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APPENDIX 3NN

MODEL PROPERTIES AND SEISMIC ANALYSIS RESULTS R/B-PCCV-CONTAINMENT INTERNAL STRUCTURE

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ACRONYMS AND ABBREVIATIONS

Acronyms	Definitions
3D	three-dimensional
ARS	acceleration response spectra
BE	best estimate
COV	coefficient of variation
CSDRS	certified seismic design response spectra
DCD	Design Control Document
FE	finite element
EBE	embedded best estimate
ELB	embedded lower bound
EHB	embedded high bound
EUB	embedded upper bound
FH/A	fuel handling area
GMRS	ground motion response spectra
HB	high bound
ISRS	in-structure response spectra
LB	lower bound
OBE	operating-basis earthquake
PCCV	prestressed concrete containment vessel
R/B	reactor building
SBE	surface best estimate
SLB	surface lower bound
SUB	surface upper bound
SRSS	square root sum of the squares
SSE	safe-shutdown earthquake
SSI	soil-structure interaction
UB	upper bound

3NN MODEL PROPERTIES AND SEISMIC ANALYSIS RESULTS FOR R/B-PCCV-CONTAINMENT INTERNAL STRUCTURE

3NN.1 Introduction

This Appendix documents the SASSI site-specific analysis of the US-APWR prestressed concrete containment vessel (PCCV), containment internal structure, and reactor building (R/B) including the fuel handling area (FH/A) of Comanche Peak Nuclear Power Plant Units 3 and 4.

As stated in Subsection 3.7.2.4.1, site-specific soil-structure interaction (SSI) analyses are performed to validate the US-APWR standard plant seismic design, and to confirm that site-specific SSI effects are enveloped by the lumped parameter SSI analysis described in Subsection 3.7.2.4. The SASSI computer program (Reference 3NN-1) serves as a computational platform for the site-specific SSI analysis. SASSI is used to model the overall stiffness and mass inertia properties of the R/B-PCCV-containment internal structure and the following SSI site-specific effects:

- Layering of the rock subgrade.
- Foundation flexibility.
- Embedment of the foundation and layering of backfill material.
- Scattering of the input control design motion.

The SASSI program provides a frequency domain solution of the SSI model response based on the complex response method and finite element (FE) modeling technique. The SASSI analyses of the US-APWR standard plant employ the subtraction method of sub-structuring to capture the above-listed SSI effects. Due to the low seismic response at the Comanche Peak site and lack of high-frequency exceedances, the spatial variation of the input ground motion is deemed not significant. Therefore, the SASSI analyses do not consider incoherence of the input control motion.

This Appendix documents the SASSI analysis of the R/B-PCCV-containment internal structure and demonstrates that the in-structure response spectra (ISRS) developed from the SASSI analysis results are enveloped by the standard plant seismic design.

3NN.2 Seismological and Geotechnical Considerations

The R/B-PCCV-containment internal structure of Units 3 and 4 will be constructed on a rock subgrade by removing the native soil above the top of the limestone layer with shear wave velocity exceeding 5000 fps that is located at nominal elevation of 782 ft. A thin layer of fill concrete will be placed on the top of the limestone to level the surface below the building basemat established at nominal elevation of 783 ft.-2 in. Fill concrete will be also placed below the surface mat located at the north-east corner of the FH/A and under the central portion of the mat underneath the PCCV. The foundation will be backfilled with a 40 ft. thick layer of engineered fill material to establish the nominal elevation of the plant ground surface at 822 ft.

Besides the best estimate (BE) values, the site-specific analyses address the variation of the subgrade properties by considering lower bound (LB) and upper bound (UB) properties. The LB and UB properties represent a coefficient of variation (COV) on the subgrade shear modulus of 0.69. The typical properties for a granular engineered backfill are adopted as the BE values for the dynamic properties of the backfill. Four profiles, LB, BE, UB, and high bound (HB) of input backfill properties are developed for the SASSI analyses considering the different coefficient of variation. The LB and BE backfill profiles are combined with corresponding LB and BE rock subgrade profiles, and the UB and HB backfill profiles are combined with the UB rock subgrade profile. The profiles address the possibility of stiffer backfill, and the project specifications limit the minimum shear wave velocity of the backfill material to 600 ft/s for 0 to 3 ft. depth, 720 ft/s for 3 to 20 ft. depth, and 900 ft/s for 20 to 40 ft. depth. Table 3NN-1 presents the COV on shear modulus used for development of different soil profiles.

The engineered backfill is not placed underneath the R/B-PPCV-Containment Internal Structure common basemat (or underneath any other seismic Category I or II structure foundations), and therefore is not used as “dental” fill. Further, the engineered backfill is not relied upon for lateral support of the building structure. Therefore, it is anticipated that shear wave velocity testing for verification of the above-cited limits will not utilize a test fill prior to placement of the backfill. Resonant column torsional shear testing (RCTS) is not required, and shear wave velocity testing during construction is also not required. Instead, testing requirements for backfill include routine pre-construction (pre-installation) mechanical and index testing to perform traditional quality control testing on physical characteristics (such as grain size, compaction, moisture content, lift thickness, etc), and in-situ shear wave velocity testing performed post construction. Subsection 2.5.4.5.4 discusses further backfill material and applicable quality control measures.

Due to the small intensity of the seismic motion and the high stiffness of the rock, the SSI analyses use rock subgrade input properties derived directly from the measured low-strain values, i.e., the dynamic properties of the rock subgrade are considered strain-independent (Refer to FSAR Subsection 2.5.2.5.2.1 for further discussion). The SSI analyses use input stiffness and damping properties of the backfill that are compatible to the strains generated by the design input motion. The strain-compatible backfill properties are obtained from site response analyses of the four backfill profiles using two horizontal acceleration time histories compatible to the GMRS that are applied as outcrop motion on the surface of the rock subgrade at nominal elevation of 782 ft. The degradation curves presented in Figure 2.5.2-232, which are derived based on standard EPRI shear modulus reduction and damping curves for granular fill, were used to model the properties of the backfill, which are non-linear. The curves' values of the soil shear modulus and the damping as a function of shear strain are listed in Table 2.5.2-227.

ACS SASSI SOIL calculated strain-compatible fill properties using 65% of the peak strain value for selection of effective soil strain. The results for the strain-compatible backfill properties obtained from the two horizontal site response analyses are averaged to obtain the backfill profiles used as the input for the site-specific SSI analyses.

The compression or P-wave velocity is developed for the rock and the backfill from the strain-compatible shear or S-wave velocity (Vs) and the measured value of the Poisson's ratio by using the following equation:

$$Vp = Vs \cdot \sqrt{2 \cdot \frac{1-v}{1-2v}}$$

The SSI analyses use identical values for the shear S-wave and compression P-wave velocity damping. Figure 3NN-1, Figure 3NN-2 and Figure 3NN-3 present, respectively, the rock subgrade LB, BE and UB profiles for shear (S) wave velocity (Vs), compression (P) wave velocity (Vp) and material damping. Figure 3NN-4, Figure 3NN-5 and Figure 3NN-6 present in solid lines the results of the site response analyses for the profiles of strain-compatible backfill properties. The plots also show with dashed lines the backfill profiles that were modified to match the geometry of the mesh of the SASSI basement model. The presented input S and P wave profiles are modified using the equal arrival time averaging method. Table 3NN-16 provides the strain-compatible backfill properties, used for the SASSI analysis for LB, BE, UB, and HB embedment conditions.

The minimum design spectra, tied to the shapes of the certified seismic design response spectra (CSDRS) and anchored at 0.1g, define the safe-shutdown earthquake (SSE) design motion for the seismic design of category I structures that is specified as outcrop motion at the top of the limestone at nominal elevation of 782 ft. Two statistically independent time histories H1 and H2 are developed compatible to the horizontal design spectrum, and a vertical acceleration time history V is developed compatible to the vertical design spectrum. The time step of the acceleration time histories used as input for the SASSI analysis is 0.005 seconds. The SASSI analysis requires the object motion to be defined as within-layer motion. The outcrop horizontal time histories are used directly as input for the SASSI analyses of surface foundations applied at the FIRS bottom of foundation elevation. The analyses of embedded foundation use "within" motion input time histories that are also applied at the FIRS input elevation. The "within" motions are obtained from a set of site response analyses, separate from these documented in Subsection 2.5.2, that are performed on a soil column consisting of the rock subgrade and the backfill, for purposes of embedded foundation SSI analysis. The design motion is applied to the soil column as layer outcrop motion at the FIRS elevation in order to calculate the within-layer motion. These site response analyses provides for each considered backfill profile, two horizontal acceleration time histories (East-West and North-South) of the design motion within the top limestone rock layer that are used as input in the SASSI analyses of embedded foundations. The time history of the vertical outcrop accelerations serves as input for both surface and embedded foundations.

3NN.3 SASSI Model Description and Analysis Approach

Figure 3NN-7 shows the three-dimensional SASSI FE model used for site-specific seismic analysis of the US-APWR R/B-PCCV-containment internal structure of Units 3 and 4. The SASSI structural model uses lumped-mass-stick models of the PCCV, containment internal structure, and R/B to represent the stiffness and mass inertia properties of the building above the ground elevation. A three-dimensional (3D) FE model, presented in Figure 3NN-8, represents the building basement and the floor slabs at ground elevation.

The model is established with reference to the Cartesian coordinate system with origin established 2 ft.-7 in. below the ground surface elevation at the center of the PCCV foundation. The origin location corresponds to the location of the coordinate system used as reference for the seismic analysis of the standard plant presented in Section 3.7. The orientation of the Z-axis is upward. The orientation of the standard plant model is modified such that the positive X-axis is oriented northward and the Y-axis is oriented westward.

The geometry and the properties of the lumped-mass-stick models representing the above ground portion of the building are identical to those of the lumped mass stick model used for the R/B-PCCV-containment internal structure seismic analysis, as addressed in Appendix 3H. SASSI 3D beam and spring elements with cross sectional properties identical to those of the standard plant models represent stiffness properties. All of the modeling characteristics present in the standard plant lumped mass stick models for the R/B-PCCV-containment internal structure are the same as for the SASSI model, with the exception of minor adjustments for compatibility with SASSI, described as follows. Because SASSI does not have rigid link capability, the rigid links in the lumped mass stick models that connect different nodal points at the same floor elevation are replaced with SASSI 3D beam elements with high stiffness properties. The 3D beam elements reproduce the rigid link behavior present in the standard plant lumped mass stick models.

The major coordinates that define the geometry of the FE basement model are listed in Table 3NN-2 to Table 3NN-5. Table 3NN-6 presents the types of SASSI finite elements used to model the different structural members in the basement model. The table also presents the material properties (modulus of elasticity and weight density) assigned to each group of finite elements. The properties assigned to each material of the SASSI model are listed in Table 3NN-7. The site-specific SASSI analysis uses the operating-basis earthquake (OBE) damping values of Chapter 3, Table 3.7.1-3(b), which is consistent with the requirements of Section 1.2 of RG 1.61 (Reference 3NN-4) for structures on sites with low seismic responses where the analyses consider a relatively narrow range of site-specific subgrade conditions.

SASSI solid FE elements, shown in Figure 3NN-9, model the stiffness and mass inertia properties of the building basemat. The modeling of the thick central part of the basemat supporting the PCCV and containment internal structure is simplified to minimize the size of the SASSI model as shown in Figure 3NN-10. Rigid shell elements connect the thick portion of the basemat with the floor slabs at the ground elevation. Rigid 3D beam elements connect the PCCV and containment internal structure lumped-mass stick models to the rigid shell elements as shown in Figure 3NN-13 and Figure 3NN-14. Massless shell elements are added at the top of the basemat solid element to accurately model the bending stiffness of the central part of the mat. Figure 3NN-11 shows the solid FE elements representing the stiffness and mass inertia of the fill concrete placed under the central elevated part of the basemat and under the surface mat at the northeast corner of the building.

SASSI 3D shell elements model the basement shear walls, the surface mat under the northeast corner of the R/B, and the R/B slabs at ground floor elevation. The elastic modulus and unit weight assigned to the material of the shell elements modeling the R/B basement shear walls shown in Figure 3NN-12 are adjusted to account for the different height of walls and reductions of stiffness due to the openings. Table 3NN-8 lists the adjusted material properties assigned to the shell elements of the walls with openings.

Rigid 3D beam elements connect the top of the basement shear walls with lumped-mass stick model representing the above ground portion of the R/B and FH/A. This modeling approach enables the R/B-FH/A to be connected to the flexible part of the building basement and decoupled from the thick central part that serves as foundation to the PCCV and containment internal structure part of the building.

The layering of the backfill profiles is modified in order to match the geometry of the mesh of the SASSI basemat model described above. The S-wave and P-wave velocities of the backfill (Vs and Vp) are adjusted using an equivalent arrival time methodology as follows:

$$Vs = \frac{D}{\sum d_i / Vs_i} \quad \text{and} \quad Vp = \frac{D}{\sum d_i / Vp_i}$$

where:

D is the thickness of the backfill layer in SASSI, d_i is the thickness of each backfill layer in the site-response analysis model, and Vs_i and Vp_i are the strain-compatible S-wave and P-wave velocities corresponding to the layering of the site response model.

The P-wave damping (Dp) of the rock and backfill is set equal to the S-wave damping. The S-wave damping (Ds) of the rock and backfill layers is calculated as a weighted average using the following formula:

$$Ds = Dp = \frac{\sum d_i \cdot Ds_i}{D}$$

where Ds_i is the S-wave damping value of each backfill layer.

In addition to the weights assigned to the lumped-mass-stick models of the US-APWR standard plant summarized in Appendix 3H, the SASSI model used for site specific analyses includes the weight of 47,085 kips pertaining to the fill concrete placed beneath the building basemat. The combined total weight of the R/B, containment internal structure, and PCCV including the basemat and the fill concrete is 781,685 kips. The equivalent uniform pressure under the building foundation is 11.86 ksf. In the SASSI model of the basement, unit mass weight is assigned only to the 3D shell elements modeling the shear walls of R/B and to the portion of the basemat represented by 3D brick elements. Table 3NN-9 presents the weights assigned to the elements of the basement structural members. The remaining weight of the basement is lumped at a single node that, as shown in Figure 3NN-10, is connected to the central portion of the foundation by rigid beams. As shown in Table 3NN-10, the magnitude and the location of the lumped mass are calculated such that, when combined with the mass inertia properties of the mat and walls, the FE model duplicates the overall lumped mass inertia properties assigned to the standard plant lumped mass stick model at basement node BS01.

Four layers of SASSI solid elements, shown Figure 3NN-15, are used to represent the stiffness and the mass inertia of the excavated backfill soil. Figure 3NN-4, Figure 3NN-5, and Figure 3NN-6 show in dashed lines the input strain-compatible properties assigned to the different layers of excavated soil elements.

The results of a SASSI analysis in which fixed-base conditions are simulated by attaching the lumped-mass-stick models to a rigid foundation resting on a rigid rock subgrade, verify the accuracy of the conversion of the standard plant lumped-mass-stick models into SASSI. An additional verification analysis is performed on the combined SASSI model resting on the surface of rigid half-space to identify the dynamic properties of the SASSI model. Transfer functions obtained from the “hard rock” SASSI analyses, which are compared to the results of the ANSYS model analysis, show that the peaks of the transfer functions occur at frequencies that are very close to the frequencies of the predominant modes calculated by the modal analysis. Table 3NN-11 presents the frequencies that characterize the different modes of response of the structural models. In the table, the results of the two verification SASSI analyses are compared with the results of the fixed base modal analysis of the model presented in Appendix 3H.

