Evaluation of Structure-Soil-Structure Interaction(SSSI) Effects

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ABSTRACT

This technical report provides to evaluate the structure-soil-structure interaction effects on the seismic response of the APR1400 standard plant structures. The APR1400 standard plant structures are nuclear island consisting of reactor containment building and auxiliary building founded on monolithic common basemat and emergency diesel generator building.

For evaluation of the structure-soil-structure interaction effects due to presence of adjacent structures, the structure-soil-structure interaction analysis using coupled model for all structures in the power block are performed. In the structure-soil-structure interaction analysis, two generic site profile cases representing the soft and hard soil case profiles are considered. From the analysis results, the variation of the maximum seismic response (demand) parameter such as in-structure response spectra under the design-basis seismic ground motion input is investigated.

Due to model size limitation of the Fast Solver version of the ACS-SASSI computer program, the coupled structure-soil-structure interaction model is developed assuming a surface-supported foundation condition. This approximation reduces substantially the number of DOFs, thus, eliminates the structure-soil-structure interaction model size limitation problem. Since Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses (DC/COL-ISG-017) addresses the analysis case of “Embedded Structures Analyzed as Surface Structures in the Certified Design”, and since surface structure provides more conservative seismic responses than embedded structure, this approximation is acceptable.

In order to evaluate the adequacy of the surface-founded assumption, an additional set of SSSI analyses are performed with the embedded foundation configuration for the combined model of the NI and EDGB/DFOT room.

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ACRONYMS AND ABBREVIATIONS

AB	auxiliary building
APR1400	Advanced Power Reactor 1400
CPB	compound building
CS	containment structure
CSDRS	certified seismic design response spectra
DFOT	diesel fuel oil tank
DOF	degree of freedom
EDGB	emergency diesel generator building
E-W	east-west
EPRI	Electric Power Research Institute
FEM	finite element model
FVM	flexible volume method
IS	internal structure
ISRS	in-structure response spectra
ISG	interim staff guidance
KEPCO	Korea Electric Power Corporation
NI	nuclear island
N-S	north-south
OBE	operating basis earthquake
PGA	peak ground acceleration
PSW	primary shield wall
PZR	pressurizer
RCB	reactor containment building
RCS	reactor coolant system
RG	regulatory guide
RV	reactor vessel
SFG	structural fill granular
SGA	switchgear area
SRP	Standard Review Plan
SRSS	square-root-of-the-sum-of-squares
SSE	safe shutdown earthquake
SSI	soil-structure interaction
SSSI	structure-soil-structure interaction
SSW	secondary shield wall
TI	turbine island

TGB	turbine generator building
TGP	turbine generator pedestal
COL	combined license

1 INTRODUCTION

The purpose of this technical report is to present the structure-soil-structure interaction (SSSI) analysis methodologies and results for the advanced power reactor 1400 (APR1400) standard plant structures which consist of the reactor containment building (RCB), auxiliary building (AB), and emergency diesel generator building (EDGB). It describes the seismic ground motion input, site conditions, dynamic models, and analysis methodology and procedures used in carrying out the seismic SSSI analysis. The key analysis results obtained from the analysis are also presented.

The APR1400 nuclear island (NI) structures include the RCB and AB founded on monolithic common basemat. The RCB is structurally separated from the AB with a minimum seismic gap of 6 in. above the common basemat. The RCB which is a seismic category I structure consists of pre-stressed concrete cylindrical shell and hemispherical type of dome, and reinforced concrete internal structure which are supported on reinforced concrete mat foundation. The AB is wrapping around the RCB leaving a space for the seismic gap above the common basemat. The AB which is a seismic category I structure consists of reinforced concrete shear walls and floor slabs which are lateral load resisting systems, and frames which support the vertical loads. The EDGB which is a seismic category I structure consists of reinforced concrete shear walls and floor slabs which are lateral load resisting systems. The EDGB is separated from the AB with a typical 3 ft building gap.

For evaluating the SSSI effects of the NI structures and EDGB due to presence of adjacent structures as required in the NRC Standard Review Plan (SRP) Section 3.7.2 (Ref. 6), the SSSI analyses using coupled model for all structures in the power block are performed to investigate the variation of maximum seismic response (demand) parameter such as in-structure response spectra (ISRS) under the design-basis seismic ground motion input.

For the APR1400 standard plant design, a total of eight (8) generic site soil profile cases and two (2) concrete stiffness cases, namely, uncracked and cracked cases, have been considered for the design-basis soil-structure interaction (SSI) analysis. The assessment of SSSI effects can be considered as a parametric sensitivity study. For such a study, a subset of the 2 soil profile cases combined with the more conservative uncracked concrete stiffness case is considered adequate. Two soil cases (soft and hard) are selected for assessing the SSSI effects. However, it is anticipated that the SSSI effects will be more noticeable for the soft soil case and less sensitive for the hard soil case, but the hard soil case generally controls the responses.

This technical report consists of seven (7) sections and one (1) appendix. Section 1 provides an introductory note and background information. Section 2 presents the description of the seismic category I and II structures which are located in the APR1400 power block and are considered in the SSSI analyses. Section 3 describes seismic design bases including design ground motion and selected generic site soil profiles for the SSSI analysis. Section 4 describes the methodology of the SSSI analysis using the coupled structure model. Section 5 provides SSSI analysis results and SSSI effects on the standard plant structures. Section 6 provides additional SSSI analysis results and SSSI effects on the EDGB. And the references cited in this technical report are listed in Section 7. Appendix A describes an additional SSSI analysis using the combined model of the NI and EDGB/DFOT room with the embedded foundation configuration to evaluate the adequacy of the surface-founded assumption.

2 DESCRIPTION OF STRUCTURES IN POWER BLOCK

This section presents description of the APR1400 seismic category I structures (RCB, AB, and EDGB) and seismic category II structures such as the compound building (CPB) and turbine generator building (TGB) which are located in the power block. The schematic layout of the APR1400 power block is shown in Figure 2-1.

The AB is bordered on its west side by the TGB, on part of its south side by the CPB and on part of its east side by the EDGB. The gaps provided between the AB and TGB, between the AB and CPB, and between the AB and EDGB are all 3 ft. These gaps below the plant's finished grade are backfilled with compacted structure fill granular (SFG).

2.1 Description of NI

The NI structures are classified as safety-related seismic category I structures. The RCB and AB are separate from each other above the basemat with a minimum 6 in. seismic gap. In plant layout, the AB wraps around the RCB completely. The plant's finished grade is at El. 98'-8". The top of the NI common basemat is at El. 55'-0". Thus, the exterior walls of AB are embedded to a depth of 43'-8" below the plant's finished grade. The thickness of the NI reinforced concrete basemat is nominally 10 ft.

2.1.1 RCB

The RCB is a safety-related seismic category I structure and is comprised of three concrete substructures:

- Containment structure (CS)
- Primary shield wall (PSW)
- Secondary shield wall (SSW)

The CS is also called the pre-stressed concrete containment vessel. The PSW and SSW are combined to form the reinforced concrete internal structure (IS), and are the supporting structures for the reactor coolant system (RCS).

The CS and IS are separated by 2 in. gap and only connected at their basemat at El. 78'-0". Therefore, there is no interaction between the two structures except through this common basemat.

Figure 2-2 shows the typical section view of the RCB.

2.1.2 AB

The AB is a safety-related seismic category I structure with an embedment depth of 53'-8" including basemat thickness. It encloses the RCB in the center without structural connection except at the common basemat.

The AB is a rectangular-shaped reinforced concrete structure. The building includes the electrical and control area, main steam valve house, chemical and volume control system areas, emergency diesel generator area, spent fuel pool, cask loading pit, refueling canal, and auxiliary feed water tanks.

The AB structure system is composed of reinforced concrete shear walls in both east-west (E-W) and north-south (N-S) directions for the lateral load resistance and the composite of reinforce concrete walls and slabs with the columns and girders for vertical load resistance.

Figure 2-3 shows the typical section view of the AB.

2.2 Description of EDGB

The EDGB is a safety-related seismic category I structure and is comprised of two separate concrete structures:

- EDGB
- Diesel fuel oil tank (DFOT) room

The EDGB is one of the APR1400 standard plant structures with an embedment depth of 6’-8”. Also the DFOT room is an APR1400 standard plant structure with an embedment depth of 39’-8”. The EDGB separates from the AB with a typical 3 ft building gap, and separates from the DFOT room with a typical 3 ft gap.

The structural system of the EDGB consists of shear walls in both E-W and N-S directions, and a total of 2 major floor slabs. These walls and slabs are made of reinforced concrete structures. The DFOT room consists of reinforced concrete shear walls and roof slabs. Steel girders are used to support the DFOT room roof.

Figure 2-4 shows the typical section view of the EDGB.

2.3 Description of CPB

The CPB is a non-safety-related seismic category II structure with an embedment depth of 42 ft approximately. The CPB separates from the AB with a typical 3 ft gap. The top of basemat is at El. 63'-0". The exterior walls of the CPB are embedded about 36 ft.

The shape of the CPB is a rectangular type. The major dimension of the CPB is 216 ft long and 178 ft wide. The CPB is composed of rectangular reinforced concrete walls, steel columns, steel girders, and reinforced concrete slabs. The CPB structure is designed to preclude a structural failure that results from the safe shutdown earthquake (SSE) and that degrades the structural integrity of the adjacent AB.

The CPB is a five-story structure. The major floors are located at El. 63'-0", 85'-0", 100'-0", 120'-0" and 139'-6". The labyrinth walls that create numerous compartments utilized for the radwaste management system components are arranged in the basement and first two floors.

Figure 2-5 shows the typical section view of CPB.

2.4 Description of TI

The three structures, namely, (1) TGB, (2) switchgear area (SGA), and (3) turbine generator pedestal (TGP), of the turbine island (TI) are separate above their common basemat. The TGB and TGP are structurally completely separated above the common basemat with a seismic gap between them. The TGB and SGA are structurally connected below the plant’s finished grade but are structurally separated above grade with also a seismic gap between them.

The top surface of the TI common basemat is mostly at El. 73’-0”, but some areas of the basemat sink further down to El. 55’-0”. The configuration of the entire TI structures are approximately rectangular in plan having maximum plan dimensions of about 340 ft in the plant EW direction and about 195 ft in the plant NS direction. The TGB has an overall height of about 127 ft above the plant grade and the outside walls of the TI are embedded to a depth of about 50 ft below grade.

The section view of the TI structures is presented in Figure 2-6.

2.4.1 TGB

The TGB is a composite of braced steel frame and concrete shear wall structure. The TGB structure above grade is a braced steel frame structure, consisting of 11 transverse frames, each of which is in a plane aligned in the plant N-S direction and 8 longitudinal frames aligned in a plane in the plant E-W direction. The TGB structure below grade is primarily a concrete shear-wall structure. Some interior steel columns above grade for the steel frame structure extend further down below grade to the top of the basemat.

The TGB has two floors above basemat, the tops of which are at El. 100'-0" and El. 136'-6". The floor slab of each of the two floors is a reinforced concrete slab fully composite with a grid of slab-supporting steel girders and beams for carrying out-of-plane vertical loads. The slab at El. 100'-0" has a rectangular opening in its central area. Similarly the slab at El. 136'-6" has a rectangular opening in the same central area. These openings on the two floor-slabs accommodate the reinforced concrete TGP frame structure.

The roof truss is about 11 ft tall from El. 216'-3" to El. 227'-0". Two (main and auxiliary) overhead-cranes oriented in the plant N-S direction service the TGB open bay above the floor at El. 136'-6". Each overhead crane is supported on two longitudinal crane girders. When the cranes are not in service, they are positioned and parked at the east-end of TGB.

2.4.2 SGA

The SGA is in plan a rectangular reinforced concrete shear wall structure with two levels of reinforced concrete floor slabs at El. 100'-0" and 122'-0", and a reinforced concrete roof slab at El. 145'-0". The structure is situated at the north-east corner of the TI structures.

The structure in plan measures about 73 ft in the plant N-S direction and about 101 ft in the plant E-W direction. The overall structure has a height of 45 ft above grade. The east-end portion of the SGA, that covers a below grade common tunnel, is one story shorter than the rest of the SGA. The roof slab of this portion is at El. 122'-0".

There are four interior steel columns, which are supported on top of basemat and extend all the way to the bottom side of the roof slab, supporting the interior portions of the SGA floor and roof slabs. Similar to the TGB floor slabs, the SGA reinforced concrete floor and roof slabs are supported by steel girders and beams that have full composite action with the reinforced concrete slabs for resisting the vertical loads on the slabs.

2.4.3 TGP

The TGP is a rectangular reinforced concrete moment-frame structure, which is about 229 ft long in the plant E-W direction and about 51 ft wide in the plant N-S direction. The structure is supported on top of the TI common basemat.

The TGP structure consists of six transverse (in the plant N-S direction) rows of two columns lined up longitudinally (in the plant E-W direction). The columns have rectangular cross-section shape and are rigidly connected at their top ends to a horizontal reinforced concrete frame, which is comprised of two longitudinal girders and six transverse beams. The top of the horizontal frame is flushed with the TGB operating floor at El. 136'-6".

The TGP columns supported on top of the TI common basemat have different heights. The two columns on the east and west ends are supported on the top of the basemat at El. 73'-0. The four interior rows of TGP columns are supported on an area of basemat that sinks down further, having its top surface at El. 55'-0". The TGP frame structure is completely separated from the TGB structure above the basemat.

3 APR1400 SEISMIC ANALYSIS BASES

This section presents description of the APR1400 seismic analysis bases such as design ground motions and low-strain site soil profiles.

3.1 Design Ground Motion

The basic seismic design input parameters used in the seismic analysis of the APR1400 standard plant structures consist of (a) design ground motion for the SSE and operating basis earthquake (OBE) conditions and (b) design time histories to be used for the seismic analysis.

For the APR1400, the design ground motion for the OBE considered for design is set equal to one-third (1/3) of SSE. Thus, in accordance with the NRC Standard Review Plan (SRP) Section 3.7.1, Revision 4, guidelines (Ref. 5), an explicit seismic analysis or design for the OBE is not required. Hence, only the design ground motion for the SSE need be considered for the seismic analysis of the safety-related structures.

For APR1400, the design ground motion for the SSE considered in seismic design consists of two sets of ground motion parameters. Namely, (a) horizontal and vertical design (ground motion) response spectra of the site-independent SSE referred to as the certified seismic design response spectra (CSDRS) and anchored to peak ground acceleration (PGA) of 0.3g, where g is the acceleration of gravity, and (b) horizontal and vertical design time histories compatible with CSDRS.

The spectral values of the CSDRS for frequencies below 9 Hz are the same as the spectral values of the NRC Regulatory Guide (RG) 1.60 design response spectra (Ref. 8) anchored to PGA value of 0.3g. The spectral values of the CSDRS for frequencies in the higher frequency range between 9 and 50 Hz are enhanced from the corresponding spectral values of the RG 1.60 design response spectra. At the frequency of 25 Hz, the spectral values of the CSDRS are increased from the corresponding spectral values of the RG 1.60 spectra by 30%. Then, the spectral values for frequencies between 9 and 50 Hz are obtained by linear interpolation in log-log scale of enhanced spectral values at 25 Hz and the RG 1.60 spectral values at 9 and 50 Hz. Figures 3-1 and 3-2 show the horizontal and vertical CSDRS, respectively. The digitized values of the resulting horizontal and vertical CSDRS are provided in Table 3-1.

For the APR1400 standard design, the control point of the CSDRS is defined at the surface of the plant's finished grade.

The three design acceleration time histories composed of two horizontal (H1 and H2) and one vertical (VT) components which envelop the CSDRS are applied to the APR1400 seismic analysis. The initial seed recorded motions that are modified to create the design time histories are actual recorded Northridge earthquake time histories.

The design time histories are generated with a time step size of 0.005 seconds. Figures 3-3, 3-4, and 3-5 show the acceleration, velocity, and displacement time histories for H1, H2, and VT components for each time step, respectively. The design time histories, H1, H2, and VT are applied in the E-W, N-S, and vertical direction, respectively. The design time histories are statistically independent, because the correlation coefficients between the design time histories are less than 0.16 as specified in SRP 3.7.1. Therefore, the representative maximum response of interest of the APR1400 structures, systems, and components can be obtained either by performing separate analyses for each of the three components of design time histories, or by performing a single analysis with all three components of design time histories applied simultaneously. The design time histories have a total time duration equal to 20.48 seconds and a corresponding stationary phase, strong motion duration defined as the time required for the Arias Intensity rise from 5 percent to 75 percent greater than 6 seconds.

The details of CSDRS and the CSDRS-compatible design time histories are provided in the technical report, 1-300-C462-001, entitled "Seismic Design Bases for the ARP1400 Standard Plant Design" (Ref. 2).

3.2 Low-strain Site Profiles

The APR1400 standard plant design considers the plant is supported in various generic site profiles. A total of eight generic site profiles plus a 9th fixed-base support condition. The eight generic site conditions considered are all horizontally layered sites with site shear wave velocities varying from soft to medium to firm soil sites and soft to medium to hard rock sites. To develop the generic site profiles to be used as the input for the seismic SSI analyses, free-field site response analyses are performed using the low-strain site profiles.

The eight low-strain site profiles considered for design of the APR1400 standard plant consist of six site-layering categories, labeled as Site-Layering Category A through F with their site-layer thickness and depths from the ground surface as follows:

Site-Layering Category	Layer Thickness (ft)	Layer Depth Range (ft)
A	55	0 ~ 55
B	45	55 ~ 100
C	100	100 ~ 200
D	300	200 ~ 500
E	500	500 ~ 1000
F	Infinite	Half space > 1000

In addition to six site-layering categories, five shear-wave-velocity categories, labelled as P1 through P5, with their shear-wave-velocity values as shown below are considered:

Shear-Wave-Velocity Category	Shear Wave Velocity (ft/sec)
P1	1,200
P2	2,000
P3	4,000
P4	6,000
P5	9,200

The site soil/rock material unit weight (weight density), Poisson's ratio, and types of shear-strain-dependent modulus-degradation and damping-value-variation curves for the soil/rock material (sand, soft rock, and rock) considered for each of the categories P1 through P5 are shown in Table 3-2.

The eight low-strain site profiles considered for design of APR1400 standard plant, designated as S1 through S4 and S6 through S9, are developed with combinations of the site-layering categories A through F and the shear-wave-velocity categories P1 through P5, as shown in Table 3-3. Figure 3-6 shows the low-strain shear wave velocity profiles vs. depth for the eight low-strain site profiles considered.

The shear-strain-dependent, soil/rock-modulus-degradation and damping-value variation curves for the soil/rock materials (sand, soft rock, and rock) considered for the eight low-strain site profiles are shown in Figures 3-7 for sand, Figure 3-8 for soft rock, and Figure 3-9 for rock. The curves for sand considered, as shown in Figure 3-7, adopt the sand curves published in the EPRI report (Ref. 10). The curves for soft rock, as shown in Figure 3-8, adopt the curves for soft rock published in Silva's report (Ref. 12). While the curves for rock considered, as shown in Figure 3-9, adopt the curves for rock used in the SHAKE computer program (Refs. 13, 14).

3.3 Groundwater Table Elevation

For the APR1400 standard plant design, the design groundwater level is 2 ft below the ground surface at El. 96'-8" (Ref. 1). In the seismic analyses of seismic Category I structures, the extreme groundwater level is considered at the ground surface at El. 98'-8" to induce more conservative analysis results. If the compression wave velocity of subgrade soil has a value less than the compression wave velocity of water (4,800 ft/sec), the compression wave velocity value of the soil is taken to be not less than 4,800 ft/sec.

4 SSSI ANALYSIS

For the APR1400 standard plant design, a total of eight generic site soil profile cases and two concrete stiffness cases are considered for the design basis SSI analysis. The assessment of SSSI effects can be considered as a parametric sensitivity study. For such a study, a subset of the 8 soil profile cases combined with the more conservative uncracked concrete stiffness case is considered adequate. Therefore, two soil cases (soft and hard) are selected for assessing the SSSI effects. Generally the SSSI effects are more noticeable for the soft soil case and less sensitive for the hard soil case, but the hard soil case controls the seismic responses.

This section describes the scope for the assessment of seismic SSSI effects on the APR1400 standard plant structures, the methodologies for SSSI analysis and the adopted SSSI analysis models.

4.1 Design Basis SSI Analysis

The design basis SSI analysis is performed for all eight generic site profile cases S1 through S4 and S6 through S9 plus a 9th analysis case with very rigid uniform half-space supporting medium simulating the fixed-base analysis case, labelled as S10. In addition, both uncracked and cracked concrete stiffness cases are considered in the design basis SSI analysis.

For the APR1400 standard plant design, seismic SSI analyses considering the actual embedment of structure are performed using SASSI analysis methodology (Ref. 15) and its associated SASSI computer program (Ref. 16). Following the SASSI analysis methodology, the foundation embedment of the individual structure is considered in the SASSI analysis using the Direct Method of substructuring.

Since the Direct Method is adopted for the SASSI analyses of the embedded standard plant structures, which are modeled using finite element models (FEMs), the resulting SASSI analysis models developed for the SASSI analysis contain a large number of dynamic degrees of freedom (DOFs) along with a large number of SSI nodal DOFs below grade. As a result, in order to generate seismic SSI responses for all analysis cases described above, the presently available large capacity Fast Solver version of the ACS-SASSI computer program (Ref. 16) is adopted to perform the design basis SSI analysis.

4.2 SSSI Analysis Methodology

This subsection describes the analysis methodology used to assess the SSSI effects on the APR1400 standard plant design. Basically, the combined license (COL) applicant is to confirm that the any site-specific non-seismic category I structures are designed to do not degrade the function of a seismic category I structures to an unacceptable safety level due to their structural failure or interaction.

Based on the APR1400 standard plant layout shown in Figure 2-1, the coupled model for all structures in the power block (NI structures, EDGB, CPB, and TI structures) is developed and used in the SSSI analysis. Soil cases S1 and S9 are selected to represent the soft and hard soil cases, respectively, in SSSI analysis.

Due to model size limitation of the Fast Solver version of the ACS-SASSI computer program, the coupled SSSI models are developed assuming a surface-supported foundation condition. This approximation reduces substantially the number of DOFs, thus, eliminates the SSSI model size limitation problem. Since NRC Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses (DC/COL-ISG-017) addresses the analysis case of “Embedded Structures Analyzed as Surface Structures in the Certified Design” (Ref. 9), and since surface structure provides more conservative seismic responses than embedded structure, this approximation is acceptable.

However, this approximation has the drawback that, unless the structures are truly surface-supported, thus, the seismic responses obtained from their design basis SSI analyses performed previously could not be compared directly with the seismic responses from SSSI analysis using surface-supported foundation

condition, and SSI re-analyses for the stand-alone structures with surface-supported SSI models are required, to enable assessment SSSI effects.

The procedure of the SSSI analysis for the embedded APR1400 structures to be analyzed as surface structures is as follow:

- Assume the bottom elevation of the NI common basemat, El. 45'-0", as ground surface.
- Perform the site response analysis removing the soil layers corresponding to the embedment depth of the NI structures to compute site response motions at foundation level in the free-field.
- Perform individual SSI analysis for the site response motion computed at foundation level with each structure model assuming the structure founded at El. 45'-0".
- Perform coupled SSSI analysis for the site response motion computed at foundation level with model for the all structures in the power block assuming the surface-supported structures founded at El. 45'-0".

To assess the SSSI effects, the seismic responses obtained from individual SSI analysis and coupled SSSI analysis are compared.

4.3 Free-field Site Response Analysis

For the purpose of evaluation of SSSI effects, the free-field site response analyses adopting the concept specified in DC/COL-ISG-017 (Ref. 9) are performed for two selected low-strain layered soil profiles: S1 and S9.

In accordance with DC/COL-ISG-017, the site response motion at foundation level is computed when the seismic analyses of structures as surface structures with no embedment considered in the SSI analysis. For computation of site response motion at foundation level, (a) the free-field site response analysis is performed for the soil column analysis for the full soil column with no truncation to include these effects and to develop the set of strain-compatible soil velocity and damping profiles, and then (b) using the strain-compatible soil profiles obtained, the soil layers corresponding to the embedment depth of the structure are removed, and (c) the second round of soil column analysis is performed with the truncated soil columns with no further iteration on soil properties. The resulting response motions at the truncated surface are used as input motion in individual SSI analysis and coupled SSSI analysis.

Horizontal free-field site response analyses have been carried out using the eight low-strain site profiles, S1 through S4 and S6 through S9, subjected to the free-field seismic ground motion input at the ground surface at El. 98'-8" in the design basis SSI analysis. The free-field seismic ground motion input is the CSDRS-compatible acceleration time histories H1 and H2 applied in the plant E-W and N-S directions, respectively. The shear-strain-compatible shear wave velocity profiles obtained from the analyses using H1 and H2 seismic inputs have been averaged to produce the averaged shear-strain-compatible shear-wave-velocity profile for each generic site profile. Based on the averaged shear-strain-compatible shear-wave-velocity profiles and the associated compression-wave-velocity profiles obtained for generic site profiles S1 and S9 as given in Tables 4-1 through 4-3, the soil layers from the plant's finished grade to the bottom elevation of NI common basemat are removed, and then the horizontal and vertical site response analyses are performed with the truncated soil column models without further iteration on soil properties to generate free-field site response motions convolved up to the NI foundation level, El. 45'-0".

The resultant site response motions at the truncated surface to be used as the seismic inputs to the individual SSI analyses and coupled SSSI analyses for S1 and S9 cases are shown in Figure 4-1.

4.4 Individual SSI Analysis Models

The individual SSI analysis models developed to assess the coupled SSSI effects on APR1400 standard plant structures consist of two substructure models, namely, (a) free-field site model, and (b) structure models.

- Free-Field Site Models

  The SASSI free-field site models for individual SSI analysis are the same as the truncated soil column models to generate free-field site response motions convolved up to the NI foundation level, El. 45'-0", i.e. the generic soil profiles given in Tables 4-1 through 4-3 eliminating soil layers 1 to 11.

- Structure Models for Power Block

  The NI (RCB, AB) and EDGB as seismic category I structures, and CPB and TI (TGB, TGP, and SGA) as seismic category II structures are located in the power block. The structure model for the NI structures which is the combined SASSI FEM for the RCB and AB supported on the common basemat is shown in Figure 4-2. Especially, the methodology and results of developing FEMs for the APR1400 NI are presented in the Technical Report 1-300-C462-002, "Finite Element Seismic Models for SSI Analyses of the NI Buildings" (Ref. 3). The structure model for the SASSI FEM for EDGB is shown in Figure 4-3. The structure model for SASSI FEM for CPB is shown in Figure 4-4. The structure model for the TI structures which is the combined SASSI FEM for the TGB, TGP and SGA supported on the common basemat is shown in Figure 4-5. The major base elevations of all structure models are at El. 45'-0".

4.5 Coupled SSSI Analysis Model

- Free-Field Site Models

  The SASSI free-field site models for coupled SSSI analysis are the same as the truncated soil column models to generate free-field site response motions convolved up to the NI foundation level, El. 45'-0", i.e. the generic soil profiles given in Tables 4-1 through 4-3 eliminating soil layers 1 to 11.

- Coupled SASSI Model for Power Block

  The coupled model for the NI structures, EDGB, CPB, and TI structures located in the power block is shown in Figure 4-6. The coupled model is developed by combing each structure model with actual gaps.

The coupled SASSI model for the NI structures consists of the following attributes:

Total number of nodes	=	82,250
Total number of interaction nodes	=	3,770
Total number of solid elements	=	26,294
Total number of shell elements	=	29,498
Total number of beam elements	=	7,600
Total number of spring elements	=	2,078

The SASSI model data are coded using the Fast Solver version of the ACS-SASSI computer program.

4.6 Individual SSI and Coupled SSSI Analysis Cases

To evaluate the SSSI effects on the APR1400 standard plant structures, individual SSI analyses for stand-alone structure and coupled SSSI analyses for the power block are performed for a total of two soil cases. The two soil cases analyzed with uncracked concrete condition are designated as cases S1U and S9U.

For each of the two analysis cases, SASSI analyses are separately performed for the three directions of seismic input. Namely, (a) horizontal E-W direction with the seismic input of the E-W response time history, (b) horizontal N-S direction with the seismic input of the N-S response time history, and (c) vertical direction with the seismic input of the vertical response time history at the NI foundation level.

Due to the different seismic-wave-passage cutoff frequency and the different SSI system frequencies for each site profile case considered, the number of frequencies within the seismic-wave-passage cutoff frequency used for each SASSI analysis case varies. The total number of frequencies analyzed for the different analysis cases considered are summarized in Table 4-4.

To validate that the surface structure gives more conservative seismic responses than the embedded structure as mentioned in subsection 4.2, the ISRS at El. 156’-0” of AB obtained from the design basis SSI analysis are compared to those obtained from individual SSI analysis assuming the surface structure. Figures 4-7 through 4-9 show the results for the embedded structure case, and Figures 4-10 through 4-12 show the results for surface structure case. As can be seen on figures, the ISRS for surface structure are absolutely greater than the ISRS for embedded structure.

5 ANALYSIS AND ASSESSMENT RESULTS

Results of SASSI analyses obtained from the individual SSI analyses and coupled SSSI analysis described previously in Subsection 4.6 are post-processed to generate the ISRS for assessment of SSSI effects.

Post-processing procedures used to generate ISRS are described in the Technical Report No. 1-300-C462-003, “SSI Analysis Methodology and Results of NI Buildings of the APR14000 Standard Plant” (Ref. 4). The plots of ISRS generated from the post-processing are presented and compared in this section.

Since SASSI analyses are performed separately for the three directions (E-W, N-S, and vertical) of seismic input, the ISRS are first generated from the results of SASSI analyses obtained for the individual direction of seismic input. Then, the maximum ISRS due to the combined three directions of seismic input are combined using the square-root-of-the-sum-of-squares (SRSS) combination rule.

5.1 ISRS

The SASSI analysis output-acceleration-response time histories obtained for each analysis case at selected nodal points of the SASSI FEM on the designated elevations of the RCB (CS, PSW, and SSW), AB, and EDGB are used to compute the ISRS. The ISRS are computed for constant spectral damping value of 5%.

The ISRS generated for individual SSI analysis of each stand-alone structure at all selected nodal points on each designated structure elevation are first enveloped to generate the enveloped ISRS for the elevation and, then, widened by ± 15% in frequency as required in the RG 1.122 (Ref. 7). However, The ISRS generated for coupled SSSI analysis of the all structures in the power block are enveloped only. Because the individual SSI analysis is considered similar to design basis SSI analysis, while coupled SSSI analysis is considered as a parametric sensitivity study.

The comparisons of 5%-damped ISRS generated in both analyses are presented in Figures 5-1 through 5-96.

The selected nodal points on each of the designated structure elevations in the RCB are summarized in Tables 5-1 through 5-3. Table 5-1 provides the selected nodal points in CS, Table 5-2 in PSW, and Table 5-3 in SSW. The selected nodal points on each designated floor area of each designated floor elevation in AB are summarized in Tables 5-4 and 5-5. Table 5-4 lists the selected nodal points on each designated floor area at the shear wall locations of each designated floor elevation for which ISRS for seismic response motions in all three directions, E-W (X), N-S (Y), and vertical (Z), are generated. Table 5-5 lists the selected nodal points on floor slabs of each designated floor area of each designated floor elevation for which ISRS for the vertical (Z) seismic response motions are generated. The selected nodal points on each designated floor area of each designated floor elevation in the EDGB are summarized in Tables 5-6.

The locations of the selected nodes on the designated elevations in the FEM are shown in Figures 5-97 through 5-124.

5.2 SSSI Effects on APR1400 Standard Plant Structures

The individual SSI analyses for each stand-alone structure and coupled SSSI analyses for the all structures in the power block using two selected generic site soil profiles, one soft (S1) and one hard (S9) soil cases, are performed. The comparison results between individual SSI and coupled SSSI analyses are used to evaluate the SSSI effects on the APR1400 standard plant structures.

The 5%-damped ISRS which obtained from the individual SSI and coupled SSSI analyses at key locations throughout the APR1400 standard plant structures (RCB, AB, and EDGB) are compared to each other. Comparisons of the ISRS for each analysis case indicate that the adjacent structures have insignificant

effects on the seismic responses of the NI structures. However, comparisons of the ISRS indicate that the NI structures have noticeable effects on the vertical seismic responses of the EDGB for the soft soil case, S1, while NI structures have no significant effects on the seismic responses of the EDGB for the hard soil case, S9. The increase of approximately 30% on the vertical ISRS for the EDGB is observed for soft soil case S1U only.

In terms of the nodal maximum accelerations, the seismic responses of the RCB and AB obtained from the coupled SSSI analysis are generally reduced. The presence of the EDGB, CPB, and TI structures has insignificant effects on the seismic responses of NI structures.

Based on the above assessment, it can be concluded that the NI structures have negligible effects on their seismic responses due to adjacent structures such as EDGB, CPB and TI structures. However, the EDGB vertical seismic responses are significantly affected by the NI structures for soft soil cases.

6 ADDITIONAL SSSI ANALYSES AND ASSESSMENT

According to the assessment of the SSSI effects in Subsection 5.2, the adjacent structures including the NI structures have noticeable effects on the seismic responses of the EDGB for the soft soil case, S1, while they have no effects on the seismic responses of the EDGB for the hard soil case, S9.

To evaluate the SSSI effects on the EDGB in detail, individual SSI analyses for the stand-alone EDGB and coupled SSSI analyses for the all structures in the power block are performed for additional three soft soil cases. The additional three generic soil profiles analyzed with uncracked concrete condition are designated as cases S2U, S3U, and S4U. The SASSI free-field site models for individual SSI analyses are the same as the truncated soil column models to generate free-field site response motions convolved up to the NI foundation level, El. 45'-0", i.e. the generic soil profiles given in Tables 6-1 through 6-3 eliminating soil layers 1 to 11.

The number of frequencies within the seismic-wave-passage cutoff frequencies used for each SASSI analysis case varies due to the different seismic-wave-passage cutoff frequency and the different SSI system frequencies for each site profile case considered. The total number of frequencies analyzed for the additional analysis cases are summarized in Table 6-4.

6.1 Analysis Results

Seismic response parameters important to the EDGB design consist of (a) ISRS and (b) maximum structural response forces. The results of SASSI analyses for the SSE obtained for each analysis case are post-processed to generate the above seismic response parameters. The results are then enveloped to produce the analysis-cases-enveloped seismic response parameters, and to determine the amplification factors for design-basis seismic response parameters of the EDGB.

Since SASSI analyses for each analysis case are performed separately for the three directions (E-W, N-S, and vertical) of seismic input, the maximum seismic response parameters of interest are first generated from the results of SASSI analyses performed for the each direction of seismic input. Then, the maximum seismic response parameters of interest due to the combined three directions of seismic input are combined using the SRSS combination rule.

- ISRS

The enveloped ISRS for the EDGB obtained from the SSSI analyses using coupled model for all structures in the power block are compared with the enveloped ISRS obtained from the individual SSI analyses using the stand-alone EDGB model for soft soil cases, S1 through S4. As comparison results, the ratio of enveloped 5%-damped ISRS of the EDGB between the SSSI analyses and individual SSI analyses is presented in Figure 6-1. The ratio of enveloped 5%-damped ISRS of the DFOT room is presented in Figure 6-2. The ISRS ratios, which are lesser than 1.0, are modified to 1.0 in order to prevent reduction of the design-basis ISRS.

The 5%-damped ISRS ratios in Figures 6-1 and 6-2 are considered as the amplification factors to be applied to increment of the design-basis ISRS of the EDGB and DFOT room for soft soil cases, S1 through S4.

- Structural Response Forces

The maximum seismic response forces (axial and shear forces) are generally governed by the response accelerations at the zero period in ISRS. Figures 6-1 and 6-2 indicate that the ratio of response accelerations at zero period between the SSSI analyses and individual SSI analyses for soft soil cases are lesser than or equal to 1.0 except ISRS for the vertical direction at basemat level of the EDGB and DFOT room. In other words, the adjacent NI structures have negligible effects on the horizontal shear forces of the EDGB for the soft soil cases, while the NI structures have significant effects on the vertical axial forces

of the EDGB for the soft soil cases.

The amplification factors of the vertical ISRS at zero period reach 4% for the EDGB and 19% for the DFOT room. Therefore, the vertical axial forces of the EDGB and DFOT room for the soft soil cases need to be increased to consider the SSSI effects.

However, the enveloped design-basis seismic axial forces of the EDGB and DFOT room are governed by the axial force obtained from fixed-base analysis among eight SSI analysis and one fixed-base analysis cases. The enveloped axial forces of the EDGB and DFOT room for the design-basis SSI analysis cases, S1 through S4, are 1376 kips and 497 kips, respectively, while the axial forces of the EDGB and DFOT room for the design-basis fixed-base case are 1576 kips and 591 kips, respectively. The ratios of the axial forces of design-basis fixed-base analysis case and the enveloped axial forces of design-basis SSI analysis cases S1 and S4 for the EDGB and DFOT room are 1.15 and 1.19, respectively. These ratios are greater than or equal to the amplification factors of ISRS determined from the SSSI analyses for the soft soil cases. Therefore, the design-basis seismic response forces need not be increased to consider the SSSI effects on the EDGB.

6.2 Reflection of SSSI effects on EDGB

Based on the assessment of SSSI effects, it can be concluded that the NI structures have negligible effects on their seismic responses due to adjacent structures. However, the EDGB seismic responses are affected by the adjacent structures including the NI structures for soft soil cases only as mentioned in Subsection 5.2.

The results of the assessment of dynamic SSSI effects are used as the basis to increase seismic design parameters such as enveloped ISRS which are obtained from the design-basis SSI analyses using the stand-alone EDGB model.

Based on the comparisons between the ISRS of individual SSI analyses and coupled SSSI analyses for soft soil cases, the amplification factors of ISRS for each designated major floor elevation and for each direction are computed to incorporate the SSSI effects on the EDGB seismic response. The final enveloped design-basis ISRS of the EDGB are increased by multiplying these amplification factors by ISRS obtained from design-basis SSI analyses for twenty analysis cases conservatively.

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Table 3-1

APR1400 CSDRS

Horizontal

Damping Ratio (%)	Amplification Factor for Control Points						
	0.1 Hz	0.2 Hz	0.25 Hz	2.5 Hz	9 Hz	25 Hz	50 Hz
2	0.0276	0.111	0.171	1.275	1.062	0.511	0.300
3	0.0254	0.102	0.159	1.125	0.939	0.498	0.300
4	0.0238	0.096	0.147	1.020	0.852	0.487	0.300
5	0.0226	0.090	0.141	0.939	0.783	0.479	0.300
7	0.0207	0.084	0.129	0.816	0.681	0.464	0.300
10	0.0188	0.075	0.117	0.684	0.570	0.447	0.300

Vertical

Damping Ratio (%)	Amplification Factor for Control Points						
	0.1 Hz	0.2 Hz	0.25 Hz	3.5 Hz	9 Hz	25 Hz	50 Hz
2	0.0184	0.075	0.114	1.215	1.062	0.511	0.300
3	0.0170	0.069	0.105	1.074	0.939	0.498	0.300
4	0.0159	0.063	0.099	0.972	0.852	0.487	0.300
5	0.0151	0.060	0.093	0.894	0.783	0.479	0.300
7	0.0138	0.057	0.087	0.777	0.681	0.464	0.300
10	0.0125	0.051	0.078	0.651	0.570	0.447	0.300

Table 3-2

Dynamic Properties of Low-strain Soil/Rock Materials for Site Shear-Wave-Velocity Categories P1 through P5

Shear Wave-Velocity Categories No.	Shear Wave-Velocity (ft/sec)	Soil/Rock Unit Weight (lb/ft^3)	Poisson's Ratio (ν)	Degradation Curve Type (EPRI)
P1	1,200	125	0.40	Sand
P2	2,000	130	0.38	Sand
P3	4,000	135	0.35	Soft Rock
P4	6,000	145	0.33	Rock
P5	9,200	155	0.33	Rock

Table 3-3

Site Layering and Shear-Wave-Velocity Categories Considered for Eight Low-strain Site Profiles

Layer Site Category Depth from Ground Surface (ft)	Generic Soil Profile No.							
	S1	S2	S3	S4	S6	S7	S8	S9
	Shear-Wave-Velocity No.							
A **0 ~ 50 ft**	P1	P1	P2	P2	P2	P2	P4	P4
B **50 ~ 100 ft**	P1	P1	P2	P2	P3	P3	P4	P4
C **100 ~ 200 ft**	P1	P2	P2	P3	P3	P4	P4	P5
D **200 ~ 500 ft**	P2	P3	P3	P4	P5	P5	P5	P5
E **500 ~ 1,000 ft**	P3	P4	P5	P5	P5	P5	P5	P5
F **> 1,000 ft**	P5	P5	P5	P5	P5	P5	P5	P5

Table 4-1 (1 of 3)

Generic Site Profile S1

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
1	Sand	5	0	5	0.125	1155	4800	0.020	0.47
2		5	5	10	0.125	1132	4800	0.031	0.47
3		5	10	15	0.125	1102	4800	0.041	0.47
4		5	15	20	0.125	1087	4800	0.048	0.47
5		5	20	25	0.125	1142	4800	0.037	0.47
6		5	25	30	0.125	1138	4800	0.042	0.47
7		5	30	35	0.125	1138	4800	0.046	0.47
8		5	35	40	0.125	1141	4800	0.050	0.47
9		5	40	45	0.125	1144	4800	0.053	0.47
10		5	45	50	0.125	1149	4800	0.056	0.47
11		5	50	55	0.125	1224	4800	0.043	0.47
12		5	55	60	0.125	1234	4800	0.044	0.46
13		5	60	65	0.125	1246	4800	0.046	0.46
14		5	65	70	0.125	1257	4800	0.047	0.46
15		5	70	75	0.125	1271	4800	0.047	0.46
16		5	75	80	0.125	1285	4800	0.048	0.46
17		5	80	85	0.125	1299	4800	0.048	0.46
18		5	85	90	0.125	1314	4800	0.049	0.46
19		5	90	95	0.125	1328	4800	0.050	0.46
20		5	95	100	0.125	1342	4800	0.050	0.46
21		5	100	105	0.125	1357	4800	0.050	0.46
22		5	105	110	0.125	1373	4800	0.051	0.46
23		5	110	115	0.125	1389	4800	0.051	0.45
24		5	115	120	0.125	1406	4800	0.051	0.45
25		5	120	125	0.125	1489	4800	0.039	0.45
26		5	125	130	0.125	1506	4800	0.039	0.45
27		5	130	135	0.125	1523	4800	0.039	0.44
28		5	135	140	0.125	1540	4800	0.039	0.44
29		5	140	145	0.125	1556	4800	0.039	0.44
30		5	145	150	0.125	1573	4800	0.039	0.44
31		5	150	155	0.125	1590	4800	0.039	0.44
32		5	155	160	0.125	1608	4800	0.039	0.44
33		5	160	165	0.125	1625	4800	0.039	0.44
34		5	165	170	0.125	1642	4800	0.039	0.43
35		5	170	175	0.125	1659	4800	0.039	0.43
36		5	175	180	0.125	1676	4800	0.039	0.43
37		5	180	185	0.125	1692	4800	0.039	0.43
38		5	185	190	0.125	1709	4800	0.039	0.43
39		5	190	195	0.125	1725	4800	0.039	0.43
40		5	195	200	0.125	1742	4845	0.039	0.43
41		10	200	210	0.13	2780	6650	0.022	0.39
42		10	210	220	0.13	2814	6732	0.022	0.39

Table 4-1 (2 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer Top (ft)	Depth Layer Bottom (ft)	Weight Density (kcf)	Seismic Wave Velocity Avg. Vs (fps)	Seismic Wave Velocity Vp (fps)	Avg. Damping	Poisson's Ratio
43	Sand	10	220	230	0.13	2845	6813	0.022	0.39
44		10	230	240	0.13	2876	6894	0.023	0.39
45		10	240	250	0.13	2907	6973	0.023	0.39
46		10	250	260	0.13	2992	7051	0.018	0.39
47		10	260	270	0.13	3022	7128	0.019	0.39
48		10	270	280	0.13	3053	7204	0.019	0.39
49		10	280	290	0.13	3083	7279	0.019	0.39
50		10	290	300	0.13	3113	7353	0.019	0.39
51		10	300	310	0.13	3142	7426	0.019	0.39
52		10	310	320	0.13	3172	7498	0.019	0.39
53		10	320	330	0.13	3200	7569	0.019	0.39
54		10	330	340	0.13	3229	7639	0.019	0.39
55		10	340	350	0.13	3258	7707	0.019	0.39
56		10	350	360	0.13	3286	7775	0.019	0.39
57		10	360	370	0.13	3314	7842	0.019	0.39
58		10	370	380	0.13	3342	7907	0.019	0.39
59		10	380	390	0.13	3369	7972	0.019	0.39
60		10	390	400	0.13	3396	8035	0.019	0.39
61		10	400	410	0.13	3423	8098	0.019	0.39
62		10	410	420	0.13	3449	8159	0.019	0.39
63		10	420	430	0.13	3475	8220	0.019	0.39
64		10	430	440	0.13	3501	8279	0.019	0.39
65		10	440	450	0.13	3526	8337	0.019	0.39
66		10	450	460	0.13	3550	8395	0.019	0.39
67		10	460	470	0.13	3574	8451	0.019	0.39
68		10	470	480	0.13	3598	8506	0.019	0.39
69		10	480	490	0.13	3621	8560	0.019	0.39
70		10	490	500	0.13	3644	8613	0.019	0.39
71	Soft Rock	20	500	520	0.135	5748	12029	0.035	0.35
72		20	520	540	0.135	5792	12120	0.035	0.35
73		20	540	560	0.135	5833	12208	0.035	0.35
74		20	560	580	0.135	5872	12292	0.035	0.35
75		20	580	600	0.135	5909	12372	0.035	0.35
76		20	600	620	0.135	5944	12448	0.035	0.35
77		20	620	640	0.135	5978	12520	0.035	0.35
78		20	640	660	0.135	6009	12588	0.035	0.35
79		20	660	680	0.135	6038	12653	0.035	0.35
80		20	680	700	0.135	6066	12714	0.035	0.35
81		20	700	720	0.135	6092	12771	0.035	0.35
82		20	720	740	0.135	6115	12824	0.035	0.35
83		20	740	760	0.135	6136	12873	0.035	0.35
84		20	760	780	0.135	6157	12919	0.036	0.35
85		20	780	800	0.135	6175	12960	0.036	0.35

Table 4-1 (3 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
86	Soft Rock	20	800	820	0.135	6191	12998	0.036	0.35
87		20	820	840	0.135	6206	13032	0.036	0.35
88		20	840	860	0.135	6218	13062	0.036	0.35
89		20	860	880	0.135	6229	13089	0.036	0.35
90		20	880	900	0.135	6238	13111	0.036	0.35
91		20	900	920	0.135	6245	13130	0.036	0.35
92		20	920	940	0.135	6251	13145	0.036	0.35
93		20	940	960	0.135	6254	13156	0.036	0.35
94		20	960	980	0.135	6256	13163	0.036	0.35
95		20	980	1000	0.135	6255	13166	0.037	0.35
96	Rock		1000	-	0.155	9200	18264	0.004	0.33

Table 4-2 (1 of 3)

Deleted

Table 4-2 (2 of 3)

Table 4-2 (3 of 3)

Table 4-3 (1 of 3)

Generic Site Profile S9

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
1	Rock	5	0	5	0.145	4692	9315	0.003	0.33
2		5	5	10	0.145	4709	9348	0.005	0.33
3		5	10	15	0.145	4722	9382	0.006	0.33
4		5	15	20	0.145	4730	9415	0.007	0.33
5		5	20	25	0.145	4741	9448	0.007	0.33
6		5	25	30	0.145	4753	9481	0.008	0.33
7		5	30	35	0.145	4765	9513	0.008	0.33
8		5	35	40	0.145	4778	9546	0.008	0.33
9		5	40	45	0.145	4785	9578	0.008	0.33
10		5	45	50	0.145	4793	9610	0.009	0.33
11		5	50	55	0.145	4802	9642	0.009	0.34
12		5	55	60	0.145	4811	9674	0.009	0.34
13		5	60	65	0.145	4821	9706	0.009	0.34
14		5	65	70	0.145	4832	9737	0.010	0.34
15		5	70	75	0.145	4842	9768	0.010	0.34
16		5	75	80	0.145	4853	9799	0.010	0.34
17		5	80	85	0.145	4864	9830	0.010	0.34
18		5	85	90	0.145	4875	9861	0.010	0.34
19		5	90	95	0.145	4886	9892	0.011	0.34
20		5	95	100	0.145	4897	9922	0.011	0.34
21		5	100	105	0.155	9200	18264	0.010	0.33
22		5	105	110	0.155	9200	18264	0.010	0.33
23		5	110	115	0.155	9200	18264	0.010	0.33
24		5	115	120	0.155	9200	18264	0.010	0.33
25		5	120	125	0.155	9200	18264	0.010	0.33
26		5	125	130	0.155	9200	18264	0.010	0.33
27		5	130	135	0.155	9200	18264	0.010	0.33
28		5	135	140	0.155	9200	18264	0.010	0.33
29		5	140	145	0.155	9200	18264	0.010	0.33
30		5	145	150	0.155	9200	18264	0.010	0.33
31		5	150	155	0.155	9200	18264	0.010	0.33
32		5	155	160	0.155	9200	18264	0.010	0.33
33		5	160	165	0.155	9200	18264	0.010	0.33
34		5	165	170	0.155	9200	18264	0.010	0.33
35		5	170	175	0.155	9200	18264	0.010	0.33
36		5	175	180	0.155	9200	18264	0.010	0.33
37		5	180	185	0.155	9200	18264	0.010	0.33
38		5	185	190	0.155	9200	18264	0.010	0.33
39		5	190	195	0.155	9200	18264	0.010	0.33
40		5	195	200	0.155	9200	18264	0.010	0.33
41		10	200	210	0.155	9200	18264	0.010	0.33
42		10	210	220	0.155	9200	18264	0.010	0.33

Table 4-3 (2 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
43	Rock	10	220	230	0.155	9200	18264	0.010	0.33
44		10	230	240	0.155	9200	18264	0.010	0.33
45		10	240	250	0.155	9200	18264	0.010	0.33
46		10	250	260	0.155	9200	18264	0.010	0.33
47		10	260	270	0.155	9200	18264	0.010	0.33
48		10	270	280	0.155	9200	18264	0.010	0.33
49		10	280	290	0.155	9200	18264	0.010	0.33
50		10	290	300	0.155	9200	18264	0.010	0.33
51		10	300	310	0.155	9200	18264	0.010	0.33
52		10	310	320	0.155	9200	18264	0.010	0.33
53		10	320	330	0.155	9200	18264	0.010	0.33
54		10	330	340	0.155	9200	18264	0.010	0.33
55		10	340	350	0.155	9200	18264	0.010	0.33
56		10	350	360	0.155	9200	18264	0.010	0.33
57		10	360	370	0.155	9200	18264	0.010	0.33
58		10	370	380	0.155	9200	18264	0.010	0.33
59		10	380	390	0.155	9200	18264	0.010	0.33
60		10	390	400	0.155	9200	18264	0.010	0.33
61		10	400	410	0.155	9200	18264	0.010	0.33
62		10	410	420	0.155	9200	18264	0.010	0.33
63		10	420	430	0.155	9200	18264	0.010	0.33
64		10	430	440	0.155	9200	18264	0.010	0.33
65		10	440	450	0.155	9200	18264	0.010	0.33
66		10	450	460	0.155	9200	18264	0.010	0.33
67		10	460	470	0.155	9200	18264	0.010	0.33
68		10	470	480	0.155	9200	18264	0.010	0.33
69		10	480	490	0.155	9200	18264	0.010	0.33
70		10	490	500	0.155	9200	18264	0.010	0.33
71		20	500	520	0.155	9200	18264	0.010	0.33
72		20	520	540	0.155	9200	18264	0.010	0.33
73		20	540	560	0.155	9200	18264	0.010	0.33
74		20	560	580	0.155	9200	18264	0.010	0.33
75		20	580	600	0.155	9200	18264	0.010	0.33
76		20	600	620	0.155	9200	18264	0.010	0.33
77		20	620	640	0.155	9200	18264	0.010	0.33
78		20	640	660	0.155	9200	18264	0.010	0.33
79		20	660	680	0.155	9200	18264	0.010	0.33
80		20	680	700	0.155	9200	18264	0.010	0.33
81		20	700	720	0.155	9200	18264	0.010	0.33
82		20	720	740	0.155	9200	18264	0.010	0.33
83		20	740	760	0.155	9200	18264	0.010	0.33
84		20	760	780	0.155	9200	18264	0.010	0.33
85		20	780	800	0.155	9200	18264	0.010	0.33

Table 4-3 (3 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
86	Rock	20	800	820	0.155	9200	18264	0.010	0.33
87		20	820	840	0.155	9200	18264	0.010	0.33
88		20	840	860	0.155	9200	18264	0.010	0.33
89		20	860	880	0.155	9200	18264	0.010	0.33
90		20	880	900	0.155	9200	18264	0.010	0.33
91		20	900	920	0.155	9200	18264	0.010	0.33
92		20	920	940	0.155	9200	18264	0.010	0.33
93		20	940	960	0.155	9200	18264	0.010	0.33
94		20	960	980	0.155	9200	18264	0.010	0.33
95		20	980	1000	0.155	9200	18264	0.010	0.33
96			1000	0	0.155	9200	18264	0.004	0.33

Table 4-4

Total Number of Frequencies and Highest Frequency for Each Analysis Case

Analysis Cases	S1U	S9U
Total Number of Frequencies	71	116
Highest Frequency Analyzed	20.07	71.01

Table 5-1

Selected Nodal Points on Designated Structure Elevations of CS for Generation of ISRS

Elevation (ft)	Identification	SASSI Node Numbers
78.00	CS Base at Interface with Concrete Pedestal	13663, 13704, 13694, 13699, 13679, 13674,13682
100.00	CS Shell	19988, 20015, 20016, 20025, 20030, 20037, 20011, 19992
156.00	Bottom Ring at Equipment Hatch	28225, 28234, 28229, 28226, 28202, 28232, 27207, 28242
254.50	CS Spring Line	31939, 31943,31968, 31931, 31949, 31969, 31941, 31974
331.75	Dome Apex	32522

Table 5-2

Selected Nodal Points on Designated Structure Elevations of PSW for Generation of ISRS

Elevation (ft)	Identification	SASSI Node Numbers
78.00	4 Corners at RV Pit Walls (Top)	13581, 13585, 13586, 13595
100.00	Top of Concrete Pedestal	19674, 19341, 19665, 19354, 19194, 19275, 19375, 19265, 19189, 19168
156.00	Operating Deck	28097, 28124, 27764, 27264, 27607, 28039, 28007, 27886
191.00	PZR Corners	30307, 30352

Table 5-3

Selected Nodal Points on Designated Structure Elevations of SSW for Generation of ISRS

Elevation (ft)	Identification	SASSI Node Numbers
78.00	SSW at Concrete Pedestal Bottom	13318, 13328, 13338, 13349, 13353, 13323, 13333, 13345
100.00	SSW at Interface with Concrete Pedestal Top	19698, 19712, 19334, 19724, 19719, 19705, 19717, 19729
156.00	Operating Deck	27225, 27761, 27280, 27466, 27387, 27237, 27224, 27768
191.00	Top Elevation of SSW	30301, 30323, 30331, 30298, 30299, 30341

Table 5-4

Selected Nodal Points at Shear Wall Locations on Designated Floor Elevations of AB for Generation of ISRS

Floor Elevation	Floor Identification	SASSI Model Node Numbers
55'-0"	Basemat	10600, 10642, 10647, 10715, 10717, 10751, 10803, 10806, 10863, 10876, 10884, 10936, 10942, 10946, 11021, 11025
100'-0"	Ground Floor	18085, 18140, 18165, 18173, 18289, 18382, 18488, 18496, 18526, 18532, 18632, 18692, 18812, 18820, 18856, 18950
156'-0"	Fourth Floor	27250, 27256, 27273, 27281, 27453, 27474, 27546, 27660, 27666, 27739, 27791, 27791, 27804, 27817
195'-0"	Sixth Floor Areas 1 and 3	30375, 30443, 30542, 30545, 30556, 30557, 30590, 30837
213'-6"	Fuel Handling Area	31421, 31470, 31519, 31525
114'-0"	Intermediate Floor Area 2, Fuel Handling Area	21680, 21693, 21770

Table 5-5

Selected Nodal Points on Floor-Slab Panels on Designated Floor Elevations of AB for Generation of Vertical ISRS

Floor Elevation	Floor Slab Identification	SASSI Model Node Numbers
55'-0"	Basemat	9501,9579,9604,9709, 9743,9861,9905
100'-0"	Ground Floor	18163,18183,18187,18218,18264,18268,18302,18325,18378,18431,18460,18470,18557,18582,18603,18608,18638,18676,18680,18700,18702,18717,18750,18766,18796,18827,18852,18871,18879,18913,18914,18944,18954,18974,18987,19024,19035,19039,19049,19051,19056,19062,19066,19068,19076,19095,19105,19111,19120,19133
156'-0"	Fourth Floor	27317,27325,27343,27423,27488,27516,27551,27582,27620,27656,27693,27750,27760,27779,27785,27798,27802,27813,27822,27833,27880,27892,27895,27896,27904,27910,27926,27968,27974,27980,28020,28023,28036,28088,28108,28119
195'-0"	Roof at Area 1 & 3 Roof at Main Control Room	30367,30393,30416,30417,30550,30587,30597,30604,30621,30631,30651,30667,30771,30860,30597,30604
213'-6"	Fuel Handling Area Roof	31477,31527
195'-0"	Roof at Area 2	30462,30751
100'-0"	Ground Floor, Fuel Handling Area, Area 2	18676,18700,18913
114'-0"	Spent Fuel Pool Bottom Slab, Area 2	21699,21731,21738

Table 5-6

Selected Nodal Points on Designated Structure Elevations EDGB for Generation of ISRS

Elevation	Identification	SASSI Model Node Numbers
63'-0"	DFOT Room Wall	60127,60131,60135,60221,60226,60231,60243, 60248,60253
	DFOT Room Slab	60127,60135,60181,60187,60234,60240,60243,60253
100'-0"	DFOT Room Wall	60506,60510,60514,60587,60592,60598,60626,60636
	DFOT Room Slab	60506,60514,60526,60530,60610,60615,60626,60636
	EDGB Wall	60637,60640,60643,60663,60665,60679,60682,60685, 60695,60707,60722,60725,60728
	EDGB Slab	60637,60643,60646,60649,60674,60690,60717, 60720,60722,728
135'-0"	EDGB Wall	61045,61049,61053,61078,61079,61093,61096,61099, 61107,61129,61139,61143,61147
	EDGB Slab	61045,61053,61056,61060,61072,61082,61083,61110, 61111,61115,61132,61136,61139,61147

Table 6-1 (1 of 3)

Generic Site Profile S2

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
1	Sand	5	0	5	0.125	996	4,800	0.022	0.48
2		5	5	10	0.125	958	4,800	0.037	0.48
3		5	10	15	0.125	930	4,800	0.048	0.48
4		5	15	20	0.125	902	4,800	0.059	0.48
5		5	20	25	0.125	954	4,800	0.047	0.48
6		5	25	30	0.125	950	4,800	0.052	0.48
7		5	30	35	0.125	948	4,800	0.056	0.48
8		5	35	40	0.125	947	4,800	0.061	0.48
9		5	40	45	0.125	948	4,800	0.064	0.48
10		5	45	50	0.125	950	4,800	0.067	0.48
11		5	50	55	0.125	1,025	4,800	0.051	0.48
12		5	55	60	0.125	1,034	4,800	0.052	0.48
13		5	60	65	0.125	1,044	4,800	0.053	0.48
14		5	65	70	0.125	1,054	4,800	0.054	0.47
15		5	70	75	0.125	1,065	4,800	0.055	0.47
16		5	75	80	0.125	1,075	4,800	0.056	0.47
17		5	80	85	0.125	1,086	4,800	0.057	0.47
18		5	85	90	0.125	1,098	4,800	0.057	0.47
19		5	90	95	0.125	1,110	4,800	0.058	0.47
20		5	95	100	0.125	1,123	4,800	0.059	0.47
21		5	100	105	0.130	2,044	4996	0.029	0.40
22		5	105	110	0.130	2,055	5,037	0.03	0.40
23		5	110	115	0.130	2,065	5,077	0.031	0.40
24		5	115	120	0.130	2,074	5,117	0.031	0.40
25		5	120	125	0.130	2,134	5,157	0.024	0.40
26		5	125	130	0.130	2,147	5,197	0.025	0.40
27		5	130	135	0.130	2,160	5,236	0.025	0.40
28		5	135	140	0.130	2,174	5,275	0.025	0.40
29		5	140	145	0.130	2,188	5,314	0.026	0.40
30		5	145	150	0.130	2,202	5,353	0.026	0.40
31		5	150	155	0.130	2,216	5,392	0.026	0.40
32		5	155	160	0.130	2,229	5,430	0.026	0.40
33		5	160	165	0.130	2,242	5,468	0.027	0.40
34		5	165	170	0.130	2,255	5,506	0.027	0.40
35		5	170	175	0.130	2,267	5,543	0.027	0.40
36		5	175	180	0.130	2,280	5,581	0.027	0.40
37		5	180	185	0.130	2,293	5,618	0.027	0.40
38		5	185	190	0.130	2,306	5,655	0.028	0.40
39		5	190	195	0.130	2,319	5,692	0.028	0.40
40		5	195	200	0.130	2,332	5,728	0.028	0.40

Table 6-1 (2 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
41	Soft Rock	10	200	210	0.135	4,219	8,834	0.035	0.35
42		10	210	220	0.135	4,248	8,900	0.035	0.35
43		10	220	230	0.135	4,277	8,965	0.035	0.35
44		10	230	240	0.135	4,305	9,029	0.035	0.35
45		10	240	250	0.135	4,333	9,092	0.036	0.35
46		10	250	260	0.135	4,361	9,154	0.036	0.35
47		10	260	270	0.135	4,387	9,215	0.036	0.35
48		10	270	280	0.135	4,413	9,276	0.036	0.35
49		10	280	290	0.135	4,440	9,336	0.036	0.35
50		10	290	300	0.135	4,466	9,395	0.036	0.35
51		10	300	310	0.135	4,492	9,453	0.036	0.35
52		10	310	320	0.135	4,517	9,510	0.037	0.35
53		10	320	330	0.135	4,542	9,566	0.037	0.35
54		10	330	340	0.135	4,567	9,622	0.037	0.35
55		10	340	350	0.135	4,592	9,677	0.037	0.35
56		10	350	360	0.135	4,616	9,731	0.037	0.35
57		10	360	370	0.135	4,639	9,784	0.037	0.35
58		10	370	380	0.135	4,663	9,836	0.037	0.36
59		10	380	390	0.135	4,686	9,887	0.037	0.36
60		10	390	400	0.135	4,709	9,938	0.037	0.36
61		10	400	410	0.135	4,732	9,988	0.037	0.36
62		10	410	420	0.135	4,754	10,037	0.038	0.36
63		10	420	430	0.135	4,776	10,085	0.038	0.36
64		10	430	440	0.135	4,797	10,132	0.038	0.36
65		10	440	450	0.135	4,819	10,178	0.038	0.36
66		10	450	460	0.135	4,839	10,224	0.038	0.36
67		10	460	470	0.135	4,859	10,269	0.038	0.36
68		10	470	480	0.135	4,879	10,313	0.038	0.36
69		10	480	490	0.135	4,898	10,356	0.038	0.36
70		10	490	500	0.135	4,918	10,398	0.038	0.36
71	Rock	20	500	520	0.145	6,847	13,946	0.012	0.34
72		20	520	540	0.145	6,881	14,022	0.012	0.34
73		20	540	560	0.145	6,914	14,094	0.012	0.34
74		20	560	580	0.145	6,945	14,164	0.012	0.34
75		20	580	600	0.145	6,976	14,230	0.012	0.34
76		20	600	620	0.145	7,004	14,293	0.012	0.34
77		20	620	640	0.145	7,032	14,353	0.012	0.34
78		20	640	660	0.145	7,057	14,410	0.012	0.34
79		20	660	680	0.145	7,081	14,463	0.012	0.34
80		20	680	700	0.145	7,103	14,514	0.012	0.34
81		20	700	720	0.145	7,124	14,561	0.012	0.34
82		20	720	740	0.145	7,143	14,605	0.012	0.34

Table 6-1 (3 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
83	Rock	20	740	760	0.145	7,162	14,646	0.012	0.34
84		20	760	780	0.145	7,178	14,684	0.012	0.34
85		20	780	800	0.145	7,191	14,718	0.012	0.34
86		20	800	820	0.145	7,203	14,750	0.012	0.34
87		20	820	840	0.145	7,214	14,778	0.013	0.34
88		20	840	860	0.145	7,223	14,803	0.013	0.34
89		20	860	880	0.145	7,232	14,825	0.013	0.34
90		20	880	900	0.145	7,238	14,843	0.013	0.34
91		20	900	920	0.145	7,244	14,859	0.013	0.34
92		20	920	940	0.145	7,247	14,871	0.013	0.34
93		20	940	960	0.145	7,250	14,880	0.013	0.34
94		20	960	980	0.145	7,250	14,886	0.013	0.34
95		20	980	1000	0.145	7,249	14,889	0.013	0.34
96			1000	0	0.155	9,200	18,264	0.004	0.33

Table 6-2 (1 of 3)

Generic Site Profile S3

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
1	Sand	5	0	5	0.130	2,090	4,800	0.015	0.38
2		5	5	10	0.130	2,090	4,809	0.019	0.38
3		5	10	15	0.130	2,081	4,861	0.023	0.39
4		5	15	20	0.130	2,082	4,912	0.026	0.39
5		5	20	25	0.130	2,126	4,963	0.021	0.39
6		5	25	30	0.130	2,129	5,014	0.023	0.39
7		5	30	35	0.130	2,130	5,065	0.025	0.39
8		5	35	40	0.130	2,134	5,115	0.027	0.39
9		5	40	45	0.130	2,140	5,165	0.028	0.40
10		5	45	50	0.130	2,148	5,215	0.030	0.40
11		5	50	55	0.130	2,213	5,264	0.024	0.39
12		5	55	60	0.130	2,226	5,314	0.024	0.39
13		5	60	65	0.130	2,241	5,363	0.025	0.39
14		5	65	70	0.130	2,255	5,412	0.025	0.39
15		5	70	75	0.130	2,270	5,460	0.026	0.40
16		5	75	80	0.130	2,285	5,508	0.026	0.40
17		5	80	85	0.130	2,300	5,556	0.026	0.40
18		5	85	90	0.130	2,315	5,604	0.027	0.40
19		5	90	95	0.130	2,331	5,651	0.027	0.40
20		5	95	100	0.130	2,345	5,699	0.028	0.40
21		5	100	105	0.130	2,358	5,745	0.029	0.40
22		5	105	110	0.130	2,372	5,792	0.029	0.40
23		5	110	115	0.130	2,386	5,839	0.029	0.40
24		5	115	120	0.130	2,400	5,885	0.030	0.40
25		5	120	125	0.130	2,466	5,931	0.023	0.40
26		5	125	130	0.130	2,482	5,976	0.024	0.40
27		5	130	135	0.130	2,498	6,021	0.024	0.40
28		5	135	140	0.130	2,514	6,067	0.024	0.40
29		5	140	145	0.130	2,530	6,111	0.024	0.40
30		5	145	150	0.130	2,546	6,156	0.025	0.40
31		5	150	155	0.130	2,562	6,200	0.025	0.40
32		5	155	160	0.130	2,578	6,244	0.025	0.40
33		5	160	165	0.130	2,594	6,288	0.025	0.40
34		5	165	170	0.130	2,609	6,332	0.025	0.40
35		5	170	175	0.130	2,624	6,375	0.026	0.40
36		5	175	180	0.130	2,640	6,418	0.026	0.40
37		5	180	185	0.130	2,655	6,461	0.026	0.40
38		5	185	190	0.130	2,670	6,503	0.026	0.40
39		5	190	195	0.130	2,685	6,545	0.026	0.40
40		5	195	200	0.130	2,700	6,587	0.026	0.40

Table 6-2 (2 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer Top (ft)	Depth Layer Bottom (ft)	Weight Density (kcf)	Seismic Wave Velocity Avg. Vs (fps)	Seismic Wave Velocity Vp (fps)	Avg. Damping	Poisson's Ratio
41	Soft Rock	10	200	210	0.135	4,860	10,160	0.034	0.35
42		10	210	220	0.135	4,893	10,235	0.034	0.35
43		10	220	230	0.135	4,926	10,309	0.034	0.35
44		10	230	240	0.135	4,959	10,383	0.035	0.35
45		10	240	250	0.135	4,991	10,455	0.035	0.35
46		10	250	260	0.135	5,023	10,527	0.035	0.35
47		10	260	270	0.135	5,055	10,598	0.035	0.35
48		10	270	280	0.135	5,087	10,667	0.035	0.35
49		10	280	290	0.135	5,117	10,736	0.035	0.35
50		10	290	300	0.135	5,147	10,804	0.035	0.35
51		10	300	310	0.135	5,178	10,871	0.036	0.35
52		10	310	320	0.135	5,207	10,936	0.036	0.35
53		10	320	330	0.135	5,237	11,001	0.036	0.35
54		10	330	340	0.135	5,266	11,065	0.036	0.35
55		10	340	350	0.135	5,294	11,128	0.036	0.35
56		10	350	360	0.135	5,322	11,190	0.036	0.35
57		10	360	370	0.135	5,349	11,251	0.036	0.35
58		10	370	380	0.135	5,377	11,311	0.036	0.35
59		10	380	390	0.135	5,403	11,370	0.036	0.35
60		10	390	400	0.135	5,430	11,429	0.036	0.35
61		10	400	410	0.135	5,456	11,486	0.036	0.35
62		10	410	420	0.135	5,481	11,542	0.036	0.35
63		10	420	430	0.135	5,506	11,597	0.037	0.35
64		10	430	440	0.135	5,530	11,652	0.037	0.35
65		10	440	450	0.135	5,554	11,705	0.037	0.35
66		10	450	460	0.135	5,577	11,757	0.037	0.35
67		10	460	470	0.135	5,601	11,809	0.037	0.35
68		10	470	480	0.135	5,624	11,859	0.037	0.35
69		10	480	490	0.135	5,646	11,909	0.037	0.36
70		10	490	500	0.135	5,668	11,958	0.037	0.36
71	Rock	20	500	520	0.155	9,200	18,264	0.010	0.33
72		20	520	540	0.155	9,200	18,264	0.010	0.33
73		20	540	560	0.155	9,200	18,264	0.010	0.33
74		20	560	580	0.155	9,200	18,264	0.010	0.33
75		20	580	600	0.155	9,200	18,264	0.010	0.33
76		20	600	620	0.155	9,200	18,264	0.010	0.33
77		20	620	640	0.155	9,200	18,264	0.010	0.33
78		20	640	660	0.155	9,200	18,264	0.010	0.33
79		20	660	680	0.155	9,200	18,264	0.010	0.33
80		20	680	700	0.155	9,200	18,264	0.010	0.33
81		20	700	720	0.155	9,200	18,264	0.010	0.33
82		20	720	740	0.155	9,200	18,264	0.010	0.33

Table 6-2 (3 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer Top (ft)	Depth Layer Bottom (ft)	Weight Density (kcf)	Seismic Wave Velocity Avg. Vs (fps)	Seismic Wave Velocity Vp (fps)	Avg. Damping	Poisson's Ratio
83	Rock	20	740	760	0.155	9,200	18,264	0.010	0.33
84		20	760	780	0.155	9,200	18,264	0.010	0.33
85		20	780	800	0.155	9,200	18,264	0.010	0.33
86		20	800	820	0.155	9,200	18,264	0.010	0.33
87		20	820	840	0.155	9,200	18,264	0.010	0.33
88		20	840	860	0.155	9,200	18,264	0.010	0.33
89		20	860	880	0.155	9,200	18,264	0.010	0.33
90		20	880	900	0.155	9,200	18,264	0.010	0.33
91		20	900	920	0.155	9,200	18,264	0.010	0.33
92		20	920	940	0.155	9,200	18,264	0.010	0.33
93		20	940	960	0.155	9,200	18,264	0.010	0.33
94		20	960	980	0.155	9,200	18,264	0.010	0.33
95		20	980	1000	0.155	9,200	18,264	0.010	0.33
96			1000	0	0.155	9,200	18,264	0.004	0.33

Table 6-3 (1 of 3)

Generic Site Profile S4

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
1	Sand	5	0	5	0.130	1,813	4,800	0.016	0.42
2		5	5	10	0.130	1,802	4,800	0.021	0.42
3		5	10	15	0.130	1,794	4,800	0.026	0.42
4		5	15	20	0.130	1,790	4,800	0.029	0.42
5		5	20	25	0.130	1,820	4,800	0.025	0.42
6		5	25	30	0.130	1,817	4,800	0.027	0.42
7		5	30	35	0.130	1,818	4,800	0.029	0.42
8		5	35	40	0.130	1,820	4,800	0.031	0.42
9		5	40	45	0.130	1,826	4,800	0.033	0.42
10		5	45	50	0.130	1,832	4,800	0.034	0.41
11		5	50	55	0.130	1,898	4,800	0.026	0.41
12		5	55	60	0.130	1,909	4,800	0.027	0.41
13		5	60	65	0.130	1,921	4,800	0.027	0.40
14		5	65	70	0.130	1,930	4,800	0.029	0.40
15		5	70	75	0.130	1,939	4,800	0.029	0.40
16		5	75	80	0.130	1,949	4,800	0.030	0.40
17		5	80	85	0.130	1,958	4,831	0.032	0.40
18		5	85	90	0.130	1,967	4,873	0.033	0.40
19		5	90	95	0.130	1,975	4,914	0.033	0.40
20		5	95	100	0.130	1,984	4,955	0.034	0.40
21	Soft Rock	5	100	105	0.135	3,892	8,114	0.033	0.35
22		5	105	110	0.135	3,908	8,151	0.034	0.35
23		5	110	115	0.135	3,922	8,188	0.034	0.35
24		5	115	120	0.135	3,937	8,225	0.034	0.35
25		5	120	125	0.135	3,953	8,262	0.034	0.35
26		5	125	130	0.135	3,968	8,298	0.035	0.35
27		5	130	135	0.135	3,983	8,334	0.035	0.35
28		5	135	140	0.135	3,998	8,370	0.035	0.35
29		5	140	145	0.135	4,013	8,406	0.035	0.35
30		5	145	150	0.135	4,027	8,441	0.035	0.35
31		5	150	155	0.135	4,042	8,476	0.035	0.35
32		5	155	160	0.135	4,057	8,512	0.036	0.35
33		5	160	165	0.135	4,072	8,546	0.036	0.35
34		5	165	170	0.135	4,087	8,581	0.036	0.35
35		5	170	175	0.135	4,102	8,616	0.036	0.35
36		5	175	180	0.135	4,116	8,650	0.036	0.35
37		5	180	185	0.135	4,131	8,684	0.036	0.35
38		5	185	190	0.135	4,145	8,718	0.036	0.35
39		5	190	195	0.135	4,160	8,751	0.036	0.35
40		5	195	200	0.135	4,175	8,785	0.037	0.35

Table 6-3 (2 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
41	Rock	10	200	210	0.145	6,120	12,396	0.011	0.34
42		10	210	220	0.145	6,147	12,458	0.011	0.34
43		10	220	230	0.145	6,173	12,520	0.011	0.34
44		10	230	240	0.145	6,200	12,581	0.011	0.34
45		10	240	250	0.145	6,225	12,641	0.011	0.34
46		10	250	260	0.145	6,252	12,700	0.011	0.34
47		10	260	270	0.145	6,278	12,759	0.011	0.34
48		10	270	280	0.145	6,303	12,817	0.011	0.34
49		10	280	290	0.145	6,328	12,874	0.011	0.34
50		10	290	300	0.145	6,353	12,930	0.011	0.34
51		10	300	310	0.145	6,378	12,985	0.012	0.34
52		10	310	320	0.145	6,401	13,040	0.012	0.34
53		10	320	330	0.145	6,596	13,094	0.012	0.34
54		10	330	340	0.145	6,622	13,147	0.012	0.34
55		10	340	350	0.145	6,649	13,199	0.012	0.34
56		10	350	360	0.145	6,674	13,250	0.012	0.34
57		10	360	370	0.145	6,700	13,301	0.012	0.34
58		10	370	380	0.145	6,725	13,351	0.012	0.34
59		10	380	390	0.145	6,750	13,400	0.012	0.34
60		10	390	400	0.145	6,774	13,448	0.012	0.34
61		10	400	410	0.145	6,798	13,495	0.012	0.34
62		10	410	420	0.145	6,821	13,542	0.012	0.34
63		10	420	430	0.145	6,845	13,588	0.012	0.34
64		10	430	440	0.145	6,867	13,633	0.012	0.34
65		10	440	450	0.145	6,890	13,677	0.012	0.34
66		10	450	460	0.145	6,911	13,721	0.012	0.34
67		10	460	470	0.145	6,933	13,763	0.012	0.34
68		10	470	480	0.145	6,954	13,805	0.012	0.34
69		10	480	490	0.145	6,975	13,846	0.012	0.34
70		10	490	500	0.145	6,995	13,887	0.012	0.34
71		20	500	520	0.155	9,200	18,264	0.01	0.33
72		20	520	540	0.155	9,200	18,264	0.01	0.33
73		20	540	560	0.155	9,200	18,264	0.01	0.33
74		20	560	580	0.155	9,200	18,264	0.01	0.33
75		20	580	600	0.155	9,200	18,264	0.01	0.33
76		20	600	620	0.155	9,200	18,264	0.01	0.33
77		20	620	640	0.155	9,200	18,264	0.01	0.33
78		20	640	660	0.155	9,200	18,264	0.01	0.33
79		20	660	680	0.155	9,200	18,264	0.010	0.33
80		20	680	700	0.155	9,200	18,264	0.010	0.33
81		20	700	720	0.155	9,200	18,264	0.010	0.33
82		20	720	740	0.155	9,200	18,264	0.010	0.33

Table 6-3 (3 of 3)

Layer No.	Soil Type	Thick. (ft)	Depth Layer		Weight Density (kcf)	Seismic Wave Velocity		Avg. Damping	Poisson's Ratio
			Top (ft)	Bottom (ft)		Avg. Vs (fps)	Vp (fps)		
83	Rock	20	740	760	0.155	9,200	18,264	0.010	0.33
84		20	760	780	0.155	9,200	18,264	0.010	0.33
85		20	780	800	0.155	9,200	18,264	0.010	0.33
86		20	800	820	0.155	9,200	18,264	0.010	0.33
87		20	820	840	0.155	9,200	18,264	0.010	0.33
88		20	840	860	0.155	9,200	18,264	0.010	0.33
89		20	860	880	0.155	9,200	18,264	0.010	0.33
90		20	880	900	0.155	9,200	18,264	0.010	0.33
91		20	900	920	0.155	9,200	18,264	0.010	0.33
92		20	920	940	0.155	9,200	18,264	0.010	0.33
93		20	940	960	0.155	9,200	18,264	0.010	0.33
94		20	960	980	0.155	9,200	18,264	0.010	0.33
95		20	980	1000	0.155	9,200	18,264	0.010	0.33
96			1000	0	0.155	9,200	18,264	0.004	0.33

Table 6-4

Total Number of Frequencies and Highest Frequency for Each Analysis Case

Analysis Cases	S2U	S3U	S4U
Total Number of Frequencies	70	94	89
Highest Frequency Analyzed	20.07	41.09	35.23

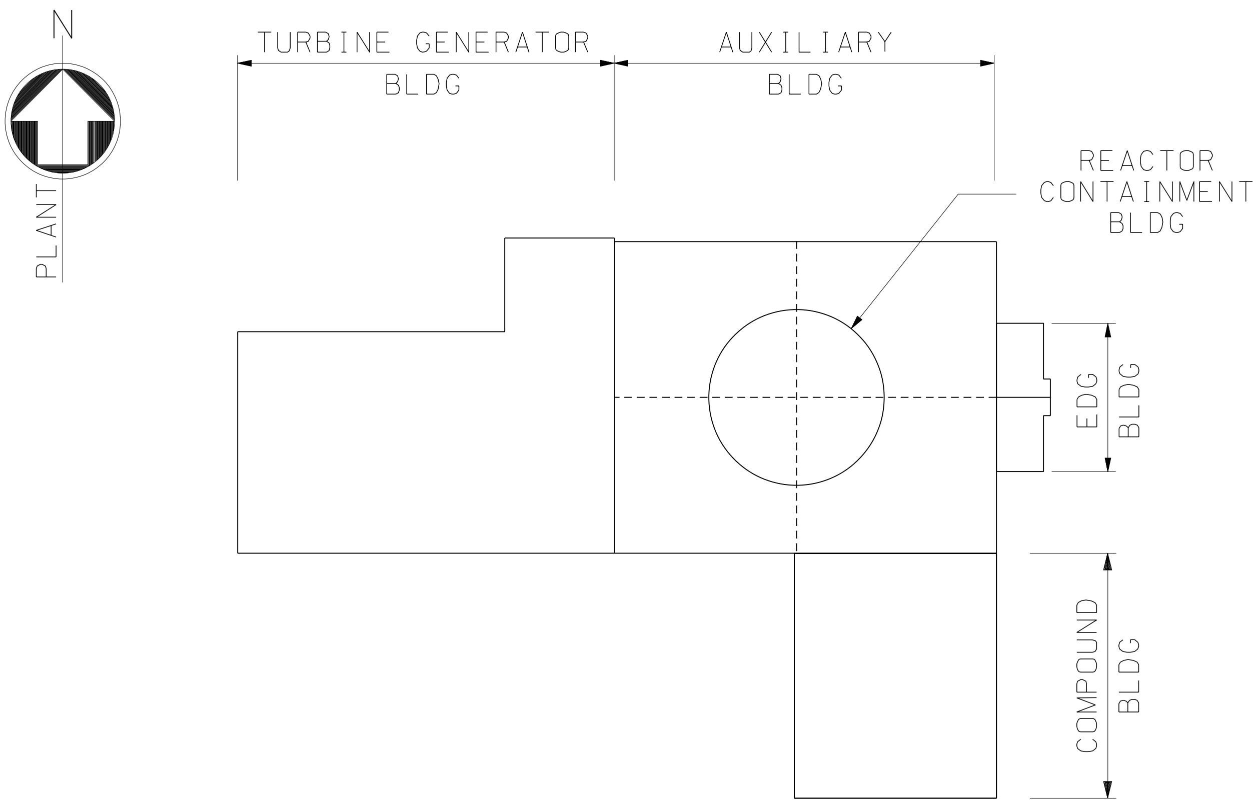


Figure 2-1 Plan Layout of APR1400 Power Block

Security-Related Information – Withhold Under 10 CFR 2.390

TS

Figure 2-2 Typical Section View of RCB

Security-Related Information – Withhold Under 10 CFR 2.390

TS

Figure 2-3 Typical Section View of AB

Security-Related Information – Withhold Under 10 CFR 2.390

TS

Figure 2-4 Typical Section View of EDGB

Security-Related Information – Withhold Under 10 CFR 2.390

TS

Figure 2-5 Typical Section View of CPB

Security-Related Information – Withhold Under 10 CFR 2.390

TS

Figure 2-6 Typical Section View of TI

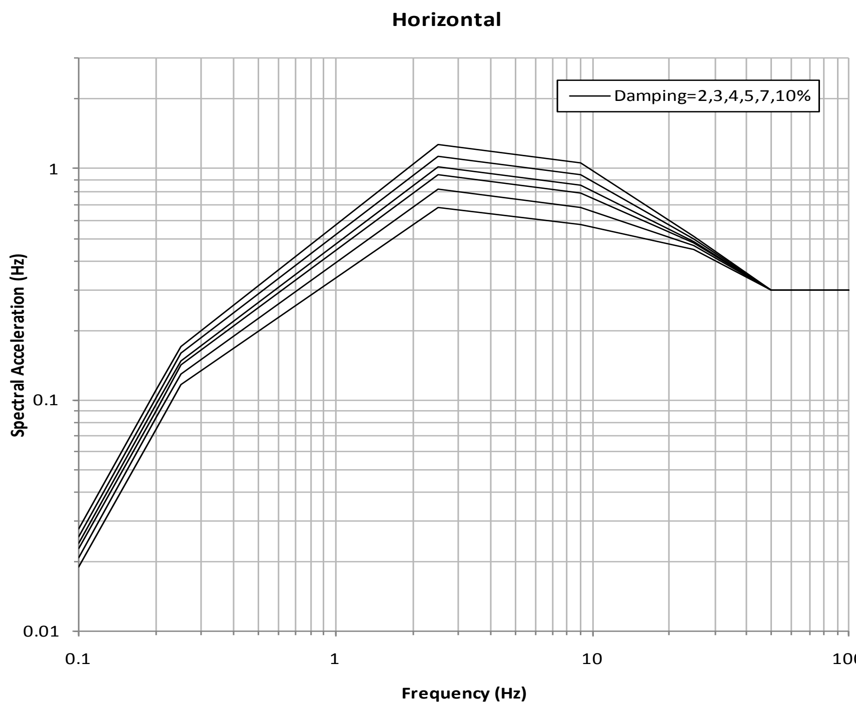


Figure 3-1 APR1400 Horizontal CSDRS

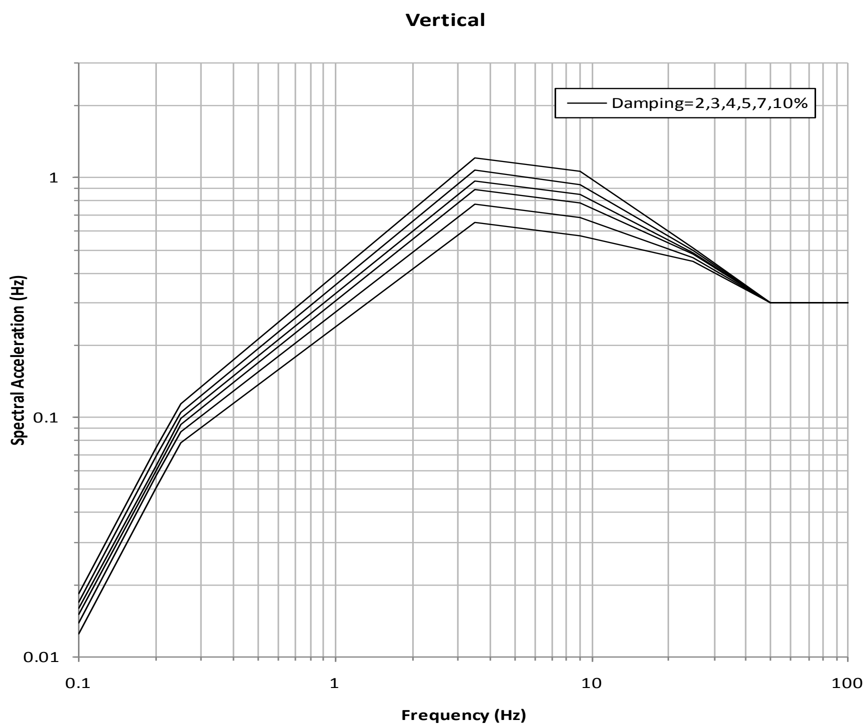


Figure 3-2 APR1400 Vertical CSDRS

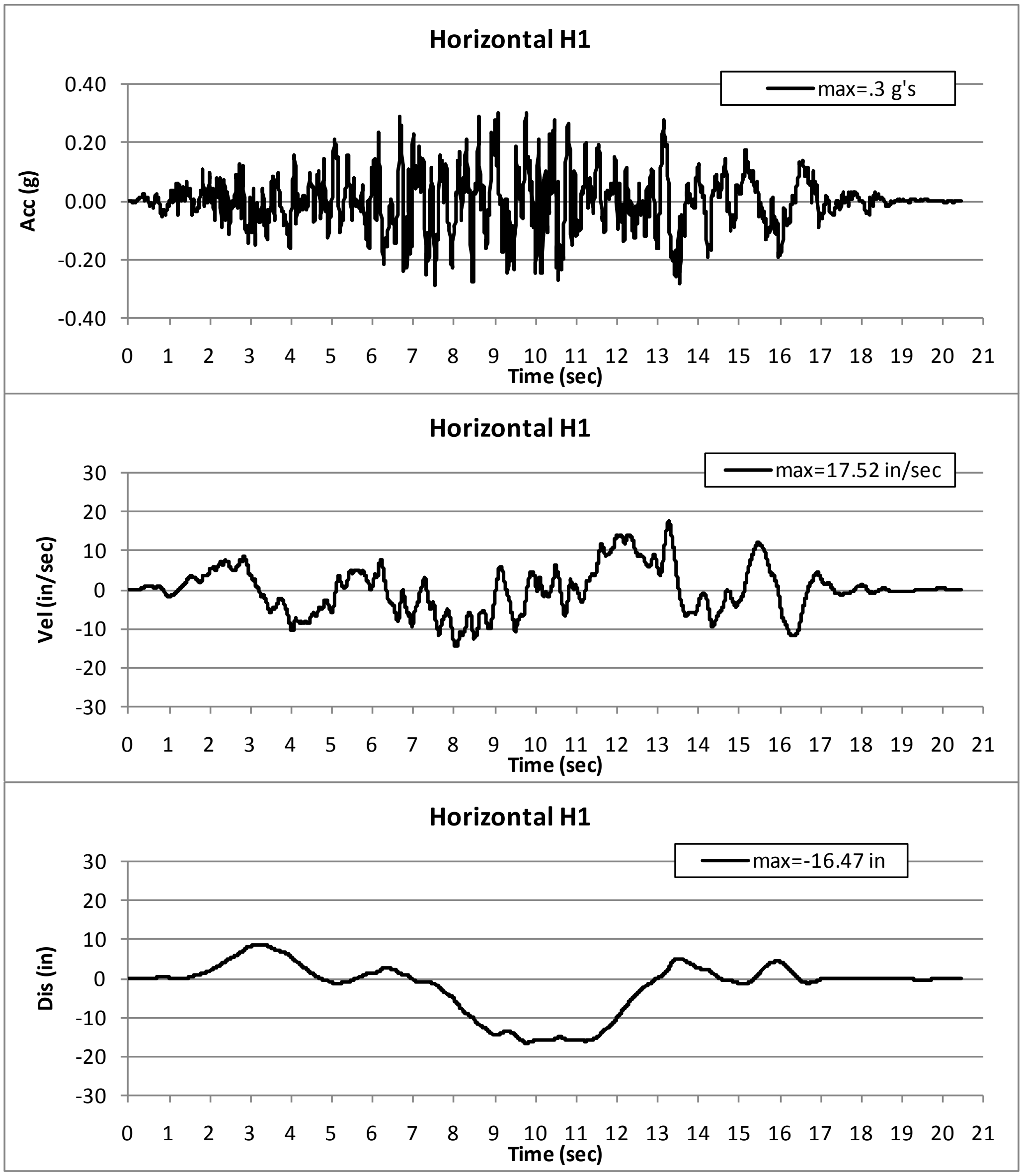


Figure 3-3 CSDRS-Compatible Design Acceleration, Velocity, and Displacement Time Histories - H1 Component

