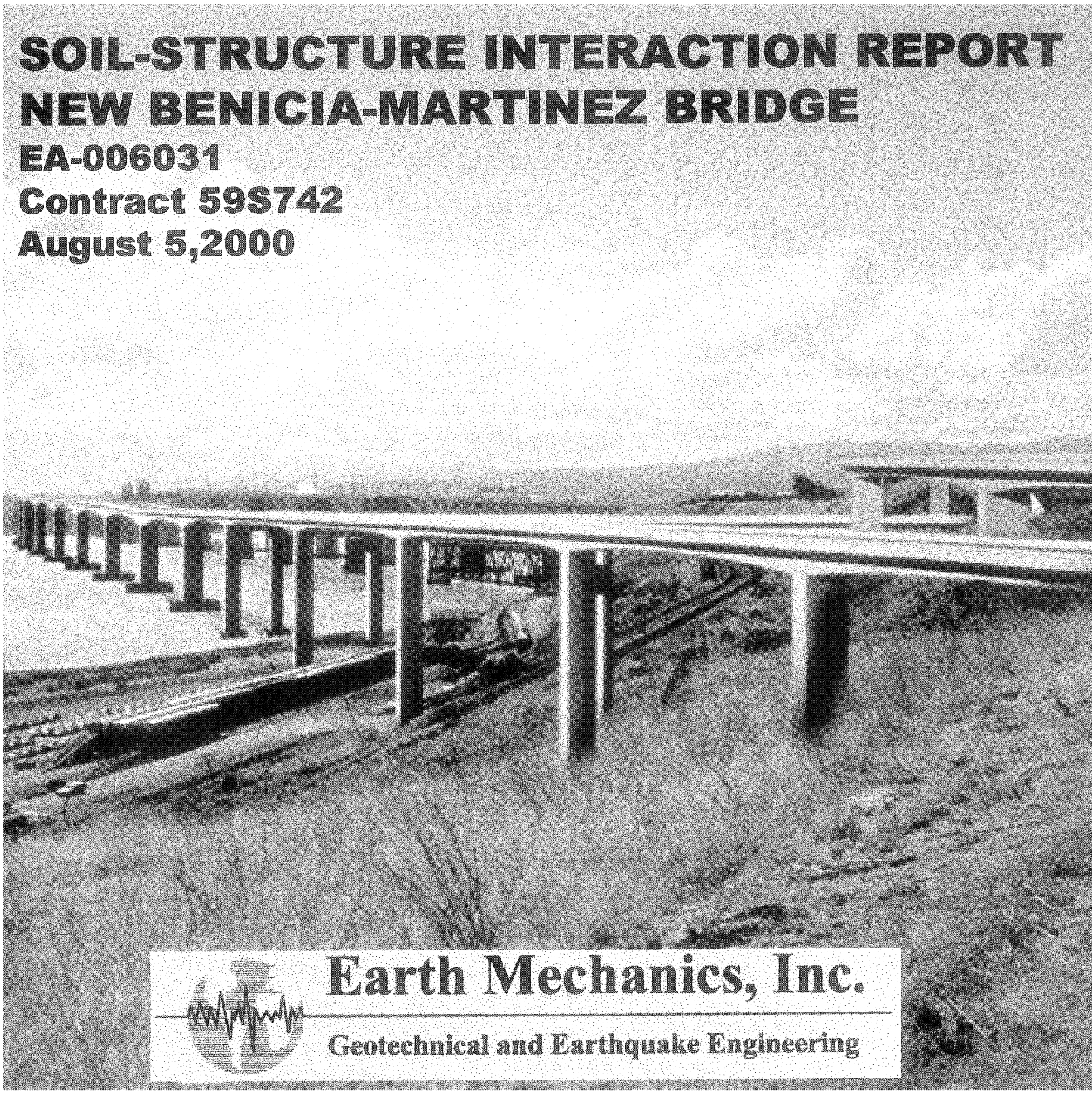
SOIL-STRUCTURE INTERACTION REPORT
NEW BENICIA-MARTINEZ BRIDGE

EA-006031

Contract 59S742

August 5,2000



Earth Mechanics, Inc.

Geotechnical and Earthquake Engineering

SOIL-STRUCTURE INTERACTION REPORT

NEW BENICIA - MARTINEZ BRIDGE
(Bridge No. 28-0153R)

EA-006031
Contract 59S742

Report to

T. Y. Lin International/CH2M Hill
A Joint Venture

Earth Mechanics, Inc.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.

Geotechnical & Earthquake Engineering

August 5, 2000

EMI Project No. 96-178

T. Y. Lin International/ CH2M Hill, A Joint Venture
825 Battery Street
San Francisco, CA 94111

Attention: Mr. Mirek Olmer, T. Y. Lin
Mr. Steve Thoman, CH2M Hill

Subject: Soil-Structure Interaction Report
New Benicia-Martinez Bridge

Dear Gentlemen:

Enclosed is our soil-structure interaction report for the New Benicia-Martinez Bridge. This report compiles all the soil-structure analyses conducted for the subject bridge. Other geotechnical information such as detailed ground motion studies and foundation data is documented in the Final Foundation Report, submitted to you on March 16, 2000. Please do not hesitate to call us for further clarifications.

Sincerely,
EARTH MECHANICS, INC

REGISTERED PROFESSIONAL ENGINEER
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A Joint Venture
825 Battery Street
San Francisco, CA 94111

Prepared by:

Earth Mechanics, Inc.
17660 Newhope St., Suite E
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August 5, 2000

EMI Project No. 96-178

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Section 1

1.0 INTRODUCTION

1.1 Background

This report summarizes soil-structure interaction tasks carried out for the New Benicia-Martinez Bridge. The project limit is from Abutment 1 through Pier 17. The original contract limit was from Abutment 1 through Pier 15; however Piers 16 and 17 have recently been added to the original contract.

The materials covered in this report include general geology, free-field ground motions, soil support curves in terms of p-y, t-z, and q-u relations, foundation masses, stiffnesses and damping coefficients for substructure application, and kinematic ground motions as effective loading at the foundation level. Detailed documentation of subsurface data, site investigation, ground motion studies, foundation loads, foundation capacities, and constructibility can be found in the Final Foundation Report dated March 16.

The existing Benicia-Martinez Bridge was built around 1955 between Solano and Contra Costa counties. This bridge is also known as George Miller Jr. Bridge on Interstate Route 680. To the northeast, there is a Southern Pacific Railroad (SPRR) bridge almost parallel to the existing Benicia-Martinez bridge. The alignment for the new bridge has been selected at some 250 meters to the northeast of the existing bridge separated by the SPRR bridge. Figure 1.1 shows the project location. The new structure consists of the Main Bridge crossing the Carquinez Strait and three Approaches as briefly described below.

Main Bridge: The Main Bridge consists of segmental box girders supported by Piers 5 through 17. The pier numbering ascends from south to north which is just opposite of the existing bridge's numbering. A shipping channel is located between Piers 7 and 8. The designers have selected pile foundations to support the superstructure. Each pile would have a 2.5-m diameter steel casing to construct a 2.2-m diameter rock socket, i.e., the upper section of the pile is 2.5 meter diameter Cast-in-Steel-Shell (CISS) constructed in non-rock sediment and the lower section is 2.2 meter diameter CIDH socketed in bedrock.

Approaches: There are three approach structures for the new bridge; South Approach leading to Martinez, "NB" Approach to Sacramento, and "NW" Approach to Benicia. The South Approach consists of Abutment 1 to Pier 4, all supported on piles. Since the structures for the "NB" and "NW" Approaches will be designed by engineers from the CALTRANS, this report does not contain the information pertaining to these two approach structures.

1.2 Project Team and Acknowledgment

The Office of Structural Foundations at California Department of Transportation (CALTRANS),

Ben C. Gerwick Inc., Norm Abrahamson, and Earth Mechanics Inc. have participated in the geotechnical studies of the New Benicia-Martinez Bridge. TY Lin International and CH2M Hill are the structural designers.

CALTRANS led the field investigation program, axial pile capacity analyses, and free-field site response studies. They also provided scour data and past construction experience. Ben C. Gerwick, Inc. is responsible for addressing construction issues with particular relevance to large diameter pile installation. Time histories of multiple support rock motion were developed by Norm Abrahamson, a seismologist who served as a consultant to this project. Earth Mechanics, Inc. performed lateral pile analyses and all the aspects of soil-structure interaction task including the development of ARS design criteria and characterization of foundation lumped parameters for seismic analyses. The individuals participated in the geotechnical studies are:

CALTRANS	:	Bogdan Komorniczak, Abbas Abghari, Angel Perez-Cobo
Ben C. Gerwick Inc.	:	George Fotino, Ben C. Gerwick, Jr.
Consultant	:	Norm Abrahamson
Earth Mechanics Inc.	:	Po Lam, Hubert Law

1.3 Organization of the Report

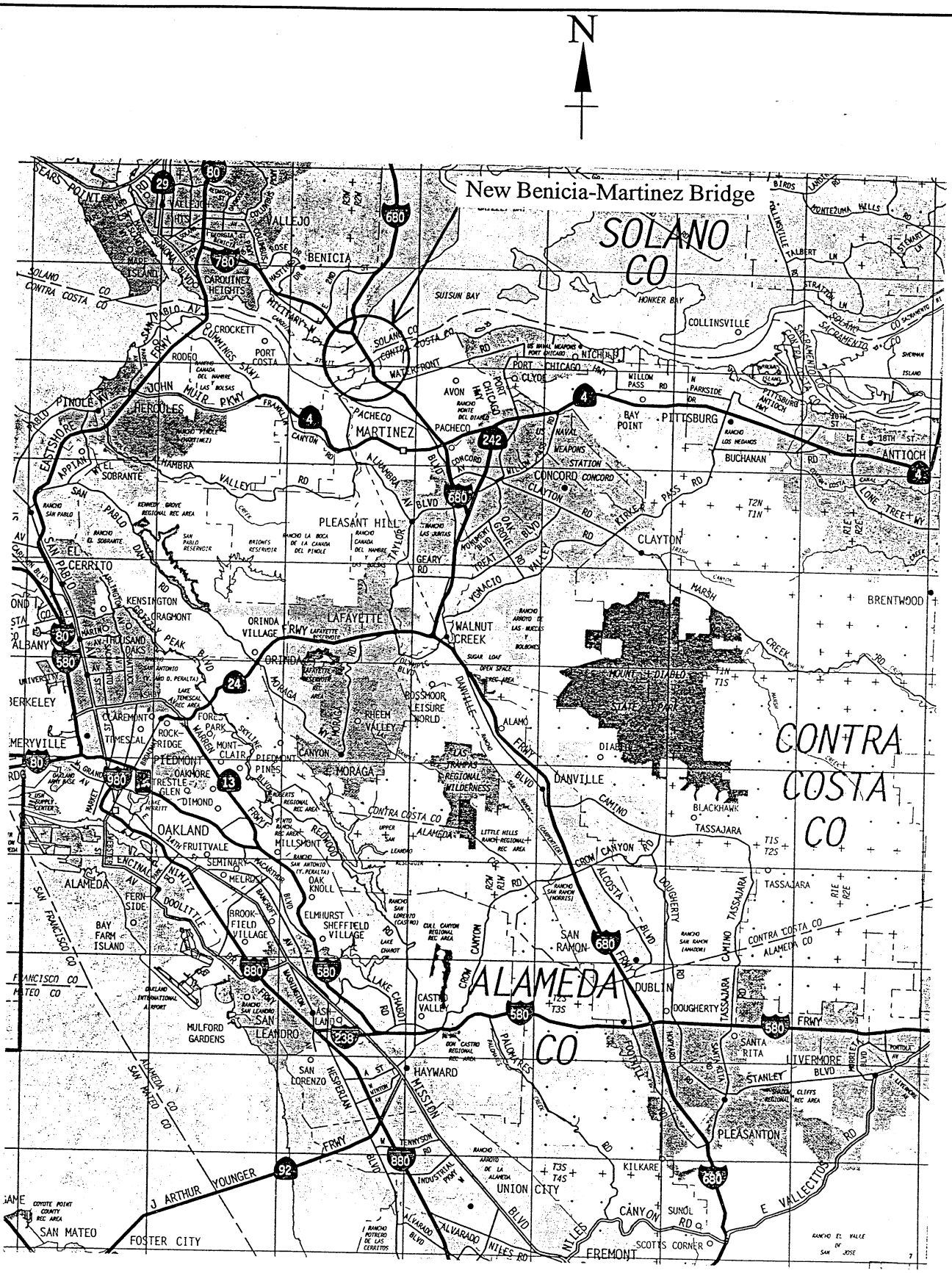
In addition to this introduction section, this report has been organized into the following sections:

Section 2. Provides background information on geology and ground motion issues including free-field site response analyses conducted by Caltrans.

Section 3. Presents descriptions of the proposed foundations for the new Benicia-Martinez bridge and the design scenarios adopted by the designers. This section also provides basic soil support curves in terms of p-y, t-z, and q-u relations.

Section 4. Describes soil-structure interaction works including fundamentals of substructuring approach to obtain a condensed foundation stiffness matrix, a mass matrix and a damping matrix. The stiffness matrices are presented for the upper bound (benchmark) and lower bound scenarios. These stiffness matrices along with mass and damping matrices were used for seismic loading. Separate foundation stiffness is also provided for service (temperature) loading.

Section 6. Conclusions



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NEW BENICIA MARTINEZ BRIDGE	
PROJECT LOCATION	Figure 1.1
Project No. 96-178	Date: 12-1-98

Section 2

2.0 GEOLOGY AND GROUND MOTION

This section provides a brief summary of geology and ground motion. Detailed discussions can be found in the Final Foundation Report including site investigation programs, subsurface information, liquefaction, seismicity, and seismic design criteria.

2.1 Geology

The Benicia-Martinez Bridge extends across the eastern part of the Carquinez Strait from bedrock ridges on both sides (See Figure 2.1). The bedrock is of primarily Mesozoic age Great Valley Sequence (about 65 to 200 million years old).

The south abutment of the existing bridge and the railroad bridge, as well as the proposed location of the new bridge, is on a low-elevation, rounded hill underlain primarily by rocks. Most of the hill at the south abutment is covered by soil so details of rock characteristics are obscured. The floor of the Carquinez Strait is underlain by a mixture of non indurated clay, silt, and sand. In very general terms, the sides of the strait are underlain predominantly by clayey sediments and the more-central area are more sandy. These sandy deposits are probably a result of river and high-flow channel deposition related to flooding of the Sacramento/San Joaquin River systems, whereas the clays and silts are either overbank river deposits or bay/estuary muds. Some of the deeper materials are highly weathered and decomposed bedrock whereas the shallower materials are all modern and Holocene-age river, bay, and estuary deposits.

Rocks in the site area are highly deformed by faulting and folding. Folding and faulting are generally related to movement along the North American/Pacific plate boundary which comprises a zone of faults and folds about 70 km wide at the latitude of the site region. The known major active faults in the site area are the Hayward fault to the west, the Calaveras fault to the south, and the Green Valley fault to the east. Another smaller active fault is the Concord fault about 2.5 km to the east. Other nearby faults that may be capable of generating destructive earthquakes are the Pinole fault about 15 km to the west, the Franklin fault about 7 km to the west, and the South Hampton fault about 4 km to the west. These faults may be northerly extensions of the active Calaveras fault to the south.

2.2 Subsurface Conditions

Since construction of the existing Benicia-Martinez Bridge, several field investigation programs have been conducted in the general area. The final alignment for the new bridge was selected at some 250 meters to the northeast of the existing bridge separated by the SPRR bridge. Along this final alignment, CALTRANS has conducted a drilling program consisting of 18 boreholes. Most

of the boreholes were drilled to the anticipated rock-socket tip elevations and at or near the pier locations.

The geologists at CALTRANS led by Mr. Bogdan Komorniczak first conceived the original soil profile using the latest soil boring data. They are also responsible for drilling the boreholes for the project. The original soil profile was later modified by Earth Mechanics, and it is used for foundation analyses and subsequent soil-structure interaction studies. This modified idealized soil profile is shown in Figure 2.2, which has been reviewed and approved by Bogdan. Elevations shown in the original logs-of-test-boring for the 1997/98 investigation are based on the Mean Lower Low Water (MLLW) level. However, all elevations on the presented figure are referred to the Mean Sea Level (MSL) datum. The figure includes SPT blow counts in soil, Rock Quality Designation (RQD) and uniaxial compressive strengths (qu) of rock. Also shown on the figure are shear wave velocity profiles as measured with a downhole geophysical sounding system.

The borings conducted for the new bridge penetrate into rock to various depths. The thickness of the sediment ranges from 5 to 35 meters, and it is underlain by interbedded claystone, siltstone, sandstone and shale. At the south approach, the surficial materials are dense sand and gravel with some boulders, and the bedrock can be found within 5 m from the current grade elevation. The rock encountered at the south approach shows various degrees of weathering ranging from very low (zero) RQD near the surface to high RQD at a 15-meter depth. Within the Carquinez Strait, interbedded layers of clay and sand are found at most of the support locations except at Pier 13 where sand is found as a major sediment unit. The surficial materials are loose/soft with blow counts typically less than 5 blows per 0.3 meter. The rock quality and strength are fairly uniform within the main bridge, and also there is no evidence of abrupt changes in bedrock contact elevations under the strait.

2.3 Seismic Hazard

The seismic hazard investigation by Geomatrix (1996) evaluated ground motions at the site from maximum earthquakes on three faults, a M_W =8 on the San Andreas fault, a M_W =7.25 on the Hayward fault, and a M_W =6.75 on the Green Valley faults. The controlling fault is the Green Valley fault for the new Benicia Martinez bridge.

The Green Valley fault, located at about 3 kilometers to the east, has a maximum moment earthquake magnitude M_w = 6.75. The reference shaking intensity was established by setting the target rock spectra. Both deterministic and probabilistic approaches have been used to define the target rock spectra for design. In addition, fault rupture directivity effects have been postulated in defining the target rock spectra and the spectrum-compatible rock motion time histories.

Two-level design earthquakes are used to design the New Benicia-Martinze Bridge; Safety Level Earthquake Event (FEE) and Functional Level Earthquake Event (SEE).

The shaking level for Safety Level Earthquake (SEE) is an event with a 1,000 to 2,000 year return period based on probabilistic design approach. Also, the shaking level falls between a mean and an 84-th percentile (mean-plus-standard deviation) confidence level based on deterministic maximum credible earthquake design approach. Figure 2.3 presents the recommended target spectra for transverse and longitudinal component motions for the Green Valley Event (the controlling fault). It should be noted that these spectra represent the level of shaking at bedrock and do not include local site effects.

The Functional Level Earthquake (SEE) has been defined as a 300 year return period event based on probabilistic design approach and the shaking level corresponds to about two thirds (0.65) of the Safety Level Shaking intensity.

2.4 ARS Seismic Design Criteria

ARS seismic loading criteria for the main bridge structure were established using kinematic soil-structure interaction analyses incorporating representative site conditions, free-field motions and pile foundation properties within the strait. The acceleration response spectra (ARS criteria) arising from soil-structure interaction analyses are shown in Figures 2.4 to 2.5 for the longitudinal and transverse component motions, respectively. The corresponding relative displacement spectra are shown in Figures 2.6 to 2.7. Detailed ground motion studies can be found in the Final Foundation Report.

For the south approach structures, the ARS curves developed for rock have been recommended due to rock outcrop with localized surficial soil cover.

2.5 Multiple Support Time Histories

In addition to designing the bridge to the appropriate design spectra, it has been designed, as well as independent checked against 3 sets of time histories where each of the rock motion is spectrum compatible to the same target rock spectra. The input motions for time history analysis of the new Benicia-Martinez bridge include state-of-the-art technologies in various fields covering seismology, site response and soil-structure interaction approaches. Major features include the following:

- Consideration of near-field forward fault rupture directivity effects.
- Spatial varying multiple support motions arising from effects of wave passage and random statistical scatters in observed ground motions.
- Modifications in characteristics of ground motions due to local site specific soil properties to account for site response effects.

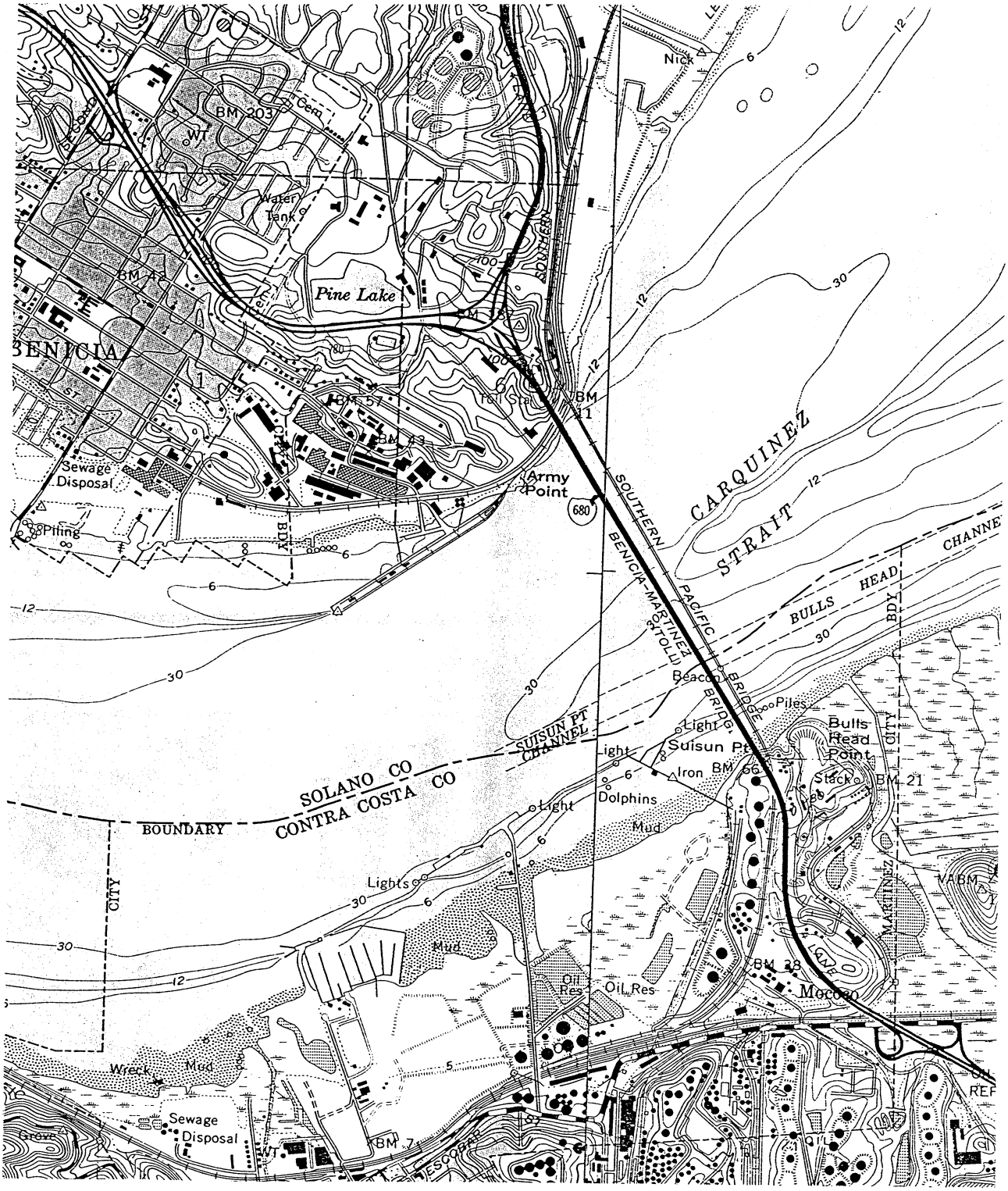
- Soil-structure interaction effects in how the ground excitations are transmitted to the bridge structure.

Three sets of rock motions were developed; they correspond to Green Valley Event, Hayward Event, and San Andrea Event. All three sets have been calibrated to the SEE level and are spectrum compatible to the target spectra.

The multiple support rock motions were used in the site response analyses conducted by Caltrans (Office of Structure Foundations) to obtain depth-varying free-field motions. Plots of free-field motions as computed from one-dimensional site response analysis are presented in Appendices A, B and C for ground motions Set-1, Set-2 and Set-3, respectively. These depth-varying free-field motions were in turn used in the kinematic soil-pile interaction analyses to define effective loading at the pile-cap level. Comparisons of depth varying free-field motions and kinematic motions extracted at the pile-cap level are also shown on the plots in the appendices. The structural engineers also used the depth-varying free-field motions directly in their so-called total-system model where individual piles and soil springs are explicitly included. The multiple-support kinematic motions as derived from the kinematic soil-pile interaction analyses can be used in the substructure model which simplifies the foundation component by representing with a foundation stiffness matrix. The concept of substructure model is explained in the next section.

2.6 Studies on Vertical Motions

Well calibrated site response techniques for vertical component motion are not currently available, and therefore no site response analysis has been conducted at the Benicia-Martinez Bridge for the vertical direction. A conservative approach for vertical ground motion may be adopted which takes no credit for the reduction in shaking amplitude with depth, but account for wave-passage effect with depth. Incorporating wave-passage effects tends to reduce vertical shaking intensity at a short period range. The structural designers are given an option to implement the wave passage effects in the total-system bridge model for multiple support time history analyses.



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NEW BENICIA MARTINEZ BRIDGE

EXISTING BRIDGE AND VICINITY — Figure 2.1

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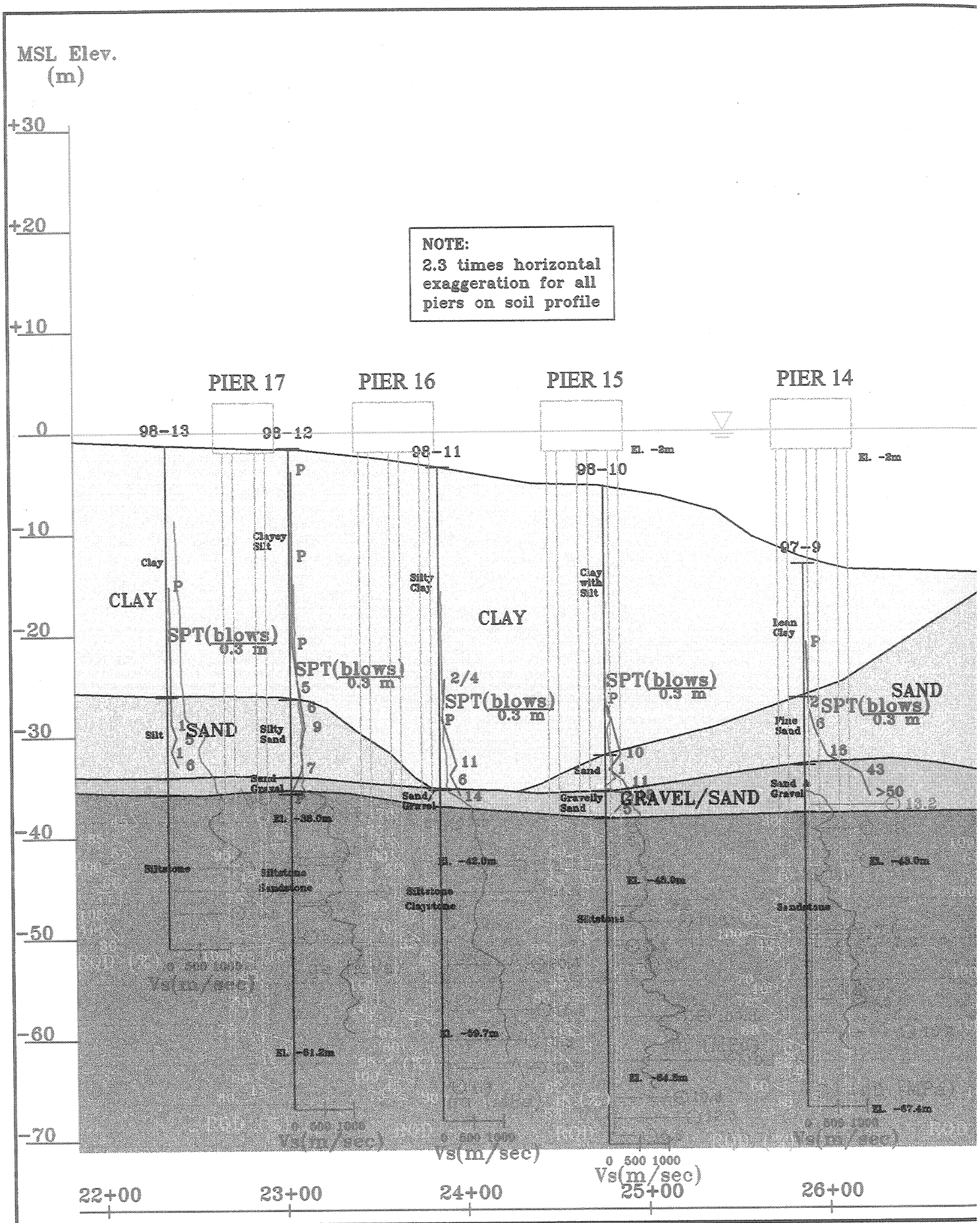

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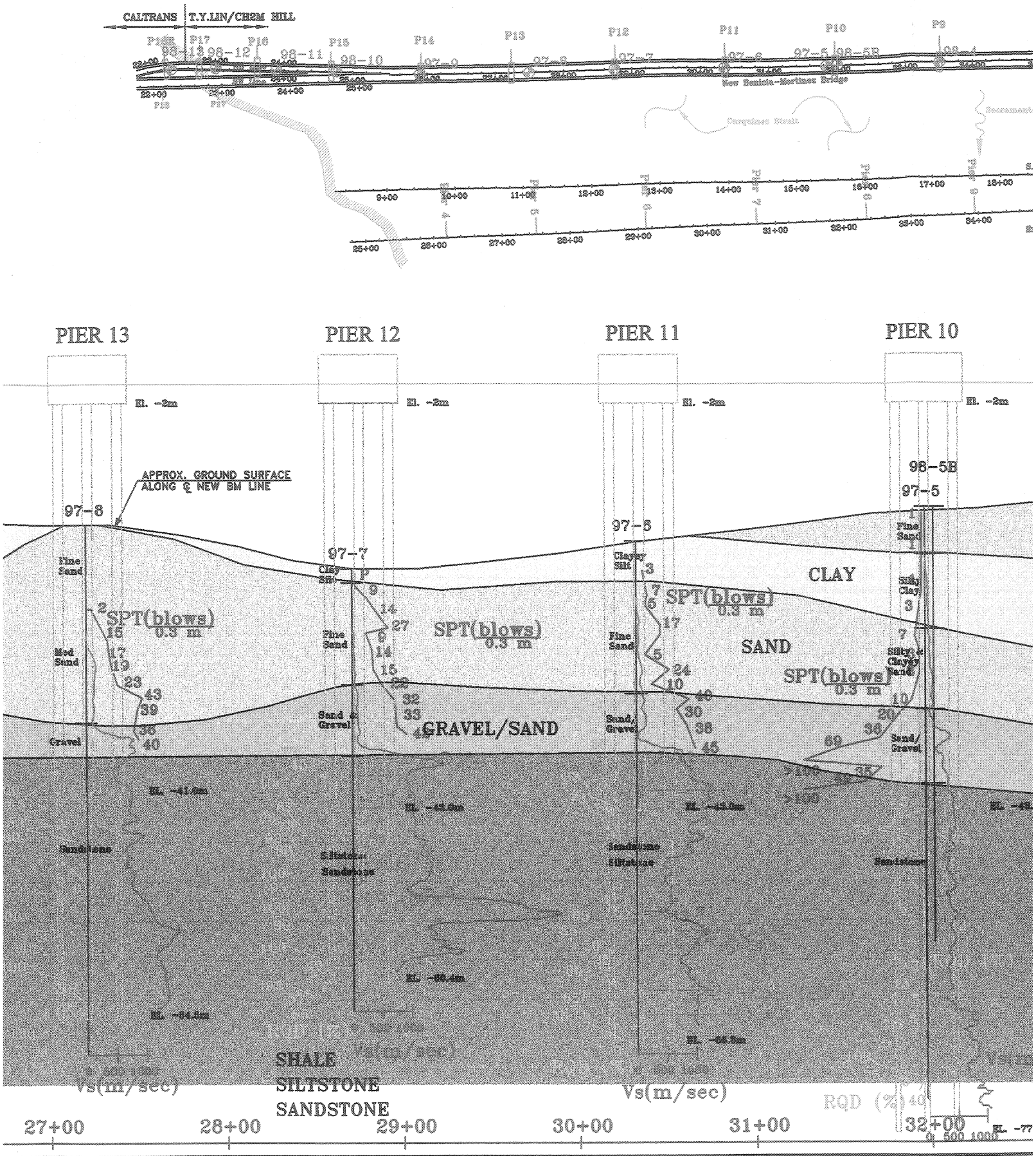

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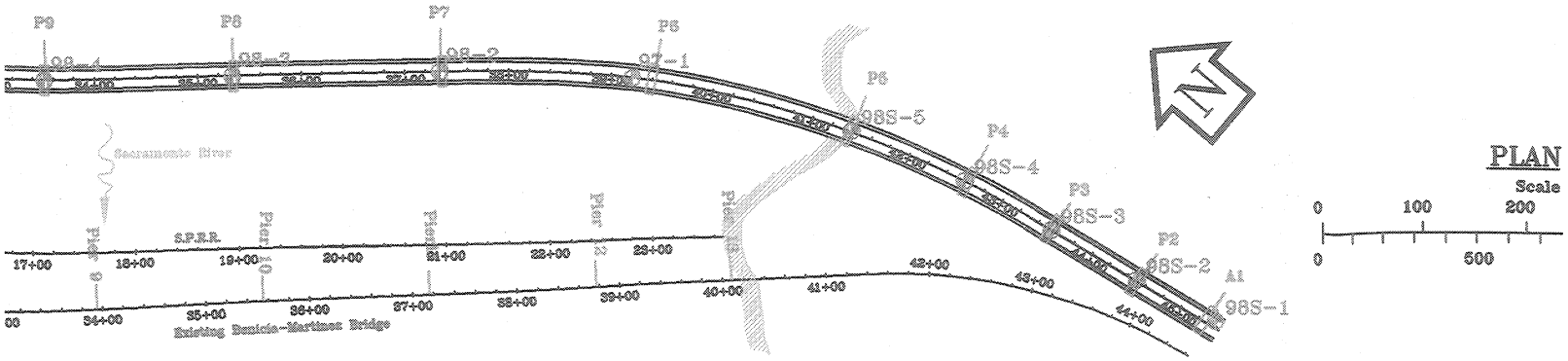

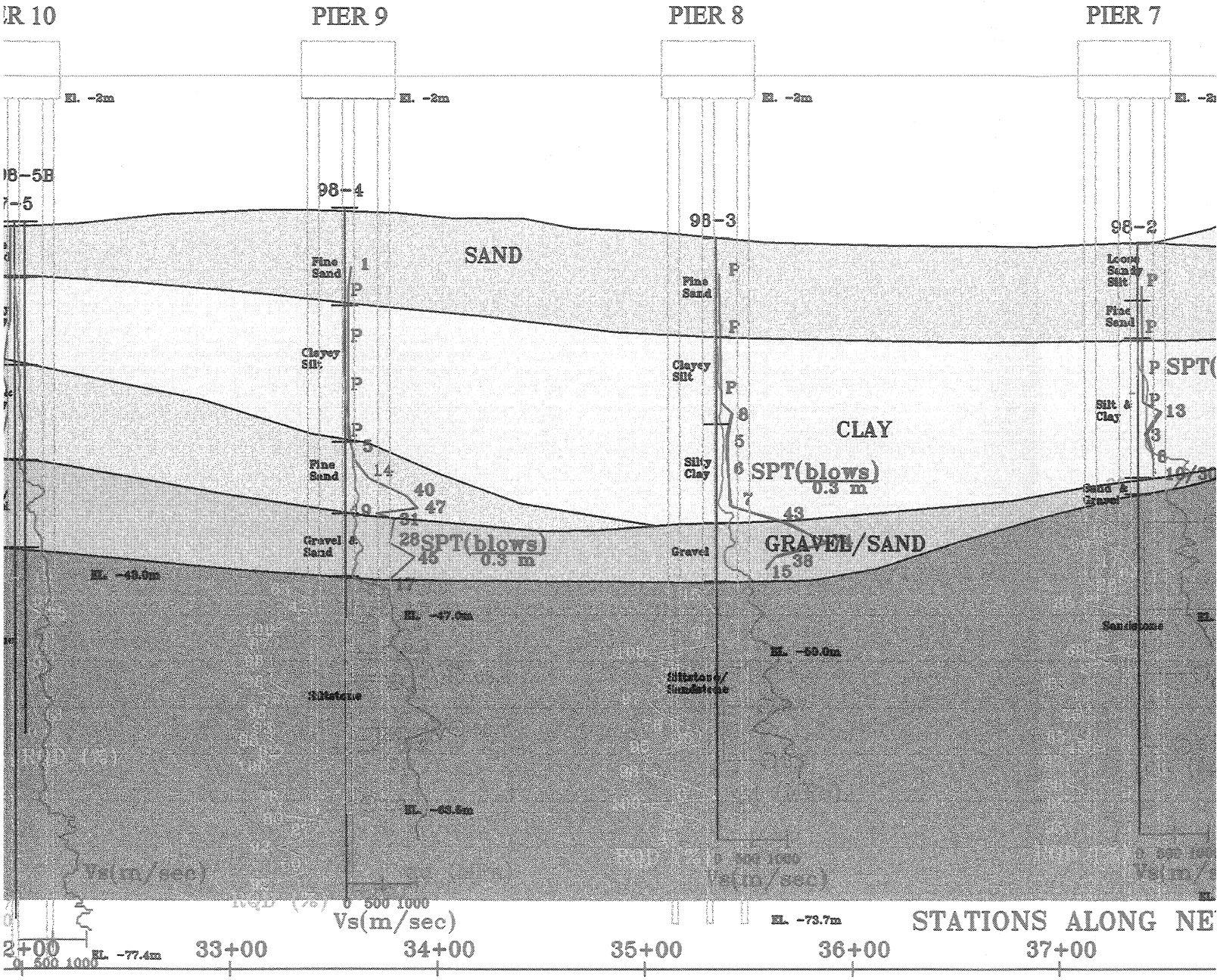

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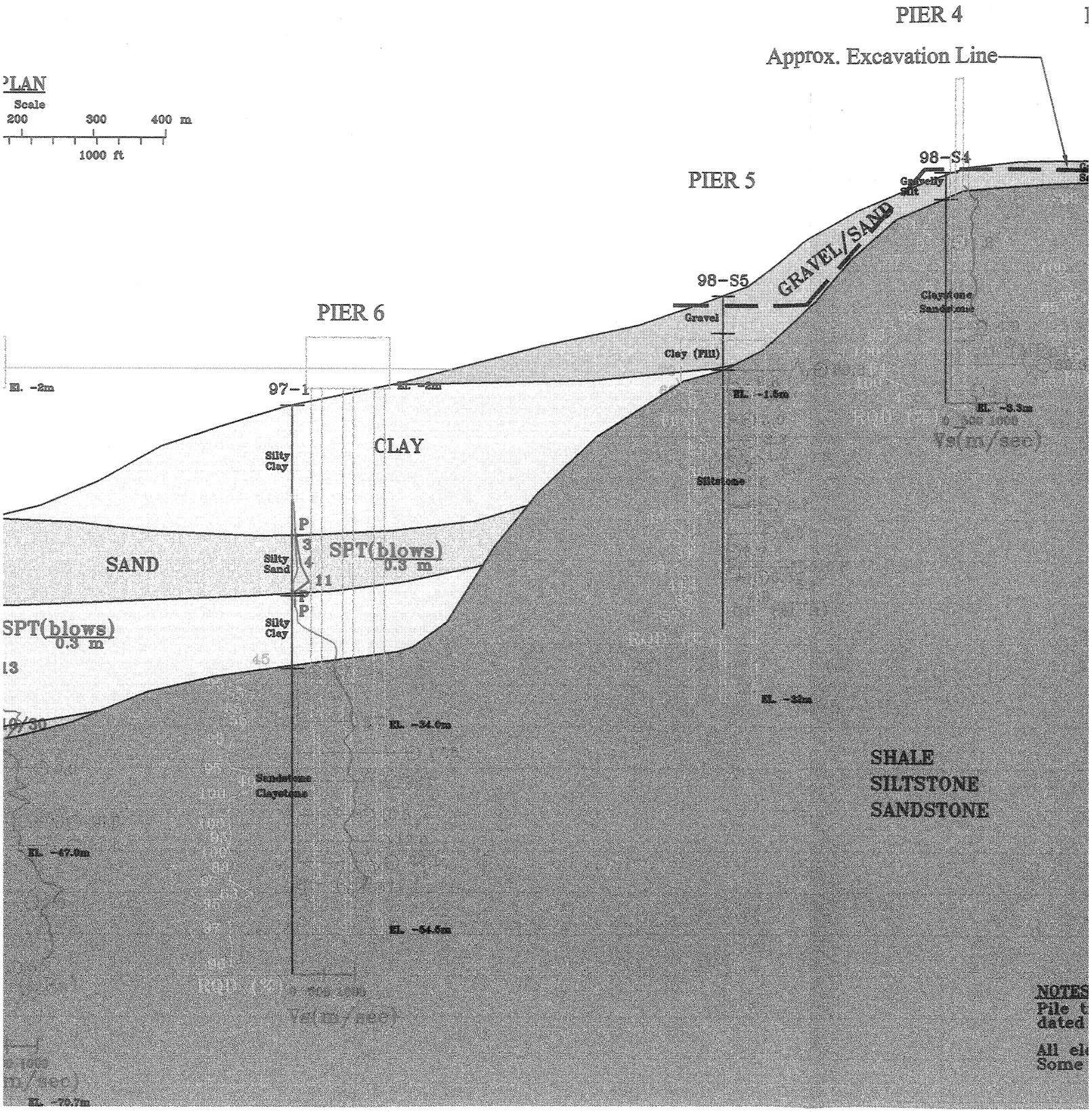

