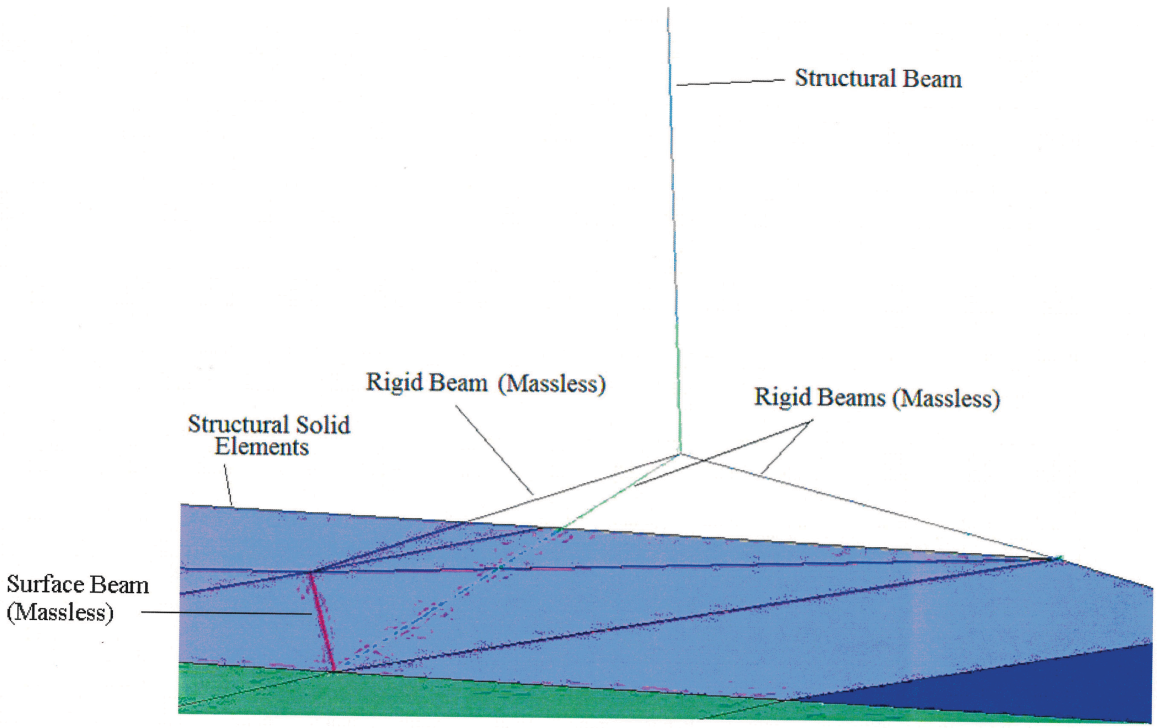


Figure 4.3.1.1-6 Connection of Beam to Solid Elements

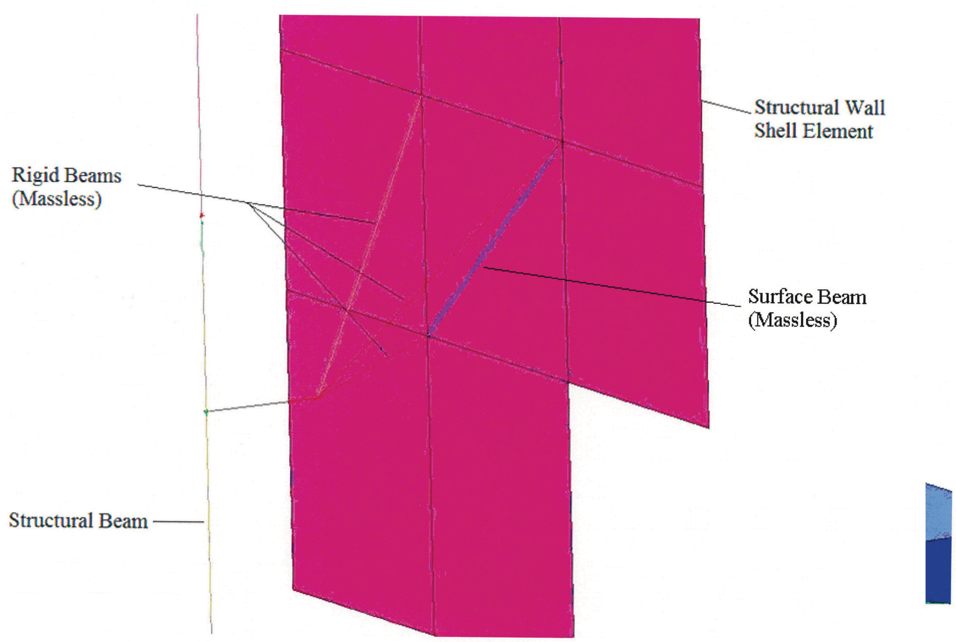


Figure 4.3.1.1-7 Connection of Beam to Shell Elements

4.3.1.2 Discretization Considerations: Mesh Size

The 3-D FE models have an adequate number of discrete mass degrees of freedom to capture the global and local translational, rocking, and torsional responses of the structures. The element size is selected such that the dynamic response of the structure and the SSI effects will be adequately captured. The mesh size also ensures that the discretized structures with full (uncracked concrete) stiffness properties is able to capture the local responses and responses of significant modes of vibration with frequencies equal to or below 70 Hz.

For wave passage in the structure, in order to transmit shear waves with frequencies up to 70 Hz, the maximum element size shall not be greater than one fifth of the wave length to be transmitted (Reference 12). The maximum structural element size is determined as follows:

Given: Concrete Strength f_c'=4,000 psi, Poisson's Ratio υ =0.17 and unit weight γ = 0.15 kcf

The modulus of Elasticity and Shear Modulus of concrete are:

$$E_c = 57\sqrt{f_c'} = 57 \cdot \sqrt{4000} = 3605\, ksi = 519120\,\text{ksf}$$

$$G_c = \frac{E_c}{2(1+\nu)} = \frac{519120}{2(1+0.17)} = 221846\,\text{ksf}$$

The shear velocity of the concrete is:

$$Vs_c = \sqrt{\frac{G_c \cdot g}{\gamma}} = \sqrt{\frac{221846 \cdot 32.2}{0.15}} = 7119\, ft/\sec$$

Wave length of the wave with frequency of 70 Hz:

$$\lambda_c = TVs_c = \frac{Vs_c}{f_{\max}} = \frac{7119}{70} = 102\,\text{ft}$$

The maximum size of an element determined by wave passage in the structure alone:

$$d_{FE} = \frac{\lambda_c}{5} = \frac{102\,\text{ft}}{5} \approx 20\,\text{ft}$$

Therefore, the mesh size of the model is equal or less than 20 ft in order to be able to transfer shear waves with frequencies of up to 70 Hz.

The capability of the basemat FE model for wave passage from the subgrade to the structure is considered in conjunction with the stiffness properties of the subgrades used in the site-independent SSI analysis; in particular the strain-compatible shear wave velocity (Vs) of the soil layer interacting with the structure. Per the ACS SASSI manual (Reference 12), the elements at the soil-structure interface can transfer seismic shear waves with wavelengths equal to or more than five (5) times the normal mesh size (d_{FE}). Therefore, the maximum frequency for wave passage (f_{FE_max}) from the subgrade to the structure is calculated as follows:

$$f_{FE\_max} = \frac{Vs}{5 \cdot d_{FE}}$$

For a selected nominal mesh size at the basemat interface with soil d_{FE}=9 ft, Table 4.3.1.2-2 provides the wave passage frequencies for the eight different generic subgrade conditions specified in Table 4.3.1.2-1.

Table 4.3.1.2-1 Wave Passage Frequencies for Basemat FE Mesh

Soil Case	Soil Vs (fps)	d_{FE} (ft)	$f_{FE\ max}$ (Hz)
270-500	1242	9	27.6
270-200	1302		28.9
560-500	1698		37.7
560-200	1552		34.5
560-100	1588		35.3
900-200	3237		71.9
900-100	3403		75.6
2032-100	7333		163

The table shows that for the SSI analyses of harder subgrade profiles, the dynamic FE model of R/B Complex is sufficiently refined to transmit waves with frequencies up to 50 Hz through the soil-foundation interface. The SSI analyses of softer soil profiles for which the wave passage frequencies of dynamic FE model are lower than 50 Hz provide responses that are enveloped in the high frequency range by the responses obtained from analyses of harder soil profiles. Therefore, the SSI analyses of all eight generic soil profiles provide adequate envelope responses up to 50 Hz as required by ISG-01.

4.3.1.3 Modeling of Stiffness and Damping

The ACS SASSI house module introduces the stiffness and damping properties of the structure into SSI analysis in the form of a frequency-independent complex stiffness matrix (Refer to the ACS SASSI Theoretical Manual, Reference 12). Complex moduli are used to represent the stiffness and damping properties of the different structural materials which leads to stiffness and damping ratios which can be different for different materials assigned to the finite elements.

While maintaining geometry, mass, and FE meshing, two different levels of stiffness are assigned to the model in order to address the effect of concrete cracking on the seismic response. The responses obtained from the analyses of the models with two different stiffness properties are enveloped to develop the basis for standard seismic design of the US-APWR plant.

4.3.1.4 Modeling of Mass

The equivalent dynamic mass included in the R/B Complex dynamic FE model includes contributions from the structural mass in addition to that of other applicable equipment, dead loads, and live loads to which the structure is subjected.

As a general rule, the structural mass is assigned as density to the finite elements based on the material properties of the components of the structures. The density is then increased to account for equipment, live, snow and other applicable loads. A mass equivalent to 25% of floor design live load and 75% of roof design snow load, as applicable, is included in the model. Each load is applied over a particular area and the density of the elements in that area is increased such that the total increase in dynamic mass matches the applied load magnitude.

Equipment load also includes a 60 psf miscellaneous pipe load is applied on all walls and slabs on the R/B model, with the exception of a few locations where a pipe load of 100 psf is used instead.

The above process is not applicable for the nuclear steam supply system (NSSS) and major piping that constitutes the RCL. The RCL dynamic mass is included directly in the RCL lumped-mass-stick model provided in Reference 29.

In the case of the R/B, the equivalent dynamic mass is applied to the dynamic FE model in two steps. First, a mass density equal to the sum of the structural self-weight and pipe load is calculated and assigned to each of the shell elements modeling the R/B walls and slabs.

Various macros are then developed to apply the remaining loads as either additional mass densities on slab shell elements or concentrated lumped masses on wall and slab key points.

The density and thickness of the elements are further modified to account for stiffness reductions due to openings and cracking, but it is done is such a way as to not change the mass of the elements.

Liquid masses contained in the Spent Fuel Pit, Emergency Feed Water Pits, and Refueling Water Storage Pit are applied as impulsive mass to walls and slabs. The direction of the mass is perpendicular to the surface of the walls or slabs as shown in Figure 4.3.1.4-1. Nodes i and j are the nodes of walls to which the horizontal masses are attached, and node k is the node of slabs to which the vertical mass is attached. The attached directional masses are horizontal masses on nodes i and j, and vertical masses on node k.

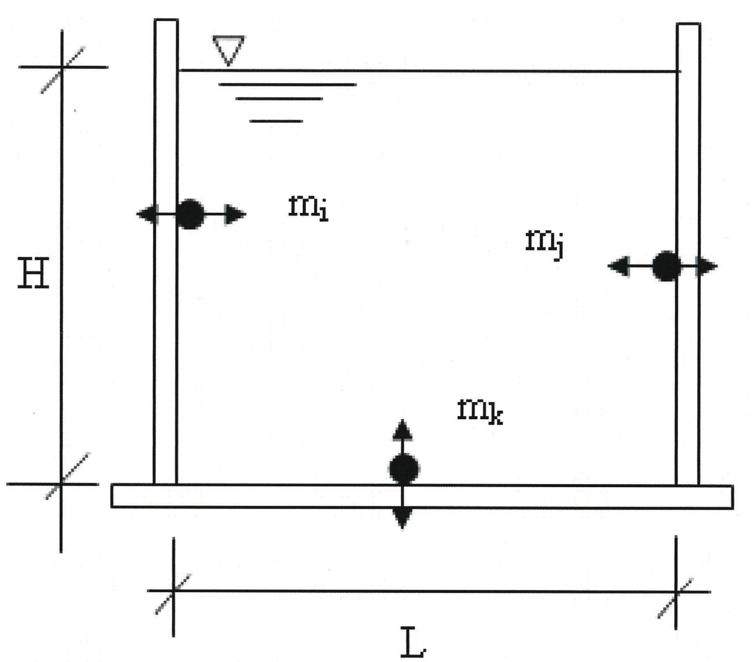


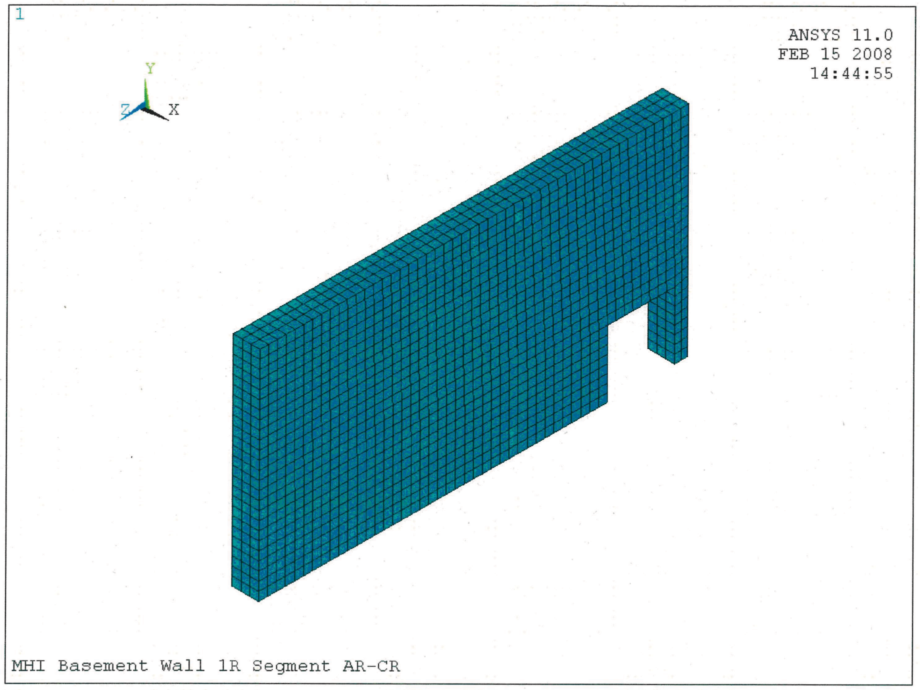
Figure 4.3.1.4-1 Perpendicular Liquid Masses

4.3.1.5 Adjustment of Stiffness and Mass Properties

The coarse FE mesh of the Dynamic FE Model does not always permit an accurate modeling of the openings in the walls. The elastic modulus and thickness of shell elements are adjusted to accurately model the reduction of shear stiffness of the wall due to openings.

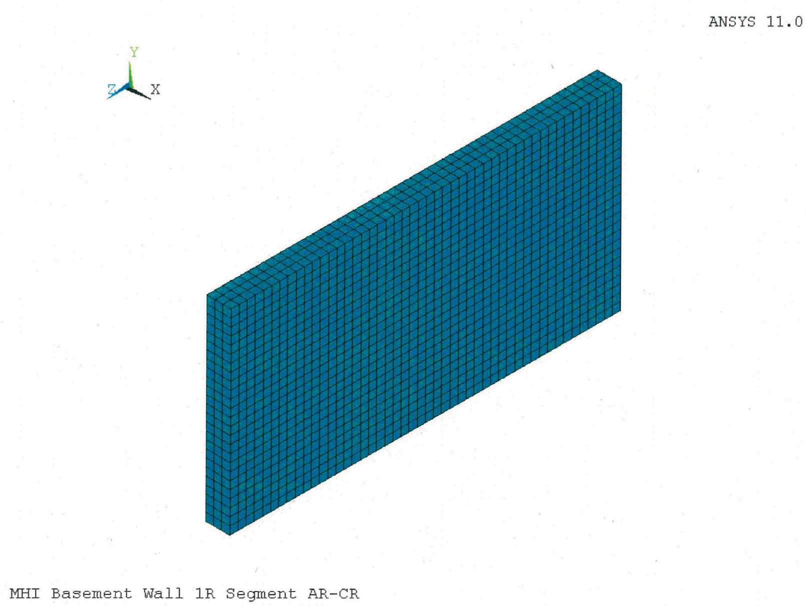
The density of shell elements is also adjusted to accurately represent the mass of the wall accounting for openings and the adjusted wall thickness.

A set of FE analyses is performed using ANSYS to obtain the stiffness reduction factors needed to adjust the material properties and account for the reduced stiffness of the shear wall openings. The correction factors are obtained by comparing the results from the static analyses of two detailed solid FE models shown in Figures 4.3.1.5-1A and B. Model A represents the actual geometry of the wall with openings, and Model B represents the wall without openings. Unit displacements are applied at the top of each model in both the in-plane and the out-of-plane directions, to generate the reactions at the bottom, which can then be used to calculate the in-plane and out-of-plane wall stiffness. The ratio between the reaction obtained from Model A and Model B is used to determine out-of-plane stiffness reduction factors (m) and the in-plane stiffness reduction factor (n) that are then used to determine the adjusted elastic modulus (E_o), thickness (t_o), and density (γ_o) of the wall as described in Section 4.3.1.7.



Model A of Actual Wall

Figure 4.3.1.5-1A FE Models to Calculate Wall Stiffness Reduction Factors – Model A



Model B of Wall in SASSI Model
Model A of Actual Wall

Figure 4.3.1.5-1B FE Models to Calculate Wall Stiffness Reduction Factors – Model B

4.3.1.6 Stiffness of Composite Steel-Concrete Beams and Columns

In the FH/A, the crane supporting steel columns and girts are continuously anchored to the exterior concrete walls with headed steel studs. The steel roof beams and girders are also continuously anchored to the concrete roof slabs. The concrete/steel composite moment of inertia is based on the effective width of concrete and the degree of compositeness provided by the studs. The shear force that can be transferred between steel and concrete depends on the capacity of the studs, the yield strength of the steel section and the ultimate compressive strength of the effective concrete.

Based on AISC 360-05 Commentary (Reference 26), 75% of the composite transformed moment of inertia is used in calculating the effective moment of inertia of the composite section (I_{eff}):

$$I_{eff} = \min\left[0.75 \cdot I_{tr}, I_x + \sqrt{Q_n / C_f} \cdot (I_{tr} - I_x)\right]$$

Where: Q_n = shear capacity of the studs

C_f = smaller of steel yield force or concrete ultimate compressive force

I_x = moment of inertia of the steel column or beam

I_{tr} = composite transformed moment of inertia, calculated as follows:

$$I_{tr} = I_X + \left(t_c + t_d + \frac{d}{2} - y_{bar}\right)^2 \cdot A_s + \frac{b_{eff} \cdot t_c}{12} + \left(y_{bar} - \frac{t_c}{2}\right)^2 \cdot b_{eff} \cdot t_c$$

Where: t_c = slab or wall thickness

t_d = steel deck thickness, if any

d = depth of the steel member

y_{bar} = centroidal distance of the transformed section, measured from the top of concrete

A_s = area of the steel member

b_{eff} = effective width of concrete, after transforming to steel = b_e/n

b_e = effective width of concrete, before transforming to steel

n = modular ratio = E_s/E_c

E_s = Young's modulus for steel

E_c = Young's modulus for concrete

In order to incorporate the composite stiffness of the steel beams and the reinforced concrete slabs the moments of inertia of the beams are increased. This modeling approach provides an accurate representation of the actual out-of-plane bending stiffness of the composite concrete-steel cross-sections which is validated through comparison of responses obtained from the detailed and dynamic models.

In the above, the effective width of concrete (before transformation to steel section) is based on AISC 360-05, Section I3 (excerpt shown below in italics):

I3. FLEXURAL MEMBERS
1. General
1a. Effective Width
The effective width of the concrete slab is the sum of the effective widths for each side of the beam centerline, each of which shall not exceed:
(1) one-eighth of the beam span, center-to-center of supports;
(2) one-half the distance to the centerline of the adjacent beam; or
(3) the distance to the edge of the slab.

Above requirements are applicable when the flange of the composite section is in compression. When the flange is in tension, smaller values of b_e could be used.

The centroidal distance of the transformed section, measured from the top of concrete is calculated as:

$$y_{bar} = \frac{0.5 \cdot b_{eff} \cdot t_c^2 + A_s \left(t_c + t_d + 0.5 \cdot d\right)}{b_{eff} \cdot t_c \cdot A_s}$$

In the Dynamic FE Model, shell elements and beams are used to represent the individual members. The locations of the centerlines of the beam and shell elements are coincident so the effective bending stiffness of the section (*EI*) in the dynamic FE model is the sum of the individual moments of inertia:

$$EI = \frac{tc^3 \cdot be}{12} \cdot E_c + I_X \cdot E_s$$

Therefore, the moment of inertia of the beam element that results in bending stiffness of the section (*EI*) that is equivalent to the stiffness of the actual composite section is calculated as follows:

$$I_S = I_X \cdot \alpha = I_{eff} - \frac{tc^3 \cdot be}{12} \cdot \frac{E_c}{E_s}$$

Where: $\alpha = I_S / I_X$ is a factor used to adjust the bending moment of inertia of the beam element in the FE model in order to simulate the actual composite stiffness of the reinforced concrete-steel beam cross sections.

4.3.1.7 Implementation of Stiffness Reduction in the Dynamic FE Model

The R/B Complex Dynamic FE Model only uses finite elements with isotropic material properties to represent the stiffness and mass properties of reinforced concrete members. The cracking of the concrete can affect different aspects of the stiffness of the members depending on the cracking pattern developed under different loading conditions. For example, a loads applied on a slab will generate cracks in the concrete that will affect mainly the out-of plane stiffness and will have a small effect on the in-plane stiffness of the slab. Modeling procedures are described for reduction of stiffness properties of beam and shell element in order to simulate different cracking effects.

The stiffness matrix of beam elements is defined by material properties (modulus of elasticity and Poisson's ratio) and the beam section properties (moment of inertia, shear area, etc). The most convenient way to reduce the stiffness of those reinforced members modeled by beam elements is through assigning reduced section properties while maintaining the same modulus of elasticity and Poisson's ratio. For example, if the flexural stiffness is required to be reduced, then the bending moment of inertia of the beam is reduced.

Four shell element input parameters including modulus of elasticity (E_0), Poisson's ratio (ν), shell thickness (t_0) and unit weight (γ_0) define the dynamic properties of the modeled reinforced concrete member. The following procedure is used to reduce stiffness of the reinforced concrete member shell elements by adjusting the shell modulus of elasticity to value (E_c), the shell thickness to value (t_c) and the shell unit weight to value (γ_c):

Case 1: If the concrete cracking reduces both in-plane and out-of-plane stiffness of the member by 1/n reduction factor, the adjusted properties of shell element are:

$$E_c = \frac{1}{n} E_o$$

$$t_c = t_0$$

$$\gamma_c = \gamma_o$$

Case 2: If the concrete cracking reduces out-of-plane stiffness of the member by 1/n reduction factor and the in-plane stiffness remains the same, the adjusted properties of shell element are:

$$E_c = \sqrt{n} E_o$$

$$t_c = \sqrt{\frac{1}{n}} t_0$$

$$\gamma_c = \sqrt{n} \gamma_o$$

Case 3: If the concrete cracking reduces in-plane stiffness of the member by 1/n reduction factor and the out-of-plane stiffness remains the same, the adjusted properties of shell element are:

$$E_c = \frac{\sqrt{n}}{n^2} E_o$$

$$t_c = \sqrt{n} t_0$$

$$\gamma_c = \frac{1}{\sqrt{n}} \gamma_o$$

It is noted that the changes in thickness and modulus of elasticity discussed above affect the in-plane axial stiffness of the shell element, as well as the shear stiffness values. Since the axial stiffness only has a minor impact on the response of slab and shear wall structures to seismic loadings, the changes of axial stiffness are acceptable.

4.3.1.8 Adjustment of Out-of-Plane Dynamic Properties of R/B Slabs

The development of the Dynamic FE Model requires simplifications of the model geometry in order to produce regular FE mesh and to minimize the size of the model to be suitable for time history frequency domain SSI analyses using ACS SASSI. In order to accurately capture the SSI effects, the R/B footprint dimensions represent the actual configuration of the basemat. The Dynamic R/B Model has the shell elements of the exterior walls placed at the perimeter of the building unlike the Detailed R/B Model where the shear walls are modeled at the centerline of the walls. These differences in modeling the building geometry affect the spans of some of the floor slabs in the Dynamic R/B Model and their local out-of-plane response. The stiffness and mass properties of these flexible slabs are adjusted to mimic the actual mass and dynamic properties of the slab.

The dynamic properties of the slabs at each major floor elevations are obtained by isolating each elevation. Figure 4.3.1.8-1 shows an FE model of the R/B floor slabs that are extracted from the Detailed FE Model. Boundary conditions are established as shown in Figure 4.3.1.8-2 at the upper and lower border of the model to restrain horizontal displacements of the walls and accurately mimic the bending stiffness at the wall/slab interfaces. The horizontal and vertical displacements of the wall are also restrained at slab elevation in order to eliminate the effects of the axial stiffness of the walls on the modal analyses results and to disregard the slab horizontal modes as well. Where the slab is supported by columns, the vertical displacement is constrained.

Modal analysis using ANSYS is performed on the isolated elevations of Detailed FE Model and the dynamic FE model to obtain the dynamic properties. If the frequency of first dominant mode of the slab obtained from the detailed FE Model with full (uncracked concrete) stiffness properties is greater than 70 Hz, the slab is considered rigid. There is no need to adjust the stiffness of the shell elements modeling rigid slabs.

For the flexible slabs with frequencies below 70 Hz, the stiffness is adjusted as needed by tuning the modulus of elasticity of the slab shell elements in the Dynamic FE Model to match the frequency obtained from the Detailed FE model. The matching criterion is the difference in the first dominant frequency of vibration of the slab obtained from the modal analyses of the two FE models is being measured within 5%.

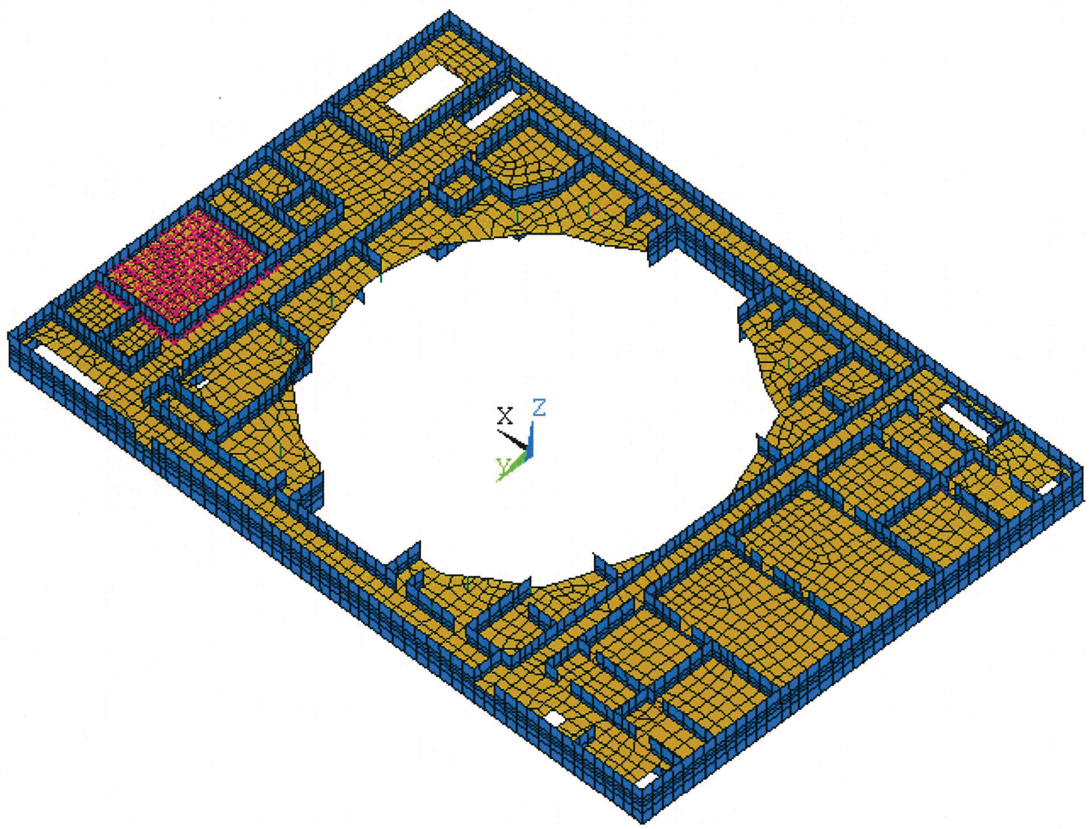


Figure 4.3.1.8-1 Extracted Detailed FE Model of Floor Slabs

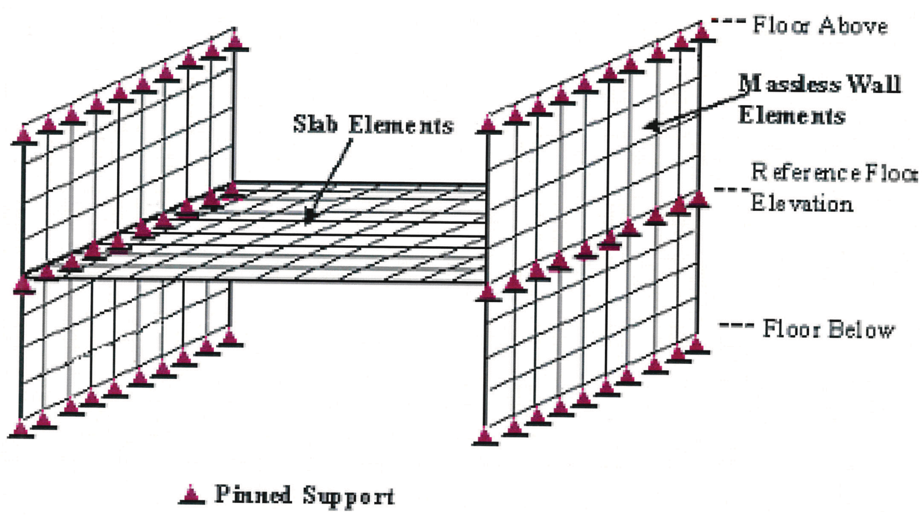


Figure 4.3.1.8--2 Floor Slab Model Boundary Conditions

4.3.1.9 Adjustment of Dynamic Properties of SC Modules

Simplifications in the geometry of the otherwise complex structure are introduced in the dynamic CIS model in order to produce a coarser FE mesh and to minimize the size of the model in order to be suitable for SSI analyses using ACS SASSI. Stiffness and mass properties of elements modeling some of the SC walls of the CIS are adjusted in order to calibrate the dynamic response of the simplified dynamic FE model to match the actual response of the CIS as represented in the Detailed FE Model. The adjustments of the unit density and the elastic moduli of the shell elements are introduced to capture the actual distribution of mass and stiffness. The calibration of the model properties is performed based on the results of a 1-g static analysis, and then verified using the results of modal and time history analyses.

4.3.2 Validation of Dynamic FE Model

The development of the R/B Complex Dynamic FE Model is based on a number of adjustments in geometry and load configurations in order to minimize the size of the model and make it suitable for SSI analysis. The validation ensures that these modeling assumptions and simplifications do not affect the ability of the Dynamic FE Model to accurately represent the dynamic response of the R/B complex structures as mandated by SRP Sections 3.7.2.II.1 and 3.7.2.II.3 and by ISG-01, Section 3.1.

In order to reduce the computational effort and speed up the validation, the R/B Complex Dynamic FE Model is divided into three parts: R/B-FH/A (including common basemat), CIS coupled with RCL, and PCCV. A series of fixed-base analyses are performed on the three separated models using ANSYS and the results are compared to the ones obtained from corresponding analyses on the Detailed FE models of the R/B, CIS and PCCV structures. The stiffness and mass attributes that are assigned to the Dynamic FE Model and Detailed FE Models are consistent.

The validation of the R/B and PCCV dynamic FE models is performed on the models with full (uncracked concrete) stiffness. In order to ensure that the model with reduced (cracked concrete) stiffness properties can meet the requirement of ISG-01 Section 3.1 (Reference 27) to accurately capture responses with frequencies up to 50 Hz, the validation of the model with full stiffness properties compares dynamic responses up to frequencies of at least 70 Hz.

Due to the complexity of the CIS, different stiffness and damping values are assigned to different types of structural components for the two bounding stiffness and damping conditions. As described in Appendix A, the reduction of stiffness applied to the CIS to account for cracking of the concrete of SC modules, reinforced concrete slabs and massive concrete portions is non-uniform. Therefore, unlike the other US-APWR standard plant Category I structures, two sets of validation analyses are performed for the CIS to ensure the adequacy of the CIS dynamic FE model with full (uncracked concrete) stiffness and reduced (cracked concrete) stiffness.

The FE analysis computer program ANSYS (Reference 12) serves as the platform for three different types of analyses performed to validate the dynamic properties of the R/B Complex Dynamic FE Model:

1. 1g Static Analysis

2 Modal Analysis

3. Modal Superposition Time History Analysis

4.3.3 Conversion of the R/B Complex Dynamic FE Model from ANSYS to ACS SASSI Format

The translator built into the ACS SASSI code serves as the platform for the translation of the Dynamic FE Model from ANSYS to ACS SASSI house module format. Prior to the translation, the nodes of the model are renumbered according to the guidelines provided in the ACS SASSI manual (Reference 2) in order to minimize the bandwidth of the complex stiffness matrix and thus, reduce the computational effort.

The translation of the model from ANSYS into ACS SASSI format is validated by performing validation SSI analyses of the translated ACS SASSI Dynamic FE Model in which fixed-base conditions are simulated by placing the model on a very rigid elastic half-space. The results of the validation of the SSI analyses for Amplification Transfer Functions (ATFs) and 5% damping Acceleration Response Spectra (ARS) at selected locations are compared with the results of the ANSYS fixed base dynamic analyses. The peaks in the ATF's indicate that the dominant natural frequencies of the structure are compared to the results of the fixed base modal analyses. The 5% damping ARS results are compared with the corresponding 5% damping ARS results obtained from the ANSYS mode superposition time history analyses.

The following guidelines are used to confirm the accuracy of the translation through comparison of results obtained from the validation of SSI and ANSYS analyses.

- The frequency ATF's peak indicating the first dominant natural frequency of the structure shall be within 5% of the first dominant frequency extracted from the ANSYS modal analyses of the dynamic FE model.
- The peaks indicating the subsequent dominant frequencies of the structure shall be within 10% of the results calculated by the ANSYS fixed base modal analyses of the dynamic FE model.
- The frequencies where the significant peaks occur in the ARS calculated from the ACS SASSI SSI validation analyses shall be within 10% of those obtained from the ANSYS time history analyses of the dynamic FE model.
- The ARS results obtained for the ACS SASSI validation analyses shall be within 10% of those obtained from the time history analyses of the dynamic FE model.

The comparison of the results from the ANSYS fixed base analyses and ACS SASSI validation analyses can indicate larger deviation than those specified in the guidelines above.
The following are some sources of deviations that can be observed in the ARS results obtained from ANSYS modal superposition and ACS SASSI frequency domain time history analyses that are investigated on the case by case basis:

- The "rigid" soil foundation for the SSI model is not "infinitely rigid". The relative flexibility of the subgrade may produce some minor SSI effects differences in the higher frequency range. These SSI effects are manifested by some small deviations from 1.00 of the acceleration transfer functions calculated for the response at the foundation-stiff subgrade interface.

- ACS SASSI uses a mixed mass matrix (average lumped and consistent masses) to represent the mass of the structure. The mode superposition analyses in ANSYS are performed using either a lumped or consistent mass matrix.

- The ANSYS modal superposition time history analysis uses analysis time integration scheme to solve the decoupled dynamic response equations. ACS SASSI frequency domain solution is based on the convolution of the complex Fourier spectra of the input motion and the complex acceleration transfer functions computed for a limited number of selected frequencies, not at all Fourier points.

- ANSYS uses constant value modal damping ratio to account for the dissipation of energy due to structural damping. ACS SASSI uses the complex damping approach in which the dissipation of energy due to structural damping is accounted for in the complex stiffness matrix of the system that is assembled from the complex stiffness matrices of the finite elements. The ACS SASSI analyses allow different structural damping to be used to account for the dissipation of energy in different structural components.

4.4 ACS SASSI Dynamic Finite Element Model of PS/B

Similar to the R/B complex model, the dynamic FE model of the PS/B is first developed using ANSYS (Reference 12) before being translated into the format of ACS SASSI (Reference 2) by using the built-in converter in ACS SASSI. The node numbering is adjusted following the guidelines of the ACS SASSI manual in order to optimize the computational effort.

Static and dynamic analyses using ANSYS solvers are then performed on the Dynamic FE Model by establishing fixed boundary condition at the base of the structure. An identical set of fixed base analyses are also performed on a Detailed FE model of the PS/B to obtain a validation basis. The PS/B Detailed FE Model is also developed using ANSYS (Reference 12) but with a finer average mesh size of 1’ to 4’. Figure 4.4.1.1-1 shows the overview of the PS/B detailed FE model. Structural details such as openings in walls and slabs are included in the model, with the exception of a few minor details and openings. Results obtained from the two set of analyses are than compared to demonstrate the ability of the less refined Dynamic FE Model to adequately capture the dynamic behavior of the corresponding Detailed FE Model.

The translator built into the ACS SASSI code serves as the platform for the translation of the Dynamic FE Model from ANSYS to ACS SASSI house module format. In order to validate the translation of the model, validation of the SSI analyses are performed on the ACS SASSI Dynamic FE Model resting on a very rigid elastic half-space. The dynamic properties of the model revealed by the resulting ATFs and 5% damping Acceleration Response Spectra (ARS) at selected locations are compared to the fixed base dynamic properties and responses obtained from the Detailed and Dynamic ANSYS analyses to ensure the translation is completed correctly.

4.4.1 Development of the PS/B Dynamic FE Model

4.4.1.1 Finite Element Modeling

The PS/B Dynamic FE model is generated only for the West PS/B of the US-APWR standard plant. Since the East and West PS/B structures are nearly identical structurally, this model is used to represent both structures for seismic design. The two PS/B structures do have different roof configurations such as openings at the roof level for air inlets and supply and exhaust systems. Theses differences will have some impact on the vertical ISRS at the roof level. However, the openings in both PS/Bs are for penetration of duct only and the interaction between the roof and the duct will be minimal. Therefore, the difference in the ISRS at the roof level will not impact the design and safety of the HVAC systems or the supply and exhaust systems. In addition, an intermediate partial floor spans between column lines 4P and 5P, between column lines AP and CP in the west PS/B only. While this intermediate floor would affect the out-of-plane behavior of the shear walls to which it is connected, it is not anticipated to have a significant impact on the in-plane behavior. The impact will be addressed in the stress analysis and detailed design of the PS/B structures.

The PS/B Dynamic FE model includes shell elements representing walls and slabs, beam elements representing beams and columns, and solid elements representing the basemat, with a mesh varying in size from 4’ to 8’. To reduce the size of the Dynamic FE model and to permit a coarser mesh size, minor structural details and minor wall/slab openings are not included in the model. The use of finite elements provides an accurate representation of the dynamic properties of the structures and the foundation that enables an accurate modeling of dynamic interaction with the flexible foundation and the surrounding soil. The ANSYS finite element types used in the model are compatible with the ACS SASSI built in converter. Table 4.4.1-1 provides the different element types that are used in the PS/B Dynamic FE Model. Figure 4.4.1.1-2 shows overview of the PS/B Dynamic FE model.

