APPENDIX 2B

PARAMETRIC STUDIES RELATED TO AP600 DESIGN SOIL PROFILES

This appendix describes studies performed to:

- Supplement Appendix 2A in the selection of the design soil profiles used in the seismic analysis of the AP600 nuclear island and its components
- Demonstrate the adequacy of parameters related to the design soil profiles identified in Appendix 2A

The selection of the design soil profiles is based on two-dimensional soil-structure interaction (2D SSI) parametric studies using a wide range of shear wave velocity profiles presented in Section 2A.2 and additional profiles evaluated in this appendix. The shear wave velocity profiles considered are summarized in Figure 2B-1. An upper bound case with a shear wave velocity, V_s, equal to 20,000 fps is analyzed in addition to the velocities shown in the figure. Table 2B-1 summarizes the two-dimensional SASSI SSI analyses described in this appendix. The SSI case ID number shown in the table corresponds to the legend used in the acceleration response spectra plots. The analyses used representative stick models of the nuclear island structures. Some of the design changes were made as a result of the seismic analyses presented in Appendix 2A. As an example, the concrete embedment for the containment vessel was extended from elevation 82' 6" to elevation 100' to increase the vessel frequency. The changes are minor and do not invalidate the conclusions of Appendix 2A. The additional soil profiles used the Idriss 1990 soil degradation curves. The analyses were performed using computer program SASSI (References 9 and 10) and procedures described in Appendix 2A, Section 2A.5.83.

Based on the additional studies shown in this appendix and the parametric studies presented in Appendix 2A, the AP600 design soil profiles presented in Appendix 2A, Section 2A.6 are modified to include:

- A hard rock profile, (fixed-base BSAP case)
- A soft rock profile
- A soft-to-medium soil profile with a parabolic distribution of the shear wave velocity with depth and Idriss 1990 soil properties
- An upper bound to the soft-to-medium soil profile with a parabolic distribution of the shear wave velocity with depth and Idriss 1990 soil properties

2B.1 2D SSI Analysis Parameters and Procedures

Free-field site response analyses and two-dimensional soil-structure interaction analyses of the representative two-dimensional stick models of the nuclear island structures are performed using the procedures presented in Sections 2A.4 and 2A.5 of Appendix 2A.

2B.1.1 Structural Models

Two-dimensional lumped mass stick models of the AP600 nuclear island structures suitable for the two-dimensional SSI analysis were developed from three-dimensional lumped mass stick models similar to those described in subsection 3.7.2.3. (The models described in subsection 3.7.2.3 have an improved representation of the shield building roof that was not available at the time of the analyses described in this Appendix. The changes are minor and do not invalidate the conclusions of Appendix 2B.) Two-dimensional lumped mass stick models were developed for the coupled auxiliary and shield buildings, the steel containment vessel, and the containment internal structures. In the two dimensional containment internal structure (CIS) model, only the mass of the reactor coolant loop (RCL) model was included as lumped masses to the tributary RCL support locations on the CIS model. Comparisons of the modal frequencies and modal masses of the two-dimensional and three-dimensional lumped mass stick models are shown in Tables 2B-2 through 2B-4.

2B.1.2 SASSI Foundation Models

The same foundation model and procedures presented in Section 2A.5 of Appendix 2A were used to represent the basemat and side walls in the additional two-dimensional SSI analyses. The SASSI foundation model in the XZ-plane is shown in Figures 2A-25 and 2A-26. The SASSI foundation model in the YZ-plane is presented in Figures 2A-27 and 2A-28.

2B.1.3 Soil Properties for SSI Analysis

One-dimensional free-field soil column analyses, using the computer program SHAKE (Reference 2A-5) were performed to obtain the safe shutdown earthquake (SSE) strain-compatible soil properties of the additional soil profiles. The average soil properties obtained from the free-field analysis using both the H1 and H2 SSE components of input motion were used in the two-dimensional SSI analysis. The average strain-compatible soil properties are shown in Tables 2B-5, 2B-6 and 2B-7 for the lower bound of the soft soil profile, the soft-to-medium soil profile and the upper bound of the soft-to-medium soil profile.

For the additional two-dimensional SSI analysis of soil cases previously analyzed and presented in Appendix 2A, the average strain-compatible soil properties shown in Tables 2A-9 through 2A-12 were used as input.

2B.1.4 Input Motion

For the horizontal analysis, the H1 and H2 components of the time history developed in subsection 3.7.1 were used in the X- and Y-directions, respectively. The vertical component was used in the Z-direction. The control motions were defined at the finished grade at elevation 100 feet in the free-field.

2B.1.5 Two-Dimensional Enveloped SSI Results

In the studies presented in this appendix, the acceleration response spectra and member force results are compared against two-dimensional enveloped SSI results. Similar to the analyses performed in Appendix 2A, the results from the horizontal and vertical analyses are determined separately, and co-directional responses are not combined for these additional studies.

The two-dimensional enveloped SSI results are obtained from the four two-dimensional SSI cases corresponding to the AP600 design soil profiles of the soft-to-medium soil profiles with parabolic distribution (1.0xG_{max} and 2.0xG_{max}), the soft rock profile, and the upper bound case (V_s=20,000 fps, used to replicate the fixed-base BSAP case). The two-dimensional enveloped SSI acceleration response spectra are broadened 15 percent on each side of the peaks in accordance with the procedure shown in subsection 3.7.2.5. Acceleration response spectra are computed at the representative locations listed below.

Location	Elev.	Node	Note
Nuclear island	66.5′	#3001	Top of nuclear island basemat
Nuclear island	100′	#3003	Plant grade level
Nuclear island	117.5′	#3004	Control Room
Nuclear island	153′	#3006	Auxiliary building roof, Area 1/2
Nuclear island	180′	#3008	Auxiliary building roof, Area 5/6
Nuclear island	307.25′	#3016	Shield building roof
Steel containment vessel	205.33′	#3110	Polar crane support
Steel containment vessel	256.33′	#3115	Top of the containment vessel
Concrete internal structure	107′	#3203	Grade level inside containment
Concrete internal structure	135′	#3204	Operating deck

2B.2 Design Soil Profiles

The selection of the design soil profiles is based on two dimensional soil-structure interaction (2D SSI) parametric studies using a wide range of shear wave velocity profiles presented in Section 2A.2 and the following profiles evaluated below:

- A lower bound case for the soft soil with V_s = 707 fps
- A firm rock case with V_s = 3,500 fps

- A soft-to-medium soil profile with a parabolic distribution of shear wave velocity of 1000 ft/sec at grade level increasing to 2400 ft./sec at 240 ft.-depth. Upper and lower bound cases are considered for this soil profile

- An upper bound case with V_s = 20,000 fps replicating the fixed-base BSAP case

2B.2.1 Lower Bound of Soft Soil Profile (V_s=707 fps)

The soft soil profiles considered in the SSI analysis (see Figure 2A-7) have a linear shear wave velocity profile varying from 1000 ft./sec. at the ground surface to 1200 ft./sec. at 240 ft.-depth. This profile is considered to be the minimum "best estimate" velocity profile for the soil cases and is consistent with the site interface limit that the shear wave velocity exceeds 1000 ft./sec.

In order to study the effect of lower bound shear wave velocities associated with the variation in the "best estimate" profile, a reduction of 50 percent in maximum low-strain values of the shear modulus is applied. The resultant shear wave velocity for the lower bound case has a maximum low-strain velocity of 707 ft./sec. at the ground surface increasing to 850 ft./sec. at 240 ft. depth. This profile was analyzed using program SHAKE and Idriss 1990 soil curves. The resultant SSE strain-compatible soil properties were used in the two-dimensional SSI analysis in the NS direction considering the depth to base rock of 120 ft. and the water table at grade level.

The SSI results of this case (marked as the lower bound soft soil case) are compared with the SSI results of the minimum "best estimate" profile (marked as the soft soil case) and with those of other design profiles (hard rock, soft rock, soft-to-medium soil) in Figure 2B-2. As shown in the figure, the results of the lower bound soft soil case are governed by the results of other SSI cases except for small exceedences at very low frequencies (less than 1 cps responses) with no significant effect on the design responses. The member forces at the base of the structures from this case are compared with the two-dimensional enveloped SSI results in Table 2B-8.

2B.2.2 Firm Rock Profiles (V_s=3500 fps)

For the case of a firm rock profile with 3500 fps velocity, the following two-dimensional SSI cases were analyzed for the E-W direction:

- A hard rock profile with shear wave velocity of 8000 fps
- A firm rock profile with shear wave velocity of 3500 fps

The results of these two-dimensional SSI cases are compared with the results of the upper bound case, the soft rock case and the two-dimensional enveloped SSI results in Figure 2B-3. The member forces at the base of the structures from these two-dimensional SSI cases are compared with the two-dimensional enveloped SSI results in Table 2B-9.

The comparison shows that the firm rock case responses are enveloped by the two-dimensional enveloped SSI results with the exception of two member forces which are less than 3 percent higher. This confirms the adequacy of the two-dimensional enveloped SSI results. A separate firm rock case is not warranted.

2B.2.3 Parabolic Distribution of Soil Profile with Sandy Soil Material

Typical stiffness variations of sandy soil sites are expected to be curvilinear instead of the linear distribution shown in Figure 2A-7 for the soft-to-medium soil profile, with most of the increase in soil stiffness occurring near the upper one-third part of the soil layer due to the nonlinear effects of depth of burial on stiffness.

In order to assess the effect of such soil variations, a free-field SHAKE analysis was performed for the soft-to-medium soil profile with a parabolic distribution of shear wave velocity of 1000 ft./sec. at grade level increasing to 2400 ft./sec. at 240 ft depth. The maximum low-strain shear wave velocity and the SSE strain-compatible velocity for this soil profile obtained from the SHAKE analysis are shown in Figure 2B-4. The response spectra of the free-field motion at 40-ft. depth (foundation mat elevation) corresponding to the parabolic shear wave velocity case and the linear shear wave velocity case are compared in Figure 2B-5. The response motion using the parabolic velocity distribution shows small variations from that of the linear velocity distribution depending on the frequency.

To evaluate the impact of the parabolic velocity distribution on the SSI responses, two-dimensional SSI analyses were performed in the EW direction using the soft-to-medium stiff soil profile with the parabolic and linear distribution of shear wave velocity profiles. In these analyses, the water table was modeled at the grade level and the base rock was modeled at 120-ft. depth. The SSE strain-compatible properties obtained from the SHAKE analyses were used in the SSI analysis.

The two-dimensional SSI responses of the parabolic distribution case are compared with the two-dimensional SSI responses of the linear velocity distribution case and the two-dimensional enveloped SSI responses in Figure 2B-6. The figure shows some differences in the SSI responses between the linear and the parabolic soil profiles. Since the variation of shear wave velocity with depth at typical sandy soil sites is generally curvilinear rather than linear, and since the results using the parabolic profile are generally larger than those using the linear profile, the parabolic profile is selected instead of the linear distribution for the three-dimensional design soil profile.

2B.2.4 Variation of Soil Properties and 60 Percent Requirement of Free-Field Spectra at Foundation Level

To evaluate the effect of soil property variation, upper bound and lower bound shear wave velocity profiles were developed using $2.0xG_{max}$ and $0.50xG_{max}$ where G_{max} is the initial soil shear modulus corresponding to the soft-to-medium soil parabolic profile. The results of free-field SHAKE analyses in the E-W direction (using the H2 time history as input motion) at the foundation basemat level are compared with the input motion at grade level and 60 percent of the design input motion in Figure 2B-7. The figure shows that the envelope of the motion at the foundation level for these three profiles, corresponding to $1.0xG_{max}$, $2.0xG_{max}$ and $0.50xG_{max}$ profiles, meets the 60 percent criterion specified in the Standard Review Plan for limitation of the reduction of motion at the foundation level in the free-field.

The strain-compatible soil properties for the above three soft-to-medium soil ($1.0xG_{max}$, $2.0xG_{max}$ and $0.50xG_{max}$) profiles were subsequently used in the two-dimensional SSI analysis in the EW direction. The results for $2.0xG_{max}$ and $0.50xG_{max}$ are compared with the two-dimensional enveloped SSI results in Figure 2B-8. The seismic forces for $2.0xG_{max}$ and $0.50xG_{max}$ at the base of the structures are compared with the two-dimensional enveloped SSI results in Table 2B-10.

The design soil profiles include the $1.0xG_{max}$ and the $2.0xG_{max}$ soft-to-medium cases. The two-dimensional enveloped SSI results also cover the results of the lower bound $0.50xG_{max}$ profile except for small exceedences at low frequencies which have no significant effect on the design.

2B.2.5 AP600 Design Soil Profiles

The AP600 design soil profiles presented in Section 2A.6 are modified, based on the two-dimensional parametric SSI results presented above and in Appendix 2A, to consist of:

- A hard rock profile (fixed-base BSAP case)
- A soft rock profile
- A soft-to-medium soil profile with a parabolic distribution of the shear wave velocity with depth and Idriss 1990 soil properties
- An upper bound to the soft-to-medium soil profile with a parabolic distribution of the shear wave velocity with depth and Idriss 1990 soil properties.

The acceleration response spectra at the foundation basemat level, from free-field SHAKE analyses of the design soil profiles, are compared with the input motion at grade level and 60 percent of the design input motion in Figure 2B-9. The envelope of the spectra of the design soil profiles at the foundation basemat level is higher than 60 percent of the design input ground response spectrum.

2B.3 Soil Profile Parametric Studies:

The following parameters were investigated to confirm the adequacy of the selected design soil profiles:

- Depth to base rock,
- Soil property curves for clay material,

- Poisson's ratio for soil above the water table,
- Fixed-base vs. SSI analysis for the hard rock site

2B.3.1 Depth-to-Base Rock

As shown in Table 2A-16, the effect of depth to base rock was studied for the soft rock profile, the soft-to-medium soil profile (linear distribution) and the soft soil profile considering 40 ft., 120 feet and very deep base rock. Based on this parametric study, the depth of 120 feet to base rock results in larger SSI responses and is selected as the critical depth to base rock in the design soil profiles.

Five additional depths to base rock of 40 ft., 50 ft., 60 ft., 80 ft. and 120 ft. were analyzed using the two-dimensional SSI model in the E-W direction. The analyses were based on the soft-to-medium soil profile with the parabolic distribution of shear wave velocity and Idriss 1990 soil curves. The acceleration response spectra for 2 percent damping for the five depth to base rock cases are compared with the enveloped two-dimensional SSI results in Figure 2B-10. The member forces at the base of the structures from these two-dimensional SSI cases are compared with the two-dimensional enveloped SSI results in Table 2B-11.

A depth to baserock of 50 feet was also analyzed for the soft soil profile in the E-W direction. The SSI results of this case are compared with the results for the depth to 120 ft. and similar soft-to-medium soil profiles in Figure 2B-11.

The comparisons show that the enveloped two-dimensional SSI responses adequately cover the responses of the other depths to base rock. It is concluded that the depth to base rock of 120 ft. used in the design soil profiles is adequate.

2B.3.2 Soil Curves for Clay Material

The soil curves for cohesive soils are mainly a function of the plasticity index and differ from those of cohesionless soil. The strain-dependent shear modulus curves for cohesive soil reported by Seed et al. (Reference 1) for plasticity indices of 10 to 70 are compared with the Idriss 1990 sand curve in Figure 2B-12. As recommended by Seed in Reference 2, the 1970 damping curves (Figure 2B-16) are applicable to cohesive soils.

Based on Reference 1 information, seven free-field SHAKE analyses were performed using the soft-to-medium soil profile with the parabolic distribution of the shear wave velocity and the H2 time history as input motion. The seven SHAKE runs consisted of:

- Five SHAKE runs using shear modulus degradation curves corresponding to plasticity index of 10, 20, 30, 50, and 70 (see Figure 2B-12) and the damping curve representing the average curve of the Seed & Idriss 1970 range (see Figure 2B-16)

- Two SHAKE runs using the Idriss 1990 soil shear modulus degradation and damping curves for sandy material (see Figures 2B-15 and 2B-16)

The initial shear wave velocities were those for the $2.0xG_{max}$ and $0.50xG_{max}$ cases corresponding to the soft-to-medium soil profile with parabolic distribution of shear wave velocity. The strain-compatible shear wave velocities from the seven SHAKE runs are shown in Figure 2B-13. As shown in this figure, the properties associated with the upper and lower bound sandy soil cases cover the range of properties associated with the five clay curves.

The results provided in Figure 2B-13, together with the SSI result comparison presented in Section 2B.2.4 on variation of soil properties for the soft-to-medium soil profile, indicate that the SSI responses using the clay curves are bounded by the two-dimensional enveloped SSI responses. Therefore, no further consideration of the clay curves is warranted.

2B.3.3 Poisson's Ratio for Soil above Water Table

As stated in SSAR Section 2A.4, "The SSI results, particularly the horizontal responses, are believed to be insensitive to the change of Poisson's ratio. On the other hand, the vertical responses for each soil/rock case were governed by the respective shallow water table case due to the fact that use of P-wave velocity of water results in less attenuation of motion with depth, thus resulting in large effective foundation motion. The parametric SSI study on depth to the water table concluded that the water table at grade level is the governing conditions for each respective generic soil profile analyzed. For these cases, the Poisson's ratio is assumed such that the P-wave velocity of the water is maintained."

The soft-to-medium parabolic soil profile was analyzed with both the water table and the base rock at 120 ft depth to investigate the effect of change in the Poisson's ratio on the SSI responses. Two SSI analyses were performed using the two-dimensional SSI model of the nuclear island in the NS direction and a constant Poisson's ratio of 0.25 and 0.35, respectively, for the soil layers. The results of the SSI analyses using Poisson's ratio equal to 0.25 and 0.35 are compared in Figure 2B-14. The effect of changing the Poisson's ratio is not significant. The results of this investigation do not affect the selection of the design soil profiles, in which the water table is defined at grade level and the Poisson's ratios are adjusted to maintain the P-wave velocity of water.

2B.3.4 Fixed-Base vs. SSI Analysis for the Hard Rock Site

A two-dimensional SSI case is described in subsection 2B.2.2 for the E-W direction for a hard rock profile with a shear wave velocity of 8000 fps. The results of this hard rock case are compared to the results of the upper bound case, the soft rock case and the two-dimensional enveloped SSI results in Figure 2B-3. The two-dimensional enveloped SSI results adequately cover the results of the two-dimensional SSI hard rock (8000 fps) case with only insignificant exceedences.

The results of the hard rock case with 8000 fps velocity are also compared with the upper bound case (v_s=20,000 fps, replicating the fixed base condition) in Figure 2B-3. These results show similar response in terms of frequency characteristics and amplitude of the response, confirming the adequacy of the fixed-base analysis for sites with shear wave velocity in excess of 8000 fps.

2B.3.5 Idriss 1990 Soil Curves

The soil curves, used in the two-dimensional SSI analyses presented in Appendix 2A (Figures 2A-8 and 2A-9), are based on the strain-dependent shear modulus and damping degradation model recommended by H.B. Seed and I.M. Idriss in 1970 (Reference 6 in Appendix 2A). The range of soil degradation curves proposed by Seed & Idriss in 1970 are shown in Figures 2B-15 and 2B-16. The average curves corresponding to this range, with soil material damping limited to a value of 15 percent, are shown in the figures (labeled as Appendix 2A analyses) and used in the SSI analyses presented in Appendix 2A.

In 1990, new soil curves were reported by Idriss (Reference 2) and are also presented in Figures 2B-15 and 2B-16. To assess the impact of the new soil degradation curves on the SSI responses, the updated two-dimensional SSI models of the nuclear island were analyzed for the soft-to-medium linear soil profile (case B2Y of Appendix 2A) using the Seed 1970 and the Idriss 1990 soil degradation curves. The results of the two-dimensional analyses are compared together with the two-dimensional enveloped SSI results in Figure 2B-17. Small variations are observed with respect to the frequency and amplitude of the response between the results using the 1970 soil curves and the results using the 1990 soil curves. The Idriss 1990 curves are selected as the basis for the 3D design soil profiles.

2B.3.6 Soil density

For each SSI analysis case, the average strain-compatible soil properties obtained from the free-field analysis of the same case using H1 and H2 time histories are used as input (see Tables 2A-10 to 2A-12). The soil densities used in the SSI analyses are the typical densities that are expected from materials under the in-situ conditions. The range of soil densities depends on the material type and the moisture content and is typically between 100 pcf to 120 pcf. The density of 110 pcf used in the analyses represents the average soil total density, including the soil and its water content. The soil shear modulus was subsequently obtained from the selected velocity profiles and the density of the soil.

In the SSI analyses, the effects of soil properties are represented in terms of the foundation impedance and scattered motion. Both of these responses are in turn functions of the foundation size, the frequency of vibration and the soil shear wave velocity. Given the foundation size and embedment depth of the AP600 nuclear island, it is only the soil shear wave velocity that affects the impedance and scattered motion. Since the soil low-strain shear wave velocities have been selected to cover a wide range of soil properties, the change in the total density would only change the initial shear modulus associated with each shear wave velocity profile. The change in the soil density is, however, very small under the saturated and moist conditions. The effect of a small variation in the soil density on shear modulus is well within the range of variation due to the wide range of the shear wave velocities considered.

2B.4 References

1. Sun J.I., R. Golesorkhi, and H.B. Seed, "Dynamic Moduli and Damping Ratios for Cohesive Soils," Report No. UCB/EERC-88/15, Earthquake Engineering Research Center, University of California, Berkeley, CA., August 1988.

2. Idriss I.M., "Response of Soft Soil Sites during Earthquakes," H. Bolton Seed Memorial Symposium Proceedings, May 1990.

Table 2B-1

TWO-DIMENSIONAL SSI ANALYSIS CASE IDS ADDITIONAL STUDIES

Shear Wave Velocity Profile	Depth to Base Rock (ft)	Depth to Water Table (ft)	SSI Case ID No. X-Shaking	SSI Case ID No. Y-Shaking	SSI Case ID No. Z-Shaking	Remarks
Upper Bound, (V_s=20,000 fps)	---	---	---	R1-BY	---	---
Hard Rock, (V_s=8,000 fps)	---	---	R1-AX	R1-AY	---	---
Firm Rock, (V_s=3,500 fps)	120	deep	---	H2-Y	---	Note (3)
Soft Rock	120	deep	A2-X	A2-Y	---	Note (3)
Soft-to-Medium Soil, Linear V_s Profile	120	0	B2-WX	B2-WY	---	Note (1)
	120	0	---	B2-WY.REG	---	Note (2)
	120	deep	B2-X	---	---	Notes (1) & (4)
	120	deep	B2-LX	---	---	Notes (1) & (5)
Soft-to-Medium Soil, Parabolic V_s Profile	120	0	---	B2-MY	---	Notes (1)
	80	0	---	B2M3Y	---	Note (1)
	60	0	---	B2M4Y	---	Note (1)
	50	0	---	B2M6Y	---	Note (1)
	40	0	---	B2M7Y	---	Note (1)
Soft-to-Medium Soil, Lower Bound, Parabolic V_s Profile	120	0	---	B2M1Y	---	Note (1)
Soft-to-Medium Soil, Upper Bound, Parabolic V_s Profile	120	0	---	B2M2Y	---	Note (1)
Soft Soil	120	0	C2-WX	C2-WY	---	Note (1)
	50	0	---	C2W6Y	---	Note (1)
Soft Soil, Lower Bound	120	0	D2-WX	---	---	Note (1)

<u>Note:</u>

(1) Idriss 1990 Soil degradation curves were used
(2) Seed and Idriss 1970 soil degradation curves were used
(3) Seed and Idriss 1970 rock degradation curves were used
(4) Poisson's Ratio = 0.35 (value used in two-dimensional analyses, Appendices 2A and 2B)
(5) Poisson's Ratio = 0.25

Table 2B-2

THREE-DIMENSIONAL VS TWO-DIMENSIONAL MODAL PROPERTIES OF COUPLED AUXILIARY AND SHIELD BUILDINGS LUMPED MASS STICK MODEL

	Modal Properties of 3D Model		Modal Properties of 2D Model	
Direction of Modal Properties	Frequency (cps)	Percent Mass [(1)]	Frequency (cps)	Percent Mass [(1)]
X-Modes	4.42	25.4	4.44	25.4
	6.76	37.5	6.77	37.9
	12.45	50.7	-	-
	13.35	62.1	12.97	61.9
	22.13	68.3	22.17	68.1
	29.12	71.7	29.17	71.3
Y-Modes	4.04	28.2	4.06	28.1
	6.66	38.9	6.68	39.5
	12.10	62.0	12.17	62.1
	22.06	64.9	22.21	67.9
	28.39	71.2	28.47	71.0
Z-Modes	6.55	11.1	6.57	10.2
	6.66	13.8	6.68	14.0
	19.63	44.1	19.98	45.2
	34.26	64.4	34.99	59.4
	35.09	66.9	35.55	67.0

Note:
(1) The cumulative percentage of the mass with respect to the total mass in each direction

Table 2B-3

MODAL PROPERTIES OF STEEL CONTAINMENT VESSEL LUMPED MASS STICK MODEL

	Modal Properties of Model [(2)]	
Direction of Modal Properties	**Frequency (cps)**	**Percent Mass [(1)]**
X-Modes	5.06	28.4
	8.03	75.8
	22.03	90.5
Y-Modes	2.19	11.2
	7.61	75.8
	22.02	90.5
Z-Modes	4.46	10.4
	18.38	73.3
	30.08	89.6

Note:

(1) The cumulative percentage of the mass with respect to the total mass in each direction.

(2) The model of the steel containment vessel and polar crane is symmetric about the X and Y axes; therefore, its two-dimensional and three-dimensional modal properties are the same.

Table 2B-4

THREE-DIMENSIONAL VS TWO-DIMENSIONAL MODAL PROPERTIES OF CONTAINMENT INTERNAL STRUCTURES LUMPED MASS STICK MODEL

	Modal Properties of Three-Dimensional Model		Modal Properties of Two-Dimensional Model	
Direction of Modal Properties	Frequency (cps)	Percent Mass (1)	Frequency (cps)	Percent Mass (1)
X-Modes	14.38	41.7	14.53	43.9
	40.54	93.5	40.55	92.8
Y-Modes	12.36	35.3	12.41	40.1
	38.05	48.0	37.49	45.5
	40.18	98.9	39.95	99.0
Z-Modes	46.59	42.0	47.03	43.3

Note:
(1) The cumulative percentage of the mass with respect to the total mass in each direction.

Table 2B-5

SHAKE ANALYSIS RESULTS
LOWER BOUND SOFT SOIL PROFILE
(AVERAGE OF H1 AND H2 ANALYSES)

Depth (ft)	Thickness (ft)	Layer No.	Density (KCF)	SSE Avg (H1 and H2) Vs(FPS)	Vp(FPS)	Damping
0						
10	10	1	0.11	666	1632	0.024
20	10	2	0.11	583	1428	0.049
30	10	3	0.11	507	1241	0.077
40	10	4	0.11	446	1093	0.098
60	20	5	0.11	432	1057	0.106
80	20	6	0.11	428	1048	0.110
120	40	7	0.11	394	965	0.127
160	40	8	0.11	348	853	0.143
200	40	9	0.11	311	762	0.150
240	40	10	0.11	214	525	0.150
Halfspace	-	-	0.11	849	2080	0.020

For submerged layers, Vp = 5,000 FPS is used

Table 2B-6

SHAKE ANALYSIS RESULTS
SOFT-TO-MEDIUM SOIL PROFILE, 1.0XG_{MAX}
(AVERAGE OF H1 AND H2 ANALYSES)

Depth (ft)	Thickness (ft)	Layer No.	Density (KCF)	SSE Avg (H1 and H2)		
				Vs(FPS)	Vp(FPS)	Damping
0						
10	10	1	0.11	961	2001	0.016
20	10	2	0.11	1110	2311	0.025
30	10	3	0.11	1245	2592	0.027
40	10	4	0.11	1331	2770	0.031
60	20	5	0.11	1420	2956	0.035
80	20	6	0.11	1508	3141	0.039
120	40	7	0.11	1622	3376	0.042
160	40	8	0.11	1768	3680	0.042
200	40	9	0.11	1897	3950	0.040
Halfspace	-	-	0.11	2400	4997	0.020

For submerged layers, Vp = 5,000 FPS is used

Table 2B-7

SHAKE ANALYSIS RESULTS
SOFT-TO-MEDIUM SOIL PROFILE, 2.0XG_{MAX}
(AVERAGE OF H1 AND H2 ANALYSES)

Depth (ft)	Thickness (ft)	Layer No.	Density (KCF)	SSE Avg (H1 and H2) Vs(FPS)	Vp(FPS)	Damping
0						
10	10	1	0.11	1379	2871	0.011
20	10	2	0.11	1629	3391	0.016
30	10	3	0.11	1829	3807	0.019
40	10	4	0.11	1973	4107	0.021
60	20	5	0.11	2136	4447	0.023
80	20	6	0.11	2302	4792	0.025
120	40	7	0.11	2492	5188	0.027
160	40	8	0.11	2680	5579	0.029
200	40	9	0.11	2838	5908	0.031
Halfspace	-	-	0.11	3394	7067	0.020

For submerged layers, Vp = 5,000 FPS is used

Table 2B-8

COMPARISON OF SEISMIC MEMBER FORCES
LOWER BOUND OF SOFT SOIL PROFILE
TWO-DIMENSION SSI ANALYSIS
EAST-WEST SEISMIC EXCITATION

	Coupled Aux./Shield Bldg. @ Elev. 100'		**Containment Internal Structures @ Elev. 82.5'**		**Steel Containment Vessel @ Elev. 100'**	
SSI Case ID #	**Shear ($x10^3$ kip)**	**Moment ($x10^3$ k-ft)**	**Shear ($x10^3$ kip)**	**Moment ($x10^3$ k-ft)**	**Shear ($x10^3$ kip)**	**Moment ($x10^3$ k-ft)**
2-D Envelop, Note (1)	43.6	4944	16.6	638	4.6	475
Note (2)	16.5	1828	7.6	233	1.8	185

<u>Note</u>:
(1) 2-D envelop consisted of (1) the upper bound case, V_s = 20,000 fps; (2) the soft rock case; (3) the soft-to-medium parabolic profile with $2.0xG_{max}$; and (4) the soft-to-medium parabolic profile with $1.0xG_{max}$.

(2) Results of lower bound of soft soil profile.

Table 2B-9

COMPARISON OF SEISMIC MEMBER FORCES
FIRM ROCK PROFILES
TWO-DIMENSION SSI ANALYSIS
EAST-WEST SEISMIC EXCITATION

	Coupled Aux./Shield Bldg. @ Elev. 100'		Containment Internal Structures @ Elev. 82.5'		Steel Containment Vessel @ Elev. 100'	
SSI Case ID #	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)
2-D Envelop, Note (1)	43.6	4944	16.6	638	4.6	475
Note (2)	44.8	4573	16.3	611	4.4	480

<u>Note</u>:

(1) 2-D envelop consisted of (1) the upper bound case, V_s = 20,000 fps; (2) the soft rock case; (3) the soft-to-medium parabolic profile with $2.0xG_{max}$; and (4) the soft-to-medium parabolic profile with $1.0xG_{max}$.

(2) Envelop results of the firm rock case, V_s = 3500 fps and the hard rock case, V_s = 8000 fps.

Table 2B-10

COMPARISON OF SEISMIC MEMBER FORCES
VARIATION OF SOIL PROPERTIES
TWO-DIMENSION SSI ANALYSIS
EAST-WEST SEISMIC EXCITATION

	Coupled Aux./Shield Bldg. @ Elev. 100'		Containment Internal Structures @ Elev. 82.5'		Steel Containment Vessel @ Elev. 100'	
SSI Case ID #	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)
2-D Envelop, Note (1)	43.6	4994	16.6	638	4.6	475
Note (2)	42.1	4938	12.7	393	2.9	310

Note:

(1) 2-D envelop consisted of (1) the upper bound case, V_s = 20,000 fps; (2) the soft rock case; (3) the soft-to-medium parabolic profile with $2.0xG_{max}$; and (4) the soft-to-medium parabolic profile with $1.0xG_{max}$.

(2) Envelop results of the soft-to-medium stiff parabolic soil profile, 120 feet to base rock and analysis cases of $0.5xG_{max}$ and $2.0xG_{max}$.

Table 2B-11

COMPARISON OF SEISMIC MEMBER FORCES
DEPTH TO BASE ROCK
TWO-DIMENSION SSI ANALYSIS
EAST-WEST SEISMIC EXCITATION

	Coupled Aux./Shield Bldg. @ Elev. 100'		Containment Internal Structures @ Elev. 82.5'		Steel Containment Vessel @ Elev. 100'	
SSI Case ID #	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)	Shear ($x10^3$ kip)	Moment ($x10^3$ k-ft)
2-D Envelop, Note (1)	43.6	4944	16.6	638	4.6	475
Note (2)	37.6	4302	13.7	463	2.8	296

Depth to Base Rock

Note:

(1) 2-D envelop consisted of (1) the upper bound case, V_s = 20,000 fps; (2) the soft rock case; (3) the soft-to-medium parabolic profile with $2.0xG_{max}$; and (4) the soft-to-medium parabolic profile with $1.0xG_{max}$.

(2) Envelop results of the soft-to-medium stiff parabolic soil profile with $1.0xG_{max}$, analysis cases of 40 feet, 50 feet, 60 feet, 80 feet and 120 feet to base rock.

