\STRESS_MAX.txt
Table File : C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\STRESS_MAX.txt  written
```

Gr.	Elem.	SXX	SYY	TXY	MXX	MYY	MXY
34	1	0.0619	1.3769	1.7051	0.2896	0.2343	0.3228
34	2	0.0092	1.6048	2.6930	0.2101	0.8928	0.1681
34	3	0.1953	1.0696	2.6461	0.5233	0.8652	0.1771
34	4	0.1861	0.7625	2.1855	0.2927	1.1031	0.1119
34	5	0.0589	0.8005	4.2785	0.5619	1.8940	0.0472
34	6	0.0849	0.7012	4.9323	0.8285	1.8190	0.1373
34	7	0.0262	0.6604	3.4275	0.6116	0.2215	0.4655
34	8	0.0329	0.4823	1.7195	0.2640	1.7506	0.5377
34	9	0.0498	0.7906	1.7139	0.7083	1.3001	0.2326
34	10	0.0864	0.5886	2.4700	0.5667	0.5384	0.1734

UI Plot Nodal Contours Using Binary Databases



UI Processing for Node or Element Animation Frame Lists for ACC, THD and THS Histories



New options added to Process Animations for each database that can be loaded into memory

Functionally is the same as ACCDBANI, DISPDBANI and THSDBANI commands

Old UI command options that use the text frame list files still work the same

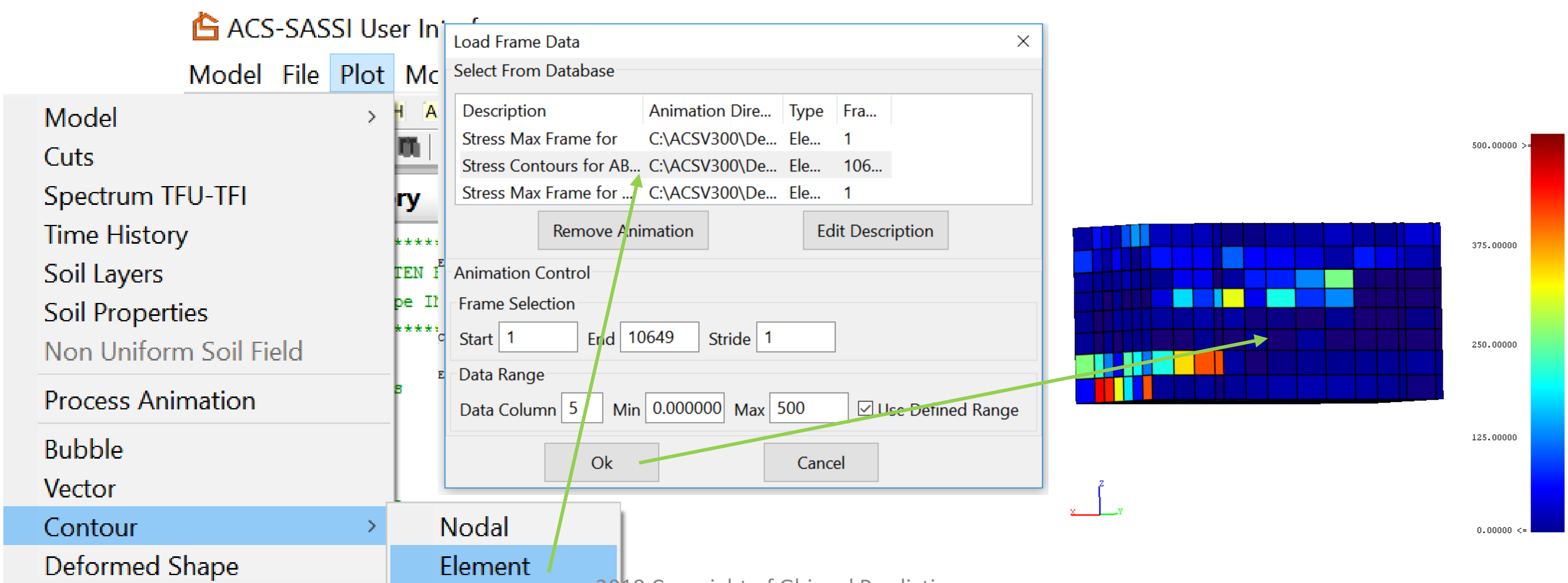
Plotting STRESS History of Max Element Outputs

```
INPUT FILE REACHED EOF, INPUT SWITCHED TO KEYBOARD
LOADTHSDB,C:\ACSV300\DEMO_PROBLEMS\DEMO9\XYZ_Analysis\STRESS\Combined\THS\AB_SHEAR_NL_STRESS.BIN
Database read took 7.110000 Seconds
LOADVAR,elist,C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\element_output_list.txt
Variable Loaded Sucessfully from file
MAXDBFRAME,THS,C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\STRESS\Combined\THS\Max_Frame_Contour
Max Frame added user interface animation database
```

1

1-10649

THSDBANI,C:\ACSV300\Demo_Problems\Demo9\XYZ_Analysis\STRESS\Combined\THS\All_Frame_Contour



Post-Processing SSI Responses Using Binary Databases Described in Detail in Demo 13

*** Define Variable for Working Directory**
VAR,PATH,C:\ACSV300\Demo_Problems\Demo13

*** Combining Three-Direction Response RELDISP Displacement Binary Databases for Each Seismic Input**
COMBDISPDIR,@PATH[1]\XDIR\ABShear_TR_X_thd.bin,@PATH[1]\XDIR\ABShear_TR_Y_thd.bin,@PATH[1]\XDIR\ABShear_TR_Z_thd.bin,@PATH[1]\XDIR\ABShear_thd.bin
COMBDISPDIR,@PATH[1]\YDIR\ABShear_TR_X_thd.bin,@PATH[1]\YDIR\ABShear_TR_Y_thd.bin,@PATH[1]\YDIR\ABShear_TR_Z_thd.bin,@PATH[1]\YDIR\ABShear_thd.bin
COMBDISPDIR,@PATH[1]\ZDIR\ABShear_TR_X_thd.bin,@PATH[1]\ZDIR\ABShear_TR_Y_thd.bin,@PATH[1]\ZDIR\ABShear_TR_Z_thd.bin,@PATH[1]\ZDIR\ABShear_thd.bin

*** Combining SSI Responses Computed for X, Y and Z Inputs Using Binary Databases for MOTION, RELDISP and STRESS**
COMBACCDB,@PATH[1]\XDIR\ABShear_ACC.bin,@PATH[1]\YDIR\ABShear_ACC.bin,@PATH[1]\ZDIR\ABShear_ACC.bin,@PATH[1]\Combined\ABShear_ACC.bin,0
COMBDISPDB,@PATH[1]\XDIR\ABShear_thd.bin,@PATH[1]\YDIR\ABShear_thd.bin,@PATH[1]\ZDIR\ABShear_thd.bin,@PATH[1]\Combined\ABShear_thd.bin,0
COMBTHSDB,@PATH[1]\XDIR\ABShear_STRESS.bin,@PATH[1]\YDIR\ABShear_STRESS.bin,@PATH[1]\ZDIR\ABShear_STRESS.bin,@PATH[1]\Combined\ABShear_STRESS.bin,0

*** Loading Binary Databases into the ACS SASSI UI for Fast SSI Response History Post-Processing**
LOADACCDB,@PATH[1]\Combined\ABShear_ACC.bin
LOADDISPDB,@PATH[1]\Combined\ABShear_THD.bin
LOADTHSDB,@PATH[1]\Combined\ABShear_STRESS.bin

Post-Processing SSI Responses Using Binary Databases Described in Detail in Demo 13

*** Plotting and Saving Results as Text Files from Binary Databases**

* Nodal Accelerations (MOTION Module)
ACCDBANI,@PATH[1]\Combined\ACC,Demo 13 Acceleration Time History
MAXDBFRAME,ACC,@PATH[1]\Combined\ACC_Max

* Nodal Relative Displacements (RELDISP Module)
DISPDBANI,@PATH[1]\Combined\THD,Demo 13 Relative Displacement
MAXDBFRAME,DISP,@PATH[1]\Combined\THD_Max

* Element Stresses/Forces (STRESS Module)
THSDBANI,@PATH[1]\Combined\STRESS,Demo 13 Stress Contour