3NN.4 Seismic Analysis Results

The buildings surrounding the R/B (including FH/A), PCCV, and containment internal structures are separated by expansion joints to prevent their interaction during an earthquake. A part of the building foundation is embedded in backfill of engineered granular material. The site-specific SSI analyses address the effects of these site-specific conditions by considering both surface foundation and foundation basement embedded in backfill that is modeled as infinite in the horizontal direction. Seven sets of SASSI analyses are performed that consider the following site conditions:

1. SLB - Foundation without backfill resting on the surface of the rock subgrade profile with LB properties.
2. SBE - Foundation without backfill resting on the surface of the rock subgrade profile with BE properties.
3. SUB - Foundation without backfill resting on the surface the rock subgrade profile with UB properties.
4. ELB - Foundation embedded in backfill with LB properties resting on the surface of the rock subgrade profile with LB properties.
5. EBE - Foundation embedded in backfill with BE properties resting on the surface of the rock subgrade profile with BE properties.
6. EUB - Foundation embedded in backfill with UB properties resting on the surface of the rock subgrade profile with UB properties.
7. EHB - Foundation embedded in backfill with high bound HB properties resting on the surface of the rock subgrade profile with UB properties.

Each set of SASSI runs includes three runs where the input motion is applied to the models at top of the rock subgrade in North-South (NS), East-West (EW) and vertical direction. The responses obtained for the earthquake components in the three global orthogonal directions are combined in accordance with RG 1.92 (Reference 3NN-3) using the square root sum of the squares (SRSS) method.

Each set of SASSI runs has a minimum cut-off frequency of 50 Hz. For each set of SASSI runs, the minimum of frequencies of analysis for the surface foundation conditions is 48, and the minimum number of frequencies of analysis for the embedded foundation is 51.

Table 3NN-12, Table 3NN-13, and Table 3NN-14 present maximum absolute accelerations (zero period acceleration values) at lumped-mass locations of the R/B-PCCV-containment internal structure in NS, EW, and vertical direction, respectively. The results obtained from each set of SASSI analysis are listed together with the enveloped values for the surface and embedded foundation site conditions. The last column in the tables presents the ratio between the envelopes of the embedded foundation results with the envelopes of the surface foundation results that serves as an indicator of the embedment effects. The comparisons indicate that the embedment in general lowers the maximum horizontal accelerations. Exceptions are some portions of the building, in particular the Fuel Handling Area (FH/A), where the embedment resulted in magnified maximum horizontal accelerations due to local resonance effects. The comparison of the maximum acceleration results indicates that the reflection of the P-waves in the embedment soil resulting from the stiffness mismatch between the backfill and subgrade magnifies the vertical accelerations of R/B complex structures.

Table 3NN-15 presents the influence of different SSI effects on the response of the PCCV, R/B, and containment internal structures.

3NN.5 In-Structure Response Spectra (ISRS)

The site-specific SASSI analysis provides results for the 5 percent damping acceleration response spectra (ARS) at all lumped mass locations for the three orthogonal directions. The ARS results for the three components of the input earthquake are combined using the SRSS method and compared with the US-APWR standard plant ISRS. Figure 3NN-16, Figure 3NN-20 and Figure 3NN-24 compare of the ARS results for seismic response in three directions at ground elevation at the nominal center of the basement (mass location CV00) with the corresponding CSDRS. The comparison of the ARS results for the response at the top of PCCV (mass node CV11) with the corresponding ISRS are shown in Figure 3NN-17, Figure 3NN-21, and Figure 3NN-25. Figure 3NN-18, Figure 3NN-22, and Figure 3NN-26 present the comparison of ISRS and ARS results for the containment internal structure response at lumped mass location IC18. The ARS results for the response of R/B structure at lumped mass location RE05 are presented in Figure 3NN-19, Figure 3NN-23 and Figure 3NN-27. The ISRS envelope by a high margin all of the ARS results at all lumped mass locations, which confirms the validity of the US-APWR R/B-PCCV-containment internal structure standard plant seismic design for the Comanche Peak Units 3 and 4 site.

3NN.6 References

3NN-1 *An Advanced Computational Software for 3D Dynamic Analysis Including Soil Structure Interaction,* ACS SASSI Version 2.2, Ghiocel Predictive Technologies, Inc., July 23, 2007.

3NN-2 Deleted

3NN-3 *Combining Responses and Spatial Components in Seismic Response Analysis*, Regulatory Guide 1.92, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, July 2006.

3NN-4 *Damping Values for Seismic Design of Nuclear Power Plants*, Regulatory Guide 1.61, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

Table 3NN-1

Variation in Input Soil Properties

Stratum	Coefficient Of Variation on Shear Modulus		
	Lower Bound (LB)	Upper Bound (UB)	High Bound (HB)
Backfill	0.69	0.69	1.25
Rock Subgrade	0.65	0.65	0.65

Table 3NN-2

Basement Model Z-Coordinates (Bottom to Top)

Z (ft)	Elevation (ft)	Description
-37.420	782.00	Basemat Bottom
-24.083	795.34	Bottom of Basemat under Reactor
2.583	822.00	Ground Elevation

Table 3NN-3

Basement Model X-Coordinates (South to North)

X (ft)	Column Line	Description
-161.67	LR	South Exterior Wall
-139.33	K1R	R/B South Basement Wall
-127.00	KR	R/B South Basement Wall
-106.00	J1R	E-W Interior Wall R/B South Basement
-94.00	JR	Reactor Basemat South End
-39.08	D1R & ER	Reactor Basement South Edge
0.00	FR	Reactor E-W Centerline
39.08	GR & G2R	Reactor Basement North Edge
94.00	CR	North Interior Wall
102.25	BR	Reactor Basemat North End
124.42	A1R	Basement Exterior Wall under Fuel Handling Area Surface Mat
147.25	AR	Basement North Exterior Wall

Table 3NN-4

Basement Model Y-Coordinates (East to West)

Y (ft)	Column Line	Description
-106.67	11R	Basement East External Wall
-92.167	10R	Reactor Basemat East End
-85.667	9bR	R/B Basement N-S Interior Wall
-70.00	9R	R/B Basement N-S Interior Wall
-48.75	8aR & 8R	Reactor Basement East Edge
-43.917	8R	N-S External Wall under Fuel Handling Area Surface Mat
-38.833	7R	R/B Basement N-S Interior Wall
0.00	6R	Reactor N-S Centerline
17.833	5aR	Tendon Gallery Access Exterior Wall
39.333	4bR	Tendon Gallery Access West Wall
39.333	5R	R/B Basement N-S Interior Wall
48.75	5R & 4aR	Reactor Basement West Edge
63.71	4R	Fuel Handling Area N-S Interior Wall
70.000	3R	R/B Basement N-S Interior Wall
86.583	2aR	Fuel Handling Area and R/B N-S Interior Wall
92.167	2R	Reactor Basemat West End
106.67	1R	Basement West External Wall

Table 3NN-5

Basement Model Radial Coordinates

R (ft)	Description
0.00	Reactor Center
9.86	Reactor Pit Radius
59.00	Radius of Elevated Part of Reactor Foundation
71.83	Tendon Gallery Inner Radius
80.42	Tendon Gallery Outer Radius
93.50	Reactor Foundation Radius

Table 3NN-6

Finite Elements Assigned to Basement Model

Structural Member	Element	Mass	Material	Young's Modulus, E ($x10^{-5}$ ksf)	Weight Density (kcf)
Upper Portion of Reactor Mat	Shell	Weightless	Concrete f_c=4000psi	5.191	N/A
Fuel Handling Area Surface Basemat	Shell	Weightless	Concrete f_c =4000psi	5.191	N/A
NS Exterior Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	Varies with Location of Wall	Varies with Location of Wall
EW Exterior Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	Varies with Location of Wall	Varies with Location of Wall
NS Basement Inner Shear Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	Varies with Location of Wall	Varies with Location of Wall
EW Basement Inner Shear Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	Varies with Location of Wall	Varies with Location of Wall
Connecting Shells	Shell	Weightless	Rigid	N/A	N/A
Ground Floor Slabs	Shell	Concrete	Concrete f_c =4000psi	5.191	0.15
Tendon Gallery Floor	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	4.209	0.14
Basemat	Solid	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)	2.982	0.125
Fill Concrete	Solid	Concrete	Concrete f_c =3000psi	4.496	0.15
Rigid Rim at top of Reactor Mat	Beam	Weightless	Rigid	N/A	N/A
PCCV stick Rigid Connection	Beam	Weightless	Rigid	N/A	N/A
Containment Internal Structure Stick Rigid Connection	Beam	Weightless	Rigid	N/A	N/A
R/B-Fuel Handling Area Stick Rigid Connection	Beam	Weightless	Rigid	N/A	N/A
BS01 Lumped Mass Rigid Connection	Beam	Weightless	Rigid	N/A	N/A

Table 3NN-7

Input Material Properties

Structural Component	Concrete Compressive Strength (psi)	Young's Modulus ($x10^5$ ksf)	Poisson's Ratio	Damping OBE
PCCV	7,000	6.86	0.17	3%
R/B including FH/A, and Basement	4,000	5.191	0.17	4%
Containment Internal Structure	4,000	5.191	0.17	4%
Fill Concrete	3,000	4.496	0.17	4%

Table 3NN-8

Adjusted Material Properties of Basement Shear Walls with Openings

Wall Location	Wall Dimensions (ft)			Openings Dimensions (ft)		Stiffness Ratios		Adjusted	
	Thick.	Width	Height	Width	Height	Outplane	Inplane	E (x10^5 ksf)	w (kcf)
CL-1R segment AR-CR	3.33	53.25	27.25	8.33	8.33	0.812	0.800	4.153	0.146
CL-1R segment CR-JR CL-11R segment CR-JR	3.33	188.0	27.25	8.33	8.33	0.902	0.940	4.880	0.146
CL-1R segment JR-KR CL-11R segment JR-KR	3.33	45.33	27.25	6.66	8.33	0.823	0.807	4.189	0.146
CL-1R segment KR-LR CL-11R segment KR-LR	3.33	33.0	27.25	6.66	8.33	0.779	0.738	3.833	0.146
CL-2R segment CR-ER CL-10R segment CR-ER	2.67	55.92	26.58	3,6.6,9	6.6,10,14.41	0.750	0.672	3.490	0.149
CL-2R segment GR-JR CL-10R segment GR-JR	2.67	55.92	26.58	7.5,6.6,3	14.41,10,6.6	0.727	0.610	3.167	0.149
CL-CR segments 1R-2R & 10R-11R	3.33	12.83	26.58	6.66	8.33	0.551	0.676	2.902	0.150
CL-J1R segments 2aR-3R & 9bR-9R	2.67	16.58	25.92	3.33	6.66	0.927	0.814	4.223	0.146
CL-J1R segments 3R-5R & 7R-9R	1.67	31.17	25.92	6.66	8.33	0.950	0.866	4.494	0.146
CL-J1R segments 5R-6R & 6R-7R	1.67	38.83	25.92	6.66	8.33	0.931	0.838	4.353	0.146
CL-K1R segments 1R-2aR & 11R-9bR	2.00	18.32	25.92	3.33	6.66	0.944	0.873	4.530	0.146

Table 3NN-9

Weights Assigned to Basement Structural Members in SASSI FE Model

FE Component	Weight (kips)
EW Exterior Walls	8370
NS Exterior Walls	5871
NS Interior Walls	7337
EW Interior Walls	5167
Basemat	75855
Fill Concrete	47085
Weight assigned to basement	102600
Total Weight including fill concrete	149685

Table 3NN-10

Basement Mass Inertia

Component	Mass ($k\text{-}s^2/ft$)	I_{mx} ($k\text{-}s^2\text{-}ft$)	I_{my} ($k\text{-}s^2\text{-}ft$)	I_{mz} ($k\text{-}s^2\text{-}ft$)	Center of Mass (ft)		
					X	Y	Z
FE Mass	3186.3	16,649,068	30,226,708	46,335,404	-21.71	2.27	-25.10
Lumped Mass	1720.5	1,552,795	6,425,121	7,960,663	25.94	-1.69	-24.92
DCD BS01	4906.8	18,245,342	39,251,208	56,935,818	-5.00	0.88	-25.04

Table 3NN-11

Dynamic Properties of SASSI Model

Response		Characteristic Frequency (Hz)		
Model	**Direction**	**DCD Lumped Mass Stick Model**	**SASSI Above Ground Stick Models**	**SASSI Combined FE Model**
PCCV	NS	4.57	4.59	4.54
		12.93	13.01	12.94
	EW	4.57	4.59	4.52
		12.93	13.04	12.96
	Vertical	12.54	12.62	12.45
		22.96	23.12	23.05
R/B-FH/A	NS	5.29	5.30	5.20
		10.48	10.05	10.15
	EW	6.34	6.17	5.69
		13.13	12.20	11.55
	Vertical	16.94	16.60	15.58
Containment Internal Structure	NS	5.73	5.74	5.71
		9.42	9.35	9.23
	EW	6.25	6.20	6.20
		9.12	9.10	8.99
	Vertical	20.76	20.68	20.12
		25.12	25.95	24.85

Table 3NN-12 (Sheet 1 of 2)

Maximum Accelerations in NS Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g)				Embedded Foundation (g)					Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
			SLB	SBE	SUB	Env.	ELB	EBE	EUB	EHB	Env.			
PCCV	CV11	230.2	0.496	0.595	0.722	0.72	0.495	0.493	0.661	0.653	0.66	92%	0.72	2.03
	CV10	225.0	0.481	0.586	0.707	0.71	0.481	0.485	0.648	0.639	0.65	92%	0.71	1.99
	CV09	201.7	0.434	0.540	0.629	0.63	0.409	0.446	0.582	0.569	0.58	93%	0.63	1.81
	CV08	173.1	0.384	0.476	0.559	0.56	0.346	0.395	0.508	0.505	0.51	91%	0.56	1.55
	CV07	145.6	0.374	0.407	0.494	0.49	0.335	0.341	0.448	0.446	0.45	91%	0.49	1.30
	CV06	115.5	0.356	0.375	0.417	0.42	0.321	0.305	0.374	0.380	0.38	91%	0.42	1.09
	CV05	92.2	0.324	0.342	0.346	0.35	0.295	0.284	0.311	0.321	0.32	93%	0.35	0.91
	CV04	76.4	0.292	0.306	0.313	0.31	0.268	0.260	0.281	0.293	0.29	94%	0.31	0.78
	CV03	68.3	0.272	0.286	0.293	0.29	0.251	0.244	0.264	0.275	0.28	94%	0.29	0.71
	CV02	50.2	0.223	0.235	0.239	0.24	0.207	0.204	0.217	0.227	0.23	95%	0.24	0.57
	CV01	25.3	0.163	0.159	0.164	0.16	0.154	0.147	0.139	0.158	0.16	96%	0.16	0.47
	CV00	1.9	0.129	0.124	0.128	0.13	0.114	0.126	0.123	0.118	0.13	98%	0.13	N/A
Containment Internal Structure	IC09	139.5	0.913	1.054	1.156	1.16	0.819	0.869	0.976	0.911	0.98	84%	1.16	2.77
	IC08	112.3	0.507	0.574	0.627	0.63	0.497	0.494	0.520	0.523	0.52	83%	0.63	1.51
	IC18	110.8	0.482	0.546	0.595	0.60	0.477	0.470	0.493	0.499	0.50	84%	0.60	1.44
	IC61	96.6	0.266	0.305	0.349	0.35	0.233	0.301	0.287	0.266	0.30	86%	0.35	1.15
	IC62	96.6	0.272	0.301	0.347	0.35	0.238	0.300	0.294	0.267	0.30	86%	0.35	1.14
	IC05	76.4	0.224	0.252	0.278	0.28	0.189	0.237	0.219	0.209	0.24	85%	0.28	0.91
	IC07	76.4	0.224	0.252	0.278	0.28	0.189	0.237	0.219	0.209	0.24	85%	0.28	N/A
	IC15	59.2	0.199	0.207	0.221	0.22	0.164	0.195	0.193	0.187	0.20	88%	0.22	0.72
	IC04	50.2	0.186	0.189	0.201	0.20	0.155	0.178	0.177	0.176	0.18	89%	0.20	0.64
	IC14	45.7	0.177	0.179	0.189	0.19	0.148	0.169	0.169	0.162	0.17	89%	0.19	0.59
	IC03	35.6	0.156	0.159	0.163	0.16	0.135	0.151	0.151	0.150	0.15	93%	0.16	0.48
	IC02	25.3	0.139	0.139	0.142	0.14	0.127	0.135	0.133	0.132	0.14	95%	0.14	0.45
	IC01	16.0	0.132	0.132	0.132	0.13	0.120	0.131	0.128	0.124	0.13	99%	0.13	0.44
	IC00	1.9	0.129	0.124	0.128	0.13	0.114	0.127	0.124	0.119	0.13	98%	0.13	N/A