The development of the PS/B dynamic model also allows that the connection between two different FE types is such that an adequate transfer of forces and/or moments from one structural component to the other is enabled. The nodes of the ACS SASSI solid elements have only three translational degrees of freedom and can therefore not transfer the moments from shell or beam elements. In order to enable the transfer of bending moments from the walls modeled by shell elements to the basemat modeled by solid elements, the shell elements are extended into the solid elements so that the moments can be transferred to 2 layers of nodes belonging to the solid elements as shown in Figure 4.3.1.1-5. Shell elements providing the connection have identical stiffness properties as the shells modeling the walls but are assigned a zero mass

Table 4.4.1-1 Summary of Element Types

Structure	Structural Members	Finite Elements		
		Type	ANSYS	ACS SASSI
Basemat	--	Brick Element	Solid45	8-node Solid
Power Source Building (PS/B)	Walls	Shell Element	Shell63	4-node Shell
	Floor and Roof Slabs	Shell element	Shell63	4-node Shell
	Columns and Beams	Beam Element	Beam4	3-node Beam

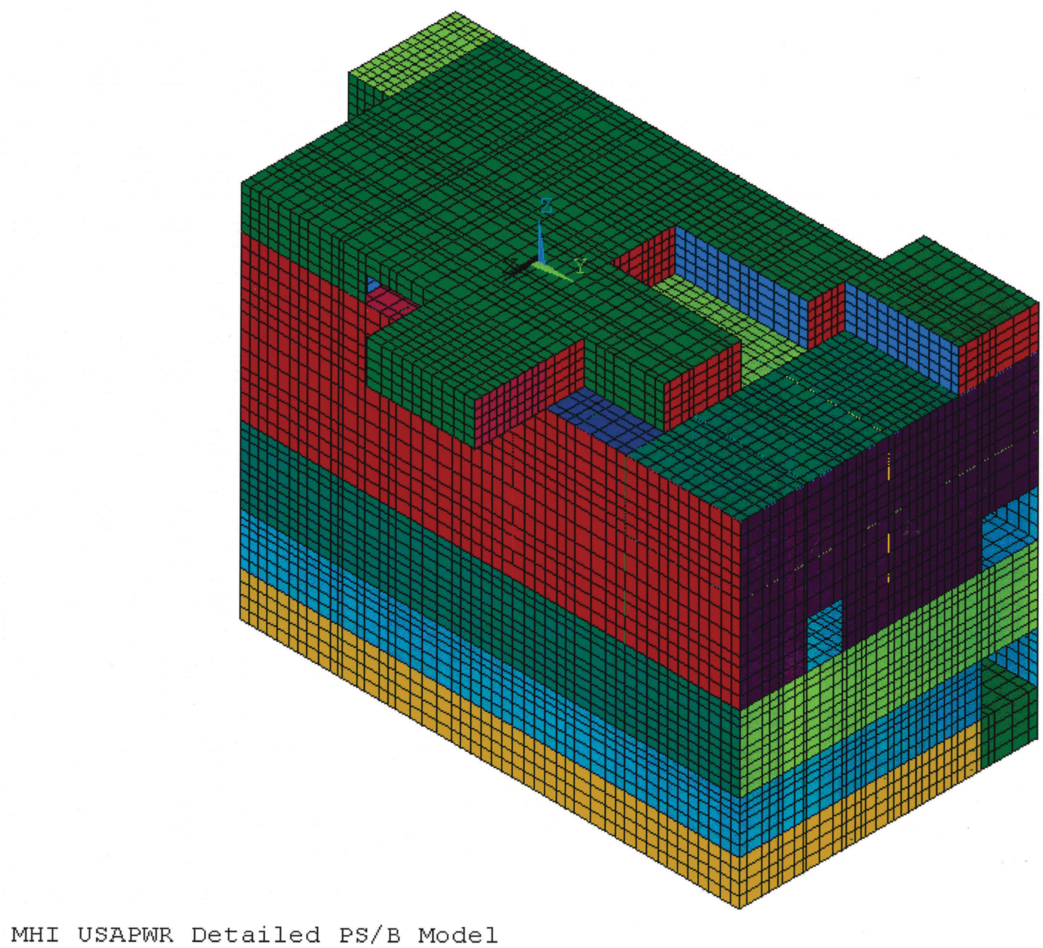
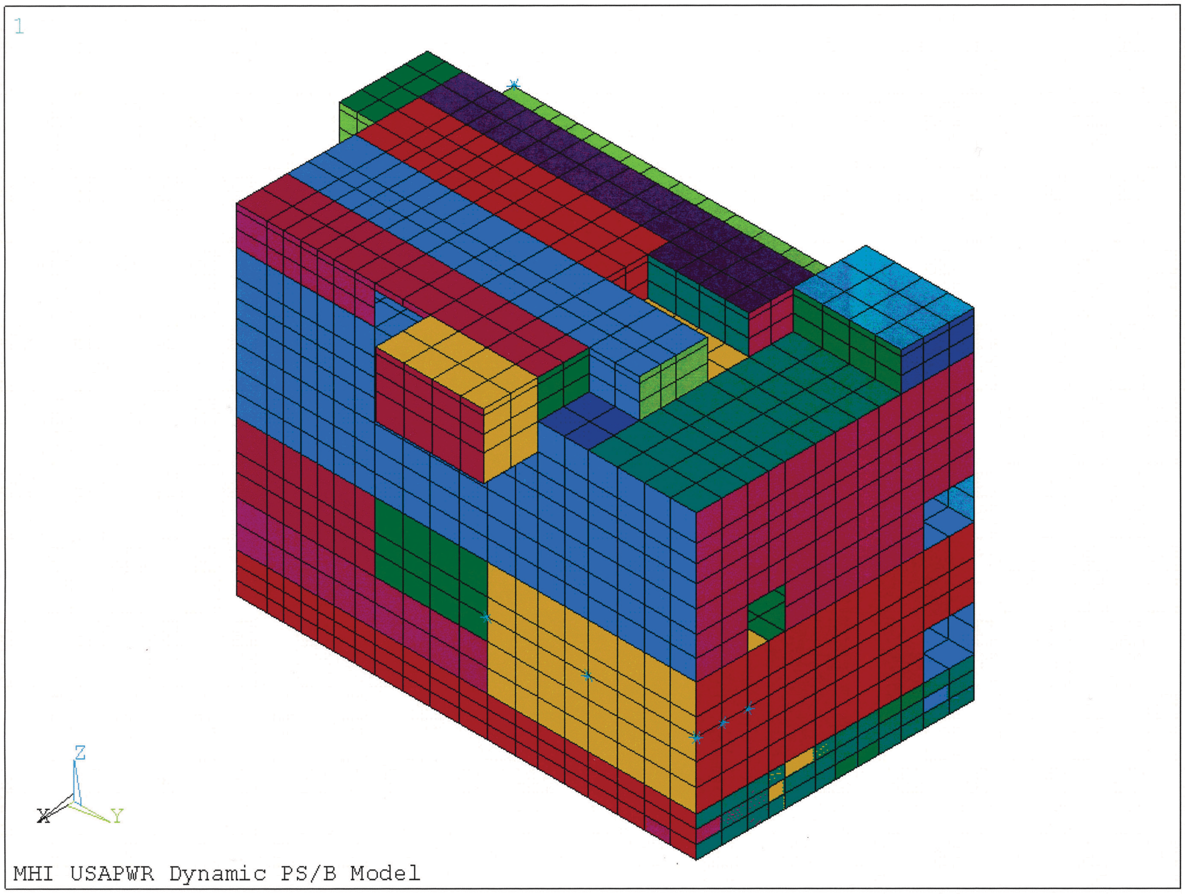


Figure 4.4.1.1-1 Overview of the PS/B Detailed FE Model



MHI USAPWR Detailed PS/B Model

Figure 4.4.1.1-2 Overview of the PS/B Dynamic FE Model

4.4.1.2 Discretization Considerations: Mesh Size

Using the methodology described in Section 4.3.1.2, the element size of the PS/B Dynamic FE Model is selected such that the structural response is not significantly affected by further refinement of the element size. The model mesh size also ensures that the discretized structure with full (uncracked concrete) stiffness properties is able to capture the local responses and responses of significant modes of vibration with frequencies equal to or less than 70 Hz. As mentioned before, this will ensure that the model with reduced stiffness is capable of capture the response of significant modes with frequencies up to 50 Hz.

For consideration of wave passage in the structure only, in order to transmit shear waves with frequencies up to 70 Hz, the maximum element size shall not be greater than one-fifth of the wave length to be transmitted (Reference 12). As determined in Section 4.3.1.2 for a concrete strength of 4,000 psi with a Poisson’s ratio of 0.17 and a unit density of 0.15 kcf, the maximum structural element determined by wave passage of shear wave with frequencies up to 70 Hz in the structure alone is 20 ft. The PS/B maximum element size of the PS/B Dynamic FE model is about 8 ft and satisfies this requirement.

The capability of the PS/B basemat for wave passage from the subgrade to the structure is considered in conjunction with the stiffness properties of the subgrades used in the site-independent SSI analysis; in particular, the strain-compatible shear wave velocity (Vs) of the soil layer directly interacting with the structure, i.e. the top soil layer for analysis of surface mounted structure. Per Section 4.3.1.2, for a selected average mesh size of 6 ft at the basemat interface, the maximum wave passage frequencies at the PS/B soil-structure interface are as follows:

Table 4.4.1-2 Wave Passage Frequencies for Basemat FE Mesh

Soil Case	Soil Vs (fps)	d_{FE} (ft)	$f_{FE\ max}$ (Hz)
270-500	1242	6	41.4
270-200	1302		43.4
560-500	1698		56.6
560-200	1552		51.7
560-100	1588		52.9
900-200	3237		107.9
900-100	3403		113.4
2032-100	7126		237.5

Table 4.4.1-2 shows that for the SSI analyses with subgrade profiles of 560 series and harder, the PS/B dynamic FE model is refined enough to transmit waves with frequencies up to 50 Hz through the soil-foundation interface. For the profiles of 270-200 and 270-500, the element size of 6 ft will allow transmitting wave with frequencies up to 41 to 43 Hz, respectively. It is expected that, in high frequency range, the response of the soil-structure system will be controlled by the harder soils. Therefore, the SSI analyses of all eight generic soil profiles provide adequate envelope responses up to 50 Hz as required by ISG-01.

4.4.1.3 Modeling of Stiffness and Damping

As mentioned in Section 4.3.1.3, two different levels of stiffness and damping are assigned to the PS/B model in order to address the effect of concrete cracking on the seismic response. They are presented in Table 4.4.1-3 and can be summarized as follows:

- A full stiffness level representing the case when the stresses in the PS/B reinforced concrete structure are of low intensity such that the concrete remains essentially uncracked ($E_c = 57\sqrt{f_c'} = 57 \cdot \sqrt{4000} = 3605\,ksi = 519120\,\text{ksf}$ for f'_c = 4,000 psi). An OBE damping value of 4% is assigned to the PS/B model in this case to account for the lower energy dissipation levels in the structure.

- A reduced stiffness level representing the case when the reinforced concrete structure is subjected to higher stress levels resulting in cracking of concrete and a 50% reduction of its stiffness. An SSE damping value of 7% is assigned to the PS/B model in this case to account for the higher energy dissipation levels in the structure.

The implementation of stiffness reduction in the PS/B Dynamic FE Model follows methodology specified in Section 4.3.1.7 of this report.

Responses obtained from the two sets of analyses are enveloped to develop design SSE loads and In-Structure Response Spectra (ISRS) while the ones obtained from analyses on the model with reduced stiffness are enveloped to develop SSE loads. The results are provided for standard seismic design of the US-APWR plant.

Table 4.4.1-3 Assigned Stiffness and Damping Properties

Model Stiffness Level	Stiffness	Damping
Full (Uncracked) Stiffness	100%	4%
Reduced (Cracked) Stiffness	50%	7%

4.4.1.4 Modeling of Mass

The equivalent dynamic mass included in the PS/B Dynamic FE Model includes contributions from the structural mass in addition to that of all applicable permanent equipment, 50 psf floor/wall miscellaneous dead loads representing minor equipment, piping, electrical raceways, etc., 25 percent of floor design live loads, and 25 percent of roof design live load and 75% snow loads, whichever is greater.

As a general rule, the structural mass is assigned as density to the finite elements based on the material properties of the components of the structures. The density is then increased to account for all other applicable loads. Each load is applied over a particular area and the density of the elements in that area is increased such that the total increase in dynamic mass matches the applied load magnitude. Grating floor loads are included as nodal masses in the model.

The density and thickness of the elements are further modified to account for stiffness reductions due to openings and cracking, but it is done is such a way as to not change the mass of the elements.

4.4.1.5 Adjustment of Stiffness and Mass Properties

The elastic modulus and thickness of the PS/B shell elements are adjusted using the method described in Section 4.3.1.5 to accurately model the reduction of shear stiffness of walls due to openings.

4.4.1.6 Implementation of Stiffness Reduction in the Dynamic FE Model

The implementation of the stiffness reduction in the PS/B dynamic FE model is performed as described in Section 4.3.1.6.

4.4.2 Out-of-Plane Dynamic Properties of PS/B Slabs

The development of the Dynamic FE Model requires simplifications of the model geometry in order to produce a regular FE mesh and to minimize the size of the model to be suitable for SSI analyses using ACS SASSI. In order to accurately capture the SSI effects, the PS/B footprint dimensions represent the actual configuration of the basemat. The PS/B Dynamic FE Model has the shell elements of the exterior walls placed at the perimeter of the building, unlike the PS/B Detailed FE Model where the shear walls are modeled at the centerline of the walls. These differences in modeling the structure geometry may affect the spans of some of the floor slabs in the PS/B Dynamic FE Model and their local out-of-plane response. The stiffness and mass properties of these flexible slabs are checked to verify if they mimic the actual mass and dynamic properties of the slab obtained from the Detailed model.

The dynamic properties of the slabs at each major floor elevations are obtained by isolating each elevation. Figure 4.4.2-1 shows a typical FE model of the PS/B isolated floor slabs that are extracted from the Detailed FE Model. Boundary conditions are established as shown in Figure 4.4.2-2 at the upper and lower border of the model to restrain horizontal displacements of the walls and accurately mimic the bending stiffness at the wall/slab interfaces. The horizontal and vertical displacements of the slab are also restrained at slab elevation in order to eliminate the effects of the axial stiffness of the walls on the modal analyses results and to disregard the slab horizontal modes as well. Where the slab is supported by columns, the vertical displacement is constrained.

Modal analysis using ANSYS is performed on the isolated elevations of Detailed FE Model and Dynamic FE model to obtain the dynamic properties. If the frequency of the first dominant mode of the slab obtained from Detailed FE Model with full (uncracked concrete) stiffness properties is greater than 70 Hz, the slab is considered rigid. There is no need to adjust the stiffness of the shell elements modeling rigid slabs.

For the flexible slabs with frequency less than 70 Hz, the stiffness of flexible slabs is adjusted as needed by tuning the modulus of elasticity of the slab shell elements in the Dynamic FE Model to match the frequency obtained from the Detailed FE model. The matching criterion is that the difference in the first dominant frequency of vibration of the slab obtained from the modal analyses of the two FE models is within 5%.

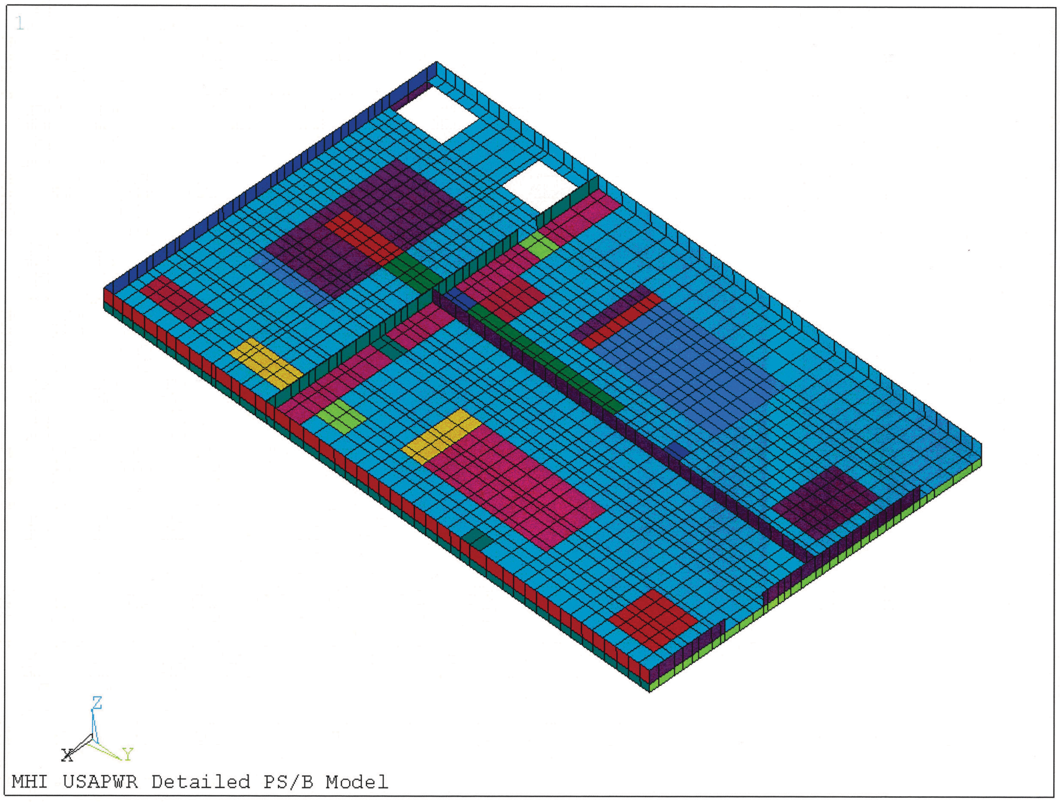


Figure 4.4.2-1 Extracted Detailed FE Model of Floor Slabs

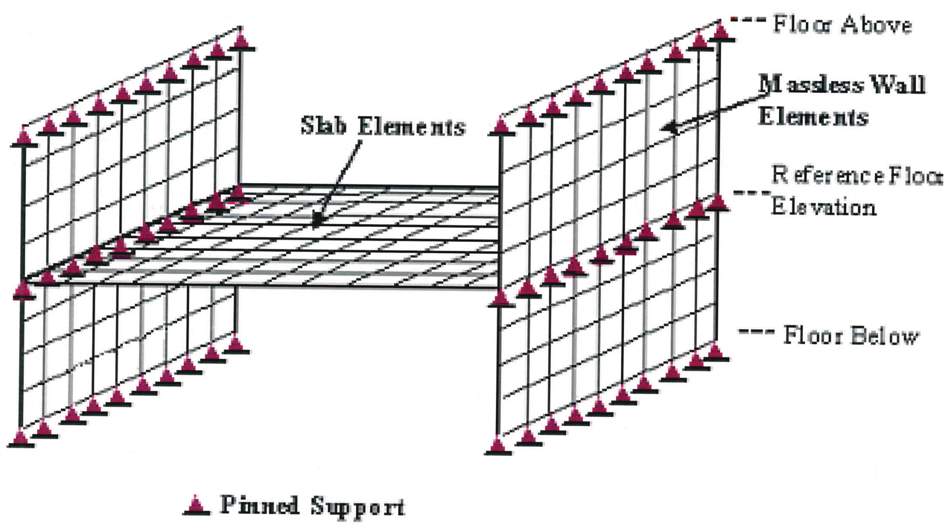


Figure 4.4.2-2 Floor Slab Model Boundary Conditions

4.4.3 Validation of PS/B Dynamic FE Model

The development of the PS/B Dynamic FE Model is based on a number of adjustments in geometry and load configurations in order to minimize the size of the model and make it suitable for SSI analysis. The validation ensures that these modeling assumptions and simplifications do not affect the ability of the Dynamic FE Model to accurately represent the dynamic response of the PS/B structure as mandated by SRP Sections 3.7.2.II.1 and 3.7.2.II.3 (Reference 4) and of ISG-01 Section 3.1 (Reference 27).

A series of fixed-base analyses are performed on both the PS/B Dynamic FE and Detailed FE Models using ANSYS and the results are compared. The stiffness and mass attributes assigned to the PS/B Dynamic FE model with full stiffness and reduced stiffness are consistent. Therefore, the validation of the PS/B Dynamic FE Model is performed with full (uncracked concrete) stiffness. In order to ensure that the model with reduced (cracked concrete) stiffness properties can meet the requirement of ISG-01 Section 3.1 (Reference 27) to accurately capture responses with frequencies up to 50 Hz, the validation of the Dynamic model with full stiffness properties compares dynamic responses up to frequencies of at least 70 Hz.

The three different types of analyses performed to validate the dynamic properties of PS/B Dynamic FE model are the same as those used in the validation of the R/B Complex Dynamic FE Model. They consist of a:

1. 1g Static Analysis
2. Modal Analysis
3. Modal Superposition Time History Analysis

4.4.4 Conversion of the PS/B Dynamic FE Model from ANSYS to ACS SASSI Format

The PS/B dynamic FE model is translated into the ACS SASSI Format and the translation is validated as described in Section 4.3.3. ATF's at selected locations are checked to compare the resonant frequencies revealed by ANSYS modal analyses and ACS SASSI analyses. 5% damped Acceleration Response Spectra (ARS) are also compared. Same acceptance criteria as described in 4.3.3 are applied for PS/B dynamic FE model validation.

4.5 Consideration of Concrete Cracking in Dynamic Analyses

In order to capture the variations of dynamic properties of US-APWR standard plant Category I structures due to concrete cracking, the site-independent SSI analyses consider two levels of stiffness and damping properties:

1) full (uncracked concrete) stiffness and lower OBE material damping; and
2) reduced (cracked concrete) stiffness and higher SSE material damping

The bounding case of a full stiffness level represents the case when the stresses in the reinforced concrete, prestressed concrete and steel-concrete modular structures are of low intensity such that the concrete remains essentially uncracked. The OBE Damping values specified in Table 3.7.3-1(a) of the US-APWR DCD (Reference 28) are assigned to the model with full (uncracked) stiffness to account for the lower dissipation of energy in the structures when subjected to low stress levels. A reduced stiffness level considers the case when the structures are subjected to higher stress levels that result in cracking of the concrete. The SSE damping values specified in Table 3.7.3-1(b) of the US-APWR DCD are assigned to the model with reduced (cracked concrete) stiffness to account for the higher dissipation of energy in the structures when subjected to higher stress levels.

This section describes the approach used to include the effect of the concrete cracking on the stiffness and damping properties in the dynamic structural models of PCCV, CIS, R/B and PS/B. An explanation of the methodology implemented to address the effect of concrete cracking in the development of seismic design basis is also provided together with a matrix of required seismic response analyses required of the R/B Complex and PS/B models with different stiffness and damping levels.

4.5.1 Effects of Concrete Cracking on Reinforced Concrete Shear Wall Structures

In accordance with ASCE 4-98 (Reference 13), Section 3.1.2, and ASCE/SEI 43-05 (Reference 14), Section 3.1.2, traditional reinforced concrete members and elements are to be modeled as either cracked or uncracked sections, depending on their stress level due to the most critical load combinations that include seismic design loads. For the uncracked sections/elements, the stiffness is directly obtained from the concrete linear elastic properties and the section or element geometric dimensions. For the cracked concrete, a reduction to the uncracked concrete stiffness is taken into account. The reduction factors shown in Table 3-1 of ASCE/SEI 43-05 are used in linear elastic analysis to address the effects of concrete cracking on the seismic response of the US-APWR seismic Category I structures.

The design of the reinforced concrete shear wall structures is based on the ultimate capacity of the reinforced concrete sections. Therefore, the design of reinforced concrete members addresses code stress limits corresponding to reduced cracked concrete stiffness properties and higher SSE material damping levels as discussed in Section 1.2 of RG 1.61 (Reference 31). However, there is a possibility that the response of the structure under lower stress levels at certain frequency ranges will be higher than the response corresponding to the higher stress state under cracked conditions. In order to ensure that the structural integrity and functionality of the components and the equipment is not compromised under all possible seismic loading conditions, the development of in-structure response spectra (ISRS) has to also consider the responses of the reinforced concrete structure with full (uncracked concrete) stiffness properties and lower OBE damping levels.

The seismic response analyses of reinforced concrete shear wall type of structures consider two stiffness and damping in order to address the possible variations in the extent of concrete cracking:

1. Full stiffness representing low stress levels corresponding to uncracked concrete properties where the stiffness of the members are represent by gross cross sectional properties.

2. Reduced stiffness representing higher stress levels resulting in cracking of the concrete where the stiffness of the members are reduced in accordance with guidelines provided in Table 3-1 of ASCE/SEI 43-05. The stiffness of the composite

members made of reinforced concrete and steel beams, such as the walls and the roof of Fuel Handling Area (FH/A) are also reduced accordingly to represent 50% reduction in stiffness in the reinforced concrete part of the composite sections.

The structural material damping values used for these two different stress levels are OBE damping of 4% for the full (uncracked concrete) stiffness condition and SSE damping of 7% for the reduced (cracked concrete) stiffness condition.

4.5.2 Effects of Concrete Cracking on the CIS

The US-APWR Containment Internal Structure (CIS) is comprised of different types of structural members including composite steel-concrete (SC) walls, massive reinforced concrete sections, and reinforced concrete slabs that serve different functions such as supporting the NSSS equipment, providing primary or secondary radiological shielding and containment of the refueling water. The members can experience varying levels of stress resulting in different patterns of concrete cracking under the different loading conditions that can exist in the reactor containment. Depending on the reactor operating conditions, the CIS members can be subjected to design seismic loads in combination with normal operating or accidental thermal loads resulting in different levels of stiffness reduction due to concrete cracking. Appendix A describes the methodology to address the effect of concrete cracking on CIS dynamic properties and provides for the different CIS members that are classified in six categories, two stiffness levels corresponding to:

1. Normal operating conditions characterized with insignificant reduction of stiffness and concrete cracking; and

2. Accidental conditions characterized with significant reduction of stiffness due to cracking of the concrete under high accidental thermal loads.

Different material damping values are assigned to the different members depending on the level of stresses and corresponding concrete cracking. For the SC walls, OBE damping of 4% is used for normal operating loading conditions, and SSE damping of 5% for accidental loading conditions.

Similar to the CIS, the level of stresses in the PCCV during a seismic design event depend on the reactor containment operating conditions. The design of the PCCV structure is based on the premise that during normal operating conditions the pre-stress concrete cross sections remain in compression. During the normal operating conditions, the earthquake design loads can cause only limited cracking having insignificant effect on the overall stiffness of the PCCV. Accordingly, the dissipation of energy due to material damping of the PCCV structure under normal operating conditions is low. The accident loading conditions include high temperatures and pressure loads in the reactor containment that can generate high stresses in the prestressed concrete accompanied with cracking that can result in a reduction of the global stiffness of the PCCV structure and higher dissipation of energy due to the material damping. The stress evaluations provided in Appendix B, indicate that the reduction of the overall stiffness of PCCV structure under seismic design loads in combination with accident loads can be up to 50%.

Two stiffness levels are considered by the seismic response analyses of PCCV:

1. Normal operating conditions corresponding to insignificant concrete cracking and full (uncracked concrete) stiffness of the prestressed concrete structure; and

2. Accident conditions when the high thermal and pressure loads generate high stresses that can result in significant cracking of the prestressed concrete and a 50% reduction of the stiffness.

The structural material damping values used for these two different stiffness and stress levels are OBE damping of 3% for the full (uncracked concrete) stiffness or normal operating conditions and SSE damping of 5% for the reduced (cracked concrete) stiffness or accidental conditions.

4.5.3 Approach to Address Concrete Cracking in Site-Independent SSI Analyses

In order to address the effect of concrete cracking on the standard seismic design basis of US-APWR reinforced concrete structures, two sets of site-independent SSI analyses of PS/B dynamic FE model are performed using structural models representing two bounding stiffness and damping levels:

1) full (uncracked concrete) stiffness;

2) reduced (cracked concrete) stiffness.

Two sets of analyses are also performed on the dynamic FE model of R/B complex using full (uncracked concrete) stiffness and reduced (cracked concrete) stiffness. The dynamic FE model of the R/B complex with full stiffness represents the levels of concrete cracking of the PCCV and the CIS corresponding to normal operating conditions in the reactor containment. In order provide overall bounding responses of the R/B complex corresponding to lower levels of stresses and structural material damping, the models of the CIS and the PCCV with full stiffness are accompanied with the FE model of the R/B reinforced concrete structure having full (uncracked concrete) stiffness. The R/B complex model with reduced stiffness will provide responses of the CIS and PCCV corresponding to accidental conditions. The PCCV and CIS models with reduced stiffness will be accompanied with model of the R/B complex having reduced (cracked concrete) stiffness in order to obtain overall bounding responses of the R/B complex structures representing higher stress and damping levels.

The seismic response analyses of the R/B complex and the PS/B provide results that serve as basis for development of SSE loads for design of structural members, maximum displacements for evaluation of gaps between buildings and in-structure response spectra (ISRS) for design of components and equipment. Responses obtained from the models with two different levels of stiffness and damping are enveloped in order to develop ISRS for design of the seismic category I and II equipment and components. The SSE loads used for the PCCV and the CIS design are also developed based on the responses obtained from the analyses of models with two different level of stiffness in order to ensure that the design uses seismic loads enveloping both normal operating and accident loading conditions.

Responses obtained from models with reduced (cracked concrete) stiffness and SSE damping are used to develop SSE loads for the design of shear walls or reinforced concrete structures since this condition corresponds to the ultimate stress conditions. This approach is consistent with Section 1.2 of RG 1.61. The models with reduced (cracked concrete) stiffness properties will also provide the bounding results for maximum seismic displacements relative to the free field, which are used for evaluation of the gaps between buildings.

Table 4.5.4-1 provides the percent of stiffness reduction and damping values used for the different structural components for the site-independent SSI analyses of US-APWR R/B complex and PS/B. Table 4.5.4-1 also provides a describing how the results of the SSI analyses of models with different stiffness are used to develop the basis for standard seismic design of the different US-APWR buildings.

Table 4.5.4-1 Material Properties of Models used for Seismic Response Analyses

<table>
<tr><th rowspan="2">Stiffness Level</th><th rowspan="2">Model</th><th rowspan="2">Structural Component</th><th rowspan="2">Stiffness</th><th rowspan="2">Damping</th><th colspan="3">Design Basis</th></tr>
<tr><th>SSE Load</th><th>ISRS</th><th>Max. Displ.</th></tr>
<tr><td rowspan="9">Full (Uncracked) Stiffness</td><td rowspan="7">R/B Complex</td><td>SC module (CIS)</td><td>100%</td><td>4%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Pre-stressed (PCCV)</td><td>100%</td><td>3%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Reinforced Concrete (R/B)</td><td>100%</td><td>4%</td><td></td><td>X</td><td>X</td></tr>
<tr><td>Composite (FH/A)</td><td>100%</td><td>4% conc.
3% steel</td><td></td><td>X</td><td>X</td></tr>
<tr><td>Steel</td><td>100%</td><td>3%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>RCL</td><td>100%</td><td>3%</td><td>N/A</td><td>X</td><td>X</td></tr>
<tr><td>massive concrete</td><td>100%</td><td>4%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">PS/B</td><td>Reinforced Concrete</td><td>100%</td><td>4%</td><td></td><td>X</td><td>X</td></tr>
<tr><td>Steel</td><td>100%</td><td>3%</td><td></td><td>X</td><td>X</td></tr>
<tr><td rowspan="9">Reduced (Cracked) Stiffness</td><td rowspan="7">R/B Complex</td><td>SC module (CIS)</td><td colspan="2">50%
5%See Appendix A</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Pre-stressed (PCCV)</td><td>50%</td><td>5%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Reinforced Concrete (R/B)</td><td>50%</td><td>7%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Composite (FH/A)</td><td>50% concrete</td><td>7% conc.
4% steel</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Steel</td><td>100%</td><td>4%</td><td>X</td><td>N/A</td><td>N/A</td></tr>
<tr><td>RCL</td><td>100%</td><td>3%</td><td>N/A</td><td>X</td><td>X</td></tr>
<tr><td>Massive concrete</td><td>100%</td><td>4%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">PS/B</td><td>Reinforced Concrete</td><td>50%</td><td>7%</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Steel</td><td>100%</td><td>4%</td><td>X</td><td>N/A</td><td>N/A</td></tr>
</table>

5 RESULTS AND CONCLUSIONS

5.1 CSDRS Compatible Ground Motion Time Histories

One set of three statistically independent components of a modified seed recorded time history motion is generated for use as the input seismic motion to the earthquake response analysis of the US-APWR standard plant including the R/B, PCCV, CIS, and PS/Bs. The three individual time history orthogonal direction components represent the CSDRS earthquake ground motion, labeled in this report as two horizontal (“H1” and “H2”) and one vertical (“V”). The artificial time history motion plots for the ground accelerations, velocity, and displacements in three orthogonal directions (“H1,” “H2,” and “V”) are shown in Figures 5.1-1, 5.1-2, and 5.1-3, respectively. The time history motion plots of the ground acceleration, velocity, and displacement are shown together to demonstrate their non-stationary process.

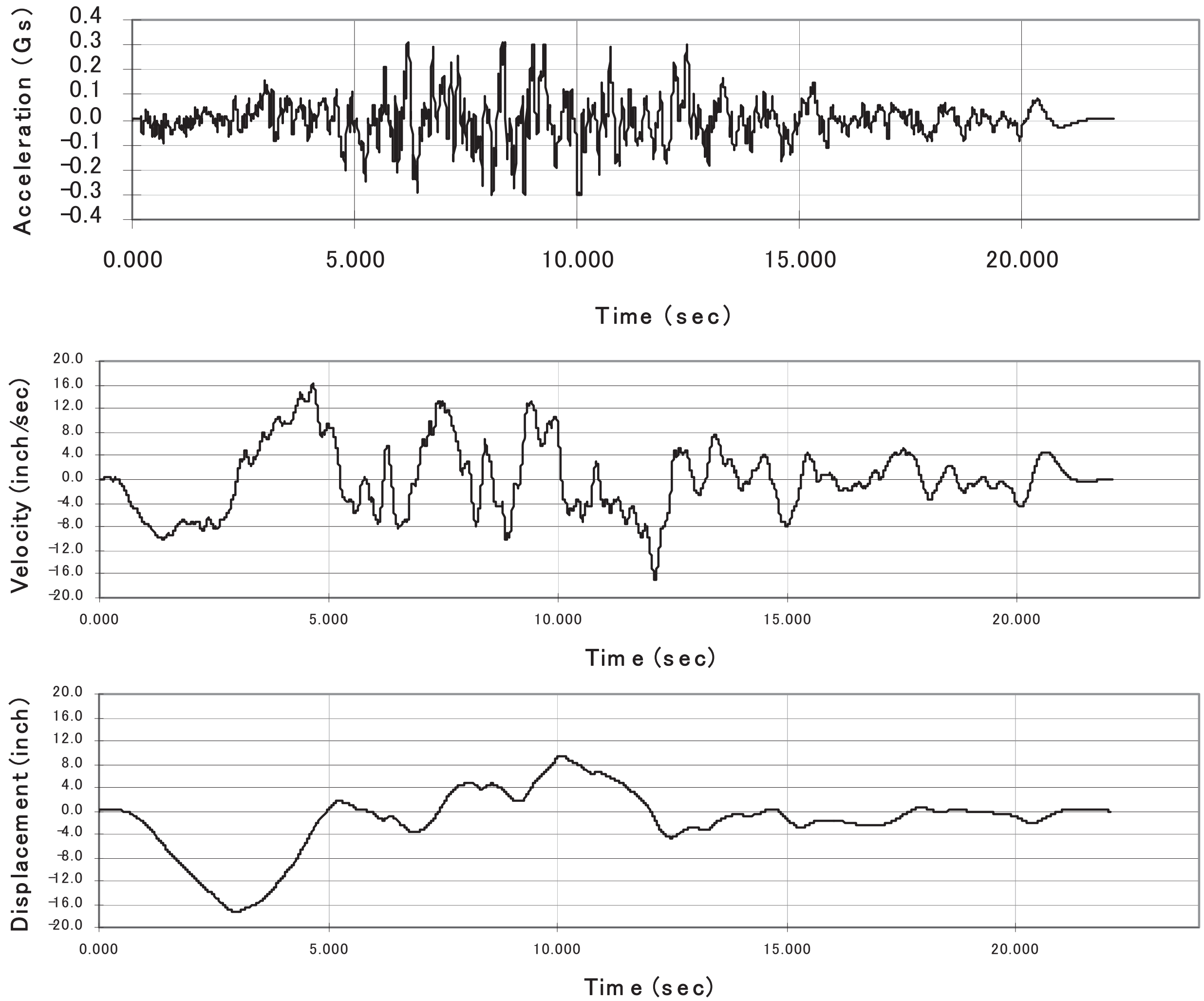


Figure 5.1-1 Acceleration, Velocity, and Displacement Time History for Component H1 (180)

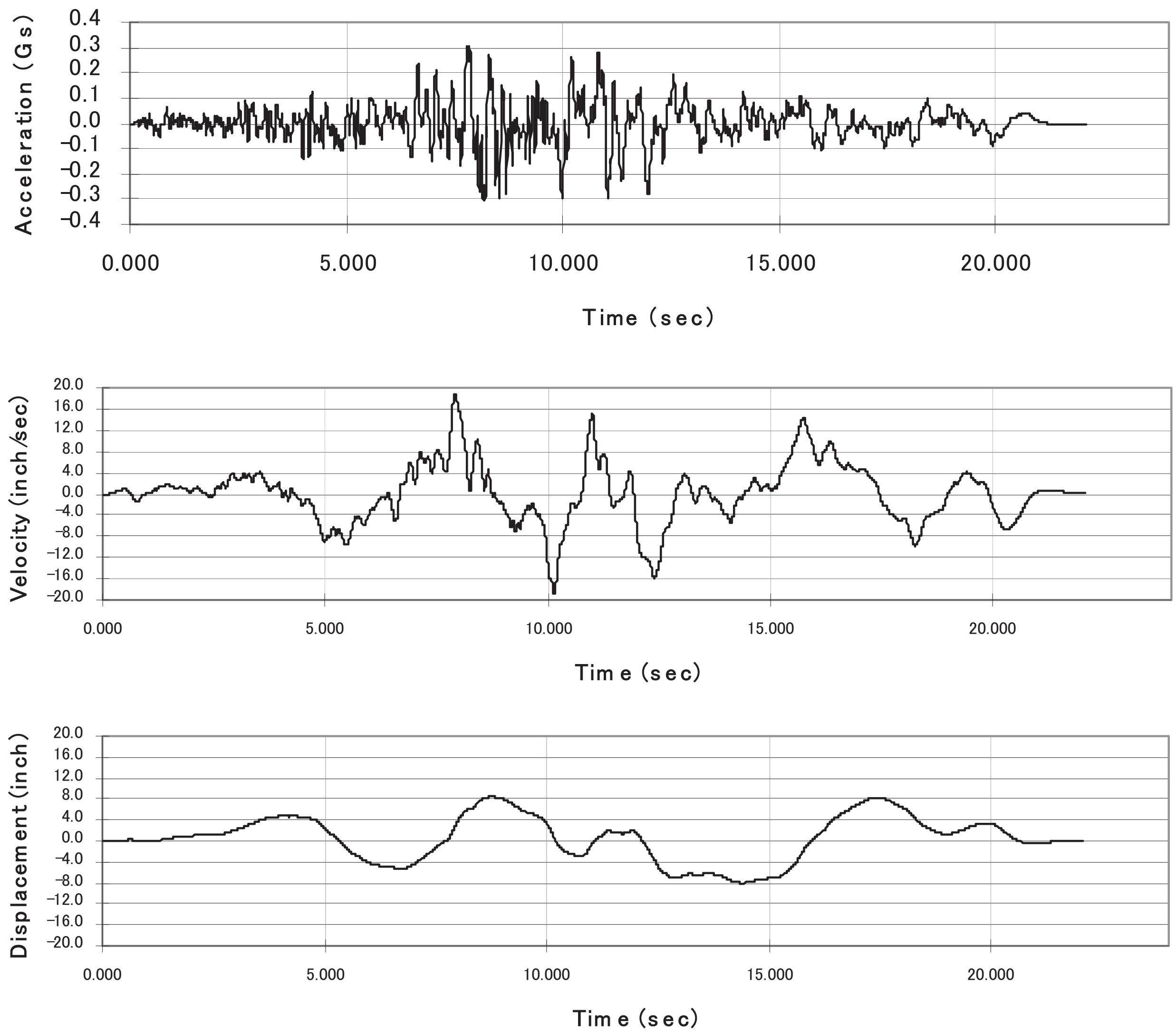


Figure 5.1-2 Acceleration, Velocity and Displacement Time History for Component H2 (090)

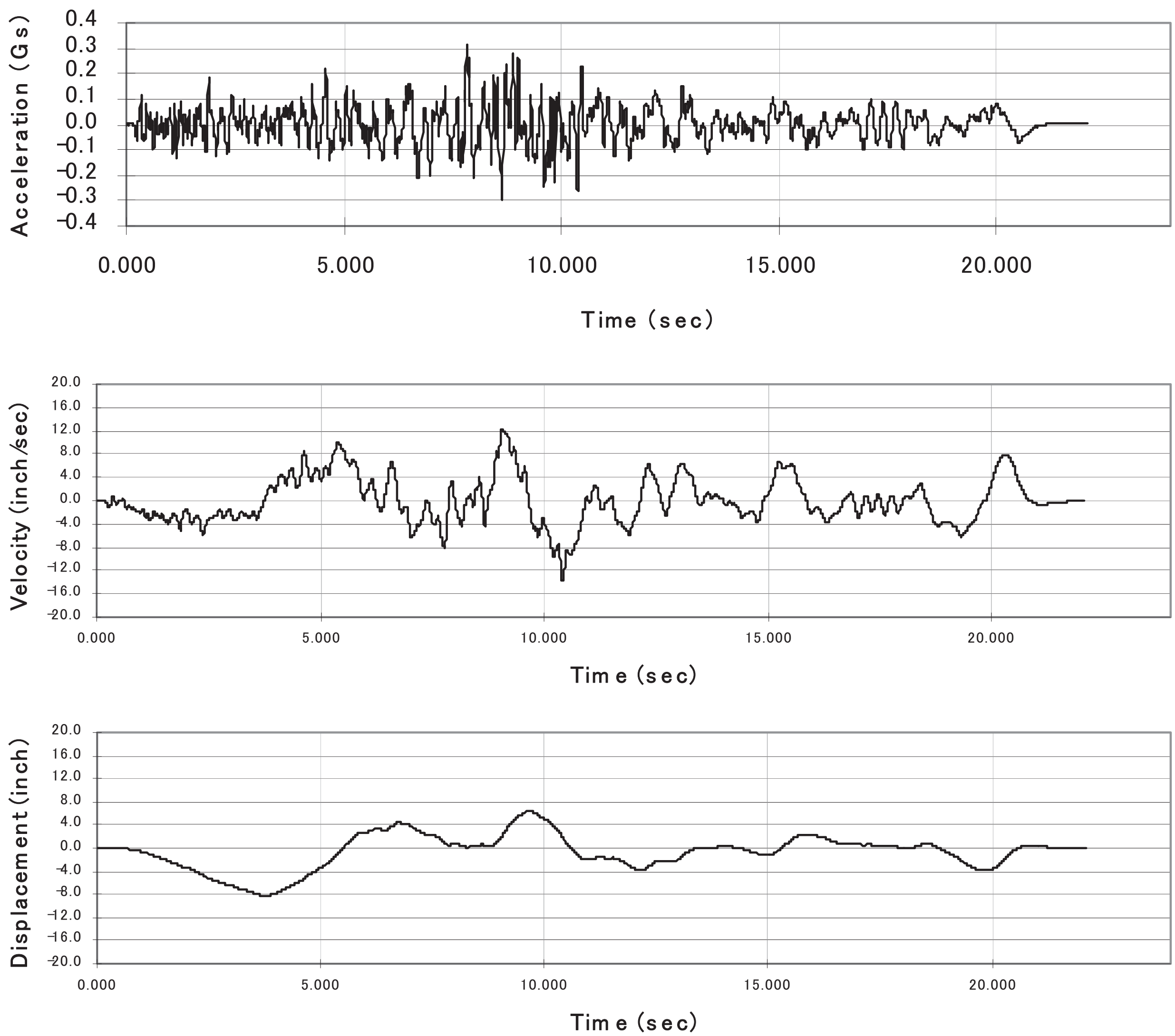


Figure 5.1-3 Acceleration, Velocity and Displacement Time History for Component V (UP)

Figures 5.1-4, 5.1-5 and 5.1-6 show the ARS of the US-APWR artificial time histories with 5% damping for the three orthogonal directions H1, H2, and V, respectively. The plots of the CSDRS are superimposed on the figures to illustrate that the ARS converted from the artificial time histories match those of the CSDRS for 5% damping. The CSDRS plots connect the control points shown in Table 4.1-1 and are based on the modified Regulatory Guide (RG) 1.60 (Reference 16) response spectra as described in Subsection 3.7.1.1 of the DCD. The horizontal and vertical modified RG 1.60 response spectra used as the target spectra are extended to a lower frequency of 0.1 Hz. These figures demonstrate that the artificial acceleration time histories do not have significant gaps in the response spectra, and are also not biased high with respect to the target CSDRS to demonstrate uniform energy distribution.