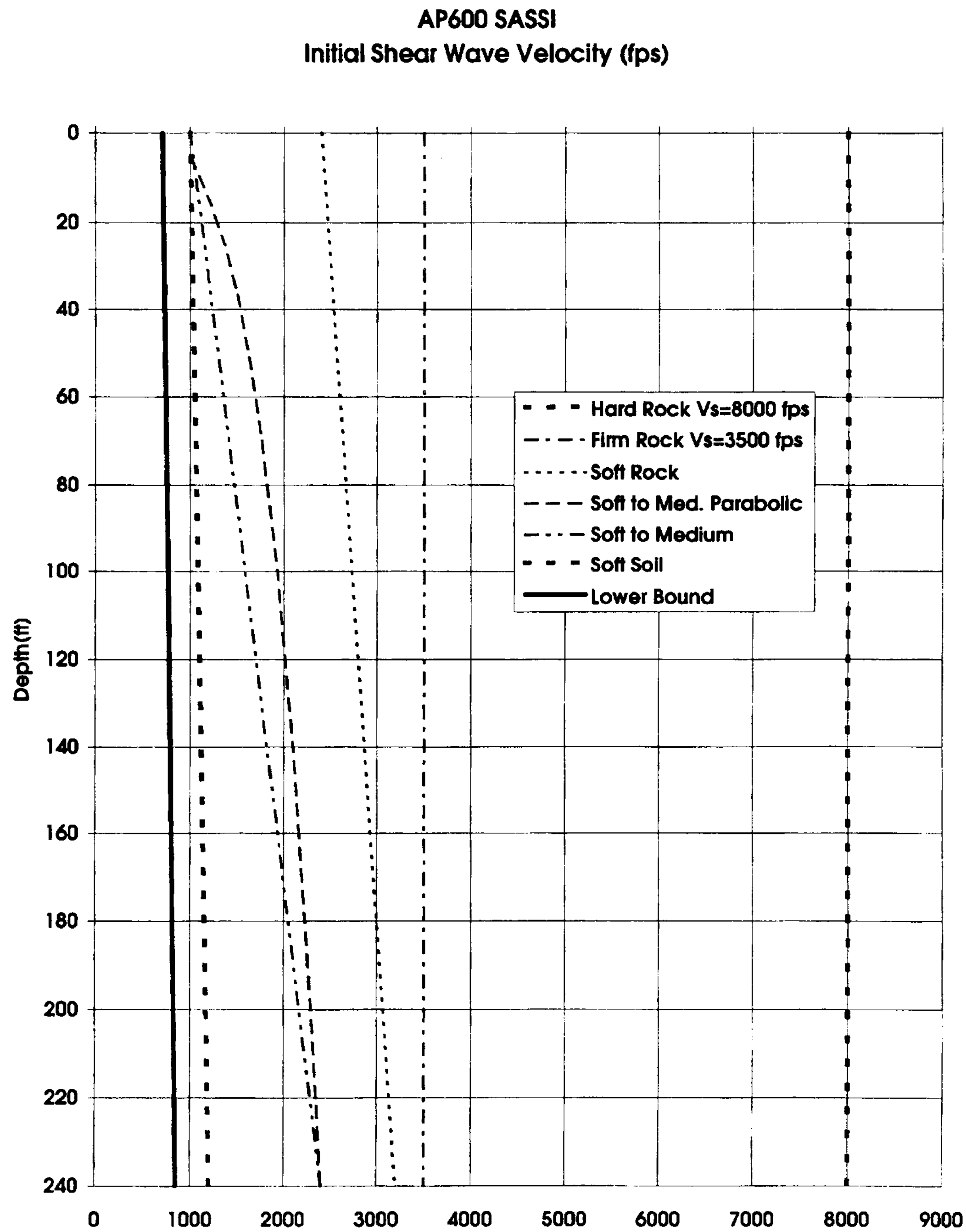


Figure 2B-1

Two-Dimensional SASSI Analysis Shear Wave Velocity Profiles Considered

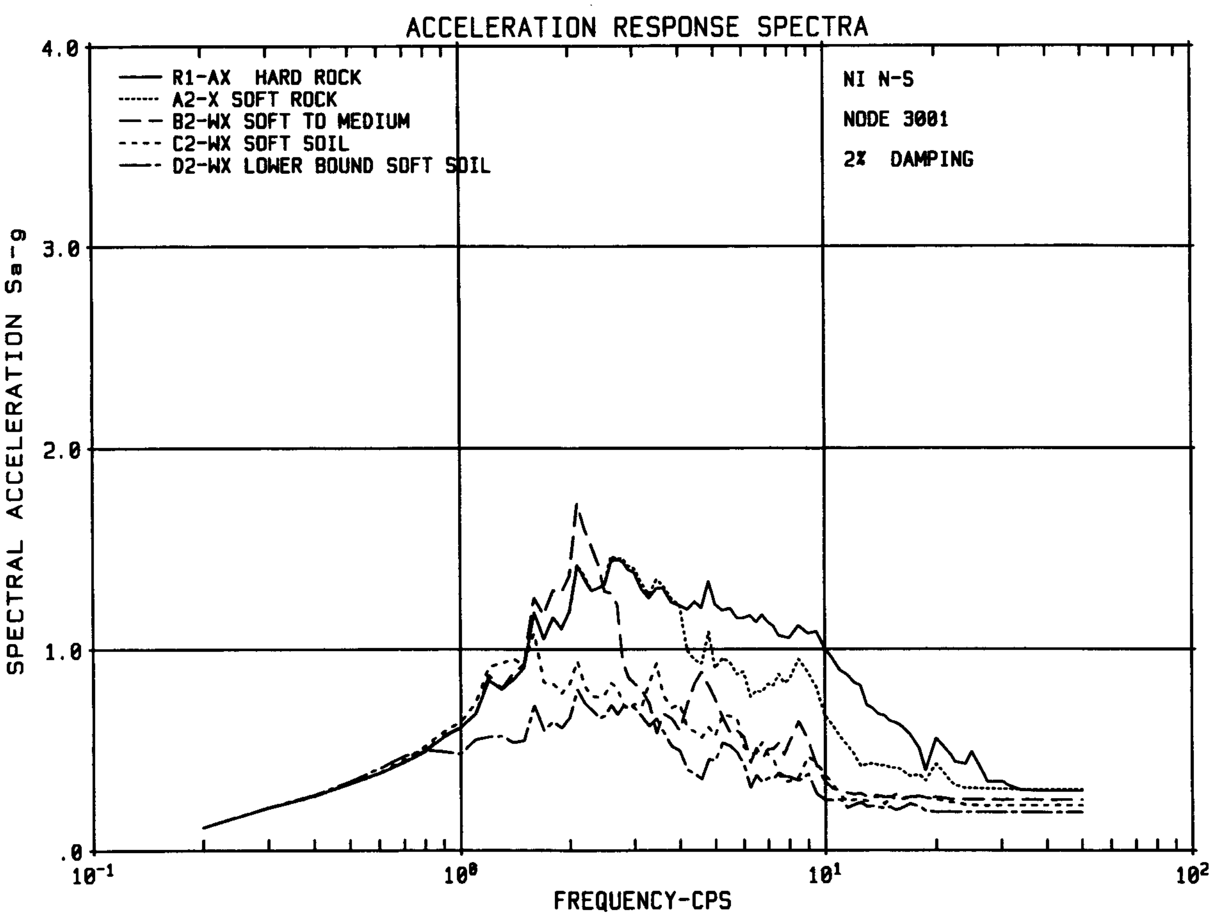


Figure 2B-2 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

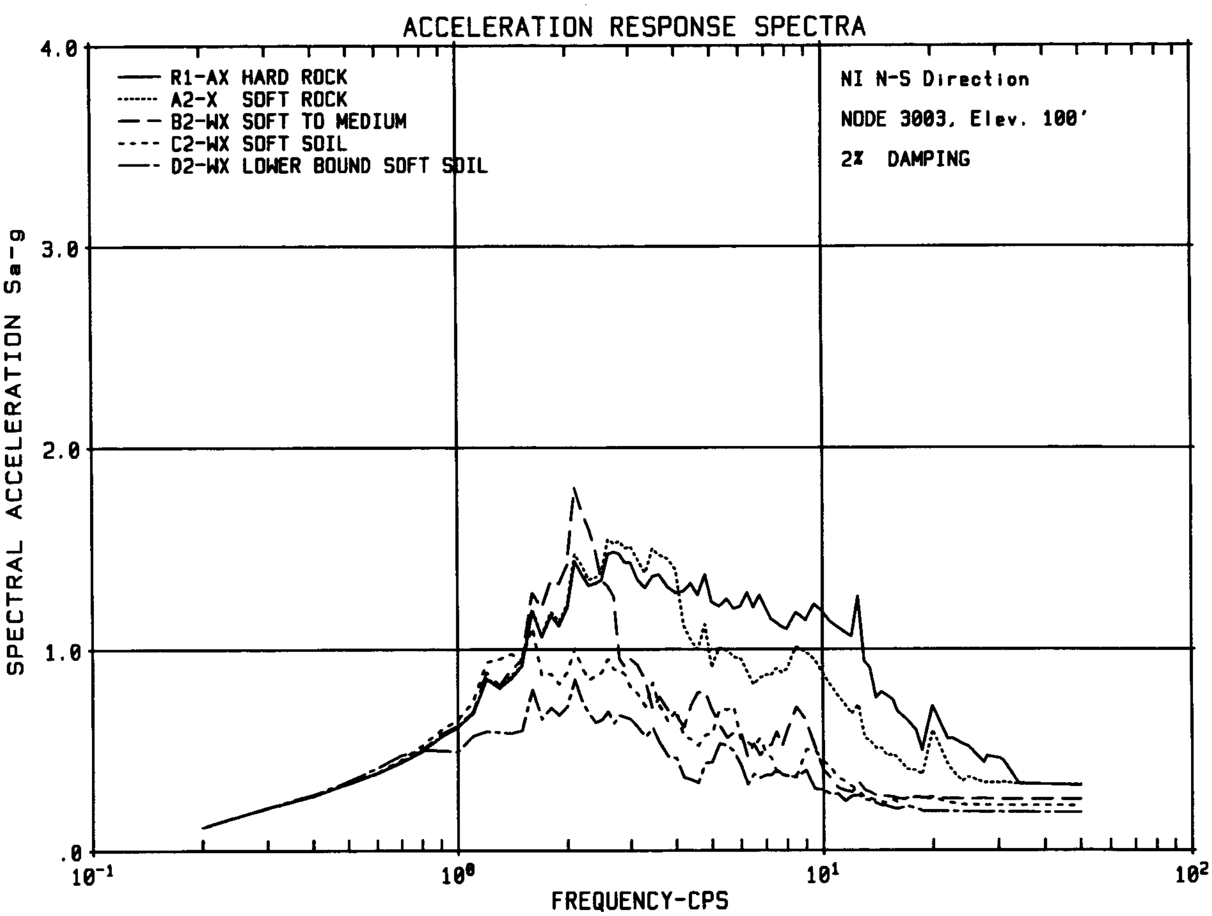


Figure 2B-2 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

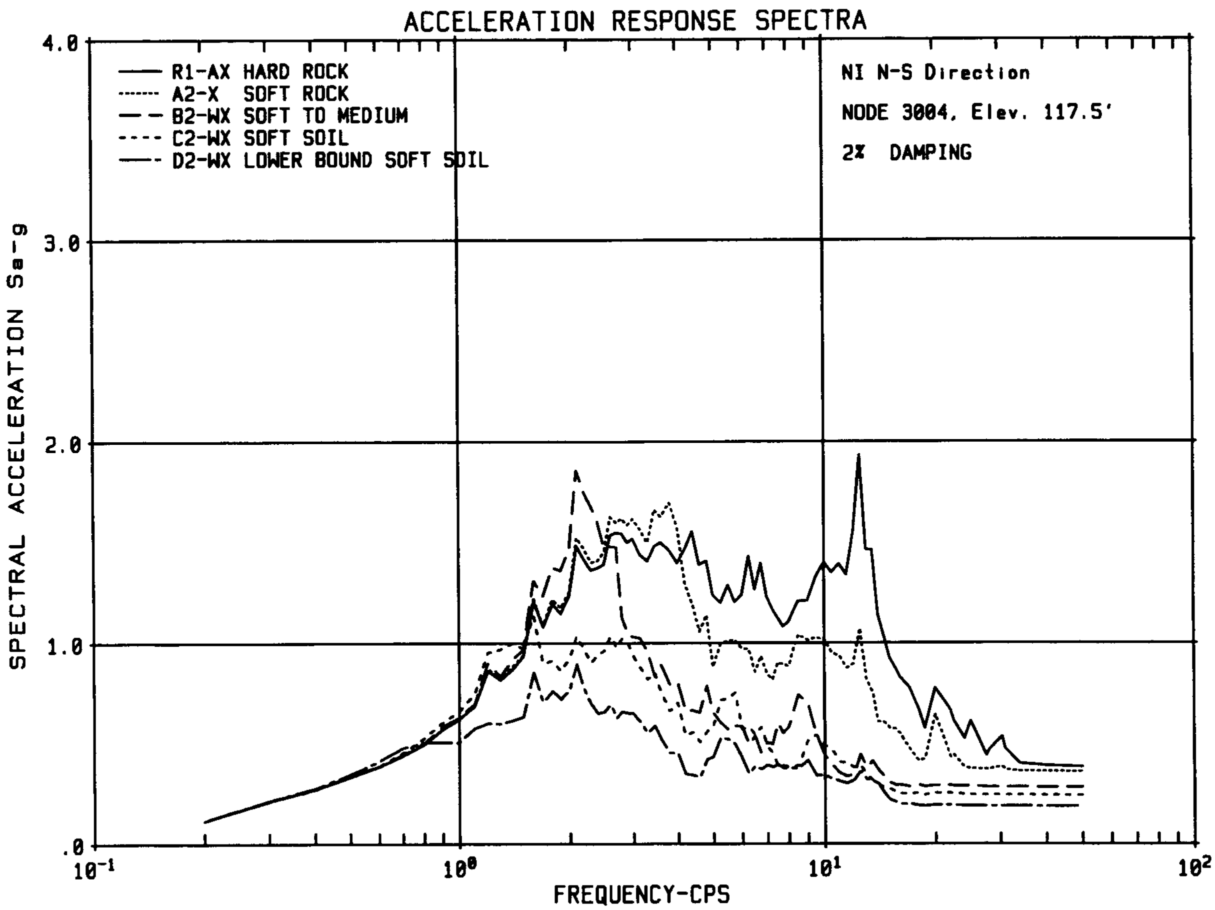


Figure 2B-2 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

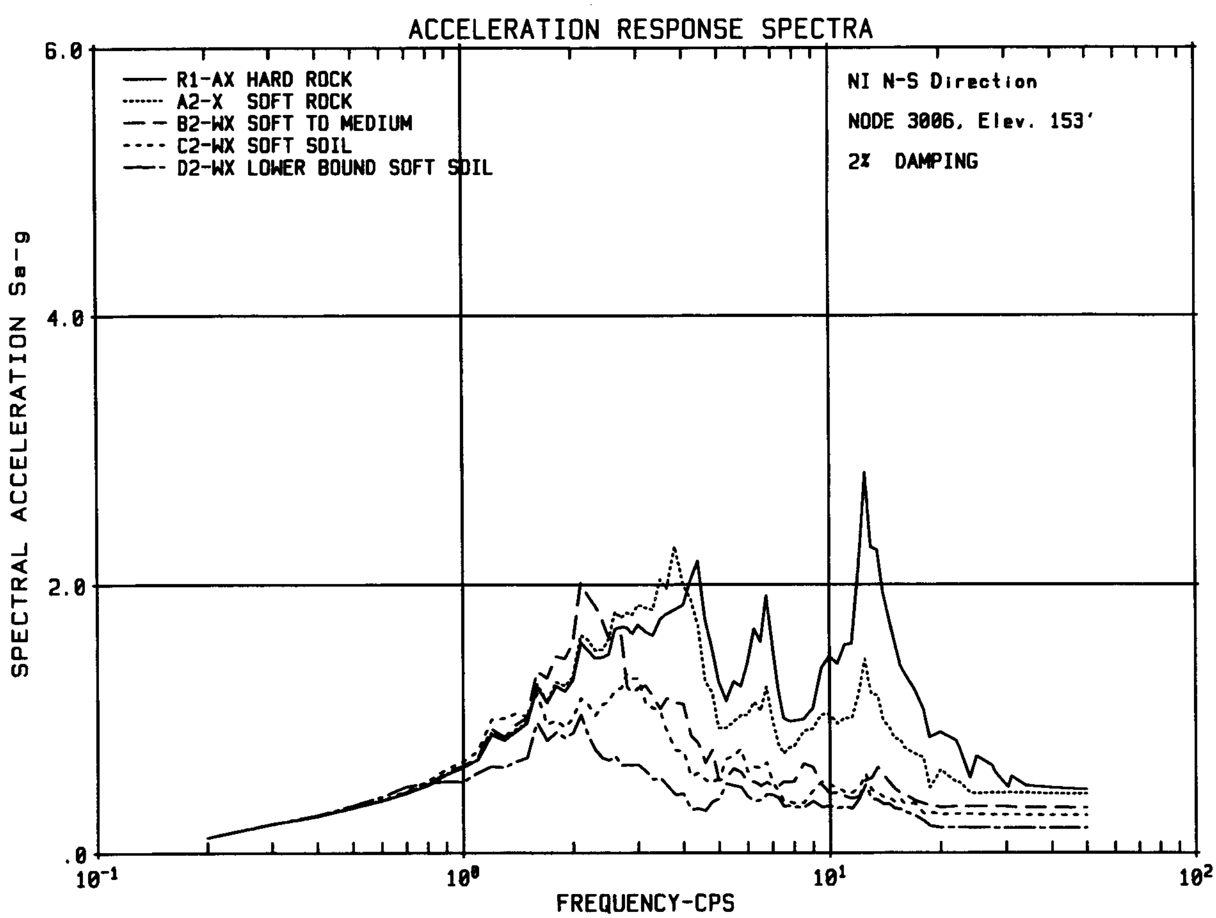


Figure 2B-2 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

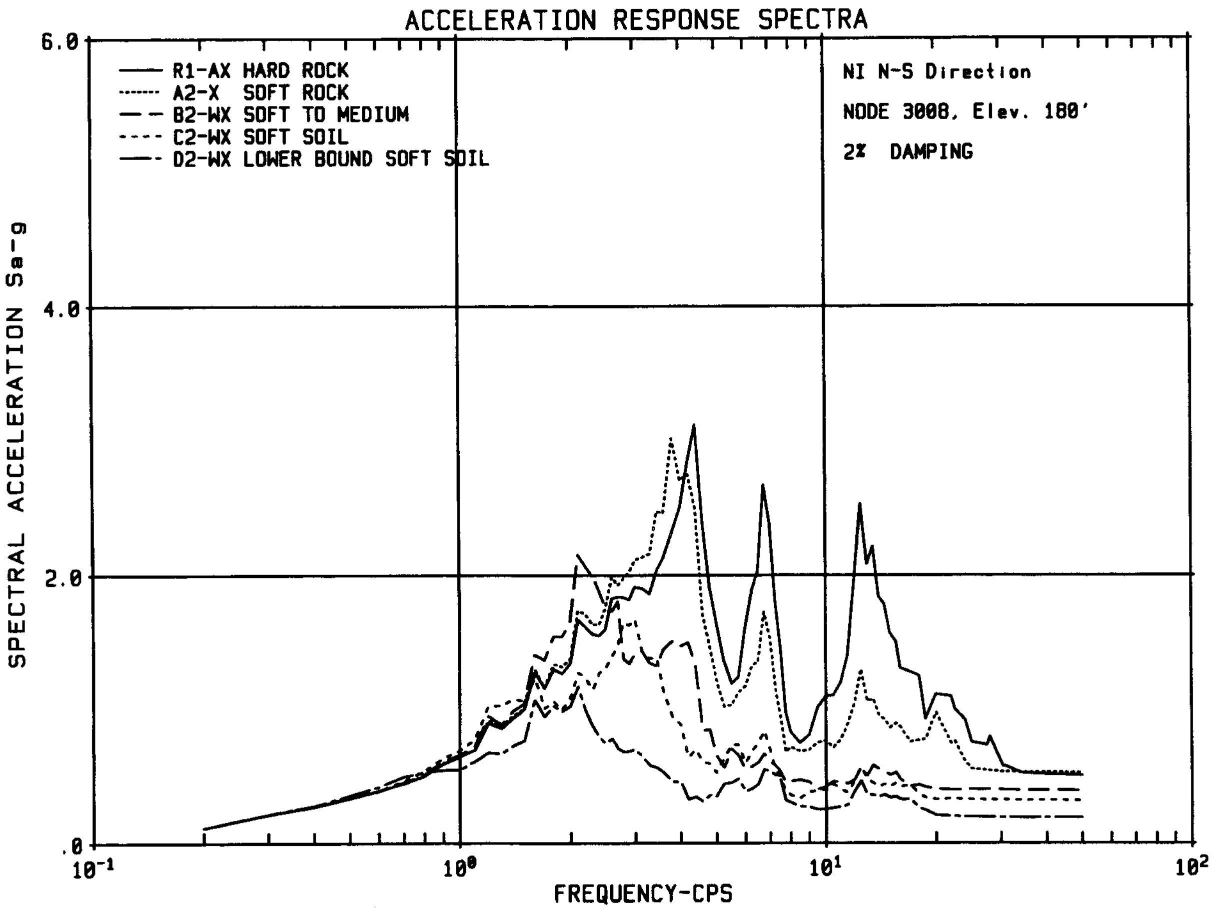


Figure 2B-2 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

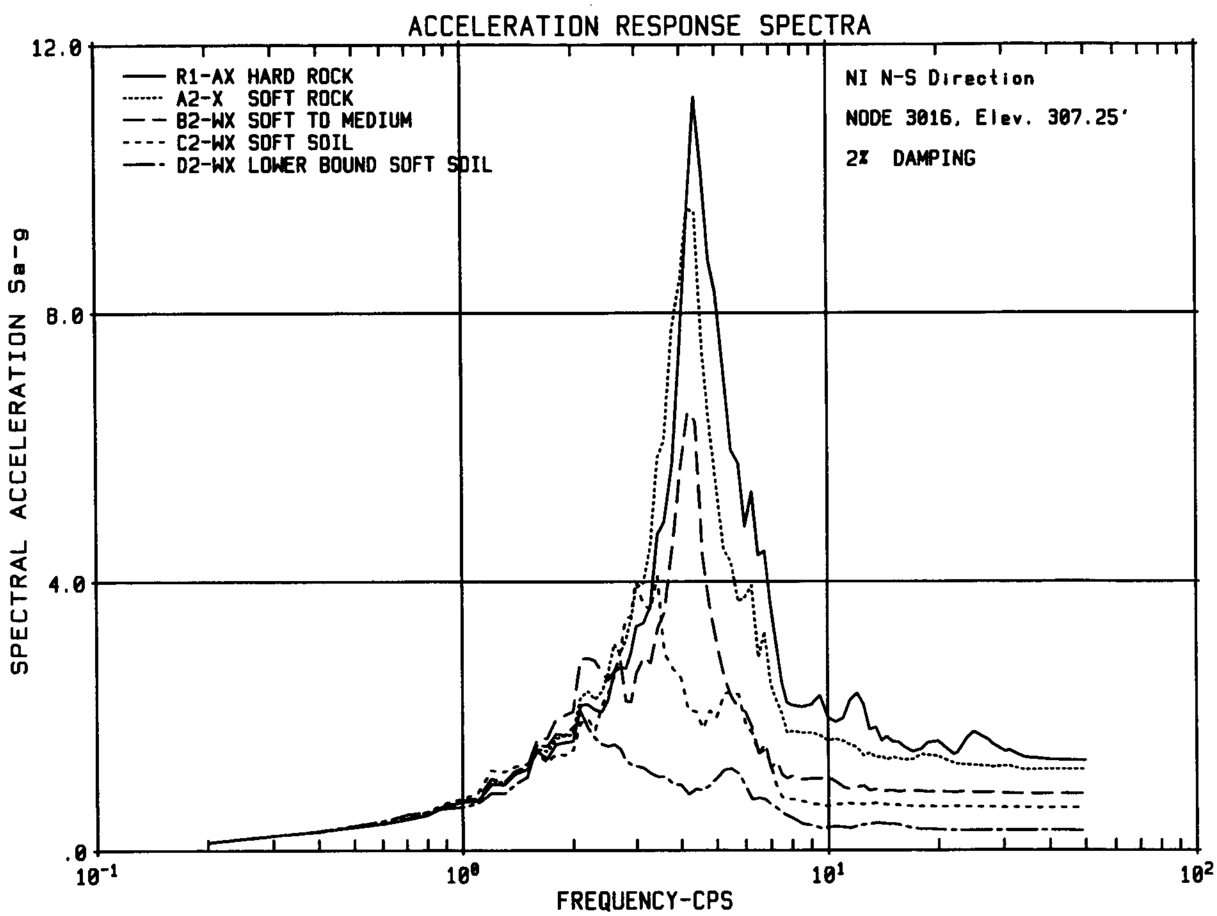


Figure 2B-2 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

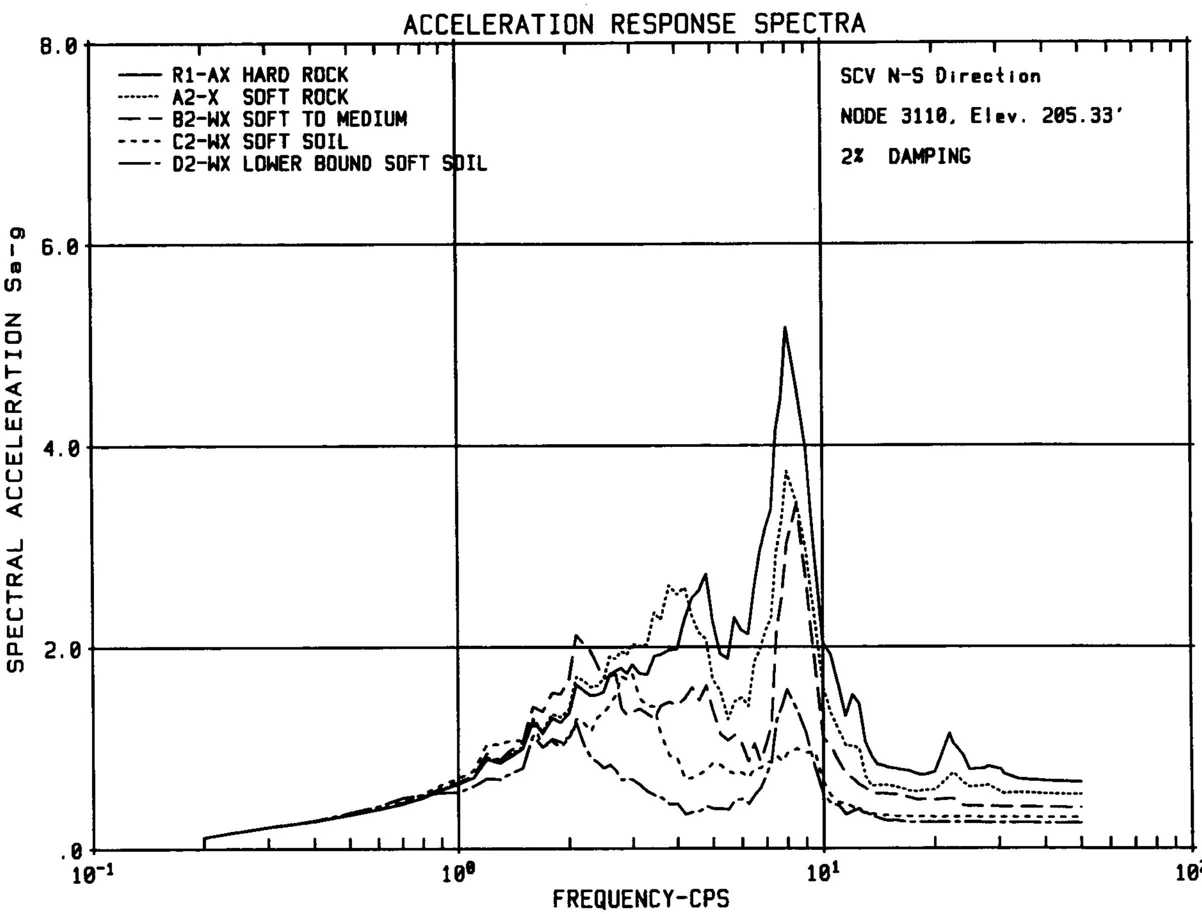


Figure 2B-2 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

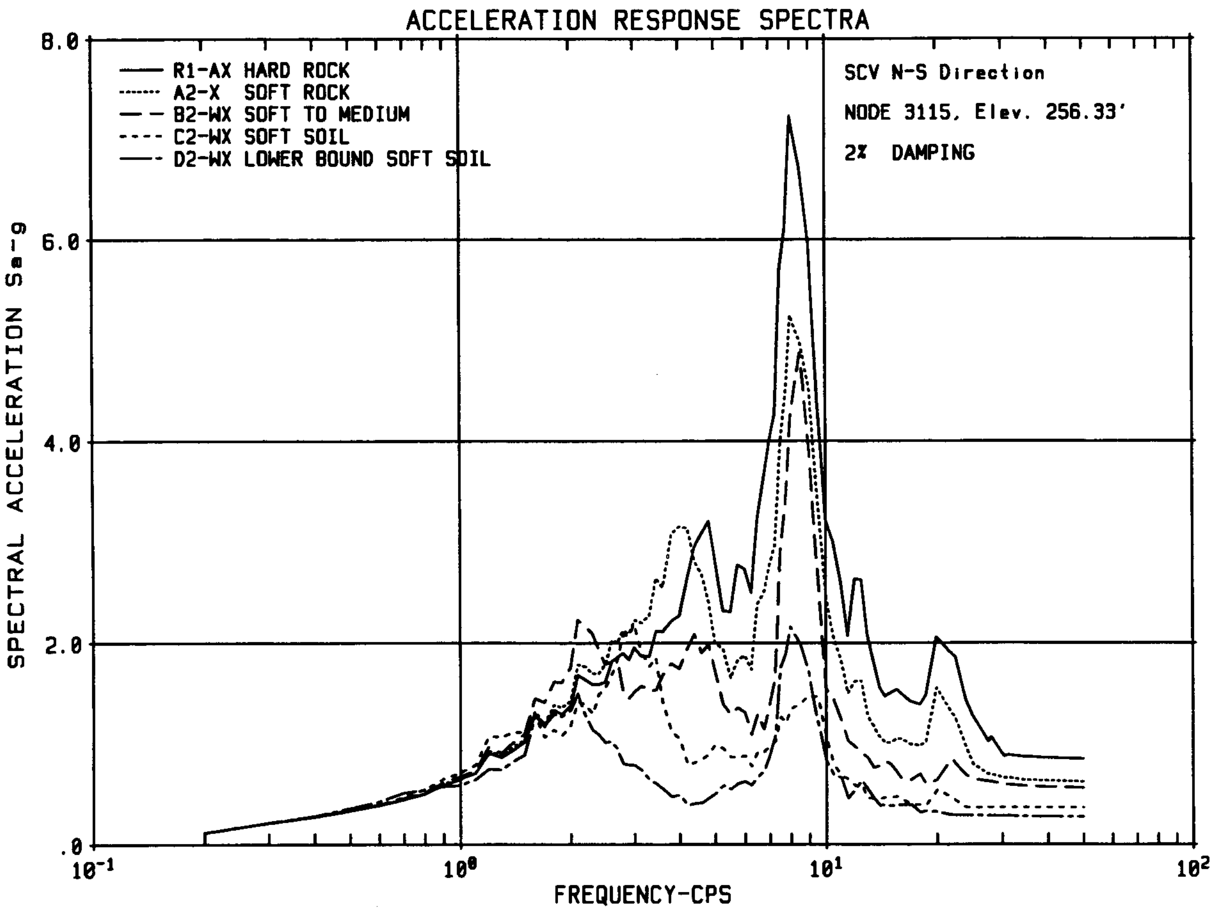


Figure 2B-2 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

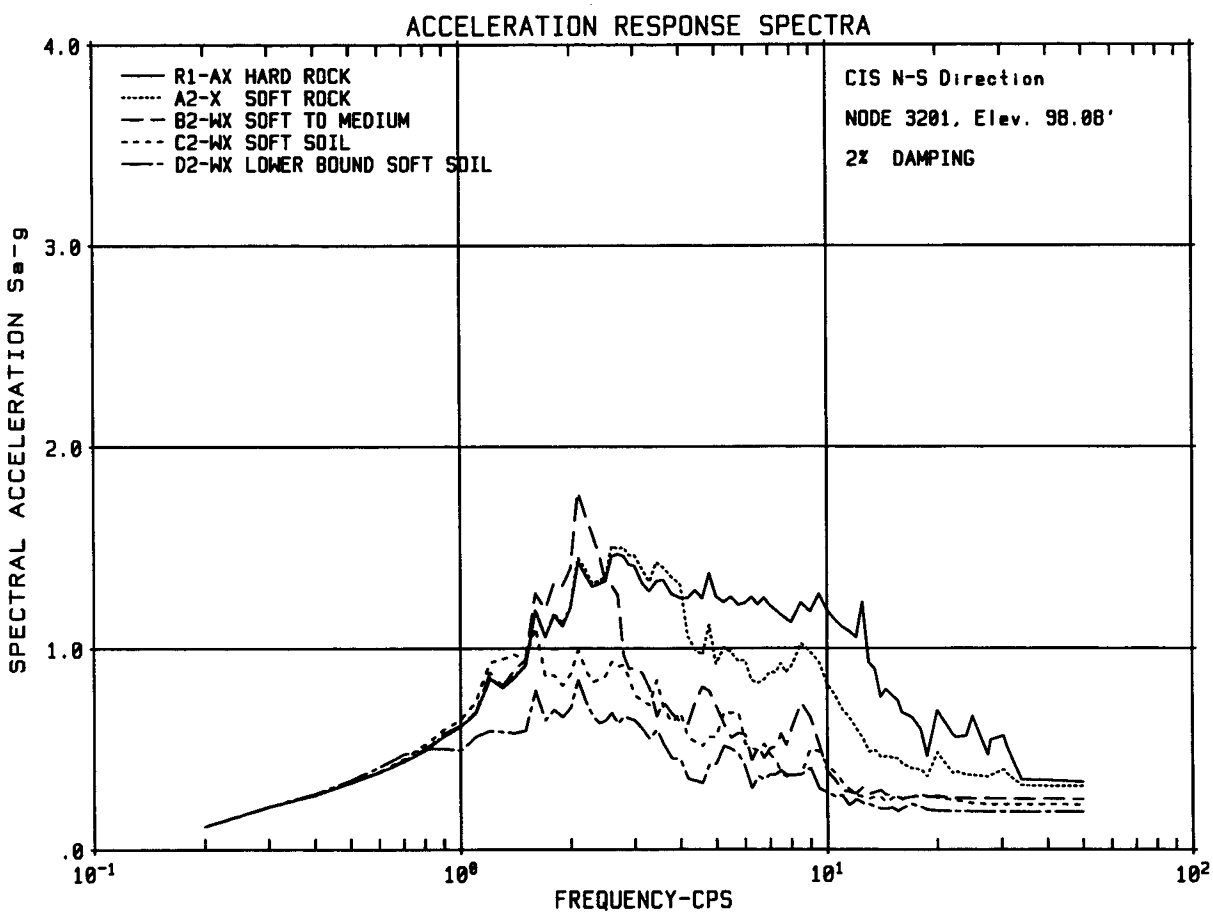


Figure 2B-2 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

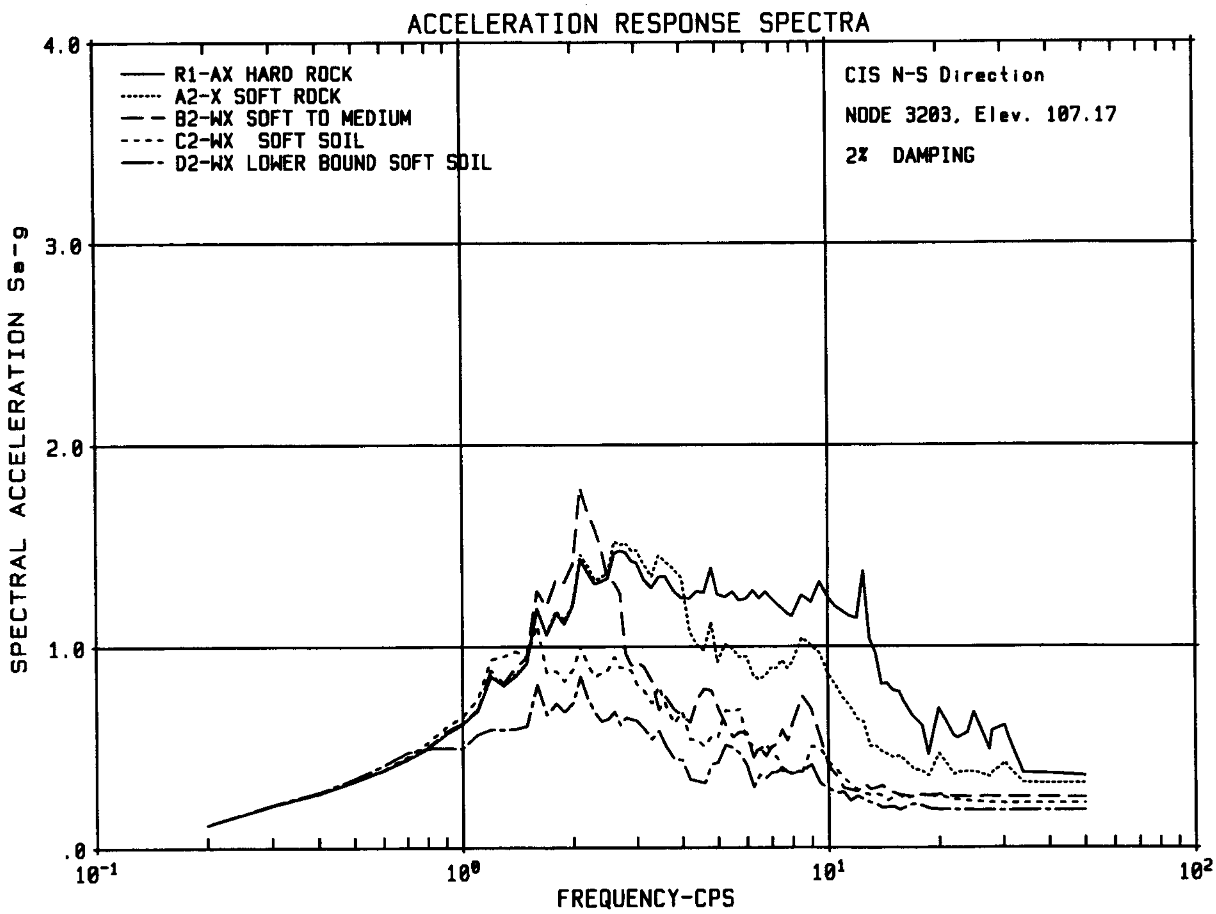


Figure 2B-2 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, N-S Direction Lower Bound Soft Soil Profile

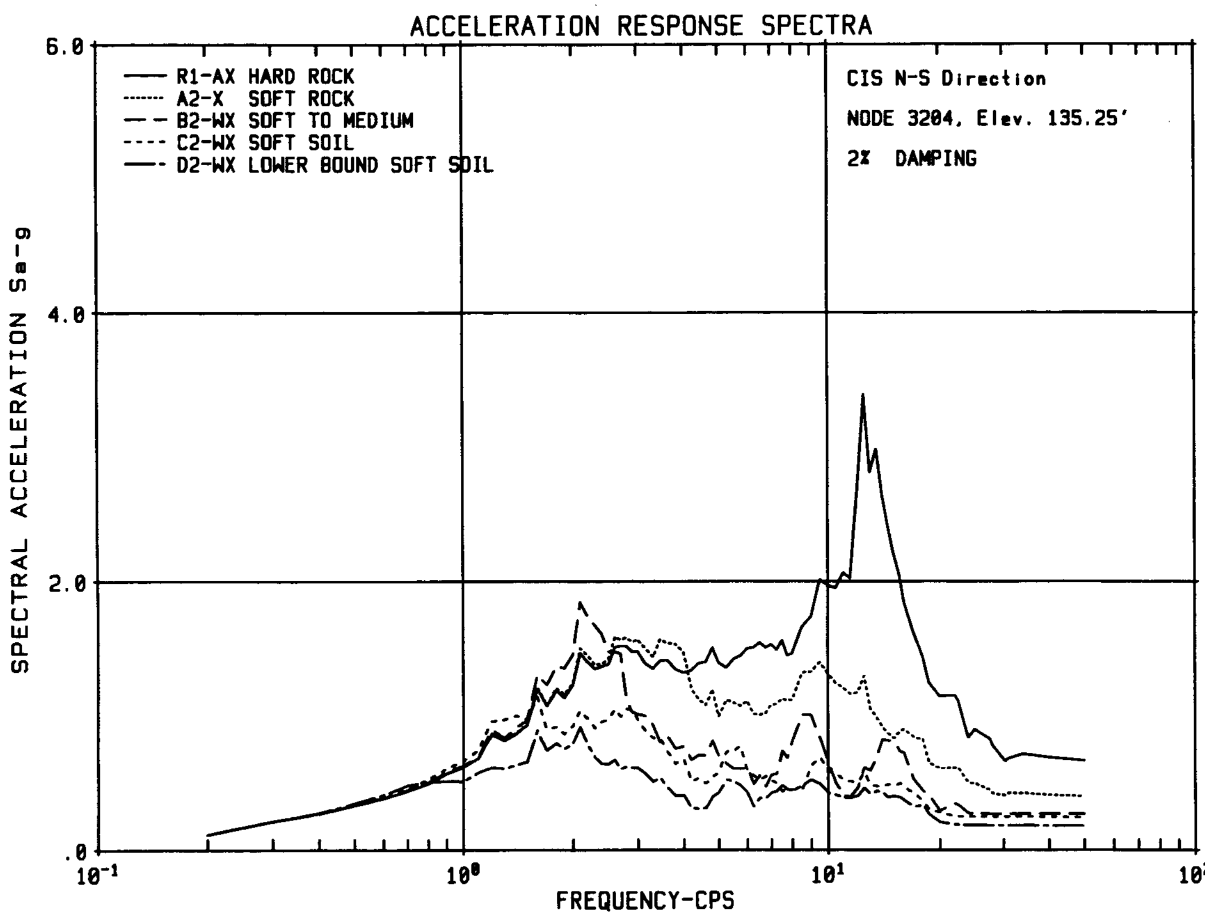


Figure 2B-2 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Lower Bound Soft Soil Profile

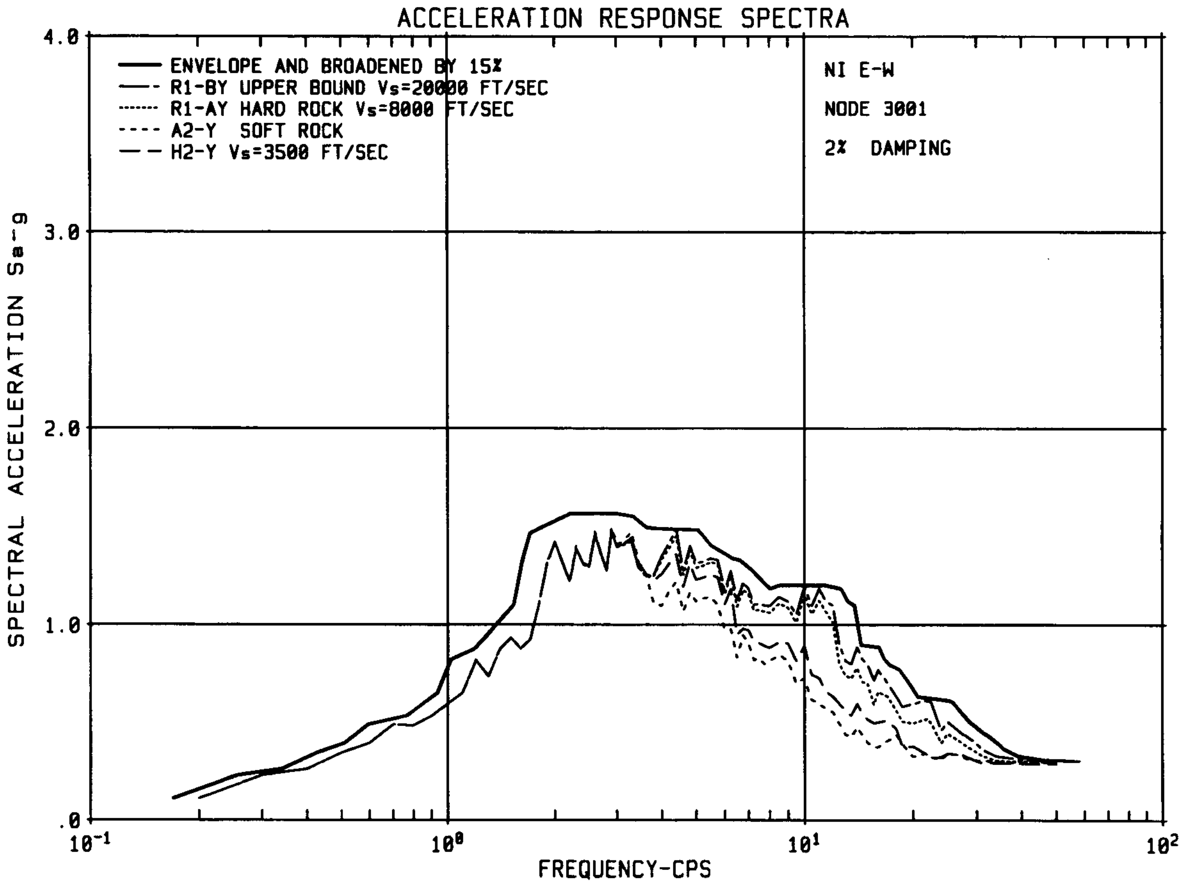


Figure 2B-3 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

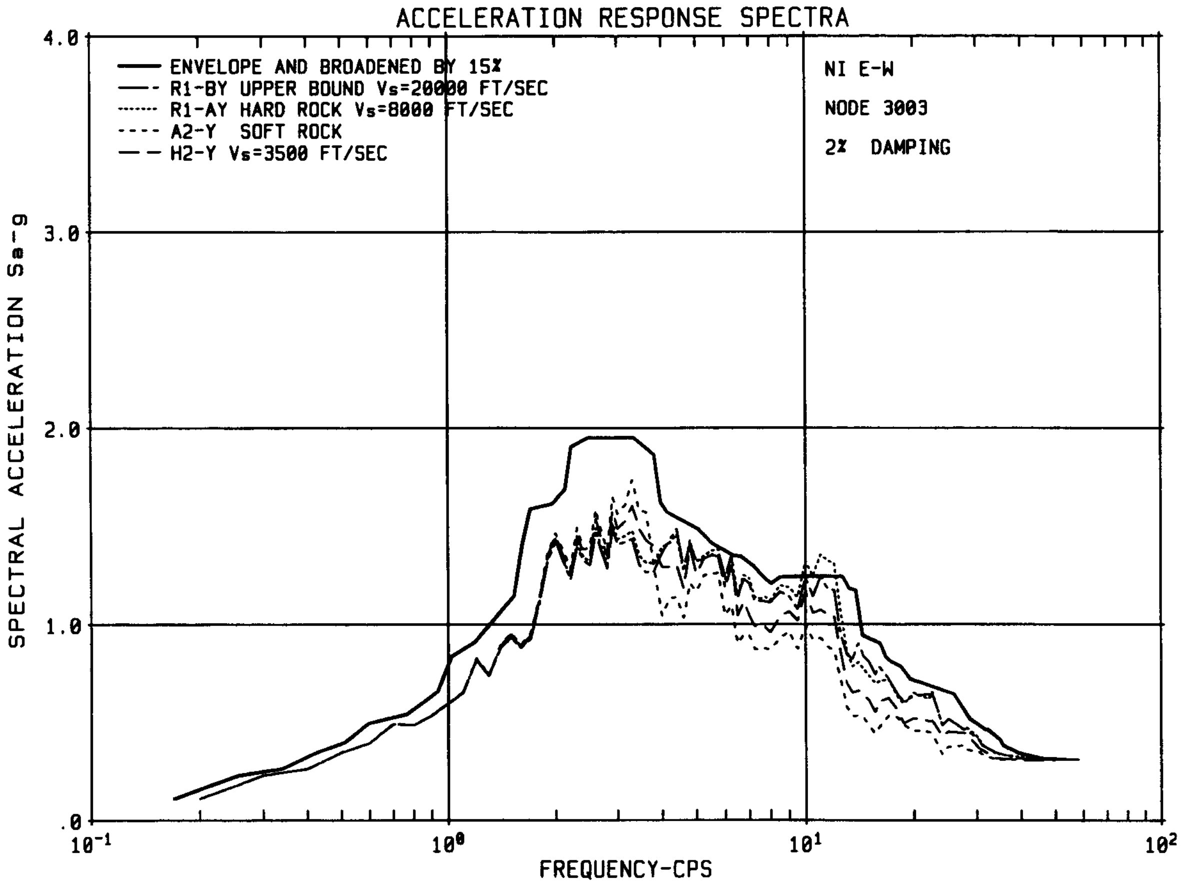


Figure 2B-3 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

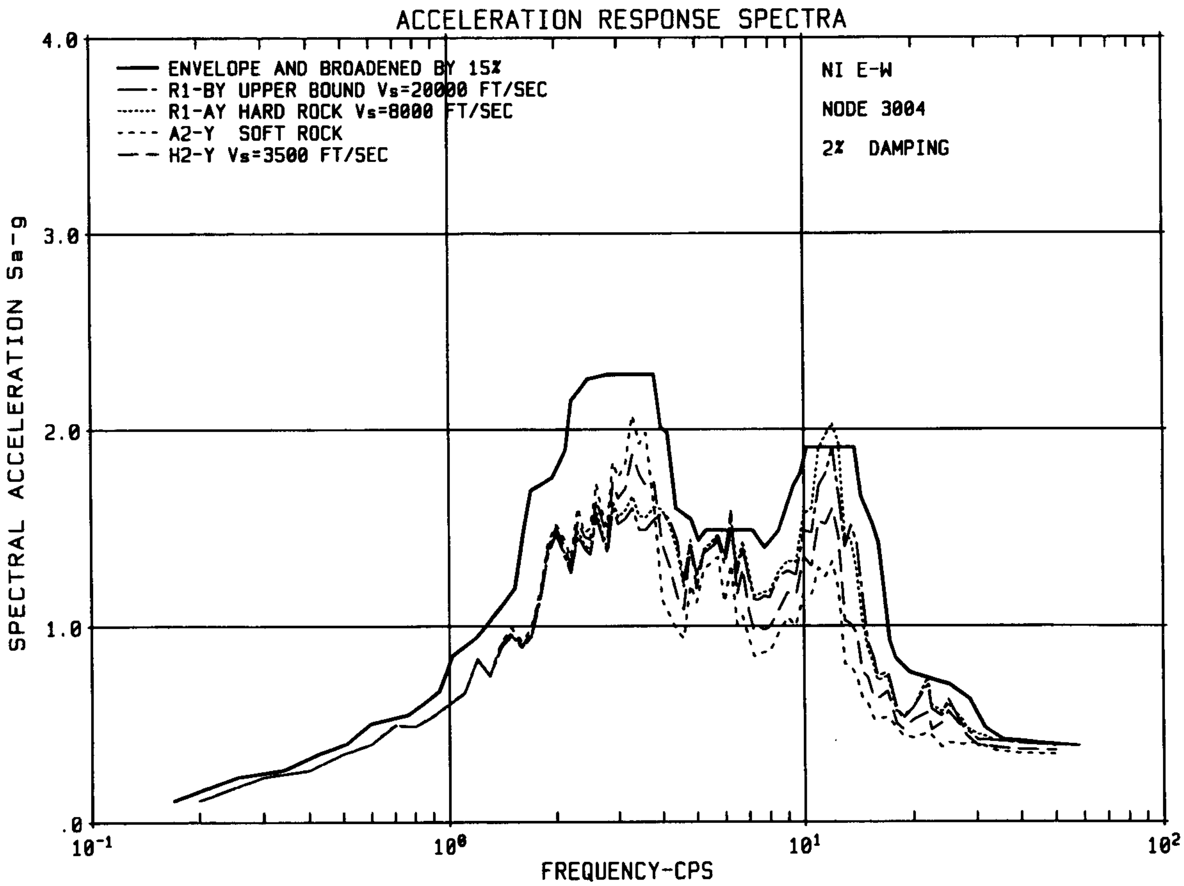


Figure 2B-3 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

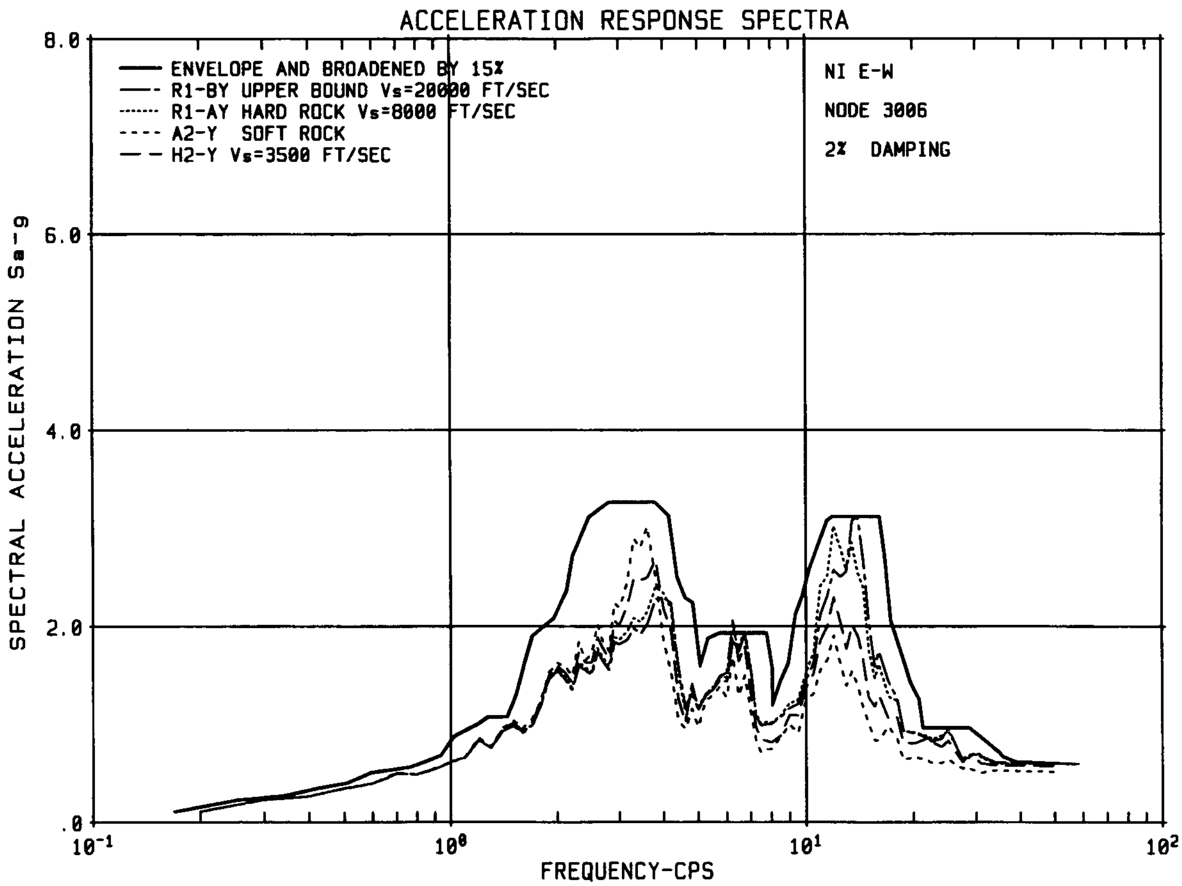


Figure 2B-3 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

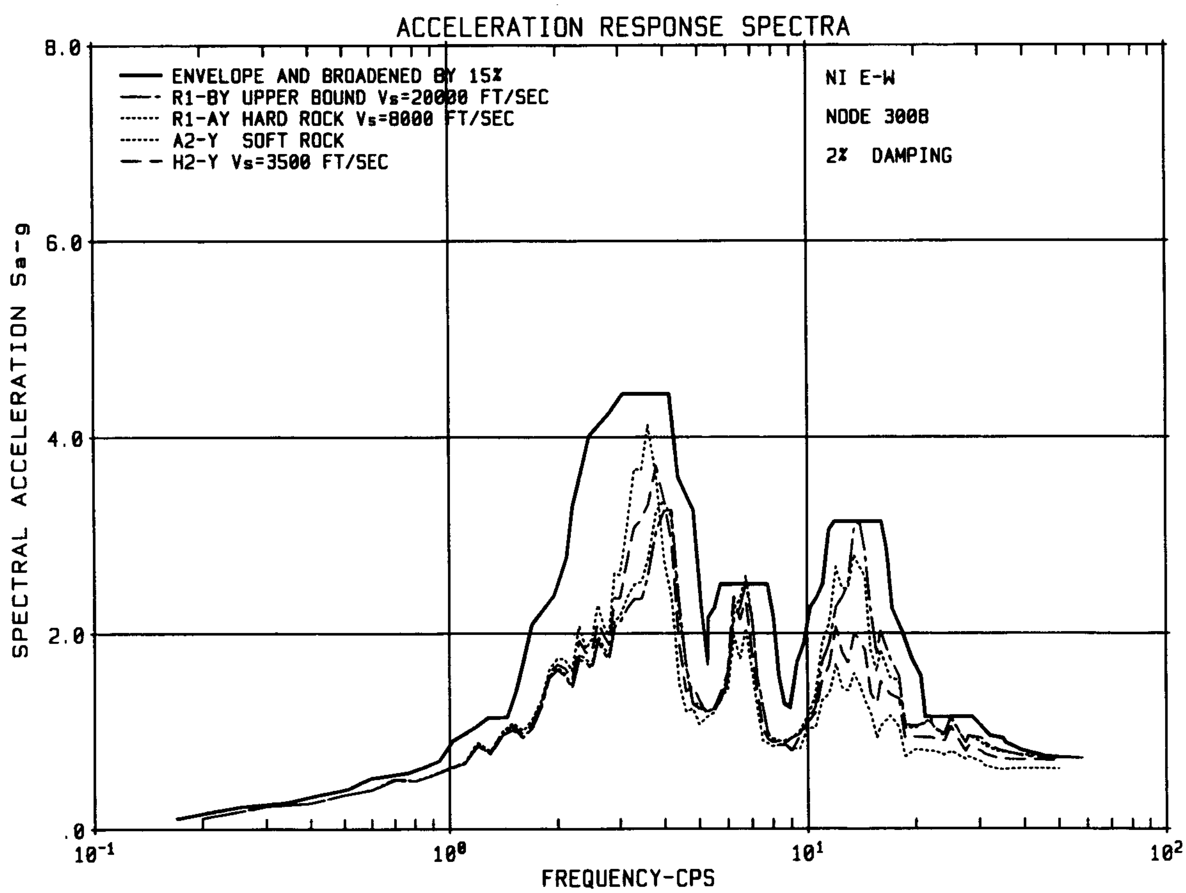


Figure 2B-3 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Firm Rock Profile Evaluation