Table 3NN-12 (Sheet 2 of 2)

Maximum Accelerations in NS Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g)				Embedded Foundation (g)					Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
			SLB	SBE	SUB	Env.	ELB	EBE	EUB	EHB	Env.			
R/B-FH/A	FH08	154.5	0.606	0.701	0.780	0.78	0.586	0.892	0.742	0.723	0.89	114%	0.89	2.21
	FH07	125.7	0.384	0.444	0.506	0.51	0.396	0.557	0.450	0.472	0.56	110%	0.56	1.23
	RE05	115.5	0.218	0.250	0.277	0.28	0.210	0.252	0.325	0.260	0.33	117%	0.33	0.71
	RE04	101.0	0.192	0.213	0.254	0.25	0.175	0.209	0.307	0.228	0.31	121%	0.31	0.69
	RE41	101.0	0.205	0.229	0.263	0.26	0.189	0.217	0.303	0.238	0.30	115%	0.30	0.68
	RE42	101.0	0.209	0.232	0.283	0.28	0.190	0.225	0.298	0.236	0.30	105%	0.30	0.92
	FH06	101.0	0.247	0.289	0.322	0.32	0.239	0.331	0.284	0.295	0.33	103%	0.33	0.74
	RE03	76.4	0.178	0.191	0.222	0.22	0.162	0.189	0.233	0.195	0.23	105%	0.23	0.57
	RE02	50.2	0.163	0.173	0.183	0.18	0.144	0.174	0.190	0.163	0.19	104%	0.19	0.50
	RE01	25.3	0.144	0.154	0.159	0.16	0.136	0.155	0.157	0.136	0.16	99%	0.16	0.47
	RE00	3.6	0.127	0.125	0.127	0.13	0.115	0.118	0.126	0.121	0.13	99%	0.13	N/A

Table 3NN-13 (Sheet 1 of 2)

Maximum Accelerations in EW Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g) SLB	SBE	SUB	Env.	Embedded Foundation (g) ELB	EBE	EUB	EHB	Env.	Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
PCCV	CV11	230.2	0.565	0.713	0.854	0.85	0.538	0.552	0.704	0.691	0.70	82%	0.85	2.15
	CV10	225.0	0.555	0.699	0.837	0.84	0.532	0.541	0.689	0.678	0.69	82%	0.84	2.11
	CV09	201.7	0.510	0.635	0.757	0.76	0.506	0.491	0.620	0.616	0.62	82%	0.76	1.90
	CV08	173.1	0.445	0.544	0.644	0.64	0.427	0.420	0.526	0.528	0.53	82%	0.64	1.60
	CV07	145.6	0.389	0.448	0.526	0.53	0.366	0.349	0.427	0.439	0.44	83%	0.53	1.41
	CV06	115.5	0.321	0.347	0.405	0.41	0.298	0.276	0.327	0.341	0.34	84%	0.41	1.21
	CV05	92.2	0.283	0.306	0.319	0.32	0.253	0.237	0.269	0.280	0.28	88%	0.32	1.03
	CV04	76.4	0.249	0.276	0.280	0.28	0.220	0.212	0.237	0.243	0.24	87%	0.28	0.90
	CV03	68.3	0.230	0.259	0.261	0.26	0.202	0.199	0.221	0.223	0.22	85%	0.26	0.82
	CV02	50.2	0.185	0.214	0.213	0.21	0.163	0.169	0.188	0.181	0.19	88%	0.21	0.66
	CV01	25.3	0.133	0.151	0.153	0.15	0.120	0.136	0.139	0.128	0.14	91%	0.15	0.47
	CV00	1.9	0.119	0.118	0.117	0.12	0.102	0.111	0.120	0.111	0.12	101%	0.12	N/A
Containment Internal Structure	IC09	139.5	0.920	1.034	1.108	1.11	0.790	0.965	1.054	0.937	1.05	95%	1.11	2.86
	IC08	112.3	0.511	0.561	0.622	0.62	0.480	0.540	0.569	0.552	0.57	91%	0.62	1.73
	IC18	110.8	0.484	0.532	0.593	0.59	0.461	0.514	0.541	0.527	0.54	91%	0.59	1.67
	IC61	96.6	0.333	0.353	0.373	0.37	0.241	0.279	0.294	0.287	0.29	79%	0.37	1.22
	IC62	96.6	0.333	0.353	0.373	0.37	0.241	0.279	0.294	0.287	0.29	79%	0.37	1.22
	IC05	76.4	0.254	0.260	0.262	0.26	0.189	0.218	0.223	0.232	0.23	89%	0.26	0.84
	IC07	76.4	0.256	0.264	0.266	0.27	0.198	0.212	0.216	0.226	0.23	85%	0.27	N/A
	IC15	59.2	0.192	0.197	0.204	0.20	0.167	0.182	0.184	0.200	0.20	98%	0.20	0.64
	IC04	50.2	0.175	0.180	0.182	0.18	0.159	0.173	0.170	0.183	0.18	101%	0.18	0.57
	IC14	45.7	0.164	0.168	0.168	0.17	0.150	0.164	0.159	0.171	0.17	102%	0.17	0.53
	IC03	35.6	0.144	0.146	0.146	0.15	0.130	0.146	0.134	0.143	0.15	100%	0.15	0.47
	IC02	25.3	0.126	0.131	0.128	0.13	0.112	0.129	0.127	0.124	0.13	98%	0.13	0.46
	IC01	16.0	0.123	0.124	0.123	0.12	0.107	0.119	0.123	0.118	0.12	99%	0.12	0.45
	IC00	1.9	0.119	0.118	0.117	0.12	0.102	0.111	0.120	0.112	0.12	101%	0.12	N/A

Table 3NN-13 (Sheet 2 of 2)

Maximum Accelerations in EW Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g) SLB	SBE	SUB	Env.	Embedded Foundation (g) ELB	EBE	EUB	EHB	Env.	Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
R/B-FH/A	FH08	154.5	0.350	0.413	0.455	0.46	0.320	0.425	0.482	0.462	0.48	106%	0.48	1.18
	FH07	125.7	0.292	0.304	0.343	0.34	0.264	0.327	0.442	0.350	0.44	129%	0.44	0.96
	RE05	115.5	0.271	0.317	0.383	0.38	0.247	0.308	0.337	0.333	0.34	88%	0.38	0.80
	RE04	101.0	0.230	0.267	0.337	0.34	0.234	0.267	0.285	0.284	0.29	85%	0.34	1.06
	RE41	101.0	0.246	0.306	0.382	0.38	0.247	0.285	0.326	0.319	0.33	85%	0.38	0.93
	RE42	101.0	0.241	0.288	0.364	0.36	0.242	0.272	0.310	0.306	0.31	85%	0.36	0.96
	FH06	101.0	0.245	0.247	0.282	0.28	0.223	0.267	0.287	0.266	0.29	102%	0.29	0.86
	RE03	76.4	0.198	0.206	0.229	0.23	0.194	0.217	0.221	0.207	0.22	97%	0.23	0.66
	RE02	50.2	0.174	0.179	0.185	0.19	0.161	0.180	0.195	0.168	0.20	105%	0.20	0.58
	RE01	25.3	0.149	0.151	0.146	0.15	0.137	0.144	0.167	0.139	0.17	111%	0.17	0.48
	RE00	3.6	0.126	0.125	0.125	0.13	0.114	0.115	0.136	0.113	0.14	108%	0.14	N/A

Table 3NN-14 (Sheet 1 of 2)

Maximum Accelerations in Vertical Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g)				Embedded Foundation (g)					Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
			SLB	SBE	SUB	Env,	ELB	EBE	EUB	EHB	Env.			
PCCV	CV11	230.2	0.437	0.482	0.515	0.52	0.362	0.394	0.626	0.430	0.63	122%	0.63	1.43
	CV10	225.0	0.388	0.420	0.448	0.45	0.323	0.341	0.543	0.334	0.54	121%	0.54	1.29
	CV09	201.7	0.313	0.327	0.349	0.35	0.230	0.240	0.398	0.249	0.40	114%	0.40	0.98
	CV08	173.1	0.271	0.283	0.302	0.30	0.185	0.220	0.327	0.212	0.33	108%	0.33	0.85
	CV07	145.6	0.255	0.266	0.284	0.28	0.174	0.212	0.303	0.203	0.30	107%	0.30	0.81
	CV06	115.5	0.227	0.237	0.253	0.25	0.163	0.196	0.263	0.187	0.26	104%	0.26	0.72
	CV05	92.2	0.201	0.209	0.223	0.22	0.152	0.179	0.232	0.170	0.23	104%	0.23	0.65
	CV04	76.4	0.180	0.188	0.201	0.20	0.144	0.166	0.209	0.158	0.21	104%	0.21	0.59
	CV03	68.3	0.169	0.177	0.188	0.19	0.138	0.159	0.196	0.149	0.20	104%	0.20	0.56
	CV02	50.2	0.148	0.154	0.159	0.16	0.127	0.141	0.166	0.132	0.17	104%	0.17	0.49
	CV01	25.3	0.128	0.132	0.133	0.13	0.117	0.122	0.130	0.120	0.13	98%	0.13	0.39
	CV00	1.9	0.110	0.112	0.113	0.11	0.111	0.110	0.108	0.122	0.12	108%	0.12	N/A
Containment Internal Structure	IC09	139.5	0.199	0.220	0.264	0.26	0.242	0.232	0.275	0.249	0.28	104%	0.28	1.03
	IC08	112.3	0.192	0.214	0.253	0.25	0.231	0.222	0.263	0.235	0.26	104%	0.26	0.97
	IC18	110.8	0.190	0.213	0.252	0.25	0.229	0.220	0.261	0.233	0.26	104%	0.26	0.96
	IC61	96.6	0.160	0.181	0.205	0.21	0.176	0.180	0.203	0.198	0.20	99%	0.21	0.68
	IC62	96.6	0.160	0.182	0.209	0.21	0.173	0.178	0.208	0.195	0.21	100%	0.21	0.68
	IC05	76.4	0.121	0.133	0.146	0.15	0.144	0.143	0.163	0.134	0.16	112%	0.16	0.54
	IC07	76.4	0.157	0.178	0.208	0.21	0.181	0.184	0.204	0.178	0.20	98%	0.21	N/A
	IC15	59.2	0.112	0.122	0.132	0.13	0.131	0.129	0.146	0.123	0.15	111%	0.15	0.49
	IC04	50.2	0.108	0.117	0.126	0.13	0.123	0.122	0.136	0.117	0.14	108%	0.14	0.46
	IC14	45.7	0.106	0.113	0.122	0.12	0.119	0.117	0.131	0.117	0.13	107%	0.13	0.43
	IC03	35.6	0.106	0.107	0.112	0.11	0.116	0.112	0.118	0.119	0.12	106%	0.12	0.39
	IC02	25.3	0.107	0.109	0.109	0.11	0.114	0.108	0.107	0.119	0.12	109%	0.12	0.35
	IC01	16.0	0.109	0.111	0.111	0.11	0.112	0.108	0.105	0.121	0.12	109%	0.12	0.34
	IC00	1.9	0.110	0.112	0.113	0.11	0.111	0.110	0.107	0.122	0.12	108%	0.12	N/A

Table 3NN-14 (Sheet 2 of 2)

Maximum Accelerations in Vertical Direction

Structure	Lumped Mass	El. (ft)	Surface Foundation (g)				Embedded Foundation (g)					Embed. /Surf	Enveloped Accelerations (g)	Standard Plant Enveloped Accelerations (g)
			SLB	SBE	SUB	Env,	ELB	EBE	EUB	EHB	Env.			
R/B-FH/A	FH08	154.5	0.318	0.361	0.392	0.39	0.363	0.401	0.501	0.408	0.50	128%	0.50	1.23
	FH07	125.7	0.290	0.330	0.358	0.36	0.331	0.373	0.473	0.374	0.47	132%	0.47	1.03
	RE05	115.5	0.264	0.294	0.312	0.31	0.262	0.306	0.325	0.322	0.33	104%	0.33	0.87
	RE04	101.0	0.245	0.273	0.286	0.29	0.241	0.291	0.308	0.309	0.31	108%	0.31	0.97
	RE41	101.0	0.314	0.354	0.371	0.37	0.348	0.420	0.512	0.400	0.51	138%	0.51	0.92
	RE42	101.0	0.259	0.292	0.325	0.33	0.274	0.309	0.354	0.305	0.35	109%	0.35	0.89
	FH06	101.0	0.265	0.300	0.332	0.33	0.302	0.342	0.438	0.345	0.44	132%	0.44	0.84
	RE03	76.4	0.131	0.140	0.148	0.15	0.164	0.182	0.228	0.174	0.23	154%	0.23	0.53
	RE02	50.2	0.124	0.127	0.127	0.13	0.153	0.164	0.205	0.154	0.21	161%	0.21	0.46
	RE01	25.3	0.117	0.119	0.119	0.12	0.143	0.147	0.172	0.141	0.17	145%	0.17	0.39
	RE00	3.6	0.111	0.114	0.115	0.12	0.135	0.134	0.139	0.126	0.14	121%	0.14	N/A

Table 3NN-15

SASSI Results for R/B-PCCV-Containment Internal Structure Seismic Response

SSI Effect	Observed Response
Rock Subgrade	The rock subgrade, due to its high stiffness, has insignificant SSI effect on the seismic response of PCCV, R/B, and containment internal structures. The structural natural frequencies characterize the response obtained from SASSI analyses of the surface foundation.
Backfill Embedment	The embedment affects the overall response of the PCCV, R/B, and containment internal structure. In general, the horizontal response of the structures is reduced due to the dissipation of energy in the backfill. The reduction is more pronounced for cases of soft backfill, which has higher values of strain-compatible material damping.
Motion Scattering Effects	Motion scattering effects are inherent in the SASSI analysis results. The dynamic properties mismatch between the backfill and the rock results in reflection of the seismic waves within the backfill stratum. The response of the backfill is characterized by multiple modes that magnify the response of the structure as their frequencies approach the structural frequencies. These resonance effects are most pronounced in the vertical direction is for stiffer backfill with low material damping.
Basement Flexibility	The flexibility of the basement shear walls has some effect on the structural response. Due to the flexibility of the shear walls under the R/B, and FH/A, their response at ground elevation is decoupled from the response of PCCV and containment internal structures that are supported directly on the central thick portion of the basemat.