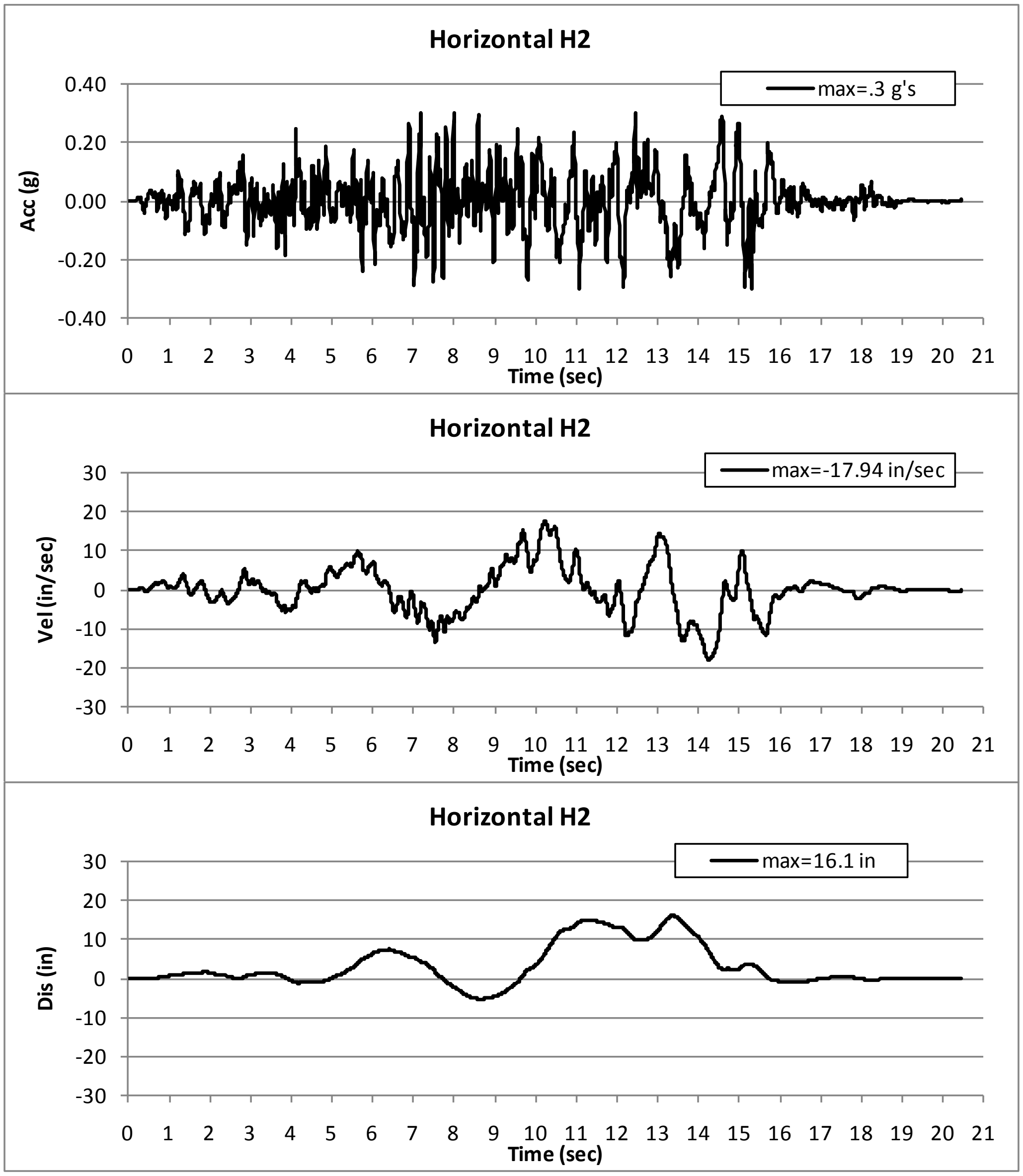


Figure 3-4 CSDRS-Compatible Design Acceleration, Velocity, and Displacement Time Histories - H2 Component

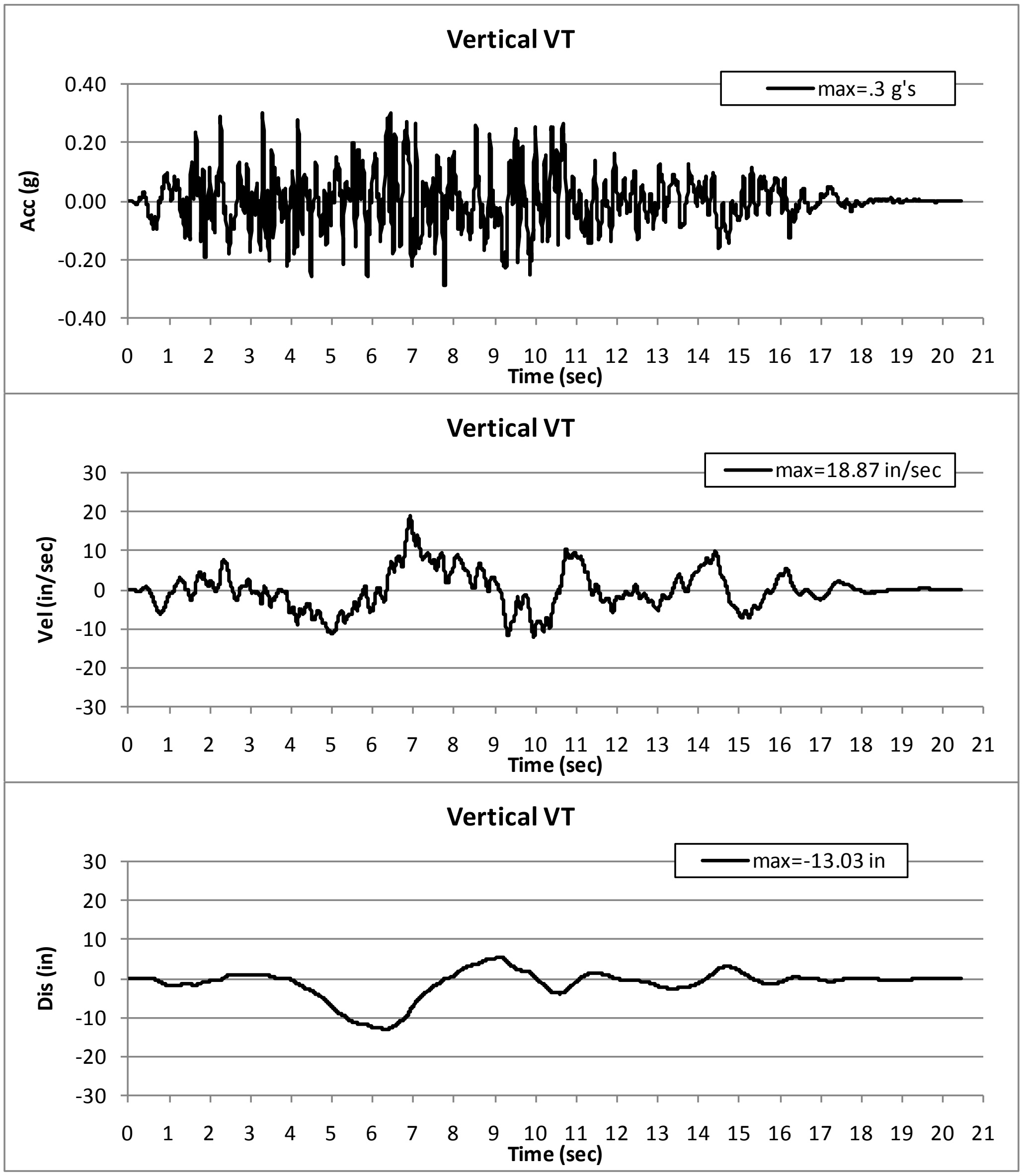


Figure 3-5 CSDRS-Compatible Design Acceleration, Velocity, and Displacement Time Histories - VT Component

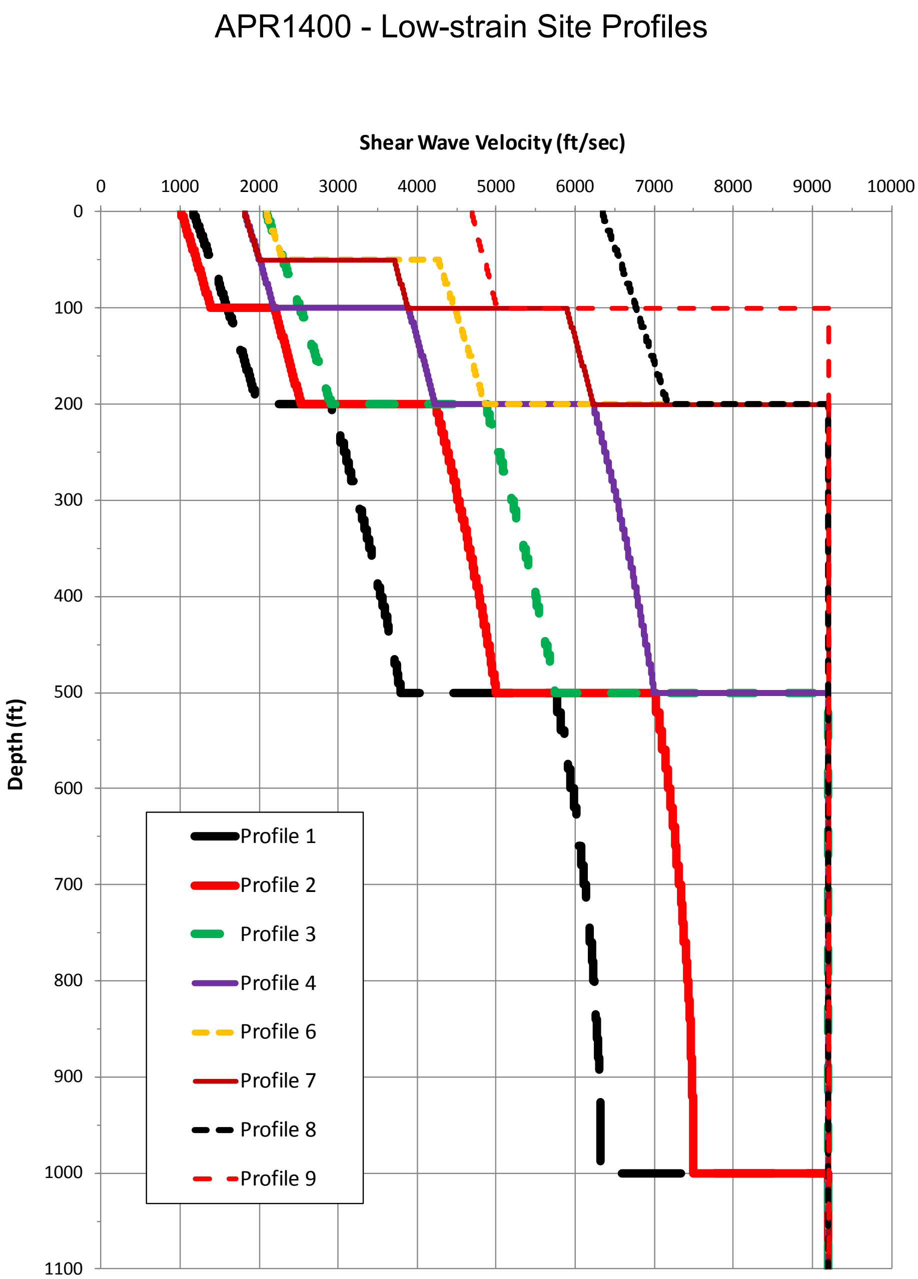
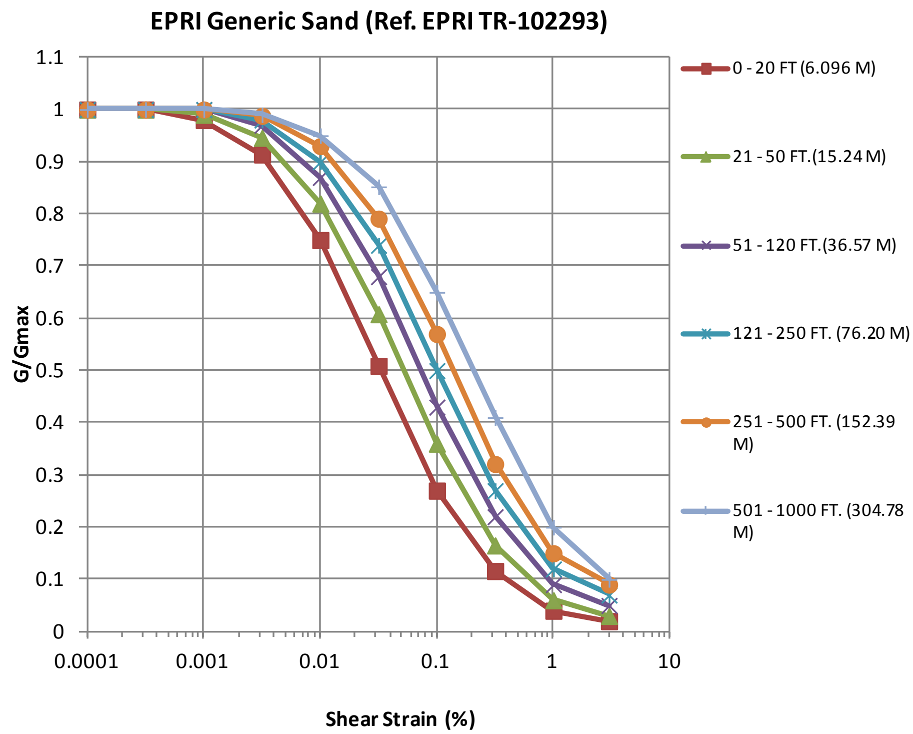


Figure 3-6 Low-Strain Shear Wave Velocity Profiles vs. Depth for Eight Low-strain Site Profiles Considered for APR1400



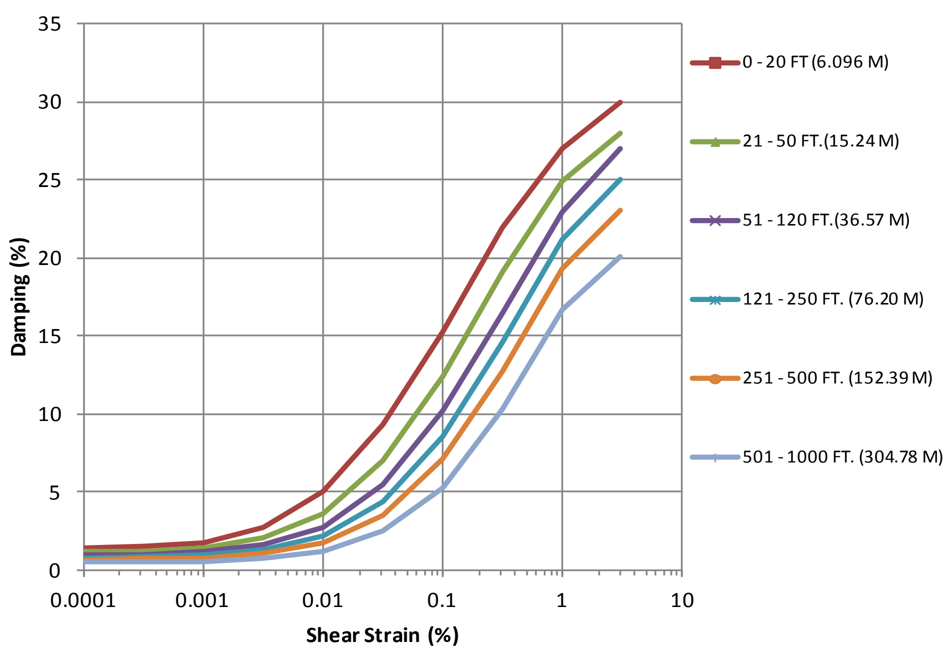
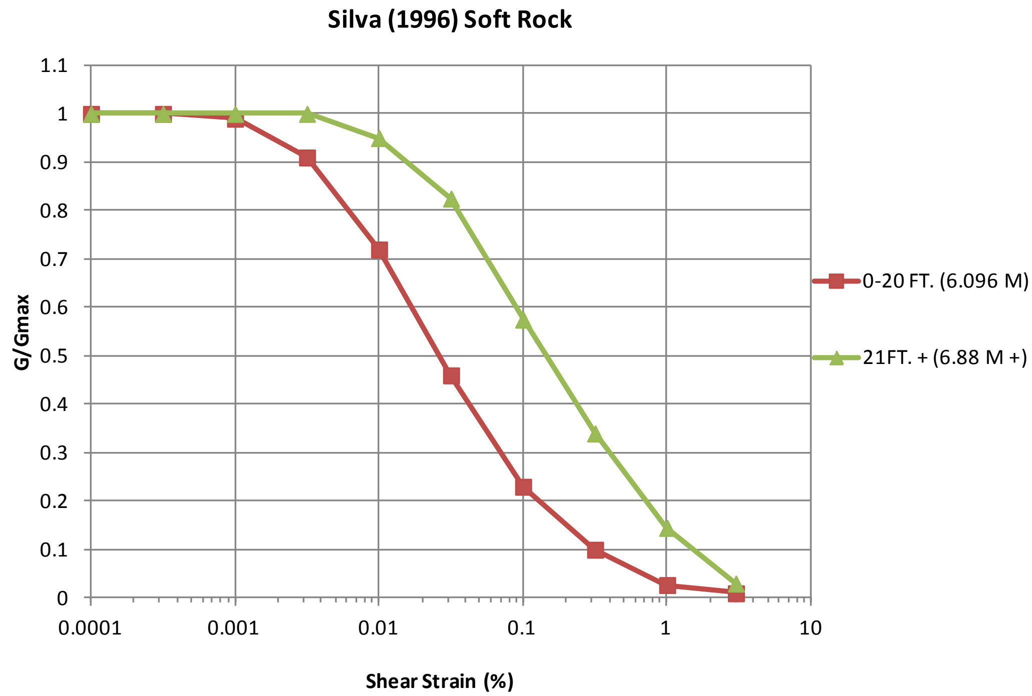


Figure 3-7 Shear-Modulus-Degradation and Damping-Value Variation Curves for Sand Considered for APR1400



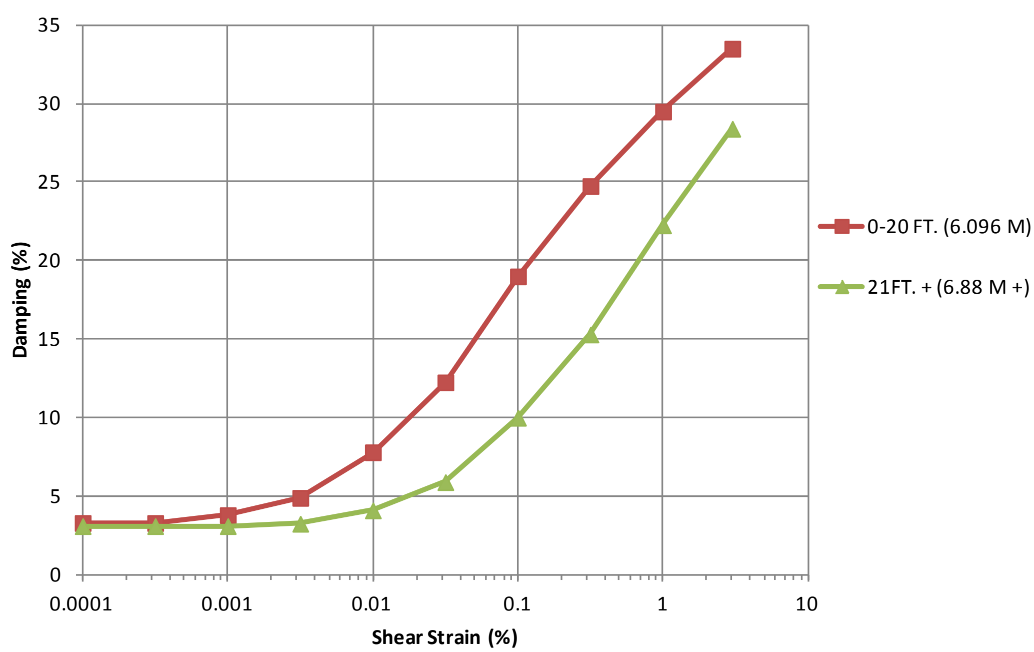
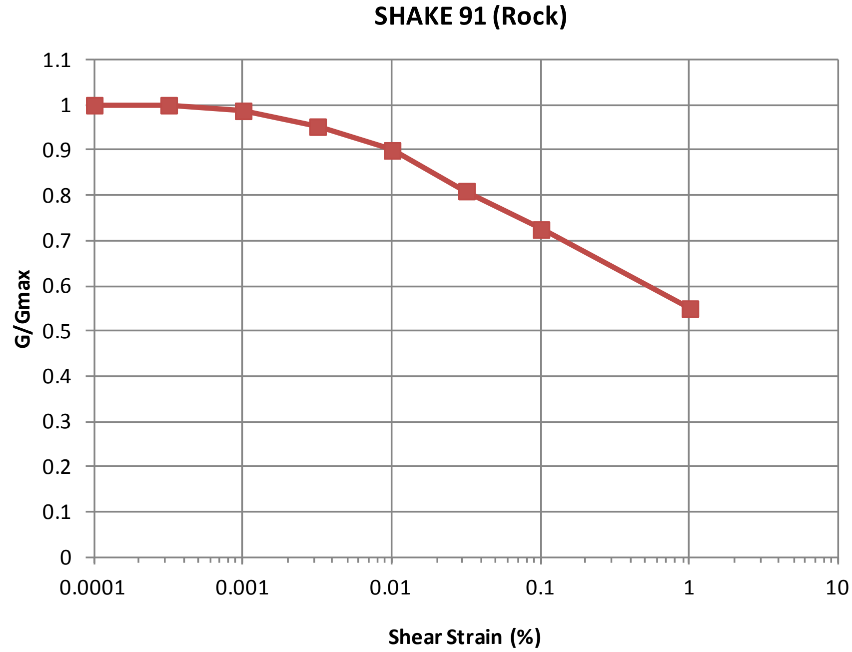


Figure 3-8 Shear-Modulus-Degradation and Damping-Value Variation Curves for Soft Rock Considered for APR1400



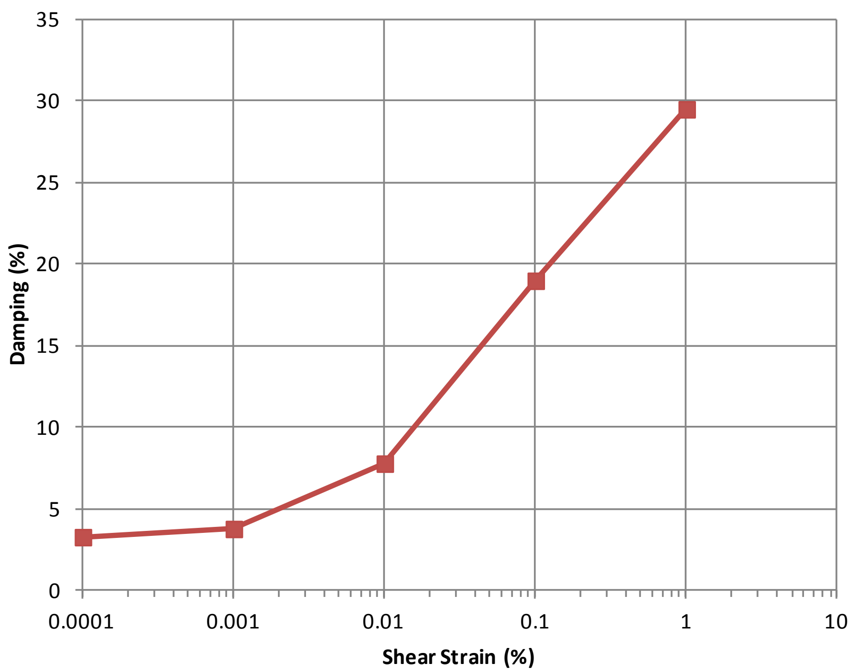
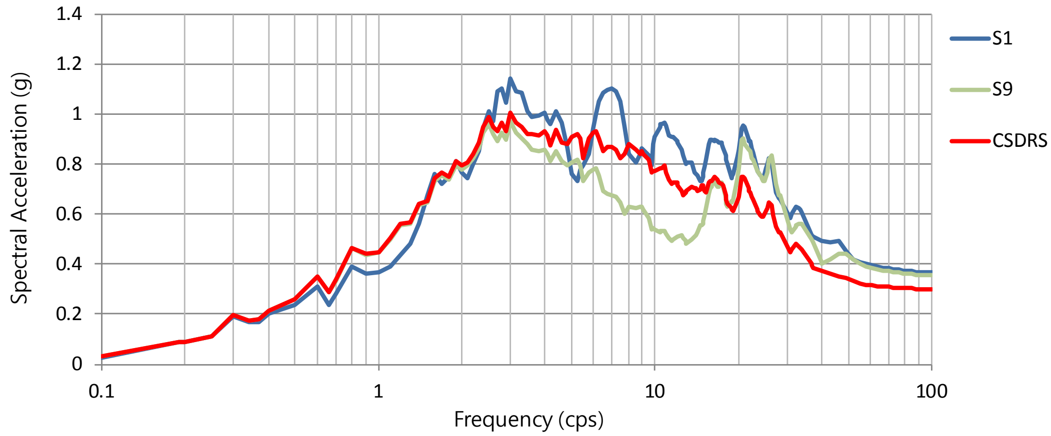
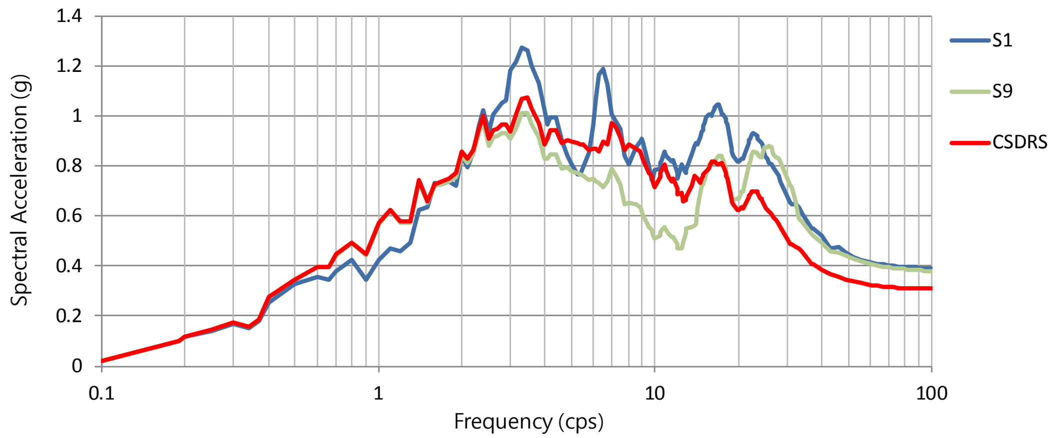


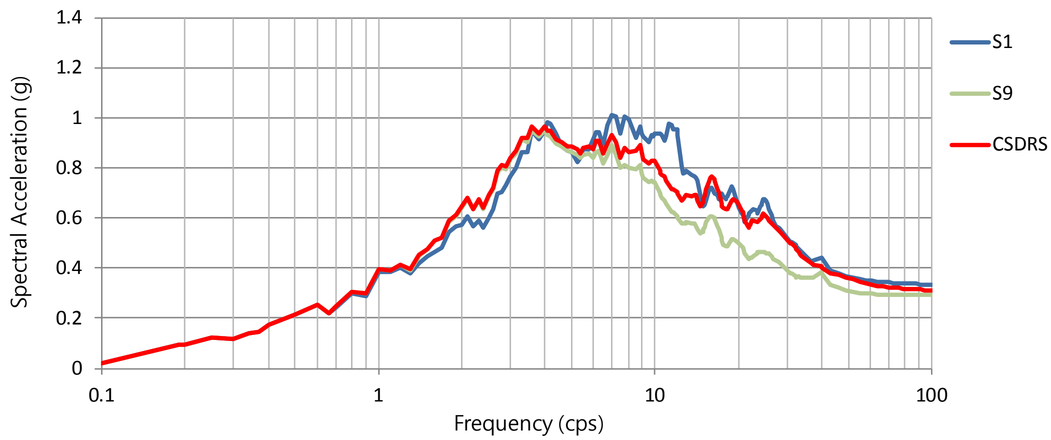
Figure 3-9 Shear-Modulus-Degradation and Damping-Value Variation Curves for Rock Considered for APR1400



(a) EW Motion



(b) NS Motion



(c) Vertical Motion

Figure 4-1 Site Response Motions at Truncated Surface for S1 and S9 Cases

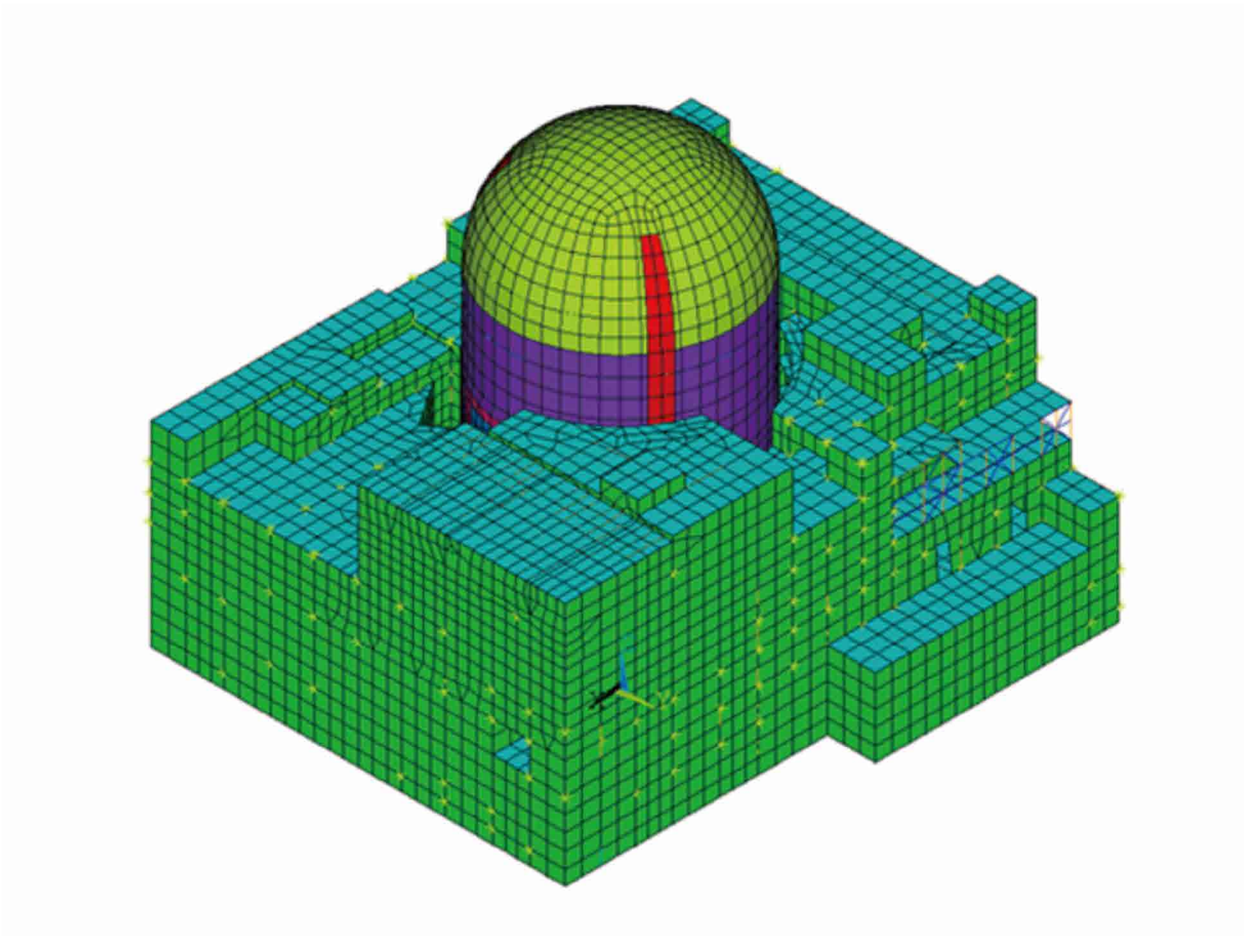
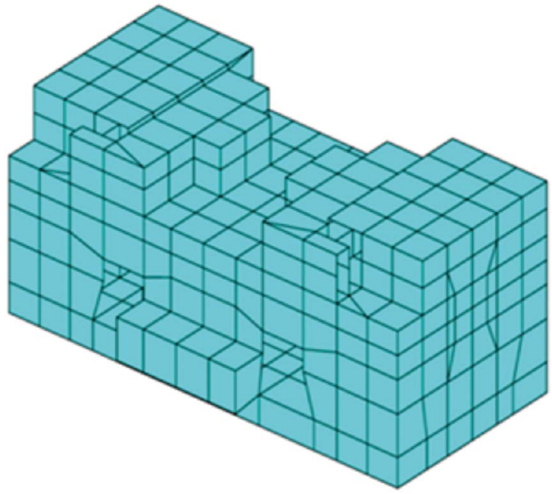
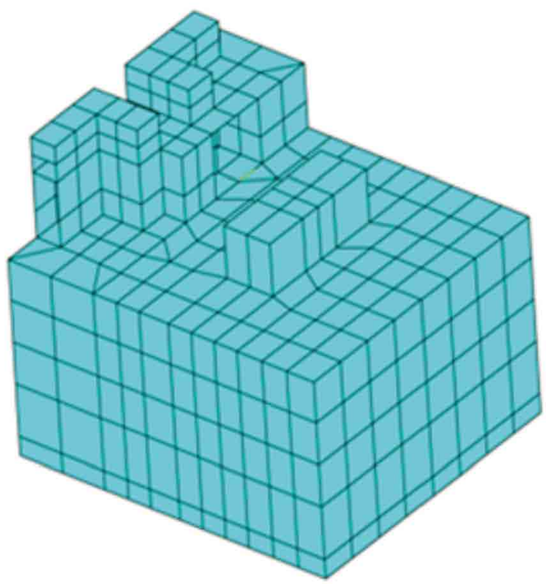


Figure 4-2 Combined SASSI SSI FEM of NI



(a) EDGB



(b) DFOT Room

Figure 4-3 SASSI SSI FEM of EDGB

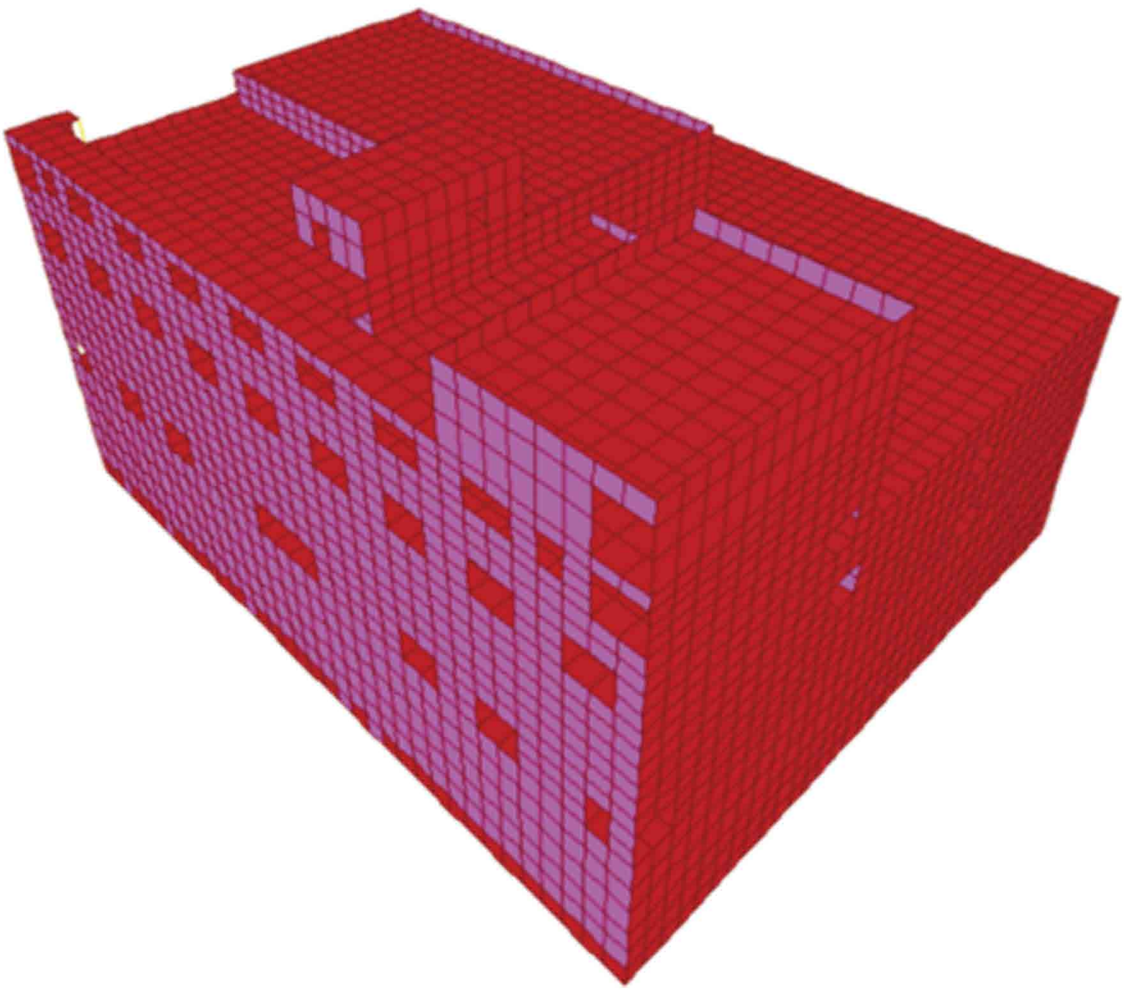


Figure 4-4 SASSI SSI FEM of CPB

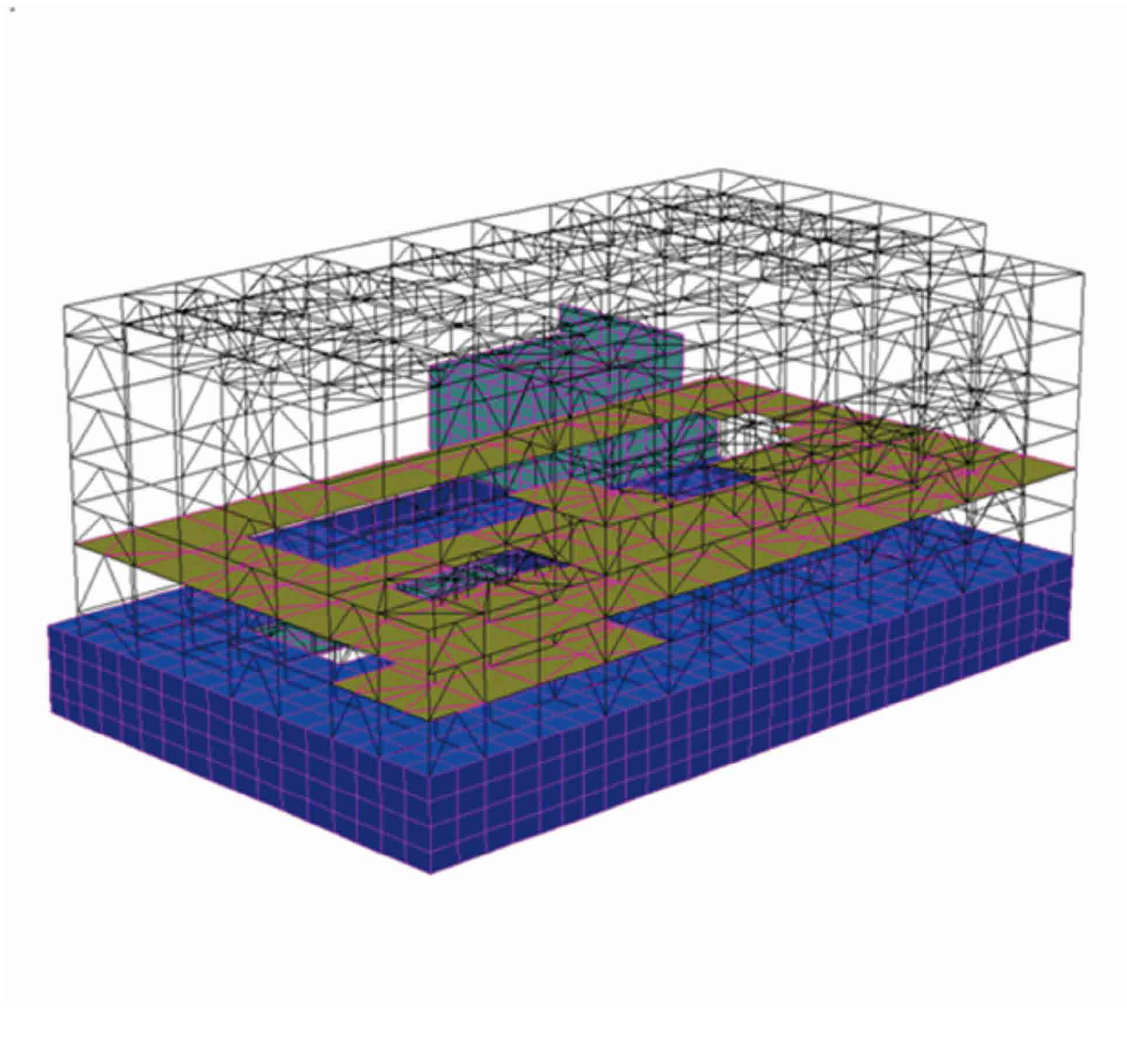


Figure 4-5 SASSI SSI FEM of TI

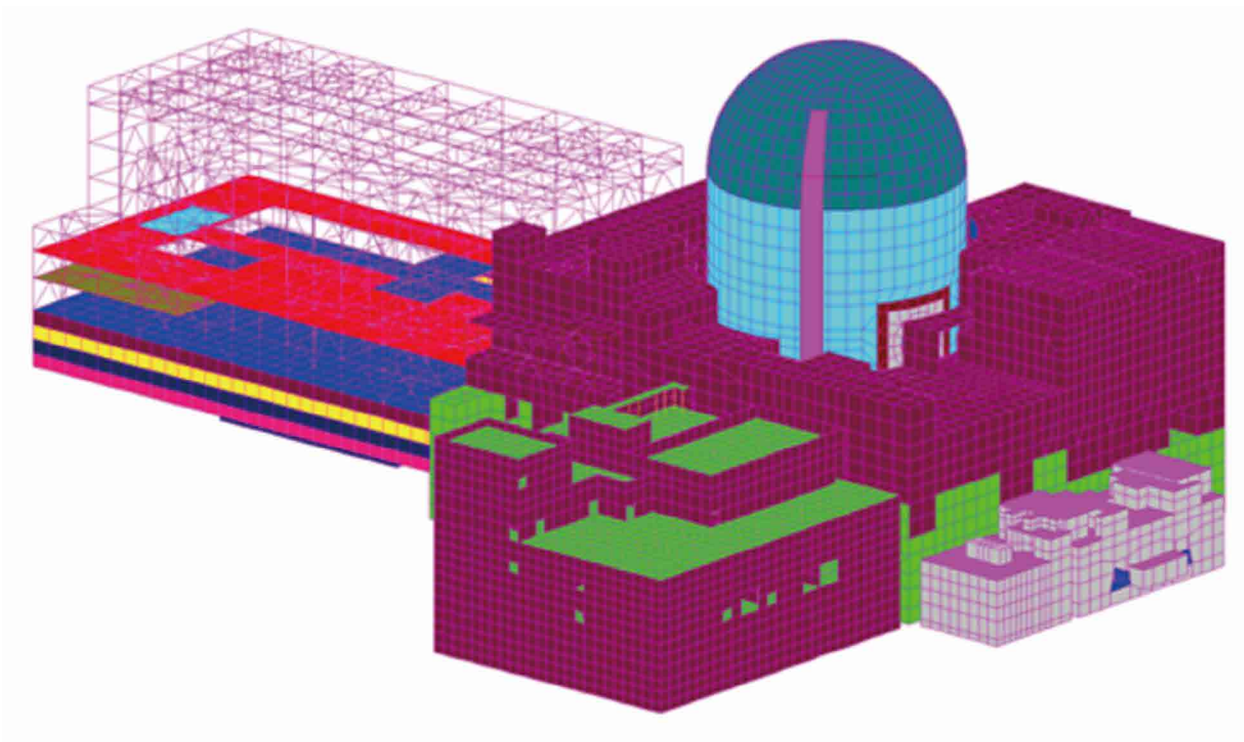
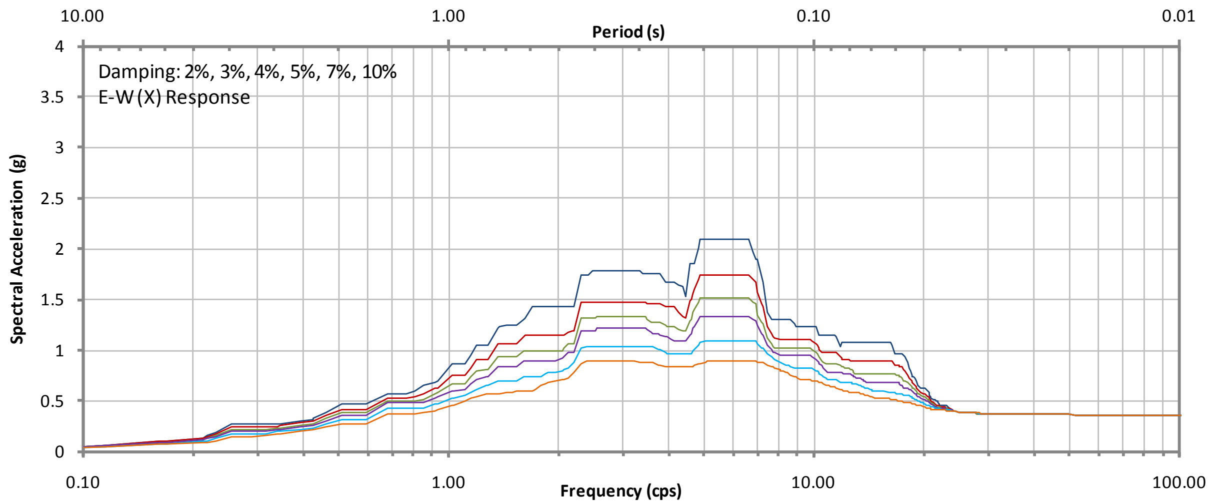
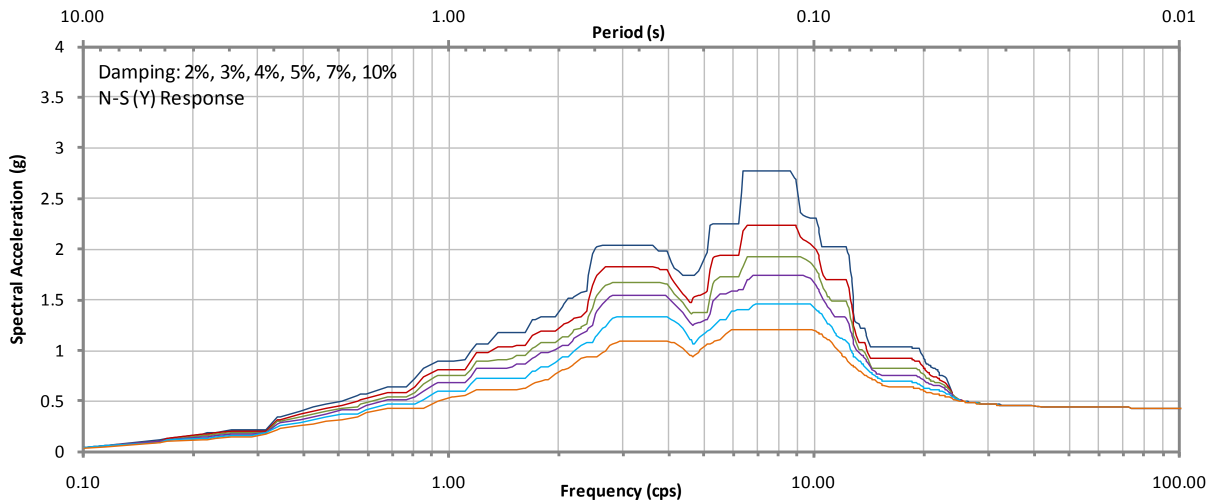


Figure 4-6 SASSI SSSI FEM of Power Block





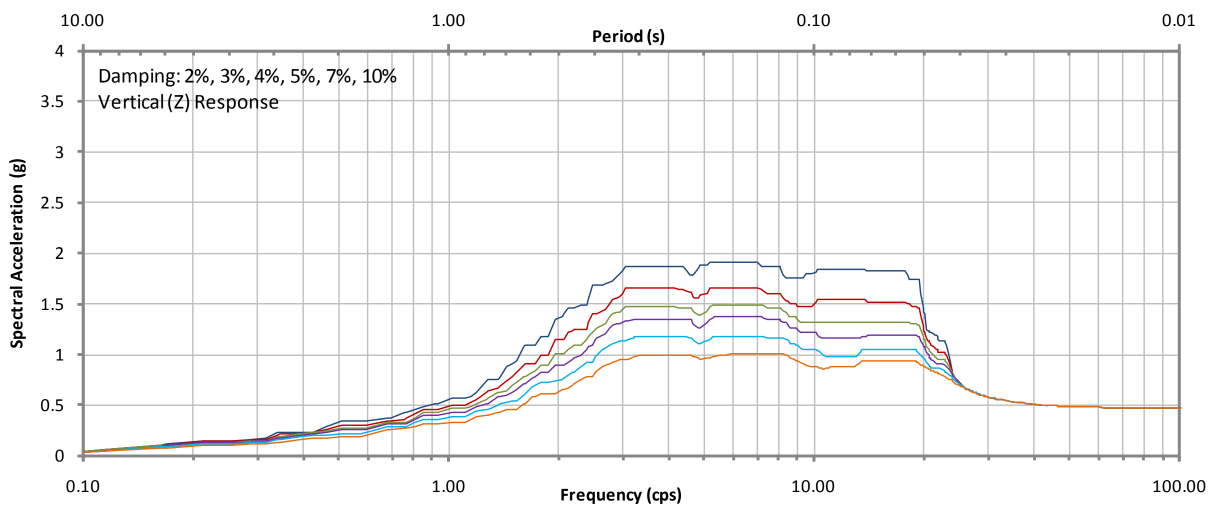


Figure 4-7 ISRS at AB El. 156’-0” for Design Basis SSI Analysis (Embedded Structure) S1U

Figure 4-8 Deleted

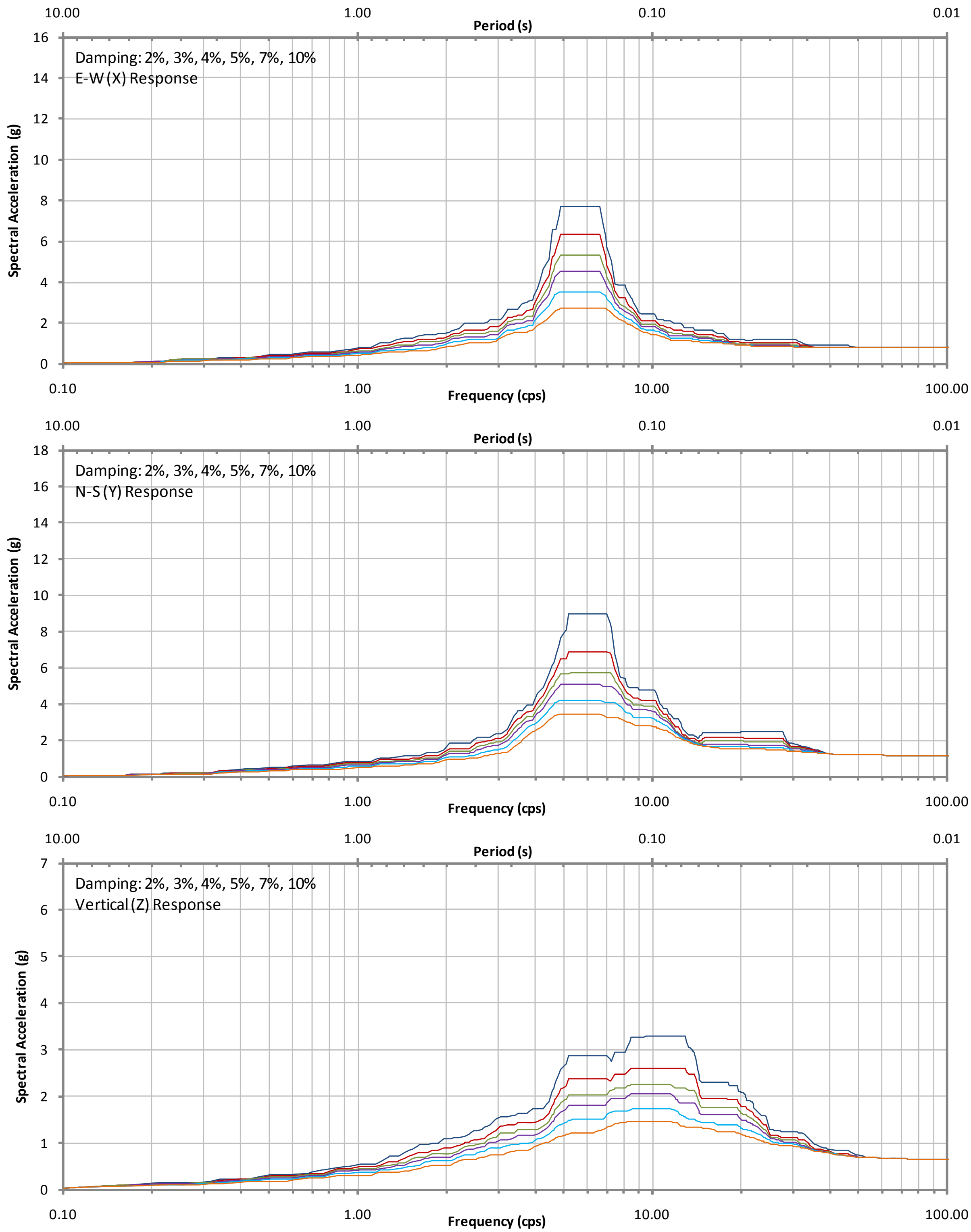


Figure 4-9 ISRS at AB El. 156’-0” for Design Basis SSI Analysis (Embedded Structure) S9U

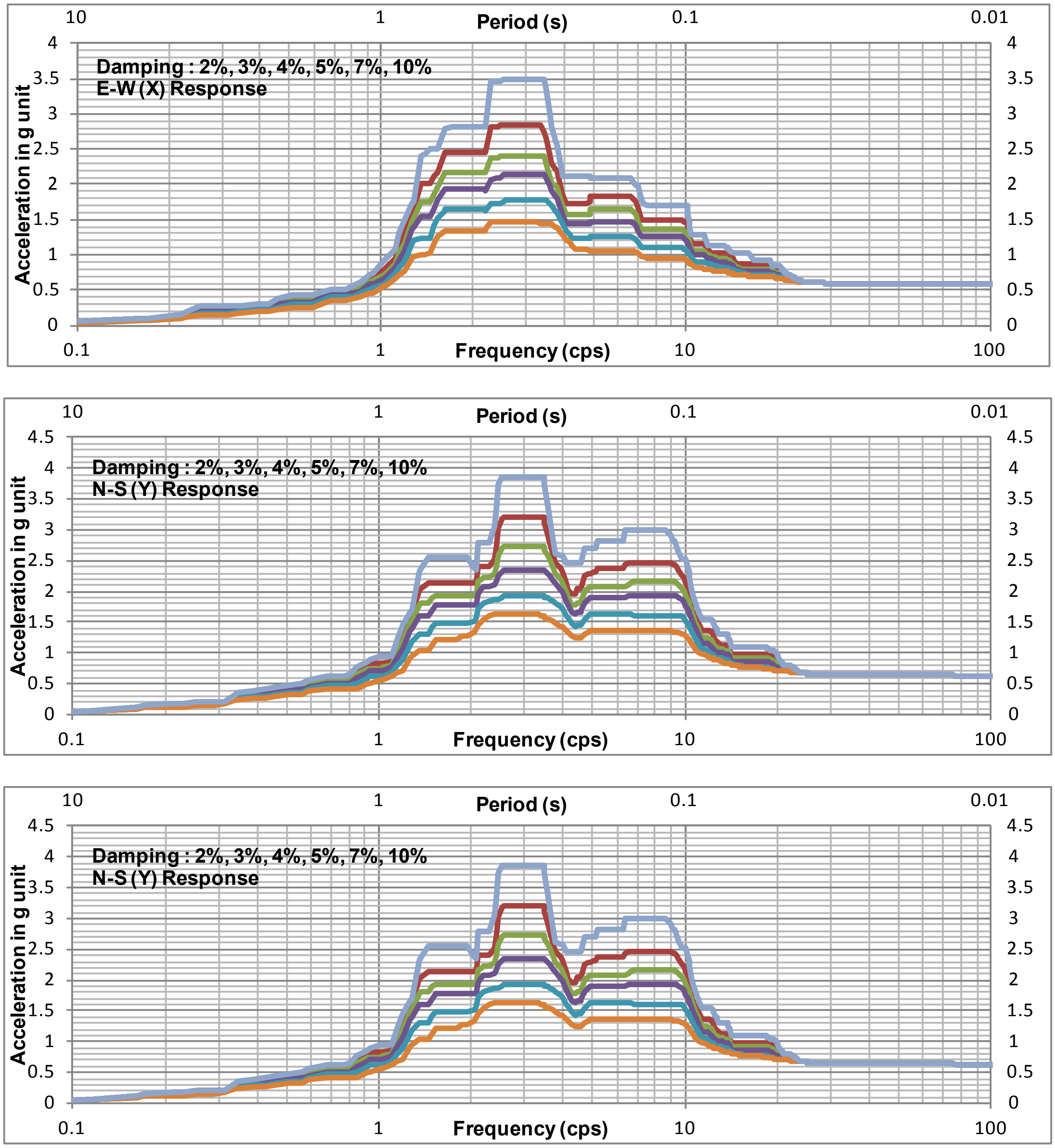


Figure 4-10 ISRS at AB El. 156'-0" for Individual SSI Analysis (Surface Structure) S1U

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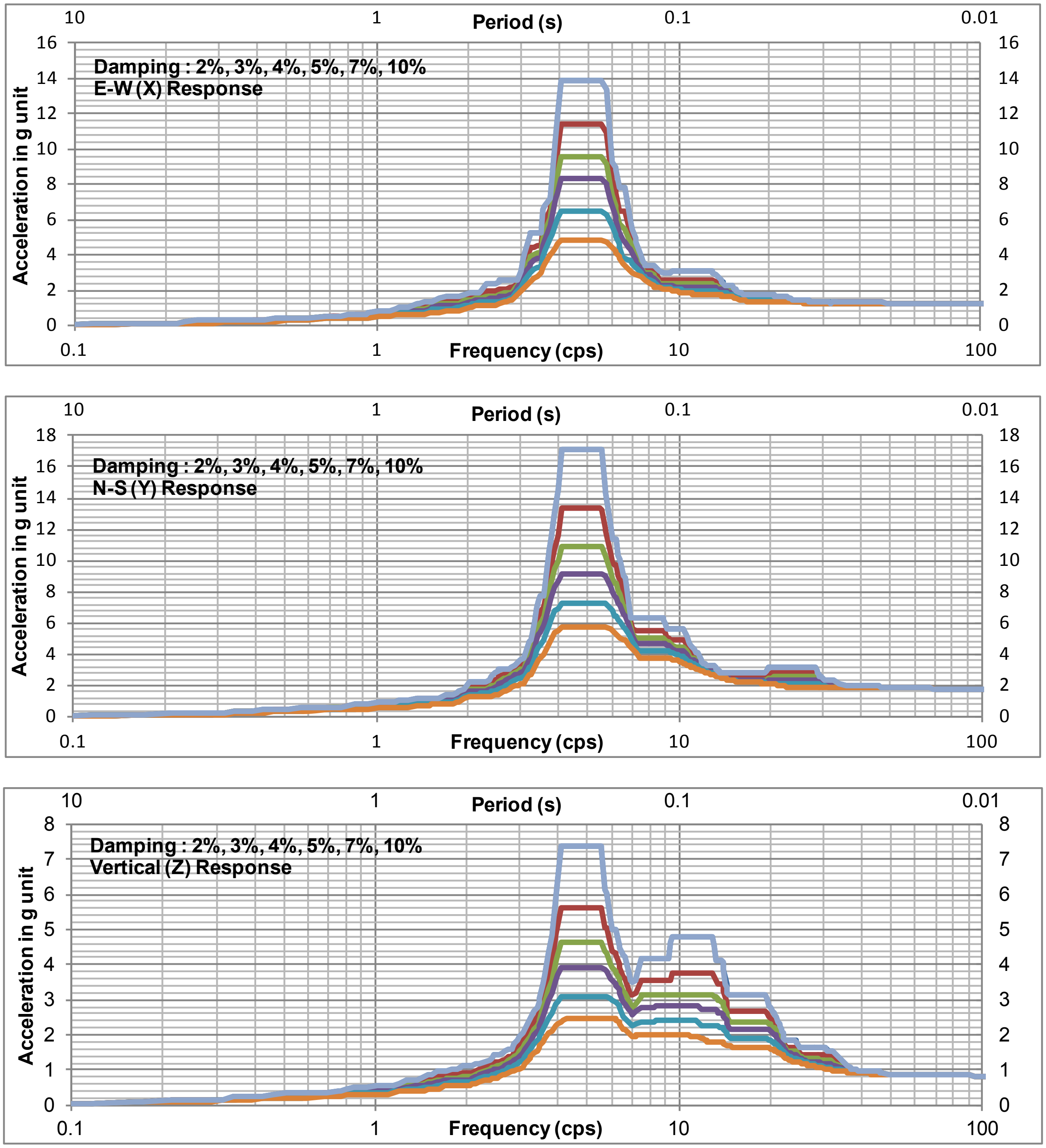


Figure 4-12 ISRS at AB El. 156'-0" for Individual SSI Analysis (Surface Structure) S9U

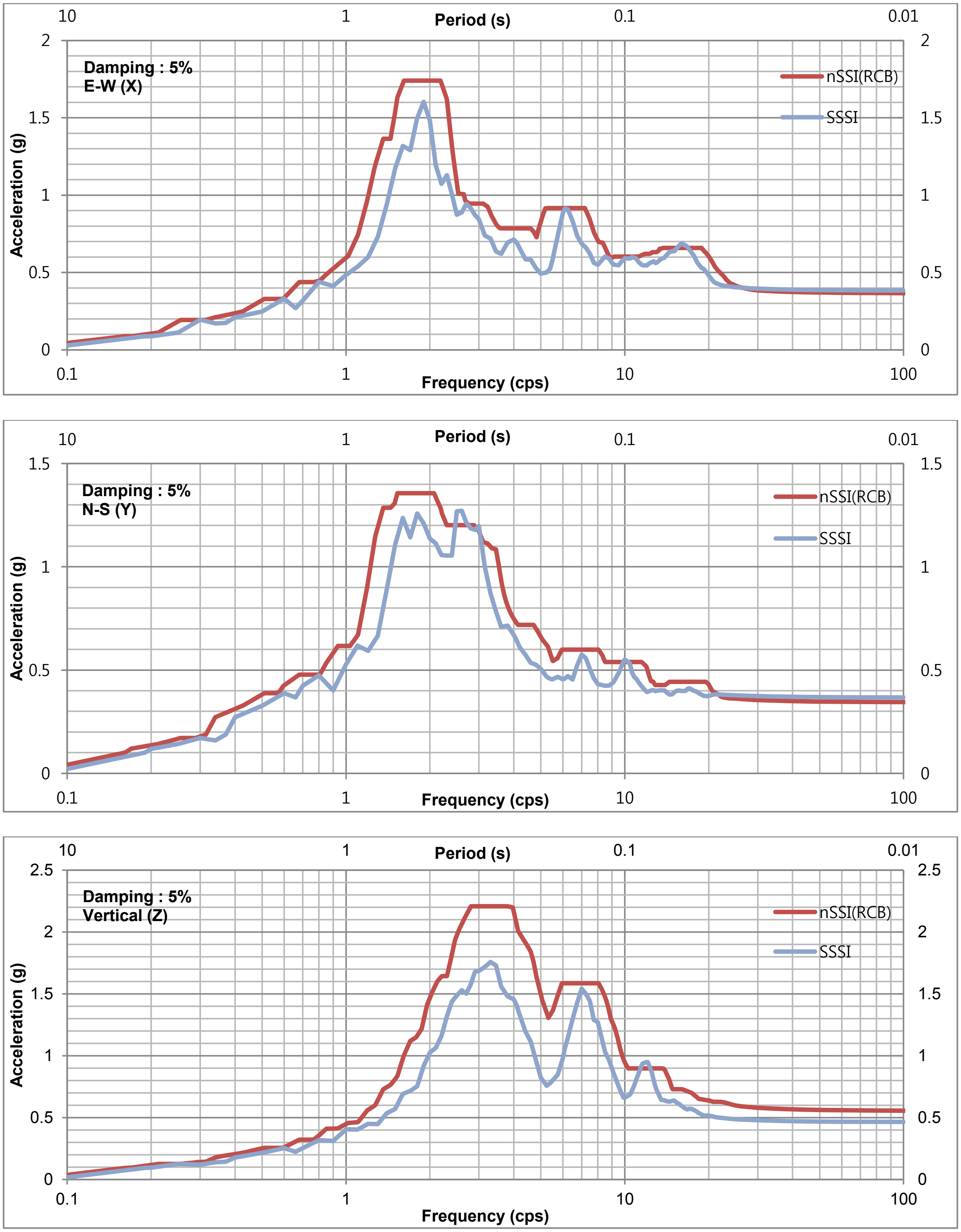


Figure 5-1 S1U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 78'-0"

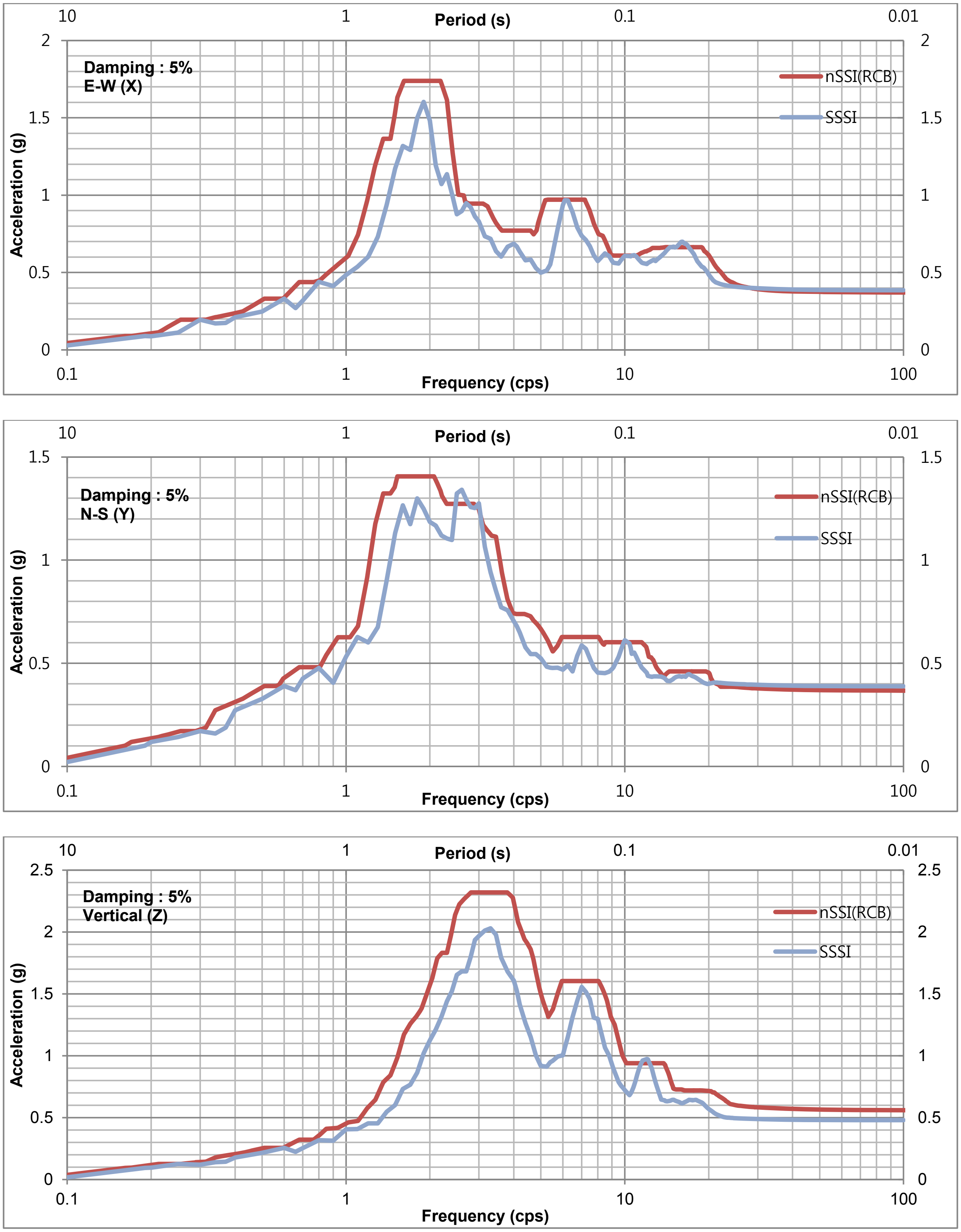


Figure 5-2 S1U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 100’-0”

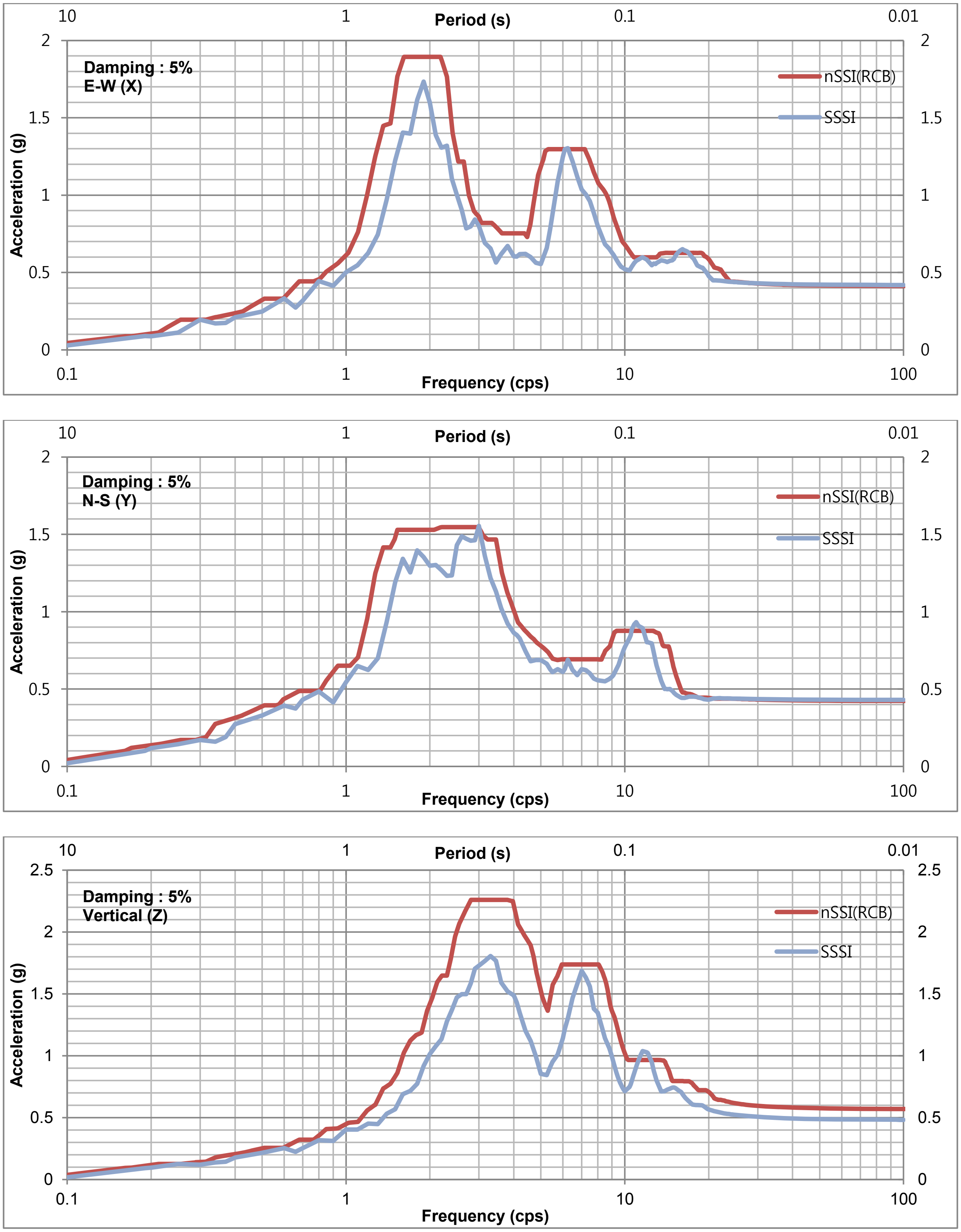


Figure 5-3 S1U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 156'-0"

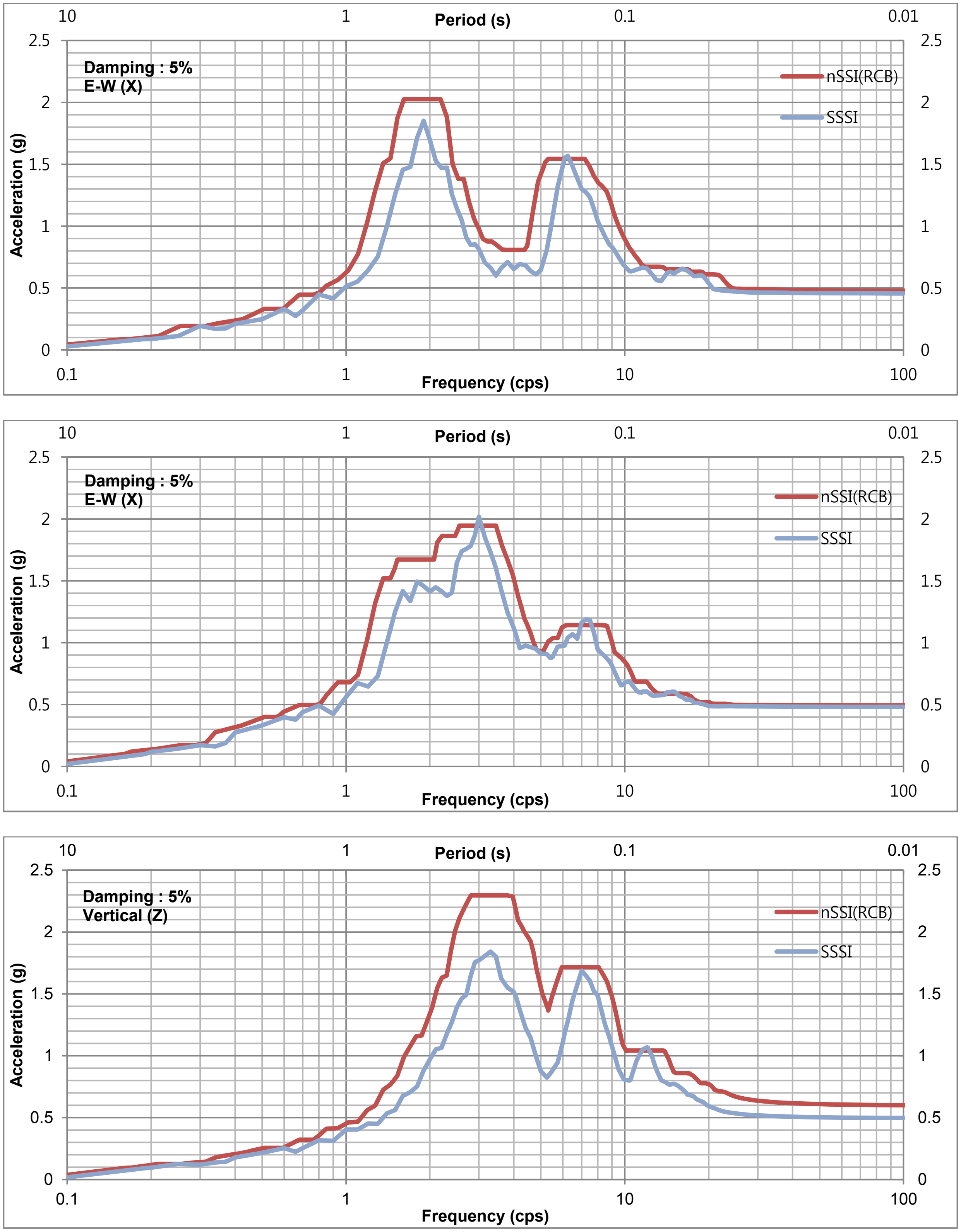


Figure 5-4 S1U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 254’-6”

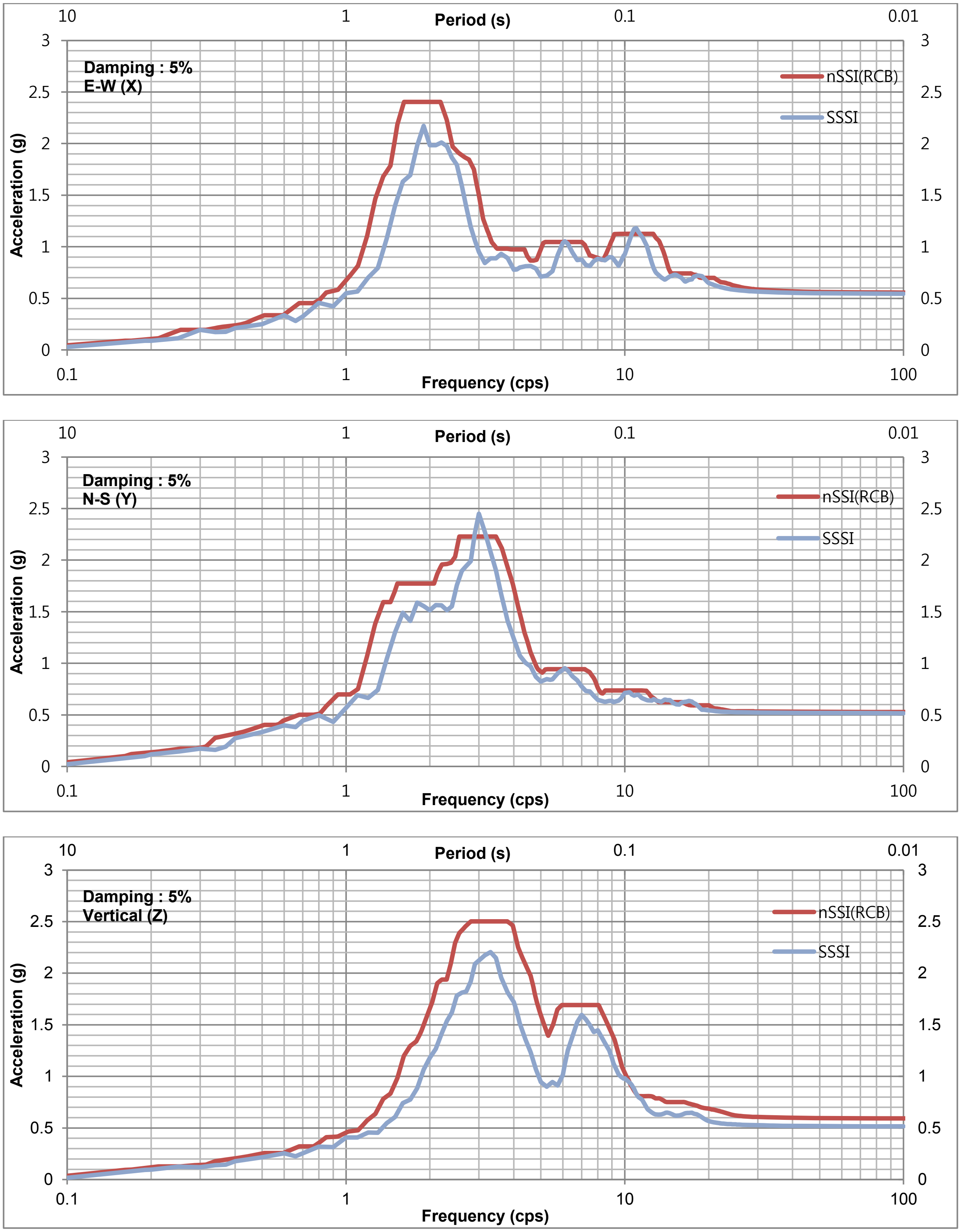
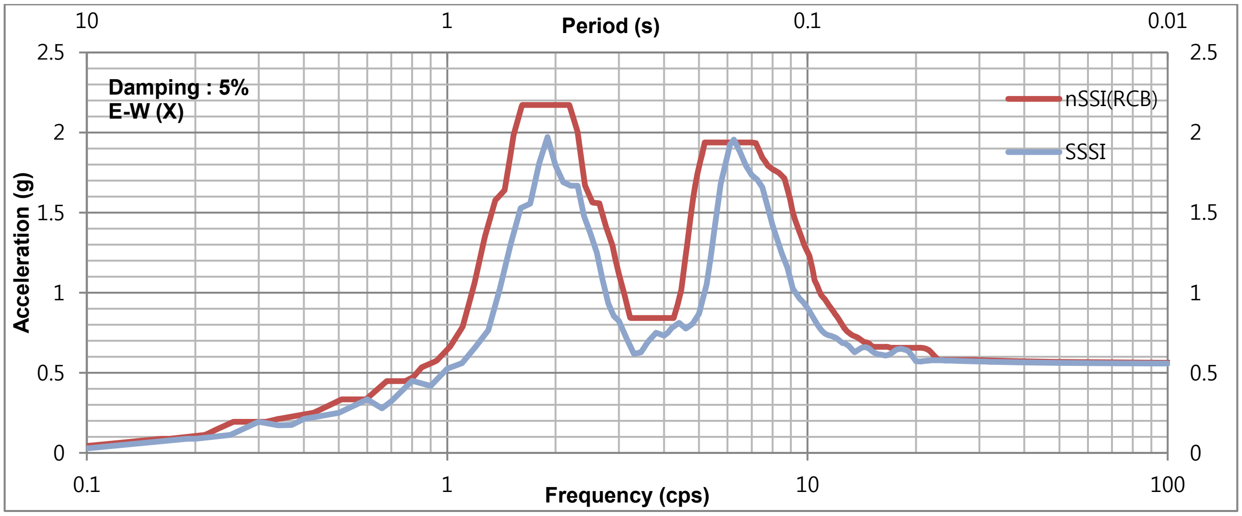
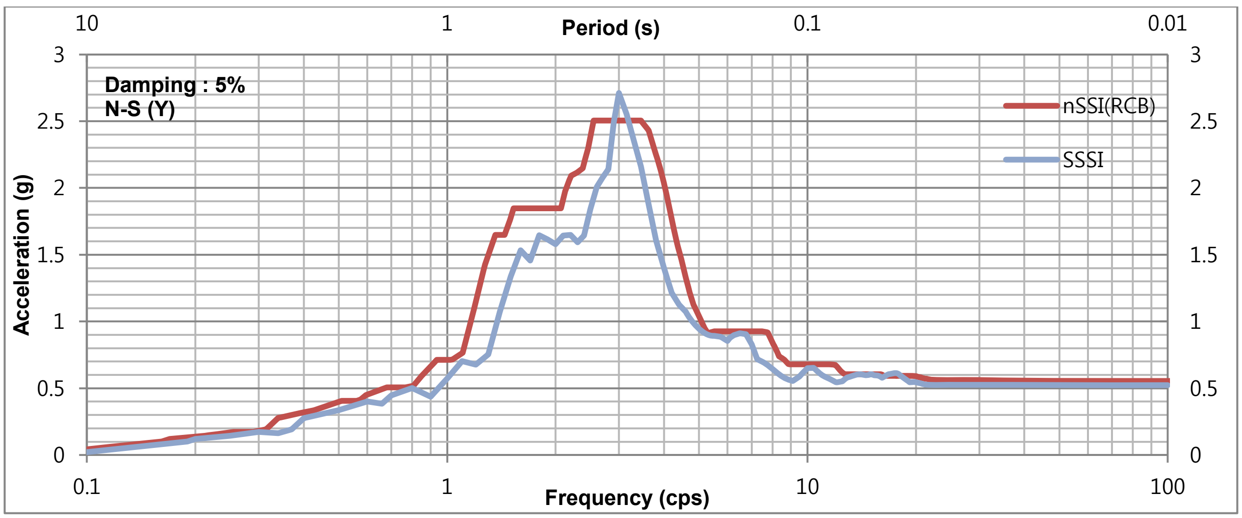


Figure 5-5 S1U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 331'-9"





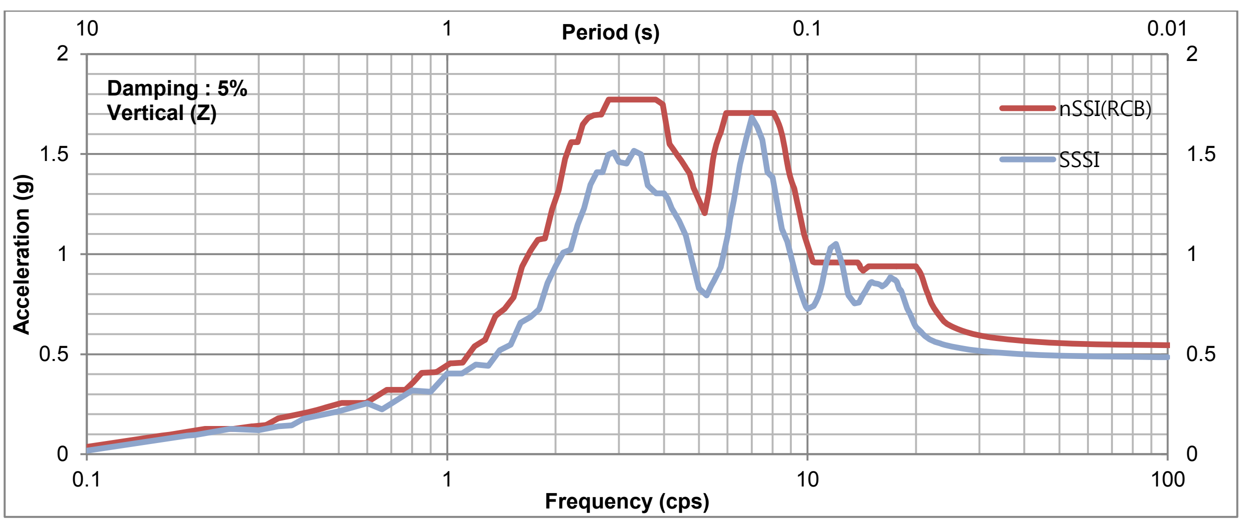


Figure 5-6 S1U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 78’-0”

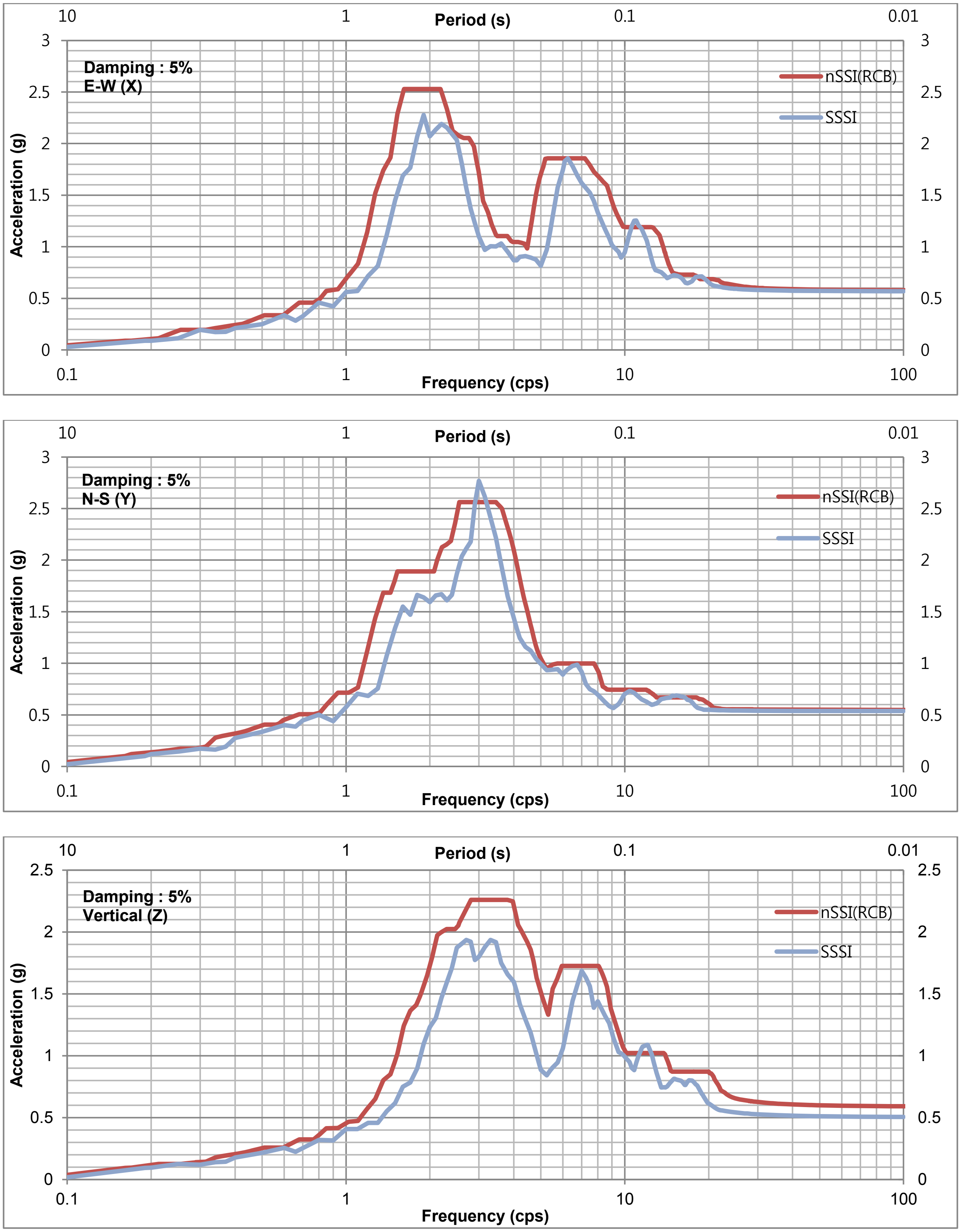


Figure 5-7 S1U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 100’-0”