MAXDBFRAME,THS,@PATH[1]\Combined\Stress_Max

* Saving Binary Database Results to Text Files
VAR,OUTNODES,63,137,205,219,253,271
VAR,OUTELEM,1,2,3,4,5,6,7,8,9,10,11,12,13,14

* Accelerations (MOTION Module)
ACCDBTHFILE,OUTNODES,1,@PATH[1]\COMBINED
BINFRAMEOUT,ACC,-1,0,0,@PATH[1]\Combined
BINFRAMEOUT,ACC,1000,0,0,@PATH[1]\Combined
BINFRAMEOUT,ACC,5.5,0.005,0,@PATH[1]\Combined

* Displacement (RELDISP Module)
DISPDBTHFILE,OUTNODES,1,@PATH[1]\COMBINED

* Stress (STRESS Module)
THSDBTHFILE,19,OUTELEM,1,@PATH[1]\Combined
BINSTRTBL,19,OUTELEM,-1,@PATH[1]\Combined\Group19_Max_Stress.txt
BINSTRTBL,19,OUTELEM,1000,@PATH[1]\Combined\Group19_tstep_1000_Stress.txt

A list of nodes or elements must be assigned to an ACS SASSI UI variable when saving specific nodes or elements to text files. These are not required when saving a frame containing all nodes or elements

The output direction is controlled by this argument, so 1 = X, 2 = Y, and 3 = Z

Use **ACC**, **DISP**, or **THS** for this argument in the BINFRAMEOUT command to save frames for acceleration, displacement, or stress, respectively

The output group number and stress component is controlled by this arguments, respectively

Coordinate Transformation for Forces and Moments in Shell Elements – Details in Demo 14

To apply coordinate transformations to element forces and moments, the requested elements must first be added to a (section cut) submodel in the ACS SASSI UI.

This submodeling operation conveniently allows for multiple walls or floors to be stored independently without having to redefine any grouping currently present in the model, as well as plotted separately to visualize the elements selected to apply coordinate transformation to.

Coordinate Transformation Commands

For Planar Geometry - CTRVEC,1,0,1,0,@PATH[1],MAX
For Cylindrical Geometry - CTRCCV,2,@PATH[1],MAX

Defines a vector for the X-axis of the coordinate system to transform to. CTRCCV does not require this argument, as it is calculated internally for the cylindrical surface

Some Useful Commands for Selecting Elements t

CutAdd,<cut num>,<group num>,<elem 1>, … <elem N>
CutAdd,<cut num>,<group num>,RANGE,<elem start>,[elem end], [stride]
CutVol,<cutnum>,[Xmin],[Xmax],[Ymin],[Ymax],[Zmin],[Zmax]
SLICE,<cutnum>,<pointx>,<pointy>,<pointz>,<normalx>,<normaly>,<normalz>

Section-Cuts Capabilities

Section-Cuts Using ESTRESS Text Frames

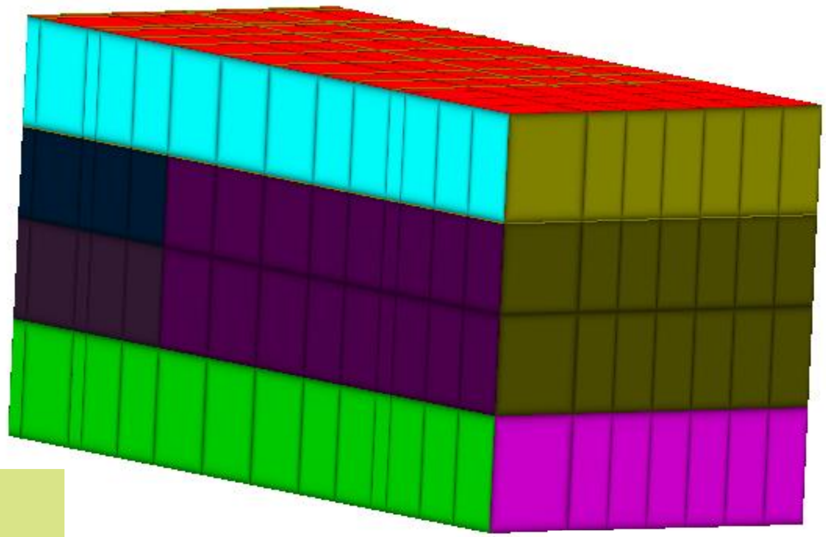
The UI Section-Cut capability has two options:

1) Uses *a single frame of stress data* (single .ess frame file) to compute the section-cut forces and moments on a cross-section at a specific time step.

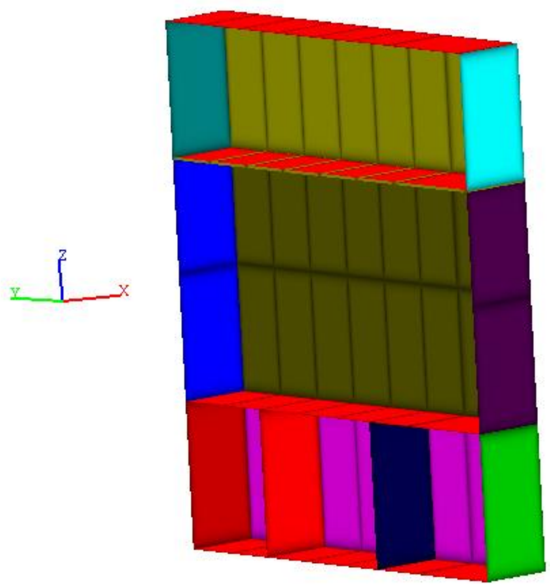
2) Uses a *multiple frames of stress data* (all .ess frame files) to compute the full time-history of the section-cut forces and moments.

Demo 8

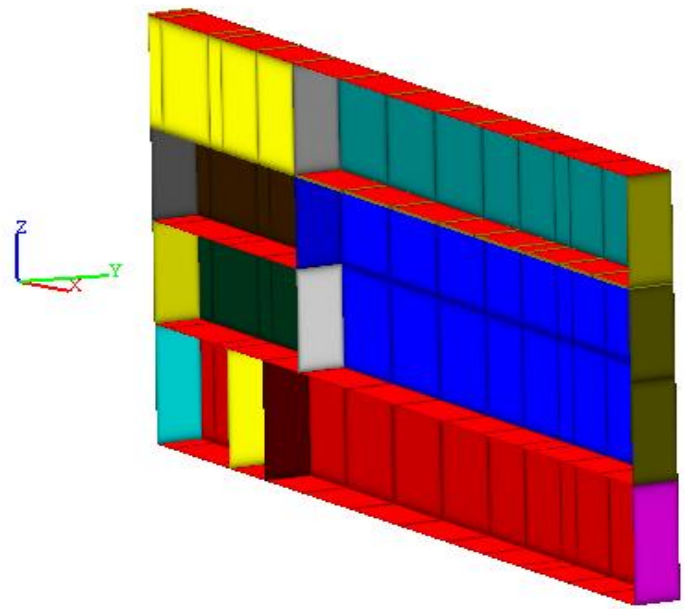
Section-Cut Submodel Models



Transverse Wall



Longitudinal Wall



Section-Cut for Single ESTRESS Stress Frame

* Read element center stress frame
READSTR, estress_02617.ess, C:\DEMOS\DEMO8\ESS_STRESS

*For the 1st section-cut in the SUBMODELER command line, type

CUTVOL,1,132.4
*The blank arguments to this command are interpreted as the respective
*minimum or maximum extent of the building model geometry. This cut volume
*is saved to cut #1.

CSECT,1,1,0,0,15.3,0,0,1
*This creates a cross-section model from cut #1 through point (0.0, 0.0, 15.3),
*with a cross-section plane normal unit vector of (0.0, 0.0, 1.0). The cut cross-
*section is saved to model #1

CALCPAR, 0.0, 0.0, 1.0, 1.0, 0.0, 0.0" in the command SUBMODELER window to calculate the cross-section parameters, seismic forces and moments

Section-Cut Results