Table 3NN-16

Backfill Strain Compatible Properties

Elevation (ft)	Unit Weight (pcf)	Poisson's Ratio	S-Wave Velocity (fps)				P-Wave Velocity (fps)				Damping Ratio (%)			
			LB	LB	UB	HB	LB	BE	UB	HB	LB	BE	UB	HB
822	125	0.35	475	633	834	969	990	1317	1740	2017	3.00	2.40	2.00	1.80
819	125	0.35	540	739	999	1174	1125	1539	2080	2444	4.75	3.65	2.70	2.25
815	125	0.35	477	691	958	1143	994	1438	1993	2379	7.45	5.15	3.70	3.00
811	125	0.35	425	649	925	1113	885	1351	1926	2316	10.05	6.55	4.45	3.55
806	125	0.35	383	618	900	1088	797	1287	1874	2265	12.45	7.55	5.10	4.05
802	125	0.35	623	890	1213	1431	1296	1854	2526	2978	6.25	4.10	3.00	2.50
797	125	0.35	603	871	1199	1419	1256	1814	2497	2954	7.00	4.60	3.25	2.70
792	125	0.35	587	855	1188	1409	1223	1779	2473	2932	7.60	4.95	3.50	2.90
787	125	0.35	576	842	1180	1400	1199	1753	2456	2915	8.10	5.25	3.70	3.00
782	Top of Limestone (Foundation Bottom)													