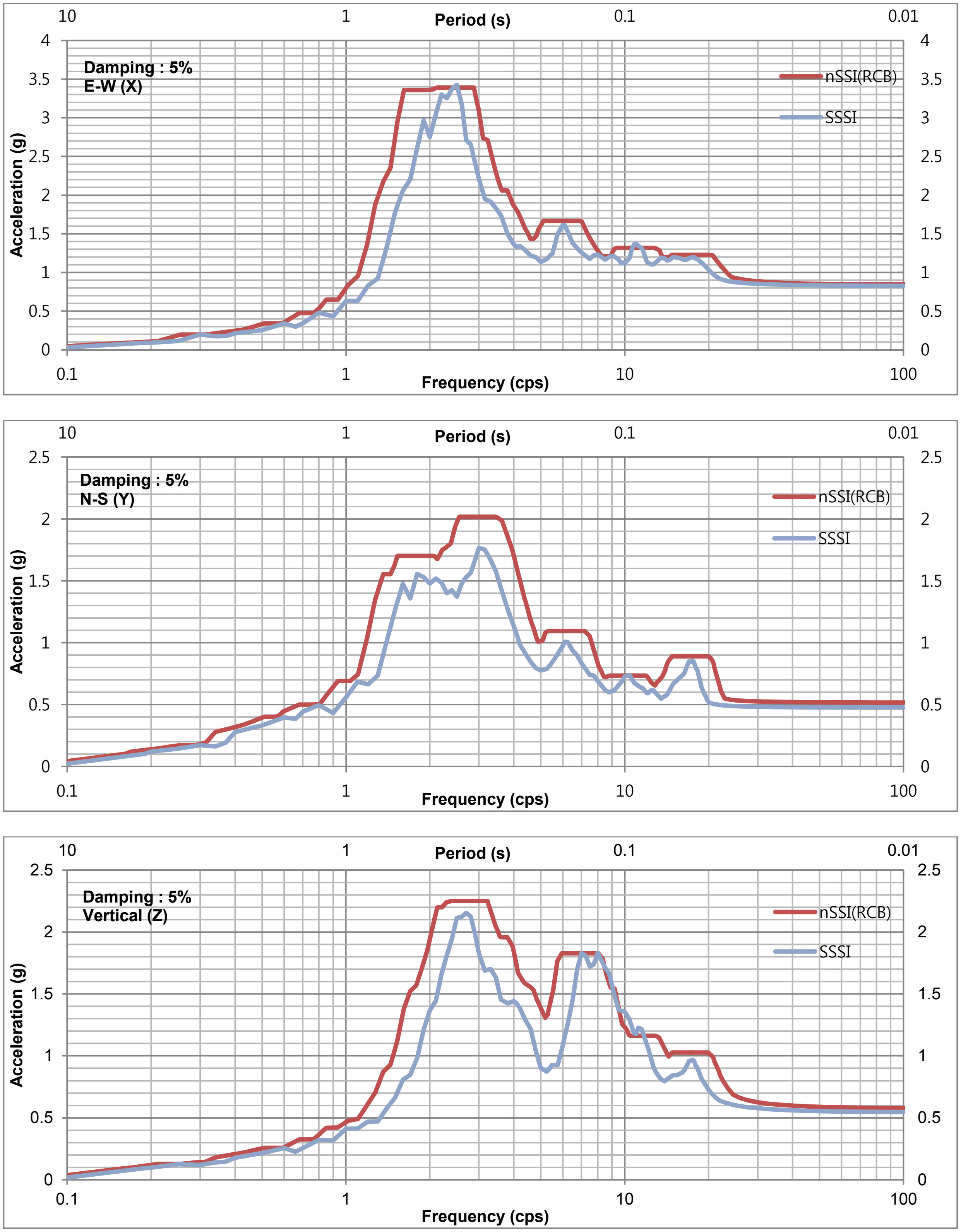


Figure 5-8 S1U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 156'-0"

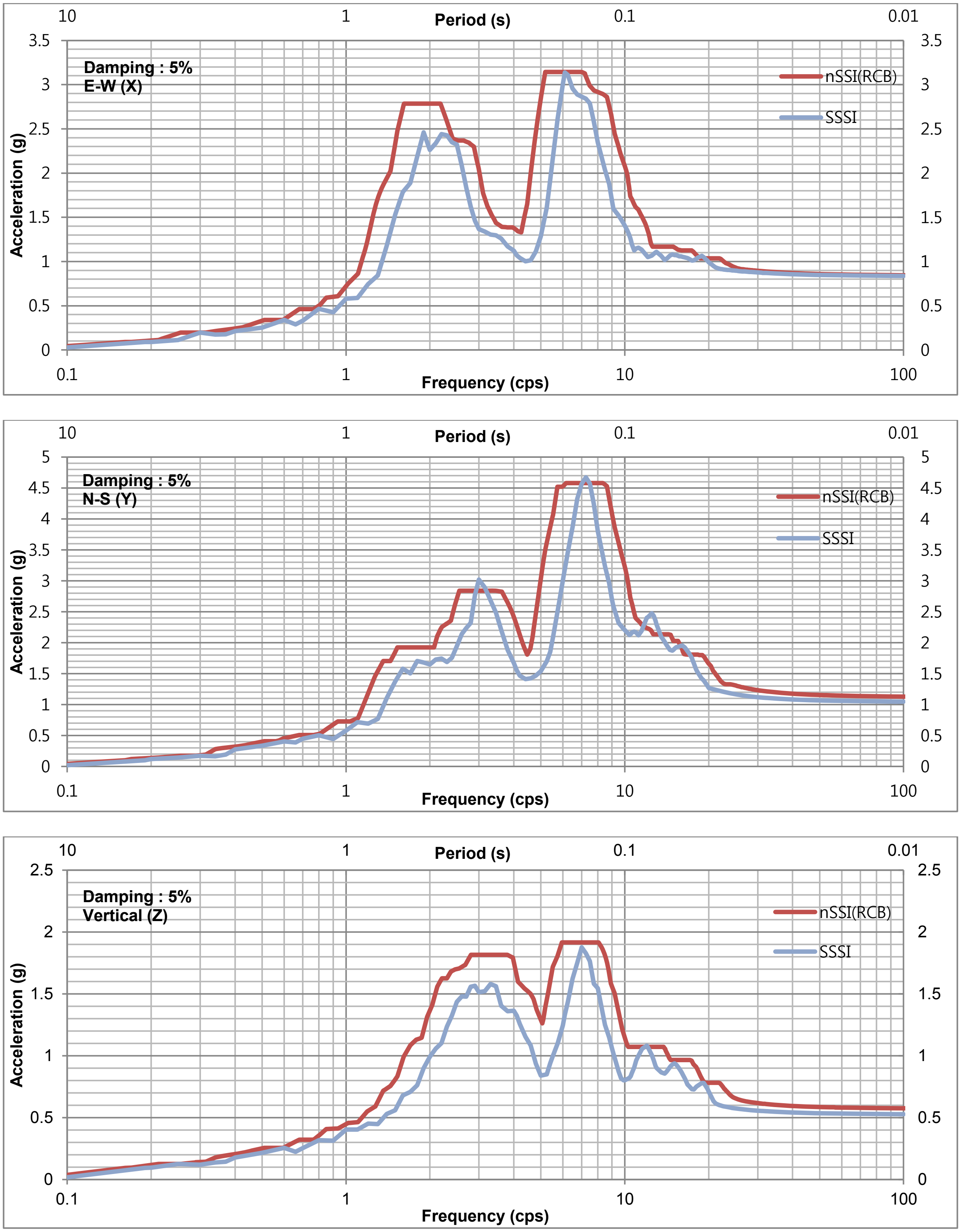


Figure 5-9 S1U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 191’-0”

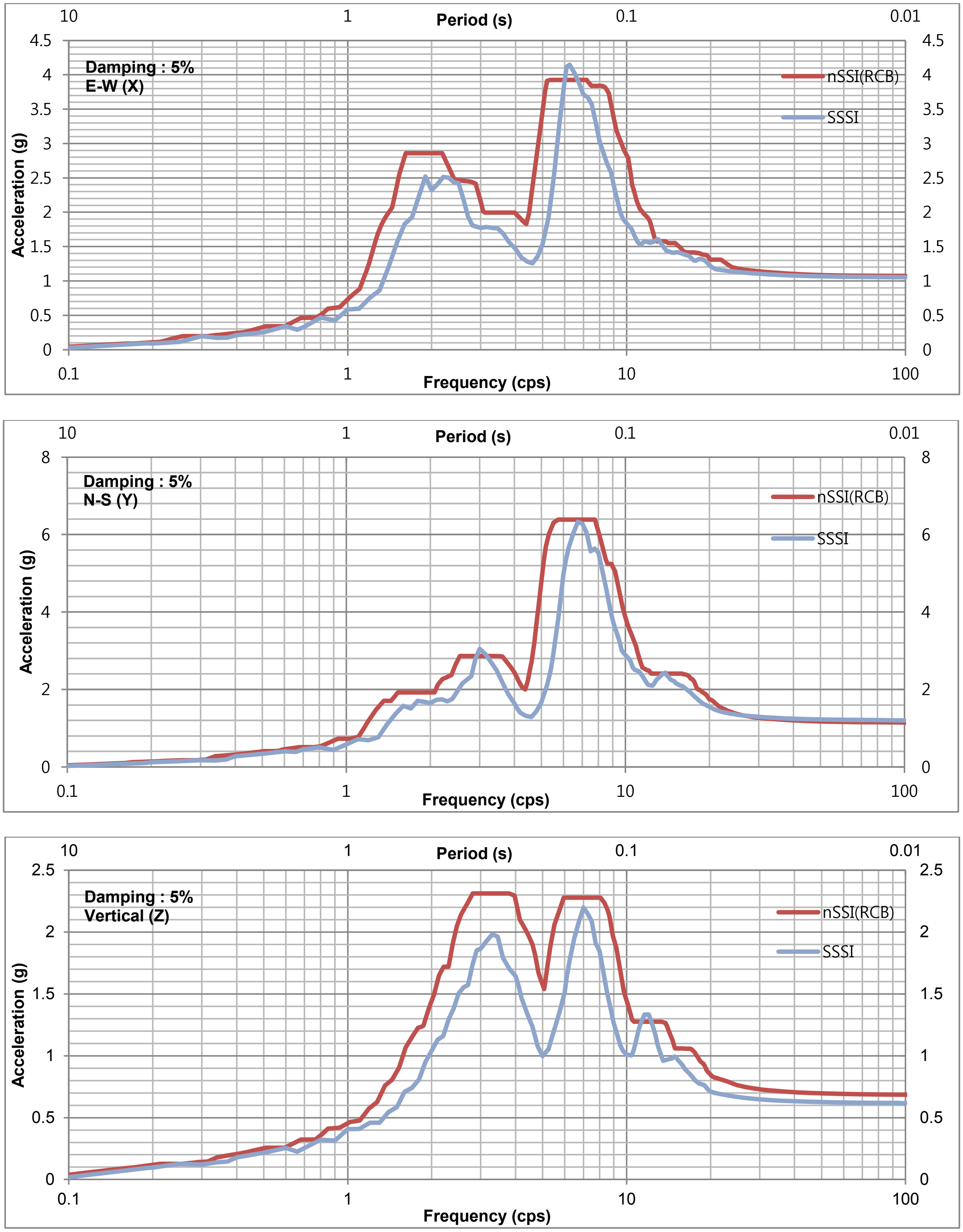


Figure 5-10 S1U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 78'-0"

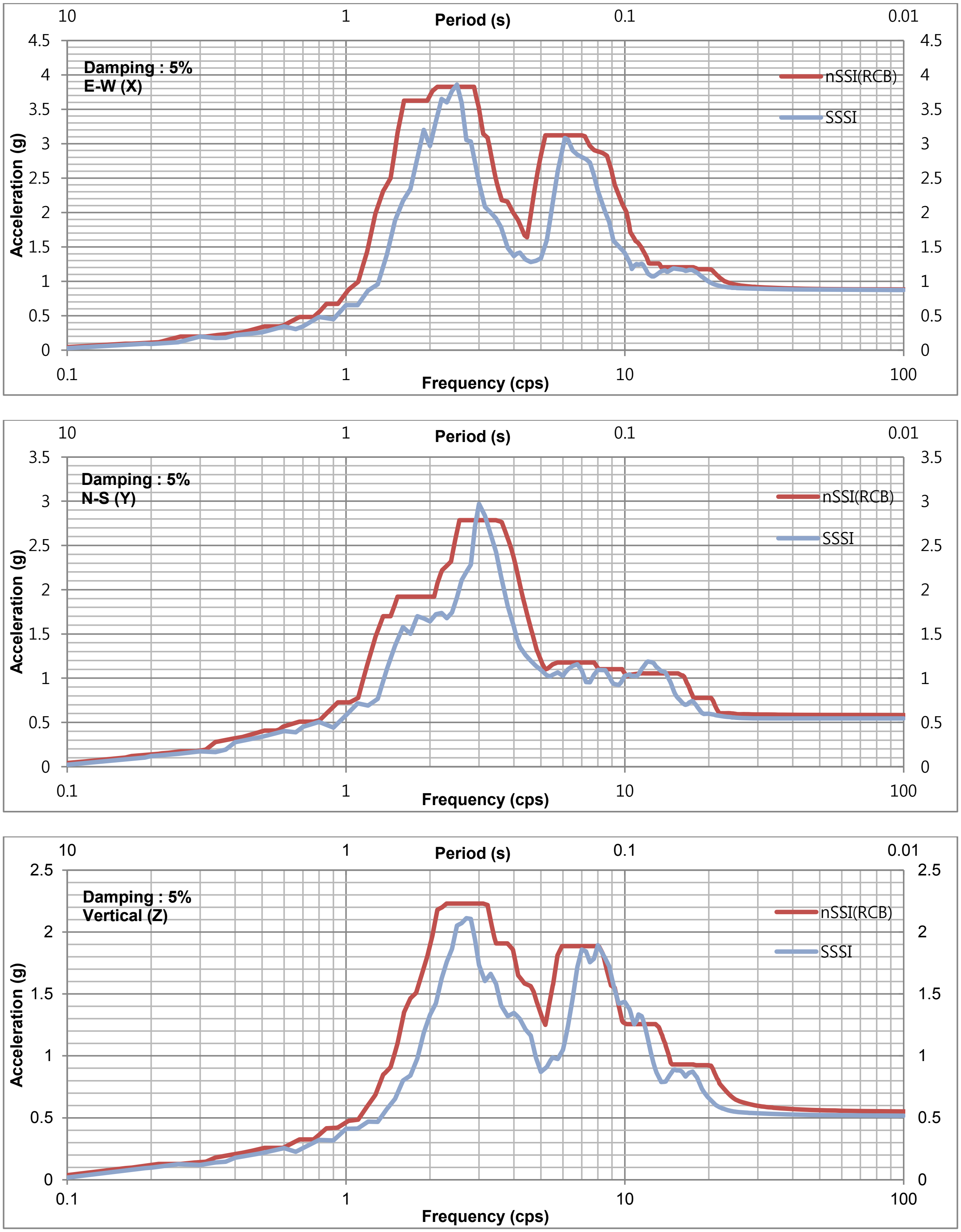


Figure 5-11 S1U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 100'-0"

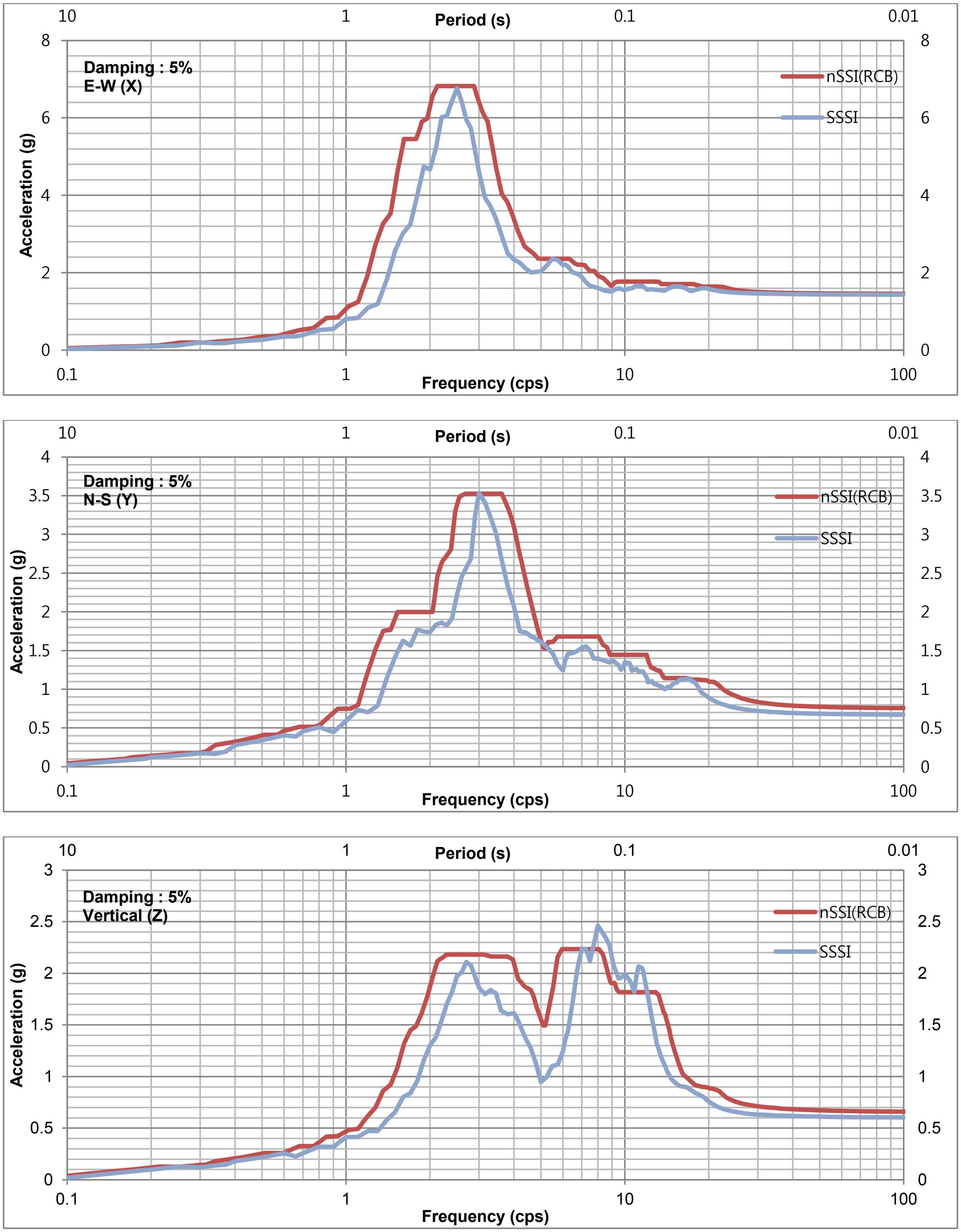


Figure 5-12 S1U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 156'-0"

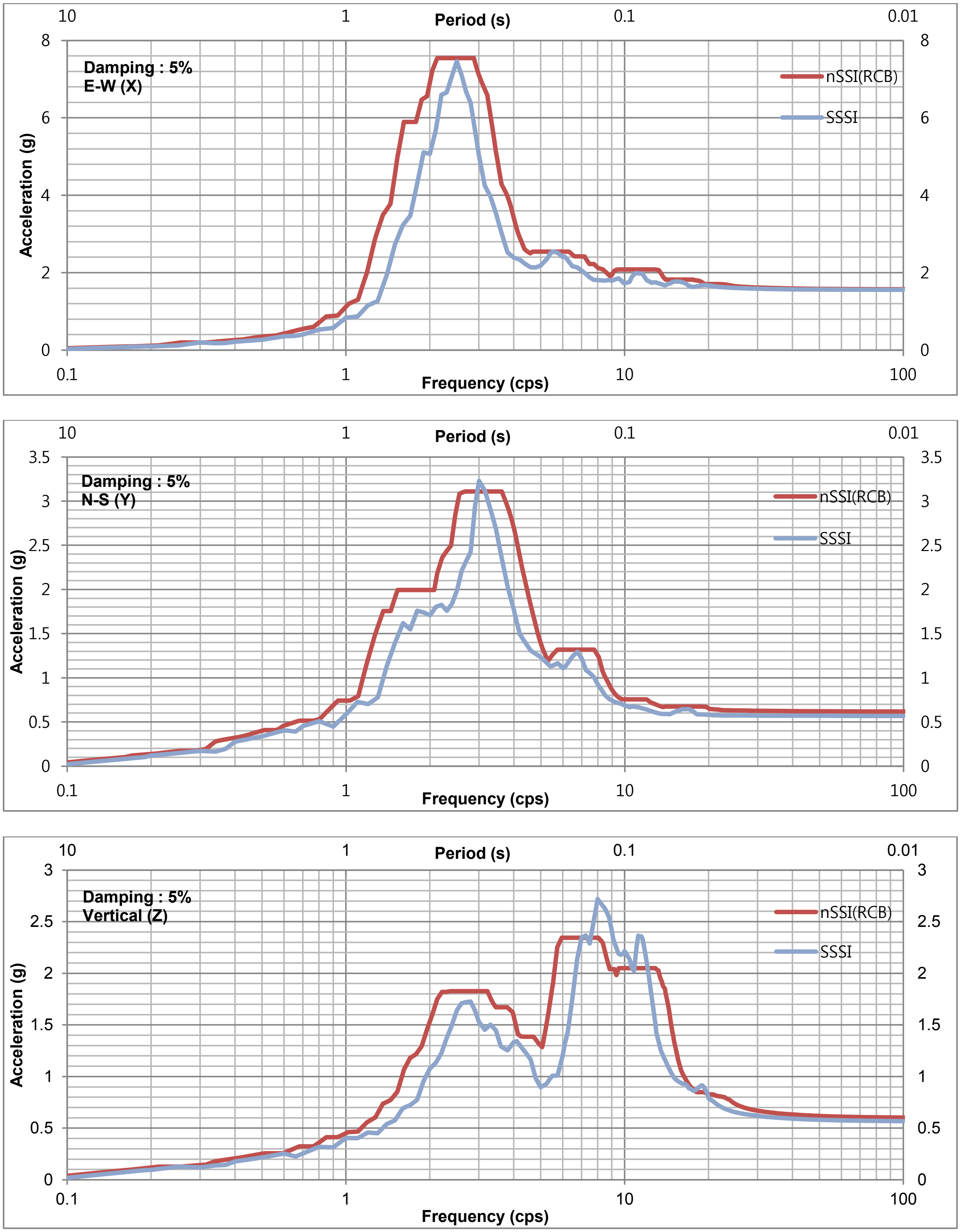


Figure 5-13 S1U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 191’-0”

Figure 5-14 Deleted

Figure 5-15 Deleted

Figure 5-16 Deleted

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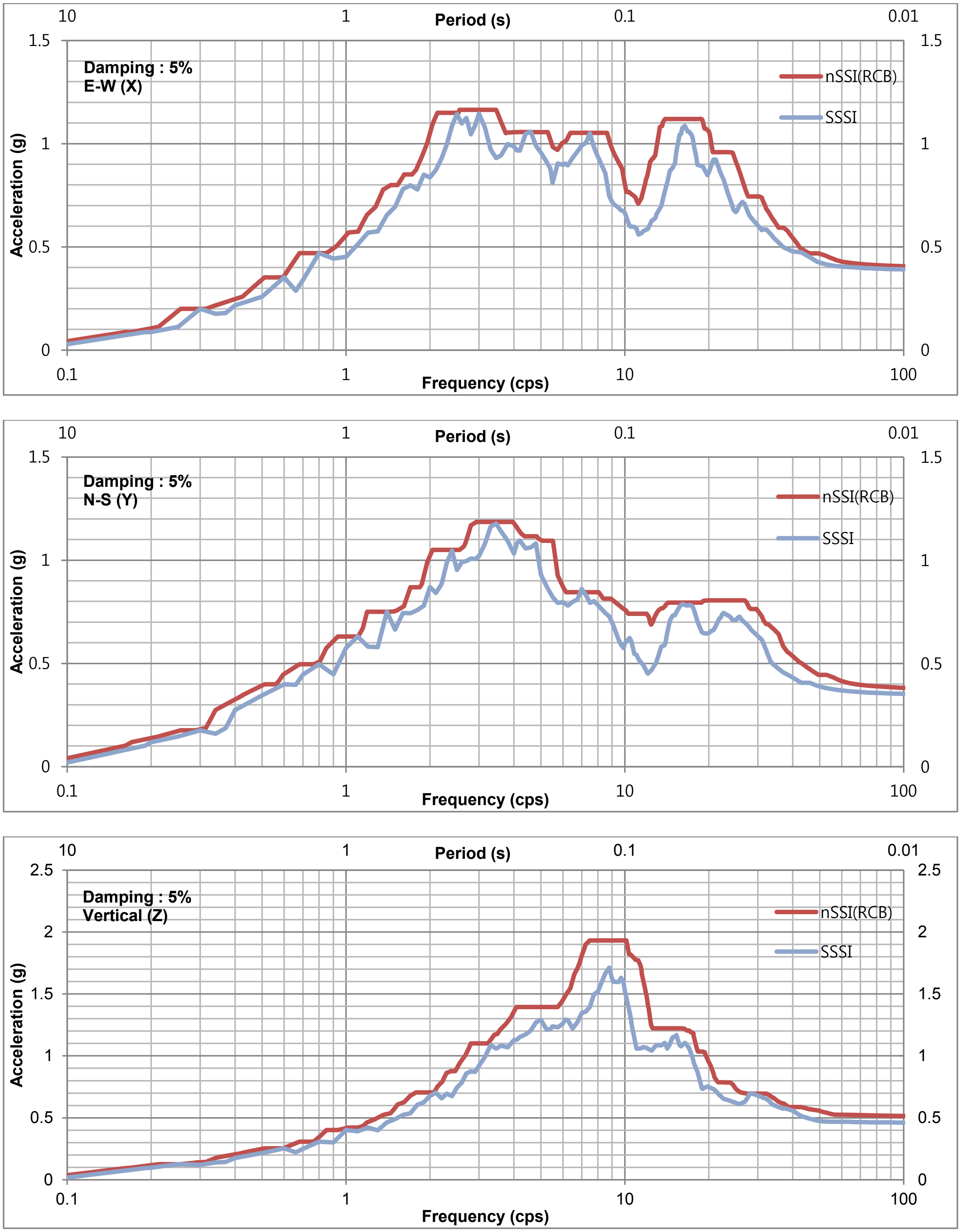


Figure 5-27 S9U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 78'-0"

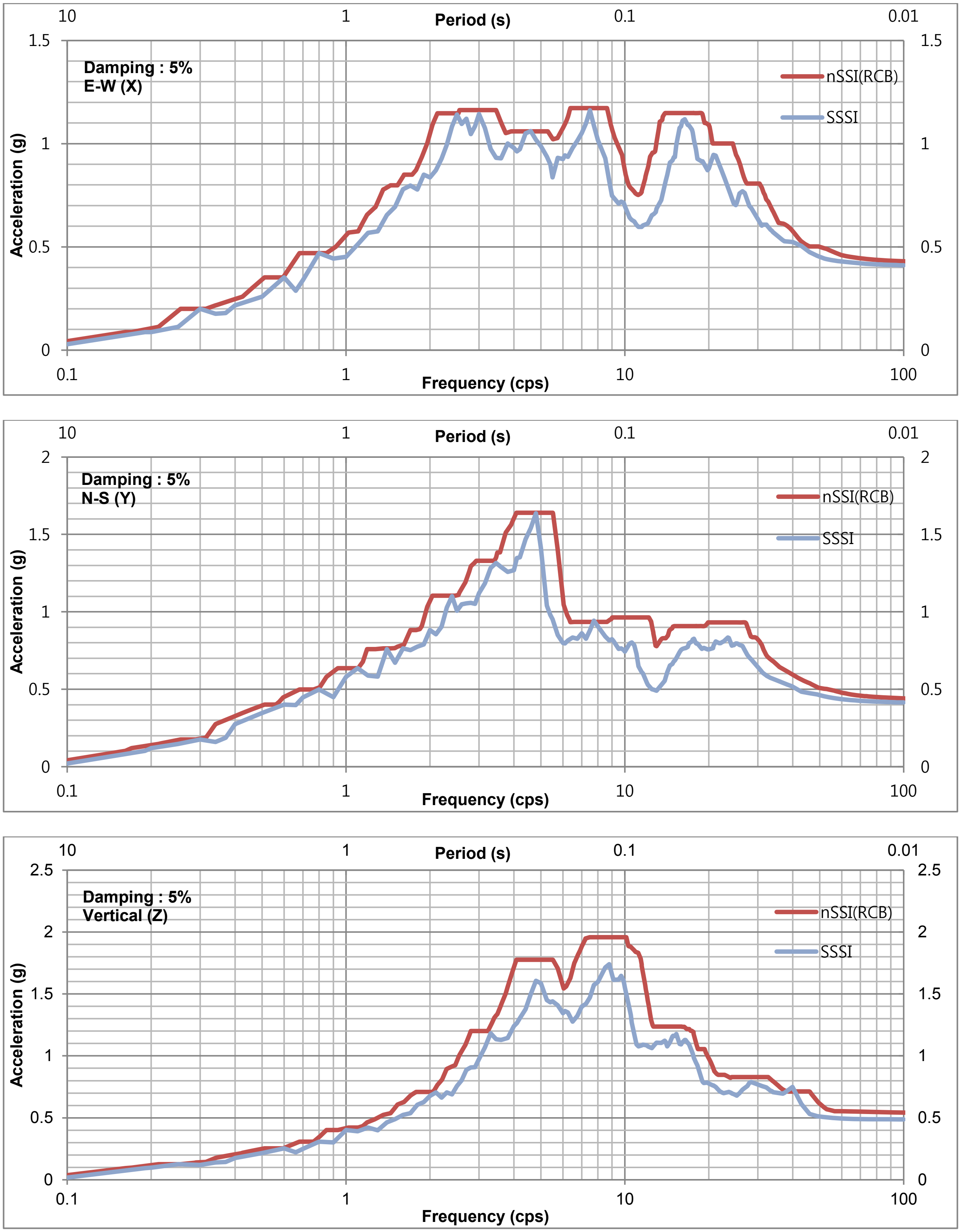


Figure 5-28 S9U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 100'-0"

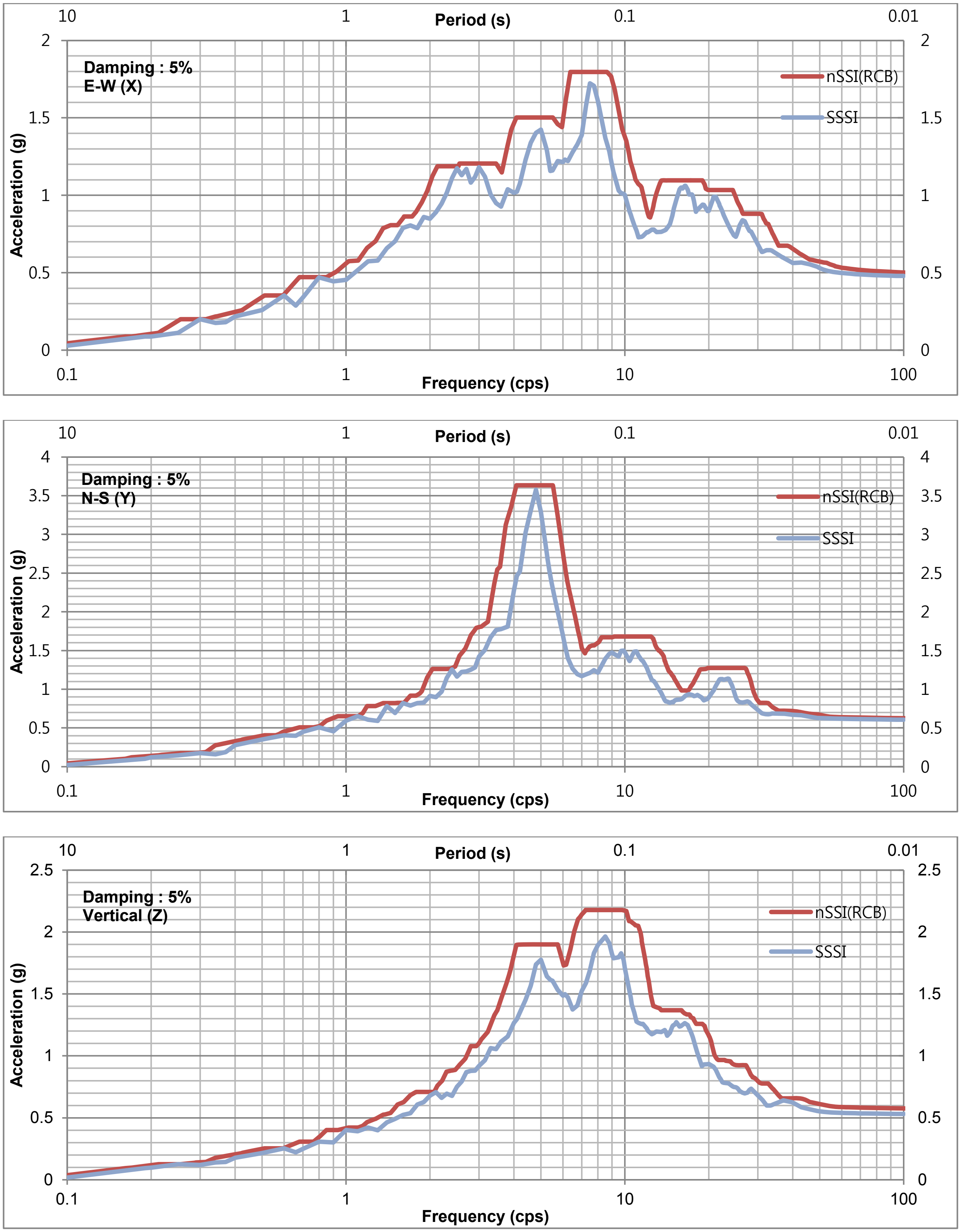


Figure 5-29 S9U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 156'-0"

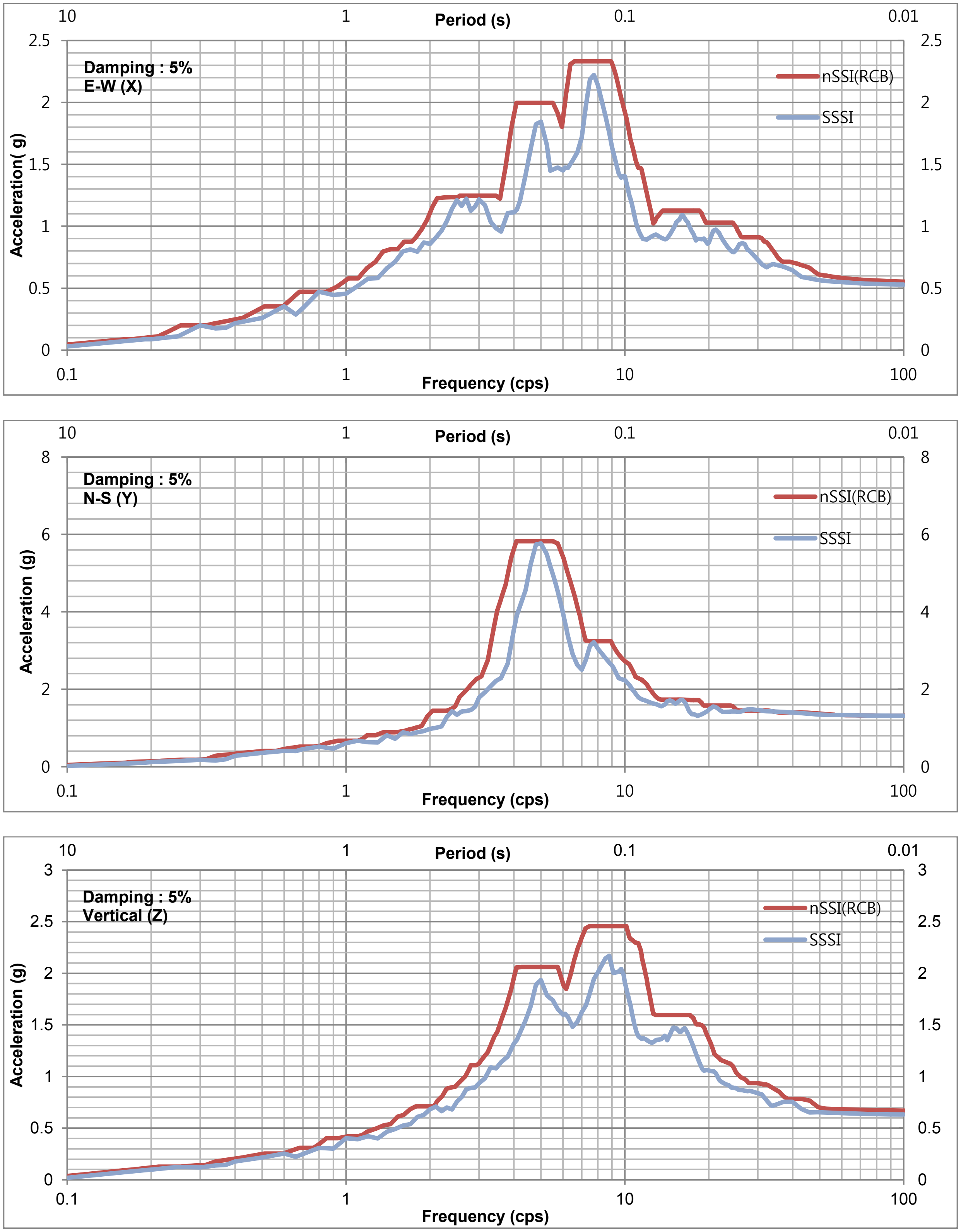


Figure 5-30 S9U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 254'-6"

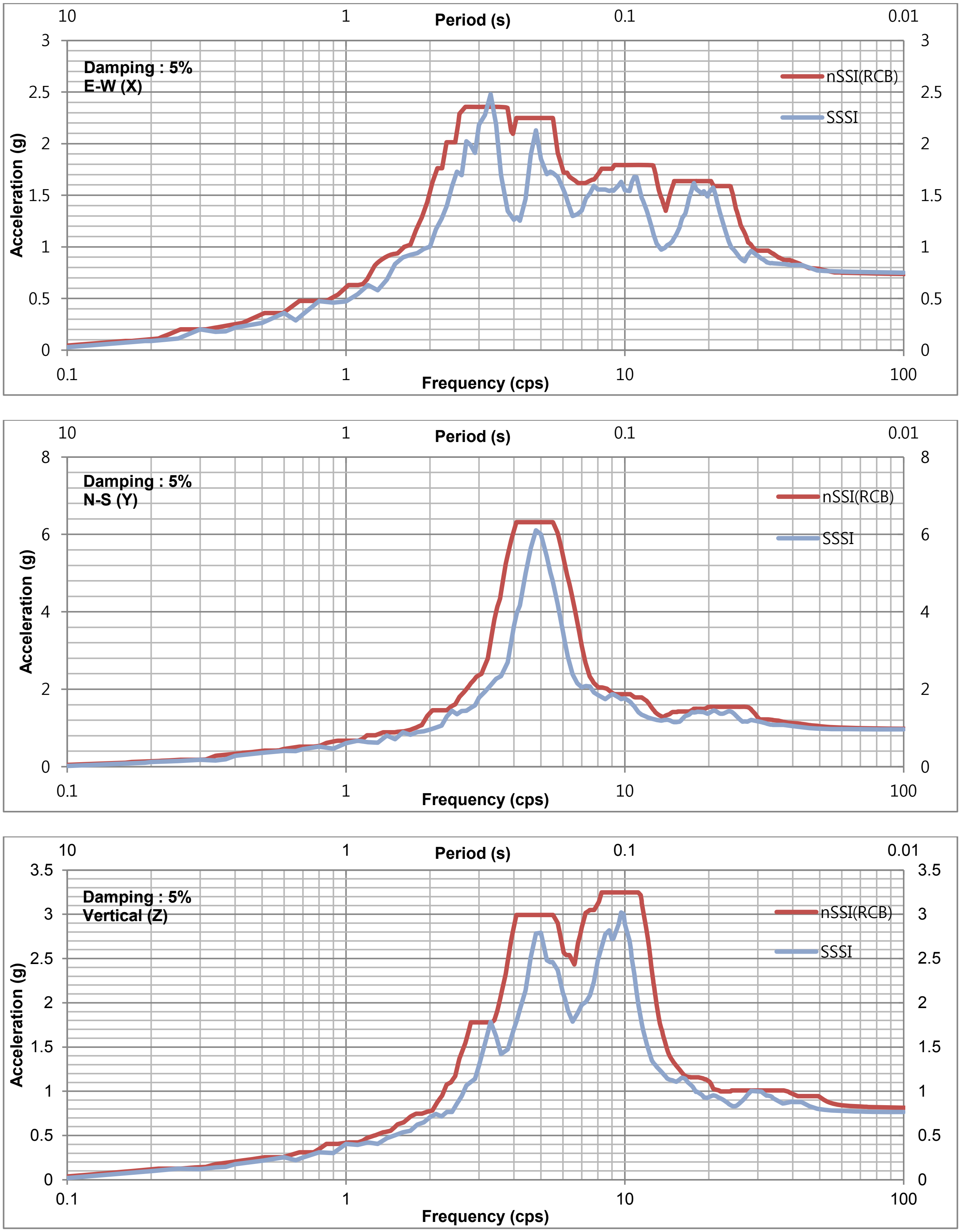


Figure 5-31 S9U-Comparison of RCB CS ISRS (SSI vs SSSI) at El. 331'-9"

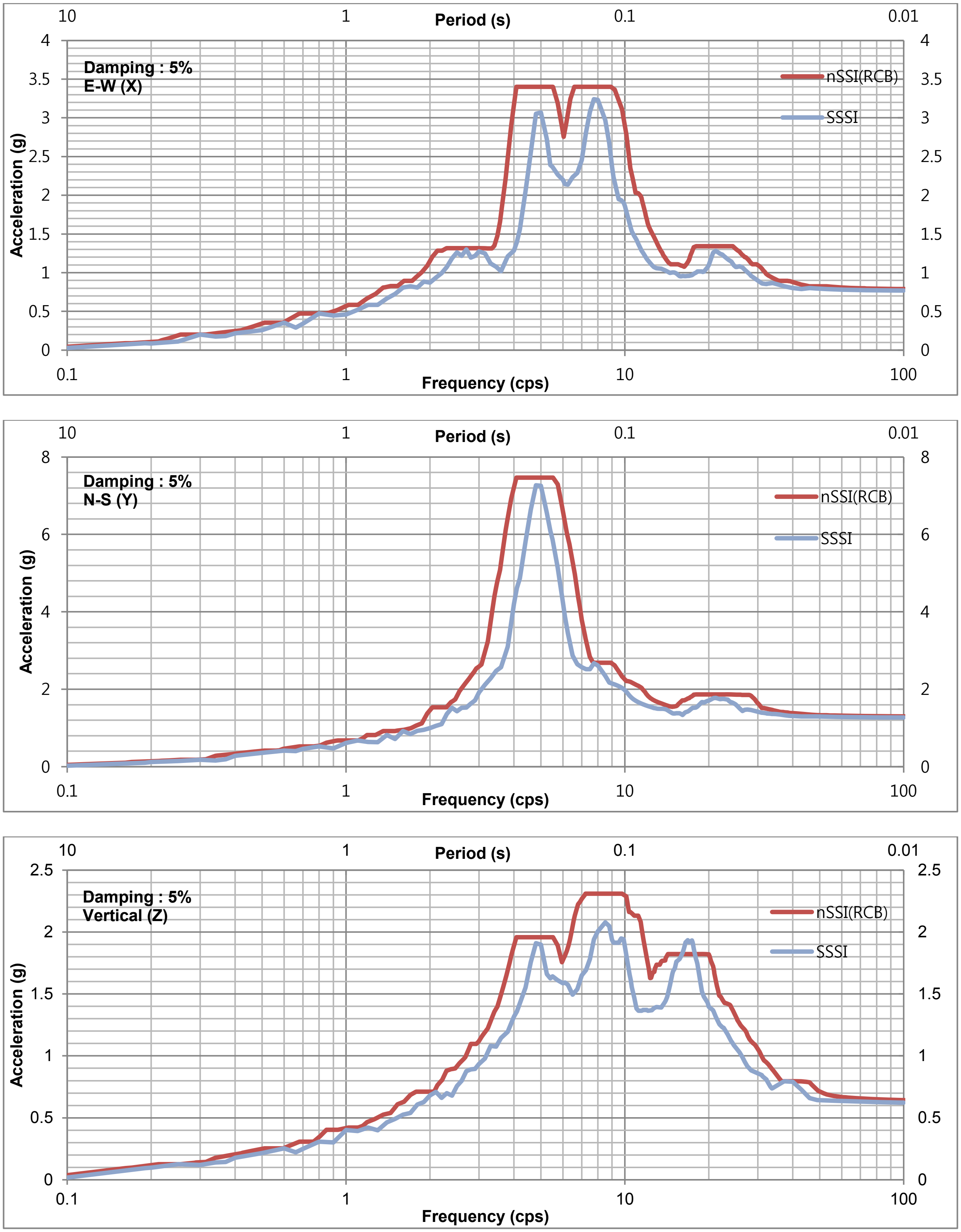


Figure 5-32 S9U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 78'-0"

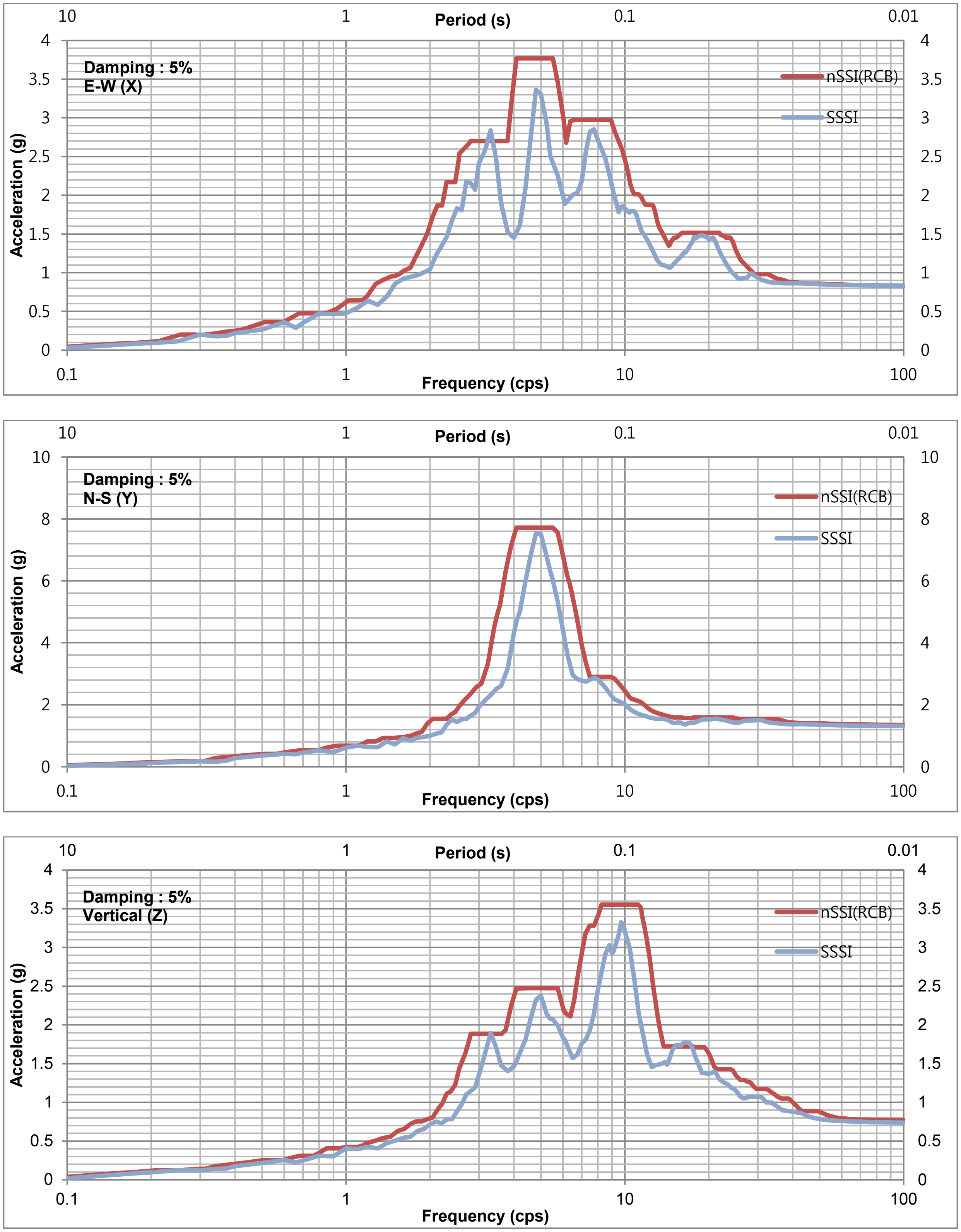


Figure 5-33 S9U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 100’-0”

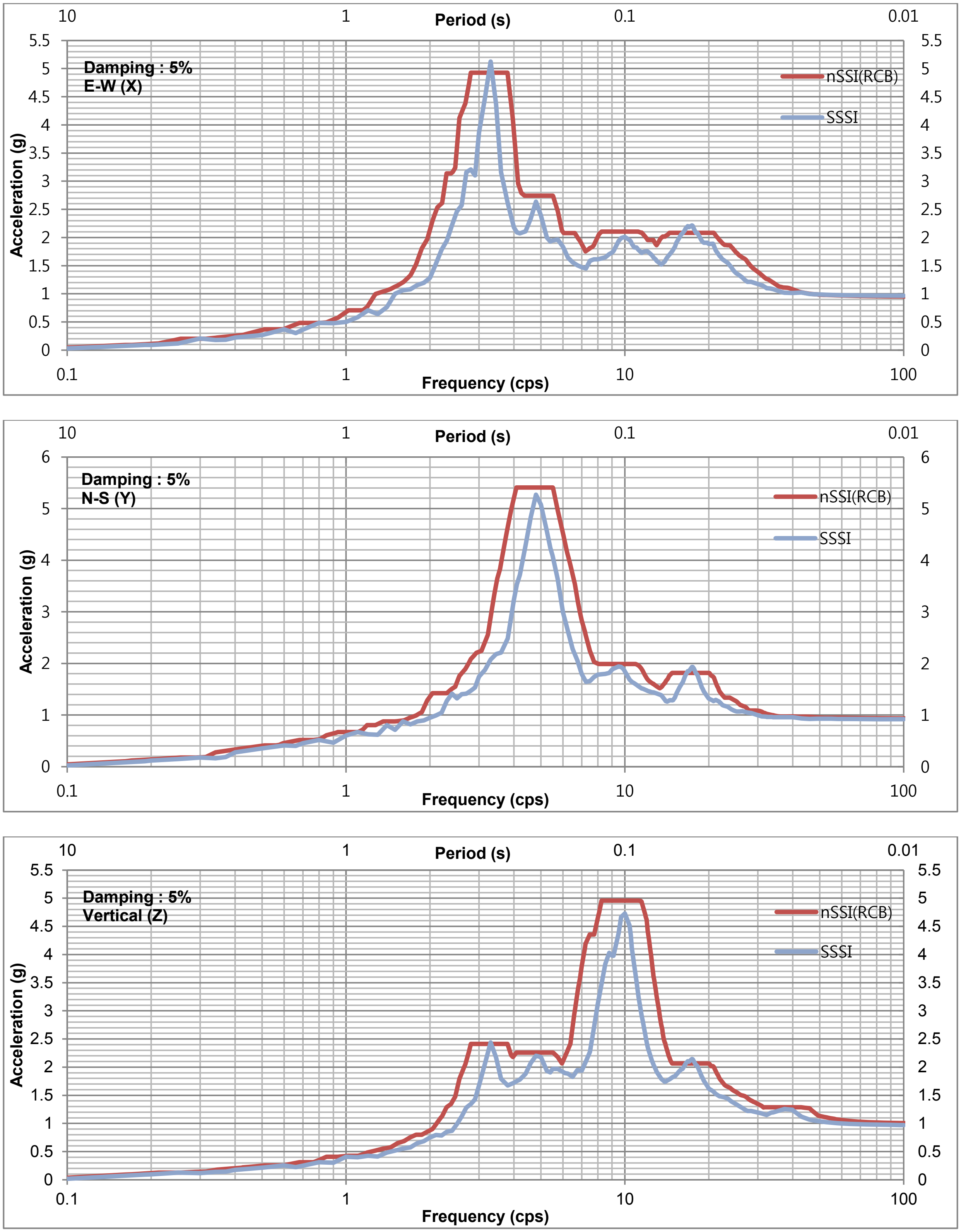
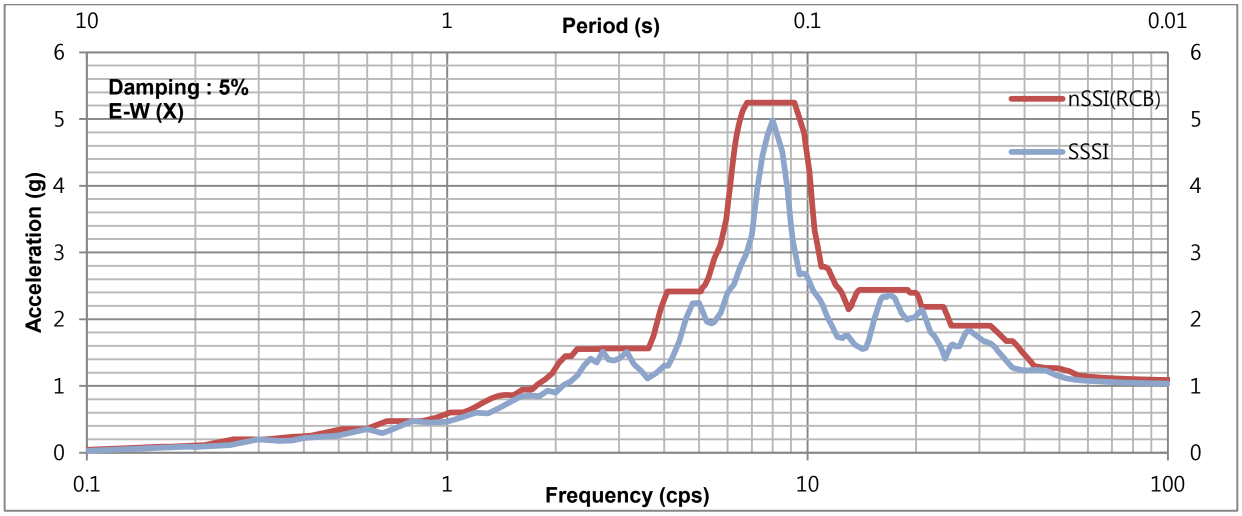
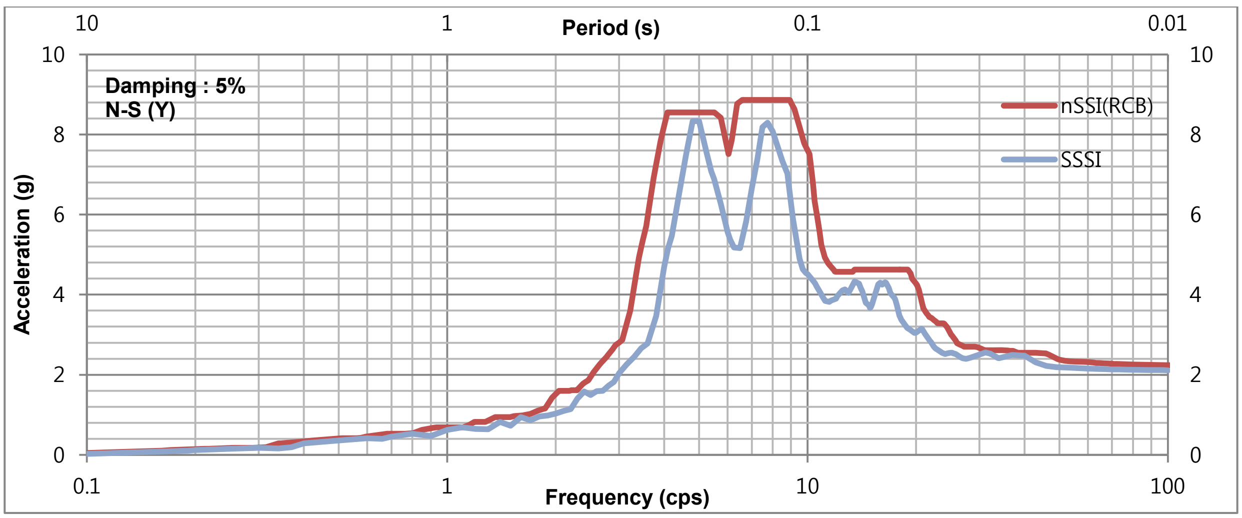


Figure 5-34 S9U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 156'-0"





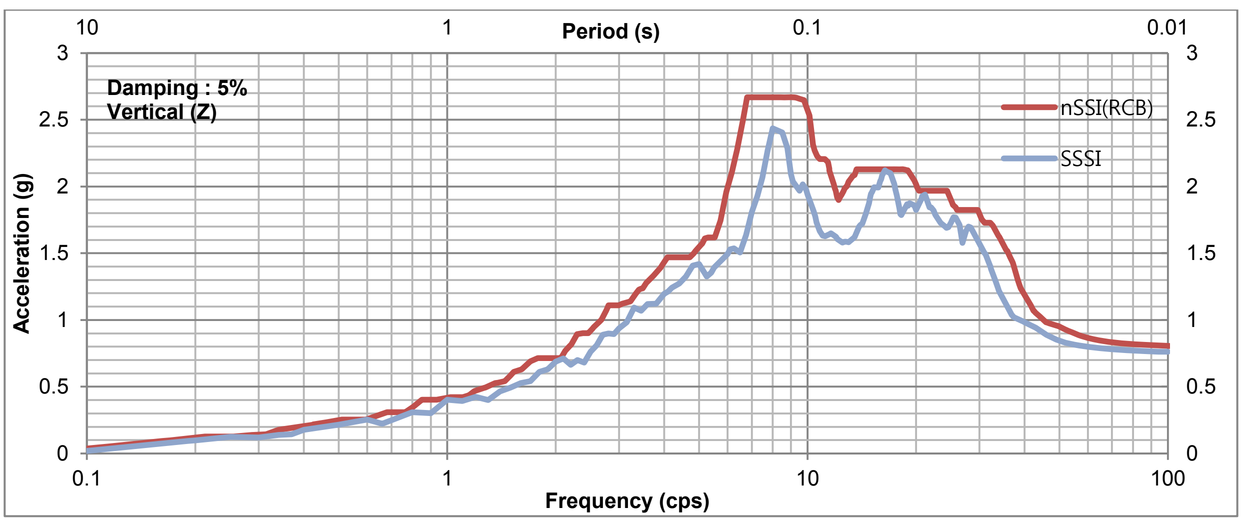


Figure 5-35 S9U-Comparison of RCB PSW ISRS (SSI vs SSSI) at El. 191’-0”

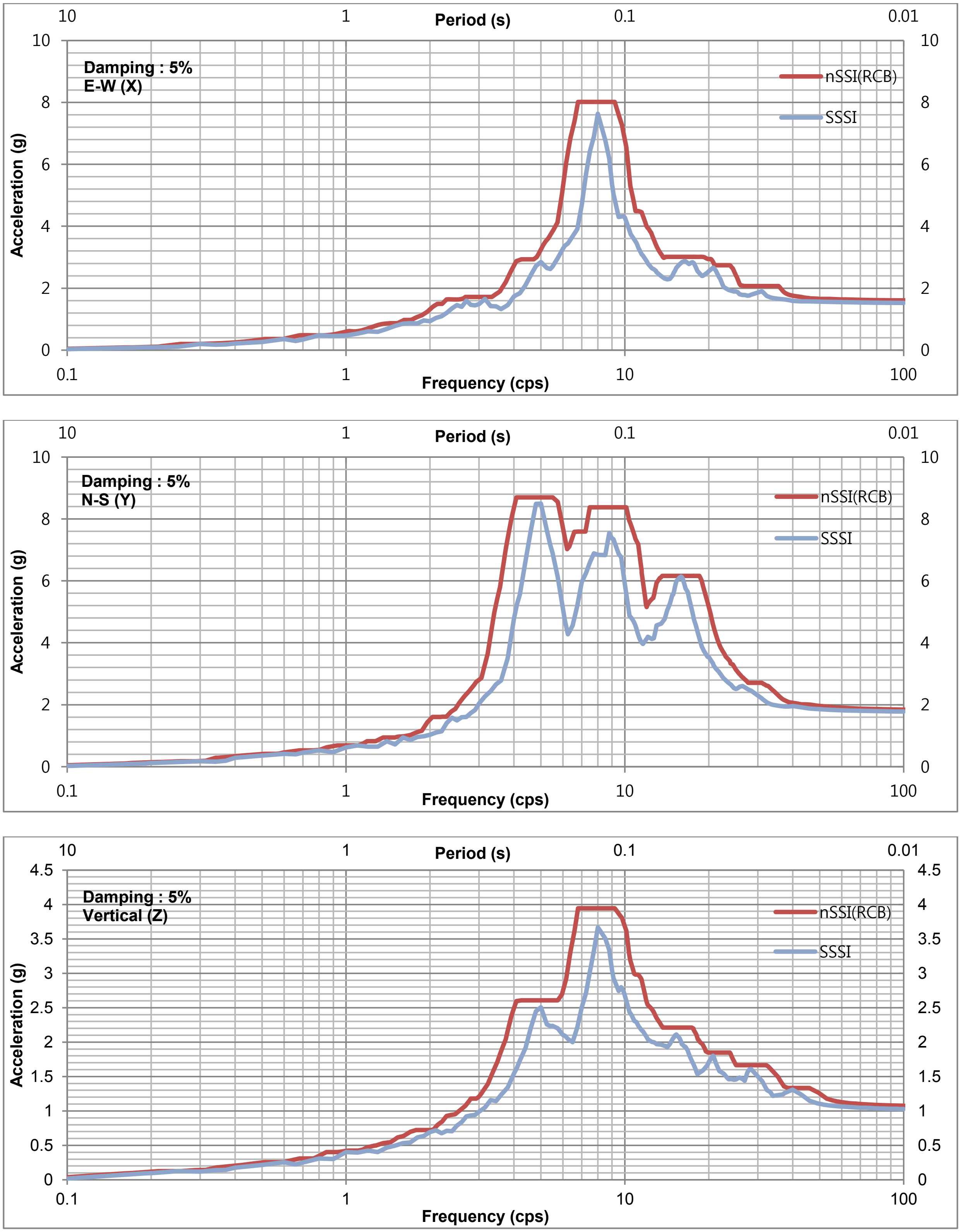


Figure 5-36 S9U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 78'-0"

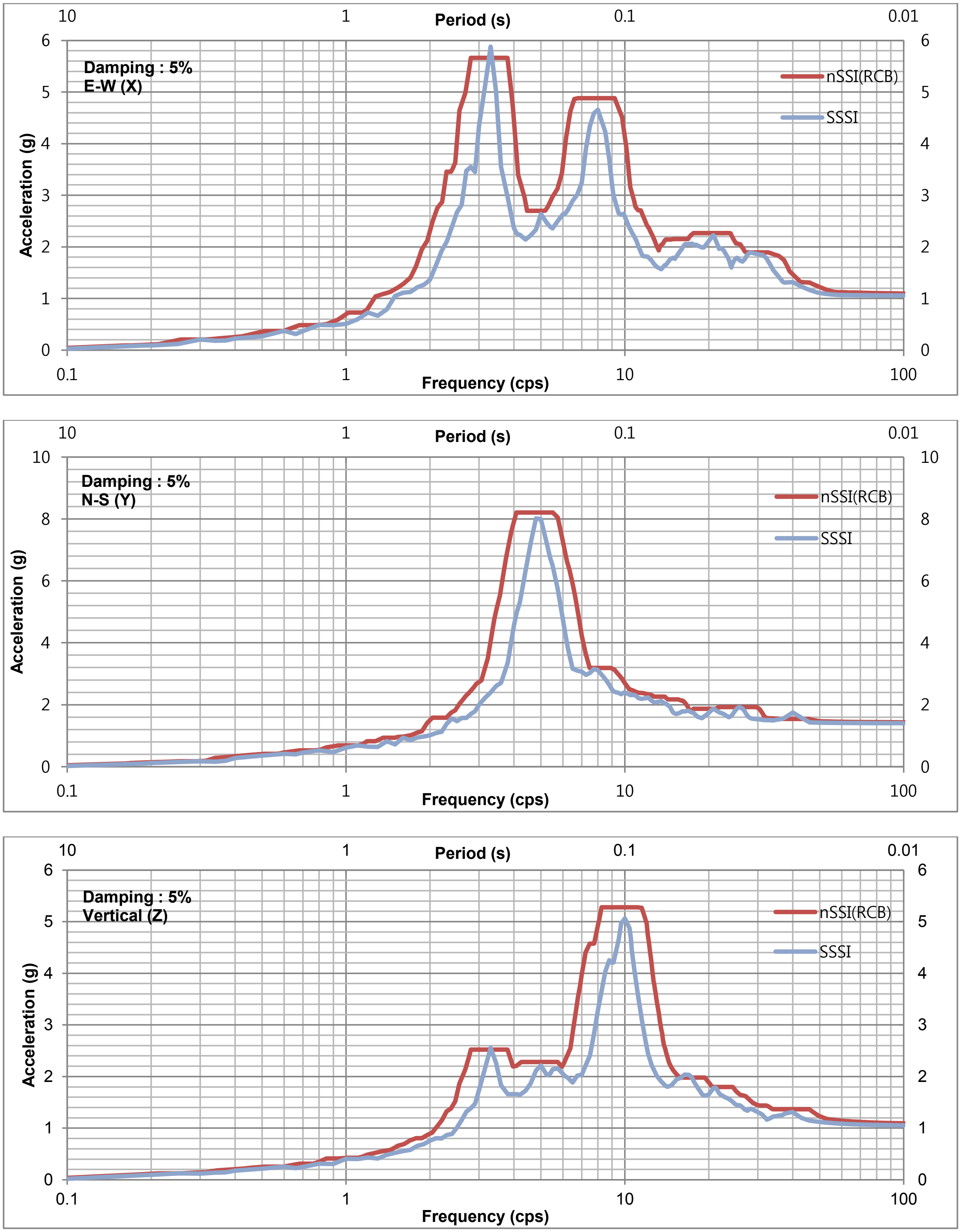


Figure 5-37 S9U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 100'-0"

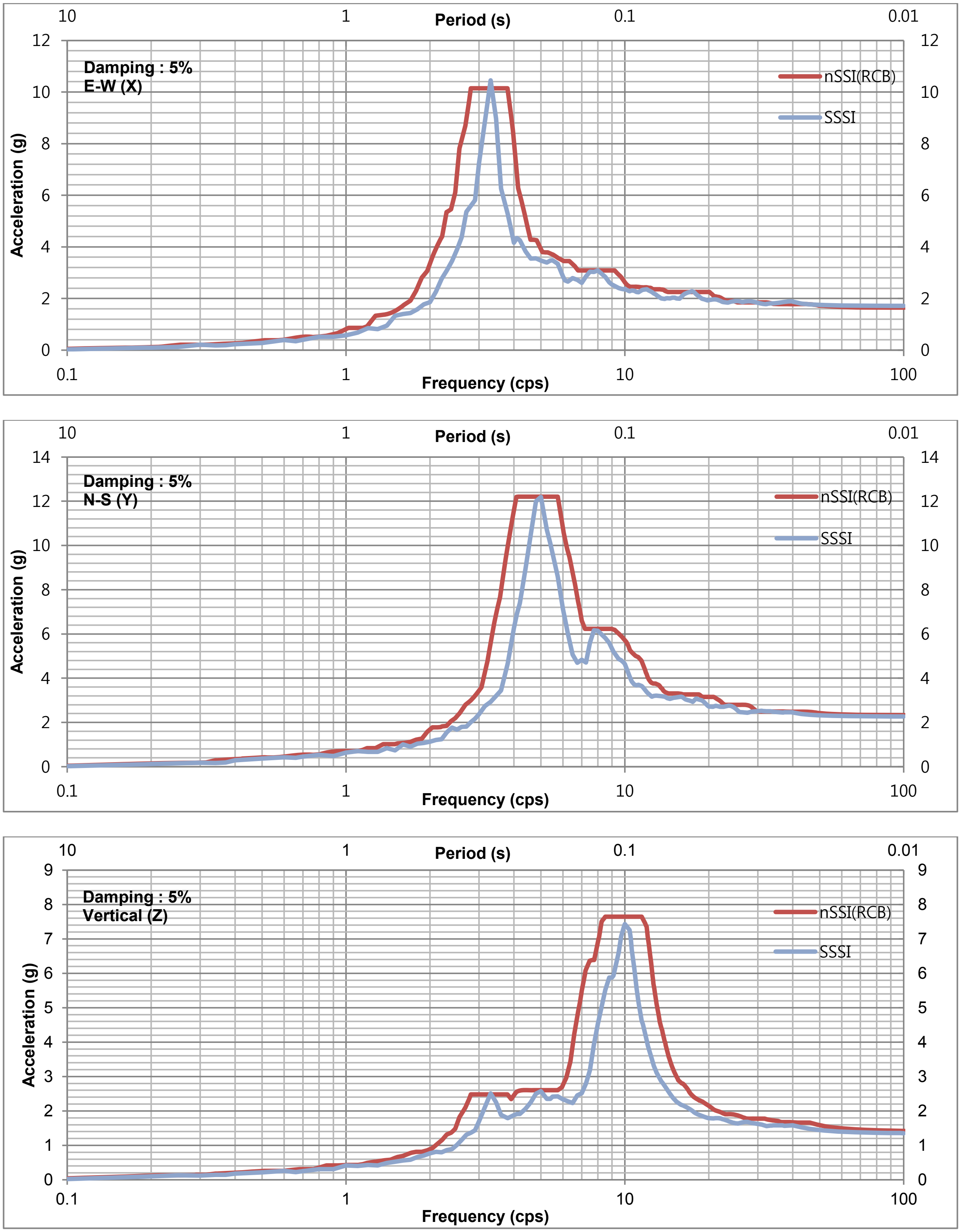


Figure 5-38 S9U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 156’-0”

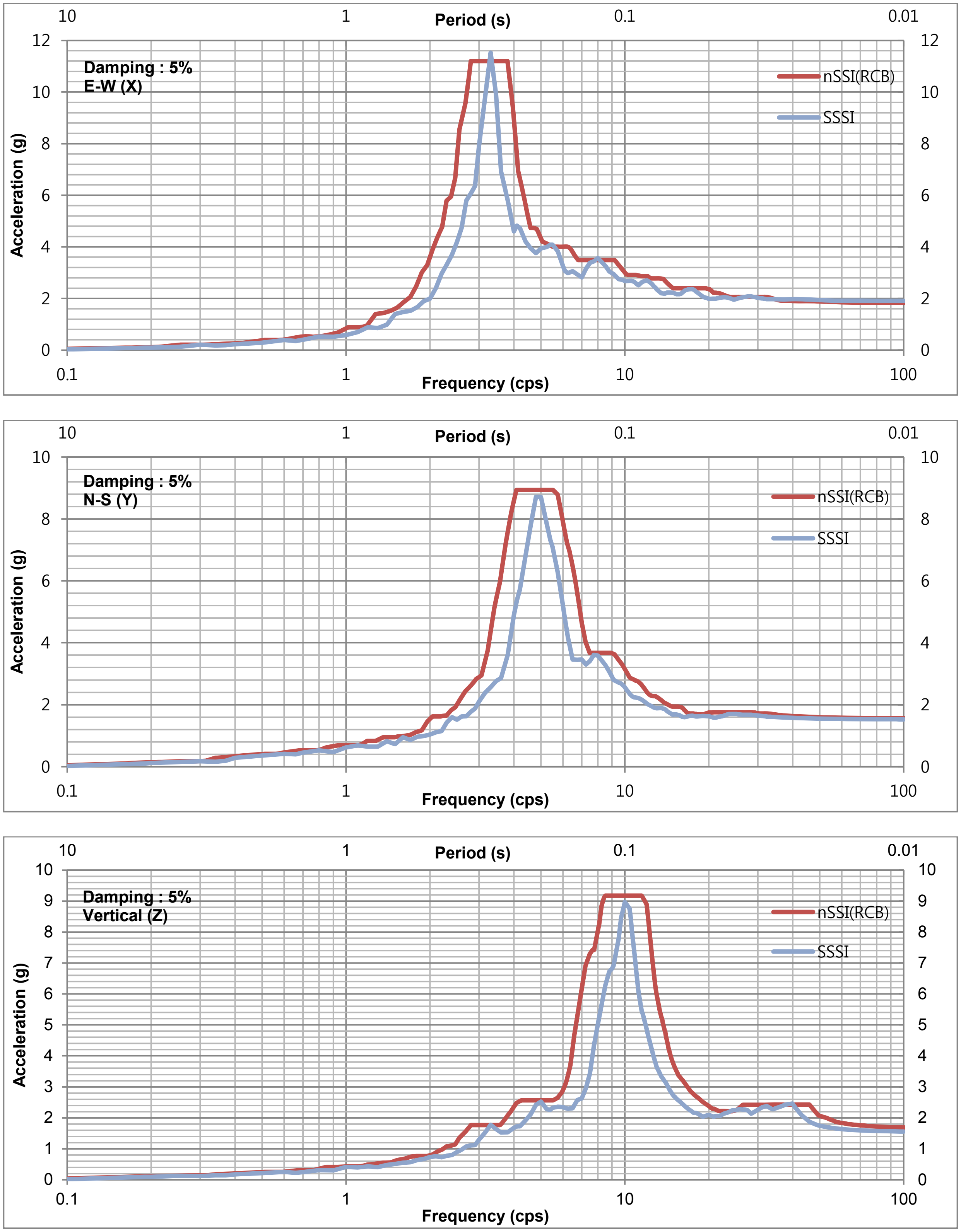


Figure 5-39   S9U-Comparison of RCB SSW ISRS (SSI vs SSSI) at El. 191’-0”

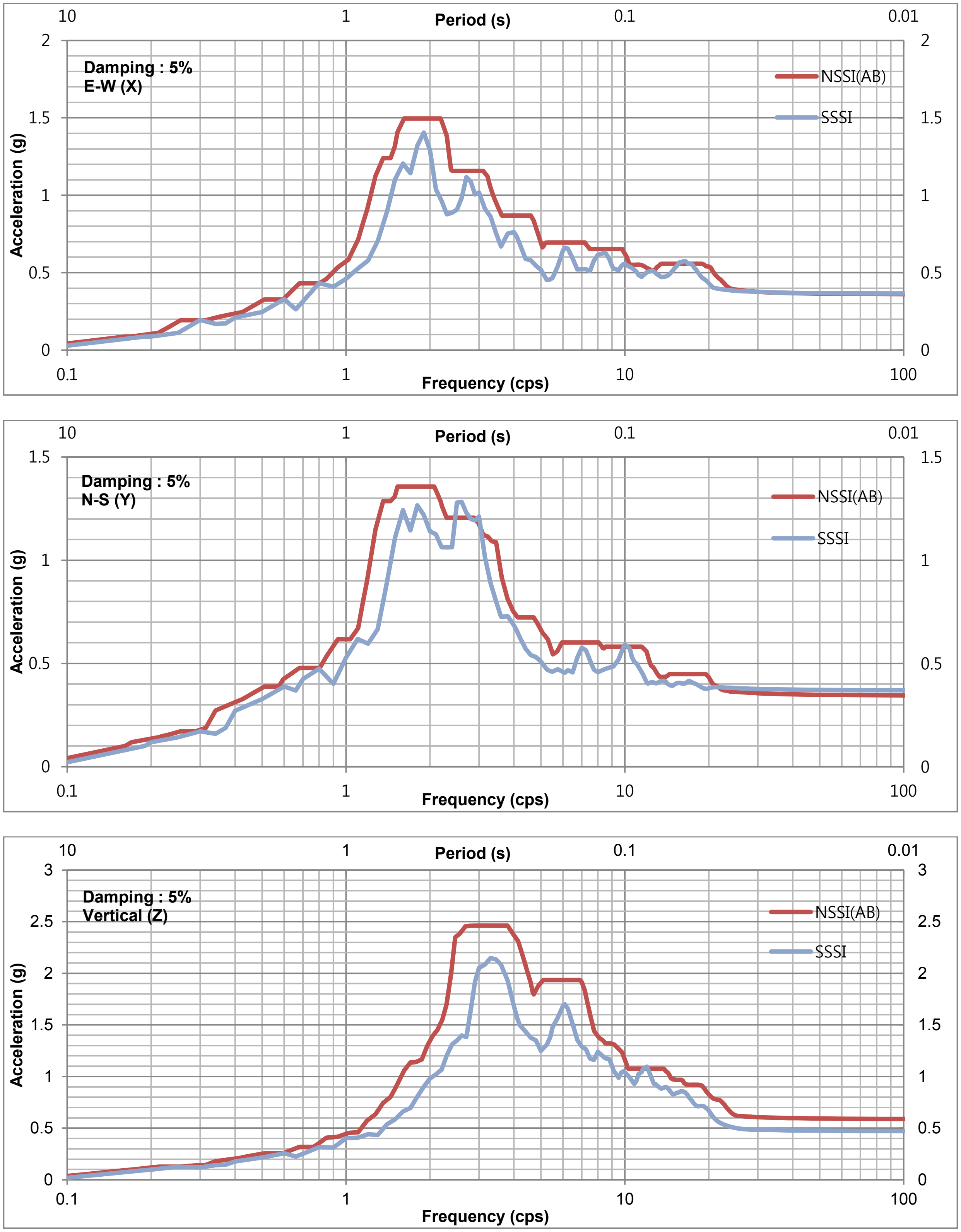


Figure 5-40 S1U-Comparison of AB ISRS (SSI vs SSSI) at El. 55’-0”

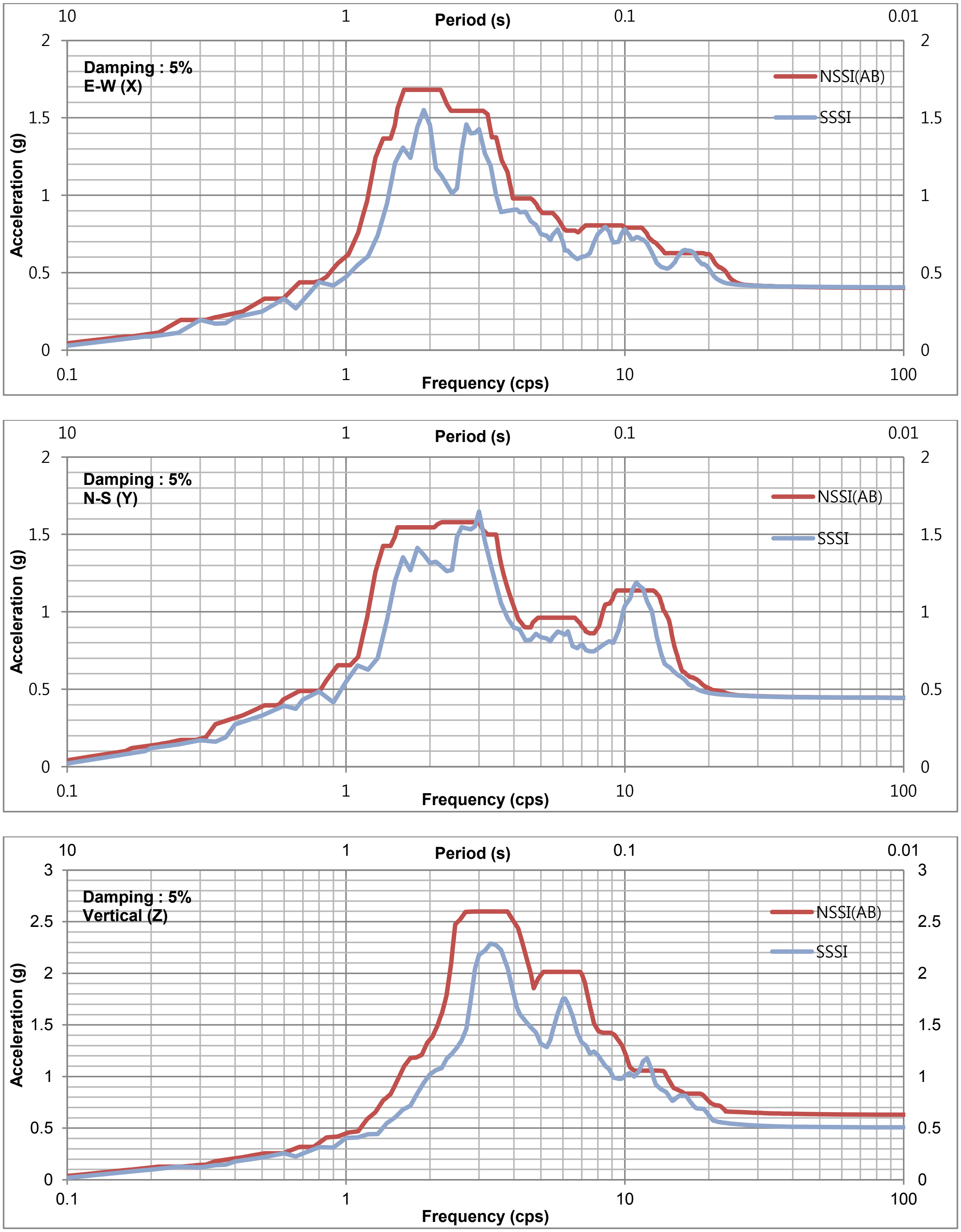


Figure 5-41 S1U-Comparison of AB ISRS (SSI vs SSSI) at El. 100'-0"

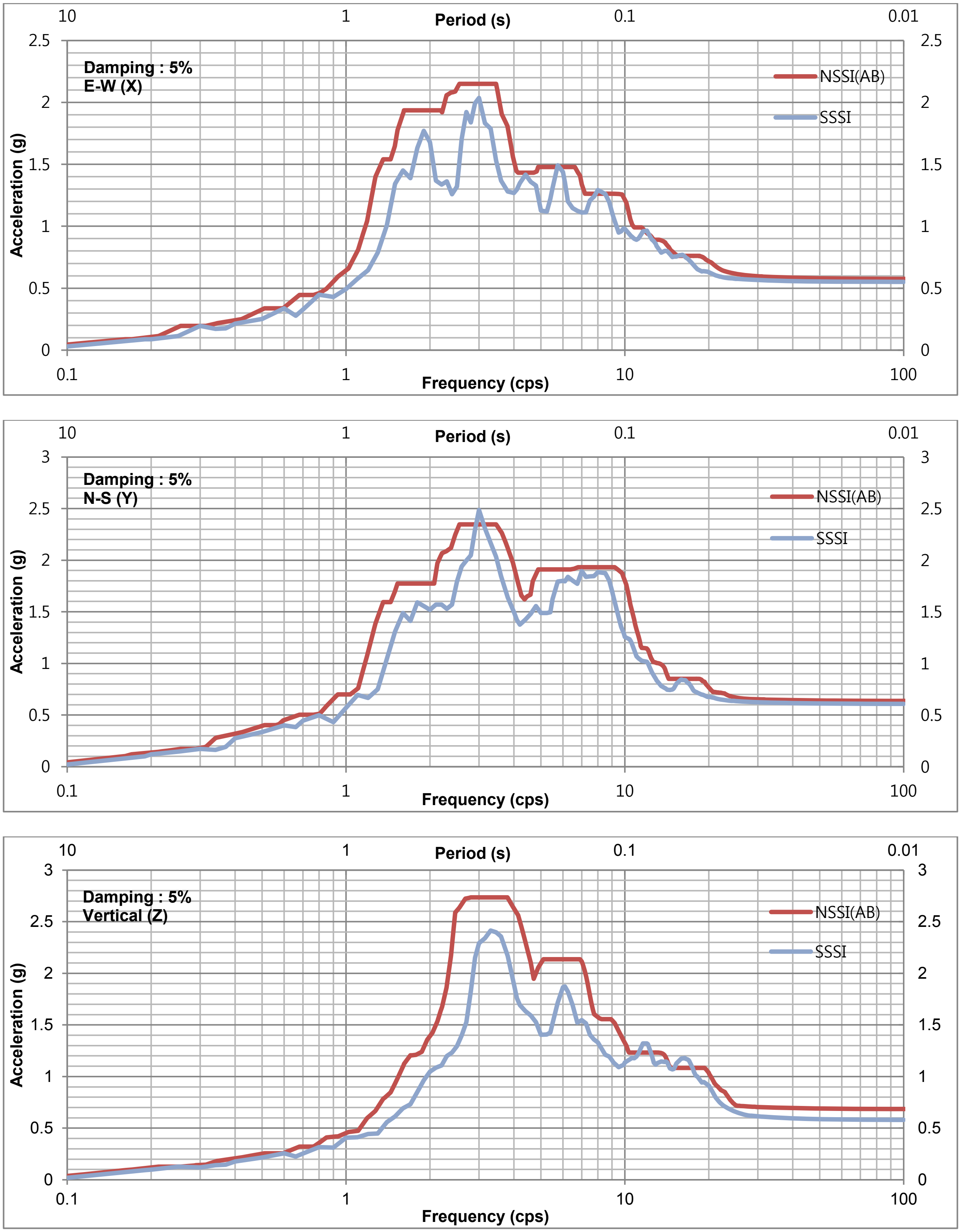


Figure 5-42 S1U-Comparison of AB ISRS (SSI vs SSSI) at El. 156'-0"

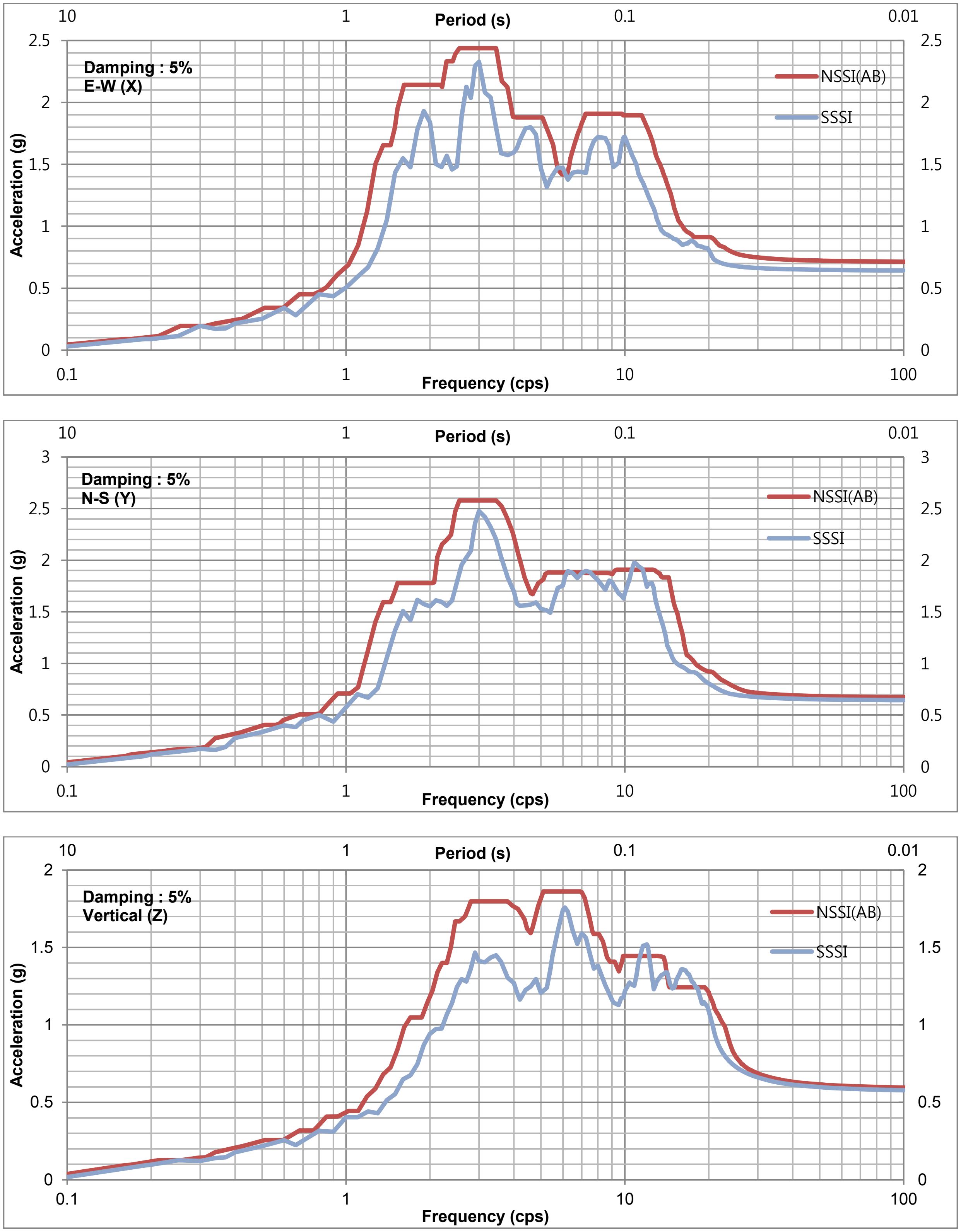


Figure 5-43 S1U-Comparison of AB ISRS (SSI vs SSSI) at El. 195'-0"