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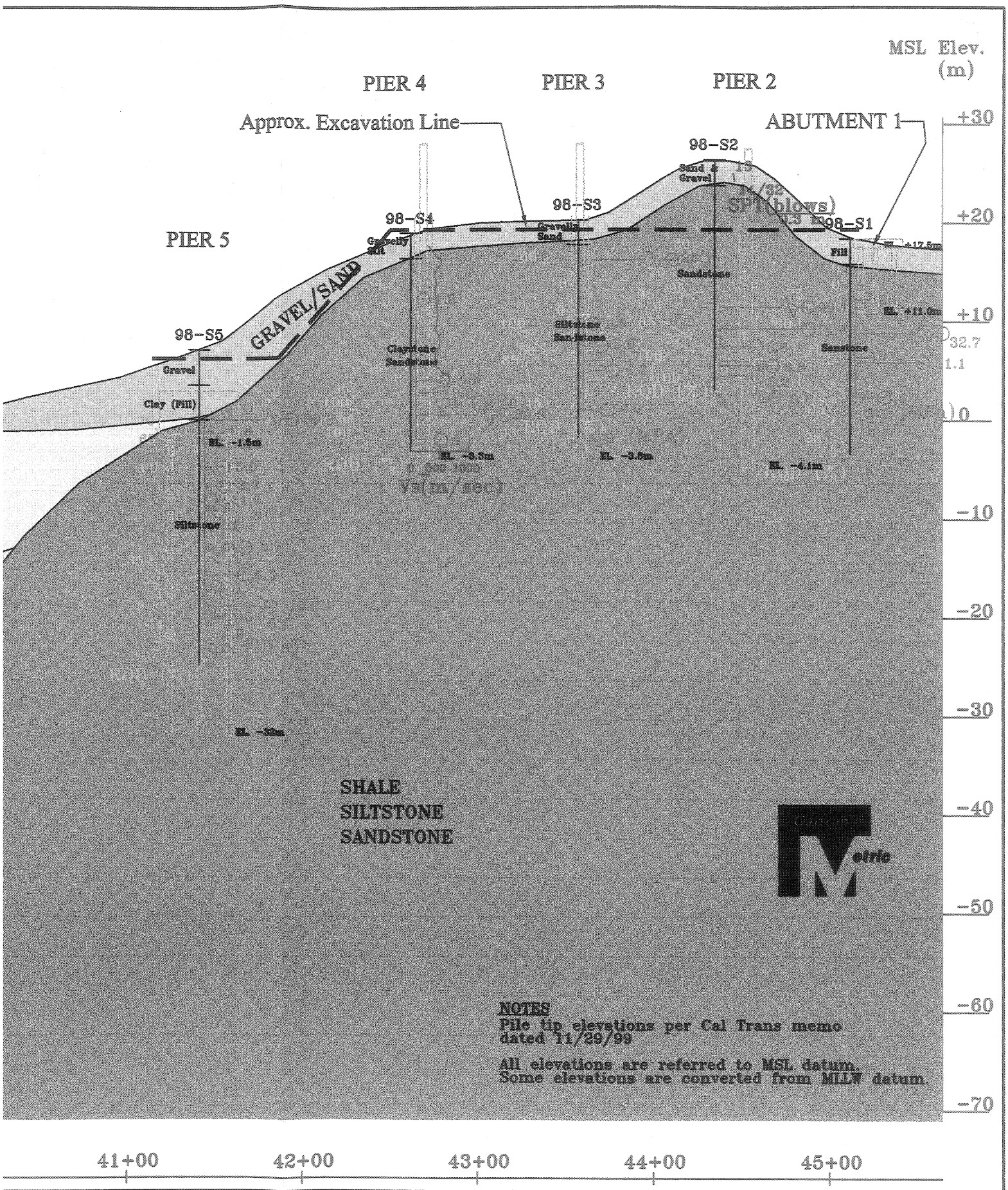
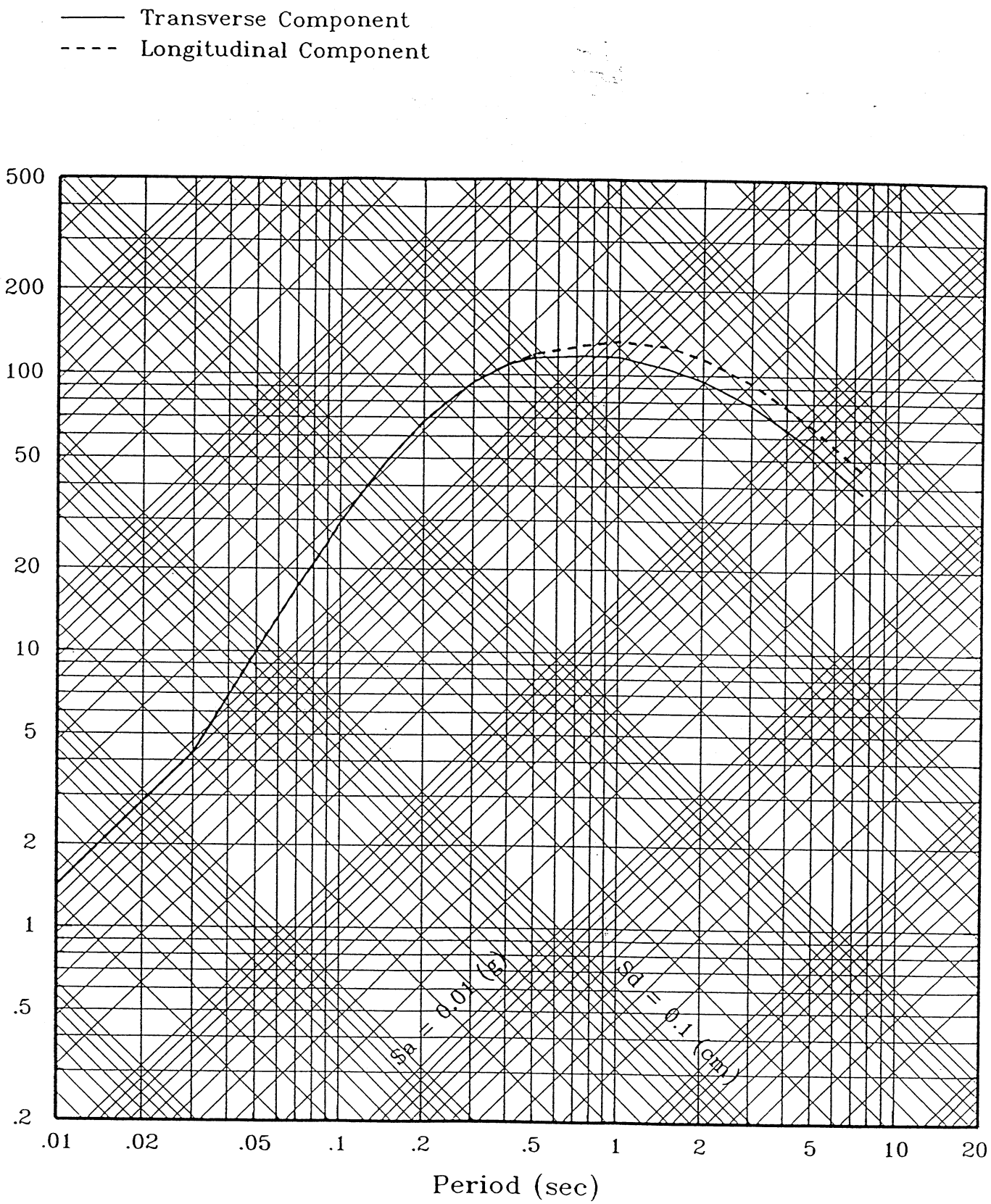


NOTES
Pile tip elevations per Cal Trans memo dated 11/29/99

All elevations are referred to MSL datum.
Some elevations are converted from MLLW datum.

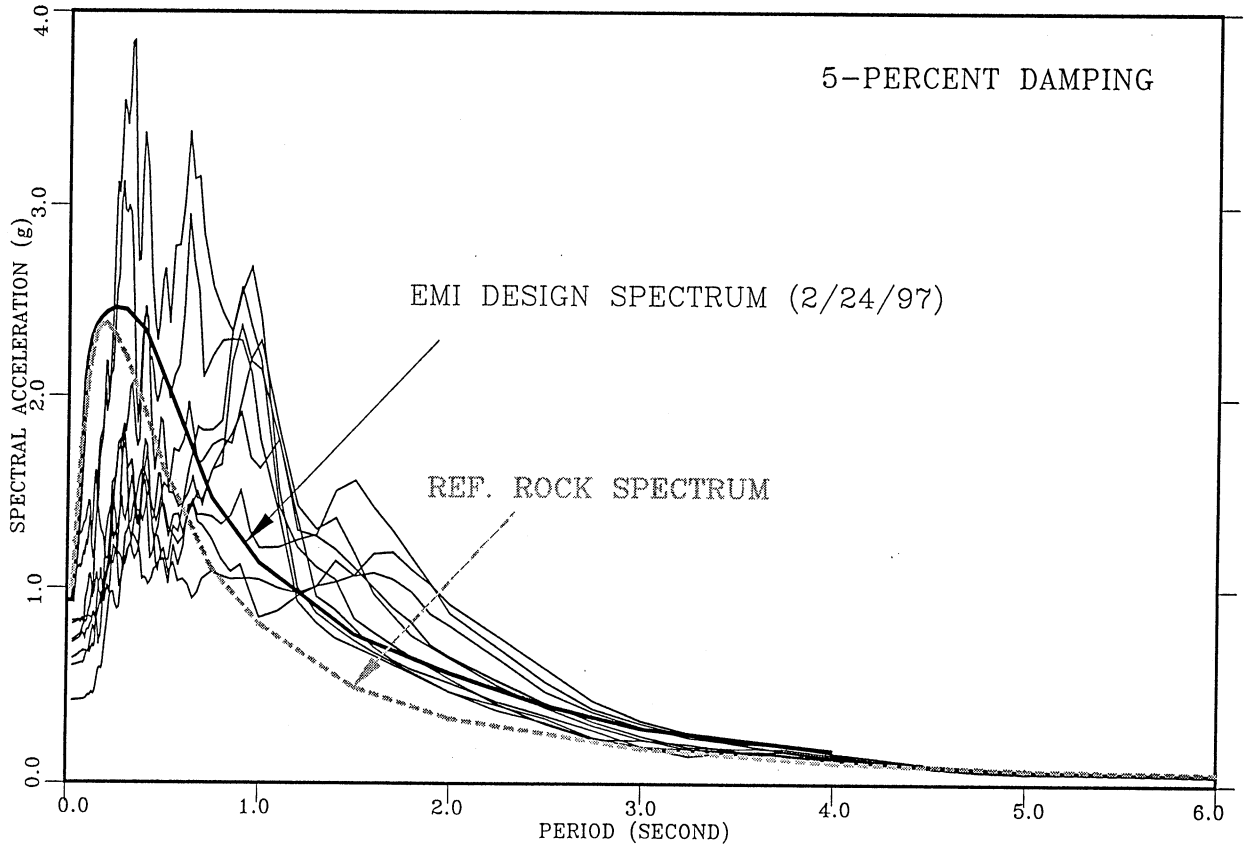
OIL PROFILE ALONG NEW BRIDGE

Figure 2-2



After Geomatrix (1996)

Figure 2.3 Target Response Spectra (5% Damped) for the Longitudinal and Transverse Components Associated with the Green Valley Event, Benicia-Martinez Bridge



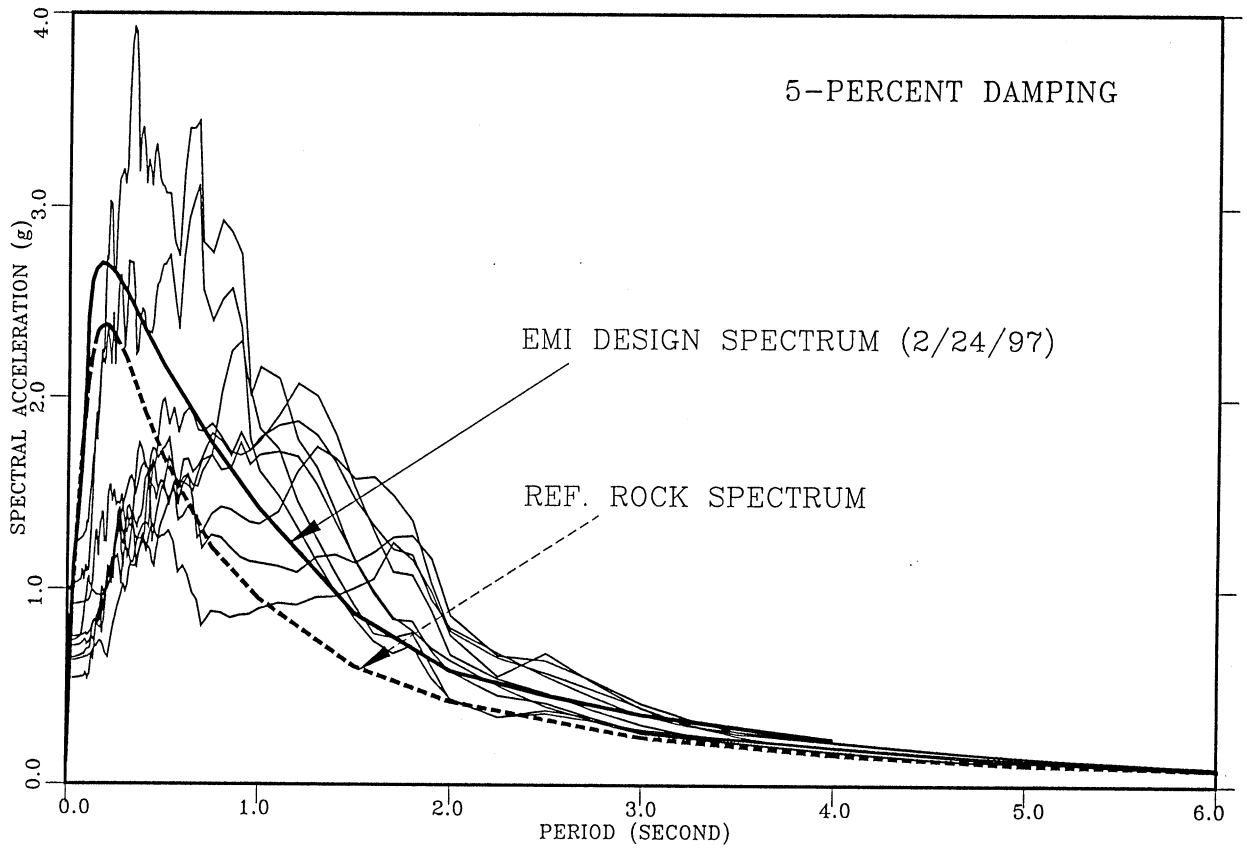
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

NEW BENICIA-MARTINEZ BRIDGE

EMI Project No.: 95-178 | Date: MAR. 27, 1997

M.L. ACCELERATION SPECTRA
LONGITUDINAL COMPONENT

Figure 2. 4



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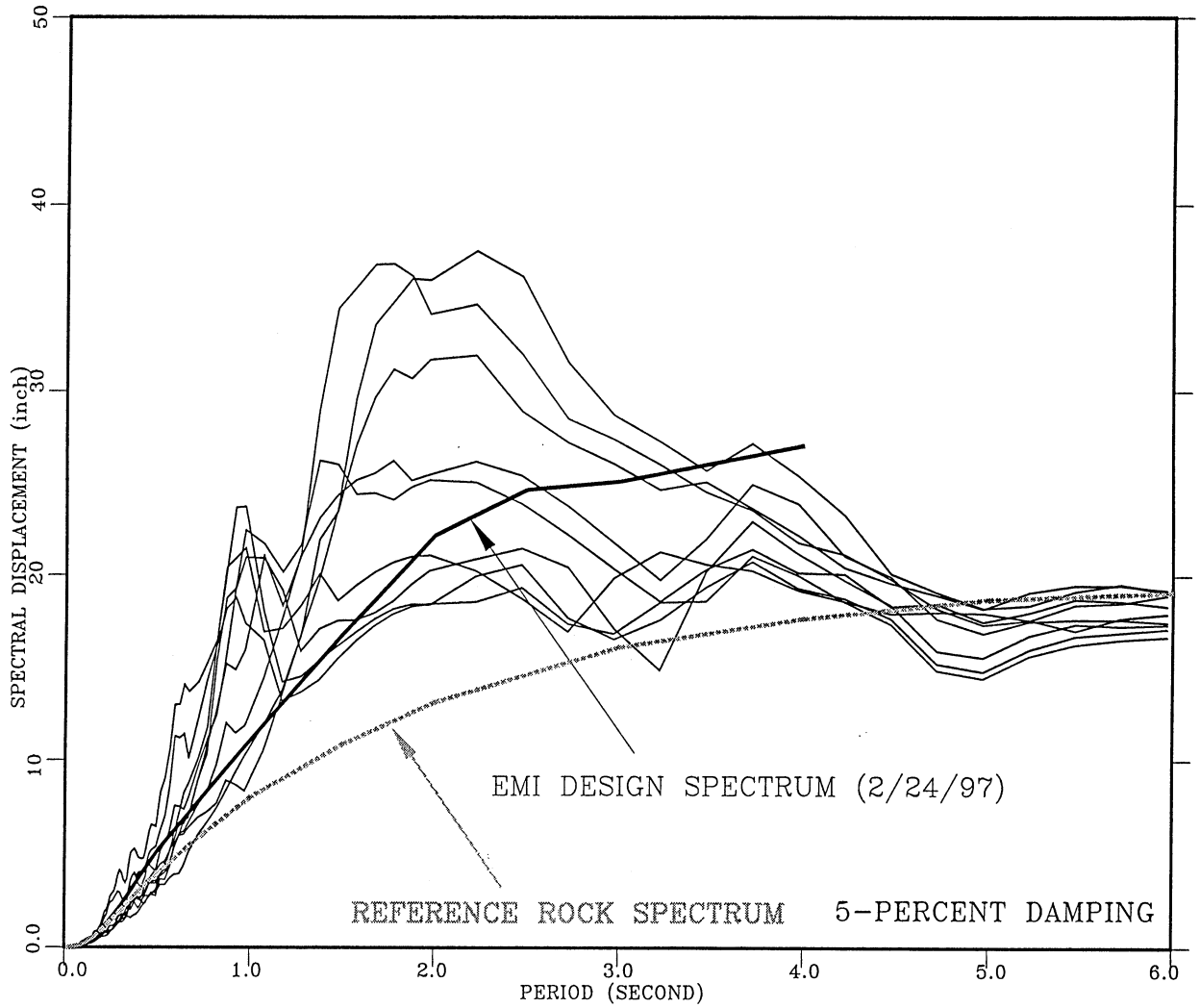
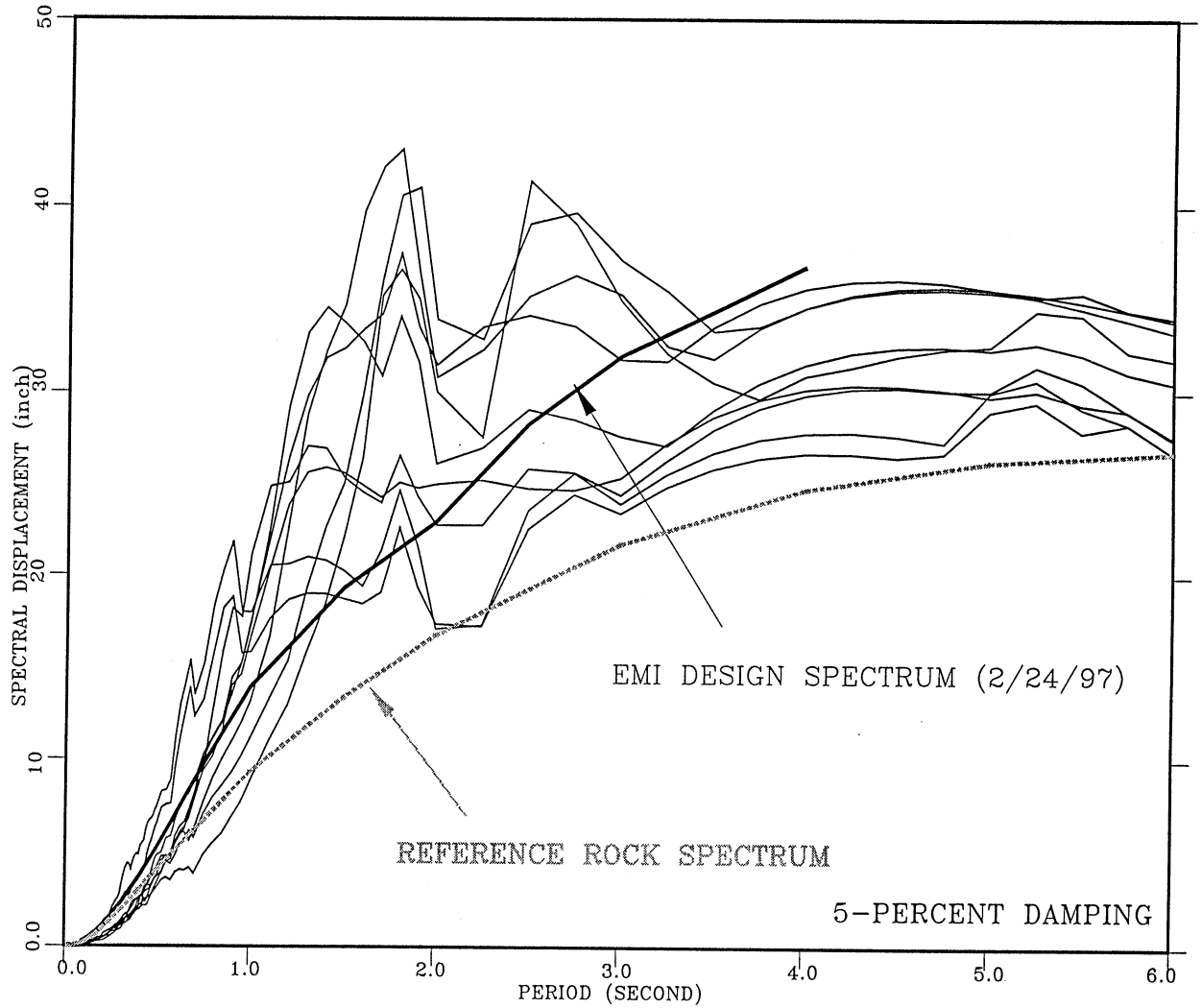
M.L. ACCELERATION SPECTRA FOR TRANSVERSE COMP. MOTION

Figure 2.5



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	NEW BENICIA-MARTINEZ BRIDGE	DISPLACEMENT SPECTRA FOR LONGITUDINAL COMP. MOTION
	EMI Project No.: 95-178 Date: MAR. 27, 1997	Figure 2.6



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NEW BENICIA-MARTINEZ BRIDGE

EMI Project No.: 95-178 | Date: MAR. 27, 1997

M.L. DISPLACEMENT SPECTRA FOR TRANSVERSE COMP. MOTION

Figure 2.7

Section 3

3.0 PROPOSED FOUNDATION

3.1 Foundation Descriptions

The proposed new bridge would be supported on pile foundations. At the south approach, Abutment 1 through Pier 4 constitute a single frame denoted as Frame 4. Abutment 1 is to be founded on 0.750-m diameter CIDH piles, and the end wall of the abutment is 3 meter in height. Figure 3.1 shows a schematic of Abutment 1. Piers 2, 3 and 4 are designed to have two 2.5-m diameter octagonal columns, each supported directly to a 2.6-m diameter CIDH pile, as shown in Figures 3.2, 3.3 and 3.4, respectively. The portion of the column below the grade elevation is isolated in an oversized casing, and the annulus spacing between the column and the casing is 150 mm. Furthermore, a pinned condition is designed at the connection between the column and the CIDH pile.

The structure supported on Piers 5 through 17 is often referred to as the main bridge consisting of three frames (denoted as Frames 3, 2 and 1). Pier 17 is the first support point for Frame 1 and Pier 5 is the last support for Frame 3. All the foundations at the main bridge are on either 9 piles arranged in a 3x3 matrix or 8 piles arranged in 3x3 without the center one except Pier 17. There are 8 piles at Pier 17 arranged in two rows. The bottom of pile-cap is at an elevation -2 m, leaving the pile with a long cantilever length above the mudline at most piers. Each pile is installed by using a 2.5-m diameter steel casing driven into the bedrock to the specified casing tip elevation and constructing a 2.2-m diameter CIDH pile socketed into rock except at Pier 5 where the steel casing is not used. Figures 3.5 through 3.17 illustrate foundation configurations and soil layering at Piers 5 through 17.

3.2 Design Scenarios

Design of New Benicia - Martinez bridge is governed by seismic performance which typically addresses two separate items; demand versus capacity. To determine demands, foundation springs are needed to perform seismic evaluation. It is not obvious to engineers how to be conservative in calculating foundation springs for dynamic analyses; for example softer springs would imply a longer natural period and underestimate seismic loads while stiffer springs might underestimate displacement demands from the ductility point of view. For this reason, we used the "best estimated" soil strength parameters (as opposed to lower strengths) to generate soil springs, such as p-y and t-z curves as a benchmark case. It has been our design philosophy for all the toll bridge seismic retrofit projects and the new bridge designs to determine the most realistic foundation demands without inherent conservatism. That is to use the most probable shear strength estimates in p-y and t-z calculations. Once the demands are available, they are compared with the capacities. When defining the capacity, we can then include some level of conservatism, for example using lower shear strengths for calculating pile tip elevations.

Other than using the most probable soil parameters in the calculations of foundation stiffness, the following features are considered in the benchmark case:

- Existing mudline without scour
- Conventional p-y, t-z and q-u curve criteria for monotonic loading without softening to account for cyclic degradation and pile group effects
- Including end-bearing in axial pile stiffness

This benchmark case would be considered as an upper-bound stiffness scenario because the design team also wanted to examine a lower stiffness scenario in order to account for the following considerations:

- Potential for local scour
- Soil softening to account for cyclic degradation and pile group effects
- Ignoring end-bearing in developing axial stiffness

One-half of the scour depth was used for the lower bound case so as to be consistent with the recommendations by Bridge Design Specifications (BDS) when combining with a seismic load case.

3.3 P-y Curves

P-y curves for clay were based on the criteria developed by Matlock (1970) and p-y curves for sand were based on criteria published in API RP2A (1993). However, there is no published guideline for development of p-y curves in rock. We have examined "rock p-y" curves by using a three-dimensional finite element model consisting of a 2.5m CIDH pile embedded in soft clay with a section of 2.2m Rock Socket in shale. Both shale and clay were modeled using elasto-plastic constitutive relations (Von Mises type). The pile was loaded laterally to compute soil reaction. We calibrated parameters for the p-y curves using Matlock's criteria by matching the finite element solutions. From this calibrating process, it appeared that the appropriate values for ε_{50} would be 0.0023 and for J would be 0.5 for rock to achieve a reasonable comparison between the finite element solutions and the conventional p-y criteria. Detailed documentation on the finite element solutions and the comparison can be found in the Final Foundation Report.

The soil parameters for generating p-y curves in each soil unit are presented in Figures 3.1 through 3.17. The coordinates of p-y curves developed using these parameters are presented in Tables 3.1 through 3.17. Both upper bound (benchmark case) and lower bound values are provided in the tables. We applied a p-multiplier of 0.5 to obtain the lower bound p-y curves from the benchmark case to account for potential soil softening and pile group effects. Soil supports within the design scour zone would also be eliminated for the lower bound evaluation.

3.4 T-z and q-u Curves

Skin friction resistance versus axial pile displacement relations (t-z curves) for individual piers were developed. The ultimate skin friction resistance in the t-z curve can be obtained by multiplying a unit skin friction of soil with the pile circumference, and therefore the t-z curves are presented per a linear pile length basis. One needs to multiply the t-z curves with tributary pile lengths to obtain nonlinear lumped springs along the pile for a finite element model. Tables 3.18 to 3.33 provide coordinates of the t-z curves for each soil layer, and the behavior is assumed plastic beyond the last coordinate of the curve. Also, the presented data are for loading in compression only, whereas a scale factor of 0.75 can be applied on soil resistance (t) for tension loading.

An end bearing versus displacement relation is also provided. Since the displacement for mobilizing full end bearing is relatively large compared to skin friction, the contribution of end bearing resistance will be small during load transfer analyses. It is noted that there is no resistance in tension.

Table 3.1A Abut 1 (End Wall) Upper Bound Soil Condition p-y Curves for 0.750m (2.5ft) CIDH 5/24/99

Grade Elevation (m)= 20.1 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= 17.4 Pile Top Deflection for Linearization (m)=

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
17.7	2.4	Fill	0	0.000	39	0.001	180	0.003	297	0.006	355	0.009	391	0.018	391	0.029	
17.1	3.0	Fill	0	0.000	58	0.001	266	0.003	439	0.007	526	0.010	578	0.021	578	0.035	
16.5	3.7	Fill	0	0.000	80	0.001	368	0.004	609	0.008	729	0.012	801	0.024	801	0.040	
15.5	4.6	Fill	0	0.000	120	0.001	554	0.005	915	0.010	1095	0.015	1203	0.029	1203	0.048	
14.9	5.2	Sandstone	0	0.000	1612	0.004	2321	0.013	3224	0.035	3224	0.088					
14.0	6.1	Sandstone	0	0.000	1616	0.004	2327	0.013	3232	0.035	3232	0.088					
11.0	9.1	Sandstone	0	0.000	1631	0.004	2349	0.013	3262	0.035	3262	0.088					

Table 3.1B Abut 1 (End Wall) Lower Bound Soil Condition p-y Curves for 0.750m (2.5ft) CIDH 5/24/99

Grade Elevation (m)= 20.1 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= 17.4 Pile Top Deflection for Linearization (m)=

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
17.7	2.4	Fill	0	0.000	19	0.001	90	0.003	148	0.006	178	0.009	195	0.018	195	0.029	
17.1	3.0	Fill	0	0.000	29	0.001	133	0.003	220	0.007	263	0.010	289	0.021	289	0.035	
16.5	3.7	Fill	0	0.000	40	0.001	184	0.004	304	0.008	365	0.012	401	0.024	401	0.040	
15.5	4.6	Fill	0	0.000	60	0.001	277	0.005	457	0.010	548	0.015	602	0.029	602	0.048	
14.9	5.2	Sandstone	0	0.000	806	0.004	1161	0.013	1612	0.035	1612	0.088					
14.0	6.1	Sandstone	0	0.000	808	0.004	1164	0.013	1616	0.035	1616	0.088					
11.0	9.1	Sandstone	0	0.000	815	0.004	1174	0.013	1631	0.035	1631	0.088					

Table 3.1C Abut 1 (Wing Wall 1) Upper Bound Soil Condition p-y Curves for 0.750m (2.5ft) CIDH 5/24/99

Grade Elevation (m)= 21.6408 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= 20.1168 Pile Top Deflection for Linearization (m)=

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
20.1	1.5	Fill	0	0.000	27	0.001	126	0.003	209	0.007	250	0.010	275	0.020	275	0.033	
19.5	2.1	Fill	0	0.000	31	0.001	143	0.003	236	0.005	282	0.008	310	0.016	310	0.027	
18.6	3.0	Fill	0	0.000	58	0.001	266	0.003	439	0.007	526	0.010	578	0.021	578	0.035	
17.1	4.6	Fill	0	0.000	120	0.001	554	0.005	915	0.010	1095	0.015	1203	0.029	1203	0.048	
15.5	6.1	Fill	0	0.000	205	0.001	945	0.006	1561	0.012	1869	0.019	2054	0.037	2054	0.062	

Table 3.2A Pier 2 Upper Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 7.6 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
6.1	1.5	Sandstone	0	0.000	5386	0.015	7756	0.045	10772	0.119	10772	0.298	0	0.000	0	0.000	
-10.7	18.3	Sandstone	0	0.000	5436	0.015	7828	0.045	10873	0.119	10873	0.298	0	0.000	0	0.000	

Table 3.2B Pier 2 Lower Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 7.6 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
6.1	1.5	Sandstone	0	0.000	2693	0.015	3878	0.045	5386	0.119	5386	0.298	0	0.000	0	0.000	
-10.7	18.3	Sandstone	0	0.000	2718	0.015	3914	0.045	5436	0.119	5436	0.298	0	0.000	0	0.000	

Table 3.3A Pier 3 Upper Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 9.1 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
7.6	1.5	Sandstone	0	0.000	5386	0.015	7756	0.045	10772	0.119	10772	0.298	0	0.000	0	0.000	
-9.1	18.3	Sandstone	0	0.000	5436	0.015	7828	0.045	10873	0.119	10873	0.298	0	0.000	0	0.000	

Table 3.3B Pier 3 Lower Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 9.1 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
7.6	1.5	Sandstone	0	0.000	2693	0.015	3878	0.045	5386	0.119	5386	0.298	0	0.000	0	0.000	
-9.1	18.3	Sandstone	0	0.000	2718	0.015	3914	0.045	5436	0.119	5436	0.298	0	0.000	0	0.000	

Table 3.4A Pier 4 Upper Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 11.3 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
9.8	1.5	Sandstone	0	0.000	5386	0.015	7756	0.045	10772	0.119	10772	0.298	0	0.000	0	0.000	
-19.2	30.5	Sandstone	0	0.000	5436	0.015	7828	0.045	10873	0.119	10873	0.298	0	0.000	0	0.000	

Table 3.4B Pier 4 Lower Bound Soil Condition p-y Curves for 2.6m (8.5 ft) Rock Socket 1/20/99

Grade Elevation (m)= 11.3 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= N/A Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
9.8	1.5	Sandstone	0	0.000	2693	0.015	3878	0.045	5386	0.119	5386	0.298	0	0.000	0	0.000	
-19.2	30.5	Sandstone	0	0.000	2718	0.015	3914	0.045	5436	0.119	5436	0.298	0	0.000	0	0.000	

Table 3.5A Pier 5 Upper Bound Soil Condition p-y Curves for 2.2m (7.25ft) Rock Socket

8/12/98

Grade Elevation (m)= -1.5 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= -1.5 Pile Top Deflection for Linearization (m)= 0.01

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-1.5	0.0	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-16.5	14.9	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.5B Pier 5 Lower Bound Soil Condition p-y Curves for 2.2m (7.25ft) Rock Socket

8/12/98

Grade Elevation (m)= -1.5 Scour Elevation (m)= N/A Footing Bottom Elevation (m)= -1.5 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-1.5	0.0	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-16.5	14.9	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.6A Pier 6 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -2.0 Scour Elevation (m)= -12.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.06

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
-2.3	0.3	Silty Clay	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	379
-3.5	1.5	Silty Clay	0	0.000	57	0.124	83	0.373	115	0.996	115	2.489	0	0.000	0	0.000	462
-5.0	3.0	Silty Clay	0	0.000	70	0.124	101	0.373	141	0.996	141	2.489	0	0.000	0	0.000	566
-8.1	6.1	Silty Clay	0	0.000	96	0.124	139	0.373	193	0.996	193	2.489	0	0.000	0	0.000	773
-11.7	9.8	Silty Clay	0	0.000	157	0.124	226	0.373	314	0.996	314	2.489	0	0.000	0	0.000	1260
-15.7	13.7	Silty Clay	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1508
-16.3	14.3	Silty Sand	0	0.000	194	0.002	894	0.008	1477	0.017	1769	0.025	1944	0.050	1944	0.083	78577
-20.6	18.6	Silty Sand	0	0.000	338	0.002	1553	0.011	2566	0.022	3073	0.033	3377	0.067	3377	0.111	140381
-21.2	19.2	Silty Clay	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-27.0	25.0	Silty Clay	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-31.2	29.3	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-58.7	56.7	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.6B Pier 6 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -2.0 Scour Elevation (m)= -12.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
-2.3	0.3	Silty Clay	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	189
-3.5	1.5	Silty Clay	0	0.000	29	0.124	41	0.373	58	0.996	58	2.489	0	0.000	0	0.000	231
-5.0	3.0	Silty Clay	0	0.000	35	0.124	51	0.373	71	0.996	71	2.489	0	0.000	0	0.000	283
-8.1	6.1	Silty Clay	0	0.000	48	0.124	69	0.373	96	0.996	96	2.489	0	0.000	0	0.000	386
-11.7	9.8	Silty Clay	0	0.000	78	0.124	113	0.373	157	0.996	157	2.489	0	0.000	0	0.000	630
-15.7	13.7	Silty Clay	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	754
-16.3	14.3	Silty Sand	0	0.000	97	0.002	447	0.008	739	0.017	884	0.025	972	0.050	972	0.083	39288
-20.6	18.6	Silty Sand	0	0.000	169	0.002	777	0.011	1283	0.022	1536	0.033	1688	0.067	1688	0.111	70190
-21.2	19.2	Silty Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-27.0	25.0	Silty Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-31.2	29.3	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-58.7	56.7	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.7A Pier 7 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -14.0 Scour Elevation (m)= -25.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.23