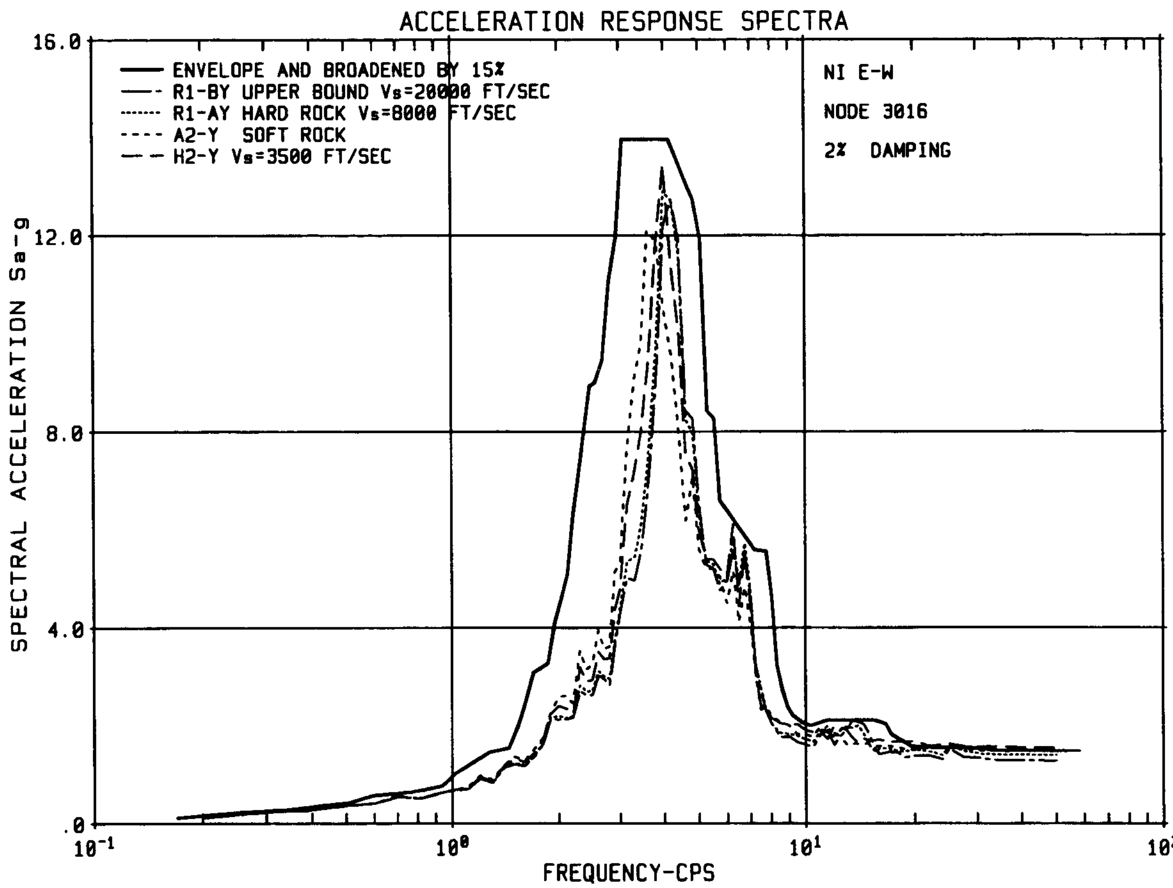


Figure 2B-3 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

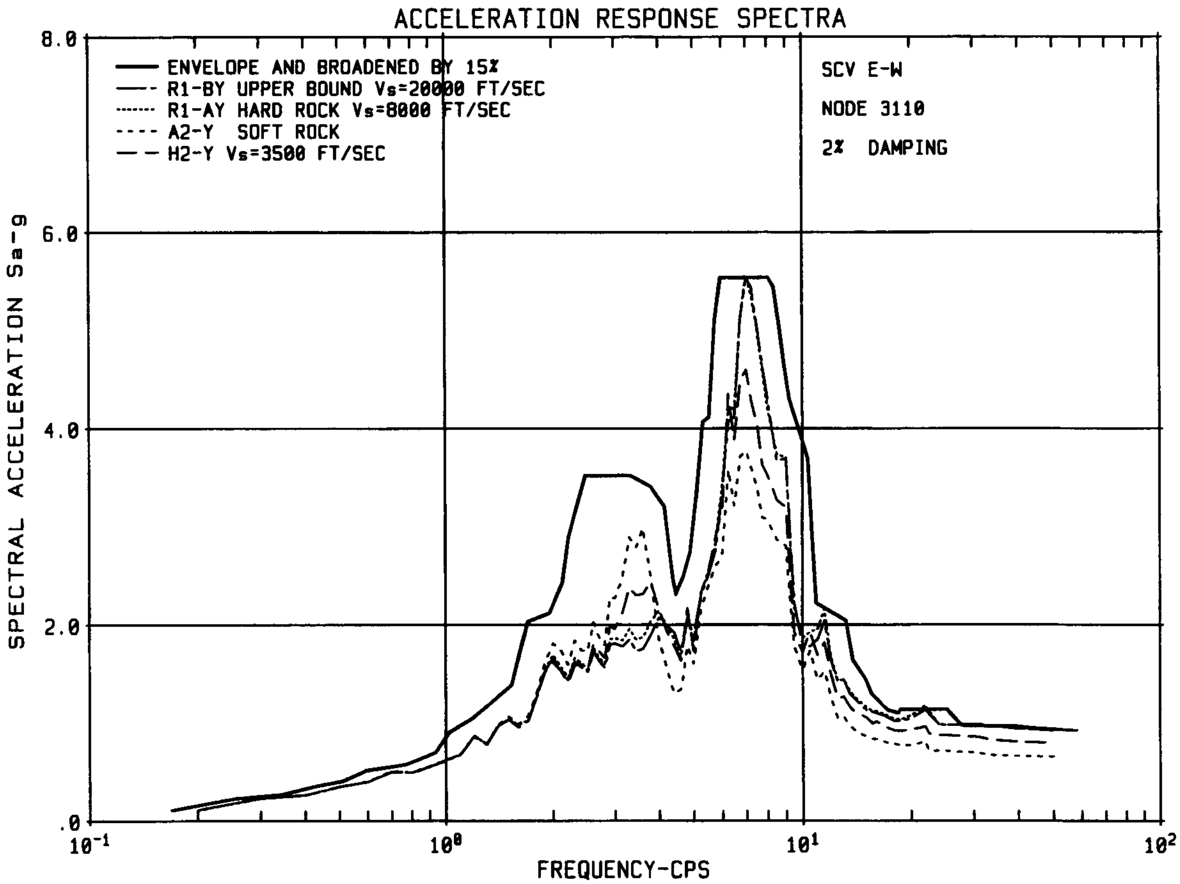


Figure 2B-3 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Firm Rock Profile Evaluation

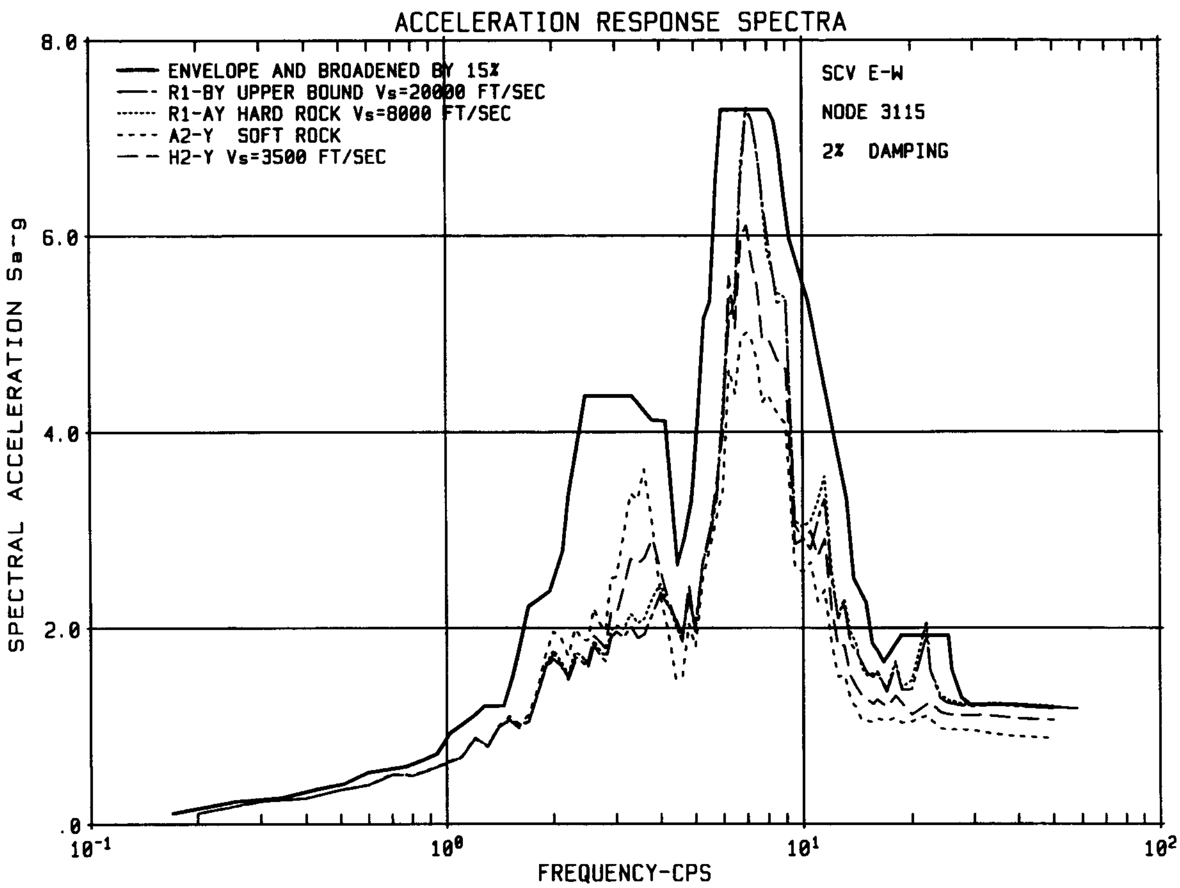


Figure 2B-3 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

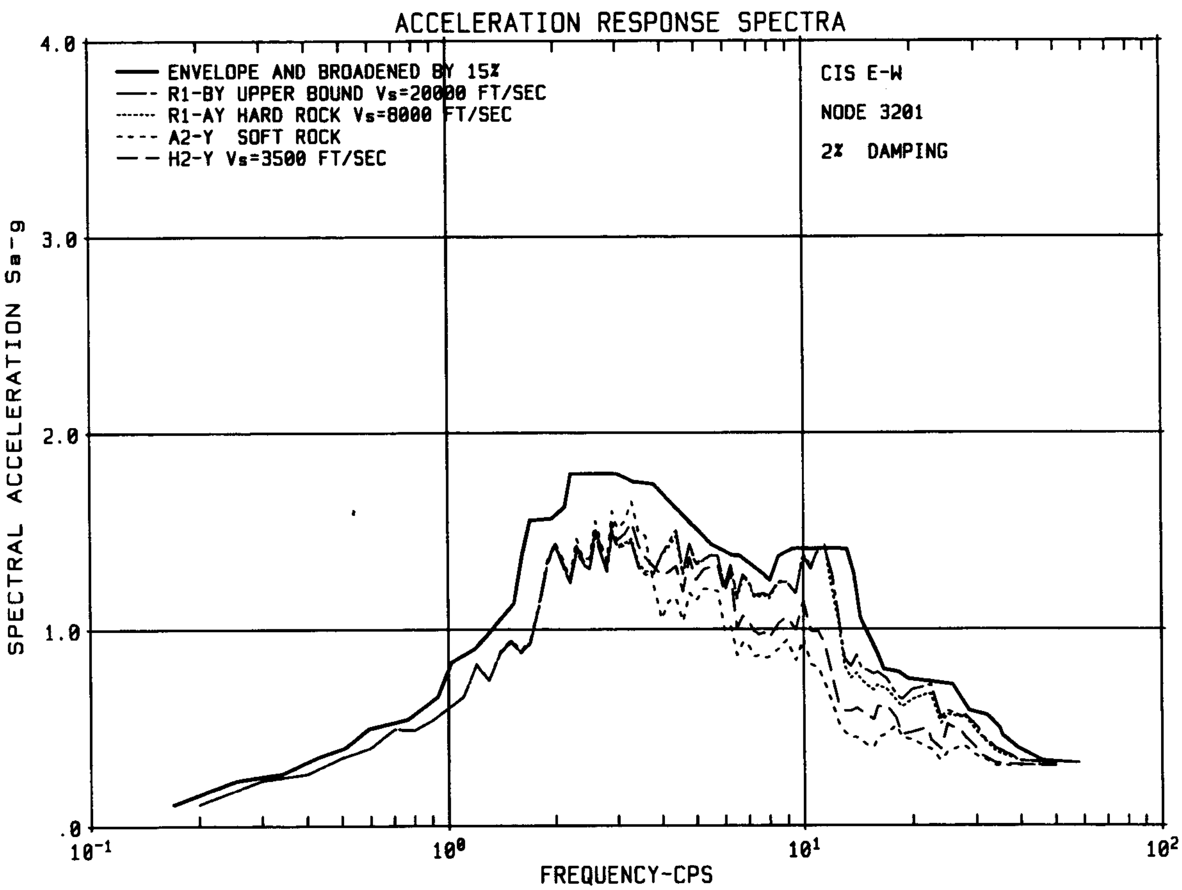


Figure 2B-3 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

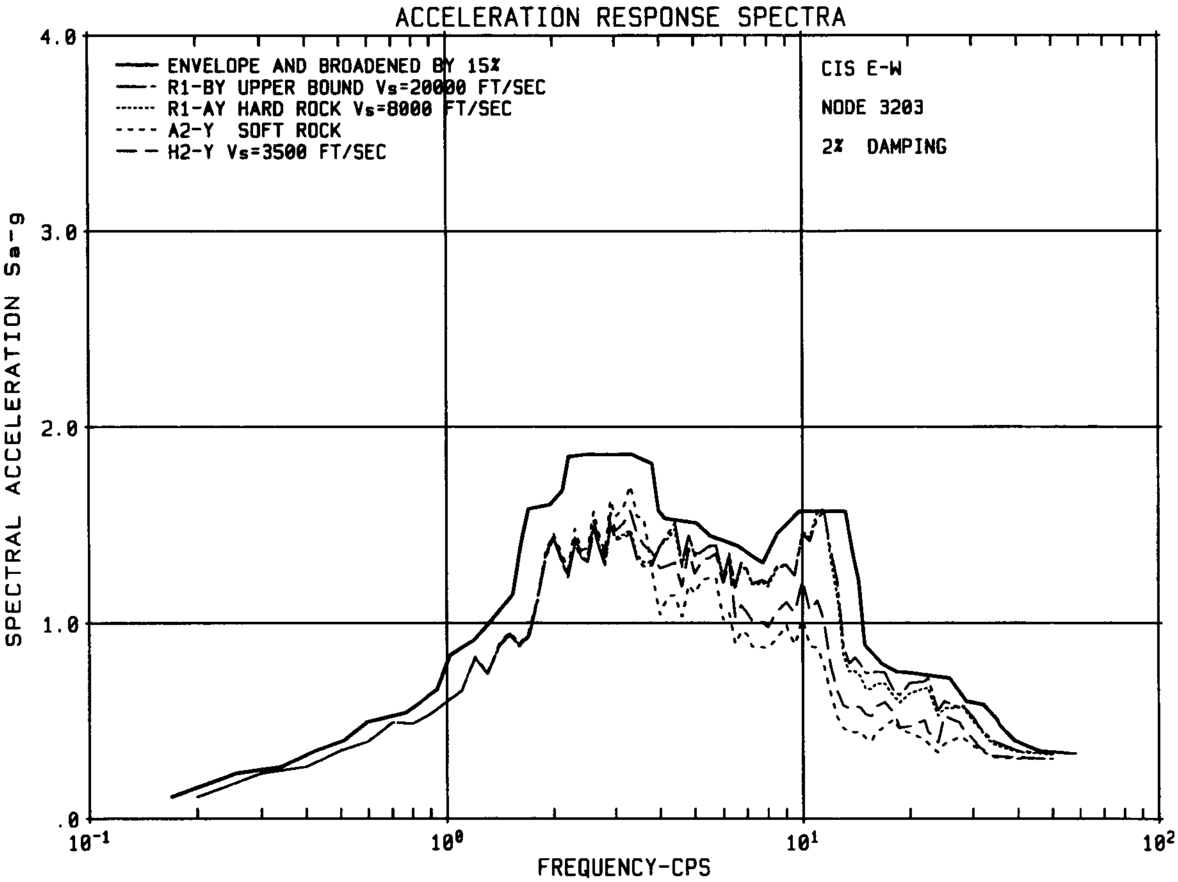


Figure 2B-3 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

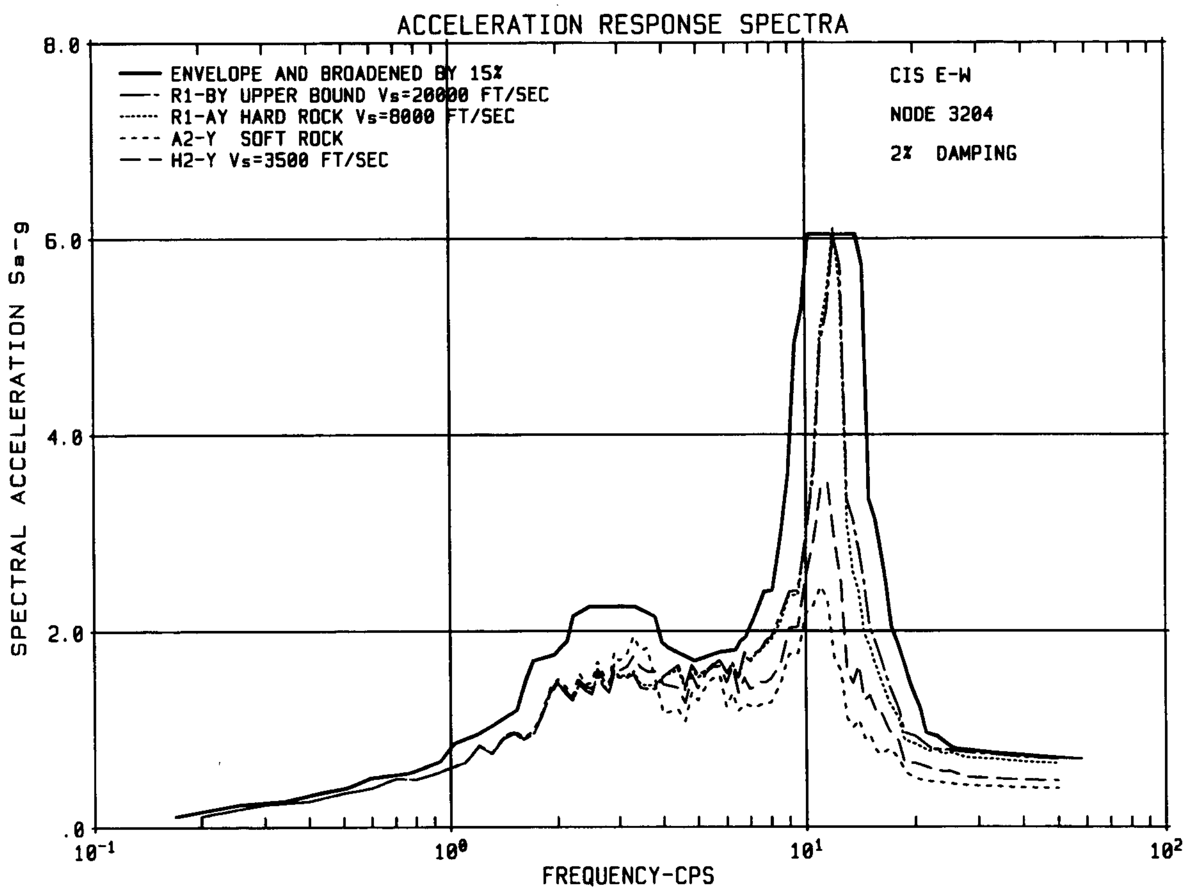


Figure 2B-3 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Firm Rock Profile Evaluation

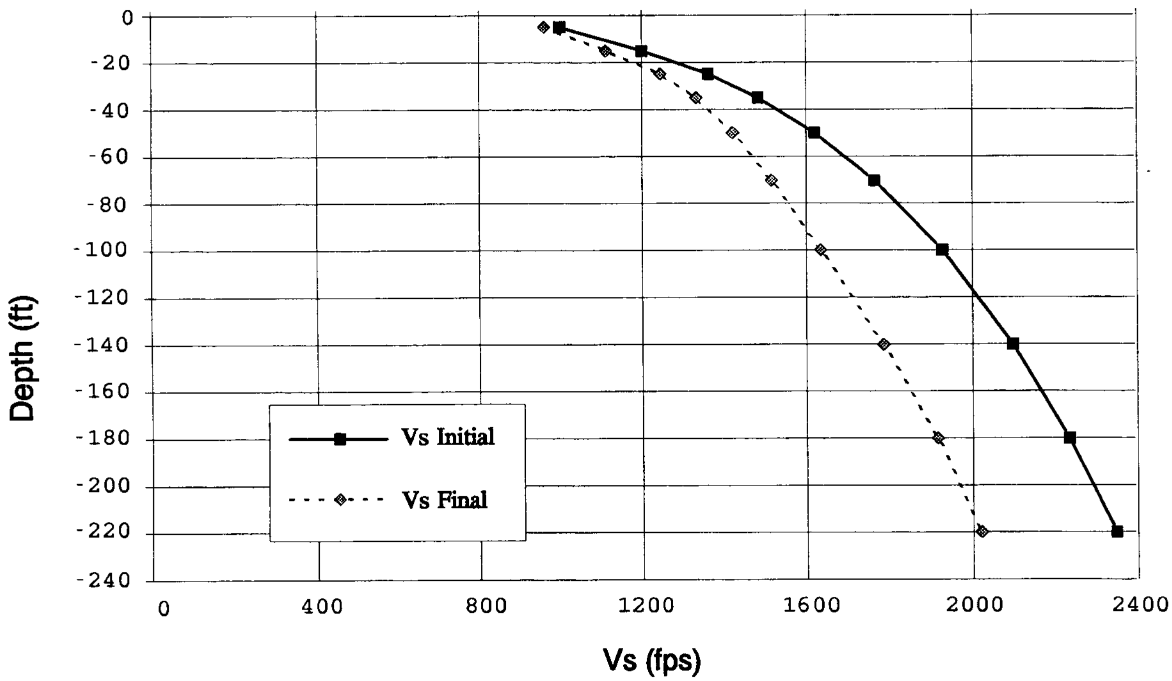


Figure 2B-4

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

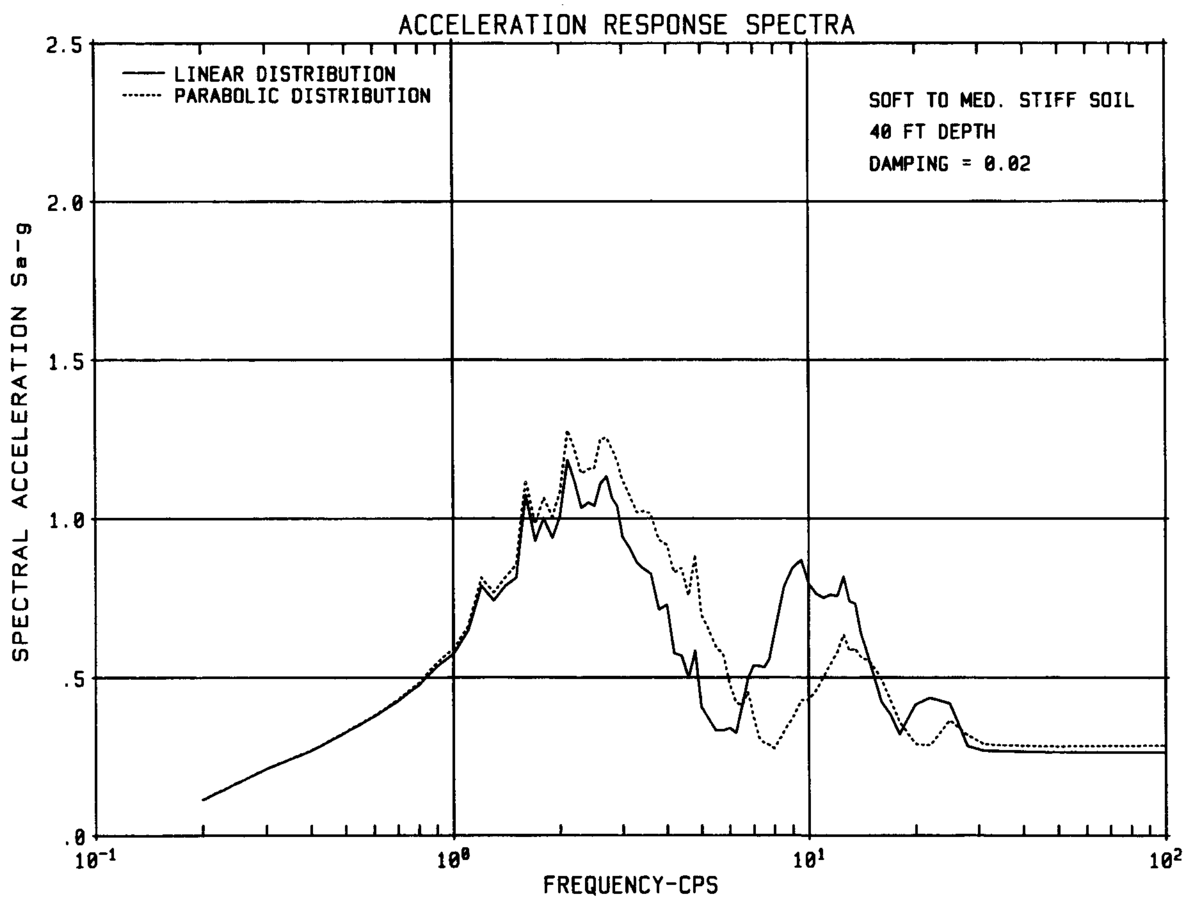


Figure 2B-5

Two-Dimensional SASSI Analysis, E-W Direction Parabolic Soil Profile Evaluation

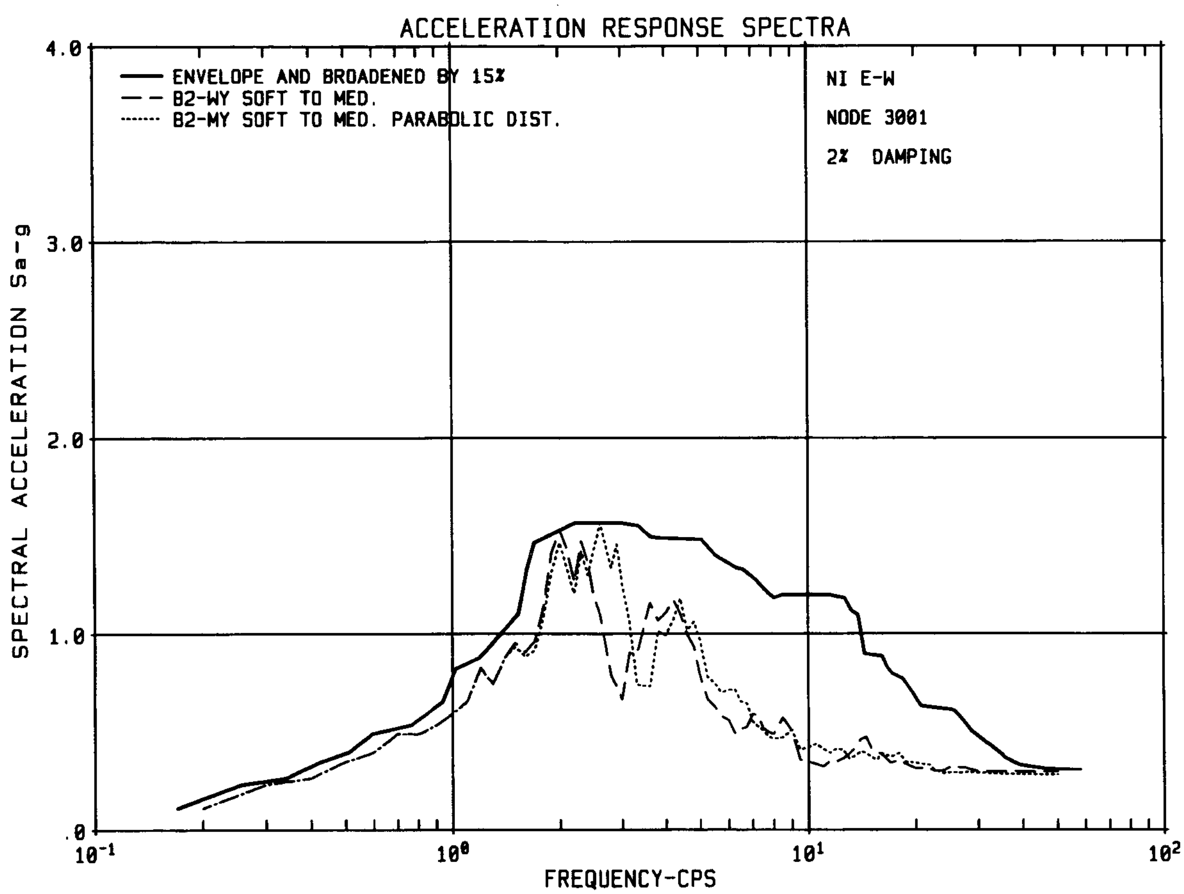


Figure 2B-6 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Parabolic Soil Profile Evaluation

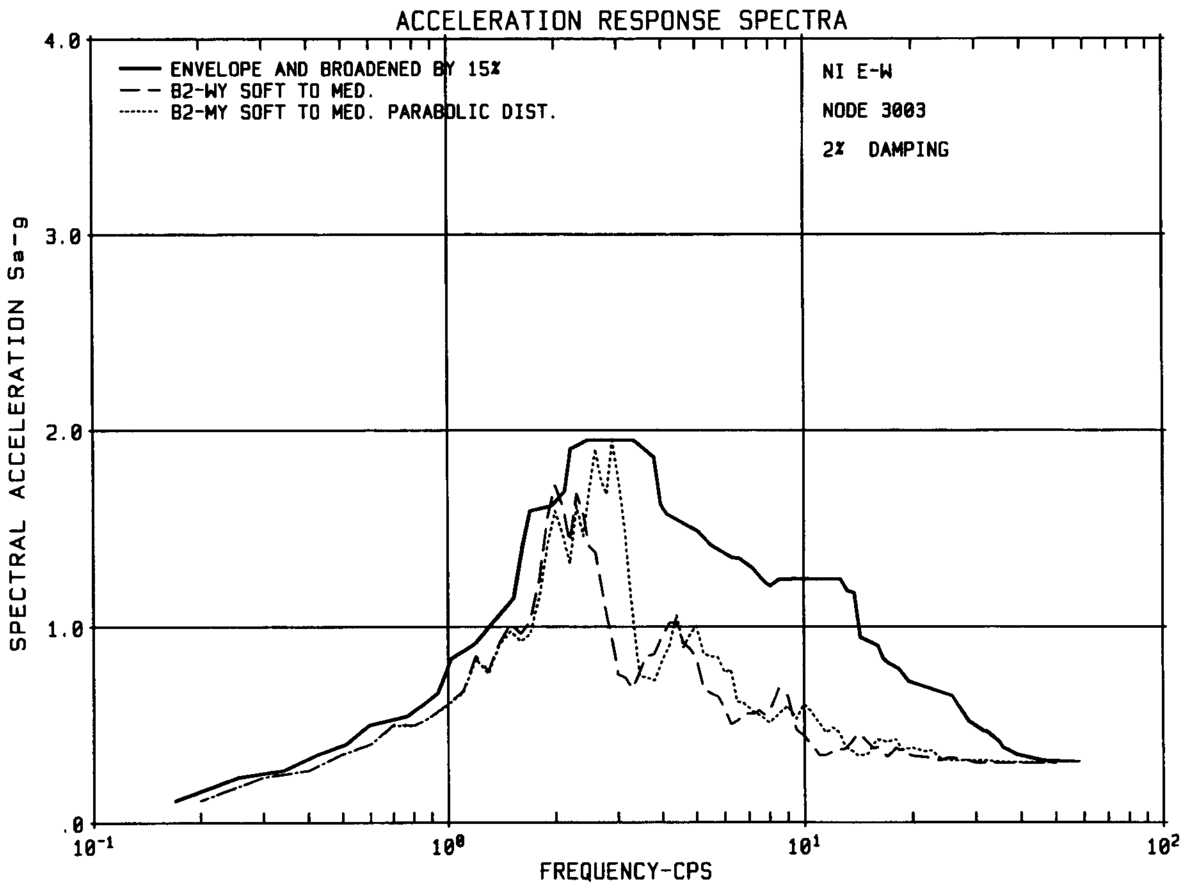


Figure 2B-6 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

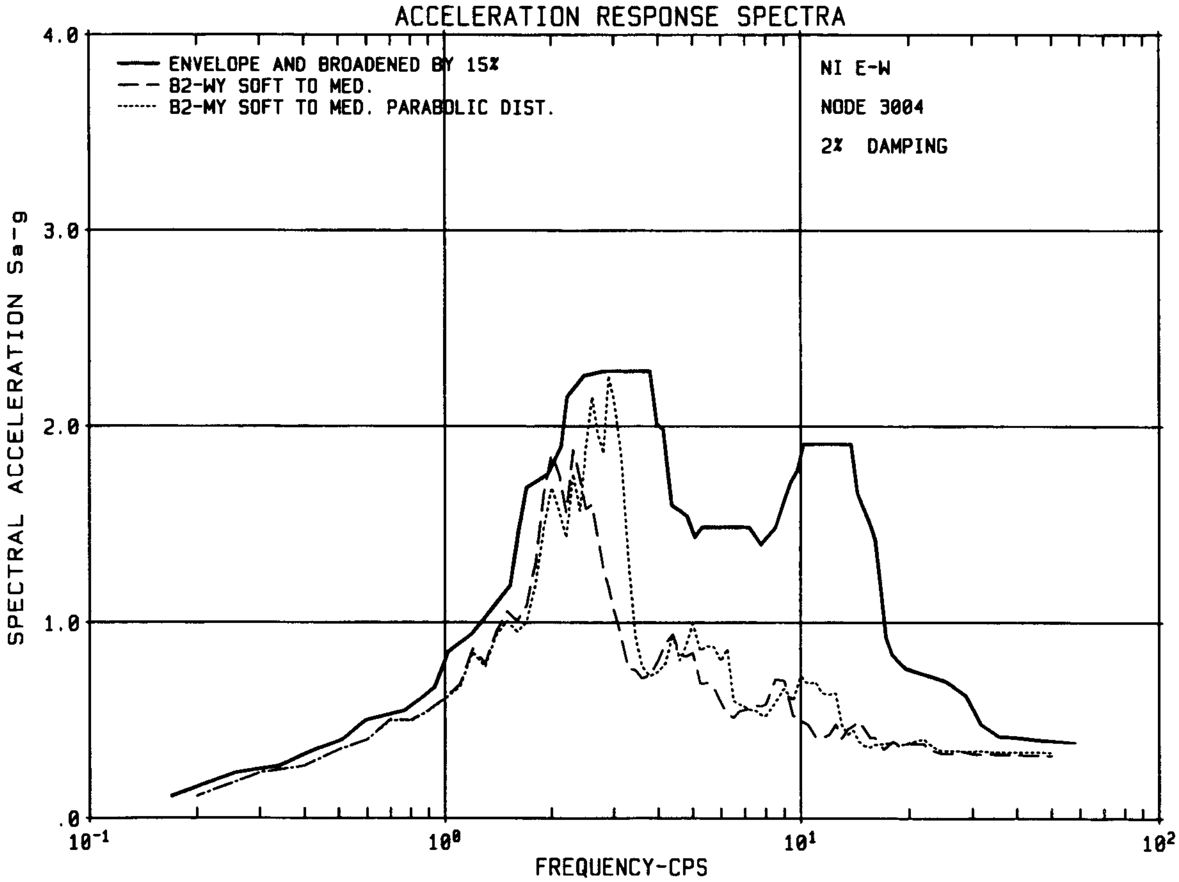


Figure 2B-6 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

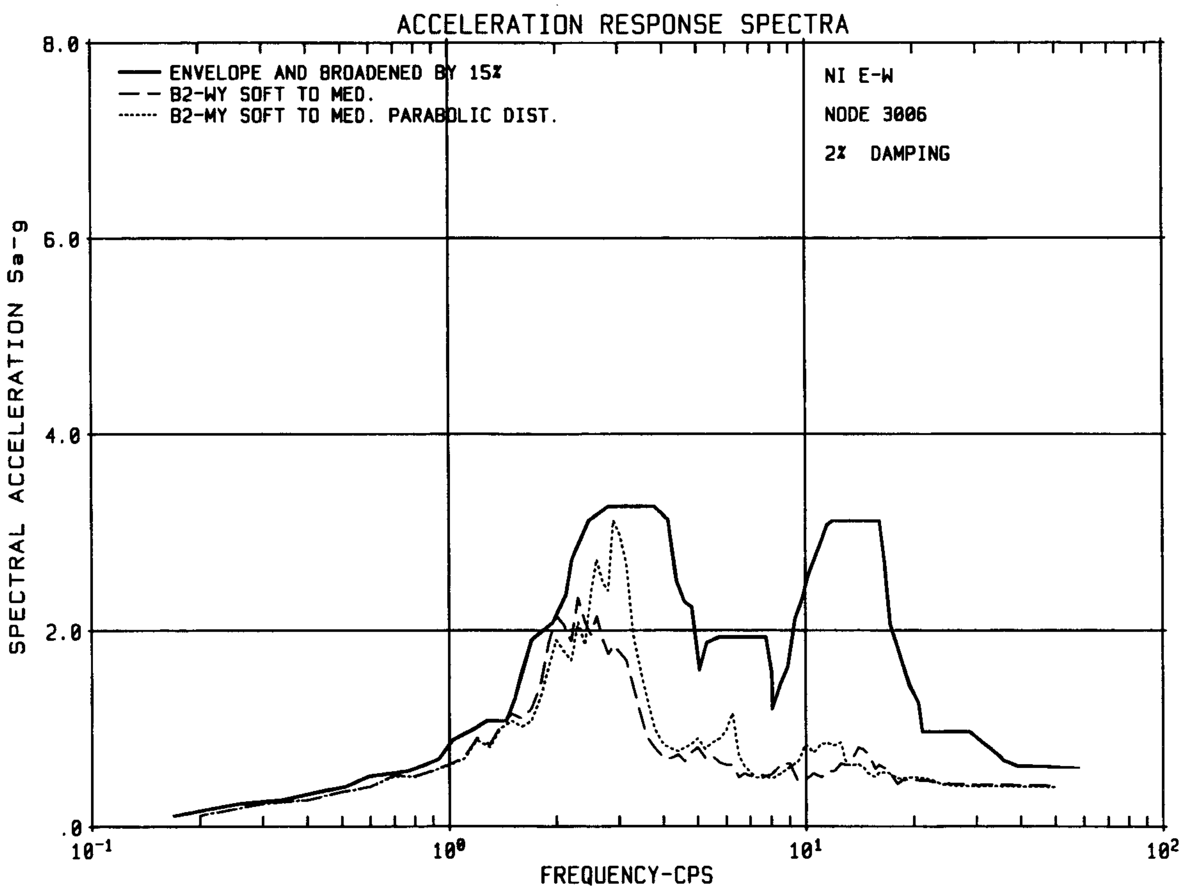


Figure 2B-6 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

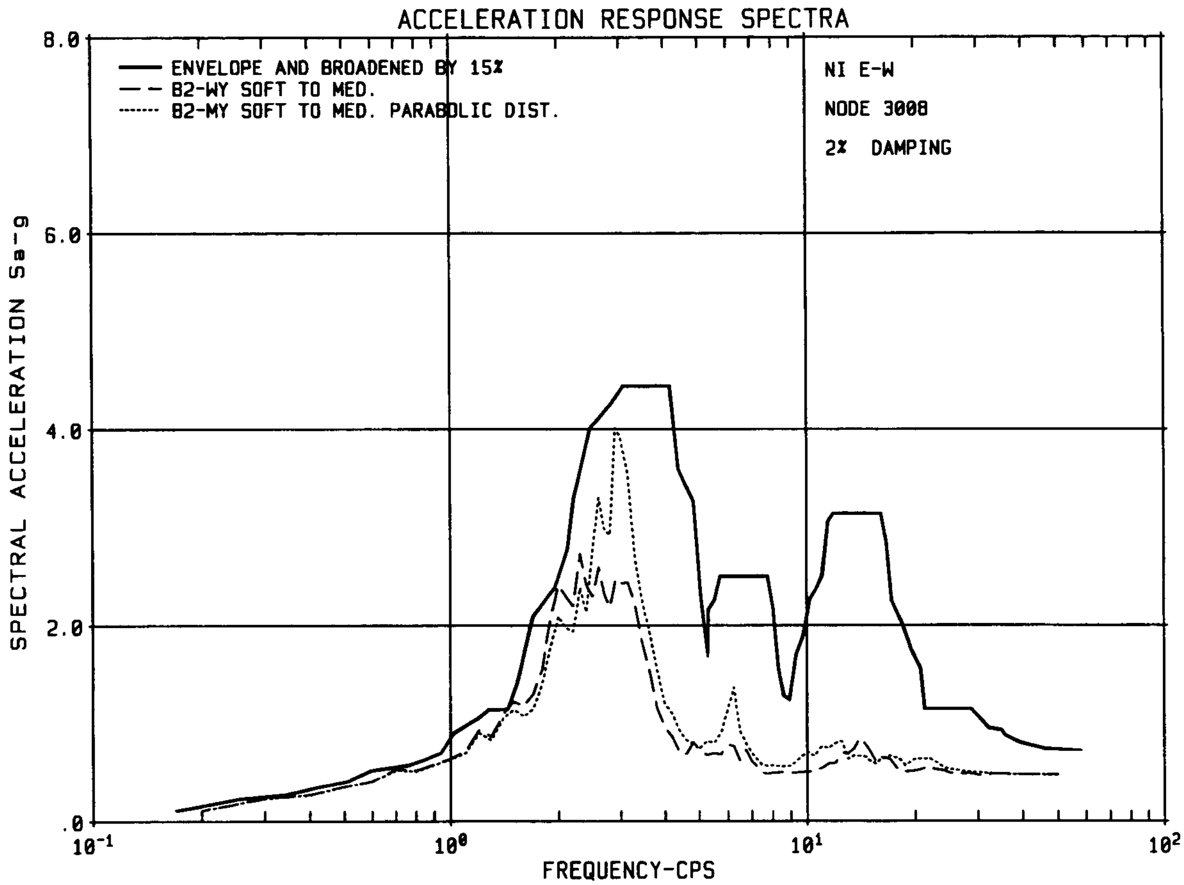


Figure 2B-6 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Parabolic Soil Profile Evaluation