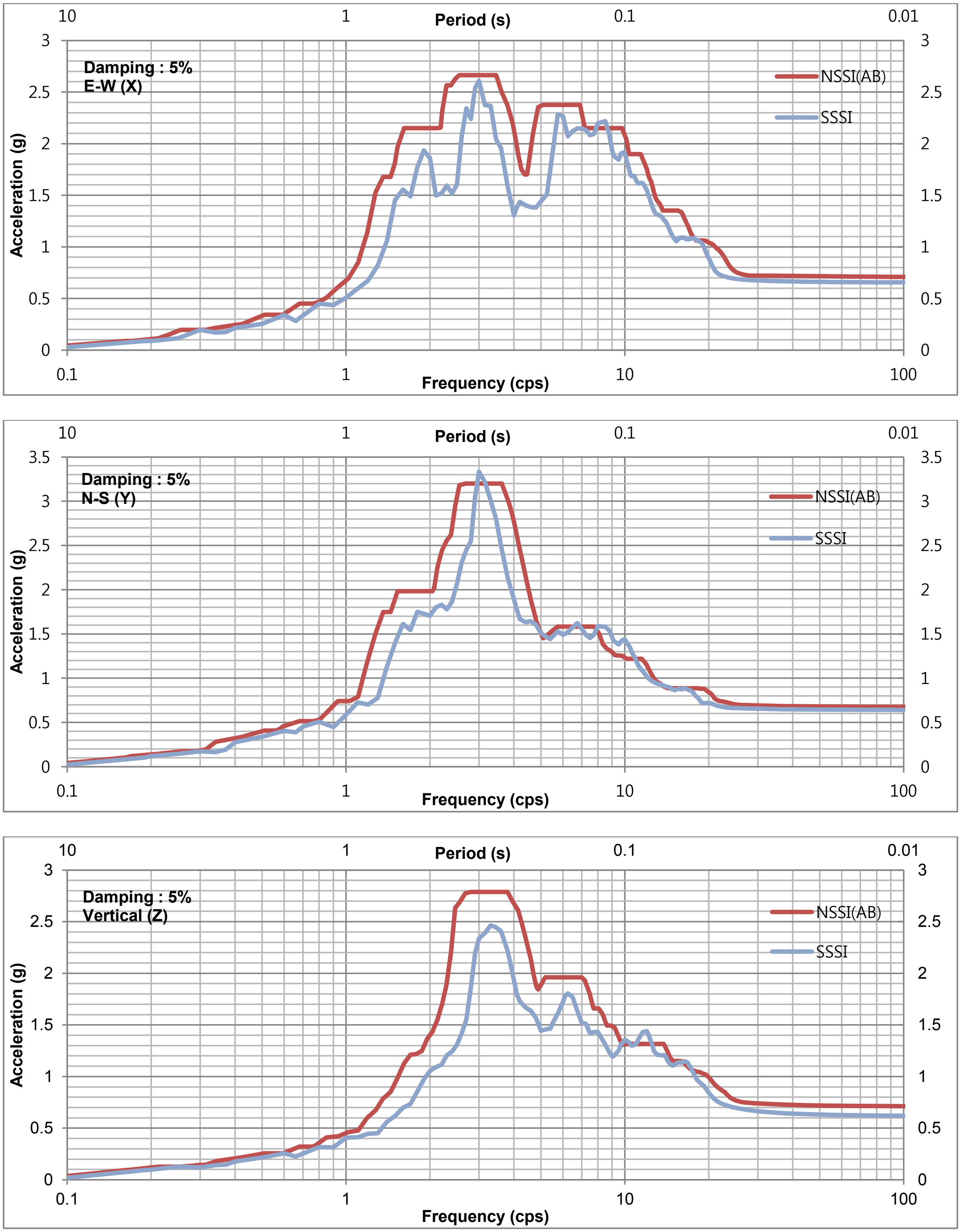


Figure 5-44 S1U-Comparison of AB ISRS (SSI vs SSSI) at El. 213’-6”

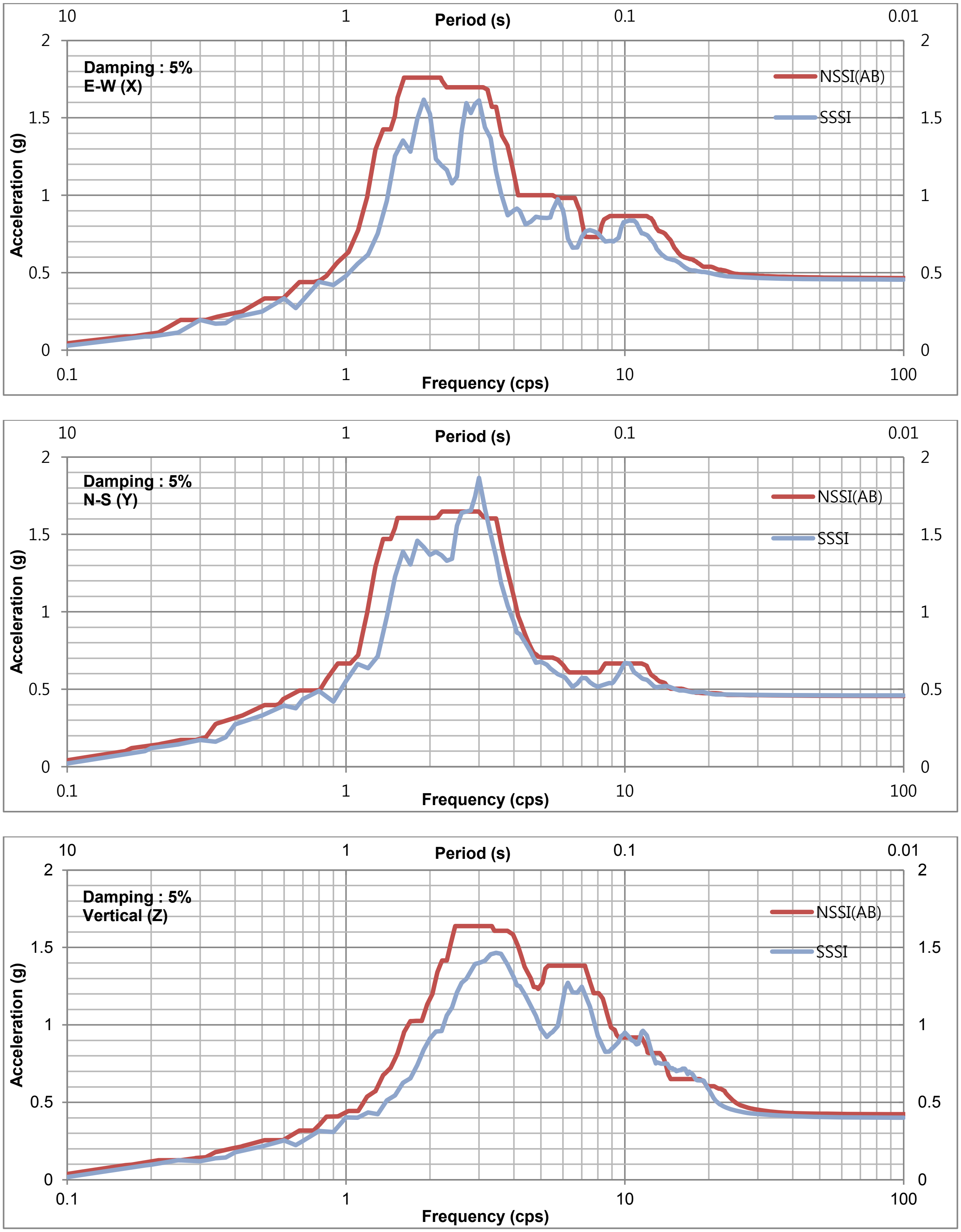


Figure 5-45 S1U-Comparison of AB SFP ISRS (SSI vs SSSI)

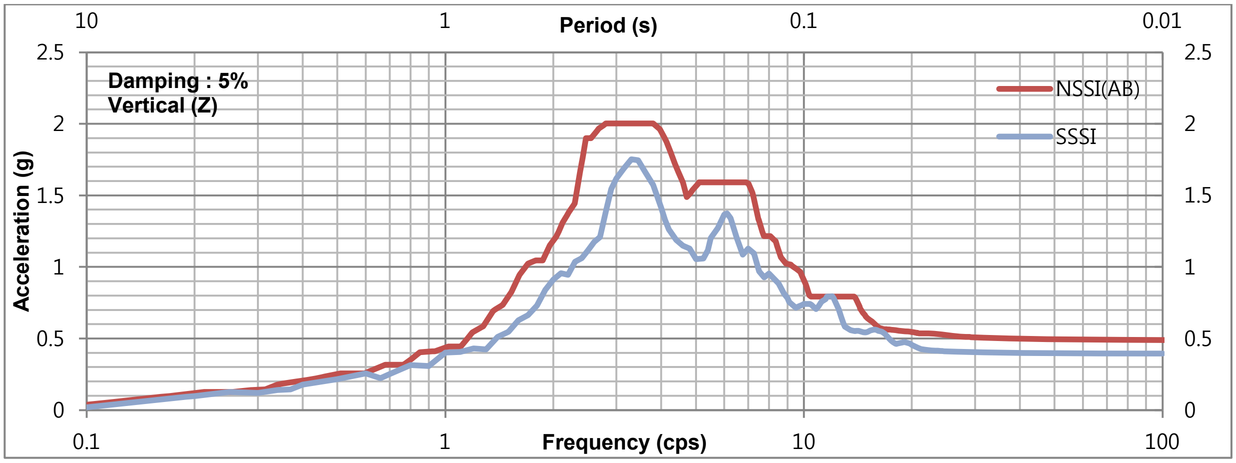


Figure 5-46 S1U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 55'-0"

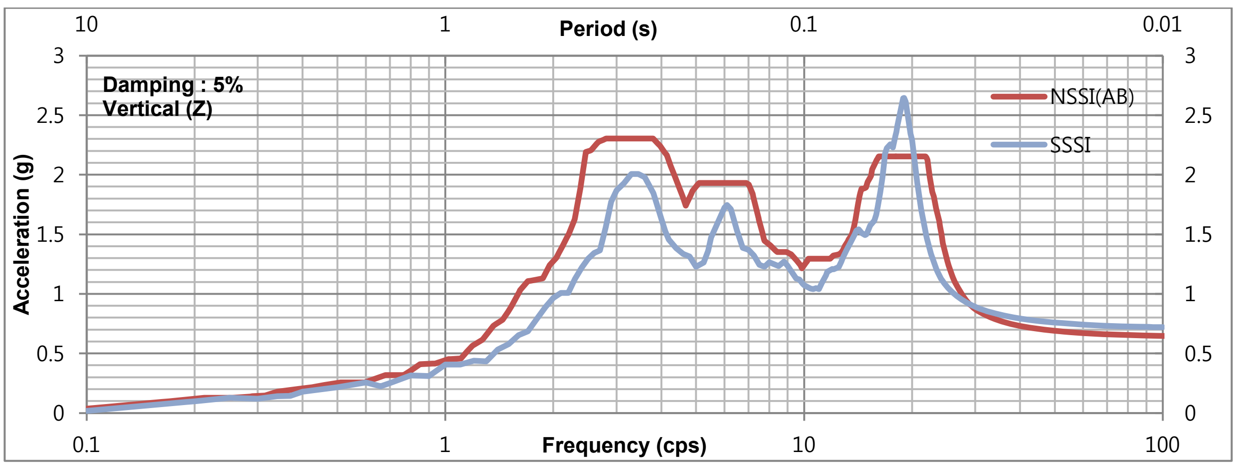


Figure 5-47 S1U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 100'-0"

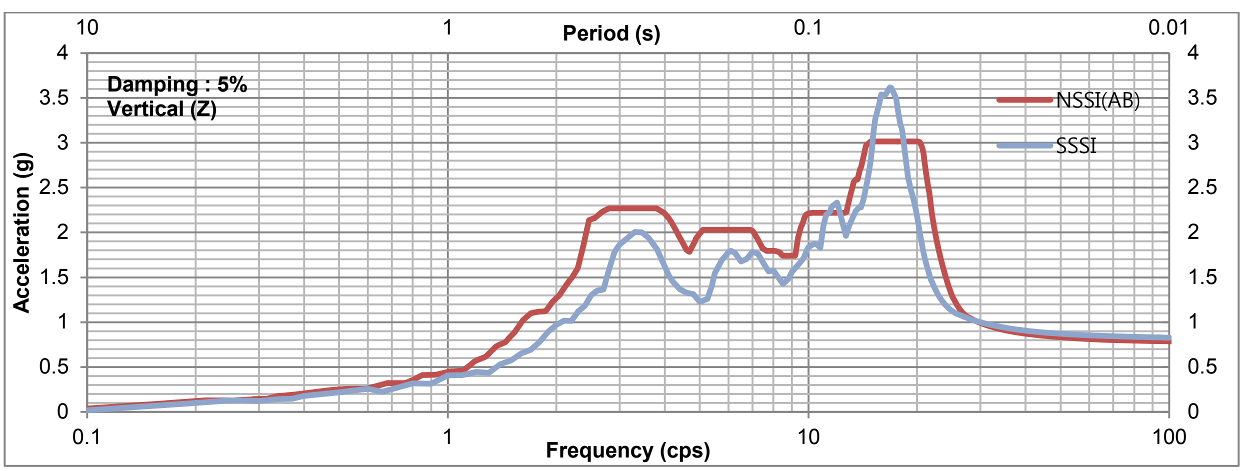


Figure 5-48 S1U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 156'-0"

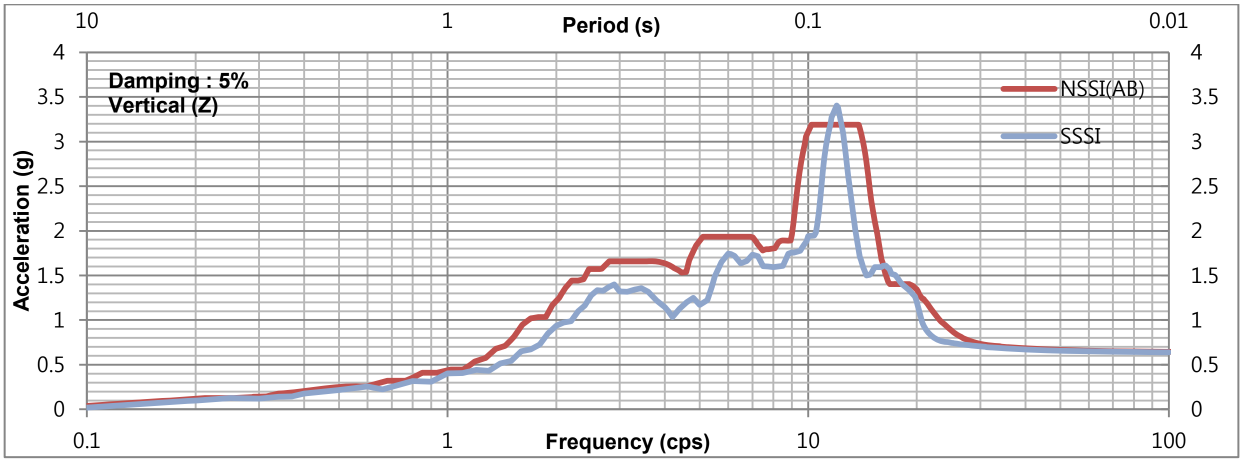


Figure 5-49 S1U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 195'-0"

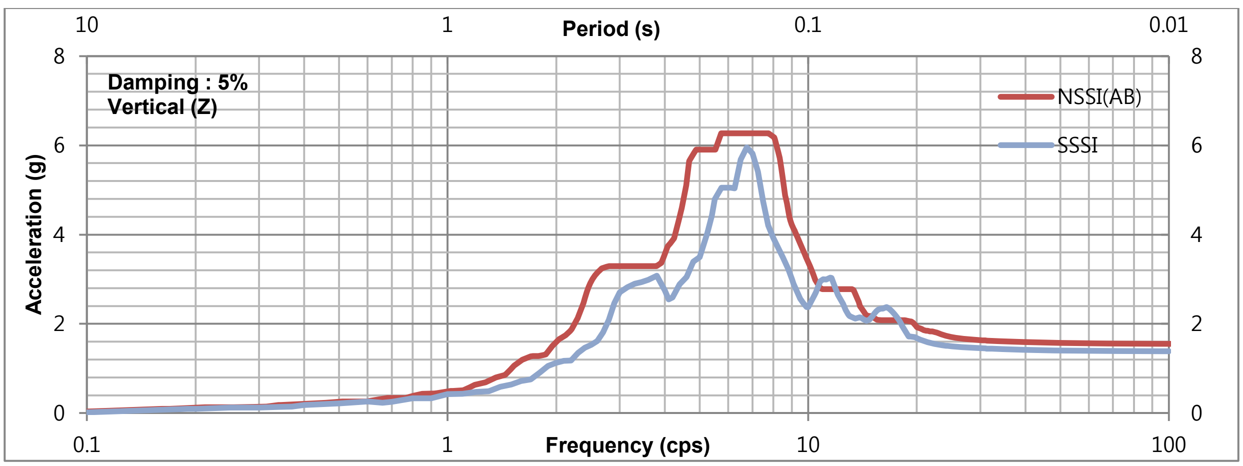


Figure 5-50 S1U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 213'-6"

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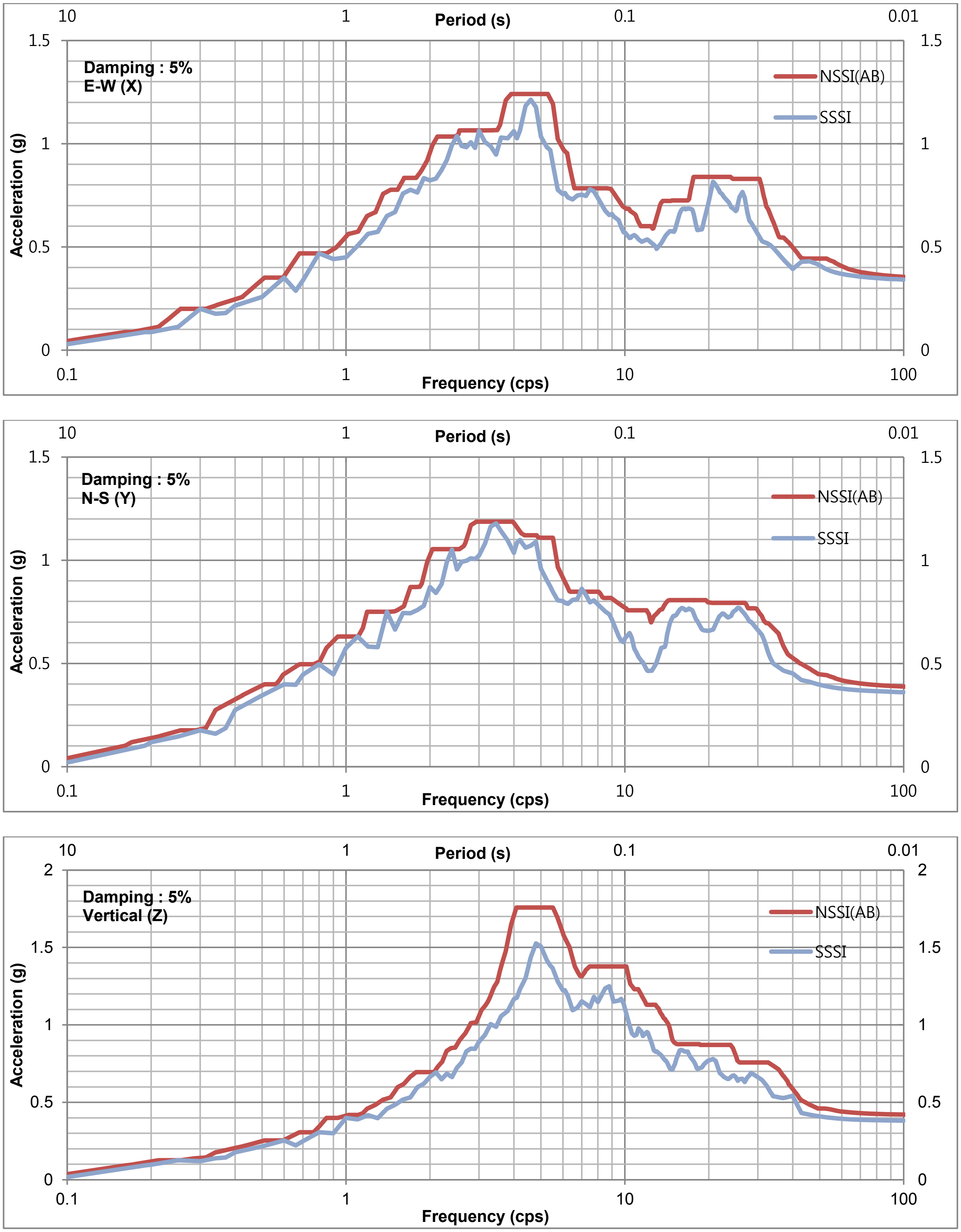

Figure 5-62 S9U-Comparison of AB ISRS (SSI vs SSSI) at El. 55'-0"

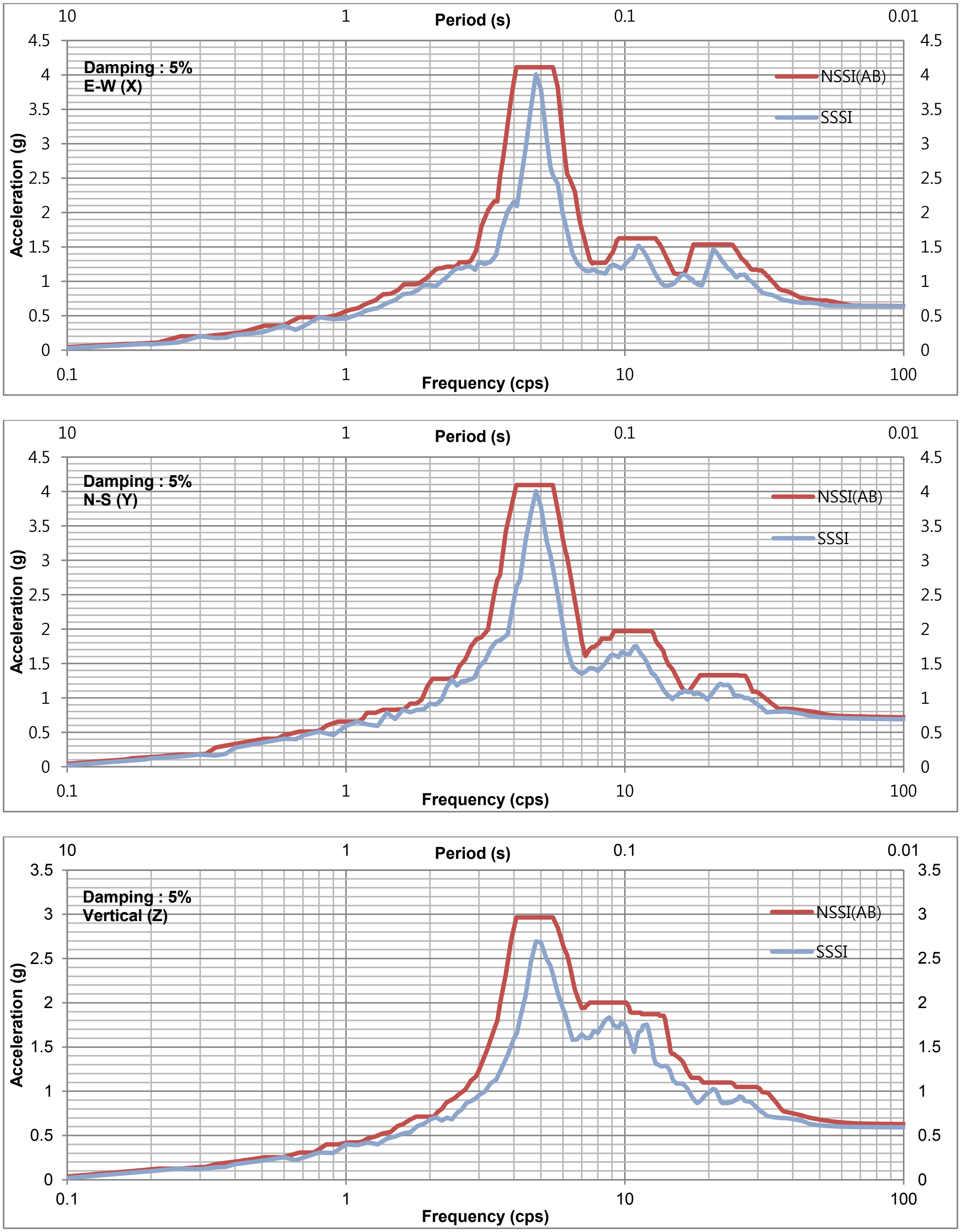

Figure 5-63 S9U-Comparison of AB ISRS (SSI vs SSSI) at El. 100'-0"

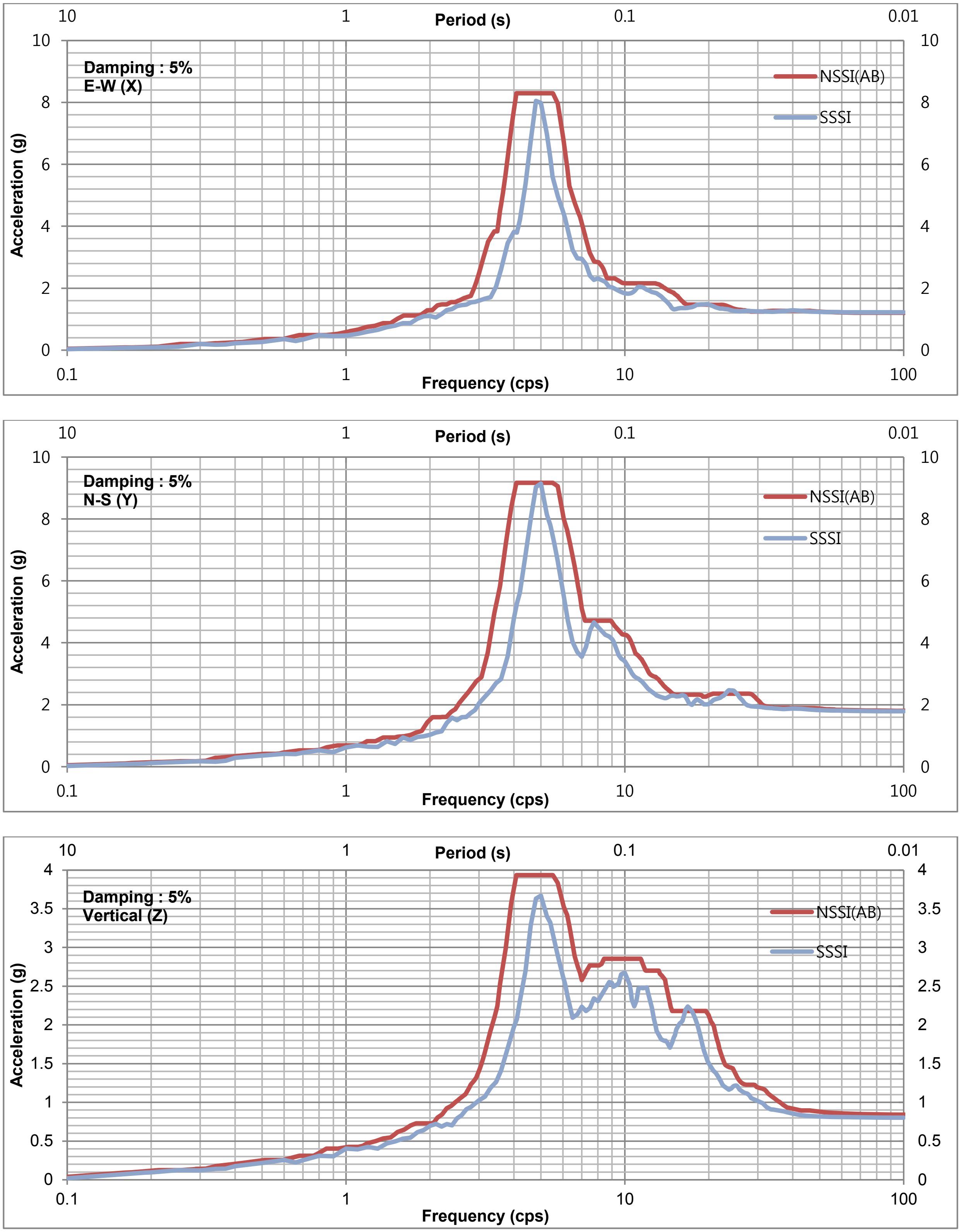

Figure 5-64 S9U-Comparison of AB ISRS (SSI vs SSSI) at El. 156'-0"

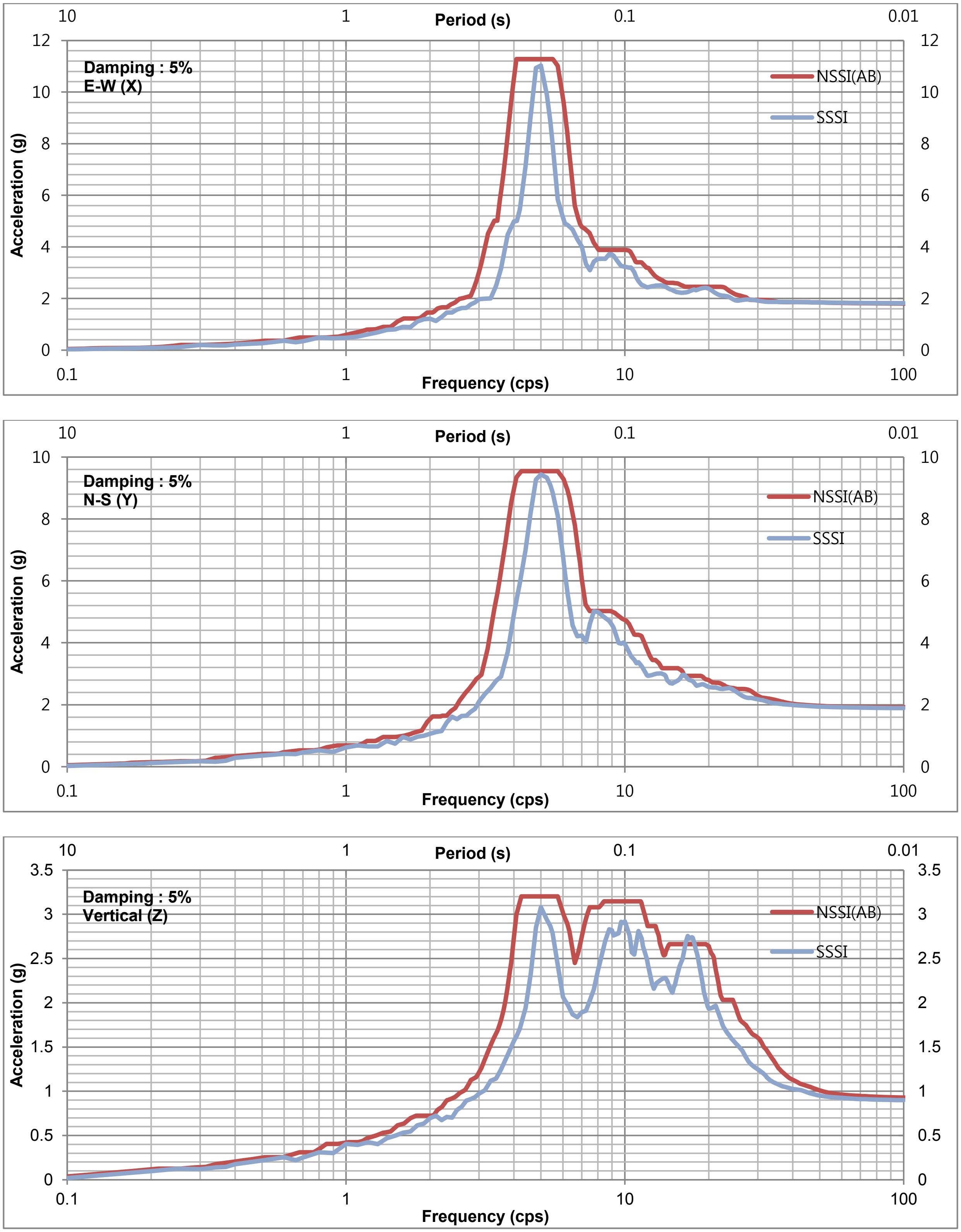

Figure 5-65 S9U-Comparison of AB ISRS (SSI vs SSSI) at El. 195'-0"

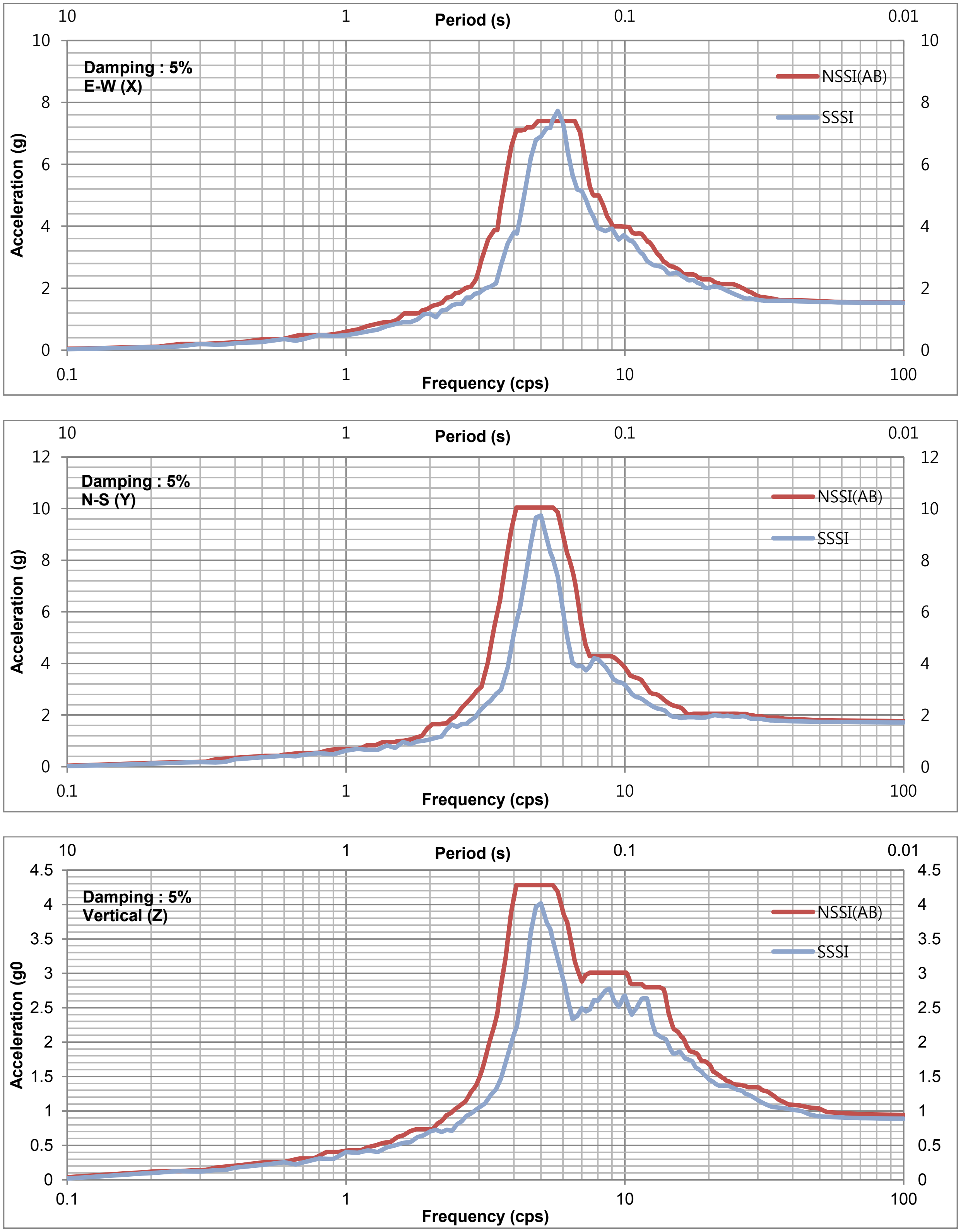

Figure 5-66 S9U-Comparison of AB ISRS (SSI vs SSSI) at El. 213’-6”

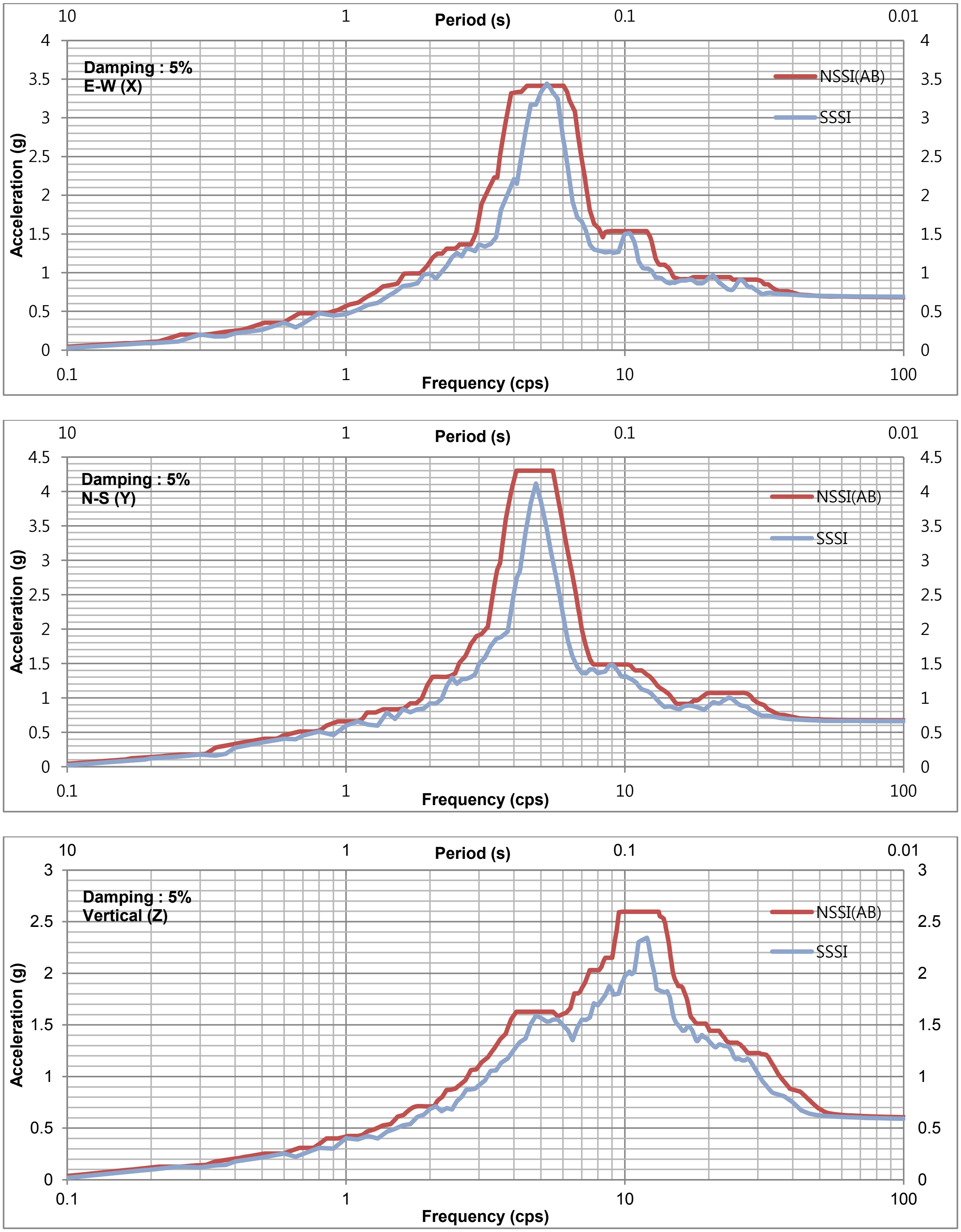

Figure 5-67 S9U-Comparison of AB SFP ISRS (SSI vs SSSI)

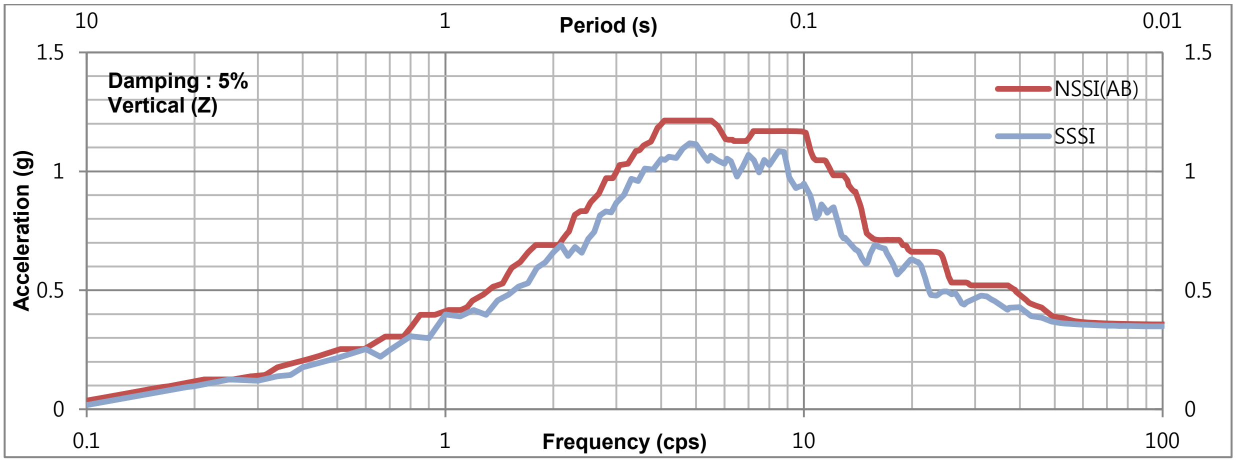

Figure 5-68 S9U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 55'-0"

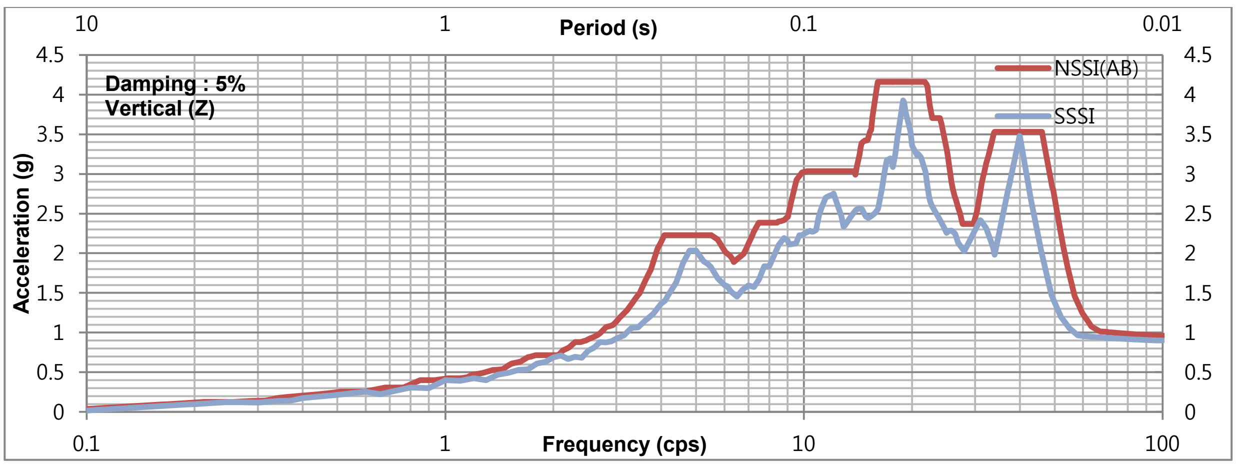

Figure 5-69 S9U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 100'-0"

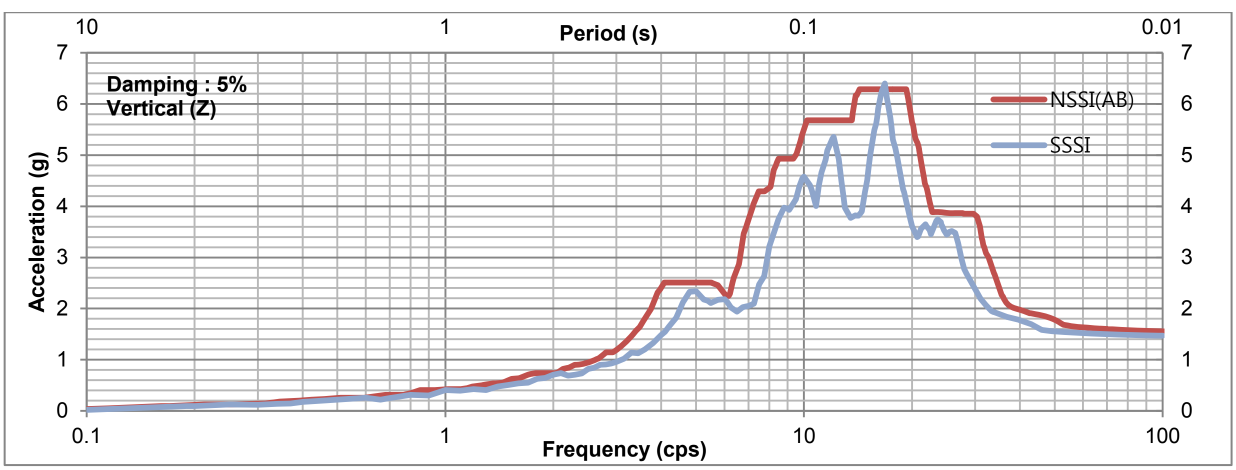

Figure 5-70 S9U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 156'-0"

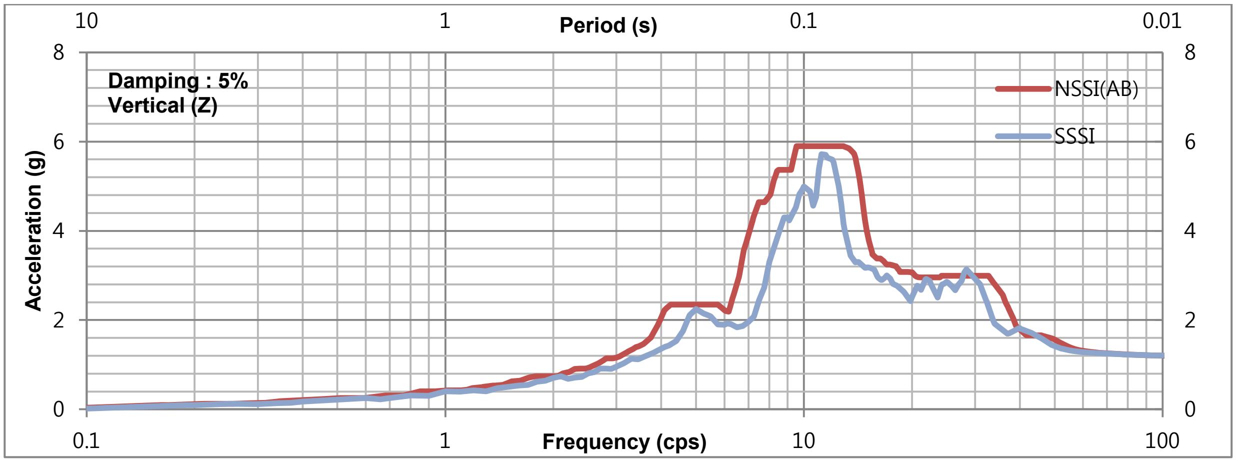

Figure 5-71 S9U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 195'-0"

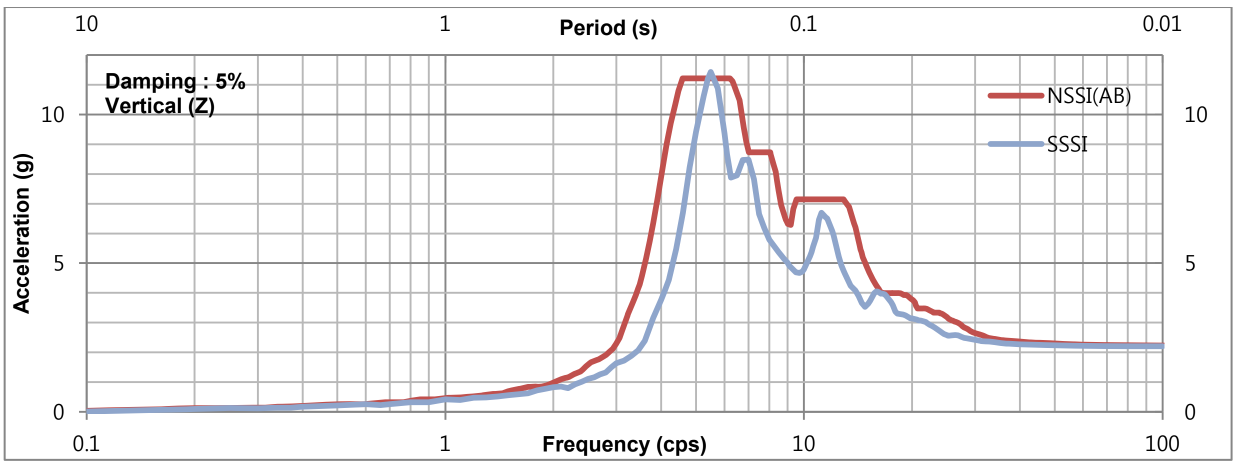

Figure 5-72 S9U-Comparison of AB PANEL ISRS (SSI vs SSSI) at El. 213'-6"

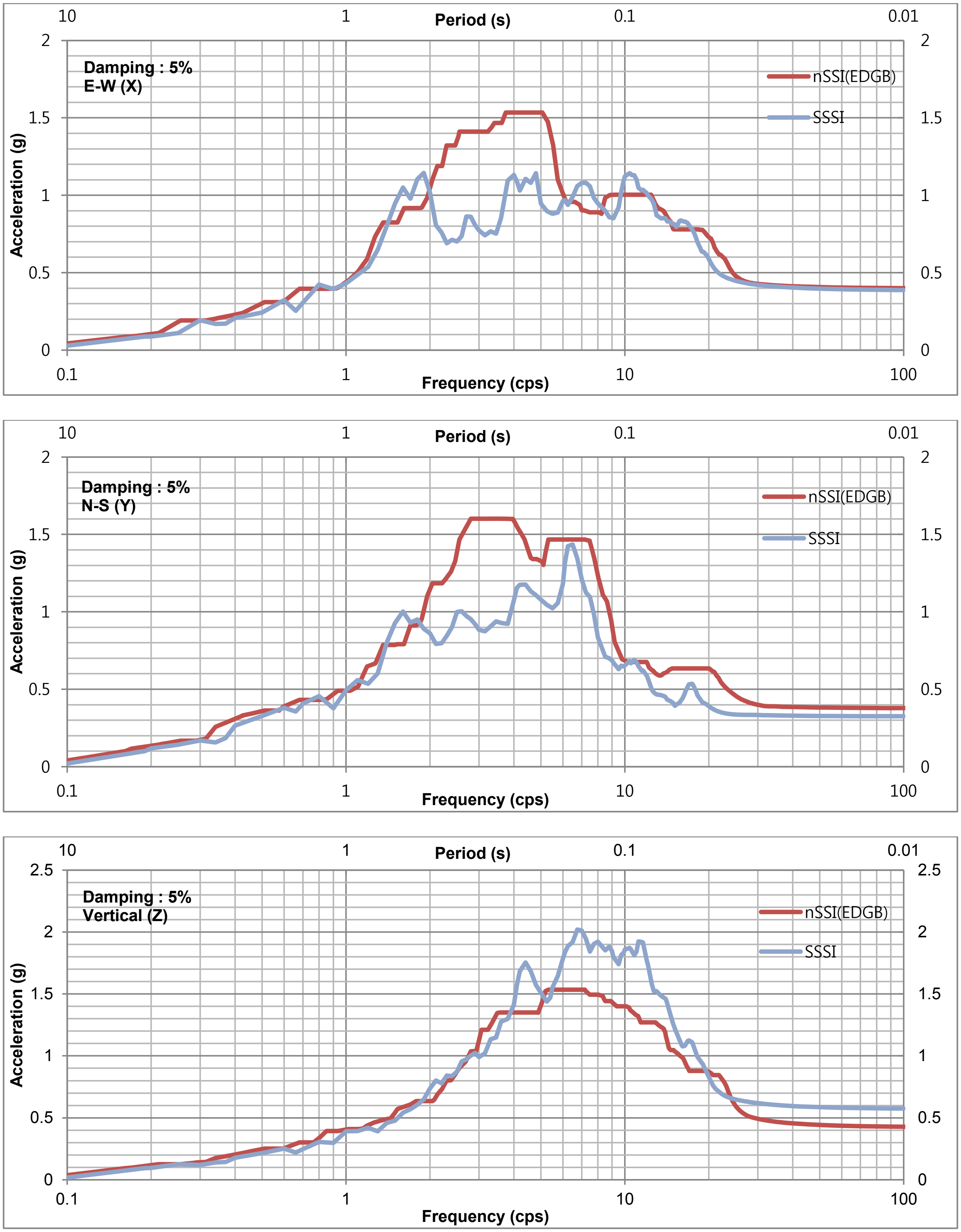

Figure 5-73 S1U-Comparison of EDGB Wall ISRS (SSI vs SSSI) at El. 100’-0”

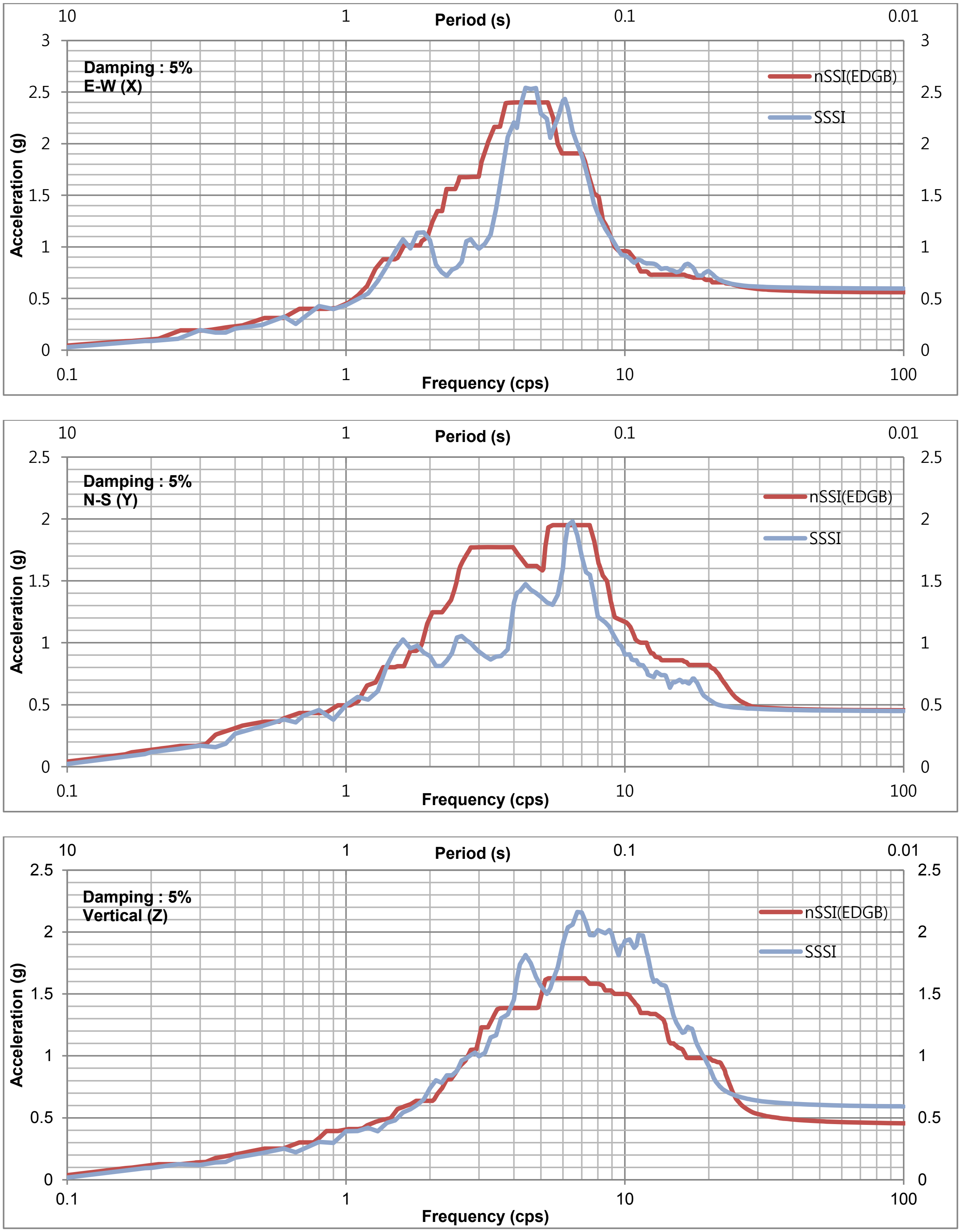

Figure 5-74 S1U-Comparison of EDGB Wall ISRS (SSI vs SSSI) at El. 135'-0"

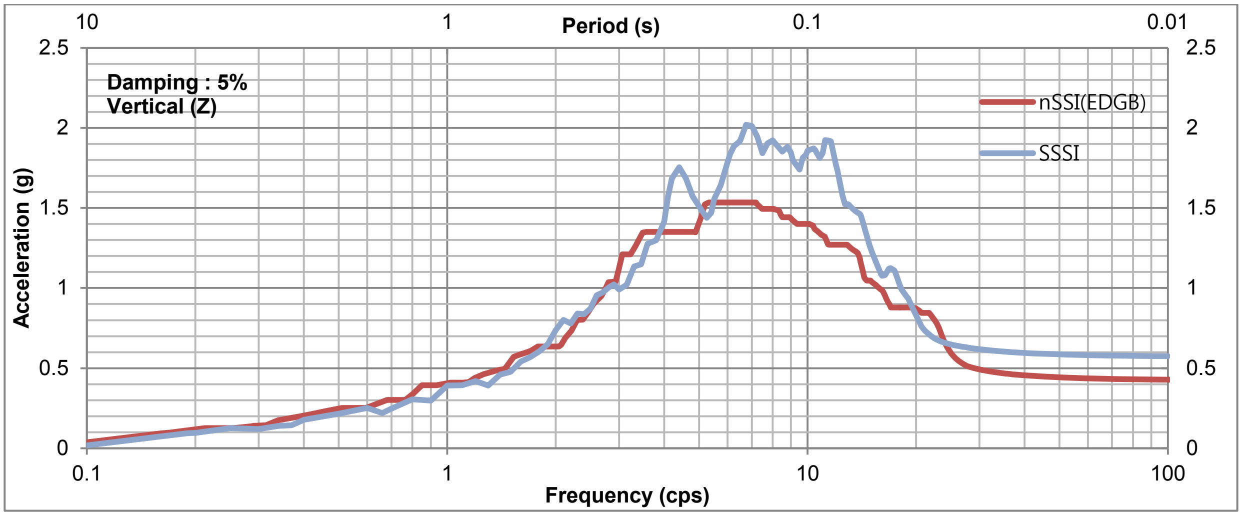

Figure 5-75 S1U-Comparison of EDGB Slab ISRS (SSI vs SSSI) at El. 100'-0"

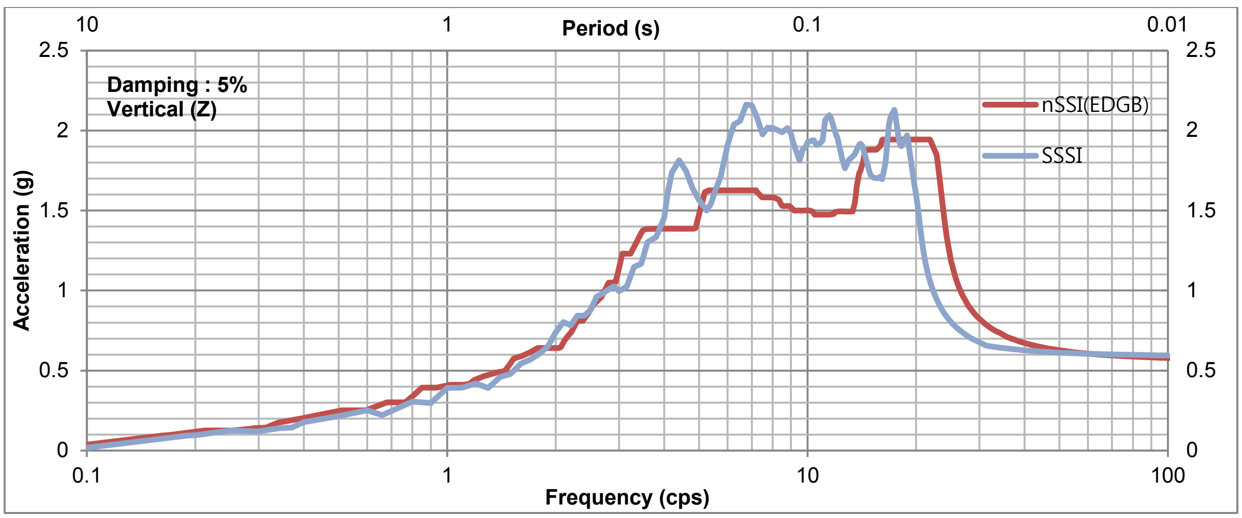

Figure 5-76 S1U-Comparison of EDGB Slab ISRS (SSI vs SSSI) at El. 135'-0"

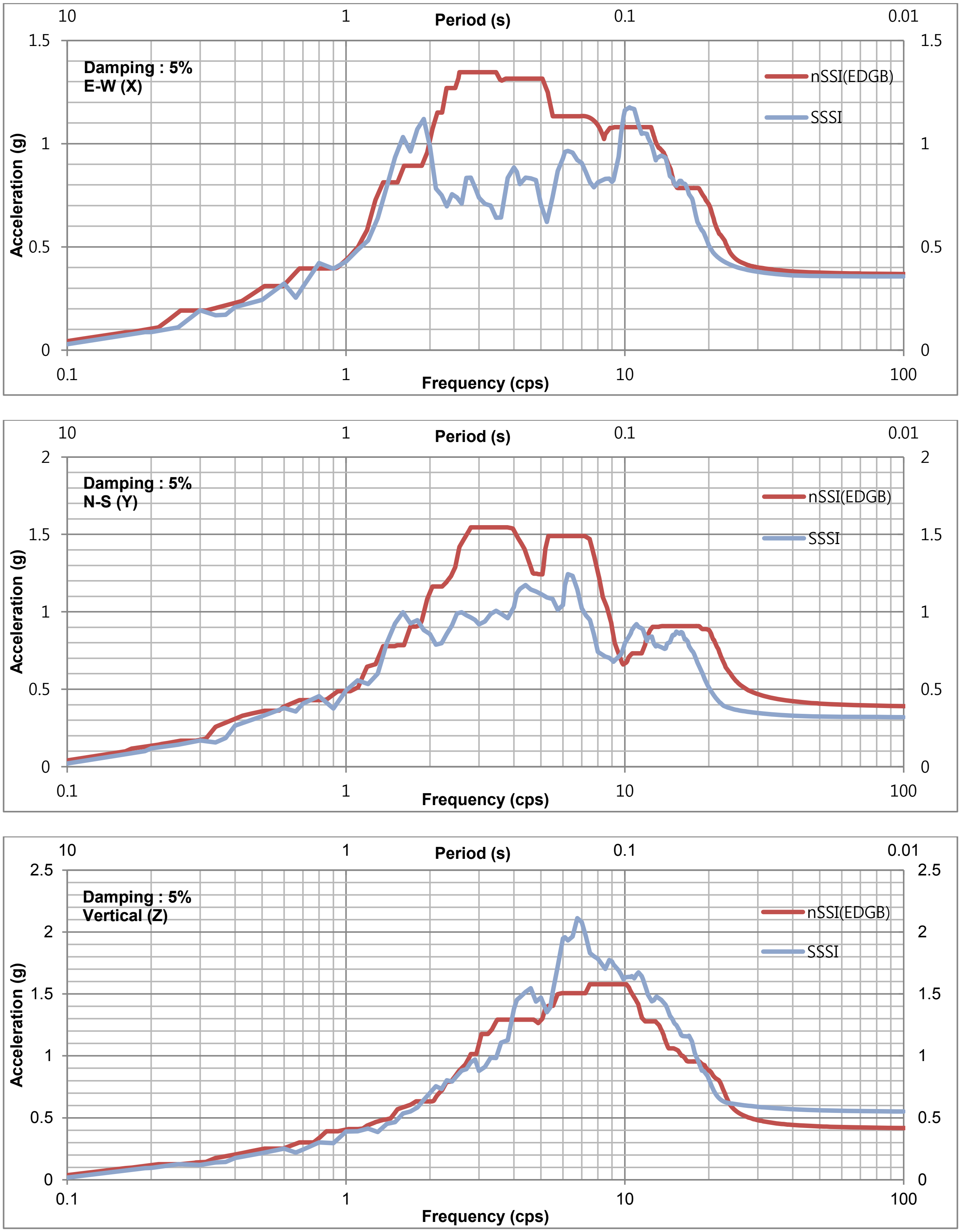

Figure 5-77 S1U-Comparison of DFOT Room Wall ISRS (SSI vs SSSI) at El. 63’-0”

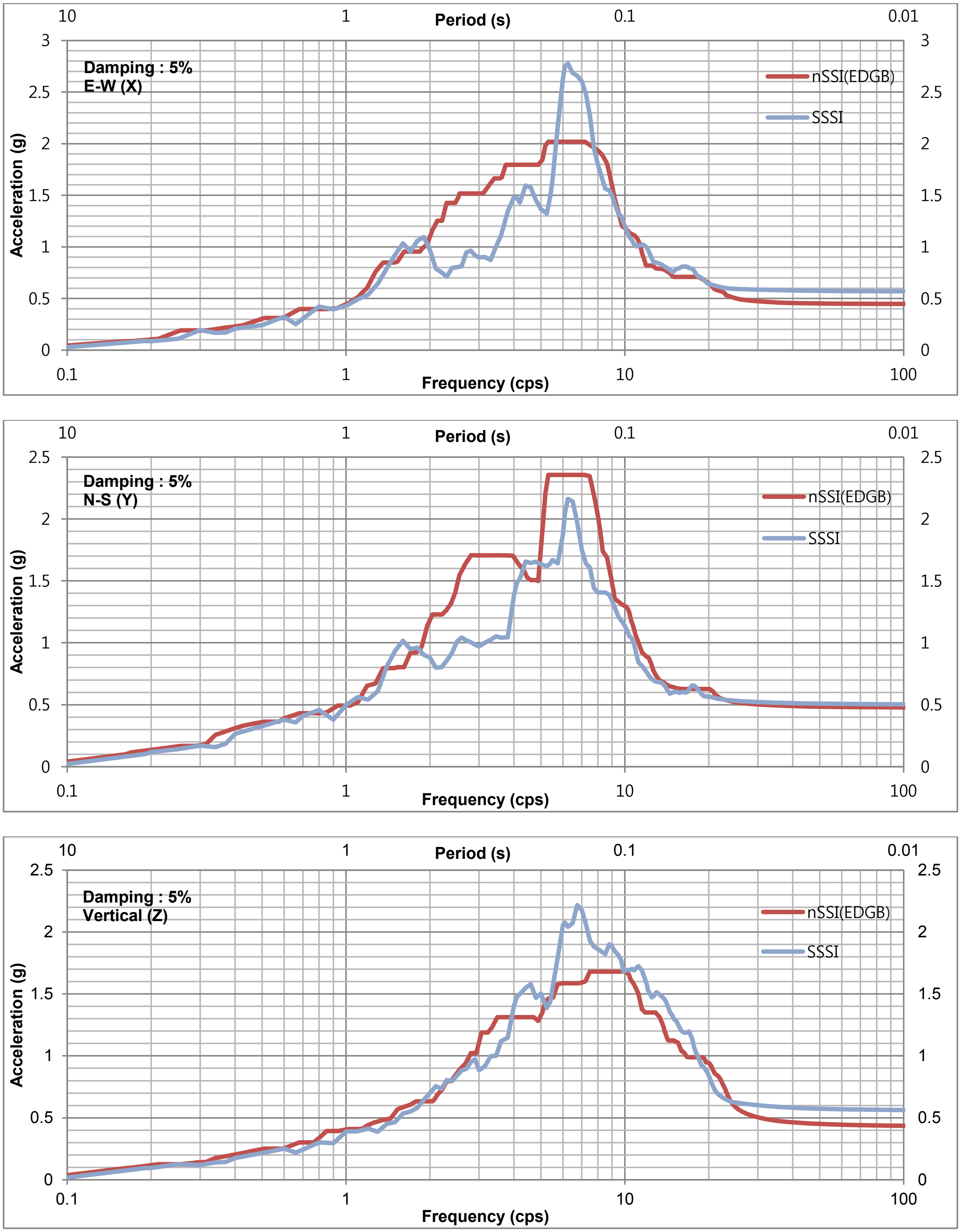

Figure 5-78 S1U-Comparison of DFOT Room Wall ISRS (SSI vs SSSI) at El. 100’-0”

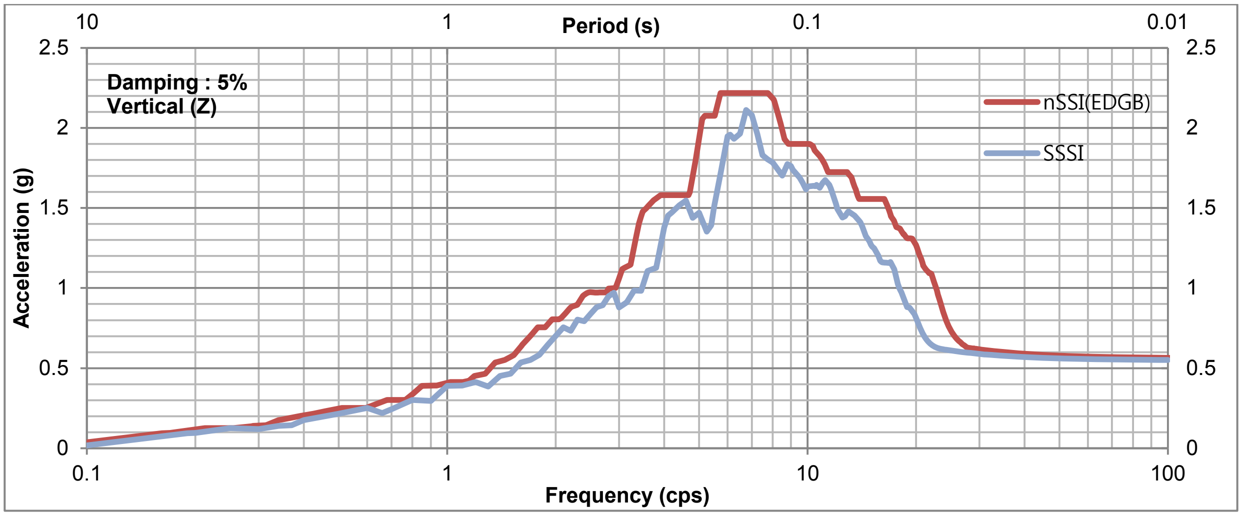

Figure 5-79 S1U-Comparison of EDGB DFOT Room Slab ISRS (SSI vs SSSI) at El. 63'-0"

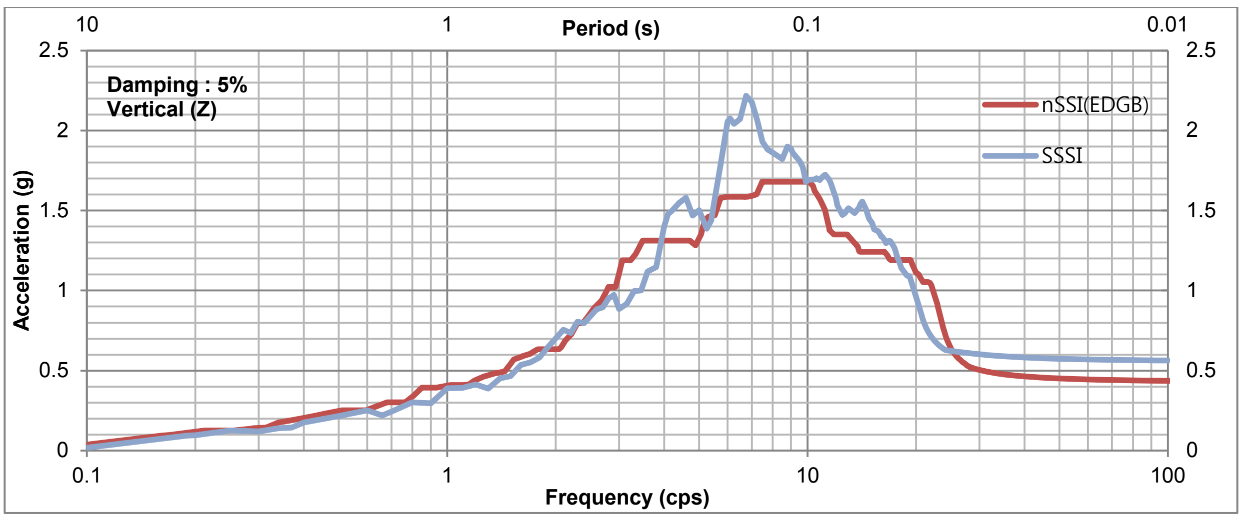

Figure 5-80 S1U-Comparison of DFOT Room Slab ISRS (SSI vs SSSI) at El. 100'-0"

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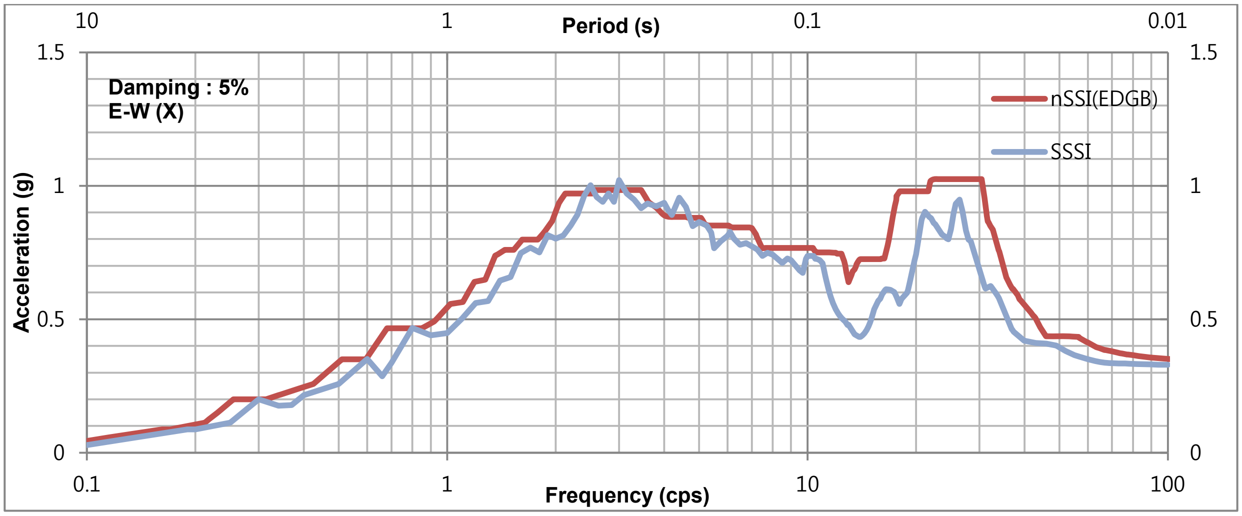
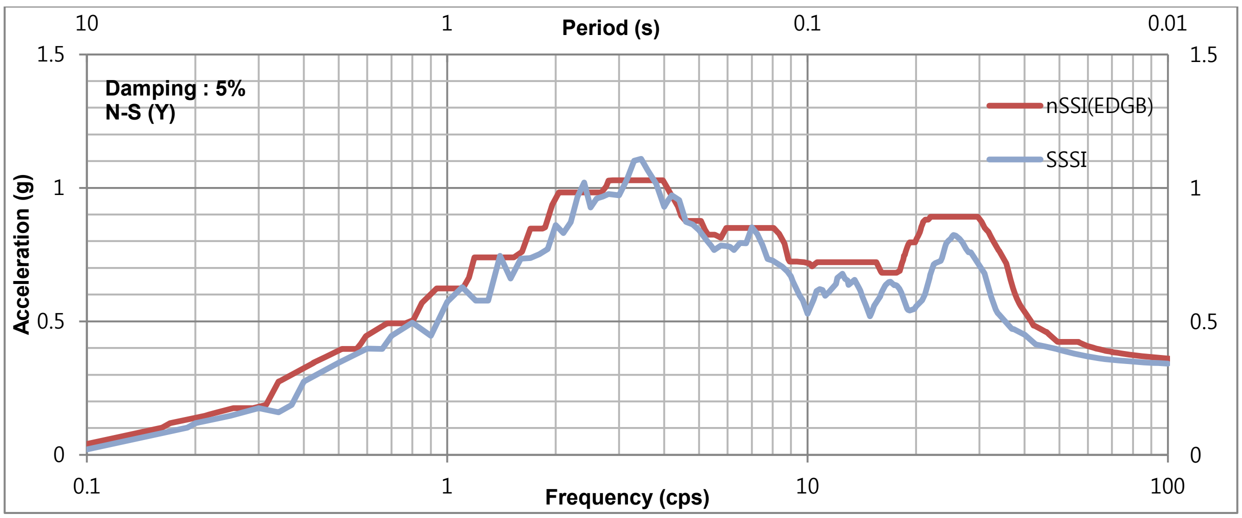




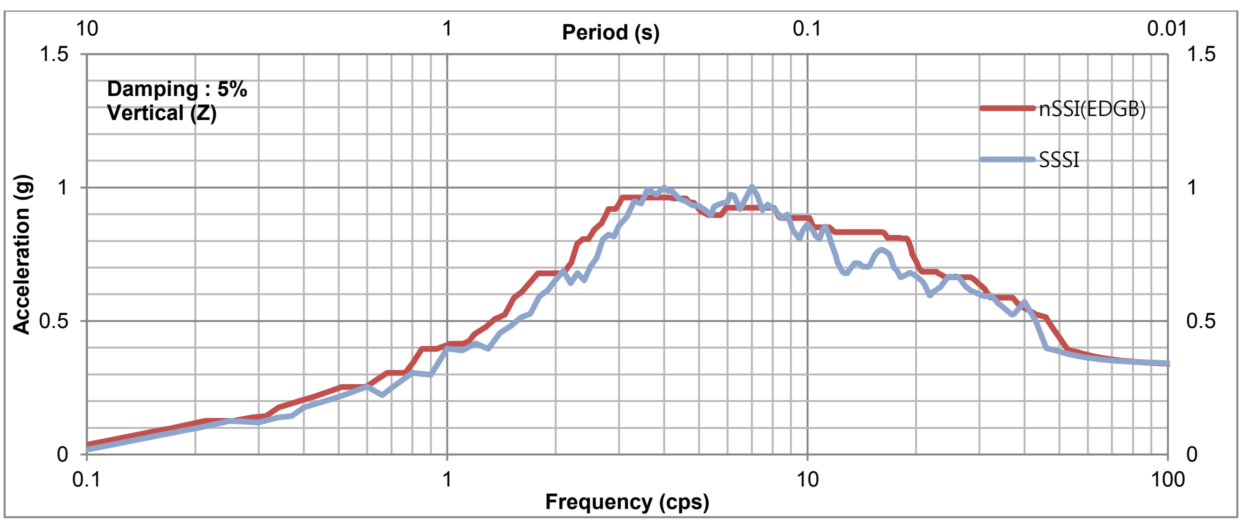


Figure 5-89 S9U-Comparison of EDGB Wall ISRS (SSI vs SSSI) at El. 100'-0"

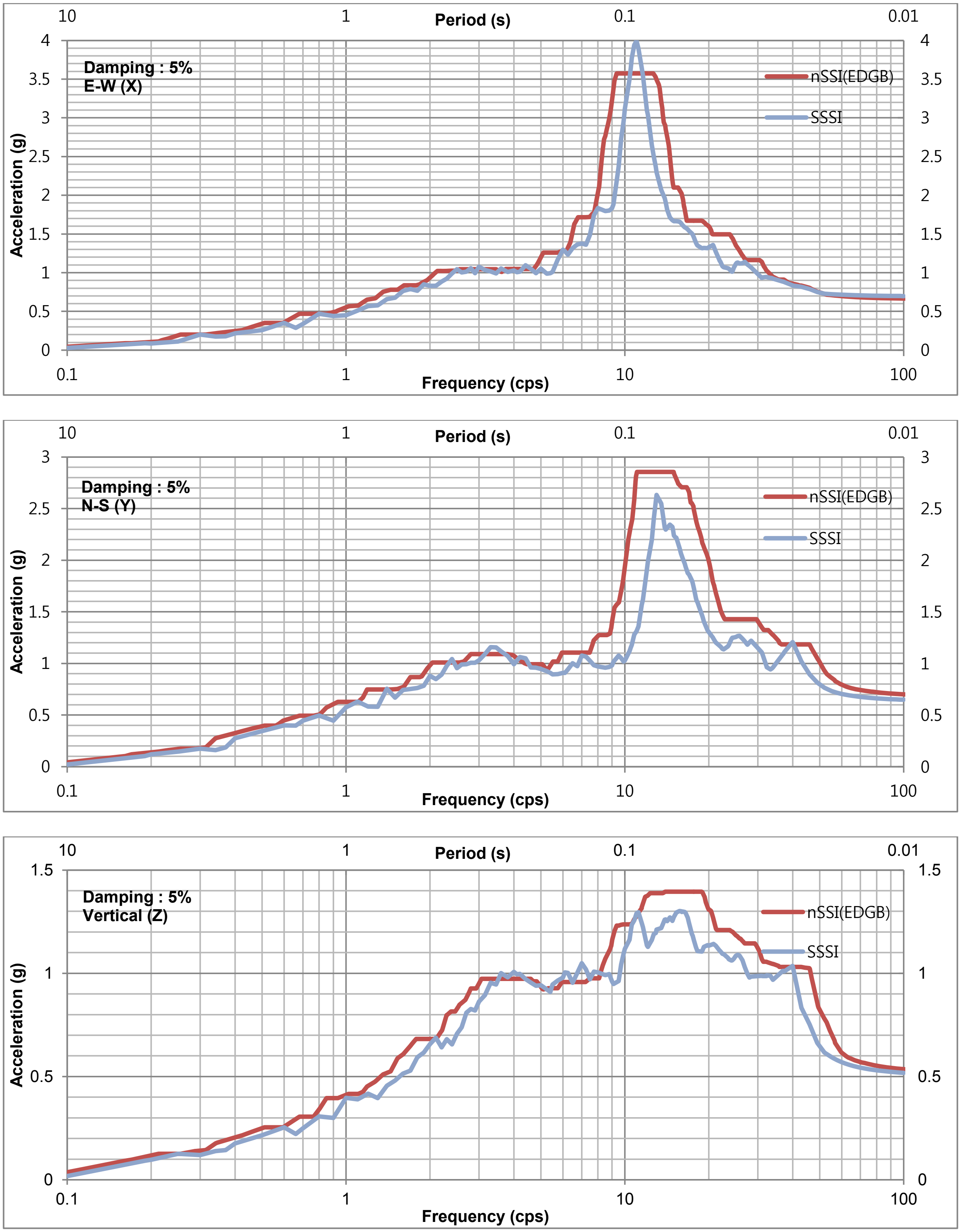


Figure 5-90 S9U-Comparison of EDGB Wall ISRS (SSI vs SSSI) at El. 135’-0”

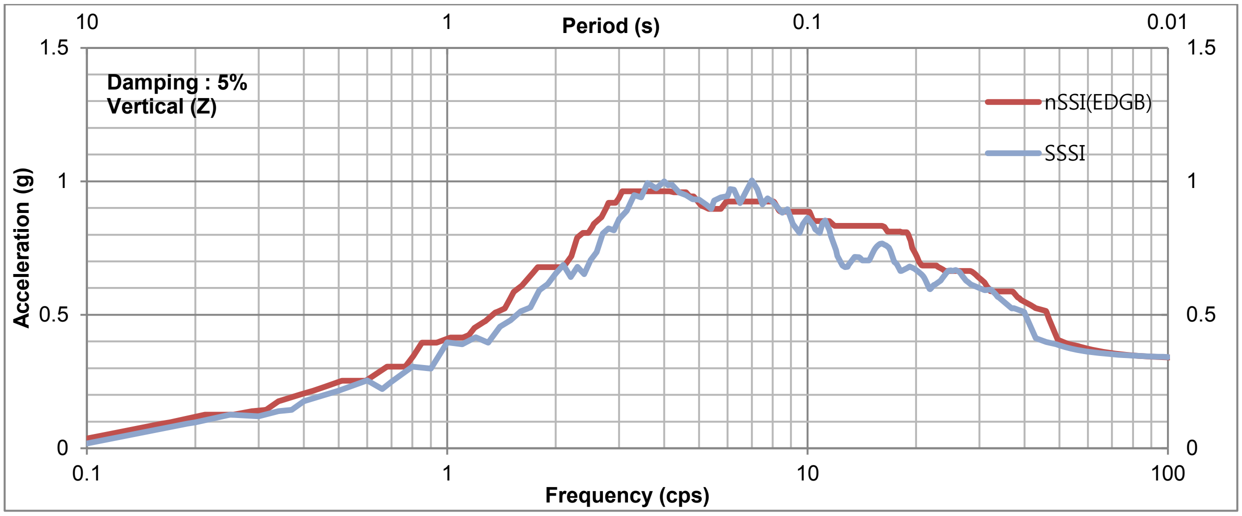


Figure 5-91 S9U-Comparison of EDGB Slab ISRS (SSI vs SSSI) at El. 100'-0"

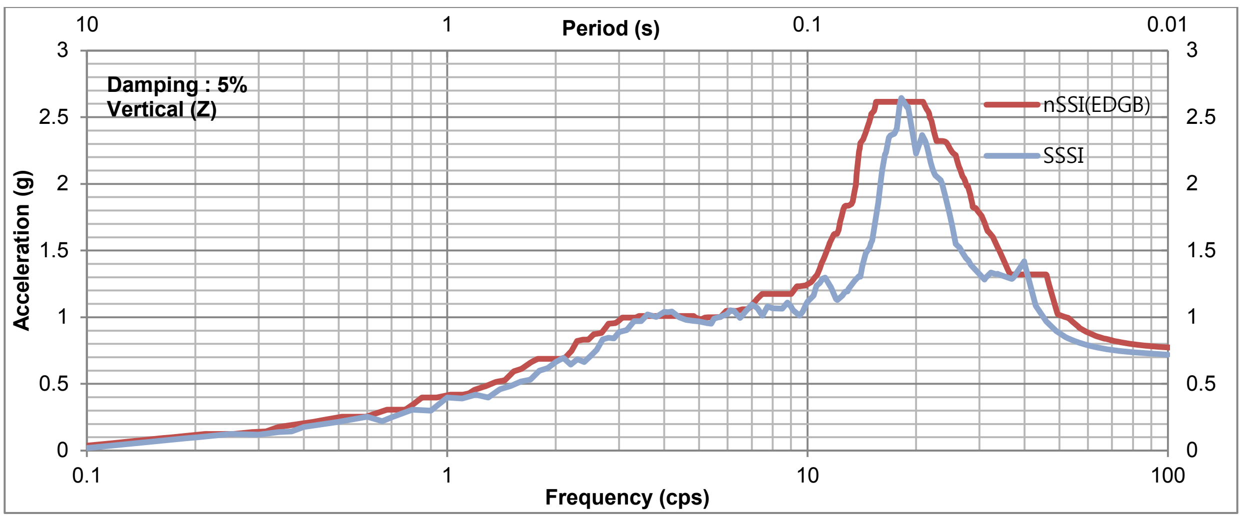
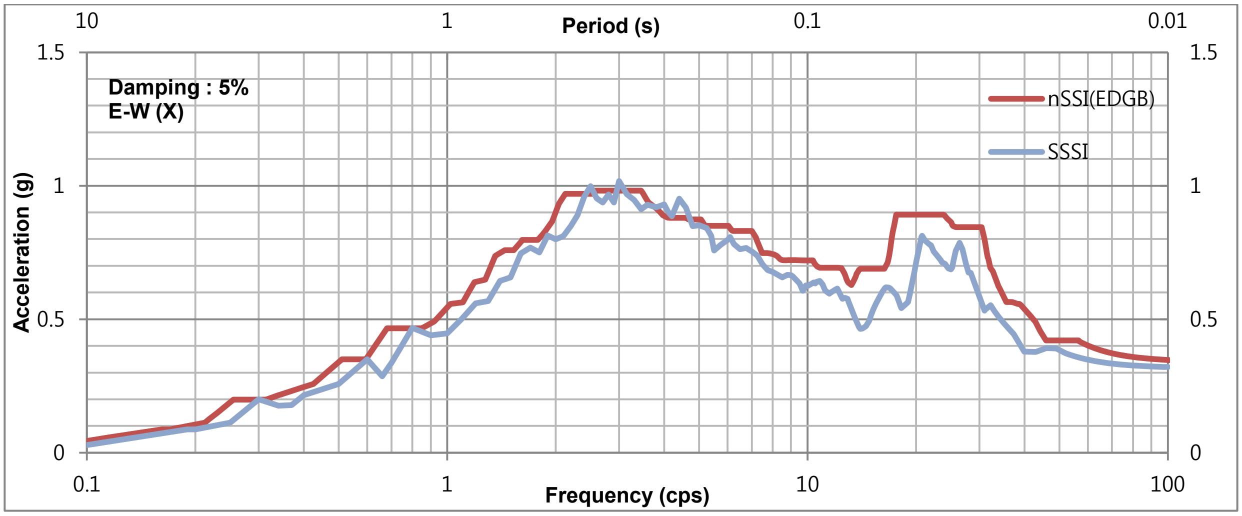
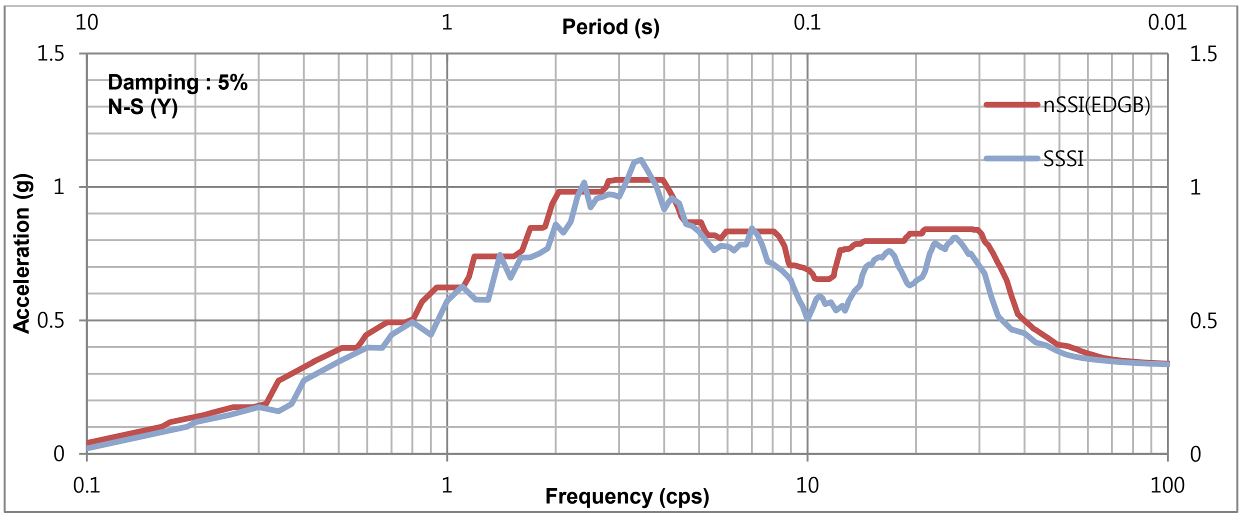