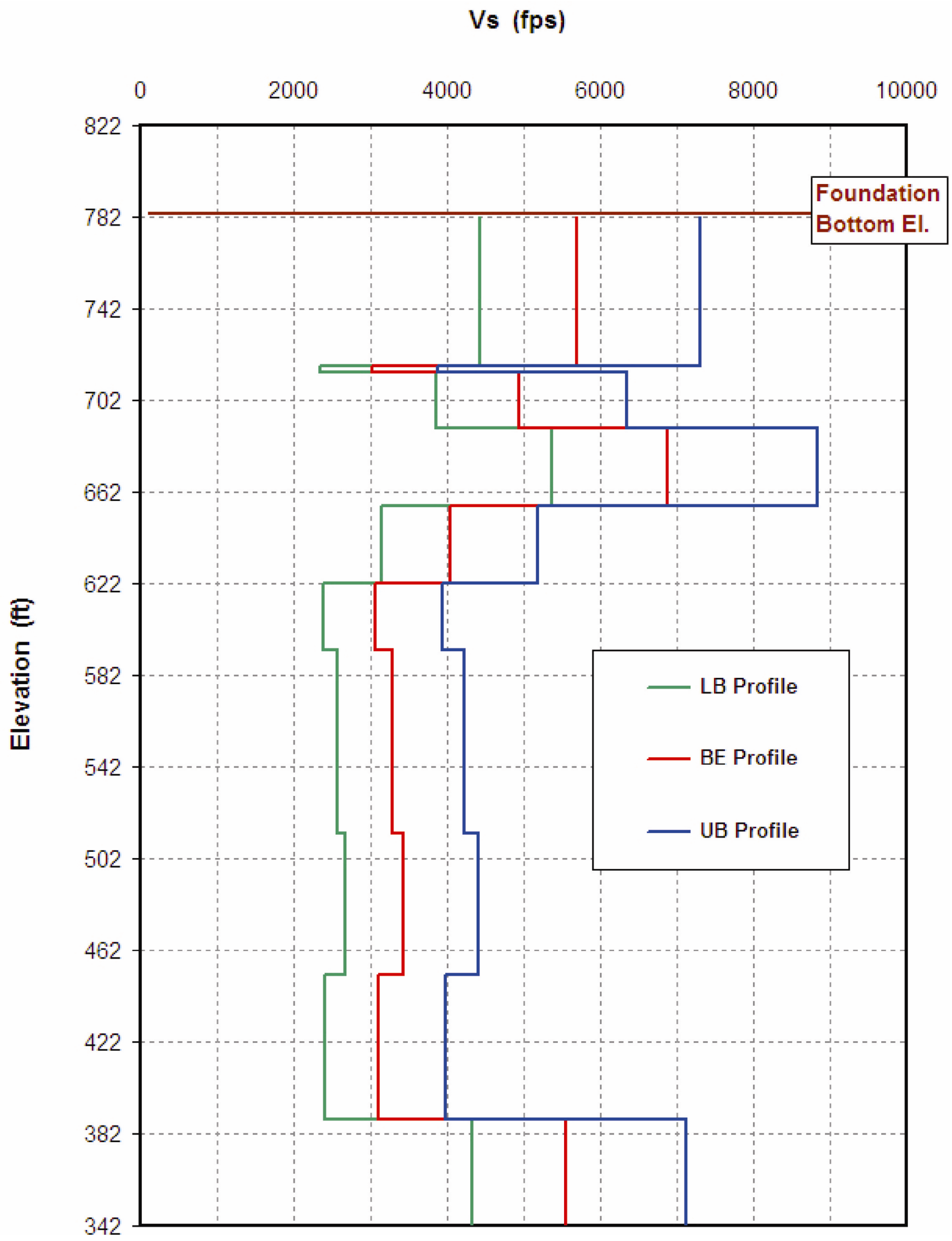

Figure 3NN-1 Rock Subgrade S-Wave Velocity Profiles

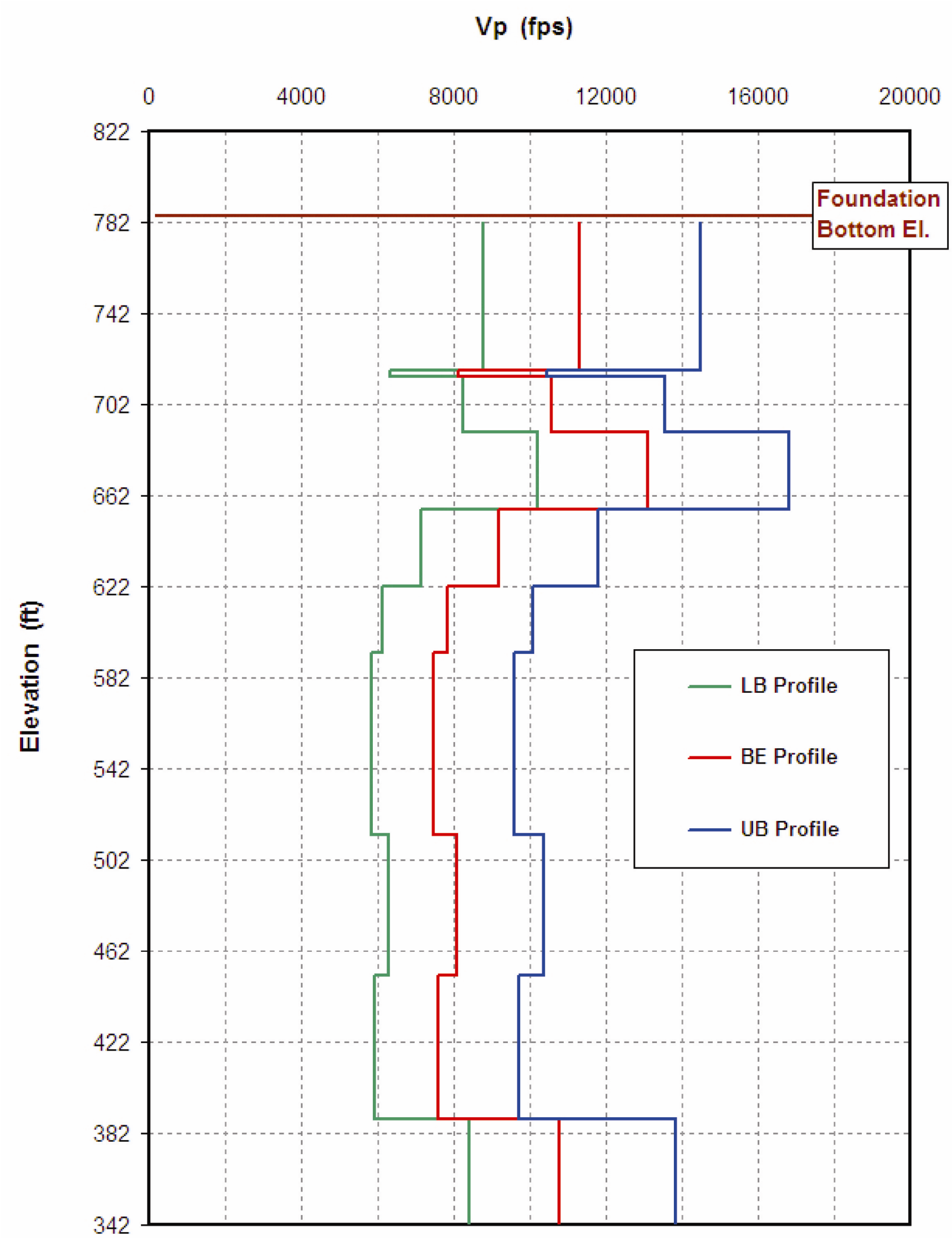

Figure 3NN-2 Rock Subgrade P-Wave Velocity Profiles

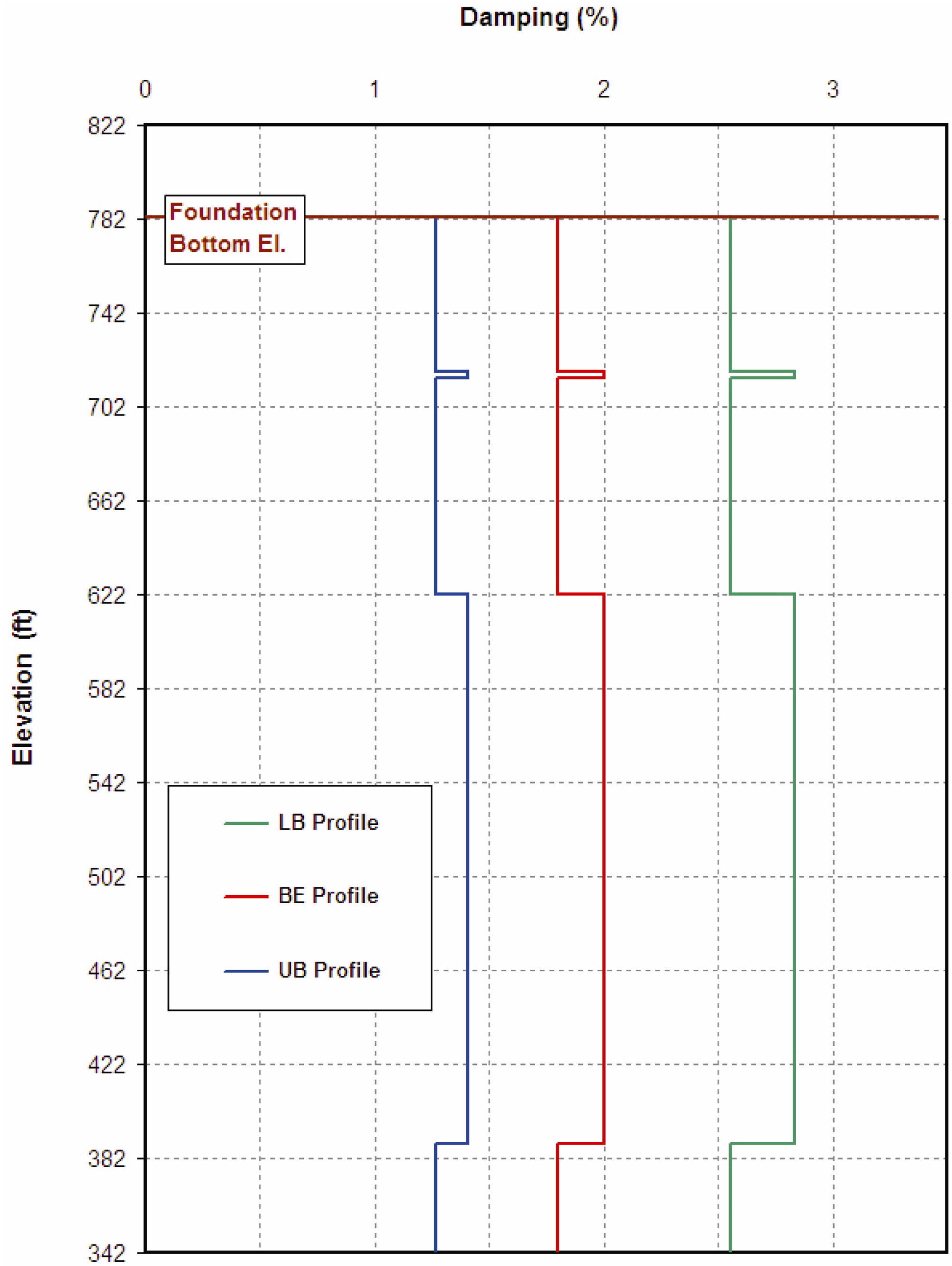

Figure 3NN-3 Rock Subgrade Damping Profiles

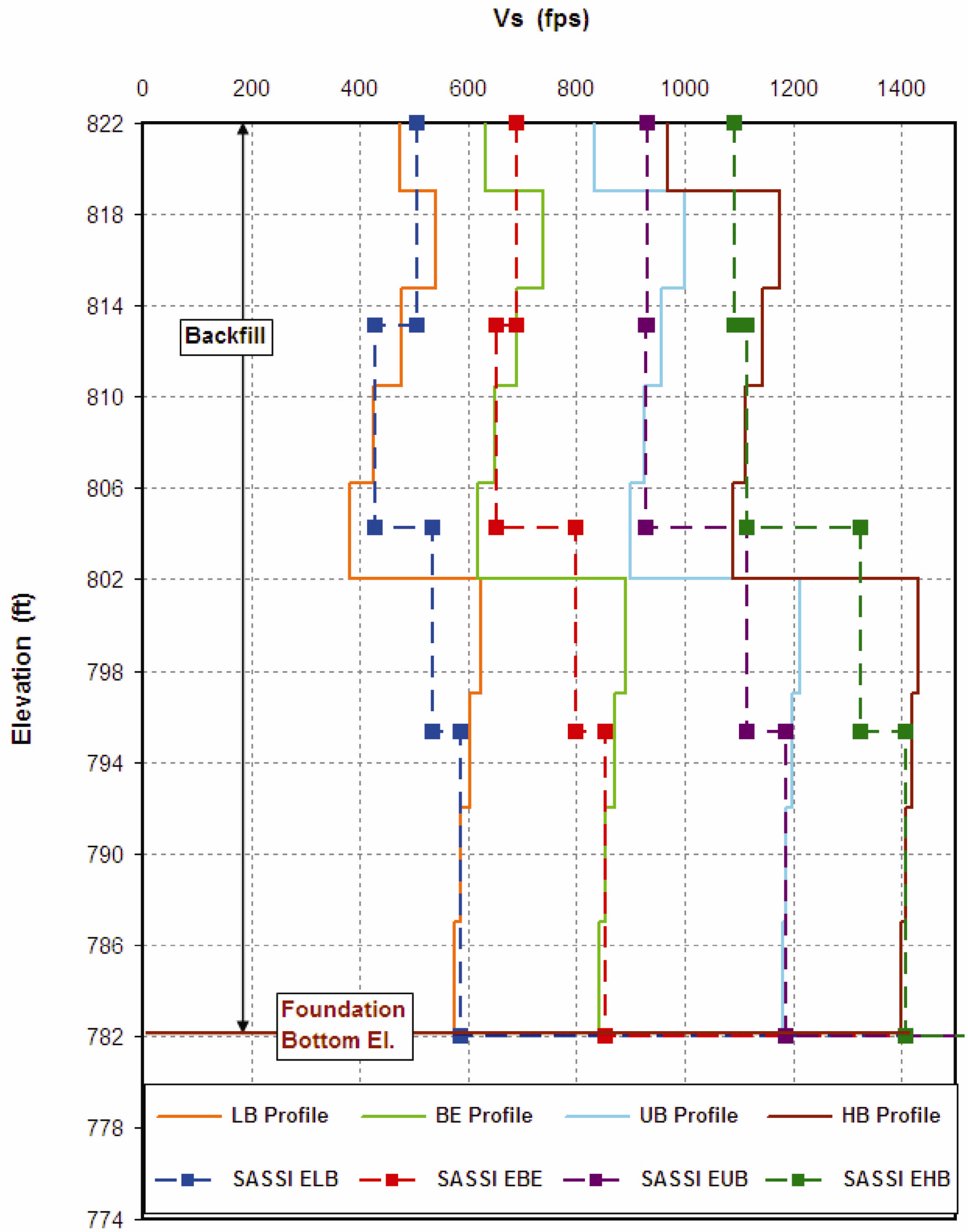

Figure 3NN-4 Backfill Strain-Compatible S-Wave Velocity Profiles

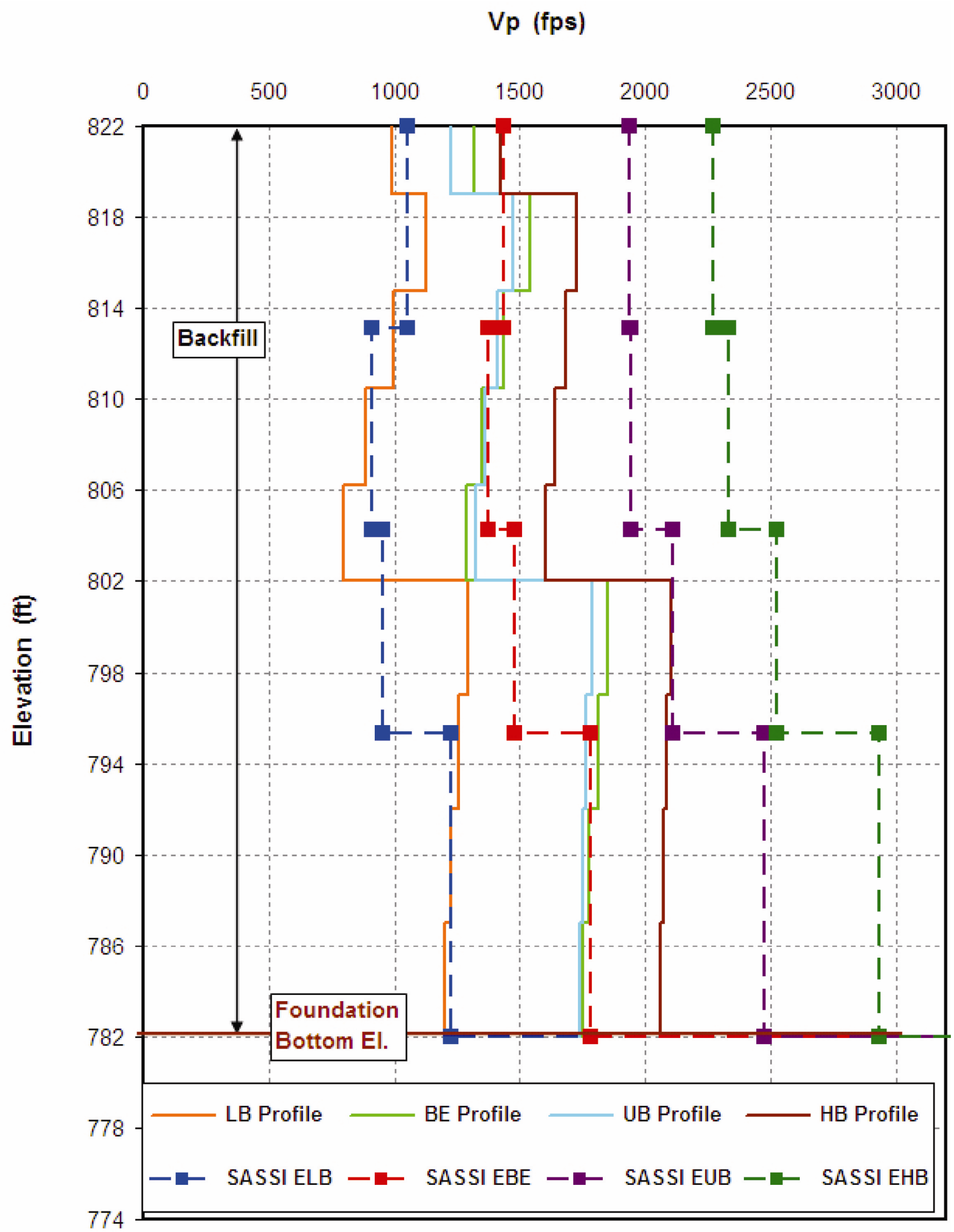

Figure 3NN-5 Backfill Strain-Compatible P-Wave Velocity Profiles

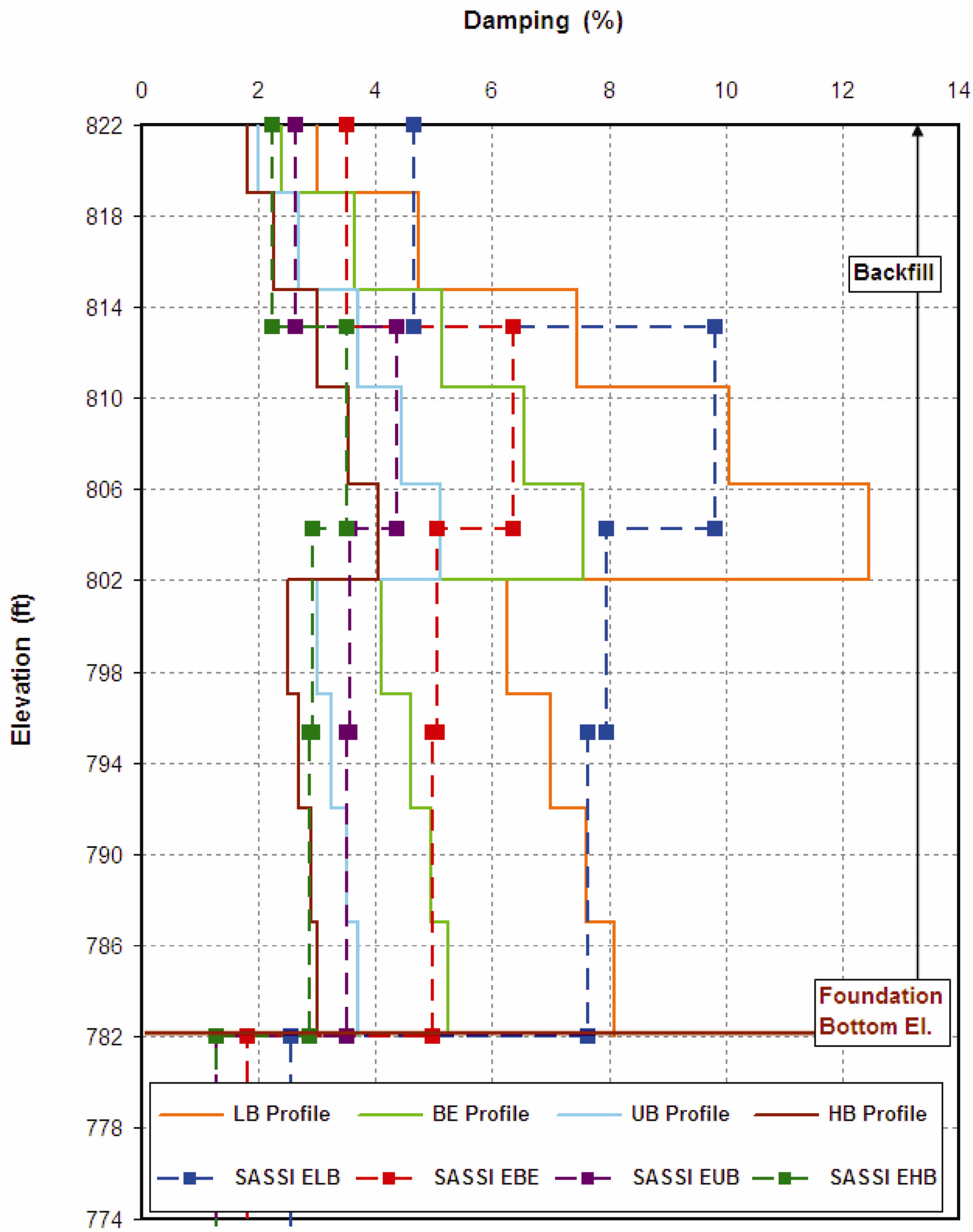

Figure 3NN-6 Backfill Strain-Compatible Damping Profiles

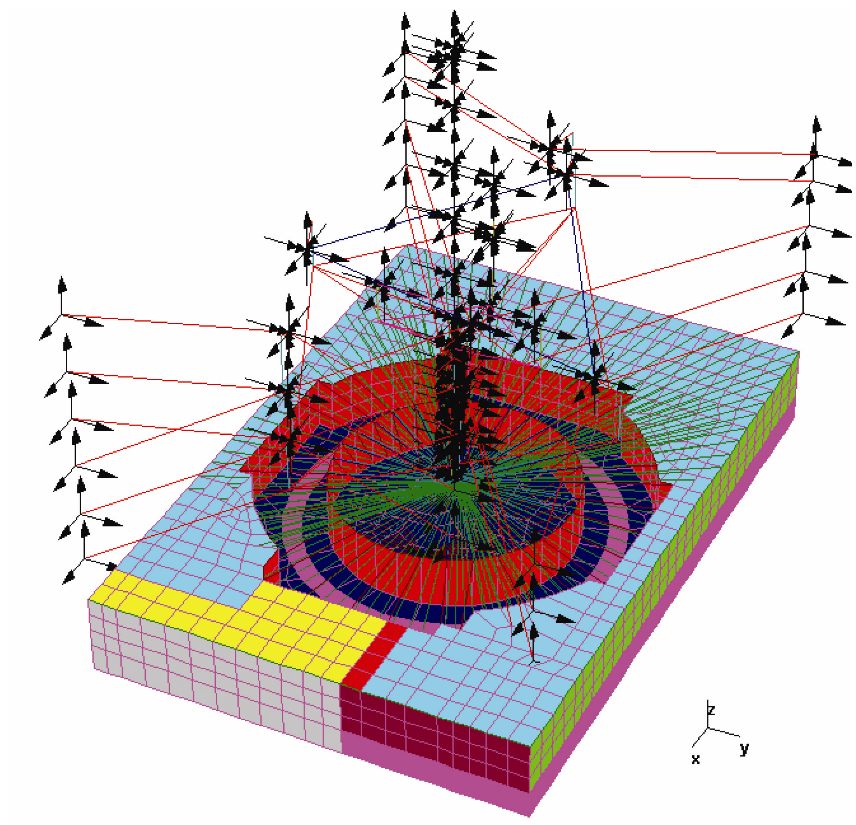

Figure 3NN-7 SASSI Structural Model of R/B-PCCV-Containment Internal Structure on Common Foundation