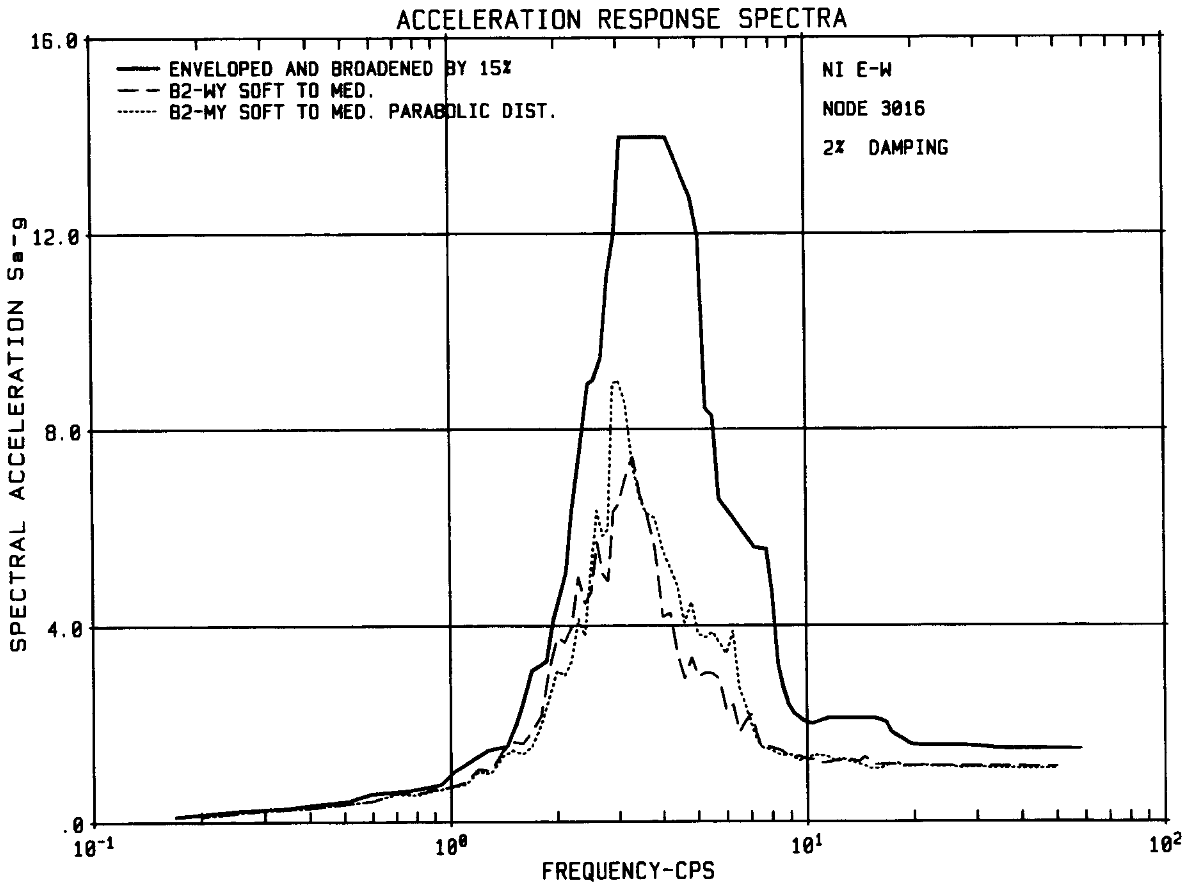


Figure 2B-6 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

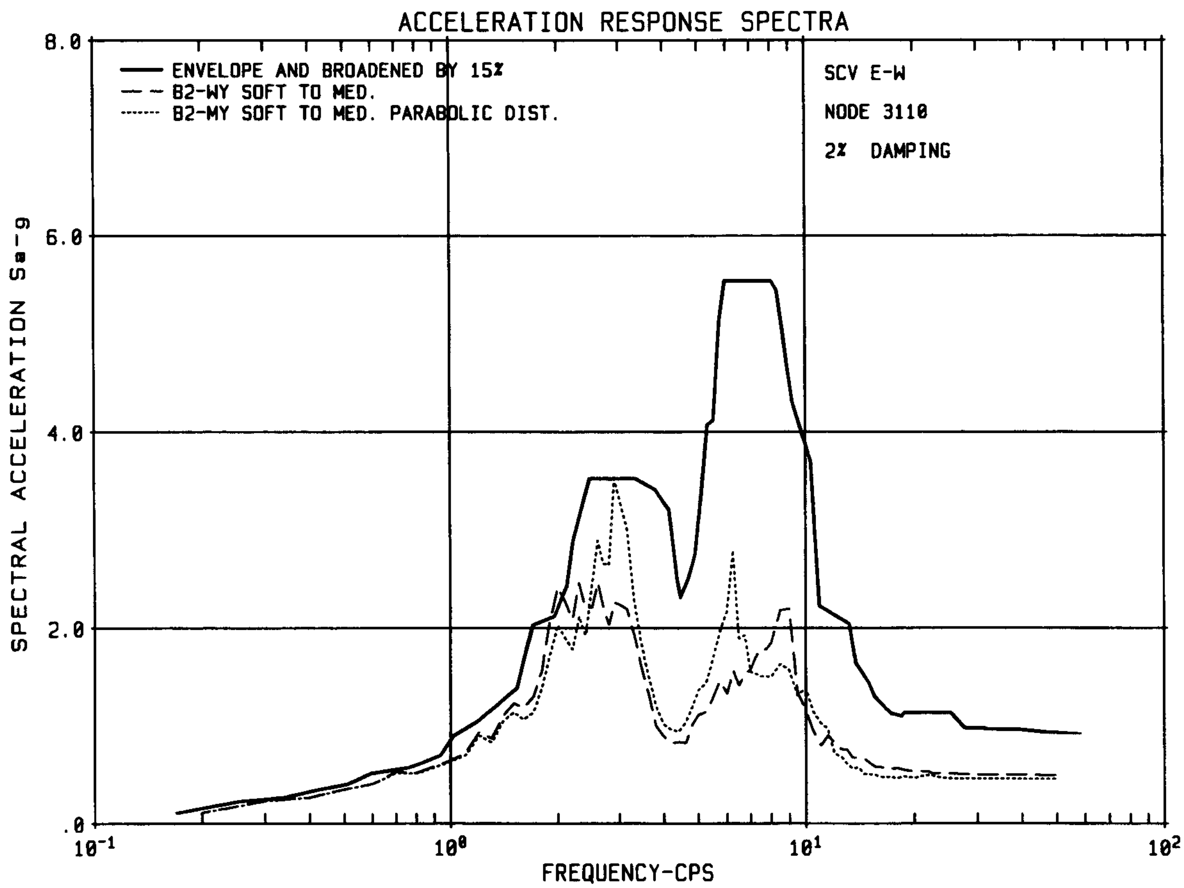


Figure 2B-6 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

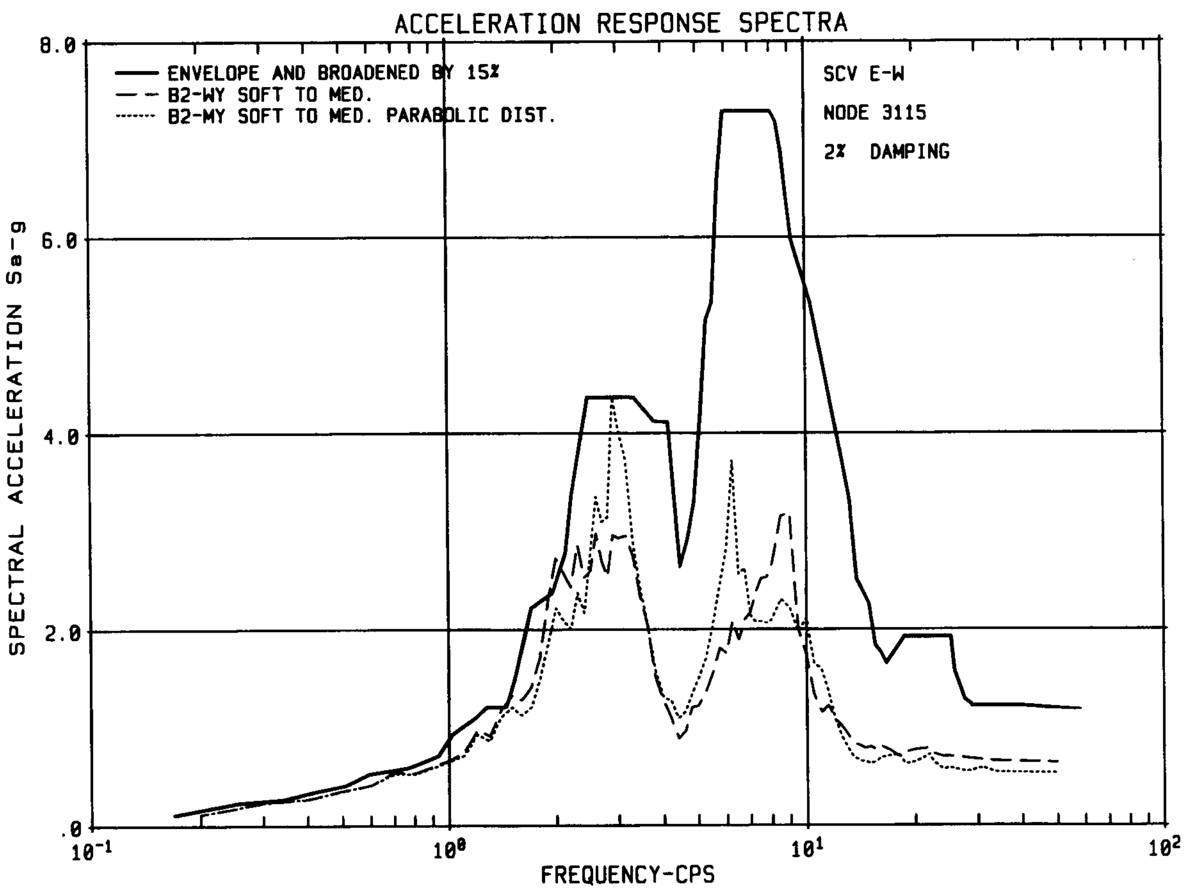


Figure 2B-6 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

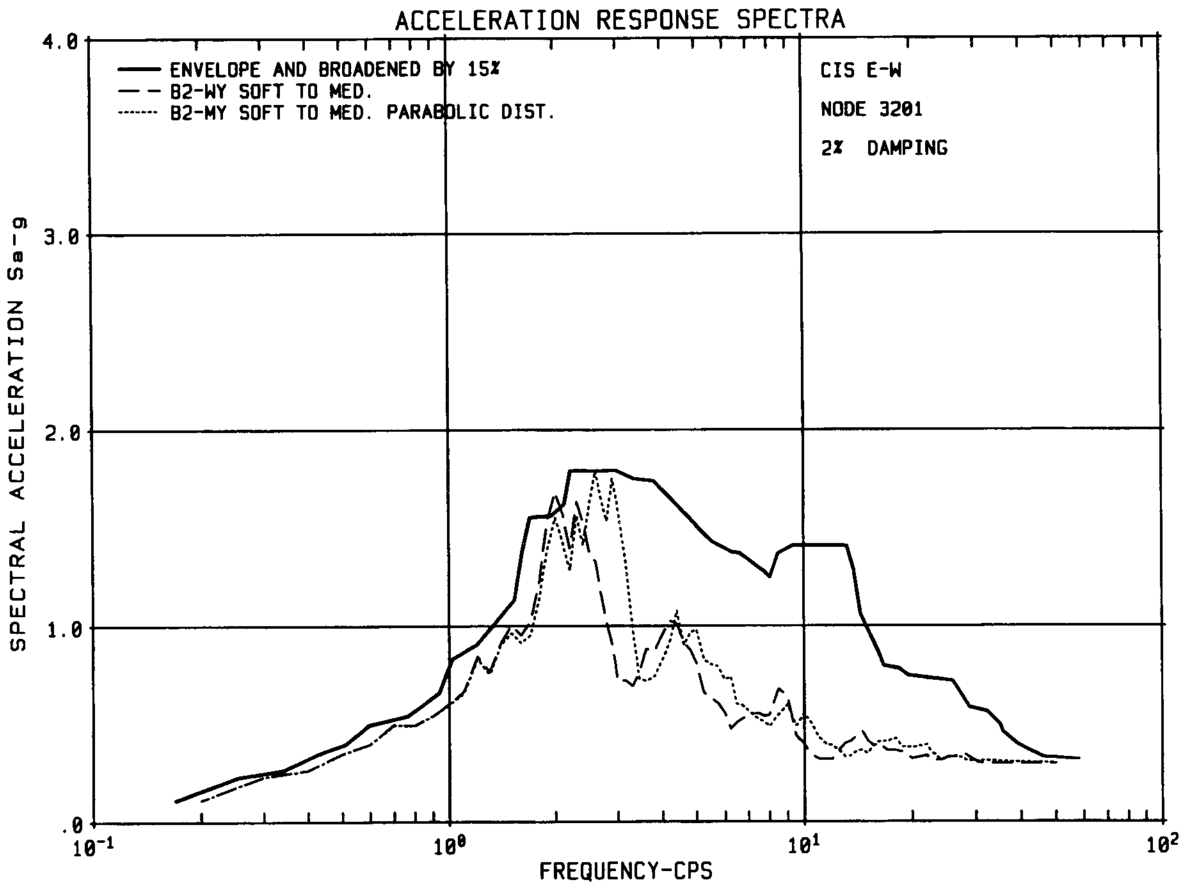


Figure 2B-6 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

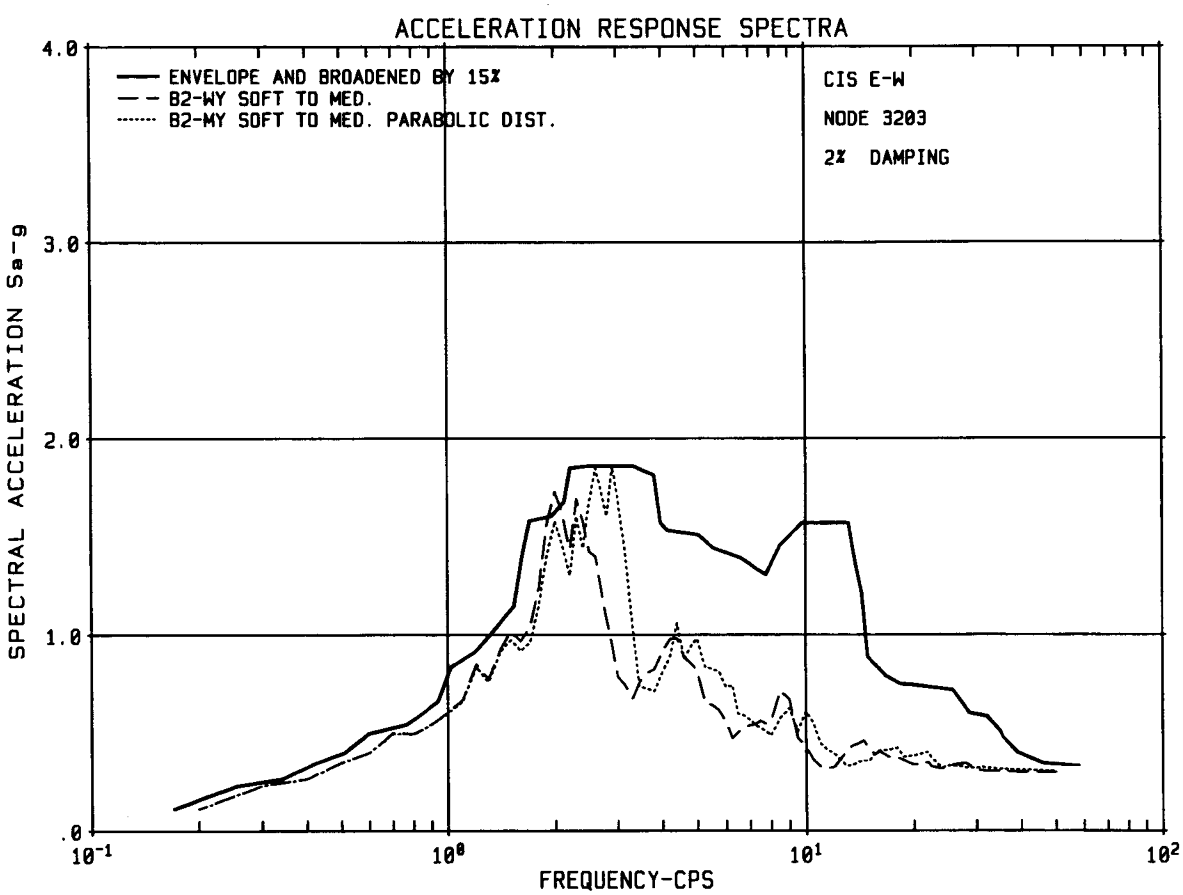


Figure 2B-6 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Parabolic Soil Profile Evaluation

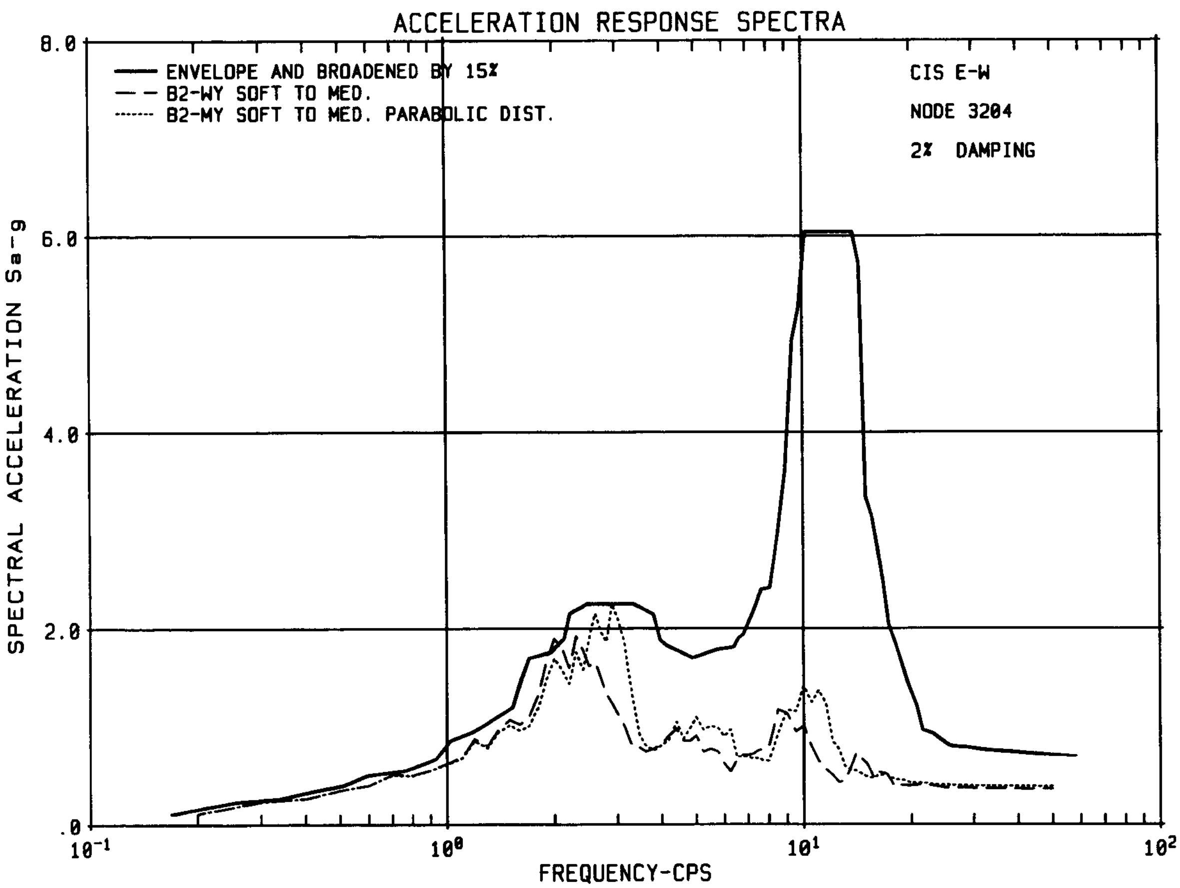


Figure 2B-6 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Parabolic Soil Profile Evaluation