Figure 5-92 S9U-Comparison of EDGB Slab ISRS (SSI vs SSSI) at El. 135'-0"





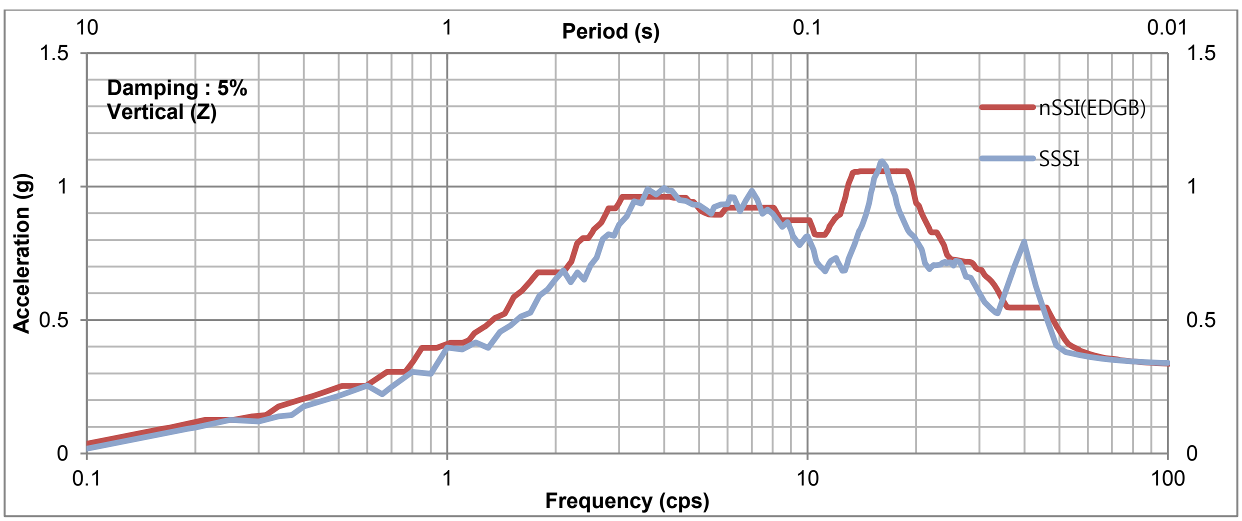


Figure 5-93 S9U-Comparison of DFOT Room Wall ISRS (SSI vs SSSI) at El. 63’-0”

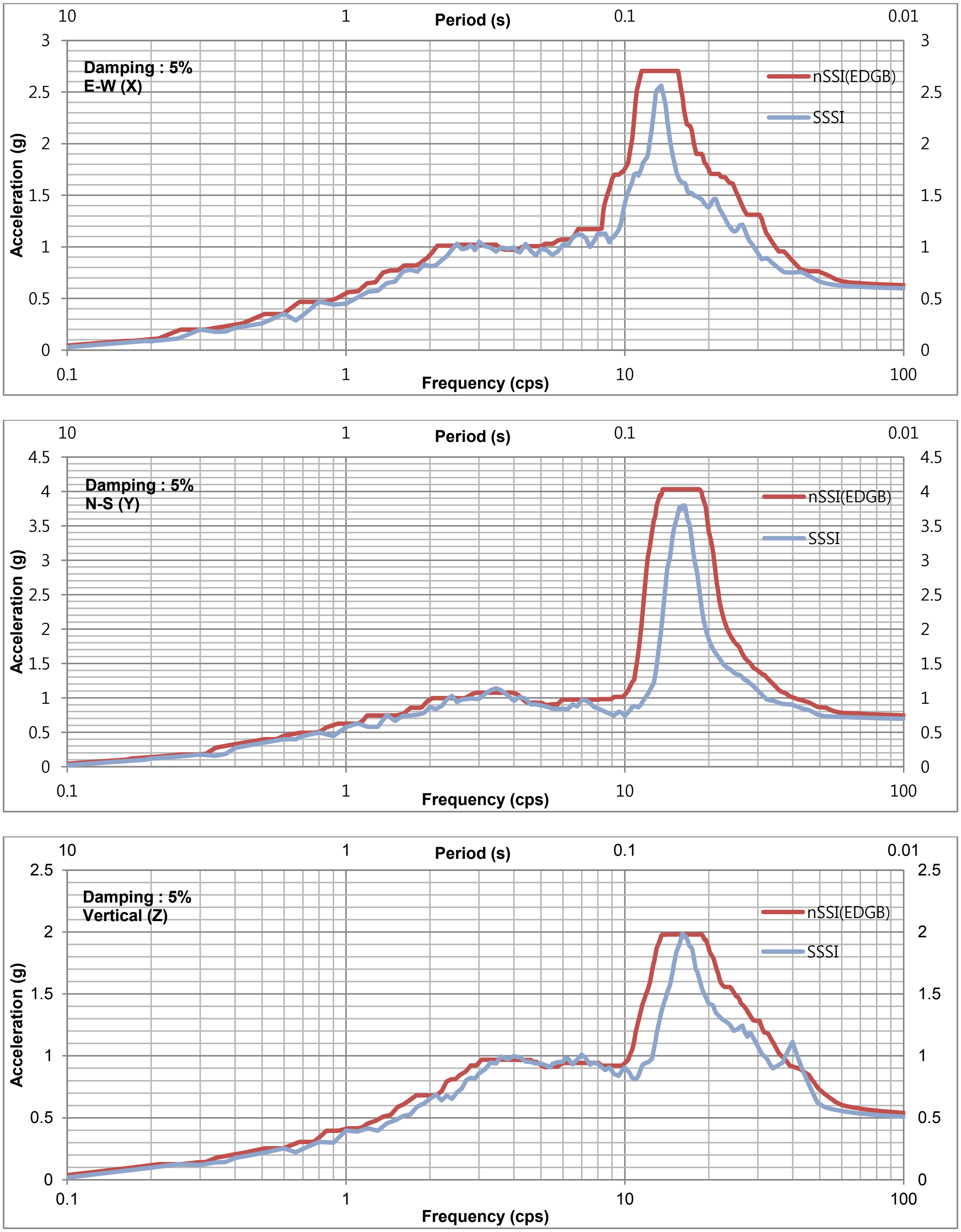


Figure 5-94 S9U-Comparison of DFOT Room Wall ISRS (SSI vs SSSI) at El. 100'-0"

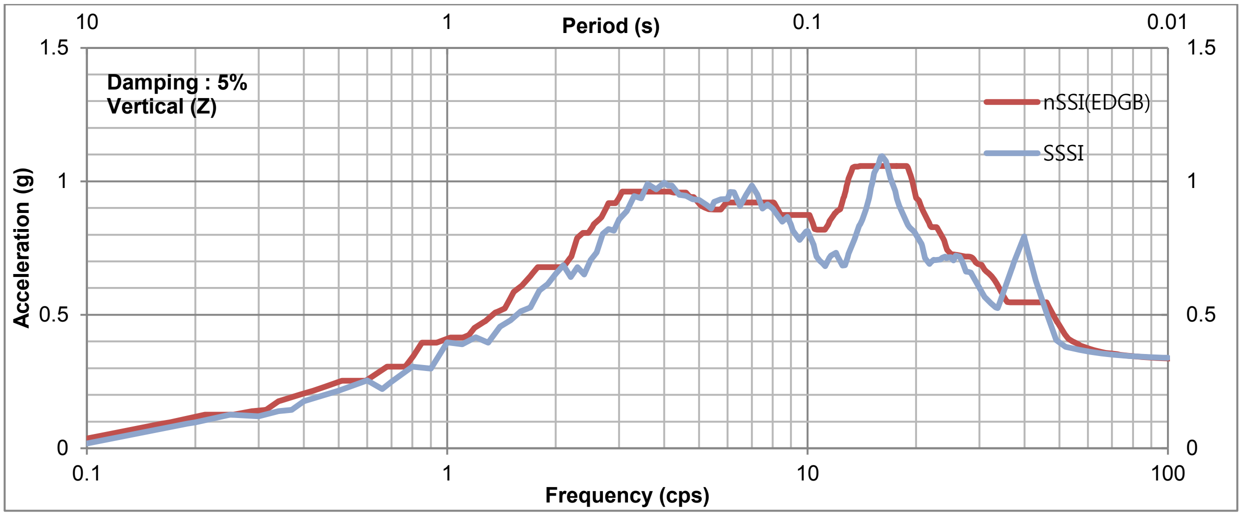


Figure 5-95 S9U-Comparison of DFOT Room Slab ISRS (SSI vs SSSI) at El. 63’-0”

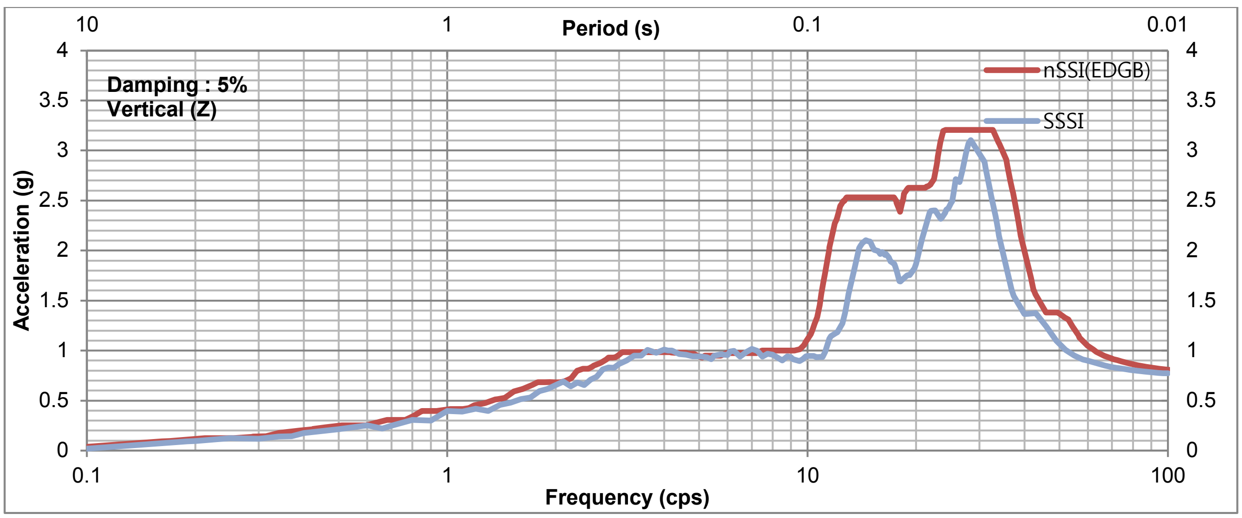


Figure 5-96 S9U-Comparison of DFOT Room Slab ISRS (SSI vs SSSI) at El. 100’-0”

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Figure 5-97 ISRS Node Locations – CS El. 78’-0”

TS

Figure 5-98 ISRS Node Locations – CS El. 103’-9”

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Figure 5-99 ISRS Node Locations – CS El. 159’-9”

TS

Figure 5-100 ISRS Node Locations – CS El. 254'-6"

TS

Figure 5-101 ISRS Node Locations – CS El. 331'-9"

TS

Figure 5-102 ISRS Node Locations – PSW El. 78’-0”

TS

Figure 5-103 ISRS Node Locations – PSW El. 100’-0”

TS

Figure 5-104 ISRS Node Locations – PSW El. 156’-0”

TS

Figure 5-105 ISRS Node Locations – PSW El. 191'-0" (b)

TS

Figure 5-106 ISRS Node Locations - SSW El. 78'-0"

TS

Figure 5-107 ISRS Node Locations - SSW El. 100’-0”

TS

Figure 5-108 ISRS Node Locations – SSW El. 156'-0"

TS

Figure 5-109 ISRS Node Locations – SSW El. 191’-0”

TS

Figure 5-110 ISRS Node Locations – AB Shear Wall Response at Floor El. 55’-0” (1-F)

TS

Figure 5-111 ISRS Node Locations – AB Shear Wall Response at Floor El. 100’-0” (3-F)

TS

Figure 5-112 ISRS Node Locations – AB Shear Wall Response at Floor El. 156’-0” (6-F)

TS

Figure 5-113 ISRS Node Locations – AB Shear Wall Response at Floor El. 195'-0" (8-1)

TS

Figure 5-114 ISRS Node Locations – AB Shear Wall Response at Floor El. 213'-6" (8-4)

TS

Figure 5-115 ISRS Node Locations – AB Shear Wall Response at Floor El. 114’-0” (3-M)

TS

Figure 5-116 ISRS Node Locations – AB Floor Slab Response at Floor El. 55'-0" (1-F)

TS

Figure 5-117 ISRS Node Locations – AB Floor Slab Response at Floor El. 100’-0” (3-F)

TS

Figure 5-118 ISRS Node Locations – AB Floor Slab Response at Floor El. 156’-0” (6-F)

TS

Figure 5-119 ISRS Node Locations – AB Floor Slab Response at Floor El. 195’-0” (8-1)

TS

Figure 5-120 ISRS Node Locations – AB Floor Slab Response at Floor El. 213'-6" (8-4)

TS

Figure 5-121 ISRS Node Locations – DFOT Room El. 63’-0”

TS

Figure 5-122 ISRS Node Locations – DFOT Room El. 100'-0"

TS

Figure 5-123 ISRS Node Locations – EDGB El. 100’-0”

TS

Figure 5-124 ISRS Node Locations – EDGB El. 135’-0”

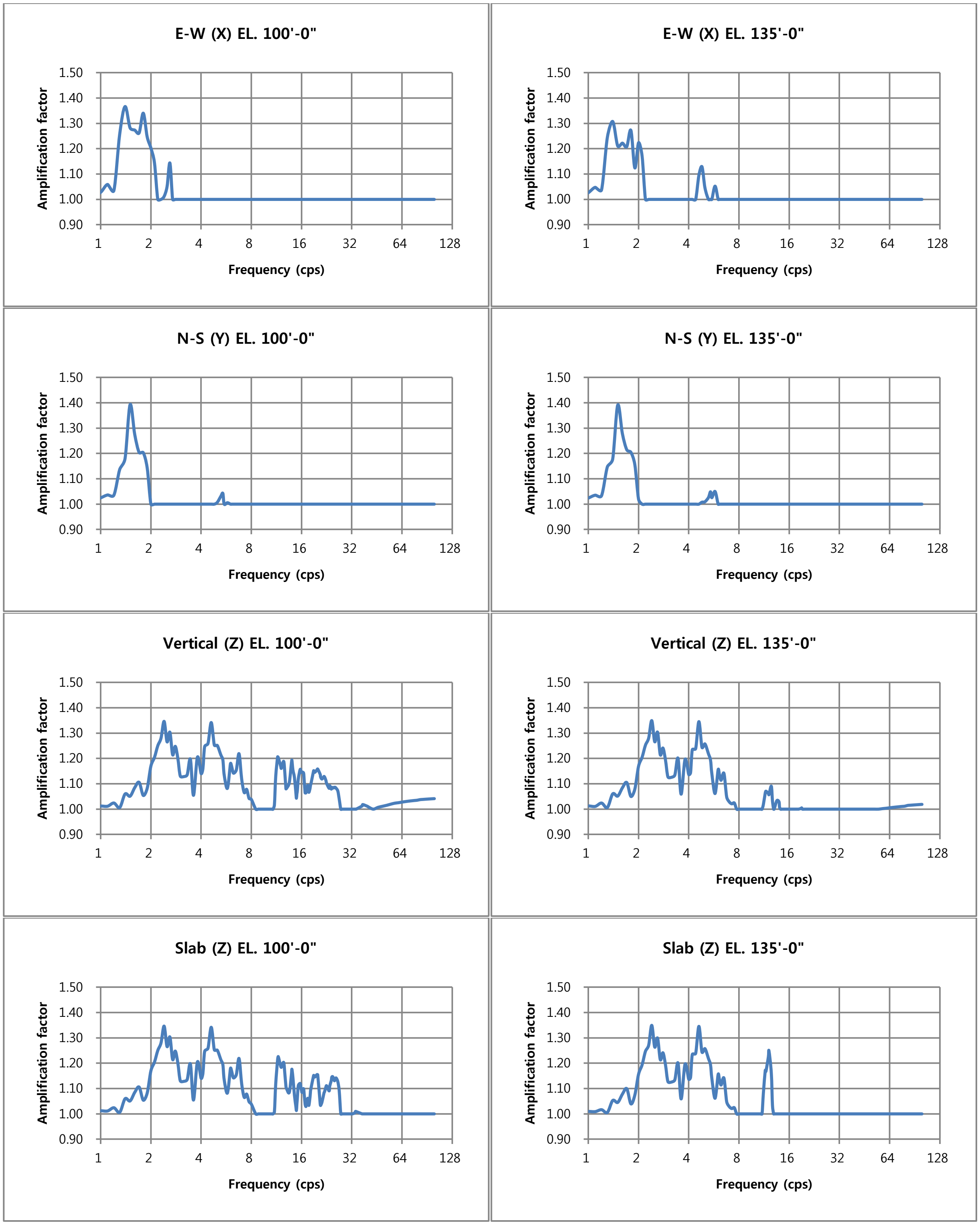

Figure 6-1 Amplification Factor of EDGB Wall & Slab ISRS

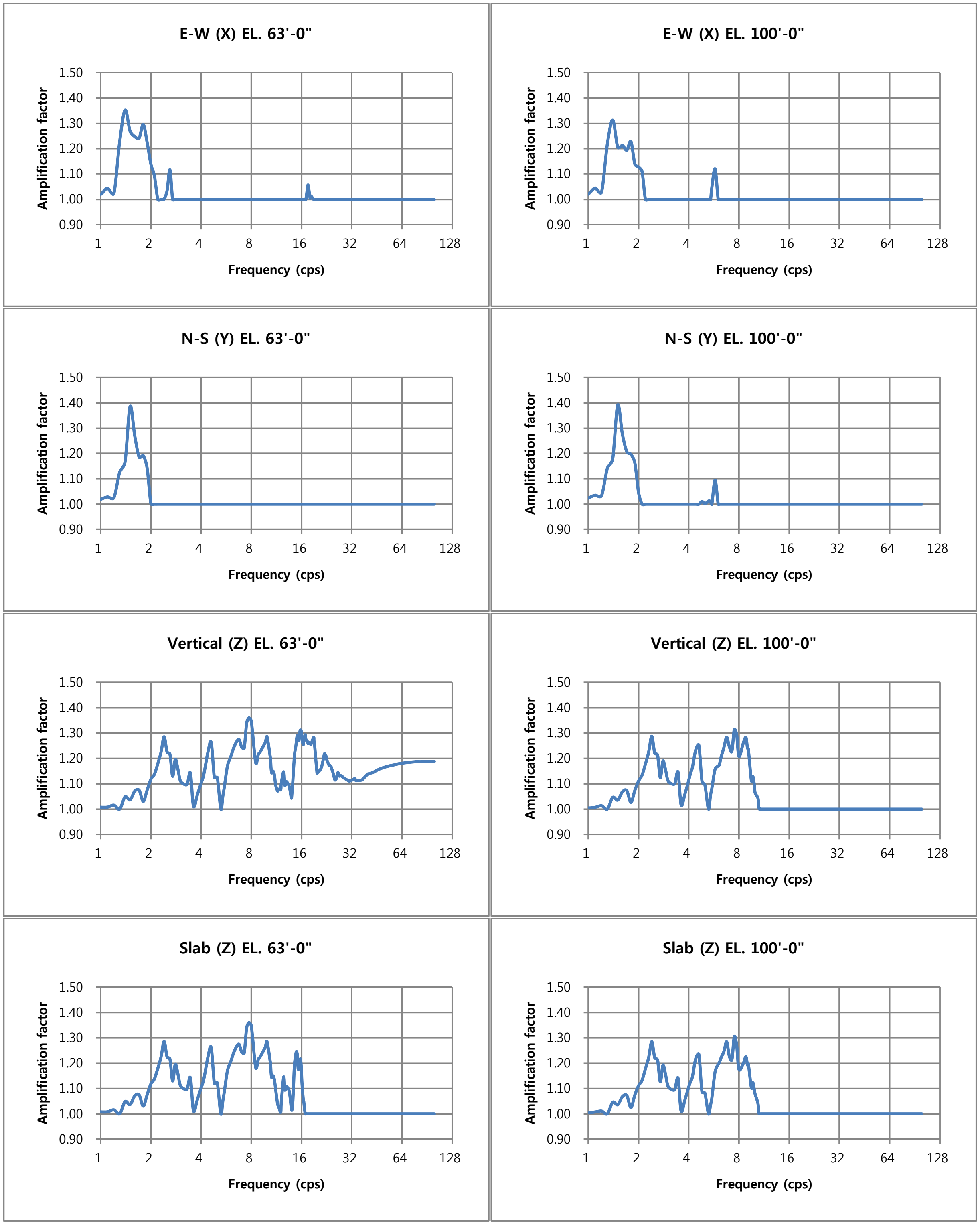

Figure 6-2 Amplification Factor of DFOT Room Wall & Slab ISRS

APPENDIX A

EVALUATION OF SSSI EFFECTS ON NI AND EDGB/DFOT ROOM COMBINED MODEL WITH EMBEDDED FOUNDATION CONFIGURATION

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A.1 INTRODUCTION

In order to evaluate the adequacy of the surface-founded assumption implemented in the SSSI analyses documented in this report, an additional set of SSSI analyses are performed with the embedded foundation configuration for the combined model of the NI and EDGB/DFOT room.

A.2 SSSI ANALYSIS WITH NI AND EDGB/DFOT ROOM COMBINED MODEL

The combined model is developed from both the NI and the EDGB/DFOT room stand-alone models. While developing the combined model, the structure portions of the NI and EDGB/DFOT room stand-alone models are not changed. The backfill and excavated soil layers for the EDGB/DFOT room are adjusted and re-meshed in order to have the same nodal Z coordinates as the NI structure as shown in Figure A-1.

The backfill nodes in the combined NI and EDGB/DFOT room SSSI analysis model are modified to have backfill elements modeled as structural elements rather than the original backfill elements modeled as replacement of the excavated soil elements. The backfill of the stand-alone NI and EDGB/DFOT room SSI analysis model are also modified in the same manner as described above for the backfill of the combined model so that the comparisons of results are on the same basis.

The SSSI analyses performed on the combined model and the SSI analyses performed on the stand-alone models consider two generic site soil profile cases, one soft (S01) and one hard (S09) soil profile case, with both uncracked and cracked concrete stiffness conditions. The ACS SASSI computer program (Ref. A1) is used for the SSSI and SSI analyses. The site model input and input motion time histories for the SSSI analyses are the same as those used for the stand-alone SSI analyses, as described in Section 3. The number of frequencies selected for the SSSI analyses are based on the corresponding stand-alone SSI analyses of the NI structures, as described in Section 4. The frequency points are almost identical except for a few points which are added or modified in order to obtain more accurate response transfer functions.

A.3 ANALYSIS RESULTS AND ASSESSMENT

The comparisons of the ISRS generated from the stand-alone SSI analyses and the corresponding SSSI analyses of the combined models are used to evaluate the SSSI effect on the APR1400 standard plant NI and EDGB/DFOT room structures. The comparisons of the 5%-damped ISRS obtained from both SSSI and SSI analyses at selected key elevations are presented in Figures A-2 ~ A-151. The selected nodal points on each of the designated structure elevations are the same as those documented in Section 5.

For the soft soil case S01, the ISRS peak responses of the SSI analyses are generally equal to or greater than the SSSI responses for most elevations in the NI structures. For the hard soil case S09, the overall SSSI responses are similar to the SSI responses except for some locations. The SSSI responses are slightly greater than the SSI responses for the containment structure at 10~20 Hz frequency range in the EW direction. Also, there are some elevations in the AB, where the SSSI responses in the EW direction are higher than the SSI responses by more than 5%. Based on the comparisons of the ISRS presented, the adjacent smaller and lighter EDGB/DFOT room structure has insignificant effects on the seismic responses of the adjacent much larger and heavier NI structures.

However, NI structures have noticeable effects on the seismic responses of the EDGB/DFOT room for the S01 and S09 soil cases. For soil case S01, the SSSI responses for EDGB/DFOT room are generally greater than the SSI responses in the vertical direction. The maximum increase of approximately 30% in the vertical ISRS for the EDGB/DFOT room is observed for soil case S01. For soil case S09, the SSSI responses are generally greater than the SSI responses for most of the EDGB/DFOT room elevations.

Due to relatively much softer backfill material as compared to the relatively much stiffer in-situ soil/rock material for the hard rock S09 site profile case, the SSSI effects between the NI and EDGB/DFOT room become more significant for S09 than such effects for S01. For the S01 soft soil case, the difference in stiffness of the SFG backfill material and the S01 in-situ soil materials is relatively smaller.

Overall, the comparisons of ISRS between the SSI and SSSI analyses results show that the SSSI effects are relatively very small on the NI structure but are relatively more significant for the EDGB/DFOT room structure. This is consistent with the expectation that the much larger and heavier NI structure should be less affected by SSSI than the smaller and lighter EDGB/DFOT room structure.

As a comparison, the ratios of 5%-damped enveloped ISRS from the SSSI analyses versus the 5%-damped enveloped and ± 15% widened ISRS from the SSI analyses of the EDGB and DFOT room structure are presented in Figure A-152 and Figure A-153, respectively. The ISRS ratios that are less than 1.0 are modified to 1.0 in order to prevent reduction of the design-basis ISRS due to the SSSI effect. The 5%-damped ISRS ratios in Figures A-152 and A-153, as modified, are considered to be the amplification factors applied to amplify the design-basis ISRS of the EDGB and DFOT room for all soil cases to account for the SSSI effects resulting from the adjacent NI structures.

The steps to amplify the ISRS incorporating the newly calculated amplification factors from the embedded foundation condition are as follows:

1. Compare the amplification factors from the SSSI analyses considering the embedded foundation with the amplification factors in Figure 6-1 and Figure 6-2, and choose the larger one at each frequency point.
2. Amplify the enveloped (S01~S09 and cracked/uncracked) ISRS from the SSI analyses multiplying by the amplification factors determined in Step 1.
3. Broaden the ISRS obtained from Step 2 for the final design ISRS of the EDGB/DFOT room.

To address whether changes in design-basis seismic forces are necessary according to the increases in ZPA of the EDGB and DFOT room, seismic equivalent accelerations which are used in the structural analysis are obtained from the SSSI and stand-alone SSI seismic forces at each floor. The seismic equivalent acceleration ratios between SSSI and SSI analyses are summarized in Table A-1. Since the

design margins of the EDGB and DFOT room cover the increased and/or decreased seismic equivalent acceleration ratios, the arrangements of rebar need not be changed due to SSSI effect.

To evaluate the peak demands computed for dynamic soil pressures and pressure distributions on the embedded walls, the maximum lateral soil pressures and their distributions on below-grade exterior walls are first developed.

The lateral pressures are calculated along the east wall of the NI and around all four walls of the DFOT room to determine if any additional coupling acts on the embedded sidewalls of the adjacent structures of the EDGB or DFOT room. For calculation purposes, the east wall of the NI is divided into three portions: the portion within the north and south footprint boundaries of the DFOT room, the portion within the north and south footprint boundaries of the EDGB, and the north portion of the wall which is beyond the north boundary of the EDGB.

The maximum horizontal forces in the relatively stiff springs which connect the below-grade exterior walls to the backfill soil in the SSI and SSSI models are used as the basis for developing the lateral soil pressures. The dynamic lateral soil pressures obtained for each of the walls are developed as follows:

1. The time histories of the spring forces generated from the SSSI and SSI analyses are extracted for each of the contact spring elements connecting the exterior-wall structural nodes to the backfill soil nodes.

2. The absolute value of the co-directional spring forces obtained from the three orthogonal seismic input motion components are combined at each time step.

3. The spring forces obtained from step 2 at each time step for all nodes at the same elevation within the wall section are summed to obtain the total maximum dynamic lateral forces at the respective elevation for the walls or wall sections.

4. The maximum lateral forces normal to the wall at each time step are obtained for each elevation of the walls or wall sections.

5. The maximum lateral forces are divided by the tributary area for each elevation to obtain the lateral soil pressure distribution for respective elevation of the wall or wall section.

Figures A-154 ~ A-167 present the comparisons of lateral pressures generated from the SSSI and SSI analyses for the soil cases S01 and S09. In general, maximum pressures at different elevations along the embedment depth do not occur at the same time step. Hence, some conservatism exists in the maximum lateral soil pressures computed using the procedures described above.

The overall lateral soil pressures computed from the SSSI analyses and SSI analyses are higher than the pressures calculated from the ASCE 4 (Ref. A2) estimate because they take into account the SSI or SSSI effects for the specific structures whereas the ASCE 4 estimates are soil pressures for elastic response of retaining walls. Furthermore, ASCE 4 estimates do not consider the contributions from the three directional seismic inputs.

Due to the much higher in-plane stiffness of the structures at the basemat and floor slab elevations in the direction normal to the embedded walls, the dynamic soil pressures computed from the SSI and SSSI analyses are higher at these elevations than those at the middle span of the walls where the out-of-plane bending stiffness normal to the walls is relatively smaller as compared to the out-of-plane stiffness of the walls at the basemat and floor slab elevations. The higher dynamic soil pressures normal to the walls at the locations of the basemat and floor slabs do not impact the out-of-plane bending design of the walls. The calculated lateral soil pressures are considered in the structural design of the exterior embedded walls of the NI and EDGB/DFOT room structures.

In addition, the maximum relative displacements are calculated from the results of the SSSI analyses and SSI analyses. The calculated displacements are relative to the center point at the top of the basemat of

each respective building. The maximum relative displacements are less than 0.2 ft. for the SSSI analyses and SSI analyses, and the values are similar for both analyses. The calculated maximum relative displacements satisfy the seismic gap requirement between the NI and EDGB/DFOT room structures.

A.4 REFERENCES

A1. ACS SASSI NQA Version 3.0 R2 Including Options A and FS, “An Advanced Computational Software for 3D Dynamic Analysis Including Soil-Structure Interaction,” User Manuals Revision 3, Ghiocel Predictive Technologies, Inc., March 2015.

A2. ASCE 4-98, “Seismic Analysis of Safety-Related Nuclear Structures and Commentary,” American Society of Civil Engineers, 2000.

Table A-1

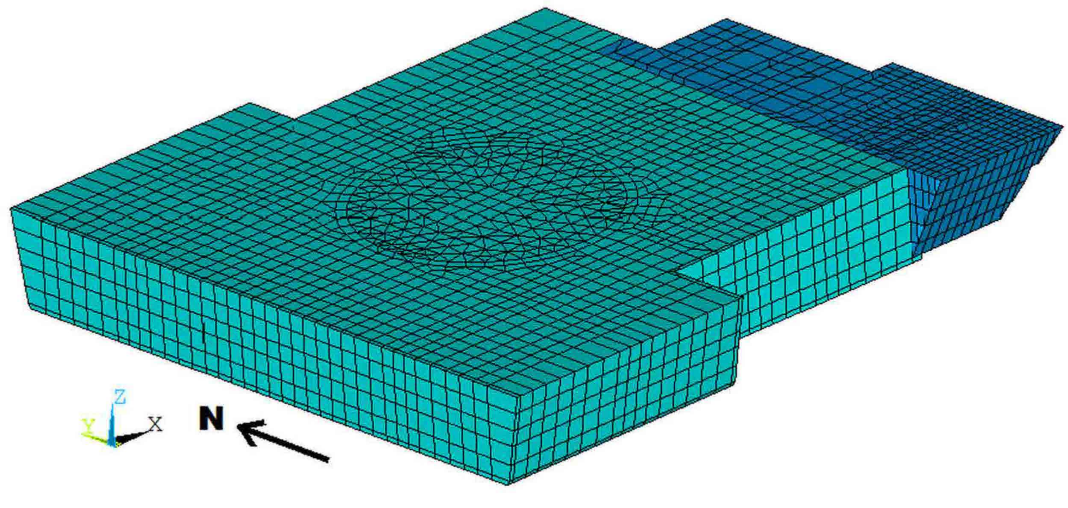
Seismic Equivalent Acceleration Ratios of EDGB and DFOT Room

EDGB

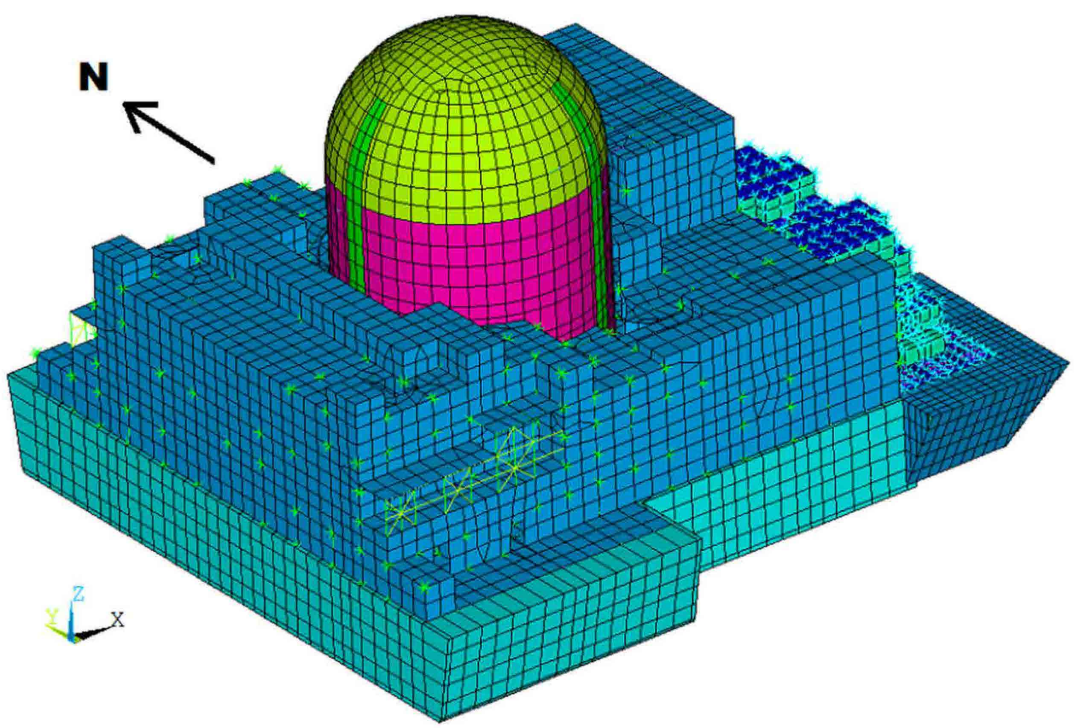
Slab Elevation	SSSI / SSI		
	E-W	N-S	Vertical
100′-0″	1.10	0.93	1.03
135′-0″	0.99	0.93	1.00

DFOT Room

Slab Elevation	SSSI / SSI		
	E-W	N-S	Vertical
63′-0″	0.92	1.05	0.99
100′-0″	0.97	0.95	1.02



(a) Excavated Soil Volume



(b) NI Structures and EDGB/DFOT Room with Excavated Soil Volume

Figure A-1 NI and EDGB/DFOT Room Combined Model

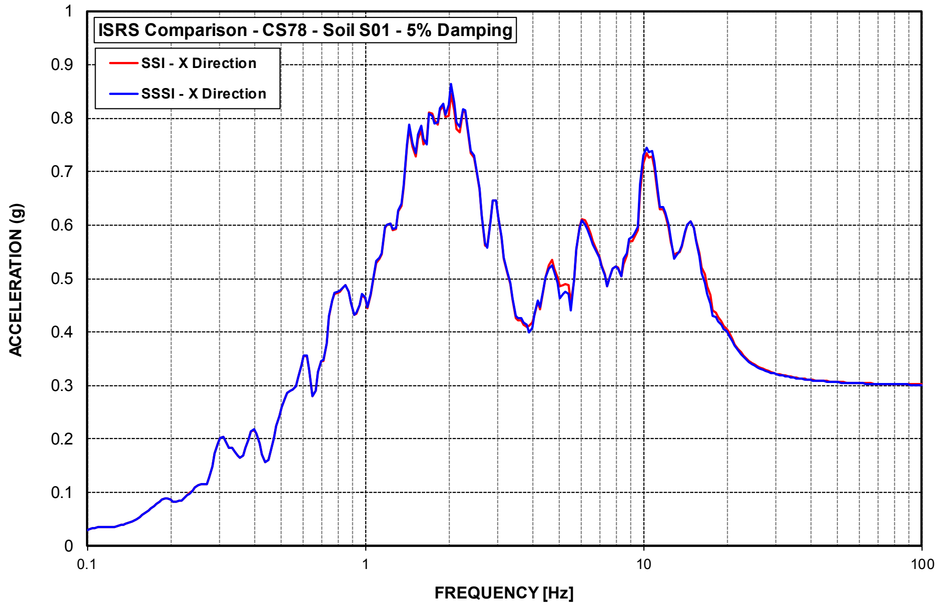


Figure A-2 ISRS – Containment Shell (CS78) at El. 78' – S01 – EW Direction

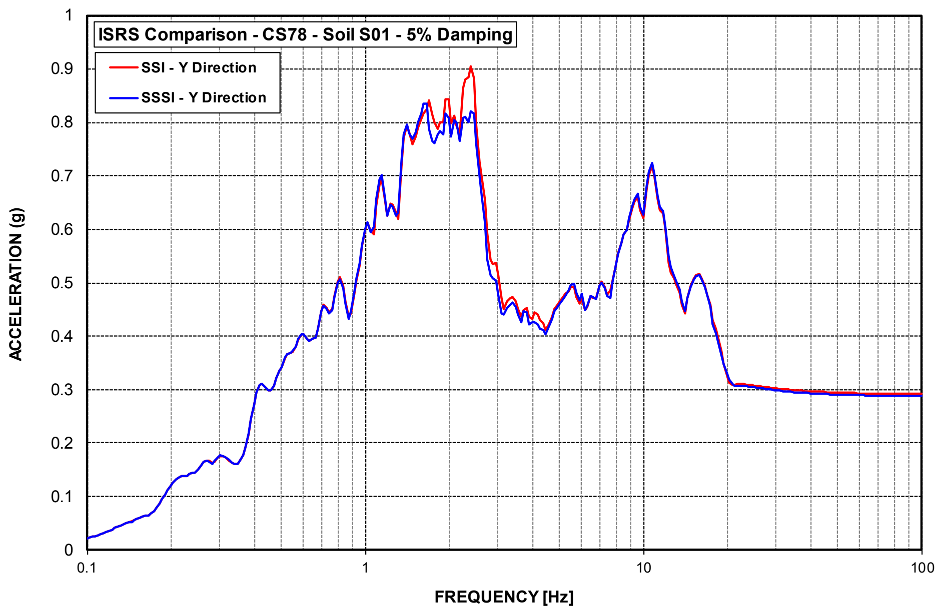


Figure A-3 ISRS – Containment Shell (CS78) at El. 78' – S01 – NS Direction

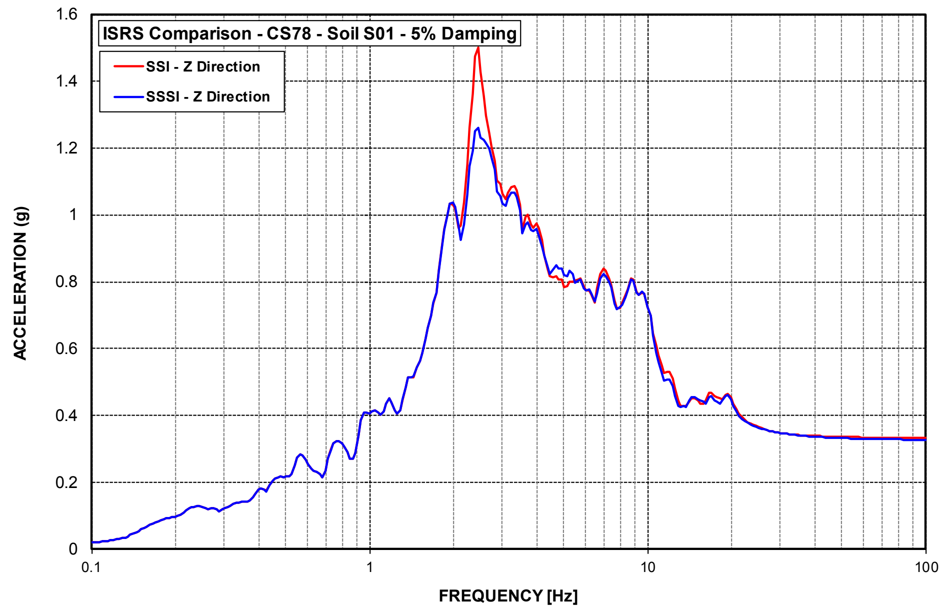


Figure A-4 ISRS – Containment Shell (CS78) at El. 78' – S01 – Vertical Direction

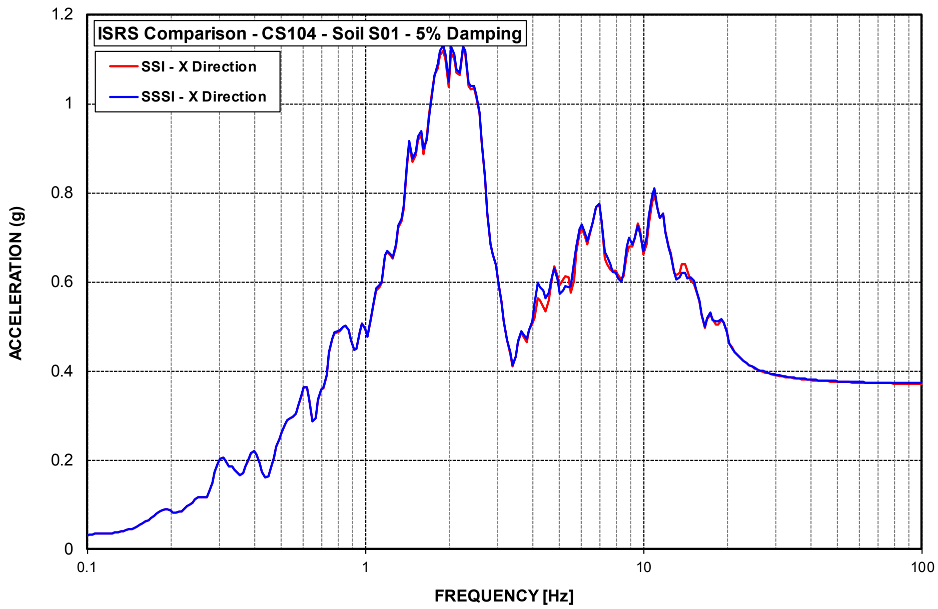


Figure A-5 ISRS – Containment Shell (CS104) at El. 103.75' – S01 – EW Direction

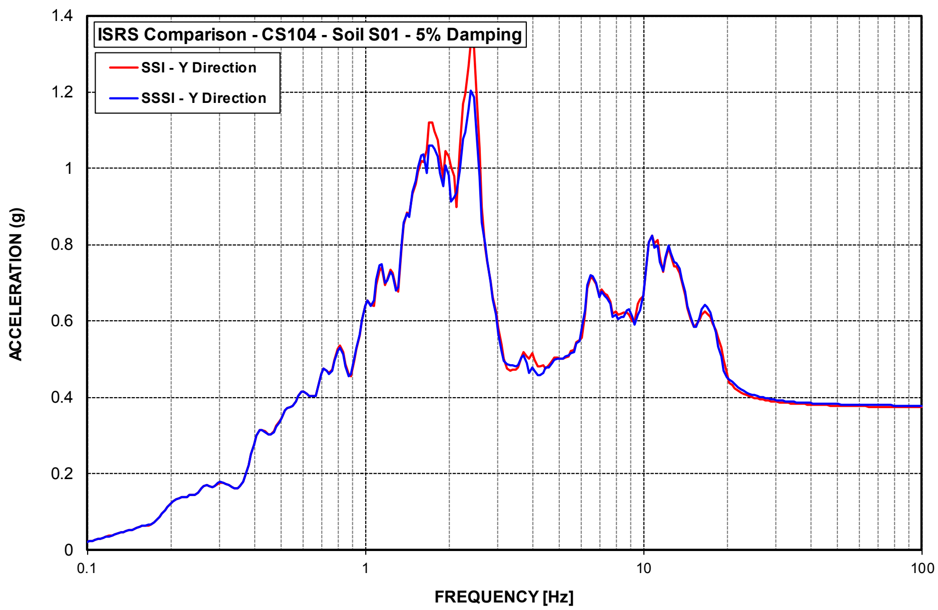


Figure A-6 ISRS – Containment Shell (CS104) at El. 103.75' – S01 – NS Direction

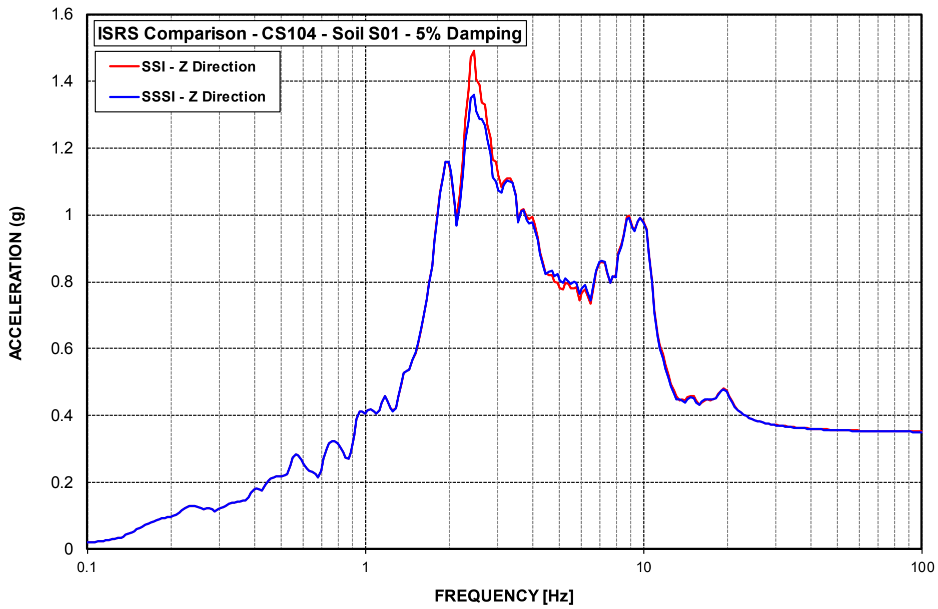


Figure A-7 ISRS – Containment Shell (CS104) at El. 103.75' – S01 – Vertical Direction

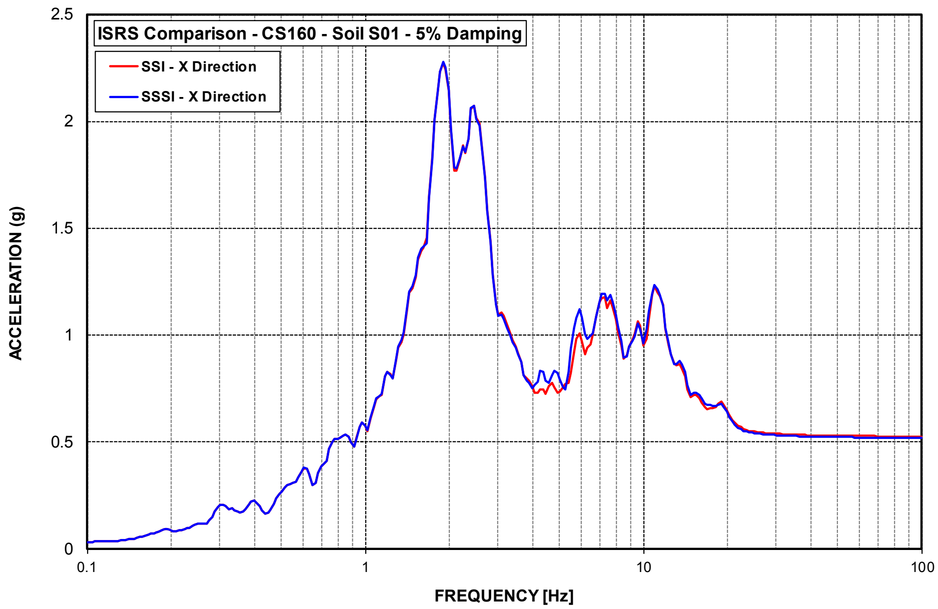


Figure A-8 ISRS – Containment Shell (CS160) at El. 159.75' – S01 – EW Direction

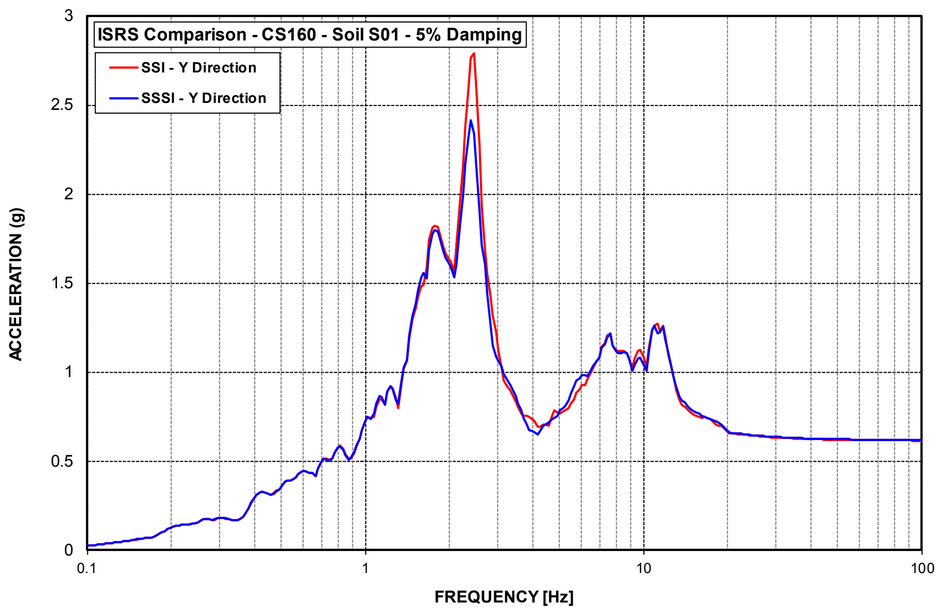


Figure A-9 ISRS – Containment Shell (CS160) at El. 159.75' – S01 – NS Direction

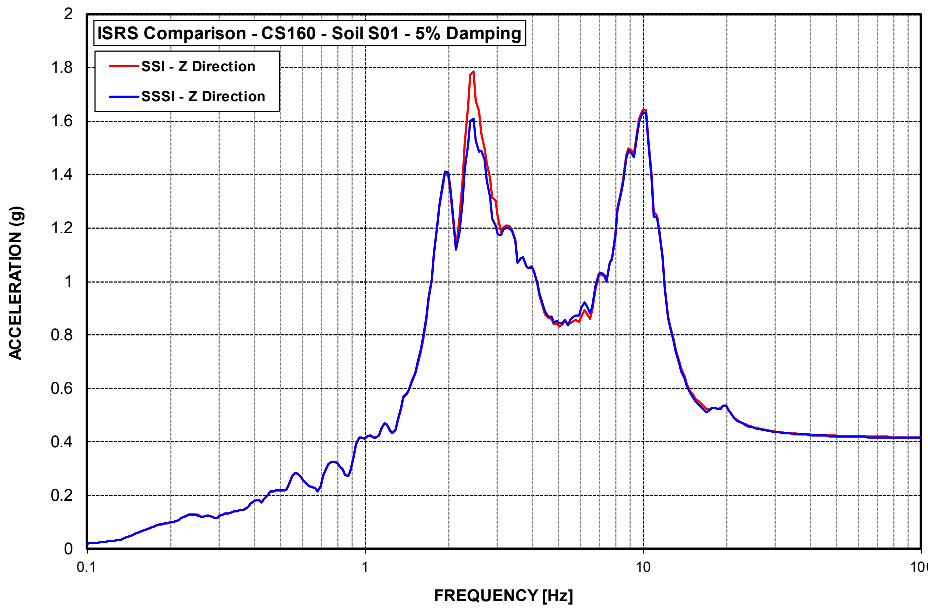


Figure A-10 ISRS – Containment Shell (CS160) at El. 159.75' – S01 – Vertical Direction

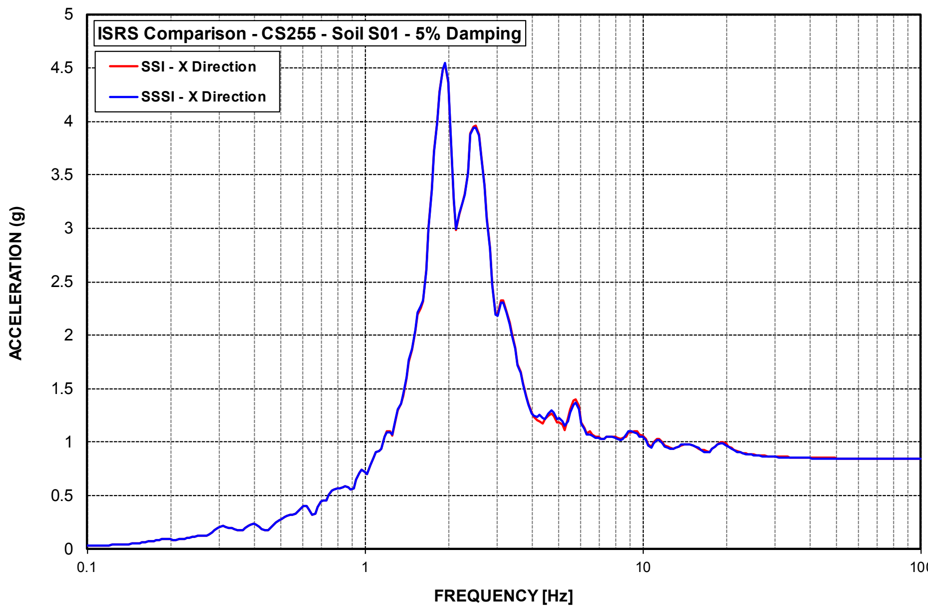


Figure A-11 ISRS – Containment Shell (CS255) at El. 254.5’ – S01 – EW Direction

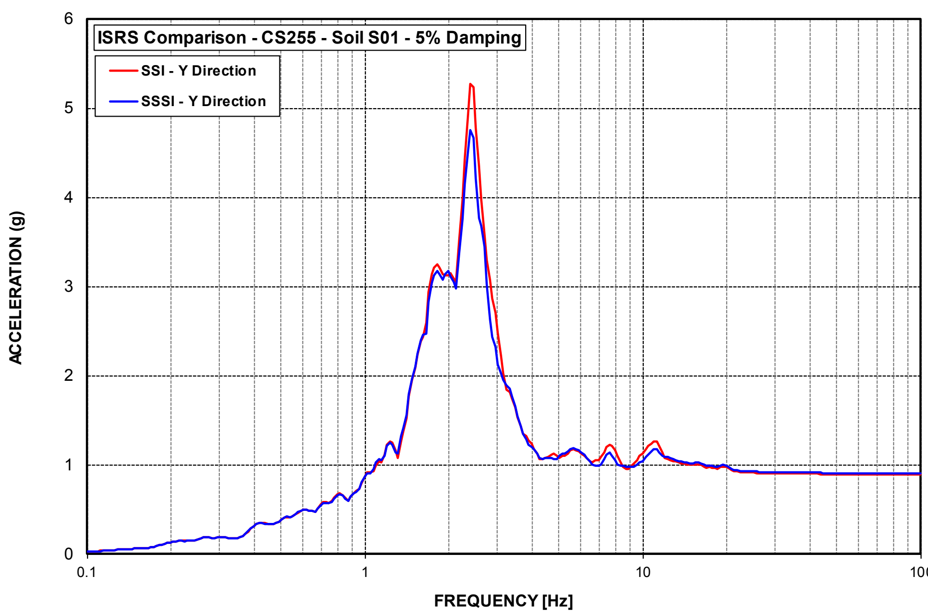


Figure A-12 ISRS – Containment Shell (CS255) at El. 254.5’ – S01 – NS Direction

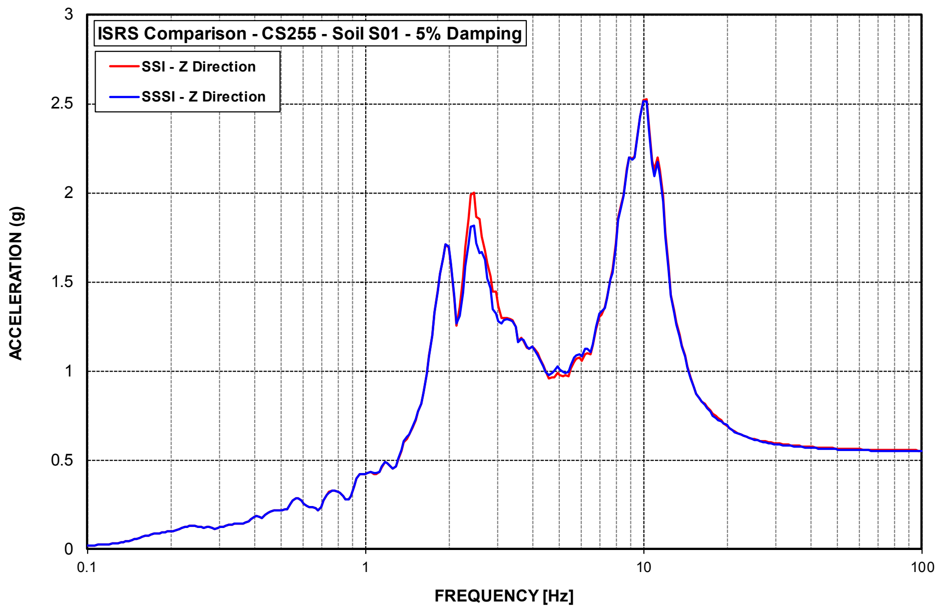


Figure A-13 ISRS – Containment Shell (CS255) at El. 254.5’ – S01 – Vertical Direction

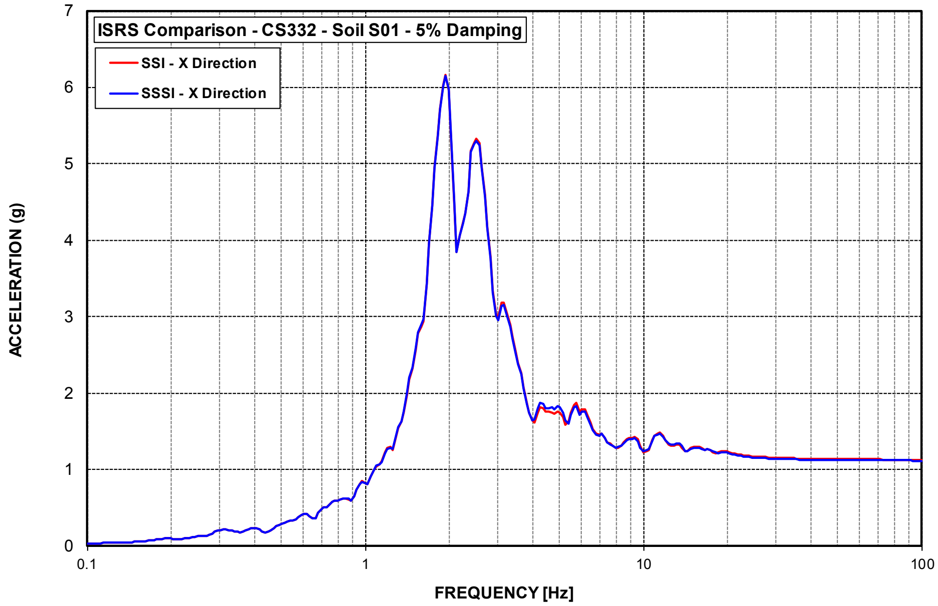


Figure A-14 ISRS – Containment Shell (CS332) at El. 331.75’ – S01 – EW Direction

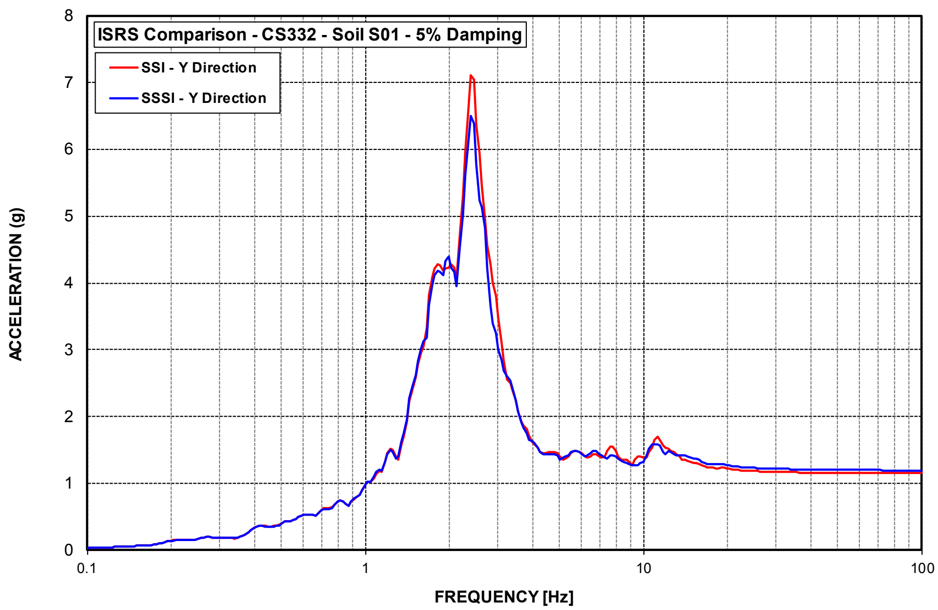


Figure A-15 ISRS – Containment Shell (CS332) at El. 331.75’ – S01 – NS Direction

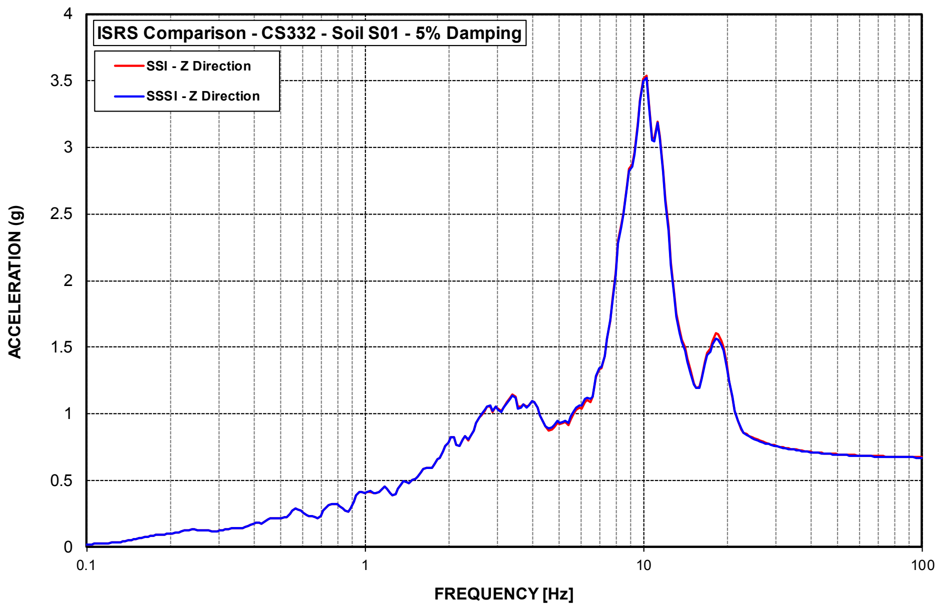


Figure A-16 ISRS – Containment Shell (CS332) at El. 331.75’ – S01 – Vertical Direction

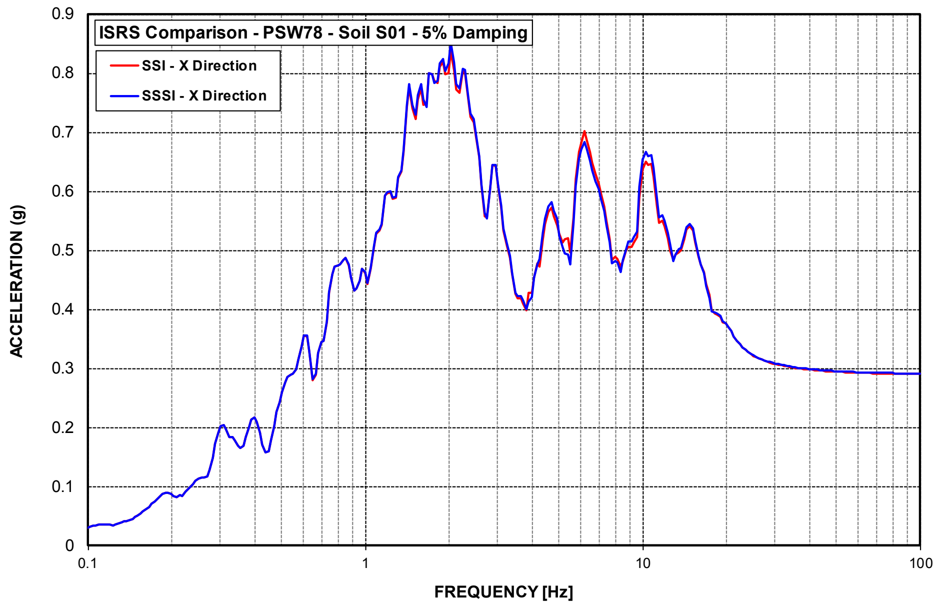


Figure A-17 ISRS – Primary Shield Wall (PSW78) at El. 78' – S01 – EW Direction

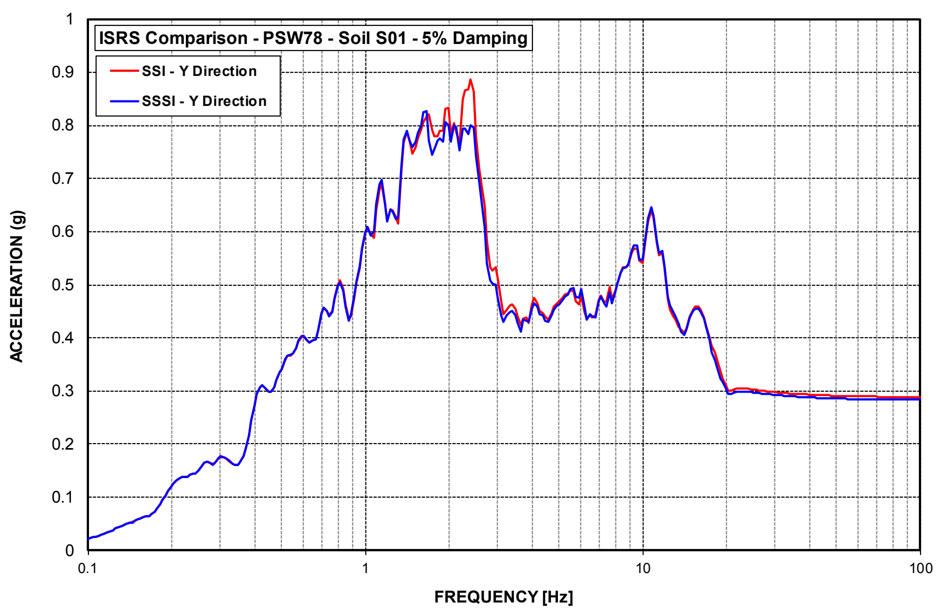


Figure A-18 ISRS – Primary Shield Wall (PSW78) at El. 78' – S01 – NS Direction

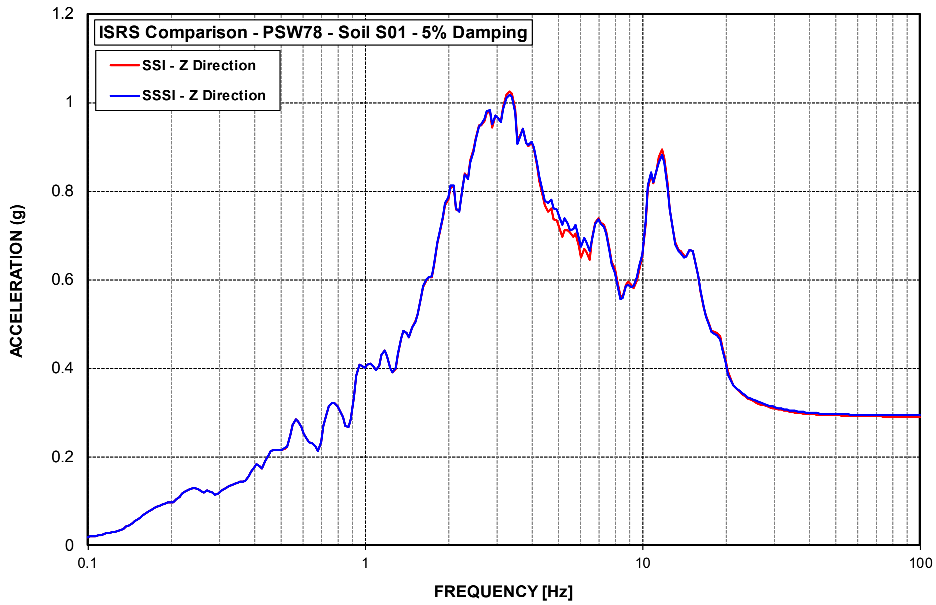


Figure A-19 ISRS – Primary Shield Wall (PSW78) at El. 78' – S01 – Vertical Direction

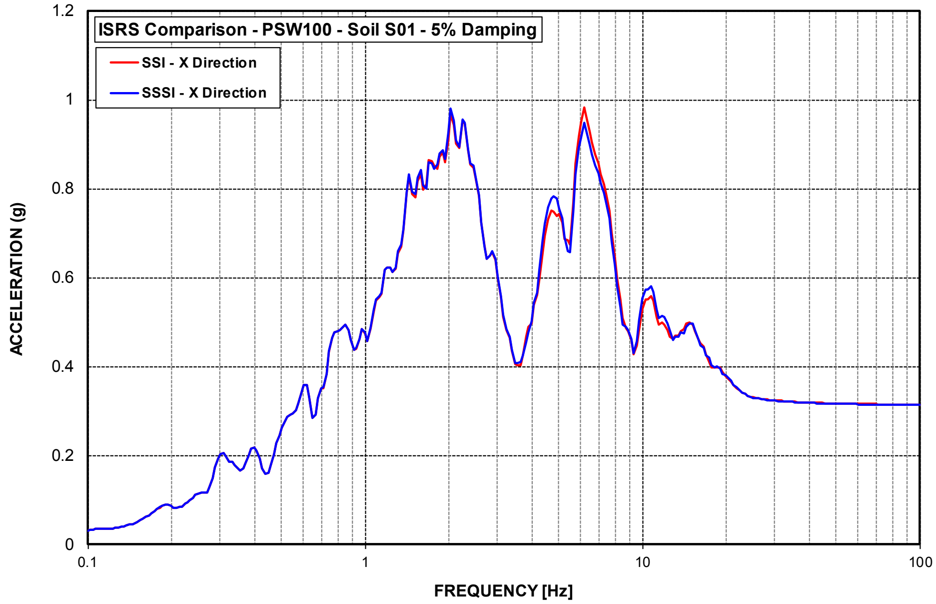


Figure A-20 ISRS – Primary Shield Wall (PSW100) at El. 100' – S01 – EW Direction

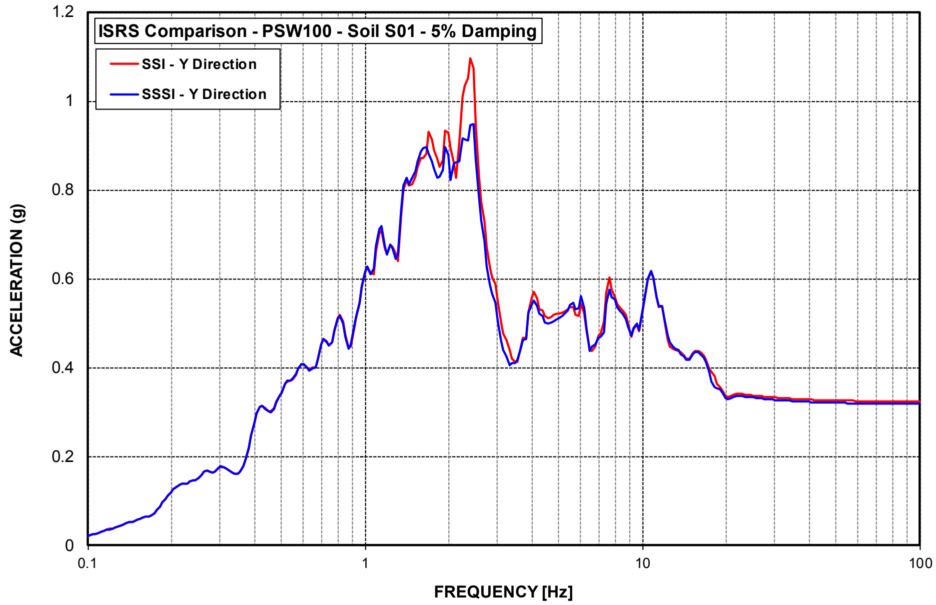


Figure A-21 ISRS – Primary Shield Wall (PSW100) at El. 100' – S01 – NS Direction

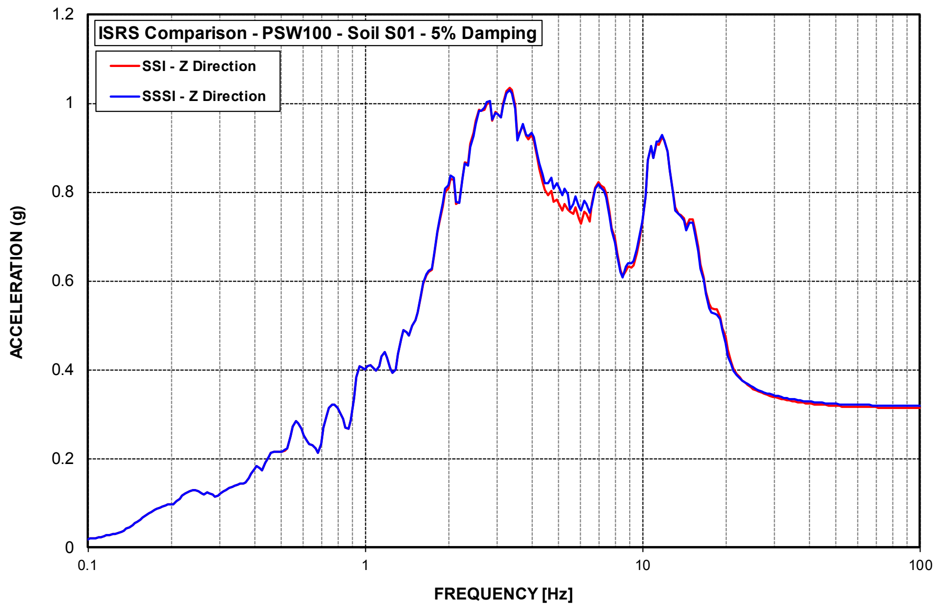


Figure A-22 ISRS – Primary Shield Wall (PSW100) at El. 100’ – S01 – Vertical Direction

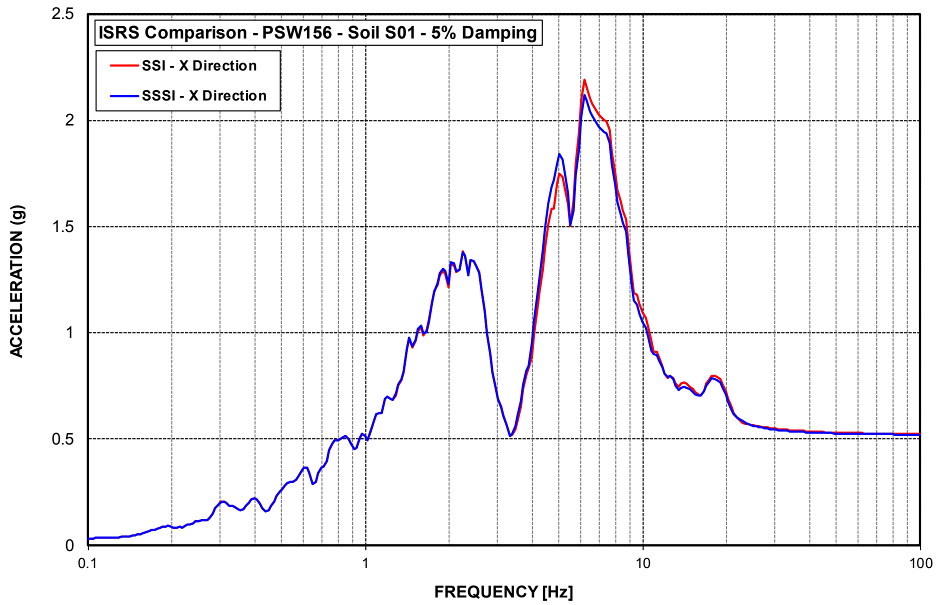


Figure A-23 ISRS – Primary Shield Wall (PSW156) at El. 156’ – S01 – EW Direction

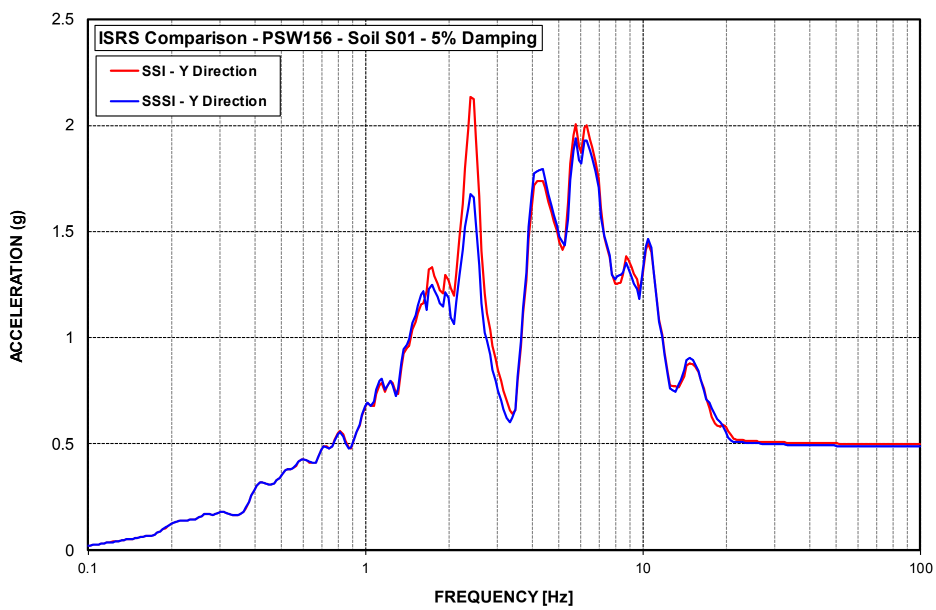


Figure A-24 ISRS – Primary Shield Wall (PSW156) at El. 156’ – S01 – NS Direction

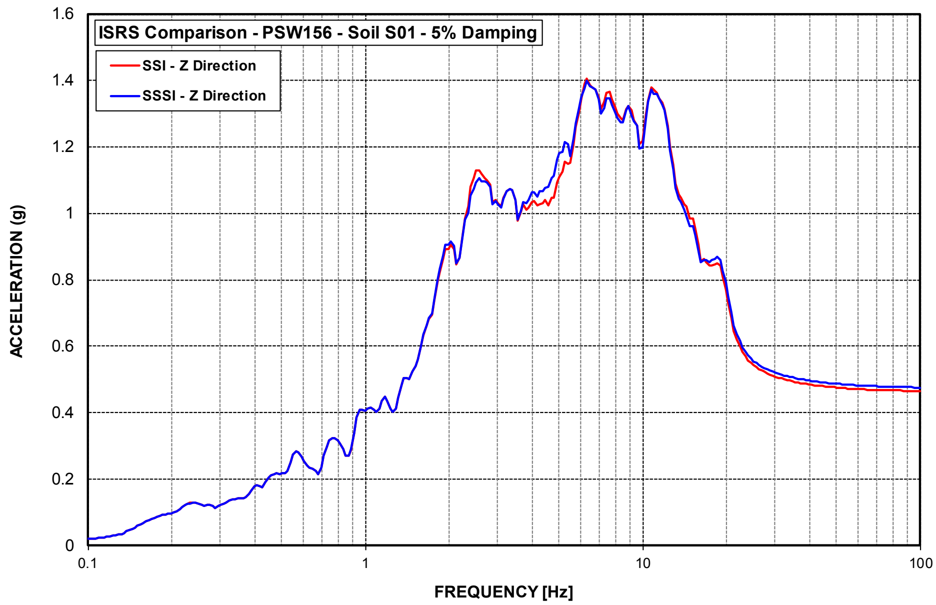


Figure A-25 ISRS – Primary Shield Wall (PSW156) at El. 156' – S01 – Vertical Direction

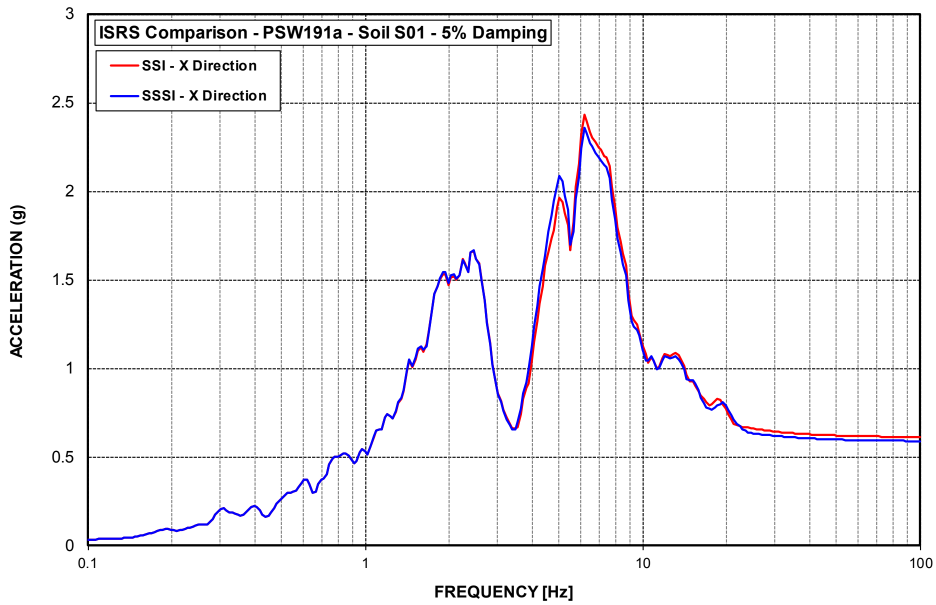


Figure A-26 ISRS – Primary Shield Wall (PSW191a) at El. 191' – S01 – EW Direction

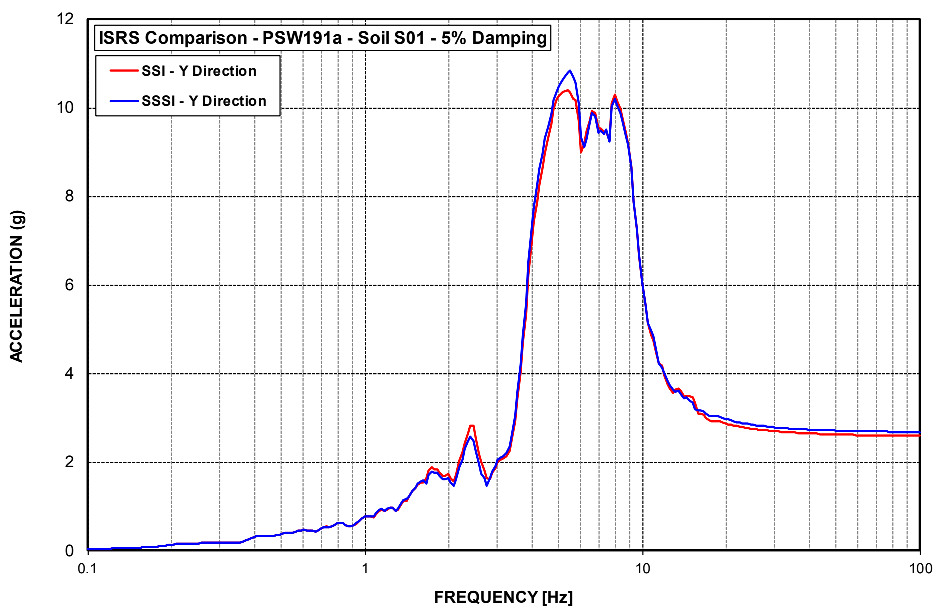


Figure A-27 ISRS – Primary Shield Wall (PSW191a) at El. 191' – S01 – NS Direction

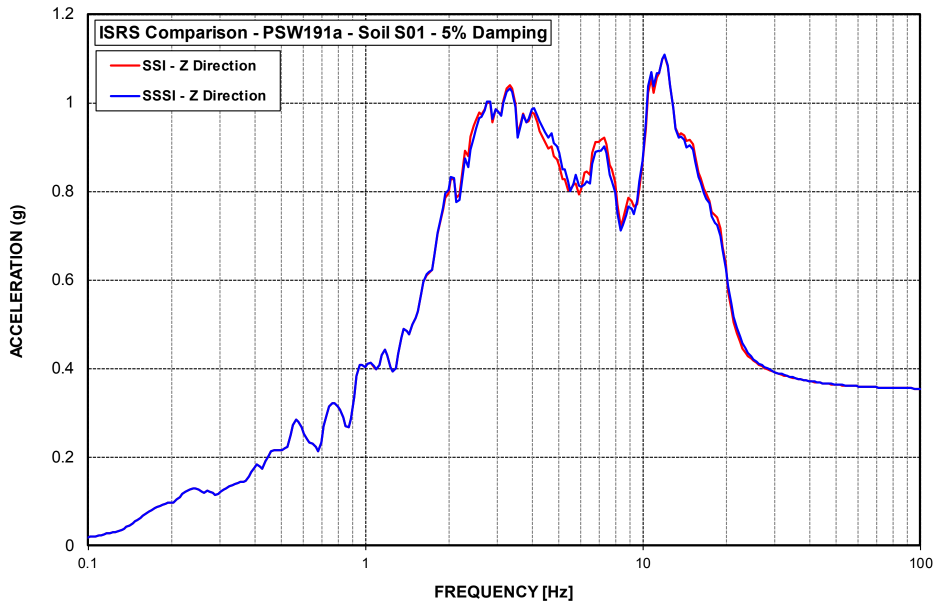


Figure A-28 ISRS – Primary Shield Wall (PSW191a) at El. 191’ – S01 – Vertical Direction