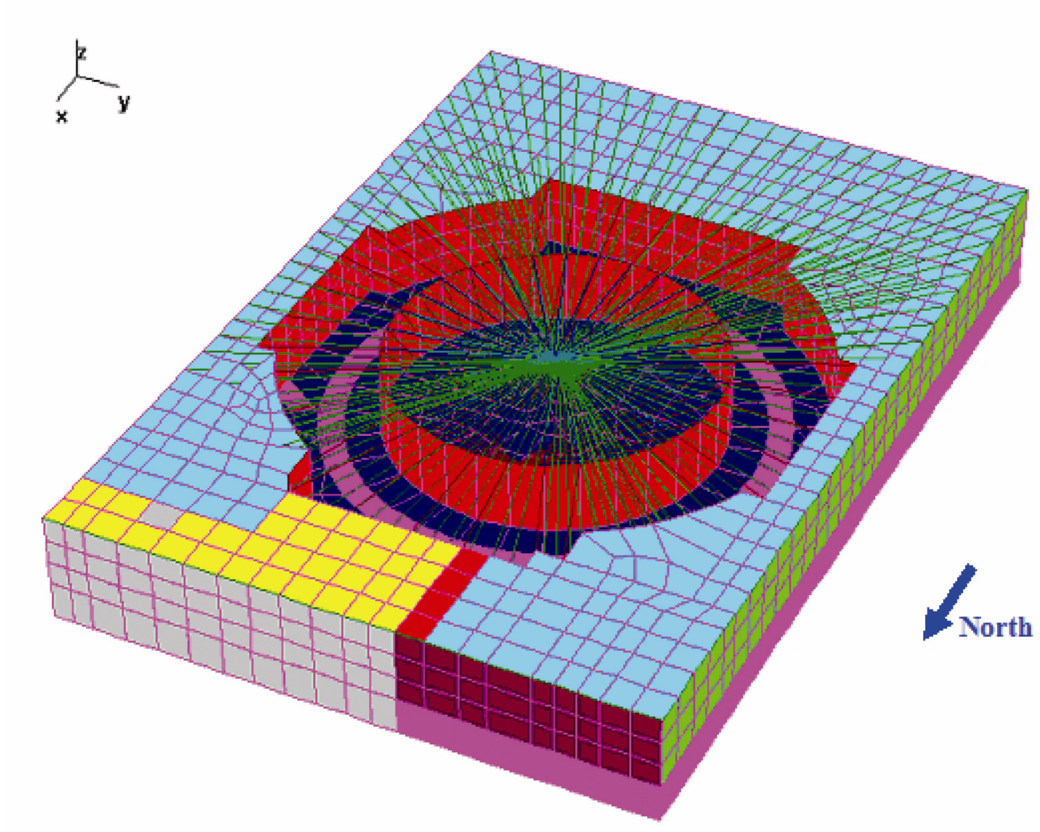

Figure 3NN-8 SASSI FE Model of Basement

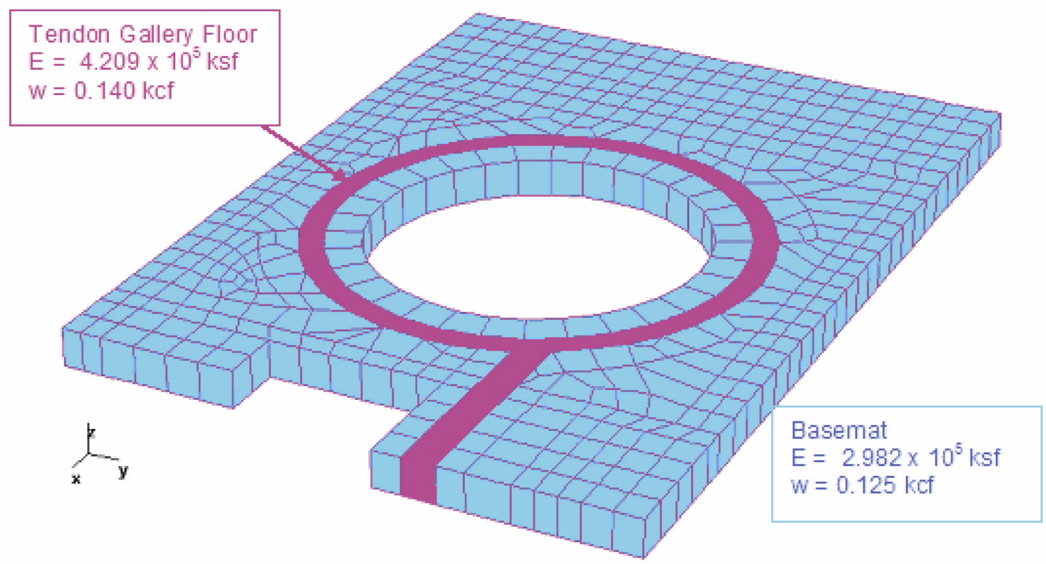

Figure 3NN-9 Solid FE of R/B Basemat

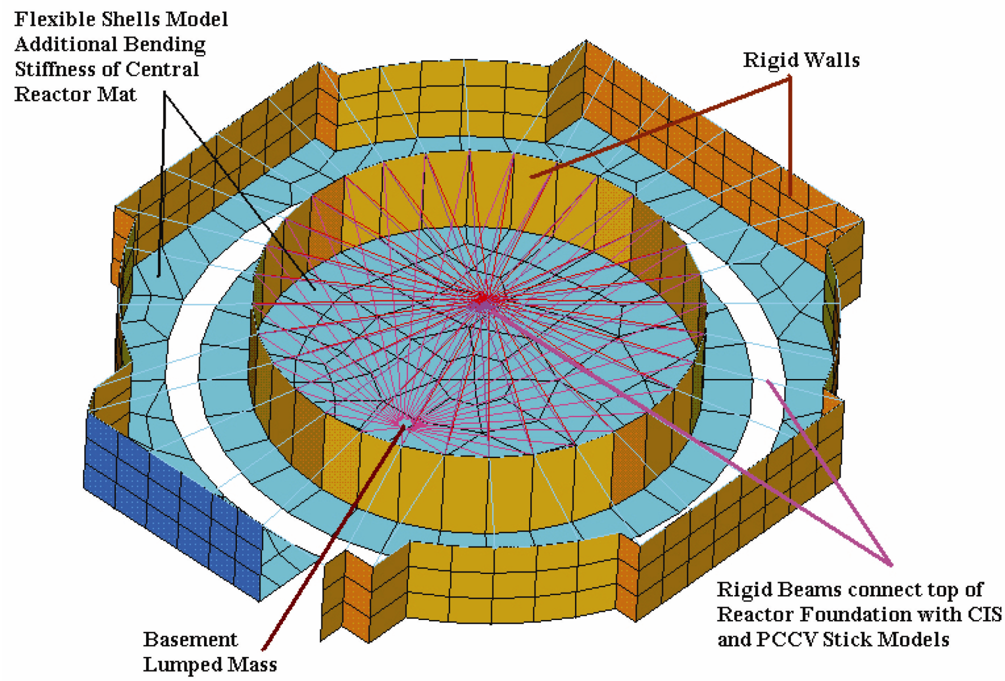

Figure 3NN-10 FE Model of Upper Portion of Thick Reactor Foundation

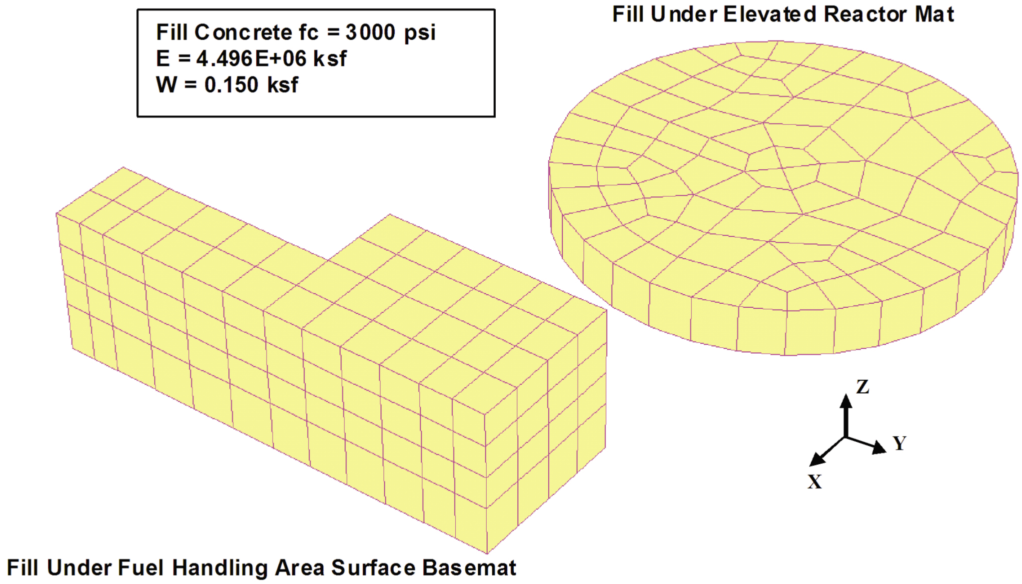

Figure 3NN-11 Fill Concrete Underneath Basemat

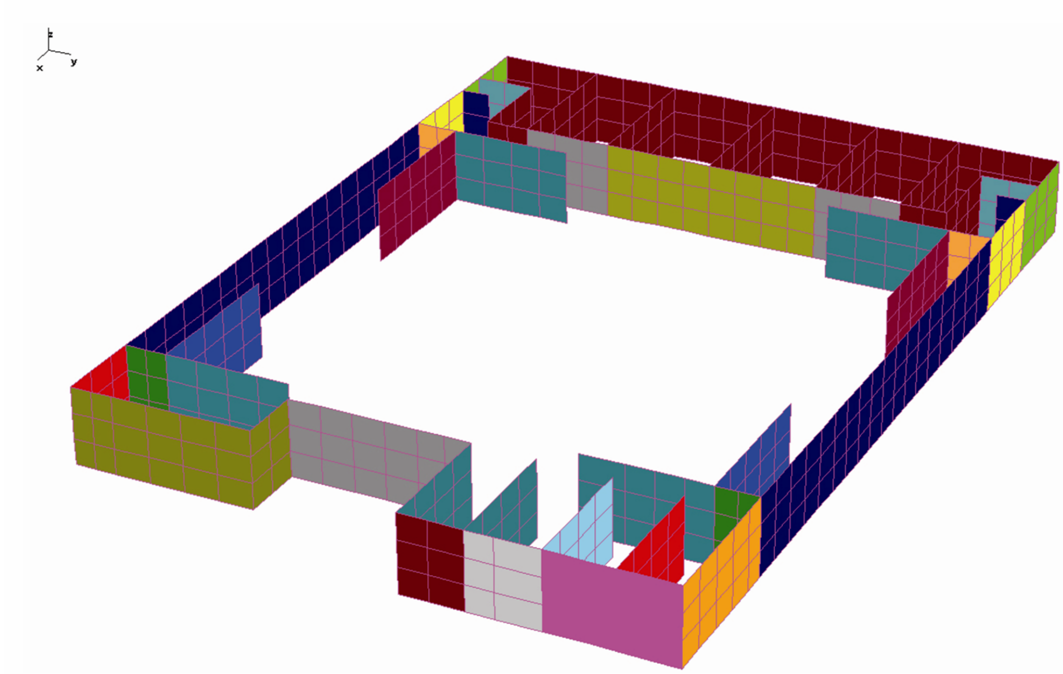

Figure 3NN-12 R/B Basement Shear Walls

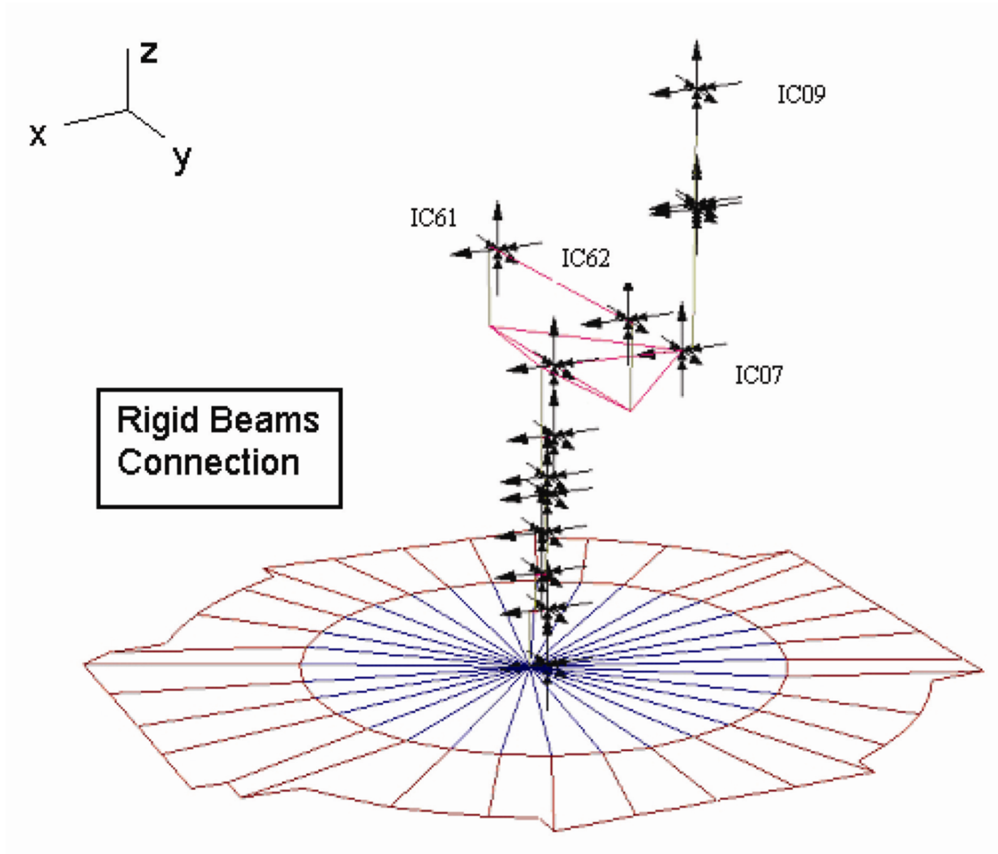

Figure 3NN-13 Containment Internal Structure Lumped Mass Stick Model with Rigid Ground Floor Connection