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-14.3	0.3	Sandy Silt	0	0.000	2	0.005	10	0.026	16	0.052	19	0.078	21	0.155	21	0.259	125
-15.5	1.5	Sandy Silt	0	0.000	12	0.006	54	0.028	89	0.057	107	0.085	118	0.171	118	0.284	722
-17.0	3.0	Sandy Silt	0	0.000	24	0.006	110	0.029	182	0.058	218	0.087	240	0.174	240	0.290	1576
-18.9	4.9	Sandy Silt	0	0.000	34	0.005	157	0.026	259	0.051	310	0.077	340	0.154	340	0.257	2511
-21.9	7.9	Sandy Silt	0	0.000	46	0.004	214	0.022	353	0.043	422	0.065	464	0.129	464	0.216	4257
-22.5	8.5	Silty Clay	0	0.000	145	0.124	209	0.373	290	0.996	290	2.489	0	0.000	0	0.000	1166
-25.0	11.0	Sily Clay	0	0.000	169	0.124	243	0.373	337	0.996	337	2.489	0	0.000	0	0.000	1354
-34.7	20.7	Silty Clay	0	0.000	402	0.124	579	0.373	805	0.996	805	2.489	0	0.000	0	0.000	3232
-35.3	21.3	Sand/Gravel	0	0.000	648	0.003	2979	0.016	4922	0.032	5894	0.048	6476	0.096	6476	0.160	187384
-36.2	22.3	Sand/Gravel	0	0.000	728	0.003	3349	0.017	5533	0.034	6625	0.052	7281	0.103	7281	0.172	198048
-36.5	22.6	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-62.5	48.5	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.7B Pier 7 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -14.0 Scour Elevation (m)= -25.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-14.3	0.3	Sandy Silt	0	0.000	1	0.005	5	0.026	8	0.052	10	0.078	11	0.155	11	0.259	62
-15.5	1.5	Sandy Silt	0	0.000	6	0.006	27	0.028	45	0.057	53	0.085	59	0.171	59	0.284	361
-17.0	3.0	Sandy Silt	0	0.000	12	0.006	55	0.029	91	0.058	109	0.087	120	0.174	120	0.290	788
-18.9	4.9	Sandy Silt	0	0.000	17	0.005	78	0.026	129	0.051	155	0.077	170	0.154	170	0.257	1255
-21.9	7.9	Sandy Silt	0	0.000	23	0.004	107	0.022	176	0.043	211	0.065	232	0.129	232	0.216	2129
-22.5	8.5	Silty Clay	0	0.000	73	0.124	104	0.373	145	0.996	145	2.489	0	0.000	0	0.000	583
-25.0	11.0	Sily Clay	0	0.000	84	0.124	121	0.373	169	0.996	169	2.489	0	0.000	0	0.000	677
-34.7	20.7	Silty Clay	0	0.000	201	0.124	290	0.373	402	0.996	402	2.489	0	0.000	0	0.000	1616
-35.3	21.3	Sand/Gravel	0	0.000	324	0.003	1490	0.016	2461	0.032	2947	0.048	3238	0.096	3238	0.160	93692
-36.2	22.3	Sand/Gravel	0	0.000	364	0.003	1675	0.017	2767	0.034	3313	0.052	3640	0.103	3640	0.172	99024
-36.5	22.6	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-62.5	48.5	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.8A Pier 8 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -13.0 Scour Elevation (m)= -25.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.23

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-13.3	0.3	Silty Sand	0	0.000	2	0.005	10	0.026	16	0.052	19	0.078	21	0.155	21	0.259	118
-14.5	1.5	Silty Sand	0	0.000	12	0.006	54	0.028	89	0.057	107	0.085	118	0.171	118	0.284	686
-16.0	3.0	Silty Sand	0	0.000	24	0.006	110	0.029	182	0.058	218	0.087	240	0.174	240	0.290	1482
-17.6	4.6	Silty Sand	0	0.000	33	0.005	152	0.027	251	0.053	300	0.080	330	0.159	330	0.266	2216
-20.6	7.6	Silty Sand	0	0.000	43	0.004	200	0.021	331	0.042	396	0.063	435	0.126	435	0.210	3566
-21.2	8.2	Silty Clay	0	0.000	142	0.124	205	0.373	284	0.996	284	2.489	0	0.000	0	0.000	1142
-26.1	13.1	Silty Clay	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1508
-37.7	24.7	Silty Clay	0	0.000	402	0.124	579	0.373	805	0.996	805	2.489	0	0.000	0	0.000	3232
-38.3	25.3	Sand/Gravel	0	0.000	899	0.004	4137	0.019	6835	0.037	8184	0.056	8994	0.112	8994	0.187	225408
-43.2	30.2	Sand/Gravel	0	0.000	1448	0.005	6659	0.025	11002	0.050	13174	0.076	14477	0.151	14477	0.252	286423
-43.5	30.5	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-66.0	53.0	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.8B Pier 8 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -13.0 Scour Elevation (m)= -25.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-13.3	0.3	Silty Sand	0	0.000	1	0.005	5	0.026	8	0.052	10	0.078	11	0.155	11	0.259	59
-14.5	1.5	Silty Sand	0	0.000	6	0.006	27	0.028	45	0.057	53	0.085	59	0.171	59	0.284	343
-16.0	3.0	Silty Sand	0	0.000	12	0.006	55	0.029	91	0.058	109	0.087	120	0.174	120	0.290	741
-17.6	4.6	Silty Sand	0	0.000	16	0.005	76	0.027	125	0.053	150	0.080	165	0.159	165	0.266	1108
-20.6	7.6	Silty Sand	0	0.000	22	0.004	100	0.021	165	0.042	198	0.063	218	0.126	218	0.210	1783
-21.2	8.2	Silty Clay	0	0.000	71	0.124	102	0.373	142	0.996	142	2.489	0	0.000	0	0.000	571
-26.1	13.1	Silty Clay	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	754
-37.7	24.7	Silty Clay	0	0.000	201	0.124	290	0.373	402	0.996	402	2.489	0	0.000	0	0.000	1616
-38.3	25.3	Sand/Gravel	0	0.000	450	0.004	2068	0.019	3418	0.037	4092	0.056	4497	0.112	4497	0.187	112704
-43.2	30.2	Sand/Gravel	0	0.000	724	0.005	3330	0.025	5501	0.050	6587	0.076	7238	0.151	7238	0.252	143211
-43.5	30.5	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-66.0	53.0	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.9A Pier 9 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -11.0 Scour Elevation (m)= -31.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.24

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-11.3	0.3	Silty Sand	0	0.000	2	0.005	10	0.026	16	0.052	19	0.078	21	0.155	21	0.259	112
-12.5	1.5	Silty Sand	0	0.000	12	0.006	54	0.028	89	0.057	107	0.085	118	0.171	118	0.284	653
-14.0	3.0	Silty Sand	0	0.000	24	0.006	110	0.029	182	0.058	218	0.087	240	0.174	240	0.290	1435
-15.5	4.6	Silty Sand	0	0.000	33	0.005	152	0.027	251	0.053	300	0.080	330	0.159	330	0.266	2167
-17.7	6.7	Silty Sand	0	0.000	35	0.004	162	0.019	269	0.039	321	0.058	353	0.116	353	0.194	2739
-18.3	7.3	Clayey Silt	0	0.000	133	0.124	192	0.373	266	0.996	266	2.489	0	0.000	0	0.000	1070
-29.6	18.6	Clayey Silt	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1508
-30.2	19.2	Fine Sand	0	0.000	331	0.002	1524	0.011	2518	0.021	3015	0.032	3313	0.064	3313	0.106	116292
-35.4	24.4	Fine Sand	0	0.000	555	0.003	2554	0.014	4220	0.028	5052	0.042	5552	0.084	5552	0.140	198725
-41.8	30.8	Sand/Gravel	0	0.000	1550	0.005	7131	0.026	11782	0.053	14107	0.079	15502	0.159	15502	0.265	292026
-42.1	31.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-65.8	54.9	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.9B Pier 9 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -11.0 Scour Elevation (m)= -31.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-11.3	0.3	Silty Sand	0	0.000	1	0.005	5	0.026	8	0.052	10	0.078	11	0.155	11	0.259	56
-12.5	1.5	Silty Sand	0	0.000	6	0.006	27	0.028	45	0.057	53	0.085	59	0.171	59	0.284	326
-14.0	3.0	Silty Sand	0	0.000	12	0.006	55	0.029	91	0.058	109	0.087	120	0.174	120	0.290	718
-15.5	4.6	Silty Sand	0	0.000	16	0.005	76	0.027	125	0.053	150	0.080	165	0.159	165	0.266	1083
-17.7	6.7	Silty Sand	0	0.000	18	0.004	81	0.019	134	0.039	161	0.058	177	0.116	177	0.194	1369
-18.3	7.3	Clayey Silt	0	0.000	67	0.124	96	0.373	133	0.996	133	2.489	0	0.000	0	0.000	535
-29.6	18.6	Clayey Silt	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	754
-30.2	19.2	Fine Sand	0	0.000	166	0.002	762	0.011	1259	0.021	1508	0.032	1657	0.064	1657	0.106	58146
-35.4	24.4	Fine Sand	0	0.000	278	0.003	1277	0.014	2110	0.028	2526	0.042	2776	0.084	2776	0.140	99363
-41.8	30.8	Sand/Gravel	0	0.000	775	0.005	3565	0.026	5891	0.053	7054	0.079	7751	0.159	7751	0.265	146013
-42.1	31.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-65.8	54.9	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.10 Pier 10 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 5/21/98

Grade Elevation (m)= -11.0 Scour Elevation (m)= -27.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.20

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-11.3	0.3	Loose Sand	0	0.000	2	0.005	10	0.026	16	0.052	19	0.078	21	0.155	21	0.259	137
-13.1	2.1	Loose Sand	0	0.000	17	0.006	77	0.029	128	0.058	153	0.087	168	0.174	168	0.290	1164
-15.5	4.6	Loose Sand	0	0.000	33	0.005	152	0.027	251	0.053	300	0.080	330	0.159	330	0.266	2727
-17.1	6.1	Soft Clay	0	0.000	96	0.124	139	0.373	193	0.996	193	2.489	0	0.000	0	0.000	773
-19.2	8.2	Soft Clay	0	0.000	114	0.124	165	0.373	229	0.996	229	2.489	0	0.000	0	0.000	919
-22.6	11.6	Soft Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1077
-23.2	12.2	Med Sand	0	0.000	146	0.001	671	0.007	1108	0.015	1327	0.022	1458	0.044	1458	0.073	33812
-25.9	14.9	Med Sand	0	0.000	223	0.002	1027	0.009	1696	0.018	2031	0.028	2232	0.055	2232	0.092	79518
-32.3	21.3	Dense Sand	0	0.000	710	0.004	3264	0.018	5393	0.035	6458	0.053	7096	0.105	7096	0.175	202441
-39.9	29.0	Dense Sand	0	0.000	1524	0.006	7010	0.028	11581	0.055	13867	0.083	15238	0.166	15238	0.277	275192
-40.2	29.3	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-67.7	56.7	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.10 Pier 10 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 5/21/98

Grade Elevation (m)= -11.0 Scour Elevation (m)= -27.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.20

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-11.3	0.3	Loose Sand	0	0.000	1	0.005	5	0.026	8	0.052	10	0.078	11	0.155	11	0.259	69
-13.1	2.1	Loose Sand	0	0.000	8	0.006	39	0.029	64	0.058	76	0.087	84	0.174	84	0.290	582
-15.5	4.6	Loose Sand	0	0.000	16	0.005	76	0.027	125	0.053	150	0.080	165	0.159	165	0.266	1363
-17.1	6.1	Soft Clay	0	0.000	48	0.124	69	0.373	96	0.996	96	2.489	0	0.000	0	0.000	386
-19.2	8.2	Soft Clay	0	0.000	57	0.124	82	0.373	114	0.996	114	2.489	0	0.000	0	0.000	460
-22.6	11.6	Soft Clay	0	0.000	67	0.124	97	0.373	134	0.996	134	2.489	0	0.000	0	0.000	538
-23.2	12.2	Med Sand	0	0.000	73	0.001	335	0.007	554	0.015	663	0.022	729	0.044	729	0.073	16906
-25.9	14.9	Med Sand	0	0.000	112	0.002	513	0.009	848	0.018	1016	0.028	1116	0.055	1116	0.092	39759
-32.3	21.3	Dense Sand	0	0.000	355	0.004	1632	0.018	2697	0.035	3229	0.053	3548	0.105	3548	0.175	101221
-39.9	29.0	Dense Sand	0	0.000	762	0.006	3505	0.028	5791	0.055	6933	0.083	7619	0.166	7619	0.277	137596
-40.2	29.3	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-67.7	56.7	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.11 Pier 11 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -16.0 Scour Elevation (m)= -28.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.17

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-16.3	0.3	Clayey Silt	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	379
-17.2	1.2	Clayey Silt	0	0.000	55	0.124	79	0.373	110	0.996	110	2.489	0	0.000	0	0.000	442
-18.7	2.7	Clayey Silt	0	0.000	68	0.124	98	0.373	136	0.996	136	2.489	0	0.000	0	0.000	545
-19.4	3.4	Fine Sand	0	0.000	38	0.001	176	0.007	290	0.014	348	0.021	382	0.042	382	0.070	5786
-20.6	4.6	Fine Sand	0	0.000	53	0.001	244	0.007	403	0.014	482	0.021	530	0.043	530	0.071	9396
-22.1	6.1	Fine Sand	0	0.000	60	0.001	277	0.006	457	0.012	548	0.018	602	0.036	602	0.061	13383
-28.2	12.2	Fine Sand	0	0.000	183	0.002	843	0.009	1392	0.018	1667	0.028	1832	0.055	1832	0.092	84714
-30.6	14.6	Fine Sand	0	0.000	257	0.002	1182	0.011	1954	0.022	2339	0.032	2571	0.065	2571	0.108	112567
-31.2	15.2	Sand/Gravel	0	0.000	422	0.003	1941	0.015	3207	0.029	3840	0.044	4219	0.087	4219	0.146	142298
-37.0	21.0	Sand/Gravel	0	0.000	894	0.004	4113	0.022	6795	0.045	8136	0.067	8941	0.134	8941	0.224	200003
-37.3	21.3	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-65.1	49.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.11 Pier 11 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -16.0 Scour Elevation (m)= -28.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-16.3	0.3	Clayey Silt	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	189
-17.2	1.2	Clayey Silt	0	0.000	28	0.124	40	0.373	55	0.996	55	2.489	0	0.000	0	0.000	221
-18.7	2.7	Clayey Silt	0	0.000	34	0.124	49	0.373	68	0.996	68	2.489	0	0.000	0	0.000	272
-19.4	3.4	Fine Sand	0	0.000	19	0.001	88	0.007	145	0.014	174	0.021	191	0.042	191	0.070	2893
-20.6	4.6	Fine Sand	0	0.000	26	0.001	122	0.007	201	0.014	241	0.021	265	0.043	265	0.071	4698
-22.1	6.1	Fine Sand	0	0.000	30	0.001	138	0.006	229	0.012	274	0.018	301	0.036	301	0.061	6691
-28.2	12.2	Fine Sand	0	0.000	92	0.002	421	0.009	696	0.018	834	0.028	916	0.055	916	0.092	42357
-30.6	14.6	Fine Sand	0	0.000	129	0.002	591	0.011	977	0.022	1170	0.032	1285	0.065	1285	0.108	56283
-31.2	15.2	Sand/Gravel	0	0.000	211	0.003	970	0.015	1603	0.029	1920	0.044	2110	0.087	2110	0.146	71149
-37.0	21.0	Sand/Gravel	0	0.000	447	0.004	2056	0.022	3397	0.045	4068	0.067	4470	0.134	4470	0.224	100001
-37.3	21.3	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-65.1	49.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.12 Pier 12 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -18.0 Scour Elevation (m)= -29.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.19

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-18.3	0.3	Clayey Silt	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	379
-19.2	1.2	Fine Sand	0	0.000	14	0.001	63	0.007	104	0.014	124	0.021	137	0.041	137	0.069	1799
-21.0	3.0	Fine Sand	0	0.000	42	0.002	194	0.009	321	0.017	384	0.026	422	0.051	422	0.085	6956
-22.6	4.6	Fine Sand	0	0.000	61	0.002	280	0.008	463	0.016	554	0.025	609	0.049	609	0.082	12472
-24.1	6.1	Fine Sand	0	0.000	66	0.001	306	0.007	506	0.013	606	0.020	666	0.040	666	0.067	17305
-25.6	7.6	Fine Sand	0	0.000	104	0.002	479	0.008	792	0.016	948	0.024	1042	0.047	1042	0.079	34009
-29.0	11.0	Fine Sand	0	0.000	212	0.002	974	0.011	1609	0.022	1926	0.033	2117	0.067	2117	0.111	73846
-30.2	12.2	Sand/Gravel	0	0.000	326	0.003	1499	0.014	2476	0.028	2965	0.042	3258	0.084	3258	0.141	108064
-33.2	15.2	Sand/Gravel	0	0.000	526	0.004	2421	0.018	3999	0.036	4789	0.055	5262	0.109	5262	0.182	144858
-36.9	18.9	Sand/Gravel	0	0.000	826	0.005	3802	0.023	6281	0.046	7521	0.069	8265	0.138	8265	0.230	179767
-37.2	19.2	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-64.9	46.9	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.12 Pier 12 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -18.0 Scour Elevation (m)= -29.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-18.3	0.3	Clayey Silt	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	189
-19.2	1.2	Fine Sand	0	0.000	7	0.001	31	0.007	52	0.014	62	0.021	68	0.041	68	0.069	900
-21.0	3.0	Fine Sand	0	0.000	21	0.002	97	0.009	160	0.017	192	0.026	211	0.051	211	0.085	3478
-22.6	4.6	Fine Sand	0	0.000	30	0.002	140	0.008	231	0.016	277	0.025	304	0.049	304	0.082	6236
-24.1	6.1	Fine Sand	0	0.000	33	0.001	153	0.007	253	0.013	303	0.020	333	0.040	333	0.067	8653
-25.6	7.6	Fine Sand	0	0.000	52	0.002	240	0.008	396	0.016	474	0.024	521	0.047	521	0.079	17004
-29.0	11.0	Fine Sand	0	0.000	106	0.002	487	0.011	804	0.022	963	0.033	1058	0.067	1058	0.111	36923
-30.2	12.2	Sand/Gravel	0	0.000	163	0.003	749	0.014	1238	0.028	1483	0.042	1629	0.084	1629	0.141	54032
-33.2	15.2	Sand/Gravel	0	0.000	263	0.004	1210	0.018	2000	0.036	2394	0.055	2631	0.109	2631	0.182	72429
-36.9	18.9	Sand/Gravel	0	0.000	413	0.005	1901	0.023	3141	0.046	3761	0.069	4132	0.138	4132	0.230	89884
-37.2	19.2	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-64.9	46.9	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.13 Pier 13 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -13.0 Scour Elevation (m)= -29.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.19

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
-13.3	0.3	Sand	0	0.000	4	0.002	18	0.008	29	0.015	35	0.023	38	0.046	38	0.077	327
-15.1	2.1	Sand	0	0.000	32	0.002	145	0.009	240	0.018	288	0.027	316	0.055	316	0.091	3224
-17.6	4.6	Sand	0	0.000	64	0.002	296	0.009	488	0.017	585	0.026	643	0.052	643	0.086	8725
-19.7	6.7	Sand	0	0.000	70	0.001	322	0.006	533	0.013	638	0.019	701	0.039	701	0.064	12957
-22.1	9.1	Sand	0	0.000	150	0.002	689	0.009	1139	0.019	1364	0.028	1499	0.057	1499	0.094	40089
-25.2	12.2	Sand	0	0.000	261	0.002	1201	0.012	1985	0.025	2377	0.037	2612	0.074	2612	0.123	89278
-28.8	15.8	Sand	0	0.000	557	0.004	2564	0.018	4236	0.037	5072	0.055	5574	0.111	5574	0.185	150291
-31.3	18.3	Sand	0	0.000	756	0.004	3476	0.022	5743	0.043	6877	0.065	7557	0.130	7557	0.217	173983
-34.3	21.3	Sand/Gravel	0	0.000	1044	0.005	4804	0.026	7937	0.051	9503	0.077	10443	0.154	10443	0.257	202523
-37.1	24.1	Sand/Gravel	0	0.000	1343	0.006	6177	0.029	10205	0.059	12219	0.088	13428	0.176	13428	0.293	228858
-37.4	24.4	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-65.1	52.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.13 Pier 13 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -13.0 Scour Elevation (m)= -29.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV	DEPTH	SOIL	P1	Y1	P2	Y2	P3	Y3	P4	Y4	P5	Y5	P6	Y6	P7	Y7	Es
m	m	TYPE	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m	m	kN/m/m
-13.3	0.3	Sand	0	0.000	2	0.002	9	0.008	14	0.015	17	0.023	19	0.046	19	0.077	163
-15.1	2.1	Sand	0	0.000	16	0.002	73	0.009	120	0.018	144	0.027	158	0.055	158	0.091	1612
-17.6	4.6	Sand	0	0.000	32	0.002	148	0.009	244	0.017	292	0.026	321	0.052	321	0.086	4362
-19.7	6.7	Sand	0	0.000	35	0.001	161	0.006	266	0.013	319	0.019	350	0.039	350	0.064	6479
-22.1	9.1	Sand	0	0.000	75	0.002	345	0.009	570	0.019	682	0.028	749	0.057	749	0.094	20044
-25.2	12.2	Sand	0	0.000	131	0.002	601	0.012	992	0.025	1188	0.037	1306	0.074	1306	0.123	44639
-28.8	15.8	Sand	0	0.000	279	0.004	1282	0.018	2118	0.037	2536	0.055	2787	0.111	2787	0.185	75146
-31.3	18.3	Sand	0	0.000	378	0.004	1738	0.022	2872	0.043	3438	0.065	3778	0.130	3778	0.217	86991
-34.3	21.3	Sand/Gravel	0	0.000	522	0.005	2402	0.026	3968	0.051	4752	0.077	5221	0.154	5221	0.257	101261
-37.1	24.1	Sand/Gravel	0	0.000	671	0.006	3088	0.029	5102	0.059	6109	0.088	6714	0.176	6714	0.293	114429
-37.4	24.4	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-65.1	52.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.14 Pier 14 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -12.0 Scour Elevation (m)= -20.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.36

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-12.3	0.3	Clay	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	216
-14.1	2.1	Clay	0	0.000	63	0.124	90	0.373	125	0.996	125	2.489	0	0.000	0	0.000	306
-16.6	4.6	Clay	0	0.000	83	0.124	120	0.373	167	0.996	167	2.489	0	0.000	0	0.000	453
-18.1	6.1	Clay	0	0.000	96	0.124	139	0.373	193	0.996	193	2.489	0	0.000	0	0.000	569
-20.2	8.2	Clay	0	0.000	142	0.124	205	0.373	284	0.996	284	2.489	0	0.000	0	0.000	972
-23.6	11.6	Clay	0	0.000	174	0.124	251	0.373	349	0.996	349	2.489	0	0.000	0	0.000	1402
-26.6	14.6	Clay	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1508
-27.2	15.2	Sand/Gravel	0	0.000	217	0.002	1000	0.009	1652	0.018	1978	0.026	2173	0.053	2173	0.088	39252
-31.8	19.8	Sand/Gravel	0	0.000	380	0.002	1747	0.012	2886	0.024	3455	0.035	3797	0.071	3797	0.118	134842
-37.0	25.0	Sand/Gravel	0	0.000	1008	0.004	4637	0.021	7661	0.042	9173	0.064	10081	0.127	10081	0.212	237630
-37.3	25.3	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-67.2	55.2	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.14 Pier 14 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -12.0 Scour Elevation (m)= -20.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-12.3	0.3	Clay	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	108
-14.1	2.1	Clay	0	0.000	31	0.124	45	0.373	63	0.996	63	2.489	0	0.000	0	0.000	153
-16.6	4.6	Clay	0	0.000	42	0.124	60	0.373	83	0.996	83	2.489	0	0.000	0	0.000	227
-18.1	6.1	Clay	0	0.000	48	0.124	69	0.373	96	0.996	96	2.489	0	0.000	0	0.000	285
-20.2	8.2	Clay	0	0.000	71	0.124	102	0.373	142	0.996	142	2.489	0	0.000	0	0.000	486
-23.6	11.6	Clay	0	0.000	87	0.124	126	0.373	174	0.996	174	2.489	0	0.000	0	0.000	701
-26.6	14.6	Clay	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	754
-27.2	15.2	Sand/Gravel	0	0.000	109	0.002	500	0.009	826	0.018	989	0.026	1087	0.053	1087	0.088	19626
-31.8	19.8	Sand/Gravel	0	0.000	190	0.002	873	0.012	1443	0.024	1728	0.035	1899	0.071	1899	0.118	67421
-37.0	25.0	Sand/Gravel	0	0.000	504	0.004	2319	0.021	3831	0.042	4587	0.064	5040	0.127	5040	0.212	118815
-37.3	25.3	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-67.2	55.2	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.15 Pier 15 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -4.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.36

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-4.3	0.3	Clay w/ Silt	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	188
-7.0	3.0	Clay w/ Silt	0	0.000	70	0.124	101	0.373	141	0.996	141	2.489	0	0.000	0	0.000	287
-10.1	6.1	Clay w/ Silt	0	0.000	96	0.124	139	0.373	193	0.996	193	2.489	0	0.000	0	0.000	414
-14.7	10.7	Clay w/ Silt	0	0.000	166	0.124	239	0.373	331	0.996	331	2.489	0	0.000	0	0.000	814
-19.2	15.2	Clay w/ Silt	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1140
-25.3	21.3	Clay w/ Silt	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-31.7	27.7	Clay w/ Silt	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-32.3	28.3	Fine Sand	0	0.000	685	0.003	3151	0.015	5206	0.030	6234	0.045	6850	0.089	6850	0.148	184354
-34.5	30.5	Fine Sand	0	0.000	805	0.003	3704	0.016	6120	0.032	7328	0.049	8053	0.097	8053	0.162	230761
-37.8	33.8	Sand/Gravel	0	0.000	1634	0.005	7517	0.025	12420	0.051	14872	0.076	16342	0.152	16342	0.254	321688
-38.1	34.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-67.1	63.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.15 Pier 15 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -4.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-4.3	0.3	Clay w/ Silt	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	94
-7.0	3.0	Clay w/ Silt	0	0.000	35	0.124	51	0.373	71	0.996	71	2.489	0	0.000	0	0.000	144
-10.1	6.1	Clay w/ Silt	0	0.000	48	0.124	69	0.373	96	0.996	96	2.489	0	0.000	0	0.000	207
-14.7	10.7	Clay w/ Silt	0	0.000	83	0.124	119	0.373	166	0.996	166	2.489	0	0.000	0	0.000	407
-19.2	15.2	Clay w/ Silt	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	570
-25.3	21.3	Clay w/ Silt	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-31.7	27.7	Clay w/ Silt	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-32.3	28.3	Fine Sand	0	0.000	342	0.003	1575	0.015	2603	0.030	3117	0.045	3425	0.089	3425	0.148	92177
-34.5	30.5	Fine Sand	0	0.000	403	0.003	1852	0.016	3060	0.032	3664	0.049	4027	0.097	4027	0.162	115381
-37.8	33.8	Sand/Gravel	0	0.000	817	0.005	3759	0.025	6210	0.051	7436	0.076	8171	0.152	8171	0.254	160844
-38.1	34.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-67.1	63.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.16 Pier 16 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/25/99

Grade Elevation (m)= -2.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.28

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-2.3	0.3	Silty Clay	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	216
-5.0	3.0	Silty Clay	0	0.000	70	0.124	101	0.373	141	0.996	141	2.489	0	0.000	0	0.000	329
-9.9	7.9	Silty Clay	0	0.000	112	0.124	161	0.373	224	0.996	224	2.489	0	0.000	0	0.000	562
-12.6	10.7	Silty Clay	0	0.000	166	0.124	239	0.373	331	0.996	331	2.489	0	0.000	0	0.000	893
-17.2	15.2	Silty Clay	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1205
-23.3	21.3	Silty Clay	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-27.9	25.9	Silty Clay	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-30.9	29.0	Silty Clay	0	0.000	402	0.124	579	0.373	805	0.996	805	2.489	0	0.000	0	0.000	3232
-33.7	31.7	Sandy Silt	0	0.000	500	0.002	2299	0.012	3798	0.023	4548	0.035	4997	0.070	4997	0.116	195161
-35.8	33.8	Sand/Gravel	0	0.000	1578	0.005	7258	0.025	11992	0.049	14359	0.074	15779	0.147	15779	0.245	317252
-36.1	34.1	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-67.2	65.2	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.16 Pier 16 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/25/99

Grade Elevation (m)= -2.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-2.3	0.3	Silty Clay	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	108
-5.0	3.0	Silty Clay	0	0.000	35	0.124	51	0.373	71	0.996	71	2.489	0	0.000	0	0.000	164
-9.9	7.9	Silty Clay	0	0.000	56	0.124	81	0.373	112	0.996	112	2.489	0	0.000	0	0.000	281
-12.6	10.7	Silty Clay	0	0.000	83	0.124	119	0.373	166	0.996	166	2.489	0	0.000	0	0.000	447
-17.2	15.2	Silty Clay	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	602
-23.3	21.3	Silty Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-27.9	25.9	Silty Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-30.9	29.0	Silty Clay	0	0.000	201	0.124	290	0.373	402	0.996	402	2.489	0	0.000	0	0.000	1616
-33.7	31.7	Sandy Silt	0	0.000	250	0.002	1149	0.012	1899	0.023	2274	0.035	2499	0.070	2499	0.116	97581
-35.8	33.8	Sand/Gravel	0	0.000	789	0.005	3629	0.025	5996	0.049	7179	0.074	7889	0.147	7889	0.245	158626
-36.1	34.1	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-67.2	65.2	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.17 Pier 17 Upper Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -2.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)= 0.28

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-2.3	0.3	Silty Clay	0	0.000	47	0.124	68	0.373	94	0.996	94	2.489	0	0.000	0	0.000	216
-5.0	3.0	Silty Clay	0	0.000	70	0.124	101	0.373	141	0.996	141	2.489	0	0.000	0	0.000	329
-9.9	7.9	Silty Clay	0	0.000	112	0.124	161	0.373	224	0.996	224	2.489	0	0.000	0	0.000	562
-12.6	10.7	Silty Clay	0	0.000	166	0.124	239	0.373	331	0.996	331	2.489	0	0.000	0	0.000	893
-17.2	15.2	Silty Clay	0	0.000	188	0.124	270	0.373	375	0.996	375	2.489	0	0.000	0	0.000	1205
-23.3	21.3	Silty Clay	0	0.000	268	0.124	386	0.373	536	0.996	536	2.489	0	0.000	0	0.000	2155
-26.4	24.4	Sandy Silt	0	0.000	340	0.002	1563	0.010	2582	0.021	3092	0.031	3398	0.062	3398	0.103	56814
-29.4	27.4	Sandy Silt	0	0.000	439	0.002	2020	0.012	3338	0.024	3997	0.035	4392	0.071	4392	0.118	159304
-33.4	31.4	Sand/Gravel	0	0.000	1392	0.005	6405	0.023	10582	0.047	12670	0.070	13923	0.140	13923	0.233	279849
-34.9	32.9	Sand/Gravel	0	0.000	1587	0.005	7301	0.025	12062	0.051	14443	0.076	15871	0.152	15871	0.254	308982
-35.2	33.2	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759
-67.2	65.2	Sandstone	0	0.000	4594	0.013	6616	0.038	9188	0.102	9188	0.254	0	0.000	0	0.000	361759

Table 3.17 Pier 17 Lower Bound Soil Condition p-y Curves for 2.5m/2.2m (8.25ft/7.25ft) CISS/Rock Socket 7/1/98

Grade Elevation (m)= -2.0 Scour Elevation (m)= -10.0 Footing Bottom Elevation (m)= -2.0 Pile Top Deflection for Linearization (m)=

ELEV m	DEPTH m	SOIL TYPE	P1 kN/m	Y1 m	P2 kN/m	Y2 m	P3 kN/m	Y3 m	P4 kN/m	Y4 m	P5 kN/m	Y5 m	P6 kN/m	Y6 m	P7 kN/m	Y7 m	Es kN/m/m
-2.3	0.3	Silty Clay	0	0.000	24	0.124	34	0.373	47	0.996	47	2.489	0	0.000	0	0.000	108
-5.0	3.0	Silty Clay	0	0.000	35	0.124	51	0.373	71	0.996	71	2.489	0	0.000	0	0.000	164
-9.9	7.9	Silty Clay	0	0.000	56	0.124	81	0.373	112	0.996	112	2.489	0	0.000	0	0.000	281
-12.6	10.7	Silty Clay	0	0.000	83	0.124	119	0.373	166	0.996	166	2.489	0	0.000	0	0.000	447
-17.2	15.2	Silty Clay	0	0.000	94	0.124	135	0.373	188	0.996	188	2.489	0	0.000	0	0.000	602
-23.3	21.3	Silty Clay	0	0.000	134	0.124	193	0.373	268	0.996	268	2.489	0	0.000	0	0.000	1078
-26.4	24.4	Sandy Silt	0	0.000	170	0.002	781	0.010	1291	0.021	1546	0.031	1699	0.062	1699	0.103	28407
-29.4	27.4	Sandy Silt	0	0.000	220	0.002	1010	0.012	1669	0.024	1999	0.035	2196	0.071	2196	0.118	79652
-33.4	31.4	Sand/Gravel	0	0.000	696	0.005	3202	0.023	5291	0.047	6335	0.070	6962	0.140	6962	0.233	139924
-34.9	32.9	Sand/Gravel	0	0.000	793	0.005	3650	0.025	6031	0.051	7221	0.076	7936	0.152	7936	0.254	154491
-35.2	33.2	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879
-67.2	65.2	Sandstone	0	0.000	2297	0.013	3308	0.038	4594	0.102	4594	0.254	0	0.000	0	0.000	180879

Table 3.18A Pier 2 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.6 m dia. CIDH rock socket 8/12/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	shale	19.0	-6.1	12.940	324.55	485.35	0	485.35	3813.90	0.025	2021.37	0.003	2860.42	0.006	3470.65	0.013	3813.90	0.025

Table 3.18B Pier 2 : q-u curve in compression (use 0 for tension) End Bearing: 2.6 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
13628.16	0.252	6132.67	0.025	8585.74	0.063	10766.25	0.126	13628.16	0.252

Table 3.19A Pier 3 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.6 m dia. CIDH rock socket 8/12/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	shale	20.1	-7.0	12.940	239.40	485.35	0	485.35	3813.90	0.025	2021.37	0.003	2860.42	0.006	3470.65	0.013	3813.90	0.025

Table 3.19B Pier 3 : q-u curve in compression (use 0 for tension) End Bearing: 2.6 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
13628.16	0.252	6132.67	0.025	8585.74	0.063	10766.25	0.126	13628.16	0.252

Table 3.20A Pier 4 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.6 m dia. CIDH rock socket 8/12/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	shale	20.1	-6.1	12.940	339.55	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.20B Pier 4 : q-u curve in compression (use 0 for tension) End Bearing: 2.6 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.21A Pier 5 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.2 m dia. CIDH rock socket 8/12/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	shale	-1.5	-16.5	12.940	193.47	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.21B Pier 5 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.22A Pier 6 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-2.0	-9.0	4.418	31.01	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	clay	-9.0	-16.0	4.418	62.02	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	sand	-16.0	-21.0	5.996	92.21	0.00	30	31.93	252.50	0.025	133.82	0.003	189.37	0.006	229.77	0.013	252.50	0.025
4	clay	-21.0	-27.0	4.418	118.63	24.08	0	24.08	190.36	0.025	100.89	0.003	142.77	0.006	173.22	0.013	190.36	0.025
5	shale	-27.0	-70.2	12.940	676.92	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.22B Pier 6 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.23A Pier 7 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	silt	-14.0	-22.0	4.418	35.43	0.00	25	6.01	47.54	0.025	25.20	0.003	35.65	0.006	43.26	0.013	47.54	0.025
2	clay	-22.0	-28.0	4.418	61.88	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	clay	-28.0	-35.0	5.207	98.43	36.11	0	36.11	285.53	0.025	151.33	0.003	214.15	0.006	259.84	0.013	285.53	0.025
4	sand	-35.0	-36.0	9.152	107.36	0.00	35	50.73	401.13	0.025	212.60	0.003	300.85	0.006	365.03	0.013	401.13	0.025
5	shale	-36.0	-70.2	12.940	549.57	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.23B Pier 7 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.24A Pier 8 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	silt	-13.0	-21.0	4.418	35.46	0.00	25	6.02	47.57	0.025	25.21	0.003	35.68	0.006	43.29	0.013	47.57	0.025
2	clay	-21.0	-29.0	4.418	70.65	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	clay	-29.0	-38.0	5.207	117.52	36.11	0	36.11	285.53	0.025	151.33	0.003	214.15	0.006	259.84	0.013	285.53	0.025
4	sand	-38.0	-43.0	9.152	163.60	0.00	35	69.30	547.95	0.025	290.41	0.003	410.96	0.006	498.64	0.013	547.95	0.025
5	shale	-43.0	-70.2	12.940	515.00	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.24B Pier 8 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.25A Pier 9 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Mid Layer Eff. Stress kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	silt	-11.0	-18.0	4.418	31.01	0.00	25	5.26	41.61	0.025	22.05	0.003	31.20	0.006	37.86	0.013	41.61	0.025
2	clay	-18.0	-30.0	4.418	84.13	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	sand	-30.0	-36.0	5.996	119.99	0.00	30	42.27	334.18	0.025	177.12	0.003	250.64	0.006	304.11	0.013	334.18	0.025
4	sand	-36.0	-42.0	9.152	175.29	0.00	35	72.79	575.54	0.025	305.04	0.003	431.66	0.006	523.75	0.013	575.54	0.025
5	shale	-43.0	-70.2	12.940	526.68	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.25B Pier 9 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.26A Pier 10 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	sand	-11.0	-16.2	4.418	22.92	0.00	25	3.89	30.75	0.025	16.30	0.003	23.06	0.006	27.98	0.013	30.75	0.025
2	clay	-16.2	-23.2	4.418	53.93	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	sand	-23.2	-32.0	5.996	106.99	0.00	30	33.32	263.46	0.025	139.63	0.003	197.59	0.006	239.74	0.013	263.46	0.025
3	sand	-32.0	-40.0	5.996	154.56	0.00	35	64.48	509.81	0.025	270.20	0.003	382.36	0.006	463.93	0.013	509.81	0.025
4	shale	-40.0	-68.0	12.940	517.81	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.26B Pier 10 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.27A Pier 11 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-16.0	-19.0	4.418	13.21	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	sand	-19.0	-25.0	5.996	49.26	0.00	30	12.94	102.28	0.025	54.21	0.003	76.71	0.006	93.07	0.013	102.28	0.025
3	sand	-25.0	-31.0	5.996	85.30	0.00	30	27.86	220.30	0.025	116.76	0.003	165.23	0.006	200.48	0.013	220.30	0.025
4	sand	-31.0	-37.0	9.152	140.32	0.00	35	55.62	439.78	0.025	233.08	0.003	329.83	0.006	400.20	0.013	439.78	0.025
5	shale	-37.0	-70.2	12.940	569.10	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.27B Pier 11 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.28A Pier 12 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-18.0	-19.0	4.418	4.45	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	sand	-19.0	-25.0	5.996	40.49	0.00	30	9.31	73.58	0.025	39.00	0.003	55.19	0.006	66.96	0.013	73.58	0.025
3	sand	-25.0	-30.0	5.996	70.50	0.00	32	24.70	195.33	0.025	103.52	0.003	146.50	0.006	177.75	0.013	195.33	0.025
4	sand	-30.0	-37.0	9.152	134.73	0.00	35	50.59	400.04	0.025	212.02	0.003	300.03	0.006	364.04	0.013	400.04	0.025
5	shale	-37.0	-70.2	12.940	563.52	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.28B Pier 12 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.29A Pier 13 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	sand	-13.0	-20.0	5.996	41.90	0.00	30	8.68	68.60	0.025	36.36	0.003	51.45	0.006	62.43	0.013	68.60	0.025
2	sand	-20.0	-27.0	7.574	95.06	0.00	32	30.48	241.02	0.025	127.74	0.003	180.76	0.006	219.33	0.013	241.02	0.025
3	sand	-27.0	-34.0	9.152	159.29	0.00	35	62.70	495.77	0.025	262.76	0.003	371.83	0.006	451.15	0.013	495.77	0.025
4	sand	-34.0	-37.0	9.152	186.94	0.00	35	85.35	674.86	0.025	357.68	0.003	506.14	0.006	614.12	0.013	674.86	0.025
5	shale	-37.0	-70.2	12.940	615.72	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.29B Pier 13 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.30A Pier 14 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-12.0	-20.0	4.418	35.32	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	clay	-20.0	-27.0	4.418	66.33	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	sand	-27.0	-34.0	5.996	108.23	0.00	30	36.15	285.80	0.025	151.47	0.003	214.35	0.006	260.07	0.013	285.80	0.025
4	sand	-34.0	-37.0	9.152	135.88	0.00	35	60.18	475.82	0.025	252.18	0.003	356.86	0.006	432.99	0.013	475.82	0.025
5	shale	-37.0	-70.2	12.940	564.66	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.30B Pier 14 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.31A Pier 15 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 6/5/98