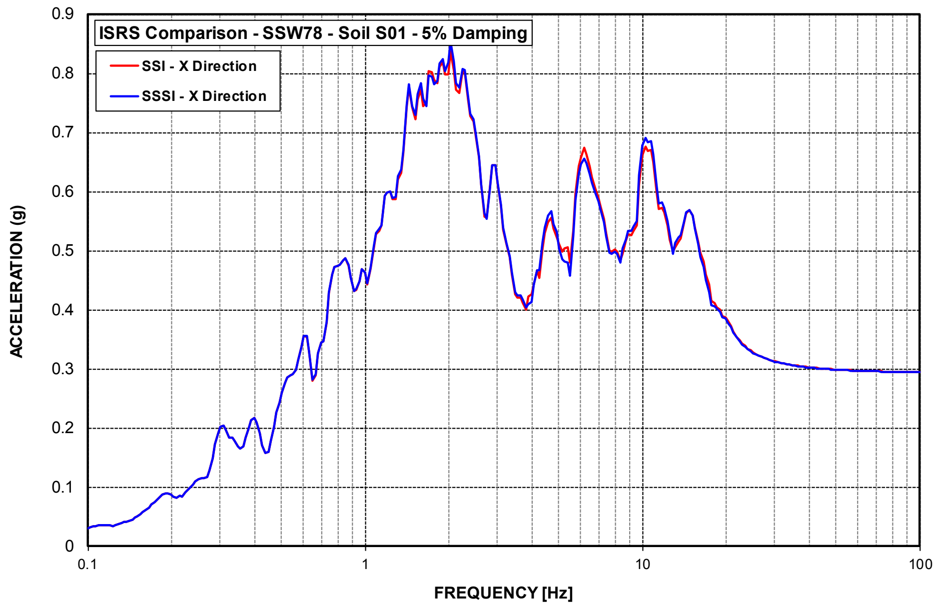


Figure A-29 ISRS – Secondary Shield Wall (SSW78) at El. 78' – S01 – EW Direction

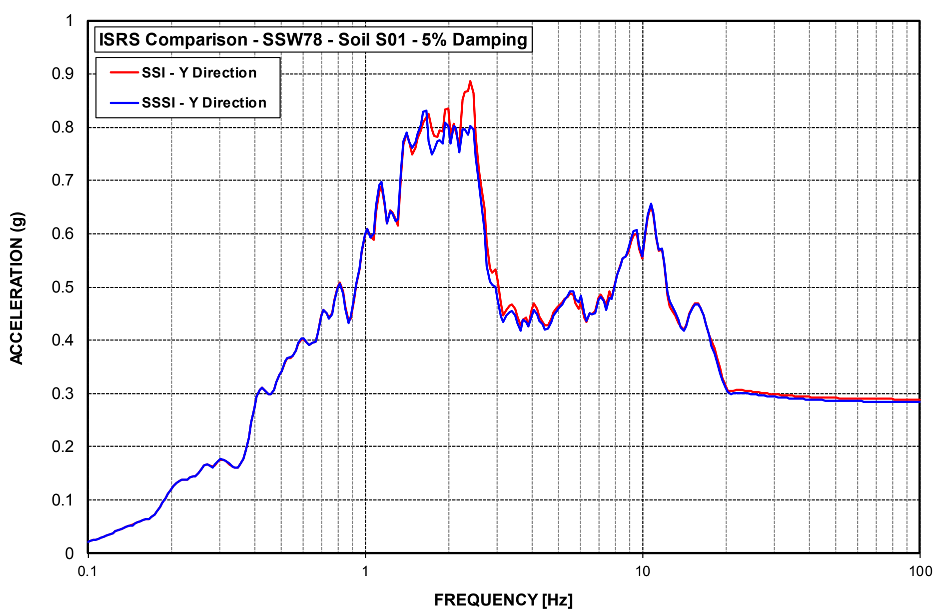


Figure A-30 ISRS – Secondary Shield Wall (SSW78) at El. 78' – S01 – NS Direction

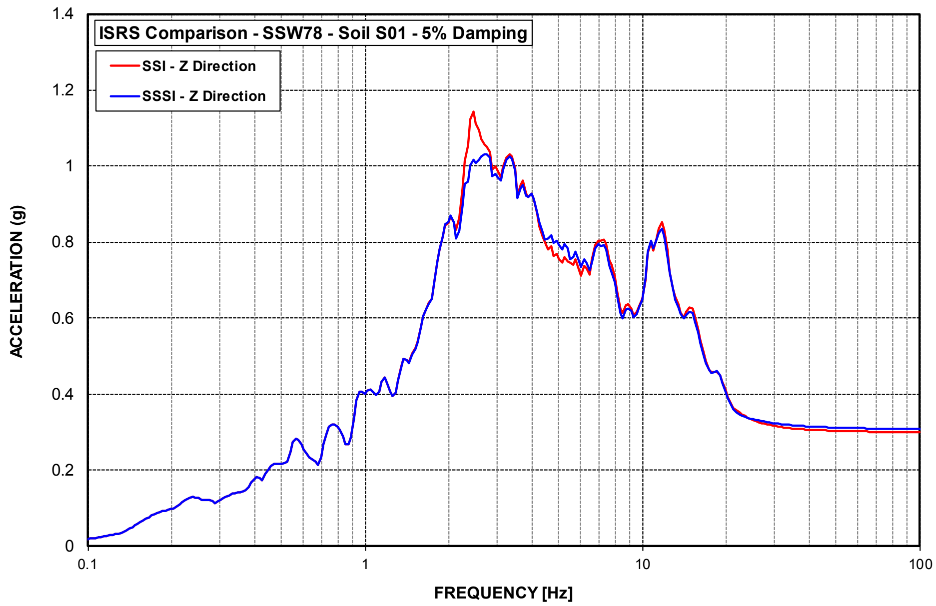


Figure A-31 ISRS – Secondary Shield Wall (SSW78) at El. 78' – S01 – Vertical Direction

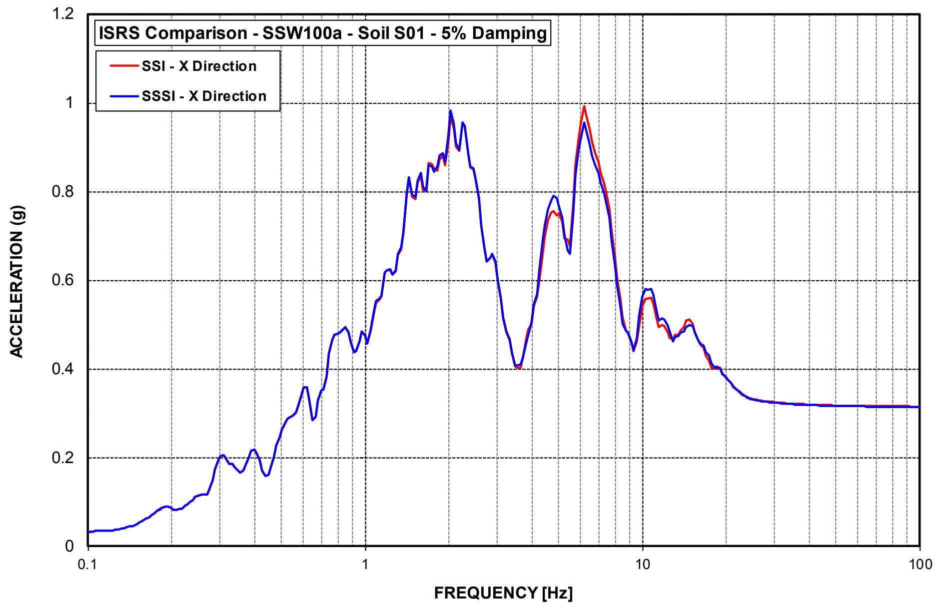


Figure A-32 ISRS – Secondary Shield Wall (SSW100a) at El. 100' – S01 – EW Direction

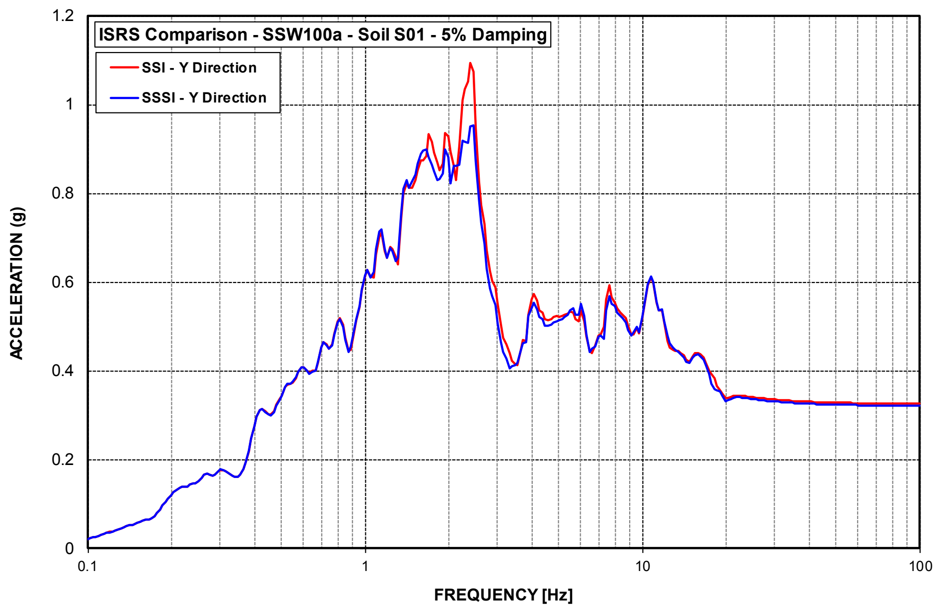


Figure A-33 ISRS – Secondary Shield Wall (SSW100a) at El. 100' – S01 – NS Direction

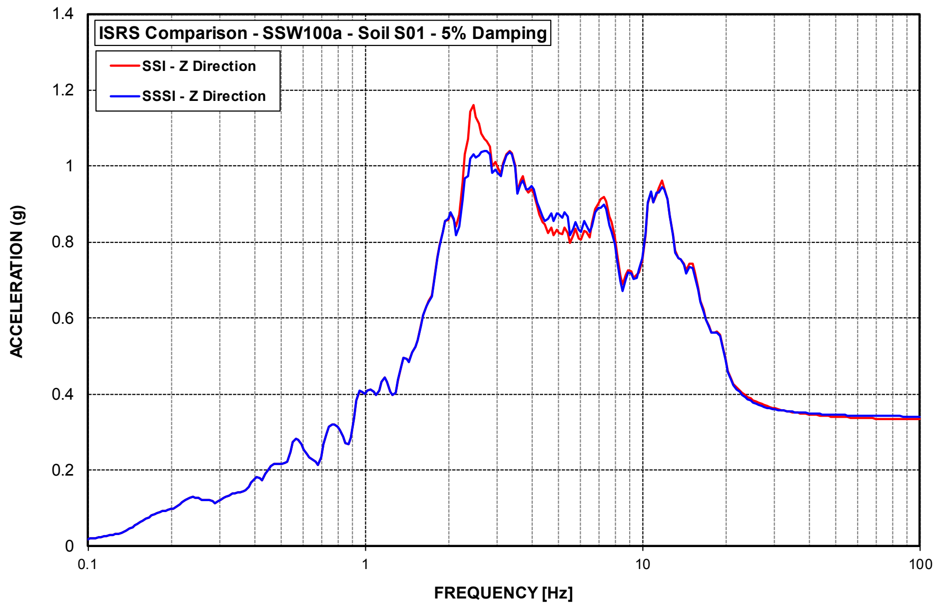


Figure A-34 ISRS – Secondary Shield Wall (SSW100a) at El. 100’ – S01 – Vertical Direction

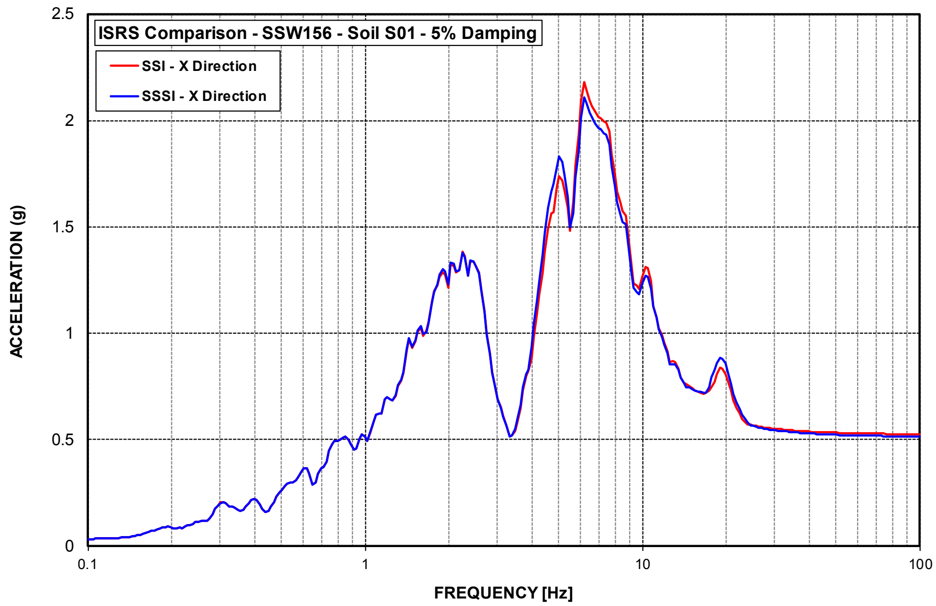


Figure A-35 ISRS – Secondary Shield Wall (SSW156) at El. 156' – S01 – EW Direction

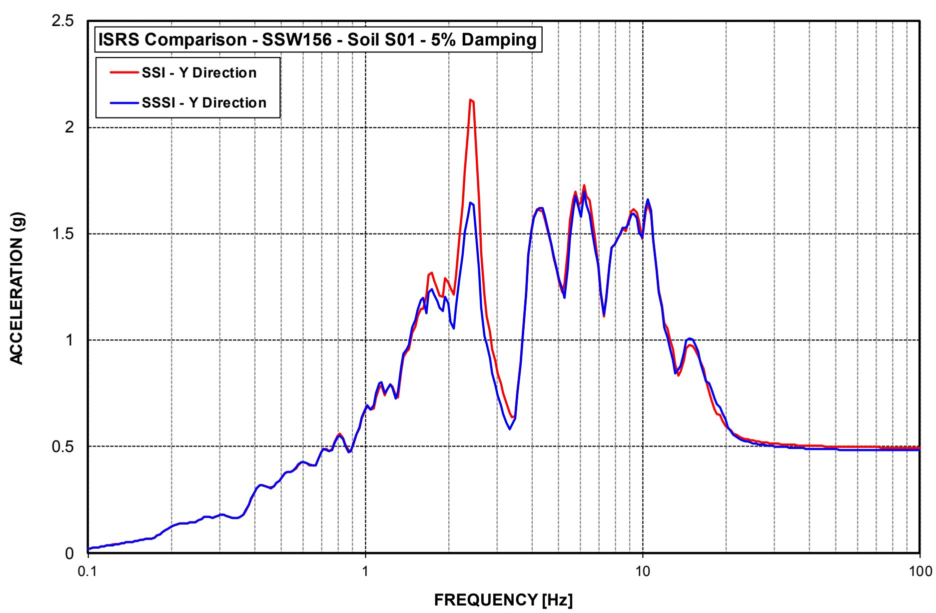


Figure A-36 ISRS – Secondary Shield Wall (SSW156) at El. 156' – S01 – NS Direction

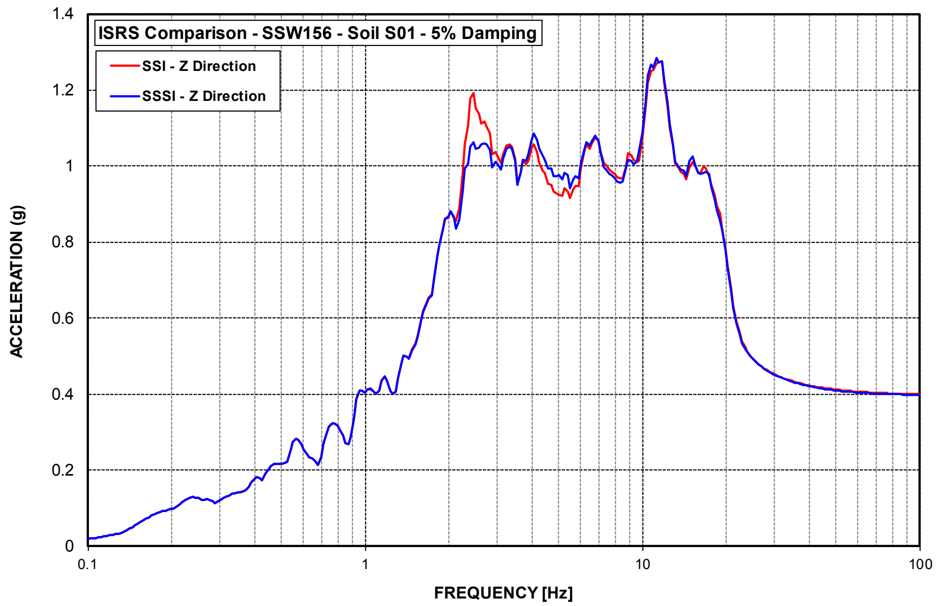


Figure A-37 ISRS – Secondary Shield Wall (SSW156) at El. 156' – S01 – Vertical Direction

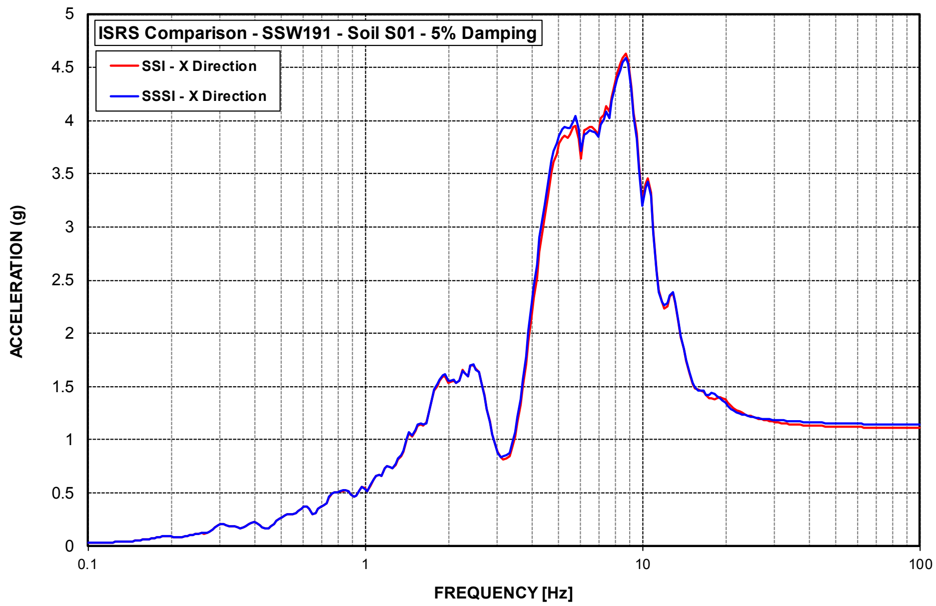


Figure A-38 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S01 – EW Direction

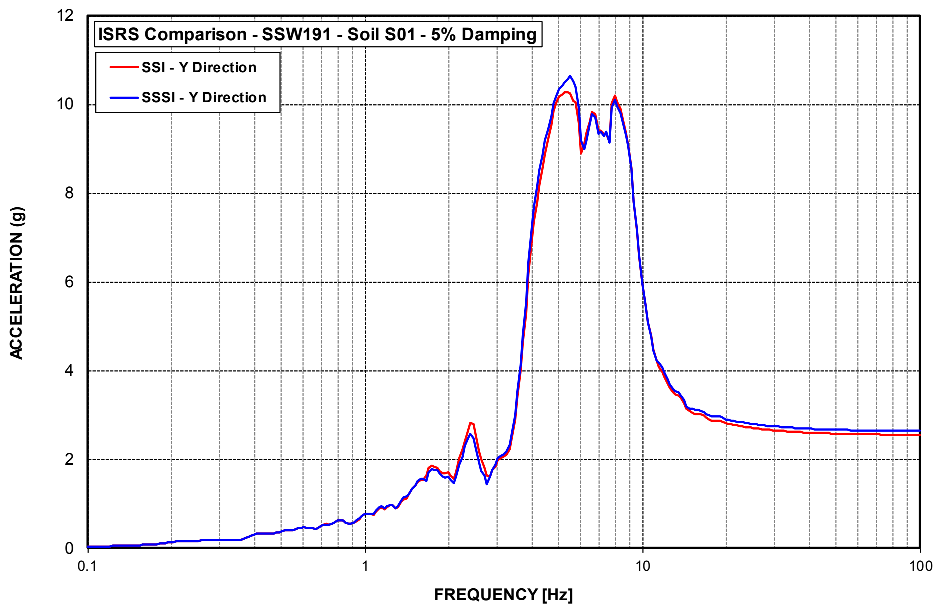


Figure A-39 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S01 – NS Direction

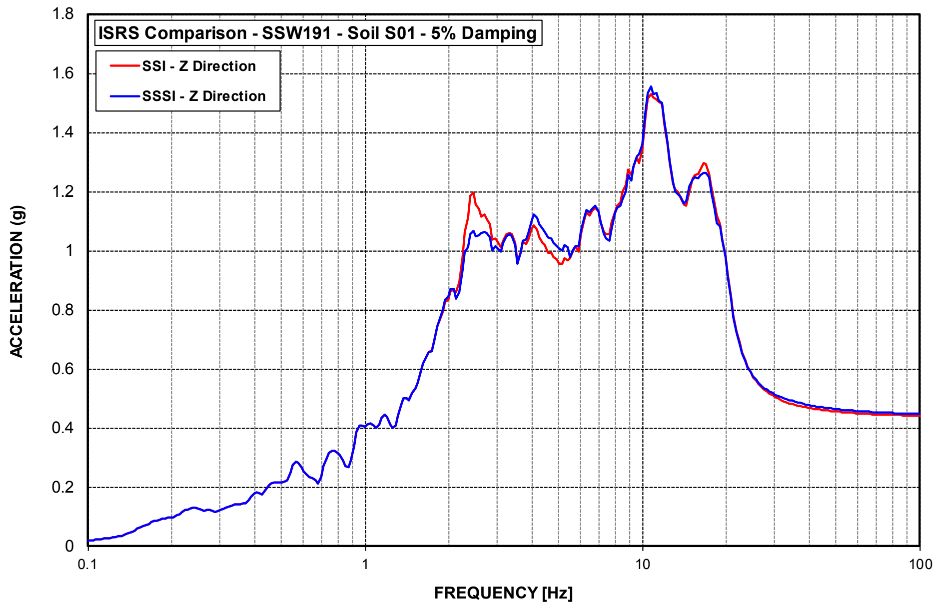


Figure A-40 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S01 – Vertical Direction

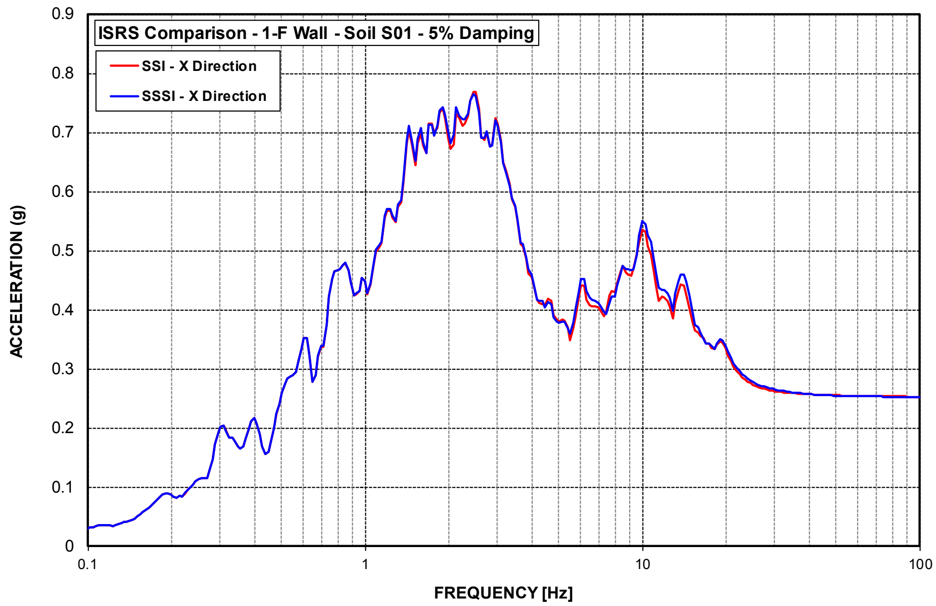


Figure A-41 ISRS – AB Shear Walls (1-F) at El. 55' – S01 – EW Direction

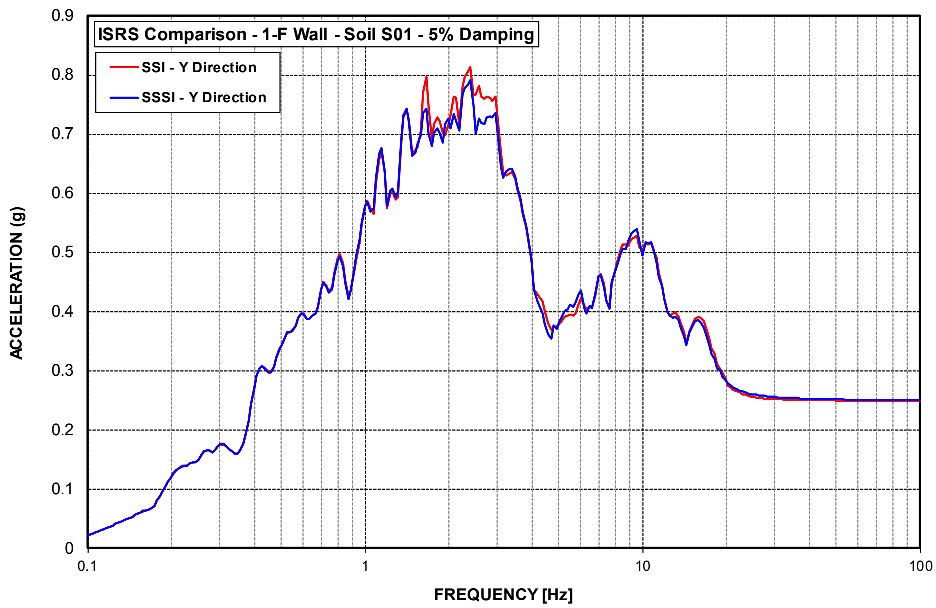


Figure A-42 ISRS – AB Shear Walls (1-F) at El. 55' – S01 – NS Direction

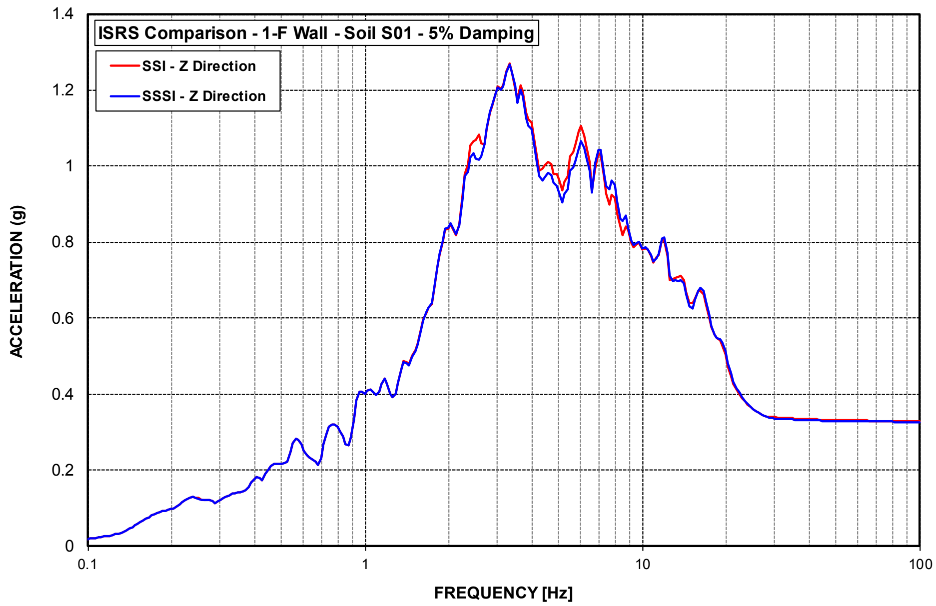


Figure A-43 ISRS – AB Shear Walls (1-F) at El. 55’ – S01 – Vertical Direction

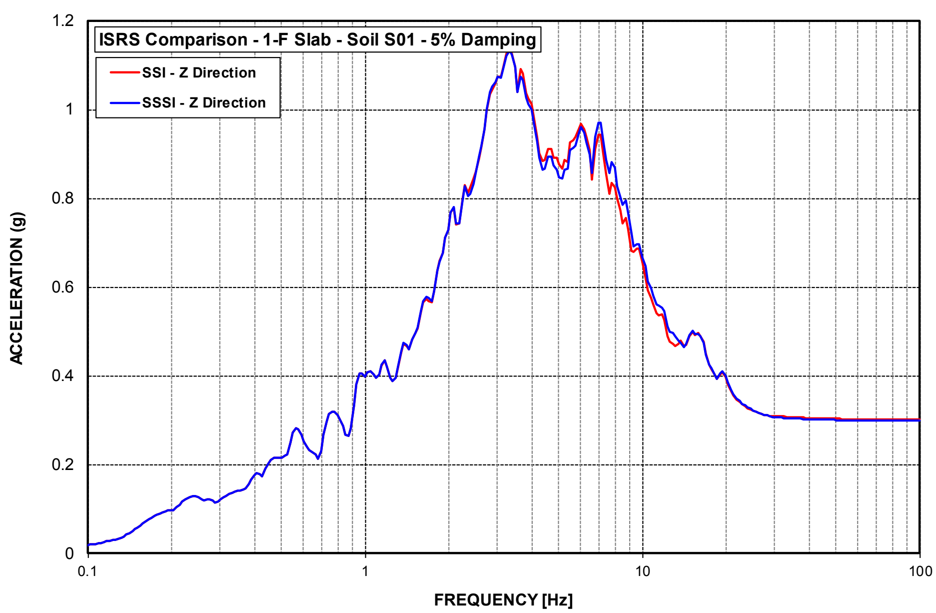


Figure A-44 ISRS – AB Floor Slabs (1-F) at El. 55’ – S01 – Vertical Direction

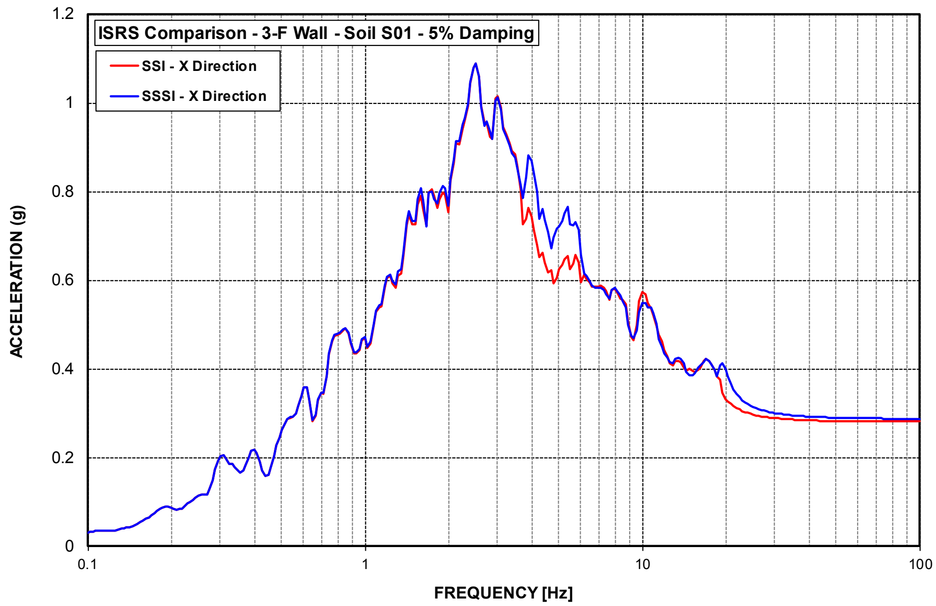


Figure A-45 ISRS – AB Shear Walls (3-F) at El. 100' – S01 – EW Direction

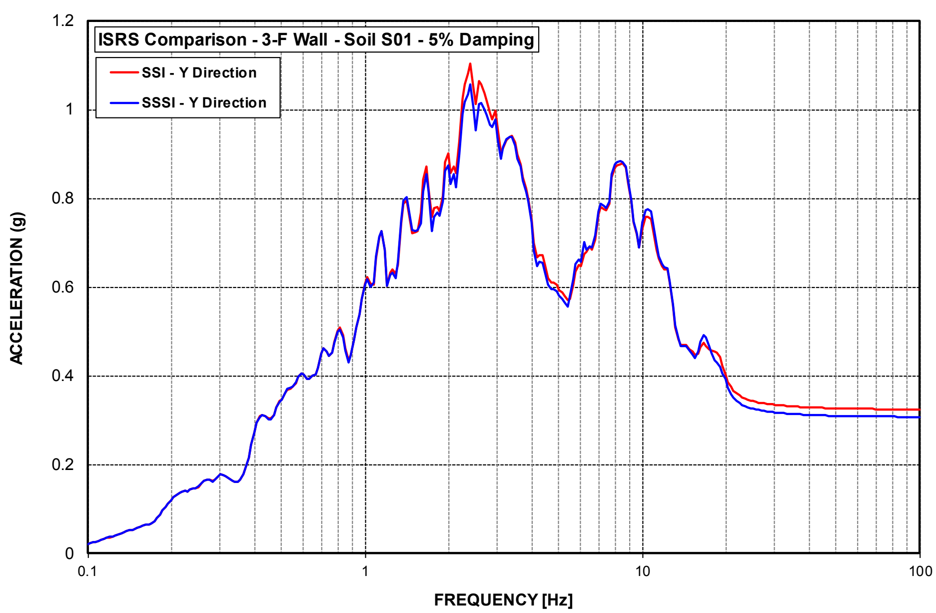


Figure A-46 ISRS – AB Shear Walls (3-F) at El. 100' – S01 – NS Direction

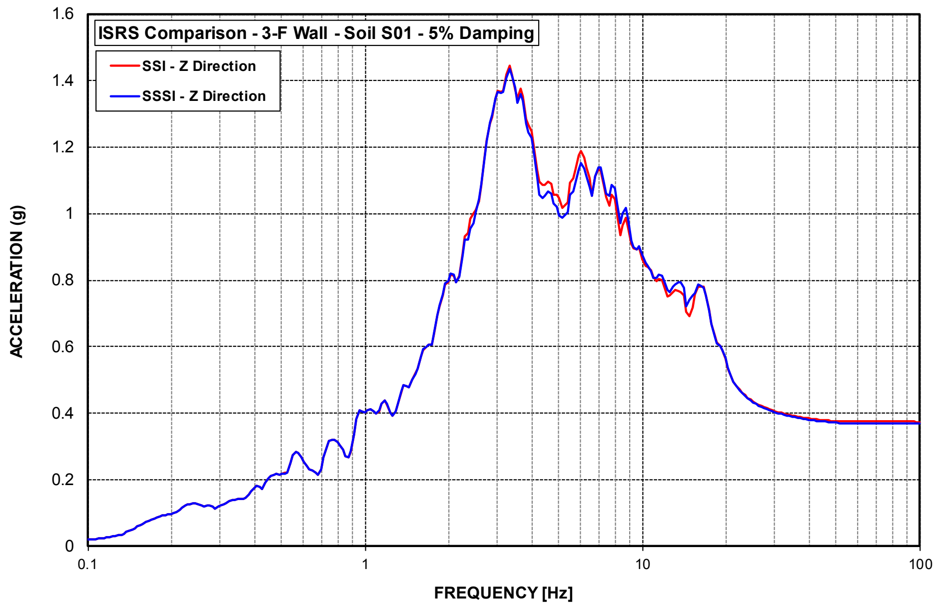


Figure A-47 ISRS – AB Shear Walls (3-F) at El. 100’ – S01 – Vertical Direction

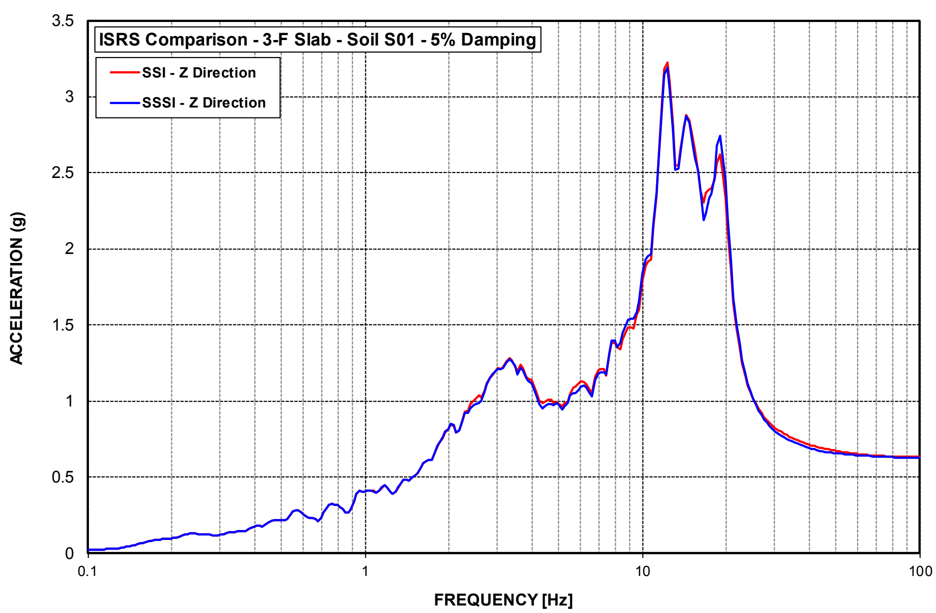


Figure A-48 ISRS – AB Floor Slabs (3-F) at El. 100’ – S01 – Vertical Direction

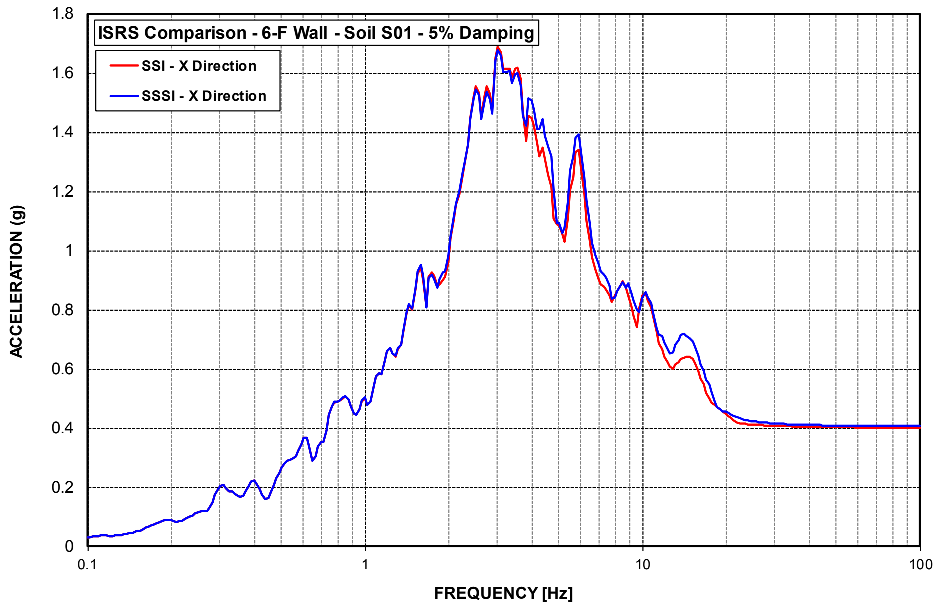


Figure A-49 ISRS – AB Shear Walls (6-F) at El. 156’ – S01 – EW Direction

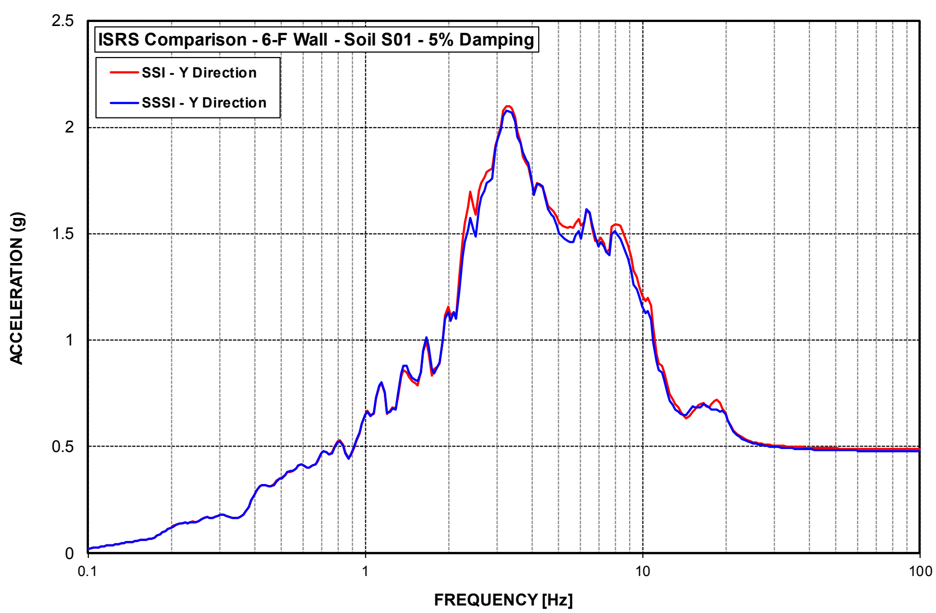


Figure A-50 ISRS – AB Shear Walls (6-F) at El. 156’ – S01 – NS Direction

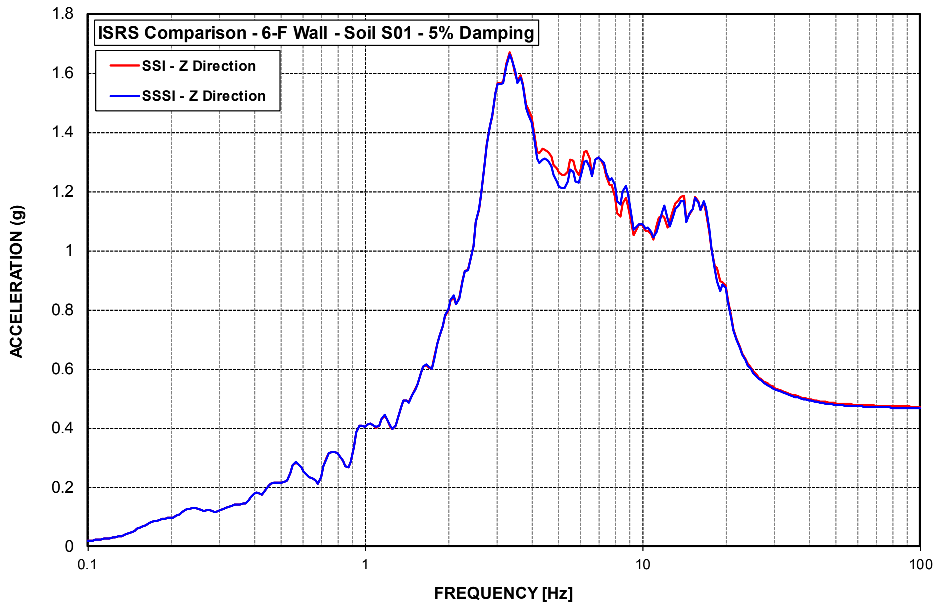


Figure A-51 ISRS – AB Shear Walls (6-F) at El. 156' – S01 – Vertical Direction

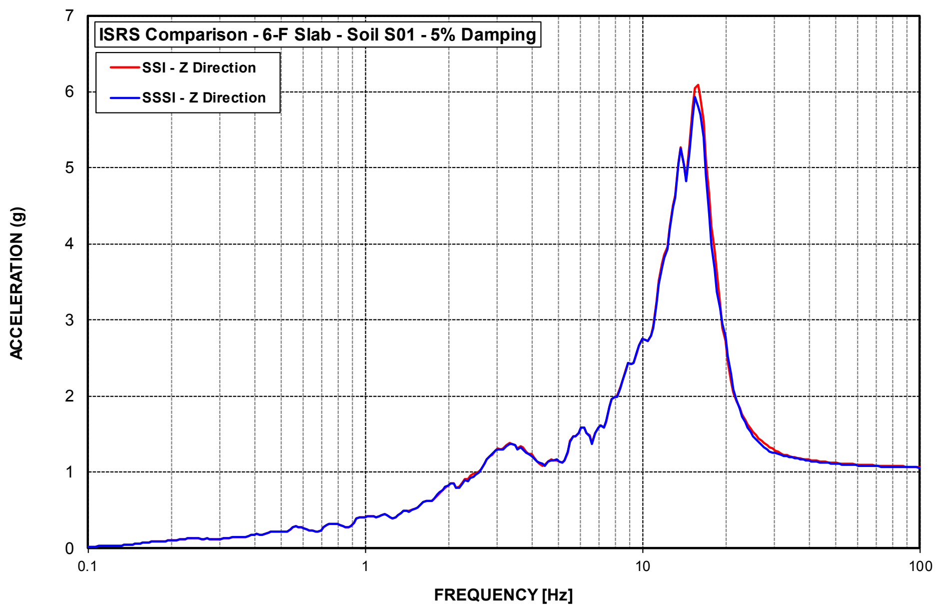


Figure A-52 ISRS – AB Floor Slabs (6-F) at El. 156' – S01 – Vertical Direction

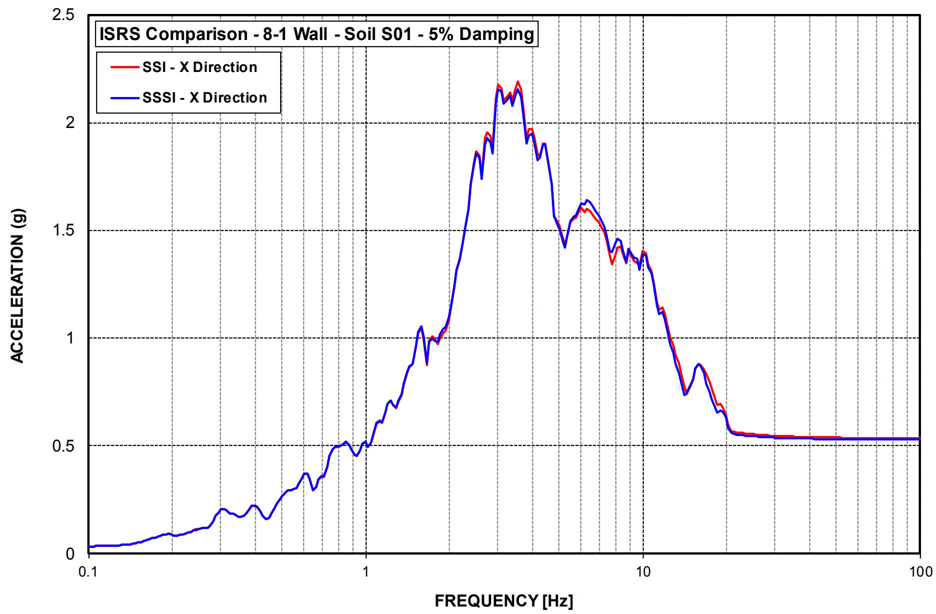


Figure A-53 ISRS – AB Shear Walls (8-1) at El. 195' – S01 – EW Direction

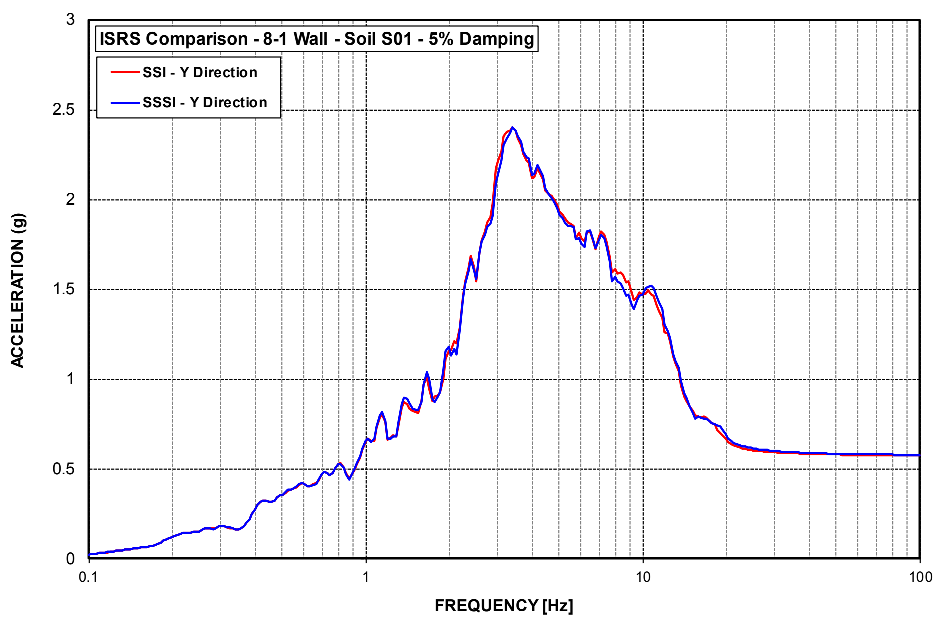


Figure A-54 ISRS – AB Shear Walls (8-1) at El. 195' – S01 – NS Direction

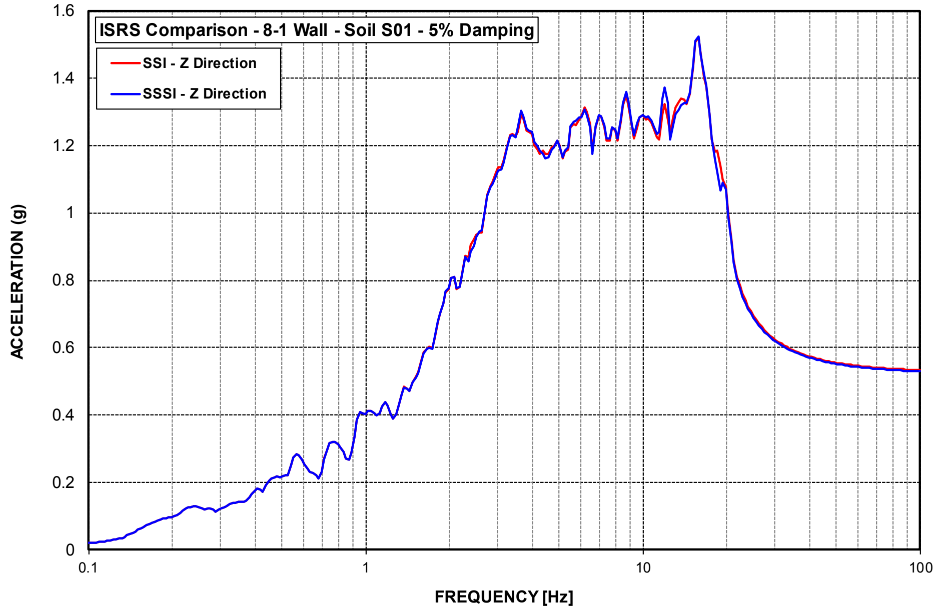


Figure A-55 ISRS – AB Shear Walls (8-1) at El. 195’ – S01 – Vertical Direction

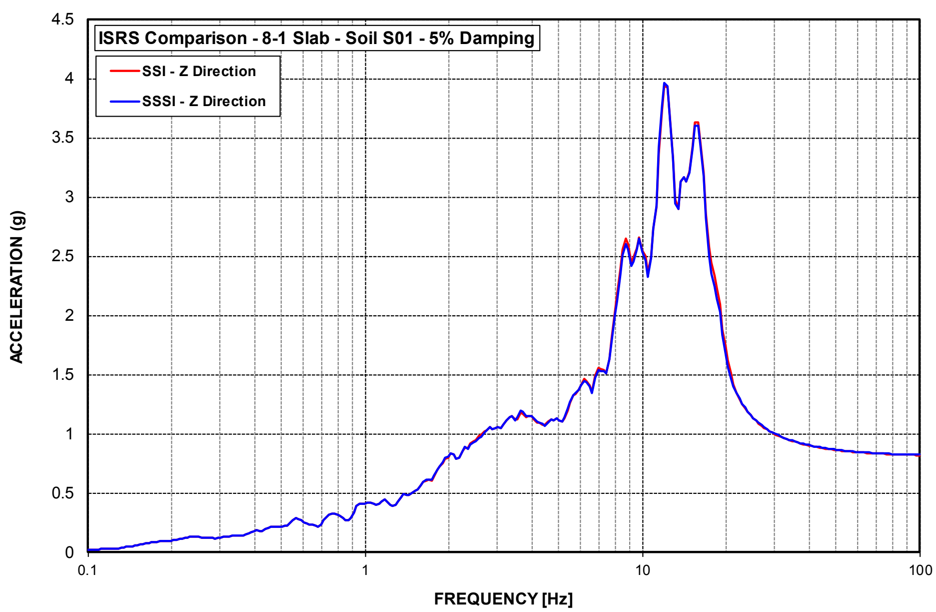


Figure A-56 ISRS – AB Floor Slabs (8-1) at El. 195’ – S01 – Vertical Direction

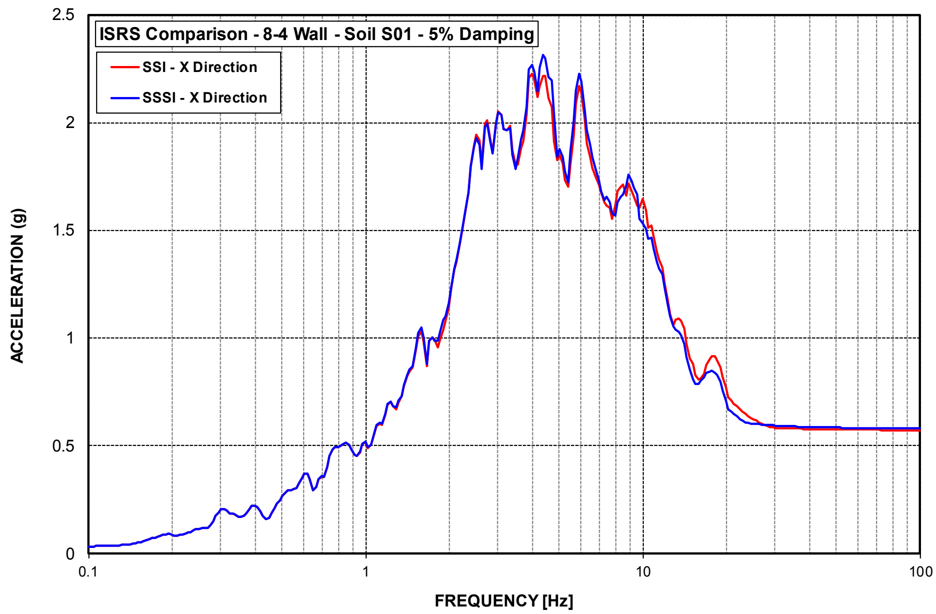


Figure A-57 ISRS – AB Shear Walls (8-4) at El. 213.5’ – S01 – EW Direction

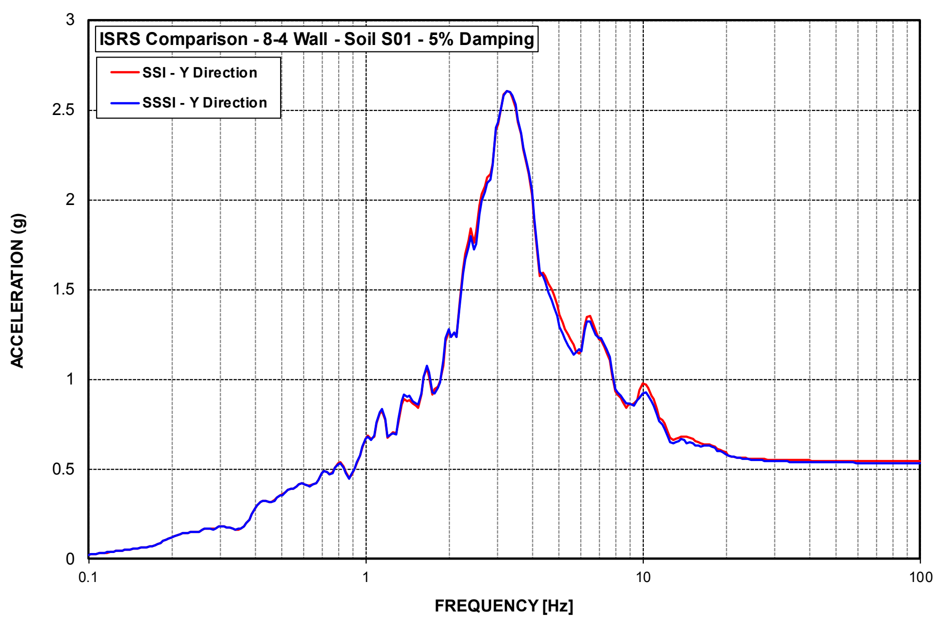


Figure A-58 ISRS – AB Shear Walls (8-4) at El. 213.5’ – S01 – NS Direction

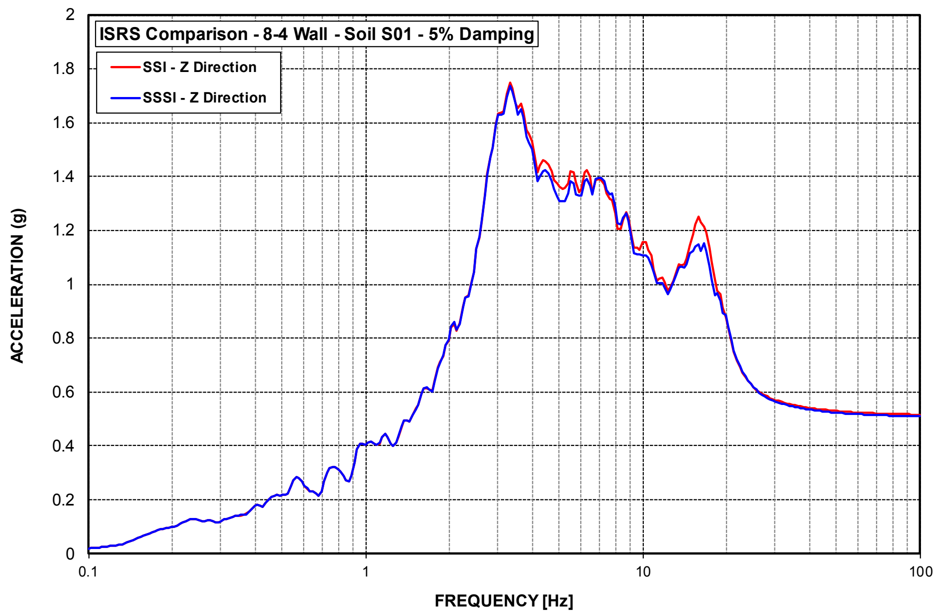


Figure A-59 ISRS – AB Shear Walls (8-4) at El. 213.5’ – S01 – Vertical Direction

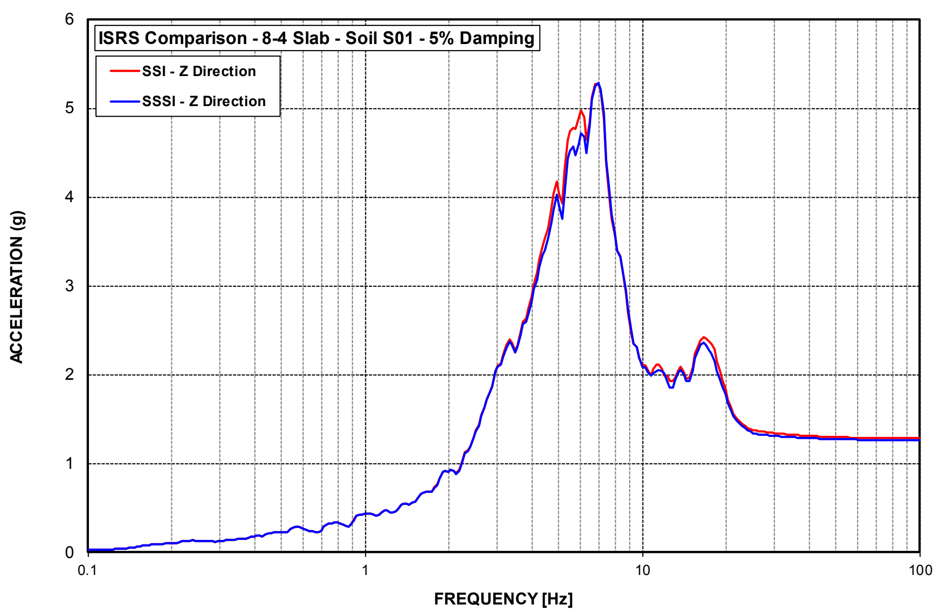


Figure A-60 ISRS – AB Floor Slabs (8-4) at El. 213.5’ – S01 – Vertical Direction

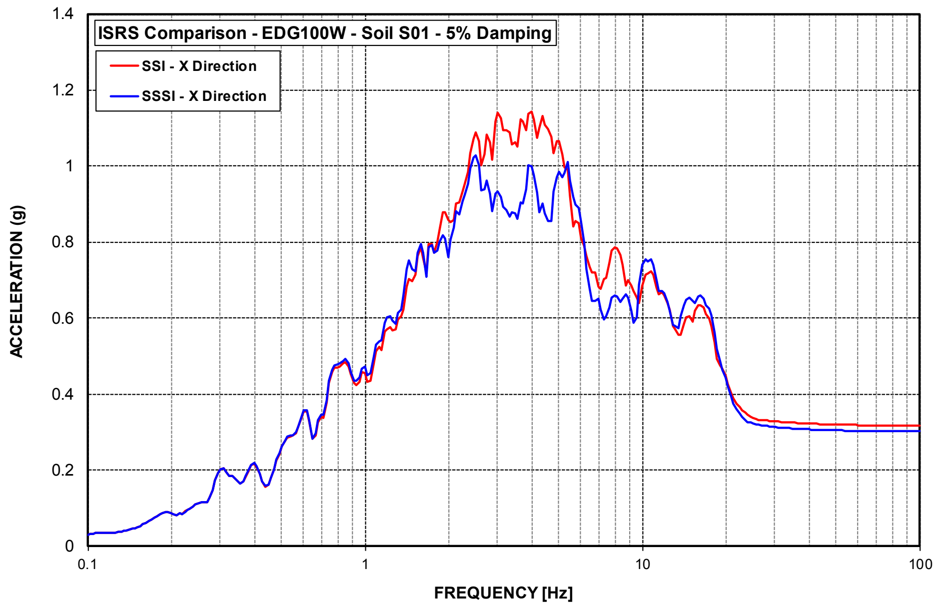


Figure A-61 ISRS – EDGB Wall (EDG100W) at El. 100' – S01 – EW Direction

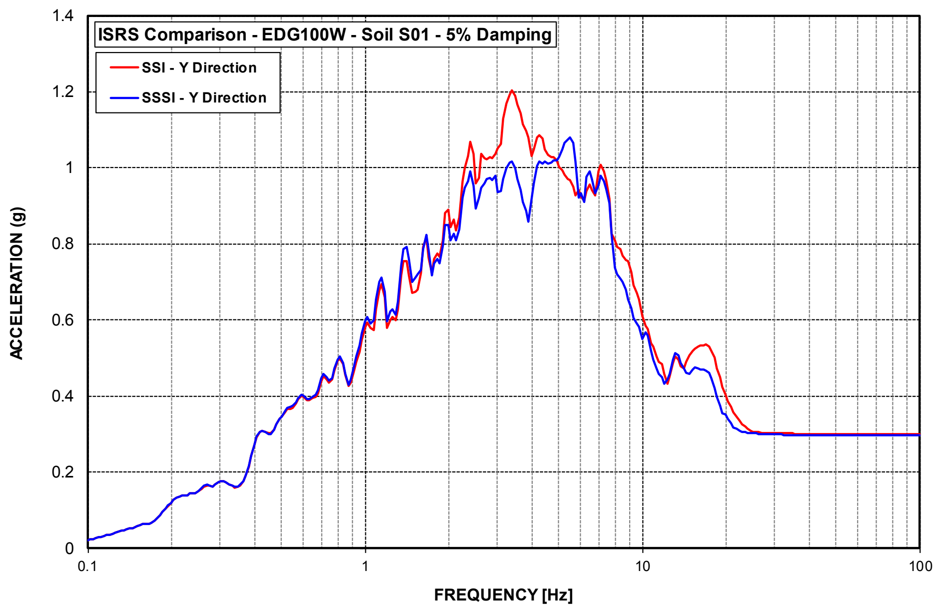


Figure A-62 ISRS – EDGB Wall (EDG100W) at El. 100' – S01 – NS Direction

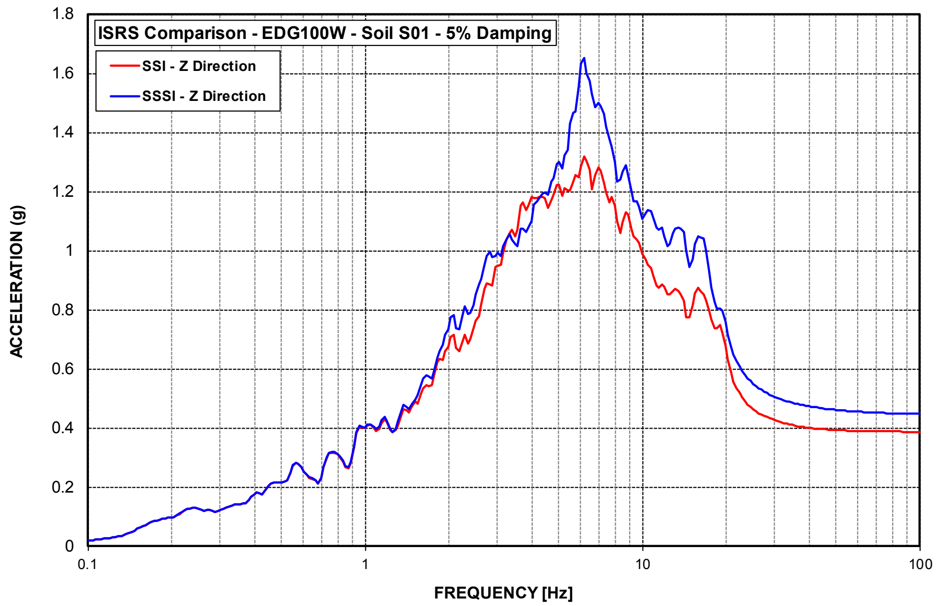


Figure A-63 ISRS – EDGB Wall (EDG100W) at El. 100' – S01 – Vertical Direction

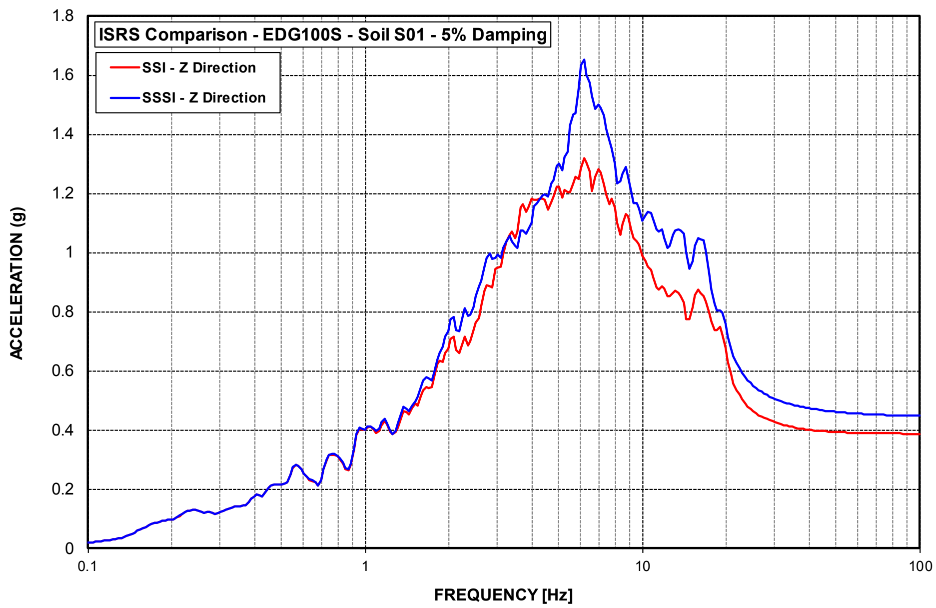


Figure A-64 ISRS – EDGB Slab (EDG100S) at El. 100' – S01 – Vertical Direction

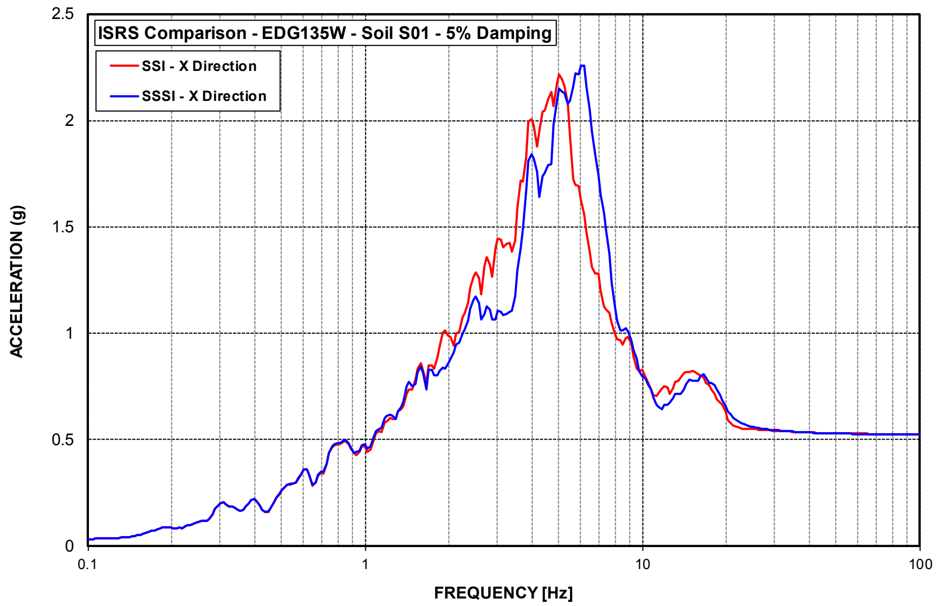


Figure A-65 ISRS – EDGB Wall (EDG135W) at El. 135' – S01 – EW Direction

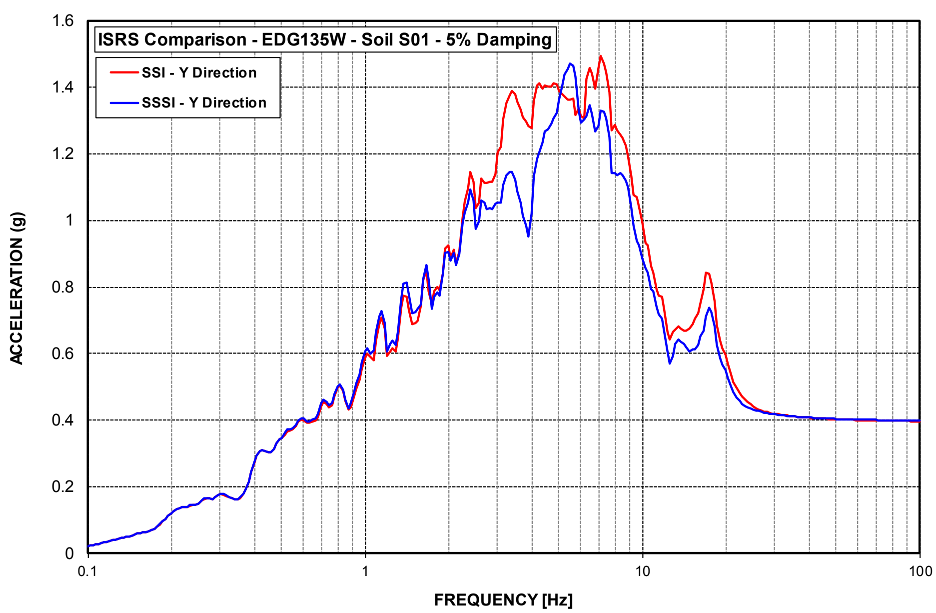


Figure A-66 ISRS – EDGB Wall (EDG135W) at El. 135' – S01 – NS Direction

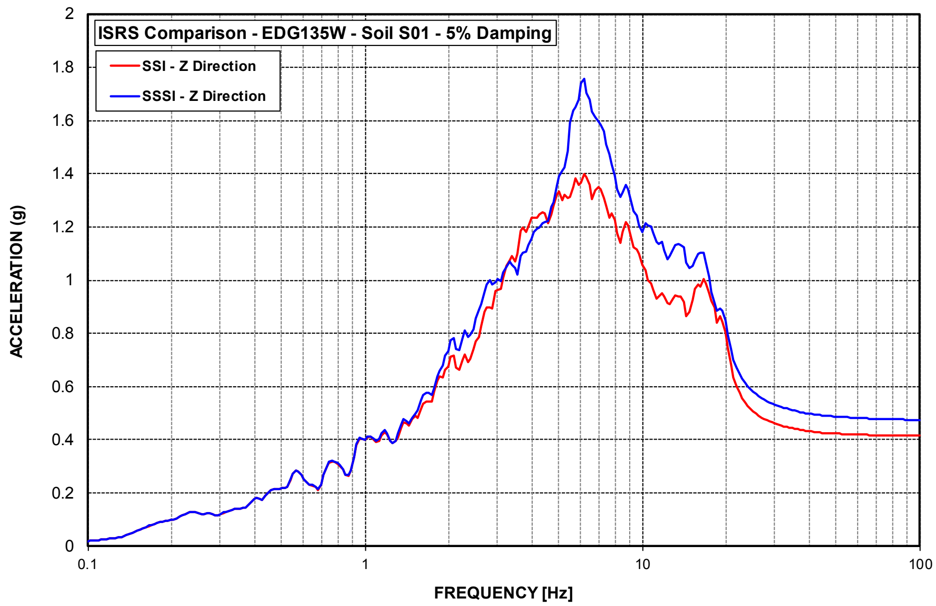


Figure A-67 ISRS – EDGB Wall (EDG135W) at El. 135' – S01 – Vertical Direction

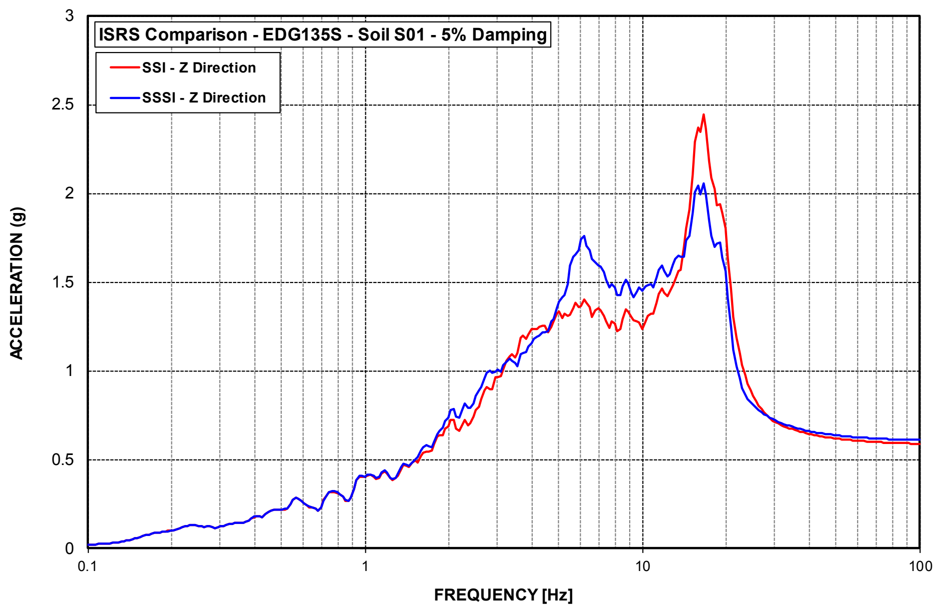


Figure A-68 ISRS – EDGB Slab (EDG135S) at El. 135' – S01 – Vertical Direction

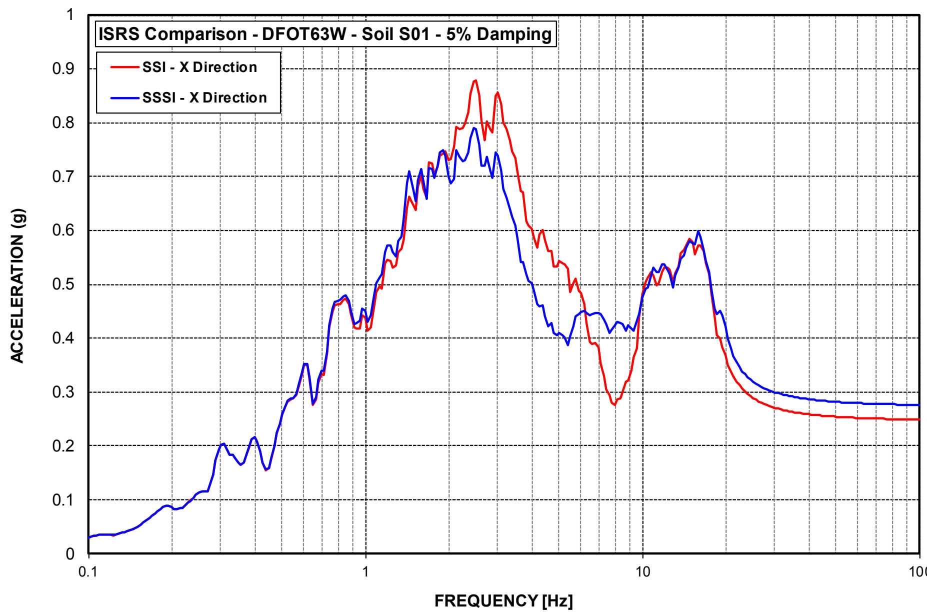


Figure A-69 ISRS – DFOT Room Wall (DFOT63W) at El. 63' – S01 – EW Direction

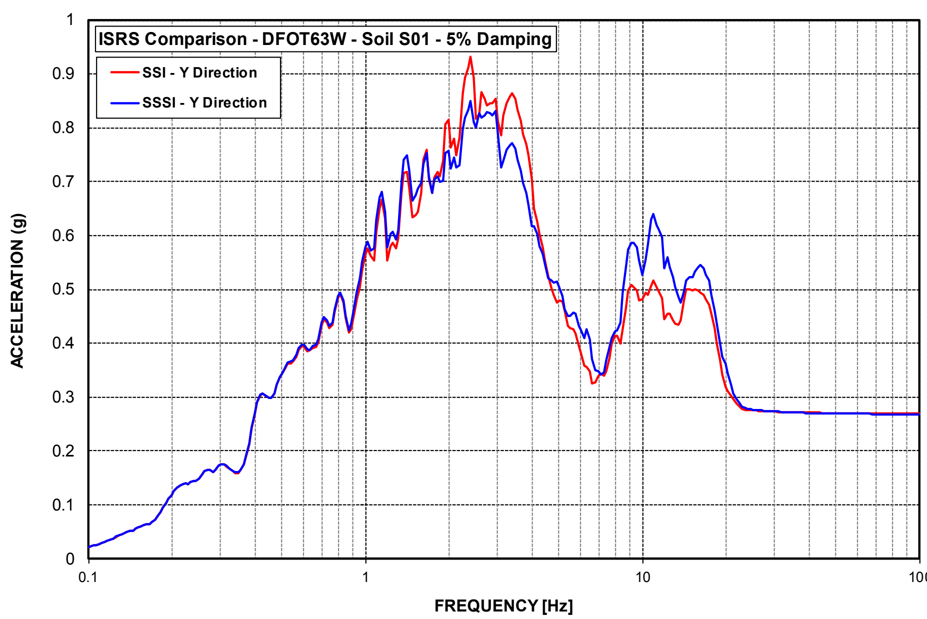


Figure A-70 ISRS – DFOT Room Wall (DFOT63W) at El. 63' – S01 – NS Direction

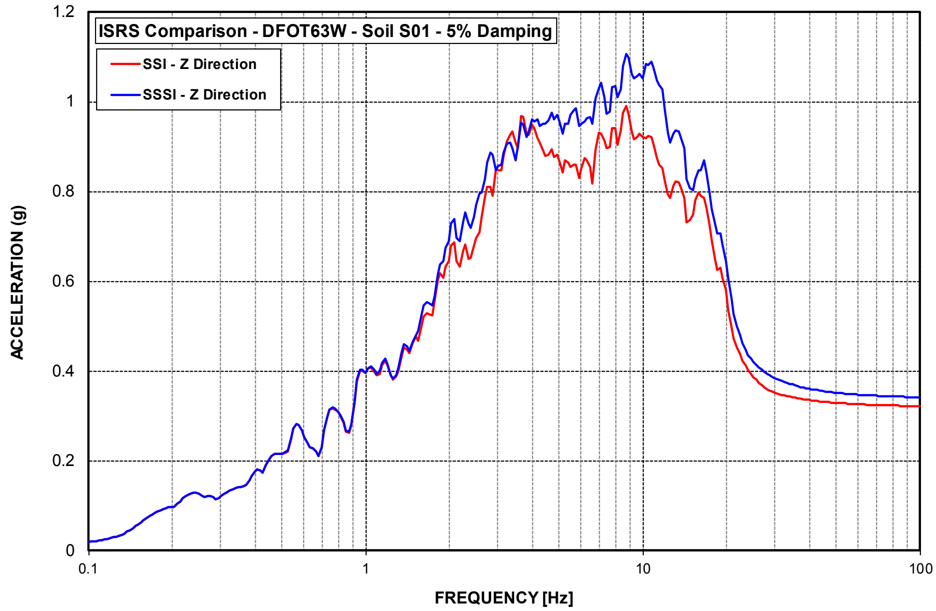


Figure A-71 ISRS – DFOT Room Wall (DFOT63W) at El. 63' – S01 – Vertical Direction

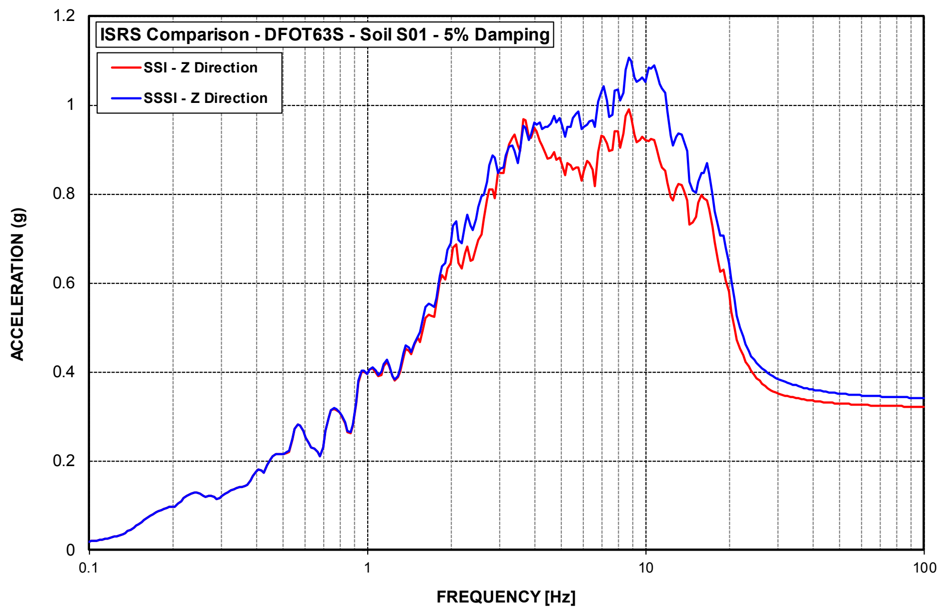


Figure A-72 ISRS – DFOT Room Slab (DFOT63S) at El. 63' – S01 – Vertical Direction

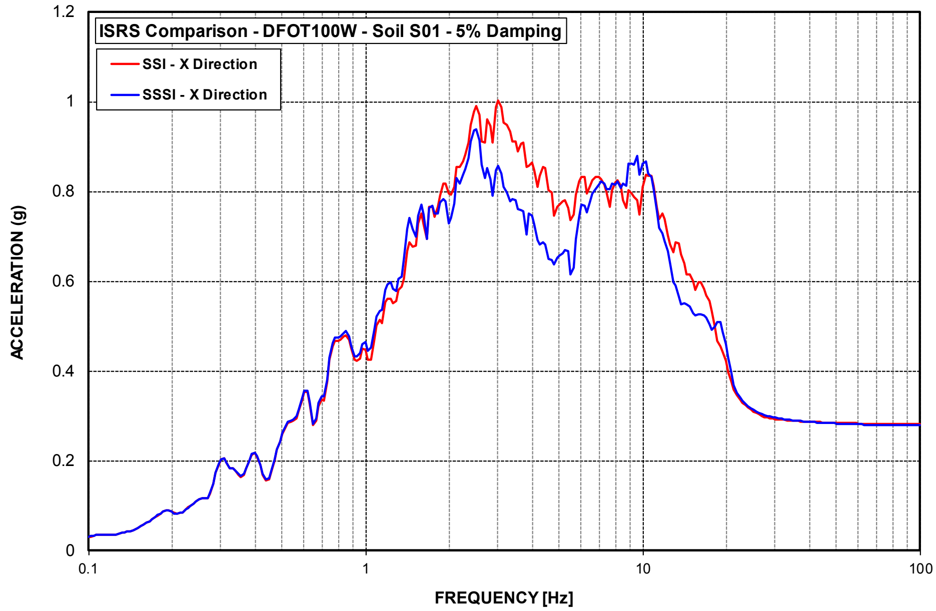


Figure A-73 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S01 – EW Direction

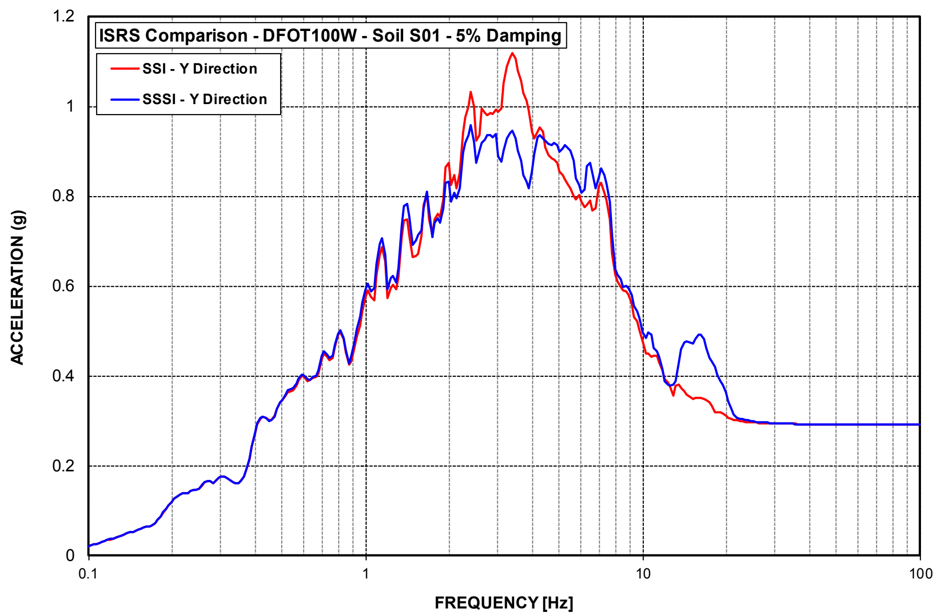


Figure A-74 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S01 – NS Direction

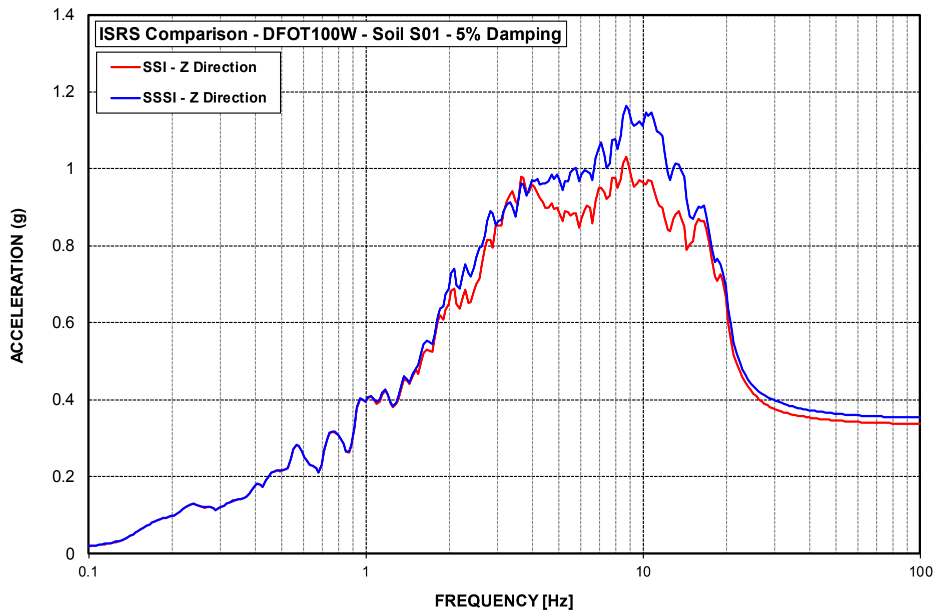


Figure A-75 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S01 – Vertical Direction

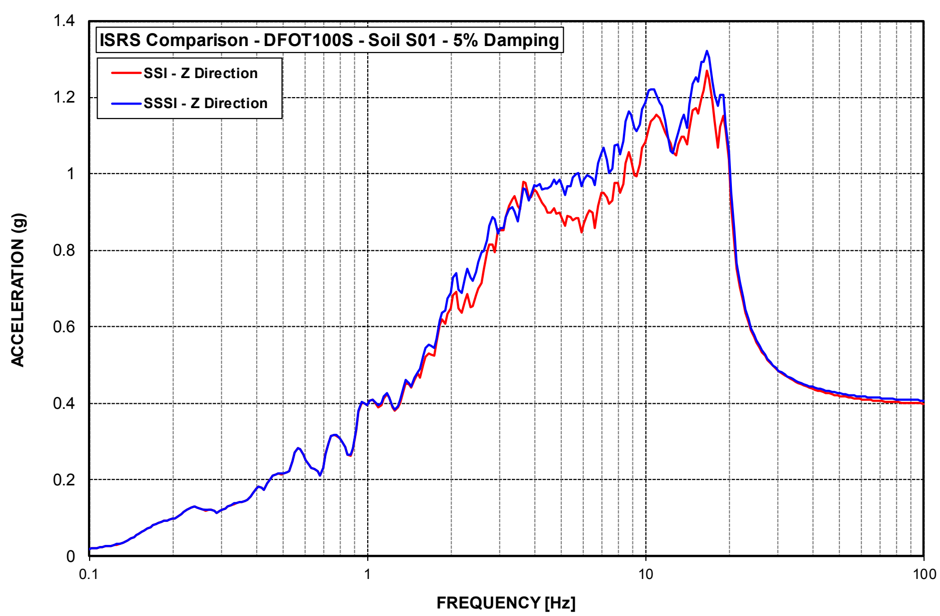


Figure A-76 ISRS – DFOT Room Slab (DFOT100S) at El. 100' – S01 – Vertical Direction