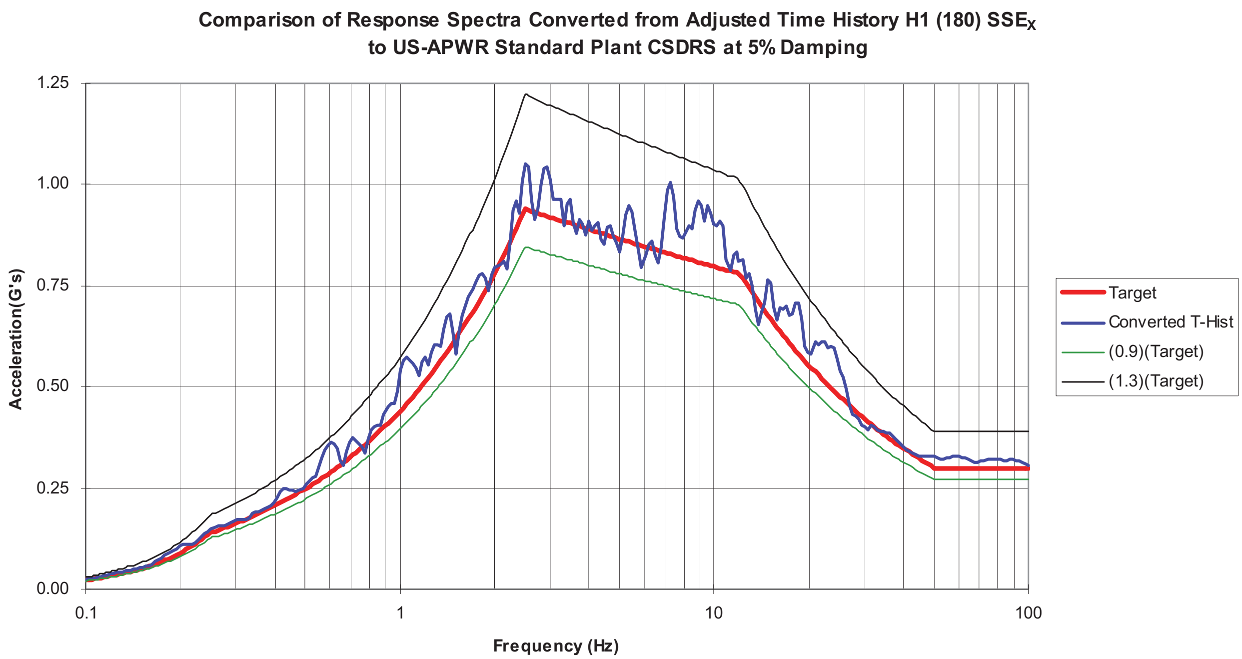


Figure 5.1-4 5% Damped Response Spectra Plots for Adjusted Northridge, BAL Component H1 (180)

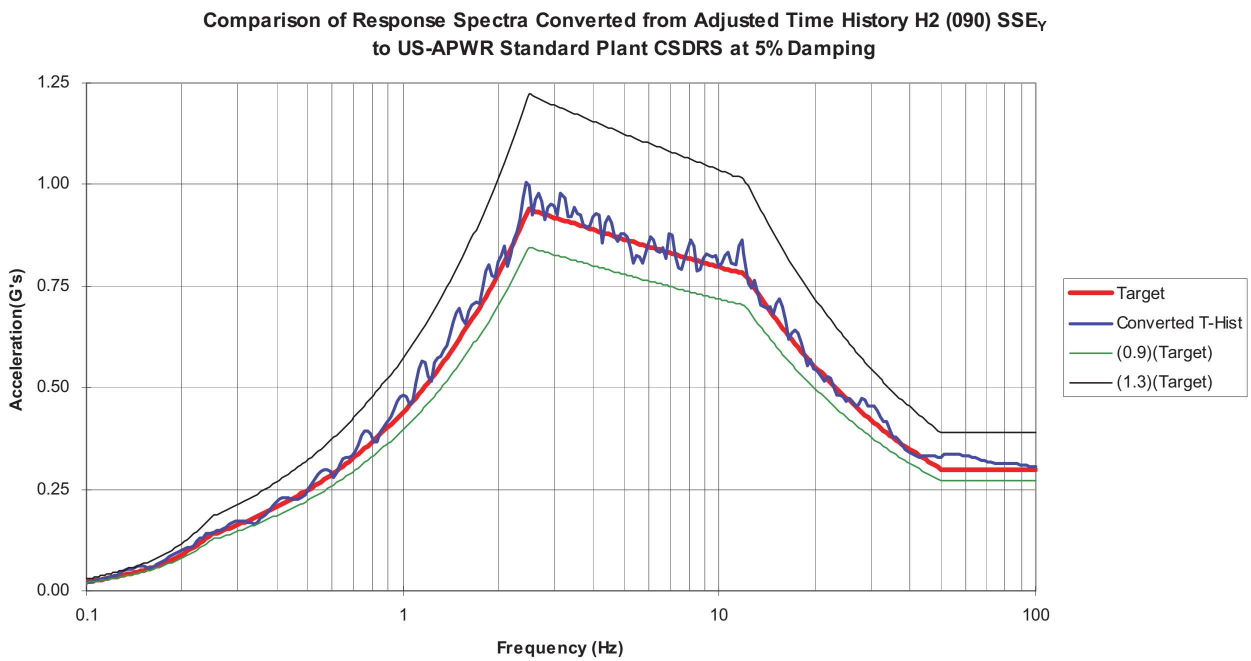


Figure 5.1-5 5% Damped Response Spectra Plots for Adjusted Northridge, BAL Component H2 (090)

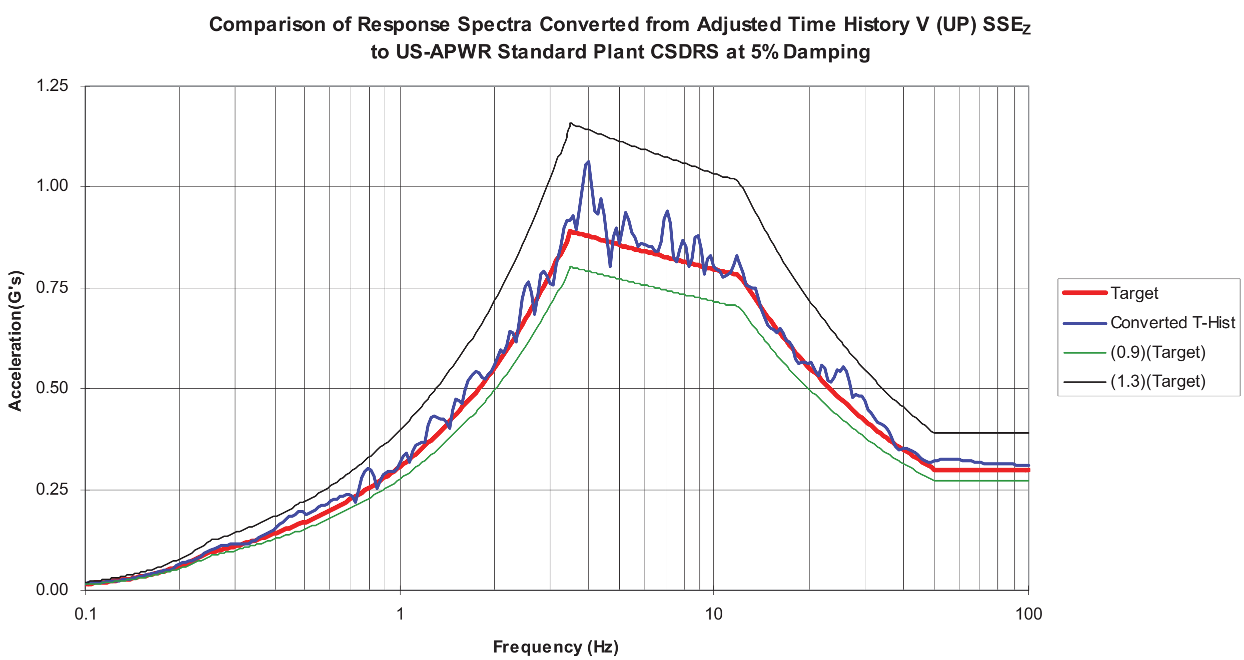


Figure 5.1-6 5% Damped Response Spectra Plots for Adjusted Northridge, BAL Component V (UP)

The time histories meet all of the requirements and conditions set forth in Section II of NUREG-0800, SRP 3.7.1 (Reference 1) for the generation of a single set of time histories Option 1, Approach 2, as summarized in Table 5.1-1 and described in the following, steps (a) through (d):

(a) The US-APWR artificial time histories have sufficiently small time increments (Δt =0.005 seconds) and a total duration of 22.005 seconds. The time history data records have a Nyquist frequency of $N_f = 1/(2\Delta t)$ =100 Hz, and meet the NUREG-0800 SRP 3.7.1 (Reference 1) requirement of a total duration of at least 20 seconds. The time increment of 0.005 seconds is lower than the maximum time increment of 0.01 seconds permitted by SRP 3.7.1. The Nyquist frequency of 100 Hz is considered to be above the range of frequencies important for the design of the US-APWR plant and assures that the seismic analysis capture the responses of SSCs in the high frequency range. This is particularly important for site-specific subgrade conditions where seismic category I structures are founded on a hard rock subgrade.

(b) The 5% damped ARSs of the US-APWR artificial time history components, shown in Figures 5.1-1, 5.1-2, and 5.1-3, are computed at 300 frequency points that are divided such that 100 frequency points are uniformly spaced over the log frequency scale from 0.1 Hz to 1 Hz, 1 Hz to 10 Hz, and 10 Hz to 100 Hz. Each ARS obtained from the three artificial ground motion time history components are compared with the target response spectra at each frequency computed in the frequency range from 0.1 Hz to 100 Hz.

(c) The 5% damped ARSs computed for each of the three US-APWR artificial time history components do not fall more than 10% below the corresponding CSDRS target response spectra at any particular frequency. In addition, within a frequency window no larger than ±10% centered at any frequency data point, none of the three ARSs (H1, H2, and V) falls below their corresponding target CSDRS. Exceeding the requirements of SRP 3.7.1 (Reference 1), is confirmed by assuring that, for each of the spectra derived from the artificial time history components, no more than nine (9) adjacent frequency points fall below the CSDRS target response spectra for frequencies between 0.1 Hz and 100 Hz. This ensures that the response spectra resulting from the artificial time history components do not fall below the corresponding target response spectra in large frequency windows. Table 5.1-1 demonstrates that these requirements are met by showing a summary of the frequency non-exceedances.

(d) In lieu of the power spectral density requirement of Option 1 Approach 1 in SRP 3.7.1 (Reference 1), Approach 2 specifies that the computed 5% damped response spectra of each artificial ground motion time history component does not exceed its target response spectra at any frequency by more than 30% (a factor of 1.3) in the frequency range of interest. For the US-APWR, the response spectra derived from the artificial time histories are checked to ensure that they do not exceed the corresponding target spectra (CSDRS) by more than 30% at any frequency range measured as described in item (b) above. The results of this check are presented in Table 5.1-2.

Table 5.1-1 Comparison of 5% Damping ARS of Artificial Time History and CSDRS

Time History	Frequency Range		0.1 – 1 Hz	1 – 10 Hz	10 – 100 Hz	0.1 – 100 Hz
	No. Freq. Data Points		**100**	**100**	**100**	**300**
Horizontal H1	ARS/CSDRS ratio	Min.	0.94	0.94	0.92	0.92
		Max	1.25	1.26	1.22	1.26
	Max. No. of Data Point Non-Exceedances Within Any One Particular Frequency Window (1)		1	4	7	7
Horizontal H2	ARS/CSDRS ratio	Min.	0.90	0.94	0.97	0.90
		Max	1.29	1.14	1.13	1.29
	Max. No. of Data Point Non-Exceedances Within Any One Particular Frequency Window (1)		7	6	6	7
Vertical V	ARS/CSDRS ratio	Min.	0.94	0.93	0.97	0.93
		Max	1.21	1.21	1.18	1.21
	Max. No. of Data Point Non-Exceedances Within Any One Particular Frequency Window (1)		6	3	6	6

(1) Maximum number of frequency data points in any one particular sequence (frequency window) for which the acceleration values of the time histories ARS are below those of the CSDRS.

Table 5.1-2 Spectra Matching Requirements for Converted Time Histories

SRP 3.7.1 Criterion for 5% Critical Damping:	H1 (180) SSE_x	H2 (090) SSE_y	V (up) SSE_z
Average of converted/target acceleration ratios for all frequency points (if > 1.0 o.k.)	1.0705	1.0402	1.0509
Rise time duration			
Arias Intensity 5%	3.94	4.635	2.08
Required for Magnitude 6.5 earthquake[(1) (2)]	1	1	1
Strong motion time duration			
Arias intensity 75% - 5%	7.52	7.145	8.77
Required for Magnitude 6.5 earthquake[(1) (2)]	7	7	7
Decay time duration			
Arias intensity 100% - 75%	10.63	10.31	11.24
Required for Magnitude 6.5 earthquake[(1) (2)]	5	5	5
Statistical Independence			
Correlation coefficient X and Y (if abs value < 0.16 o.k.)	0.0892	0.0892	
Correlation coefficient X and Z (if abs value < 0.16 o.k.)	-0.0654		-0.0654
Correlation coefficient Y and Z (if abs value < 0.16 o.k.)		-0.0836	-0.0836
SRP 3.7.1 Option 1, Approach 2			
Number of points with acceleration ratio > 1.30 (if = 0 o.k.)	0	0	0
Number of points with acceleration ratio < 0.90 (if = 0 o.k.)	0	0	0
Number of windows wider than 9 points below the target spectra (if = 0 o.k.)	0	0	0

(1) The seed recorded time history earthquake for the US-APWR Standard Plant CSDRS has a Magnitude of 6.5 (References 8 and 22).

(2) See Table 2.3-1 of ASCE 4-98 (Reference 13) for guidance on length of time appropriate for rise, strong motion, and decay

The time histories also meet the requirements set forth in Acceptance Criteria 1B, on page 3.7.1-9 of SRP 3.7.1 (Reference 1) as summarized in Table 5.1-2 and further described below:

Cross Correlation between Components

The cross-correlation coefficients between the three components of the artificial time history earthquake are as follows: ρ_{12} = 0.0892, ρ_{23} = -0.0836, and ρ_{31} = -0.0654 where 1, 2, and 3 are the three global directions corresponding to NS, EW, and vertical directions for the US-APWR standard plant. Since the absolute values of the cross-correlation coefficients of the US-APWR artificial time histories are less than 0.16, as listed above, in accordance with NUREG/CR-6728 (Reference 10), the time histories are considered statistically independent of each other.

Duration of Motion

The set of three statistically independent components of the artificial time history earthquake which are developed for design of the US-APWR seismic Category I buildings are characterized by the strong duration of motion times, listed in Table 5.1-2 and total duration of motion time of 22.085 seconds. The strong motion duration time is defined as the time required for the Arias Intensity to rise from 5% to 75%, and is required to meet a minimum of 6 seconds, in accordance with SRP 3.7.1 (Reference 1). The duration of motion of the US-APWR artificial time histories with respect to time achieved from 5% to 75% Arias intensities example provided in Table 5.1-3 shows the subtraction of Arias Intensity values to determine the duration. This is similarly computed for rise and decay times listed in Table 5.1-2. The guidance of ASCE 4-98 (Reference 13) for minimum duration, rise, and decay times for a Magnitude 6.5 earthquake is also met.

Table 5.1-3 Duration of Motion of US-APWR Artificial Time History Components Computed from Arias Intensity Values

	Arias Intensity		Arias Duration $75\%I_a - 5\%I_a$ (seconds)	ASCE 4-98 [(1)] Arias Min. Duration (seconds)
	Time for 5% (seconds)	Time for 75% (seconds)		
H1	3.94	11.46	7.52	7
H2	4.635	11.78	7.145	7
V	2.08	10.84	8.77	7

(1) ASCE 4-98 guidance for a 6.5 Magnitude Earthquake

The uniformity of the growth of this Arias Intensity is shown in Figure 5.1-7 for each of the three components of the artificial time history earthquake. The total duration of motion exceeds the minimum acceptance criterion of 20 seconds as given in SRP 3.7.1 design time histories, Option 1, Approach 2 Part (a).

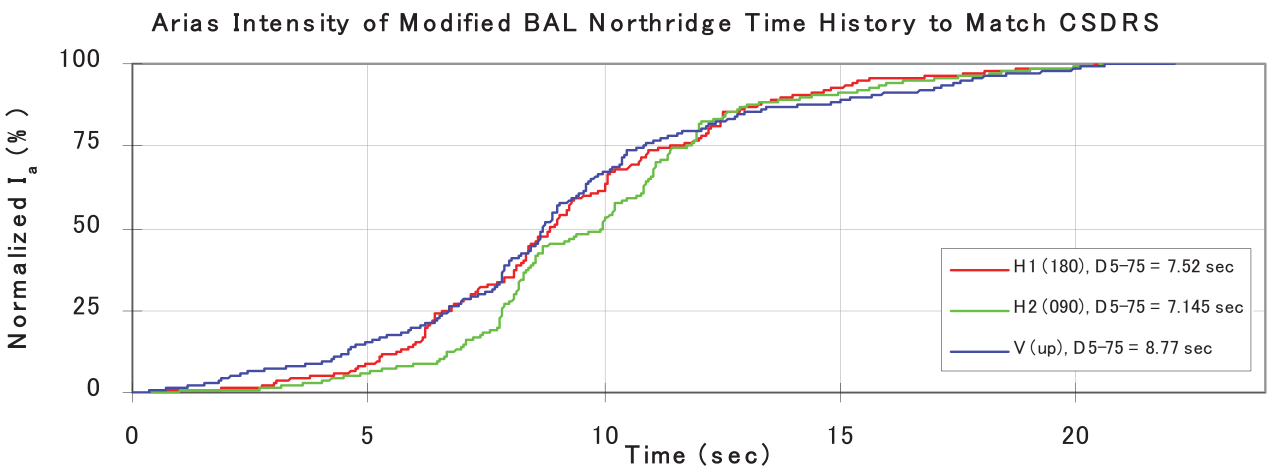


Figure 5.1-7 Normalized Arias Intensity of Time History Components Showing 5%-75% Duration

5.2 Development of Soil Profiles

Following the approach discussed in Section 4.2.2, strain compatible properties are developed for the $\overline{V_S}$ (30m) profile categories of 270 m/s, 560 m/s, 900 m/s, and 2,032 m/s. The selected shear- and compressional-wave profiles are shown in Figure 5.2-1 to their maximum depths with Poisson ratios shown in Figure 5.2-2. To accommodate realistic soil foundation conditions in developing the strain compatible properties, approximately 68 ft of soft soil is removed from the softest profile, $\overline{V_S}$ (30m) = 270 m/s. The soil removal increased the original surficial shear-wave velocity of 520 ft/s (Figure 4.2-1) to 1,247 ft/s at a foundation level, although the profile name of 270 m/s is retained (the $\overline{V_S}$ (30m) for the revised 270m/sec profile has increased to 425m/sec). The remaining three profiles are assumed to reflect appropriate conditions at the plant surface and are left unaltered. Due to their steep velocity gradients (Figure 5.2-1), the depth ranges for soft and firm rock profiles of 900 m/s and 2,032 m/s are restricted to 100 feet and 200 feet for soft rock (900 m/s) and 100 ft for firm rock (2,032 m/s). The final profile categories and depth bins are listed in Table 5.2-1.

Table 5.2-1 Final Profile Categories

Category (initial $\overline{V_S}$ [30m])	Depth to Rock* (ft)
270	200
	500
560	100
	200
	500
900	100
	200
2,032	100

* For soil and soft rock profiles 270m/sec and 560m/sec, underlying baserock conditions reflect soft rock with a shear-wave velocity of 1 km/sec. For firm rock profiles 900m/sec and 2,032m/sec, underlying baserock conditions reflect hard rock with a shear-wave velocity of 2.83 km/sec (Table 4.2-1).

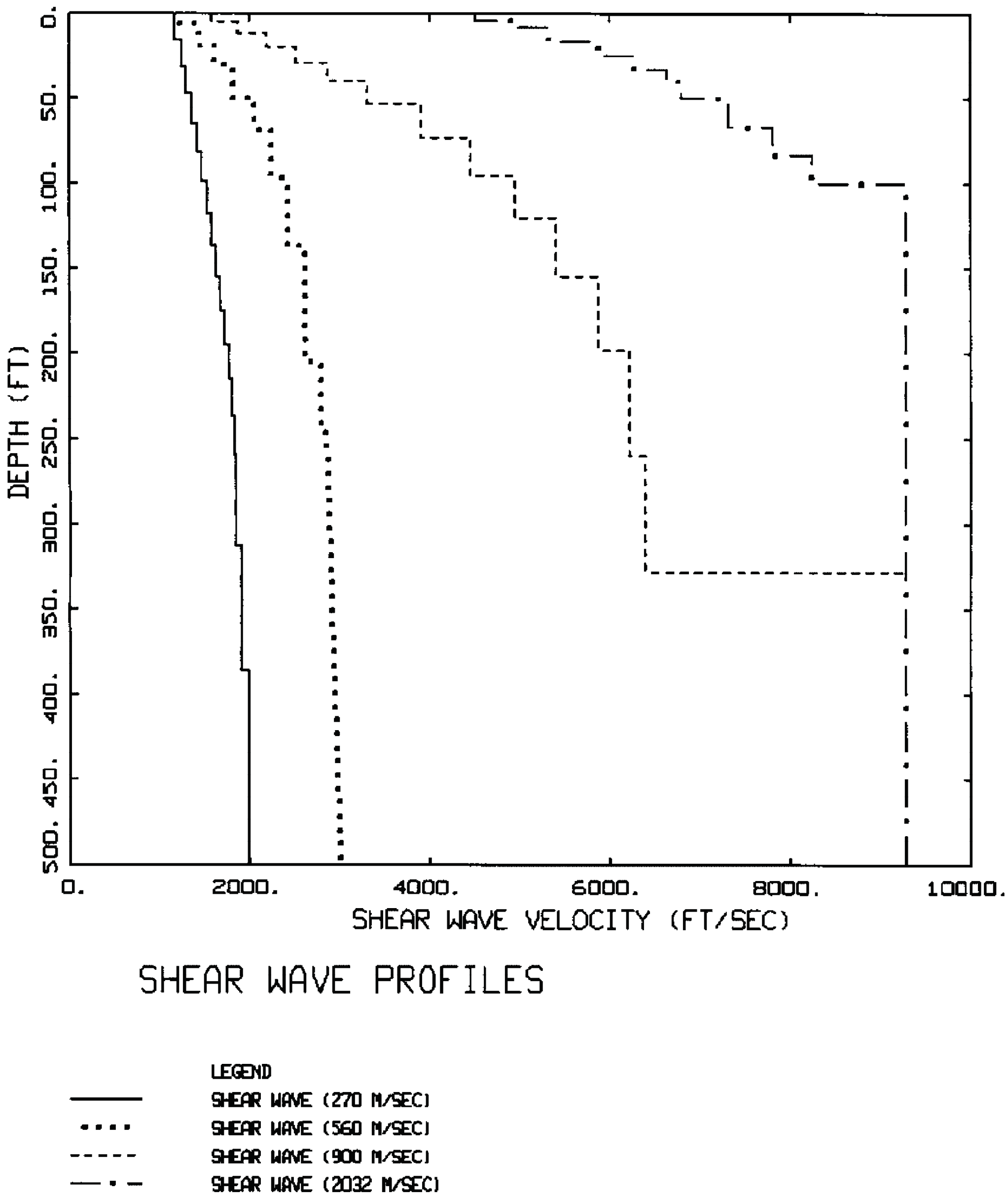


Figure 5.2-1 Final Foundation Level Base-Case Shear- And Compressional-Wave Velocity Profiles (Sheet 1 of 2)

Note: Since the water table was taken at the foundation level, the minimum compressional-wave velocity was set at 5,000 ft/s.

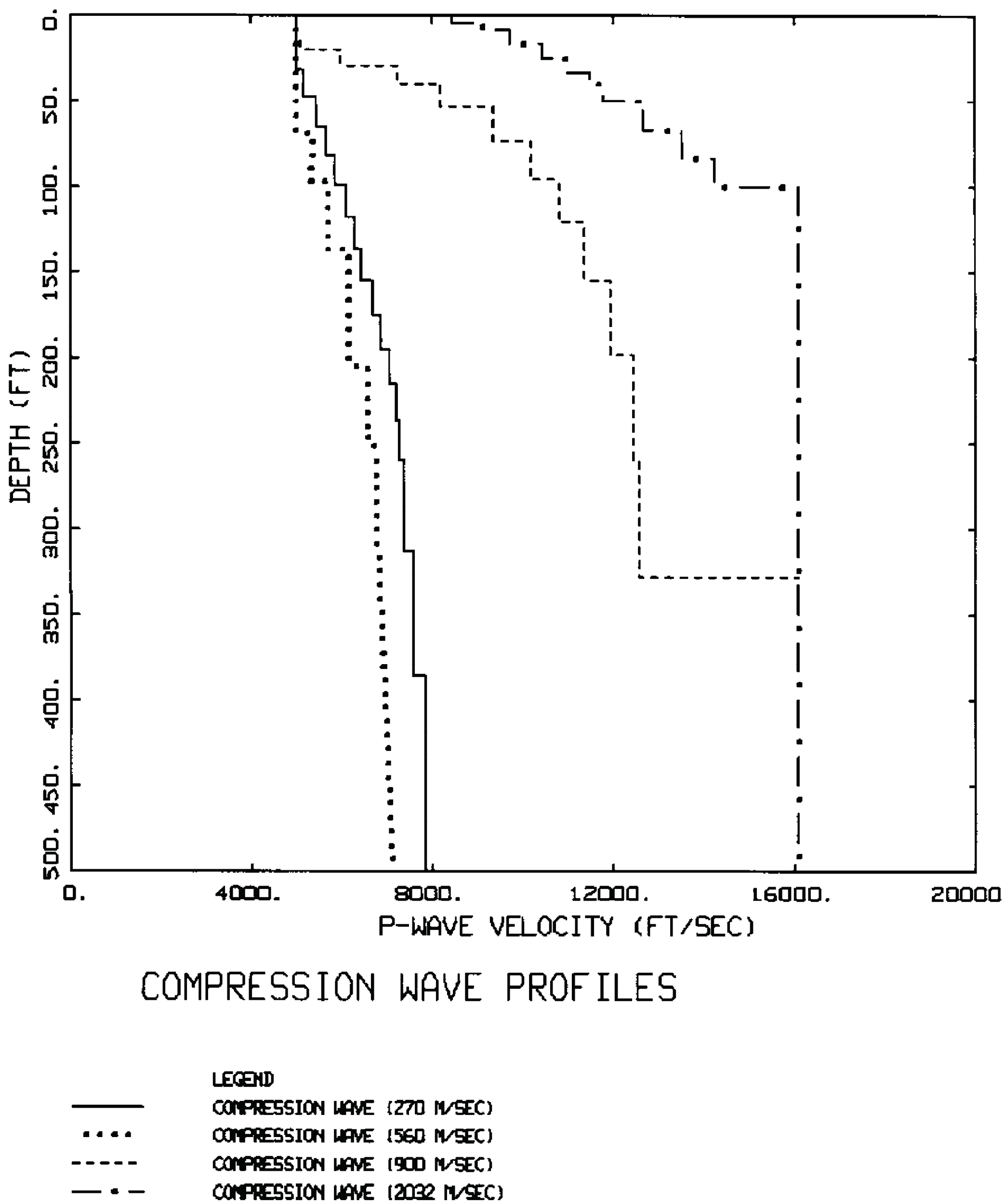


Figure 5.2-1 Final Foundation Level Base-Case Shear- And Compressional-Wave Velocity Profiles (Sheet 2 of 2)

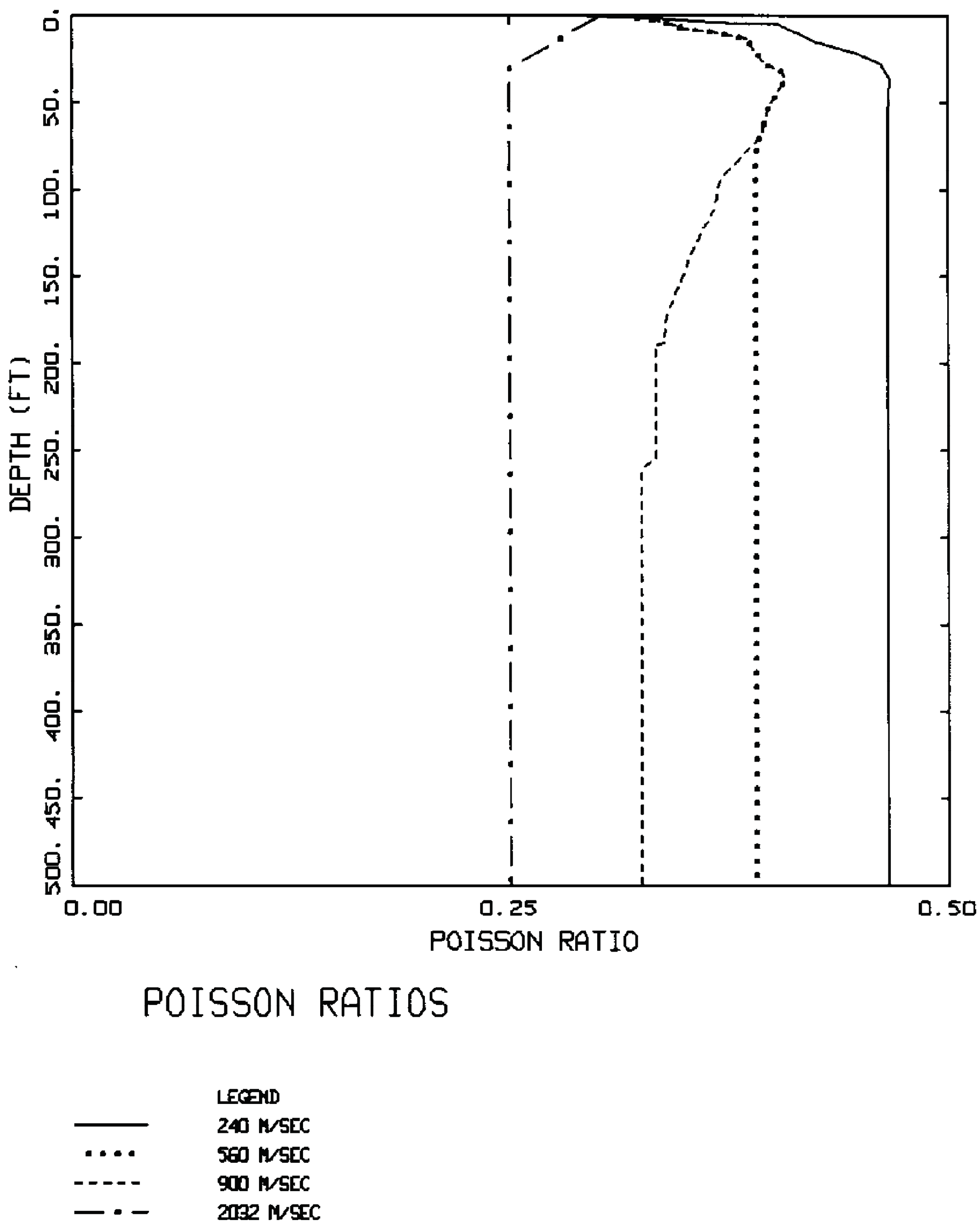


Figure 5.2-2 Poisson Ratios Computed for the Four Base-Case Profiles

5.2.1 Site Response Analyses

The site response analyses are conducted using the equivalent linear RVT approach (Reference 8, Reference 10, and NUREG/CR-6729 (Reference 17)) with the point-source model used to generate both the horizontal and vertical motions (References 8, 10, and 11). Magnitude **M**7.5 is used as its broad spectral shape is consistent with that of the CSDRS. Distances are adjusted such that the median spectrum computed for each profile approaches, but does not exceed, the horizontal and vertical CSDRS. The distances and median estimates of the horizontal and vertical peak accelerations are listed in Table 5.2-2 and the median spectrum computed for each profile is compared to the CSDRS spectrum in Figure 5.2-3 for horizontal components. Due to the shape of the US-APWR CSDRS, nearly all the profile spectra approach the design spectrum at high frequency (approximately 25 Hz to 50 Hz). This frequency range then becomes the effective control for non exceedance and associated distance adjustment for most of the profiles. The exceptions being reflected by the fundamental low-frequency resonance of the softest (270 m/s and 560m/sec) and deepest (500 feet) profiles. Figure 5.2-3 also suggests a simple manner to update the CSDRS to reflect the expected spectral shape for CEUS strong ground motions.

For the vertical motions, Figure 5.2-4 compares the median spectra computed for the profiles with the vertical component CSDRS. In this case, the vertical motions are modeled assuming incident inclined P-SV wave using a linear analysis (References 8, 10, and 11). Linear analyses for vertical motions with incident inclined P-SV waves has been shown to be appropriate for loading levels up to about 0.5g (Reference 8) and consistent with empirical GMPEs from “Empirical Response Spectral Attenuation Relations for Shallow Crustal Earthquakes” (Reference 18). Use of linear analyses is also consistent with observations of spectral shapes for vertical motions at soil sites being independent of loading level (Reference 11). For applications to sites with a water table at or very near the surface, linearity of the constrained modulus is also a realistic assumption as compressional waves control the high-frequencies in vertical motions (Refer to “Properties of Vertical Ground Motions”, Reference 19), where nonlinearity has its largest effect.

As Figure 5.2-4 shows, most of the vertical spectra fall significantly below the vertical CSDRS design spectrum which was based on the RG 1.60 (Reference 16) V/H ratio. This trend is consistent with vertical spectra recorded at both soil and rock sites in WNA and is a result of the large source distances (Reference 10) (e.g. > 50 km, Table 5.2-2). Empirical (Refer to Reference 20) as well as simulated (References 10 and 11) V/H ratios decrease with increasing distance in both WNA and CEUS and are less than one at distances exceeding 50 km.

Using the RG 1.60 (Reference 16) V/H ratios, which are conservatively independent of distance, the vertical motions are considerably elevated as shown in Figure 5.2-5. With the conservative RG 1.60 V/H ratios, there are some minor exceedances near 0.5 Hz and 1.0 Hz for the softest profile (270 m/s) and largest depths to soft rock material (500 feet).