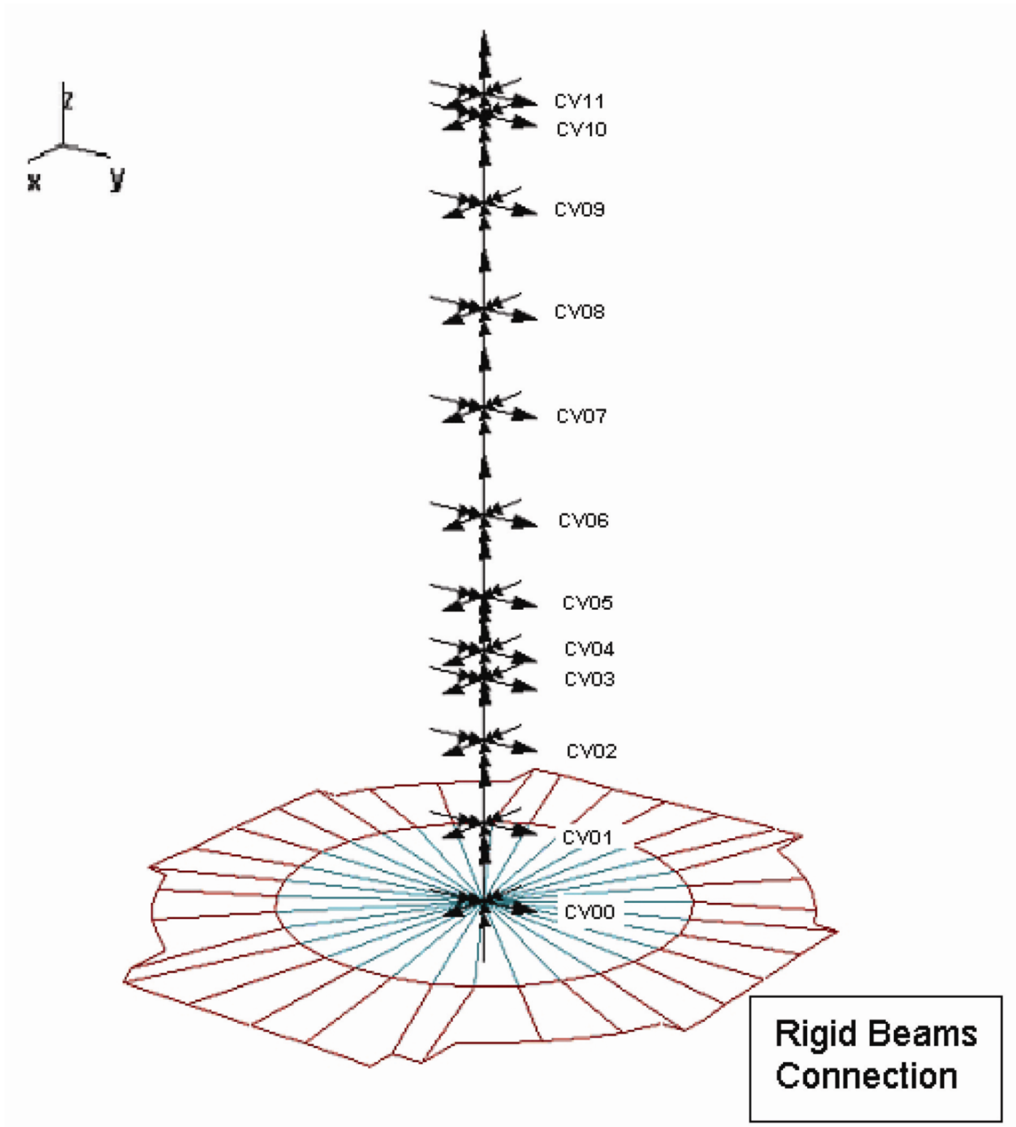

Figure 3NN-14 PCCV Lumped Mass Stick Model with Rigid Ground Floor Connection

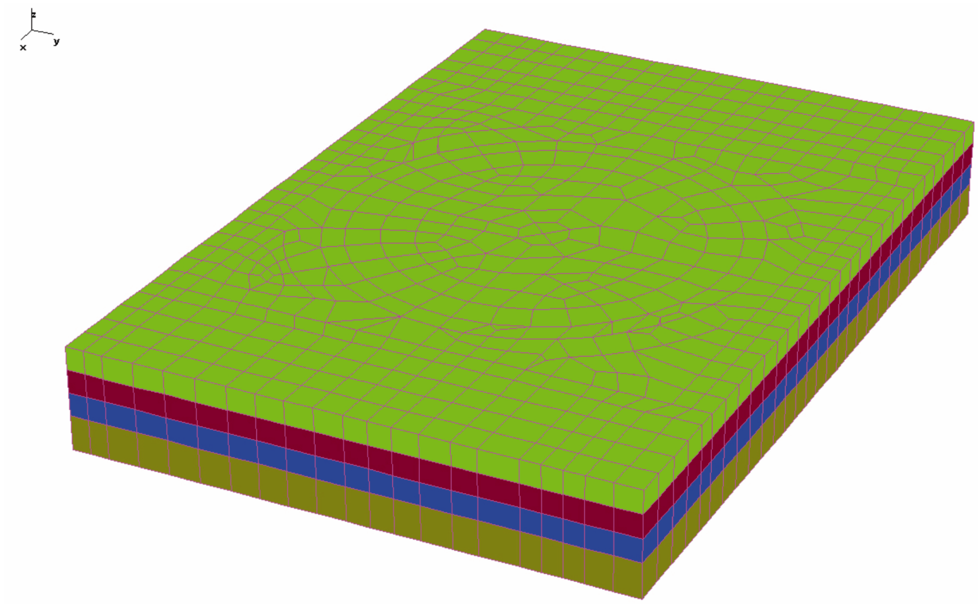

Figure 3NN-15 SASSI FE of Excavated Soil

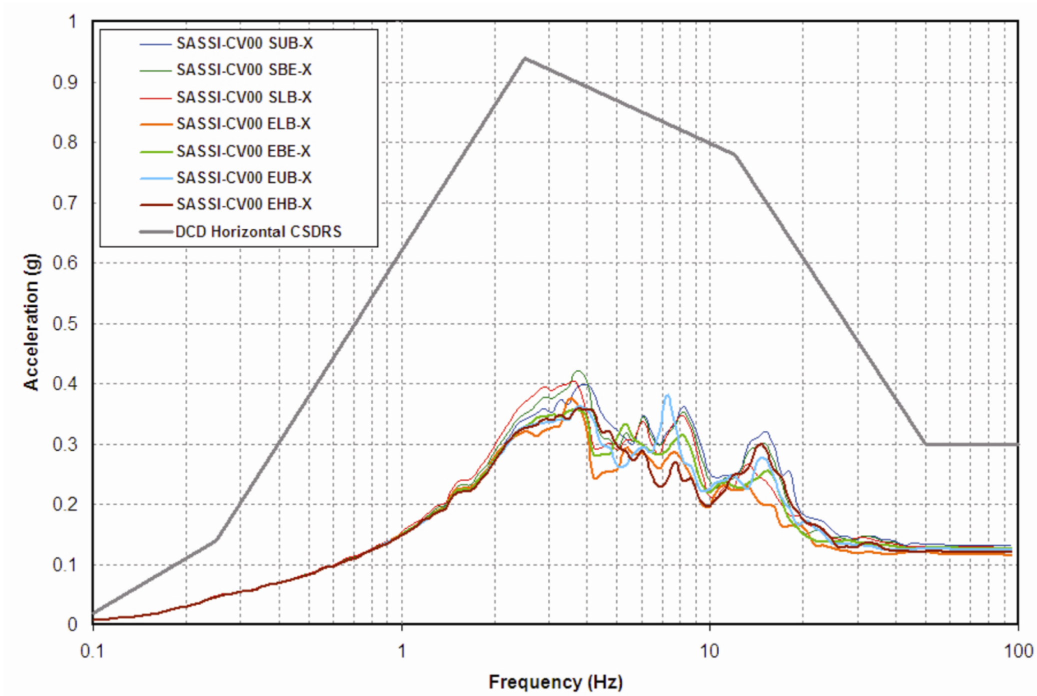

Figure 3NN-16 ISRS of PCCV CV00 (NS - Direction)

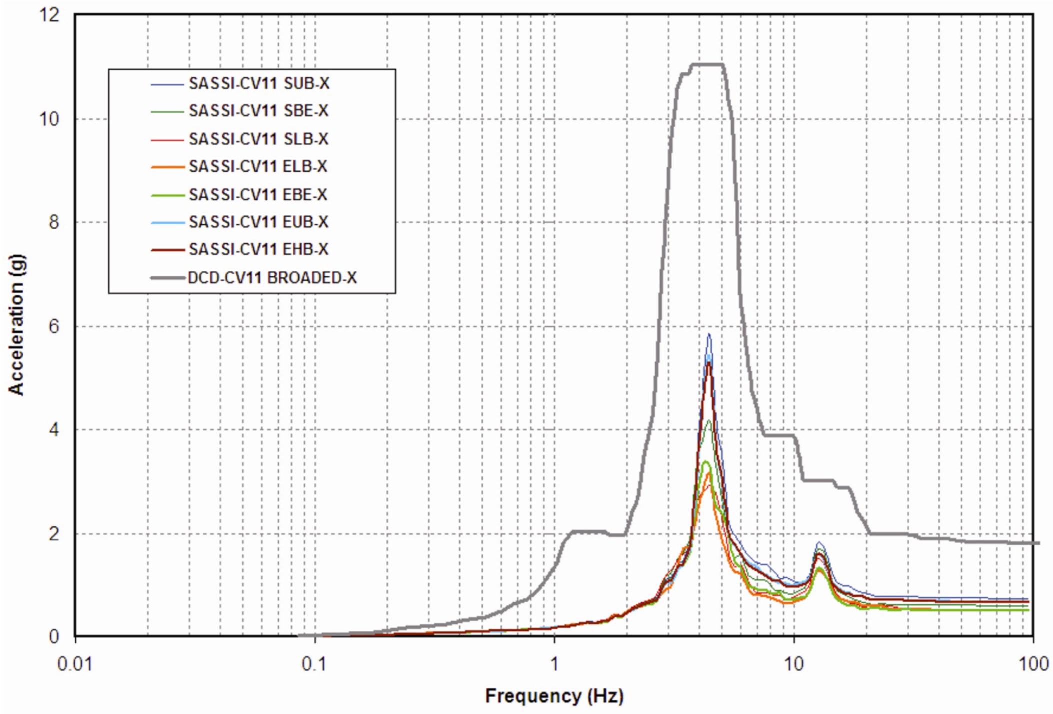

Figure 3NN-17 ISRS of PCCV CV11 (NS - Direction)

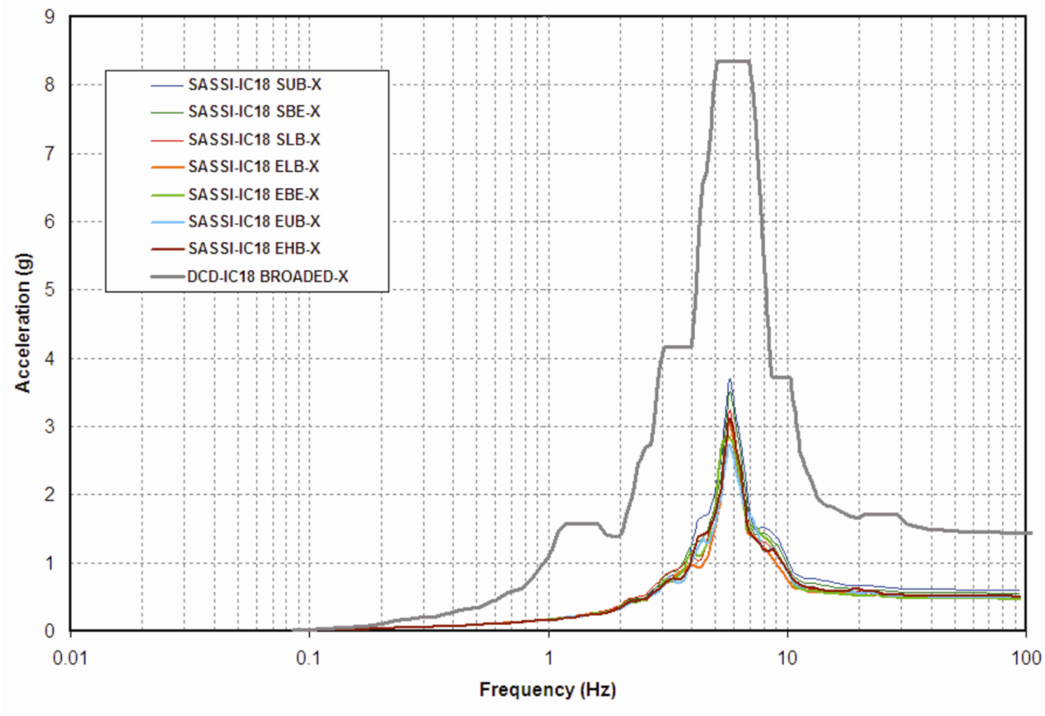

Figure 3NN-18 ISRS of Containment Internal Structure IC18 (NS - Direction)

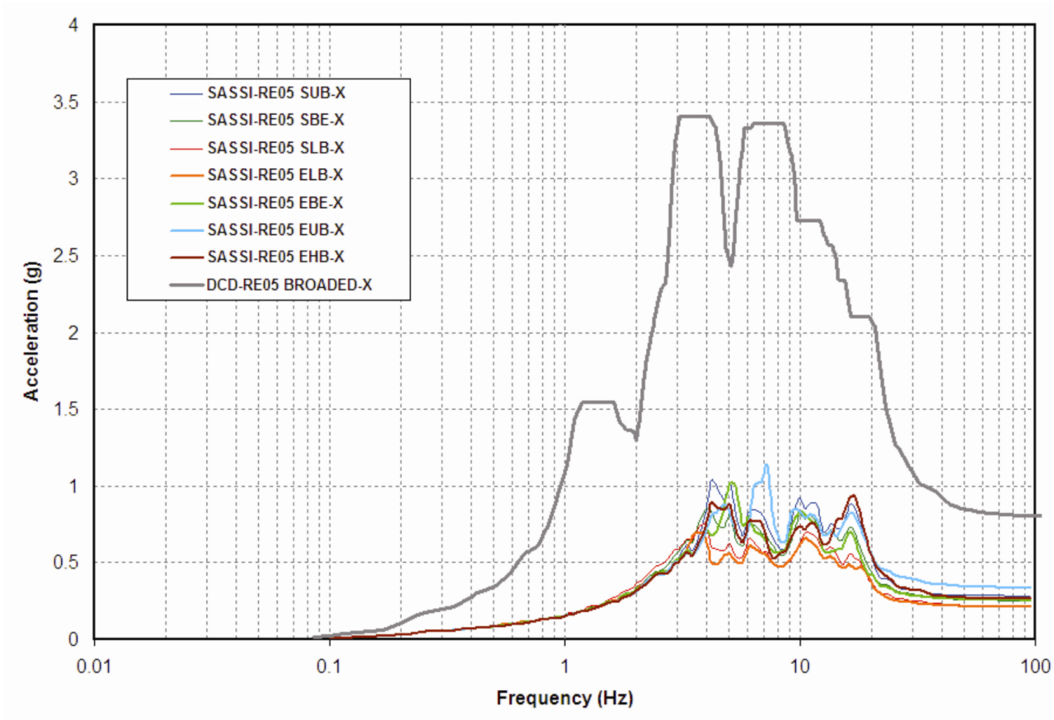

Figure 3NN-19 ISRS of R/B RE05 (NS - Direction)

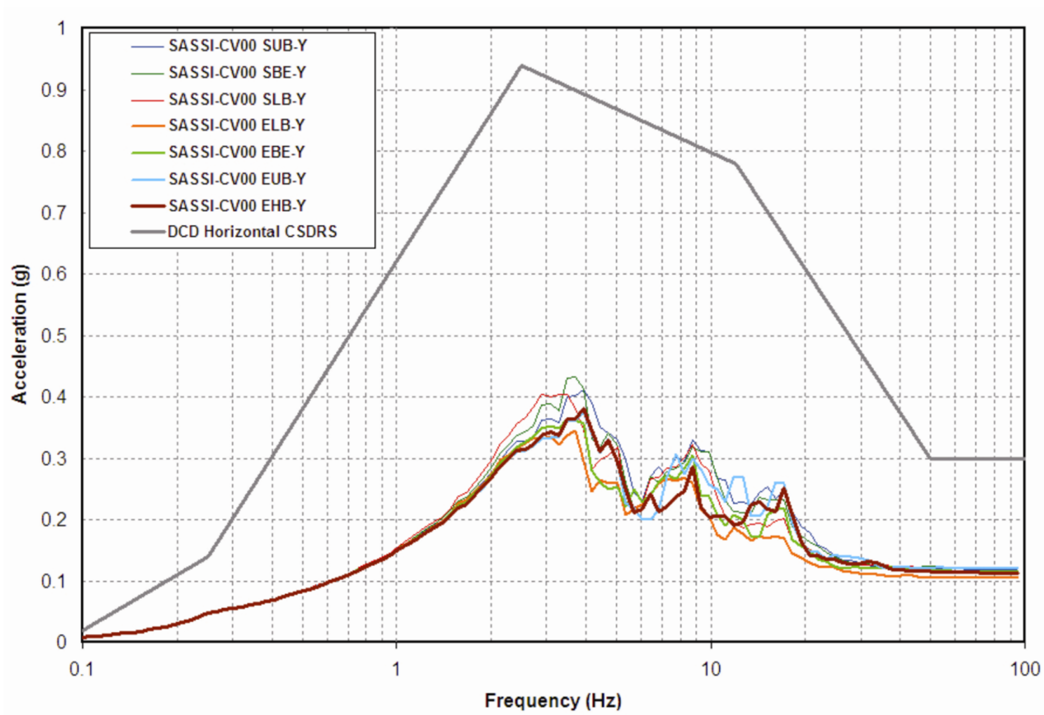

Figure 3NN-20 ISRS of PCCV CV00 (EW - Direction)

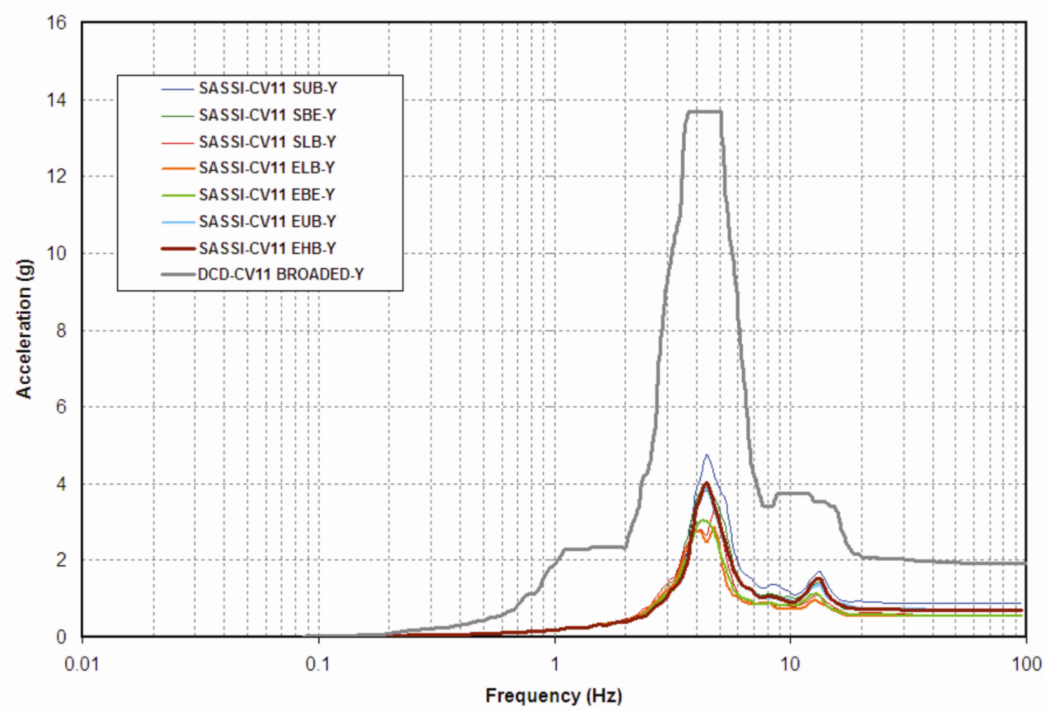

Figure 3NN-21 ISRS of PCCV CV11 (EW - Direction)