```
Model Parameters
Centroid X =145.443 Y =-149.003 Z = 15.8 Area = 342
Ixx = 305990 Iyy = 5183.71 Izz = 311174
Fx = -28.0657 Fy = 11456.9 Fz = 109.184
Mx = -323054 My = 124.862 Mz = 97618.6
```

NOTE: If the element stress frame data is not read properly or not input, the force and moment parameters will be set to "0".

CALCPAR Command Example

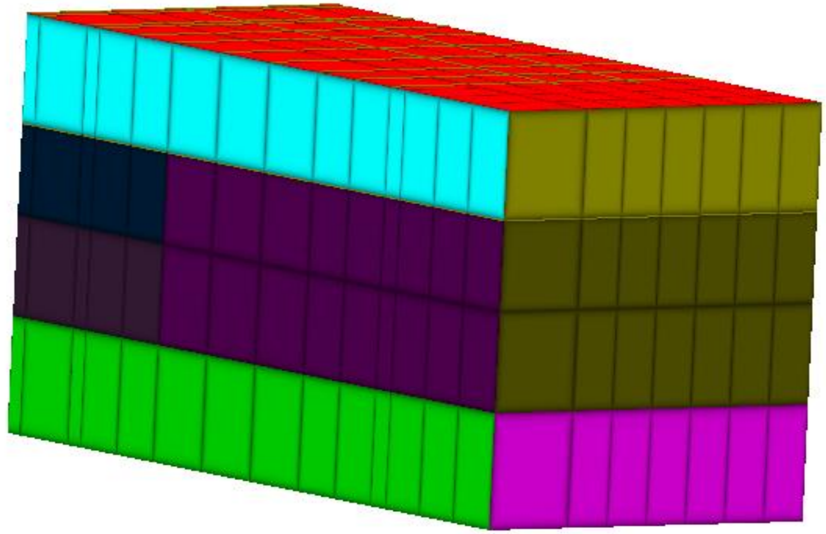
actm,0
** Load Model and stress user must change path*
inp,Demo8.pre,C:\DEMO_PROBLEMS\DEMO8
readstr,estress_02617.ess,C:\DEMO_PROBLEMS\DEMO8\ESS_STRESS
**define structural components to be cut*
cutvol,1,132.4
cutvol,2,,,-120
** create cross sectional models of selected components along a plane*
csect,1,1,0,0,15.3,0,0,1
csect,2,2,0,0,-1,0,0,1
** calculate parameters for each of the cross sections*
actm,1
calcpar,0,0,1,1,0,0,1
actm,2
calcpar,0,0,1,1,0,0,1
** output cross sections for visualization with PREP(optional)*
actm,0
cut2sub,1,3
cut2sub,2,4
actm,3
write,XSub.pre,C:\DEMO_PROBLEMS\DEMO8
actm,4
** write,YSub.pre,C:\DEMO_PROBLEMS\DEMO8*

CALCSECTHIST Command Batch Input

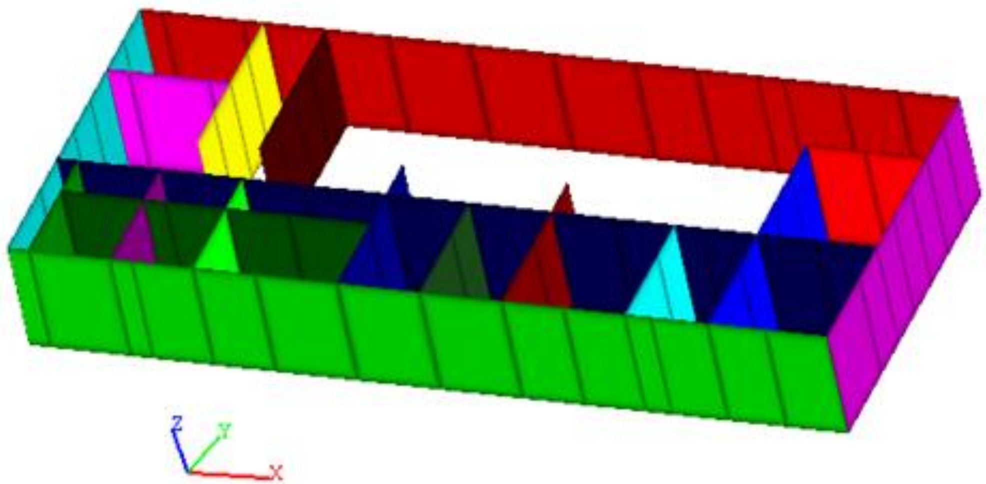
1 401   1
C:\ DEMO_PROBLEMS\DEMO8\ESS_FRAMES\
estress_02401.ess
estress_02402.ess
estress_02403.ess
estress_02404.ess
estress_02405.ess
estress_02406.ess
estress_02407.ess
estress_02408.ess
estress_02409.ess
estress_02410.ess
....
estress_02795.ess
estress_02796.ess
estress_02797.ess
estress_02798.ess
estress_02799.ess
estress_02800.ess
estress_02801.ess

Batch input file has a similar configuration with the animation files, .thani or .rsani.

Section-Cut for Time History ESTRESS Frames



Section-Cut Model



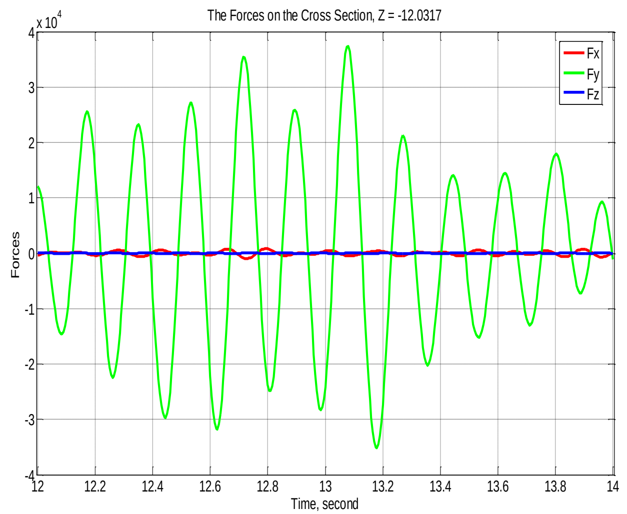
CALCSECTHIST Command Example

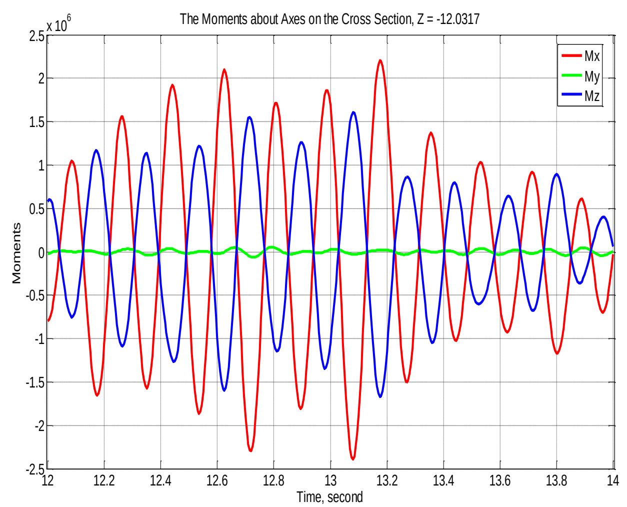
*
*Batch .pre input file of section cut for multiple frame data
*
actm,0
*Replace Directory Path
inp,demo8.pre,C:\DEMO_PROBLEMS\DEMO8\
*
* Define structure component to be cut
slice,1,0.0,0.0,-12.0317,0.0,0.0,1.0
*
* Cut the selected structure component using cutting plane
* Calculate the parameters on it, and output to given file
Calcsecthist,C:\DEMO_PROBLEMS\DEMO8\estr_frame_files.lst,1,0.0,0.0,-12.0317,0.0,0.0,1.0,1.0,0.0,0.0,1,.005,C:\DEMO_PROBLEMS\DEMO8\frc_mmt_on_cut02.txt

CALCSECTHIST Results

C:\DEMO_PROBLEMS\DEMO8\frc_mmt_on_cut02.txt file:

0.005 -343.777 12065.2 0.229168 -800746 -21965.1 581499
0.01 -268.056 11539.5 0.300395 -779248 -16700.6 600032
0.015 -189.851 10623.5 0.294853 -733816 -10990.5 593052
0.02 -114.229 9320.15 0.227868 -665089 -5282.46 558887
0.025 -44.3936 7645.78 0.144148 -573880 2.20757 497620
0.03 18.0423 5647.78 0.0908182 -461901 4514.26 411756
0.035 72.3351 3391.01 0.0894927 -331126 8011.35 305474
0.04 117.752 967.345 0.124164 -184604 10378.6 184558
... ...
1.97 -676.309 9226 0.149393 -698463 -42784.3 401711
1.975 -631.161 8753.78 0.143451 -677218 -40340.6 396997
1.98 -553.34 7862.11 0.158777 -627501 -35783.4 376102
1.985 -450.432 6584.62 0.16545 -550419 -29410.2 339107
1.99 -330.715 4981.56 0.133199 -448530 -21628.8 287164
1.995 -202.2 3116.14 0.0512961 -325035 -12940.6 221694
2 -72.0058 1058.89 -0.0630017 -184306 -3907.81 144578
2.005 53.7767 -1132.73 -0.172686 -30951.4 4886.85 57394.5





CALCSECTHISTDB Command Using STRESS Binary Database *(see Demo 9)*

CALCSECTHISTDB,<cutnum>,<px>,<py>,<pz>,<nx>,<ny>,<nz>,<rx>,<ry>,<rz>,<sys>,<ts>,[start],[end],[Stride],<outfile>

Calculate the Stress history from a cross section using the database currently loaded into User Interface memory. This command has the functionality as CALCSECTHIST does for ASCII generate stress data.

The output of this command is a 7 column text table where the 1st column is either the simulation time or step number if ts is set to 0. The rest of the six columns are the stress components of the cross section. The final line of the file will have the word MAX in the1st column. This line will contain the absolute maximum for each component in the table, but the sign of the stress will be maintained on this line.

Before using this command, the stress database for the calculation must be loaded into the UI. The associated model must be loaded into memory and set as the active model. The cut input by the user *cutnum* must be defined before this command.

Automatic Section-Cuts Capability Using STRESS Binary Databases – Applicable to Panels

Section cuts can be automatically created in the ACS SASSI UI with the EXTRACTCUTS command. For this functionality, panels must be defined first with the "P" command. Each panel should be a group containing the elements of a wall or floor, and only those elements, for which section cut calculations are to be performed.

The EXTRACTCUTS command allows for the selection of the number of section cuts to be made on each panel.

The EXTRACTCUTS command will create a pre file named AutoCuts.pre in the model directory specified in the command arguments. All of the results will be stored in directory specified in the EXTRACTCUTS command.

After the AutoCuts.pre file is created, it should be loaded into the ACS SASSI UI, where a set of time history files for the section cuts will be created in the specified folder.

See Demo 9 for a complete example of this functionality.

EXTRACTCUTS Command Using Binary STRESS Database *(see Demo 9)*

EXTRACTCUTS,<num>,<path>

Command that will automatically generate section cuts and cross sections for all defined rectangular wall panels. All cross sections will be perpendicular to one global coordinate system axis.

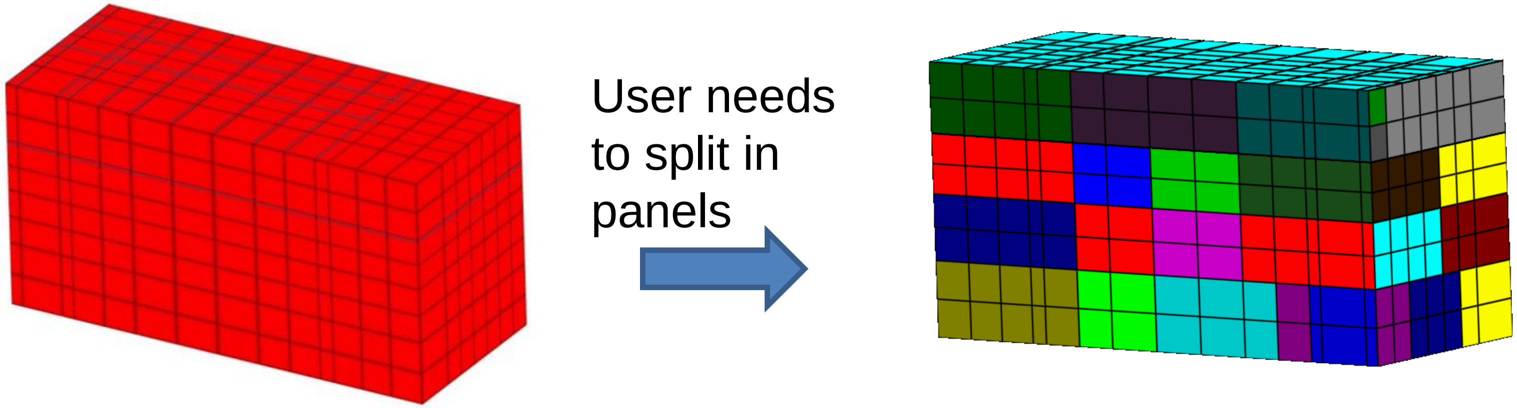
The axis the cross sections is perpendicular to will be determined by the normal vector to the face of the panel.

The <num> argument will determine how many cross sections per panel will be generated. The extents of each panel will be calculated and cross sections will be placed along each panel based on the number of cross sections requested. If a cross section would be parallel to an element boundary the cross section will be moved slightly away from the boundary so that the cross section will be include a distinct row of elements.

•num - number of cross sections per panel
•path - path for all results from the cut history calculations. This directory is where results will be written.

AutoCuts.pre will be written in the model directory.

Automatic Section-Cuts for All Building Walls



EXTRACTCUTS,3,C:\ACSV300\DEMO_PROBLEMS\DEMO9\CutResults

INP,C:\ACSV300\DEMO_PROBLEMS\DEMO9\MODEL_PREP\autocuts.pre