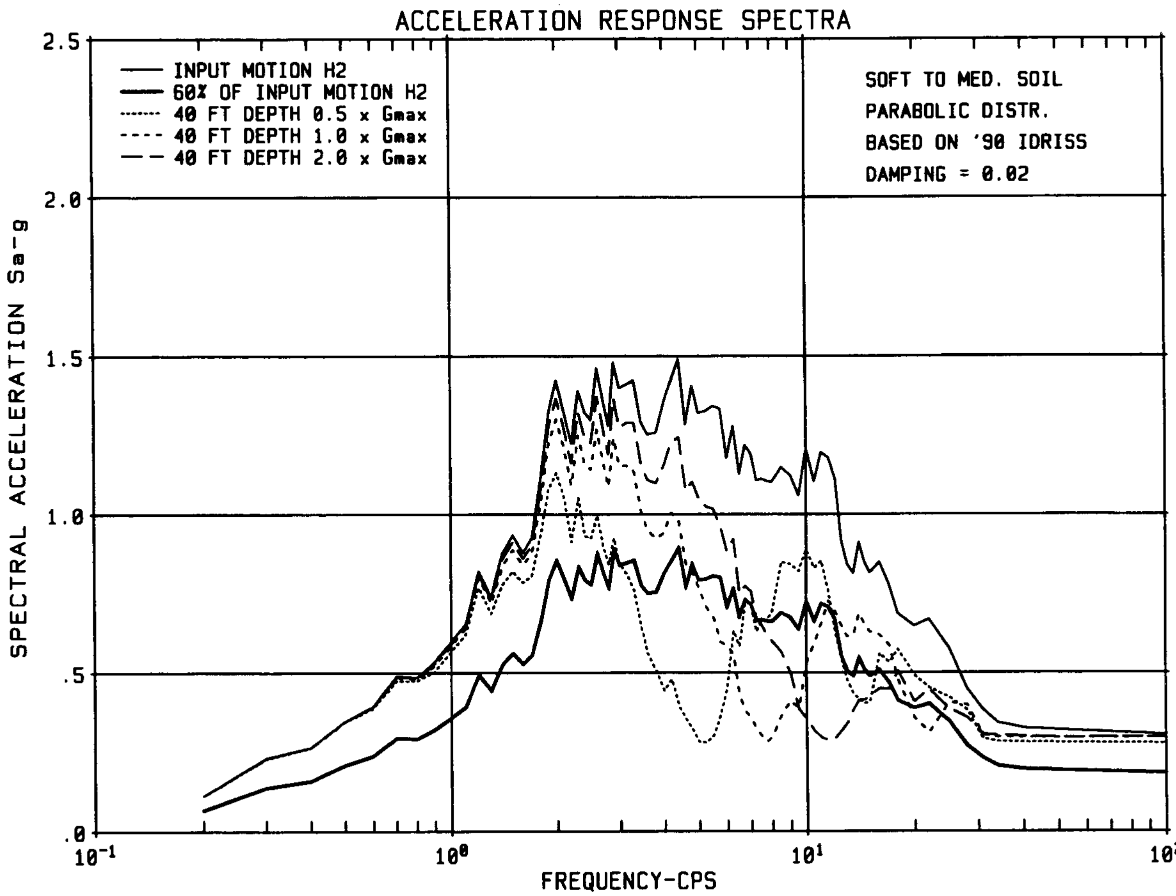


Figure 2B-7

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

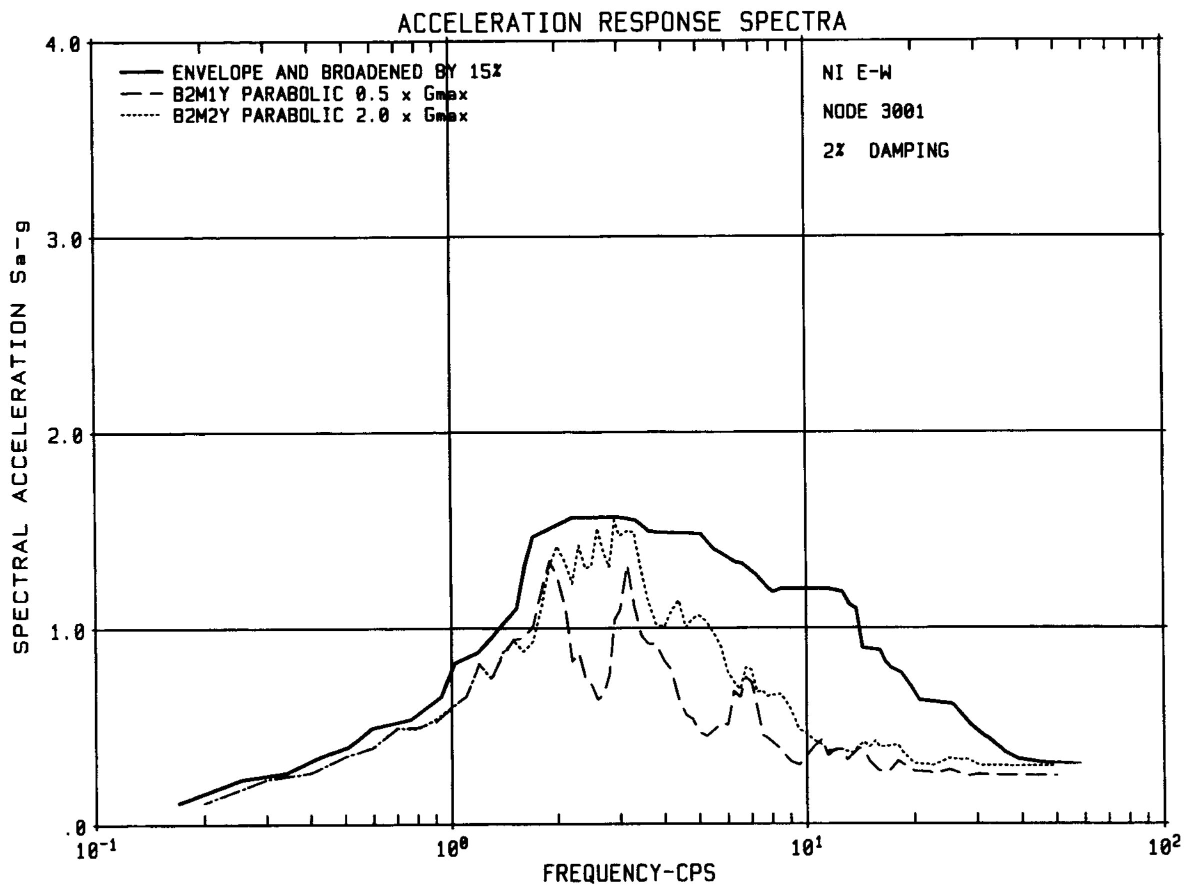


Figure 2B-8 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

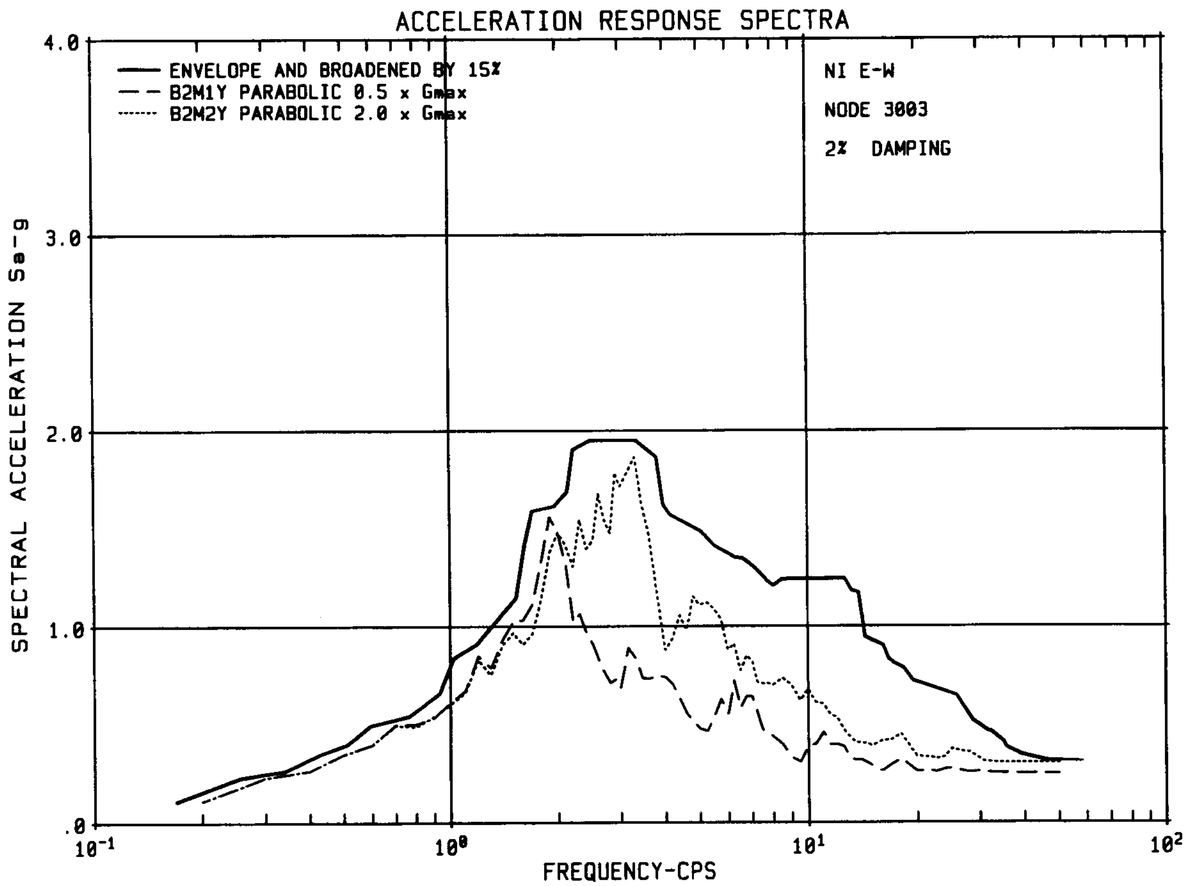


Figure 2B-8 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

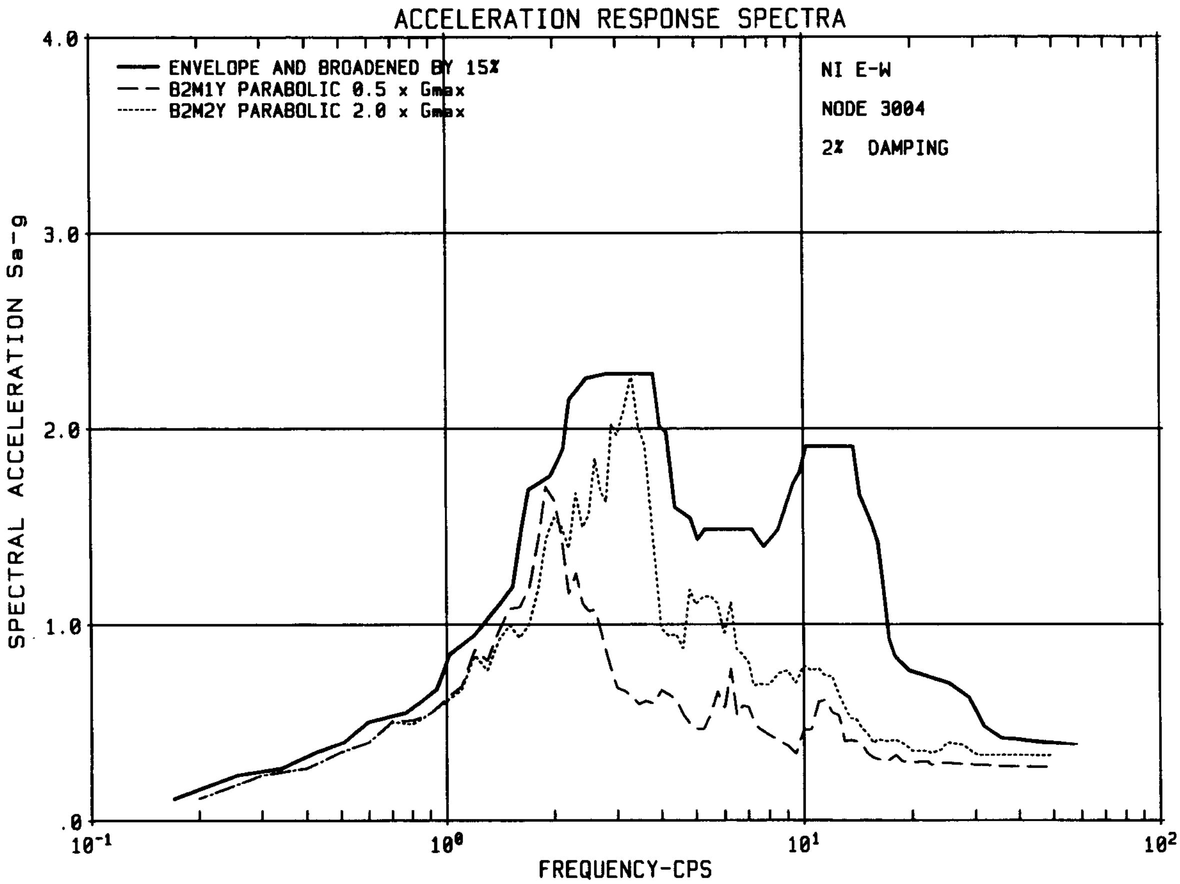


Figure 2B-8 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

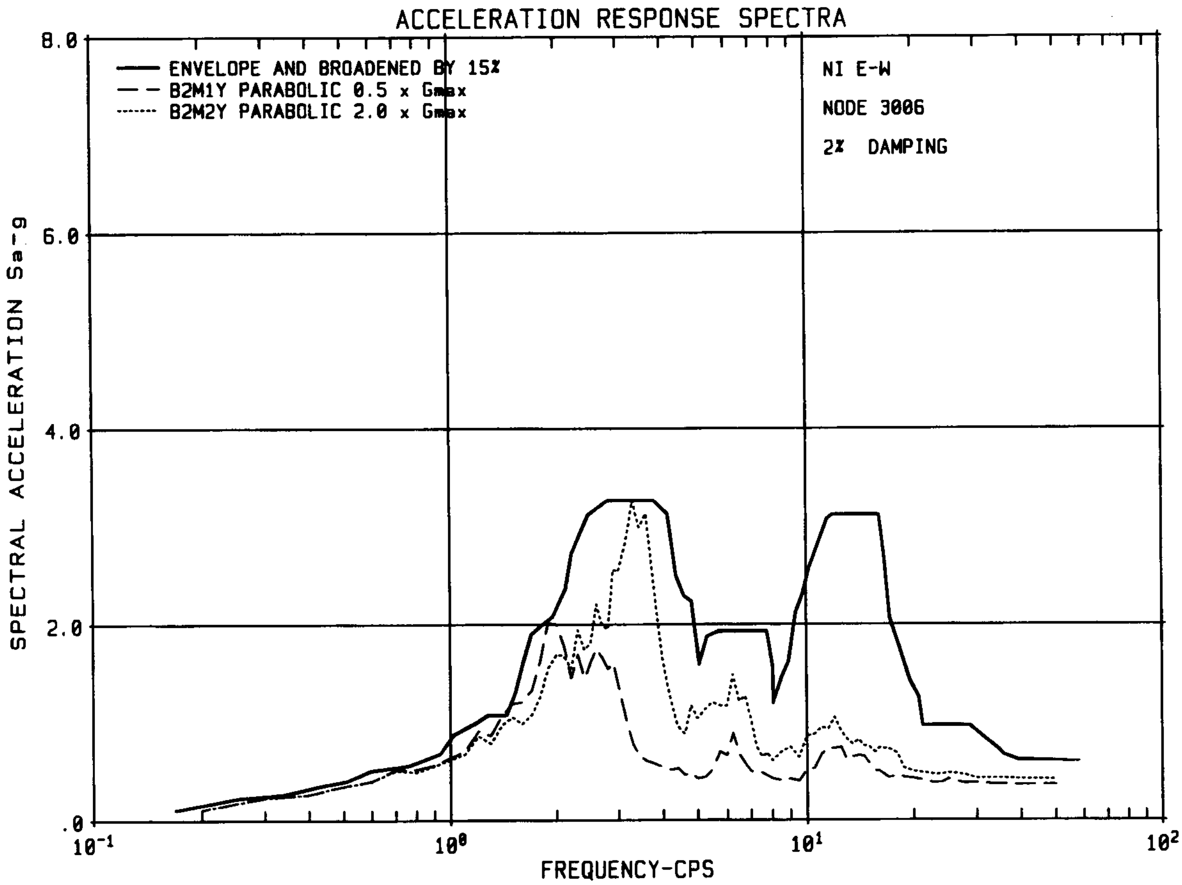


Figure 2B-8 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

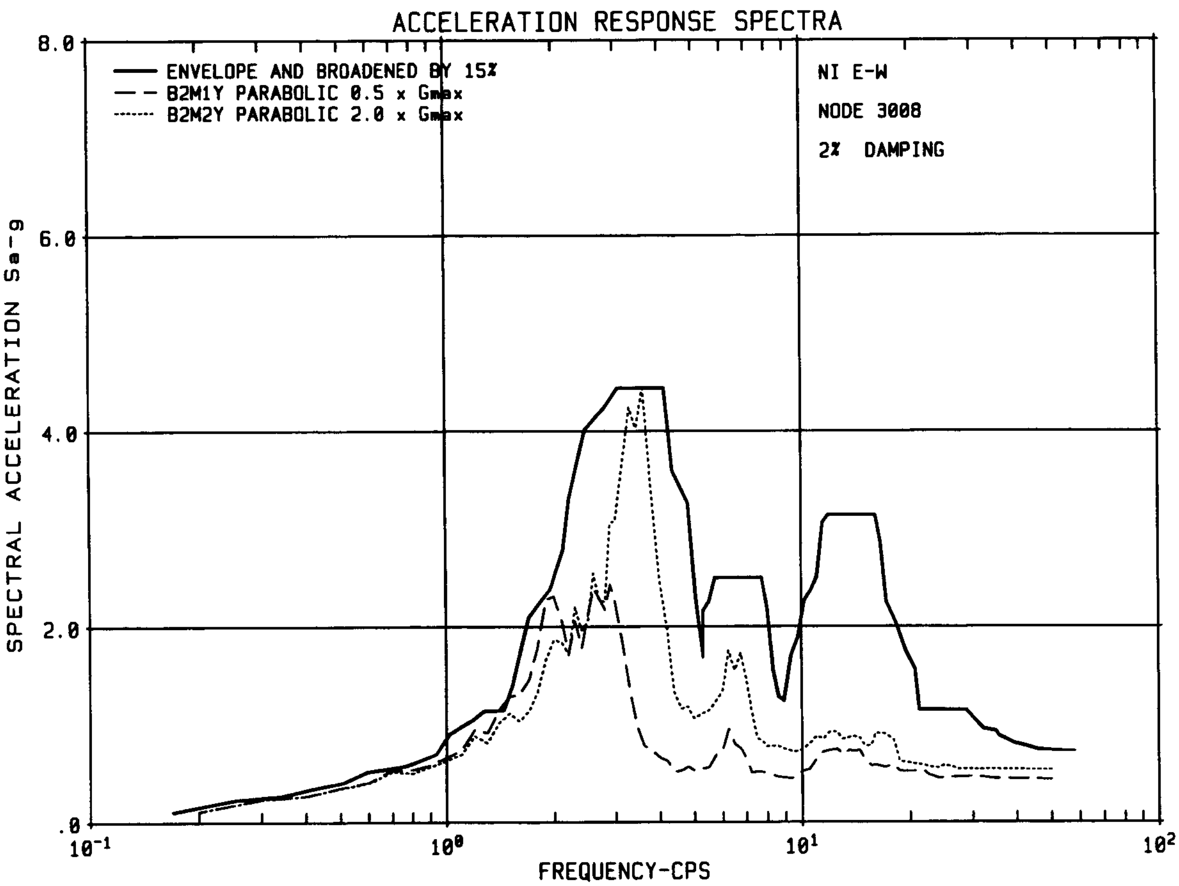


Figure 2B-8 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

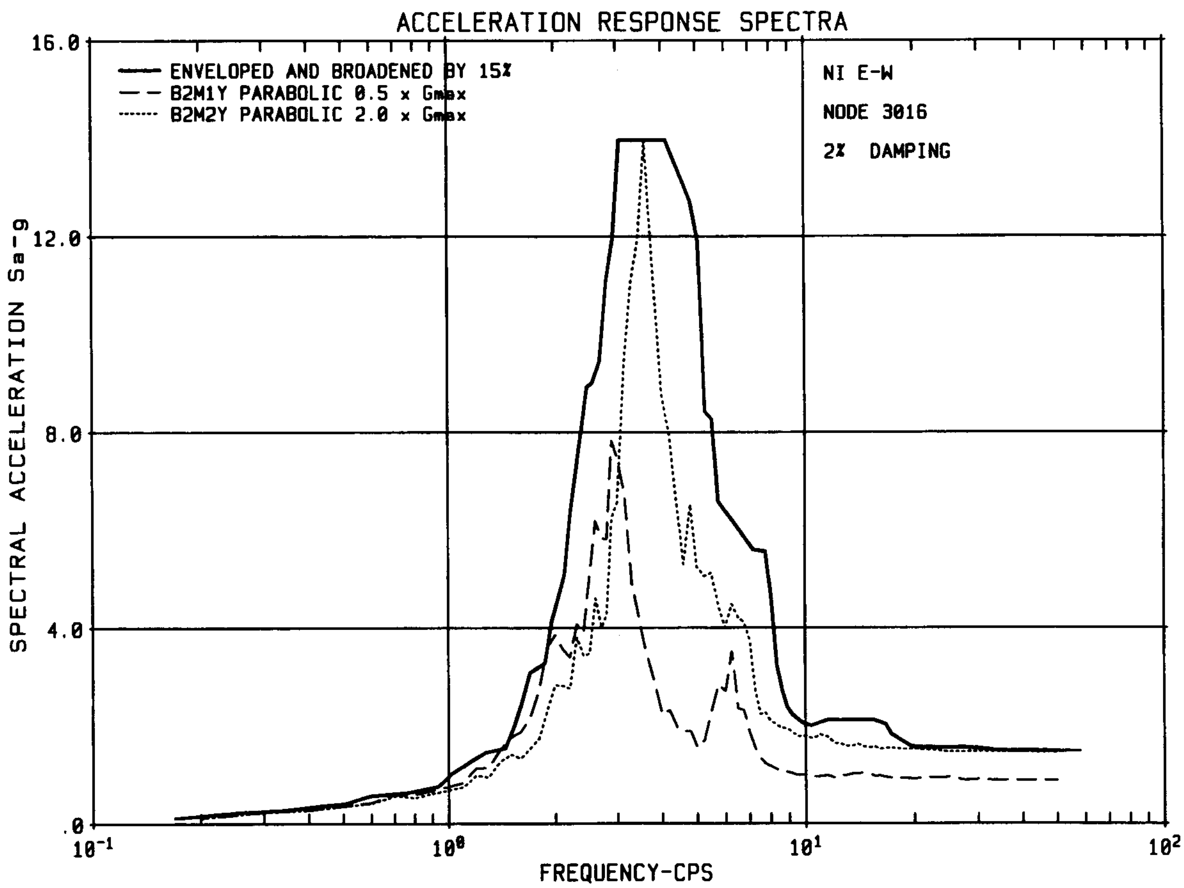


Figure 2B-8 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

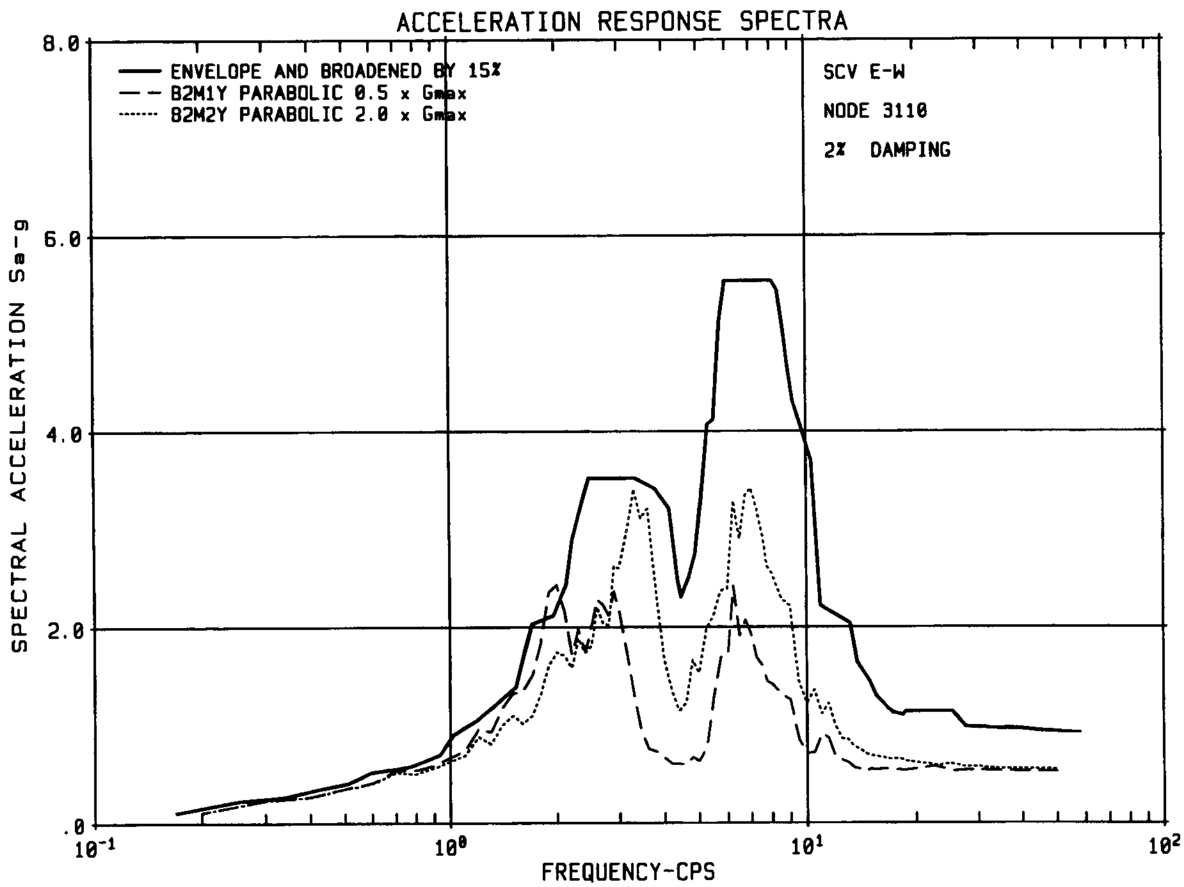


Figure 2B-8 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

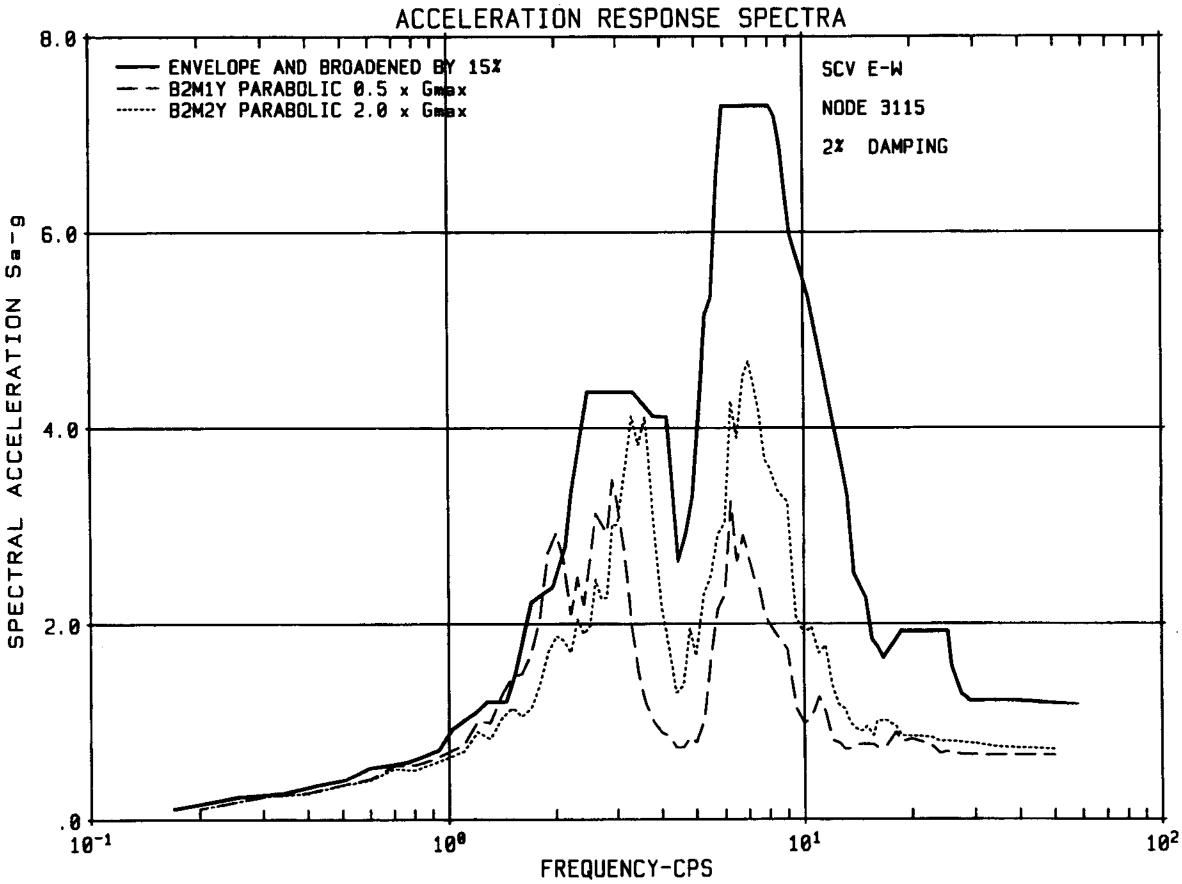


Figure 2B-8 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

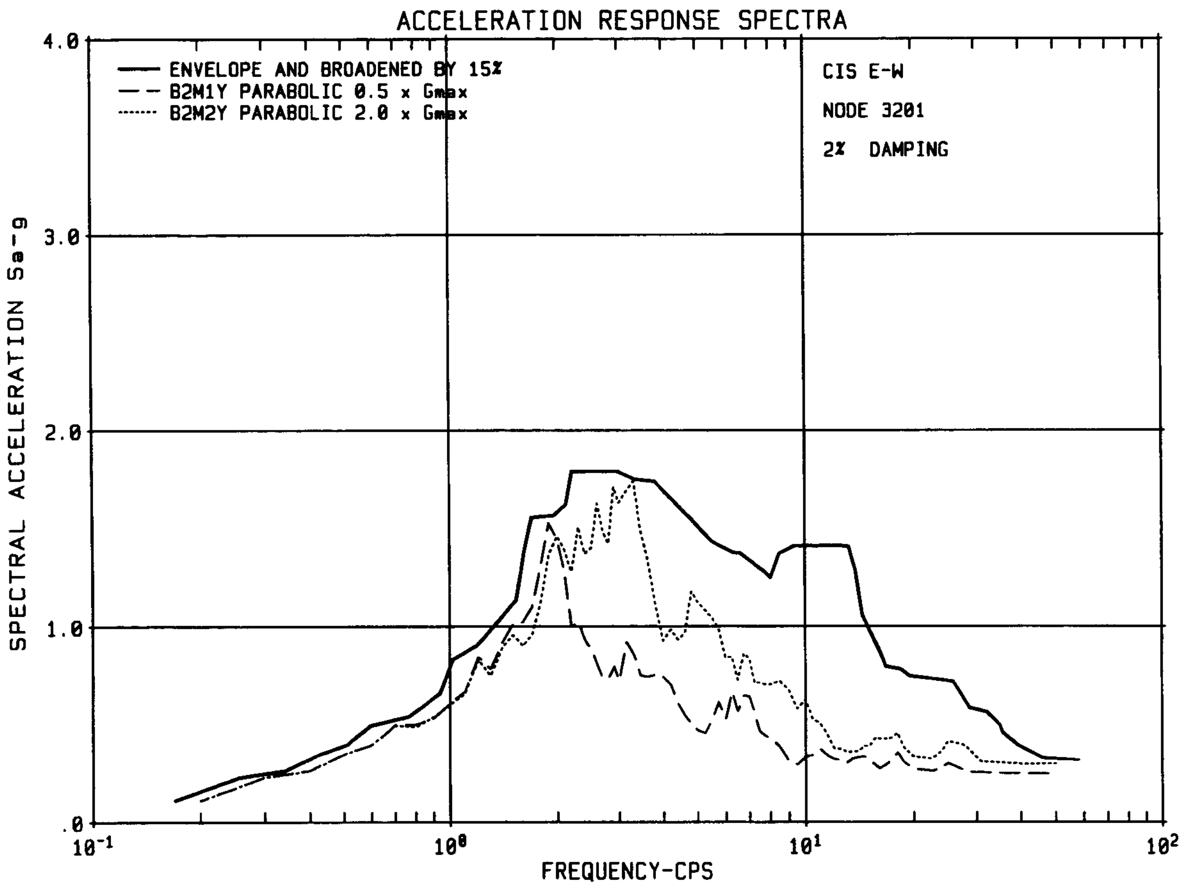


Figure 2B-8 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Soil Property Variation Study

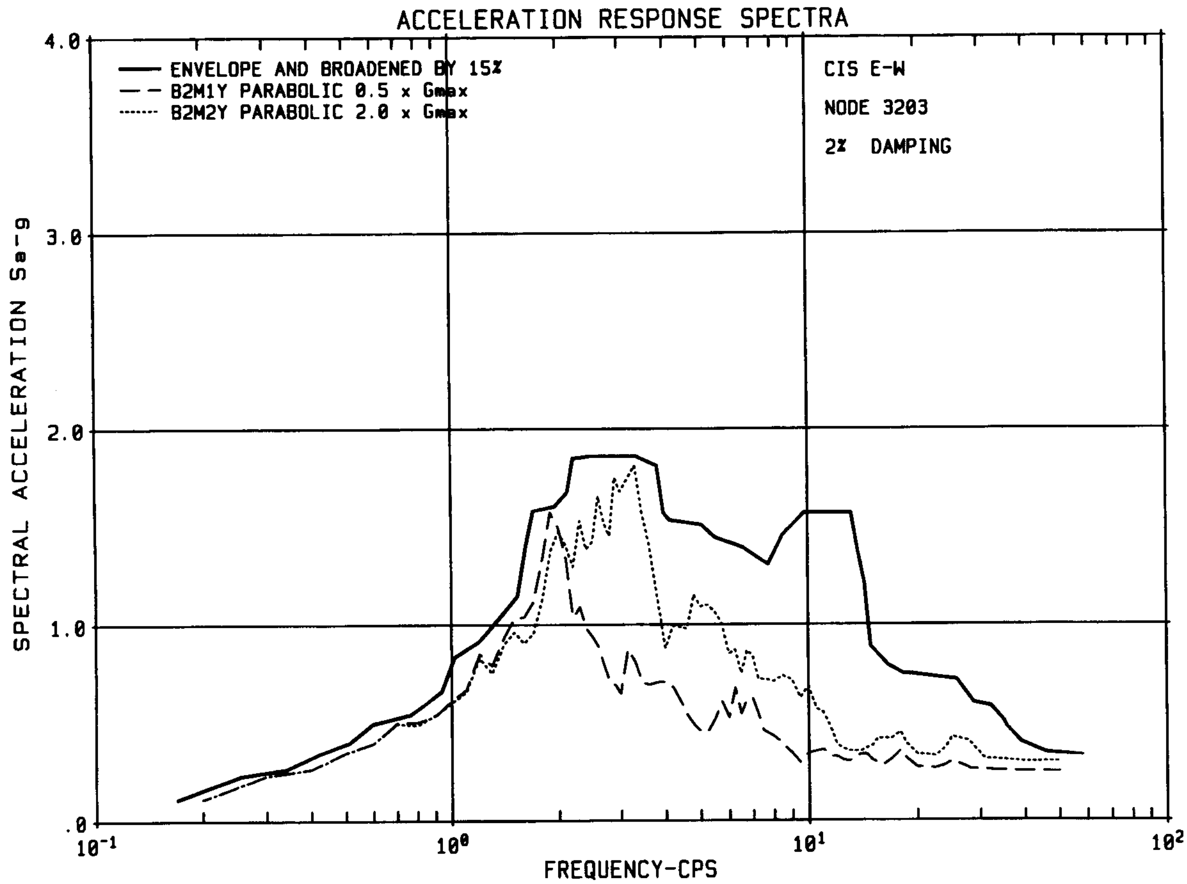


Figure 2B-8 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

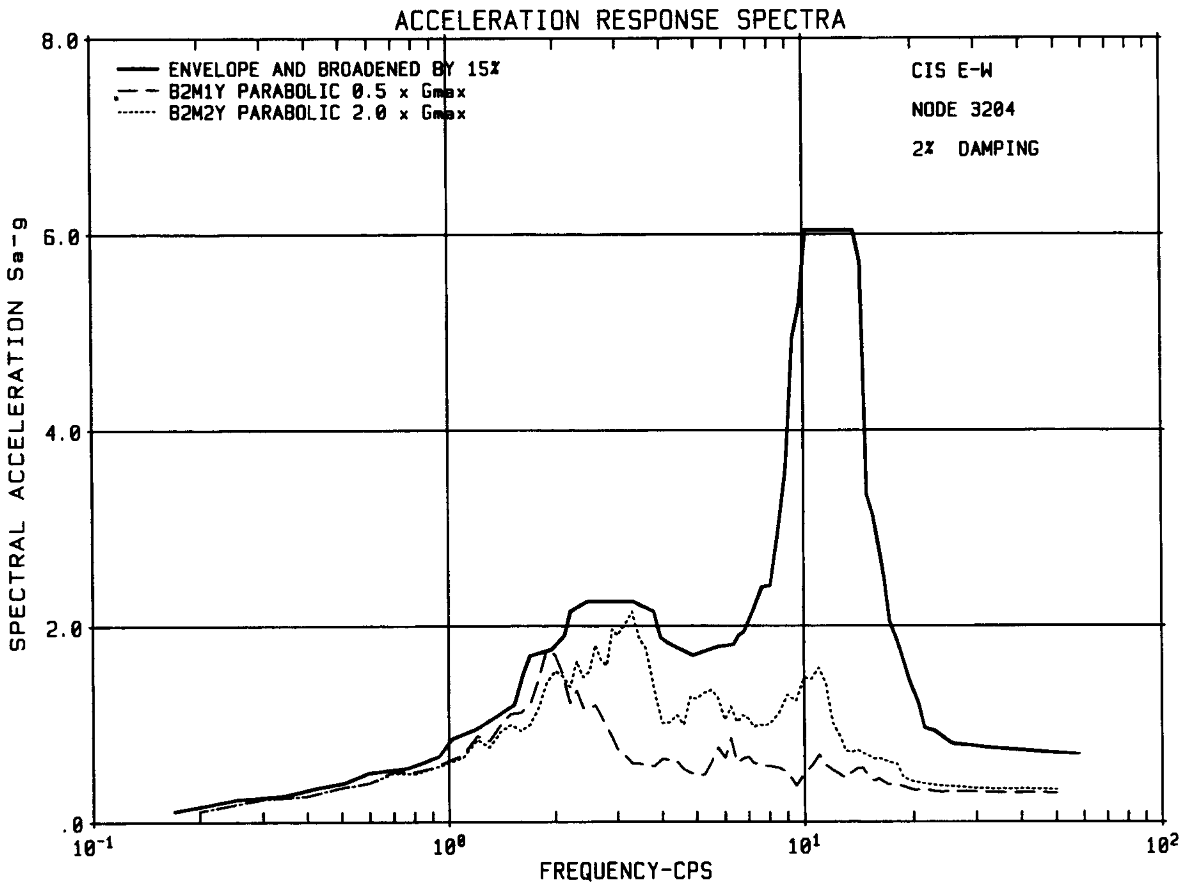


Figure 2B-8 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Property Variation Study

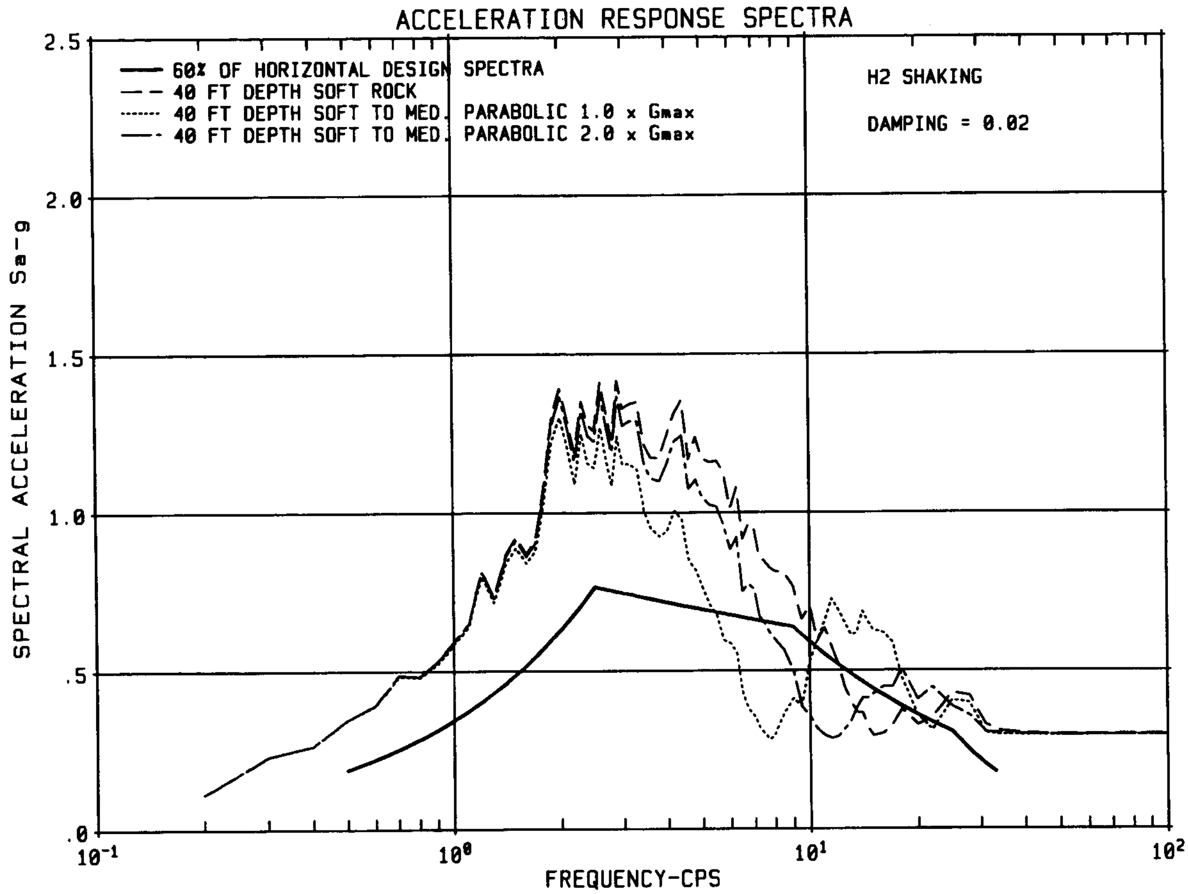


Figure 2B-9

Two-Dimensional SASSI Analysis, E-W Direction
Design Soil Profiles
Free-Field Spectra at Foundation Level