Table 5.2-2 Magnitudes, Distances, and Median Peak Accelerations

Profile	**M**	D(km)	PGA^{*}_{H}(g)	PGA^{*}_{V}(g)
270 – 200	7.5	58.0	0.262	0.124
270 – 500	7.5	50.0	0.246	0.149
560 -100	7.5	55.0	0.259	0.130
560 – 200	7.5	45.0	0.276	0.167
560 – 500	7.5	48.0	0.203	0.133
900 – 100	7.5	72.0	0.200	0.067
900 – 200	7.5	65.0	0.215	0.082
2032 - 100	7.5	58.0	0.172	0.067

$\Delta\sigma$ = 110 bars

$Q(f) = 670\ f^{0.33}$

κ = 0.006 sec, hard rock outcrop horizontal component

κ = 0.003 sec, hard rock outcrop vertical component

* Median peak acceleration at profile surface

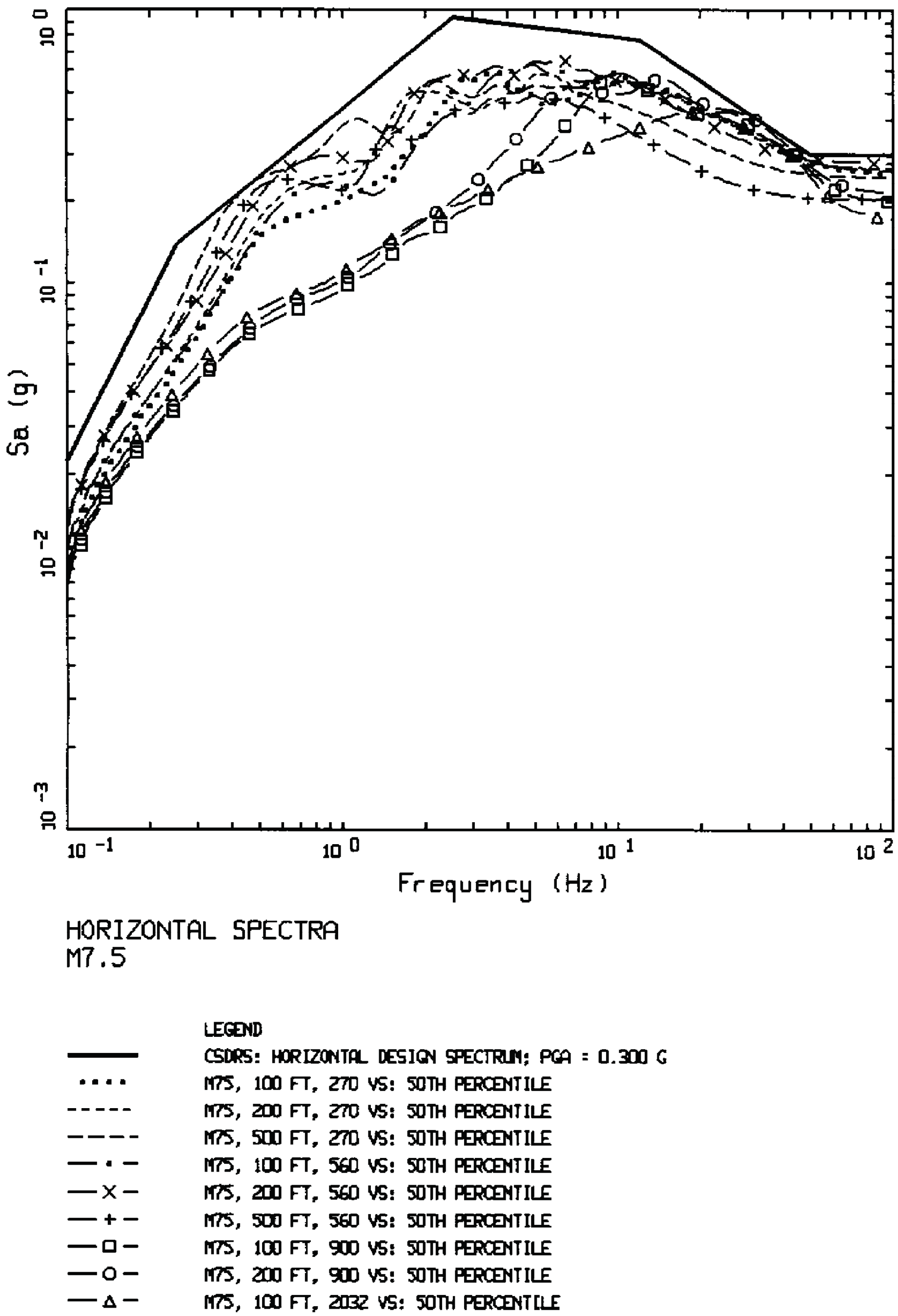


Figure 5.2-3 Median Spectra (5% damped) Compared to CSDRS Horizontal Components

Note: Magnitude is **M** 7.5 with median peak accelerations and distances listed in Table 5.2.2: Horizontal components

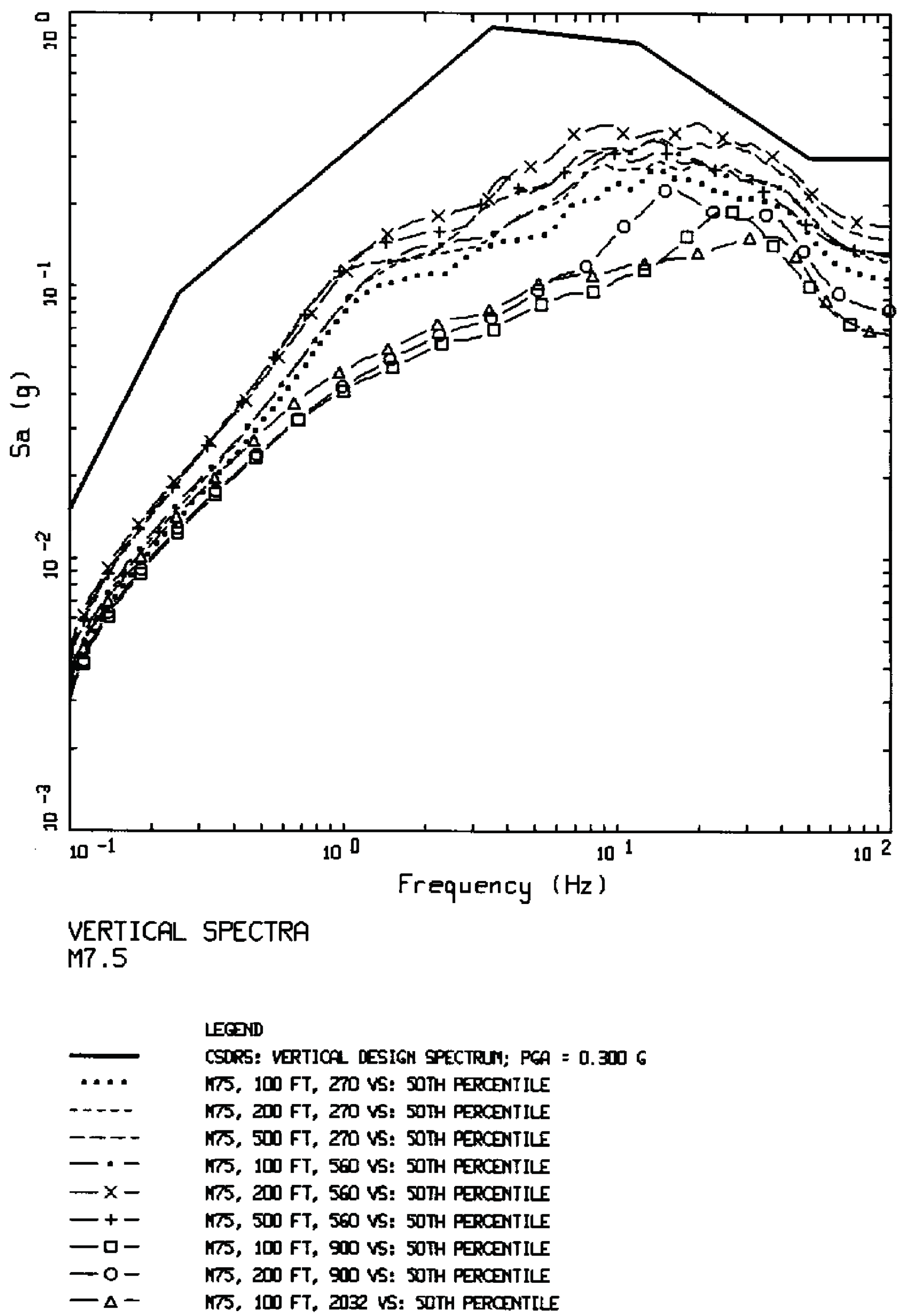


Figure 5.2-4 Median Spectra (5% damped) Compared to CSDR Vertical Components

Note: Magnitude is **M**7.5 with median peak accelerations and distances listed in Table 5.2.2: Vertical components

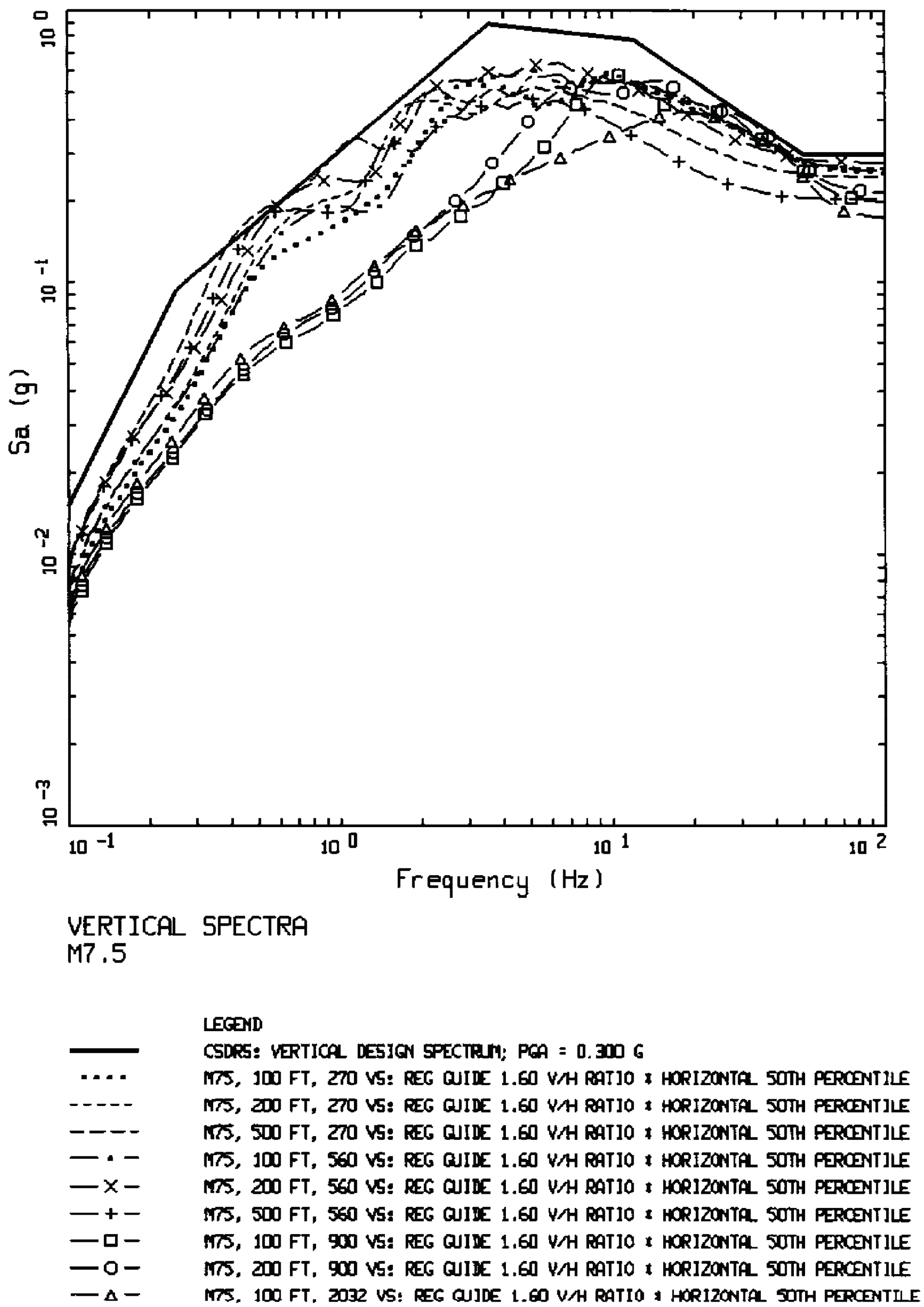


Figure 5.2-5 Median Spectra (5% damped) Compared to CSDRS Vertical Components Using RG 1.60 V/H Ratios

Note: Magnitude is **M**7.5 with median peak accelerations and distances listed in Table 5.2.2: Vertical components using RG 1.60 V/H ratios

5.2.2 Strain Compatible Properties

For the eight combinations of profile categories and depths to hard or soft rock material (Table 5.2-1) strain compatible properties are developed reflecting median (best estimate) and ± 1σ (upper and lower range) estimates over the thirty (30) realizations of profiles and G/G_{max} and hysteretic damping curves (Section 4.2.2). The strain compatible properties are summarized in Tables 5.2-4_to 5.2-11, with Figures 5.2-6 to 5.2-14 showing the median and ±1σ estimates for the shear- and compressional-wave velocities and associated damping.

Table 5.2-3 Deleted

Table 5.2-4 Strain Compatible Properties for Profile 270, 200 ft (Median) (Sheet 1 of 3)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.11660E+04	.47982E+04	.16731E+01	.11972E+01	.20000E+01	.46857E+00	.00000E+00
2	7.914	.11590E+04	.49740E+04	.24599E+01	.11972E+01	.20000E+01	.47107E+00	.79170E+01
3	7.917	.12682E+04	.53387E+04	.23650E+01	.10045E+01	.20000E+01	.46991E+00	.15831E+02
4	7.914	.13236E+04	.56247E+04	.25578E+01	.10045E+01	.20000E+01	.47043E+00	.23748E+02
5	8.580	.12801E+04	.55066E+04	.28816E+01	.10045E+01	.20000E+01	.47120E+00	.31662E+02
6	8.580	.13021E+04	.56444E+04	.30293E+01	.10045E+01	.20000E+01	.47162E+00	.40242E+02
7	8.580	.13340E+04	.58000E+04	.31269E+01	.10045E+01	.20000E+01	.47182E+00	.48822E+02
8	8.580	.13034E+04	.57097E+04	.33445E+01	.10045E+01	.20000E+01	.47234E+00	.57402E+02
9	8.580	.13347E+04	.58709E+04	.33943E+01	.10045E+01	.20000E+01	.47253E+00	.65982E+02
10	8.580	.13721E+04	.60382E+04	.34092E+01	.10045E+01	.20000E+01	.47262E+00	.74562E+02
11	9.377	.13616E+04	.60297E+04	.26165E+01	.79917E+00	.20000E+01	.47291E+00	.83142E+02
12	9.374	.14165E+04	.62649E+04	.25768E+01	.79917E+00	.20000E+01	.47282E+00	.92519E+02
13	9.377	.14500E+04	.64048E+04	.25954E+01	.79917E+00	.20000E+01	.47279E+00	.10189E+03
14	9.374	.14561E+04	.64515E+04	.26530E+01	.79917E+00	.20000E+01	.47295E+00	.11127E+03
15	9.377	.14345E+04	.63909E+04	.27704E+01	.79917E+00	.20000E+01	.47325E+00	.12064E+03
16	9.374	.14158E+04	.63254E+04	.28695E+01	.79917E+00	.20000E+01	.47341E+00	.13002E+03
17	10.000	.14825E+04	.65707E+04	.27263E+01	.79917E+00	.21000E+01	.47301E+00	.13939E+03
18	10.000	.14939E+04	.66360E+04	.27590E+01	.79917E+00	.21000E+01	.47312E+00	.14939E+03
19	10.000	.15344E+04	.68038E+04	.27415E+01	.79917E+00	.21000E+01	.47303E+00	.15939E+03
20	10.000	.15417E+04	.68552E+04	.27789E+01	.79917E+00	.21000E+01	.47316E+00	.16940E+03
21	10.000	.15986E+04	.70896E+04	.27185E+01	.79917E+00	.21000E+01	.47300E+00	.17940E+03
22	10.000	.15437E+04	.68882E+04	.28633E+01	.79917E+00	.21000E+01	.47334E+00	.18939E+03
23	0.604	.15743E+04	.70220E+04	.28200E+01	.79917E+00	.21000E+01	.47330E+00	.19939E+03
24	997.424	.33172E+04	.78122E+04	.50000E+00	.50000E+00	.21500E+01	.39002E+00	.20000E+03
25	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04

Table 5.2-4 (Sheet 2 of 3) Strain Compatible Properties for Profile 270, 200 ft (-1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.87725E+03	.36762E+04	.12233E+01	.11713E+01	.20000E+01	.46696E+00	.00000E+00
2	7.914	.84561E+03	.38036E+04	.16669E+01	.11713E+01	.20000E+01	.46772E+00	.79170E+01
3	7.917	.94557E+03	.41115E+04	.16384E+01	.98294E+00	.20000E+01	.46687E+00	.15831E+02
4	7.914	.94365E+03	.41812E+04	.16501E+01	.98294E+00	.20000E+01	.46695E+00	.23748E+02
5	8.580	.95103E+03	.42300E+04	.19344E+01	.98294E+00	.20000E+01	.46794E+00	.31662E+02
6	8.580	.97668E+03	.43949E+04	.19984E+01	.98294E+00	.20000E+01	.46816E+00	.40242E+02
7	8.580	.10477E+04	.46883E+04	.20906E+01	.98294E+00	.20000E+01	.46856E+00	.48822E+02
8	8.580	.10748E+04	.47614E+04	.22837E+01	.98294E+00	.20000E+01	.46947E+00	.57402E+02
9	8.580	.10934E+04	.49078E+04	.23529E+01	.98294E+00	.20000E+01	.46939E+00	.65982E+02
10	8.580	.11709E+04	.52081E+04	.24367E+01	.98294E+00	.20000E+01	.46979E+00	.74562E+02
11	9.377	.11129E+04	.51576E+04	.20156E+01	.78362E+00	.20000E+01	.46952E+00	.83142E+02
12	9.374	.11514E+04	.53559E+04	.19176E+01	.78362E+00	.20000E+01	.46931E+00	.92519E+02
13	9.377	.12151E+04	.55600E+04	.19367E+01	.78362E+00	.20000E+01	.46962E+00	.10189E+03
14	9.374	.11993E+04	.55169E+04	.19644E+01	.78362E+00	.20000E+01	.46969E+00	.11127E+03
15	9.377	.11783E+04	.54576E+04	.20604E+01	.78362E+00	.20000E+01	.46991E+00	.12064E+03
16	9.374	.11692E+04	.53770E+04	.21042E+01	.78362E+00	.20000E+01	.47017E+00	.13002E+03
17	10.000	.12247E+04	.55242E+04	.19749E+01	.78362E+00	.21000E+01	.47008E+00	.13939E+03
18	10.000	.12545E+04	.57085E+04	.20425E+01	.78362E+00	.21000E+01	.47006E+00	.14939E+03
19	10.000	.12924E+04	.58501E+04	.21192E+01	.78362E+00	.21000E+01	.47004E+00	.15939E+03
20	10.000	.13129E+04	.60141E+04	.21177E+01	.78362E+00	.21000E+01	.47000E+00	.16940E+03
21	10.000	.13471E+04	.61840E+04	.20697E+01	.78362E+00	.21000E+01	.46975E+00	.17940E+03
22	10.000	.12810E+04	.58859E+04	.20747E+01	.78362E+00	.21000E+01	.47008E+00	.18939E+03
23	0.604	.12627E+04	.58380E+04	.20426E+01	.78362E+00	.21000E+01	.46990E+00	.19939E+03
24	997.424	.26524E+04	.62461E+04	.50000E+00	.50000E+00	.21500E+01	.38999E+00	.20000E+03
25	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04

Table 5.2-4 (Sheet 3 of 3) Strain Compatible Properties for Profile 270, 200 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.15499E+04	.62626E+04	.22882E+01	.12237E+01	.20000E+01	.47019E+00	.00000E+00
2	7.914	.15884E+04	.65046E+04	.36304E+01	.12237E+01	.20000E+01	.47444E+00	.79170E+01
3	7.917	.17009E+04	.69321E+04	.34138E+01	.10265E+01	.20000E+01	.47297E+00	.15831E+02
4	7.914	.18566E+04	.75665E+04	.39647E+01	.10265E+01	.20000E+01	.47394E+00	.23748E+02
5	8.580	.17231E+04	.71685E+04	.42929E+01	.10265E+01	.20000E+01	.47448E+00	.31662E+02
6	8.580	.17359E+04	.72491E+04	.45920E+01	.10265E+01	.20000E+01	.47511E+00	.40242E+02
7	8.580	.16987E+04	.71754E+04	.46770E+01	.10265E+01	.20000E+01	.47511E+00	.48822E+02
8	8.580	.15806E+04	.68469E+04	.48981E+01	.10265E+01	.20000E+01	.47522E+00	.57402E+02
9	8.580	.16294E+04	.70229E+04	.48968E+01	.10265E+01	.20000E+01	.47569E+00	.65982E+02
10	8.580	.16078E+04	.70005E+04	.47699E+01	.10265E+01	.20000E+01	.47546E+00	.74562E+02
11	9.377	.16659E+04	.70492E+04	.33967E+01	.81502E+00	.20000E+01	.47632E+00	.83142E+02
12	9.374	.17426E+04	.73281E+04	.34628E+01	.81502E+00	.20000E+01	.47635E+00	.92519E+02
13	9.377	.17302E+04	.73780E+04	.34783E+01	.81502E+00	.20000E+01	.47599E+00	.10189E+03
14	9.374	.17678E+04	.75446E+04	.35830E+01	.81502E+00	.20000E+01	.47624E+00	.11127E+03
15	9.377	.17465E+04	.74839E+04	.37252E+01	.81502E+00	.20000E+01	.47661E+00	.12064E+03
6	9.374	.17143E+04	.74410E+04	.39130E+01	.81502E+00	.20000E+01	.47668E+00	.13002E+03
17	10.000	.17946E+04	.78154E+04	.37635E+01	.81502E+00	.21000E+01	.47595E+00	.13939E+03
18	10.000	.17788E+04	.77141E+04	.37267E+01	.81502E+00	.21000E+01	.47620E+00	.14939E+03
19	10.000	.18218E+04	.79130E+04	.35464E+01	.81502E+00	.21000E+01	.47603E+00	.15939E+03
20	10.000	.18103E+04	.78140E+04	.36466E+01	.81502E+00	.21000E+01	.47635E+00	.16940E+03
21	10.000	.18971E+04	.81277E+04	.35706E+01	.81502E+00	.21000E+01	.47627E+00	.17940E+03
22	10.000	.18602E+04	.80610E+04	.39515E+01	.81502E+00	.21000E+01	.47662E+00	.18939E+03
23	0.604	.19628E+04	.84461E+04	.38932E+01	.81502E+00	.21000E+01	.47672E+00	.19939E+03
24	997.424	.41487E+04	.97710E+04	.50000E+00	.50000E+00	.21500E+01	.39005E+00	.20000E+03
25	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04

Table 5.2-5 Strain Compatible Properties for Profile 270, 500 ft (Median) (Sheet 1 of 6)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.12299E+04	.50493E+04	.16601E+01	.11972E+01	.20000E+01	.46843E+00	.00000E+00
2	7.914	.11804E+04	.50528E+04	.25525E+01	.11972E+01	.20000E+01	.47098E+00	.79170E+01
3	7.917	.11883E+04	.50792E+04	.26953E+01	.10045E+01	.20000E+01	.47072E+00	.15831E+02
4	7.914	.11822E+04	.51407E+04	.30298E+01	.10045E+01	.20000E+01	.47167E+00	.23748E+02
5	8.580	.11640E+04	.51421E+04	.33561E+01	.10045E+01	.20000E+01	.47253E+00	.31662E+02
6	8.580	.12418E+04	.54980E+04	.33423E+01	.10045E+01	.20000E+01	.47261E+00	.40242E+02
7	8.580	.12999E+04	.57297E+04	.33919E+01	.10045E+01	.20000E+01	.47263E+00	.48822E+02
8	8.580	.13023E+04	.57789E+04	.35537E+01	.10045E+01	.20000E+01	.47301E+00	.57402E+02
9	8.580	.12966E+04	.57849E+04	.37461E+01	.10045E+01	.20000E+01	.47334E+00	.65982E+02
10	8.580	.12734E+04	.57444E+04	.39636E+01	.10045E+01	.20000E+01	.47387E+00	.74562E+02
11	9.377	.13165E+04	.59040E+04	.29232E+01	.79917E+00	.20000E+01	.47362E+00	.83142E+02
12	9.374	.13620E+04	.61017E+04	.29316E+01	.79917E+00	.20000E+01	.47358E+00	.92519E+02
13	9.377	.13027E+04	.58975E+04	.31497E+01	.79917E+00	.20000E+01	.47413E+00	.10189E+03
14	9.374	.13199E+04	.59871E+04	.31824E+01	.79917E+00	.20000E+01	.47421E+00	.11127E+03
15	9.377	.13377E+04	.60805E+04	.32145E+01	.79917E+00	.20000E+01	.47432E+00	.12064E+03
16	9.374	.13586E+04	.61789E+04	.32342E+01	.79917E+00	.20000E+01	.47436E+00	.13002E+03
17	10.000	.14876E+04	.66661E+04	.29353E+01	.79917E+00	.21000E+01	.47360E+00	.13939E+03
18	10.000	.14820E+04	.66630E+04	.30032E+01	.79917E+00	.21000E+01	.47376E+00	.14939E+03
19	10.000	.14934E+04	.67253E+04	.30253E+01	.79917E+00	.21000E+01	.47385E+00	.15939E+03
20	10.000	.14105E+04	.64237E+04	.32687E+01	.79917E+00	.21000E+01	.47445E+00	.16940E+03
21	10.000	.14468E+04	.65776E+04	.32370E+01	.79917E+00	.21000E+01	.47437E+00	.17940E+03
22	10.000	.14747E+04	.66981E+04	.32389E+01	.79917E+00	.21000E+01	.47433E+00	.18939E+03
23	10.598	.15474E+04	.69906E+04	.31260E+01	.79917E+00	.21000E+01	.47404E+00	.19939E+03
24	10.598	.16549E+04	.71804E+04	.26420E+01	.70326E+00	.21000E+01	.47181E+00	.20999E+03
25	11.500	.16334E+04	.71179E+04	.27211E+01	.70326E+00	.21000E+01	.47205E+00	.22059E+03
26	11.500	.16403E+04	.71529E+04	.27505E+01	.70326E+00	.21000E+01	.47210E+00	.23209E+03
27	17.668	.16864E+04	.73441E+04	.27070E+01	.70326E+00	.21000E+01	.47201E+00	.24359E+03
28	17.668	.16395E+04	.71817E+04	.28421E+01	.70326E+00	.21000E+01	.47234E+00	.26126E+03
29	17.668	.16660E+04	.73047E+04	.28448E+01	.70326E+00	.21000E+01	.47237E+00	.27893E+03
30	18.249	.16884E+04	.74114E+04	.28510E+01	.70326E+00	.21000E+01	.47242E+00	.29660E+03
31	18.249	.17179E+04	.75345E+04	.28563E+01	.70326E+00	.21000E+01	.47239E+00	.31484E+03
32	18.249	.17634E+04	.77217E+04	.28293E+01	.70326E+00	.21000E+01	.47230E+00	.33309E+03
33	18.249	.17587E+04	.77241E+04	.28719E+01	.70326E+00	.21000E+01	.47245E+00	.35134E+03

Table 5.2-5 (Sheet 2 of 6) Strain Compatible Properties for Profile 270, 500 ft (Median)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	20.001	.17507E+04	.77051E+04	.29245E+01	.70326E+00	.21000E+01	.47257E+00	.36959E+03
35	20.001	.17784E+04	.78225E+04	.29208E+01	.70326E+00	.21000E+01	.47255E+00	.38959E+03
36	20.001	.17942E+04	.78939E+04	.29289E+01	.70326E+00	.21000E+01	.47257E+00	.40959E+03
37	20.001	.17800E+04	.78500E+04	.29876E+01	.70326E+00	.21000E+01	.47271E+00	.42959E+03
38	20.001	.17642E+04	.78026E+04	.30439E+01	.70326E+00	.21000E+01	.47286E+00	.44960E+03
39	20.001	.17938E+04	.79186E+04	.30180E+01	.70326E+00	.21000E+01	.47281E+00	.46960E+03
40	10.404	.17807E+04	.78844E+04	.30544E+01	.70326E+00	.21000E+01	.47295E+00	.48960E+03
41	997.424	.31533E+04	.74231E+04	.50000E+00	.50000E+00	.21500E+01	.38991E+00	.50000E+03
42	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-5 (Sheet 3 of 6) Strain Compatible Properties for Profile 270, 500 ft (-1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.94391E+03	.39332E+04	.11679E+01	.11713E+01	.20000E+01	.46704E+00	.00000E+00
2	7.914	.86944E+03	.38399E+04	.16469E+01	.11713E+01	.20000E+01	.46825E+00	.79170E+01
3	7.917	.81988E+03	.36754E+04	.16798E+01	.98294E+00	.20000E+01	.46696E+00	.15831E+02
4	7.914	.83304E+03	.38435E+04	.18891E+01	.98294E+00	.20000E+01	.46755E+00	.23748E+02
5	8.580	.83922E+03	.39646E+04	.21364E+01	.98294E+00	.20000E+01	.46826E+00	.31662E+02
6	8.580	.89949E+03	.42980E+04	.21317E+01	.98294E+00	.20000E+01	.46824E+00	.40242E+02
7	8.580	.10653E+04	.48536E+04	.23980E+01	.98294E+00	.20000E+01	.46936E+00	.48822E+02
8	8.580	.10911E+04	.49963E+04	.25518E+01	.98294E+00	.20000E+01	.46970E+00	.57402E+02
9	8.580	.11214E+04	.50955E+04	.27350E+01	.98294E+00	.20000E+01	.47021E+00	.65982E+02
10	8.580	.10558E+04	.49410E+04	.28084E+01	.98294E+00	.20000E+01	.47043E+00	.74562E+02
11	9.377	.10870E+04	.50390E+04	.21358E+01	.78362E+00	.20000E+01	.47033E+00	.83142E+02
12	9.374	.11482E+04	.52918E+04	.21588E+01	.78362E+00	.20000E+01	.47040E+00	.92519E+02
13	9.377	.11013E+04	.51518E+04	.22948E+01	.78362E+00	.20000E+01	.47082E+00	.10189E+03
14	9.374	.11013E+04	.51876E+04	.22989E+01	.78362E+00	.20000E+01	.47074E+00	.11127E+03
15	9.377	.11221E+04	.53289E+04	.23883E+01	.78362E+00	.20000E+01	.47083E+00	.12064E+03
16	9.374	.11371E+04	.53847E+04	.24312E+01	.78362E+00	.20000E+01	.47090E+00	.13002E+03
17	10.000	.12501E+04	.57742E+04	.22078E+01	.78362E+00	.21000E+01	.47043E+00	.13939E+03
18	10.000	.12387E+04	.57546E+04	.21896E+01	.78362E+00	.21000E+01	.47048E+00	.14939E+03
19	10.000	.12169E+04	.56647E+04	.21489E+01	.78362E+00	.21000E+01	.47052E+00	.15939E+03
20	10.000	.11673E+04	.54874E+04	.24054E+01	.78362E+00	.21000E+01	.47113E+00	.16940E+03
21	10.000	.11972E+04	.55941E+04	.23149E+01	.78362E+00	.21000E+01	.47112E+00	.17940E+03
22	10.000	.12480E+04	.57842E+04	.23258E+01	.78362E+00	.21000E+01	.47122E+00	.18939E+03
23	10.598	.12929E+04	.59716E+04	.22580E+01	.78362E+00	.21000E+01	.47087E+00	.19939E+03
24	10.598	.14133E+04	.62323E+04	.18470E+01	.68591E+00	.21000E+01	.46920E+00	.20999E+03
25	11.500	.13989E+04	.62270E+04	.19221E+01	.68591E+00	.21000E+01	.46928E+00	.22059E+03
26	11.500	.14166E+04	.62870E+04	.19627E+01	.68591E+00	.21000E+01	.46945E+00	.23209E+03
27	17.668	.14275E+04	.63600E+04	.18876E+01	.68591E+00	.21000E+01	.46920E+00	.24359E+03
28	17.668	.14119E+04	.63143E+04	.19824E+01	.68591E+00	.21000E+01	.46953E+00	.26126E+03
29	17.668	.14337E+04	.64717E+04	.19796E+01	.68591E+00	.21000E+01	.46938E+00	.27893E+03
30	18.249	.14418E+04	.65566E+04	.19950E+01	.68591E+00	.21000E+01	.46931E+00	.29660E+03
31	18.249	.15043E+04	.67888E+04	.20254E+01	.68591E+00	.21000E+01	.46946E+00	.31484E+03
32	18.249	.15644E+04	.70375E+04	.20257E+01	.68591E+00	.21000E+01	.46943E+00	.33309E+03
33	18.249	.15442E+04	.70543E+04	.20417E+01	.68591E+00	.21000E+01	.46937E+00	.35134E+03

Table 5.2-5 (Sheet 4 of 6) Strain Compatible Properties for Profile 270, 500 ft (-1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	20.001	.15470E+04	.70860E+04	.21089E+01	.68591E+00	.21000E+01	.46949E+00	.36959E+03
35	20.001	.15888E+04	.72320E+04	.21376E+01	.68591E+00	.21000E+01	.46959E+00	.38959E+03
36	20.001	.15757E+04	.71363E+04	.21238E+01	.68591E+00	.21000E+01	.46964E+00	.40959E+03
37	20.001	.15967E+04	.72432E+04	.21894E+01	.68591E+00	.21000E+01	.46982E+00	.42959E+03
38	20.001	.15772E+04	.72018E+04	.22241E+01	.68591E+00	.21000E+01	.46991E+00	.44960E+03
39	20.001	.16277E+04	.72796E+04	.21970E+01	.68591E+00	.21000E+01	.47017E+00	.46960E+03
40	10.404	.15862E+04	.71998E+04	.22431E+01	.68591E+00	.21000E+01	.47009E+00	.48960E+03
41	997.424	.23741E+04	.55886E+04	.50000E+00	.50000E+00	.21500E+01	.38986E+00	.50000E+03
42	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-5 (Sheet 5 of 6) Strain Compatible Properties for Profile 270, 500 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	7.917	.16024E+04	.64820E+04	.23596E+01	.12237E+01	.20000E+01	.46982E+00	.00000E+00
2	7.914	.16025E+04	.66488E+04	.39560E+01	.12237E+01	.20000E+01	.47374E+00	.79170E+01
3	7.917	.17223E+04	.70193E+04	.43245E+01	.10265E+01	.20000E+01	.47451E+00	.15831E+02
4	7.914	.16778E+04	.68756E+04	.48592E+01	.10265E+01	.20000E+01	.47582E+00	.23748E+02
5	8.580	.16144E+04	.66694E+04	.52722E+01	.10265E+01	.20000E+01	.47685E+00	.31662E+02
6	8.580	.17144E+04	.70330E+04	.52404E+01	.10265E+01	.20000E+01	.47702E+00	.40242E+02
7	8.580	.15861E+04	.67639E+04	.47979E+01	.10265E+01	.20000E+01	.47593E+00	.48822E+02
8	8.580	.15544E+04	.66842E+04	.49489E+01	.10265E+01	.20000E+01	.47635E+00	.57402E+02
9	8.580	.14991E+04	.65676E+04	.51309E+01	.10265E+01	.20000E+01	.47648E+00	.65982E+02
10	8.580	.15357E+04	.66785E+04	.55941E+01	.10265E+01	.20000E+01	.47735E+00	.74562E+02
11	9.377	.15943E+04	.69174E+04	.40007E+01	.81502E+00	.20000E+01	.47694E+00	.83142E+02
12	9.374	.16156E+04	.70356E+04	.39812E+01	.81502E+00	.20000E+01	.47679E+00	.92519E+02
13	9.377	.15410E+04	.67511E+04	.43231E+01	.81502E+00	.20000E+01	.47747E+00	.10189E+03
14	9.374	.15820E+04	.69098E+04	.44054E+01	.81502E+00	.20000E+01	.47771E+00	.11127E+03
15	9.377	.15948E+04	.69382E+04	.43264E+01	.81502E+00	.20000E+01	.47784E+00	.12064E+03
16	9.374	.16231E+04	.70902E+04	.43025E+01	.81502E+00	.20000E+01	.47784E+00	.13002E+03
17	10.000	.17702E+04	.76957E+04	.39025E+01	.81502E+00	.21000E+01	.47678E+00	.13939E+03
18	10.000	.17731E+04	.77146E+04	.41192E+01	.81502E+00	.21000E+01	.47706E+00	.14939E+03
19	10.000	.18327E+04	.79844E+04	.42592E+01	.81502E+00	.21000E+01	.47720E+00	.15939E+03
20	10.000	.17045E+04	.75198E+04	.44420E+01	.81502E+00	.21000E+01	.47780E+00	.16940E+03
21	10.000	.17485E+04	.77340E+04	.45263E+01	.81502E+00	.21000E+01	.47764E+00	.17940E+03
22	10.000	.17427E+04	.77565E+04	.45103E+01	.81502E+00	.21000E+01	.47747E+00	.18939E+03
23	10.598	.18519E+04	.81836E+04	.43277E+01	.81502E+00	.21000E+01	.47723E+00	.19939E+03
24	10.598	.19379E+04	.82727E+04	.37793E+01	.72106E+00	.21000E+01	.47443E+00	.20999E+03
25	11.500	.19073E+04	.81362E+04	.38524E+01	.72106E+00	.21000E+01	.47482E+00	.22059E+03
26	11.500	.18994E+04	.81380E+04	.38546E+01	.72106E+00	.21000E+01	.47477E+00	.23209E+03
27	17.668	.19923E+04	.84805E+04	.38823E+01	.72106E+00	.21000E+01	.47483E+00	.24359E+03
28	17.668	.19038E+04	.81681E+04	.40747E+01	.72106E+00	.21000E+01	.47517E+00	.26126E+03
29	17.668	.19359E+04	.82449E+04	.40882E+01	.72106E+00	.21000E+01	.47538E+00	.27893E+03
30	18.249	.19771E+04	.83776E+04	.40741E+01	.72106E+00	.21000E+01	.47555E+00	.29660E+03
31	18.249	.19617E+04	.83622E+04	.40279E+01	.72106E+00	.21000E+01	.47534E+00	.31484E+03
32	18.249	.19878E+04	.84724E+04	.39517E+01	.72106E+00	.21000E+01	.47520E+00	.33309E+03
33	18.249	.20030E+04	.84576E+04	.40396E+01	.72106E+00	.21000E+01	.47555E+00	.35134E+03

Table 5.2-5 (Sheet 6 of 6) Strain Compatible Properties for Profile 270, 500 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	20.001	.19811E+04	.83784E+04	.40553E+01	.72106E+00	.21000E+01	.47567E+00	.36959E+03
35	20.001	.19905E+04	.84613E+04	.39911E+01	.72106E+00	.21000E+01	.47554E+00	.38959E+03
36	20.001	.20430E+04	.87320E+04	.40392E+01	.72106E+00	.21000E+01	.47552E+00	.40959E+03
37	20.001	.19844E+04	.85076E+04	.40768E+01	.72106E+00	.21000E+01	.47561E+00	.42959E+03
38	20.001	.19735E+04	.84535E+04	.41659E+01	.72106E+00	.21000E+01	.47583E+00	.44960E+03
39	20.001	.19768E+04	.86137E+04	.41458E+01	.72106E+00	.21000E+01	.47546E+00	.46960E+03
40	10.404	.19991E+04	.86341E+04	.41593E+01	.72106E+00	.21000E+01	.47582E+00	.48960E+03
41	997.424	.41883E+04	.98597E+04	.50000E+00	.50000E+00	.21500E+01	.38995E+00	.50000E+03
42	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-6 Strain Compatible Properties for Profile 560, 100 ft (Median) (Sheet 1 of 2)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.13266E+04	.57657E+04	.39537E+01	.32280E+01	.20000E+01	.47198E+00	.00000E+00
2	6.500	.14181E+04	.53744E+04	.49677E+01	.32115E+01	.20000E+01	.46214E+00	.60010E+01
3	6.500	.14370E+04	.56856E+04	.56024E+01	.32115E+01	.20000E+01	.46488E+00	.12501E+02
4	11.001	.14688E+04	.51086E+04	.66315E+01	.32265E+01	.20000E+01	.45386E+00	.19001E+02
5	10.000	.16120E+04	.49549E+04	.66176E+01	.32212E+01	.21000E+01	.44032E+00	.30002E+02
6	10.000	.15880E+04	.49839E+04	.70567E+01	.32212E+01	.21000E+01	.44280E+00	.40002E+02
7	18.000	.17806E+04	.48546E+04	.67765E+01	.31953E+01	.21000E+01	.42133E+00	.50002E+02
8	14.502	.19139E+04	.51151E+04	.68377E+01	.31940E+01	.21000E+01	.41771E+00	.68002E+02
9	14.499	.20266E+04	.53755E+04	.68403E+01	.31934E+01	.21000E+01	.41608E+00	.82504E+02
10	2.997	.20156E+04	.53759E+04	.69727E+01	.31934E+01	.21000E+01	.41730E+00	.97003E+02
11	997.424	.33261E+04	.78330E+04	.50000E+00	.50000E+00	.21500E+01	.39001E+00	.10000E+03
12	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.10974E+04
-1 Sigma								
1	6.001	.92872E+03	.41522E+04	.27064E+01	.31715E+01	.20000E+01	.47018E+00	.00000E+00
2	6.500	.10131E+04	.40878E+04	.33698E+01	.31290E+01	.20000E+01	.45700E+00	.60010E+01
3	6.500	.96616E+03	.42533E+04	.36430E+01	.31290E+01	.20000E+01	.45792E+00	.12501E+02
4	11.001	.10294E+04	.39144E+04	.47033E+01	.31388E+01	.20000E+01	.44596E+00	.19001E+02
5	10.000	.12345E+04	.39648E+04	.48447E+01	.31109E+01	.21000E+01	.43335E+00	.30002E+02
6	10.000	.12417E+04	.41030E+04	.51764E+01	.31109E+01	.21000E+01	.43513E+00	.40002E+02
7	18.000	.14323E+04	.40781E+04	.50212E+01	.30422E+01	.21000E+01	.41154E+00	.50002E+02
8	14.502	.15726E+04	.43720E+04	.52065E+01	.30342E+01	.21000E+01	.40768E+00	.68002E+02
9	14.499	.16950E+04	.47158E+04	.52159E+01	.30309E+01	.21000E+01	.40558E+00	.82504E+02
10	2.997	.16949E+04	.47066E+04	.53134E+01	.30309E+01	.21000E+01	.40702E+00	.97003E+02
11	997.424	.26541E+04	.62501E+04	.50000E+00	.50000E+00	.21500E+01	.38998E+00	.10000E+03
12	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.10974E+04
+1 Sigma								
1	6.001	.18950E+04	.80063E+04	.57759E+01	.32854E+01	.20000E+01	.47380E+00	.00000E+00
2	6.500	.19849E+04	.70658E+04	.73232E+01	.32961E+01	.20000E+01	.46733E+00	.60010E+01
3	6.500	.21373E+04	.76002E+04	.86157E+01	.32961E+01	.20000E+01	.47195E+00	.12501E+02
4	11.001	.20959E+04	.66671E+04	.93502E+01	.33167E+01	.20000E+01	.46189E+00	.19001E+02
5	10.000	.21048E+04	.61923E+04	.90392E+01	.33355E+01	.21000E+01	.44740E+00	.30002E+02
6	10.000	.20309E+04	.60539E+04	.96199E+01	.33355E+01	.21000E+01	.45062E+00	.40002E+02
7	18.000	.22136E+04	.57790E+04	.91453E+01	.33562E+01	.21000E+01	.43136E+00	.50002E+02
8	14.502	.23293E+04	.59845E+04	.89800E+01	.33622E+01	.21000E+01	.42798E+00	.68002E+02