```
CUTCLR,1
CUTADD,1,3,RANGE,1,4,1
CALCSECTHISTDB,1,0,0,-0.60833,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_1-Cut_1-Z.thcs
CALCSECTHISTDB,1,0,0,-12.0417,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_1-Cut_2-Z.thcs
CALCSECTHISTDB,1,0,0,-23.475,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_1-Cut_3-Z.thcs
CUTCLR,1
CUTADD,1,8,RANGE,1,1,1
CALCSECTHISTDB,1,0,0,74.5875,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_2-Cut_1-Z.thcs
CALCSECTHISTDB,1,0,0,69.2708,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_2-Cut_2-Z.thcs
CALCSECTHISTDB,1,0,0,63.9542,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_2-Cut_3-Z.thcs
CUTCLR,1
CUTADD,1,9,RANGE,1,10,1
CALCSECTHISTDB,1,0,0,73.2584,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_3-Cut_1-Z.thcs
CALCSECTHISTDB,1,0,0,62.7579,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_3-Cut_2-Z.thcs
CALCSECTHISTDB,1,0,0,51.9916,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_3-Cut_3-Z.thcs
CUTCLR,1
CUTADD,1,10,RANGE,1,10,1
CALCSECTHISTDB,1,0,0,73.2584,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_4-Cut_1-Z.thcs
CALCSECTHISTDB,1,0,0,62.7579,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_4-Cut_2-Z.thcs
CALCSECTHISTDB,1,0,0,51.9916,0,0,1,1,0,0,1,0.005,,,,C:\ACSV300\Demo_Problems\Demo9\CutResults\Panel_4-Cut_3-Z.thcs
```

Automatic Section-Cut Results for Each *Panel* (Only SOLID and SHELL elements)

Panel_1-Cut_1-Z.thcs

0.005	0	-69.9309	37.6862	-106.972	11.1526	-4.09633
0.01	0	-67.8773	63.0343	-63.5459	11.4337	-4.3319
0.015	0	-69.4638	89.6154	-69.7269	13.0914	-4.5634
0.02	0	-74.1617	99.4689	-107.692	15.3697	-4.75573
0.025	0	-78.6502	91.6602	-152.279	18.2159	-4.97347
0.03	0	-78.2464	80.1548	-170.925	20.5321	-5.26611
0.035	0	-72.3995	76.2408	-138.615	22.3218	-5.59438
0.04	0	-67.5496	75.7959	-79.6207	25.7459	-5.89959
0.045	0	-67.3373	73.6568	-31.0075	32.0366	-6.30584
0.05	0	-66.3615	68.8503	-20.0202	40.7081	-7.046
0.055	0	-62.419	62.2072	-38.712	51.0918	-8.10038
0.06	0	-58.3239	58.1724	-64.3889	62.0341	-9.02595
0.065	0	-52.6974	64.6828	-97.1783	72.2112	-9.27489
0.07	0	-45.4708	82.3545	-129.664	80.5001	-8.80717
0.075	0	-40.7844	97.2829	-158.196	86.7036	-8.5307
0.08	0	-46.1877	97.0737	-196.334	91.5329	-10.3474
0.085	0	-58.4996	83.2897	-241.41	96.4255	-13.5889
0.09	0	-65.812	70.0311	-197.27	102.053	-16.8381
0.095	0	-65.1281	73.2022	-6.5975	108.447	-19.5814
0.1	0	-59.3704	114.679	92.9067	115.873	-21.5858
0.105	0	-59.3496	184.703	53.6404	124.925	-22.7502
0.11	0	-75.7758	247.515	-43.7629	135.286	-23.1046
0.115	0	-100.635	286.312	-146.877	145.889	-22.9445
0.12	0	-122.968	302.562	-214.511	154.831	-22.7468
0.125	0	-136.99	303.197	-232.66	160.209	-22.9484

53.105	0	-0.0214116	0.0375489	-0.0963075	0.0631199	-0.00778233
53.11	0	-0.018474	0.0377019	-0.0861549	0.0469432	-0.0058273
53.115	0	-0.0207454	0.0423199	-0.0860217	0.0630984	-0.00787859
53.12	0	-0.0117089	0.0491506	-0.0760295	0.0467119	-0.00601751
53.125	0	-0.0196888	0.0515773	-0.0637794	0.0631918	-0.00793249
53.13	0	-0.0145279	0.0365844	-0.0993899	0.0467873	-0.00585364
53.135	0	-0.0239281	0.0374023	-0.0848703	0.0632725	-0.00779552
53.14	0	-0.0150359	0.0398383	-0.0872971	0.0468199	-0.0059409
53.145	0	-0.0184727	0.0501768	-0.0724727	0.0630482	-0.00799586
53.15	0	-0.0129522	0.0501052	-0.0667431	0.0469106	-0.00603752
53.155	0	-0.0208128	0.0396215	-0.0870099	0.0631481	-0.00785401
53.16	0	-0.017962	0.0358831	-0.0880544	0.0469508	-0.00586535
53.165	0	-0.0215919	0.0404553	-0.0817124	0.0632063	-0.00790823
53.17	0	-0.0114243	0.0465765	-0.0797366	0.046706	-0.0060662
53.175	0	-0.0201326	0.0531173	-0.0613133	0.0632065	-0.00800924
53.18	0	-0.0143684	0.039221	-0.0897521	0.0468201	-0.0059232
53.185	0	-0.0236251	0.0360672	-0.0888324	0.0632722	-0.00781393
53.19	0	-0.0162419	0.0389148	-0.0835934	0.0469358	-0.00593302
53.195	0	-0.0188095	0.0476641	-0.0774831	0.0630613	-0.00798414
53.2	0	-0.0137601	0.051264	-0.0665003	0.0469145	-0.0060446
53.205	0	-0.0207728	0.0430494	-0.079199	0.0631862	-0.0078587
53.21	0	-0.0177523	0.0349275	-0.0962289	0.0469123	-0.00582196
53.215	0	-0.0226185	0.0398394	-0.0815674	0.0632713	-0.00783849
53.22	0	-0.0115192	0.044413	-0.0860175	0.0467145	-0.0059828
53.225	0	-0.0192341	0.0538855	-0.0632226	0.0632074	-0.00796208
53.23	0	-0.0136478	0.0427943	-0.0819503	0.0468822	-0.0058944
53.235	0	-0.0226164	0.0358968	-0.0964186	0.0632349	-0.00776433
53.24	0	-0.0168447	0.0388522	-0.0839933	0.046985	-0.005863
53.245	0	-0.0184628	0.0455753	-0.0839083	0.0630799	-0.00792329
MAX	0	-662.478	1554.4	-5878.59	1117.13	-189.035

Batch SSI Analysis Runs

If the SSI runs are done in the batch mode under a DOS window, then, a batch file needs to be created. To run a SSI module in batch mode, the following DOS command is required:

SSI_module_name.exe < SSI_module_name.inp

where SSI_module_name could be SITE, or POINT or ANALYS. The SSI module executables are installed by default in the ACS_C directory on the hard drive, and are also provided on the ACS SASSI installation DVD in the Batch. Each input file with the SSI_module_name and the extension .inp contains only three input lines:

modelname
modelname.ext_input
modelname_SSI_module_name.out

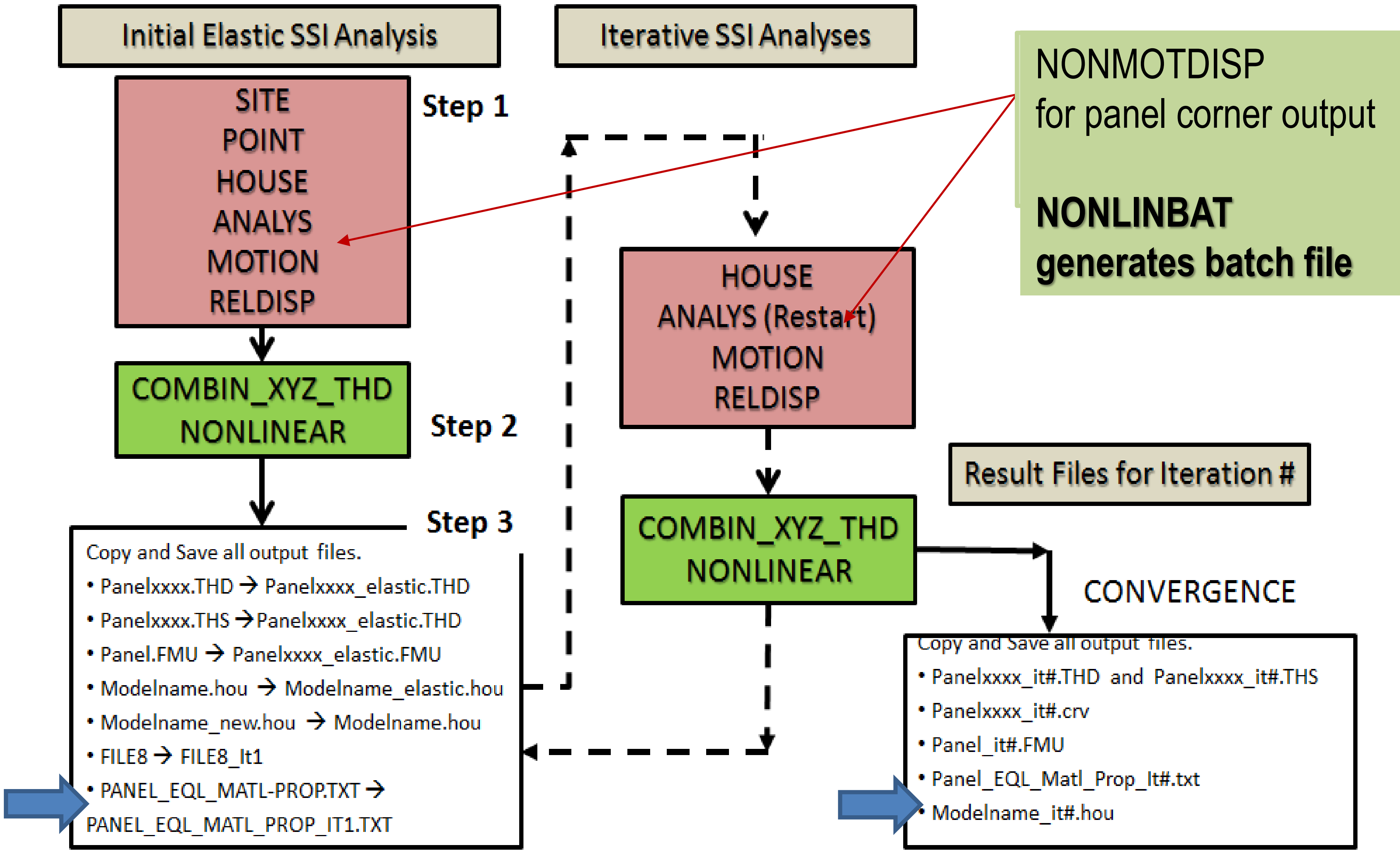
where ext_input is the extension provided by the ACS SASSI UI AFWRITE command.

Batch SSI Analysis Run Simplest Example