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-4.0	-13.0	4.418	39.61	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	clay	-13.0	-22.0	4.418	79.38	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	clay	-22.0	-32.0	4.418	123.87	24.08	0	24.08	190.36	0.025	100.89	0.003	142.77	0.006	173.22	0.013	190.36	0.025
4	sand	-32.0	-35.0	5.996	141.62	0.00	30	54.97	434.67	0.025	230.37	0.003	326.00	0.006	395.55	0.013	434.67	0.025
5	sand	-35.0	-38.0	9.152	169.55	0.00	35	76.71	606.52	0.025	321.46	0.003	454.89	0.006	551.94	0.013	606.52	0.025
6	shale	-38.0	-70.2	12.940	585.30	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.31B Pier 15 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

Table 3.32A Pier 16 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 7/25/99

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-2.0	-11.0	4.418	39.77	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	clay	-11.0	-20.0	4.418	79.54	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	clay	-20.0	-29.0	4.418	119.32	24.08	0	24.08	190.36	0.025	100.89	0.003	142.77	0.006	173.22	0.013	190.36	0.025
4	clay	-29.0	-32.0	4.418	132.80	36.11	0	36.11	285.53	0.025	151.33	0.003	214.15	0.006	259.84	0.013	285.53	0.025
5	sand	-32.0	-36.0	9.152	169.10	0.00	30	62.51	494.27	0.025	261.97	0.003	370.71	0.006	449.79	0.013	494.27	0.025
6	shale	-36.0	-70.2	12.940	611.31	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.32B Pier 16 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

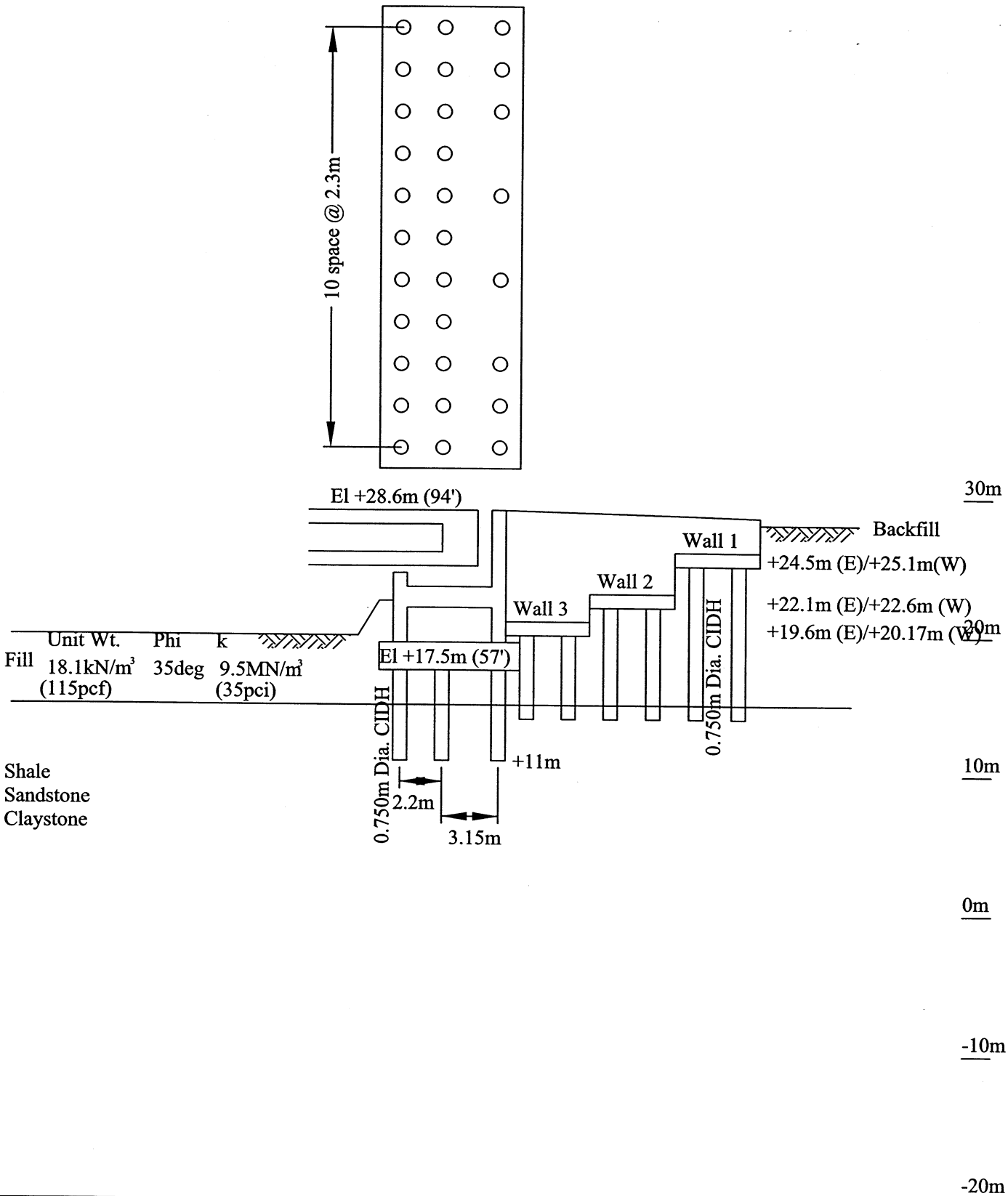
Table 3.33A Pier 17 : t-z curve in compression (use 75 % resistance for tension) Pile: 2.5 m dia. CISS pile/ 2.2 m dia. CIDH rock socket 7/25/99

Layer	Soil Type	Top El. m	Bottom El. m	Eff Unit Wt. kN/m^3	Eff. Stress at Bottom kN/m^2	c kN/m^2	phi degree	Unit Skin Friction kN/m^2	t_{max} kN/m	z_c m	t1 kN/m	z1 m	t2 kN/m	z2 m	t3 kN/m	z3 m	t4 kN/m	z4 m
1	clay	-2.0	-11.0	4.418	39.77	12.04	0	12.04	95.18	0.025	50.44	0.003	71.38	0.006	86.61	0.013	95.18	0.025
2	clay	-11.0	-20.0	4.418	79.54	16.85	0	16.85	133.25	0.025	70.62	0.003	99.94	0.006	121.26	0.013	133.25	0.025
3	clay	-20.0	-26.0	4.418	106.24	24.08	0	24.08	190.36	0.025	100.89	0.003	142.77	0.006	173.22	0.013	190.36	0.025
4	sand	-26.0	-33.0	4.418	137.25	0.00	28	46.72	369.43	0.025	195.80	0.003	277.07	0.006	336.18	0.013	369.43	0.025
5	sand	-33.0	-35.0	9.152	155.40	0.00	35	72.14	570.42	0.025	302.32	0.003	427.81	0.006	519.08	0.013	570.42	0.025
6	shale	-35.0	-70.2	12.940	610.24	485.35	0	485.35	3372.69	0.025	1787.53	0.003	2529.52	0.006	3069.15	0.013	3372.69	0.025

Table 3.33B Pier 17 : q-u curve in compression (use 0 for tension) End Bearing: 2.2 m dia.

	q_{max} kN	u_c m	q1 kN	u1 m	q2 kN	u2 m	q3 kN	u3 m	q4 kN	u4 m
	10680.32	0.252	4806.14	0.025	6728.60	0.063	8437.45	0.126	10680.32	0.252

ABUTMENT 1



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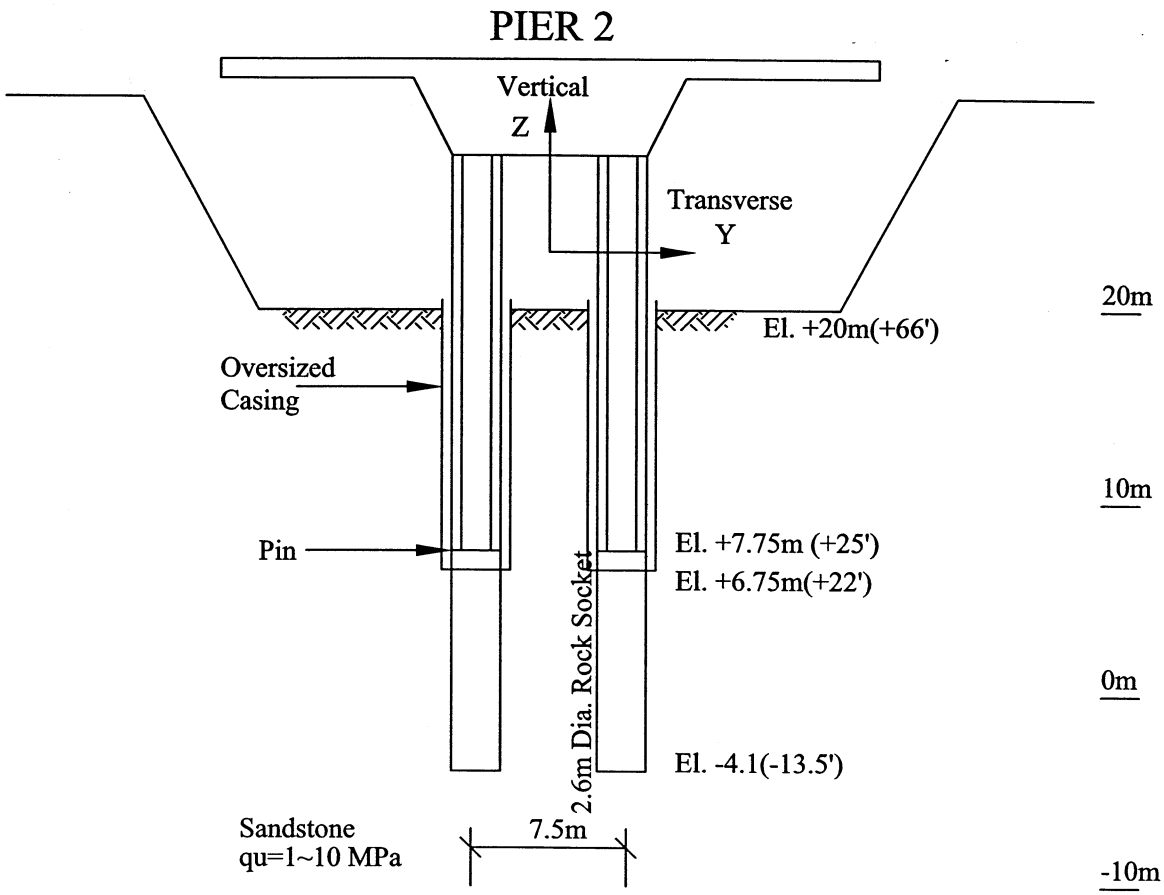
NEW BENICIA MARTINEZ BRIDGE

IDEALIZED SOIL UNIT AT ABUTMENT 1 Figure 3.1

Project No. 96-178 | Date: 5-24-99



SECTION/MATERIAL PROPERTIES

	2.6m Dia Rock Socket
A (m^2)	5.31
I_{eff} (m^4)	1.1
E (kN/m^2)	2.365E+07

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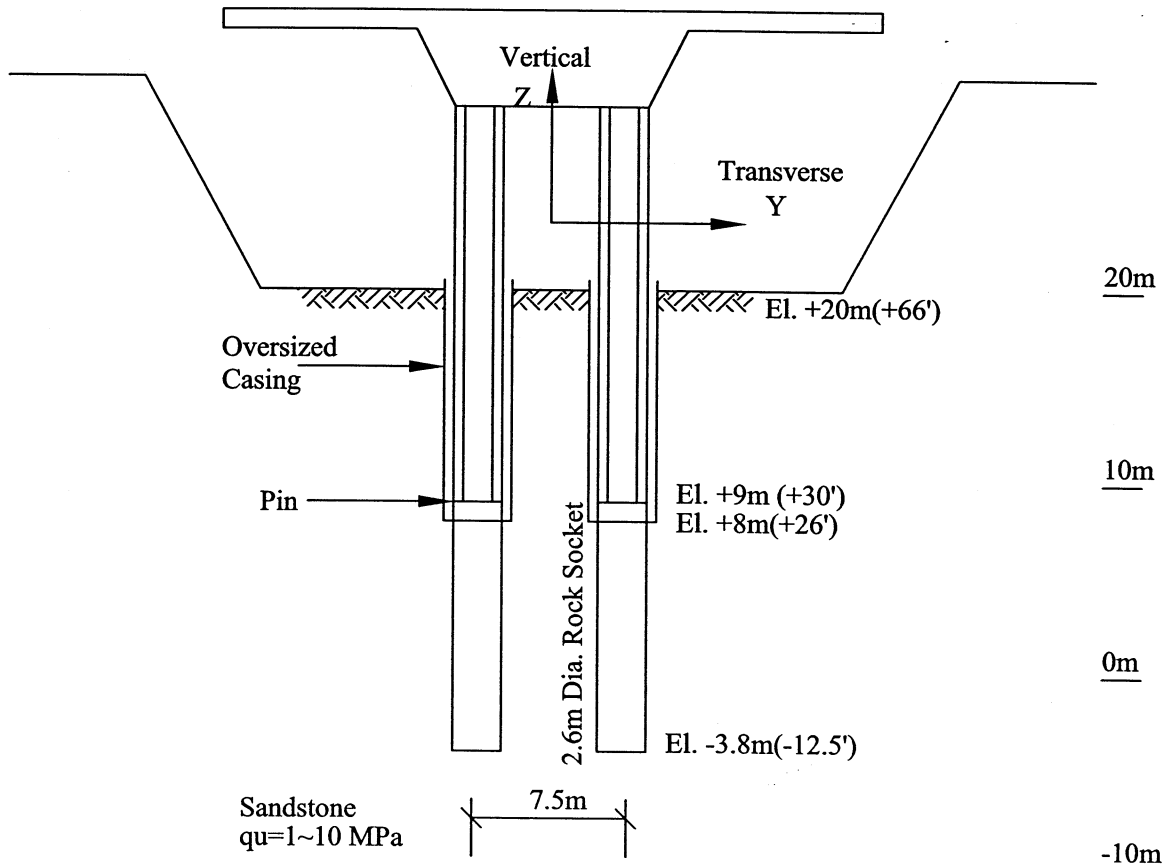
NEW BENICIA MARTINEZ BRIDGE

IDEALIZED SOIL UNIT AT PIER 2 — Figure 3.2

Project No. 96-178 | Date: 12-1-98

PIER 3



SECTION/MATERIAL PROPERTIES

	2.6m Dia Rock Socket
A (m^2)	5.31
I_{eff} (m^4)	1.1
E (kN/m^2)	2.365E+07

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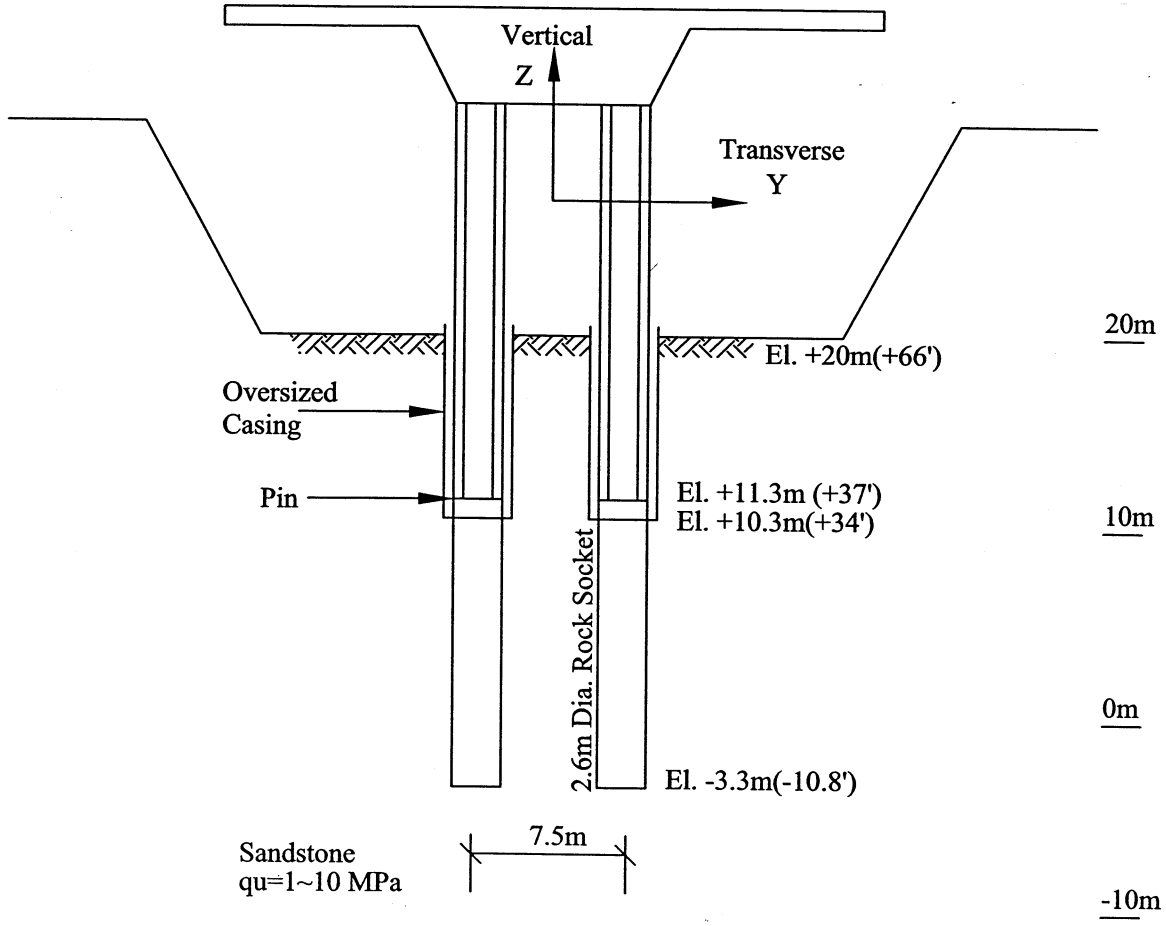
IDEALIZED SOIL UNIT AT PIER 3 — Figure 3.3

Project No. 96-178 | Date: 12-1-98

PIER 4



SECTION/MATERIAL PROPERTIES

	2.6m Dia Rock Socket
A (m^2)	5.31
I_{eff} (m^4)	1.1
E (kN/m^2)	2.365E+07

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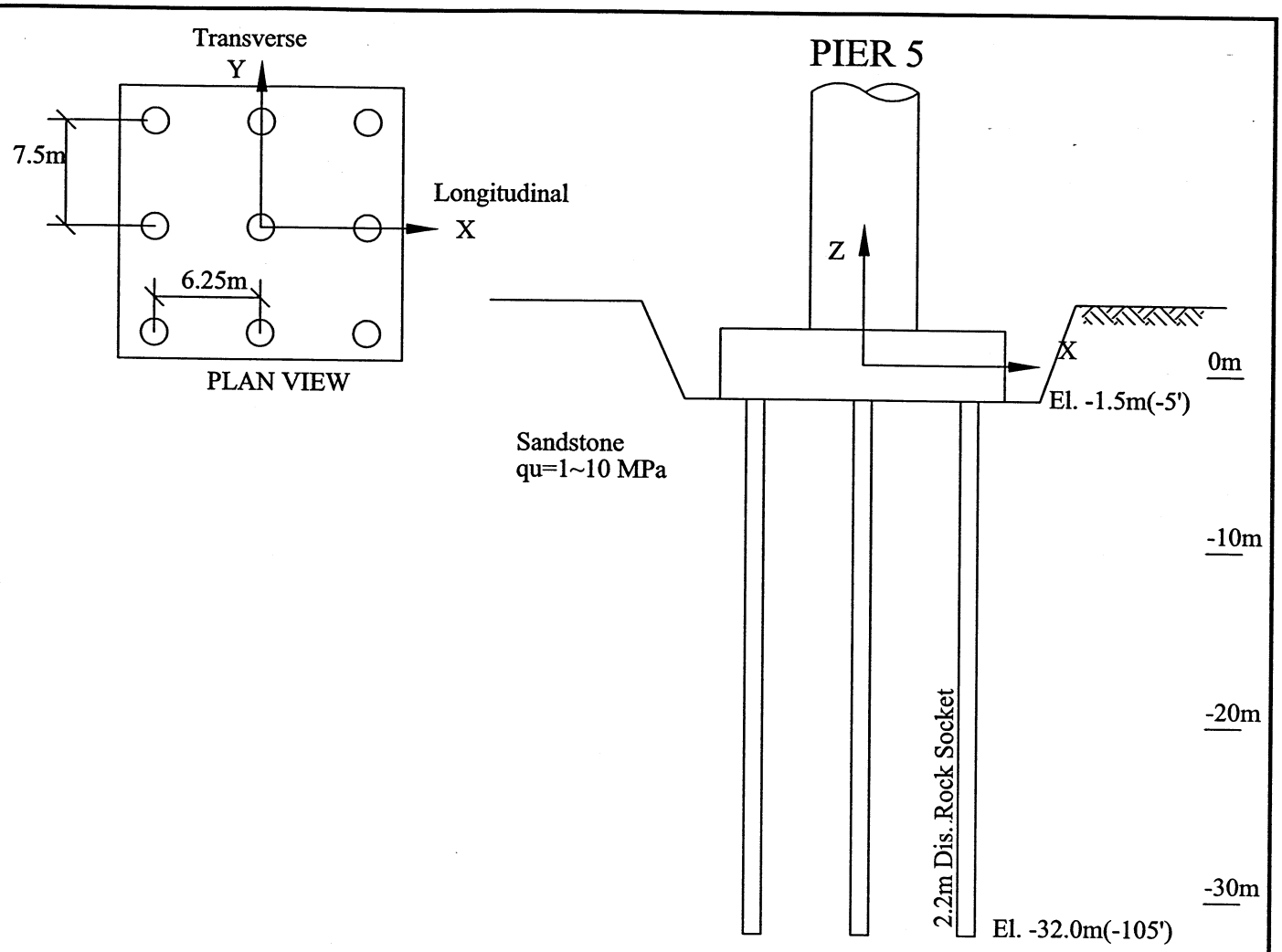
IDEALIZED SOIL UNIT AT PIER 4 — Figure 3.4

Project No. 96-178 — Date: 12-1-98



SECTION/MATERIAL PROPERTIES

	2.2m Dia Rock Socket
A (m^2)	3.80
I_{eff} (m^4)	0.68
E (kN/m^2)	2.365E+07

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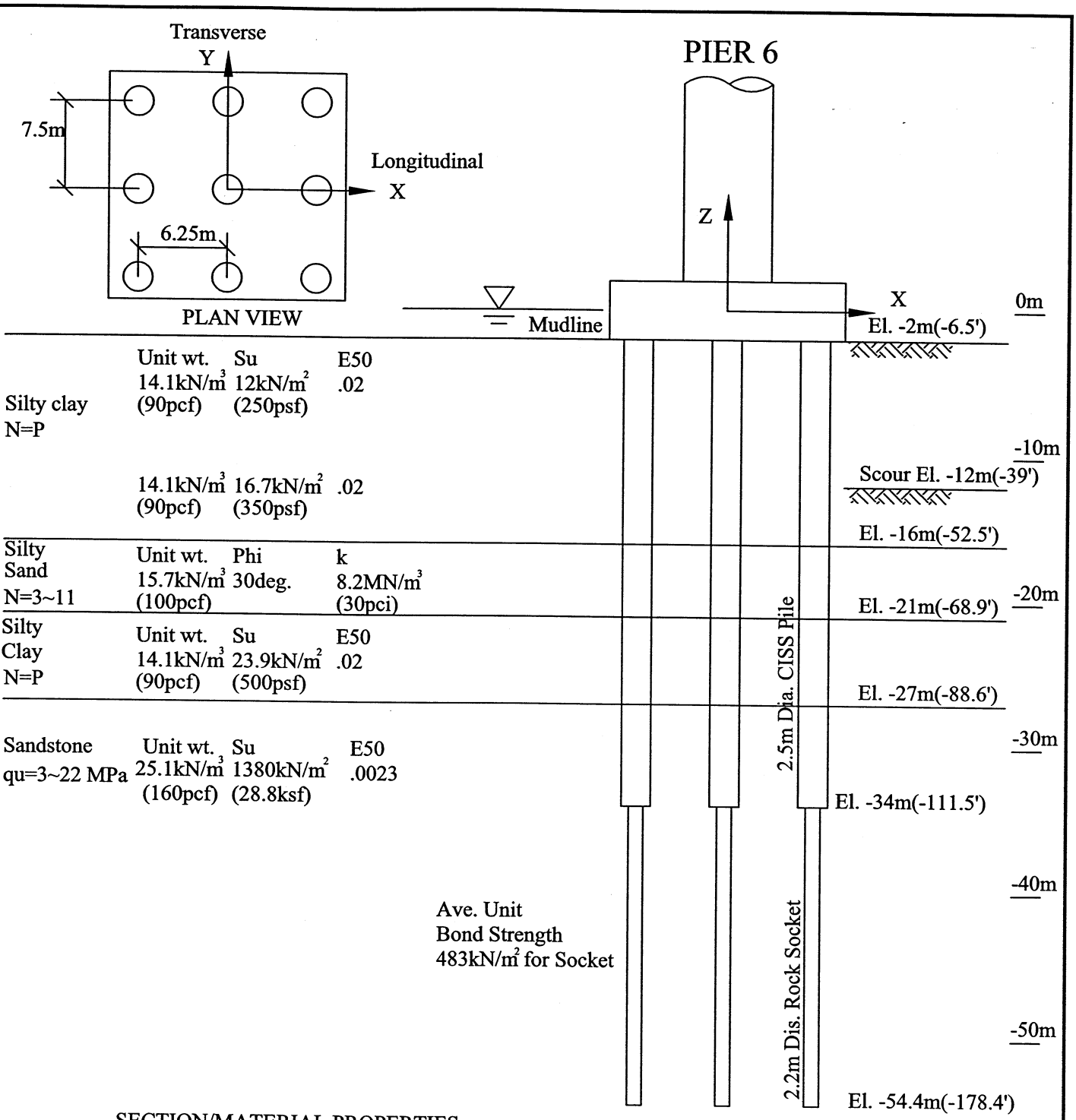
NEW BENICIA MARTINEZ BRIDGE

IDEALIZED SOIL UNIT AT PIER 5 — Figure 3.5

Project No. 96-178 | Date: 1-12-00



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m^2)	7.57	3.80
I_{eff} (m^4)	3.08	0.68
E (kN/m^2)	2.365E+07	2.365E+07

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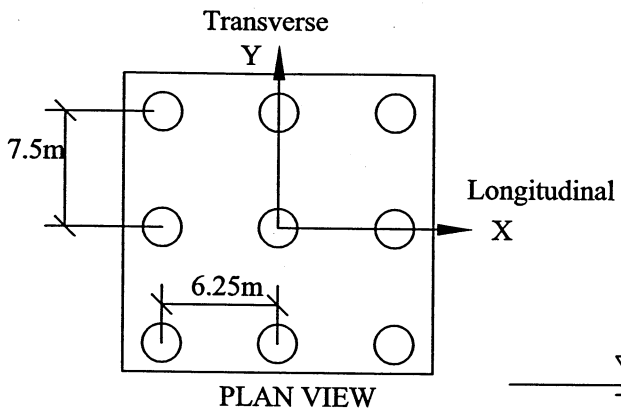
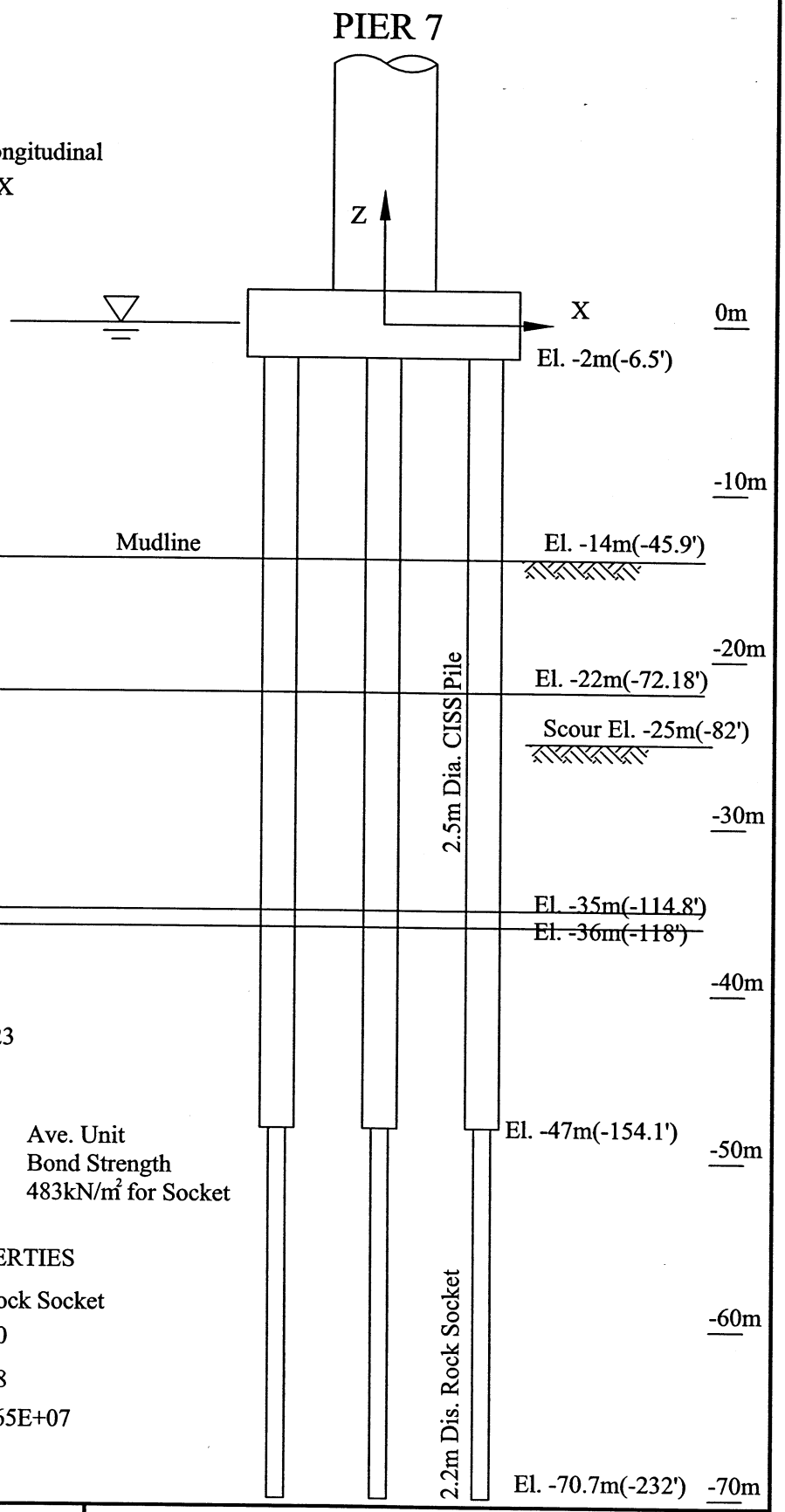
IDEALIZED SOIL UNIT AT PIER 6 — Figure 3.6

Project No. 96-178 | Date: 6-5-98





Loose Sandy Silt N=P	Unit wt.	Phi	k
	14.1kN/m³ (90pcf)	25 deg.	1.4MN/m³ (5pci)

Silt and Clay N=3~13	Unit wt.	Su	E50
	14.1kN/m³ (90pcf)	16.7kN/m² (350psf)	.02
	14.9kN/m³ (95pcf)	35.9kN/m² (750psf)	.02

Sand & Gravel N=10~30	Unit wt.	Phi	k
	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)

Sandstone qu=5~53 MPa	Unit wt.	Su	E50
	25.1kN/m³ (160pcf)	1380kN/m² (28.8ksf)	.0023

Ave. Unit Bond Strength 483kN/m² for Socket

SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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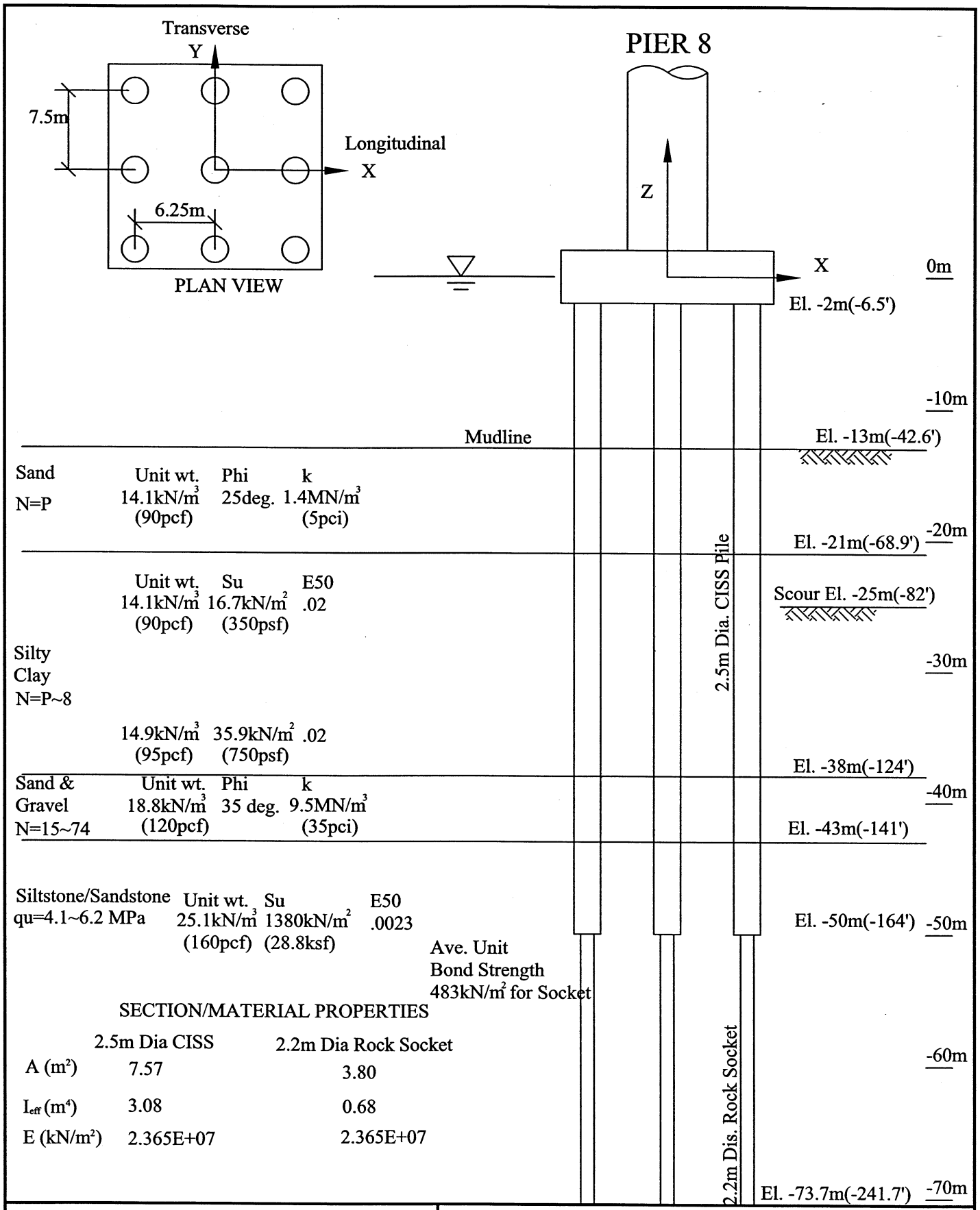
IDEALIZED SOIL UNIT AT PIER 7 — Figure 3.7

Project No. 96-178 — Date: 1-12-00



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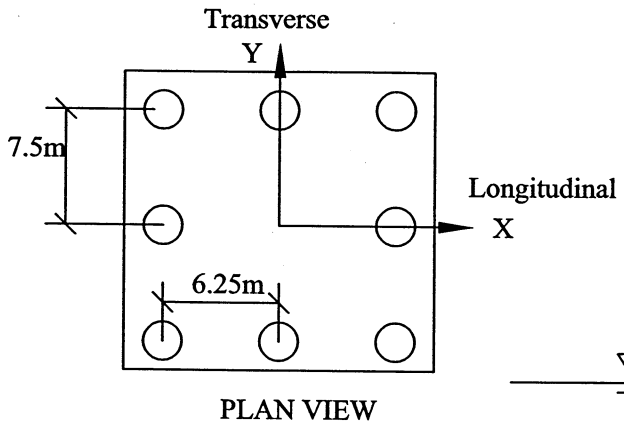
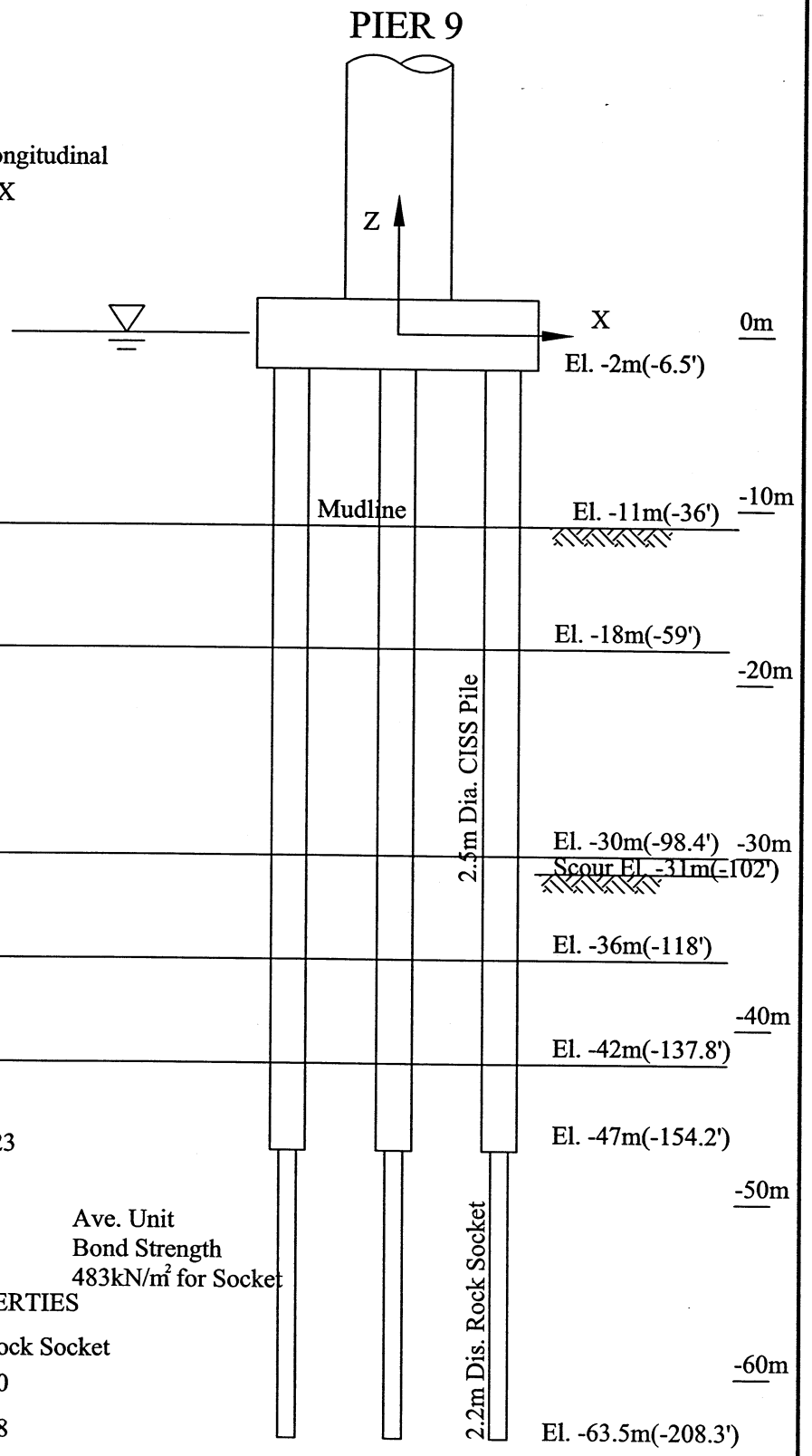
IDEALIZED SOIL UNIT AT PIER 8 — Figure 3.8