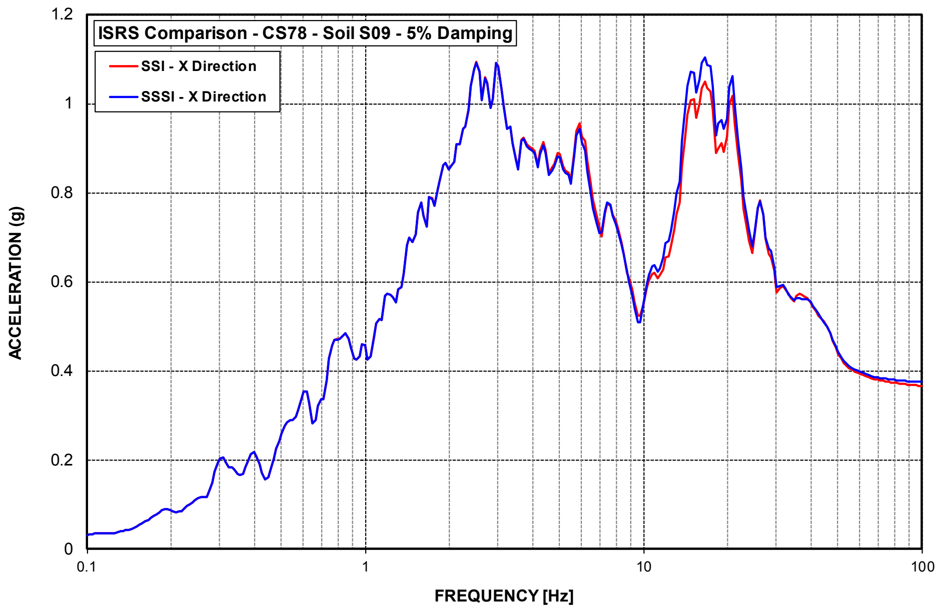


Figure A-77 ISRS – Containment Shell (CS78) at El. 78' – S09 – EW Direction

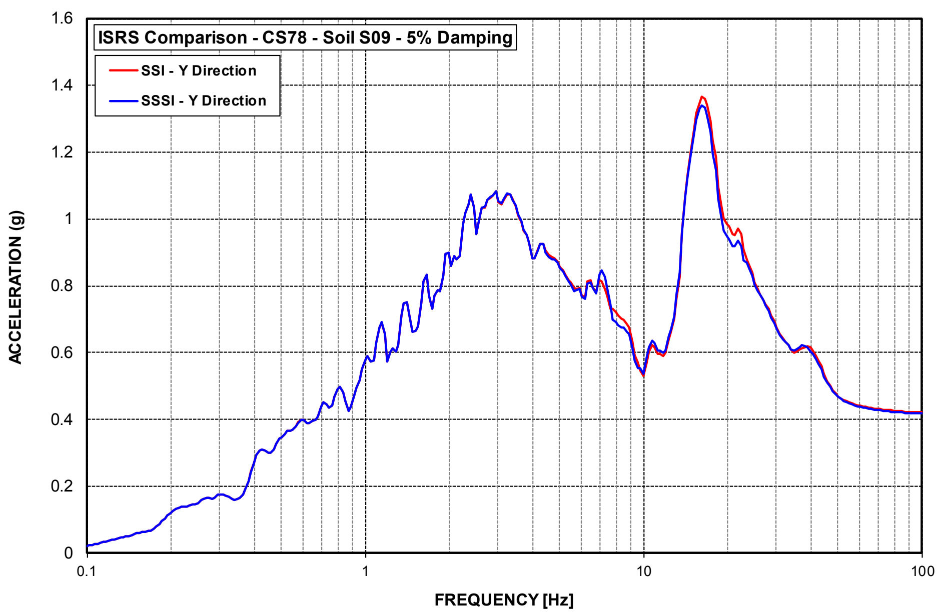


Figure A-78 ISRS – Containment Shell (CS78) at El. 78' – S09 – NS Direction

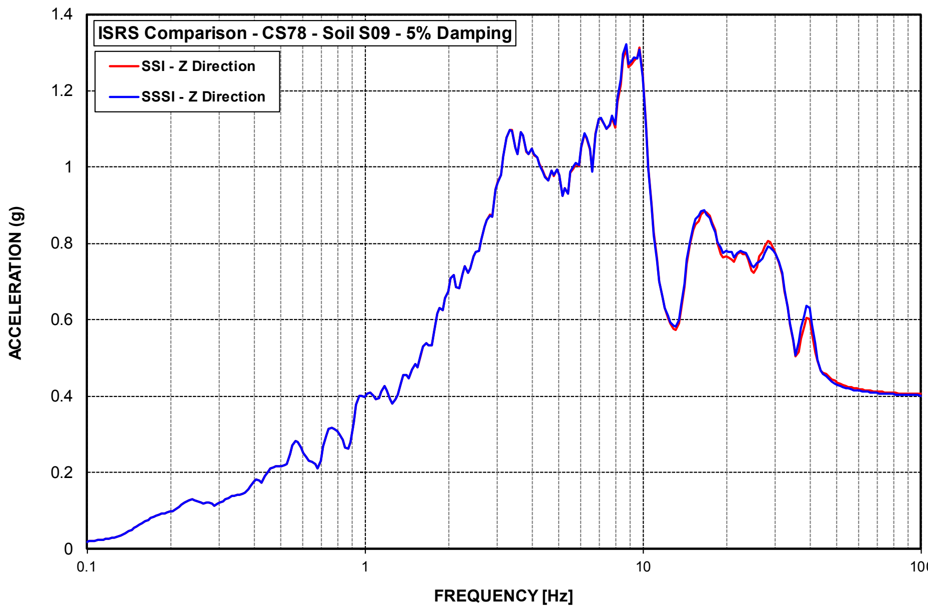


Figure A-79 ISRS – Containment Shell (CS78) at El. 78' – S09 – Vertical Direction

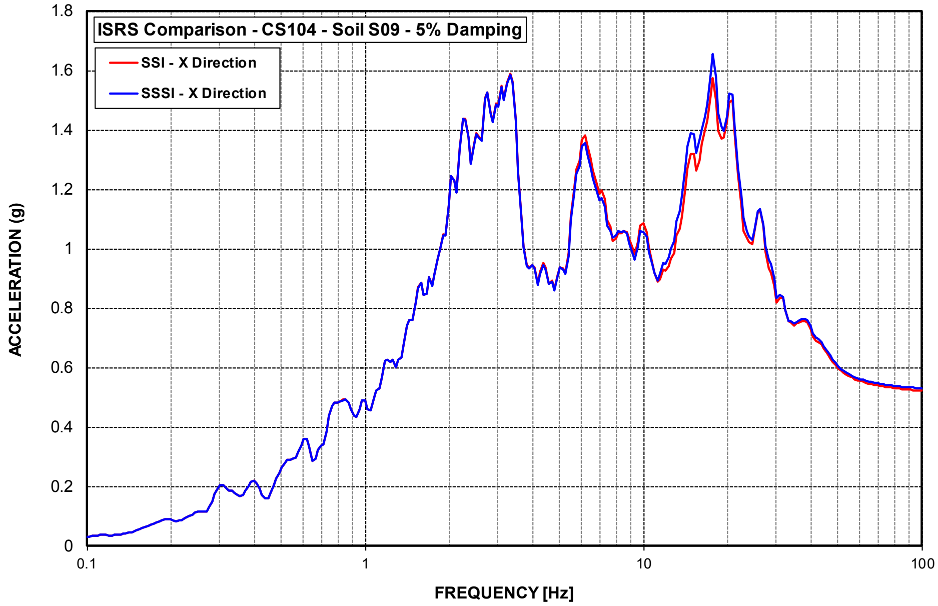


Figure A-80 ISRS – Containment Shell (CS104) at El. 103.75' – S09 – EW Direction

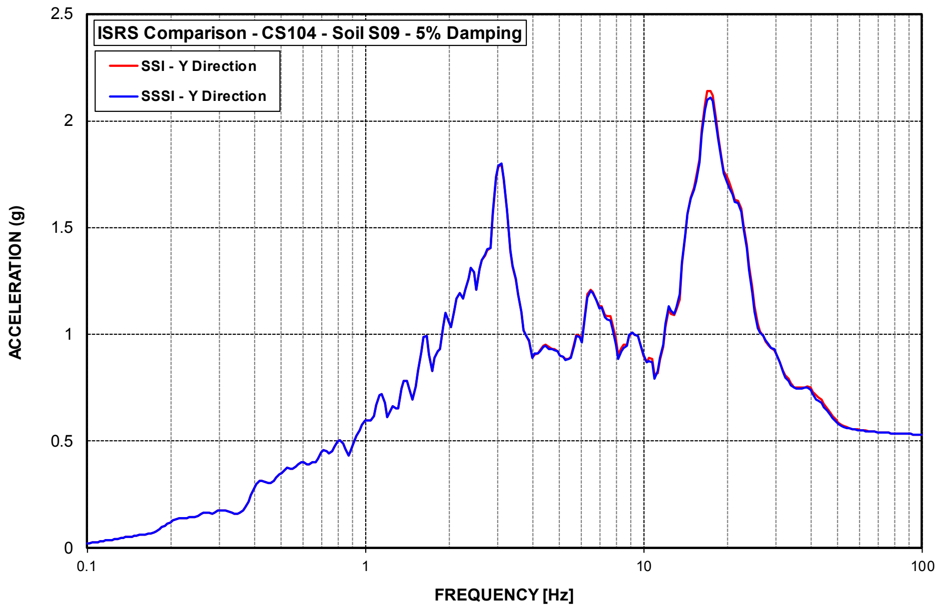


Figure A-81 ISRS – Containment Shell (CS104) at El. 103.75' – S09 – NS Direction

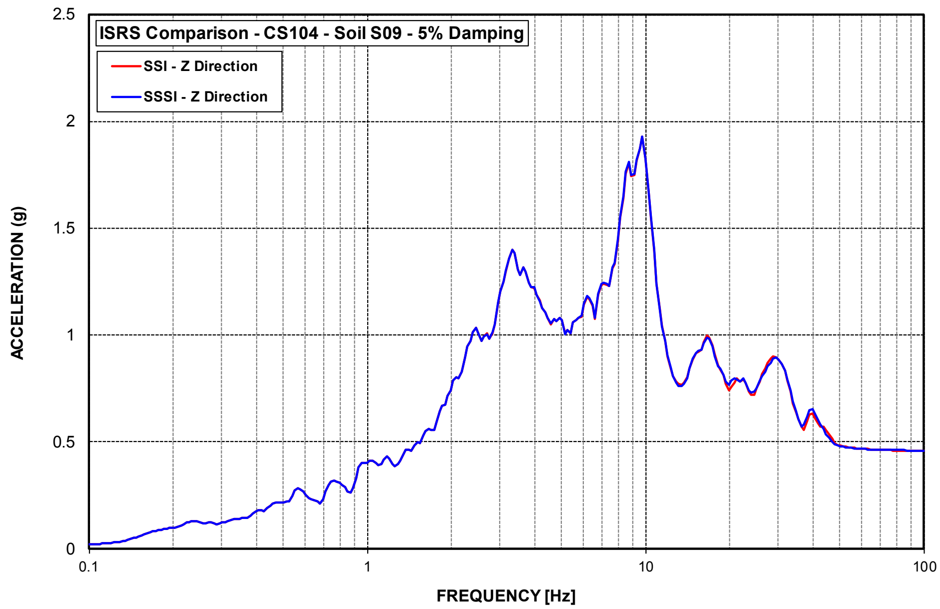


Figure A-82 ISRS – Containment Shell (CS104) at El. 103.75’ – S09 – Vertical Direction

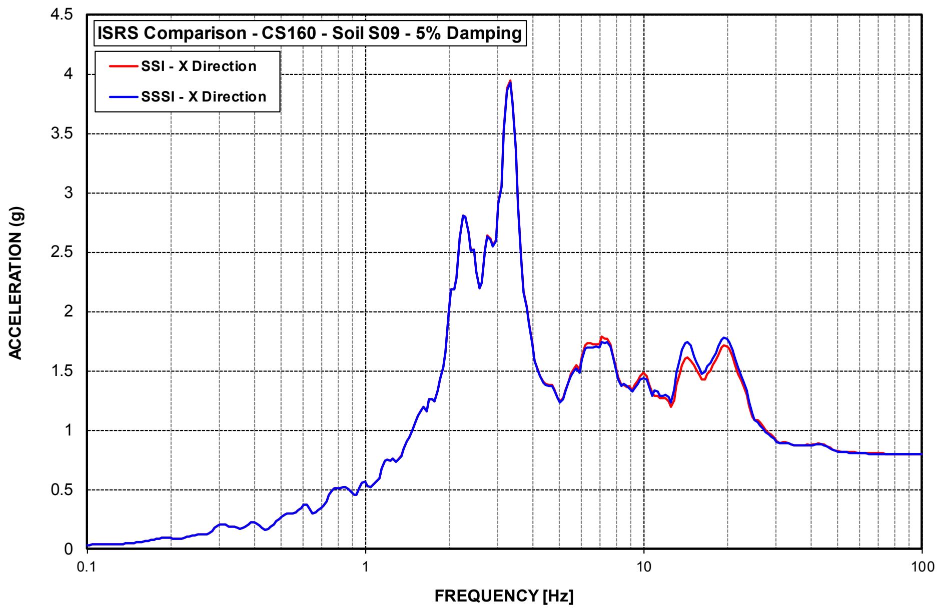


Figure A-83 ISRS – Containment Shell (CS160) at El. 159.75' – S09 – EW Direction

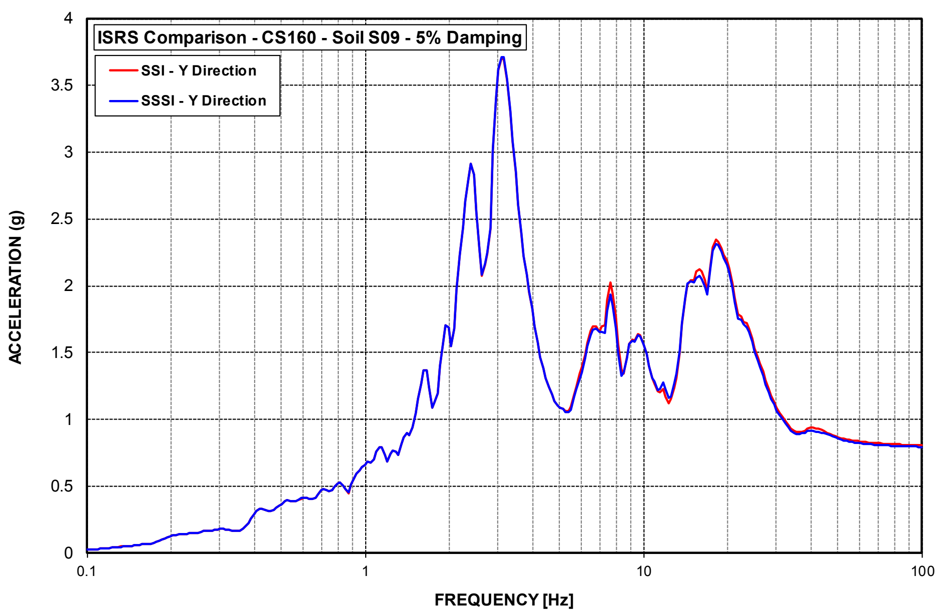


Figure A-84 ISRS – Containment Shell (CS160) at El. 159.75' – S09 – NS Direction

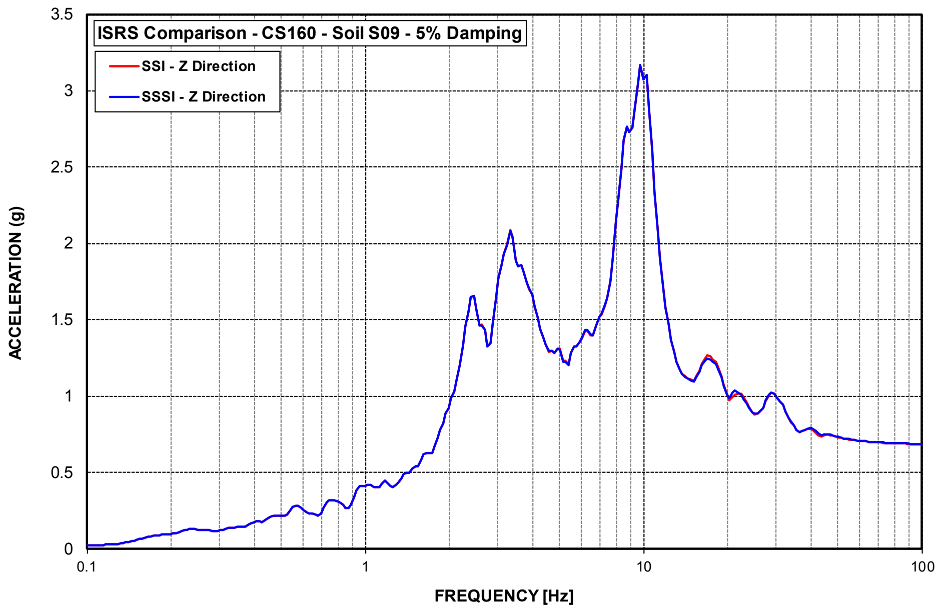


Figure A-85 ISRS – Containment Shell (CS160) at El. 159.75’ – S09 – Vertical Direction

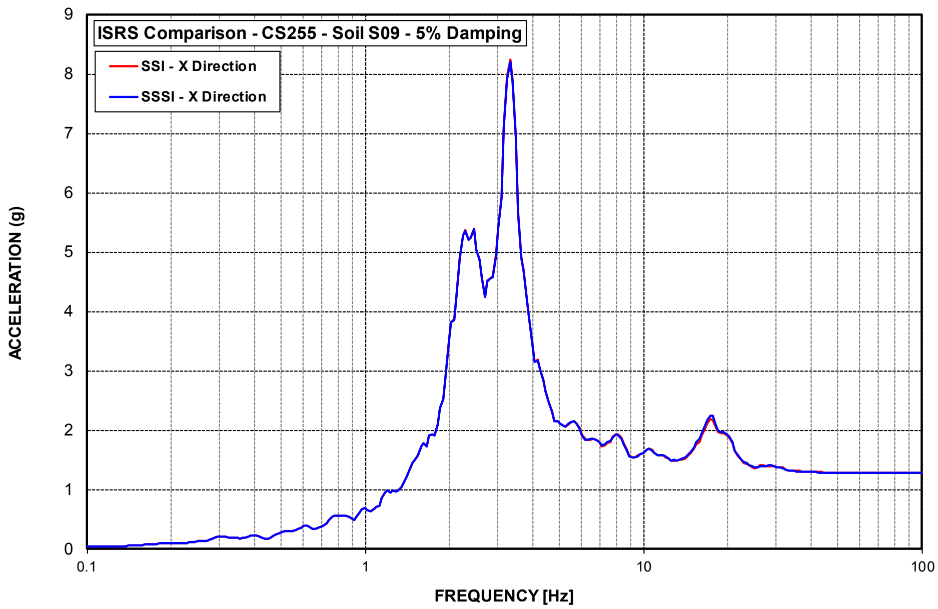


Figure A-86 ISRS – Containment Shell (CS255) at El. 254.5' – S09 – EW Direction

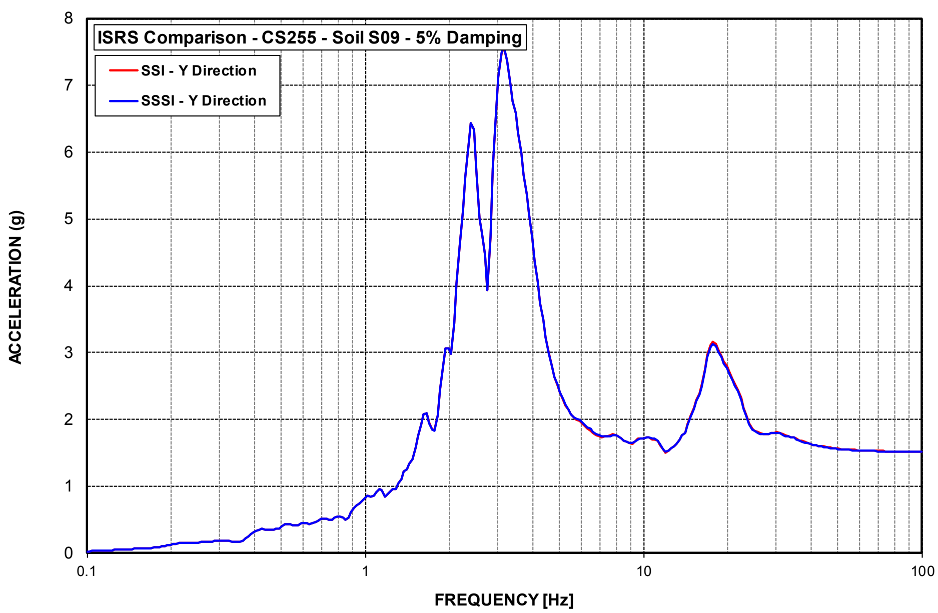


Figure A-87 ISRS – Containment Shell (CS255) at El. 254.5' – S09 – NS Direction

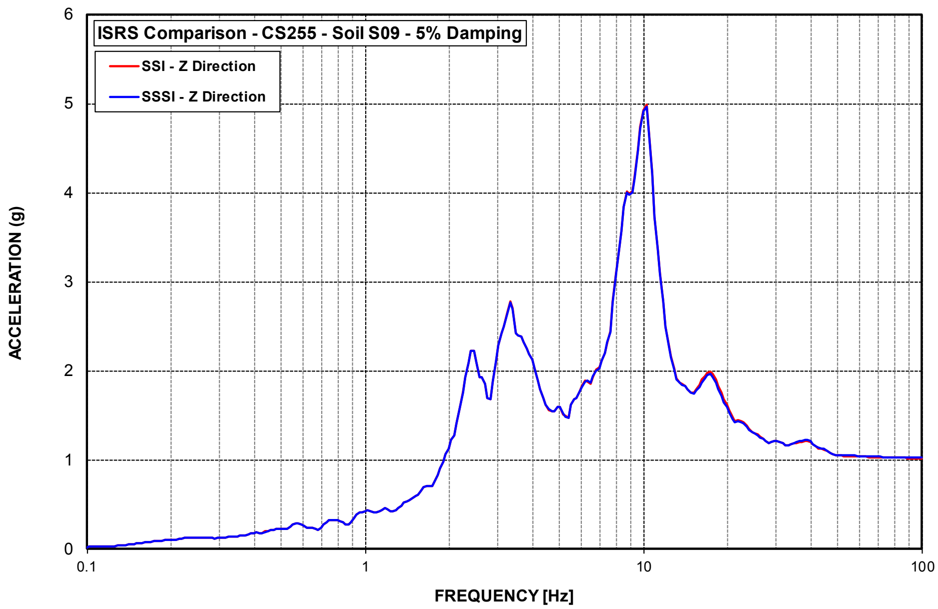


Figure A-88 ISRS – Containment Shell (CS255) at El. 254.5' – S09 – Vertical Direction

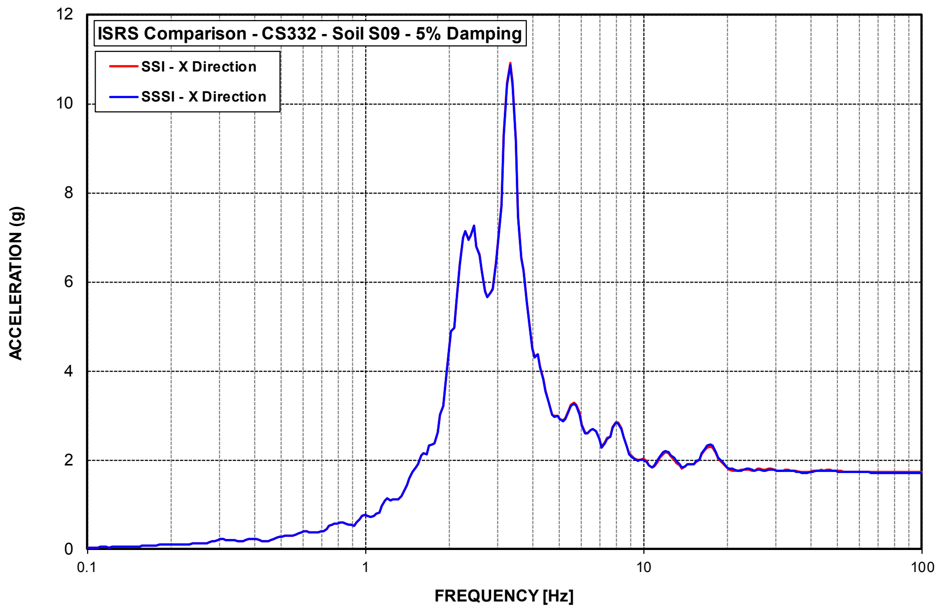


Figure A-89 ISRS – Containment Shell (CS332) at El. 331.75' – S09 – EW Direction

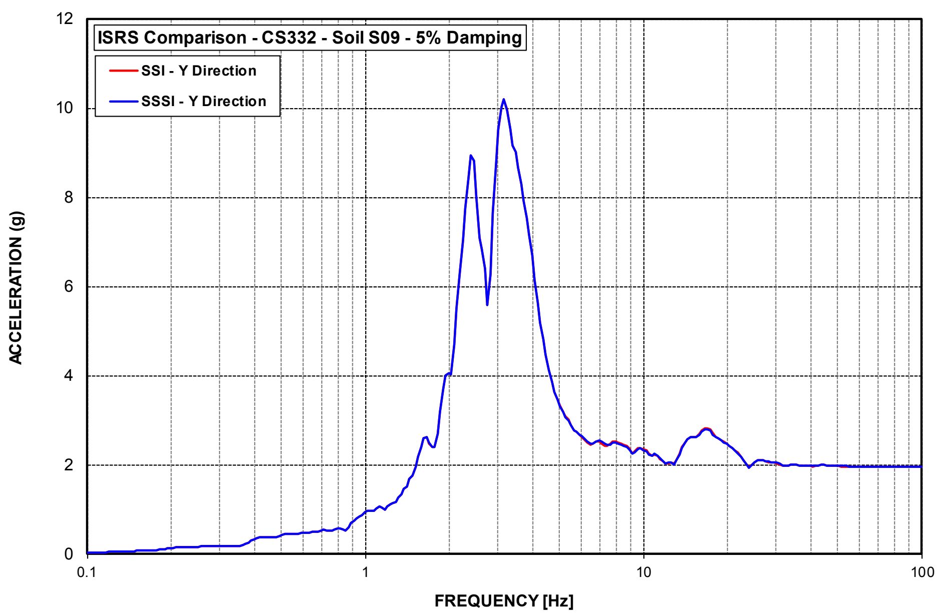


Figure A-90 ISRS – Containment Shell (CS332) at El. 331.75' – S09 – NS Direction

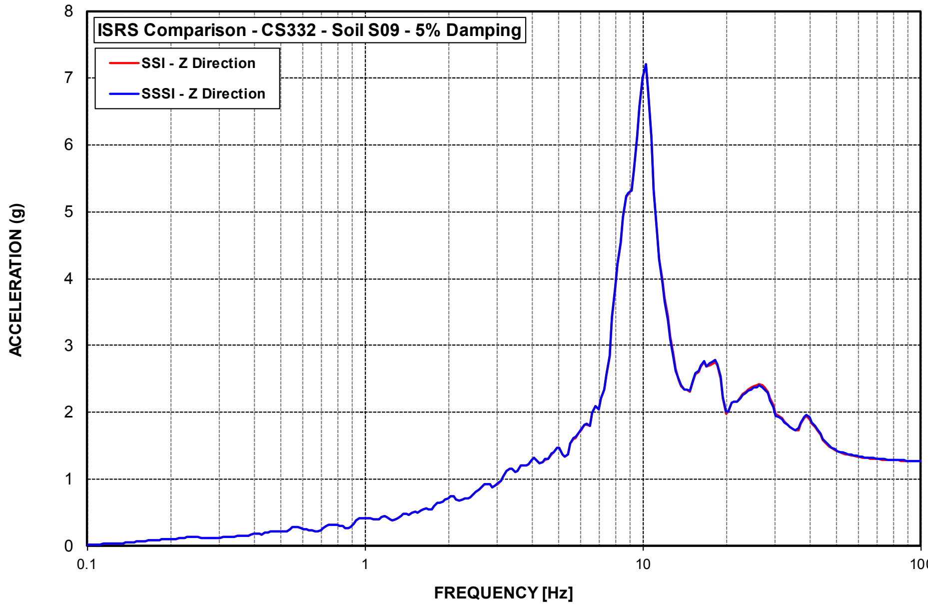


Figure A-91 ISRS – Containment Shell (CS332) at El. 331.75' – S09 – Vertical Direction

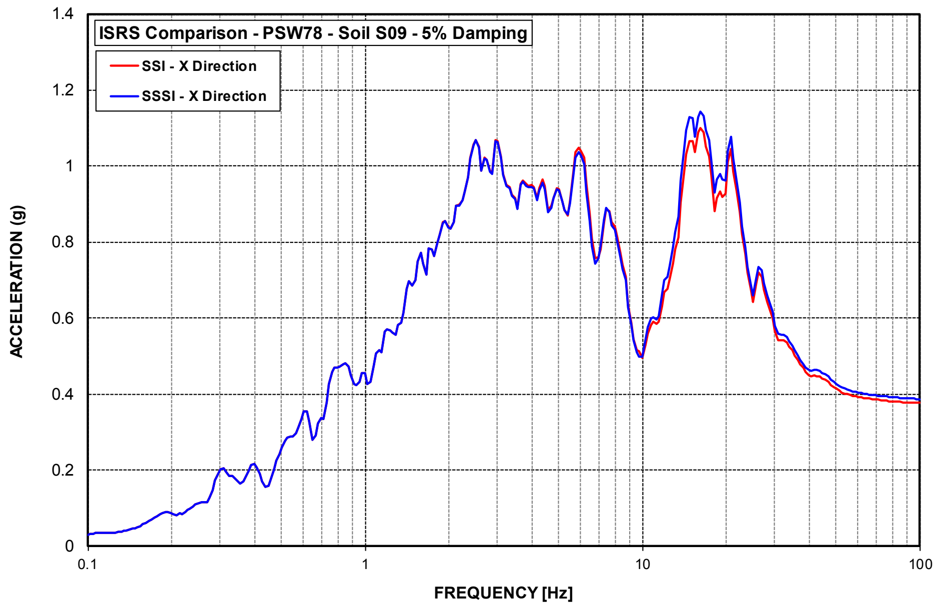


Figure A-92 ISRS – Primary Shield Wall (PSW78) at El. 78' – S09 – EW Direction

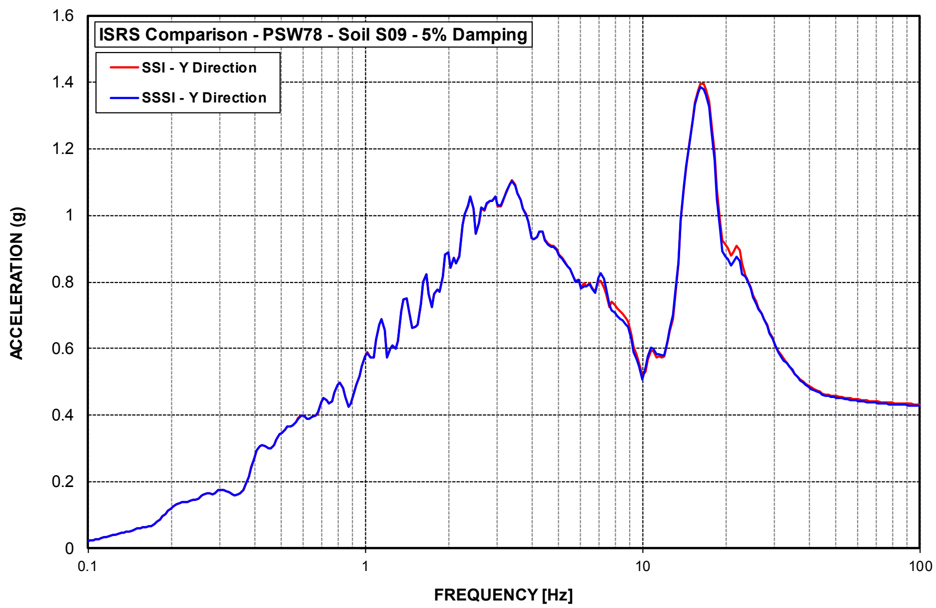


Figure A-93 ISRS – Primary Shield Wall (PSW78) at El. 78' – S09 – NS Direction

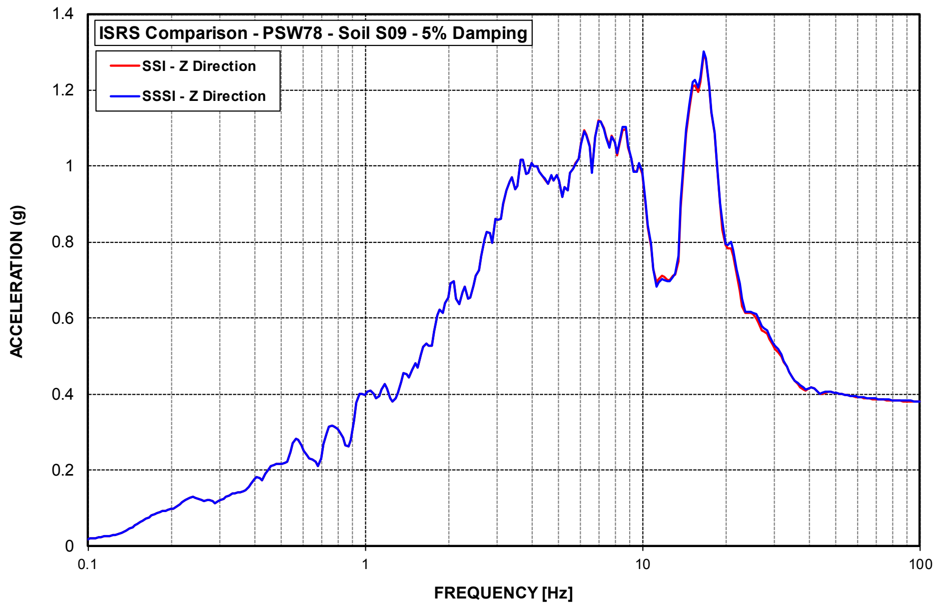


Figure A-94 ISRS – Primary Shield Wall (PSW78) at El. 78' – S09 – Vertical Direction

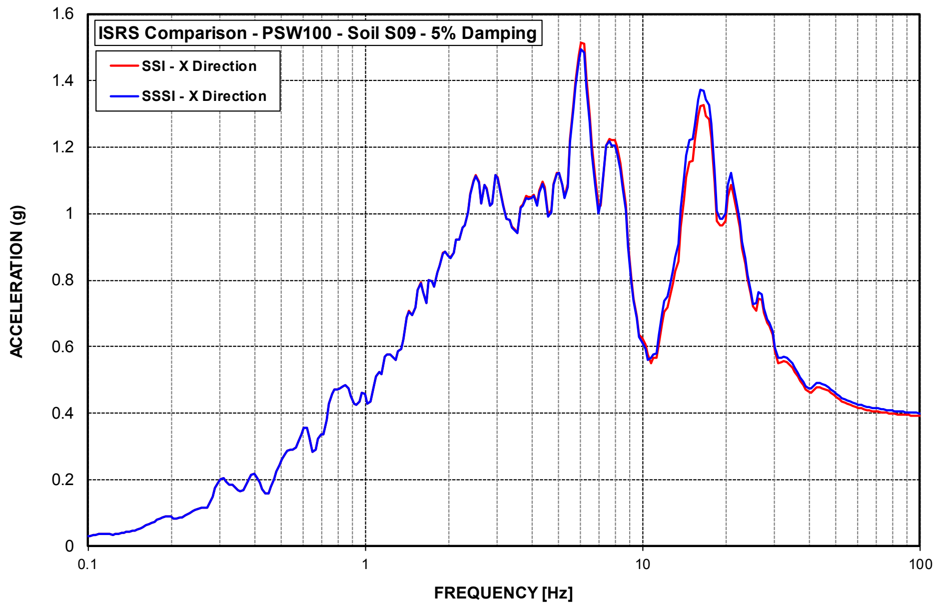


Figure A-95 ISRS – Primary Shield Wall (PSW100) at El. 100' – S09 – EW Direction

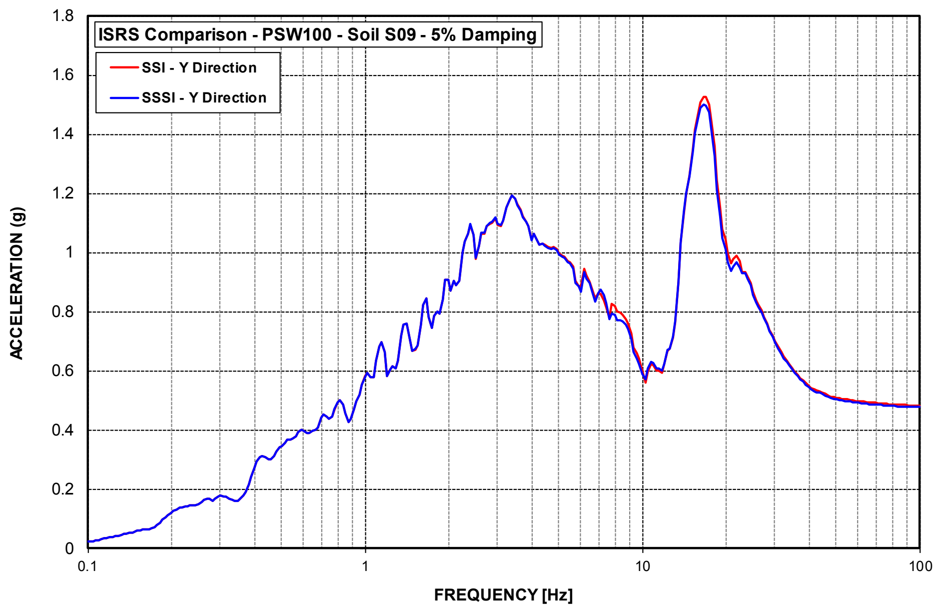


Figure A-96 ISRS – Primary Shield Wall (PSW100) at El. 100' – S09 – NS Direction

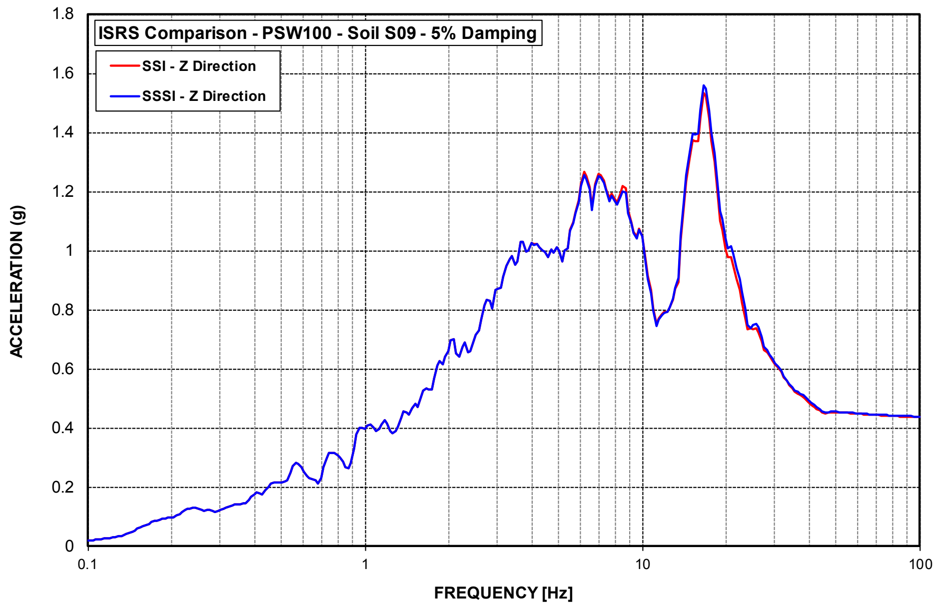


Figure A-97 ISRS – Primary Shield Wall (PSW100) at El. 100’ – S09 – Vertical Direction

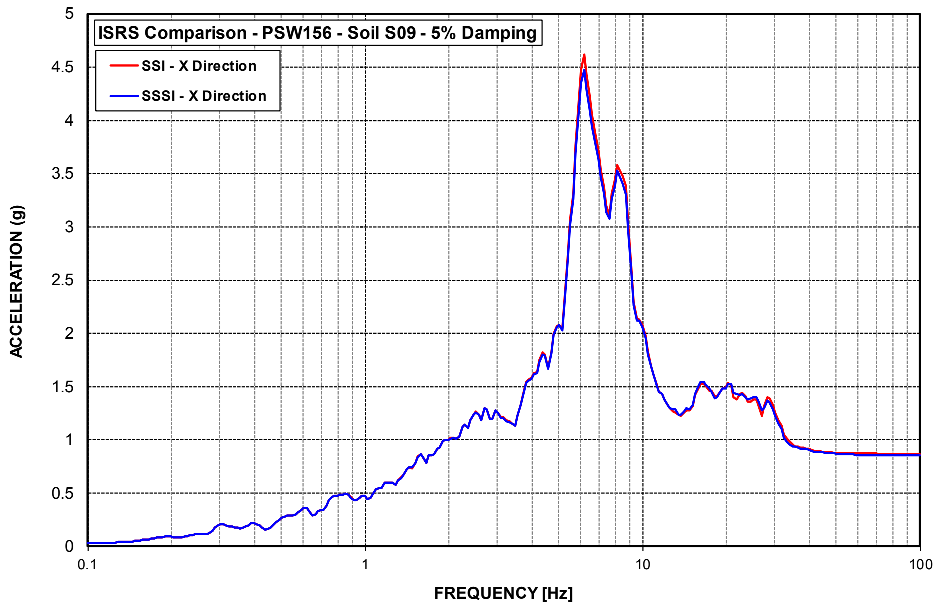


Figure A-98 ISRS – Primary Shield Wall (PSW156) at El. 156' – S09 – EW Direction

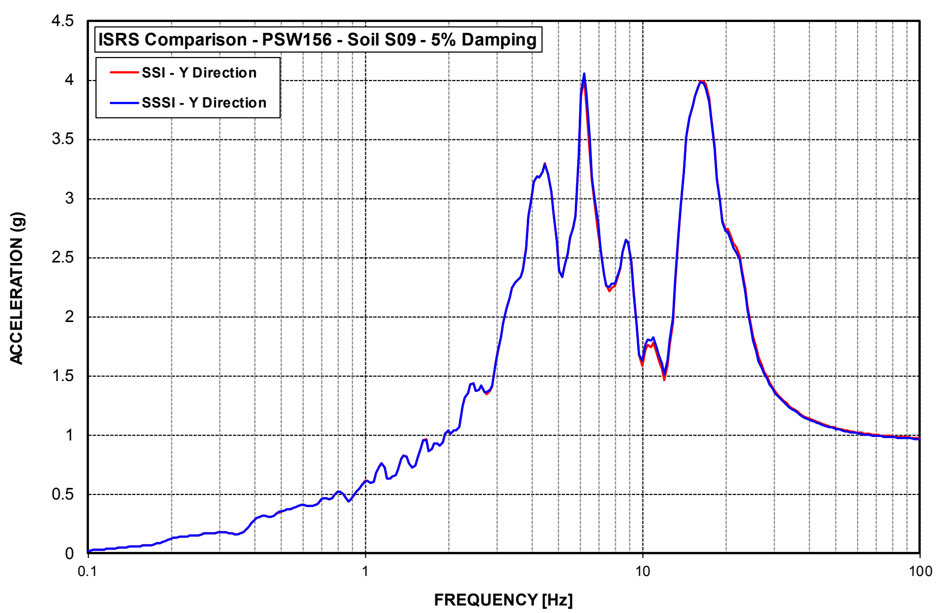


Figure A-99 ISRS – Primary Shield Wall (PSW156) at El. 156' – S09 – NS Direction

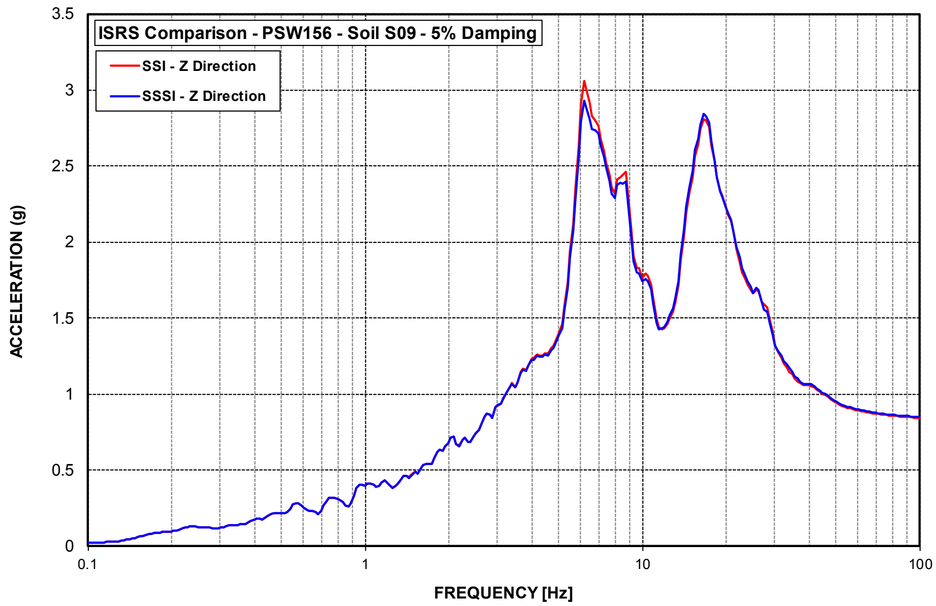


Figure A-100 ISRS – Primary Shield Wall (PSW156) at El. 156' – S09 – Vertical Direction

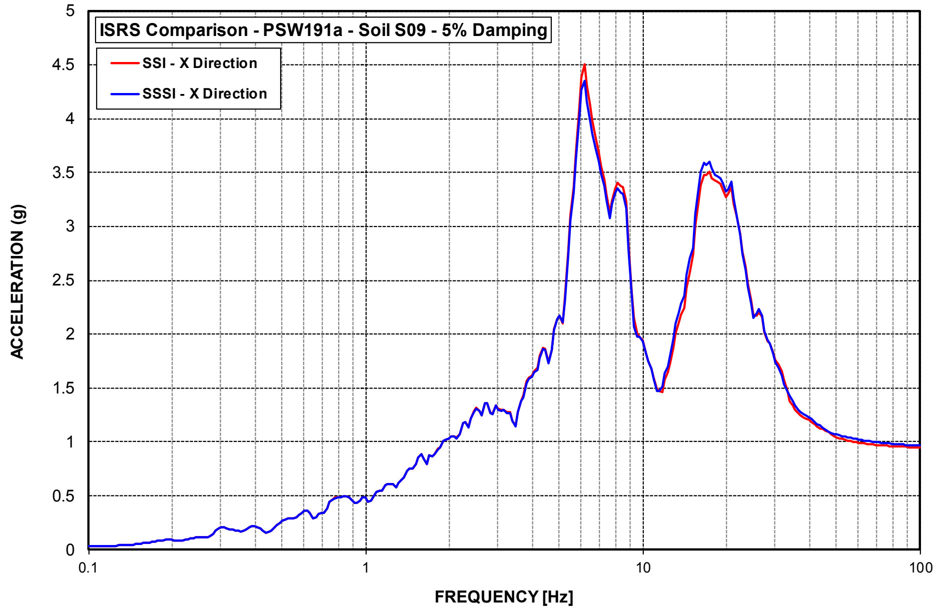


Figure A-101 ISRS – Primary Shield Wall (PSW191a) at El. 191' – S09 – EW Direction

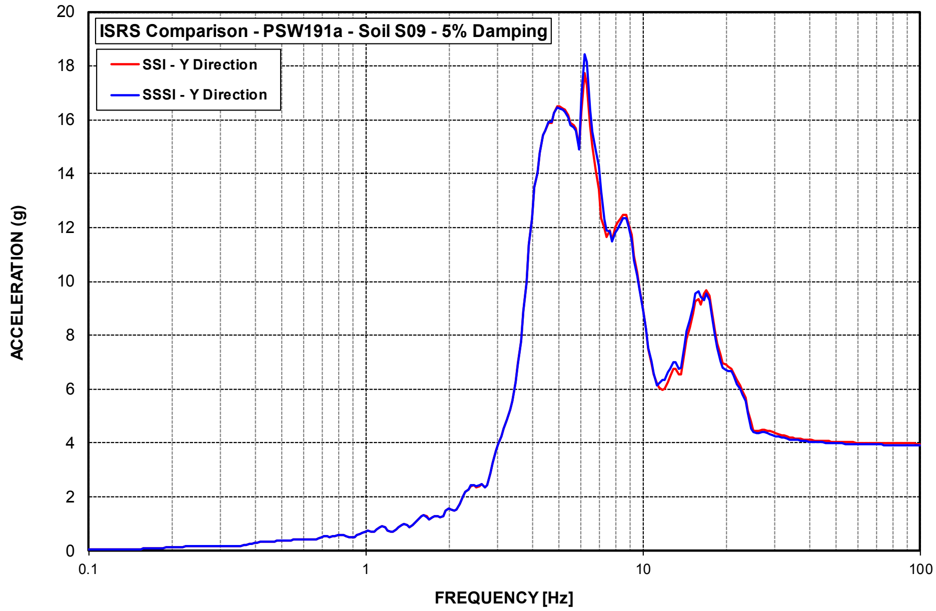


Figure A-102 ISRS – Primary Shield Wall (PSW191a) at El. 191' – S09 – NS Direction

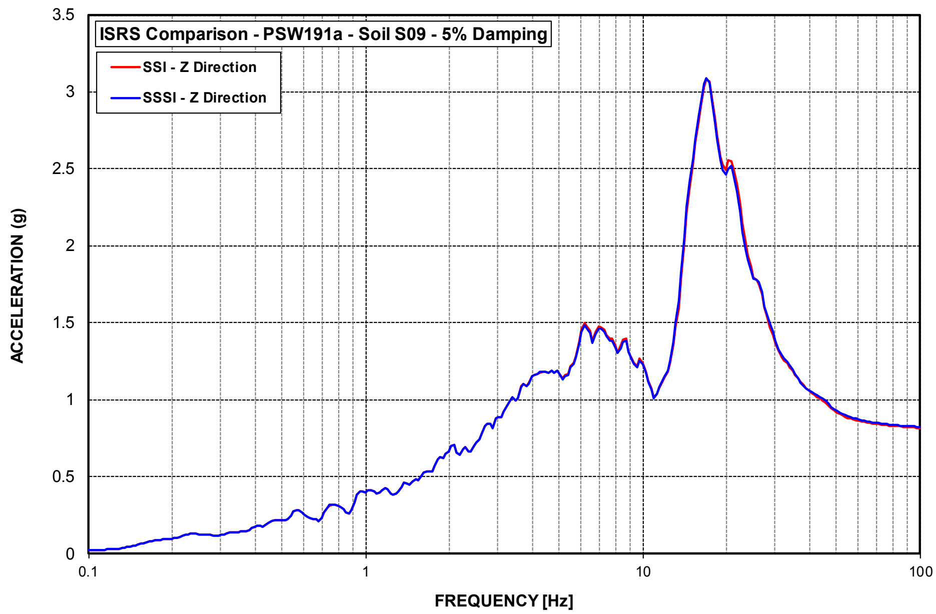


Figure A-103 ISRS – Primary Shield Wall (PSW191a) at El. 191' – S09 – Vertical Direction

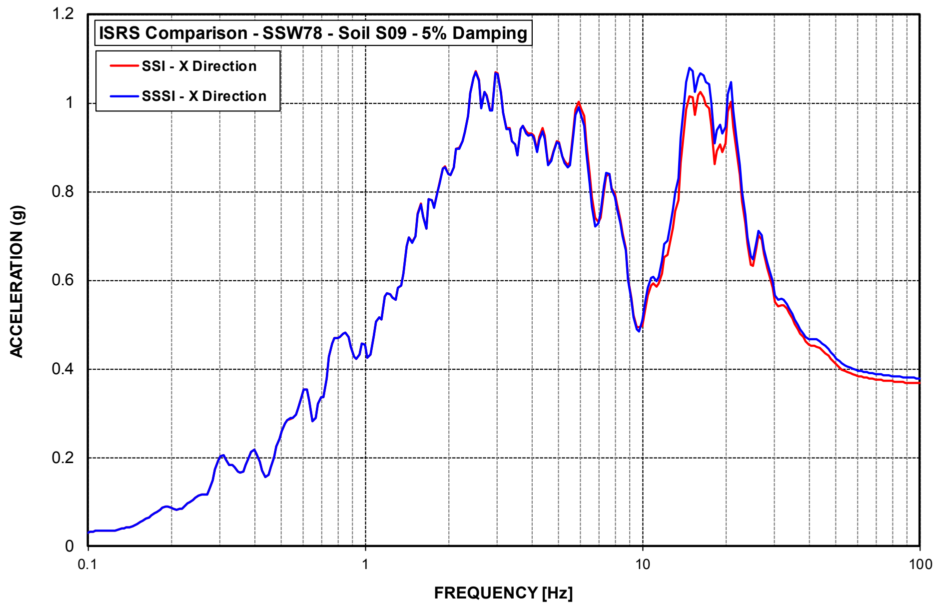


Figure A-104 ISRS – Secondary Shield Wall (SSW78) at El. 78' – S09 – EW Direction

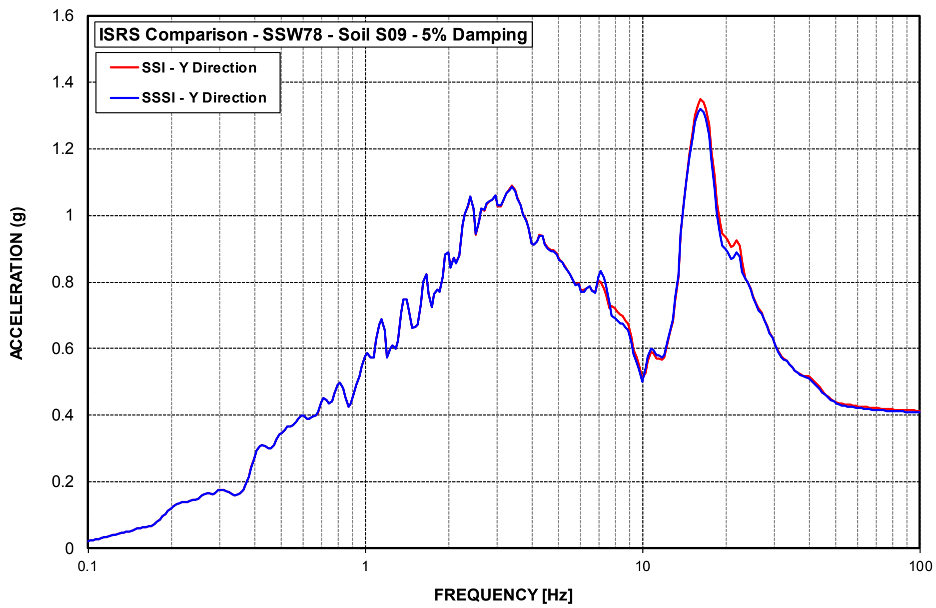


Figure A-105 ISRS – Secondary Shield Wall (SSW78) at El. 78' – NS Direction

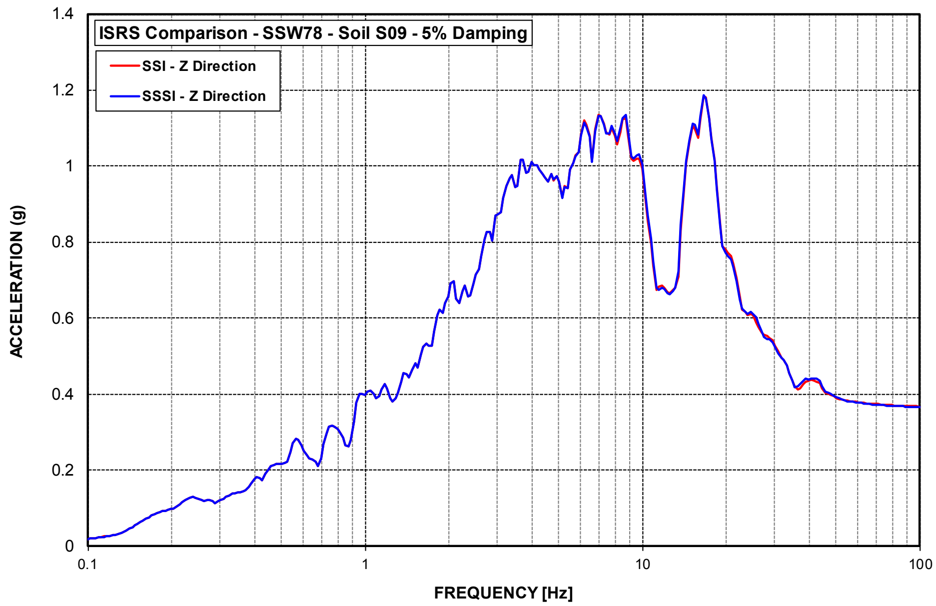


Figure A-106 ISRS – Secondary Shield Wall (SSW78) at El. 78' – S09 – Vertical Direction

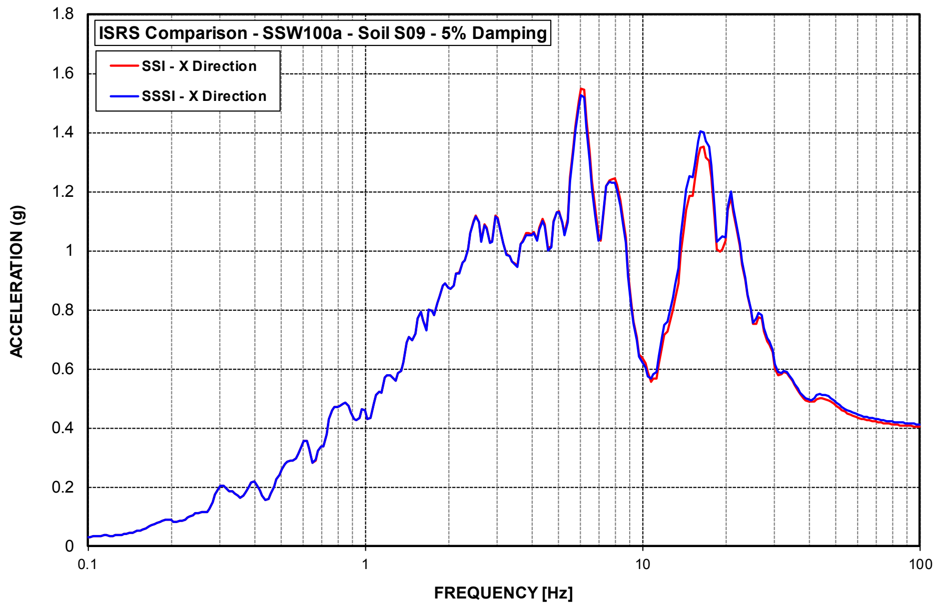


Figure A-107 ISRS – Secondary Shield Wall (SSW100a) at El. 100' – S09 – EW Direction

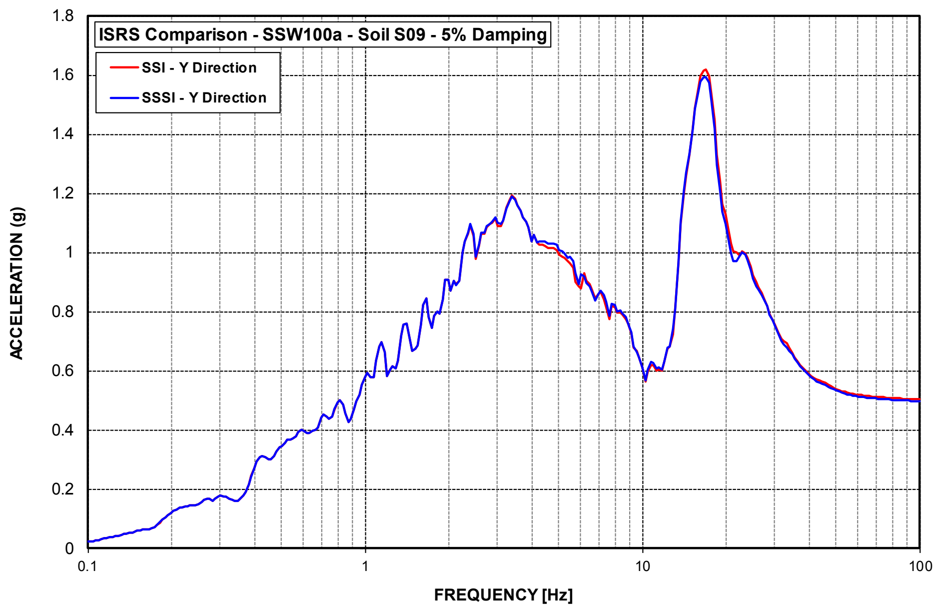


Figure A-108 ISRS – Secondary Shield Wall (SSW100a) at El. 100' – S09 – NS Direction

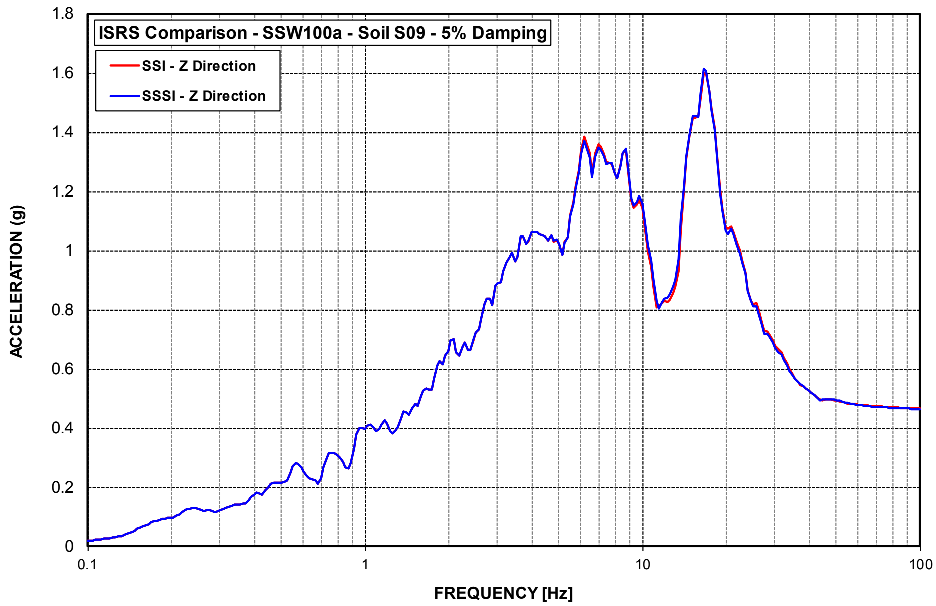


Figure A-109 ISRS – Secondary Shield Wall (SSW100a) at El. 100' – S09 – Vertical Direction

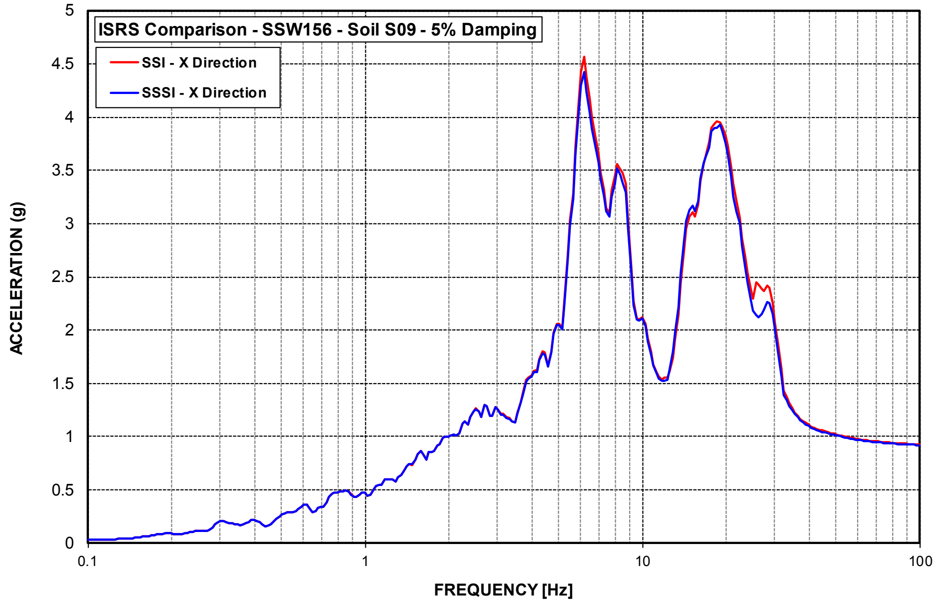


Figure A-110 ISRS – Secondary Shield Wall (SSW156) at El. 156' – S09 – EW Direction

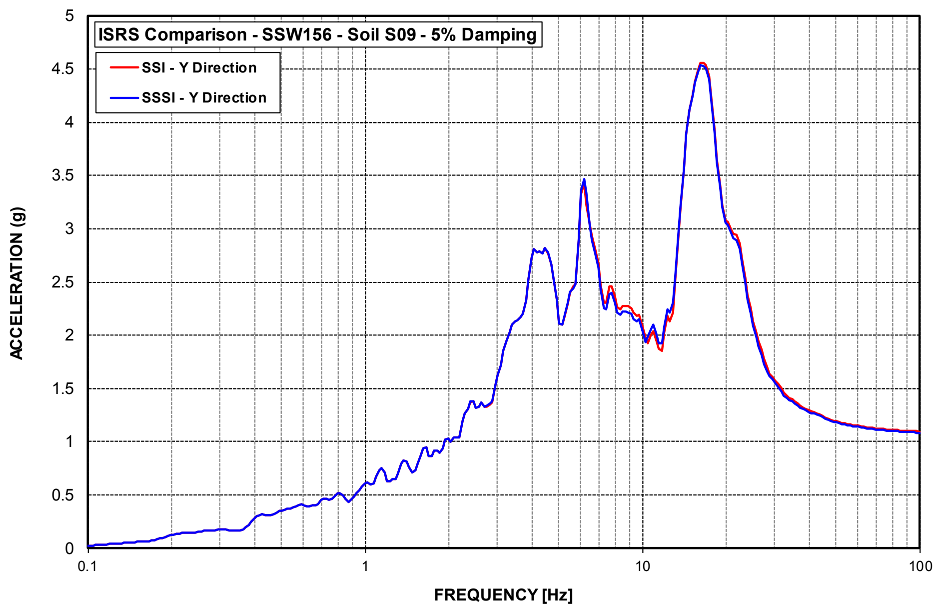


Figure A-111 ISRS – Secondary Shield Wall (SSW156) at El. 156' – S09 – NS Direction

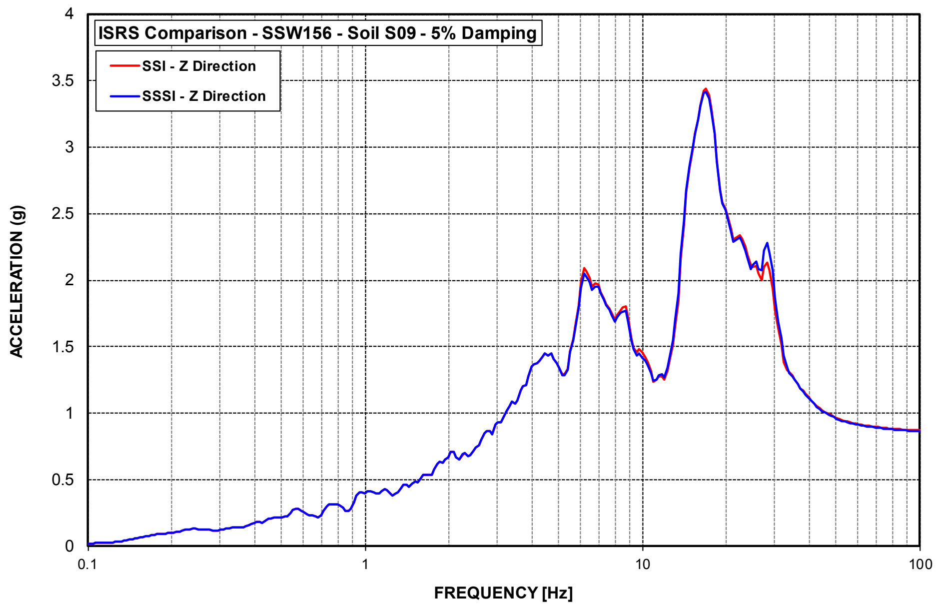


Figure A-112 ISRS – Secondary Shield Wall (SSW156) at El. 156’ – S09 – Vertical Direction

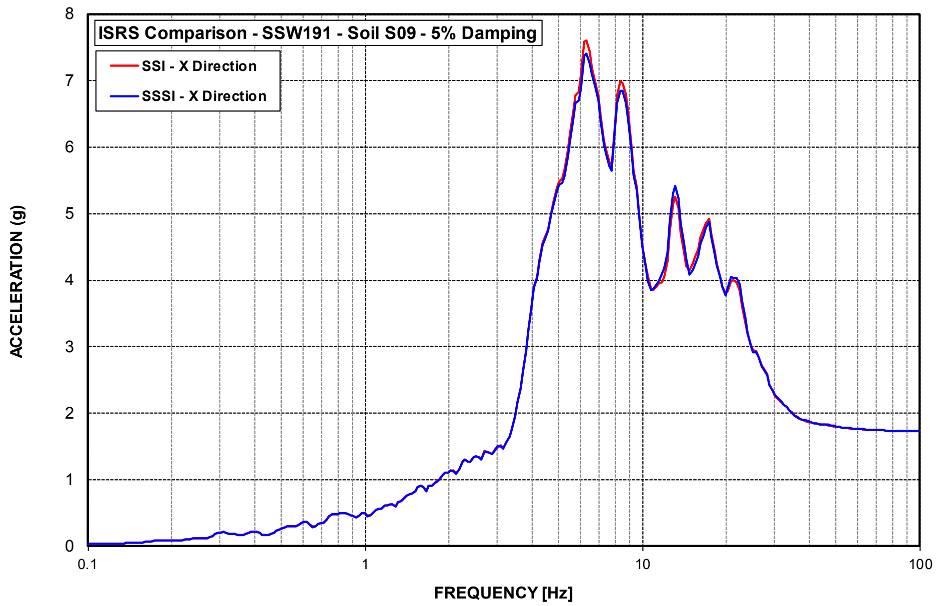


Figure A-113 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S09 – EW Direction

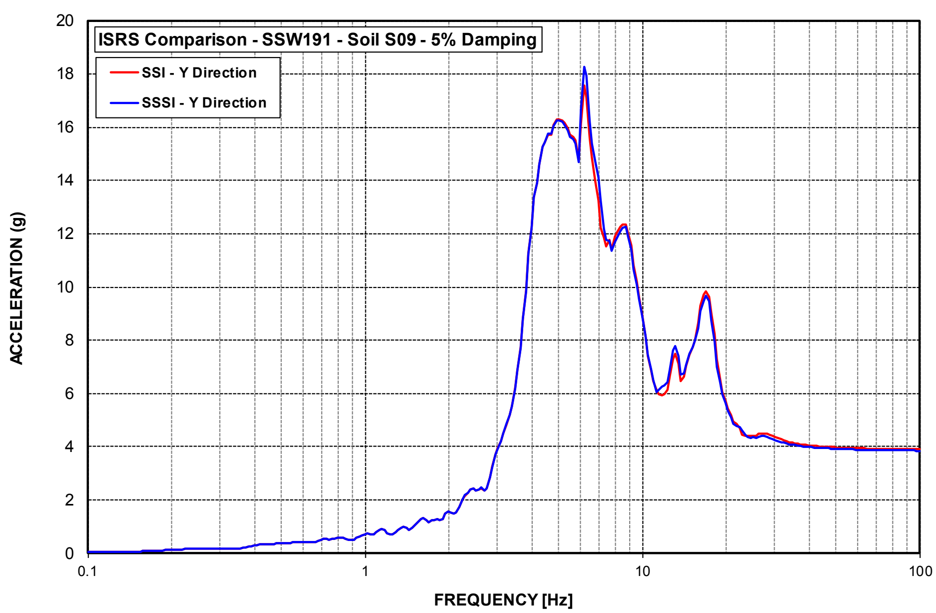


Figure A-114 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S09 – NS Direction

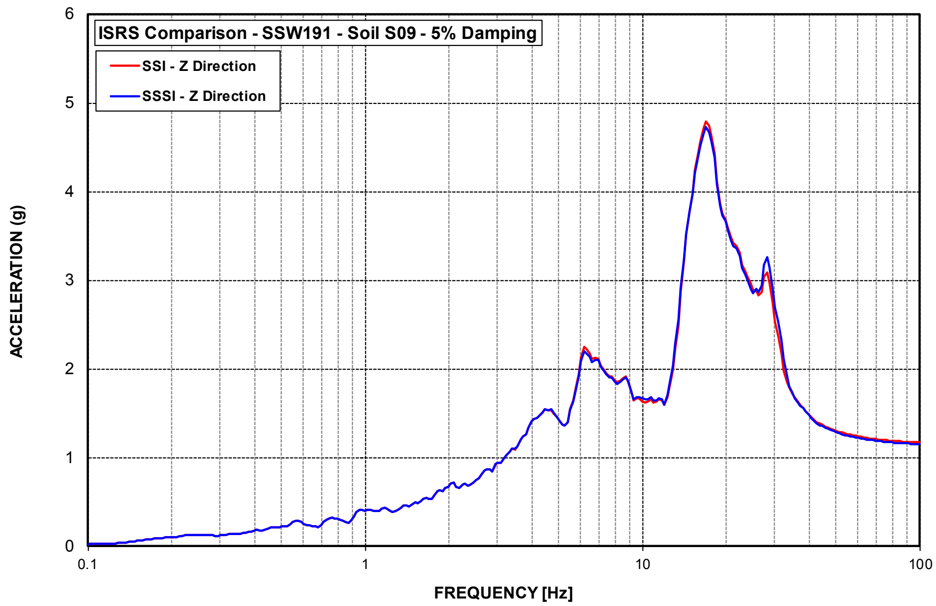


Figure A-115 ISRS – Secondary Shield Wall (SSW191) at El. 191' – S09 – Vertical Direction