```
REM Embedbment Example Batch Mode
REM This batch file is used to run the SSI modules for the embedded example.
@echo off

REM  FIRST ITERATION
C:\acsv300\EXEB\Soilb.exe < Soil.in          REM  Runs the soil module with inputs defined in the Soil.in file
C:\acsv300\EXEB\Siteb.exe < Site.in          REM  Runs the site module with inputs defined in the Site.in file
C:\acsv300\EXEB\Point3b.exe < Point.in       REM  Runs the point module with inputs defined in the Point.in file
C:\acsv300\EXEB\Houseb.exe < House.in        REM  Runs the house module with inputs defined in the House.in file
C:\acsv300\EXEB\Analysb.exe < Analys.in      REM  Runs the analys module with inputs defined in the Analys.in file
C:\acsv300\EXEB\Stressb.exe < Stress.in      REM  Runs the stress module with inputs defined in the Stress.in file

REM SECOND ITERATION
C:\acsv300\EXEB\Houseb.exe < House.in        REM  Runs the house module with inputs defined in the House.in file
C:\acsv300\EXEB\Analysb.exe < Analys.in      REM  Runs the analys module with inputs defined in the Analys.in file
C:\acsv300\EXEB\Stressb.exe < Stress.in      REM  Runs the stress module with inputs defined in the Stress.in file

REM THIRD ITERATION
C:\acsv300\EXEB\Houseb.exe < House.in        REM  Runs the house module with inputs defined in the House.in file
C:\acsv300\EXEB\Analysb.exe < Analys.in      REM  Runs the analys module with inputs defined in the Analys.in file
C:\acsv300\EXEB\Stressb.exe < Stress.in      REM  Runs the stress module with inputs defined in the Stress.in file

REM POST PROCESSING
C:\acsv300\EXEB\Motionb.exe < Motion.in                   REM Runs the motion module with inputs defined in the Motion.in file
C:\acsv300\EXEB\Stressb.exe < Stress_Post.in REM  Runs the stress module for post processing with inputs defined in the Stress_Pos
C:\acsv300\EXEB\Reldispb.exe < ReldispX.in   REM  Runs the reldisp module for x direction with inputs defined in the ReldispX.in f
C:\acsv300\EXEB\Reldispb.exe < ReldispY.in   REM  Runs the reldisp module for y direction with inputs defined in the ReldispY.in f
C:\acsv300\EXEB\Reldispb.exe < ReldispZ.in   REM  Runs the reldisp module for z direction with inputs defined in the ReldispZ.in f
```

```
Demo4
Demo4.soi
Demo4_Soil.out

Demo4
Demo4.sit
Demo4_Site.out

Demo4
Demo4.poi
Demo4_Point.out

Demo4
Demo4.hou
Demo4_House.out

Demo4
Demo4.anl
Demo4_Analys.out

Demo4
Demo4.mot
Demo4_Motion.out

Demo4
Demo4.str
Demo4_Stress.out
```

Option NON SSI Analysis Batch Run Example



NONLINBAT, 1 Generated Batch Run File

AB_SHEAR_NL.pre | RUN_EQUIVNL_XYZ.bat

```
@echo off
setlocal EnableDelayedExpansion
REM ************************************************************
REM *      Batch File for Equ. Linear Structural Analysis      *
REM ************************************************************

REM This batch file serves as a template for nonlinear SSI analysis
REM in ACS SASSI.

REM Set Model Name
set model_name=AB_SHEAR_NL
REM Set Number Iteration Number
SET /A vers=10

mkdir .\FILE8
mkdir .\OUT_Files\Elastic
mkdir .\Out_Files\It_1\
mkdir .\CRV_Files
mkdir .\NL_TH
mkdir .\work
cd .\work
REM ********************************
REM *      Run XYZ Directions      *
REM ********************************

echo %model_name% > point.inp
echo %model_name%.poi >> point.inp
echo %model_name%_poi.out >> point.inp

echo %model_name% > house.inp
echo %model_name%.hou >> house.inp
echo %model_name%_hou.out >> house.inp

echo %model_name% > analys_init.inp
echo %model_name%_init.anl >> analys_init.inp
echo %model_name%_anl_i.out >> analys_init.inp

echo %model_name% > analys_restart.inp
echo %model_name%_restart.anl >> analys_restart.inp
echo %model_name%_anl_r.out >> analys_restart.inp

```

```
for %%i in (X Y Z) do (
    copy ..\%model_name%_%%iDIR.sit %model_name%_%%iDIR.sit
    echo %model_name%_%%iDIR > site.inp
    echo %model_name%_%%iDIR.sit >> site.inp
    echo %model_name%_%%iDIR_site.out >> site.inp

    C:\ACSV300\EXEB\siteb.exe < Site.inp
    copy FILE1 FILE1%%i
)

copy ..\%model_name%.poi
copy ..\%model_name%.hou
copy ..\%model_name%_init.anl
copy ..\%model_name%_restart.anl

C:\ACSV300\EXEB\point3b.exe < Point.inp
C:\ACSV300\EXEB\houseFSb.exe  < House.inp
C:\ACSV300\EXEB\analysFSb.exe  < Analys_init.inp

move *.out ..\OUT_Files\Elastic
copy FILE8X ..\FILE8\FILE8X_Elastic
copy FILE8Y ..\FILE8\FILE8Y_Elastic
copy FILE8Z ..\FILE8\FILE8Z_Elastic

REM *************************************
REM *      Post-Process Elastic Run      *
REM *************************************

for %%i in (X Y Z) do (

    mkdir .\%%iDIR
    cd .\%%iDIR
    copy ..\FILE8%%i FILE8

    echo %model_name% > motion.inp
    echo %model_name%.mot >> motion.inp
    echo %model_name%_mot.out >> motion.inp

    copy ..\..\%model_name%.mot
    copy ..\..\%model_name%.hou
    C:\ACSV300\EXEB\motionb.exe  < Motion.inp
```

```
        for %%j in (X Y Z) do (

        echo %model_name% > reldisp.inp
        echo %model_name%.rdi >> reldisp.inp
        echo %model_name%_%%j_%%iDIR_reldisp.out >> reldisp.inp

        copy ..\..\%model_name%_%%j_%%iDIR.rdi %model_name%.rdi
        C:\ACSV300\EXEB\reldispb.exe  < reldisp.inp

    )

    move *.out ..\..\OUT_Files\Elastic
    cd ..
)

copy %model_name%.hou ..\%model_name%_Elastic.hou

REM ************************************
REM *     COMBINE X,Y,Z THD FILES      *
REM ************************************

IF EXIST ..\XYZ_THD.inp (
    copy ..\XYZ_THD.inp
    echo XYZ_THD.inp > CMB.INP
    C:\ACSV300\EXEB\COMB_XYZ_THD.exe < CMB.inp
)

REM ***************************************
REM *     COMBINE XX,YY,ZZ THD FILES      *
REM ***************************************

IF EXIST ..\XXYYZZ_THD.inp (
    copy ..\XXYYZZ_THD.inp
    echo XXYYZZ_THD.inp > CMB.INP
    C:\ACSV300\EXEB\COMB_XYZ_THD.exe < CMB.inp
)
```

```
REM ********************************
REM *     RUN NONLINEAR MODULE     *
REM ********************************

echo %model_name% > EQL.inp
echo %model_name%.eql >> EQL.inp
echo %model_name%_EQL.out >> EQL.inp

copy ..\%model_name%_XDIR.sit %model_name%.sit
copy ..\%model_name%.eql

C:\ACSV300\EXEB\nonlinear.exe < EQL.inp
copy *.CRV ..\CRV_Files\*.CRV
move %model_name%_EQL.out ..\Out_Files\It_1\
copy %model_name%_NEW.hou ..\%model_name%_It1.hou
copy %model_name%_NEW.hou %model_name%.hou

REM ***********************************************
REM *     Copy Equivalent Linear Panel Files      *
REM ***********************************************

mkdir ..\NL_TH\Elastic
IF EXIST PANEL_EQL_MATL_PROP.TXT (
    copy PANEL_EQL_MATL_PROP.TXT ..\PANEL_EQL_MATL_PROP_IT1.TXT
    FOR /F "eol=; tokens=1* delims=, " %%z in (Panel_File_List.inp) do (
        copy %%z.THD ..\NL_TH\Elastic\%%z_ELASTIC.THD
        copy %%z_ELASTIC.THS ..\NL_TH\Elastic\%%z_ELASTIC.THS
        copy %%z.THD %%z_ELASTIC.THD
        copy %%z_AXIAL.THD ..\NL_TH\Elastic\%%z_AXIAL_ELASTIC.THD
    )
)
```

```
REM ************************************************
REM *     Copy Equivalent Linear Spring Files      *
REM ************************************************

IF EXIST Spring_EQL_MATL_PROP.TXT (
    copy Spring_EQL_MATL_PROP.TXT ..\Spring_EQL_MATL_PROP_IT1.TXT
    FOR /F "eol=; tokens=1* delims=, " %%z in (Spring_File_List.inp) do (
        copy %%z.THD ..\NL_TH\Elastic\%%z_ELASTIC.THD
        copy %%z_ELASTIC.THS ..\NL_TH\Elastic\%%z_ELASTIC.THS
        copy %%z.THD %%z_ELASTIC.THD
    )
)

REM **********************************************
REM *     Copy Equivalent Linear BEAM Files      *
REM **********************************************

IF EXIST BEAM_HINGE_EQL_MATL_PROP.TXT (
    copy BEAM_HINGE_EQL_MATL_PROP.TXT ..\BEAM_HINGE_EQL_MATL_PROP_IT1.TXT
    FOR /F "eol=; tokens=1* delims=, " %%z in (BEAM_File_List.inp) do (
        copy %%z.THD ..\NL_TH\Elastic\%%z_ELASTIC.THD
        copy %%z_ELASTIC.THS ..\NL_TH\Elastic\%%z_ELASTIC.THS
        copy %%z.THD %%z_ELASTIC.THD
    )
)
```

```
REM ********************************
REM *     MAIN ITERATION LOOP      *
REM ********************************

SET /A ITER=1
FOR /L %%w in (1,1,%vers%) do (
    REM ********************************
    REM *     RUN X AND Y DIRECTIONS      *
    REM ********************************

    C:\ACSV300\EXEB\houseFSb.exe  < House.inp
    C:\ACSV300\EXEB\analysFSb.exe  < Analys_restart.inp

    mkdir ..\OUT_Files\It_!ITER!
    move *.out ..\OUT_Files\It_!ITER!\
    copy FILE8X ..\FILE8\FILE8X_It!ITER!
    copy FILE8Y ..\FILE8\FILE8Y_It!ITER!
    for %%i in (X Y) do (
        cd .\%%iDIR

        copy ..\FILE8%%i FILE8

        echo %model_name% > motion.inp
        echo %model_name%.mot >> motion.inp
        echo %model_name%_mot.out >> motion.inp

        copy ..\..\%model_name%.mot
        copy ..\..\%model_name%.hou
        C:\ACSV300\EXEB\motionb.exe  < motion.inp

        for %%j in (X Y Z) do (
            echo %model_name% > reldisp.inp
            echo %model_name%.rdi >> reldisp.inp
            echo %model_name%_%%j_%%iDIR_reldisp.out >> reldisp.inp

            copy ..\..\%model_name%_%%j_%%iDIR.rdi %model_name%.rdi
            C:\ACSV300\EXEB\reldispb.exe  < reldisp.inp
        )
        move *.out ..\..\OUT_Files\It_!ITER!
        cd ..