Table 5.2-6 (Sheet 2 of 2) Strain Compatible Properties for Profile 560, 100 ft (Median)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
9	14.499	.24232E+04	.61274E+04	.89705E+01	.33645E+01	.21000E+01	.42685E+00	.82504E+02
10	2.997	.23969E+04	.61403E+04	.91502E+01	.33645E+01	.21000E+01	.42783E+00	.97003E+02
11	997.424	.41683E+04	.98168E+04	.50000E+00	.50000E+00	.21500E+01	.39005E+00	.10000E+03
12	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.10974E+04

Table 5.2-7 Strain Compatible Properties for Profile 560, 200 ft (Median) (Sheet 1 of 2)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.13798E+04	.59564E+04	.39117E+01	.32280E+01	.20000E+01	.46979E+00	.00000E+00
2	6.500	.13834E+04	.54764E+04	.53002E+01	.32115E+01	.20000E+01	.46000E+00	.60010E+01
3	6.500	.12748E+04	.54642E+04	.65224E+01	.32115E+01	.20000E+01	.46593E+00	.12501E+02
4	11.001	.12632E+04	.51382E+04	.77433E+01	.32265E+01	.20000E+01	.45998E+00	.19001E+02
5	10.000	.14481E+04	.48111E+04	.77877E+01	.32212E+01	.21000E+01	.43540E+00	.30002E+02
6	10.000	.15515E+04	.51606E+04	.78211E+01	.32212E+01	.21000E+01	.44442E+00	.40002E+02
7	18.000	.16240E+04	.47721E+04	.78823E+01	.31953E+01	.21000E+01	.43176E+00	.50002E+02
8	14.502	.17880E+04	.49812E+04	.77629E+01	.31940E+01	.21000E+01	.42080E+00	.68002E+02
9	14.499	.18009E+04	.50396E+04	.80277E+01	.31934E+01	.21000E+01	.42146E+00	.82504E+02
10	20.001	.19370E+04	.53775E+04	.79055E+01	.31934E+01	.21000E+01	.42168E+00	.97003E+02
11	20.001	.20180E+04	.56034E+04	.68614E+01	.31425E+01	.21000E+01	.42315E+00	.11700E+03
12	22.665	.21582E+04	.58524E+04	.68022E+01	.31425E+01	.21000E+01	.41558E+00	.13701E+03
13	22.665	.21879E+04	.58977E+04	.69478E+01	.31425E+01	.21000E+01	.41471E+00	.15967E+03
14	17.665	.21444E+04	.57412E+04	.71800E+01	.31425E+01	.21000E+01	.40840E+00	.18234E+03
15	997.424	.33925E+04	.73374E+04	.50000E+00	.50000E+00	.21500E+01	.79957E+00	.20000E+03
16	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04
-1 Sigma								
1	6.001	.10955E+04	.47508E+04	.27033E+01	.31715E+01	.20000E+01	.45680E+00	.00000E+00
2	6.500	.10063E+04	.42951E+04	.35788E+01	.31290E+01	.20000E+01	.43656E+00	.60010E+01
3	6.500	.89170E+03	.42677E+04	.43596E+01	.31290E+01	.20000E+01	.44666E+00	.12501E+02
4	11.001	.87197E+03	.40042E+04	.57809E+01	.31388E+01	.20000E+01	.44166E+00	.19001E+02
5	10.000	.11059E+04	.38517E+04	.59770E+01	.31109E+01	.21000E+01	.37323E+00	.30002E+02
6	10.000	.12100E+04	.43597E+04	.59462E+01	.31109E+01	.21000E+01	.42078E+00	.40002E+02
7	18.000	.13430E+04	.41253E+04	.60608E+01	.30422E+01	.21000E+01	.41471E+00	.50002E+02
8	14.502	.14184E+04	.42793E+04	.58234E+01	.30342E+01	.21000E+01	.38970E+00	.68002E+02
9	14.499	.13964E+04	.43336E+04	.59039E+01	.30309E+01	.21000E+01	.39520E+00	.82504E+02
10	20.001	.15268E+04	.45869E+04	.57346E+01	.30309E+01	.21000E+01	.40209E+00	.97003E+02
11	20.001	.16532E+04	.47952E+04	.51326E+01	.29453E+01	.21000E+01	.40821E+00	.11700E+03
12	22.665	.17177E+04	.48870E+04	.51104E+01	.29453E+01	.21000E+01	.38604E+00	.13701E+03
13	22.665	.17795E+04	.49512E+04	.51623E+01	.29453E+01	.21000E+01	.38743E+00	.15967E+03
14	17.665	.17331E+04	.48943E+04	.55017E+01	.29453E+01	.21000E+01	.36167E+00	.18234E+03
15	997.424	.27849E+04	.58507E+04	.50000E+00	.50000E+00	.21500E+01	.29731E+00	.20000E+03
16	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04

Table 5.2-7 (Sheet 2 of 2) Strain Compatible Properties for Profile 560, 200 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.17378E+04	.74680E+04	.56602E+01	.32854E+01	.20000E+01	.48315E+00	.00000E+00
2	6.500	.19018E+04	.69827E+04	.78495E+01	.32961E+01	.20000E+01	.48471E+00	.60010E+01
3	6.500	.18226E+04	.69961E+04	.97581E+01	.32961E+01	.20000E+01	.48603E+00	.12501E+02
4	11.001	.18299E+04	.65934E+04	.10372E+02	.33167E+01	.20000E+01	.47907E+00	.19001E+02
5	10.000	.18960E+04	.60095E+04	.10147E+02	.33355E+01	.21000E+01	.50793E+00	.30002E+02
6	10.000	.19894E+04	.61086E+04	.10287E+02	.33355E+01	.21000E+01	.46940E+00	.40002E+02
7	18.000	.19638E+04	.55203E+04	.10251E+02	.33562E+01	.21000E+01	.44951E+00	.50002E+02
8	14.502	.22539E+04	.57984E+04	.10348E+02	.33622E+01	.21000E+01	.45438E+00	.68002E+02
9	14.499	.23226E+04	.58607E+04	.10916E+02	.33645E+01	.21000E+01	.44947E+00	.82504E+02
10	20.001	.24573E+04	.63044E+04	.10898E+02	.33645E+01	.21000E+01	.44224E+00	.97003E+02
11	20.001	.24632E+04	.65478E+04	.91724E+01	.33528E+01	.21000E+01	.43864E+00	.11700E+03
12	22.665	.27117E+04	.70085E+04	.90540E+01	.33528E+01	.21000E+01	.44738E+00	.13701E+03
13	22.665	.26902E+04	.70251E+04	.93508E+01	.33528E+01	.21000E+01	.44391E+00	.15967E+03
14	17.665	.26533E+04	.67347E+04	.93702E+01	.33528E+01	.21000E+01	.46116E+00	.18234E+03
15	997.424	.41328E+04	.92019E+04	.50000E+00	.50000E+00	.21500E+01	.21503E+01	.20000E+03
16	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.11974E+04

Table 5.2-8 Strain Compatible Properties for Profile 560, 500 ft (Median) (Sheet 1 of 6)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.13217E+04	.57203E+04	.38236E+01	.32280E+01	.20000E+01	.47173E+00	.00000E+00
2	6.500	.14358E+04	.53807E+04	.48580E+01	.32115E+01	.20000E+01	.46131E+00	.60010E+01
3	6.500	.13432E+04	.53015E+04	.58253E+01	.32115E+01	.20000E+01	.46511E+00	.12501E+02
4	11.001	.14994E+04	.51578E+04	.65047E+01	.32265E+01	.20000E+01	.45307E+00	.19001E+02
5	10.000	.17158E+04	.52061E+04	.64304E+01	.32212E+01	.21000E+01	.43849E+00	.30002E+02
6	10.000	.16982E+04	.52541E+04	.68593E+01	.32212E+01	.21000E+01	.44103E+00	.40002E+02
7	18.000	.18568E+04	.50461E+04	.65935E+01	.31953E+01	.21000E+01	.42021E+00	.50002E+02
8	14.502	.19803E+04	.52765E+04	.67480E+01	.31940E+01	.21000E+01	.41690E+00	.68002E+02
9	14.499	.20389E+04	.54083E+04	.68839E+01	.31934E+01	.21000E+01	.41638E+00	.82504E+02
10	20.001	.21110E+04	.56203E+04	.69776E+01	.31934E+01	.21000E+01	.41705E+00	.97003E+02
11	20.001	.21570E+04	.57199E+04	.61548E+01	.31425E+01	.21000E+01	.41656E+00	.11700E+03
12	22.665	.23136E+04	.61208E+04	.61085E+01	.31425E+01	.21000E+01	.41600E+00	.13701E+03
13	22.665	.23358E+04	.62186E+04	.62228E+01	.31425E+01	.21000E+01	.41718E+00	.15967E+03
14	22.668	.23730E+04	.63594E+04	.63608E+01	.31425E+01	.21000E+01	.41822E+00	.18234E+03
15	20.998	.24547E+04	.65804E+04	.63546E+01	.31425E+01	.21000E+01	.41826E+00	.20500E+03
16	20.998	.24518E+04	.66121E+04	.64640E+01	.31425E+01	.21000E+01	.41925E+00	.22600E+03
17	12.501	.26469E+04	.67333E+04	.58186E+01	.31508E+01	.21000E+01	.40820E+00	.24700E+03
18	12.501	.25915E+04	.66204E+04	.59320E+01	.31508E+01	.21000E+01	.40907E+00	.25950E+03
19	12.501	.27193E+04	.69146E+04	.58053E+01	.31508E+01	.21000E+01	.40810E+00	.27200E+03
20	12.501	.28421E+04	.71946E+04	.57023E+01	.31508E+01	.21000E+01	.40717E+00	.28450E+03
21	12.501	.28362E+04	.71872E+04	.57648E+01	.31508E+01	.21000E+01	.40748E+00	.29700E+03
22	12.501	.28196E+04	.71666E+04	.58295E+01	.31508E+01	.21000E+01	.40807E+00	.30950E+03
23	12.501	.28435E+04	.72286E+04	.58325E+01	.31508E+01	.21000E+01	.40811E+00	.32201E+03
24	12.501	.28395E+04	.72325E+04	.58872E+01	.31508E+01	.21000E+01	.40852E+00	.33451E+03
25	12.501	.27653E+04	.70782E+04	.60174E+01	.31508E+01	.21000E+01	.40954E+00	.34701E+03
26	12.501	.27388E+04	.70269E+04	.61000E+01	.31508E+01	.21000E+01	.41010E+00	.35951E+03
27	12.501	.27854E+04	.71390E+04	.60737E+01	.31508E+01	.21000E+01	.40987E+00	.37201E+03
28	12.501	.28390E+04	.72667E+04	.60288E+01	.31508E+01	.21000E+01	.40960E+00	.38451E+03
29	12.501	.27677E+04	.71172E+04	.61500E+01	.31508E+01	.21000E+01	.41056E+00	.39701E+03
30	12.501	.27878E+04	.71770E+04	.61685E+01	.31508E+01	.21000E+01	.41078E+00	.40951E+03
31	12.501	.27750E+04	.71536E+04	.62183E+01	.31508E+01	.21000E+01	.41109E+00	.42201E+03
32	12.501	.27582E+04	.71259E+04	.62614E+01	.31508E+01	.21000E+01	.41152E+00	.43451E+03
33	12.501	.26945E+04	.69940E+04	.63824E+01	.31508E+01	.21000E+01	.41248E+00	.44702E+03

Table 5.2-8 (Sheet 2 of 6) Strain Compatible Properties for Profile 560, 500 ft (Median)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	12.501	.26754E+04	.69630E+04	.64350E+01	.31508E+01	.21000E+01	.41300E+00	.45952E+03
35	13.124	.26416E+04	.68977E+04	.65190E+01	.31508E+01	.21000E+01	.41366E+00	.47202E+03
36	13.124	.26195E+04	.68601E+04	.65735E+01	.31508E+01	.21000E+01	.41421E+00	.48514E+03
37	1.732	.25695E+04	.67558E+04	.66759E+01	.31508E+01	.21000E+01	.41499E+00	.49827E+03
38	997.424	.33138E+04	.78040E+04	.50000E+00	.50000E+00	.21500E+01	.39002E+00	.50000E+03
39	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-8 (Sheet 3 of 6) Strain Compatible Properties for Profile 560, 500 ft (-1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.89776E+03	.40022E+04	.26798E+01	.31715E+01	.20000E+01	.46989E+00	.00000E+00
2	6.500	.97831E+03	.38756E+04	.32866E+01	.31290E+01	.20000E+01	.45663E+00	.60010E+01
3	6.500	.88911E+03	.37895E+04	.39458E+01	.31290E+01	.20000E+01	.45939E+00	.12501E+02
4	11.001	.10352E+04	.38275E+04	.45767E+01	.31388E+01	.20000E+01	.44570E+00	.19001E+02
5	10.000	.13280E+04	.42254E+04	.48054E+01	.31109E+01	.21000E+01	.43135E+00	.30002E+02
6	10.000	.13027E+04	.42418E+04	.50578E+01	.31109E+01	.21000E+01	.43353E+00	.40002E+02
7	18.000	.14628E+04	.42577E+04	.47629E+01	.30422E+01	.21000E+01	.40831E+00	.50002E+02
8	14.502	.16354E+04	.46005E+04	.49872E+01	.30342E+01	.21000E+01	.40638E+00	.68002E+02
9	14.499	.16994E+04	.46712E+04	.49713E+01	.30309E+01	.21000E+01	.40674E+00	.82504E+02
10	20.001	.17009E+04	.47001E+04	.49670E+01	.30309E+01	.21000E+01	.40744E+00	.97003E+02
11	20.001	.18092E+04	.49436E+04	.43902E+01	.29453E+01	.21000E+01	.40838E+00	.11700E+03
12	22.665	.19076E+04	.52290E+04	.43955E+01	.29453E+01	.21000E+01	.40715E+00	.13701E+03
13	22.665	.18841E+04	.52046E+04	.44382E+01	.29453E+01	.21000E+01	.40812E+00	.15967E+03
14	22.668	.18902E+04	.52974E+04	.46137E+01	.29453E+01	.21000E+01	.40804E+00	.18234E+03
15	20.998	.19889E+04	.55864E+04	.46855E+01	.29453E+01	.21000E+01	.40789E+00	.20500E+03
16	20.998	.19461E+04	.55166E+04	.46656E+01	.29453E+01	.21000E+01	.40849E+00	.22600E+03
17	12.501	.21632E+04	.56513E+04	.40773E+01	.29199E+01	.21000E+01	.40090E+00	.24700E+03
18	12.501	.21453E+04	.56360E+04	.41747E+01	.29199E+01	.21000E+01	.40155E+00	.25950E+03
19	12.501	.23201E+04	.60643E+04	.40509E+01	.29199E+01	.21000E+01	.40087E+00	.27200E+03
20	12.501	.24659E+04	.64081E+04	.40652E+01	.29199E+01	.21000E+01	.40034E+00	.28450E+03
21	12.501	.24848E+04	.64263E+04	.41369E+01	.29199E+01	.21000E+01	.40133E+00	.29700E+03
22	12.501	.24111E+04	.62789E+04	.41791E+01	.29199E+01	.21000E+01	.40129E+00	.30950E+03
23	12.501	.24993E+04	.65071E+04	.42265E+01	.29199E+01	.21000E+01	.40148E+00	.32201E+03
24	12.501	.24956E+04	.65189E+04	.42520E+01	.29199E+01	.21000E+01	.40173E+00	.33451E+03
25	12.501	.24293E+04	.63853E+04	.43182E+01	.29199E+01	.21000E+01	.40252E+00	.34701E+03
26	12.501	.24135E+04	.63241E+04	.43967E+01	.29199E+01	.21000E+01	.40359E+00	.35951E+03
27	12.501	.24735E+04	.64809E+04	.43443E+01	.29199E+01	.21000E+01	.40328E+00	.37201E+03
28	12.501	.25198E+04	.65955E+04	.42582E+01	.29199E+01	.21000E+01	.40306E+00	.38451E+03
29	12.501	.24708E+04	.65082E+04	.43289E+01	.29199E+01	.21000E+01	.40381E+00	.39701E+03
30	12.501	.24697E+04	.65174E+04	.42767E+01	.29199E+01	.21000E+01	.40388E+00	.40951E+03
31	12.501	.24729E+04	.65149E+04	.43357E+01	.29199E+01	.21000E+01	.40446E+00	.42201E+03
32	12.501	.24057E+04	.63547E+04	.43294E+01	.29199E+01	.21000E+01	.40472E+00	.43451E+03
33	12.501	.23504E+04	.62351E+04	.44656E+01	.29199E+01	.21000E+01	.40561E+00	.44702E+03

Table 5.2-8 (Sheet 4 of 6) Strain Compatible Properties for Profile 560, 500 ft (-1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	12.501	.23091E+04	.61517E+04	.45008E+01	.29199E+01	.21000E+01	.40592E+00	.45952E+03
35	13.124	.22629E+04	.60470E+04	.45886E+01	.29199E+01	.21000E+01	.40656E+00	.47202E+03
36	13.124	.22505E+04	.60450E+04	.46064E+01	.29199E+01	.21000E+01	.40681E+00	.48514E+03
37	1.732	.22296E+04	.60097E+04	.47494E+01	.29199E+01	.21000E+01	.40757E+00	.49827E+03
38	997.424	.29501E+04	.69472E+04	.50000E+00	.50000E+00	.21500E+01	.38999E+00	.50000E+03
39	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-8 (Sheet 5 of 6) Strain Compatible Properties for Profile 560, 500 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	6.001	.19457E+04	.81760E+04	.54556E+01	.32854E+01	.20000E+01	.47359E+00	.00000E+00
2	6.500	.21073E+04	.74703E+04	.71807E+01	.32961E+01	.20000E+01	.46605E+00	.60010E+01
3	6.500	.20293E+04	.74168E+04	.86001E+01	.32961E+01	.20000E+01	.47090E+00	.12501E+02
4	11.001	.21719E+04	.69505E+04	.92450E+01	.33167E+01	.20000E+01	.46056E+00	.19001E+02
5	10.000	.22169E+04	.64144E+04	.86048E+01	.33355E+01	.21000E+01	.44576E+00	.30002E+02
6	10.000	.22137E+04	.65079E+04	.93026E+01	.33355E+01	.21000E+01	.44865E+00	.40002E+02
7	18.000	.23571E+04	.59805E+04	.91278E+01	.33562E+01	.21000E+01	.43246E+00	.50002E+02
8	14.502	.23980E+04	.60518E+04	.91306E+01	.33622E+01	.21000E+01	.42768E+00	.68002E+02
9	14.499	.24461E+04	.62617E+04	.95324E+01	.33645E+01	.21000E+01	.42625E+00	.82504E+02
10	20.001	.26200E+04	.67206E+04	.98020E+01	.33645E+01	.21000E+01	.42689E+00	.97003E+02
11	20.001	.25715E+04	.66182E+04	.86287E+01	.33528E+01	.21000E+01	.42492E+00	.11700E+03
12	22.665	.28060E+04	.71646E+04	.84893E+01	.33528E+01	.21000E+01	.42503E+00	.13701E+03
13	22.665	.28958E+04	.74302E+04	.87249E+01	.33528E+01	.21000E+01	.42643E+00	.15967E+03
14	22.668	.29792E+04	.76344E+04	.87696E+01	.33528E+01	.21000E+01	.42865E+00	.18234E+03
15	20.998	.30295E+04	.77512E+04	.86183E+01	.33528E+01	.21000E+01	.42889E+00	.20500E+03
16	20.998	.30890E+04	.79252E+04	.89557E+01	.33528E+01	.21000E+01	.43030E+00	.22600E+03
17	12.501	.32387E+04	.80225E+04	.83035E+01	.34000E+01	.21000E+01	.41563E+00	.24700E+03
18	12.501	.31305E+04	.77767E+04	.84292E+01	.34000E+01	.21000E+01	.41672E+00	.25950E+03
19	12.501	.31872E+04	.78841E+04	.83195E+01	.34000E+01	.21000E+01	.41546E+00	.27200E+03
20	12.501	.32756E+04	.80776E+04	.79986E+01	.34000E+01	.21000E+01	.41412E+00	.28450E+03
21	12.501	.32372E+04	.80382E+04	.80332E+01	.34000E+01	.21000E+01	.41372E+00	.29700E+03
22	12.501	.32973E+04	.81797E+04	.81316E+01	.34000E+01	.21000E+01	.41496E+00	.30950E+03
23	12.501	.32351E+04	.80301E+04	.80487E+01	.34000E+01	.21000E+01	.41486E+00	.32201E+03
24	12.501	.32306E+04	.80242E+04	.81513E+01	.34000E+01	.21000E+01	.41542E+00	.33451E+03
25	12.501	.31478E+04	.78463E+04	.83853E+01	.34000E+01	.21000E+01	.41668E+00	.34701E+03
26	12.501	.31079E+04	.78077E+04	.84632E+01	.34000E+01	.21000E+01	.41673E+00	.35951E+03
27	12.501	.31366E+04	.78639E+04	.84915E+01	.34000E+01	.21000E+01	.41657E+00	.37201E+03
28	12.501	.31986E+04	.80063E+04	.85356E+01	.34000E+01	.21000E+01	.41624E+00	.38451E+03
29	12.501	.31002E+04	.77832E+04	.87372E+01	.34000E+01	.21000E+01	.41742E+00	.39701E+03
30	12.501	.31468E+04	.79034E+04	.88972E+01	.34000E+01	.21000E+01	.41780E+00	.40951E+03
31	12.501	.31141E+04	.78549E+04	.89183E+01	.34000E+01	.21000E+01	.41782E+00	.42201E+03
32	12.501	.31624E+04	.79907E+04	.90556E+01	.34000E+01	.21000E+01	.41844E+00	.43451E+03
33	12.501	.30889E+04	.78452E+04	.91220E+01	.34000E+01	.21000E+01	.41946E+00	.44702E+03

Table 5.2-8 (Sheet 6 of 6) Strain Compatible Properties for Profile 560, 500 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
34	12.501	.30998E+04	.78813E+04	.92003E+01	.34000E+01	.21000E+01	.42019E+00	.45952E+03
35	13.124	.30837E+04	.78681E+04	.92615E+01	.34000E+01	.21000E+01	.42088E+00	.47202E+03
36	13.124	.30490E+04	.77851E+04	.93806E+01	.34000E+01	.21000E+01	.42175E+00	.48514E+03
37	1.732	.29612E+04	.75946E+04	.93837E+01	.34000E+01	.21000E+01	.42255E+00	.49827E+03
38	997.424	.37224E+04	.87665E+04	.50000E+00	.50000E+00	.21500E+01	.39004E+00	.50000E+03
39	3281.000	.92850E+04	.16080E+05	.50000E-03	.50000E-03	.25200E+01	.24990E+00	.14974E+04

Table 5.2-9 Strain Compatible Properties for Profile 900, 100 ft (Median)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	5.000	.19759E+04	.62284E+04	.35392E+01	.32618E+01	.20000E+01	.44404E+00	.00000E+00
2	6.998	.22224E+04	.60091E+04	.39036E+01	.32602E+01	.21000E+01	.42062E+00	.50000E+01
3	7.999	.22678E+04	.53479E+04	.41119E+01	.32577E+01	.21000E+01	.38981E+00	.11998E+02
4	9.000	.27389E+04	.66072E+04	.37298E+01	.31493E+01	.21000E+01	.39600E+00	.19997E+02
5	11.001	.30377E+04	.77486E+04	.37101E+01	.31598E+01	.21000E+01	.40887E+00	.28997E+02
6	12.999	.34027E+04	.84804E+04	.35983E+01	.31567E+01	.21500E+01	.40395E+00	.39998E+02
7	20.001	.40158E+04	.96892E+04	.35060E+01	.31189E+01	.21500E+01	.39626E+00	.52997E+02
8	23.000	.47306E+04	.10840E+05	.34603E+01	.31067E+01	.22400E+01	.38236E+00	.72998E+02
9	4.001	.49301E+04	.10793E+05	.34415E+01	.30944E+01	.22400E+01	.36815E+00	.95998E+02
10	3281.0	.89361E+04	.17520E+05	.10000E-05	.10000E-05	.25200E+01	.32419E+00	.99999E+02
-1 Sigma								
1	5.000	.14455E+04	.45772E+04	.27309E+01	.31528E+01	.20000E+01	.44307E+00	.00000E+00
2	6.998	.16631E+04	.45754E+04	.26029E+01	.31097E+01	.21000E+01	.41653E+00	.50000E+01
3	7.999	.16847E+04	.40848E+04	.25906E+01	.30566E+01	.21000E+01	.38101E+00	.11998E+02
4	9.000	.21549E+04	.52896E+04	.26371E+01	.29501E+01	.21000E+01	.39013E+00	.19997E+02
5	11.001	.23108E+04	.60363E+04	.27056E+01	.29805E+01	.21000E+01	.40265E+00	.28997E+02
6	12.999	.27709E+04	.69290E+04	.26535E+01	.29716E+01	.21500E+01	.40023E+00	.39998E+02
7	20.001	.33141E+04	.80263E+04	.27333E+01	.29043E+01	.21500E+01	.39397E+00	.52997E+02
8	23.000	.40444E+04	.92935E+04	.27312E+01	.28703E+01	.22400E+01	.38057E+00	.72998E+02
9	4.001	.41619E+04	.91355E+04	.27506E+01	.28366E+01	.22400E+01	.36610E+00	.95998E+02
10	3281.0	.63383E+04	.12427E+05	.99999E-06	.99999E-06	.25200E+01	.32410E+00	.99999E+02
+1 Sigma								
1	5.000	.27009E+04	.84754E+04	.45869E+01	.33745E+01	.20000E+01	.44501E+00	.00000E+00
2	6.998	.29699E+04	.78922E+04	.58543E+01	.34181E+01	.21000E+01	.42476E+00	.50000E+01
3	7.999	.30528E+04	.70016E+04	.65264E+01	.34720E+01	.21000E+01	.39880E+00	.11998E+02
4	9.000	.34812E+04	.82528E+04	.52754E+01	.33620E+01	.21000E+01	.40195E+00	.19997E+02
5	11.001	.39934E+04	.99465E+04	.50874E+01	.33499E+01	.21000E+01	.41519E+00	.28997E+02
6	12.999	.41784E+04	.10379E+05	.48795E+01	.33534E+01	.21500E+01	.40771E+00	.39998E+02
7	20.001	.48661E+04	.11697E+05	.44972E+01	.33494E+01	.21500E+01	.39856E+00	.52997E+02
8	23.000	.55331E+04	.12644E+05	.43839E+01	.33625E+01	.22400E+01	.38415E+00	.72998E+02
9	4.001	.58400E+04	.12752E+05	.43059E+01	.33757E+01	.22400E+01	.37021E+00	.95998E+02
10	3281.0	.12599E+05	.24700E+05	.10000E-05	.10000E-05	.25200E+01	.32428E+00	.99999E+02

Table 5.2-10 Strain Compatible Properties for Profile 900, 200 ft (Median)

(Sheet 1 of 2)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	5.000	.19442E+04	.61418E+04	.37985E+01	.32618E+01	.20000E+01	.44430E+00	.00000E+00
2	6.998	.20426E+04	.55553E+04	.43178E+01	.32602E+01	.21000E+01	.42168E+00	.50000E+01
3	7.999	.23051E+04	.54548E+04	.44976E+01	.32577E+01	.21000E+01	.39085E+00	.11998E+02
4	9.000	.27398E+04	.66431E+04	.37017E+01	.31493E+01	.21000E+01	.39730E+00	.19997E+02
5	11.001	.27609E+04	.71078E+04	.38278E+01	.31598E+01	.21000E+01	.41088E+00	.28997E+02
6	12.999	.32366E+04	.81881E+04	.37513E+01	.31567E+01	.21500E+01	.40707E+00	.39998E+02
7	20.001	.40210E+04	.97553E+04	.36080E+01	.31189E+01	.21500E+01	.39757E+00	.52997E+02
8	23.000	.46531E+04	.10725E+05	.35859E+01	.31067E+01	.22400E+01	.38398E+00	.72998E+02
9	25.001	.47934E+04	.10559E+05	.35937E+01	.30944E+01	.22400E+01	.37013E+00	.95998E+02
10	34.001	.53296E+04	.11237E+05	.35554E+01	.31796E+01	.22400E+01	.35485E+00	.12100E+03
11	43.001	.58718E+04	.11956E+05	.34893E+01	.31770E+01	.22400E+01	.34102E+00	.15500E+03
12	1.998	.59183E+04	.11871E+05	.35175E+01	.31756E+01	.22400E+01	.33457E+00	.19800E+03
13	3281.000	.92641E+04	.18165E+05	.10000E-05	.10000E-05	.25200E+01	.32425E+00	.20000E+03
-1 Sigma								
1	5.000	.14247E+04	.45375E+04	.26730E+01	.31528E+01	.20000E+01	.44304E+00	.00000E+00
2	6.998	.15603E+04	.43292E+04	.27461E+01	.31097E+01	.21000E+01	.41737E+00	.50000E+01
3	7.999	.18261E+04	.44391E+04	.28096E+01	.30566E+01	.21000E+01	.38289E+00	.11998E+02
4	9.000	.21020E+04	.51680E+04	.25247E+01	.29501E+01	.21000E+01	.39173E+00	.19997E+02
5	11.001	.21557E+04	.56414E+04	.25792E+01	.29805E+01	.21000E+01	.40495E+00	.28997E+02
6	12.999	.24632E+04	.63655E+04	.26602E+01	.29716E+01	.21500E+01	.40045E+00	.39998E+02
7	20.001	.33443E+04	.82083E+04	.26943E+01	.29043E+01	.21500E+01	.39390E+00	.52997E+02
8	23.000	.37445E+04	.87038E+04	.26072E+01	.28703E+01	.22400E+01	.38058E+00	.72998E+02
9	25.001	.39467E+04	.87524E+04	.26881E+01	.28366E+01	.22400E+01	.36642E+00	.95998E+02
10	34.001	.45894E+04	.97232E+04	.26613E+01	.29227E+01	.22400E+01	.35212E+00	.12100E+03
11	43.001	.50114E+04	.10233E+05	.26798E+01	.29027E+01	.22400E+01	.33839E+00	.15500E+03
12	1.998	.51461E+04	.10370E+05	.26683E+01	.28930E+01	.22400E+01	.33118E+00	.19800E+03
13	3281.000	.71824E+04	.14082E+05	.99999E-06	.99999E-06	.25200E+01	.32413E+00	.20000E+03

Table 5.2-10 (Sheet 2 of 2) Strain Compatible Properties for Profile 900, 200 ft (+1 Sigma)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	5.000	.26531E+04	.83134E+04	.53977E+01	.33745E+01	.20000E+01	.44556E+00	.00000E+00
2	6.998	.26739E+04	.71287E+04	.67889E+01	.34181E+01	.21000E+01	.42604E+00	.50000E+01
3	7.999	.29097E+04	.67029E+04	.71996E+01	.34720E+01	.21000E+01	.39898E+00	.11998E+02
4	9.000	.35713E+04	.85394E+04	.54274E+01	.33620E+01	.21000E+01	.40295E+00	.19997E+02
5	11.001	.35360E+04	.89553E+04	.56807E+01	.33499E+01	.21000E+01	.41690E+00	.28997E+02
6	12.999	.42530E+04	.10533E+05	.52899E+01	.33534E+01	.21500E+01	.41379E+00	.39998E+02
7	20.001	.48346E+04	.11594E+05	.48316E+01	.33494E+01	.21500E+01	.40127E+00	.52997E+02
8	23.000	.57822E+04	.13215E+05	.49320E+01	.33625E+01	.22400E+01	.38740E+00	.72998E+02
9	25.001	.58218E+04	.12738E+05	.48043E+01	.33757E+01	.22400E+01	.37387E+00	.95998E+02
10	34.001	.61891E+04	.12987E+05	.47499E+01	.34590E+01	.22400E+01	.35761E+00	.12100E+03
11	43.001	.68800E+04	.13968E+05	.45434E+01	.34773E+01	.22400E+01	.34367E+00	.15500E+03
12	1.998	.68063E+04	.13590E+05	.46371E+01	.34858E+01	.22400E+01	.33800E+00	.19800E+03
13	3281.000	.11949E+05	.23433E+05	.10000E-05	.10000E-05	.25200E+01	.32437E+00	.20000E+03

Table 5.2-11 Strain Compatible Properties for Profile 2032, 100 ft (Median) (Sheet 1 of 2)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
1	4.167	.49064E+04	.91792E+04	.32250E+01	.31229E+01	.22400E+01	.30001E+00	.00000E+00
2	4.167	.51465E+04	.95494E+04	.32250E+01	.31208E+01	.22400E+01	.29533E+00	.41670E+01
3	8.334	.53930E+04	.98254E+04	.32250E+01	.31157E+01	.22400E+01	.28441E+00	.83340E+01
4	8.334	.56094E+04	.99644E+04	.32250E+01	.31082E+01	.22400E+01	.26803E+00	.16668E+02
5	8.334	.63151E+04	.11044E+05	.32250E+01	.31033E+01	.22400E+01	.25707E+00	.25002E+02
6	6.660	.65484E+04	.11343E+05	.32250E+01	.31002E+01	.22400E+01	.25003E+00	.33336E+02
7	10.007	.71260E+04	.12343E+05	.31580E+01	.31008E+01	.22400E+01	.25003E+00	.39996E+02
8	16.667	.73327E+04	.12701E+05	.31580E+01	.31008E+01	.22400E+01	.25004E+00	.50003E+02
9	16.667	.77463E+04	.13417E+05	.31580E+01	.31008E+01	.22400E+01	.24999E+00	.66670E+02
10	16.663	.81275E+04	.14077E+05	.31580E+01	.31008E+01	.22400E+01	.25001E+00	.83337E+02
11	3281.0	.85993E+04	.16794E+05	.10000E-05	.10000E-05	.25200E+01	.32231E+00	.10000E+03
-1 Sigma								
1	4.167	.36931E+04	.69093E+04	.32250E+01	.27247E+01	.22400E+01	.29993E+00	.00000E+00
2	4.167	.39987E+04	.74198E+04	.32250E+01	.27165E+01	.22400E+01	.29520E+00	.41670E+01
3	8.334	.41593E+04	.75775E+04	.32250E+01	.26973E+01	.22400E+01	.28432E+00	.83340E+01
4	8.334	.43808E+04	.77816E+04	.32250E+01	.26696E+01	.22400E+01	.26793E+00	.16668E+02
5	8.334	.50037E+04	.87506E+04	.32250E+01	.26516E+01	.22400E+01	.25690E+00	.25002E+02
6	6.660	.53247E+04	.92230E+04	.32250E+01	.26406E+01	.22400E+01	.24985E+00	.33336E+02
7	10.007	.60243E+04	.10435E+05	.31580E+01	.27293E+01	.22400E+01	.24983E+00	.39996E+02
8	16.667	.62740E+04	.10867E+05	.31580E+01	.27293E+01	.22400E+01	.24985E+00	.50003E+02
9	16.667	.65431E+04	.11333E+05	.31580E+01	.27293E+01	.22400E+01	.24978E+00	.66670E+02
10	16.663	.71188E+04	.12329E+05	.31580E+01	.27293E+01	.22400E+01	.24983E+00	.83337E+02
11	3281.0	.60295E+04	.11775E+05	.99999E-06	.99999E-06	.25200E+01	.32222E+00	.10000E+03
+1 Sigma								
1	4.167	.65181E+04	.12195E+05	.32250E+01	.35793E+01	.22400E+01	.30010E+00	.00000E+00
2	4.167	.66238E+04	.12290E+05	.32250E+01	.35853E+01	.22400E+01	.29545E+00	.41670E+01
3	8.334	.69927E+04	.12740E+05	.32250E+01	.35991E+01	.22400E+01	.28451E+00	.83340E+01
4	8.334	.71827E+04	.12760E+05	.32250E+01	.36188E+01	.22400E+01	.26814E+00	.16668E+02
5	8.334	.79703E+04	.13938E+05	.32250E+01	.36319E+01	.22400E+01	.25723E+00	.25002E+02
6	6.660	.80534E+04	.13949E+05	.32250E+01	.36399E+01	.22400E+01	.25020E+00	.33336E+02
7	10.007	.84293E+04	.14601E+05	.31580E+01	.35228E+01	.22400E+01	.25022E+00	.39996E+02

Table 5.2-11 (Sheet 2 of 2) Strain Compatible Properties for Profile 2032, 100 ft (Median)

Layer	Thick(ft)	Mean Vs(ft/s)	Mean Vp(ft/s)	Mean Damps(%)	Mean Dampp(%)	Mean Den(cgs)	Mean Poisson	Depth To Top(ft)
8	16.667	.85700E+04	.14845E+05	.31580E+01	.35228E+01	.22400E+01	.25023E+00	.50003E+02
9	16.667	.91706E+04	.15884E+05	.31580E+01	.35228E+01	.22400E+01	.25020E+00	.66670E+02
10	16.663	.92791E+04	.16073E+05	.31580E+01	.35228E+01	.22400E+01	.25018E+00	.83337E+02
11	3281.00	.12264E+05	.23952E+05	.10000E-05	.10000E-05	.25200E+01	.32241E+00	.10000E+03

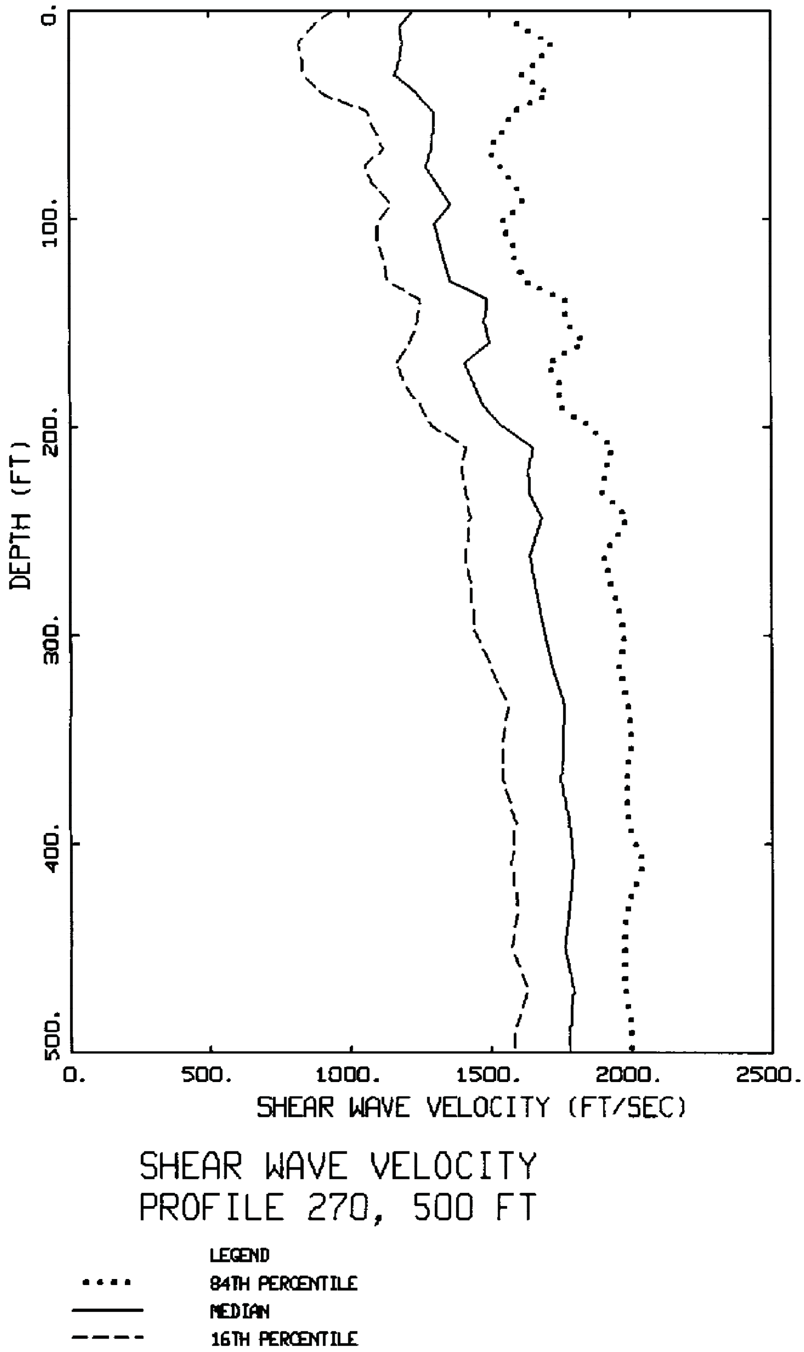


Figure 5.2-6 Strain Compatible Properties Computed for Profile 270, 500 ft Depth to Bedrock (Sheet 1 of 4)