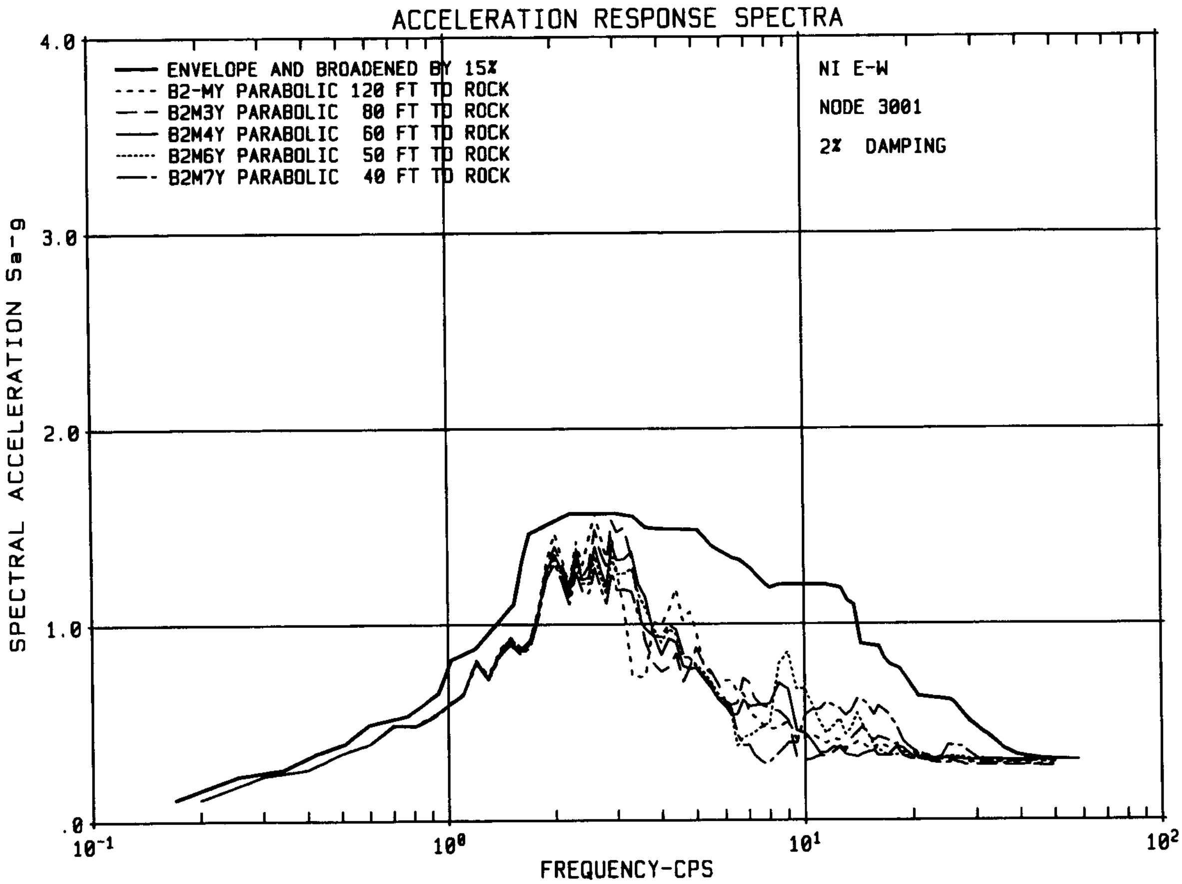


Figure 2B-10 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

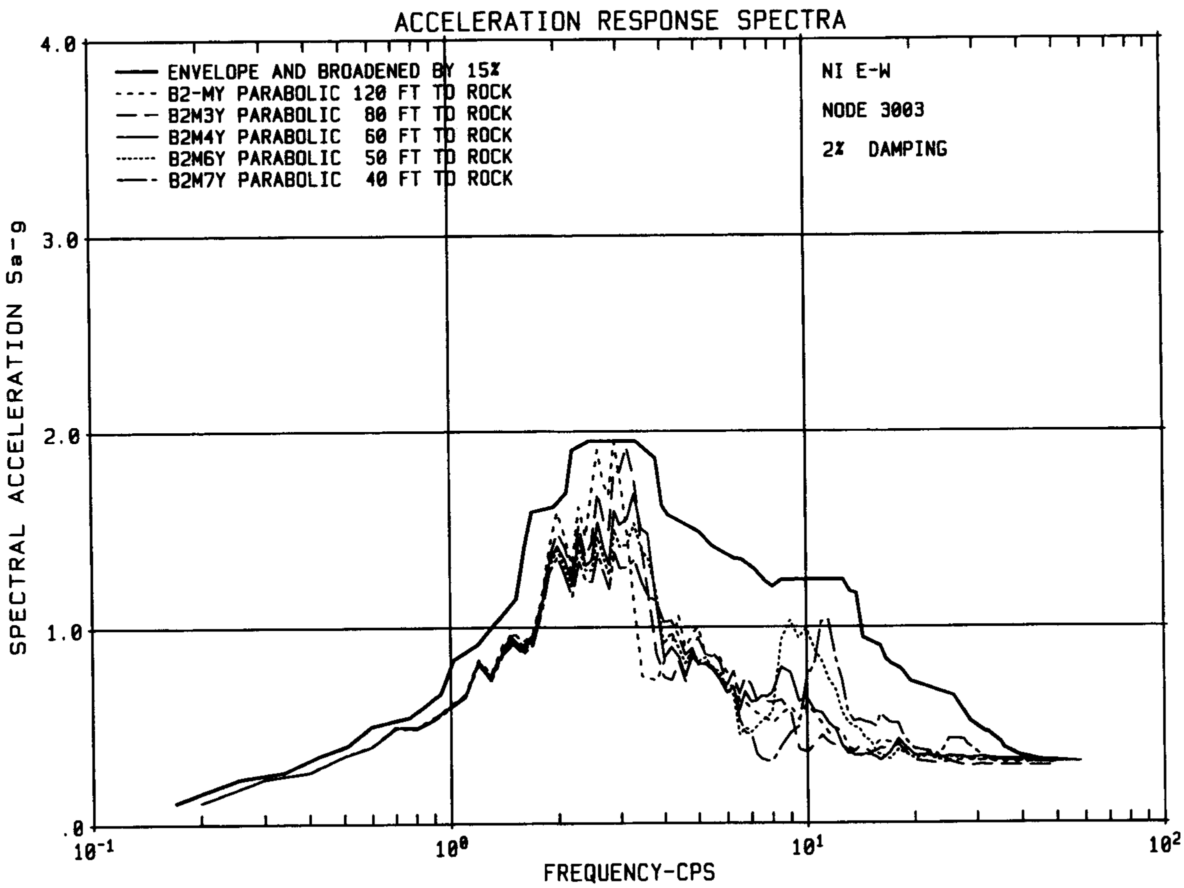


Figure 2B-10 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

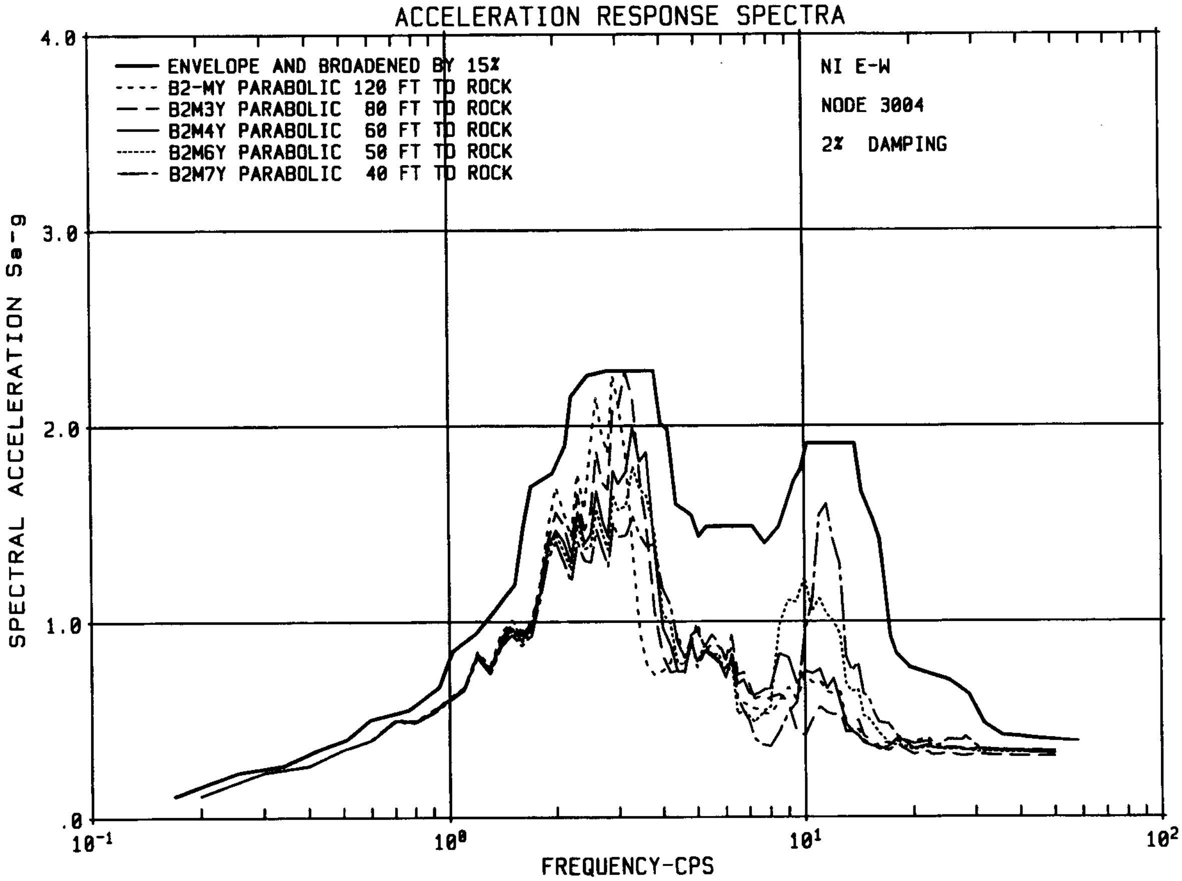


Figure 2B-10 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

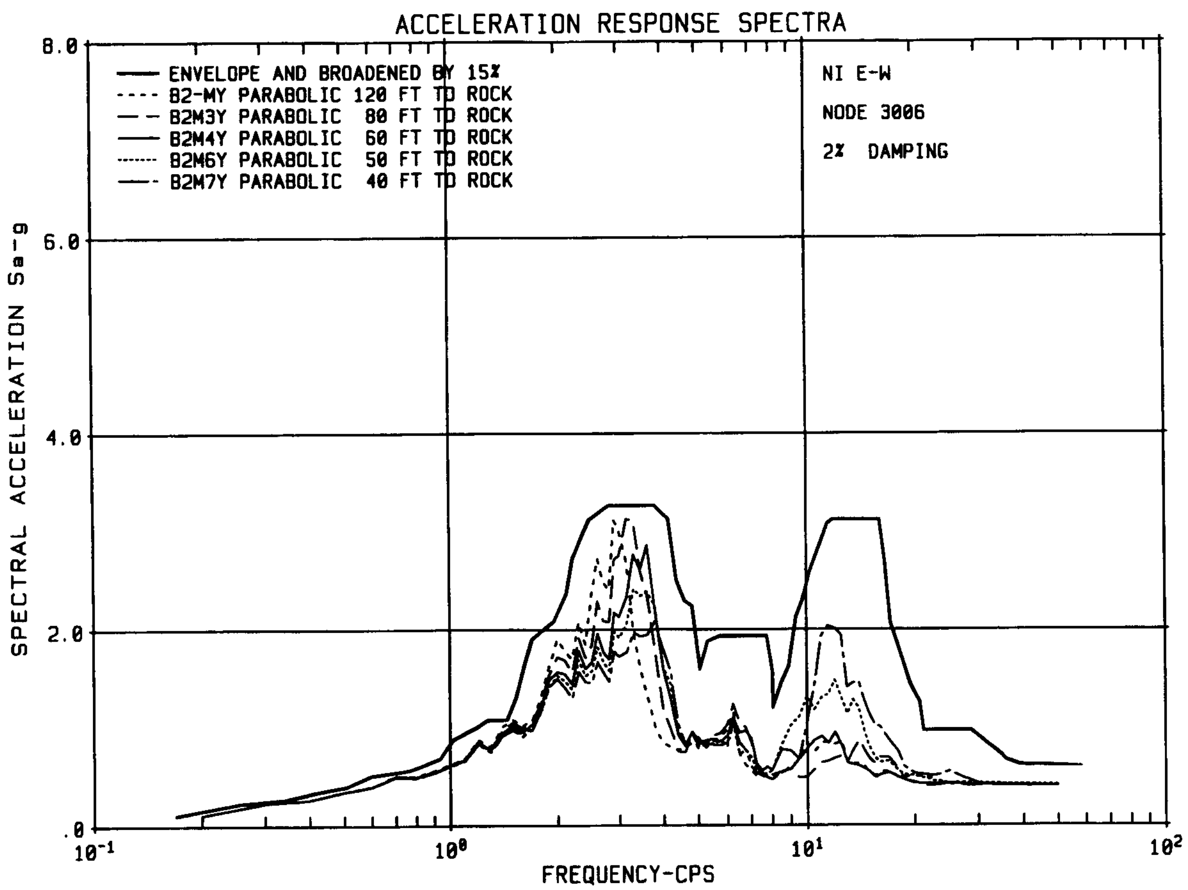


Figure 2B-10 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

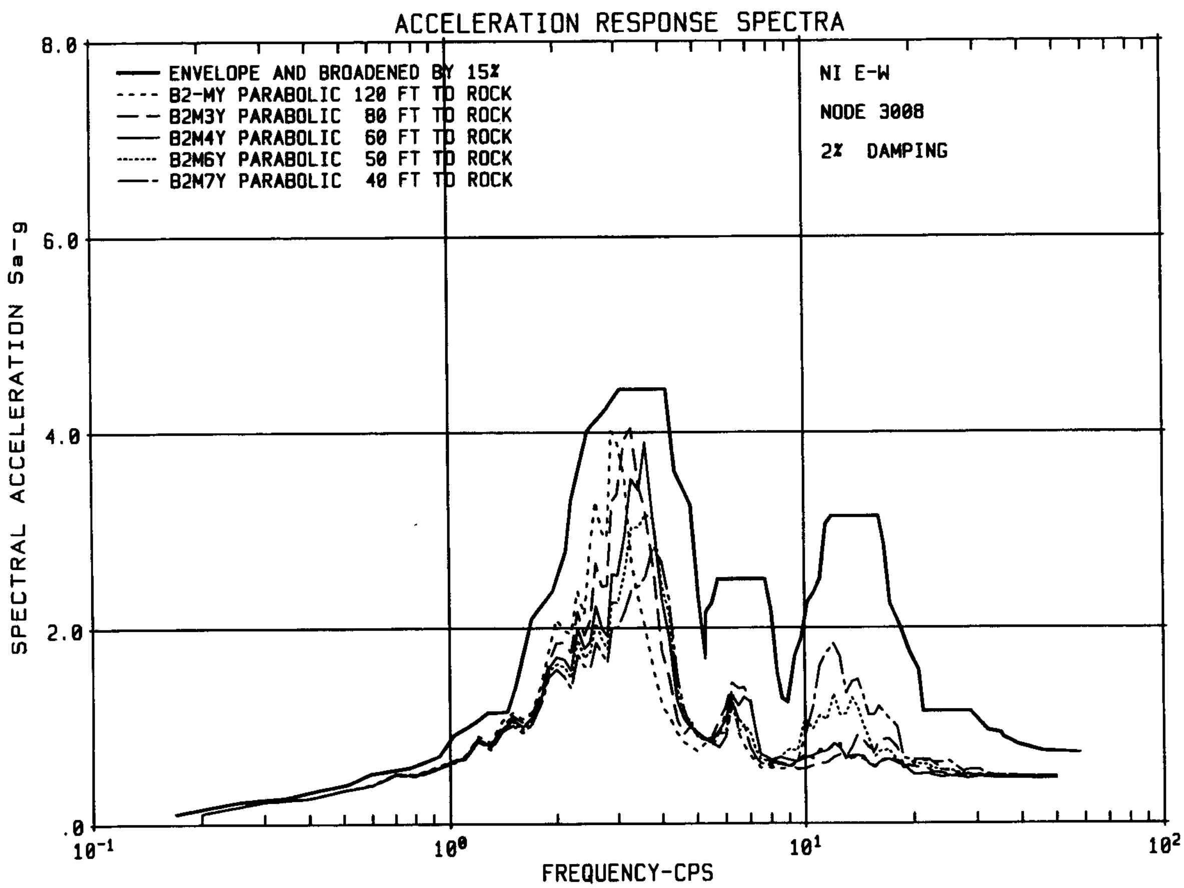


Figure 2B-10 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

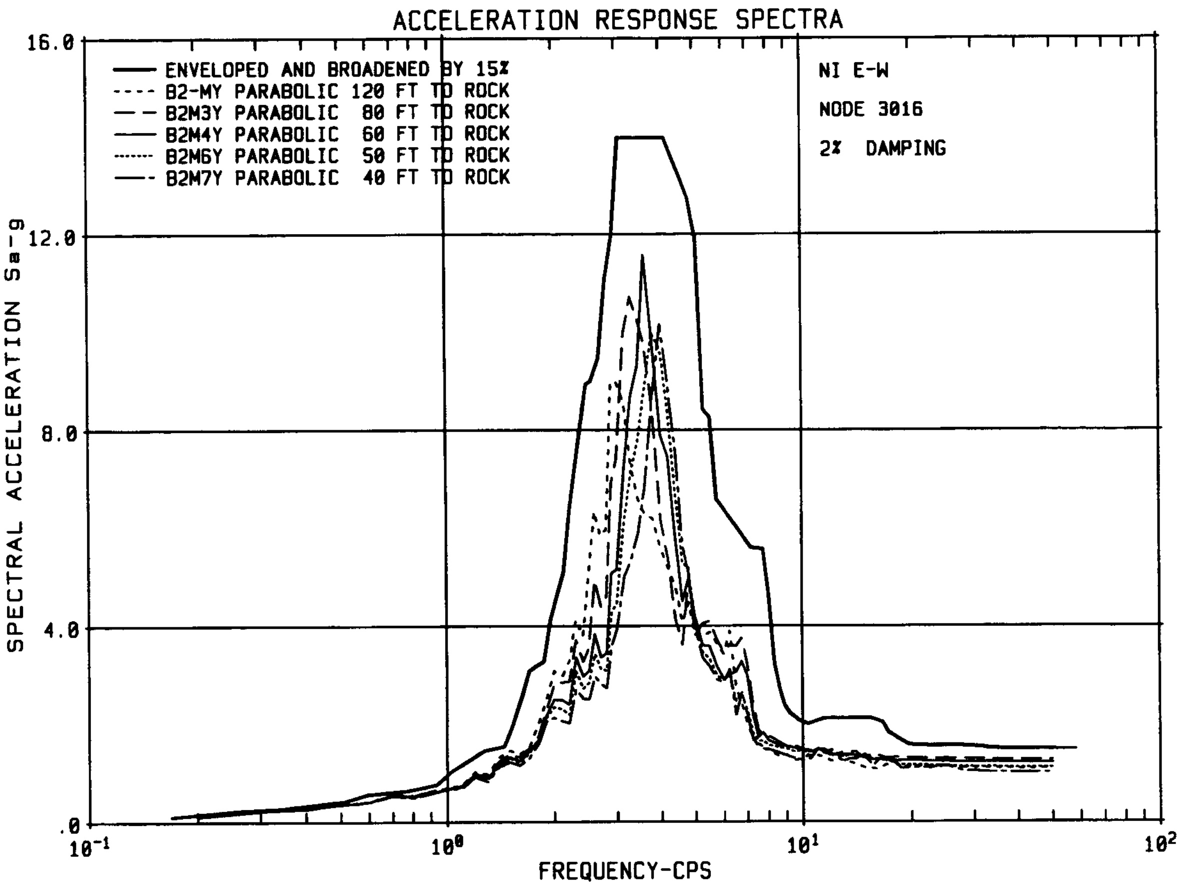


Figure 2B-10 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

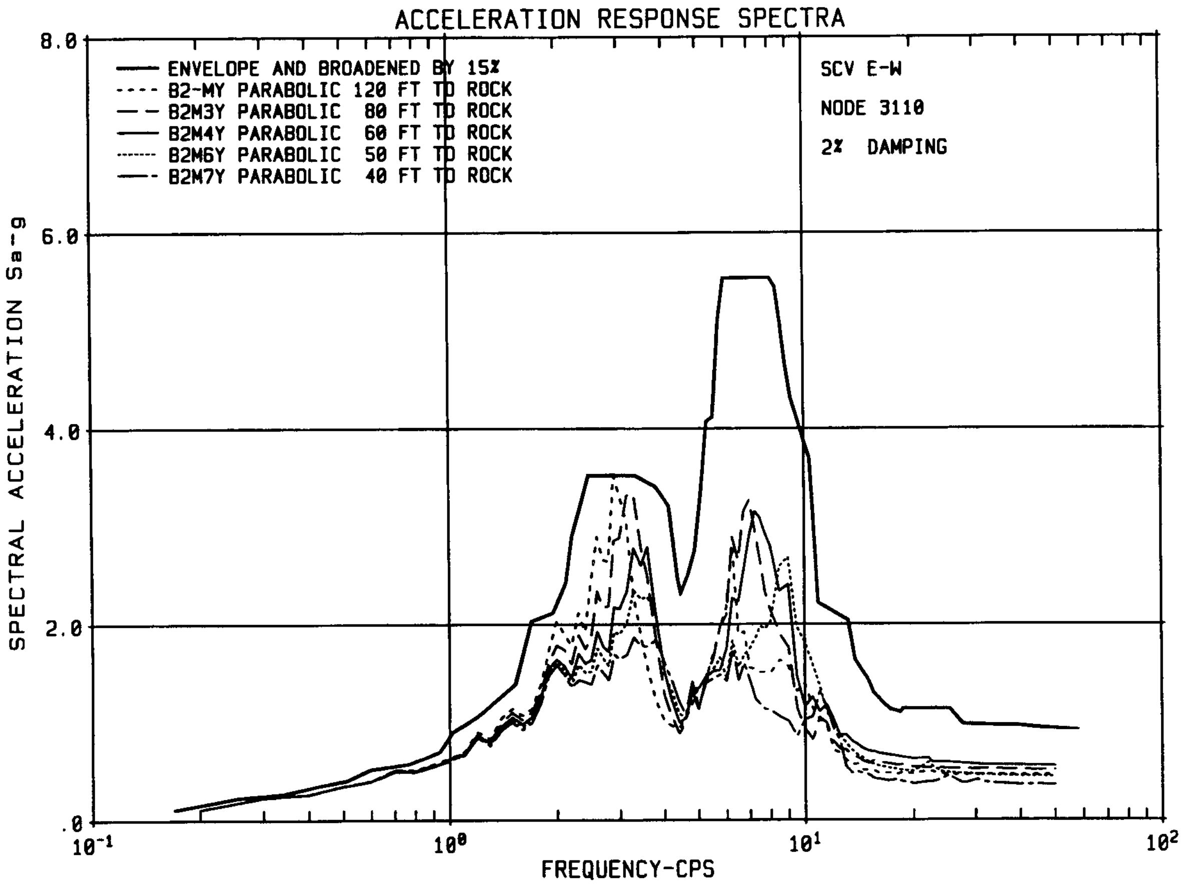


Figure 2B-10 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

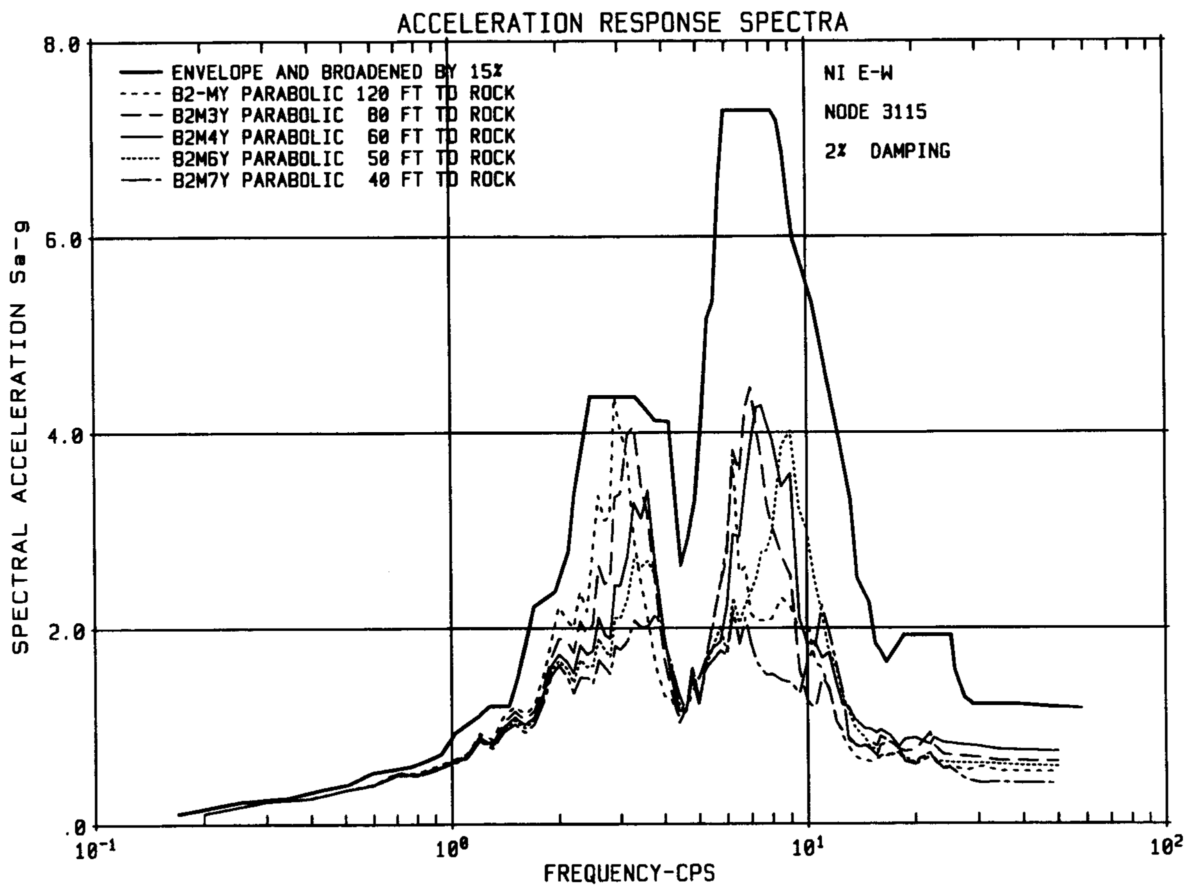


Figure 2B-10 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

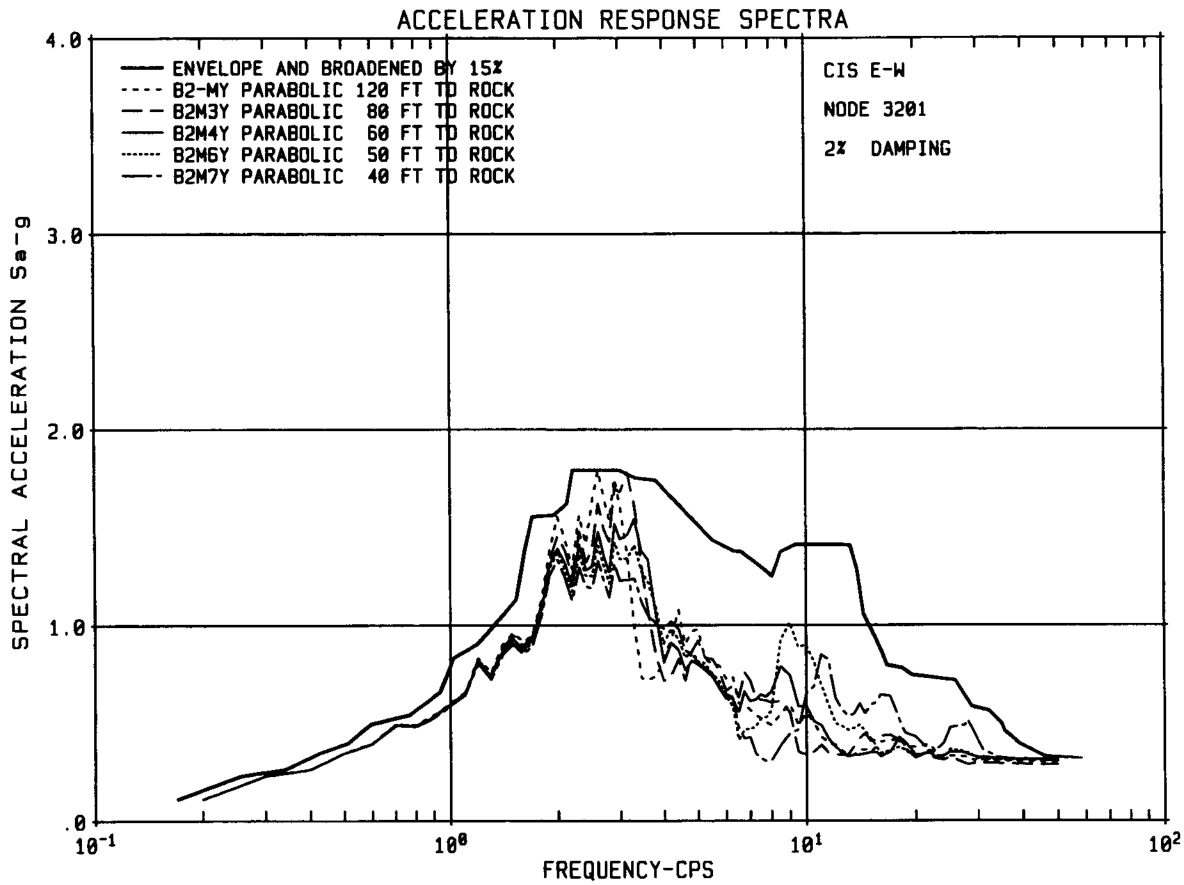


Figure 2B-10 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

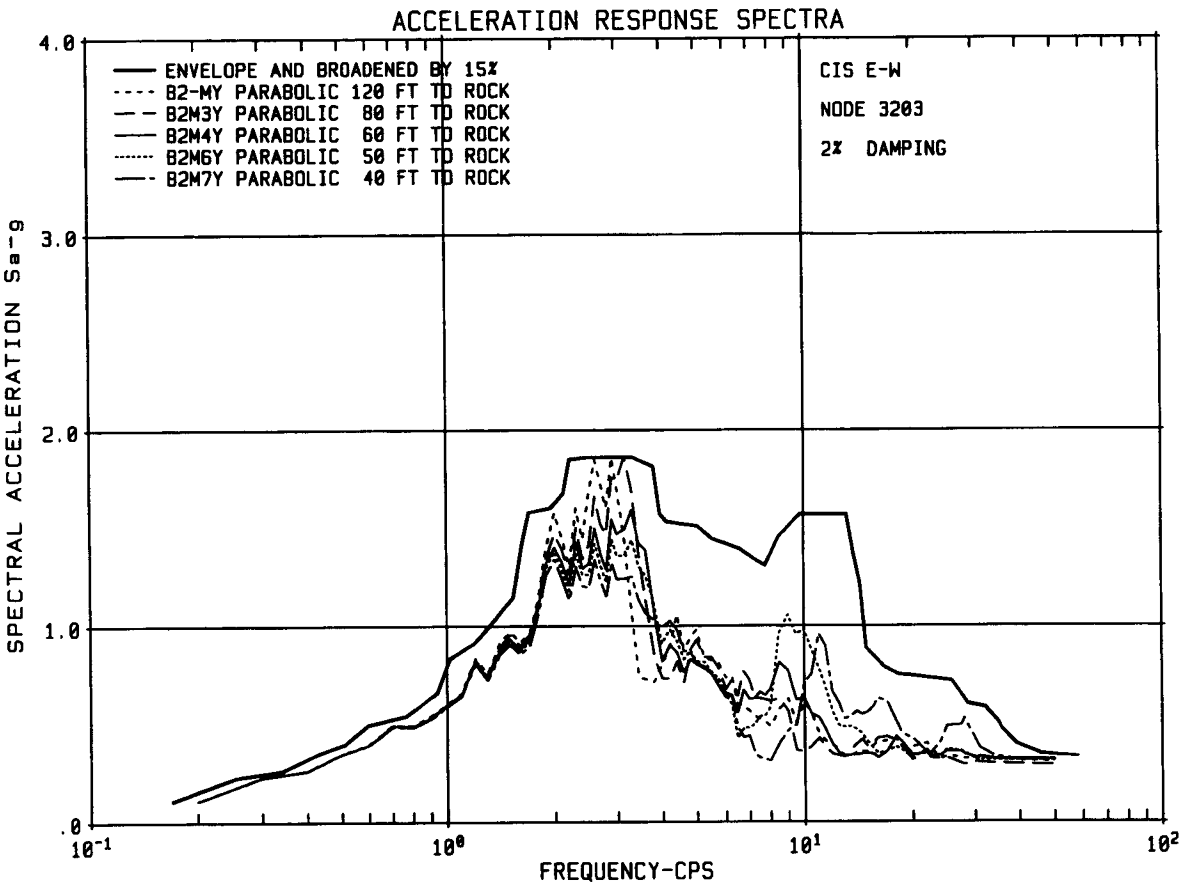


Figure 2B-10 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

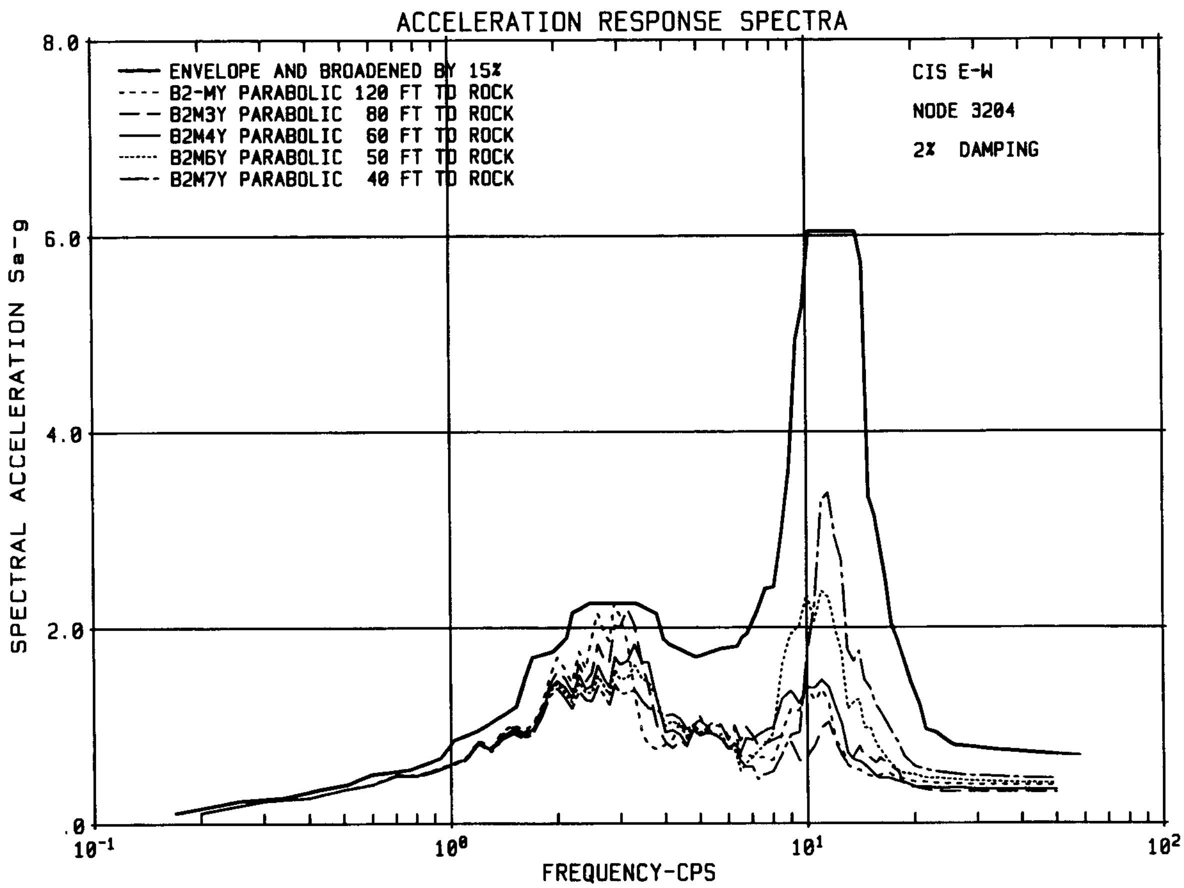


Figure 2B-10 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

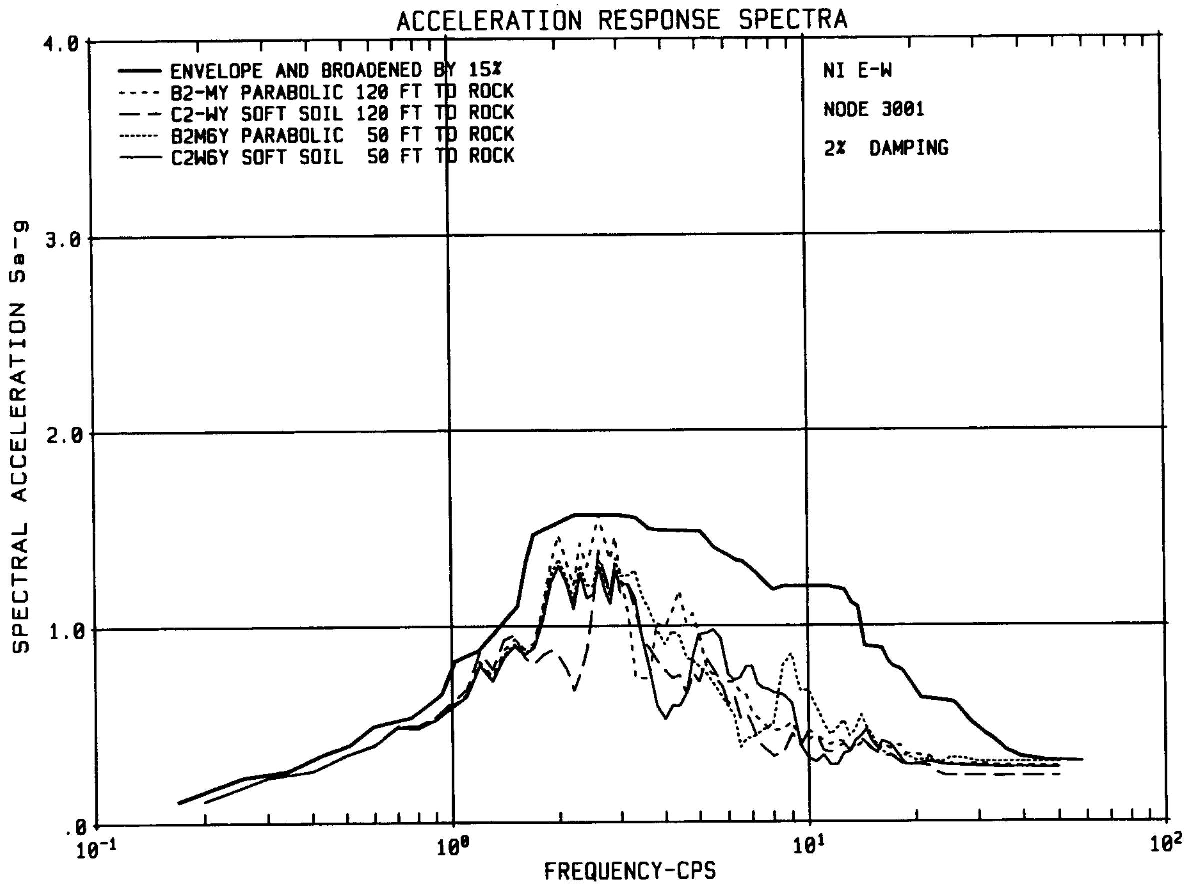


Figure 2B-11 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

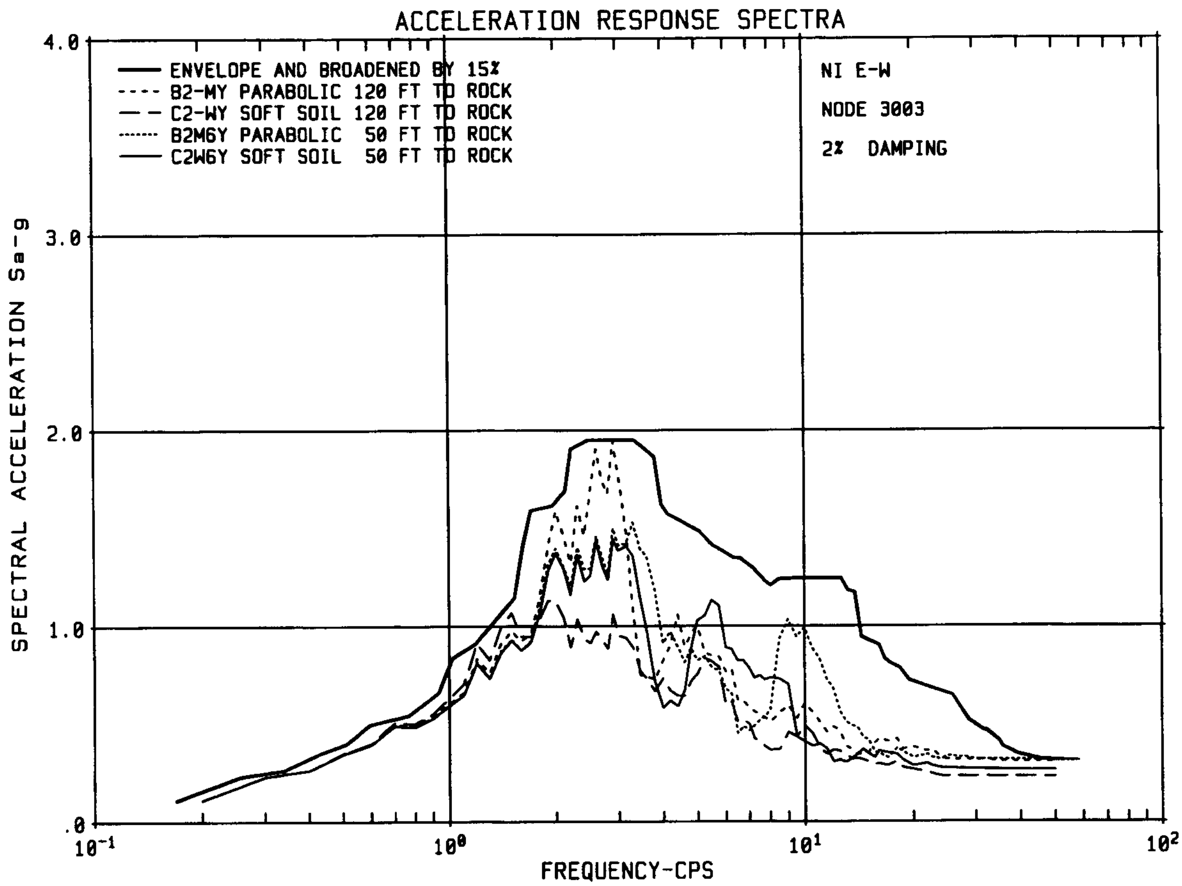


Figure 2B-11 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

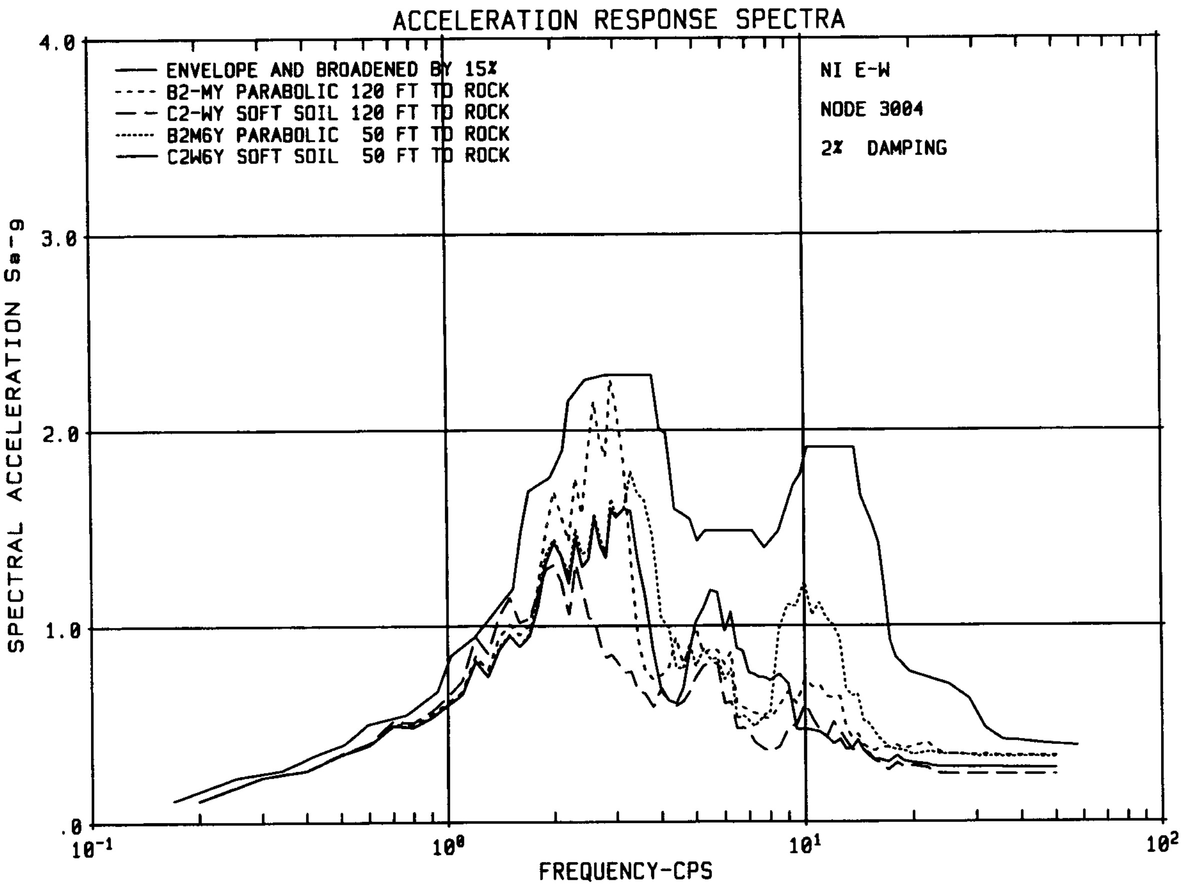


Figure 2B-11 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

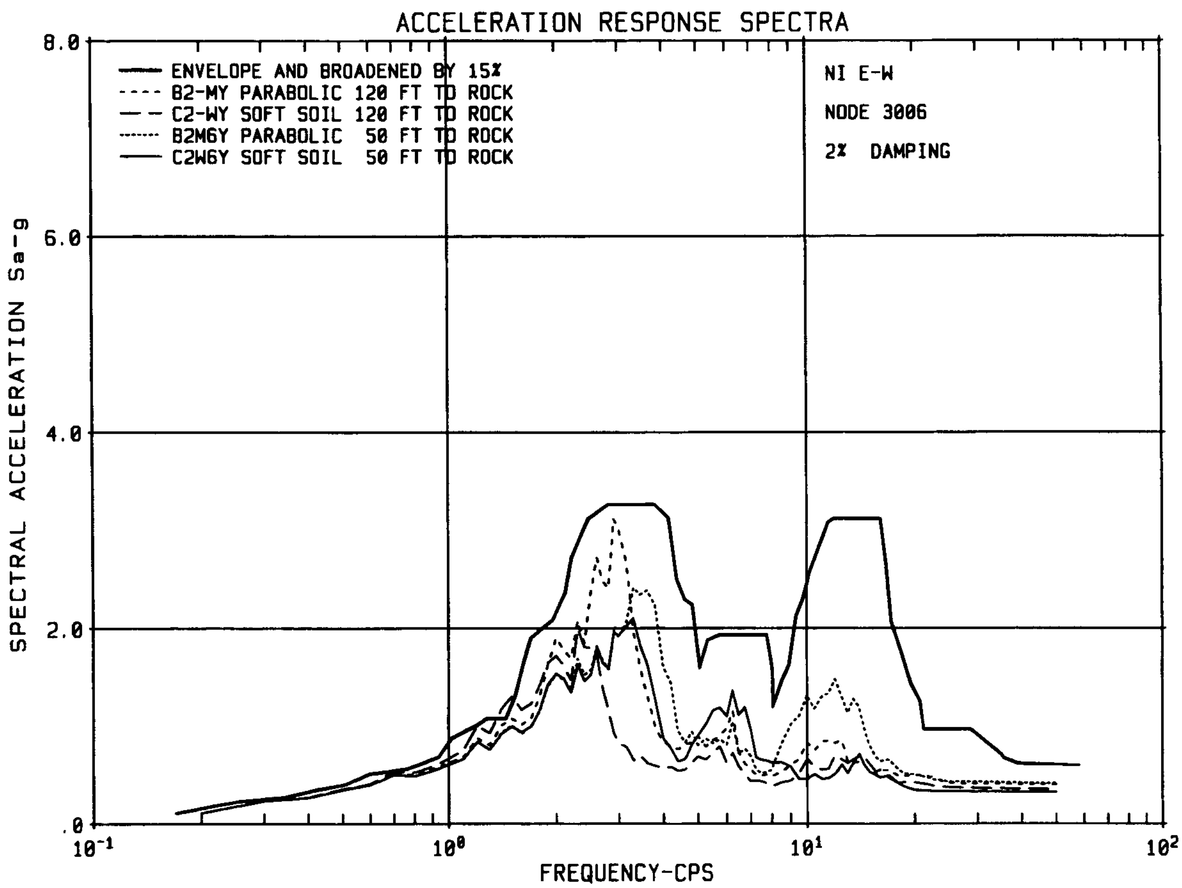


Figure 2B-11 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

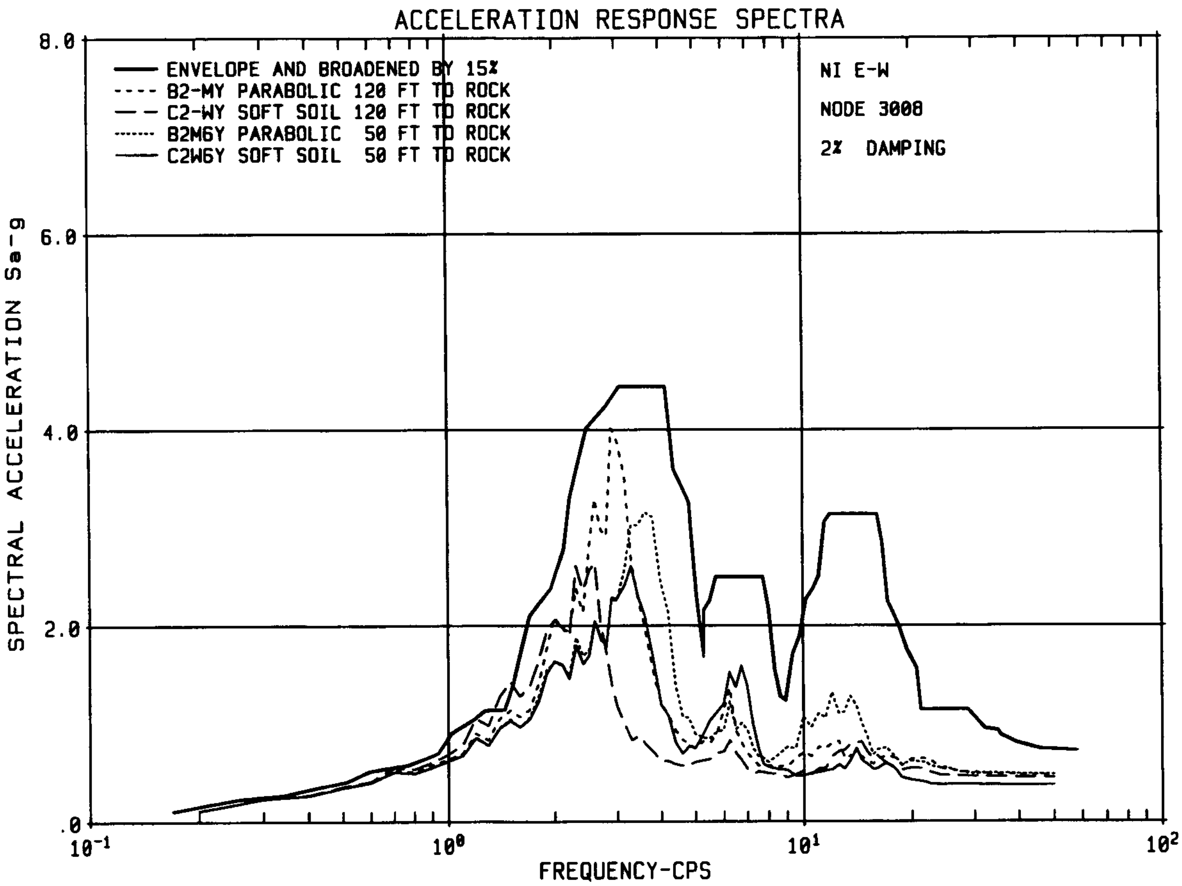


Figure 2B-11 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

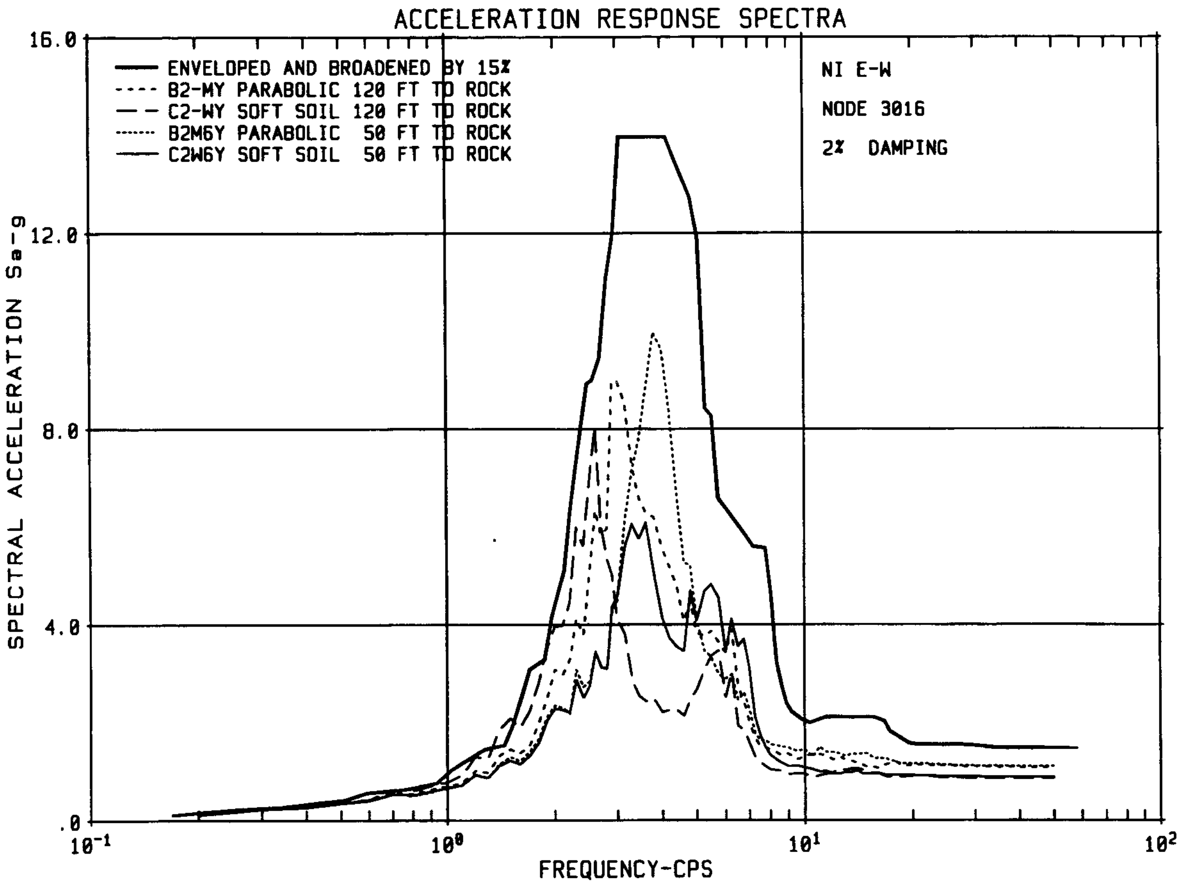


Figure 2B-11 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

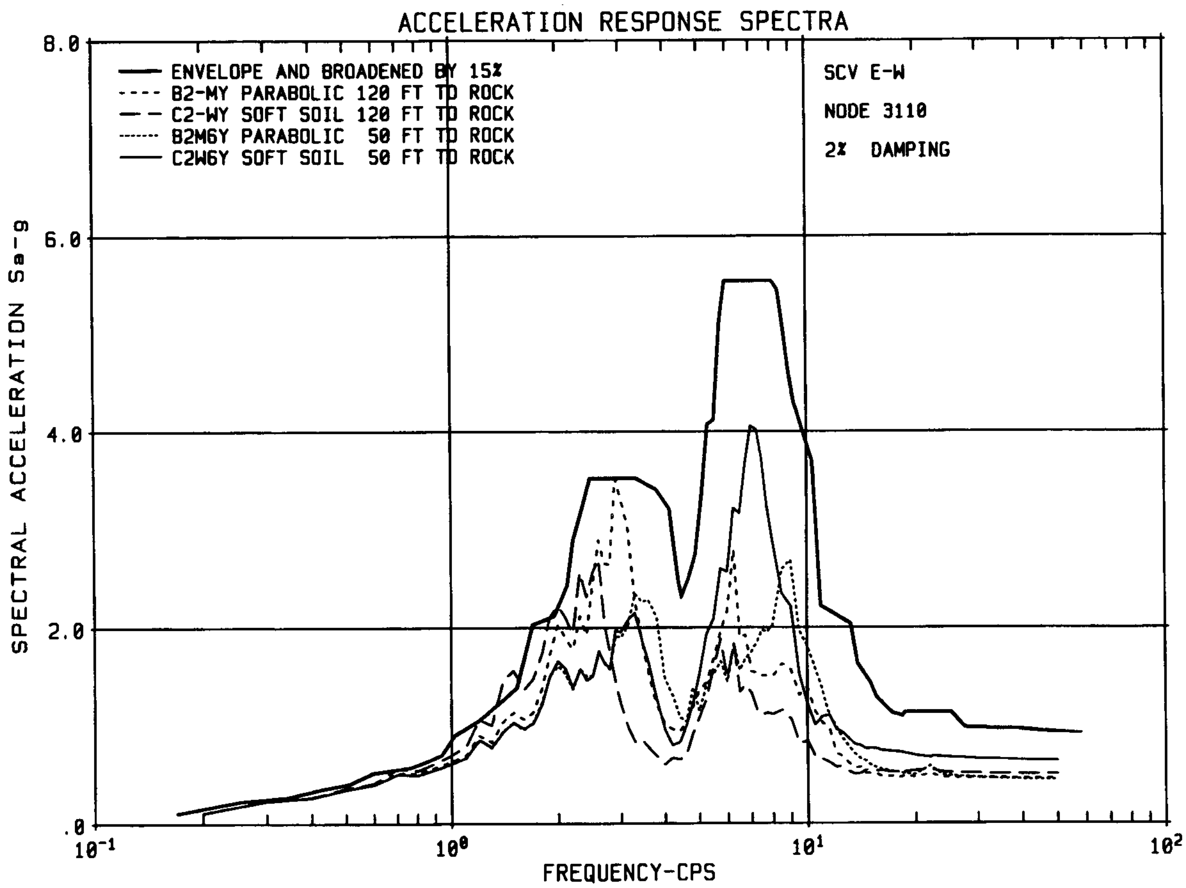


Figure 2B-11 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

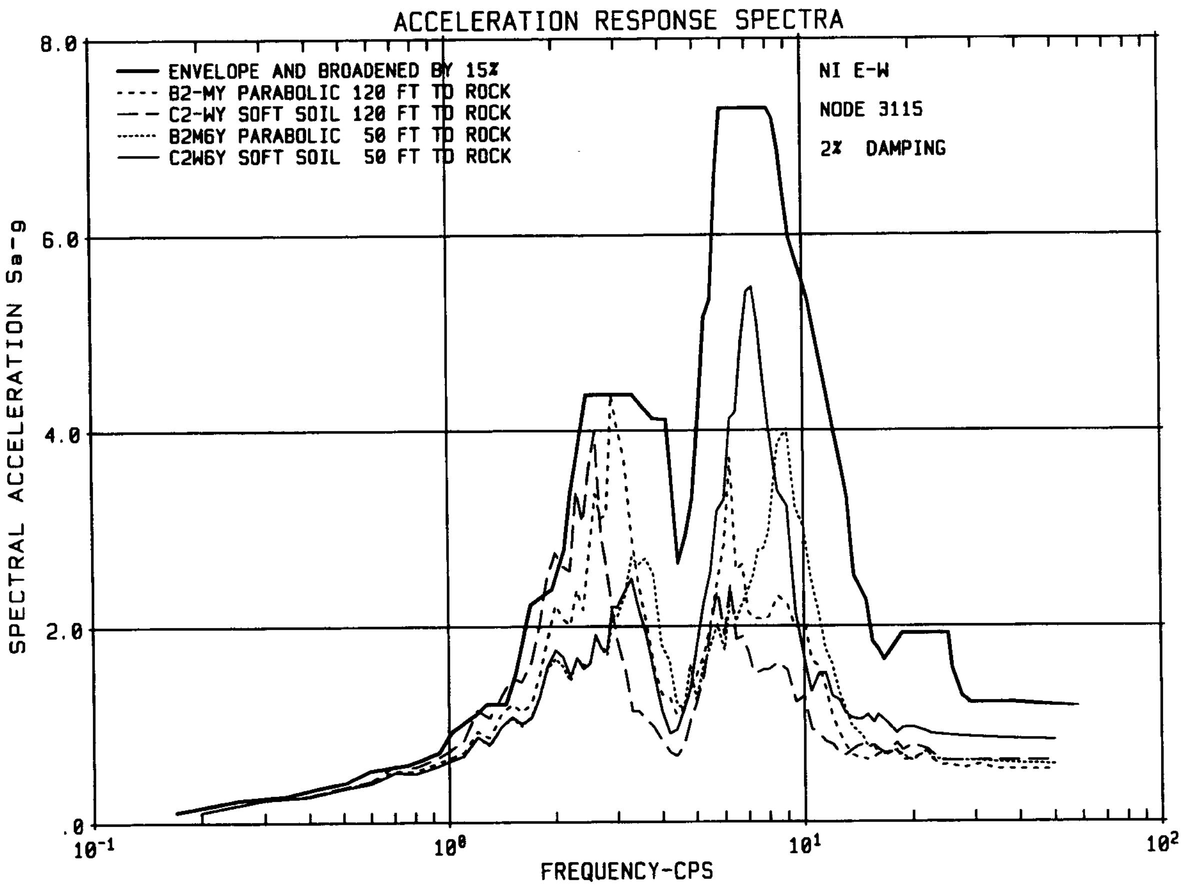


Figure 2B-11 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

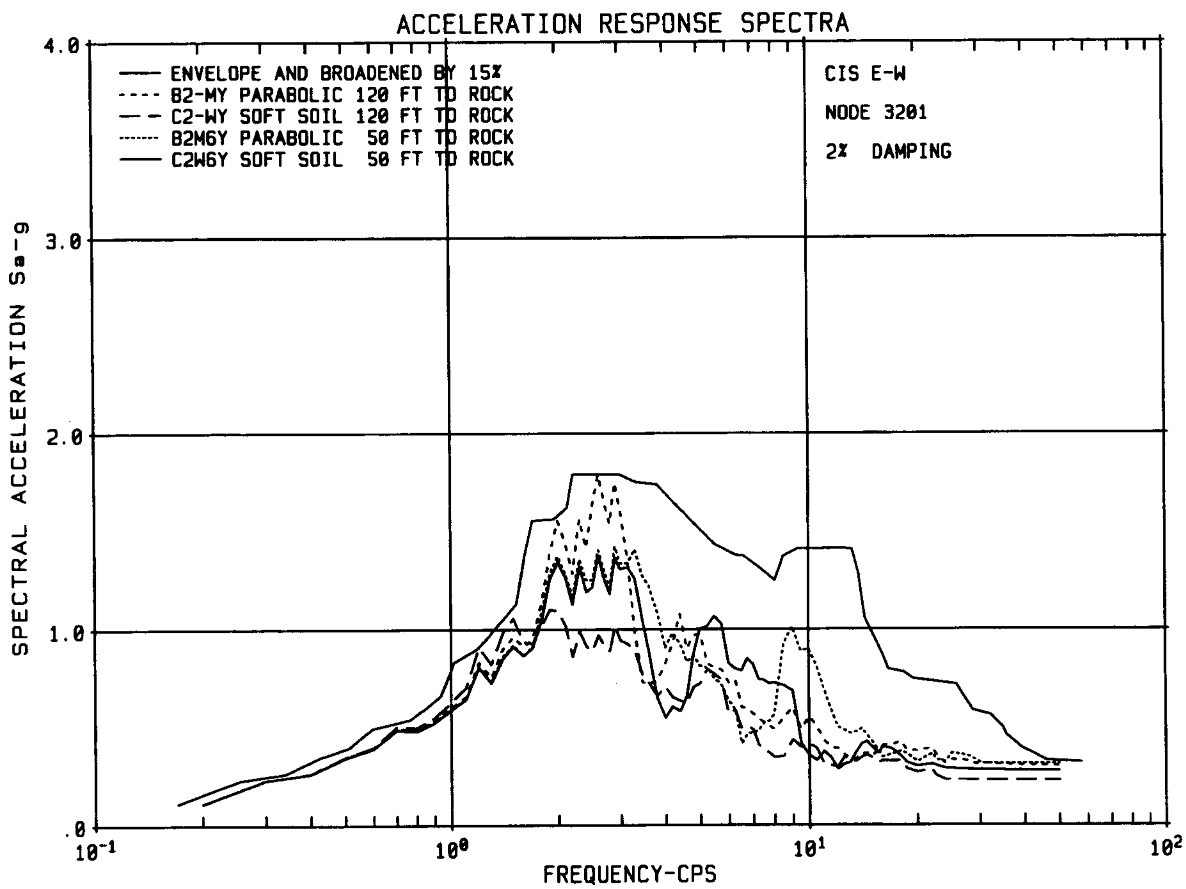


Figure 2B-11 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study

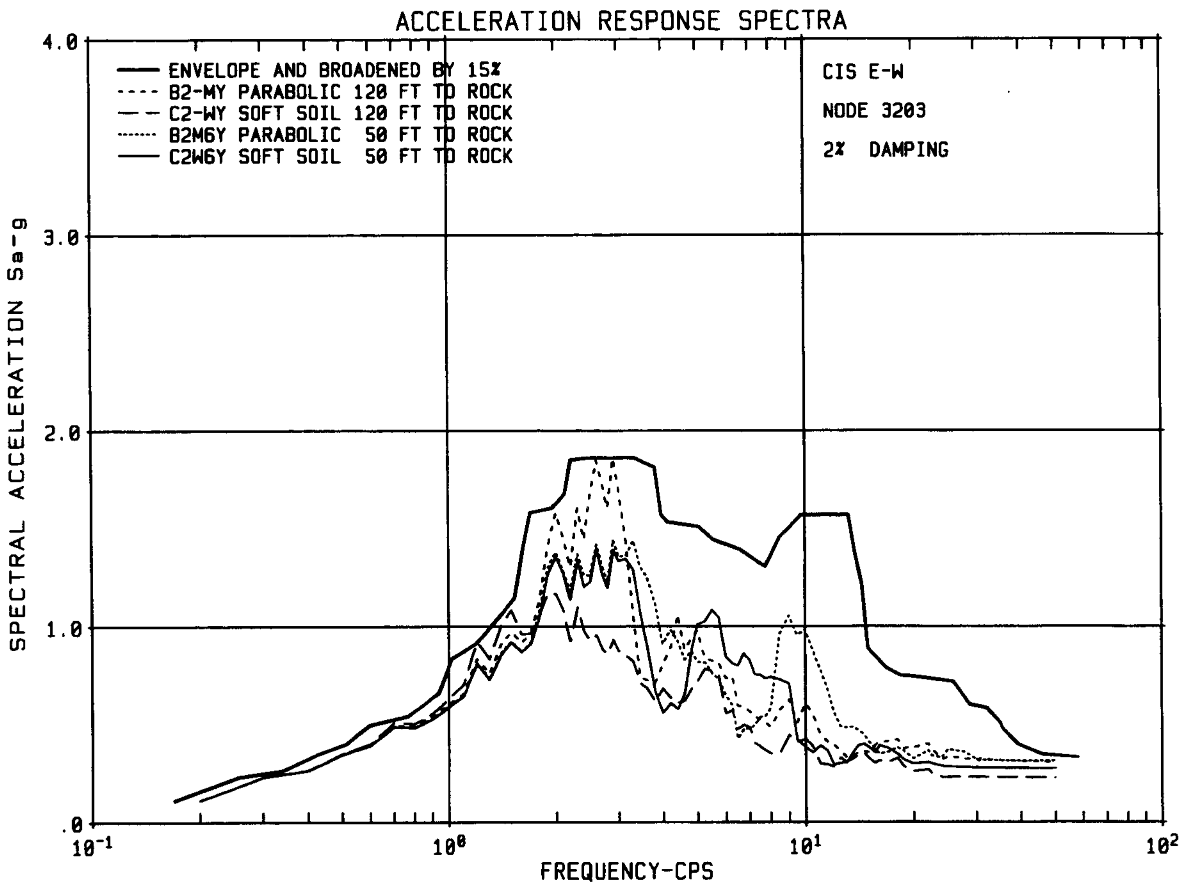


Figure 2B-11 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Depth-to-Base Rock Study