    )
```

```
REM ******************************
REM *     COMBINE THD FILES      *
REM ******************************

IF EXIST ..\XYZ_THD.inp (
    copy ..\XYZ_THD.inp
    echo XYZ_THD.inp > CMB.INP
    C:\ACSV300\EXEB\COMB_XYZ_THD.exe < CMB.inp
)

REM ***************************************
REM *     COMBINE XX,YY,ZZ THD FILES      *
REM ***************************************

IF EXIST ..\XXYYZZ_THD.inp (
    copy ..\XXYYZZ_THD.inp
    echo XXYYZZ_THD.inp > CMB.INP
    C:\ACSV300\EXEB\COMB_XYZ_THD.exe < CMB.inp
)

REM ********************************
REM *     RUN NONLINEAR MODULE     *
REM ********************************

copy ..\%model_name%_Elastic.hou %model_name%.hou
C:\ACSV300\EXEB\nonlinear.exe < EQL.inp
REM ************************************************
REM *      Copy Equivalent Linear Panel Files      *
REM ************************************************

mkdir ..\NL_TH\It_!ITER!
IF EXIST PANEL_EQL_MATL_PROP.TXT (
    FOR /F "eol=; tokens=1* delims=, " %%z in (Panel_File_List.inp) do (
        copy %%z.THD ..\NL_TH\It_!ITER!\%%z_It!ITER!.THD
        copy %%z.THS ..\NL_TH\It_!ITER!\%%z_It!ITER!.THS
        copy %%z_AXIAL.THD ..\NL_TH\It_!ITER!\%%z_AXIAL_It!ITER!.THD
    )
    copy PANEL.fmu PANEL_It!ITER!.fmu
    copy PANEL.fmu ..\PANEL_It!ITER!.fmu
)
```

```
REM ***************************************************
REM *      Copy Equivalent Linear Spring Files        *
REM ***************************************************

IF EXIST Spring_EQL_MATL_PROP.TXT (
    FOR /F "eol=; tokens=1* delims=, " %%z in (Spring_File_List.inp) do (
        copy %%z.THD ..\NL_TH\It_!ITER!\%%z_It!ITER!.THD
        copy %%z.THS ..\NL_TH\It_!ITER!\%%z_It!ITER!.THS
    )
    copy spring.fmu spring_It!ITER!.fmu
    copy spring.fmu ..\SPRING_It!ITER!.fmu
)

REM ************************************************
REM *     Copy Equivalent Linear BEAM Files        *
REM ************************************************

IF EXIST BEAM_HINGE_EQL_MATL_PROP.TXT (
    FOR /F "eol=; tokens=1* delims=, " %%z in (BEAM_File_List.inp) do (
        copy %%z.THD ..\NL_TH\It_!ITER!\%%z_IT!ITER!.THD
        copy %%z.THS ..\NL_TH\It_!ITER!\%%z_IT!ITER!.THS
    )
    copy BEAM.fmu BEAM_It!ITER!.fmu
    copy BEAM.fmu ..\BEAM_It!ITER!.fmu
)

SET /A ITER+=1
copy %model_name%_NEW.hou %model_name%.hou
copy %model_name%_NEW.hou ..\%model_name%_It!ITER!.hou
REM **********************************************************
REM *      Copy Equivalent Linear Panel Material Files       *
REM **********************************************************
IF EXIST PANEL_EQL_MATL_PROP.TXT (
    copy PANEL_EQL_MATL_PROP.TXT ..\PANEL_EQL_MATL_PROP_IT!ITER!.TXT
)
```

```
    REM *********************************************
    REM *      Copy Equivalent Linear BEAM Files      *
    REM *********************************************

    IF EXIST BEAM_HINGE_EQL_MATL_PROP.TXT (
        FOR /F "eol=; tokens=1* delims=, " %%z in (BEAM_File_List.inp) do (
            copy %%z.THD ..\NL_TH\It_!ITER!\%%z_IT!ITER!.THD
            copy %%z.THS ..\NL_TH\It_!ITER!\%%z_IT!ITER!.THS
        )
        copy BEAM.fmu BEAM_It!ITER!.fmu
        copy BEAM.fmu ..\BEAM_It!ITER!.fmu
    )

    SET /A ITER+=1
    copy %model_name%_NEW.hou %model_name%.hou
    copy %model_name%_NEW.hou ..\%model_name%_It!ITER!.hou
    REM ***********************************************************
    REM *       Copy Equivalent Linear Panel Material Files       *
    REM ***********************************************************
    IF EXIST PANEL_EQL_MATL_PROP.TXT (
        copy PANEL_EQL_MATL_PROP.TXT ..\PANEL_EQL_MATL_PROP_IT!ITER!.TXT
    )
    REM ************************************************************
    REM *       Copy Equivalent Linear Spring Material Files       *
    REM ************************************************************
    IF EXIST Spring_EQL_MATL_PROP.TXT (
        copy Spring_EQL_MATL_PROP.TXT ..\Spring_EQL_MATL_PROP_IT!ITER!.TXT
    )
    REM *********************************************************
    REM *      Copy Equivalent Linear BEAM Material Files       *
    REM *********************************************************
    IF EXIST BEAM_HINGE_EQL_MATL_PROP.TXT (
        copy BEAM_HINGE_EQL_MATL_PROP.TXT ..\BEAM_HINGE_EQL_MATL_PROP_IT!ITER!.TXT
    )
)