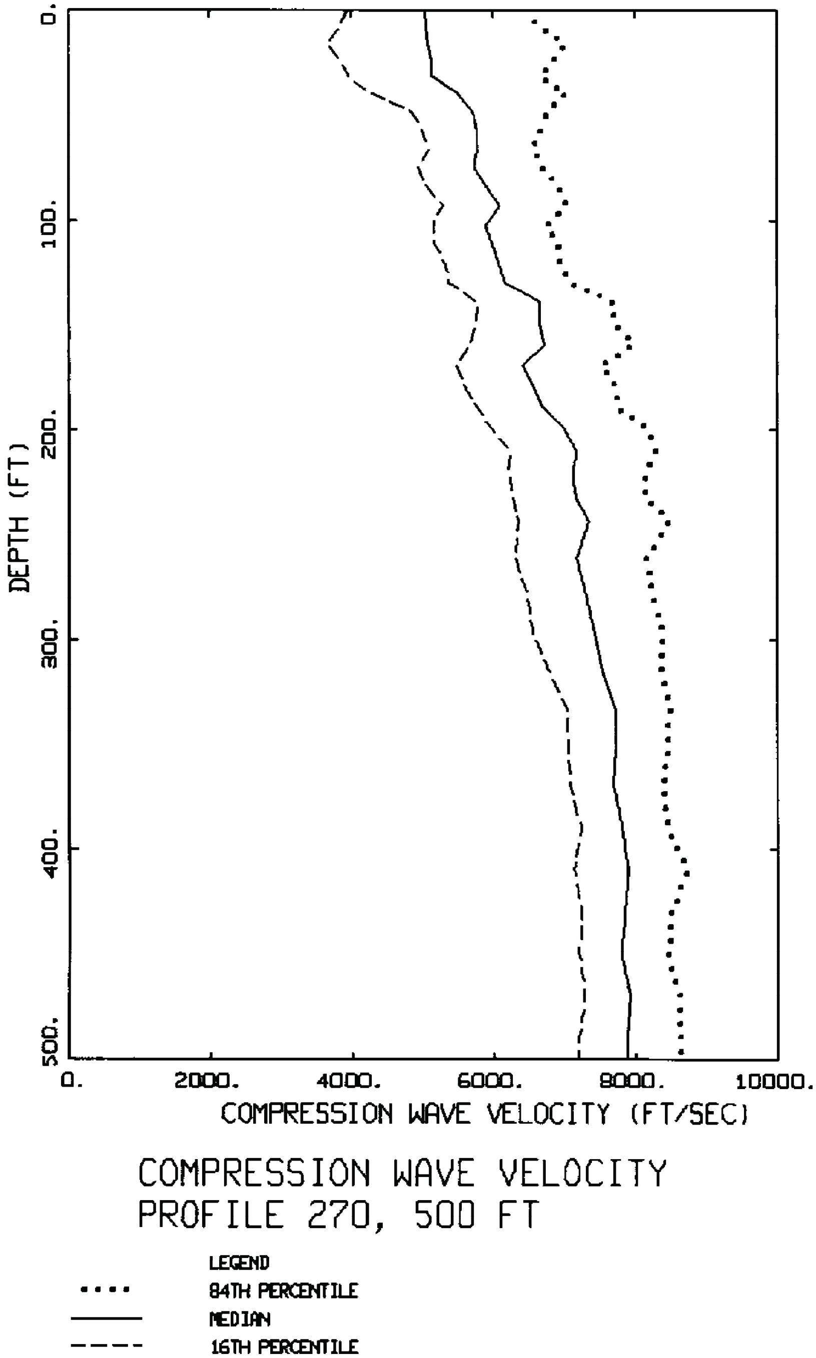


Figure 5.2-6 Strain Compatible Properties Computed for Profile 270 500 ft Depth to Bedrock (Sheet 2 of 4)

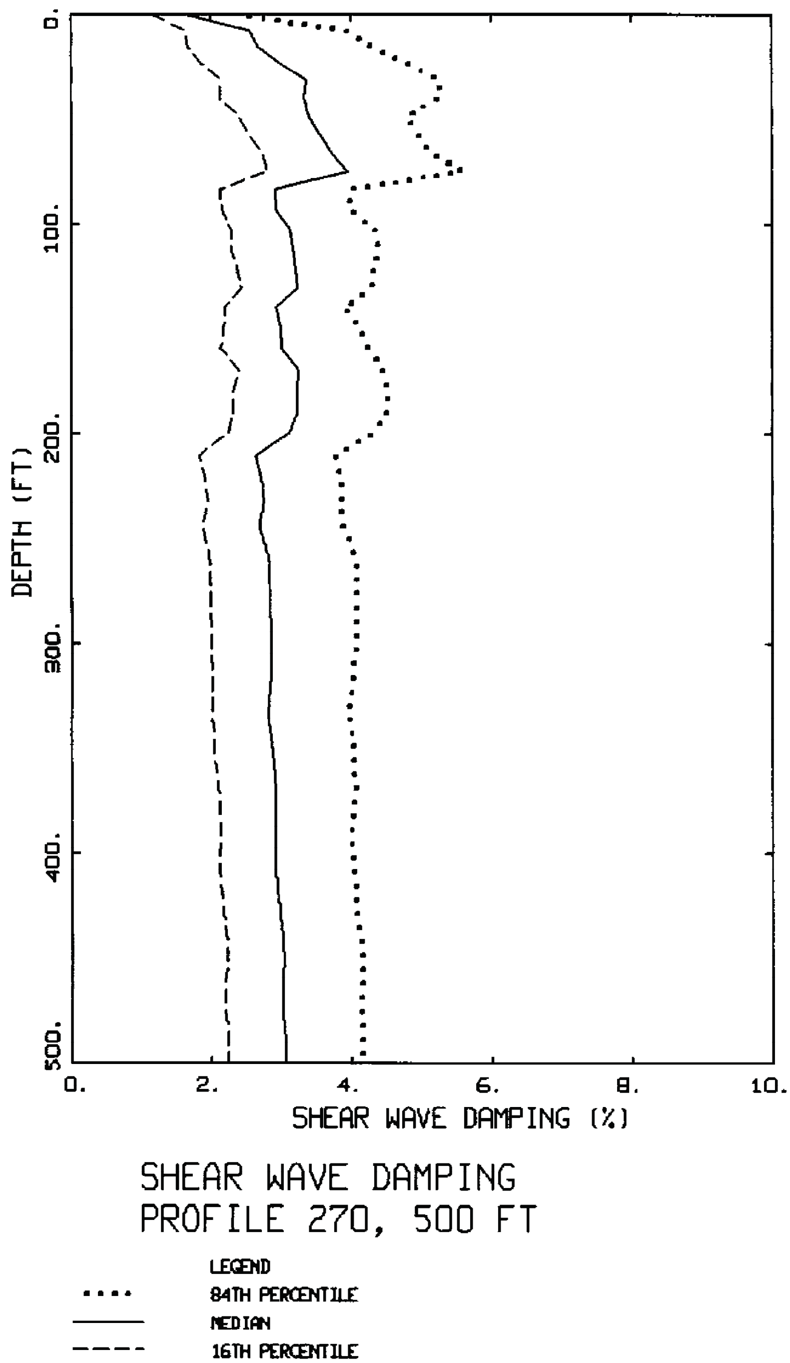


Figure 5.2-6 Strain Compatible Properties Computed for Profile 270 500 ft Depth to Bedrock (Sheet 3 of 4)

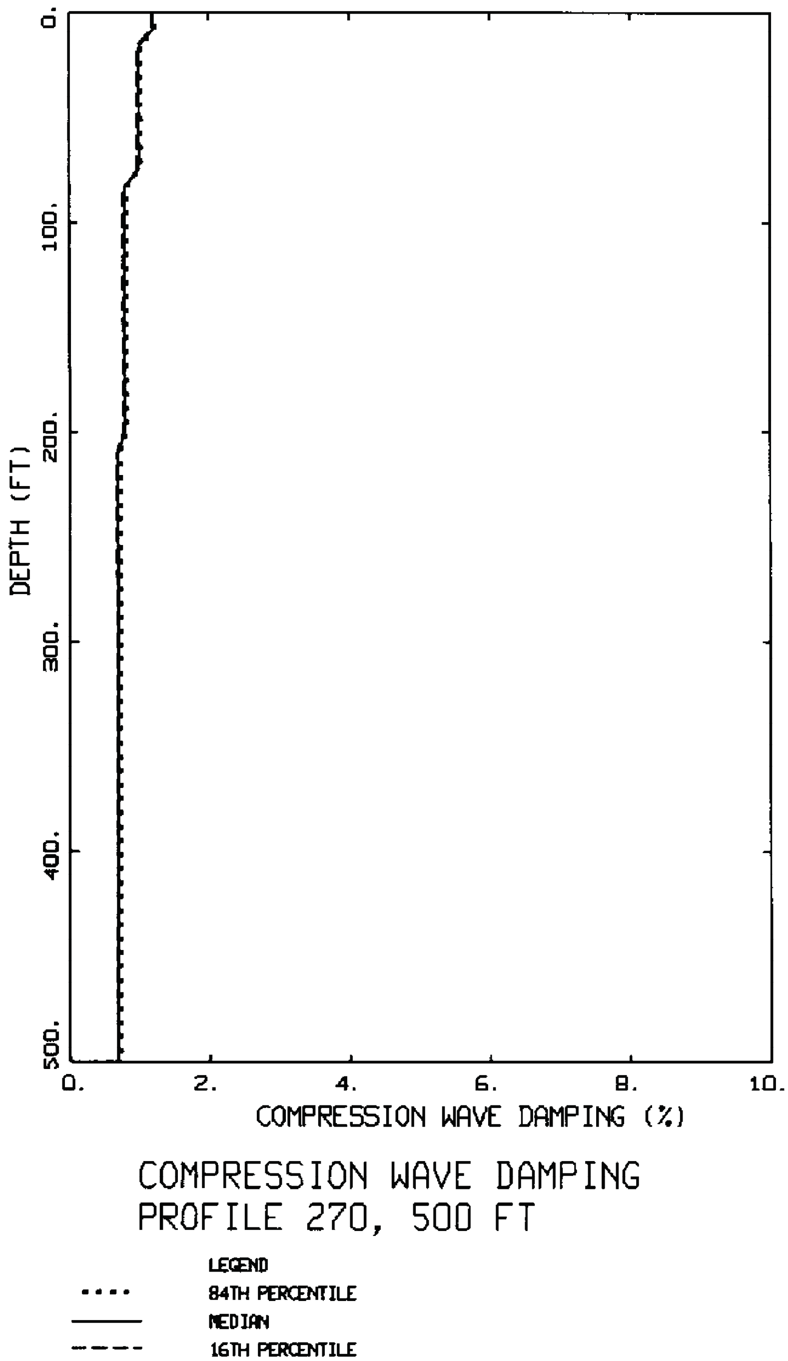


Figure 5.2-6 Strain Compatible Properties Computed for Profile 270 500 ft Depth to Bedrock (Sheet 4 of 4)

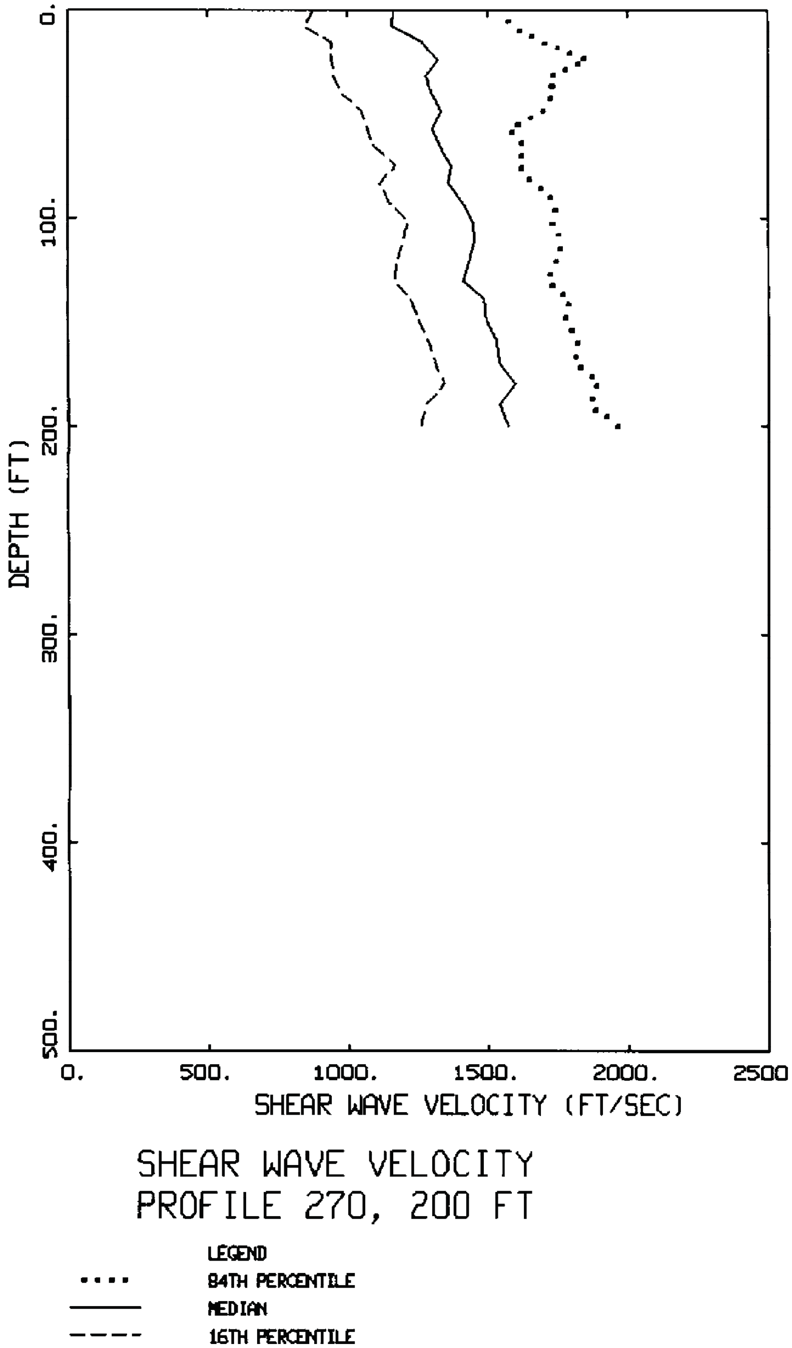


**Figure 5.2-7 Strain Compatible Properties Computed for Profile 270
200 ft Depth to Bedrock
(Sheet 1 of 4)**

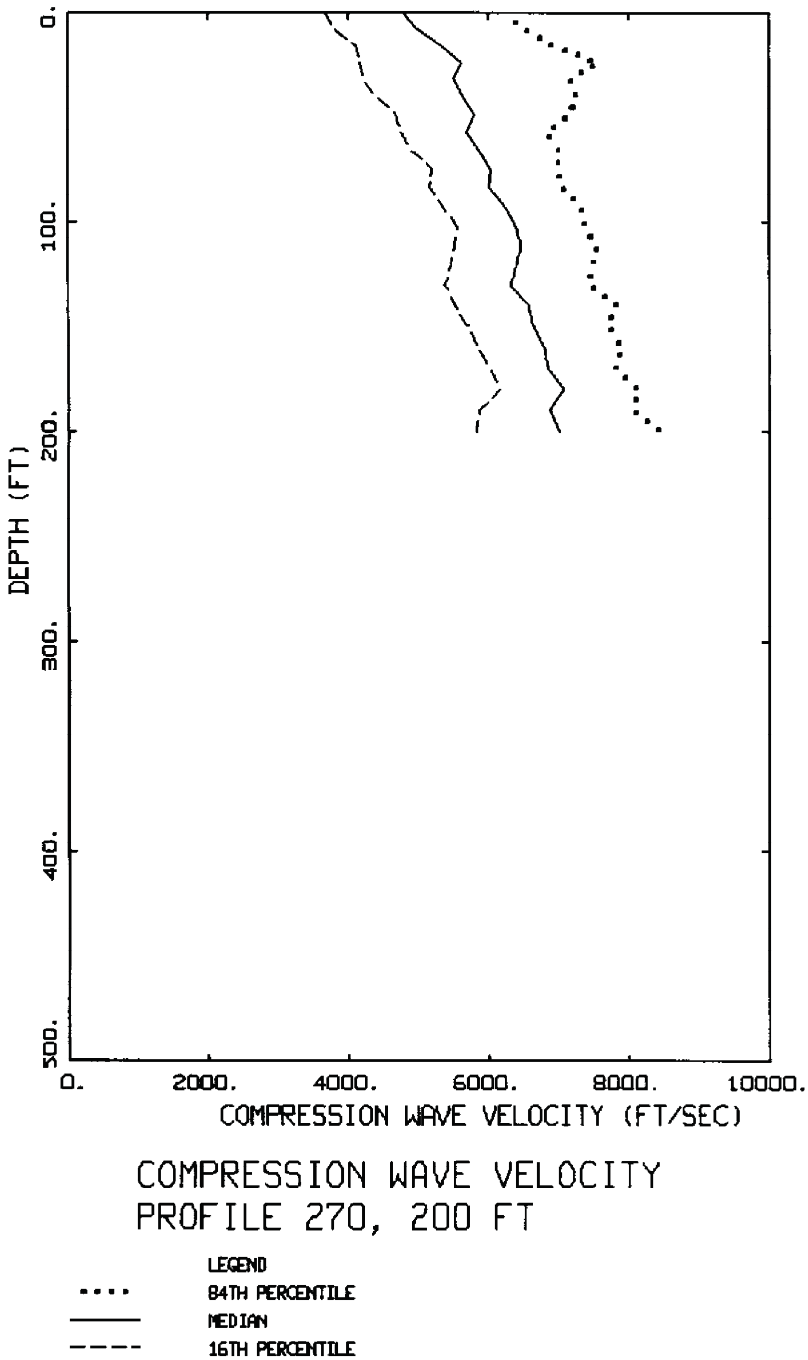


Figure 5.2-7 Strain Compatible Properties Computed for Profile 270 200 ft Depth to Bedrock (Sheet 2 of 4)

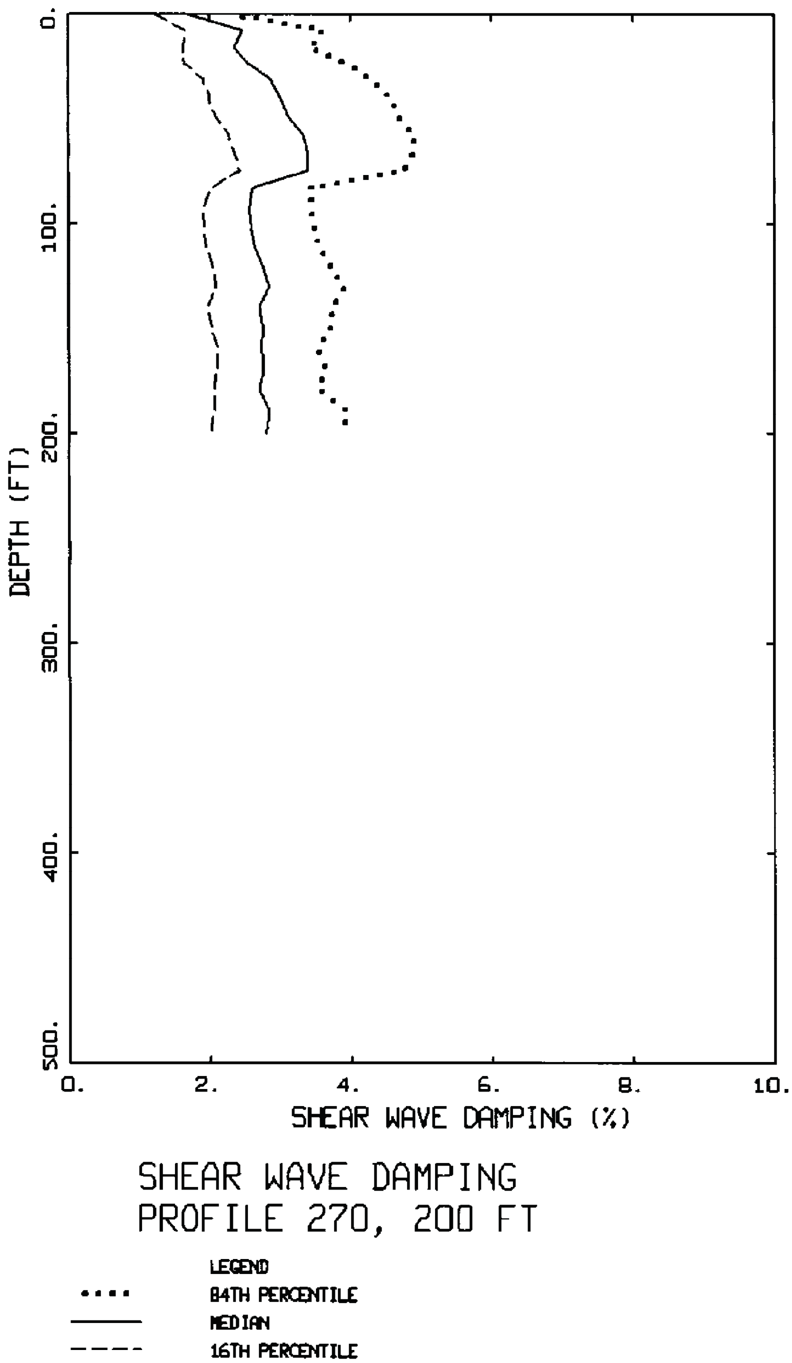


Figure 5.2-7 Strain Compatible Properties Computed for Profile 270 200 ft Depth to Bedrock (Sheet 3 of 4)

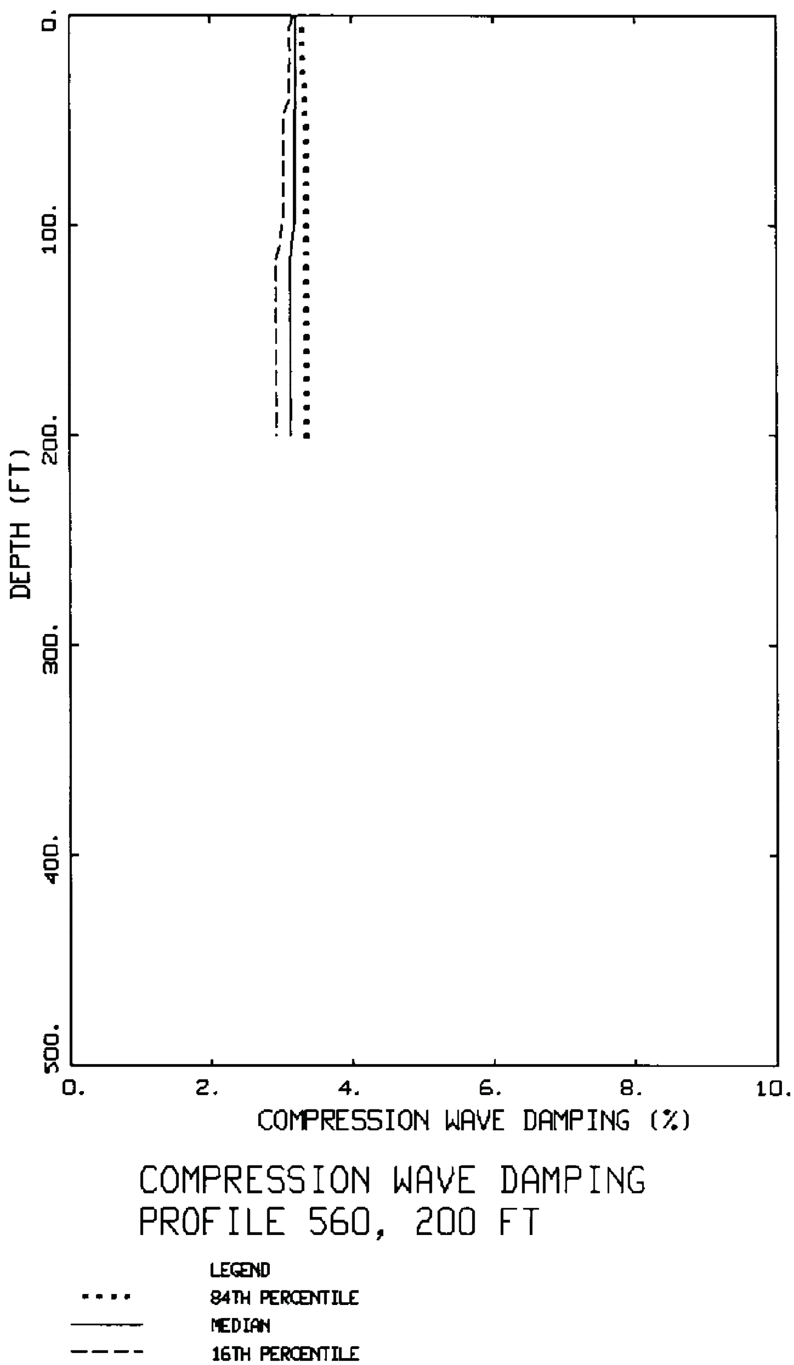


Figure 5.2-7 Strain Compatible Properties Computed for Profile 270 200 ft Depth to Bedrock (Sheet 4 of 4)

Figure 5.2-8 Deleted

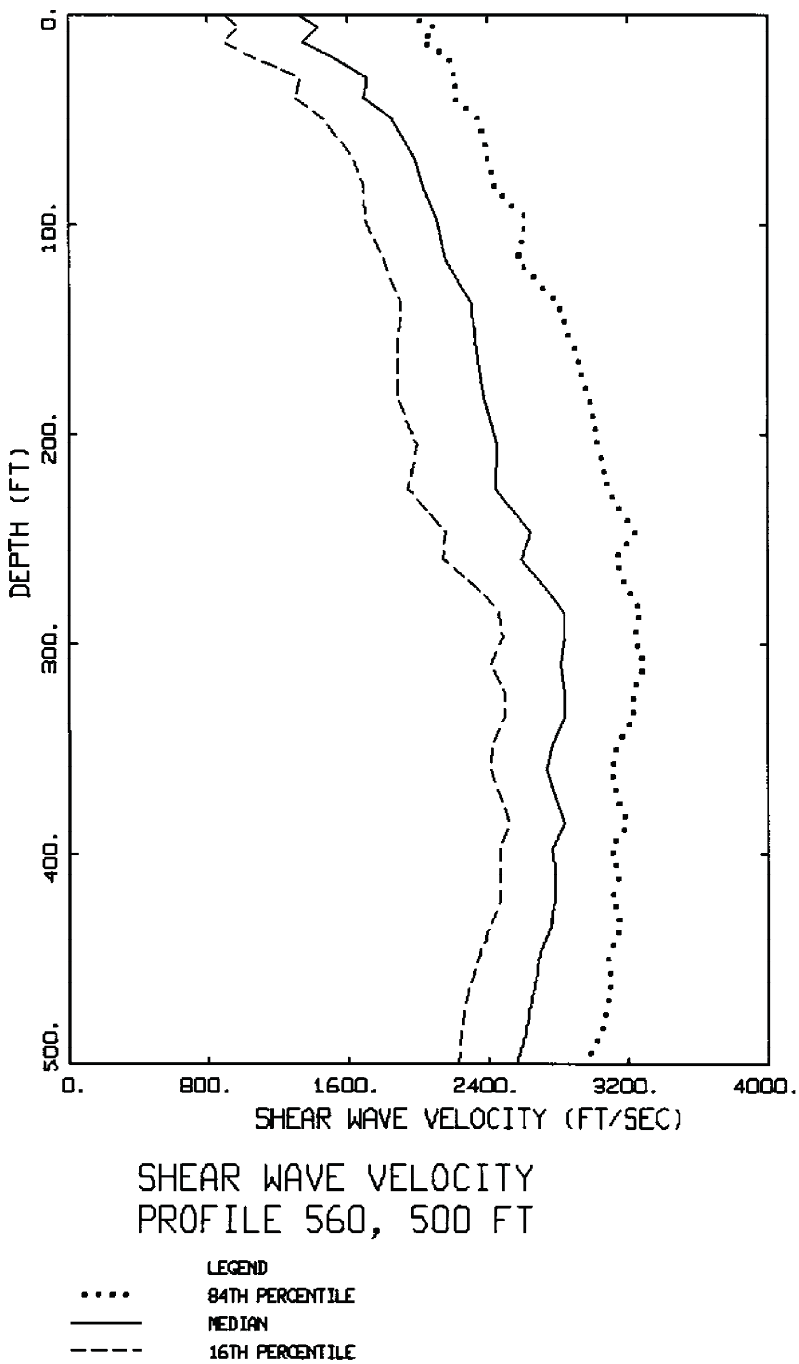


Figure 5.2-9 Strain Compatible Properties Computed for Profile 560, 500 ft Depth to Bedrock (Sheet 1 of 4)

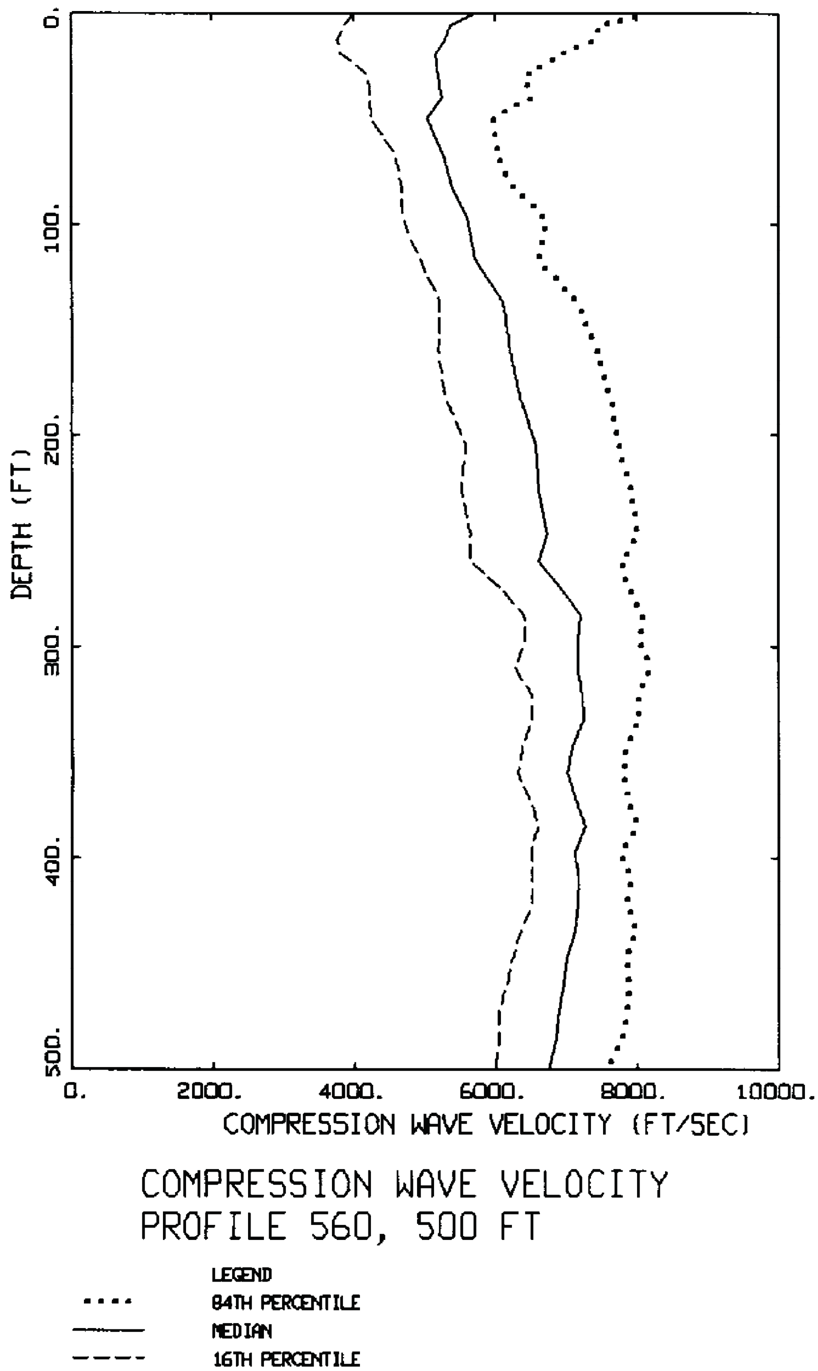


Figure 5.2-9 Strain Compatible Properties Computed for Profile 560, 500 ft Depth to Bedrock (Sheet 2 of 4)

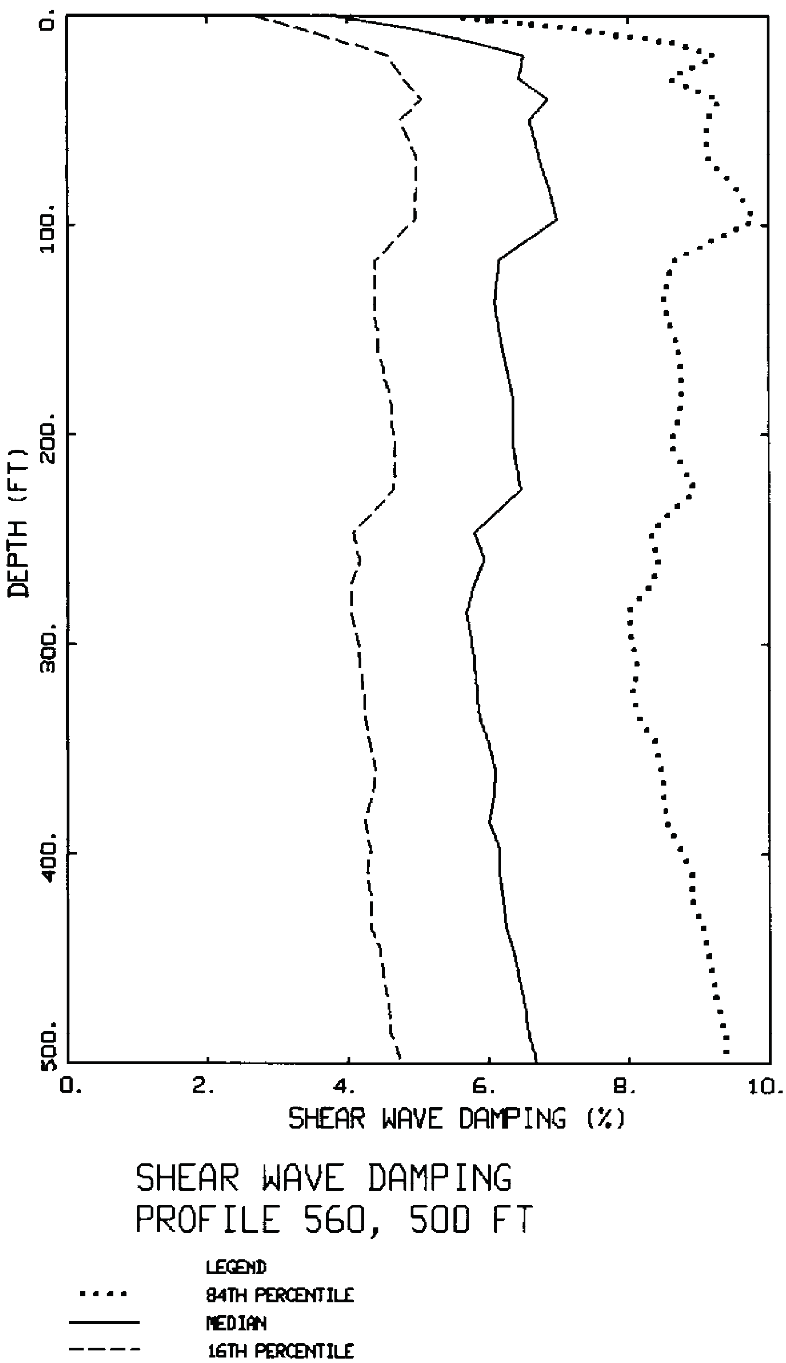


Figure 5.2-9 Strain Compatible Properties Computed for Profile 560, 500 ft Depth to Bedrock (Sheet 3 of 4)

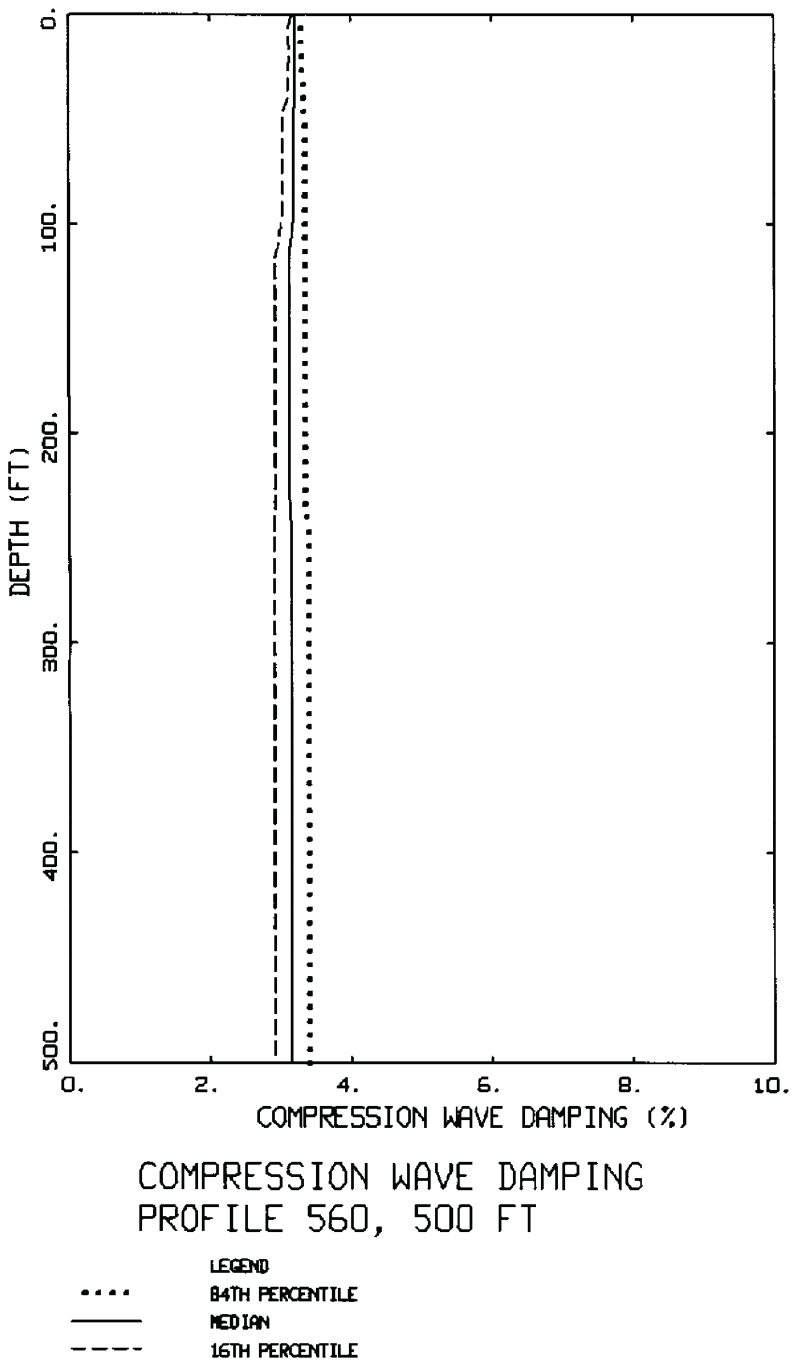


Figure 5.2-9 Strain Compatible Properties Computed for Profile 56, 500 ft Depth to Bedrock (Sheet 4 of 4)