Project No. 96-178 | Date: 1-12-00





	Unit wt.	Phi	k
Sand N=1	14.1kN/m³ (90pcf)	25 deg.	1.4MN/m³ (5pci)

	Unit wt.	Su	E50
Clayey Silt N=P	14.1kN/m³ (90pcf)	16.7kN/m² (350psf)	.02

	Unit wt.	Phi	k
Fine sand N=3~40	15.7kN/m³ (100pcf)	30 deg.	8.2MN/m³ (30pci)

	Unit wt.	Phi	k
Sand & Gravel N=17~45	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)

	Unit wt.	Su	E50
Siltstone qu=2~56.4MPa	25.1kN/m³ (160pcf)	1380kN/m² (28.8ksf)	.0023

Ave. Unit Bond Strength 483kN/m² for Socket

SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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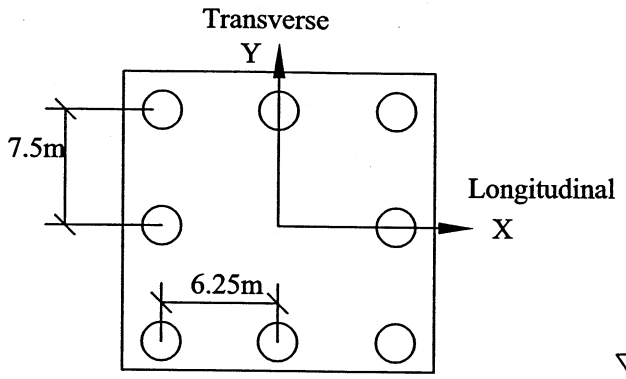
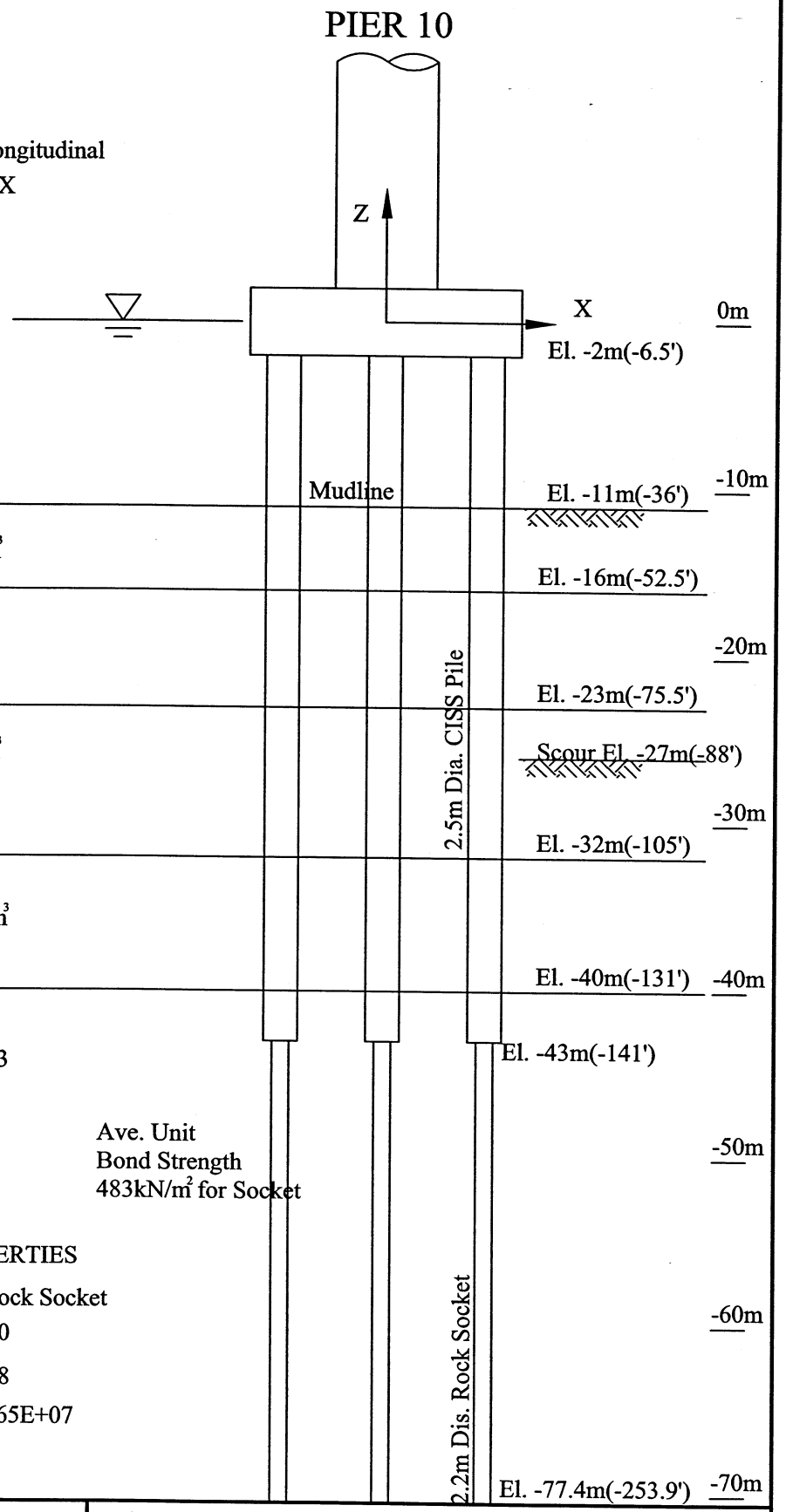
IDEALIZED SOIL UNIT AT PIER 9 — Figure 3.9

Project No. 96-178 | Date: 1-12-00



PLAN VIEW



	Unit wt.	Phi	k
Sand N=1	14.1kN/m³ (90pcf)	25 deg.	1.4MN/m³ (5pci)

	Unit wt.	Su	E50
Silty Clay N=1~3	14.1kN/m³ (90pcf)	12.0kN/m² 250psf	.02

	Unit wt.	Phi	k
Clayey Sand N=3~7	15.7kN/m³ (100pcf)	30 deg.	8.2MN/m³ (30pci)

	Unit wt.	Phi	k
Sand & Gravel N=10~70	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)

	Unit wt.	Su	E50
Sandstone qu=2~10MPa	25.1kN/m³ (160pcf)	1380kN/m² (28.8ksf)	.0023

Ave. Unit Bond Strength 483kN/m² for Socket

SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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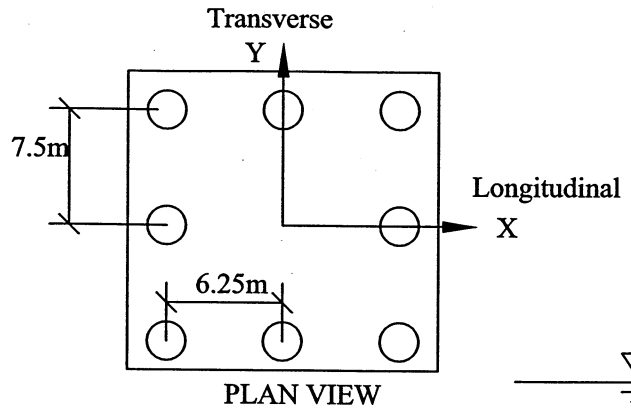
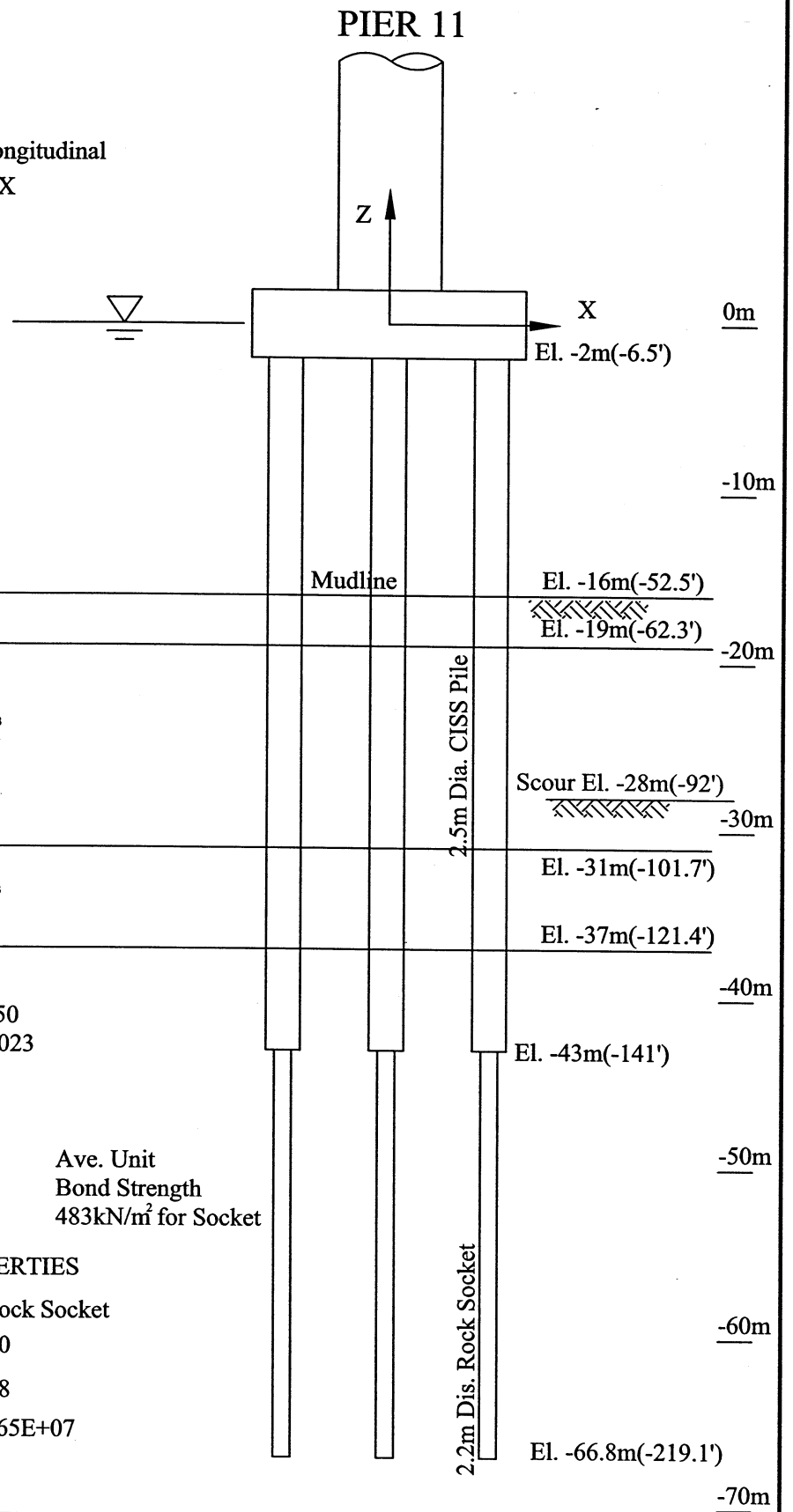
IDEALIZED SOIL UNIT AT PIER 10 — Figure 3.10

Project No. 96-178 — Date: 1-12-00





	Unit wt.	Su	E50
Clayey Silt N=3	14.1kN/m³ (90pcf)	12.0kN/m² (250psf)	.02

	Unit wt.	Phi	k
Fine Sand N=7~24	15.7kN/m³ (100pcf)	30 deg.	8.2MN/m³ (30pci)

	Unit wt.	Phi	k
Sand and Gravel N=30~45	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)

	Unit wt.	Su	E50
Sandstone qu=3.2~20 MPa	25.1kN/m³ (160pcf)	1380kN/m² (28.8ksf)	.0023

Ave. Unit Bond Strength 483kN/m² for Socket

SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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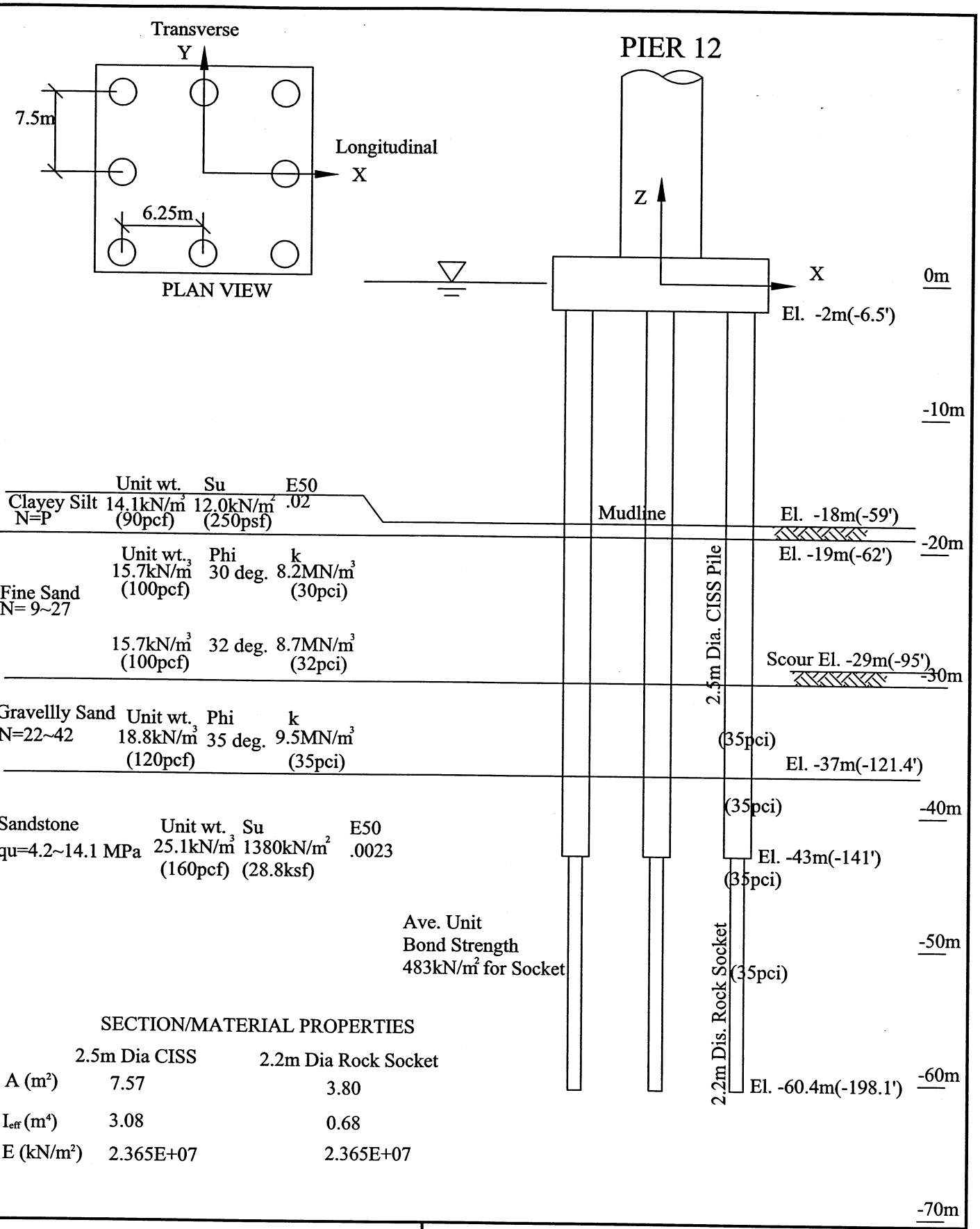
IDEALIZED SOIL UNIT AT PIER 11 — Figure 3.11

Project No. 96-178 | Date: 6-5-98



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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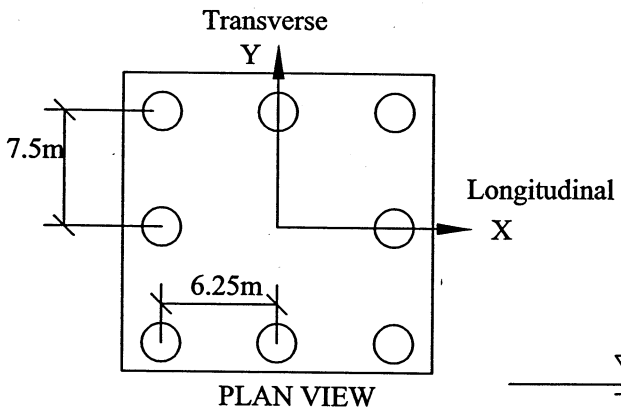
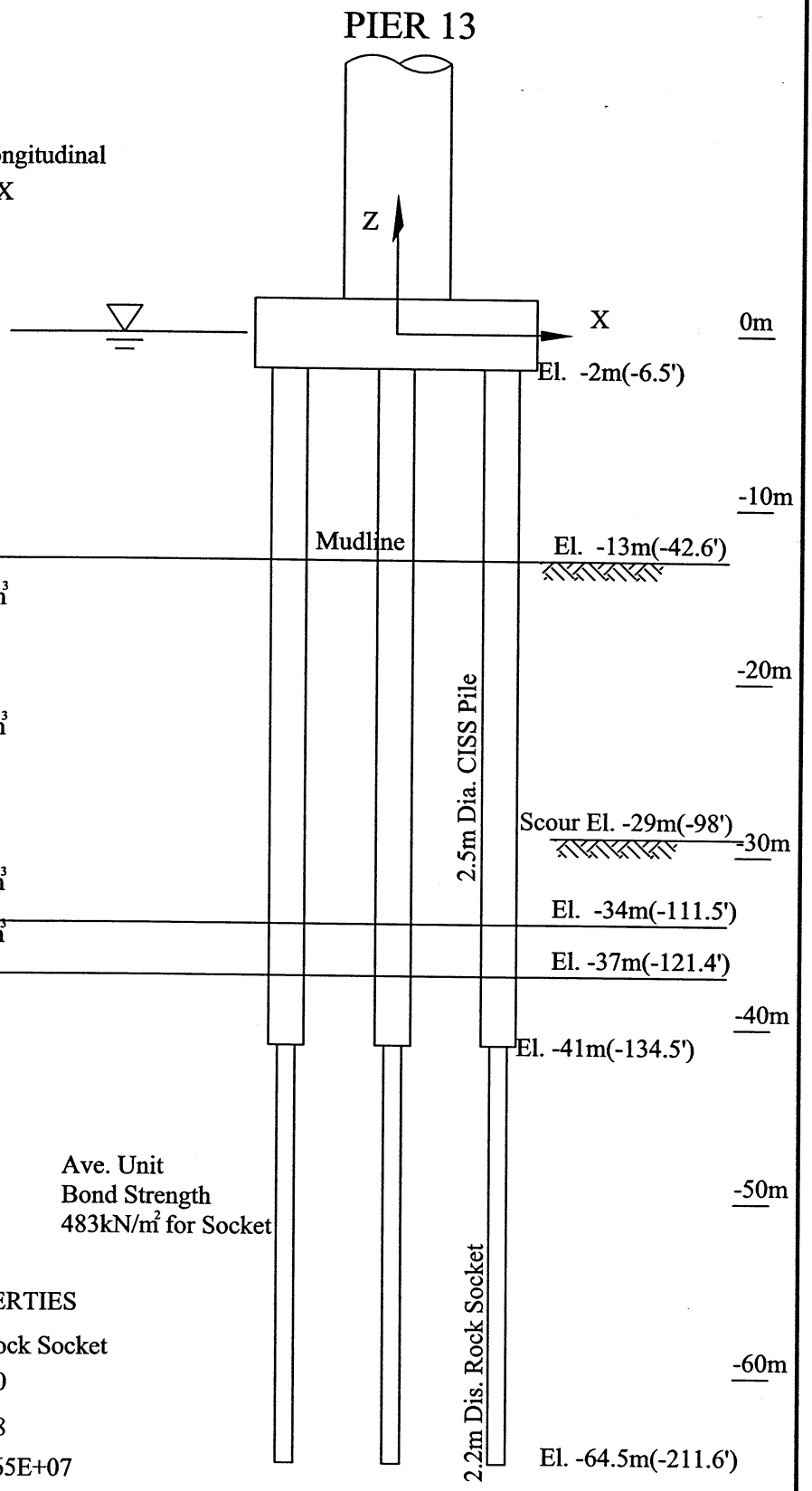
IDEALIZED SOIL UNIT AT PIER 12 Figure 3.12

Project No. 96-178 Date: 6-5-98





	Unit wt.	Phi	k
	15.7kN/m³ (100pcf)	30 deg.	8.2MN/m³ (30pci)
Sand N=2~43	17.3kN/m³ (110pcf)	32 deg.	8.7MN/m³ (32pci)
	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)
Gravel N=36~40	18.8kN/m³ (120pcf)	35 deg.	9.5MN/m³ (35pci)

Sandstone	Unit wt.	Su	E50
	25.1kN/m³ (160pcf)	1380kN/m² (28.8ksf)	.0023

Ave. Unit Bond Strength 483kN/m² for Socket

SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m²)	7.57	3.80
I_{eff} (m⁴)	3.08	0.68
E (kN/m²)	2.365E+07	2.365E+07

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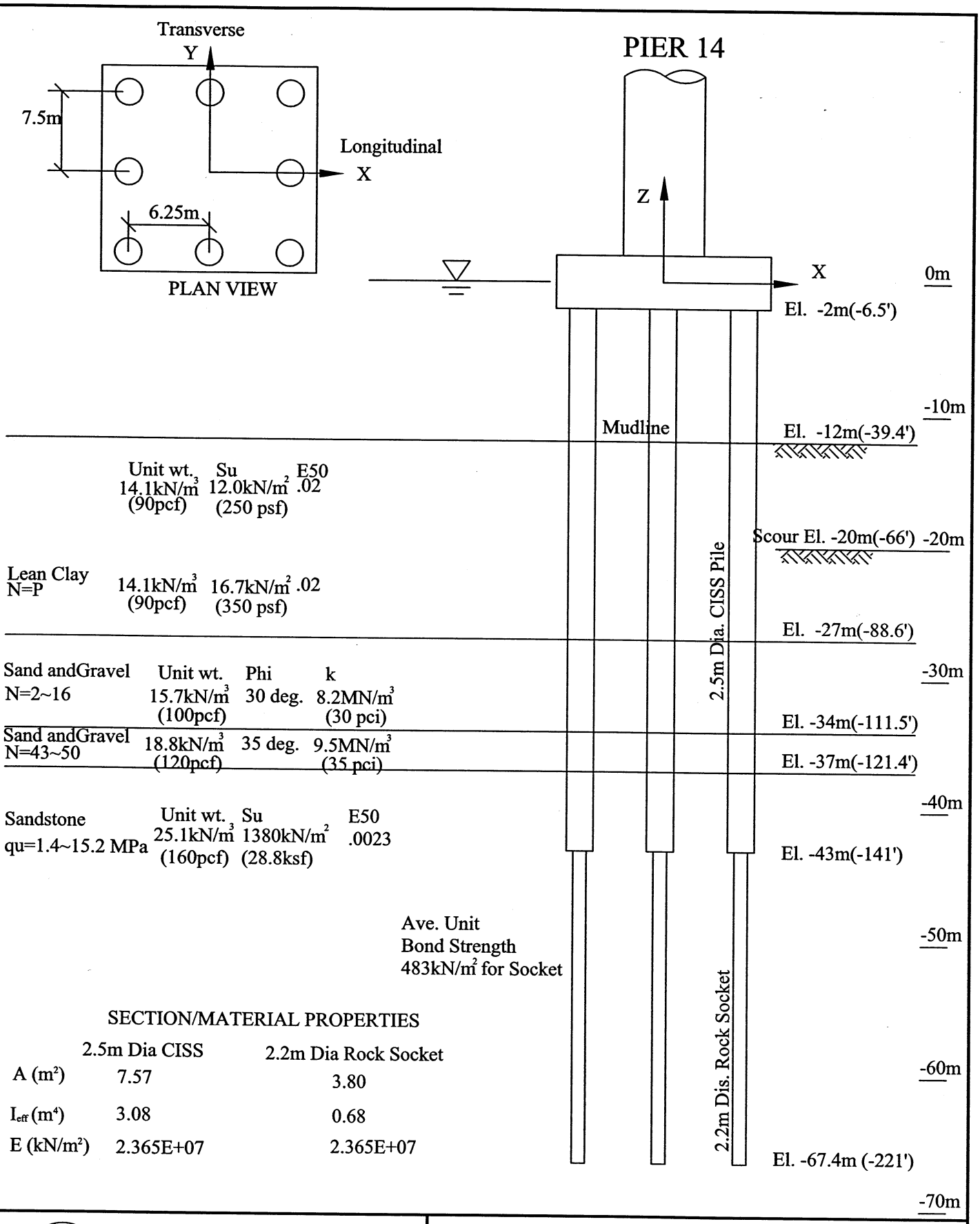
NEW BENICIA MARTINEZ BRIDGE

IDEALIZED SOIL UNIT AT PIER 13 — Figure 3.13

Project No. 96-178 | Date: 6-5-98



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m^2)	7.57	3.80
I_{eff} (m^4)	3.08	0.68
E (kN/m^2)	2.365E+07	2.365E+07

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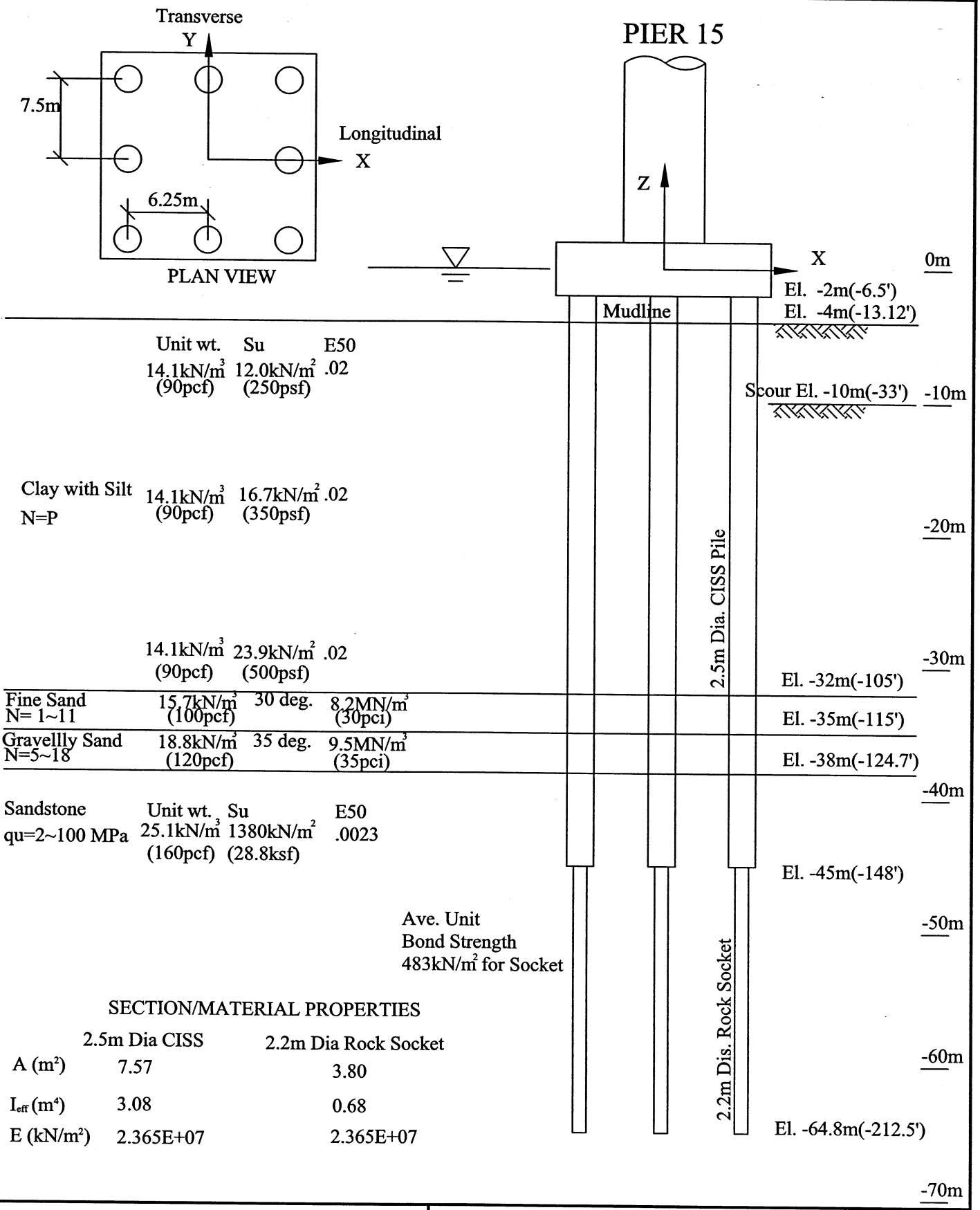
IDEALIZED SOIL UNIT AT PIER 14 Figure 3.14

Project No. 96-178 Date: 6-5-98



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m^2)	7.57	3.80
I_{eff} (m^4)	3.08	0.68
E (kN/m^2)	2.365E+07	2.365E+07

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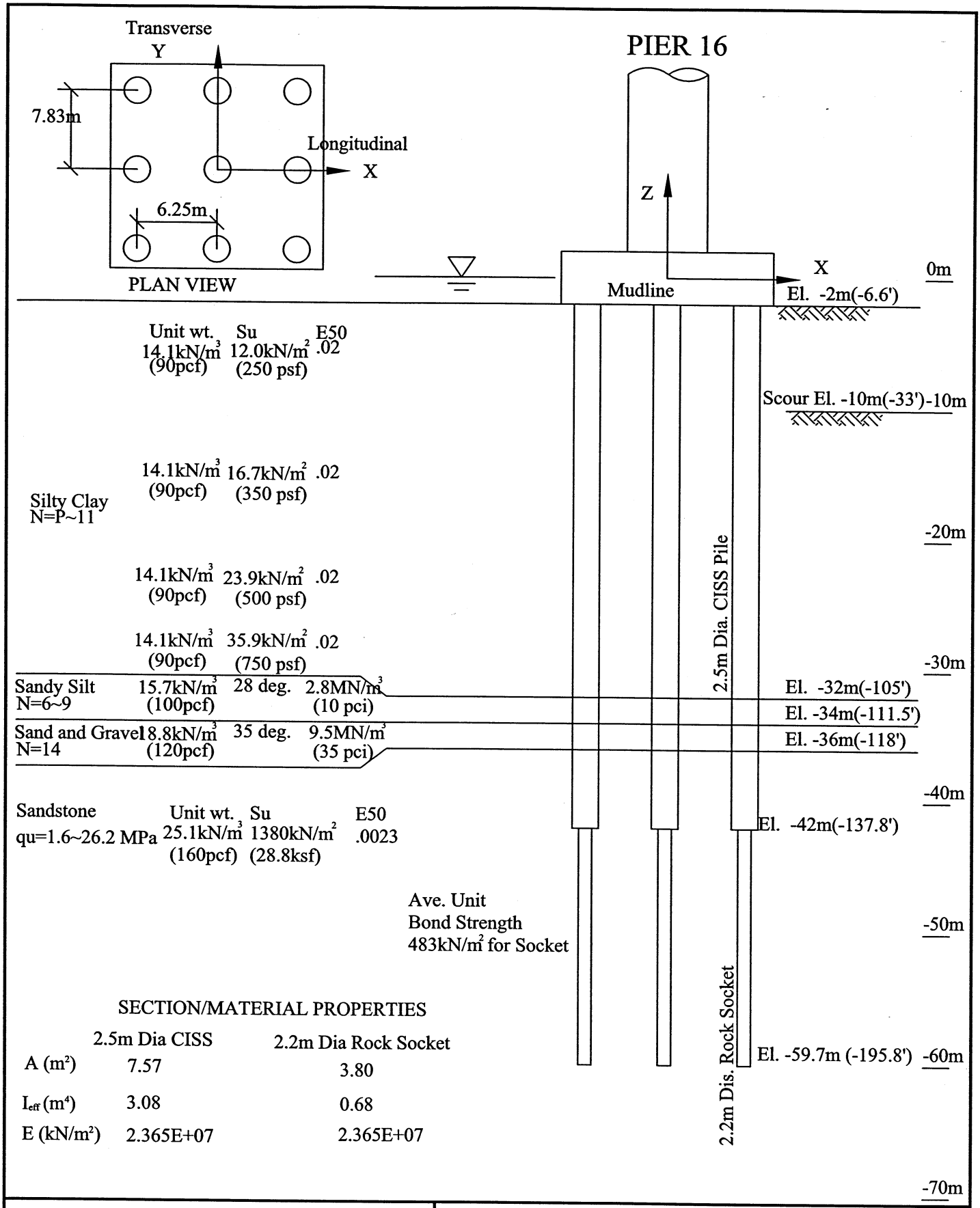
IDEALIZED SOIL UNIT AT PIER 15 Figure 3.15

Project No. 96-178 Date: 6-5-98



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m^2)	7.57	3.80
I_{eff} (m^4)	3.08	0.68
E (kN/m^2)	2.365E+07	2.365E+07

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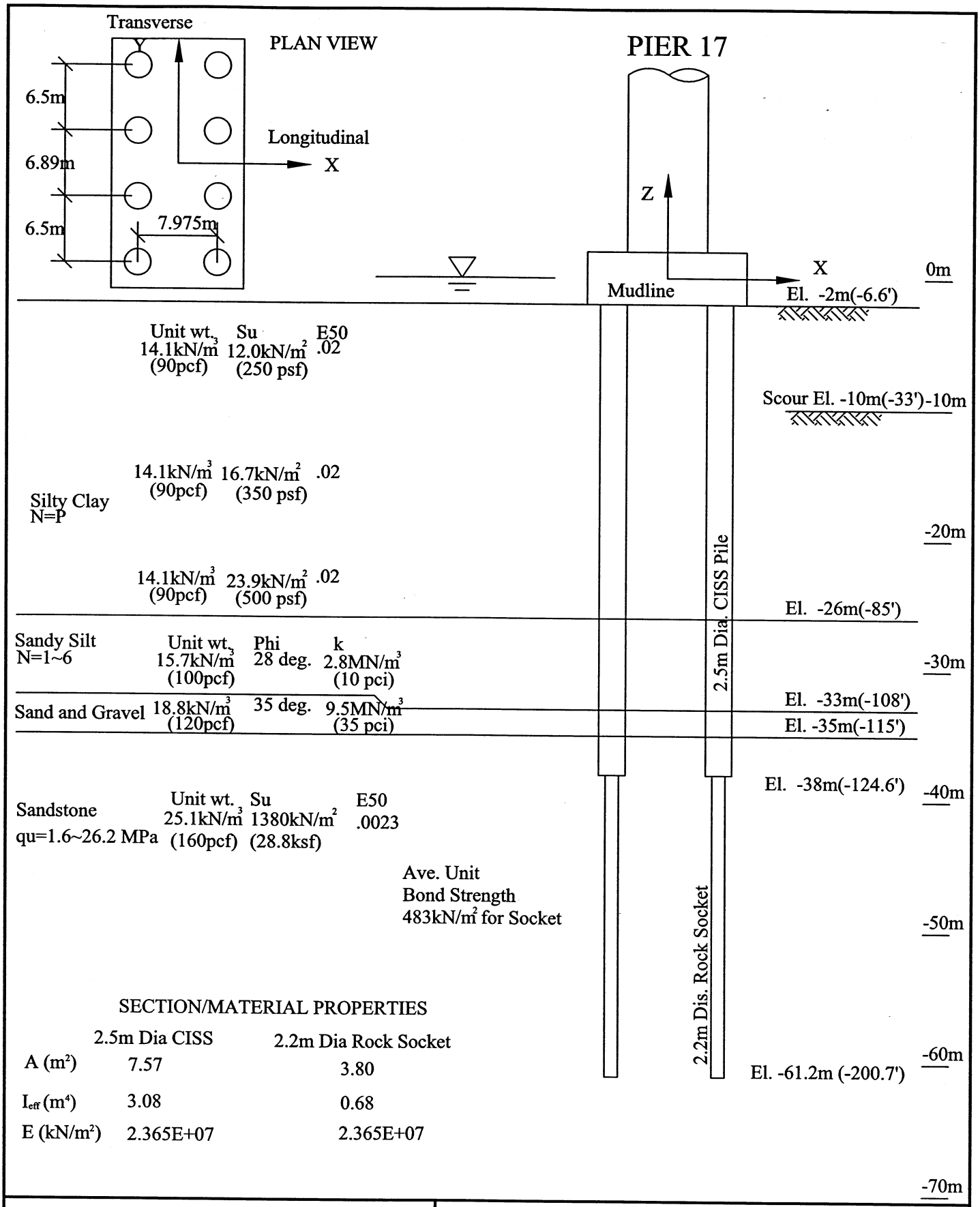
IDEALIZED SOIL UNIT AT PIER 16 Figure 3.16

Project No. 96-178 Date: 6-5-99



SECTION/MATERIAL PROPERTIES

	2.5m Dia CISS	2.2m Dia Rock Socket
A (m^2)	7.57	3.80
I_{eff} (m^4)	3.08	0.68
E (kN/m^2)	2.365E+07	2.365E+07

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NEW BENICIA MARTINEZ BRIDGE

IDEALIZED SOIL UNIT AT PIER 17 Figure 3.17

Project No. 96-178 Date: 6-5-99

Section 4

4.0 SOIL-STRUCTURE INTERACTION

4.1 Foundation Modeling

A substructuring procedure was adopted by the structural designers to determine demands on the piles. Response spectrum analyses were first conducted on the global bridge model where each pile below elevation -11 m or the entire pile-foundation below the pile-cap level was represented by a simple lumped spring (6 degrees-of-freedom) as a linear system in the initial design.

The primary design team adopted substructuring of individual piles below elevation -11 m while the independent check team adopted substructuring of the entire foundation below the pile-cap, as shown in Figure 4.1. The advantage of substructuring the individual piles below elevation -11 m is related to consideration of potential pile plastic hinges near the pile cap connection as the pile segments between the pile cap and elevation -11 m are included in the bridge model.

For the multiple support time history analyses, which were used to check against the response spectrum analyses, the structural designer adopted a total-system approach modeling individual piles and soil support springs. In this approach, p-y, t-z, q-u springs were directly attached to the individual piles and depth varying free-field ground motions from one-dimensional site response analyses were used to excite the global bridge model. It is considered the most complete model without requiring to invoke a substructuring method.