REM *********************************************
REM *      Equ. Linear Structual Analysis Complete      *
REM *********************************************
```

Auxiliary Programs:

COMB_XYZ_STRAIN applicable to 3D nonlinear soil site response or SSI analysis using iterative equivalent linear procedure. Combines three directional shear-strains for X, Y and Z inputs in the nonlinear soil solid elements at each SSI iteration.

COMB_XYZ_THD applicable to nonlinear structure SSI analysis using iterative equivalent linear procedure (*for Option NON*). Combines directional node displacements for nonlinear shell walls and spring elements at each SSI iteration.

BuildFile77 applicable to incoherent SSI analysis of deeply embedded structures, such as SMRs. Permits performing incoherent SSI analysis for basements with different level node coordinates & configurations or when incoherent input has different coherence functions at different depths.

Restart SSI Analyses

The restart analyses imply that large files were saved. The following changes of problem parameters need different levels for the restart analyses:

1. **Change in the Control Motion**
   Suppose results are required for a different time history (or response spectrum) of the control motion. Then, as long as the nature of seismic environment, i.e., the type of wave field, is not changed, only the module MOTION has to be re-executed.

2. **Change in Seismic Environment**
   Suppose that structure was originally analyzed for the effects of vertically propagated body waves and that results are required for the case of incident Rayleigh waves causing the same motion at the control point as in the free field. In this case only a part of the SITE module and ANALYS module have to be re-executed. Also, for motion incoherency.

3. **Change in Structure or Near-Field Soil**

If changes are made in the superstructure or near field soil, the HOUSE, ANALYS, STRESS or MOTION and RELDISP modules have to be re-executed.

Examples: nonlinear soil behavior, or concrete cracking in Option NON

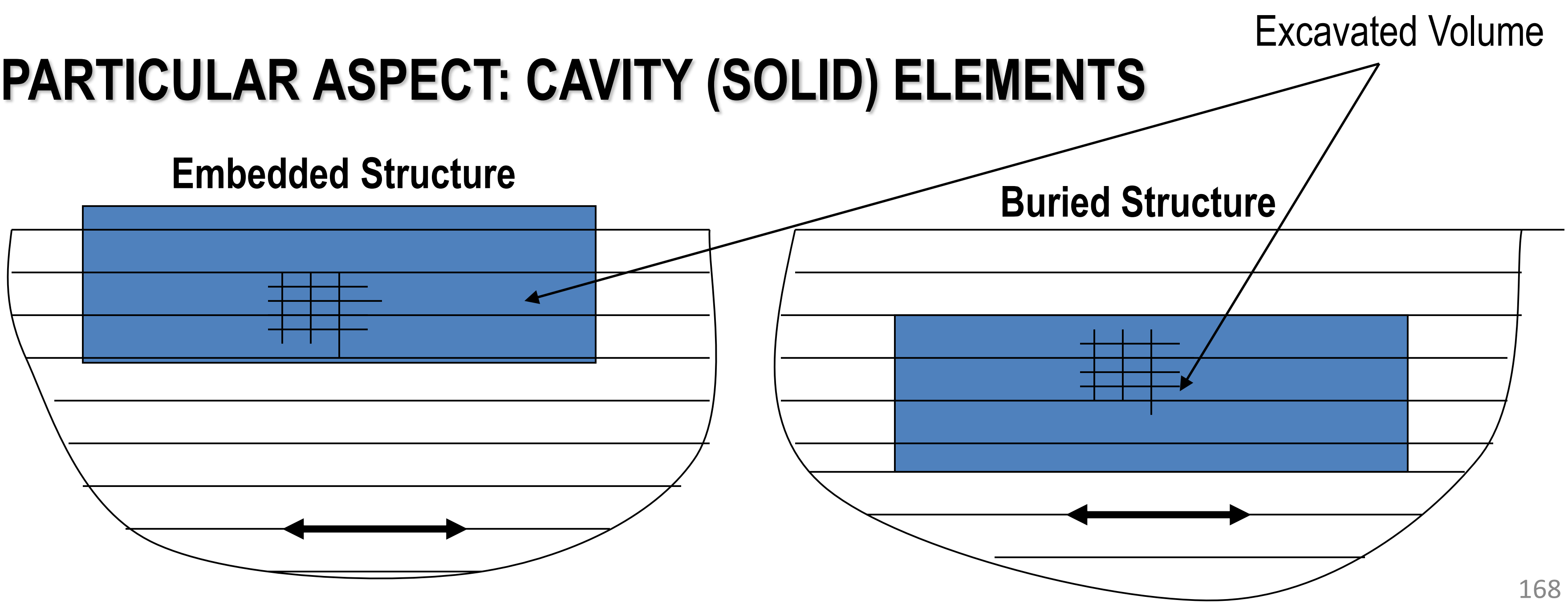
The restart files for the fast-solver are the COOXxxx and COOTKxxx, DOFSMAP, FILE90 and FILE91 files.

3. Building SSI Models Using ACS SASSI .Pre UI Commands

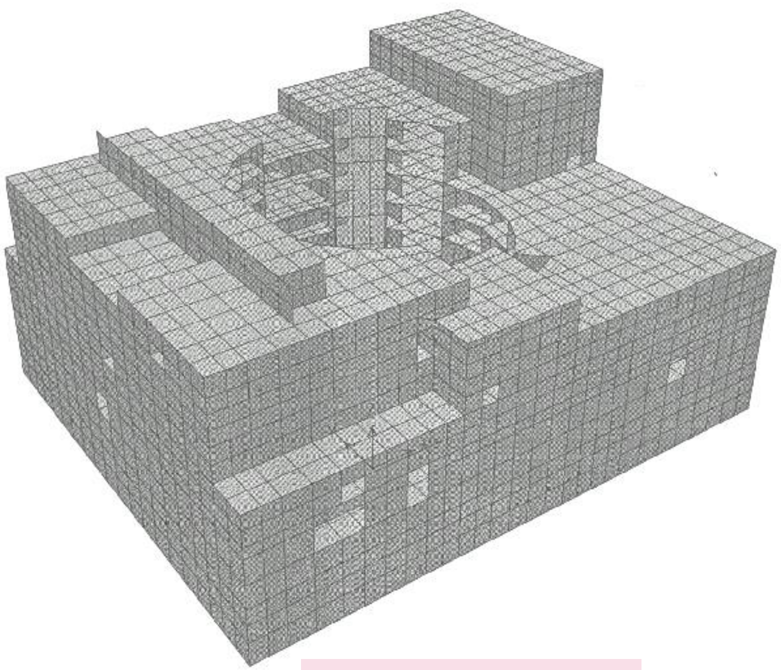
Building A SSI Analysis Models

Step 1: Define Dynamic Inputs (Seismic Motion or Forces)
Step 2: Define Soil Layering
Step 3: Define Structure and Near Field Zone Using FE Modeling
Step 4: Define Seismic Motion Spatial Incoherency
Step 5: Select SSI Analysis Options (Assumptions, Methods, Parameters)
Step 6: Manage SSI Analysis Runs
Step 7: Post Processing for Extracting Results

PARTICULAR ASPECT: CAVITY (SOLID) ELEMENTS

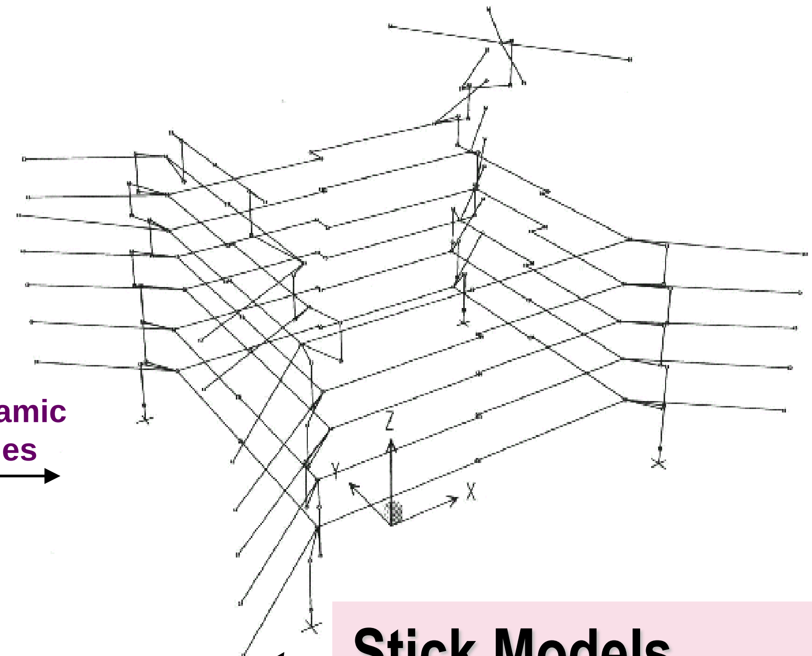


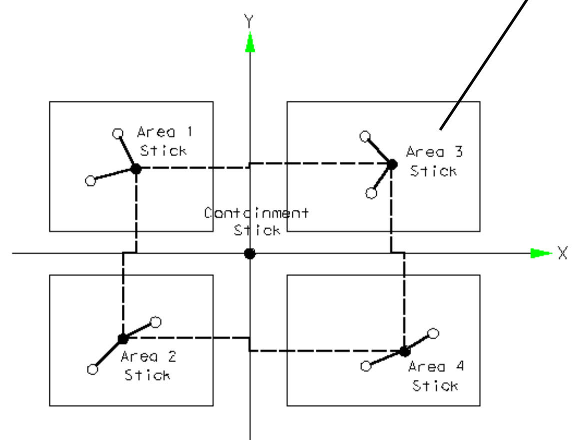
Stick Models vs. FEA SSI Models



Detailed 3D Structural FE Model

Same Dynamic Properties





Stick Models.
Labor Intensive
Calibration
Hidden Problem:
STICKS COULD BE NUMERICALLY SENSITIVE

SSI Model Building Recommendations

The user manuals contain a large number of comments on various SSI modeling aspects.

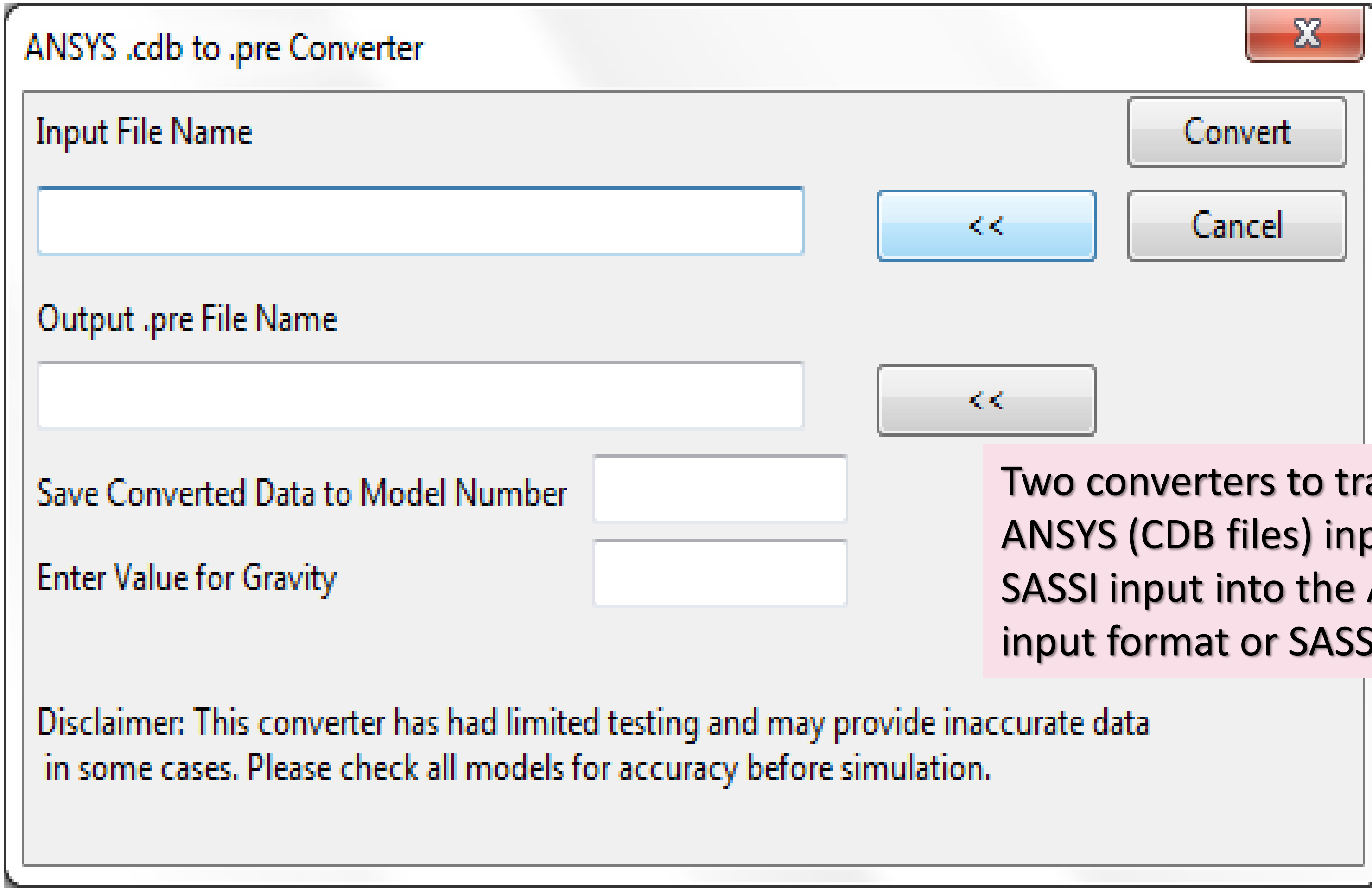
Top-level recommendations of node and element numbering:

- Soil layering to be numbered from ground surface to baserock
- Excavation volume nodes to be numbered from baserock to ground surface
- Interaction nodes defined in ascending number order
- Excavation volume layers to be numbered from ground surface to baserock
- Excavation volume elements to be numbered from ground surface to baserock

We also recommend always check the consistency of your soil layer or material element assignments for the soil excavation volume and the structural embedment part by revising the HOUSE output (modelname_HOUSE.out).

For technical support please contact us acs.sassi@ghiocel-tech.com.

ACS SASSI Model Converters



Two converters to translate ANSYS (CDB files) input or SASSI input into the ACS SASSI input format or SASSI2000.

Example of ACS SASSSI .Pre Input File for Embedded Cylinder

.PRE File Structure

```
**********************************************************************************
* THIS FILE WAS WRITTEN BY THE ACS SASSI PREPROCESSOR
* To reload model type INP,<this file> in PREP
**********************************************************************************
```

Comment lines starts by *

```
TIT,    EMBEDDED CYLINDER MODEL
```

Program title is defined by “TIT” command