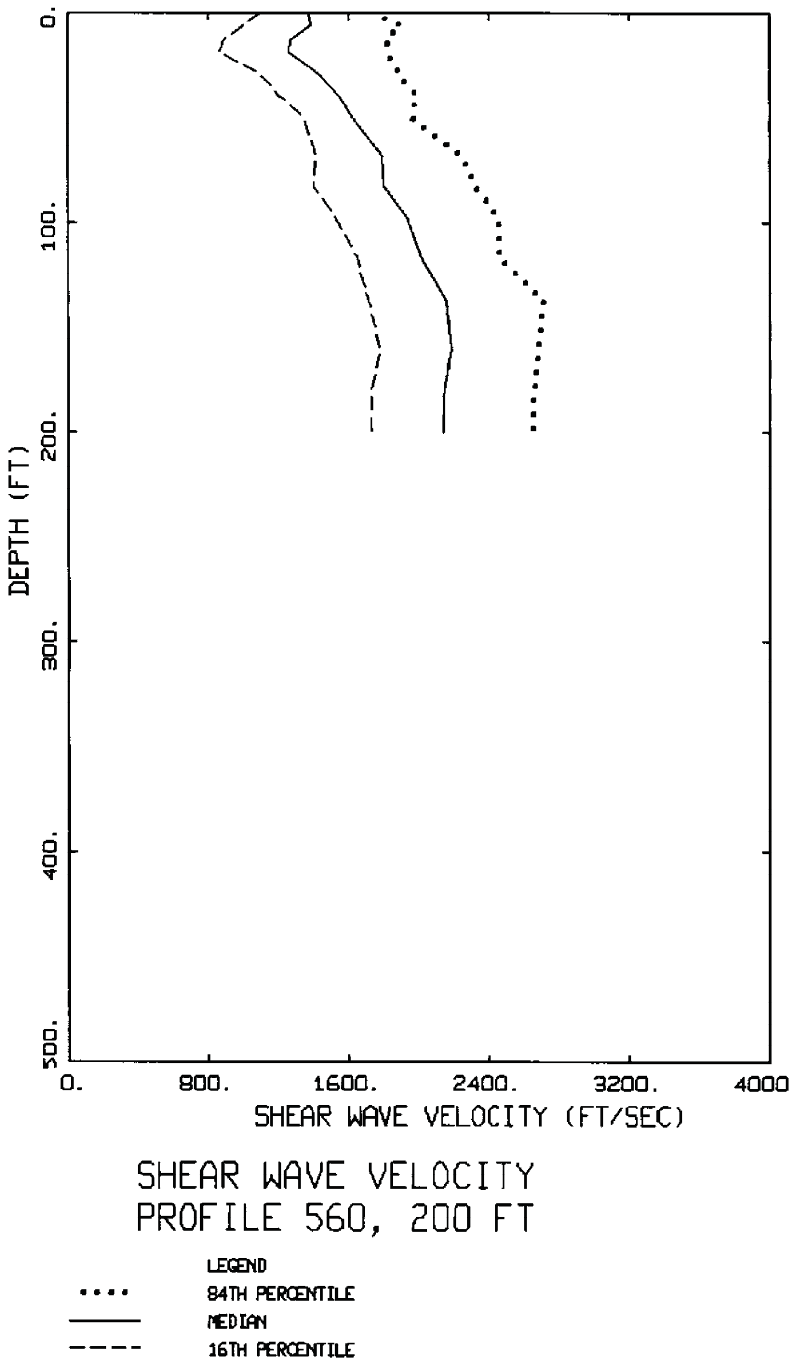


Figure 5.2-10 Strain Compatible Properties Computed for Profile 560, 200 ft Depth to Bedrock (Sheet 1 of 4)

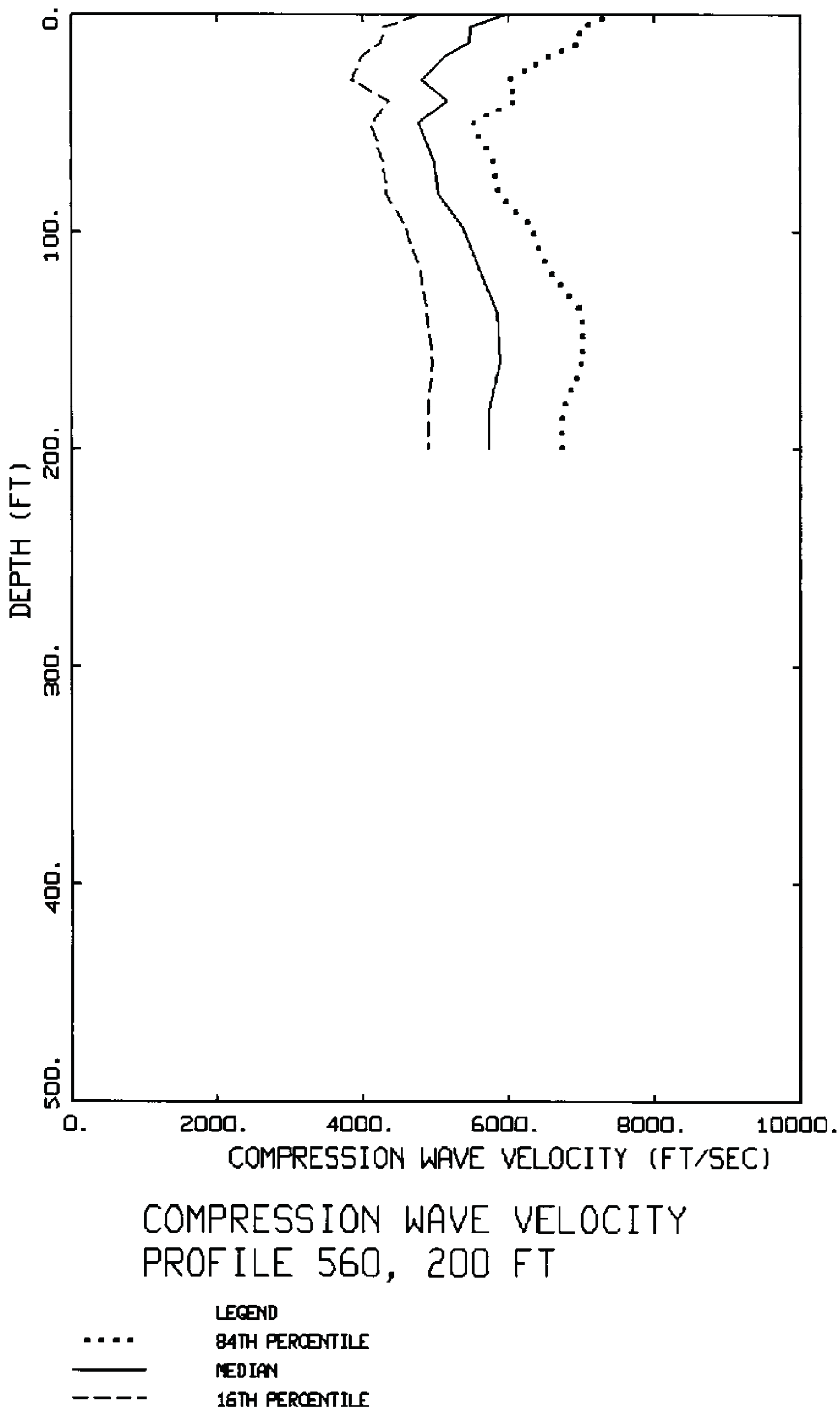


Figure 5.2-10 Strain Compatible Properties Computed for Profile 560 200 ft Depth to Bedrock (Sheet 2 of 4)

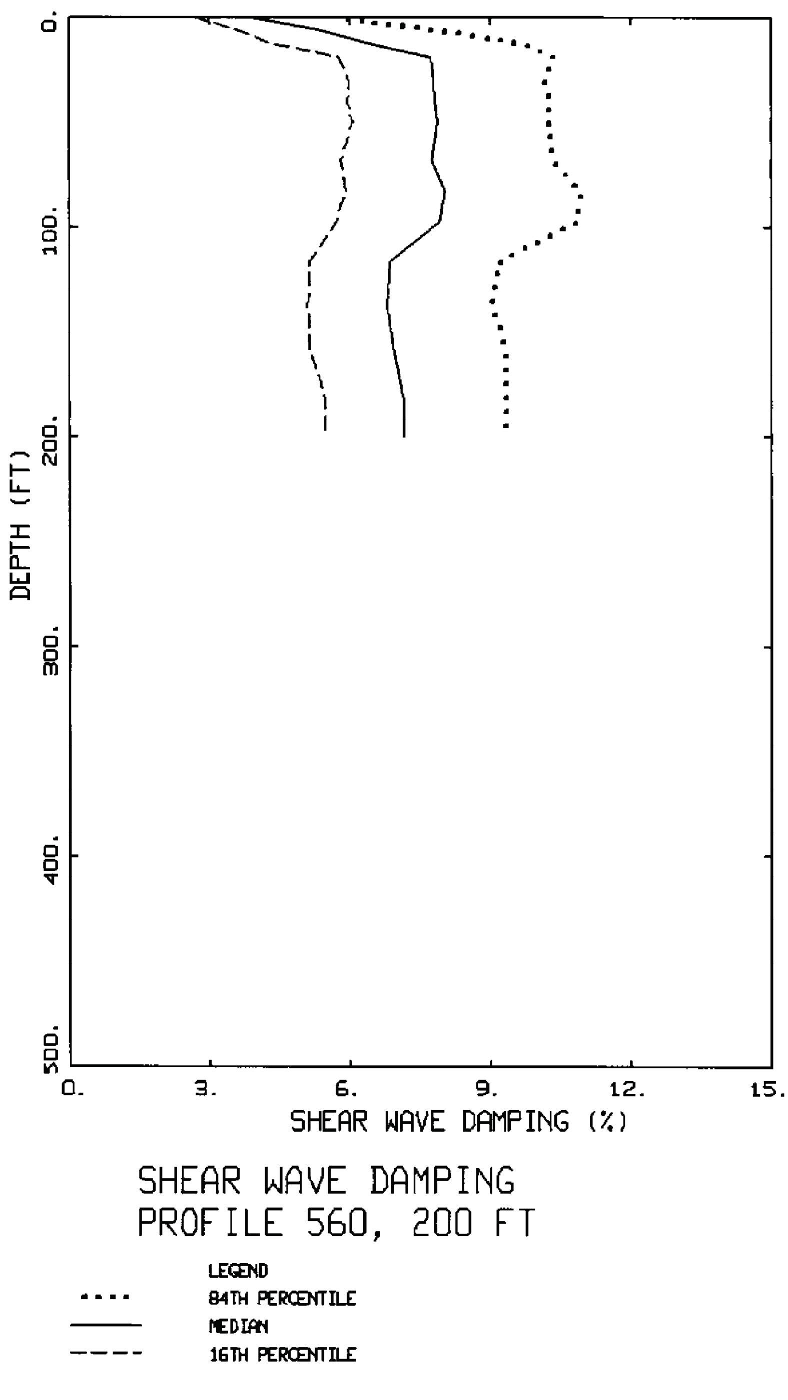


Figure 5.2-10 Strain Compatible Properties Computed for Profile 560 200 ft Depth to Bedrock (Sheet 3 of 4)

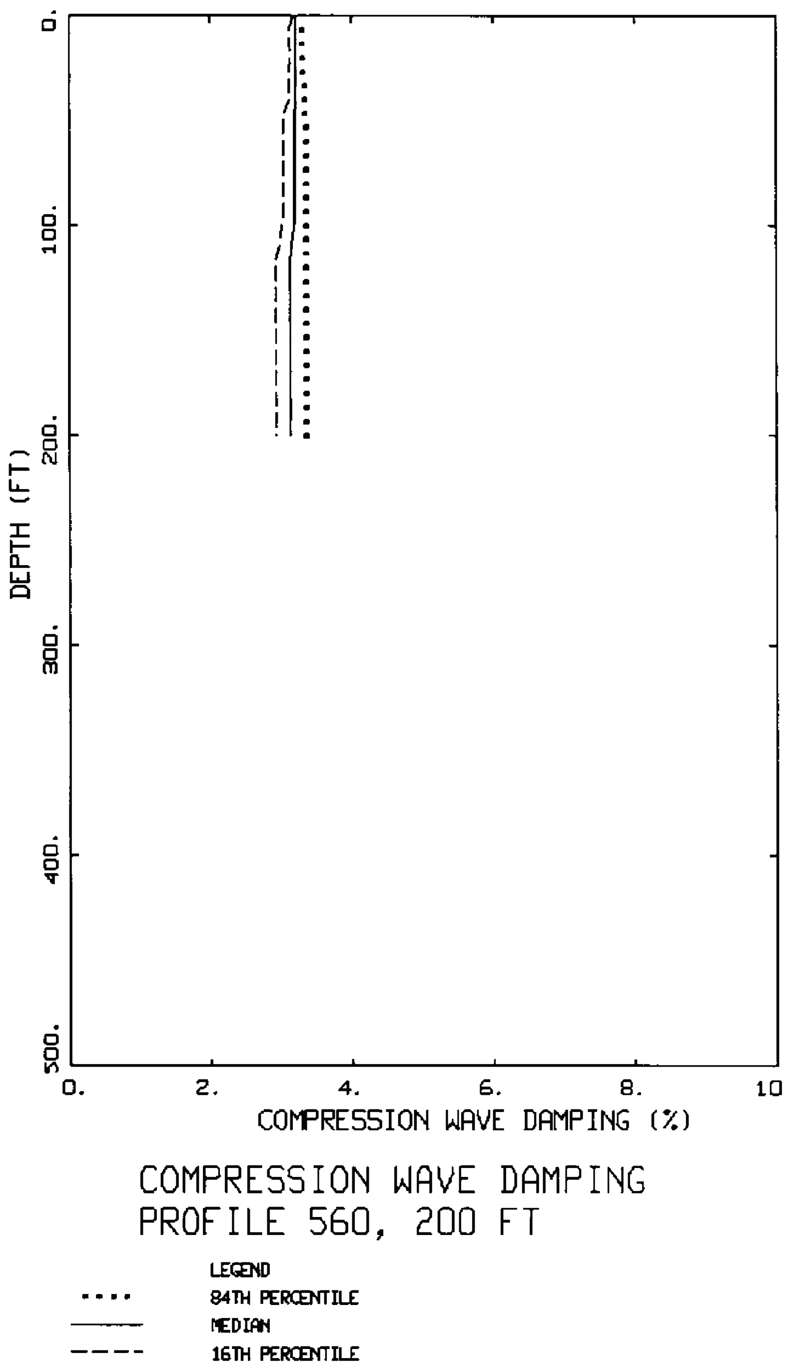


Figure 5.2-10 Strain Compatible Properties Computed for Profile 560 200 ft Depth to Bedrock (Sheet 4 of 4)

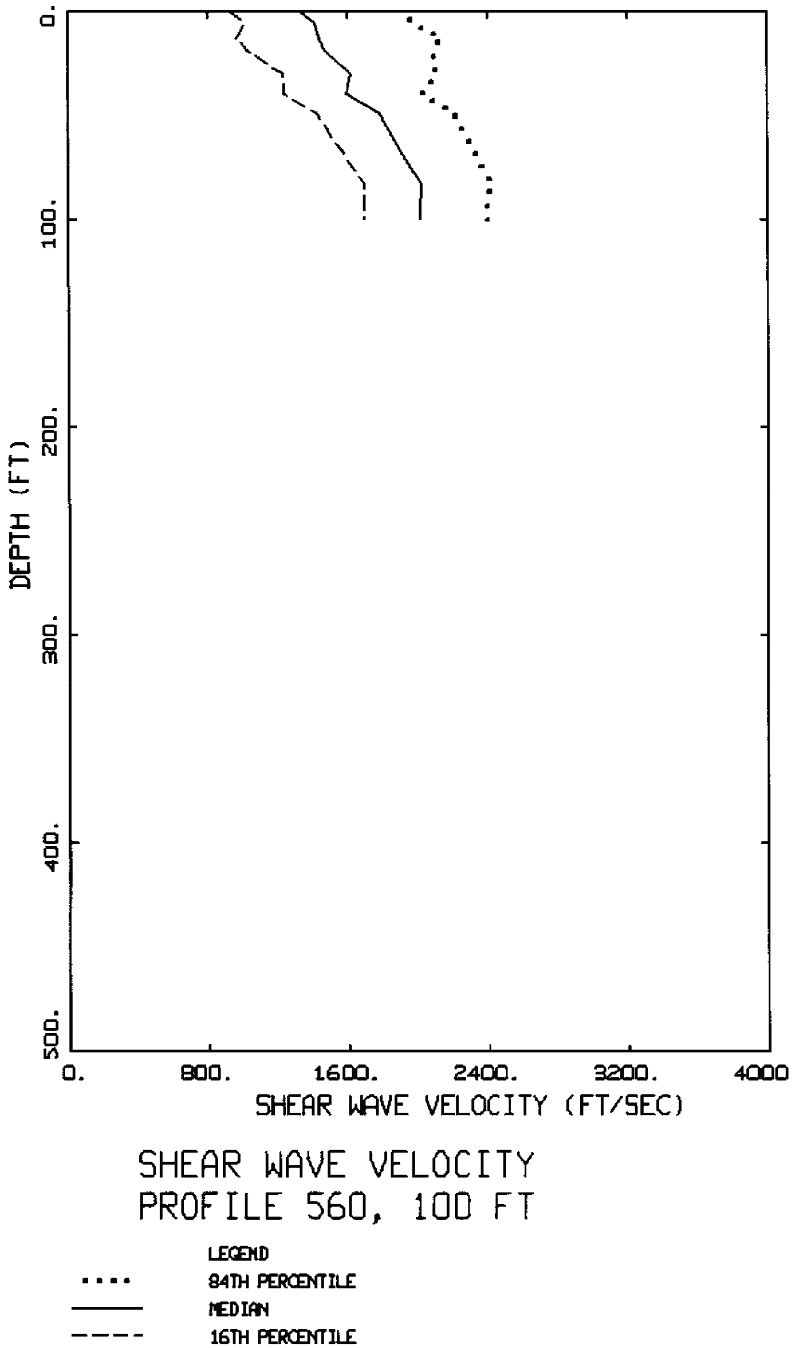


Figure 5.2-11 Strain Compatible Properties Computed for Profile 560 100 ft Depth to Bedrock (Sheet 1 of 4)

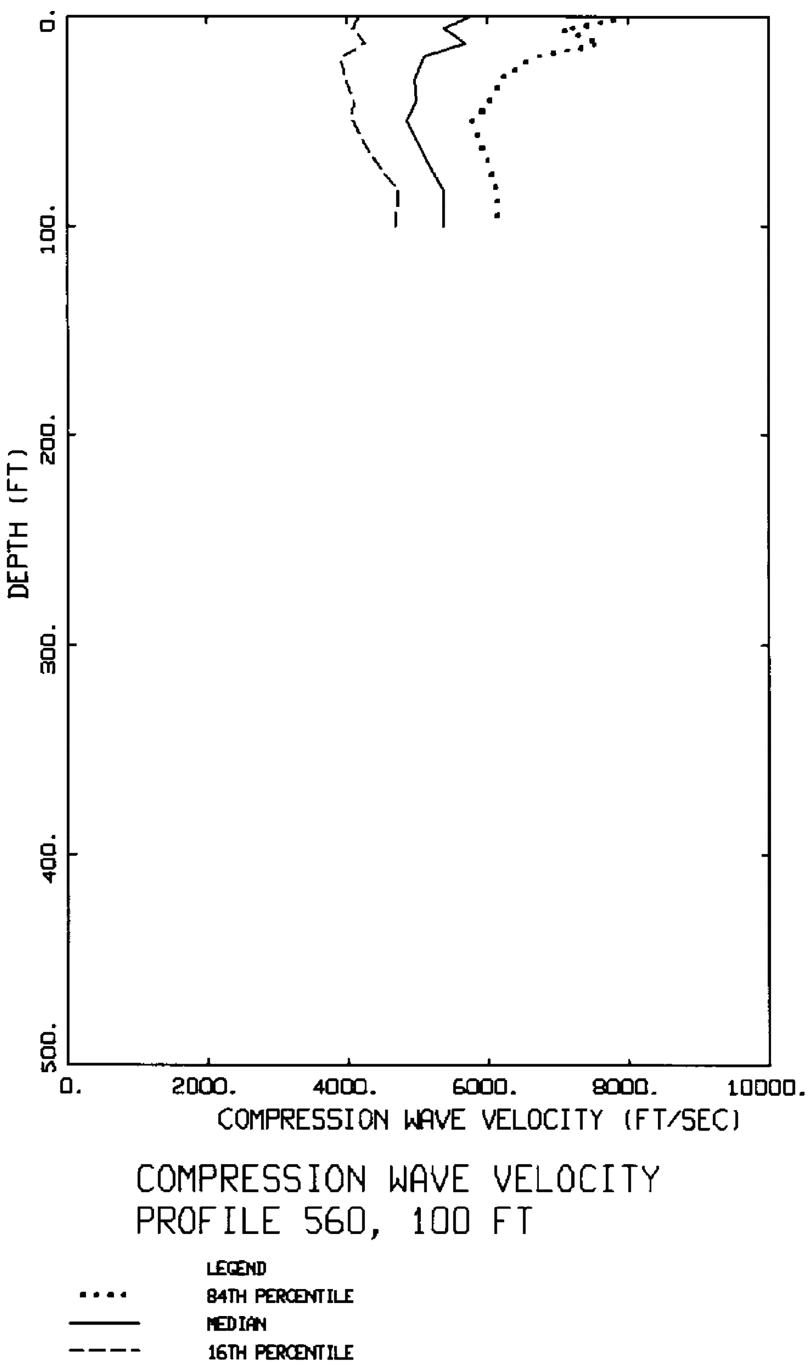


Figure 5.2-11 Strain Compatible Properties Computed for Profile 560 100 ft Depth to Bedrock (Sheet 2 of 4)

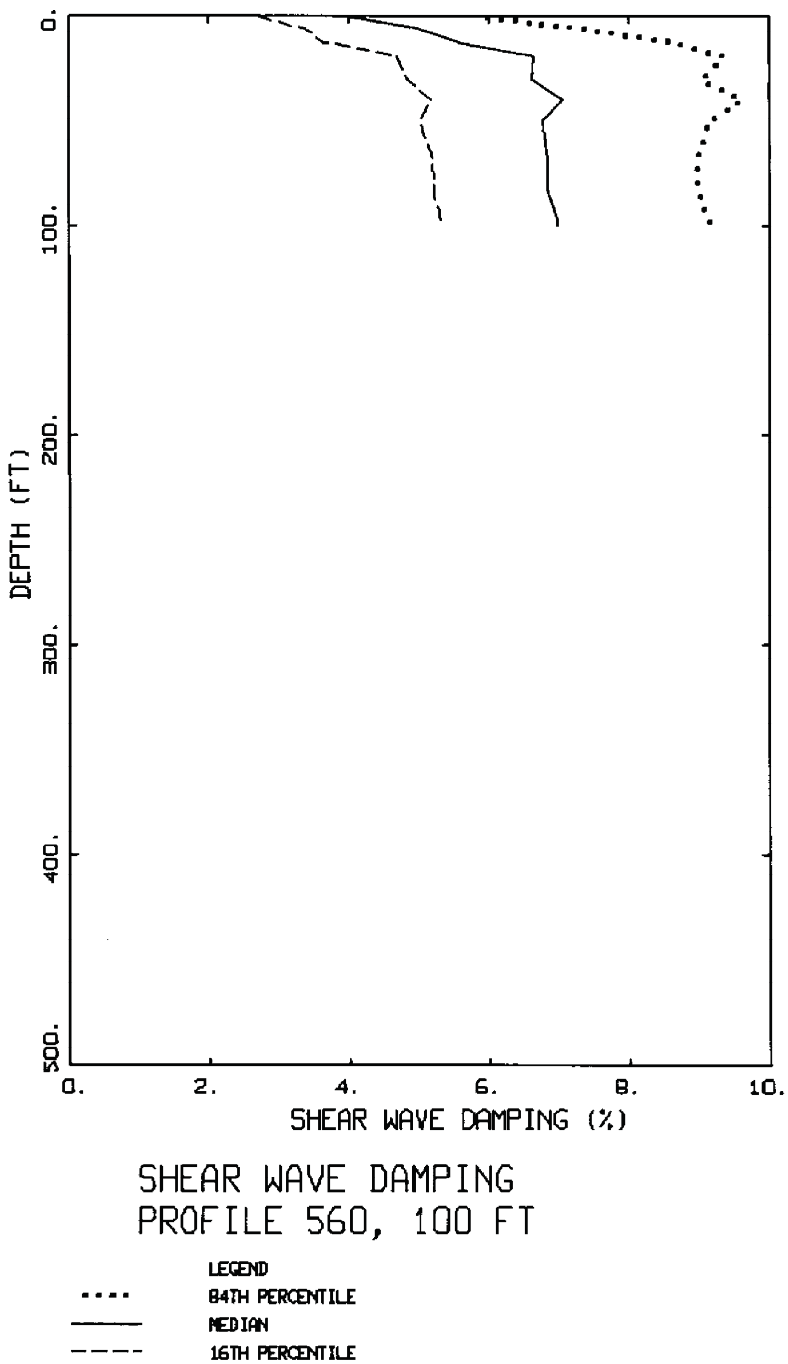


Figure 5.2-11 Strain Compatible Properties Computed for Profile 560 100 ft Depth to Bedrock (Sheet 3 of 4)

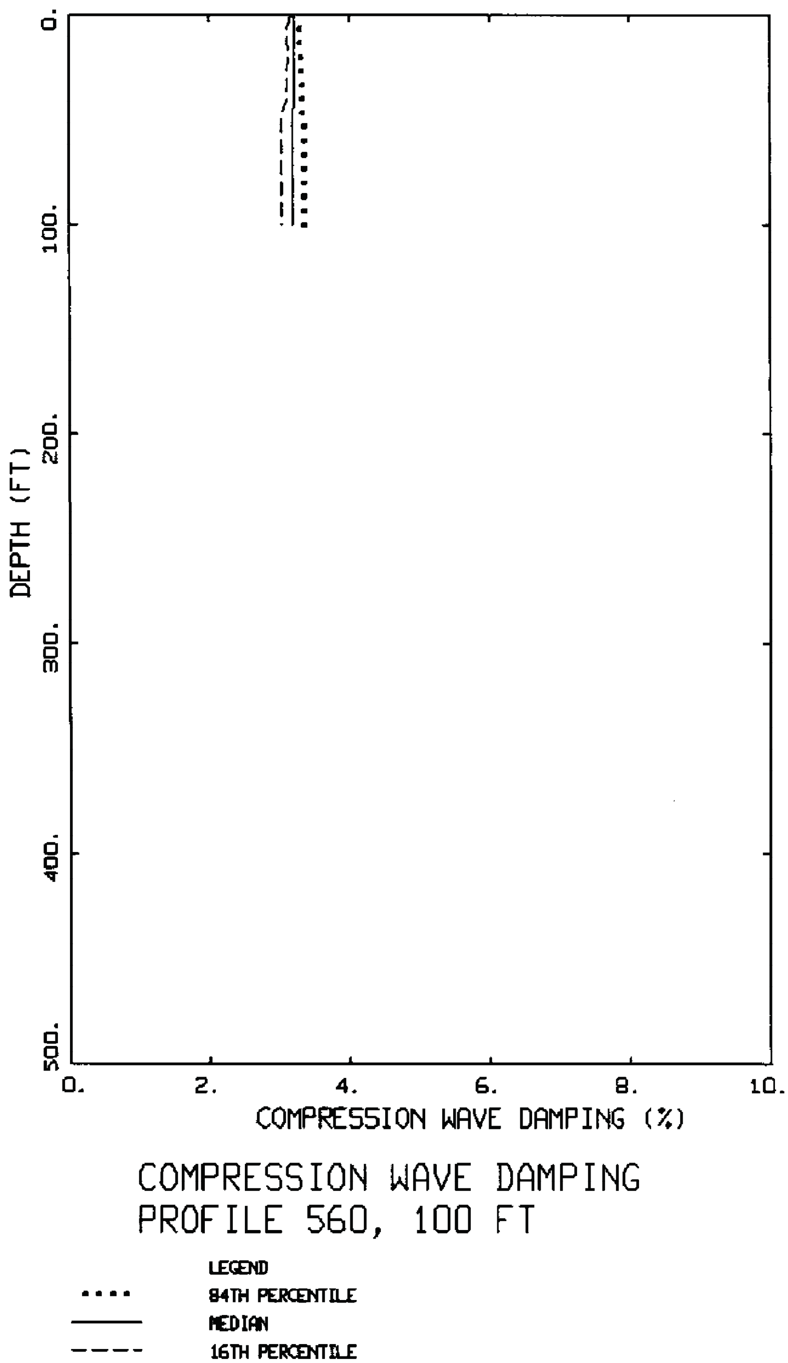


Figure 5.2-11 Strain Compatible Properties Computed for Profile 560 100 ft Depth to Bedrock (Sheet 4 of 4)

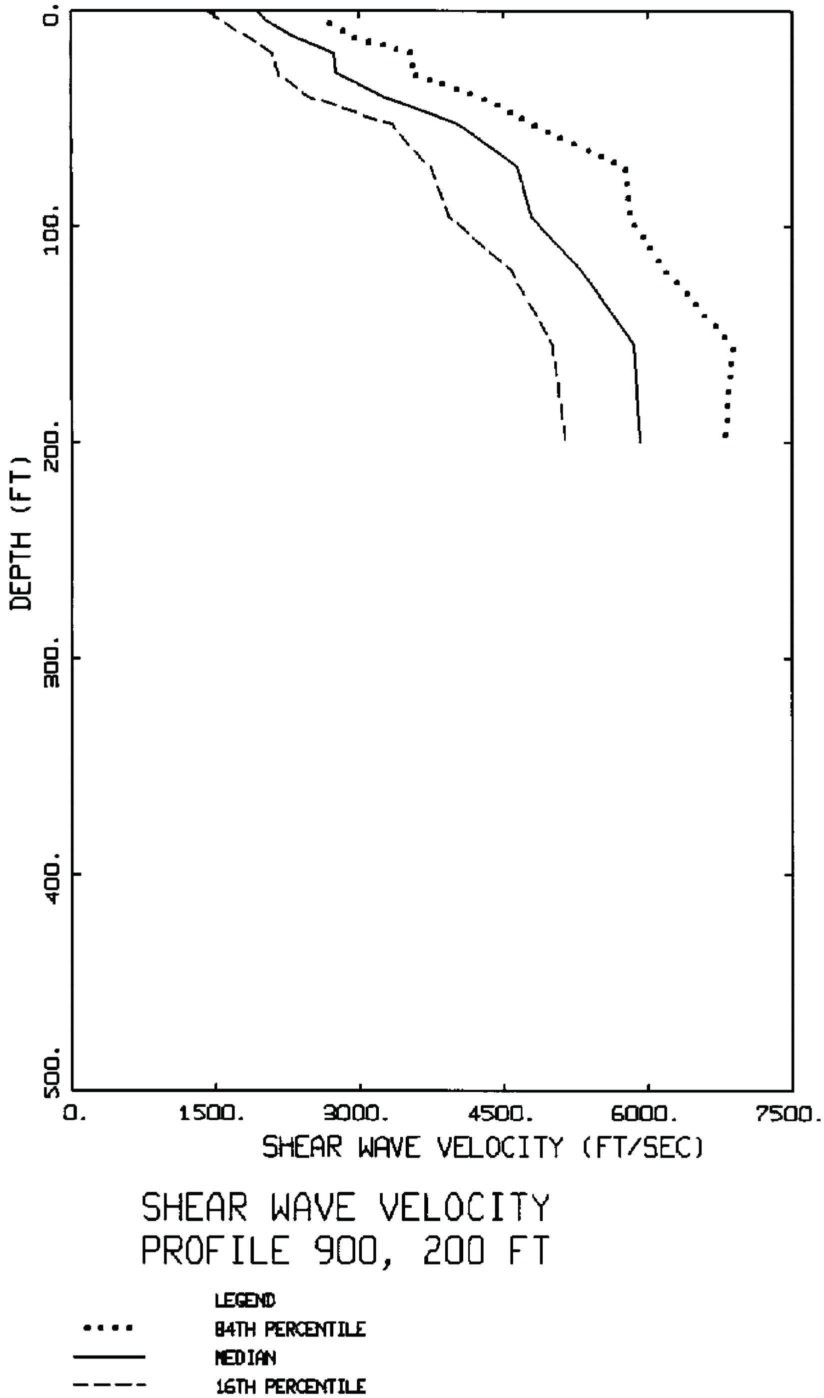


Figure 5.2-12 Strain Compatible Properties Computed for Profile 900, 200 ft Depth to Bedrock (Sheet 1 of 4)

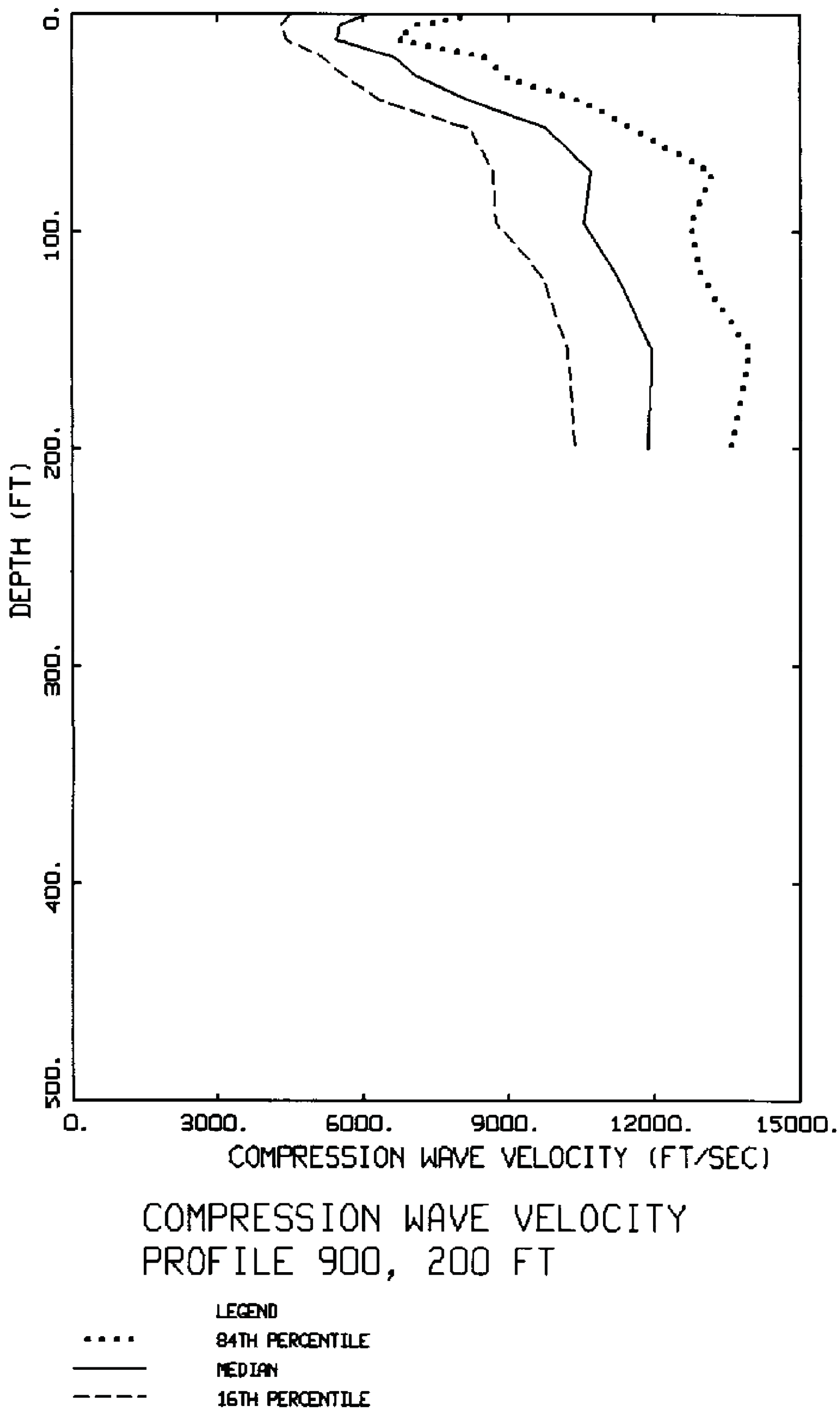


Figure 5.2-12 Strain Compatible Properties Computed for Profile 900 200 ft Depth to Bedrock (Sheet 2 of 4)

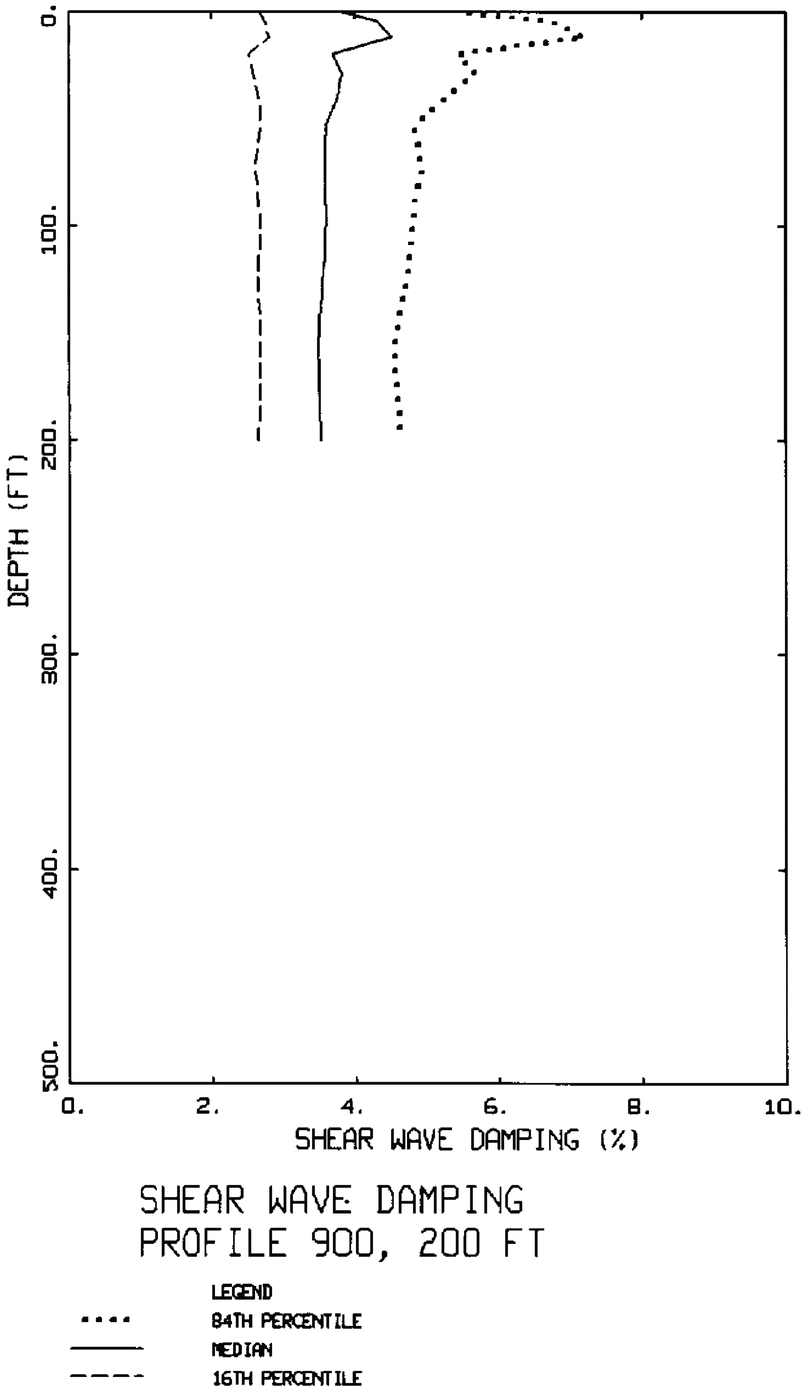


Figure 5.2-12 Strain Compatible Properties Computed for Profile 900 200 ft Depth to Bedrock (Sheet 3 of 4)