The sections that follow describe formulation of foundation stiffness matrix using the substructuring approach. The same principle was applied to define foundation parameters for the two different substructure models adopted for the new Benicia-Matinez Bridge. A set of stiffness matrices were developed at elevation –11 m for individual piles, and separate set of stiffness matrices were developed at the pile-cap level to represent the entire pile group. Other than foundation stiffness matrices, we also provided mass matrices, damping matrices and forcing for seismic response analyses.

4.2 Method of Substructuring

To develop a foundation stiffness matrix and forcing function for a substructure system, we consider a global structural model (total system) consisting of superstructure, pile-cap, and pile-foundation, as shown in Figure 4.2. For the purpose of discussion, we neglect the damping term and assume a lumped mass system. The global bridge structure is excited by depth-varying input ground motions $\{x_g(t)\}$ along the pile length, and the equations of motion for can be written as,

$$\begin{bmatrix} [m_s] & & \\ & [m_c] & \\ & & [m_p] \end{bmatrix} \begin{Bmatrix} \{\ddot{x}_s\} \\ \{\ddot{x}_c\} \\ \{\ddot{x}_p\} \end{Bmatrix} + \begin{bmatrix} [K_{ss}] & [K_{sc}] & \\ [K_{cs}] & [K_{cc}] & [K_{cp}] \\ & [K_{pc}] & [K_{pp}] \end{bmatrix} \begin{Bmatrix} \{x_s\} \\ \{x_c\} \\ \{x_p\} \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ [K_g]\{x_g\} \end{Bmatrix}$$

where $\{x_s\}$, $\{x_c\}$ and $\{x_p\}$ are displacement of the superstructure, pile-cap, and pile degrees of freedom, respectively relative to the earth inertia reference frame (i.e, total displacements). The pile-cap would have 6 degrees of freedom (three translations, and three rotations). We assume that mass of the pile is small, and can be ignored, i.e, $[m_p]=0$. Typically this is the case because inertial forces of the piles are relatively small in relation to the more massive superstructure and therefore, neglecting the foundation inertial effect does not normally cause significant error. Then the system of equations becomes

$$\begin{bmatrix} [m_s] & & \\ & [m_c] & \\ & & [0] \end{bmatrix} \begin{Bmatrix} \{\ddot{x}_s\} \\ \{\ddot{x}_c\} \\ \{\ddot{x}_p\} \end{Bmatrix} + \begin{bmatrix} [K_{ss}] & [K_{sc}] & \\ [K_{cs}] & [K_{cc}] & [K_{cp}] \\ & [K_{pc}] & [K_{pp}] \end{bmatrix} \begin{Bmatrix} \{x_s\} \\ \{x_c\} \\ \{x_p\} \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ [K_g]\{x_g\} \end{Bmatrix}$$

With the pile mass assumed to be zero, static condensation can be conducted to eliminating the pile degrees of freedom. Dynamic response analysis in time can be conducted involving only the equations involving the superstructure $\{x_s\}$ and the pile cap nodes $\{x_c\}$ from the following equation derived from the first two sets of the above equation.

$$\begin{bmatrix} [m_s] & \\ & [m_c] \end{bmatrix} \begin{Bmatrix} \{\ddot{x}_s\} \\ \{\ddot{x}_c\} \end{Bmatrix} + \begin{bmatrix} [K_{ss}] & [K_{sc}] \\ [K_{cs}] & [K] \end{bmatrix} \begin{Bmatrix} \{x_s\} \\ \{x_c\} \end{Bmatrix} = \begin{Bmatrix} 0 \\ \{f\} \end{Bmatrix}$$

where $[K]$ and $\{f\}$ in the above equation are defined as

$$[K] = [K_{cc}] - [K_{cp}][K_{pp}]^{-1}[K_{pc}]$$

$$\{f\} = -[K_{cp}][K_{pp}]^{-1}[K_g]\{x_g\}$$

It is noted that the remaining dynamic equations of motion contain only pile-cap and superstructure degrees of freedom, and in fact the solutions to these equations are what the structure engineers are seeking which represent demands for the superstructure and the pile-cap. This transformation of the original problem into the substructure system consisting only of superstructure and pile-cap is entirely based on classical static condensation. The stiffness and loading of pile foundation appear

in the form of 6x6 condensed stiffness matrix [K] and a 6x1 time-series forcing function {f} applied at the pile-cap. Both the stiffness matrix [K] (which is constant with time) and the forcing {f} (which is time dependent related to the time histories of the depth-varying free-field input ground motion) can be pre-calculated without knowledge of the response of the superstructure or the pile cap. Instead of using the forcing function {f} explicitly on the right hand side of the equations, we introduce a 6x1 vector {X}, such that

$$\{f\} = [K]\{X\}$$

From the above equation, it can be noted that loading from ground excitation is introduced into the overall structure as a right hand vector in a form of a displacement vector {X} times the foundation stiffness [K], and therefore {X} represent some form of rigid-base motion derived from the depth-varying freefield ground motion. This six-component motion {X} is termed "kinematic motion", and is a major element in defining ARS design criteria. This kinematic motion {X}, calculated at a single point on the pile cap implicitly contains the statically condensed forces transmitted from the ground to the superstructure along the entire embedded pile length due to both the depth-varying shaking intensity in soil motion as well as the depth-varying soil stiffnesses. The kinematic motion can been derived using a massless pile-group model, and therefore maintains the frequency contents of the original ground motion.

Theoretically, rigorous analysis of a pile foundation subjected to ground excitation would involve all six degrees of freedom kinematic motion in order to form the complete force vector {f}. In many cases, when the kinematic motion is derived at the pile-cap, the axial pile stiffness would imply a very large rotational stiffness of the pile cap leading to negligible pile-cap rotations, and therefore the rotational components can be neglected. By eliminating the rotational components, the kinematic motion represents pure translational rigid-base motion compatible with most earthquake engineering analyses involving firm ground input motions. Thus, Duhamel integral of the kinematic motion that has zero rotation (i.e., kinematic translations at pile-cap) would lead to the response spectra for the superstructure model. The three component response spectrum (involving the three translational component in ground motion) will then represents rigorously the equivalent ground shaking level felt by the superstructure. The steps involved in developing the kinematic motion merely assumes zero pile masses and the solutions take into accounts of all the detailed configuration of the pile group including all aspects in features of variation in the properties with depth, including ground motion and soil and the pile properties. A zero mass assumption of the pile basically allows pre-calculation of the time dependent force vector, {f} for the entire time history without the knowledge of the superstructure response. After completion of the dynamic response analyses for the second superstructure system involving both the pile cap and the superstructural nodes, the time history solution of the pile cap node can be back-substituted to the massless pile foundation to derive detailed member stresses along each of the pile.

4.3 Treatment of Mass and Damping

The substructuring approach using static condensation, as mentioned above, provides rigorous solutions for massless piles. However for piles with some limited mass, the method is only approximate and the error depends on the relative magnitude of the pile mass to the superstructure mass. The solution can be greatly improved by implementing a condensed mass in the foundation substructure. This is to maintain the fundamental mode of vibration of the entire foundation system in the condensed substructure which consists of 6 degrees of freedom (3 translation and 3 rotational modes) at the pile cap. One approach would be based on computation of eigenvalues for the soil-pile system representing the entire foundation. The condensed mass, [M], can be approximated by

$$[M] = \frac{1}{\omega^2}[K]$$

where [K] is the condensed stiffness matrix (6x6) obtained from static condensation and ω is an angular frequency. The value for ω is often chosen as the fundamental frequency (1st mode) for each of the six axes (3 translation and 3 rotation) of the entire foundation. By doing so, the condensed model consisting of 6x6 mass matrix [M] and 6x6 stiffness matrix [K] would reproduce the same 6 fundamental modes of vibration as the original foundation prior to adding the superstructure. In fact, matching of six modes of vibration is the best one can achieve for a condensed system that has only six degrees of freedom. It is not feasible to have more than six vibration modes for a six-d.o.f system.

In many cases, however, computation of natural frequencies and mode shapes for a large pile group can be difficult. A method similar to static condensation can be employed to reduce the number of degrees of freedom for a dynamic system which reduces the expense of computing eigenvalue and eigenvector. This condensation algorithm is known in the literature as Guyan reduction, mass condensation, dynamic condensation, or eigenvalue economization. In the context of pile foundation, free vibration characteristics of the pile-cap/pile system can be expressed as,

$$\left(\begin{bmatrix} [K_{cc}] & [K_{cp}] \\ [K_{pc}] & [K_{pp}] \end{bmatrix} - \omega^2 \begin{bmatrix} [m_c] & \\ & [m_p] \end{bmatrix}\right) \begin{Bmatrix} \{x_x\} \\ \{x_p\} \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

where the subscript c denotes the pile-cap d.o.f and the subscript p denotes the pile d.o.f. In order to obtain a relation between x_c and x_p, we temporarily ignore all the mass and the above equation reduces to

$$\begin{Bmatrix} \{x_c\} \\ \{x_p\} \end{Bmatrix} = [T]\{x_c\}$$

where

$$[T]=\begin{bmatrix} I \\ -[K_{pp}]^{-1}[K_{pc}]^T \end{bmatrix}$$

Substituting the above equation into the free-vibration eigen value equation and pre-multiplying by $[T]^T$ yields the condensed eigen problem as follows

$$([K]-\omega^2[M])\{x_c\}=\{0\}$$

where the reduced stiffness and mass matrices are symmetric and are given by

$$[K]=[T]^T\begin{bmatrix} [K_{cc}] & [K_{cp}] \\ [K_{pc}] & [K_{pp}] \end{bmatrix}[T]$$

and

$$[M]=[T]^T\begin{bmatrix} [m_c] & \\ & [m_p] \end{bmatrix}[T]$$

It can be seen that [T] plays a similar role as Ritz vectors in the Raleigh-Ritz method. Furthermore, it is noted the condensed mass [M] is banded and is a combination of both mass and stiffness coefficients. If the piles carry no mass, then [K] is the same matrix as produced by static condensation. If damping matrix appears in the equation of motion, the same principle can be employed to obtain a condensed damping matrix [C] as

$$[C]=[T]^T\begin{bmatrix} [C_{cc}] & [C_{cp}] \\ [C_{pc}] & [C_{pp}] \end{bmatrix}[T]$$

However, in typical seismic response analysis of global bridge foundation damping is not used explicitly. Global damping parameters such as those based on Raleigh damping coefficients are generally used.

4.4 Foundation Stiffness, Mass and Damping for Seismic Loading

The method of substructuring is an approach based on a linear theory, and it provides approximate

solutions to the problems with non-linear foundation behavior. Though p-y and t-z curves are highly non-linear, the overall behavior of foundation system, which consists of pile and soil supports, is mildly non-linear within the range of seismic loading, especially for the new Benicia-Martinez bridge due to a long cantilever length above the mudline.

The first step towards developing the foundation stiffness matrix involved linearization of the p-y curves by performing lateral pushover analysis of the single pile to a representative displacement level expected during the earthquake. The structural engineers provided their initial estimates on peak foundation displacements, while we used 65% of the peak displacement values as representative displacement levels. These displacement values are presented in Table 4.1. Once the p-y curves were linearized on the basis of lateral pushover analysis, the problem became beams on elastic springs, and the method of substructuring was applied to obtain the condensed stiffness matrix.

These stiffness matrices were then used in the global analysis to compute displacement demands. The computed foundation displacements are also tabulated in Table 4.1 which can be compared with the initial estimates used for soil springs' linearization to evaluate weather it is necessary to update the foundation stiffness. The comparison, as shown in Table 4.1, indicates that while the changes in displacements at some piers are large, for example at Pier 6, the difference in pile stiffnesses is rather small, typically less than 10% based on lateral pile behavior. Since the discrepancy is well within the range of uncertainties, updating the stiffness matrices is therefore not needed. The reason for insignificant changes in stiffness is due to the fact that overall system is mildly nonlinear.

Two sets of stiffness matrices were developed; one condensed at the elevation –11m for individual pile and the other condensed at the pile-cap level for entire pile group. The individual pile stiffness matrices condensed at elevation –11 m are provided in Tables 4.2-4.13 for Piers 6 though 17, respectively, and their coordinate system (denoted as local coordinate system) is shown in Figure 4.3 where the x-direction is along the pile axis. The mass matrices and damping matrices are also provided in the same tables. Formulation the mass matrix follows the procedure based on Guyan reduction discussed above, and therefore the condensed mass matrix is fully populated; however for simplicity, the off-diagonal terms have been neglected. Using the diagonal terms of the stiffness matrix and the matrix, an uncoupled (diagonalized) damping matrix was developed assuming a 10% damping ratio for all six modes of vibration (3 translation and 3 rotation). This 10% value is strictly related to foundation damping; it is not overall global damping of the bridge.

Piers 2 to 4 have two 2.5-m octagonal columns, each supported directly on the 2.6 m diameter CIDH pile. The pile head stiffness coefficients evaluated at the connection are tabulated in Tables 4.14 to 4.16. Since a pinned head condition is assumed, there would be zero rotational stiffness at the connection, as shown in the presented stiffness matrix. For Piers 5 through 17, pile-group stiffness matrices and the corresponding mass and damping matrices were condensed at the pile-cap level. The matrices are provided in Tables 4.17-4.29, and their coordinate system (denoted as global coordinate system) is shown in Figure 4.3. It is noted that different coordinate systems are used for the two substructure models.

As the stiffness matrices are used together with the kinematic motions to form forcing functions, two sets of kinematic motions are available. One set corresponds to the substructure model at the elevation –11 m and the other set corresponds to the substructure model at the pile-cap position. Plots of the kinematic motions condensed at the pile-cap are included in the Appendices A through C comparing with the depth-varying free-field motions.

Stiffness matrices for the lower bound case are also provided. However, the lower bound scenario considers scouring, and therefore, rock motions would be used together with the lower bound stiffness matrices. The same mass and damping matrices can be used for the lower bound case. In the both upper bound and lower bound cases, the following effective sectional properties (EI) were used for seismic loading:

2.5 m Casing	:	7.292E+6 kN-m^2 (2.54E+13 lb-in^2)
0.75 m CIDH	:	1.852E+5 kN-m^2 (6.45E+10 lb-in^2)
2.2 m CIDH	:	1.608E+7 kN-m^2 (5.60E+12 lb-in^2)
2.6 m CIDH	:	2.601E+7 kN-m^2 (9.06E+12 lb-in^2)

4.5 Foundation Stiffness for Temperature Loading

A separate set of foundation stiffness matrix has been developed for temperature loading in Tables 4.30 to 42. For this load case, we used gross sectional properties and initial branch of p-y curves without considering scouring and soil softening effects.

Table 4.1A Displacement for Linearization (First Iteration)

Pier	Peak Displacement mm	Representative Disp. for Linearization (65% of Peak)	
		mm	in
5	14	9.10	0.36
6	99	64.35	2.53
7	356	231.40	9.11
8	355	230.75	9.08
9	366	237.90	9.37
10	319	207.35	8.16
11	266	172.90	6.81
12	287	186.55	7.34
13	289	187.85	7.40
14	560	364.00	14.33
15	553	359.45	14.15
16	424	275.60	10.85

Table 4.1B Displacement for Linearization (Second Iteration)

Pier	Peak Displacement mm	Representative Disp. for Linearization (65% of Peak)	
		mm	in
5	15	9.89	0.39
6	257	167.20	6.58
7	493	320.69	12.63
8	594	386.12	15.20
9	418	271.64	10.69
10	359	233.21	9.18
11	410	266.35	10.49
12	371	241.43	9.50
13	270	175.25	6.90
14	301	195.72	7.71
15	322	209.05	8.23
16	439	285.24	11.23

Table 4.1 Percent Changes in Displacement and Stiffness

Pier		Changes Between 1st and 2nd Interation	
		Displacement (%)	Stiffness (%)
5		9	0
6		160	-6
7		39	-6
8		67	-7
9		14	-1
10		12	-5
11		54	-10
12		29	-3
13		-7	1
14		-46	8
15		-42	10
16		3	-2

Table 4.2.A Pier 6 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.14E+05	0.00E+00	0.00E+00	0.00E+00	1.90E+06
		3.14E+05	0.00E+00	-1.90E+06	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.75E+07	0.00E+00
Symmetric					1.75E+07

Table 4.2.B Pier 6 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
4.87E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	9.09E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		9.09E+01	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.2.C Pier 6 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.58E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.07E+03	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.2.D Pier 6 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.07E+05	0.00E+00	0.00E+00	0.00E+00	1.41E+06
		2.07E+05	0.00E+00	-1.41E+06	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.51E+07	0.00E+00
Symmetric					1.51E+07

Table 4.3.A Pier 7 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.32E+04	0.00E+00	0.00E+00	0.00E+00	5.34E+05
		4.32E+04	0.00E+00	-5.34E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				9.87E+06	0.00E+00
Symmetric					9.87E+06

Table 4.3.B Pier 7 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
4.89E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.86E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.86E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.3.C Pier 7 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.60E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.67E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.67E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.3.D Pier 7 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.91E+04	0.00E+00	0.00E+00	0.00E+00	4.41E+05
		2.91E+04	0.00E+00	-4.41E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				9.17E+06	0.00E+00
Symmetric					9.17E+06

Table 4.4.A Pier 8 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.98E+04	0.00E+00	0.00E+00	0.00E+00	4.84E+05
		3.98E+04	0.00E+00	-4.84E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				9.27E+06	0.00E+00
Symmetric					9.27E+06

Table 4.4.B Pier 8 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.29E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.46E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.46E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.4.C Pier 8 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.82E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.82E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.4.D Pier 8 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.49E+04	0.00E+00	0.00E+00	0.00E+00	3.88E+05
		2.49E+04	0.00E+00	-3.88E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				8.53E+06	0.00E+00
Symmetric					8.53E+06

Table 4.5.A Pier 9 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	6.30E+04	0.00E+00	0.00E+00	0.00E+00	6.93E+05
		6.30E+04	0.00E+00	-6.93E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.13E+07	0.00E+00
Symmetric					1.13E+07

Table 4.5.B Pier 9 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.29E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.31E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.31E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.5.C Pier 9 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.75E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.75E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.5.D Pier 9 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.36E+04	0.00E+00	0.00E+00	0.00E+00	5.79E+05
		4.36E+04	0.00E+00	-5.79E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.05E+07	0.00E+00
Symmetric					1.05E+07

Table 4.6.A Pier 10 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.06E+05	0.00E+00	0.00E+00	0.00E+00	1.00E+06
		1.06E+05	0.00E+00	-1.00E+06	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.36E+07	0.00E+00
Symmetric					1.36E+07

Table 4.6.B Pier 10 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.39E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.05E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.05E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.6.C Pier 10 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
9.02E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	6.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.65E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.6.D Pier 10 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	7.76E+04	0.00E+00	0.00E+00	0.00E+00	8.35E+05
		7.76E+04	0.00E+00	-8.35E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.24E+07	0.00E+00
Symmetric					1.24E+07

Table 4.7.A Pier 11 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.03E+05	0.00E+00	0.00E+00	0.00E+00	9.91E+05
		1.03E+05	0.00E+00	-9.91E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.34E+07	0.00E+00
Symmetric					1.34E+07

Table 4.7.B Pier 11 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.15E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.65E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.7.C Pier 11 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.82E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.22E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		8.22E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.7.D Pier 11 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	7.20E+04	0.00E+00	0.00E+00	0.00E+00	7.89E+05
		7.20E+04	0.00E+00	-7.89E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.20E+07	0.00E+00
Symmetric					1.20E+07

Table 4.8.A Pier 12 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.81E+04	0.00E+00	0.00E+00	0.00E+00	9.02E+05
		8.81E+04	0.00E+00	-9.02E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.29E+07	0.00E+00
Symmetric					1.29E+07

Table 4.8.B Pier 12 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.15E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		2.00E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.8.C Pier 12 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.82E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.39E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		8.39E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.8.D Pier 12 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	6.22E+04	0.00E+00	0.00E+00	0.00E+00	7.21E+05
		6.22E+04	0.00E+00	-7.21E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.15E+07	0.00E+00
Symmetric					1.15E+07

Table 4.9.A Pier 13 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.53E+05	0.00E+00	0.00E+00	0.00E+00	1.26E+06
		1.53E+05	0.00E+00	-1.26E+06	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.50E+07	0.00E+00
Symmetric					1.50E+07

Table 4.9.B Pier 13 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.20E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.23E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.23E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.9.C Pier 13 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.87E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.69E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		8.69E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.9.D Pier 13 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.99E+04	0.00E+00	0.00E+00	0.00E+00	9.17E+05
		8.99E+04	0.00E+00	-9.17E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.30E+07	0.00E+00
Symmetric					1.30E+07

Table 4.10.A Pier 14 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	6.59E+04	0.00E+00	0.00E+00	0.00E+00	7.51E+05
		6.59E+04	0.00E+00	-7.51E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.19E+07	0.00E+00
Symmetric					1.19E+07

Table 4.10.B Pier 14 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.38E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.27E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.27E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.10.C Pier 14 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
9.02E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.79E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.10.D Pier 14 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.31E+04	0.00E+00	0.00E+00	0.00E+00	6.54E+05
		5.31E+04	0.00E+00	-6.54E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.11E+07	0.00E+00
Symmetric					1.11E+07

Table 4.11.A Pier 15 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.36E+04	0.00E+00	0.00E+00	0.00E+00	6.33E+05
		5.36E+04	0.00E+00	-6.33E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.09E+07	0.00E+00
Symmetric					1.09E+07

Table 4.11.B Pier 15 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
5.38E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.26E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.26E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.11.C Pier 15 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
9.02E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.20E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.20E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.11.D Pier 15 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
3.78E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.33E+04	0.00E+00	0.00E+00	0.00E+00	5.59E+05
		4.33E+04	0.00E+00	-5.59E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				1.02E+07	0.00E+00
Symmetric					1.02E+07

Table 4.12.A Pier 16 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
2.94E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.52E+04	0.00E+00	0.00E+00	0.00E+00	3.63E+05
		2.52E+04	0.00E+00	-3.63E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				8.10E+06	0.00E+00
Symmetric					8.10E+06

Table 4.12.B Pier 16 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
6.18E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.34E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.34E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.12.C Pier 16 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.53E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.67E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		3.67E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.12.D Pier 16 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
2.94E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.81E+04	0.00E+00	0.00E+00	0.00E+00	3.07E+05
		1.81E+04	0.00E+00	-3.07E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				7.55E+06	0.00E+00
Symmetric					7.55E+06

Table 4.13.A Pier 17 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

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Translation			Rotation		
x'	y'	z'	x'	y'	z'
2.94E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.24E+04	0.00E+00	0.00E+00	0.00E+00	4.48E+05
		3.24E+04	0.00E+00	-4.48E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				9.10E+06	0.00E+00
Symmetric					9.10E+06

Table 4.13.B Pier 17 Single Pile Condensed Mass Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
6.18E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.19E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.19E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.13.C Pier 17 Single Pile Condensed Damping Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
8.53E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.92E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		3.92E+02	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.13.D Pier 17 Single Pile Condensed Stiffness Matrix at Elevation -11 m in Local Pile Coordinate
Local Pile Coordinate: x'=along pile axis, y' & z' =perpendicular to pile axis, Lower Bound
Unit; kN,m, rad

Translation			Rotation		
x'	y'	z'	x'	y'	z'
2.94E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.50E+04	0.00E+00	0.00E+00	0.00E+00	3.88E+05
		2.50E+04	0.00E+00	-3.88E+05	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				8.52E+06	0.00E+00
Symmetric					8.52E+06

Table 4.14 Pier 2 Single Pile Head Stiffness at Bottom of Pier Column in Global Coordinate (Pinned Head)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.62E+06	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.15 Pier 3 Single Pile Head Stiffness at Bottom of Pier Column in Global Coordinate (Pinned Head)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.62E+06	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.16 Pier 4 Single Pile Head Stiffness at Bottom of Pier Column in Global Coordinate (Pinned Head)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.62E+06	0.00E+00	0.00E+00	0.00E+00
			0.00E+00	0.00E+00	0.00E+00
				0.00E+00	0.00E+00
Symmetric					0.00E+00

Table 4.17.A Pier 5 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad 7/8/98

Translation			Rotation		
X	Y	Z	X	Y	Z
1.19E+07	0.00E+00	0.00E+00	0.00E+00	-2.36E+07	0.00E+00
	1.19E+07	0.00E+00	2.36E+07	0.00E+00	0.00E+00
		4.79E+07	0.00E+00	0.00E+00	0.00E+00
			1.88E+09	0.00E+00	0.00E+00
				1.33E+09	0.00E+00
Symmetric					7.54E+08

Table 4.17.B Pier 5 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
5.43E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.43E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.23E+03	0.00E+00	0.00E+00	0.00E+00
			5.16E+04	0.00E+00	0.00E+00
				3.59E+04	0.00E+00
Symmetric					3.88E+04

Table 4.17.C Pier 5 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.61E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.61E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.85E+04	0.00E+00	0.00E+00	0.00E+00
			1.97E+06	0.00E+00	0.00E+00
				1.38E+06	0.00E+00
Symmetric					1.08E+06

Table 4.17.D Pier 5 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
7.04E+06	0.00E+00	0.00E+00	0.00E+00	-1.64E+07	0.00E+00
	7.04E+06	0.00E+00	1.64E+07	0.00E+00	0.00E+00
		4.79E+07	0.00E+00	0.00E+00	0.00E+00
			1.86E+09	0.00E+00	0.00E+00
				1.32E+09	0.00E+00
Symmetric					4.46E+08

Table 4.18.A Pier 6 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
7.98E+05	0.00E+00	0.00E+00	0.00E+00	-8.24E+06	0.00E+00
	7.98E+05	0.00E+00	8.24E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.19E+09	0.00E+00	0.00E+00
				8.60E+08	0.00E+00
Symmetric					5.06E+07

Table 4.18.B Pier 6 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
8.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.20E+03	0.00E+00	0.00E+00	0.00E+00
			2.19E+05	0.00E+00	0.00E+00
				1.53E+05	0.00E+00
Symmetric					6.29E+04

Table 4.18.C Pier 6 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
5.30E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.30E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.70E+04	0.00E+00	0.00E+00	0.00E+00
			3.22E+06	0.00E+00	0.00E+00
				2.29E+06	0.00E+00
Symmetric					3.57E+05

Table 4.18.D Pier 6 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
5.97E+05	0.00E+00	0.00E+00	0.00E+00	-6.78E+06	0.00E+00
	5.97E+05	0.00E+00	6.78E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.17E+09	0.00E+00	0.00E+00
				8.49E+08	0.00E+00
Symmetric					3.79E+07

Table 4.19.A Pier 7 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
1.82E+05	0.00E+00	0.00E+00	0.00E+00	-3.04E+06	0.00E+00
	1.82E+05	0.00E+00	3.04E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.14E+08	0.00E+00
Symmetric					1.15E+07

Table 4.19.B Pier 7 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.80E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.80E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.22E+03	0.00E+00	0.00E+00	0.00E+00
			2.20E+05	0.00E+00	0.00E+00
				1.53E+05	0.00E+00
Symmetric					1.29E+05

Table 4.19.C Pier 7 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.62E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.62E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.72E+04	0.00E+00	0.00E+00	0.00E+00
			3.17E+06	0.00E+00	0.00E+00
				2.23E+06	0.00E+00
Symmetric					2.44E+05

Table 4.19.D Pier 7 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.24E+05	0.00E+00	0.00E+00	0.00E+00	-2.45E+06	0.00E+00
	1.24E+05	0.00E+00	2.45E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.07E+08	0.00E+00
Symmetric					7.86E+06

Table 4.20.A Pier 8 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
1.77E+05	0.00E+00	0.00E+00	0.00E+00	-2.92E+06	0.00E+00
	1.77E+05	0.00E+00	2.92E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.11E+08	0.00E+00
Symmetric					1.13E+07

Table 4.20.B Pier 8 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.48E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.48E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.57E+03	0.00E+00	0.00E+00	0.00E+00
			2.35E+05	0.00E+00	0.00E+00
				1.64E+05	0.00E+00
Symmetric					1.06E+05

Table 4.20.C Pier 8 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.24E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.24E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.97E+04	0.00E+00	0.00E+00	0.00E+00
			3.27E+06	0.00E+00	0.00E+00
				2.31E+06	0.00E+00
Symmetric					2.18E+05

Table 4.20.D Pier 8 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.13E+05	0.00E+00	0.00E+00	0.00E+00	-2.27E+06	0.00E+00
	1.13E+05	0.00E+00	2.27E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.04E+08	0.00E+00
Symmetric					7.16E+06

Table 4.21.A Pier 9 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad 7/8/98

Translation			Rotation		
X	Y	Z	X	Y	Z
2.13E+05	0.00E+00	0.00E+00	0.00E+00	-3.28E+06	0.00E+00
	2.13E+05	0.00E+00	3.28E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.12E+08	0.00E+00
Symmetric					1.52E+07

Table 4.21.B Pier 9 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.96E+03	0.00E+00	0.00E+00	0.00E+00
			2.09E+05	0.00E+00	0.00E+00
				1.45E+05	0.00E+00
Symmetric					8.35E+04

Table 4.21.C Pier 9 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.16E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.16E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.09E+04	0.00E+00	0.00E+00	0.00E+00
			3.08E+06	0.00E+00	0.00E+00
				2.17E+06	0.00E+00
Symmetric					2.25E+05

Table 4.21.D Pier 9 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.49E+05	0.00E+00	0.00E+00	0.00E+00	-2.69E+06	0.00E+00
	1.49E+05	0.00E+00	2.69E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.07E+08	0.00E+00
Symmetric					1.07E+07

Table 4.22.A Pier 10 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.98E+05	0.00E+00	0.00E+00	0.00E+00	-4.19E+06	0.00E+00
	2.98E+05	0.00E+00	4.19E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.15E+09	0.00E+00	0.00E+00
				8.23E+08	0.00E+00
Symmetric					2.12E+07

Table 4.22.B Pier 10 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.05E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.05E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.06E+03	0.00E+00	0.00E+00	0.00E+00
			2.12E+05	0.00E+00	0.00E+00
				1.48E+05	0.00E+00
Symmetric					7.50E+04

Table 4.22.C Pier 10 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.54E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.54E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.17E+04	0.00E+00	0.00E+00	0.00E+00
			3.13E+06	0.00E+00	0.00E+00
				2.21E+06	0.00E+00
Symmetric					2.53E+05

Table 4.22.D Pier 10 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.33E+05	0.00E+00	0.00E+00	0.00E+00	-3.60E+06	0.00E+00
	2.33E+05	0.00E+00	3.60E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.17E+08	0.00E+00
Symmetric					1.66E+07

Table 4.23.A Pier 11 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.88E+05	0.00E+00	0.00E+00	0.00E+00	-4.13E+06	0.00E+00
	2.88E+05	0.00E+00	4.13E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.15E+09	0.00E+00	0.00E+00
				8.22E+08	0.00E+00
Symmetric					2.06E+07

Table 4.23.B Pier 11 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.44E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.44E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.85E+03	0.00E+00	0.00E+00	0.00E+00
			2.05E+05	0.00E+00	0.00E+00
				1.42E+05	0.00E+00
Symmetric					1.02E+05

Table 4.23.C Pier 11 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.02E+04	0.00E+00	0.00E+00	0.00E+00
			3.06E+06	0.00E+00	0.00E+00
				2.16E+06	0.00E+00
Symmetric					2.90E+05

Table 4.23.D Pier 11 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.21E+05	0.00E+00	0.00E+00	0.00E+00	-3.46E+06	0.00E+00
	2.21E+05	0.00E+00	3.46E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.15E+08	0.00E+00
Symmetric					1.58E+07

Table 4.24.A Pier 12 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.57E+05	0.00E+00	0.00E+00	0.00E+00	-3.83E+06	0.00E+00
	2.57E+05	0.00E+00	3.83E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.19E+08	0.00E+00
Symmetric					1.83E+07

Table 4.24.B Pier 12 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.59E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.59E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.85E+03	0.00E+00	0.00E+00	0.00E+00
			2.05E+05	0.00E+00	0.00E+00
				1.42E+05	0.00E+00
Symmetric					1.14E+05

Table 4.24.C Pier 12 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.04E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.04E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.02E+04	0.00E+00	0.00E+00	0.00E+00
			3.06E+06	0.00E+00	0.00E+00
				2.16E+06	0.00E+00
Symmetric					2.89E+05

Table 4.24.D Pier 12 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.98E+05	0.00E+00	0.00E+00	0.00E+00	-3.23E+06	0.00E+00
	1.98E+05	0.00E+00	3.23E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.13E+08	0.00E+00
Symmetric					1.41E+07

Table 4.25.A Pier 13 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad 7/8/98

Translation			Rotation		
X	Y	Z	X	Y	Z
3.94E+05	0.00E+00	0.00E+00	0.00E+00	-5.04E+06	0.00E+00
	3.94E+05	0.00E+00	5.04E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.15E+09	0.00E+00	0.00E+00
				8.30E+08	0.00E+00
Symmetric					2.81E+07

Table 4.25.B Pier 13 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.09E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.09E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.85E+03	0.00E+00	0.00E+00	0.00E+00
			2.05E+05	0.00E+00	0.00E+00
				1.42E+05	0.00E+00
Symmetric					7.81E+04

Table 4.25.C Pier 13 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
4.15E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4.15E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.02E+04	0.00E+00	0.00E+00	0.00E+00
			3.07E+06	0.00E+00	0.00E+00
				2.17E+06	0.00E+00
Symmetric					2.96E+05

Table 4.25.D Pier 13 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.58E+05	0.00E+00	0.00E+00	0.00E+00	-3.85E+06	0.00E+00
	2.58E+05	0.00E+00	3.85E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.19E+08	0.00E+00
Symmetric					1.84E+07

Table 4.26.A Pier 14 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.07E+05	0.00E+00	0.00E+00	0.00E+00	-3.32E+06	0.00E+00
	2.07E+05	0.00E+00	3.32E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.14E+09	0.00E+00	0.00E+00
				8.14E+08	0.00E+00
Symmetric					1.37E+07

Table 4.26.B Pier 14 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.03E+03	0.00E+00	0.00E+00	0.00E+00
			2.12E+05	0.00E+00	0.00E+00
				1.47E+05	0.00E+00
Symmetric					8.15E+04

Table 4.26.C Pier 14 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.08E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.08E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.15E+04	0.00E+00	0.00E+00	0.00E+00
			3.11E+06	0.00E+00	0.00E+00
				2.19E+06	0.00E+00
Symmetric					2.11E+05

Table 4.26.D Pier 14 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.75E+05	0.00E+00	0.00E+00	0.00E+00	-2.98E+06	0.00E+00
	1.75E+05	0.00E+00	2.98E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.10E+08	0.00E+00
Symmetric					1.25E+07

Table 4.27.A Pier 15 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.00E+05	0.00E+00	0.00E+00	0.00E+00	-3.08E+06	0.00E+00
	2.00E+05	0.00E+00	3.08E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.10E+08	0.00E+00
Symmetric					1.43E+07

Table 4.27.B Pier 15 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.01E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.01E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		5.03E+03	0.00E+00	0.00E+00	0.00E+00
			2.12E+05	0.00E+00	0.00E+00
				1.47E+05	0.00E+00
Symmetric					7.18E+04

Table 4.27.C Pier 15 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.84E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.84E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		7.15E+04	0.00E+00	0.00E+00	0.00E+00
			3.10E+06	0.00E+00	0.00E+00
				2.18E+06	0.00E+00
Symmetric					2.02E+05

Table 4.27.D Pier 15 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.59E+05	0.00E+00	0.00E+00	0.00E+00	-2.71E+06	0.00E+00
	1.59E+05	0.00E+00	2.71E+06	0.00E+00	0.00E+00
		2.54E+07	0.00E+00	0.00E+00	0.00E+00
			1.13E+09	0.00E+00	0.00E+00
				8.06E+08	0.00E+00
Symmetric					1.13E+07

Table 4.28.A Pier 16 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.01E+05	0.00E+00	0.00E+00	0.00E+00	-2.90E+06	0.00E+00
	2.01E+05	0.00E+00	2.90E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.06E+09	0.00E+00	0.00E+00
				7.54E+08	0.00E+00
Symmetric					1.46E+07

Table 4.28.B Pier 16 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.07E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.95E+03	0.00E+00	0.00E+00	0.00E+00
			2.08E+05	0.00E+00	0.00E+00
				1.45E+05	0.00E+00
Symmetric					7.65E+04

Table 4.28.C Pier 16 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.82E+04	0.00E+00	0.00E+00	0.00E+00
			2.96E+06	0.00E+00	0.00E+00
				2.09E+06	0.00E+00
Symmetric					2.11E+05

Table 4.28.D Pier 16 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
1.45E+05	0.00E+00	0.00E+00	0.00E+00	-2.45E+06	0.00E+00
	1.45E+05	0.00E+00	2.45E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.05E+09	0.00E+00	0.00E+00
				7.49E+08	0.00E+00
Symmetric					1.03E+07

Table 4.29.A Pier 17 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.59E+05	0.00E+00	0.00E+00	0.00E+00	-3.58E+06	0.00E+00
	2.59E+05	0.00E+00	3.58E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.37E+09	0.00E+00	0.00E+00
				4.61E+08	0.00E+00
Symmetric					1.86E+07

Table 4.29.B Pier 17 Pile Group Condensed Mass Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
9.51E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	9.51E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		4.95E+03	0.00E+00	0.00E+00	0.00E+00
			2.73E+05	0.00E+00	0.00E+00
				8.17E+04	0.00E+00
Symmetric					6.83E+04

Table 4.29.C Pier 17 Pile Group Damping Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
3.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		6.82E+04	0.00E+00	0.00E+00	0.00E+00
			3.88E+06	0.00E+00	0.00E+00
				1.23E+06	0.00E+00
Symmetric					2.25E+05

Table 4.29.D Pier 17 Pile Group Condensed Stiffness Matrix at Elevation 0 in Global Coordinate
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward), Lower Bound
Unit; kN,m, rad

Translation			Rotation		
X	Y	Z	X	Y	Z
2.00E+05	0.00E+00	0.00E+00	0.00E+00	-3.11E+06	0.00E+00
	2.00E+05	0.00E+00	3.11E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.37E+09	0.00E+00	0.00E+00
				4.57E+08	0.00E+00
Symmetric					1.44E+07

Table 4.30 Pier 5 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
1.40E+07	0.00E+00	0.00E+00	0.00E+00	-4.60E+07	0.00E+00
	1.40E+07	0.00E+00	4.46E+07	0.00E+00	0.00E+00
		4.79E+07	0.00E+00	0.00E+00	0.00E+00
			1.99E+09	0.00E+00	0.00E+00
				1.44E+09	0.00E+00
Symmetric					8.88E+08

Table 4.31 Pier 6 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
1.08E+06	0.00E+00	0.00E+00	0.00E+00	-1.20E+07	0.00E+00
	1.08E+06	0.00E+00	1.20E+07	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.24E+09	0.00E+00	0.00E+00
				9.18E+08	0.00E+00
Symmetric					6.82E+07

Table 4.32 Pier 7 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
3.11E+05	0.00E+00	0.00E+00	0.00E+00	-5.22E+06	0.00E+00
	3.11E+05	0.00E+00	5.22E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.18E+09	0.00E+00	0.00E+00
				8.57E+08	0.00E+00
Symmetric					1.97E+07

Table 4.33 Pier 8 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
3.09E+05	0.00E+00	0.00E+00	0.00E+00	-5.18E+06	0.00E+00
	3.09E+05	0.00E+00	5.18E+06	0.00E+00	0.00E+00
		2.85E+07	0.00E+00	0.00E+00	0.00E+00
			1.18E+09	0.00E+00	0.00E+00
				8.57E+08	0.00E+00
Symmetric					1.96E+07