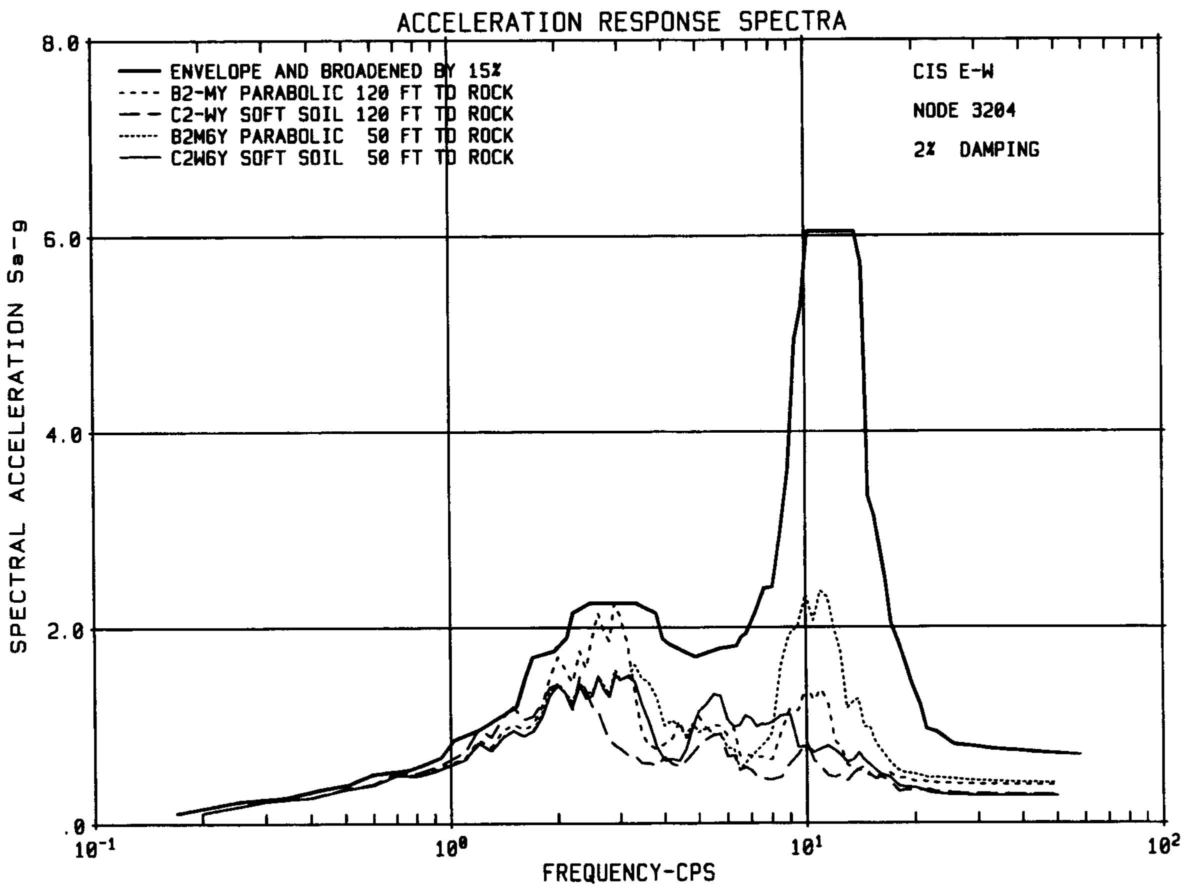
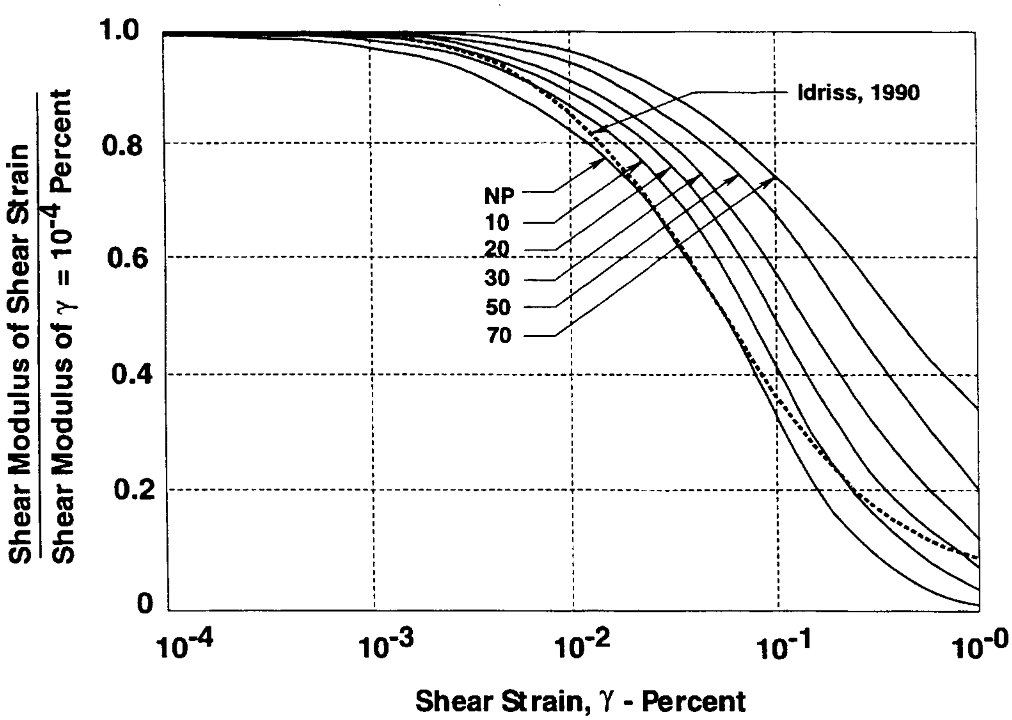


Figure 2B-11 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Depth-to-Base Rock Study



Variation of Shear Modulus with Shear Strain for Clays

Figure 2B-12

Strain Dependent Shear Modulus
Clay Material

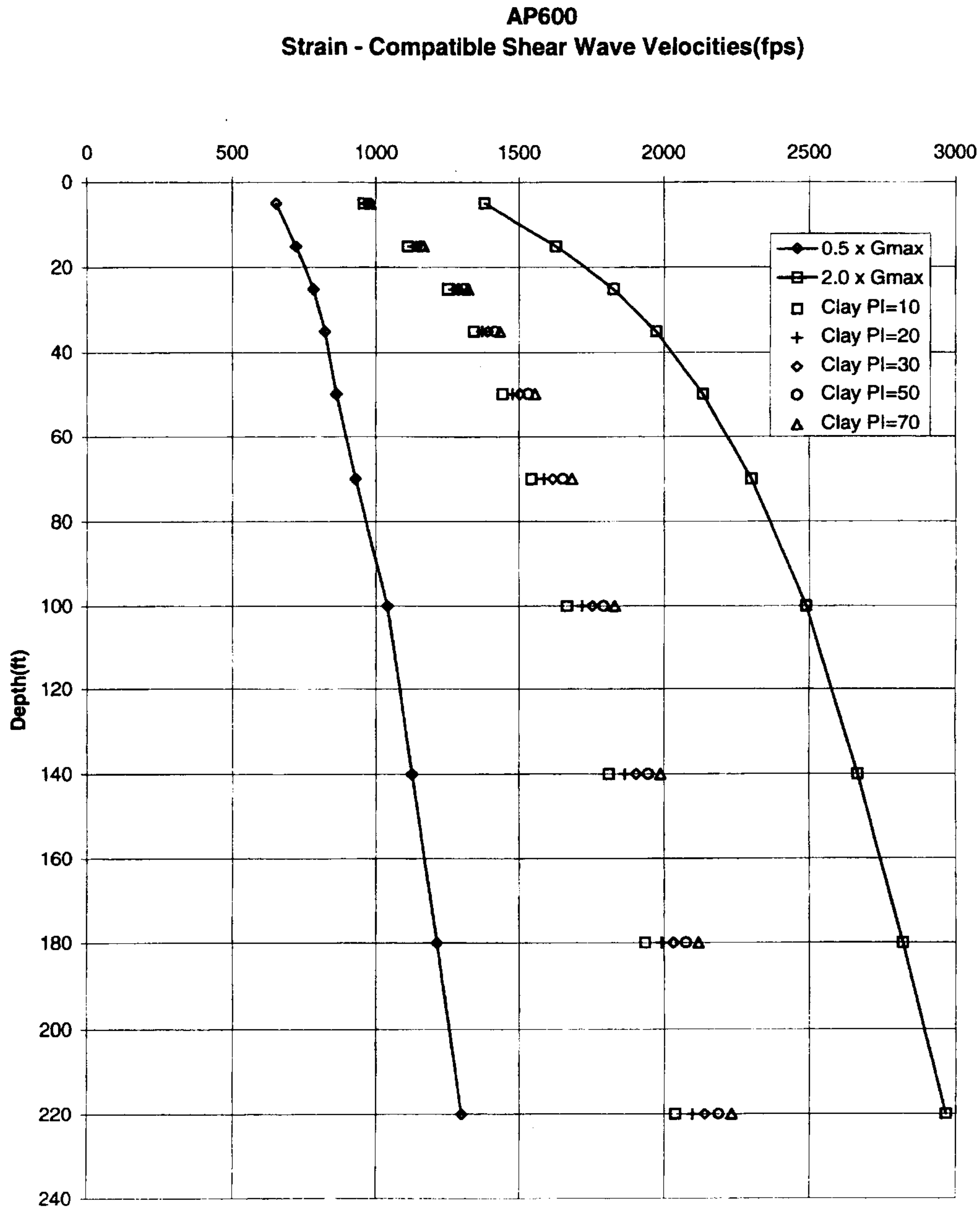


Figure 2B-13

SSE Strain Compatible Shear Wave Velocity Clay Material

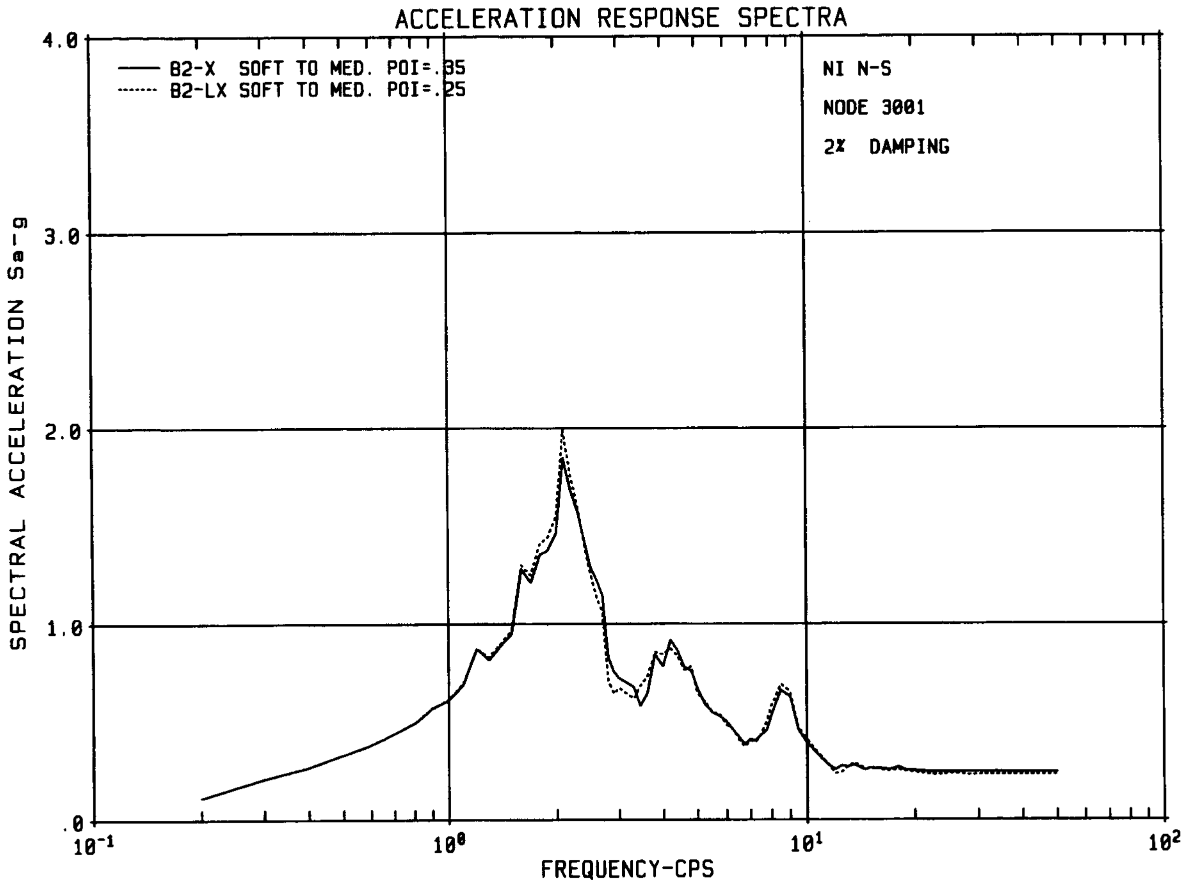


Figure 2B-14 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

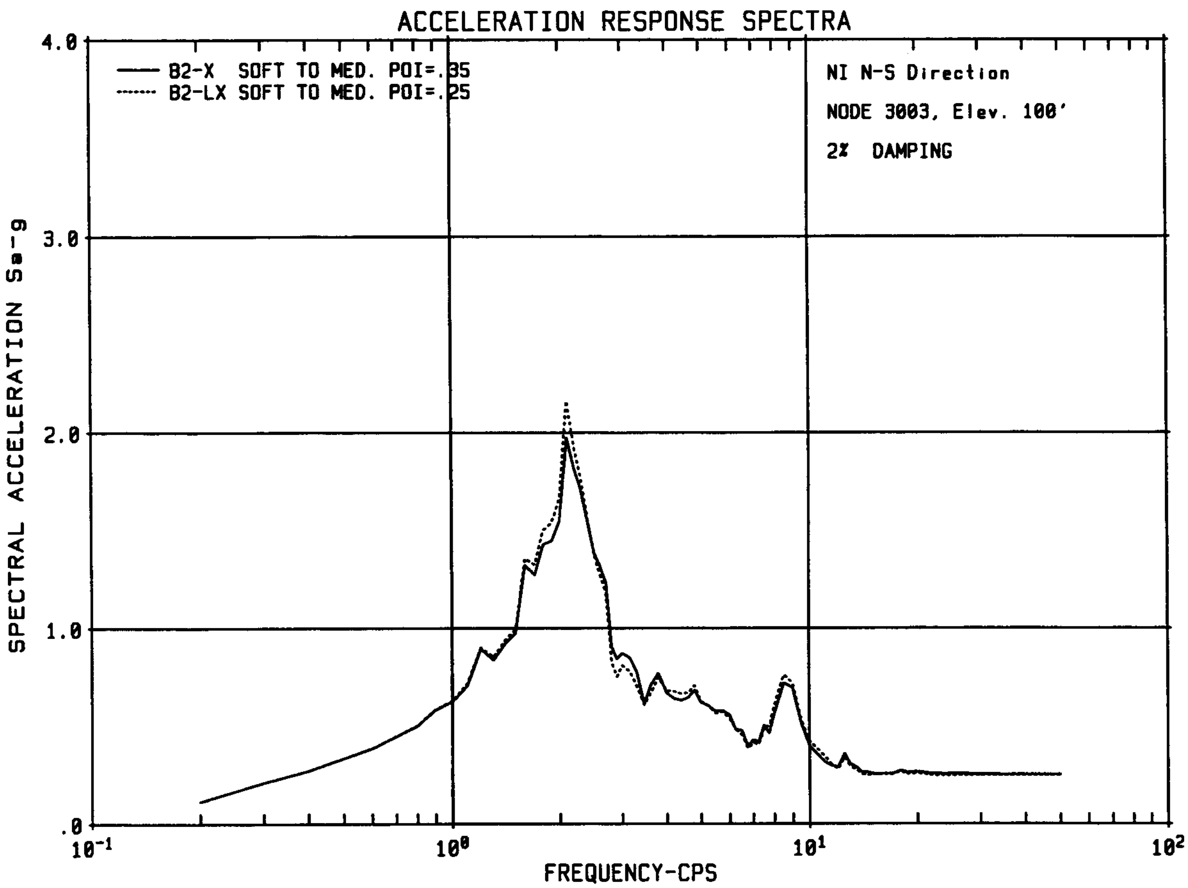


Figure 2B-14 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

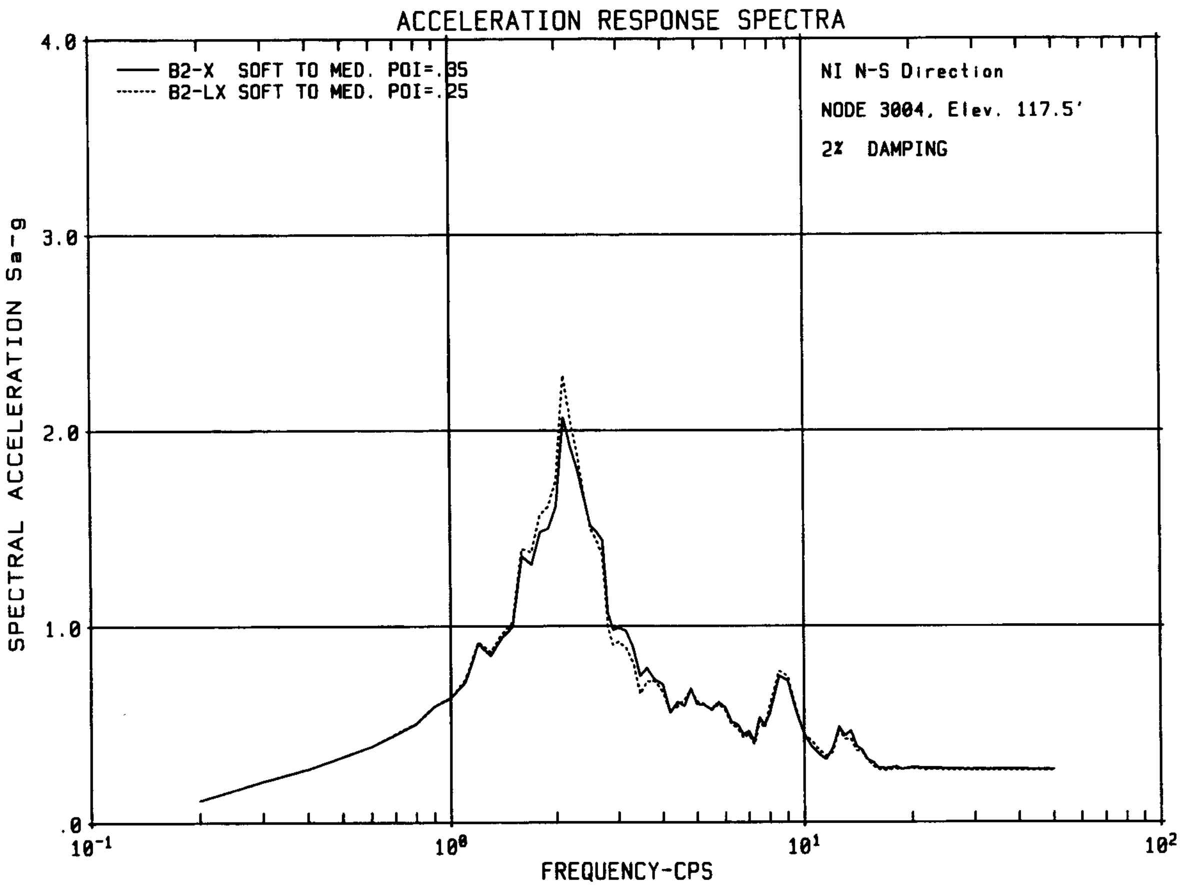


Figure 2B-14 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

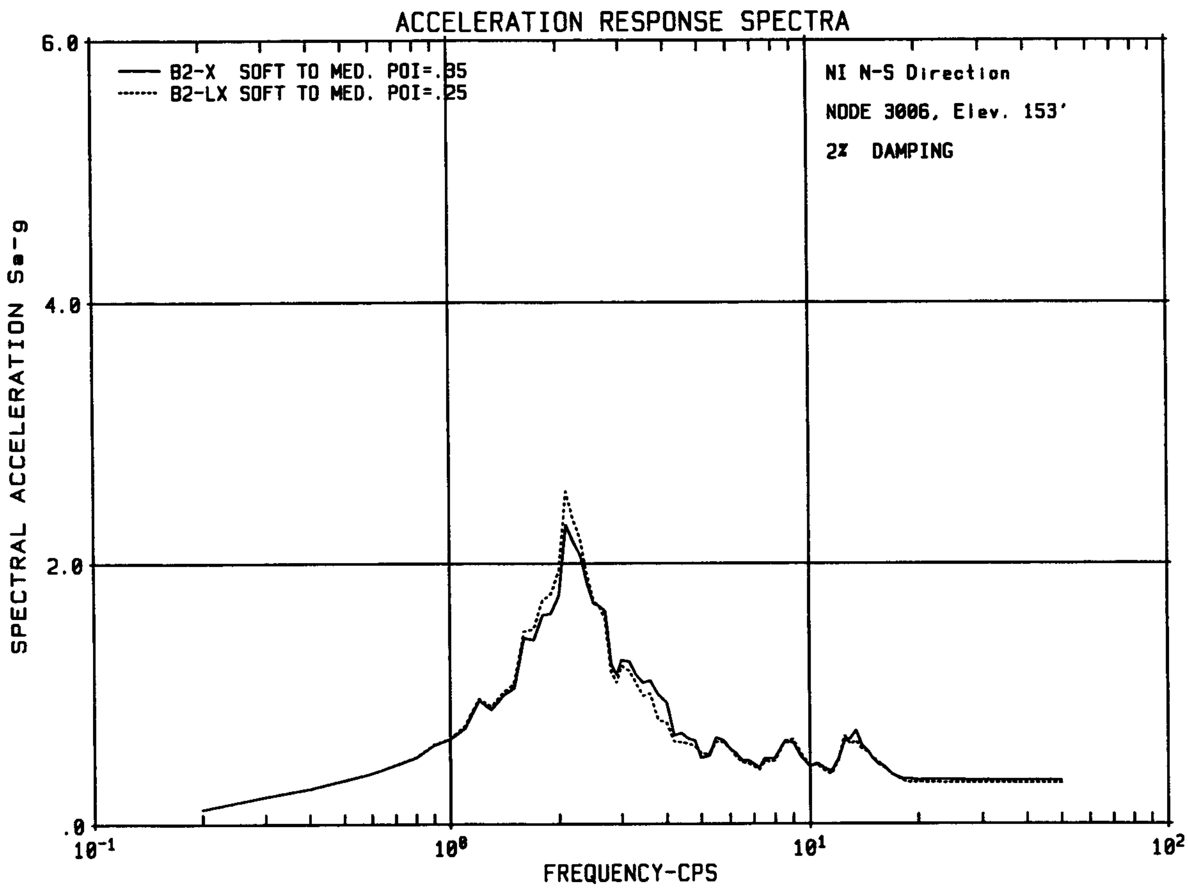


Figure 2B-14 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

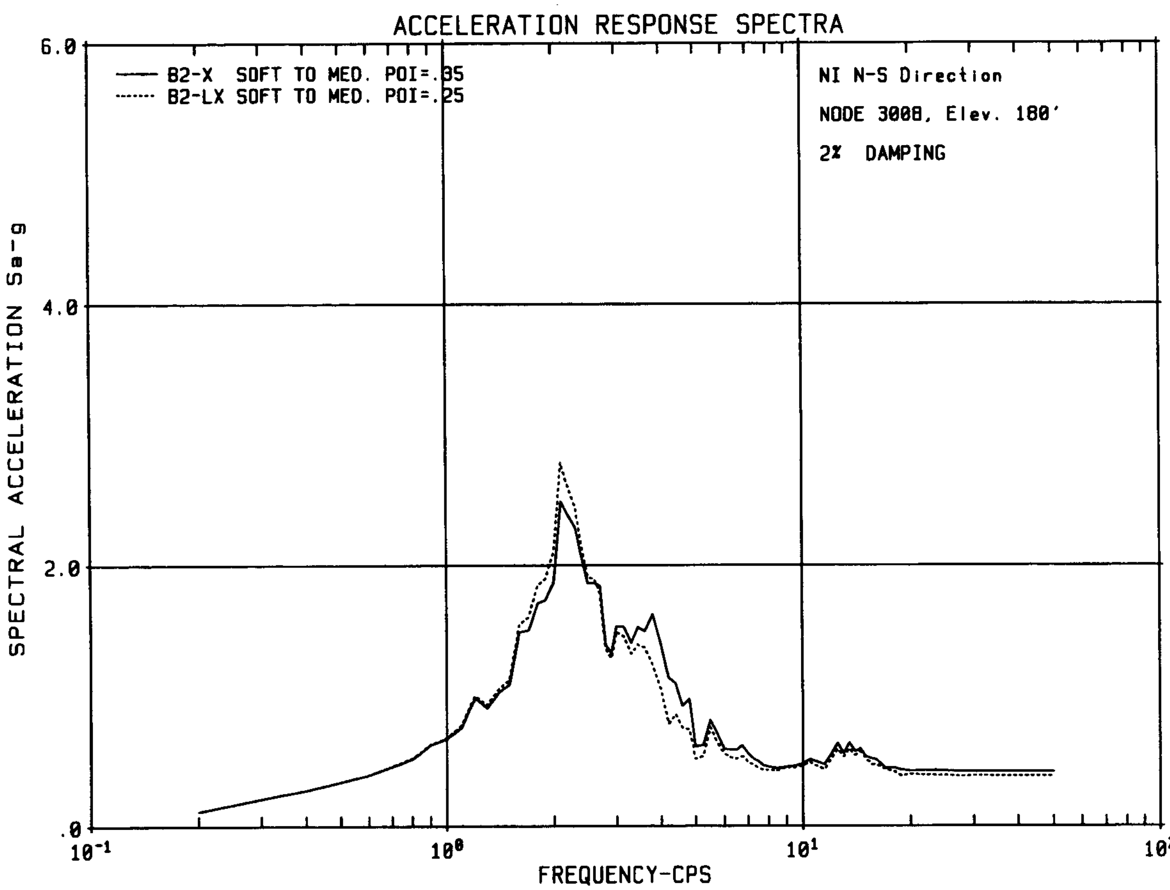


Figure 2B-14 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, N-S Direction Poisson Ratio Evaluation

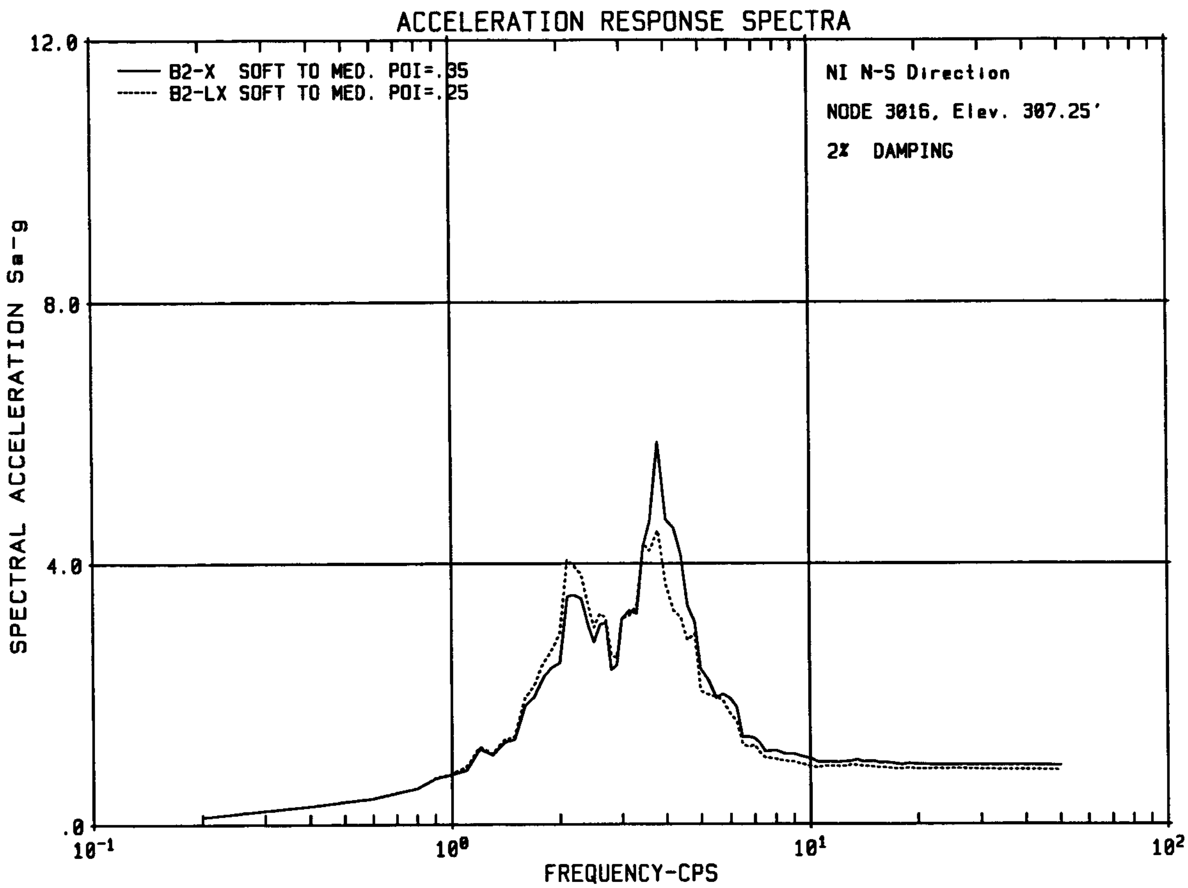


Figure 2B-14 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

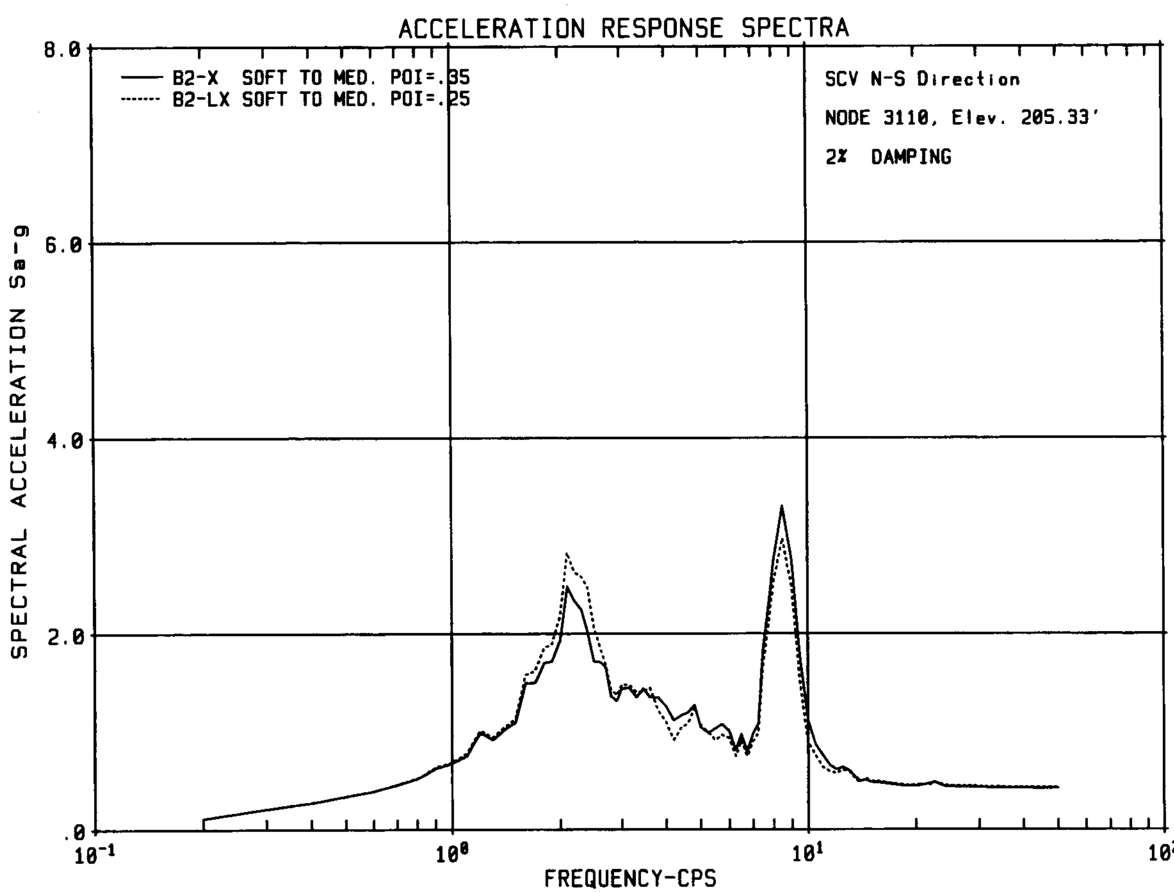


Figure 2B-14 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

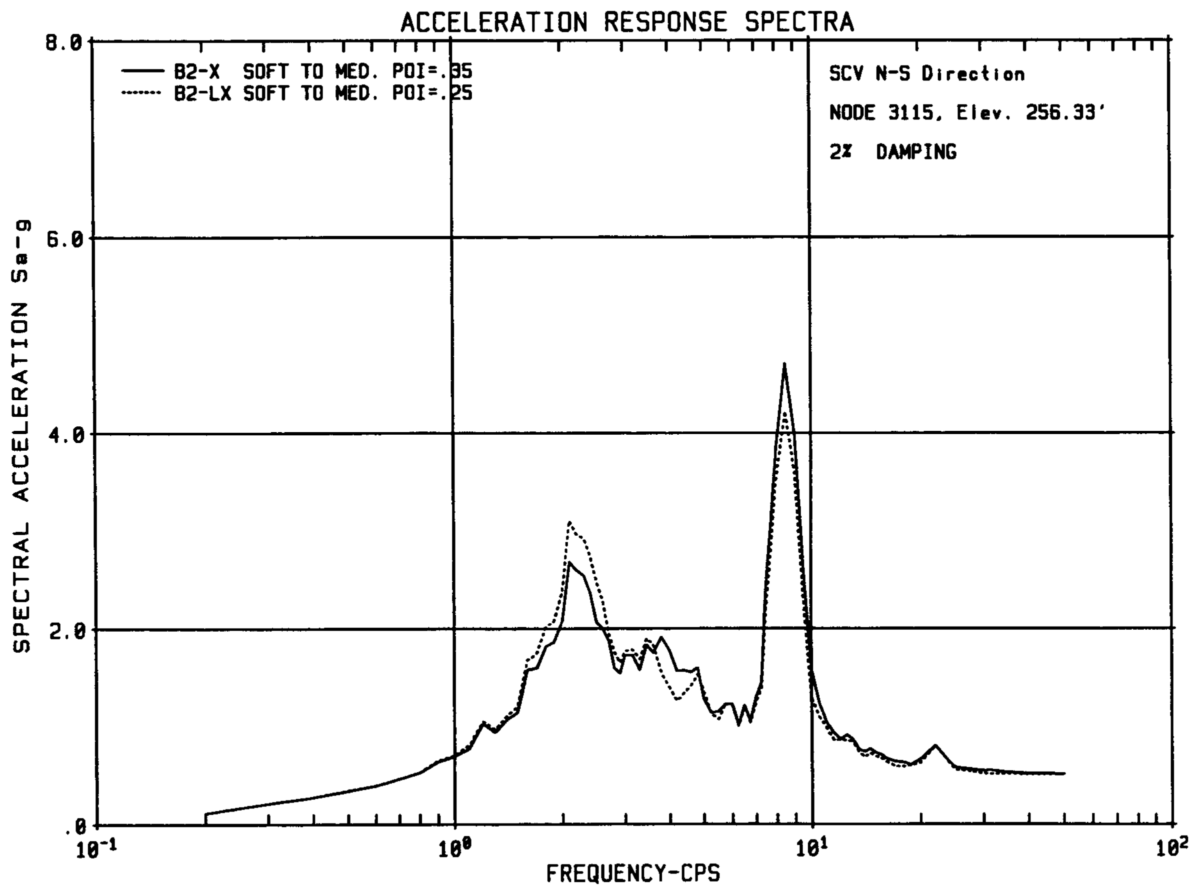


Figure 2B-14 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

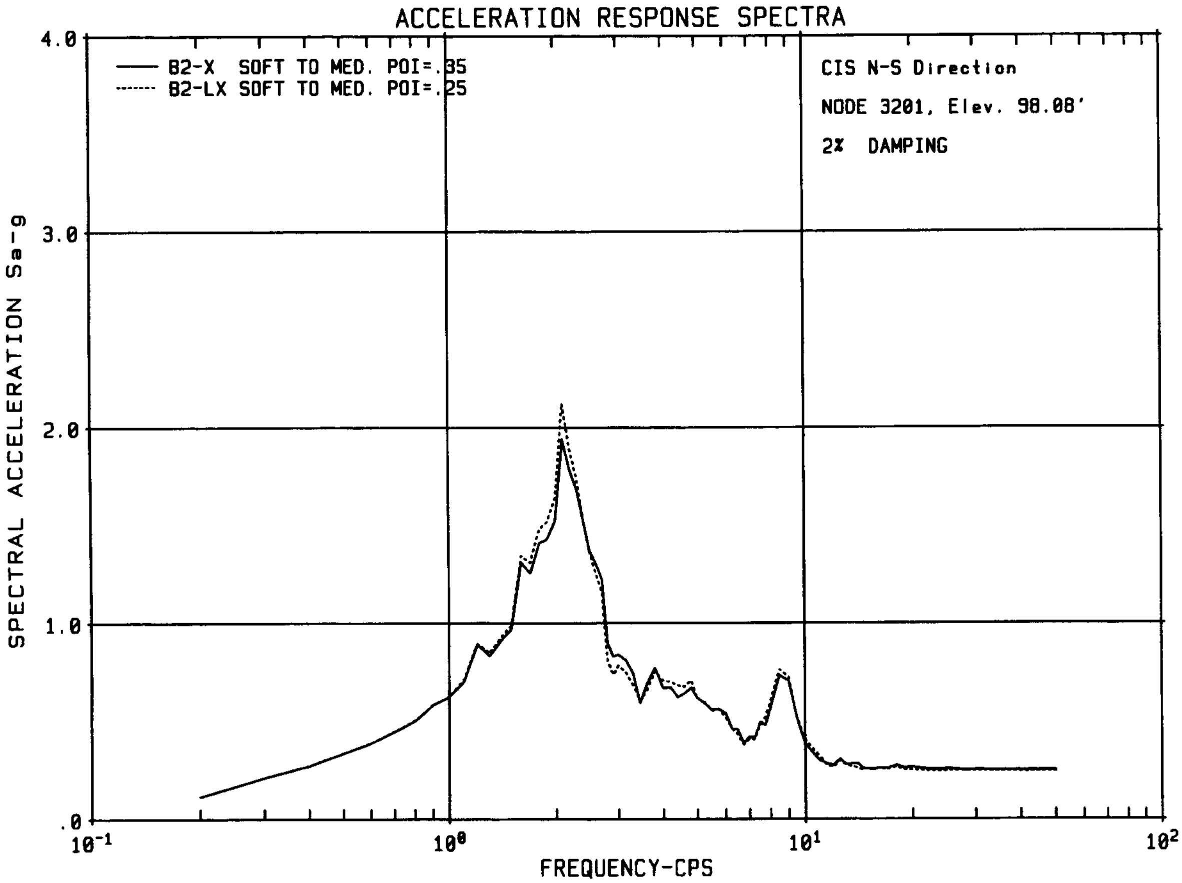


Figure 2B-14 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, N-S Direction Poisson Ratio Evaluation

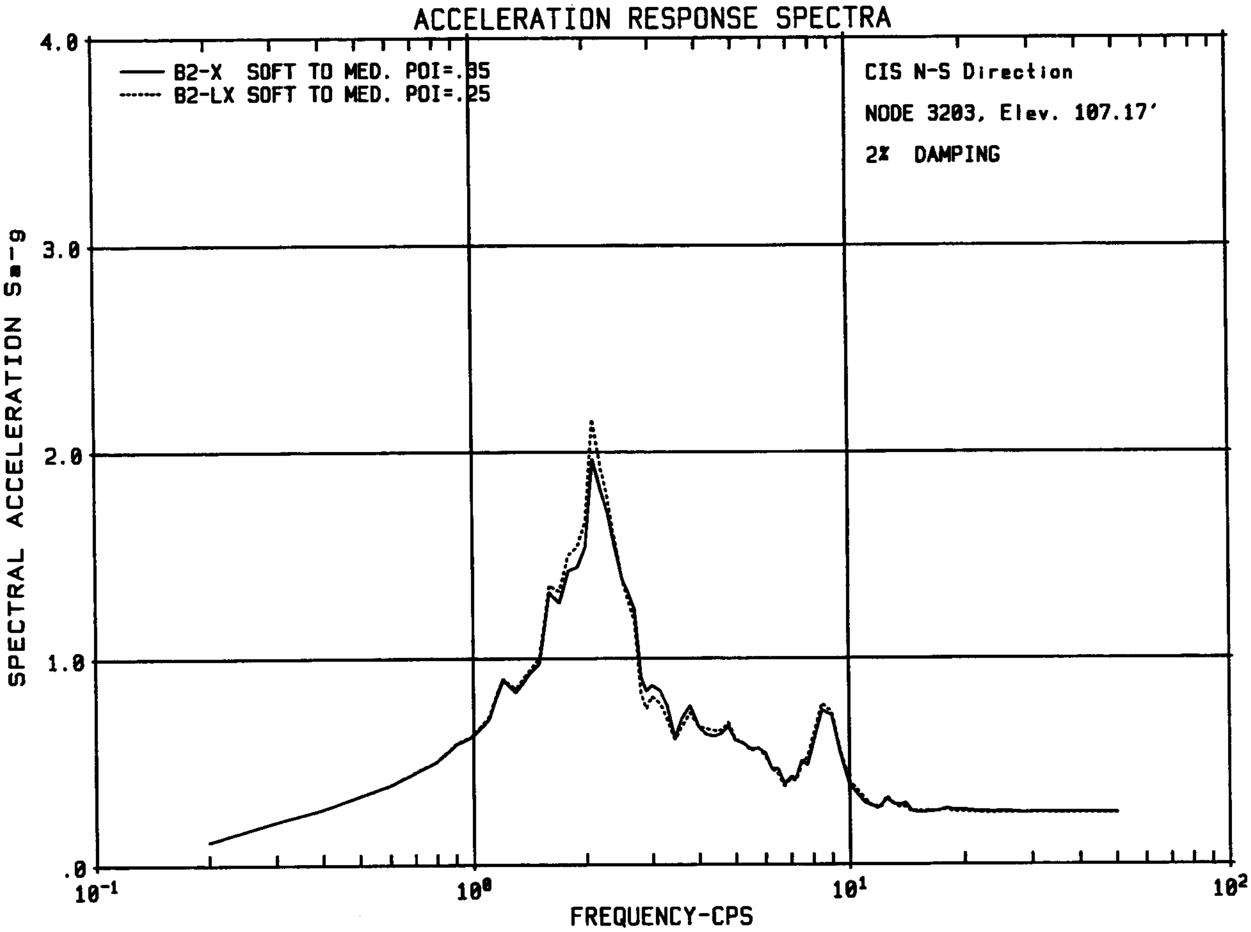


Figure 2B-14 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation

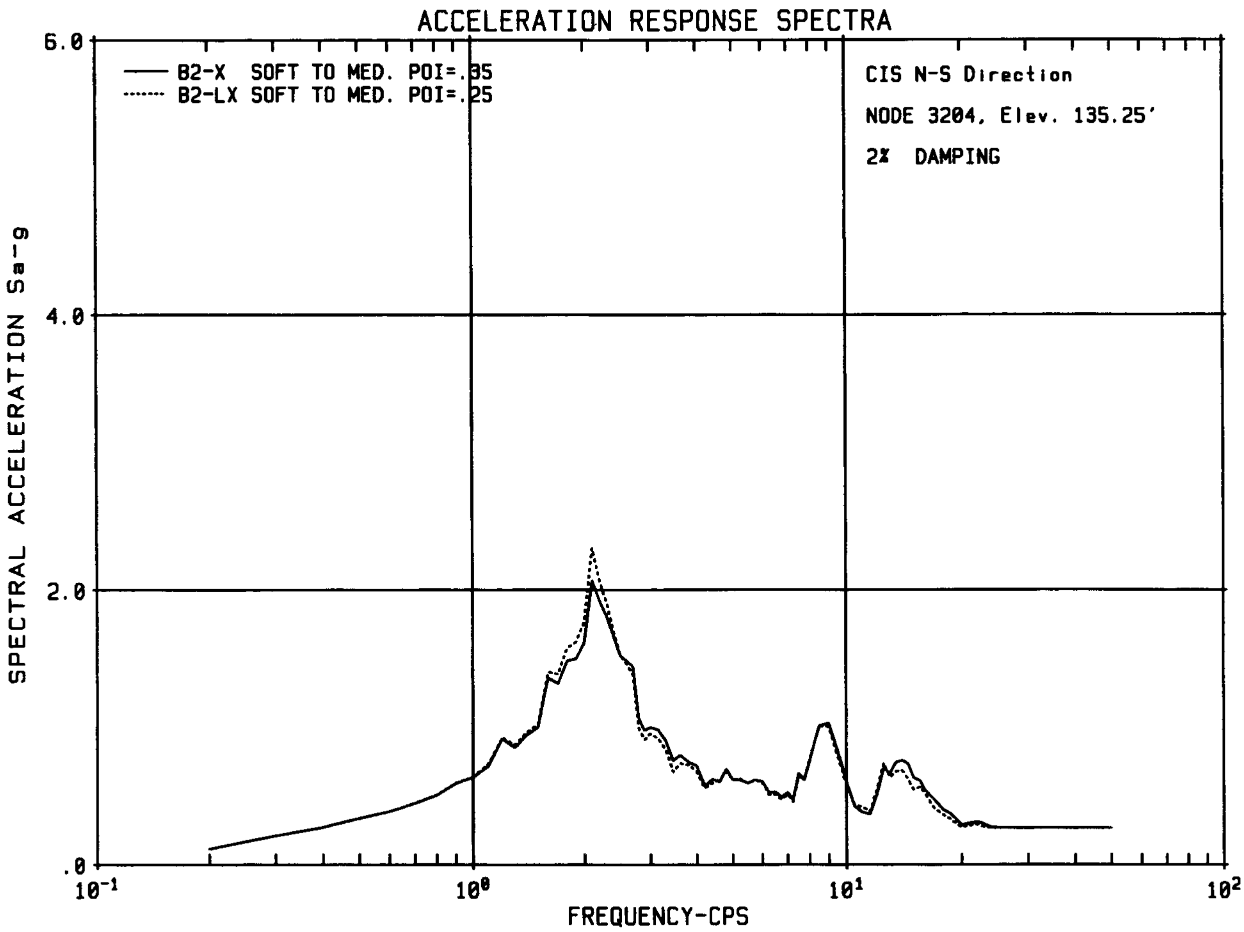
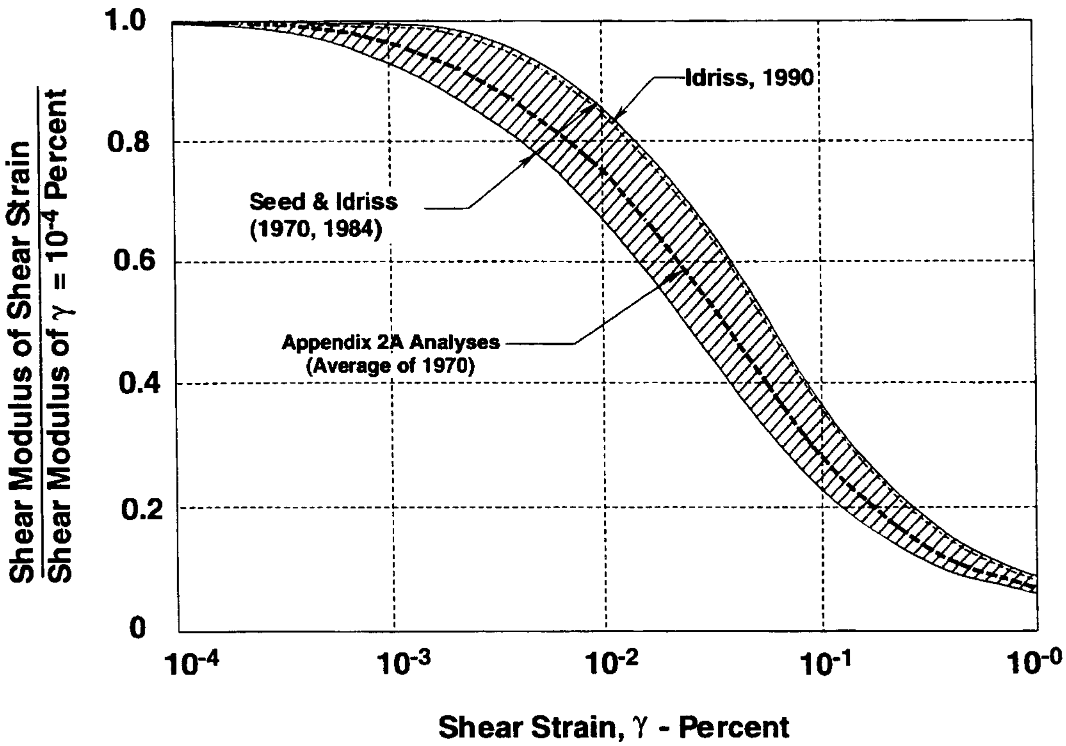