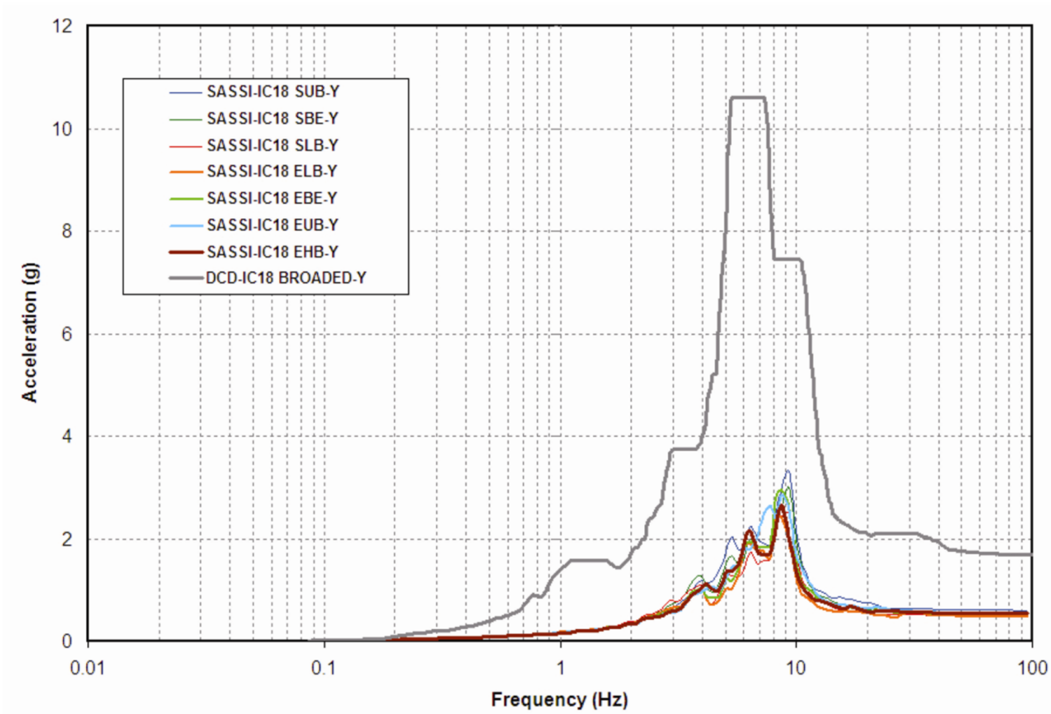

Figure 3NN-22 ISRS of Containment Internal Structure IC18 (EW - Direction)

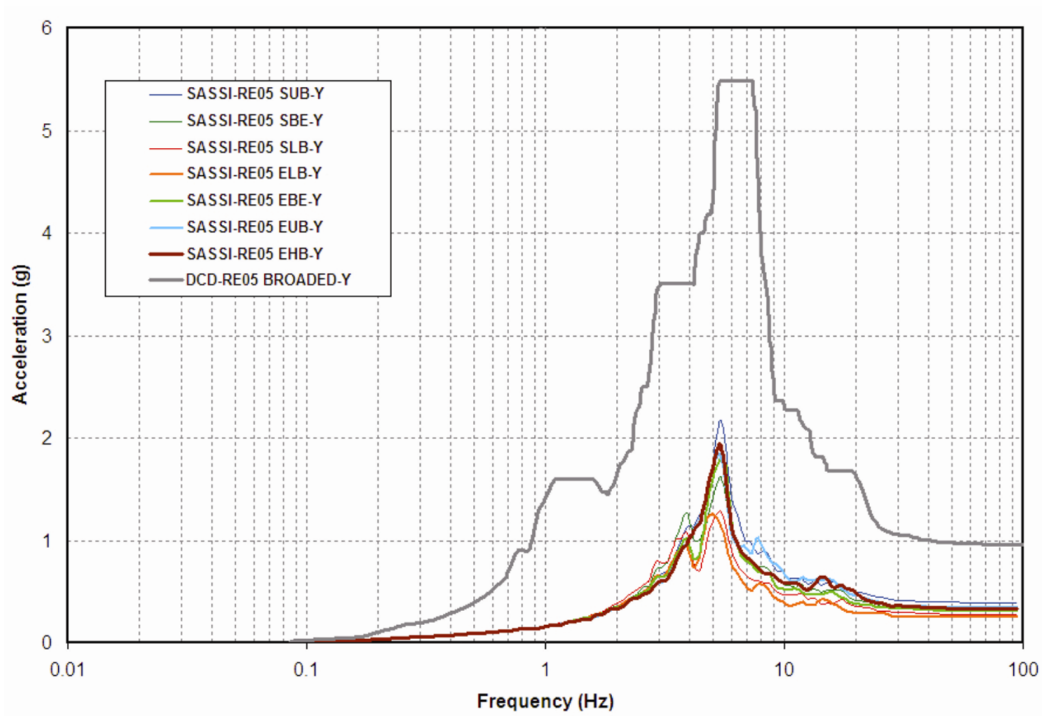

Figure 3NN-23 ISRS of R/B RE05 (EW - Direction)

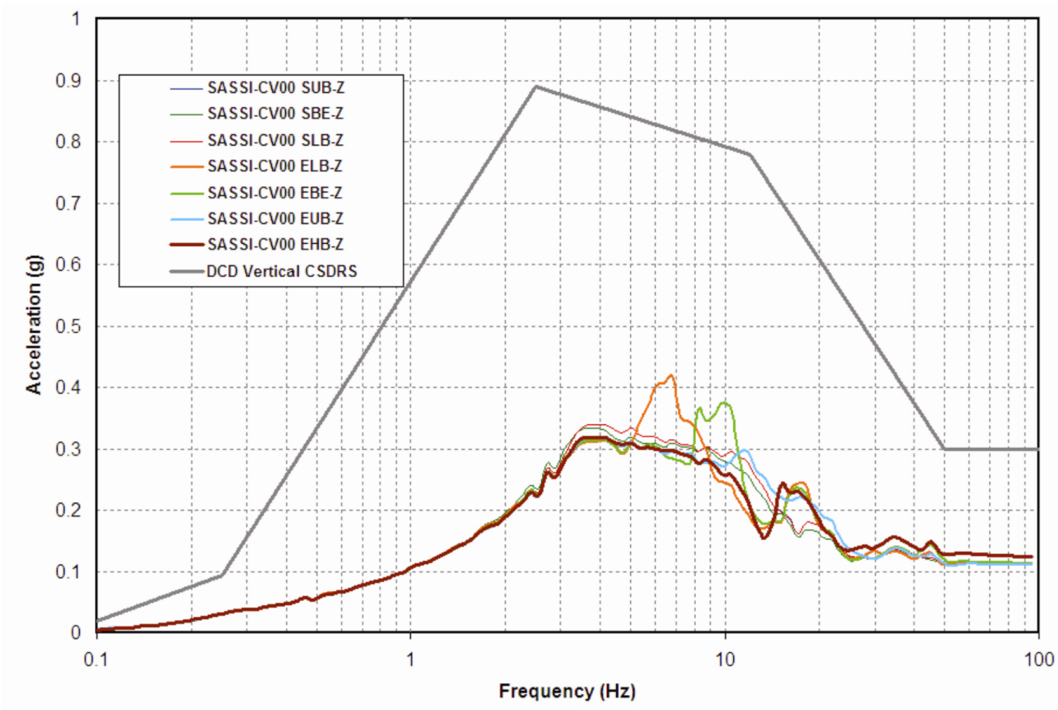

Figure 3NN-24 ISRS of PCCV CV00 (Vertical - Direction)

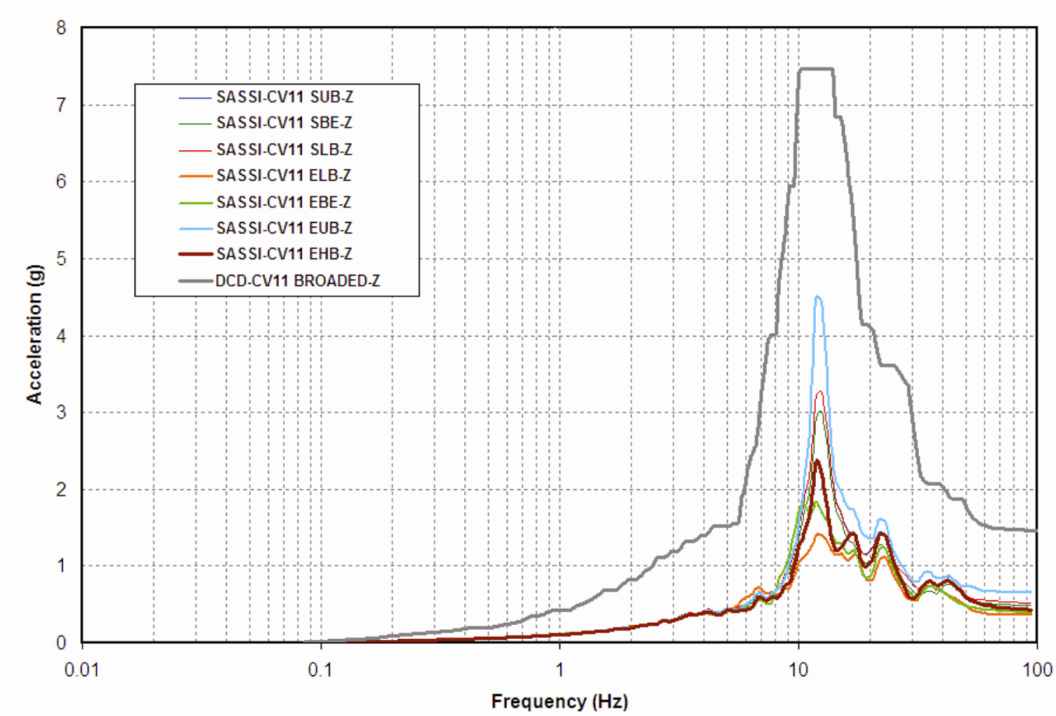

Figure 3NN-25 ISRS of PCCV CV11 (Vertical - Direction)

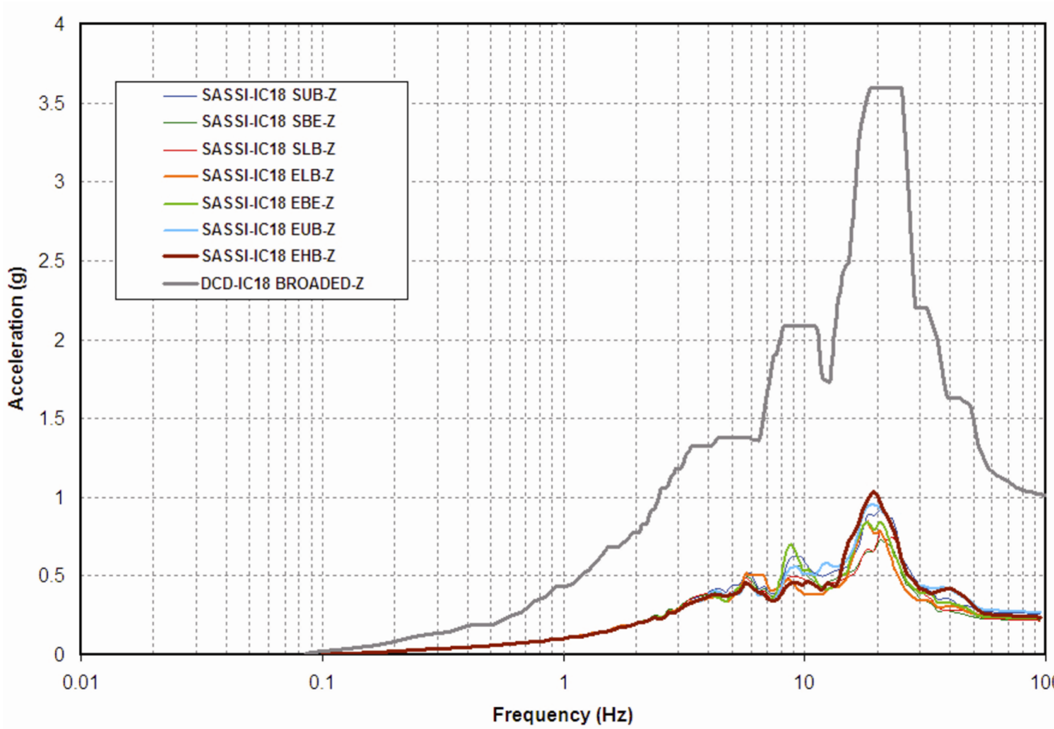

Figure 3NN-26 ISRS of Containment Internal Structure IC18 (Vertical - Direction)

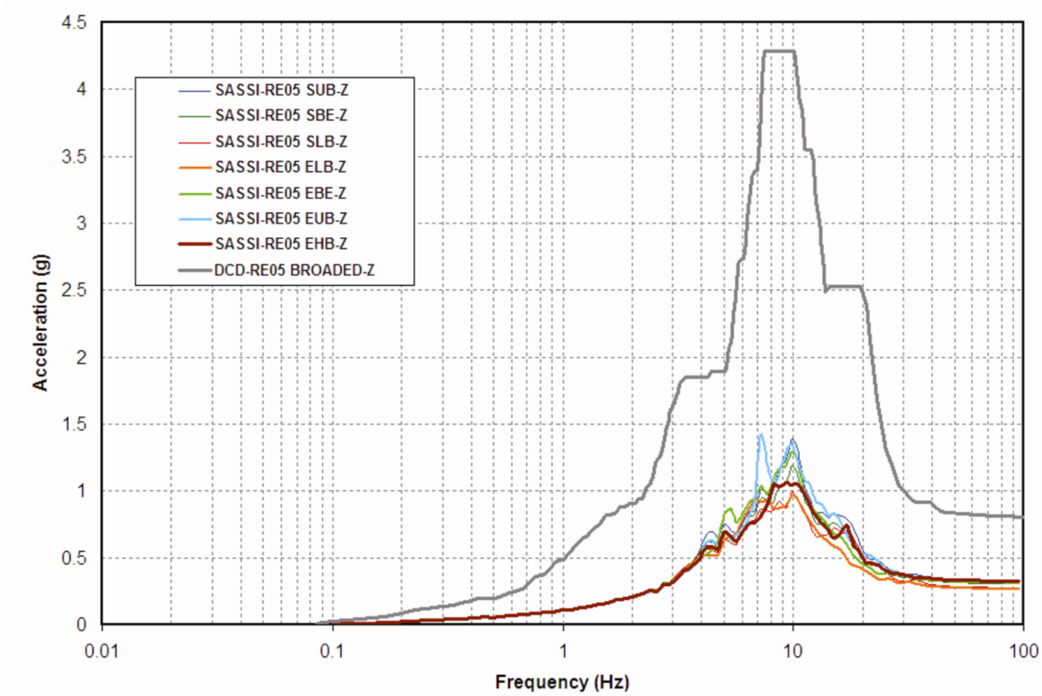

Figure 3NN-27 ISRS of R/B RE05 (Vertical - Direction)