Table 4.34 Pier 9 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
3.48E+05	0.00E+00	0.00E+00	0.00E+00	-5.40E+06	0.00E+00
	3.48E+05	0.00E+00	5.40E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.18E+09	0.00E+00	0.00E+00
				8.53E+08	0.00E+00
Symmetric					2.48E+07

Table 4.35 Pier 10 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
4.61E+05	0.00E+00	0.00E+00	0.00E+00	-6.52E+06	0.00E+00
	4.61E+05	0.00E+00	6.54E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.19E+09	0.00E+00	0.00E+00
				8.64E+08	0.00E+00
Symmetric					3.29E+07

Table 4.36 Pier 11 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
4.70E+05	0.00E+00	0.00E+00	0.00E+00	-6.59E+06	0.00E+00
	4.70E+05	0.00E+00	6.59E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.19E+09	0.00E+00	0.00E+00
				8.65E+08	0.00E+00
Symmetric					3.35E+07

Table 4.37 Pier 12 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
4.20E+05	0.00E+00	0.00E+00	0.00E+00	-6.12E+06	0.00E+00
	4.20E+05	0.00E+00	6.12E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.19E+09	0.00E+00	0.00E+00
				8.60E+08	0.00E+00
Symmetric					3.00E+07

Table 4.38 Pier 13 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
7.23E+05	0.00E+00	0.00E+00	0.00E+00	-8.84E+06	0.00E+00
	7.23E+05	0.00E+00	8.84E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.21E+09	0.00E+00	0.00E+00
				8.85E+08	0.00E+00
Symmetric					5.16E+07

Table 4.39 Pier 14 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.83E+05	0.00E+00	0.00E+00	0.00E+00	-4.71E+06	0.00E+00
	2.83E+05	0.00E+00	4.71E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.17E+09	0.00E+00	0.00E+00
				8.45E+08	0.00E+00
Symmetric					2.02E+07

Table 4.40 Pier 15 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.87E+05	0.00E+00	0.00E+00	0.00E+00	-4.75E+06	0.00E+00
	2.87E+05	0.00E+00	4.75E+06	0.00E+00	0.00E+00
		2.53E+07	0.00E+00	0.00E+00	0.00E+00
			1.17E+09	0.00E+00	0.00E+00
				8.46E+08	0.00E+00
Symmetric					2.05E+07

Table 4.41 Pier 16 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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Translation			Rotation		
X	Y	Z	X	Y	Z
2.71E+05	0.00E+00	0.00E+00	0.00E+00	-3.97E+06	0.00E+00
	2.71E+05	0.00E+00	3.97E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.08E+09	0.00E+00	0.00E+00
				7.80E+08	0.00E+00
Symmetric					1.93E+07

Table 4.42 Pier 17 Pile Group Stiffness Matrix for Service Loading (Temperature Loading)
Global Coordinate: X=longitudinal dir., Y=transverse dir., Z=vertical dir. (+ upward)
Unit; kN,m, rad

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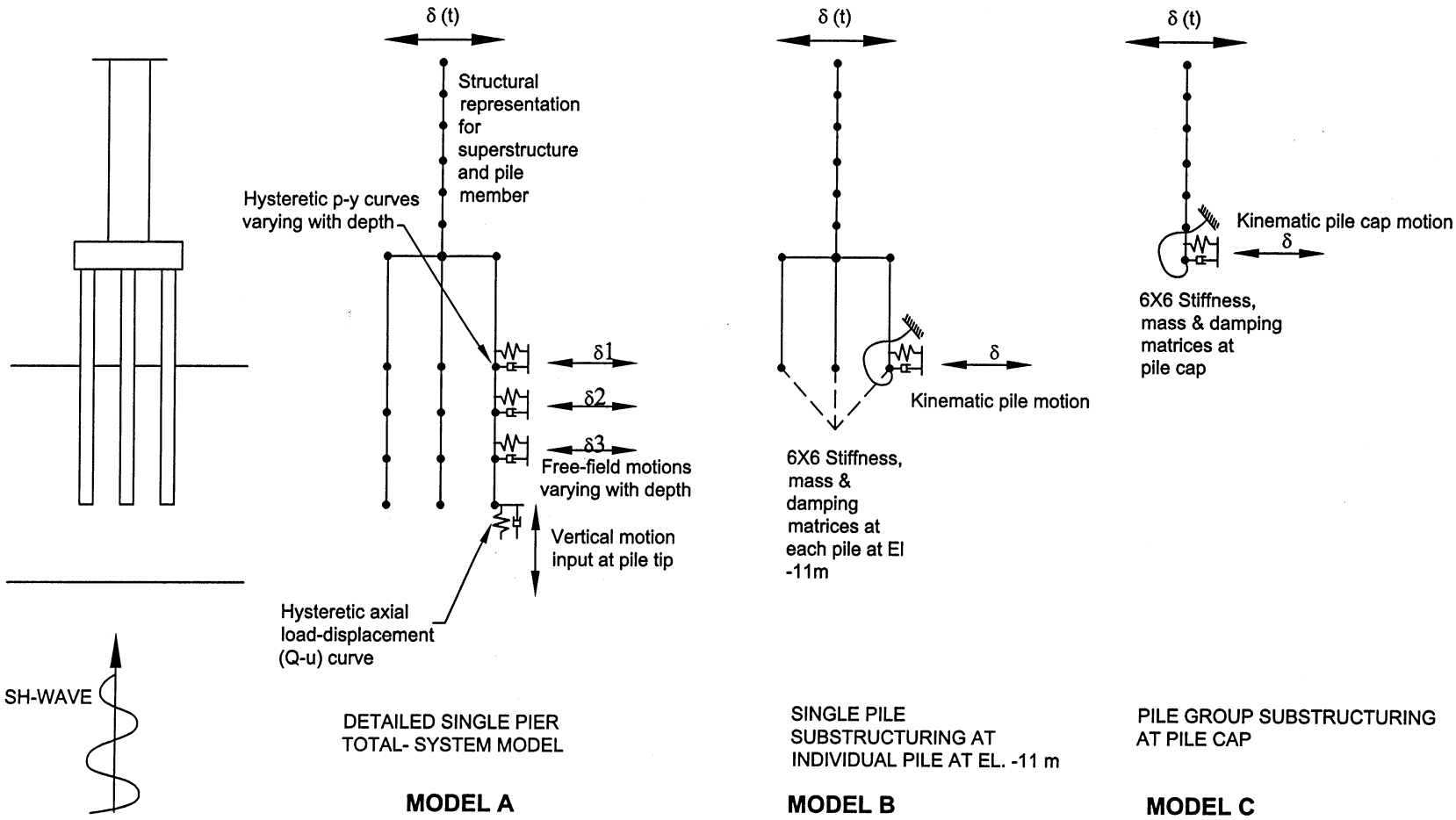
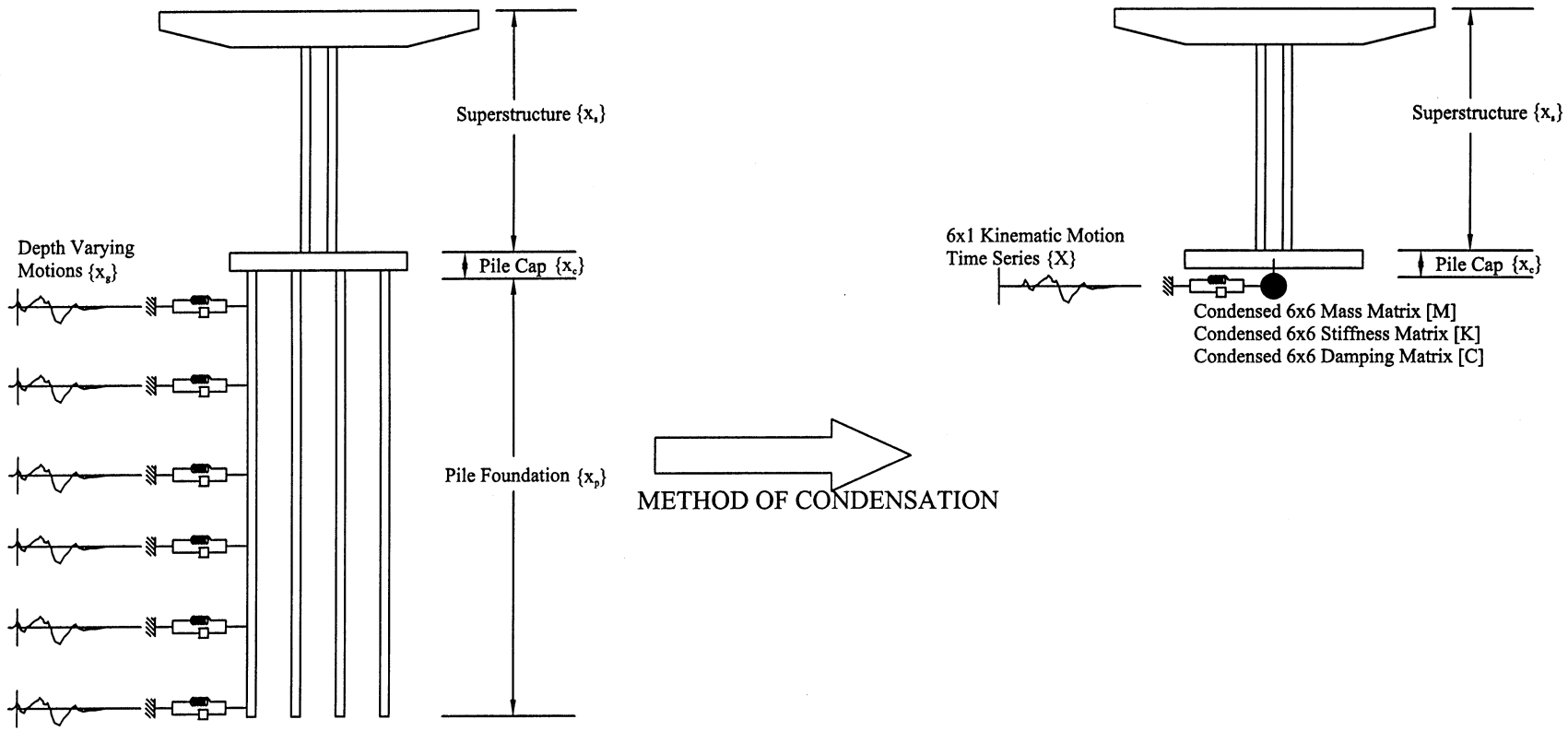
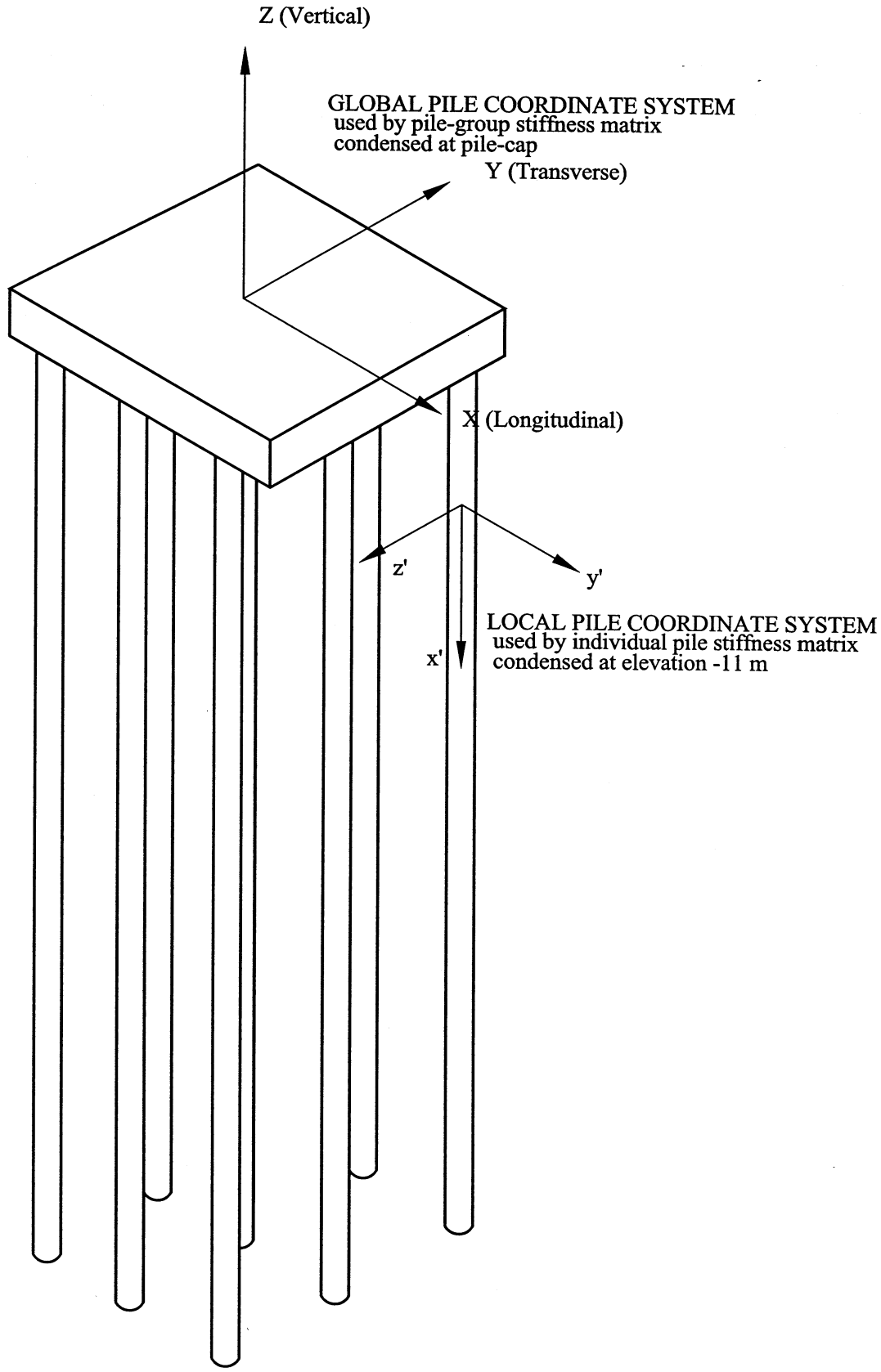
Translation			Rotation		
X	Y	Z	X	Y	Z
3.91E+05	0.00E+00	0.00E+00	0.00E+00	-5.38E+06	0.00E+00
	3.91E+05	0.00E+00	5.38E+06	0.00E+00	0.00E+00
		2.35E+07	0.00E+00	0.00E+00	0.00E+00
			1.41E+09	0.00E+00	0.00E+00
				4.96E+08	0.00E+00
Symmetric					2.80E+07



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	NEW BENICIA MARTINEZ BRIDGE	SUBSTRUCTURE MODELS OF BRIDGE
	Project No. 96-178 / Date: 7-12-00	Figure 4.1



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	NEW BENICIA-MARTINEZ BRIDGE	KINEMATIC MOTION AND CONDENSED MATRICES
	Project No. 96-178 / Date: 7-10-00	Figure 4.2



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	NEW BENICIA MARTINEZ BRIDGE	
	COORDINATE SYSTEMS	Figure 4.3
	Project No. 96-178	Date: 7-8-98

Section 5

5.0 CONCLUSIONS

The following are the outcomes of the soil-structure interaction studies conducted for the new Benicia-Martinez Bridge:

(1) The controlling fault is the Green Valley fault which is located at about 3 kilometers to the east and it has a maximum moment earthquake magnitude of 6.75.

(2) Two-level design earthquakes are used to design the New Benicia-Martinze Bridge; Safety Level Earthquake Event (FEE) and Functional Level Earthquake Event (SEE). The shaking level for the SEE is an event with a 1,000 to 2,000 year return period while the SEE has been defined as a 300 year return period event based on probabilistic design approach.

(3) The new Benicia-Martinez bridge will be designed based on the upper-bound and lower-bound stiffness scenarios to determine the demands. The upper-bound case is based on the following consideration:

- Existing mudline without scour
- Conventional p-y, f-z and q-u curve criteria for monotonic loading without softening to account for cyclic degradation and pile group effects
- Including end-bearing in axial pile stiffness

The lower-bound case is to account for the following considerations:

- Potential for local scour
- Soil softening to account for cyclic degradation and pile group effects
- Ignoring end-bearing in developing axial stiffness

(4) The structural designers adopted substructure models of the foundation in the global bridge analysis using a response spectrum approach. The primary design team adopted substructuring of individual piles below elevation -11 m while the independent check team adopted substructuring of the entire foundation below the pile-cap.

(5) The design of the bridge using the response spectrum approach was later checked against multiple-support time history analyses using three sets of motions. A total system, consisting of the superstructure and complete foundation elements (all piles and soil supports), was used for the time history analyses.

(6) P-y, t-z and q-u curves are provided.

(7) Foundation stiffness matrices, mass matrices, and damping matrices are provided for each substructure model for seismic response analyses.

(8) Kinematic motions were computed which can be used to form appropriate forcing functions in the global model when the substructuring approach is used to simplify the foundation.

(9) Foundation stiffness is presented for service (temperature) loading.

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Appendix A

APPENDIX A

DEPTH-VARYING FREE-FIELD MOTIONS
VERSUS
KINEMATIC MOTIONS CONDENSED AT PILE-CAP
SET 1

Table A. Elevations (in feet) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

Layer No.	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-6.5	-46	-43	-37	-37	-53	-60	-43	-40	-14	-6.5	-6.5
2	-15	-52	-50	-45	-43	-60	-66	-49	-48	-23	-14	-14
3	-23	-58	-57	-53	-51	-67	-72	-55	-56	-33	-23	-23
4	-31	-65	-64	-60	-56	-75	-78	-62	-66	-43	-33	-33
5	-39	-75	-70	-70	-63	-83	-84	-71	-74	-54	-43	-43
6	-50	-82	-82	-80	-74	-92	-90	-80	-82	-65	-54	-54
7	-55	-90	-92	-90	-76	-98	-95	-89	-90	-77	-65	-65
8	-60	-98	-102	-102	-85	-105	-103	-98	-98	-90	-79	-79
9	-70	-114	-112	-114	-90	-112	-111	-109	-109	-106	-93	-93
10	-80	-116	-125	-126	-106	-120	-120	-120	-120	-124	-105	-105
11	-90	-125	-141	-138	-131	-131	-131	-131	-148	-148	-118	-118
12	-115	-165	-179	-177	-180	-172	-172	-172	-184	-184	-131	-131
13	-160	-204	-217	-217	-216	-213	-213	-213	-220	-220	-174	-174
14	-204										-220	-220

Table B. Elevations (in meters) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

Layer No	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-2.0	-14.0	-13.1	-11.3	-11.3	-16.2	-18.3	-13.1	-12.2	-4.3	-2.0	-2.0
2	-4.6	-15.9	-15.2	-13.7	-13.1	-18.3	-20.1	-14.9	-14.6	-7.0	-4.3	-4.3
3	-7.0	-17.7	-17.4	-16.2	-15.5	-20.4	-22.0	-16.8	-17.1	-10.1	-7.0	-7.0
4	-9.5	-19.8	-19.5	-18.3	-17.1	-22.9	-23.8	-18.9	-20.1	-13.1	-10.1	-10.1
5	-11.9	-22.9	-21.3	-21.3	-19.2	-25.3	-25.6	-21.6	-22.6	-16.5	-13.1	-13.1
6	-15.2	-25.0	-25.0	-24.4	-22.6	-28.0	-27.4	-24.4	-25.0	-19.8	-16.5	-16.5
7	-16.8	-27.4	-28.0	-27.4	-23.2	-29.9	-29.0	-27.1	-27.4	-23.5	-19.8	-19.8
8	-18.3	-29.9	-31.1	-31.1	-25.9	-32.0	-31.4	-29.9	-29.9	-27.4	-24.1	-24.1
9	-21.3	-34.8	-34.1	-34.8	-27.4	-34.1	-33.8	-33.2	-33.2	-32.3	-28.4	-28.4
10	-24.4	-35.4	-38.1	-38.4	-32.3	-36.6	-36.6	-36.6	-36.6	-37.8	-32.0	-32.0
11	-27.4	-38.1	-43.0	-42.1	-39.9	-39.9	-39.9	-39.9	-45.1	-45.1	-36.0	-36.0
12	-35.1	-50.3	-54.6	-54.0	-54.9	-52.4	-52.4	-52.4	-56.1	-56.1	-39.9	-39.9
13	-48.8	-62.2	-66.2	-66.2	-65.9	-64.9	-64.9	-64.9	-67.1	-67.1	-53.0	-53.0
14	-62.2										-67.1	-67.1

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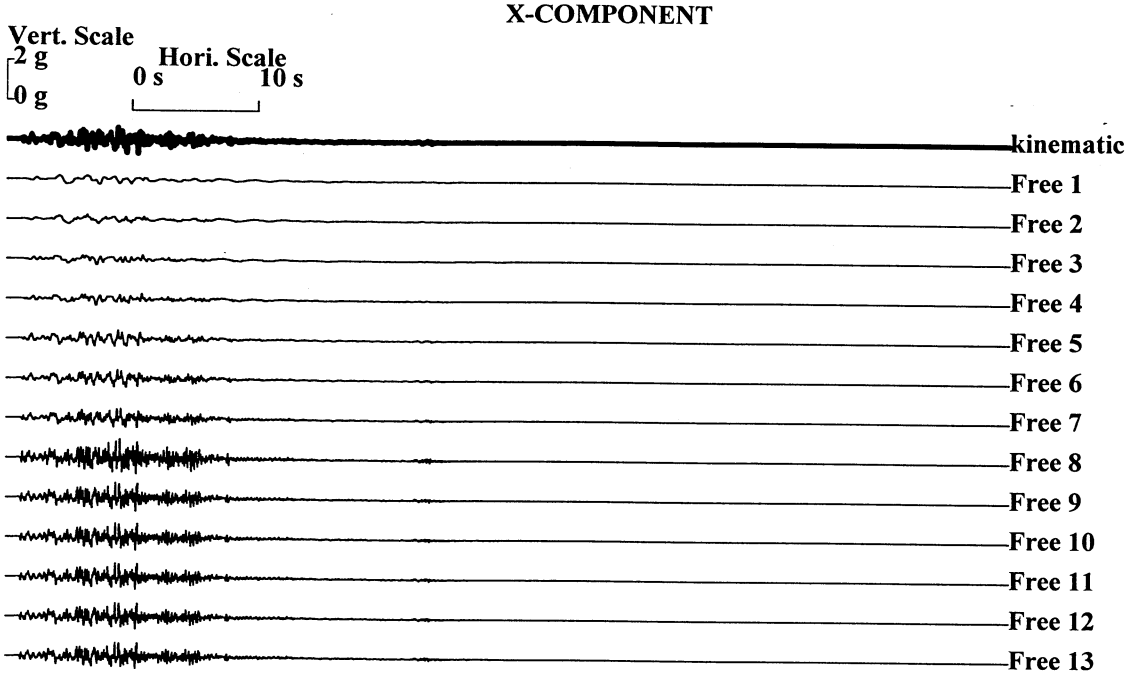
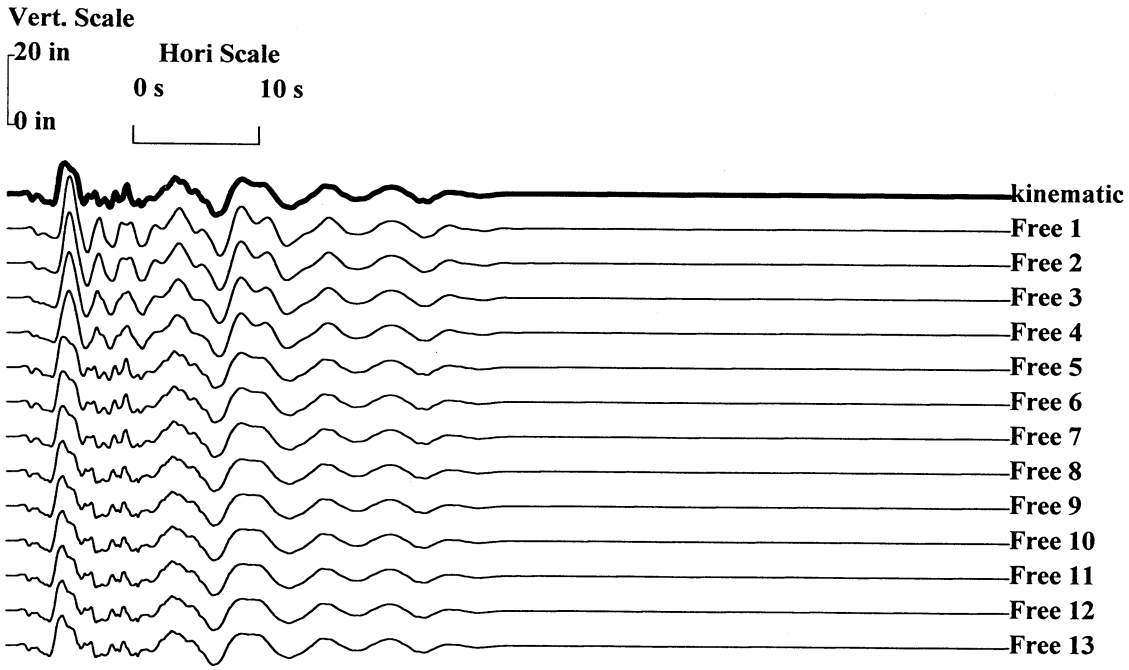
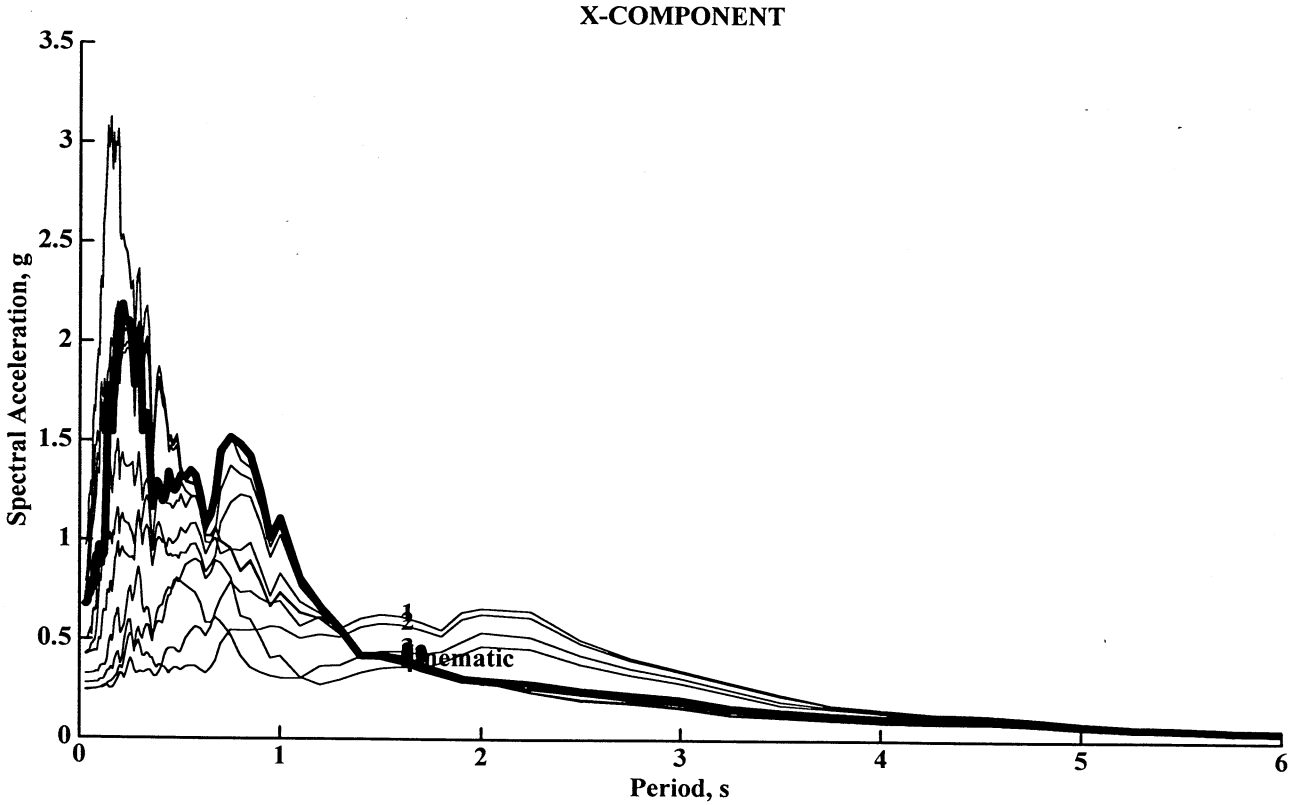
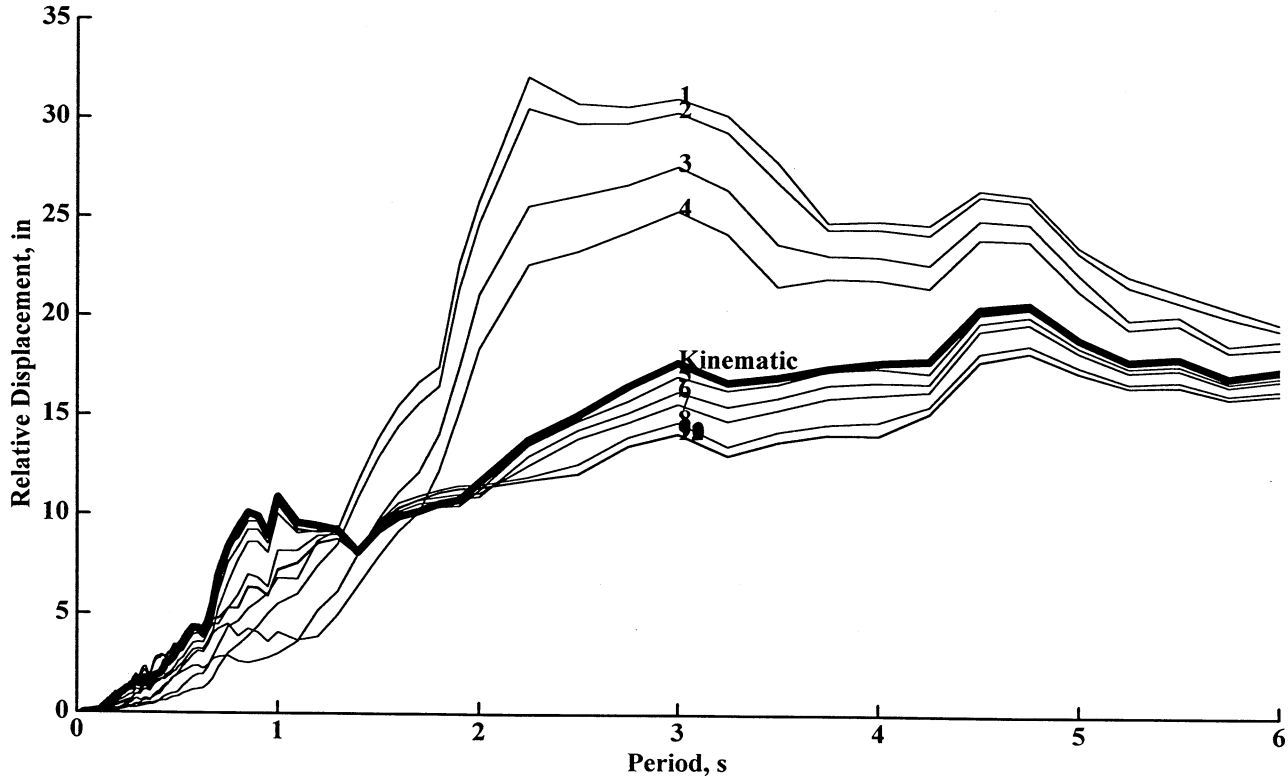




PIER 6
SET 1, Long. Dir.
BENICIA-MARTINEZ





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SET 1, Long. Dir.
BENICIA-MARTINEZ

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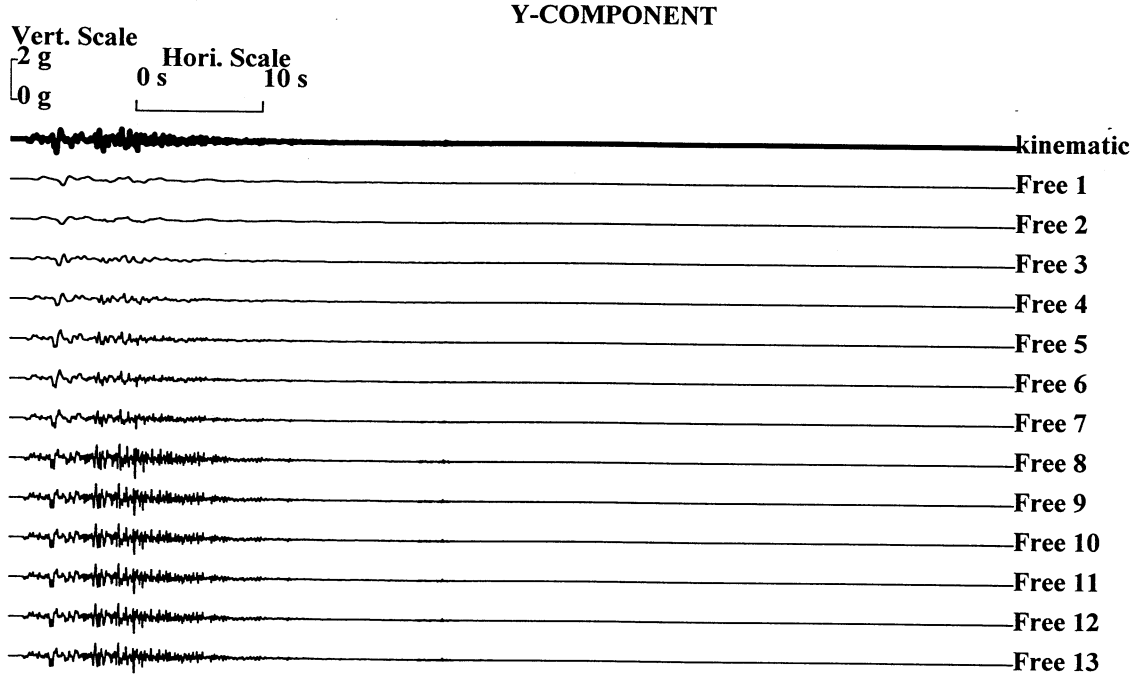

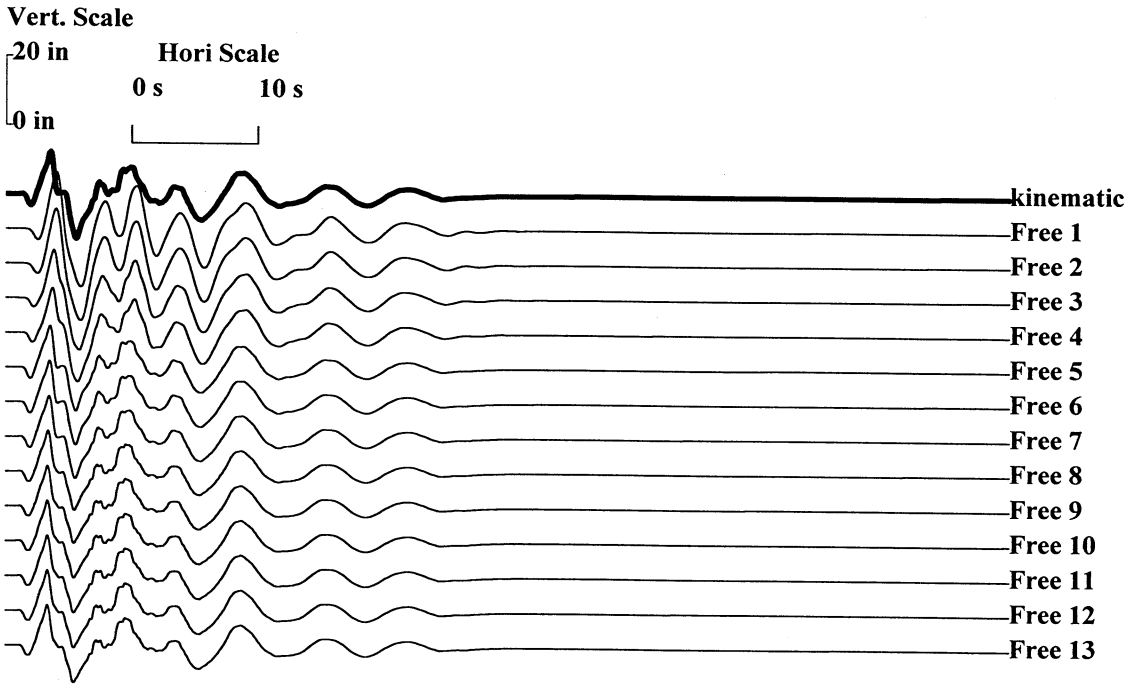

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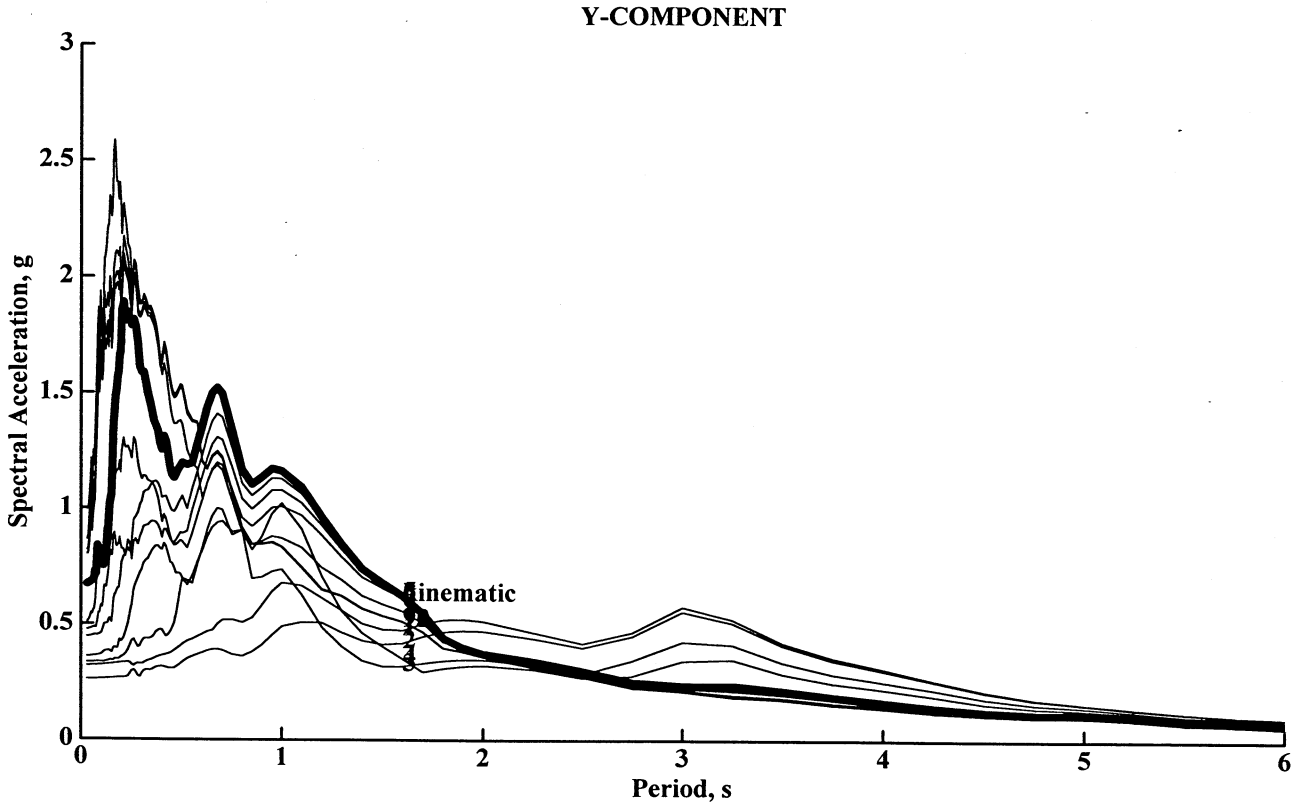