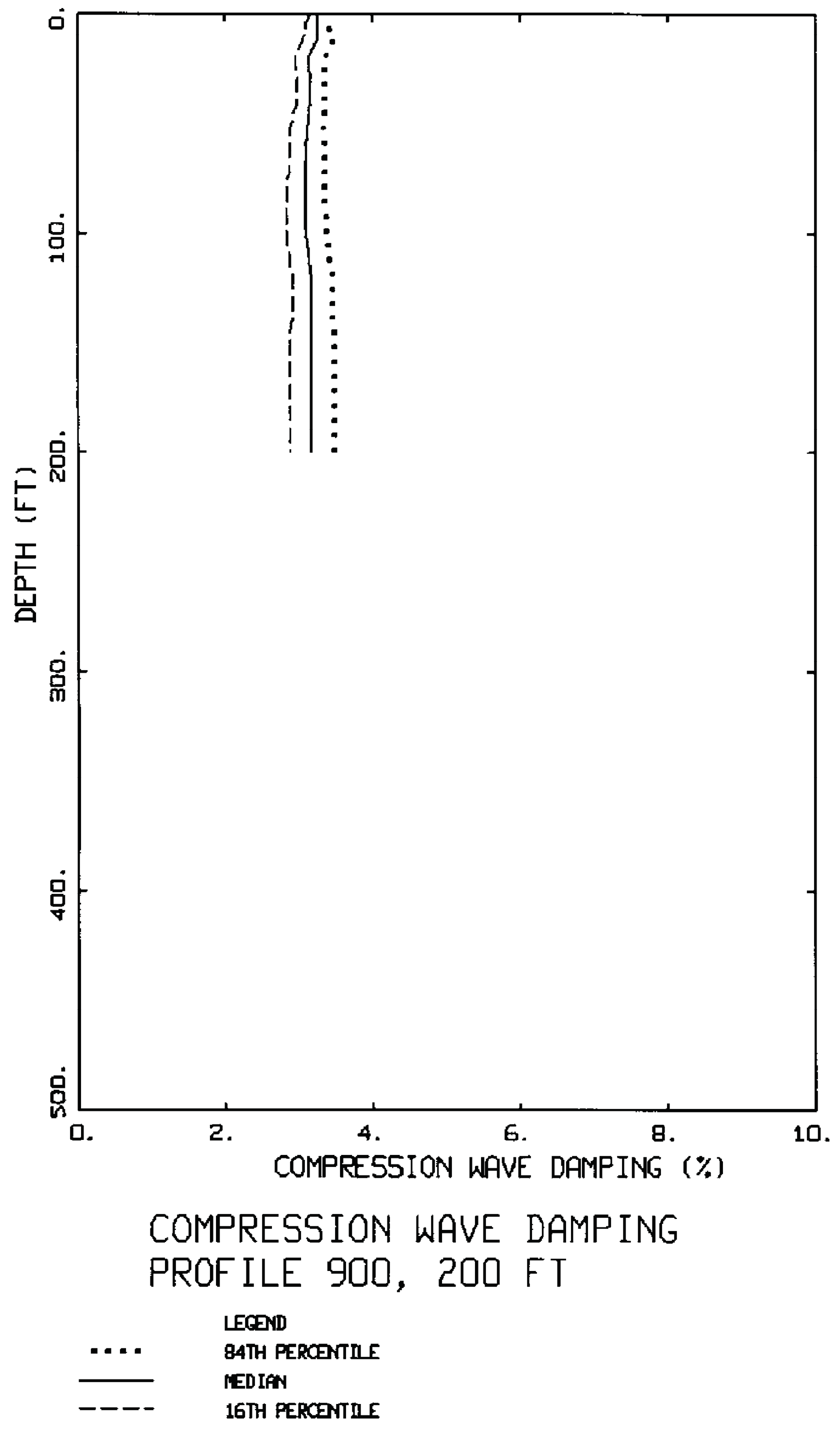


Figure 5.2-12 Strain Compatible Properties Computed for Profile 900 200 ft Depth toBedrock (Sheet 4 of 4)

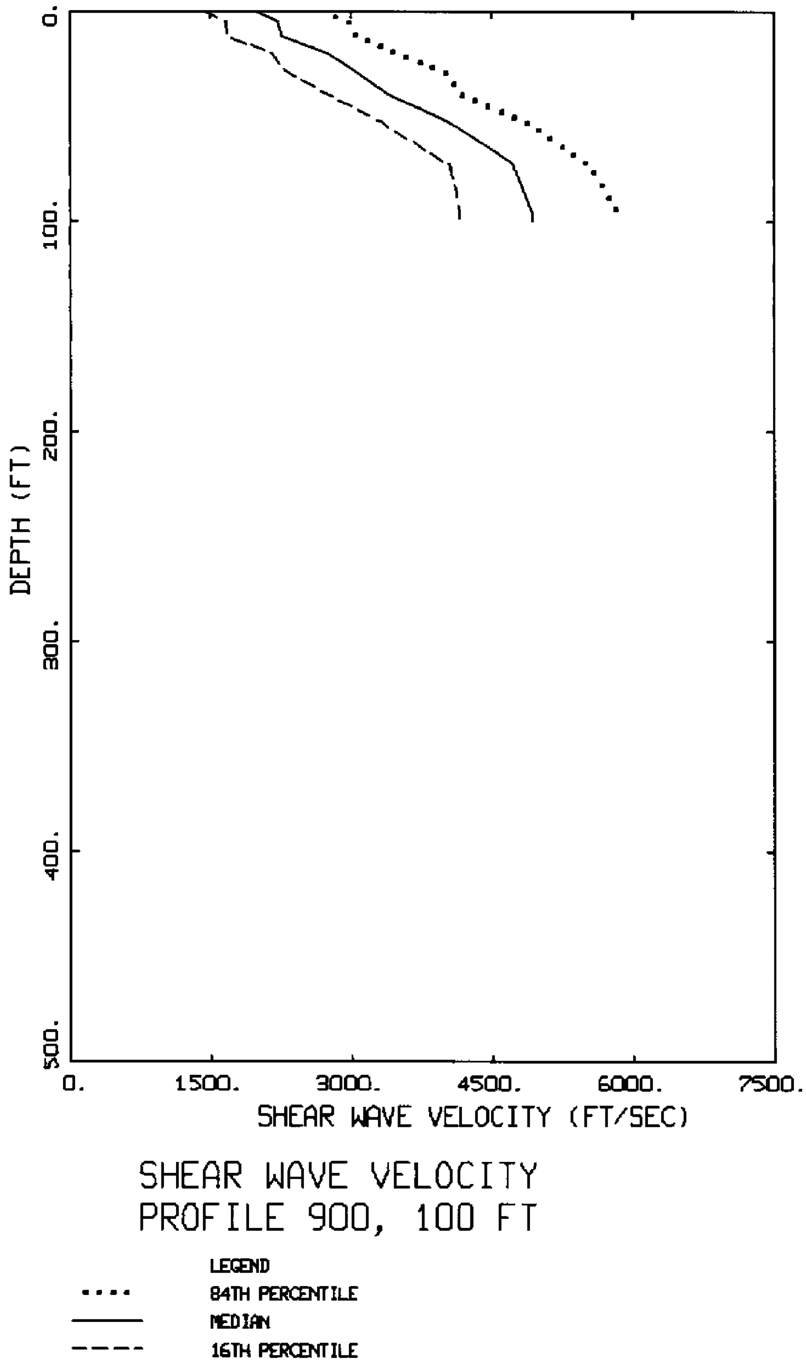


Figure 5.2-13 Strain Compatible Properties Computed for Profile 900
100 ft Depth to Bedrock
(Sheet 1 of 4)

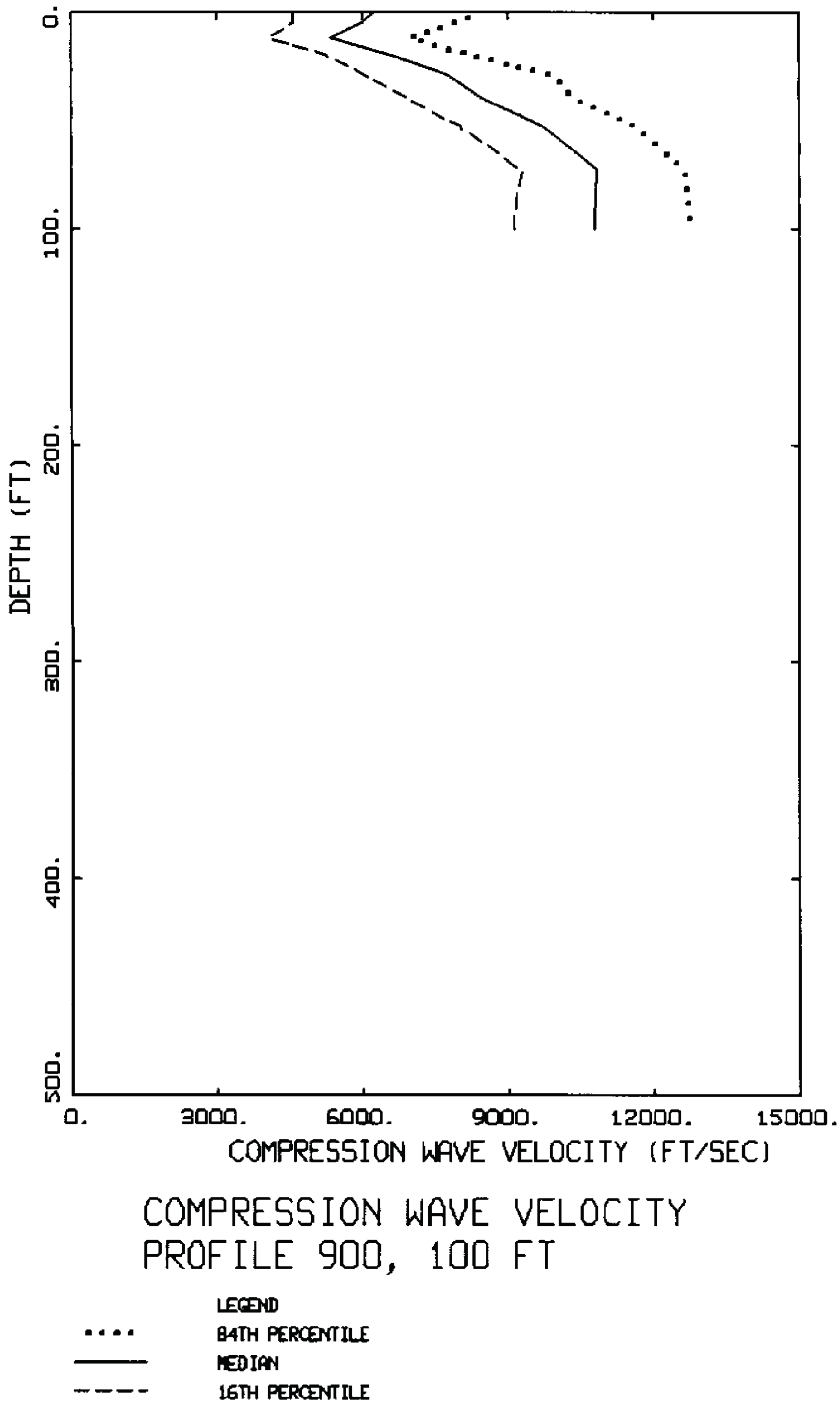


Figure 5.2-13 Strain Compatible Properties Computed for Profile 900 100 ft Depth to Bedrock (Sheet 2 of 4)

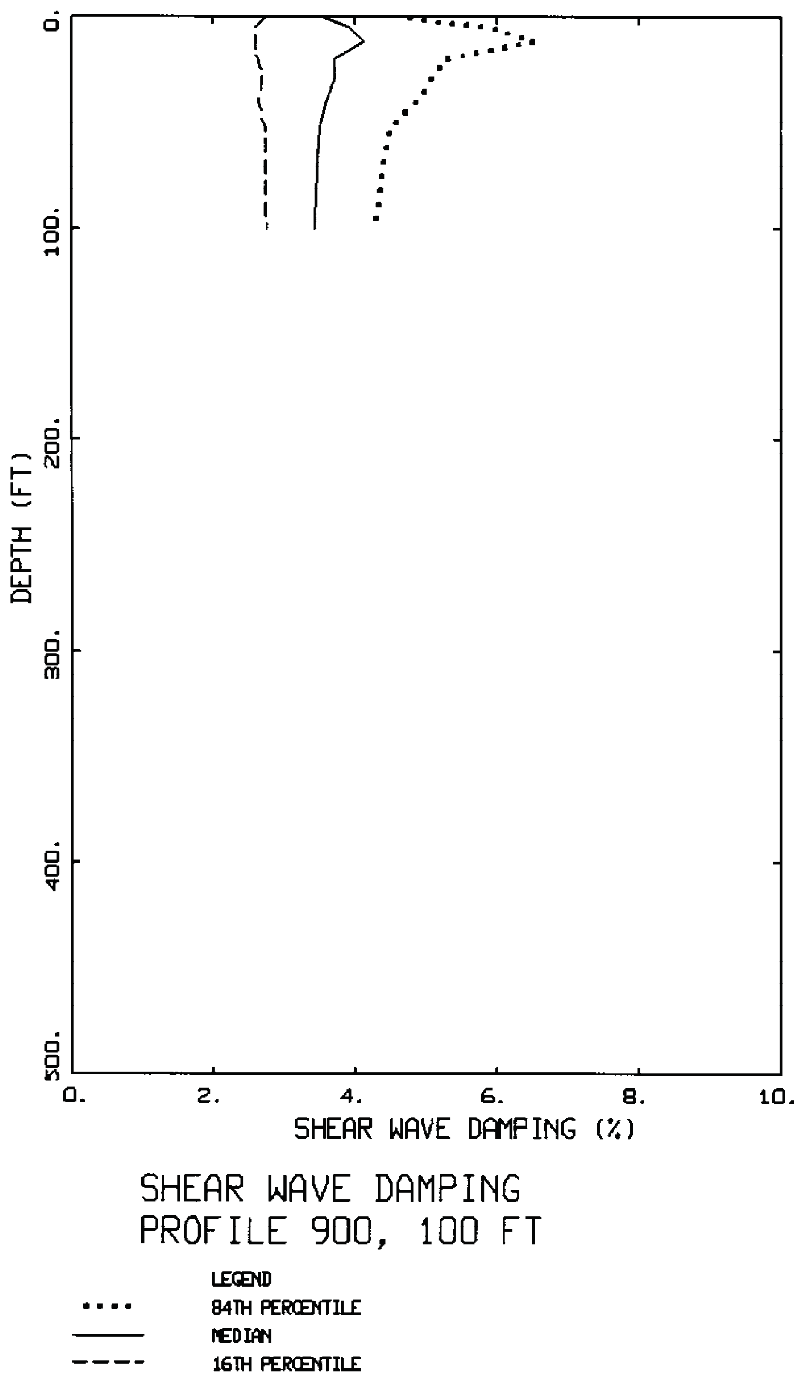


Figure 5.2-13 Strain Compatible Properties Computed for Profile 900 100 ft Depth to Bedrock (Sheet 3 of 4)

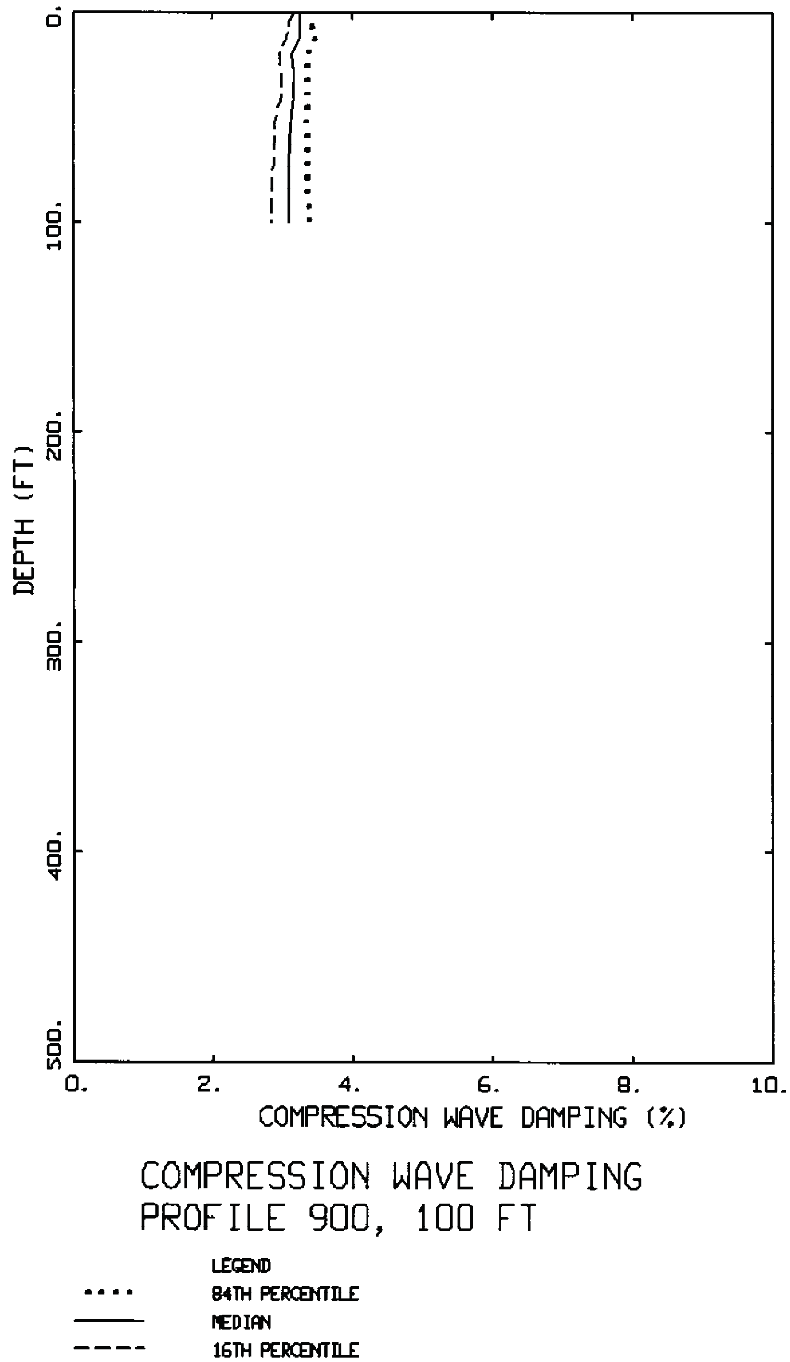


Figure 5.2-13 Strain Compatible Properties Computed for Profile 900 100 ft Depth to Bedrock (Sheet 4 of 4)

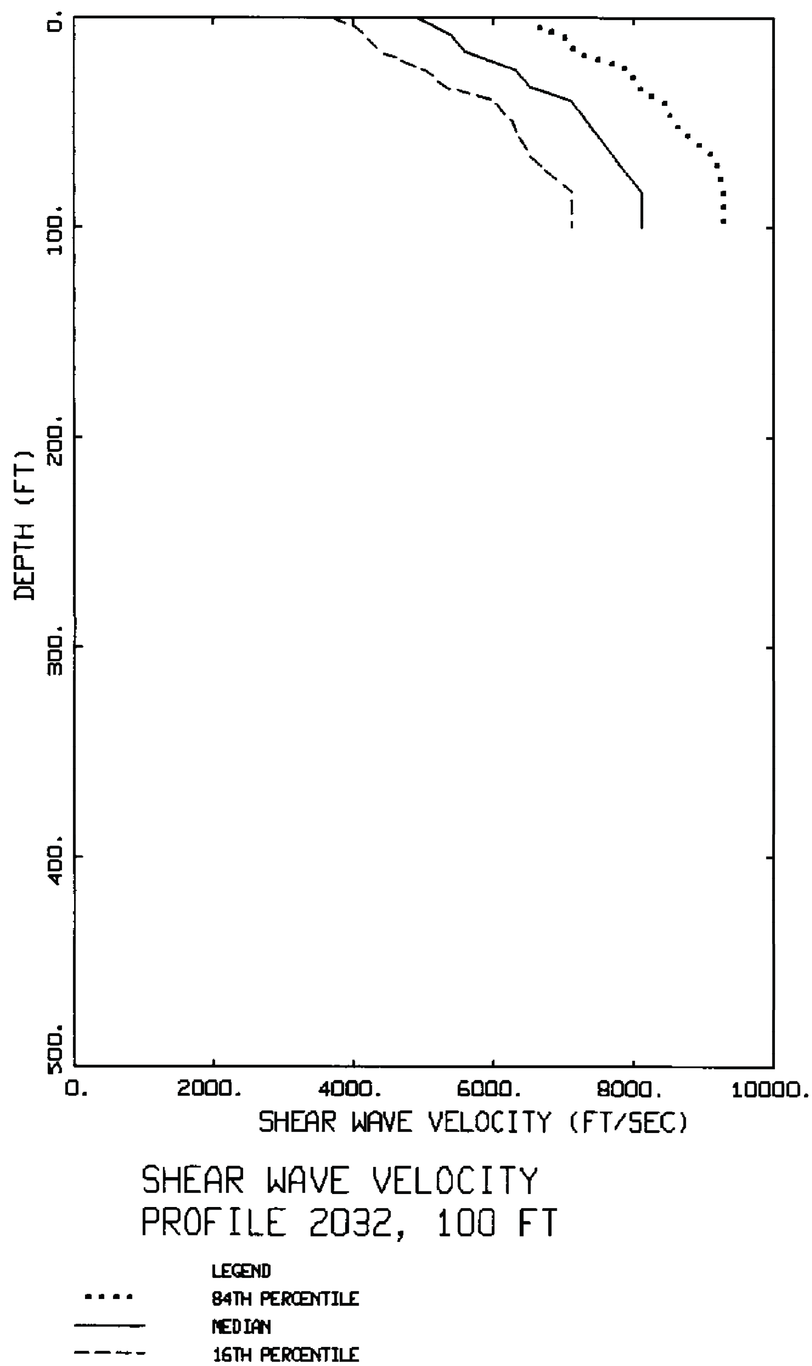


Figure 5.2-14 Strain Compatible Properties Computed for Profile 2032 100 ft Depth to Bedrock (Sheet 1 of 4)

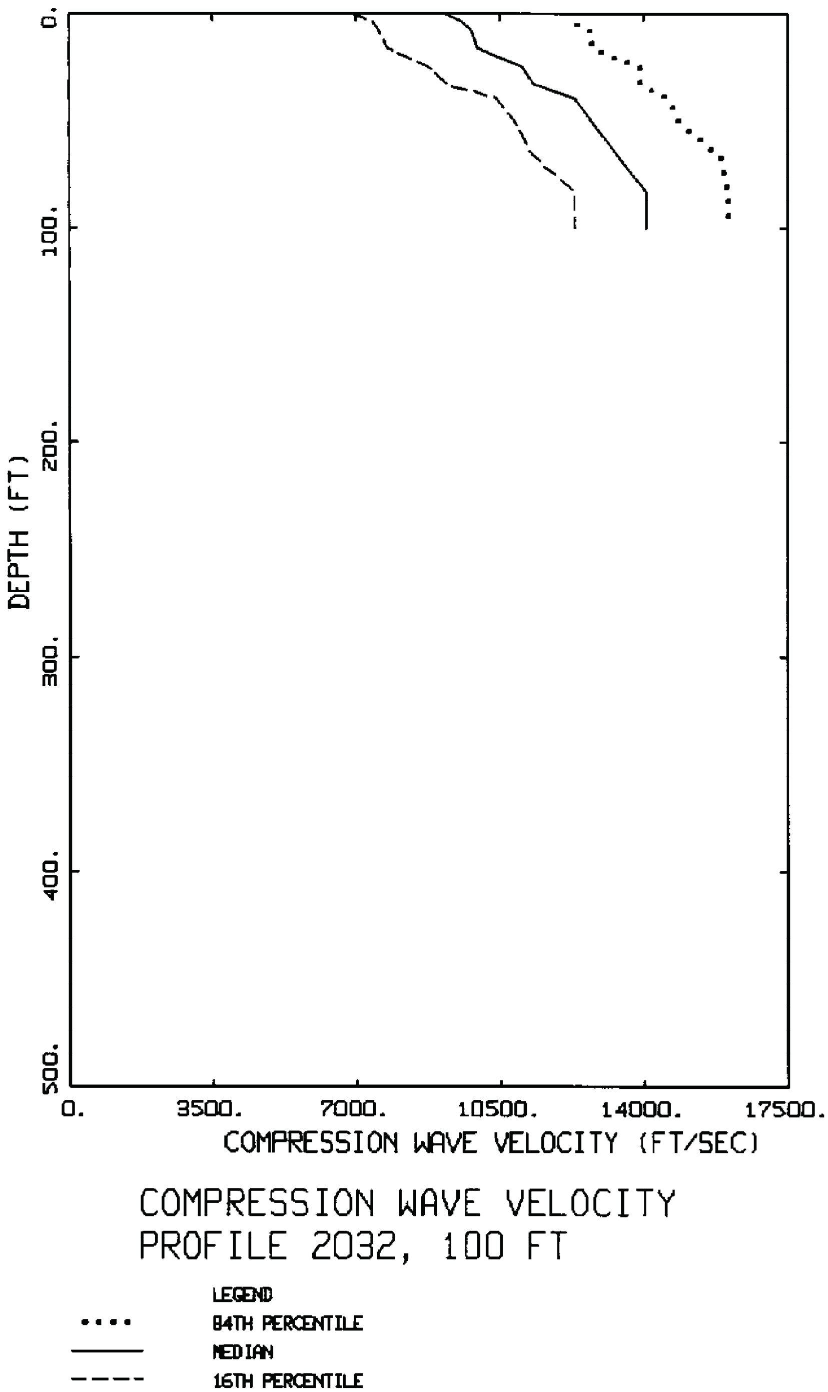


Figure 5.2-14 Strain Compatible Properties Computed for Profile 2032 100 ft Depth to Bedrock (Sheet 2 of 4)

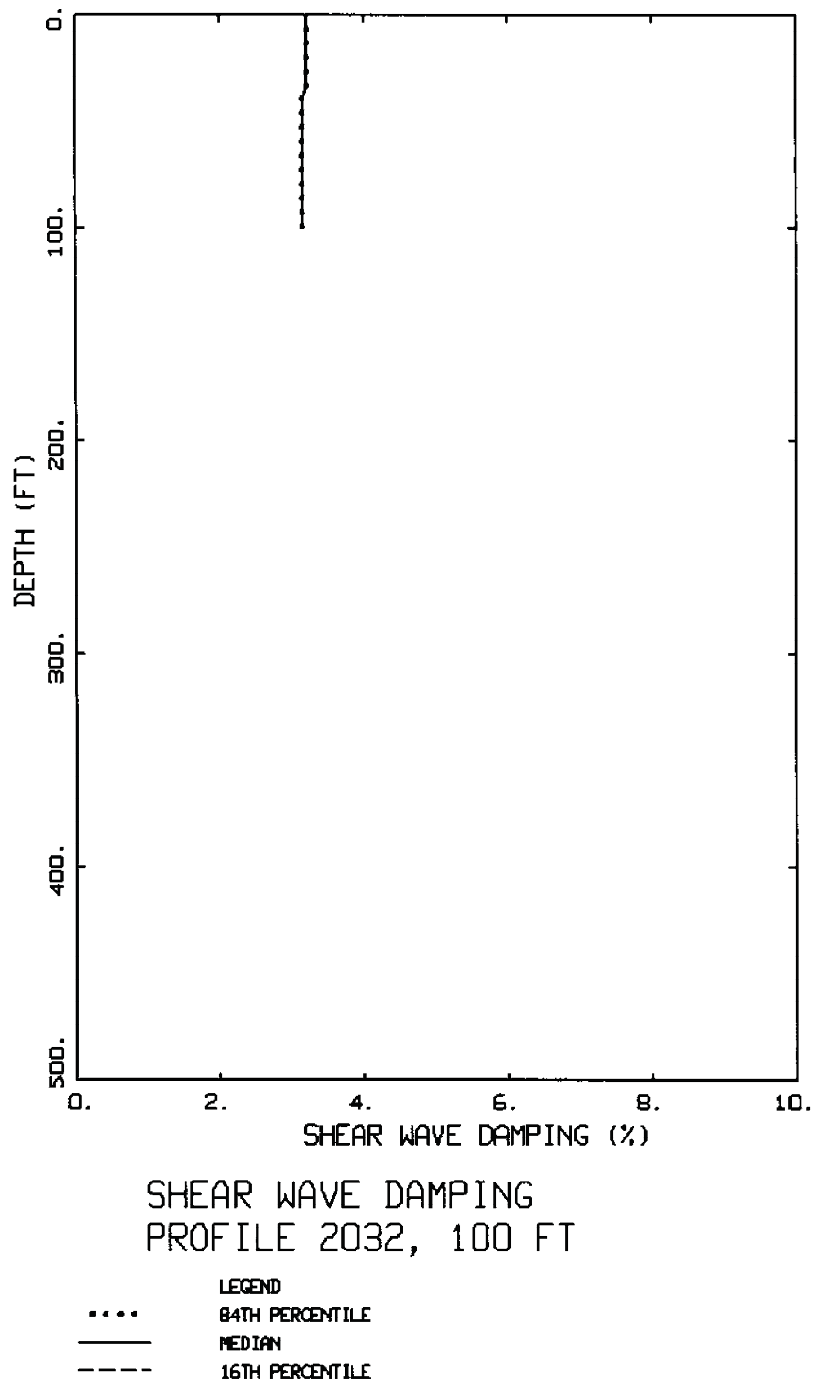


Figure 5.2-14 Strain Compatible Properties Computed for Profile 2032 100 ft Depth to Bedrock (Sheet 3 of 4)

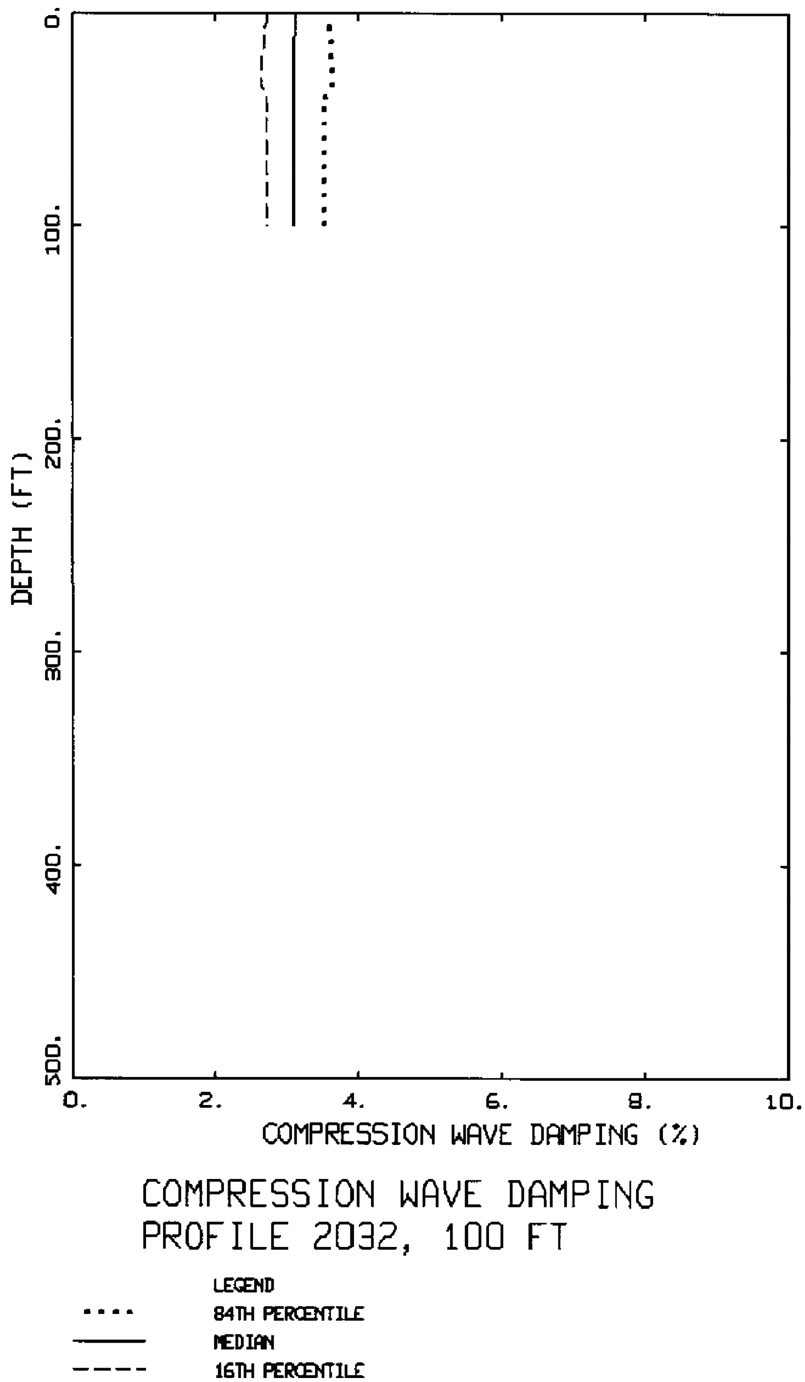


Figure 5.2-14 Strain Compatible Properties Computed for Profile 2032 100 ft Depth to Bedrock (Sheet 4 of 4)

5.3 ACS SASSI FE Model of the R/B Complex

5.3.1 Development of the R/B Complex Dynamic FE Model

Built using the ANSYS preprocessor, the R/B Complex Dynamic FE model is an integrated 3-D model of the R/B-FH/A, PCCV and CIS structures resting on top of a common 9'-11" thick basemat. Typical element size in the basemat and the slabs is about 9 ft, while the element size for the walls in the vertical direction is approximately 1.5 times larger (Refer to Section 4.3.1.1 and Table 4.3.1.1-1 for the element type used to simulate the R/B Complex structure). As a result, the total number of nodes in the model is 18,598 and the total number of elements is 22,390. Figure 5.3.1-1 shows an overview of the R/B model, while Figures 5.3.1-2 and 5.3.1-3 reveal the interior structures with section views. Figure 5.3.1-4 through Figure 5.3.1-6 show the PCCV, CIS (including the RCL). Note that the global origin is located at the center of the PCCV and top of the basement with X pointing North, Y pointing West, and Z pointing upward.

The R/B Complex Dynamic FE Model is developed incrementally using the ANSYS postprocessor n the following seven steps:

Step 1: R/B complex structures geometry is created in a manner that allows control of the model FE mesh.

Step 2: Attributes are assigned and additional mass are applied on each of the structures.

Step 3: Mesh controls are set and the model excluding the RCL is meshed.

Step 4: Modifications are implemented as needed to make the model more consistent with the Detailed FE model

Step 5: The nodes are renumbered sequentially in the order of their X, Y, and Z coordinates as recommended by ACS SASSI Manual in order to enhance computational efficiency

Step 6: The lumped mass stick model used for ANSYS analyses of RCL is translated into format that can be translated into ACS SASSI.

Step 7: RCL structure is added to the FE model of R/B complex structures and proper connections are implemented to represent the physical supports attached to the CIS structure

In order to accurately capture the effects of foundation geometry for SSI, the basemat footprint in the Dynamic FE model is extended to the external face of perimeter walls instead of their centerline. For simplicity without compromising accuracy, slab elevations in the Dynamic FE Model are slightly shifted upward or downward such that the middle planes of nearby upper or lower slabs fall into a major common horizontal plane. Also, only large openings in slabs and walls are included in the model. Wall properties are adjusted to account for the presence of small openings not included in the model as described in Section 4.3.1.5.

Special attention is given in the Dynamic FE Model as to how wall and slab shell elements are connected to the basement/mat solid elements. Wall shell elements are extended into the basemat solid elements to ensure a proper transfer of bending moment between them. Likewise, slab shell elements joining the basement walls are extended one element to overlay the basement top surface. These connecting elements are also assigned a zero density not to increase the overall mass of the basemat.

Also for simplicity, only the main steel frame in the Fuel Handling crane support system, including a simplified rail truss girder, is modeled in the Dynamic FE Model. The steel sections are modeled as beam elements within, but unattached to concrete shell elements representing the Fuel Handling exterior walls and slab. As a result, the composite behavior of the crane support system is not really represented in the FE model. To compensate for such a deficiency, all steel sections are assigned an increased moment of inertia in their strong axis to account for their composite behavior. An adjusted moment of inertia is also assigned to the embedded sections of the crane support steel columns between elevation 65'-0" and 76'-5", encased in 7'-8" by 4'-0" concrete columns.

The thickness of the PCCV is also simplified for ease of modeling. Only the large equipment hatch is modeled and the elements modeling the buttresses on the East and West sides of the structure are not offset with respect to adjacent elements. Also, the personnel airlocks as well as the Main Steam and Feed Water penetrations are not modeled in the Dynamic FE Model. Figure 5.3.1-4 shows the Dynamic PCCV Model.

The Dynamic CIS Model contains approximately 3600 elements and 2600 nodes with nominal mesh size of 7.2' in vertical direction and 9' in horizontal direction. It consists of a combination of shell, solid and beam elements. The solid elements shown in Figure 5.3.1-5 make up the CIS base which starts at elevation 2'-7" and the reactor support which extends up to elevation 35'-10.87". The shell elements model the remaining walls and slabs of the structure and begin at the same elevation as the CIS solid elements, but extend to the top of the pressurizer compartment at 138'-7". The beam elements model the supports for the RCL components, and the columns between the 2nd and 4th floors. Connection details and explanation for the interface between the varying element types are presented in Section 4.3.1.1.

The Dynamic CIS model utilizes numerous simplifications to preclude meshing difficulties. The geometry of some of the CIS components are simplified, and the various small openings throughout the structure are neglected. In order to maintain the dynamic properties of the detailed CIS model,the material properties of some of the CIS members are modified.

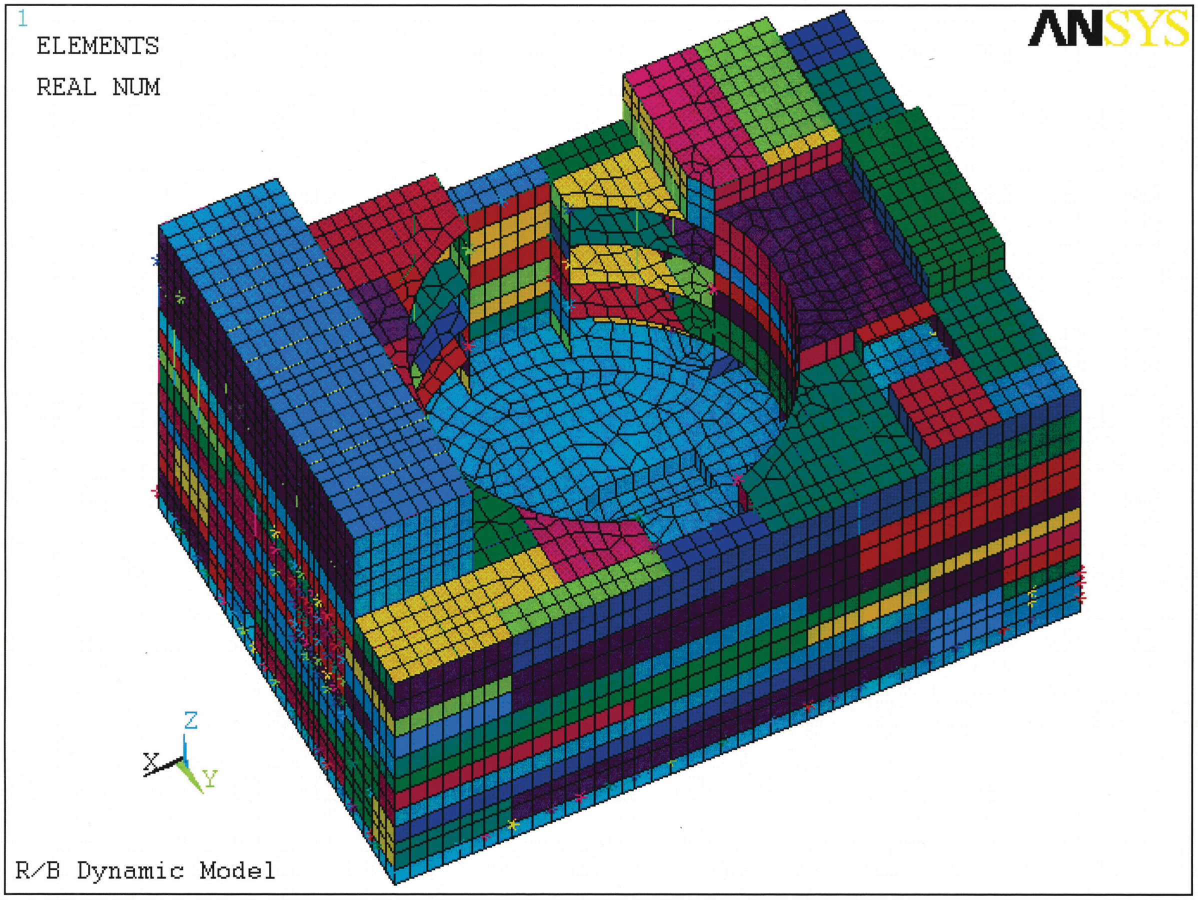


Figure 5.3.1-1 Dynamic R/B Model