```
* Nodes
N,1,0,0,-70
N,2,17.5,0,-70
N,3,12.374,12.374,-70
N,4,0,17.5,-70
N,5,-12.374,12.374,-70
N,6,-17.5,0,-70
N,7,-12.374,-12.374,-70
```

Input Node Coordinates by “N” command:

NGEN command

- **NGEN**, *ITIME*, *INC*, *NODE1*, *NODE2*, *NINC*, *DX*, *DY*, *DZ*

Generates additional nodes from a pattern of nodes.

ITIME, *INC*

Do this generation operation a total of *ITIME* times, incrementing all nodes in the given pattern by *INC* each time after the first. *ITIME* must be > 1 for generation to occur.

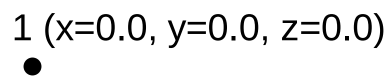
NODE1, *NODE2*, *NINC*

Generate nodes from the pattern of nodes beginning with *NODE1* to *NODE2* in steps of *NINC*

DX, *DY*, *DZ*

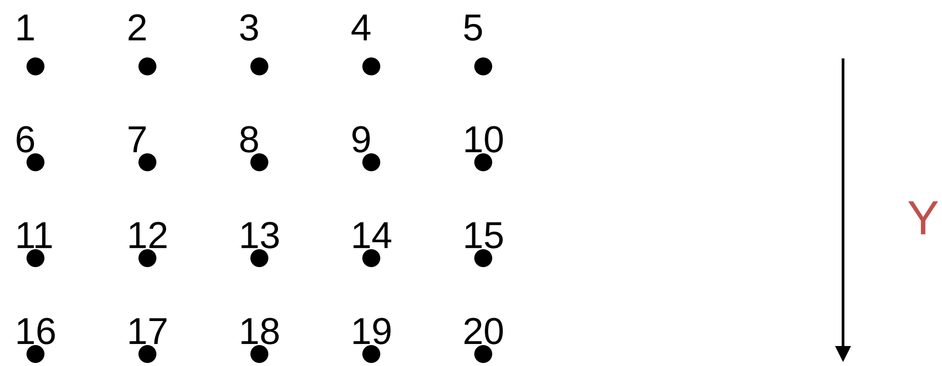
Node location increments

N, 1, 0.0, 0.0, 0.0



NGEN, 4, 1, 1,1,1, 1,0,0

NGEN, 3, 5,1, 5, 1,0,1,0



NGEN, 1, 20,1,20,1,0,0,1

.PRE File Structure

Input constrained displacement by “D” command:

* Boundary Conditions
D,1,414,1,1,ROTX,ROTY,ROTZ

Input interaction nodes by “INT” command:

* Interaction Nodes
INT,1,414,1,1,0

Input material properties by “M” command:

* Material Table
M,1,1e+012,0.2,0,0,0,1,

.PRE File Structure

* Soil Layer Table
L,1,14,0.12,1400,700,0.05,0.05
L,2,10,0.12,1400,700,0.05,0.05

Input soil layer table by “D” command:

* Groups and Elements
GROUP,1,SOLID

Input element group information by “GROUP” command:

.PRE File Structure

Input solid element by “E” command:

```
E,1,278,279,277,277,347,348,346,346
E,2,279,280,277,277,348,349,346,346
E,3,280,281,277,277,349,350,346,346
E,4,281,282,277,277,350,351,346,346
```

EINT command for solid element

```
EINT,1,440,1,1
```

MSET command for solid element

```
MSET,1,88,1,1
MSET,89,176,1,2
MSET,177,264,1,3
```

.PRE File Structure

GROUP,2,SOLID
E,1,278,279,277,277,347,348,346,346
E,2,279,280,277,277,348,349,346,346
E,3,280,281,277,277,349,350,346,346
E,4,281,282,277,277,350,351,346,346

Input solid element (Group #2) by “E” command:

ETYPE,1,440,1,1

“ETYPE” command for element group 2

EINT,1,440,1,2

“EINT” command for element group 2

MSET,1,440,1,2

MSET command for beam element

EGEN Command

- **EGEN**, *ITIME*, *NINC*, *IEL1*, *IEL2*, *IEINC*

Generates elements from an existing pattern.

ITIME, *NINC*

Do this generation operation a total of *ITIME*s, incrementing all nodes in the given pattern by *NINC* each time after the first.

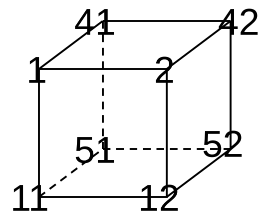
IEL1, *IEL2*, *IEINC*

Generate elements from selected pattern beginning with *IEL1* to *IEL2* in steps of *IEINC*

MINC

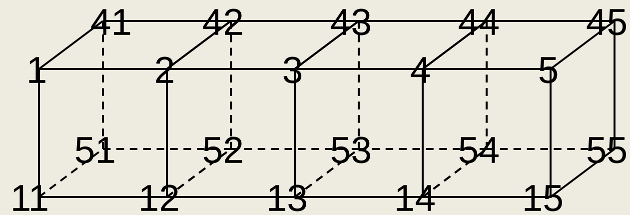
Increment material number of all elements in the given pattern by *MINC* each time after the first.

E,1,1,2,42,41,11,12,52,51



Element #1

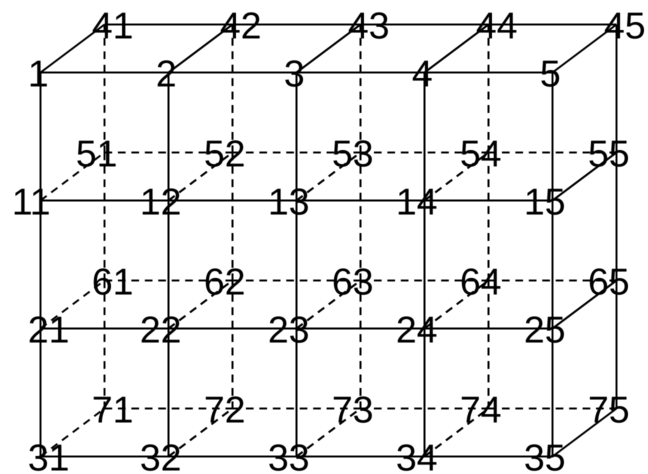
EGEN,3,1,1,1,1



E #1-4

(old 1) (new 2-4)

EGEN,2,10,1,4,1



E #1-12

(old 1-4, new 5-12)

.PRE File Structure

* Model Options
MOPT,1,0,0,0

"MOPT" command

USING PREP ANALYSIS OPTION WINDOW DIALOGS

* Analysis Options
AOPT,0,0,0,1,1,1,0,0,1,0,0,0

Analysis options: "AOPT" command

EQUAKE,0,0,0,0,0,1

"EQUAKE" command

See Other .pre Input Files

4. Run Selected Demos and Describe Additional Example Problems Prepared for This Training

ACS SASSI Demo Problems

Demo Problem	Software Features		Description
Demo 1	X	Base Software	Introductory demo for ACS SASSI. This demo covers basic ACS SASSI functionality, such as loading model files, running modules, and basic post-processing and result visualization.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 2	X	Base Software	This demo includes a procedure for stress post processing, including creating stress contour plot animations for critical time steps using the ACS SASSI UI.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 3	X	Base Software	This demo introduces macros for combination of post-processing results, as well as using the ACS SASSI UI to determine critical frequencies.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 4	X	Base Software	This demo includes a procedure for performing an SSI analysis with nonlinear soil.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 5	X	Base Software	This demo includes a procedure for for transferring SSI loads to an ANSYS model for equivalent static or dynamic analysis. The conversion of ANSYS models to the ACS SASSI format is demonstrated as well.
	X	Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 6	X	Base Software	This demo includes a procedure for creating soil finite element models for equivalent static linear soil pressure analysis, and nonlinear soil pressure analysis including foundation separation.
	X	Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 7	X	Base Software	This demo includes a procedure for performing SSI analysis for surface and embedded structures using mass, stiffness, and damping matrices from ANSYS.
		Option A	
	X	Option AA	
		Option PRO	
		Option NON	

Demo Problem		Software Features	Description
Demo 8	X	Base Software	This demo includes a procedure for computing section cut forces and moments in a shearwall structure using the ACS SASSI UI.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 9	X	Base Software	This demo includes a procedure for performing nonlinear SSI analysis with Option NON for a shearwall structure. It demonstrates how to split a model into nonlinear panels and define backbone curves and nonlinear analysis options.
		Option A	
		Option AA	
		Option PRO	
	X	Option NON	
Demo 10	X	Base Software	This demo includes a procedure for performing nonlinear SSI analysis for a base-isolated shearwall structure.
		Option A	
		Option AA	
		Option PRO	
	X	Option NON	
Demo 11	X	Base Software	This demo includes a procedure for using ANSYS MATRIX50 elements in an SSI analysis in ACS SASSI.
		Option A	
	X	Option AA	
		Option PRO	
		Option NON	
Demo 12	X	Base Software	This demo performs a pushover analysis of a reactor building reinforced concrete containment shell
		Option A	
		Option AA	
		Option PRO	
	X	Option NON	
Demo 13	X	Base Software	The demo includes a procedure for post-processing SSI analysis results using binary databases. It includes combination of binary database, extracting text files from databases, and creating animations from binary databases.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Demo 14		Base Software	This demo includes a procedure for performing coordinate transformation and strain calculations for shell elements in the ACS SASSI UI.
		Option A	
		Option AA	
		Option PRO	
		Option NON	

Additional Example Problems

Example Problem	Software Features		Description
Deterministic Nonlinear SSI Analysis	X	Base Software	Example of deterministic nonlinear analysis of shearwall building for 5 input sets of time histories using Option NON
		Option A	
		Option AA	
		Option PRO	
	X	Option NON	
Probabilistic SSI Analysis	X	Base Software	Example of a probabilistic SSI analysis of shearwall building using Option PRO.
		Option A	
		Option AA	
	X	Option PRO	
		Option NON	
Concrete Pool Model with Near Field Soil	X	Base Software	Example of a embedded concrete pool structure with and without including near field soil.
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Nonuniform Embedded Block Model	X	Base Software	Example shows a nonuniform near-field soil model
		Option A	
		Option AA	
		Option PRO	
		Option NON	
Concrete Pool Modelling with ANSYS FLUID80 Elements in ACS SASSI	X	Base Software	Example includes a procedure for performing an SSI analysis in ACS SASSI for a water concrete pool structure with ANSYS FLUID80 elements using Option AA.
		Option A	
	X	Option AA	
		Option PRO	
		Option NON	
Incoherent Post-Processing with Macros	X	Base Software	Example of post-processing an incoherent SSI analysis using macros in the ACS SASSI UI.
		Option A	
		Option AA	
		Option PRO	
		Option NON	

End of Slides