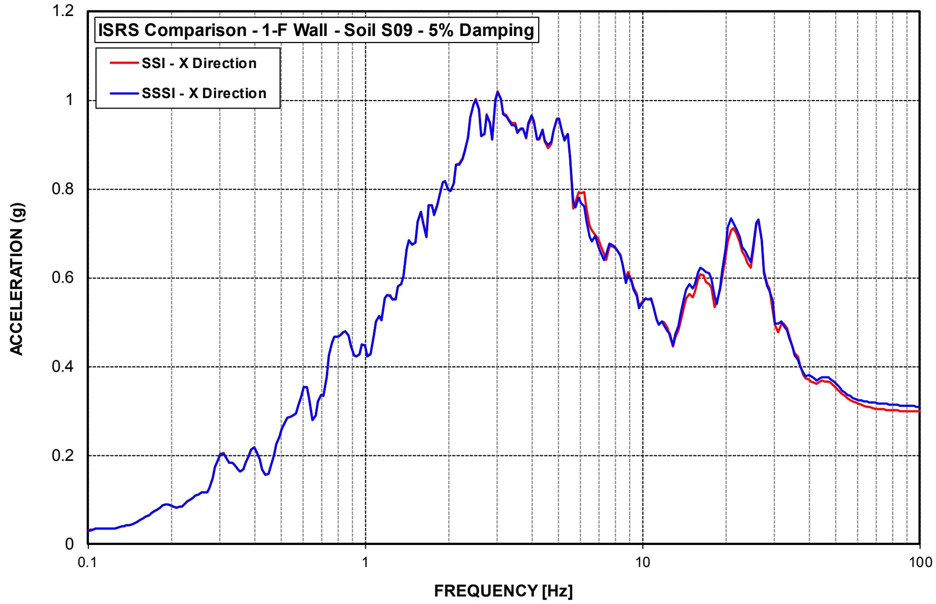


Figure A-116 ISRS – AB Shear Walls (1-F) at El. 55’ – S09 – EW Direction

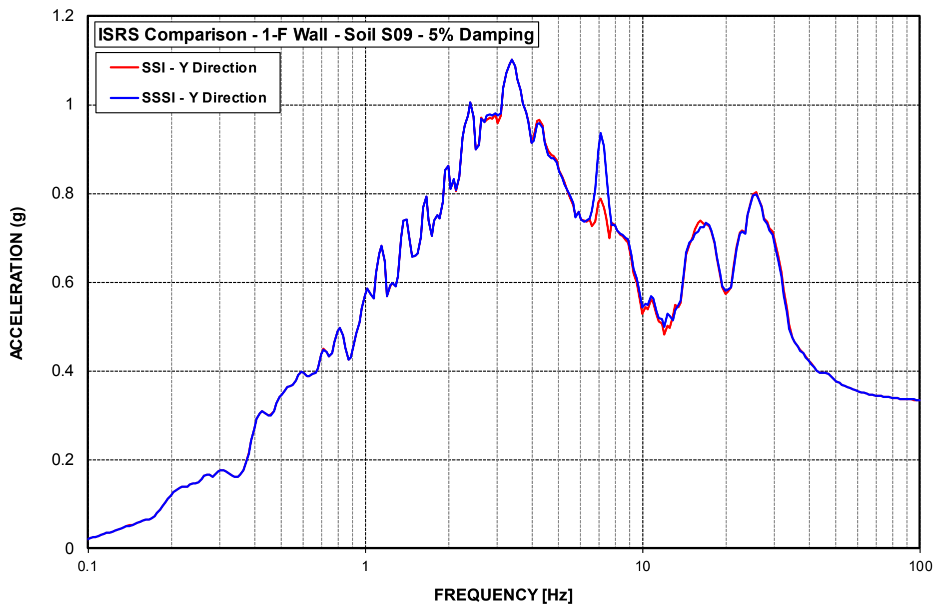


Figure A-117 ISRS – AB Shear Walls (1-F) at El. 55’ – S09 – NS Direction

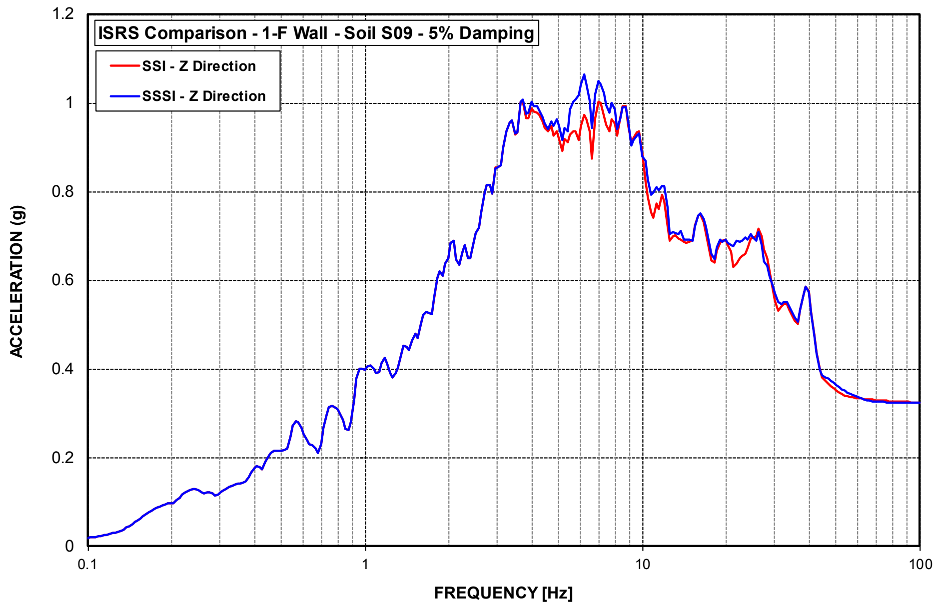


Figure A-118 ISRS – AB Shear Walls (1-F) at El. 55' – S09 – Vertical Direction

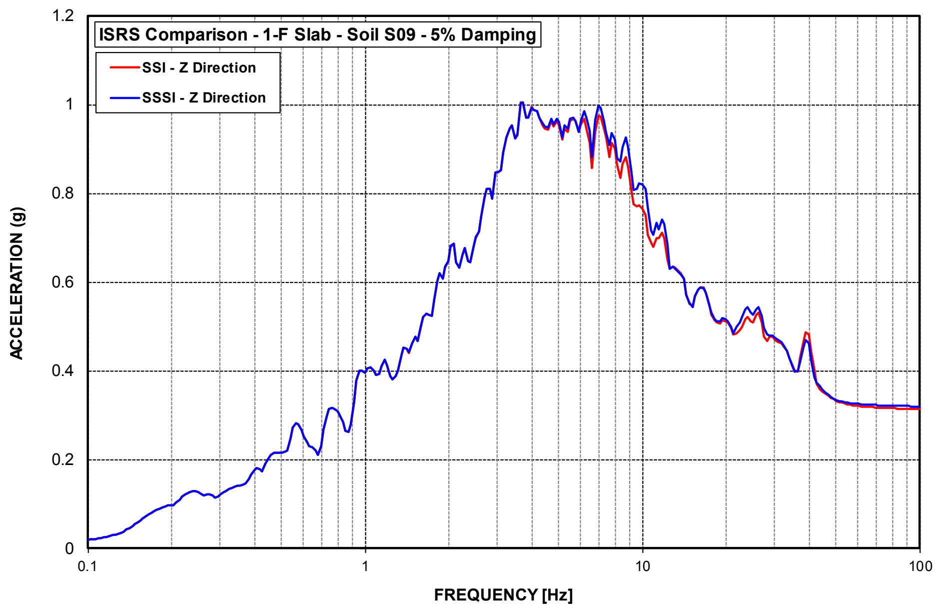


Figure A-119 ISRS – AB Floor Slabs (1-F) at El. 55' – S09 – Vertical Direction

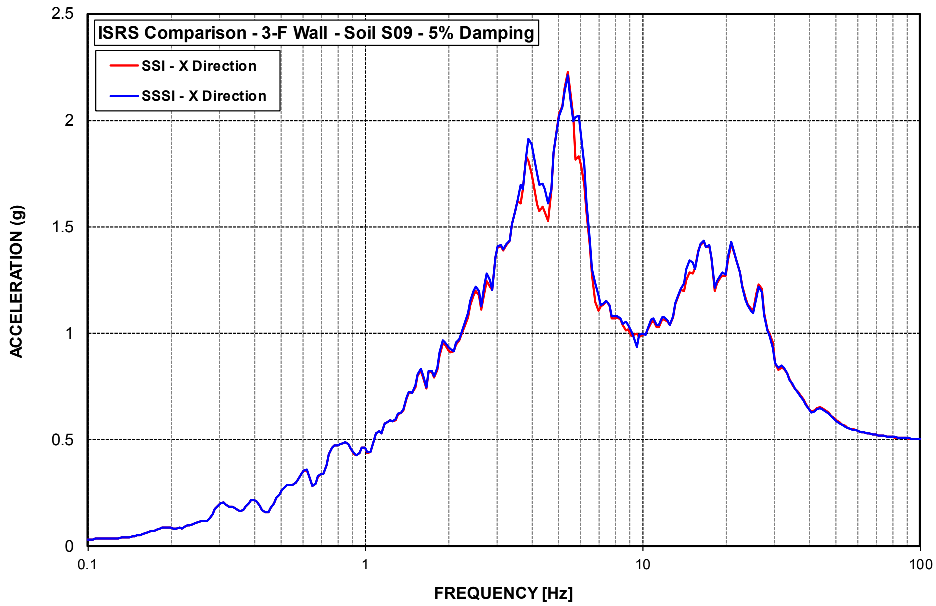


Figure A-120 ISRS – AB Shear Walls (3-F) at El. 100’ – S09 – EW Direction

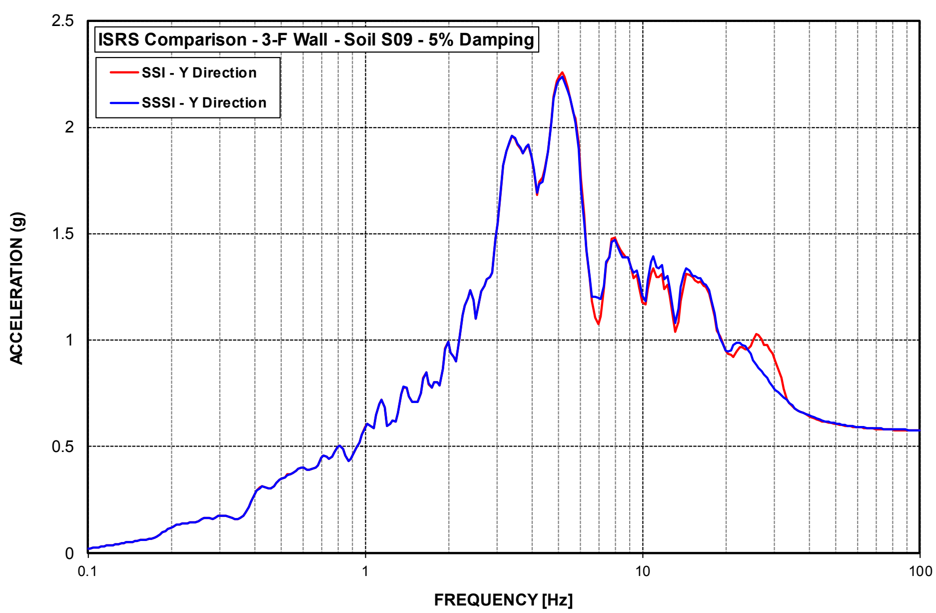


Figure A-121 ISRS – AB Shear Walls (3-F) at El. 100’ – S09 – NS Direction

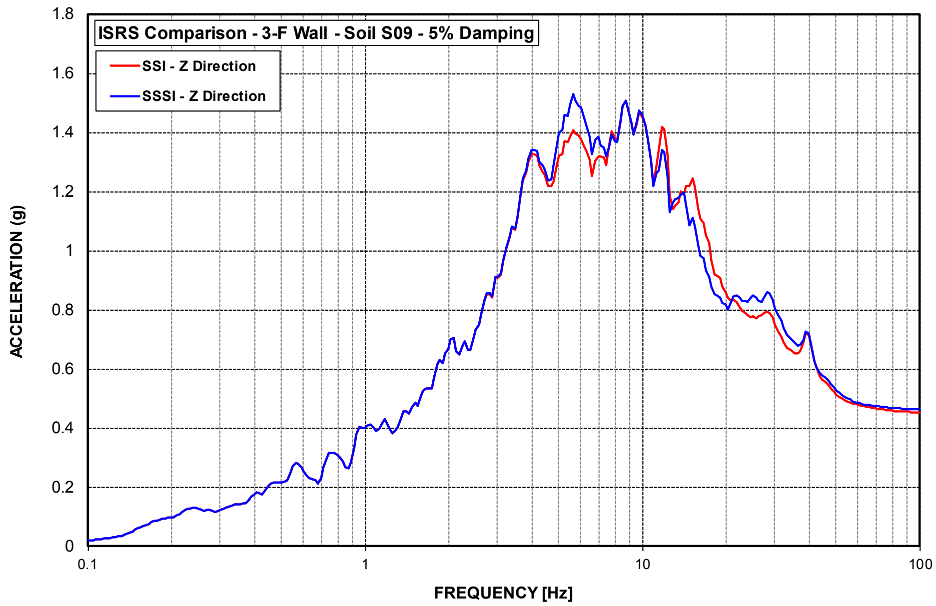


Figure A-122 ISRS – AB Shear Walls (3-F) at El. 100' – S09 – Vertical Direction

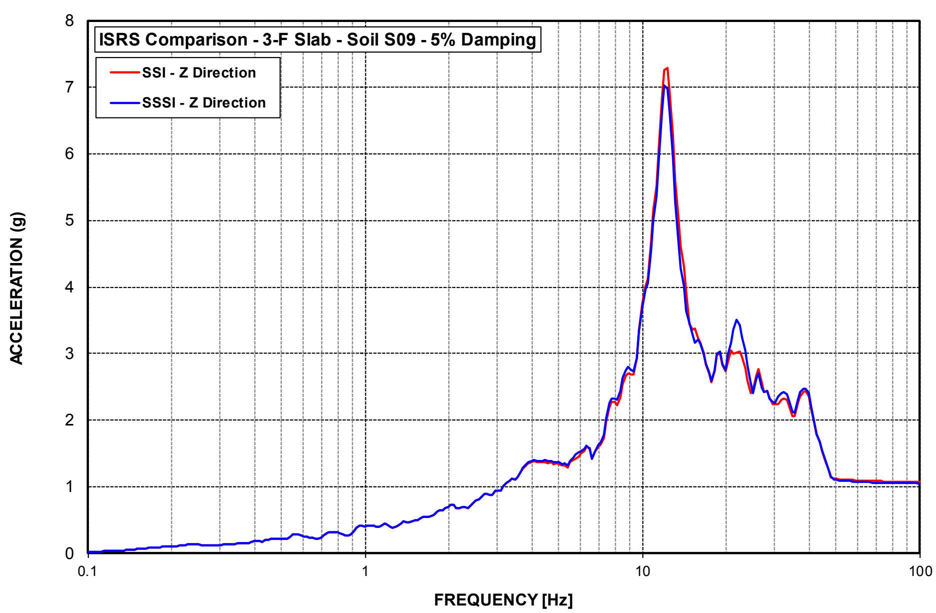


Figure A-123 ISRS – AB Floor Slabs (3-F) at El. 100' – S09 – Vertical Direction

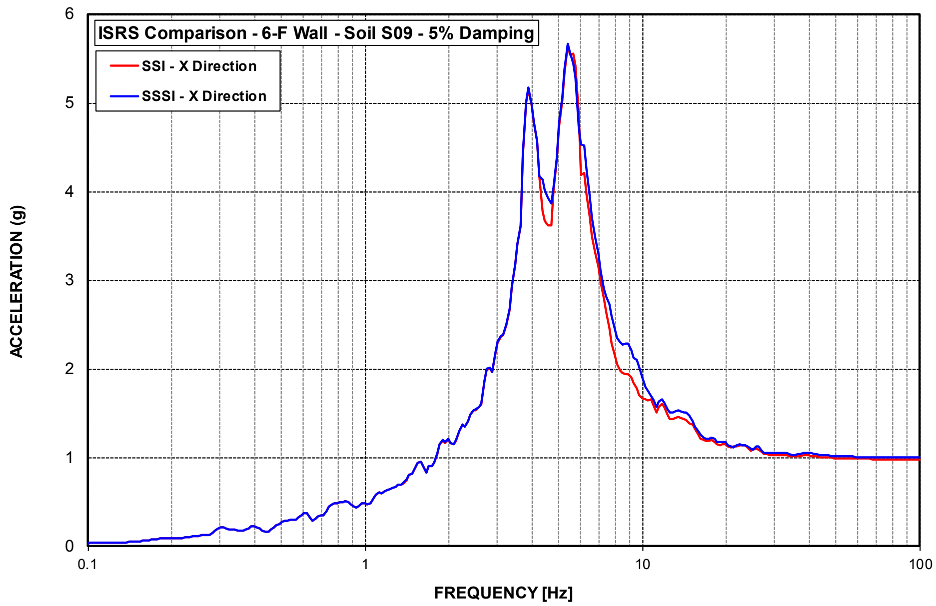


Figure A-124 ISRS – AB Shear Walls (6-F) at El. 156' – S09 – EW Direction

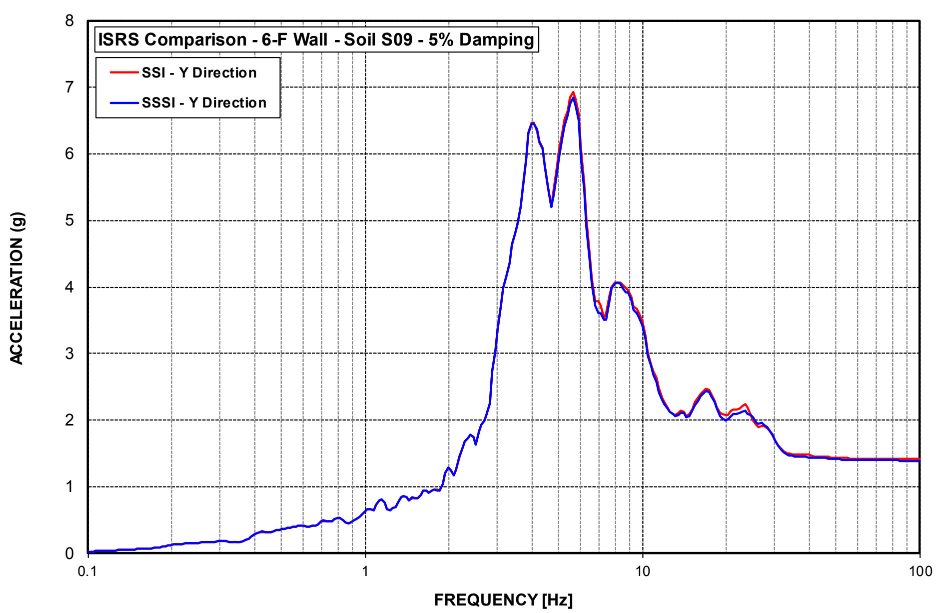


Figure A-125 ISRS – AB Shear Walls (6-F) at El. 156' – S09 – NS Direction

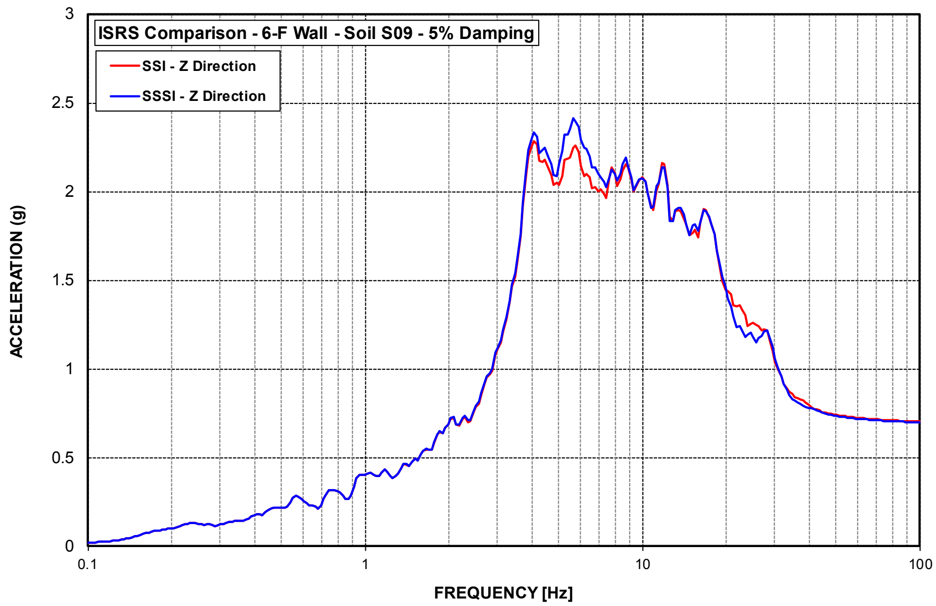


Figure A-126 ISRS – AB Shear Walls (6-F) at El. 156' – S09 – Vertical Direction

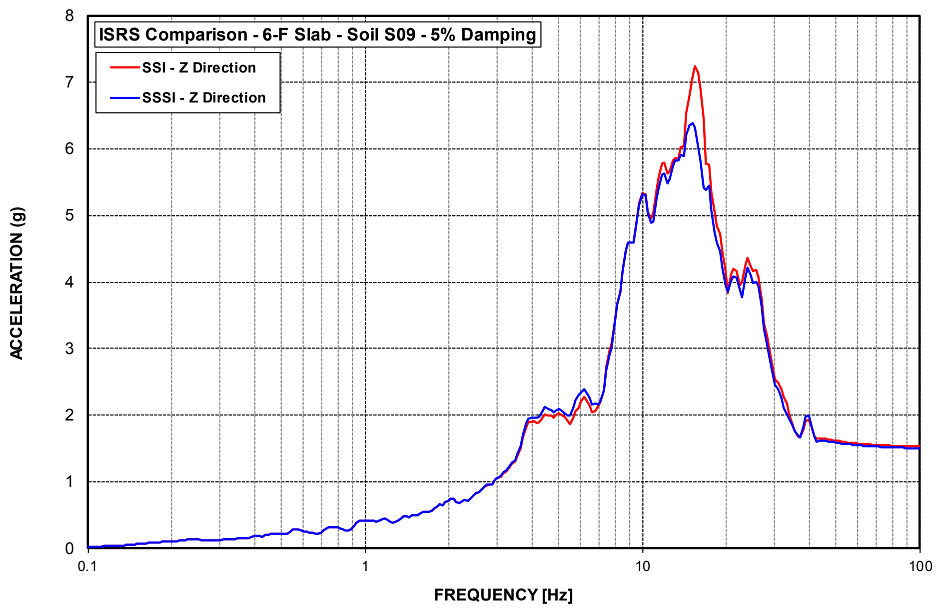


Figure A-127 ISRS – AB Floor Slabs (6-F) at El. 156' – S09 – Vertical Direction

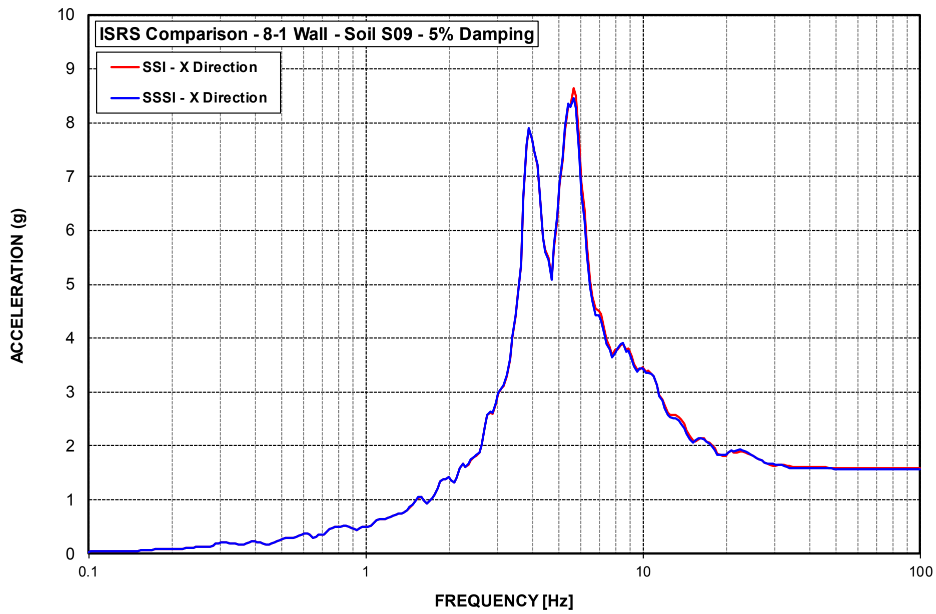


Figure A-128 ISRS – AB Shear Walls (8-1) at El. 195' – S09 – EW Direction

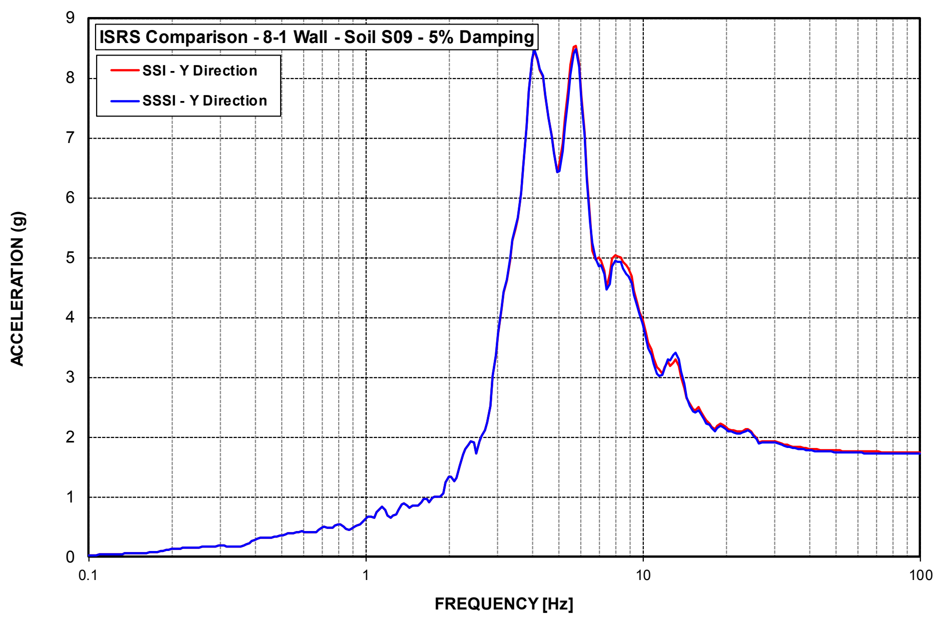


Figure A-129 ISRS – AB Shear Walls (8-1) at El. 195' – S09 – NS Direction

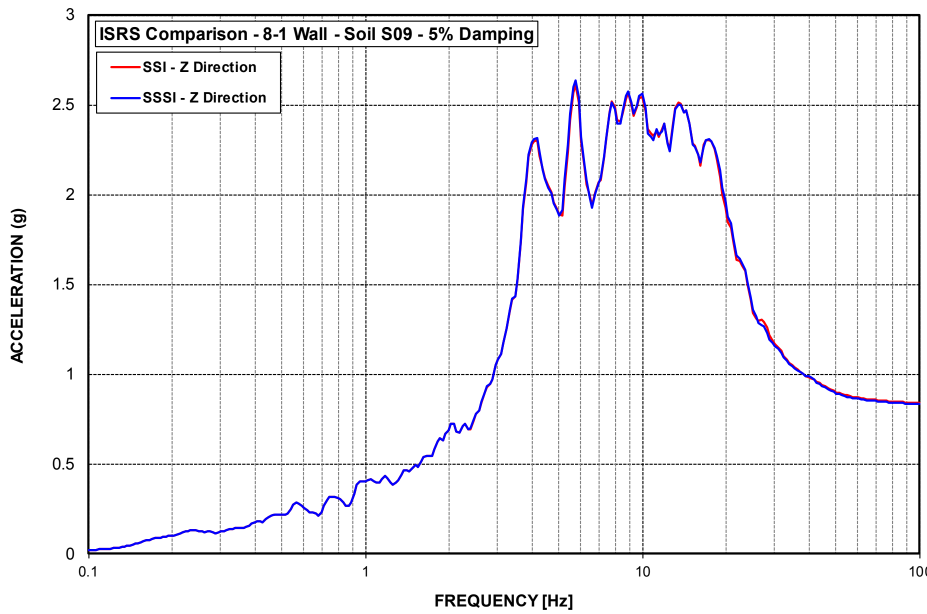


Figure A-130 ISRS – AB Shear Walls (8-1) at El. 195' – S09 – Vertical Direction

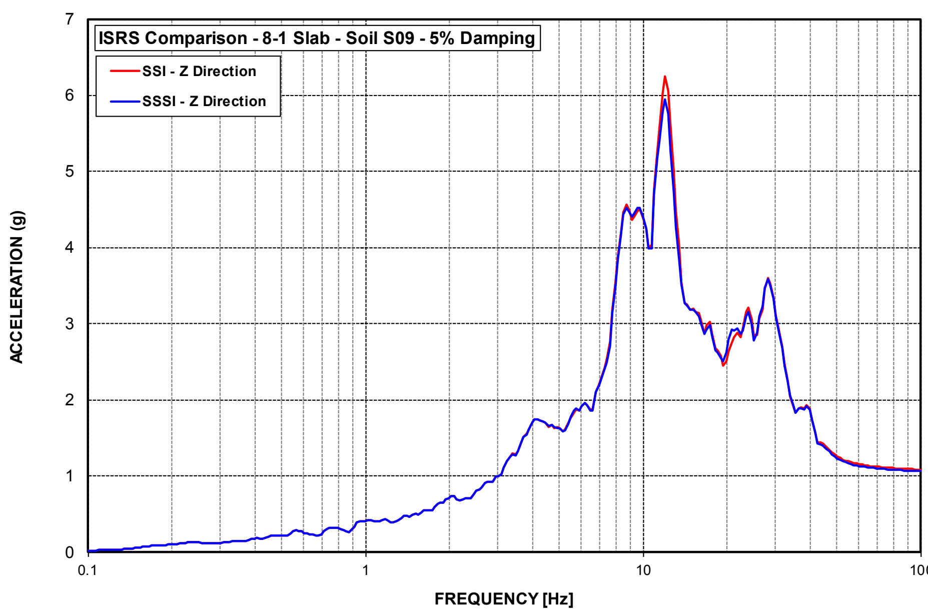


Figure A-131 ISRS – AB Floor Slabs (8-1) at El. 195' – S09 – Vertical Direction

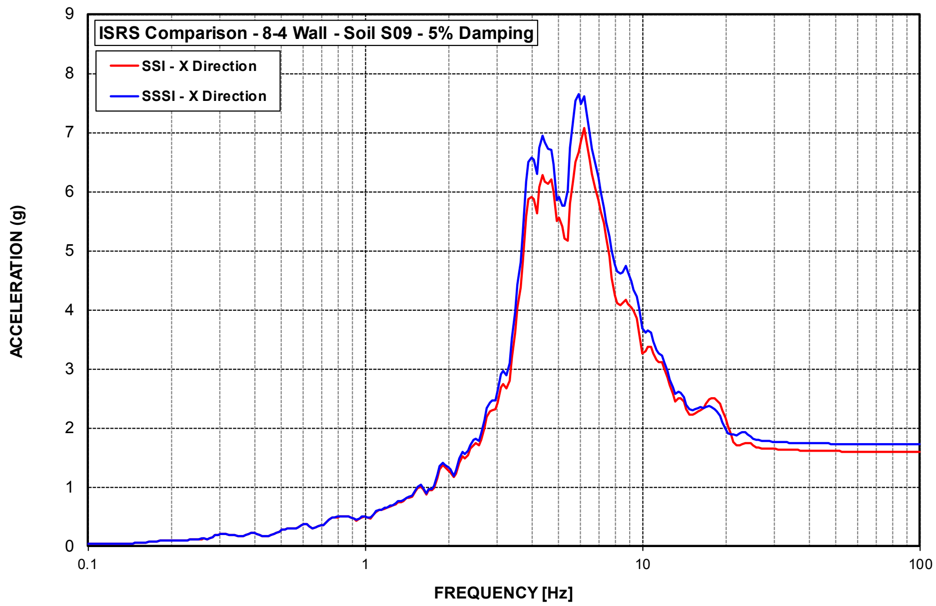


Figure A-132 ISRS – AB Shear Walls (8-4) at El. 213.5’ – S09 – EW Direction

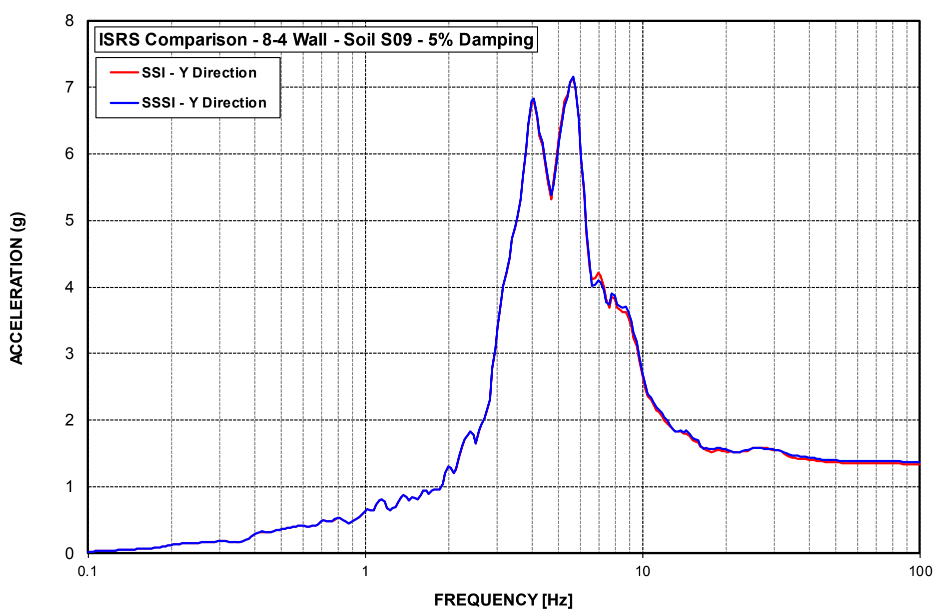


Figure A-133 ISRS – AB Shear Walls (8-4) at El. 213.5’ – S09 – NS Direction

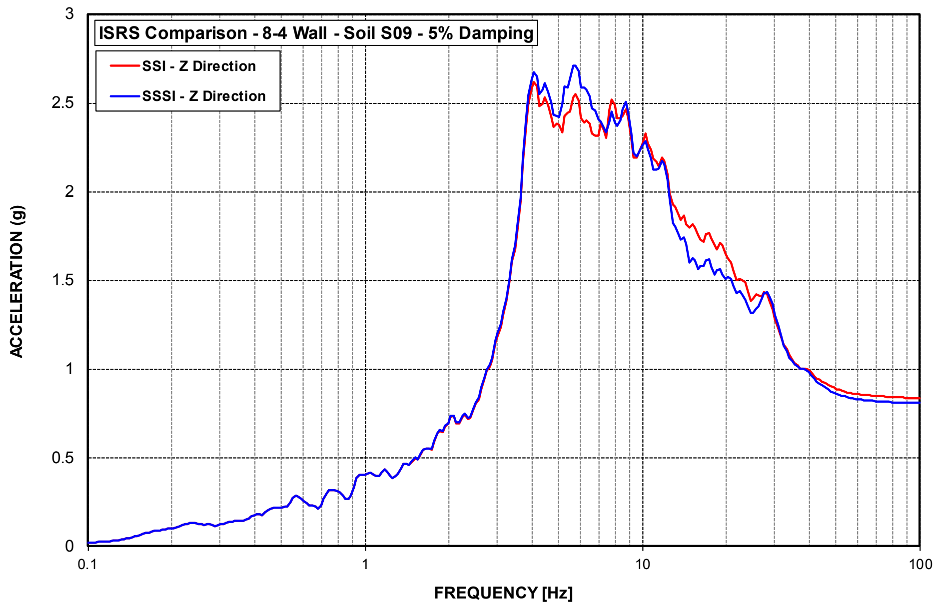


Figure A-134 ISRS – AB Shear Walls (8-4) at El. 213.5' – S09 – Vertical Direction

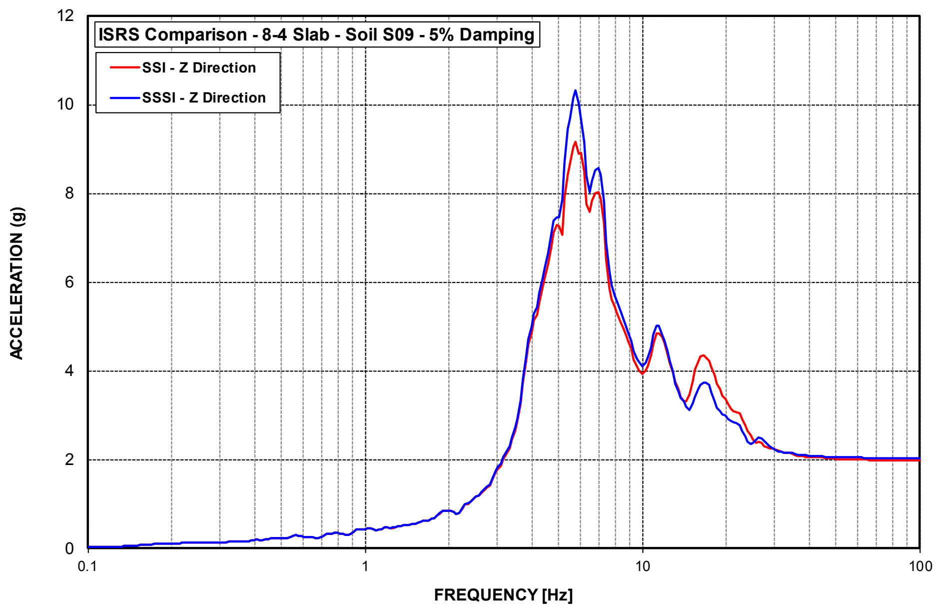


Figure A-135 ISRS – AB Floor Slabs (8-4) at El. 213.5' – S09 – Vertical Direction

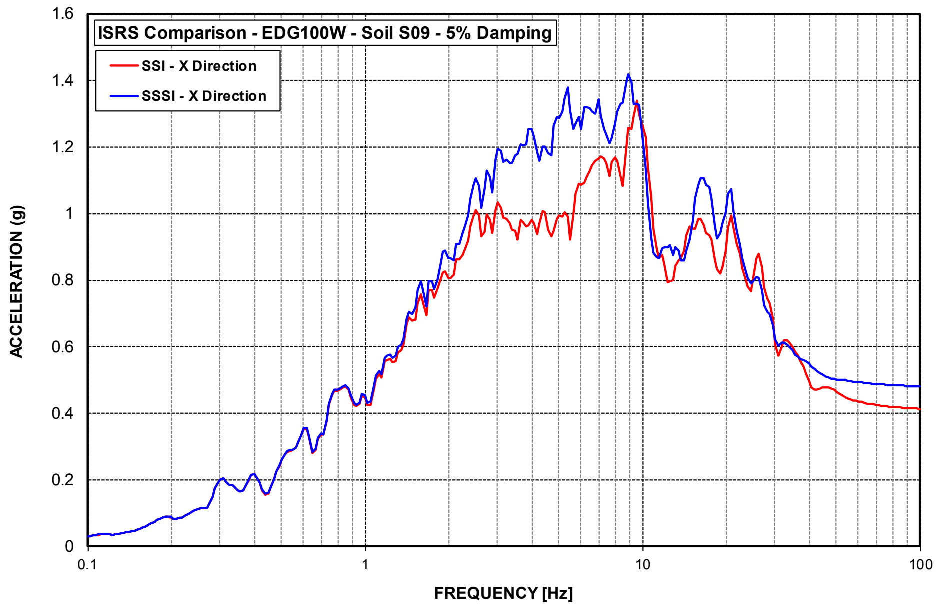


Figure A-136 ISRS – EDGB Wall (EDG100W) at El. 100' – S09 – EW Direction

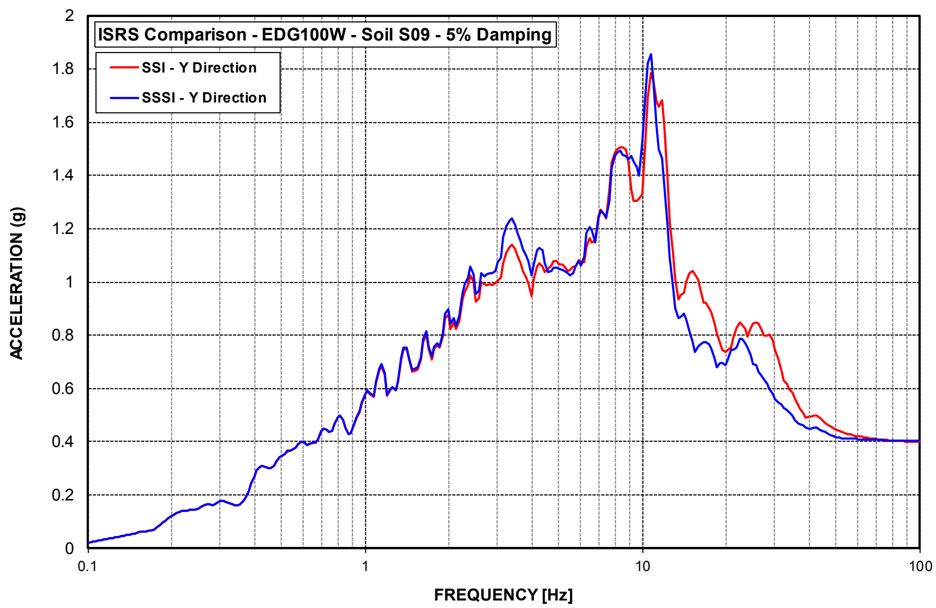


Figure A-137 ISRS – EDGB Wall (EDG100W) at El. 100' – S09 – NS Direction

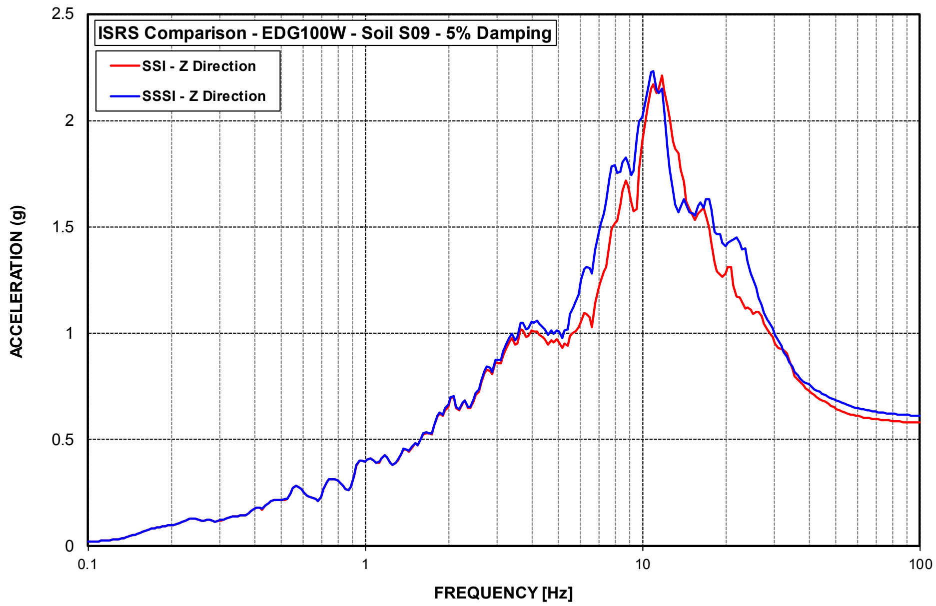


Figure A-138 ISRS – EDGB Wall (EDG100W) at El. 100' – S09 – Vertical Direction

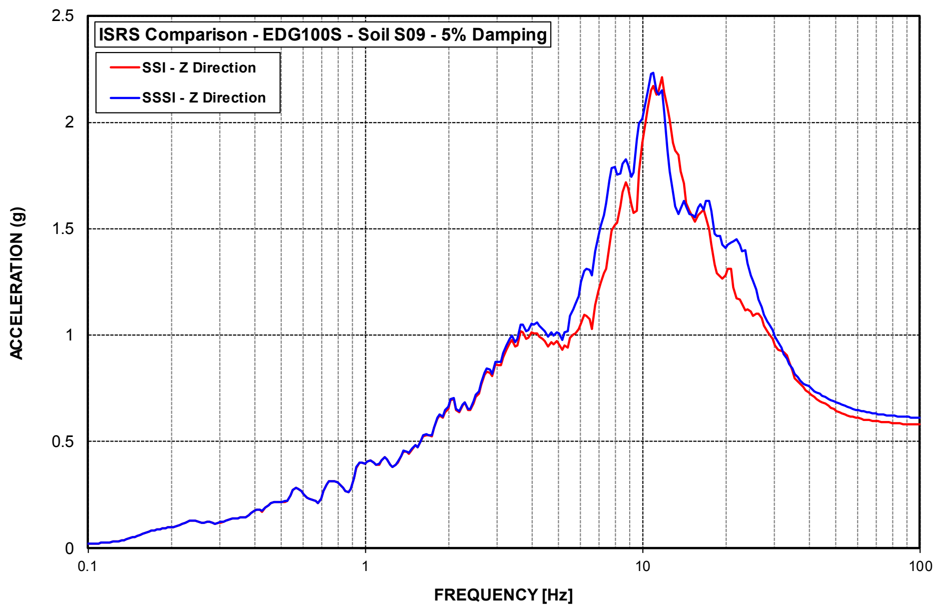


Figure A-139 ISRS – EDGB Slab (EDG100S) at El. 100' – S09 – Vertical Direction

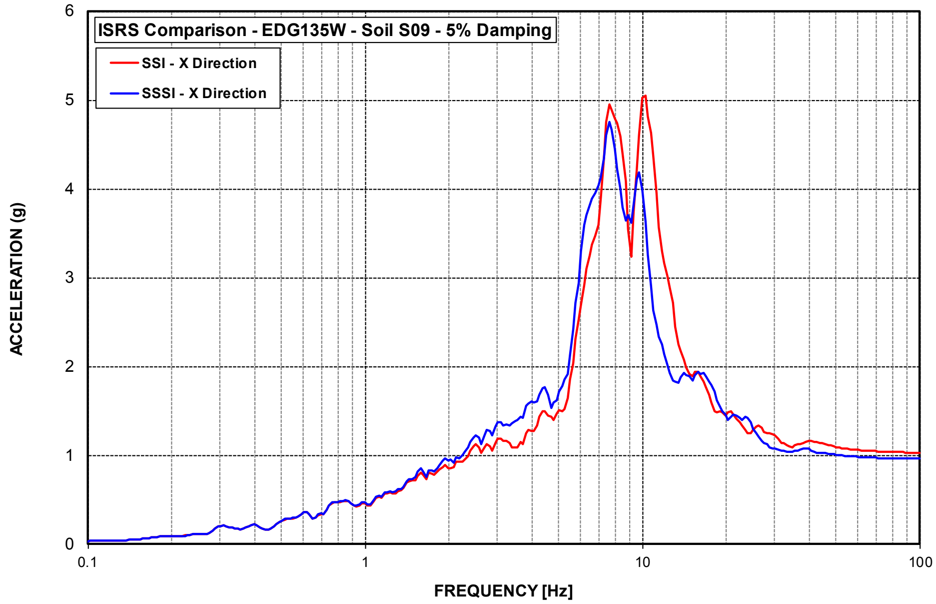


Figure A-140 ISRS – EDGB Wall (EDG135W) at El. 135' – S09 – EW Direction

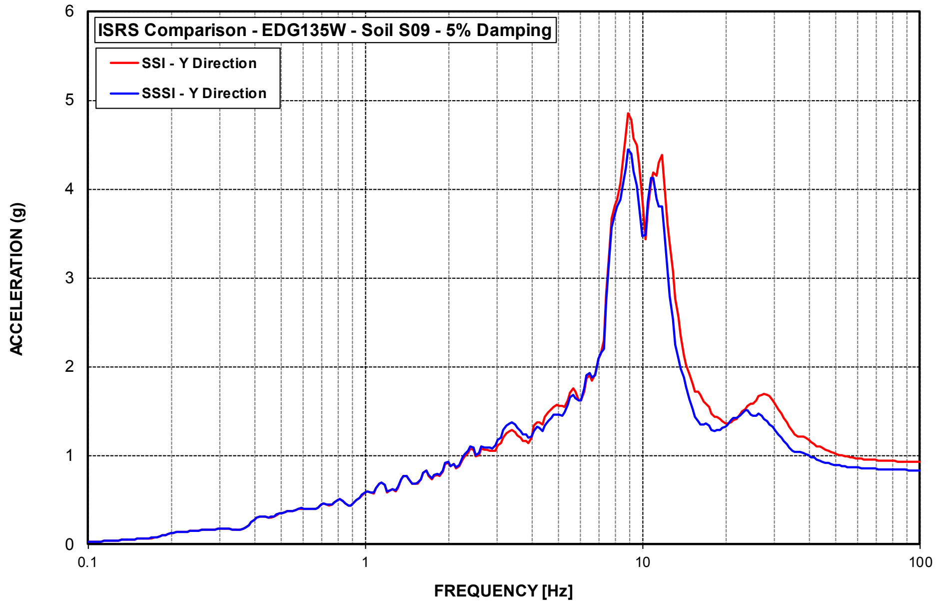


Figure A-141 ISRS – EDGB Wall (EDG135W) at El. 135' – S09 – NS Direction

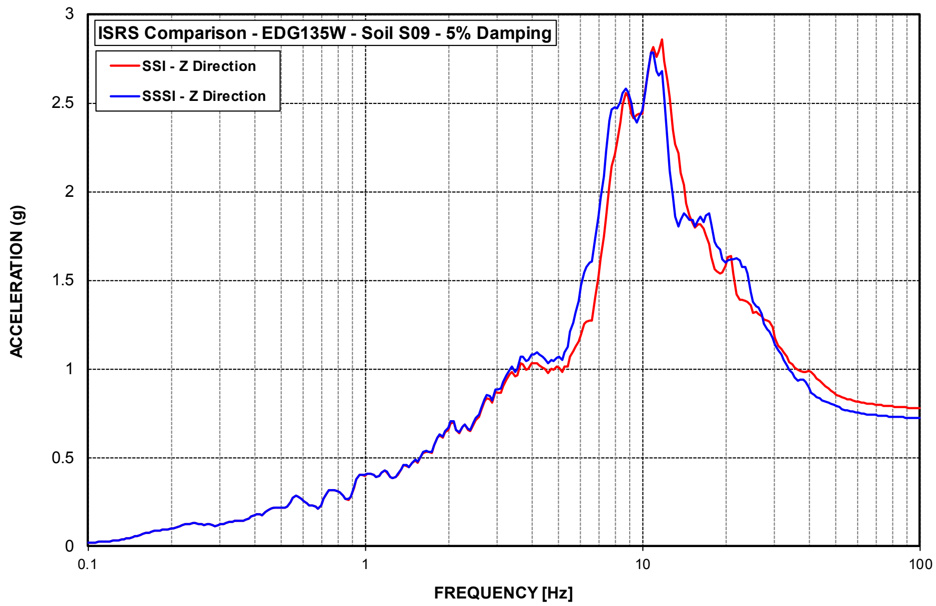


Figure A-142 ISRS – EDGB Wall (EDG135W) at El. 135’ – S09 – Vertical Direction

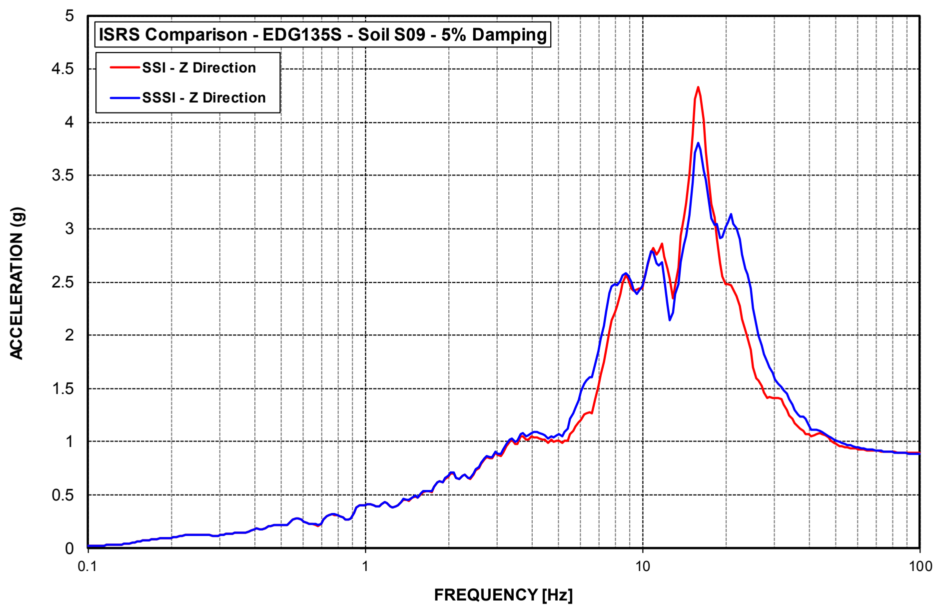


Figure A-143 ISRS – EDGB Slab (EDG135S) at El. 135’ – S09 – Vertical Direction

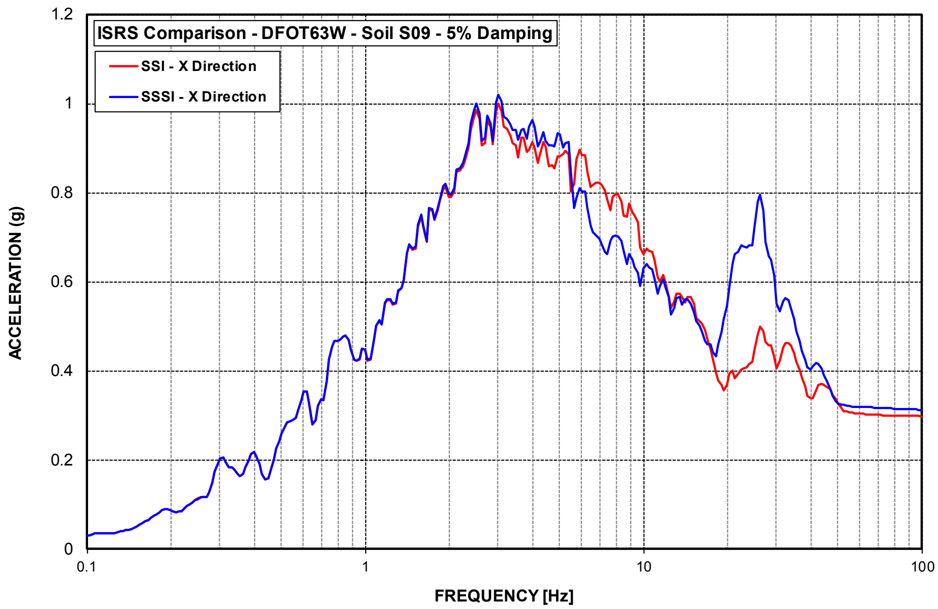


Figure A-144 ISRS – DFOT Room Wall (DFOT63W) at El. 63' – S09 – EW Direction

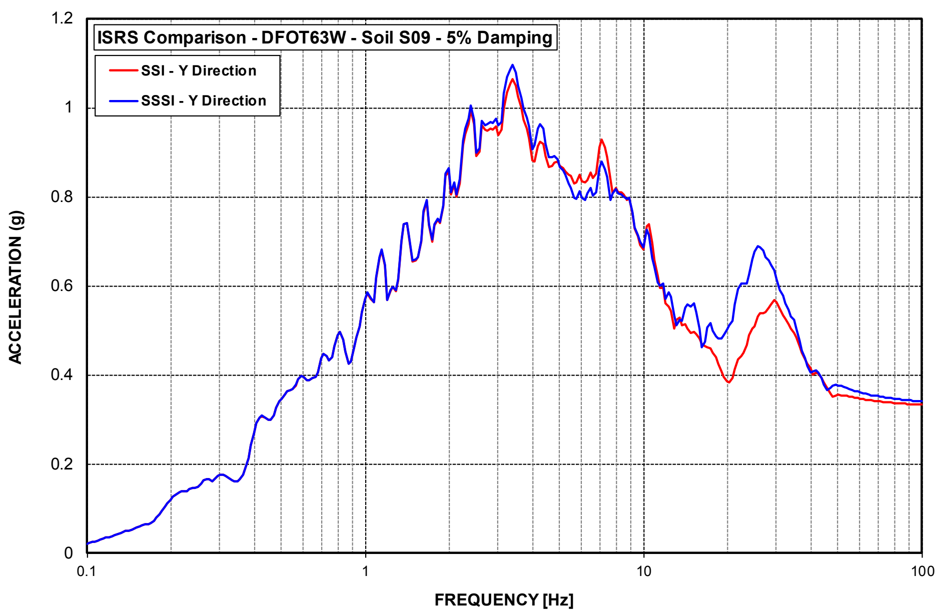


Figure A-145 ISRS – DFOT Room Wall (DFOT63W) at El. 63' – S09 – NS Direction

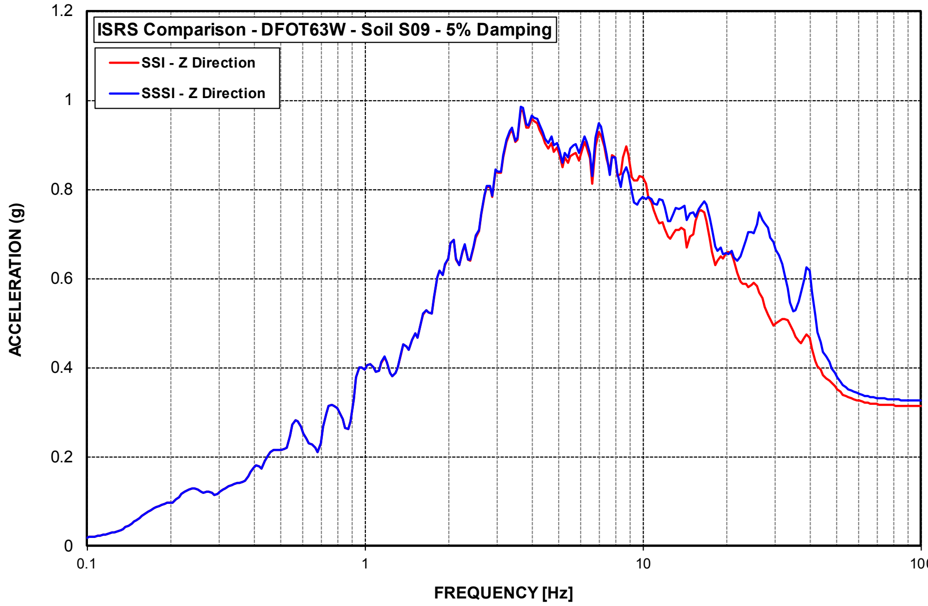


Figure A-146 ISRS – DFOT Room Wall (DFOT63W) at El. 63’ – S09 – Vertical Direction

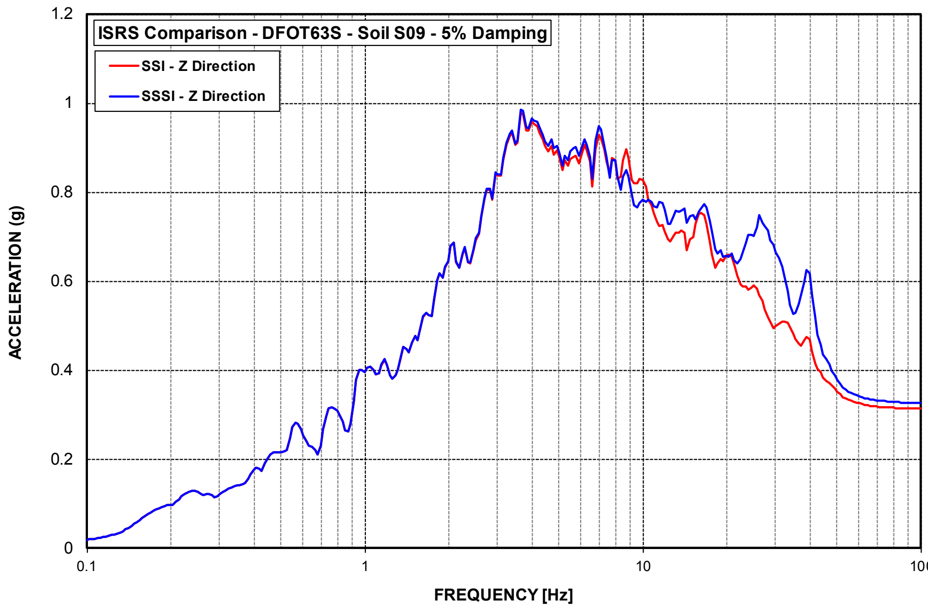


Figure A-147 ISRS – DFOT Room Slab (DFOT63S) at El. 63’ – S09 – Vertical Direction

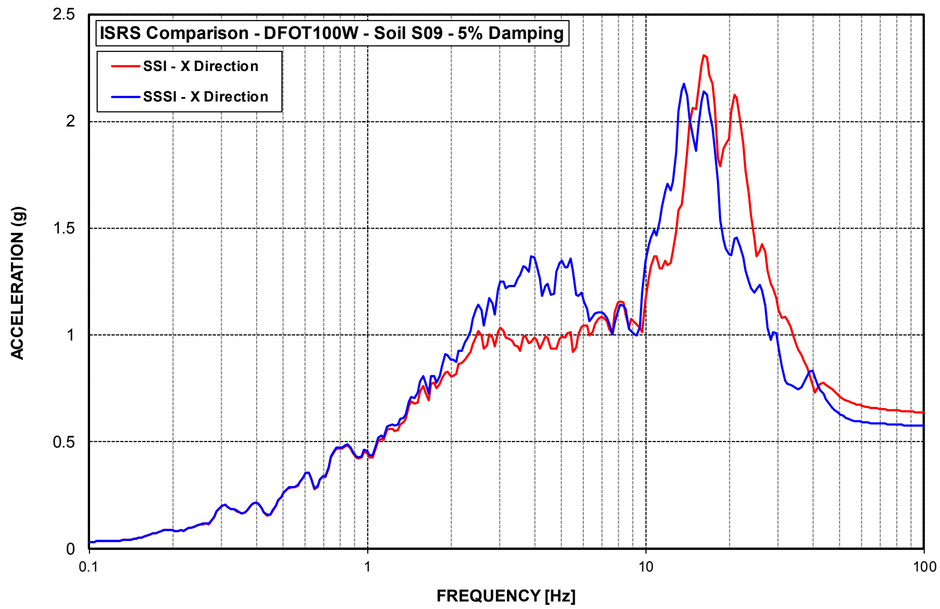


Figure A-148 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S09 – EW Direction

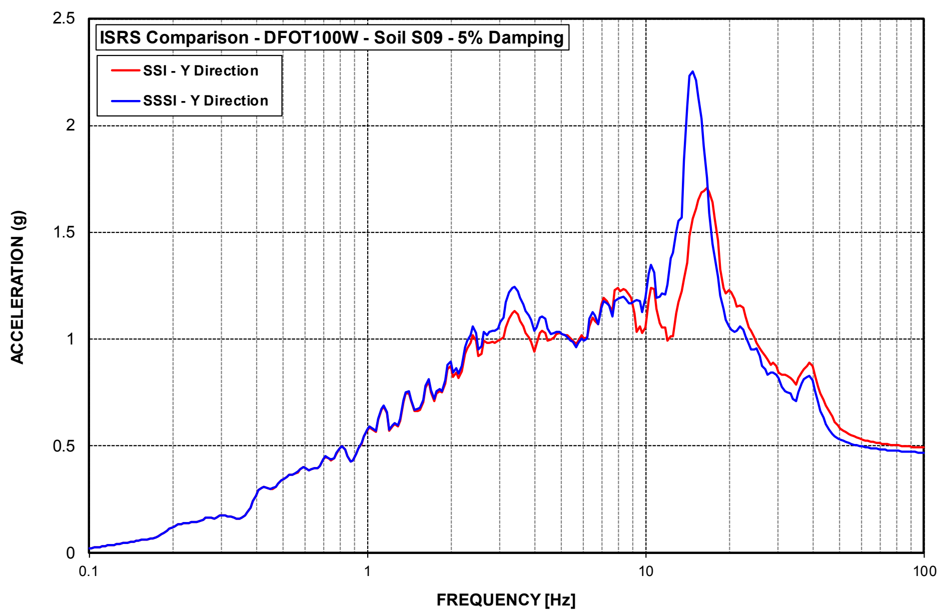


Figure A-149 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S09 – NS Direction

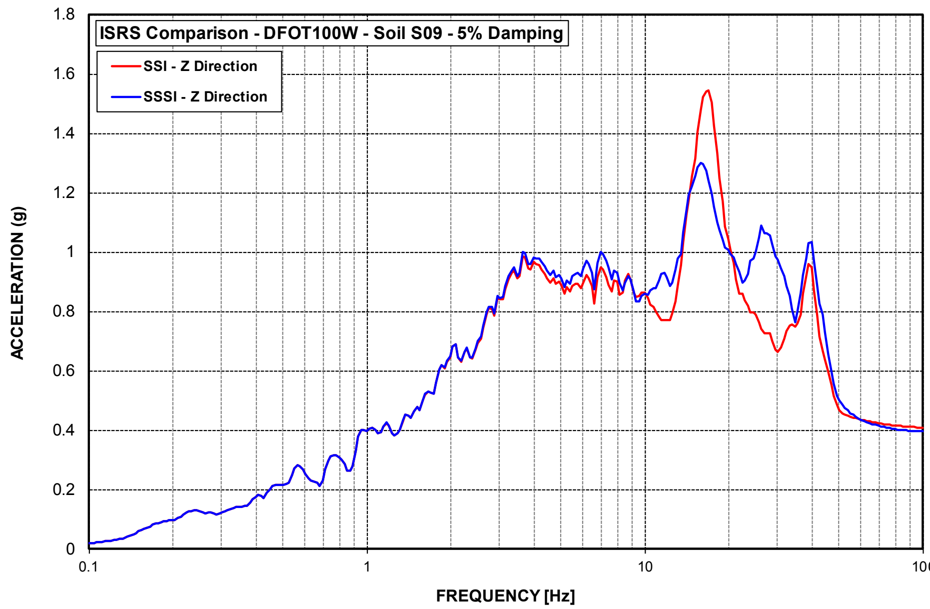


Figure A-150 ISRS – DFOT Room Wall (DFOT100W) at El. 100' – S09 – Vertical Direction

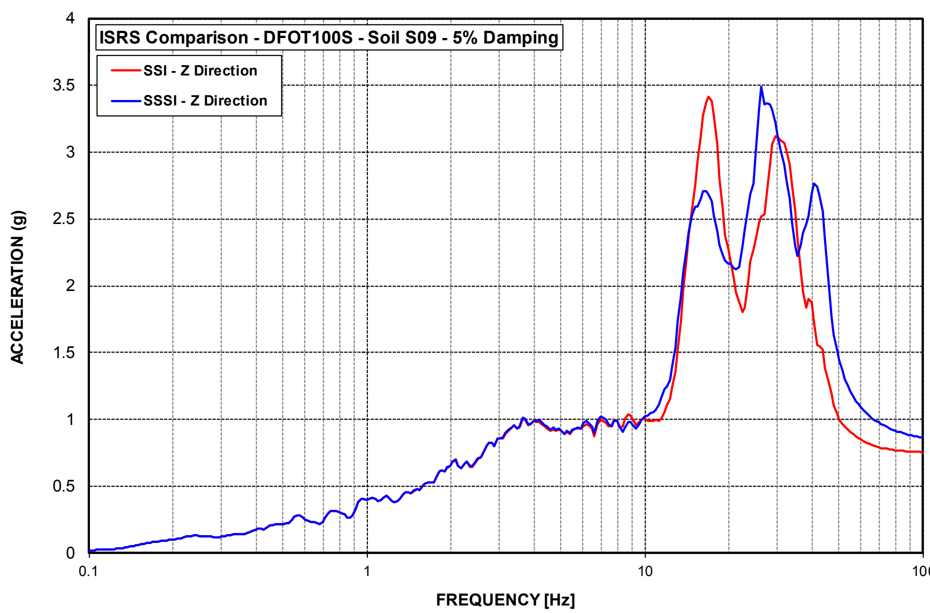


Figure A-151 ISRS – DFOT Room Slab (DFOT100S) at El. 100' – S09 – Vertical Direction

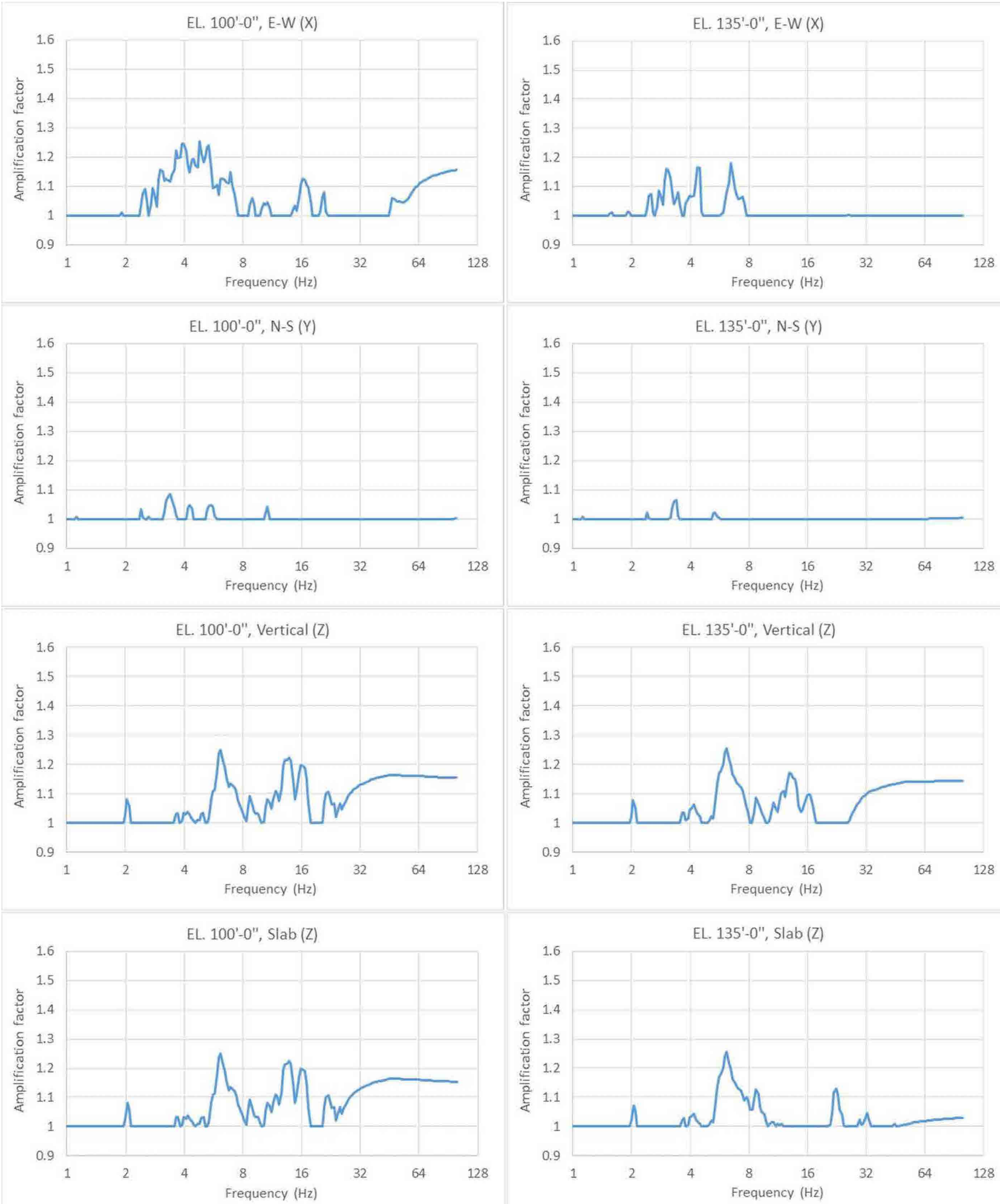


Figure A-152 Amplification Factor for EDGB Wall and Slab ISRS

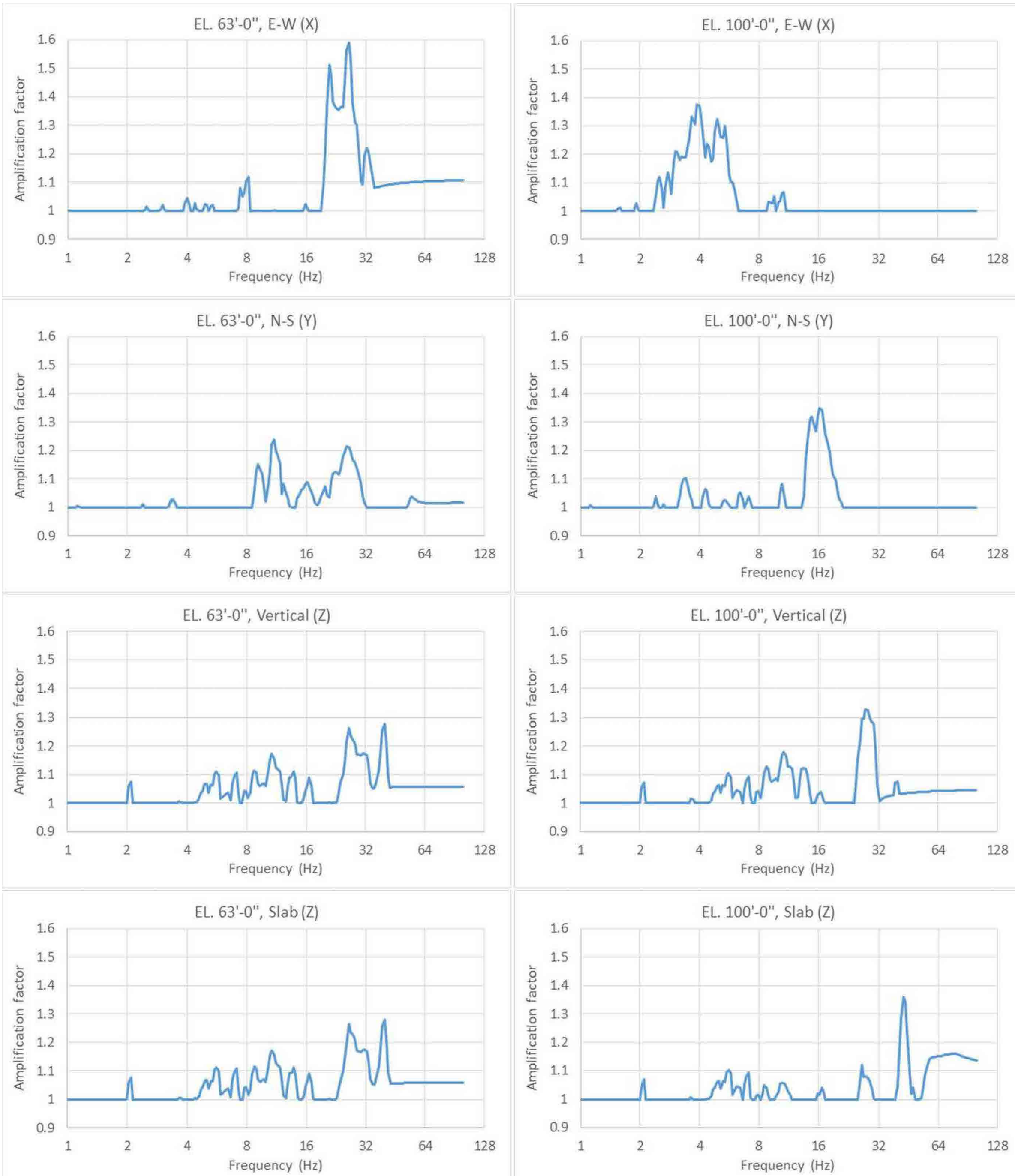


Figure A-153 Amplification Factor for DFOT Room Wall and Slab ISRS

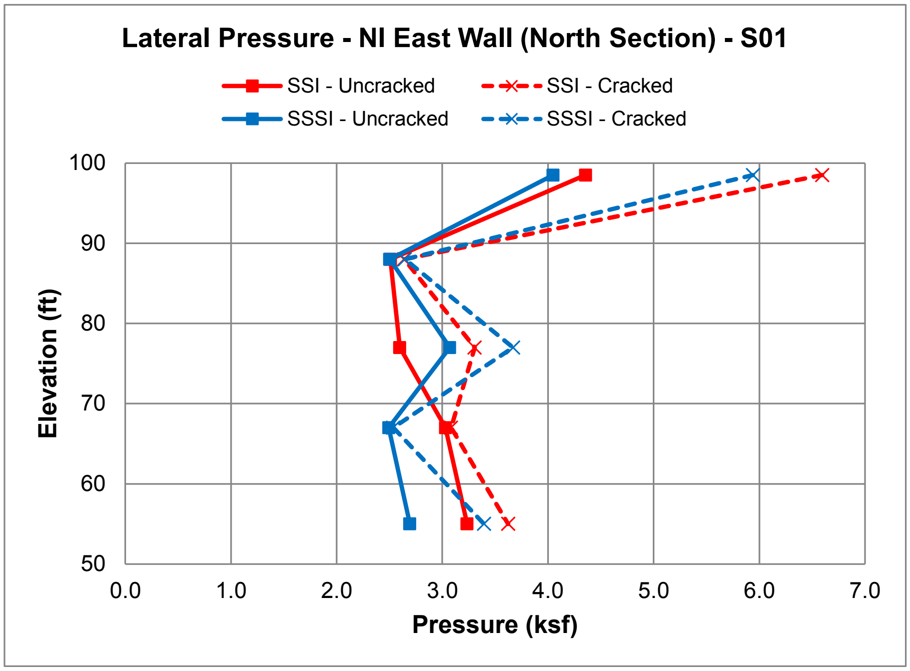


Figure A-154 Maximum Lateral Soil Pressures at NI East Wall (North Section) – S01

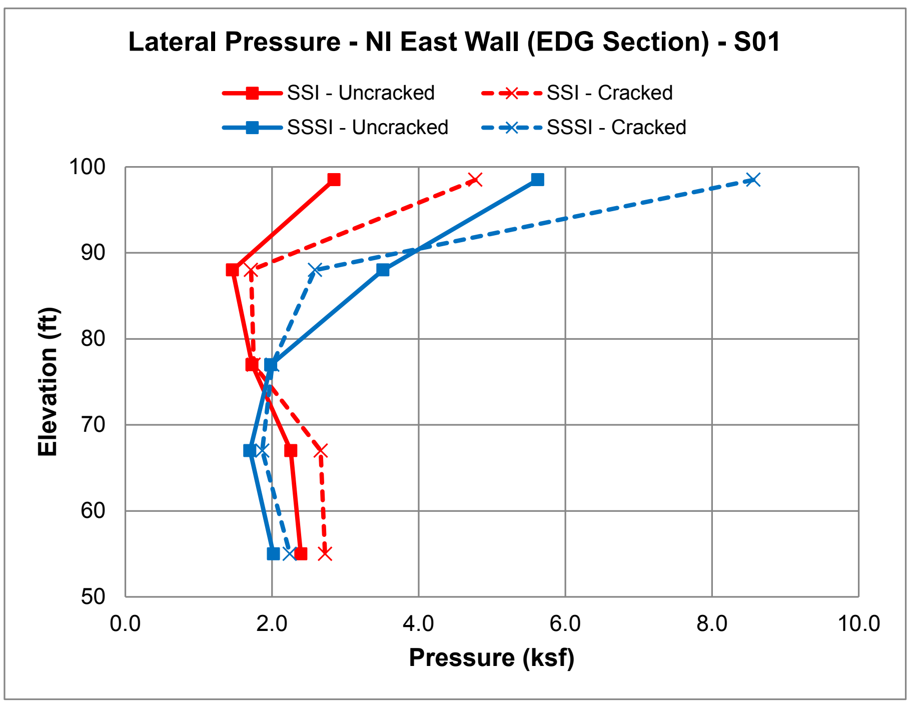


Figure A-155 Maximum Lateral Soil Pressures at NI East Wall (EDGB Section) – S01

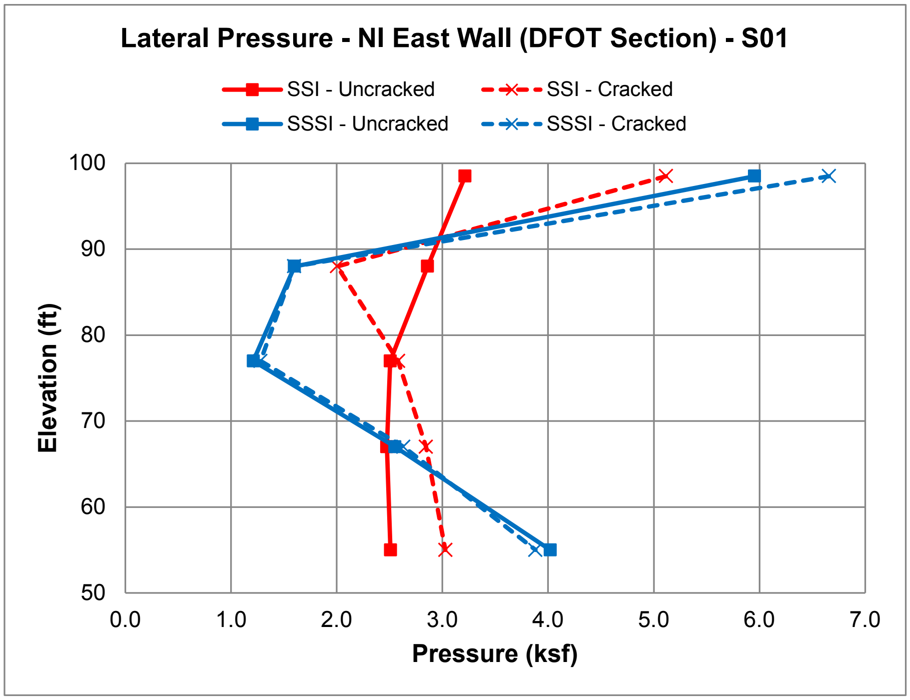


Figure A-156 Maximum Lateral Soil Pressures at NI East Wall (DFOT Room Section) – S01

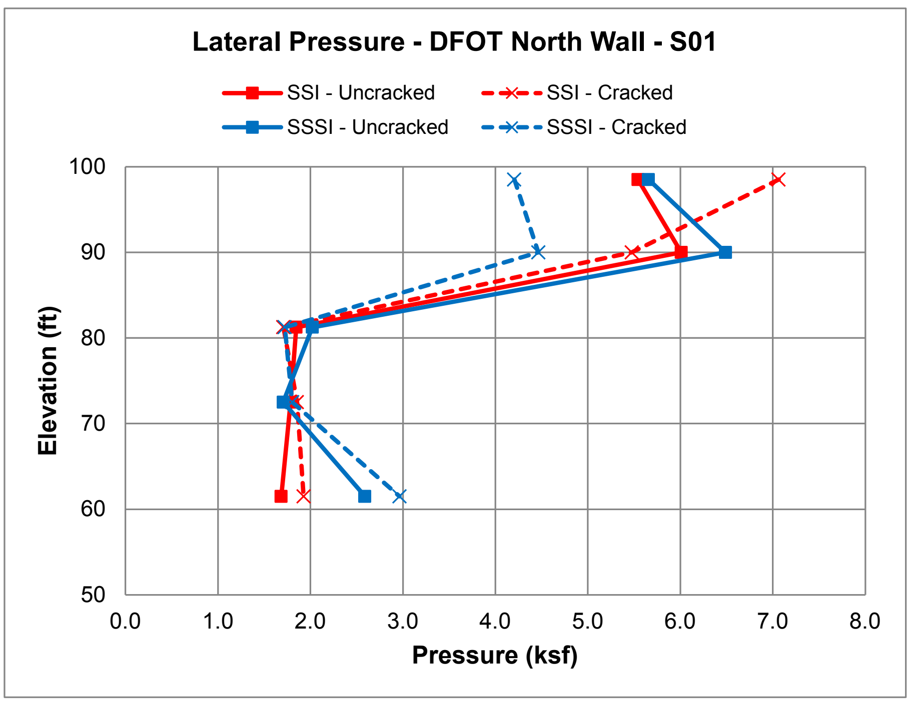


Figure A-157 Maximum Lateral Soil Pressures at DFOT Room North Wall – S01

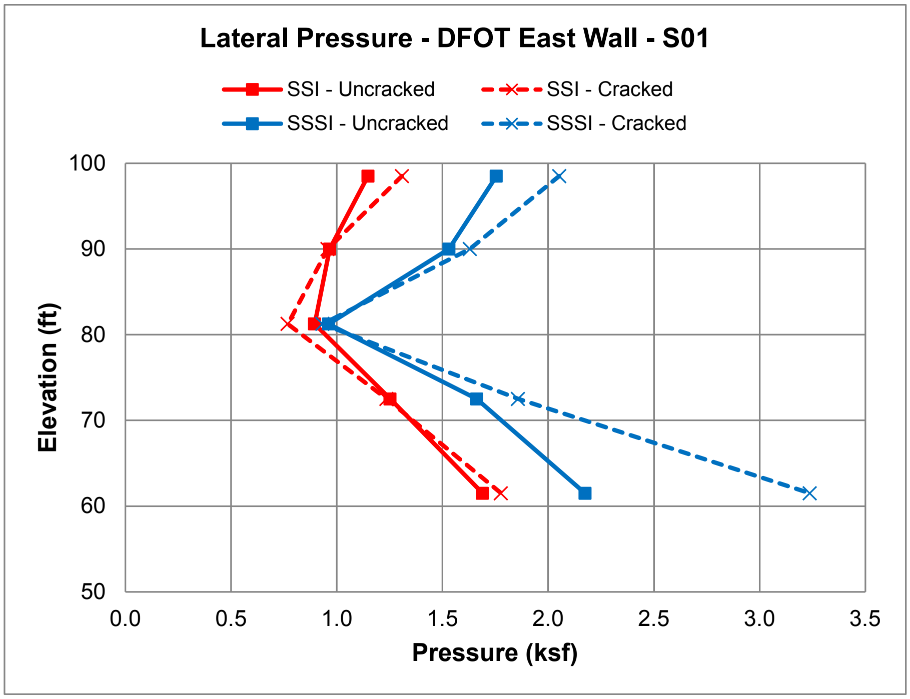


Figure A-158 Maximum Lateral Soil Pressures at DFOT Room East Wall – S01

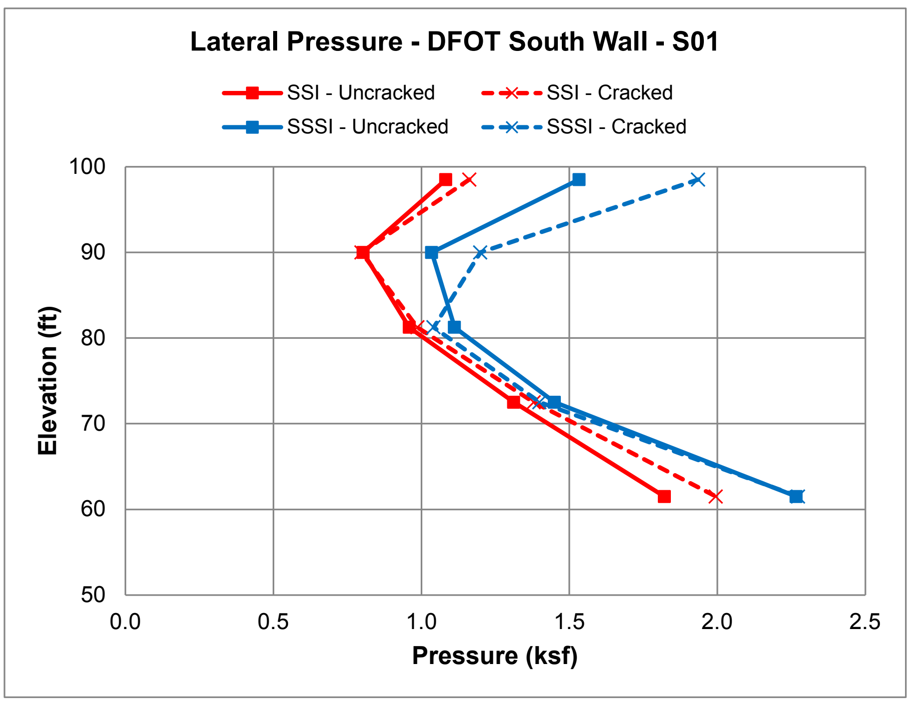


Figure A-159 Maximum Lateral Soil Pressures at DFOT Room South Wall – S01

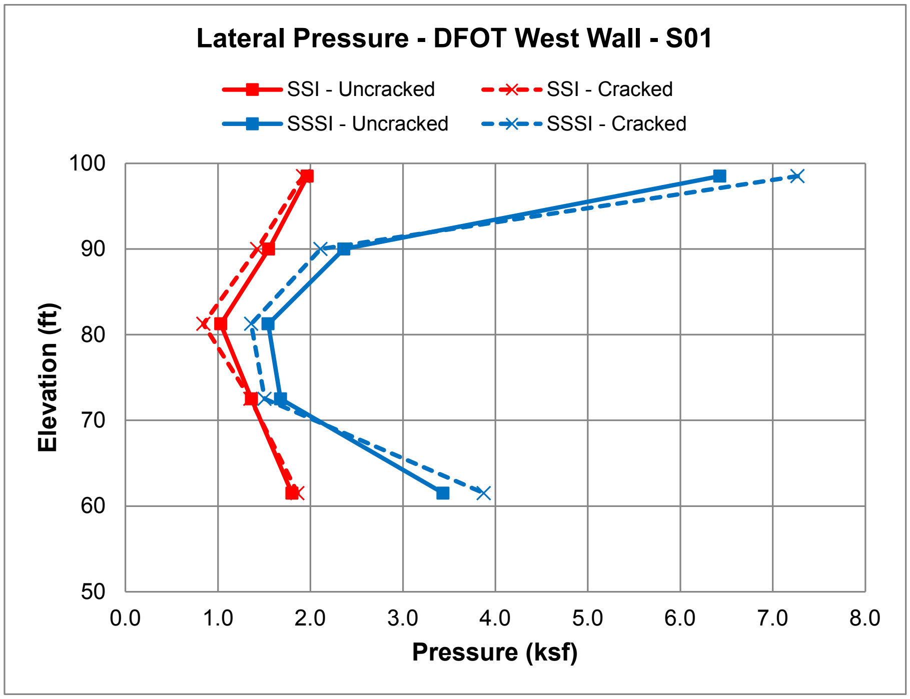


Figure A-160 Maximum Lateral Soil Pressures at DFOT Room West Wall – S01

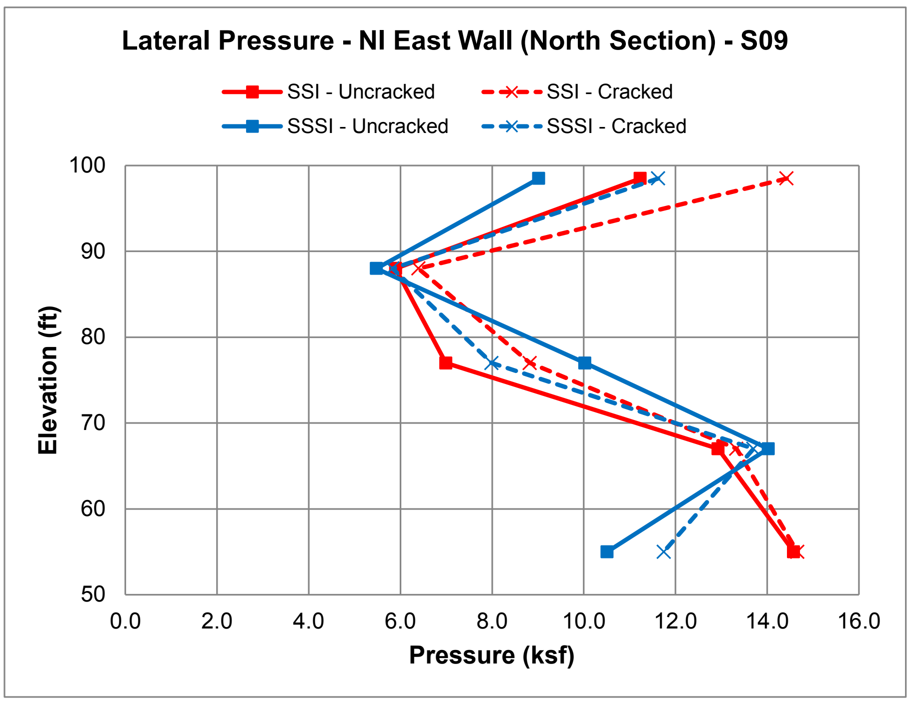


Figure A-161 Maximum Lateral Soil Pressures at NI East Wall (North Section) – S09

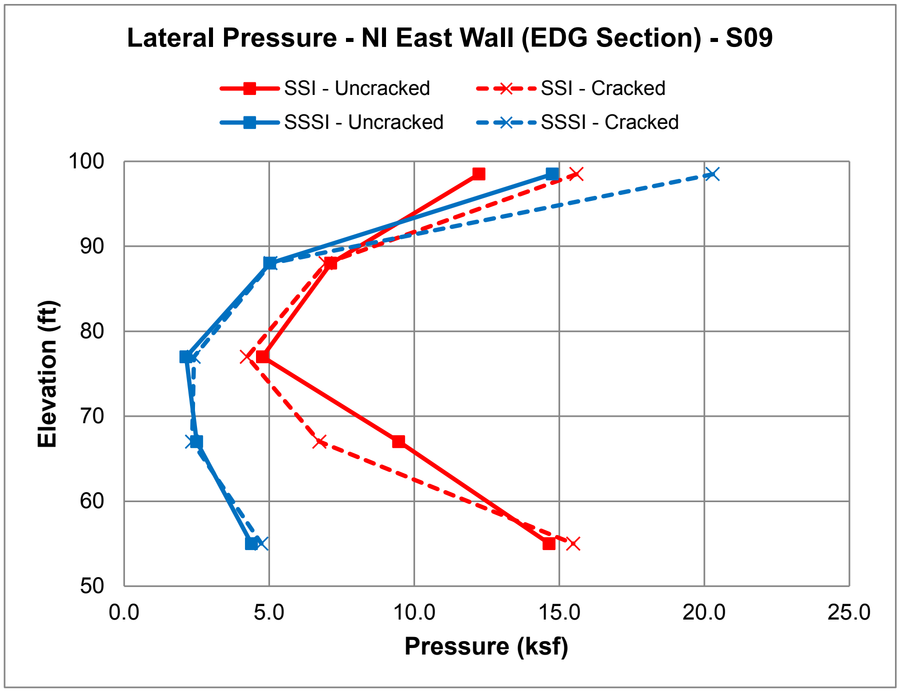


Figure A-162 Maximum Lateral Soil Pressures at NI East Wall (EDGB Section) – S09

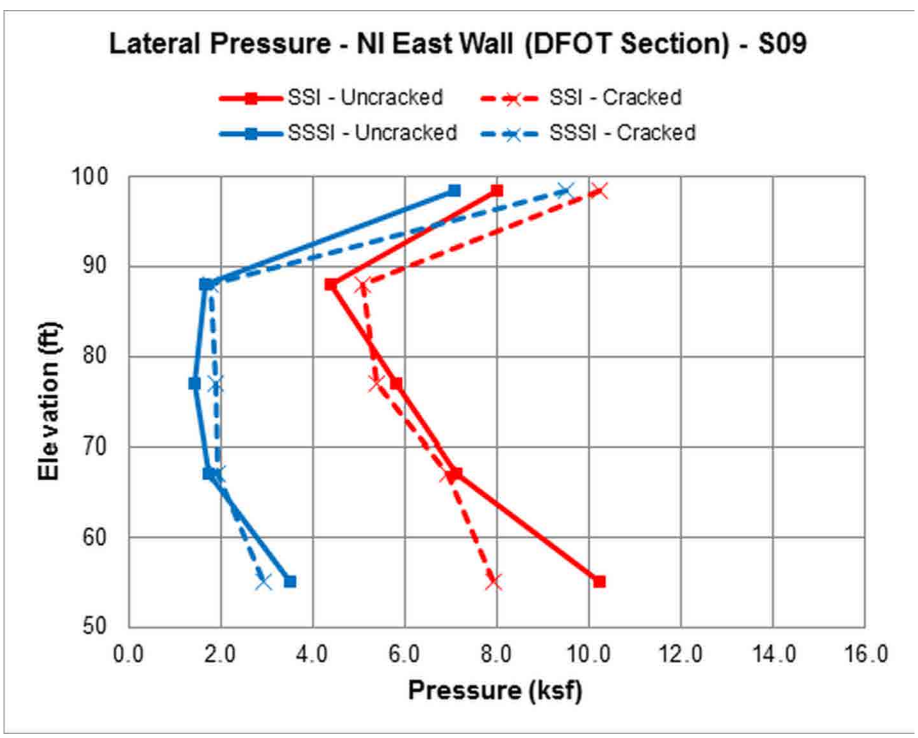


Figure A-163 Maximum Lateral Soil Pressures at NI East Wall (DFOT Room Section) – S09

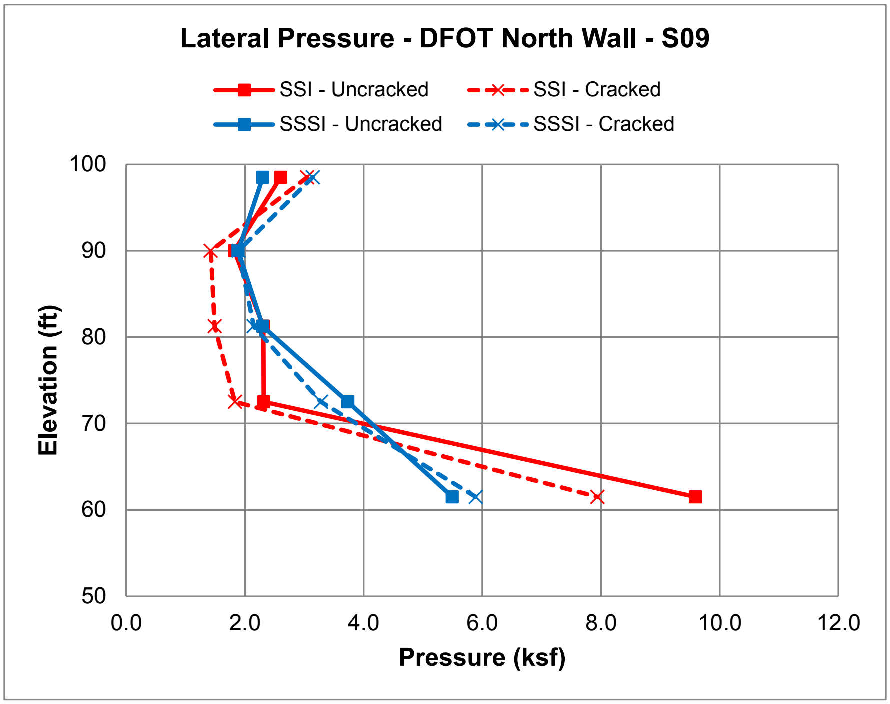


Figure A-164 Maximum Lateral Soil Pressures at DFOT Room North Wall – S09

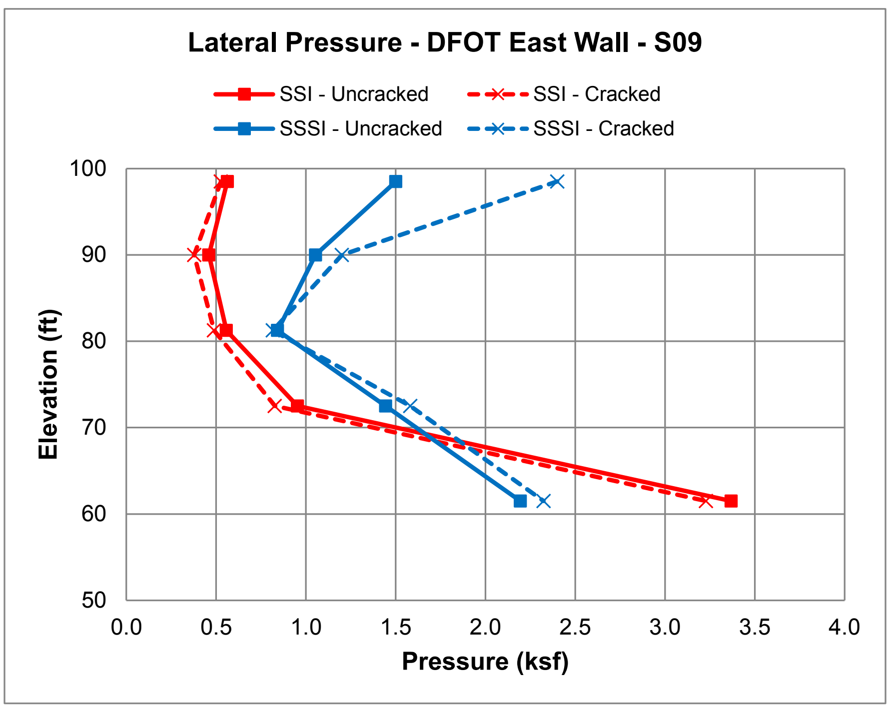


Figure A-165 Maximum Lateral Soil Pressures at DFOT Room East Wall – S09

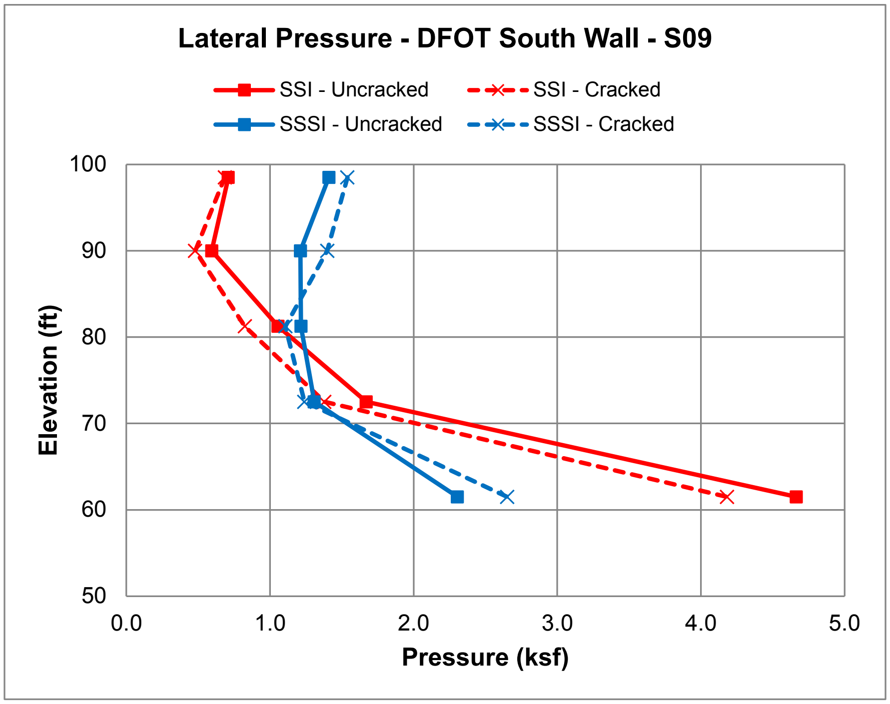


Figure A-166 Maximum Lateral Soil Pressures at DFOT Room South Wall – S09

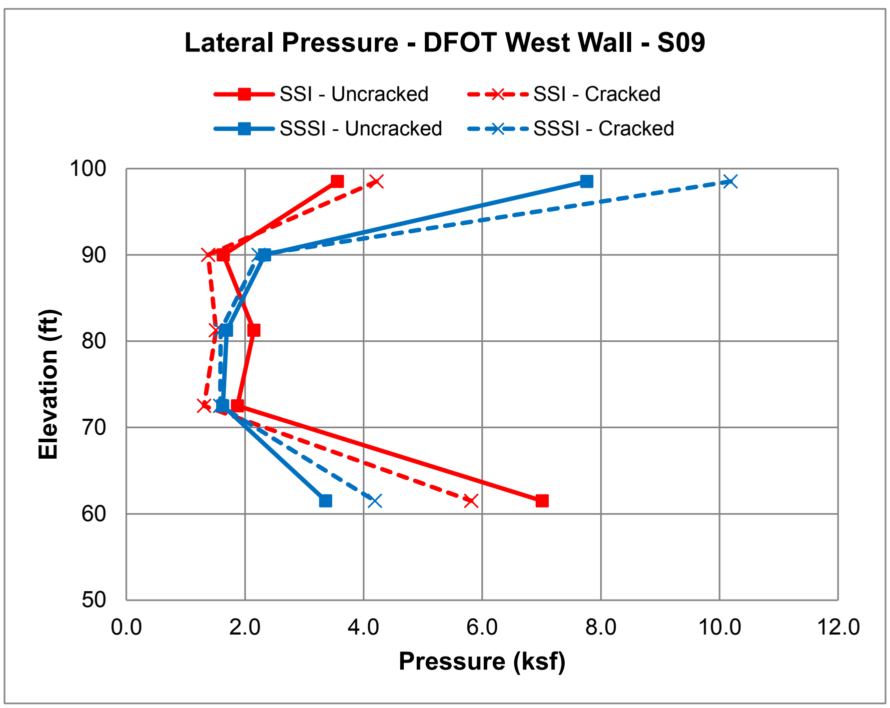


Figure A-167 Maximum Lateral Soil Pressures at DFOT Room West Wall – S09

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