Figure 2B-14 (Sheet 11 of 11)

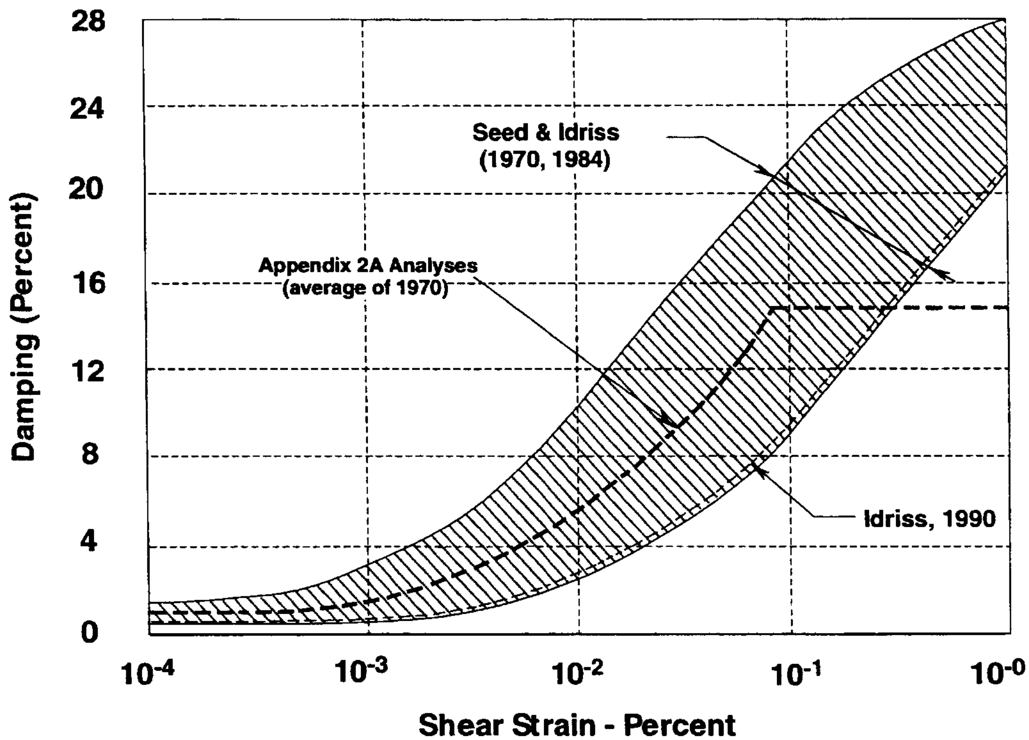
Two-Dimensional SASSI Analysis, N-S Direction
Poisson Ratio Evaluation



Variation of Shear Modulus with Shear Strain for Sands

Figure 2B-15

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation



Damping Ratios For Sands

g&hes draft- sassi/damping ratios for sands
terry/ig2/21/94 rev.4/18/95rg

Figure 2B-16

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

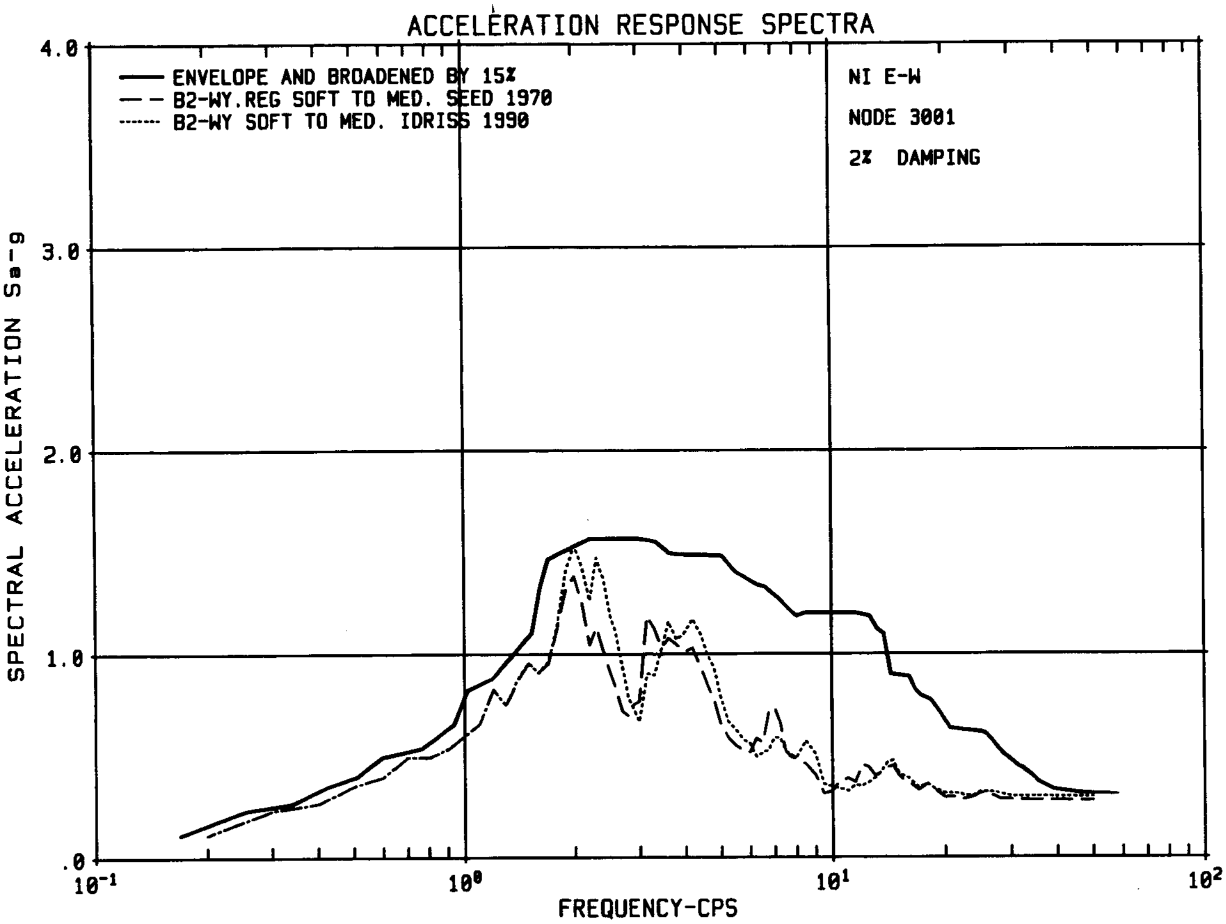


Figure 2B-17 (Sheet 1 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

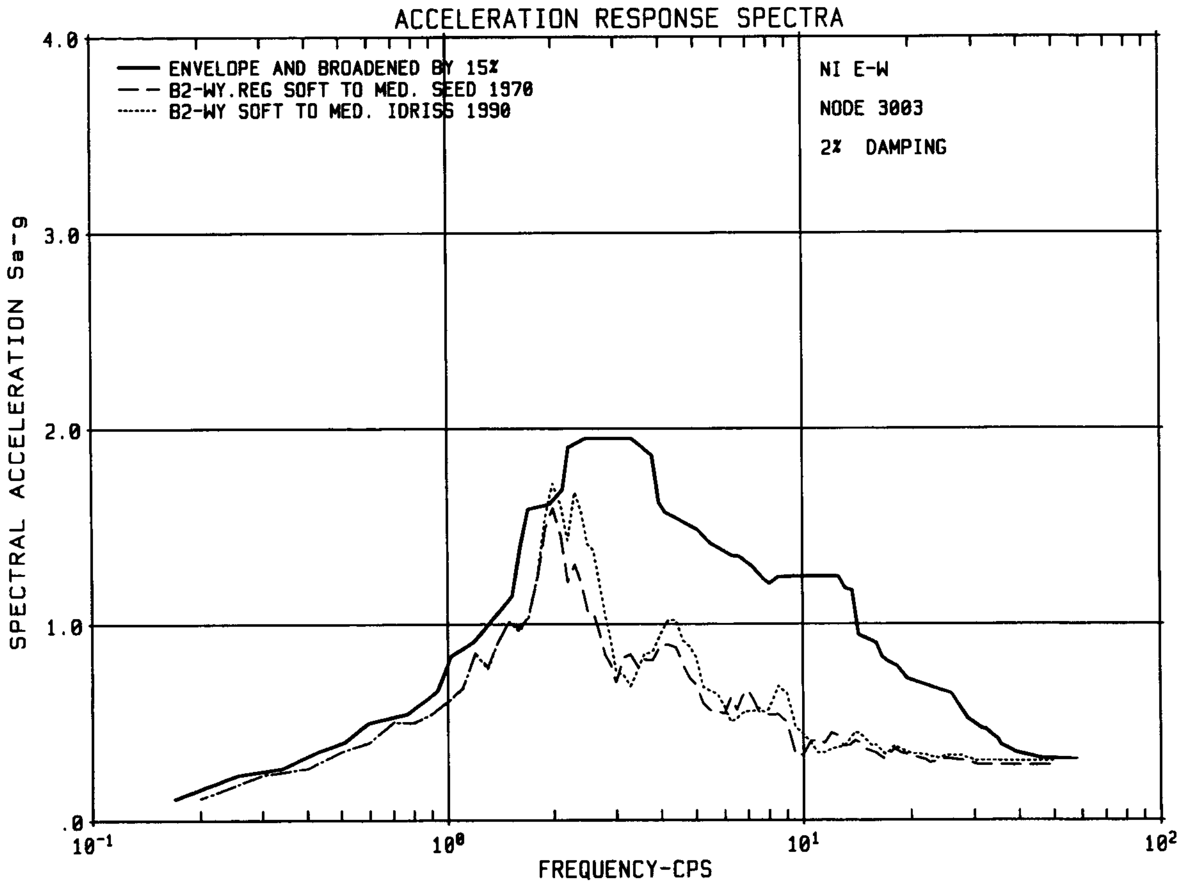


Figure 2B-17 (Sheet 2 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

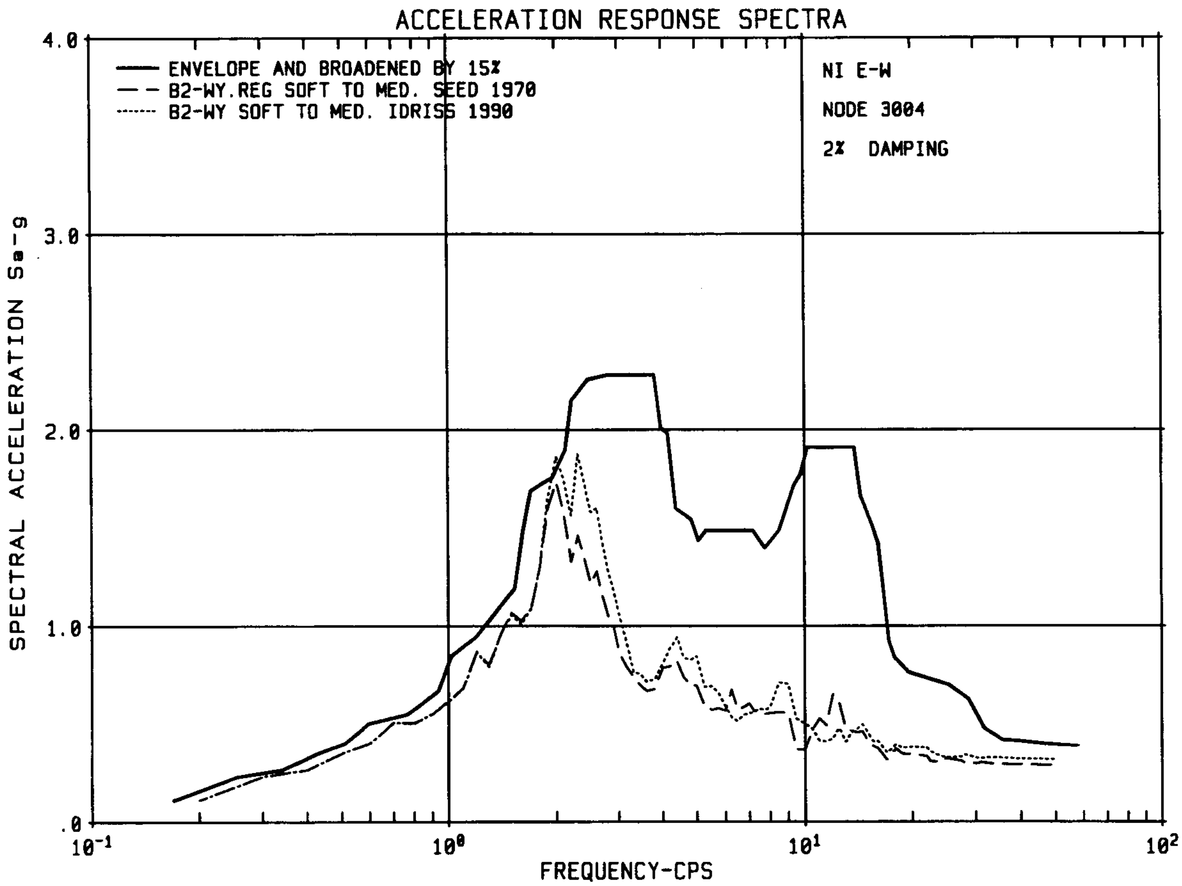


Figure 2B-17 (Sheet 3 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Soil Degradation Curve Evaluation

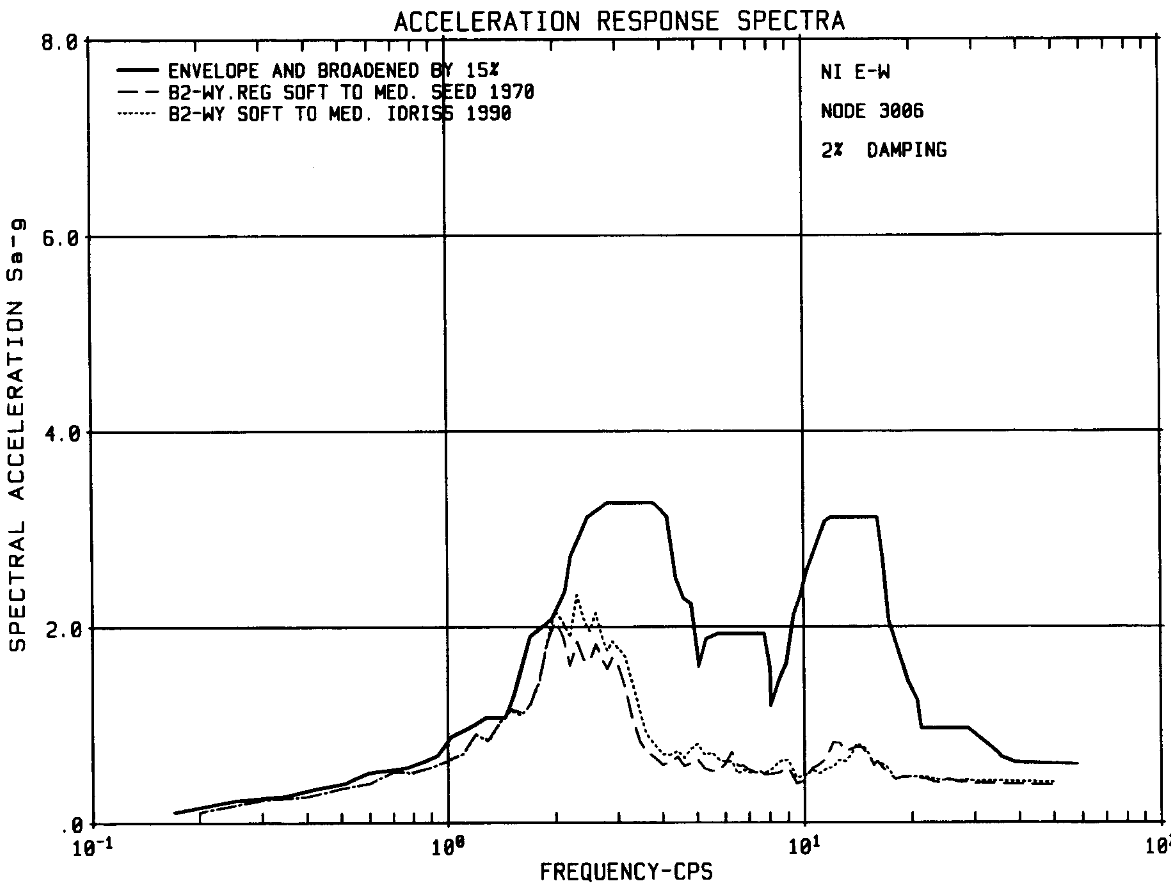


Figure 2B-17 (Sheet 4 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

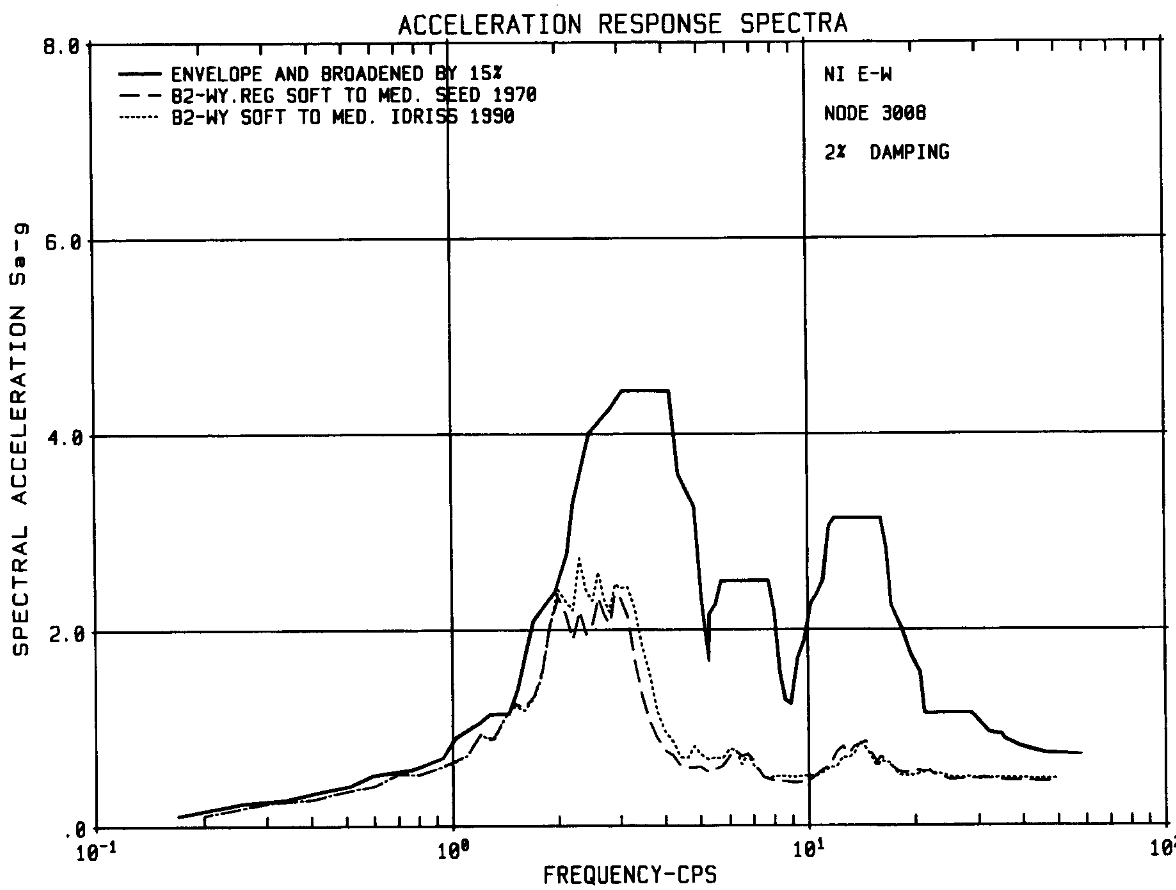


Figure 2B-17 (Sheet 5 of 11)

Two-Dimensional SASSI Analysis, E-W Direction Soil Degradation Curve Evaluation

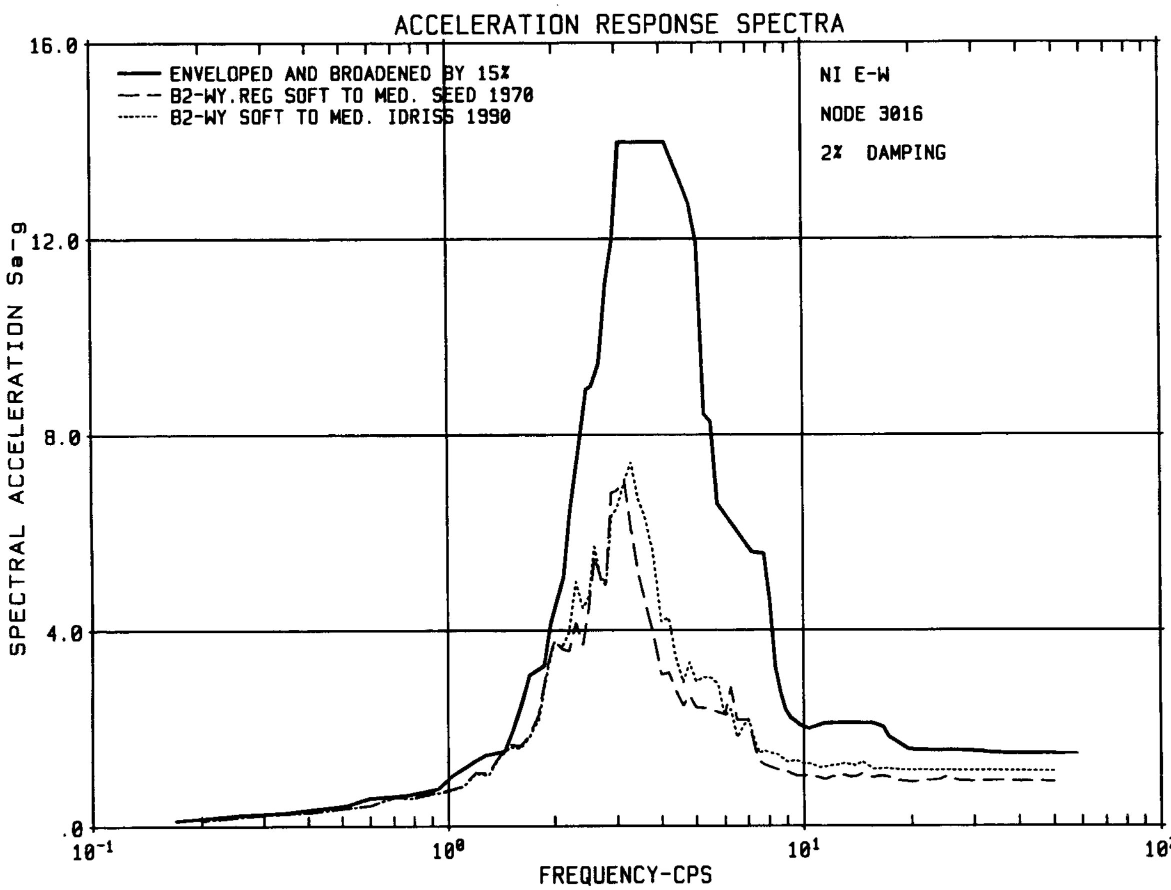


Figure 2B-17 (Sheet 6 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

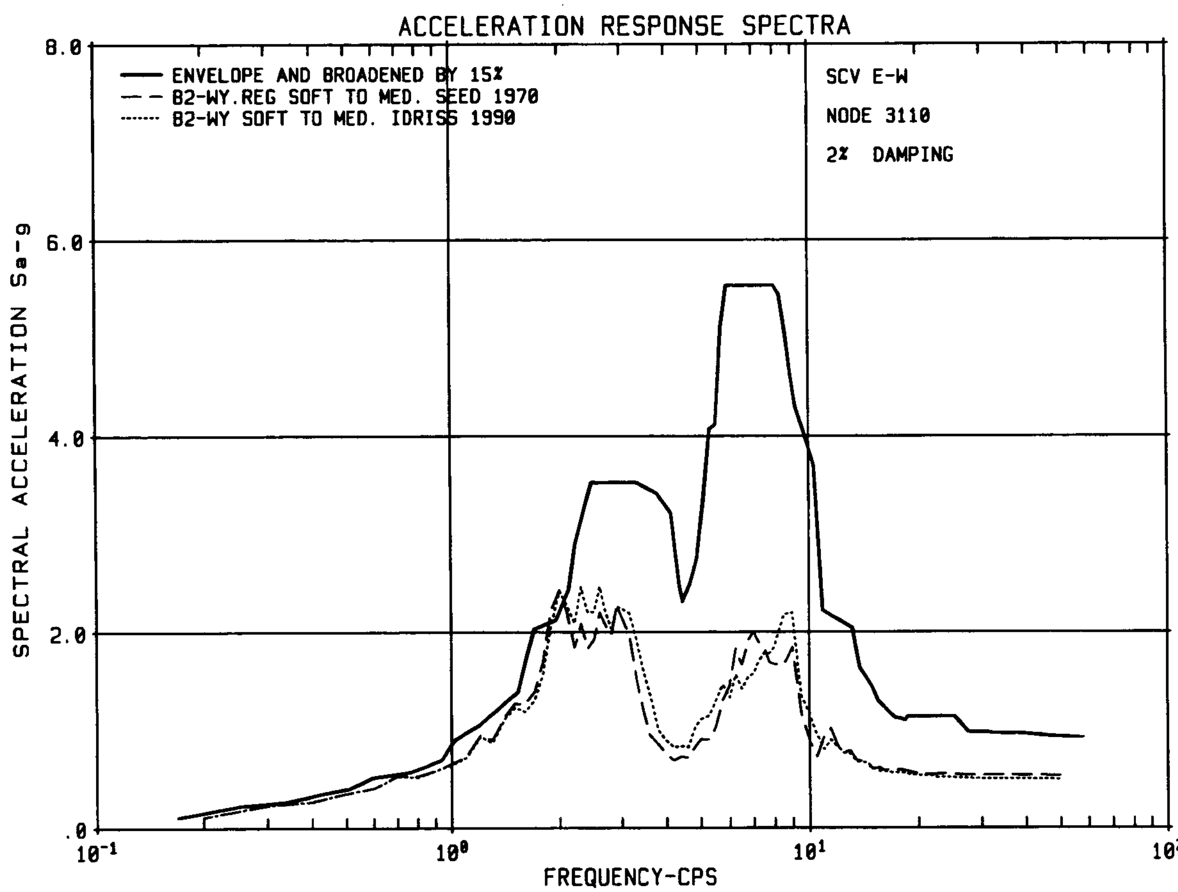


Figure 2B-17 (Sheet 7 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

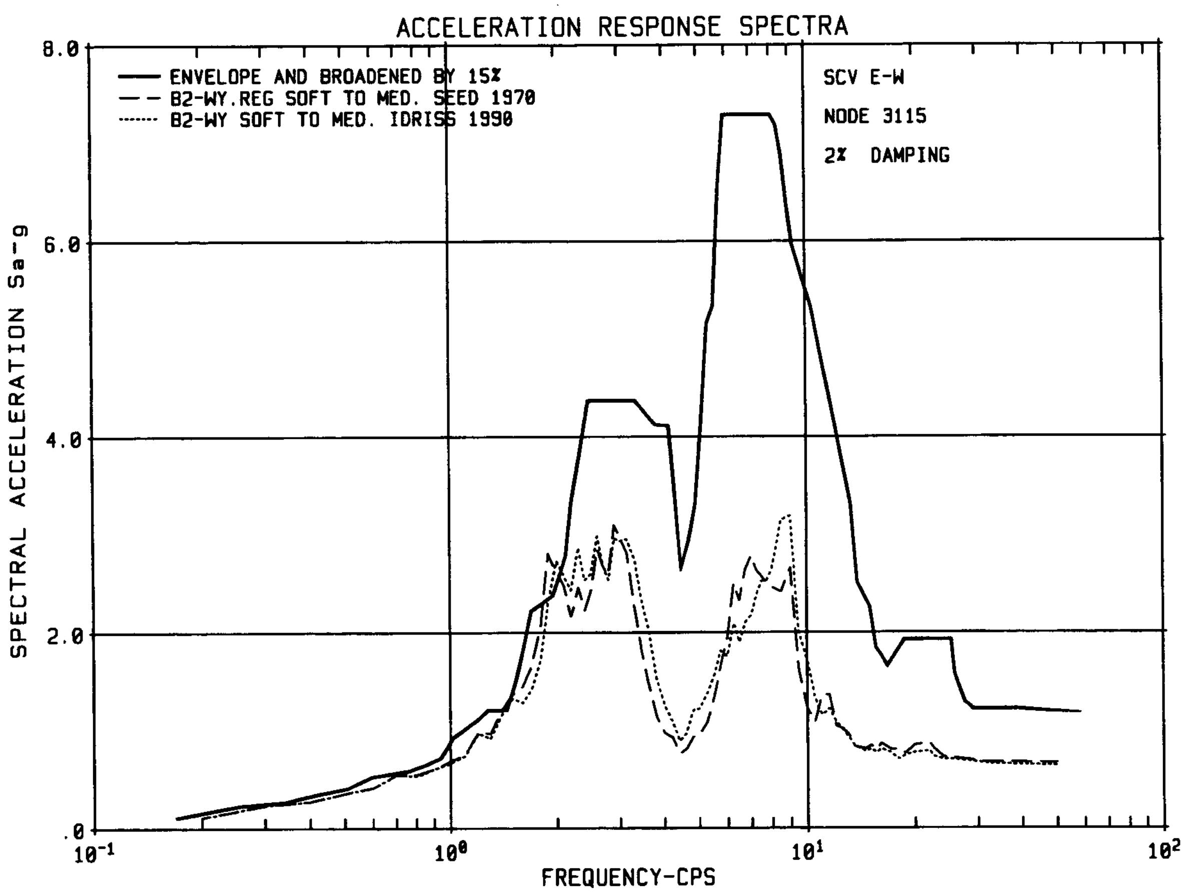


Figure 2B-17 (Sheet 8 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

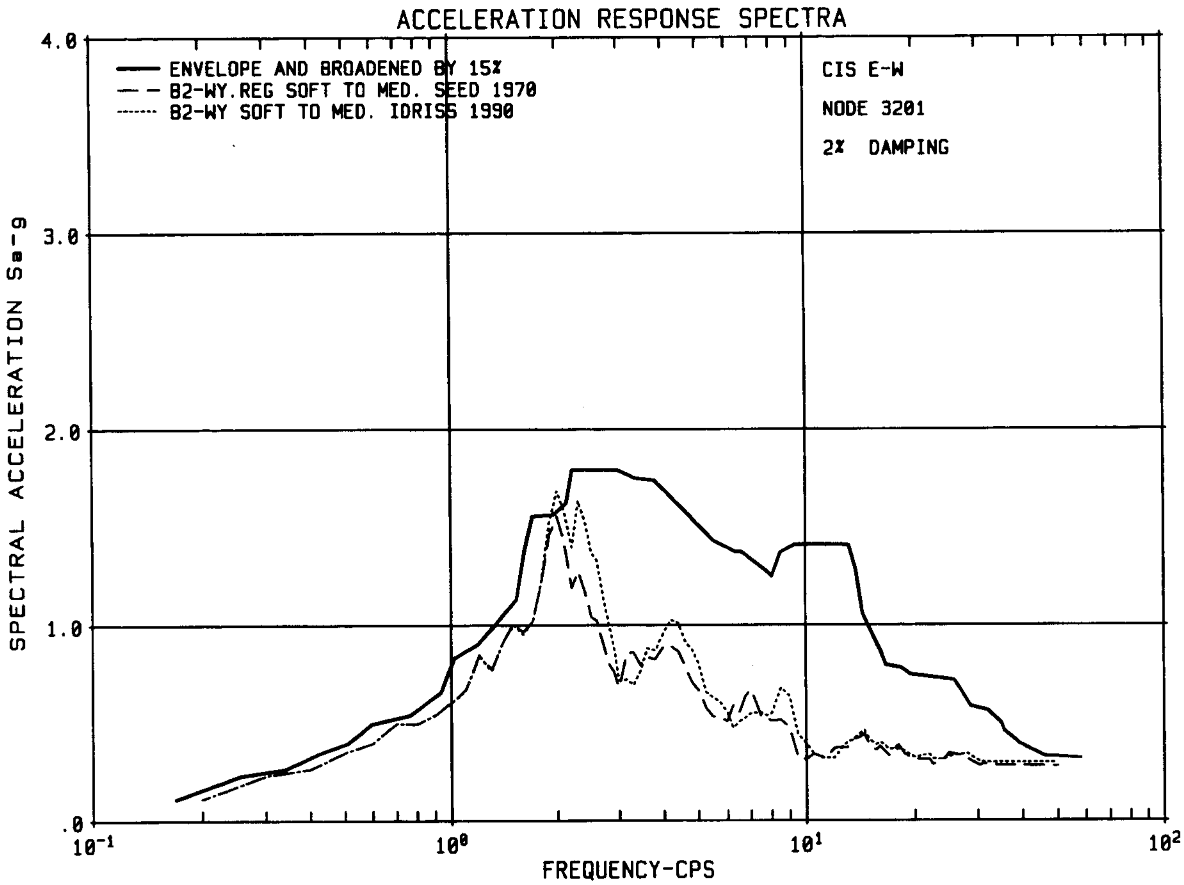


Figure 2B-17 (Sheet 9 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

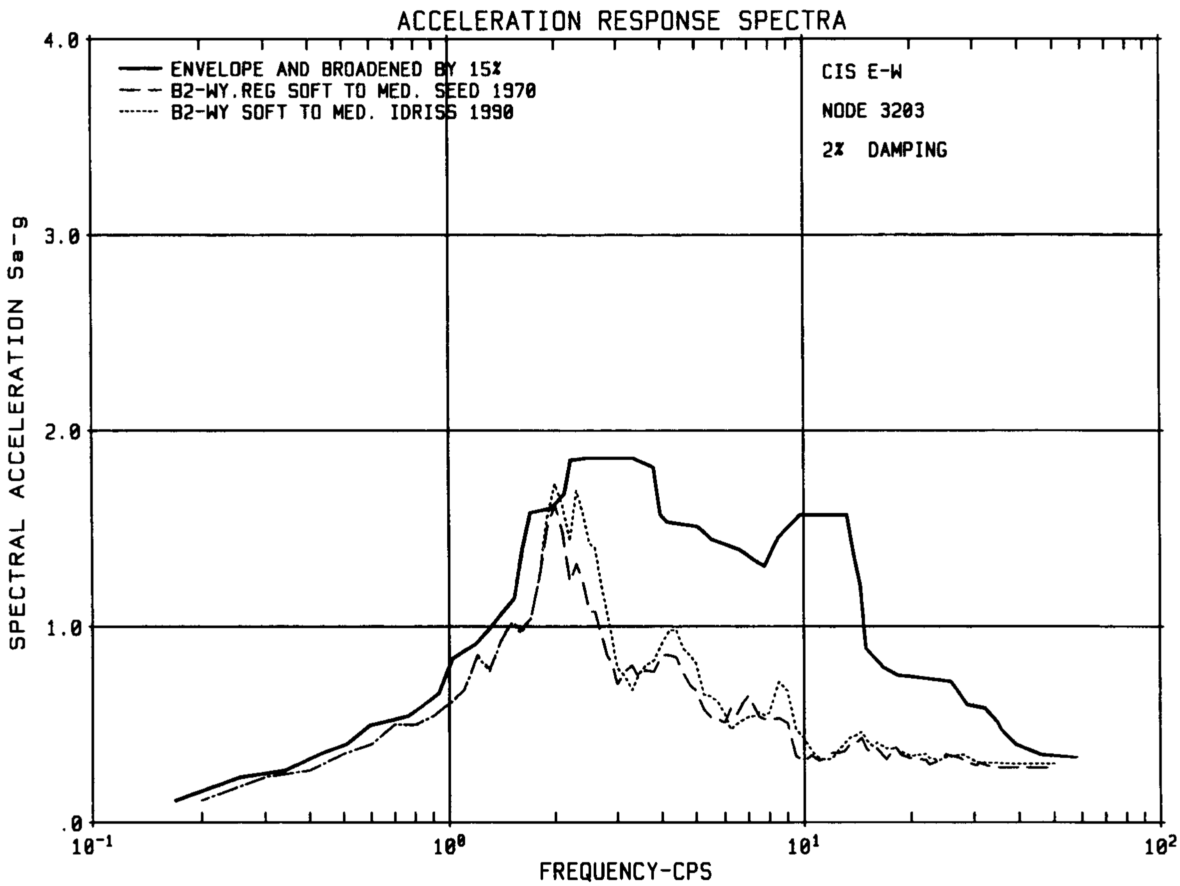


Figure 2B-17 (Sheet 10 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation

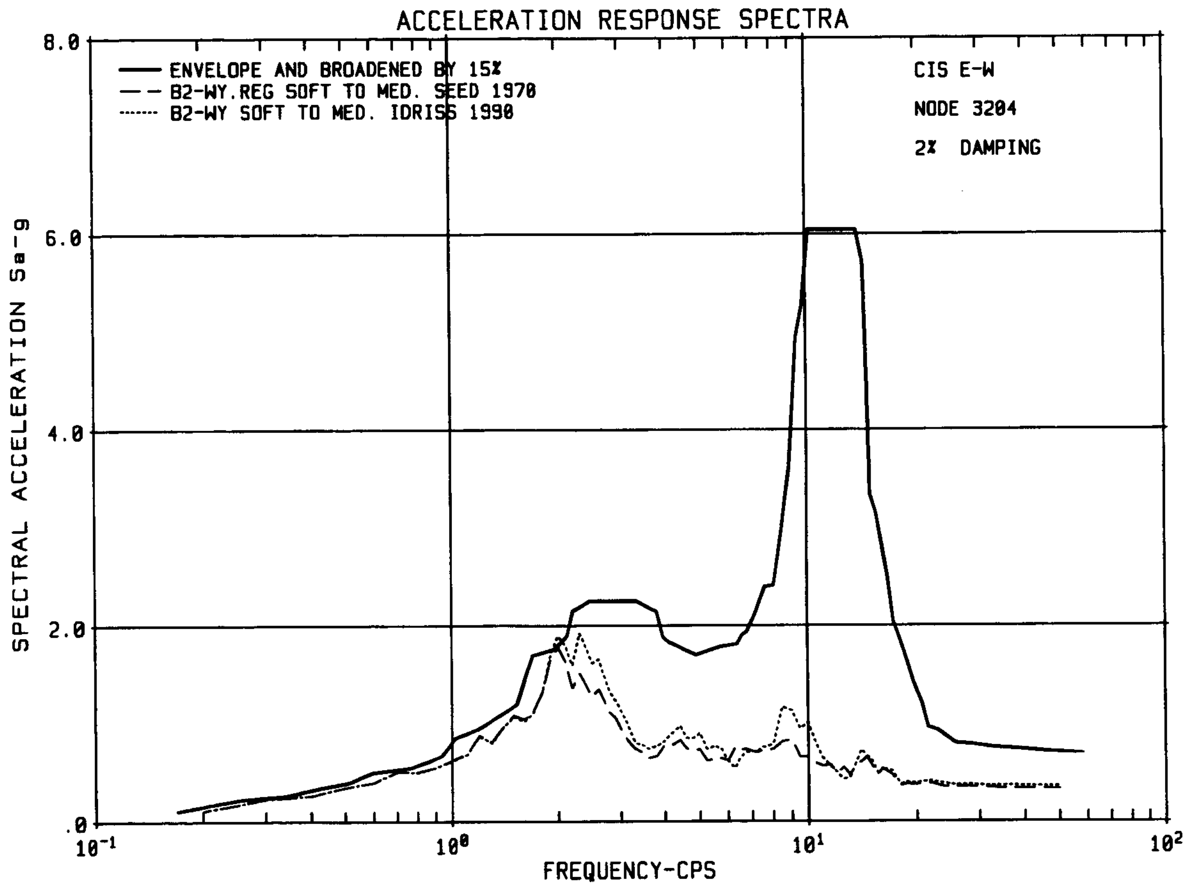


Figure 2B-17 (Sheet 11 of 11)

Two-Dimensional SASSI Analysis, E-W Direction
Soil Degradation Curve Evaluation