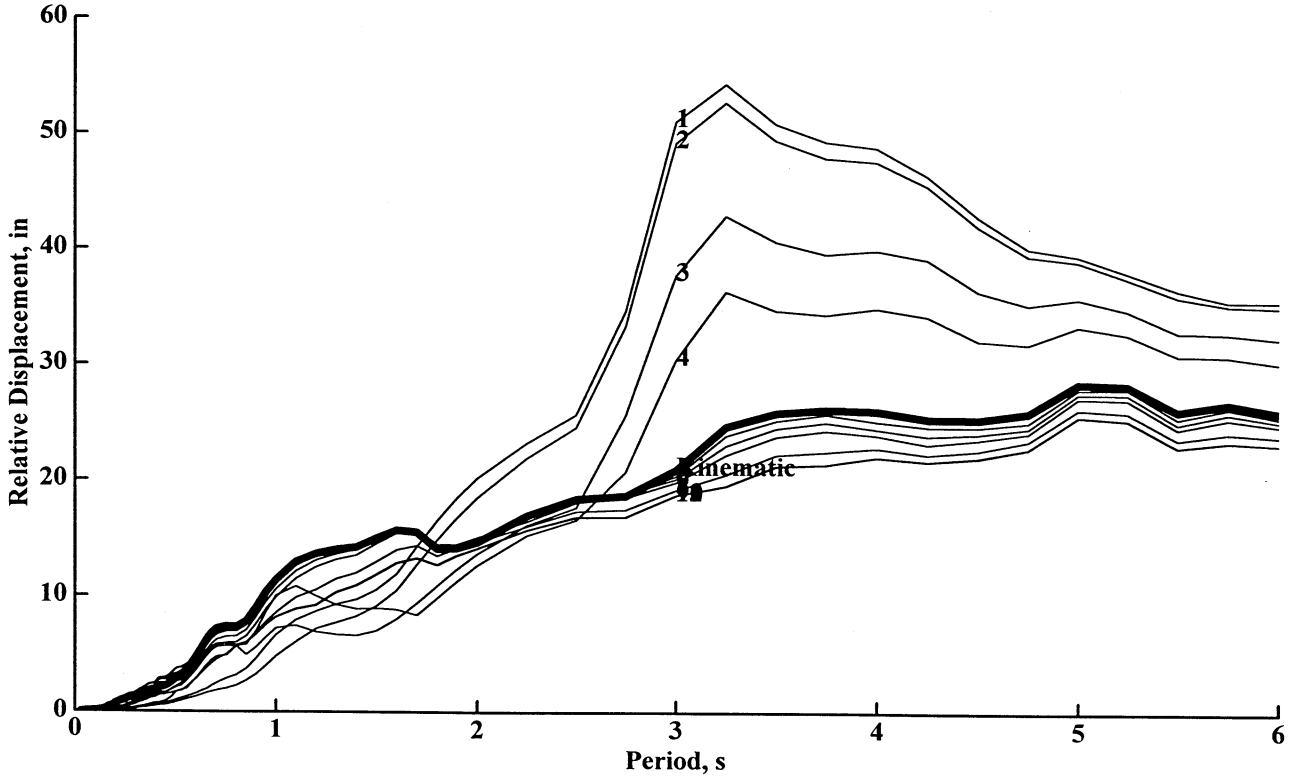

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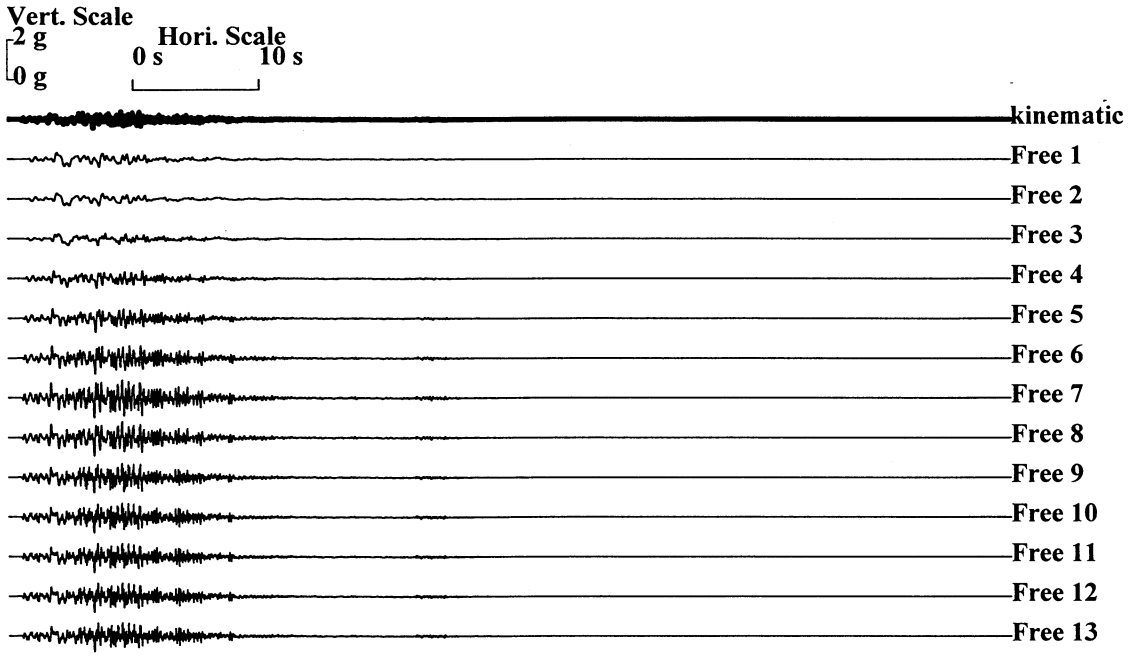

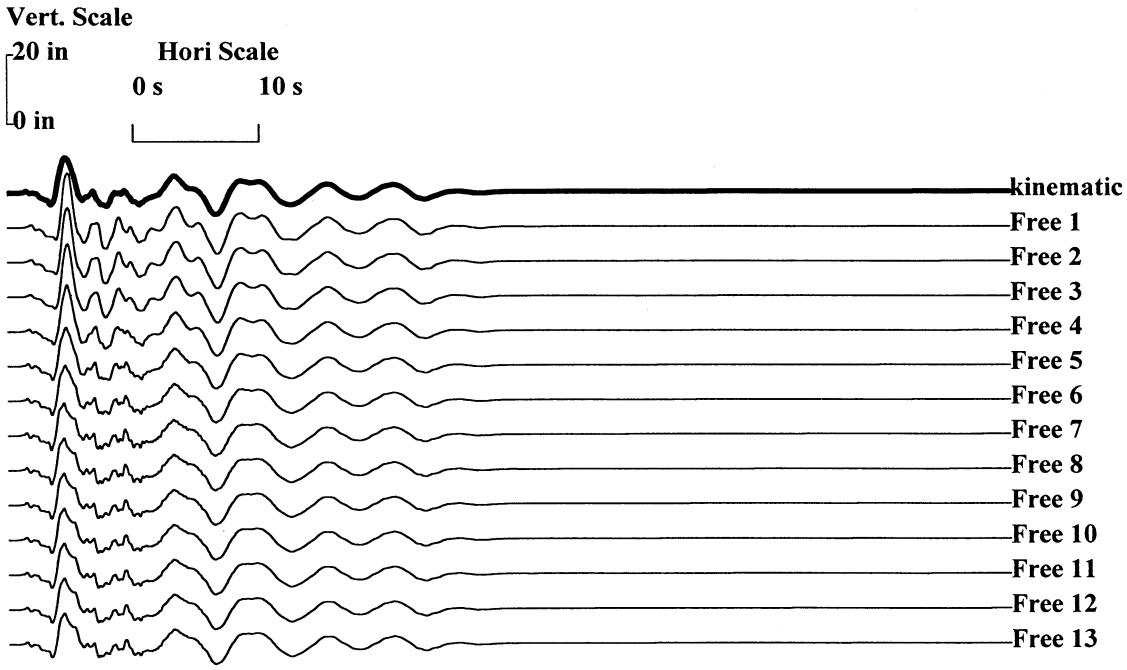

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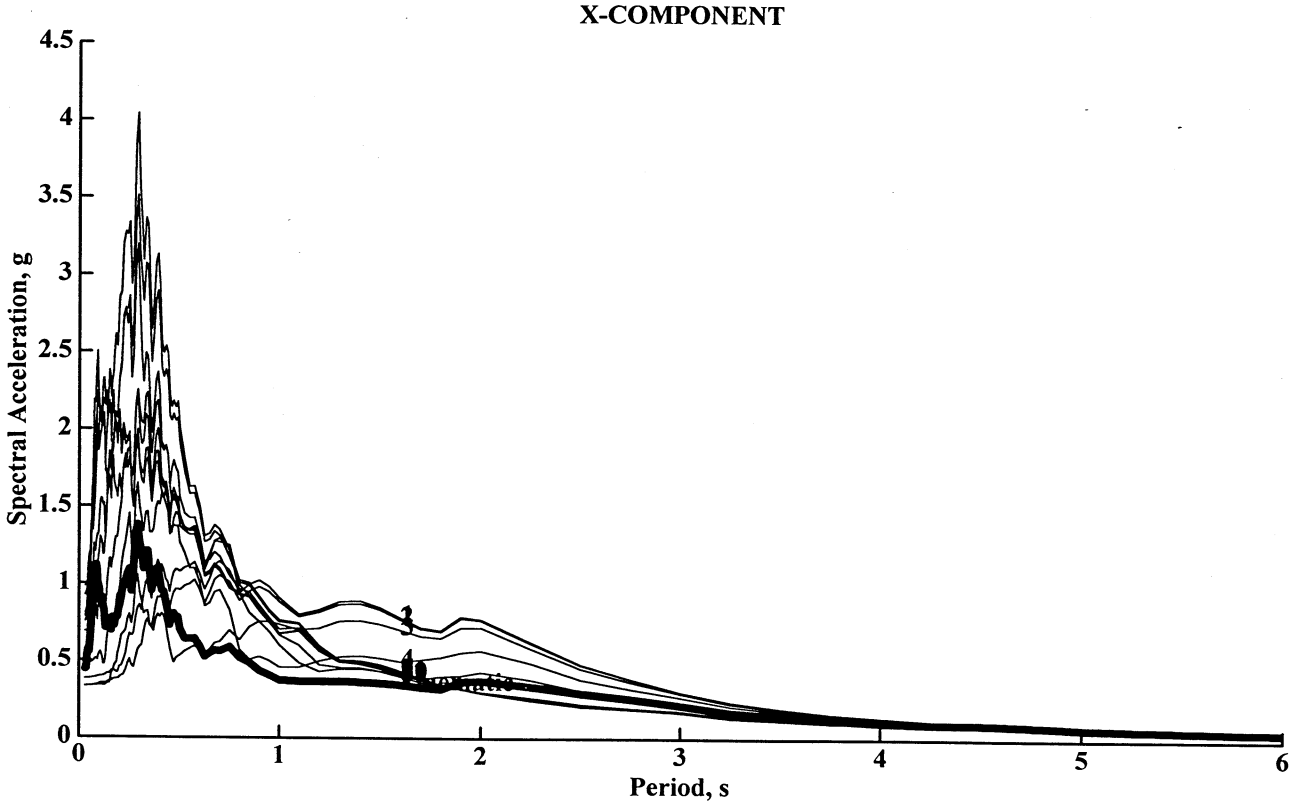

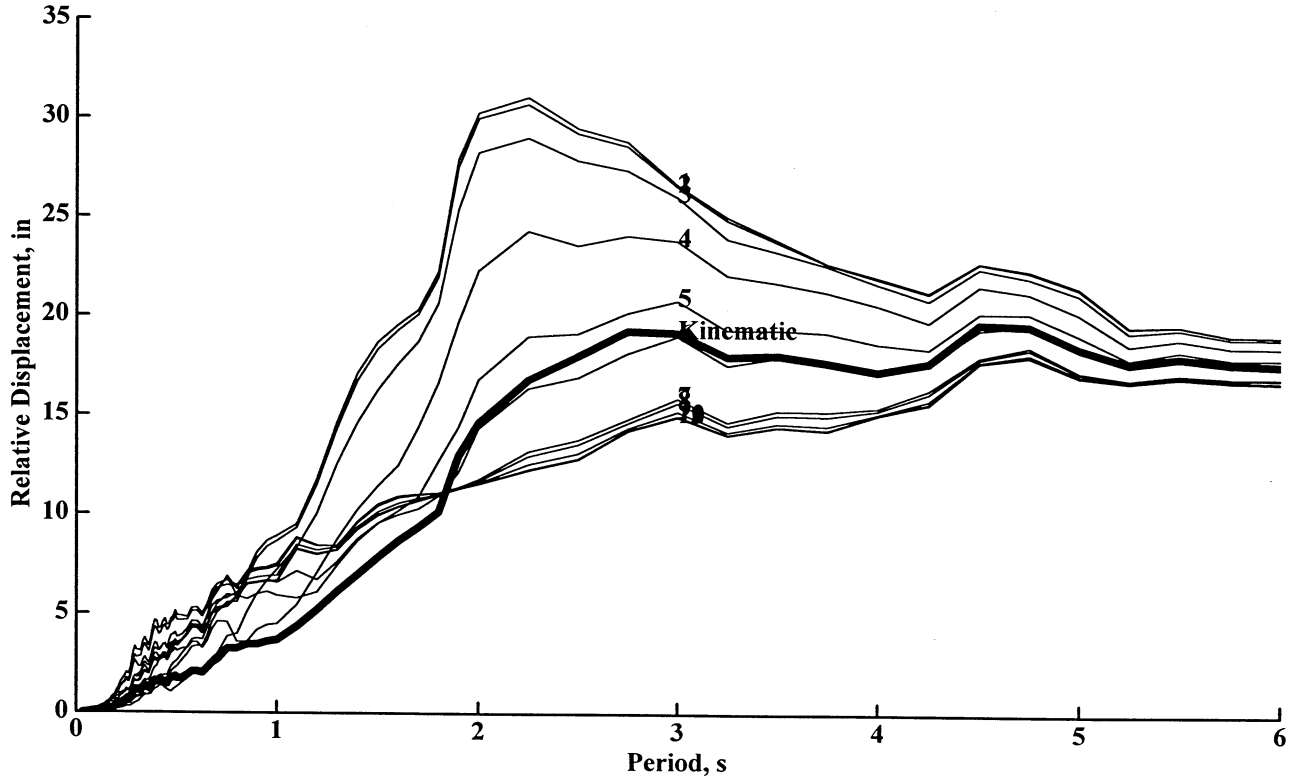

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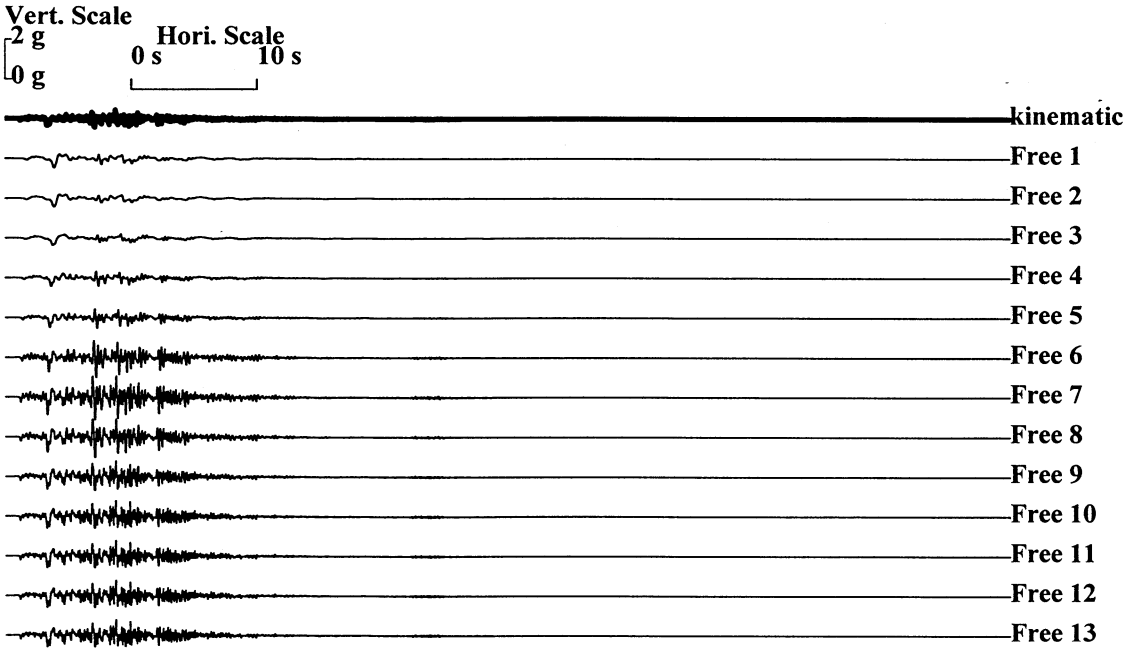

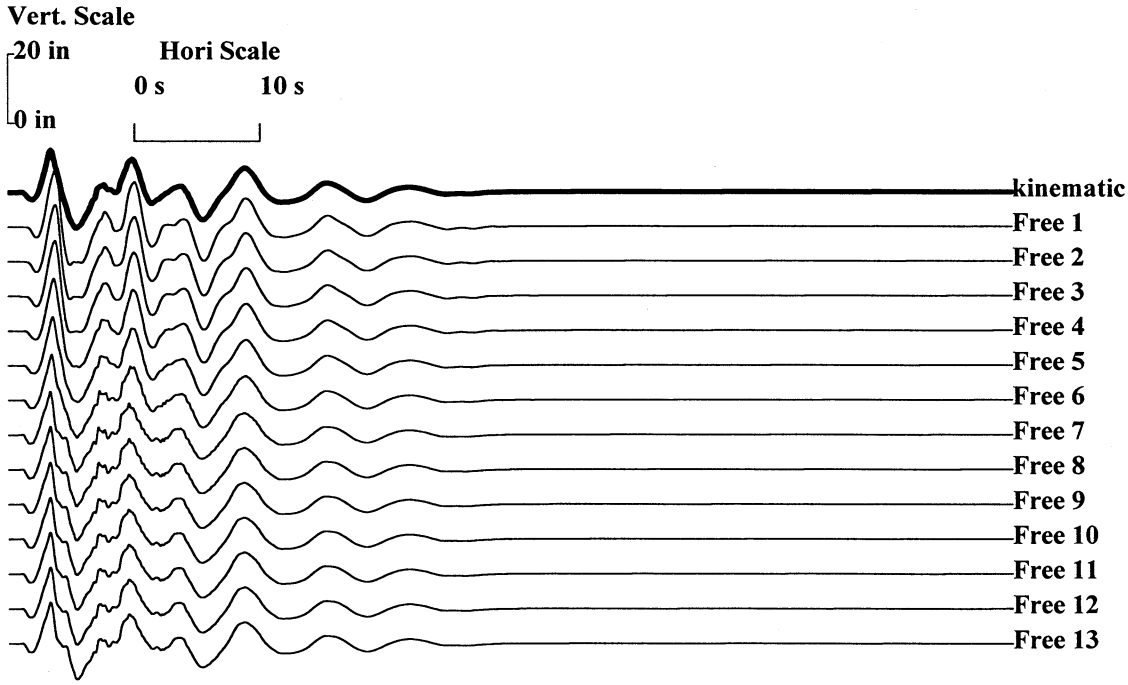

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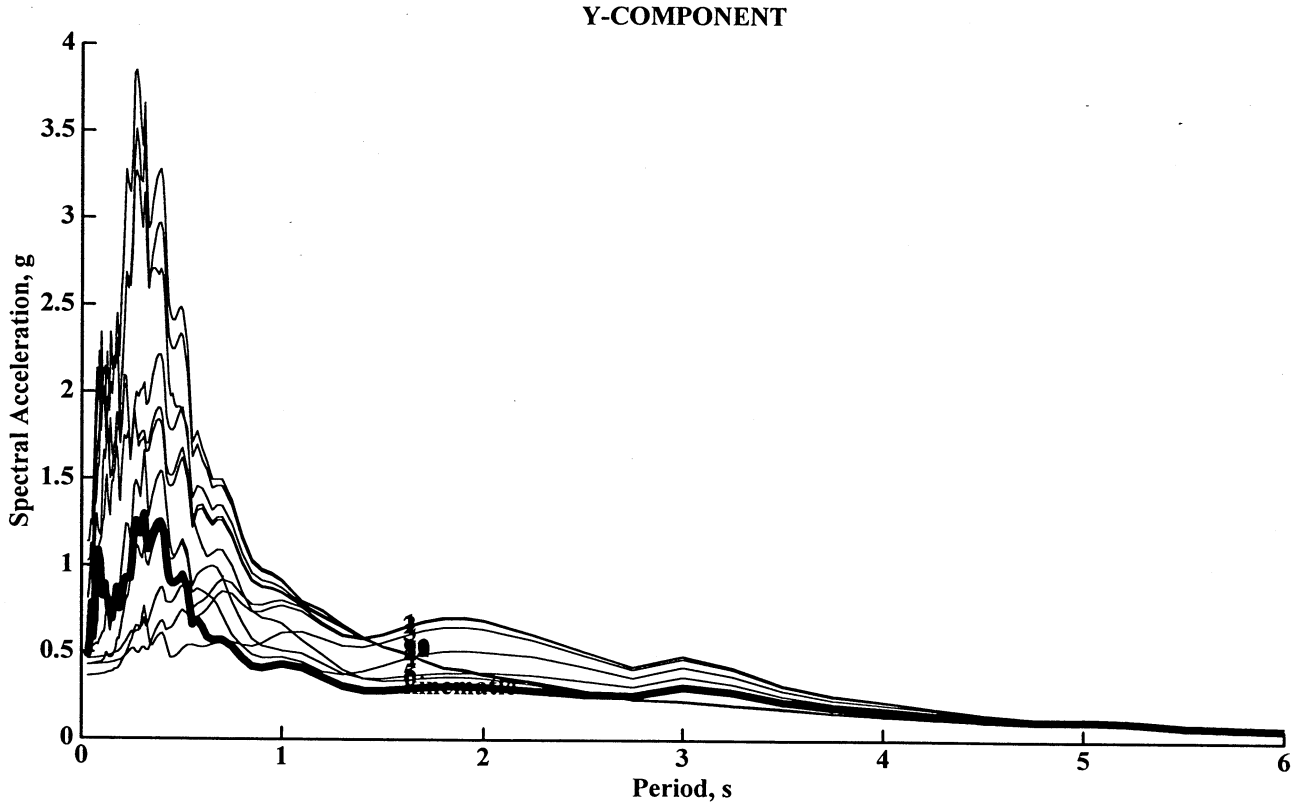

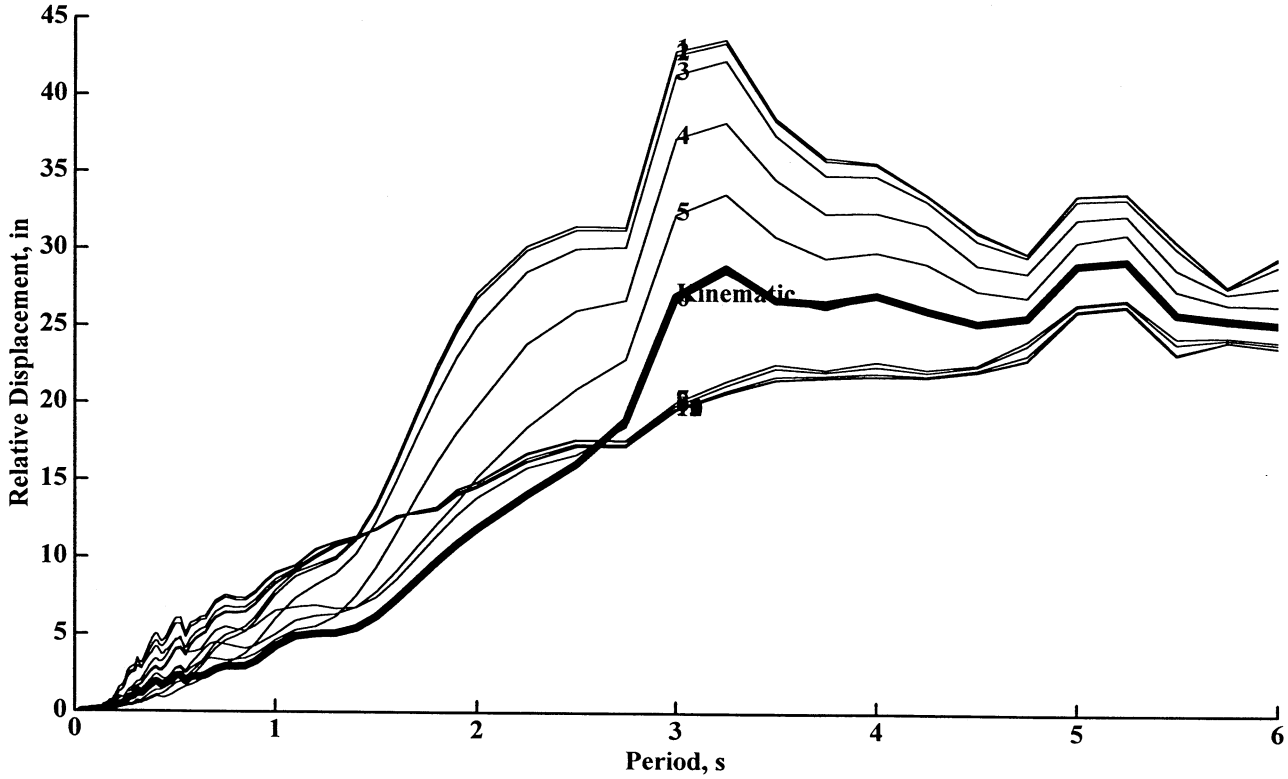

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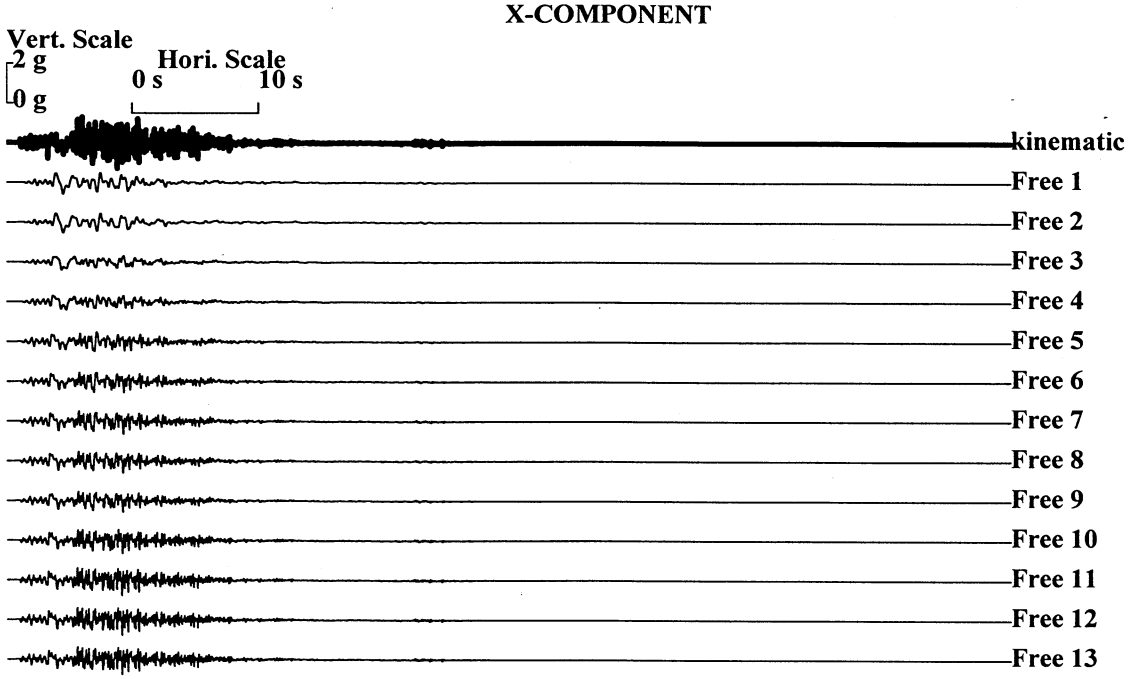

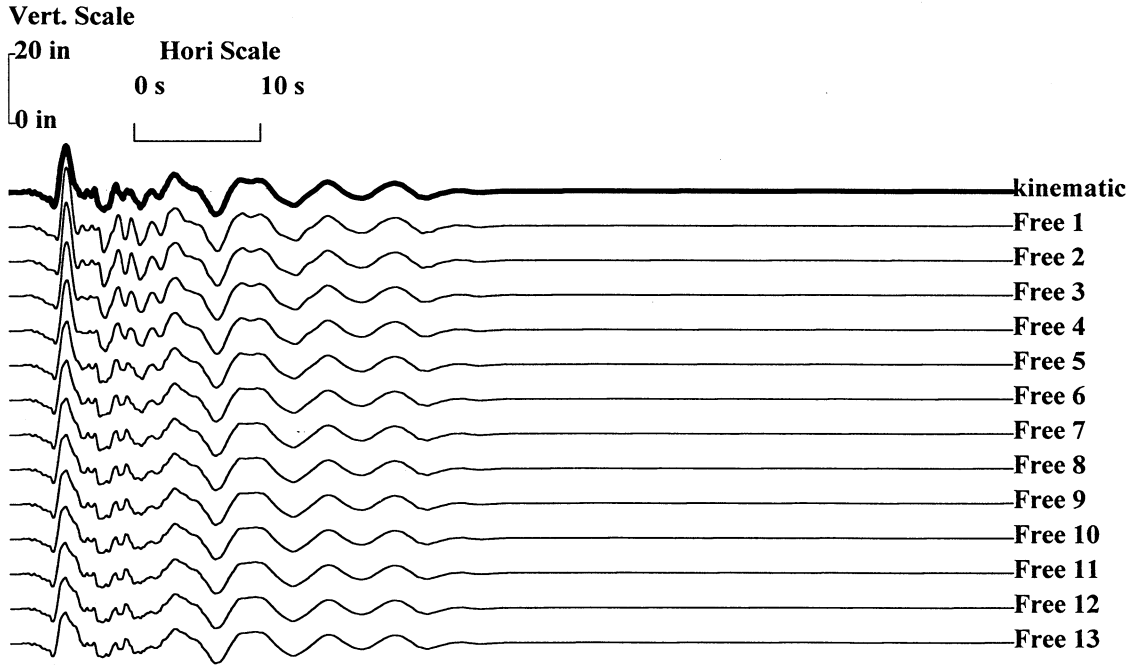

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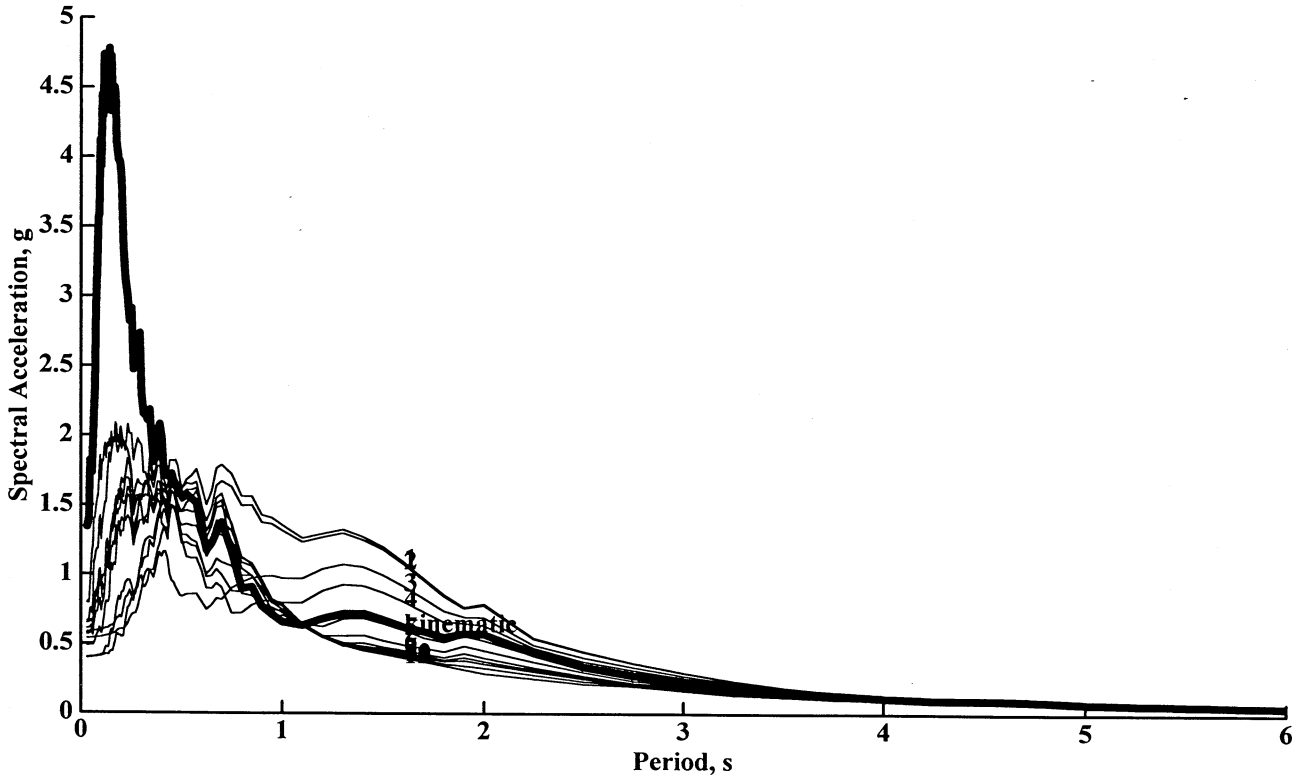

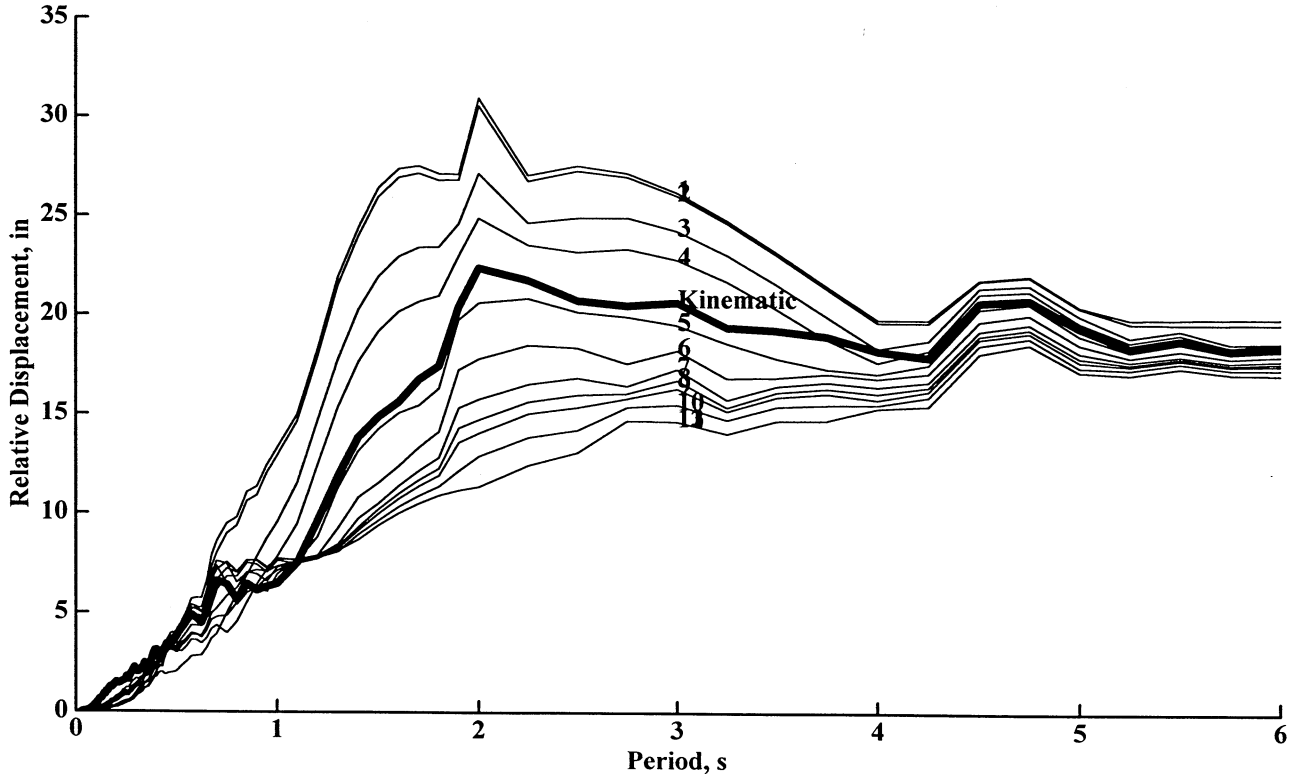

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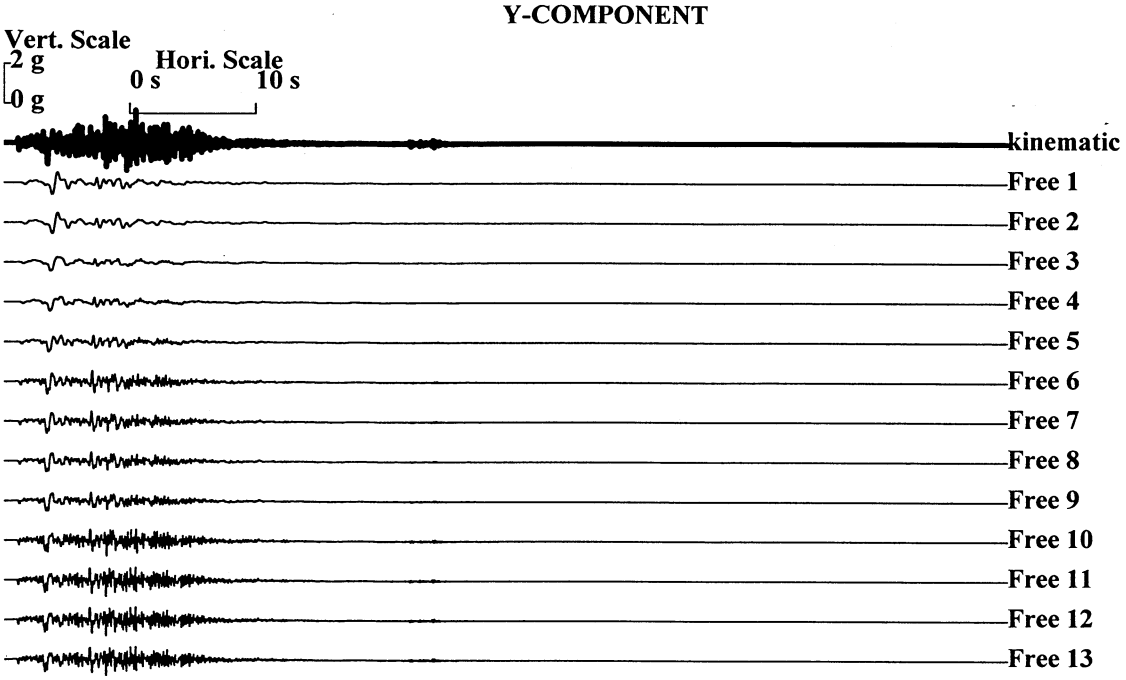

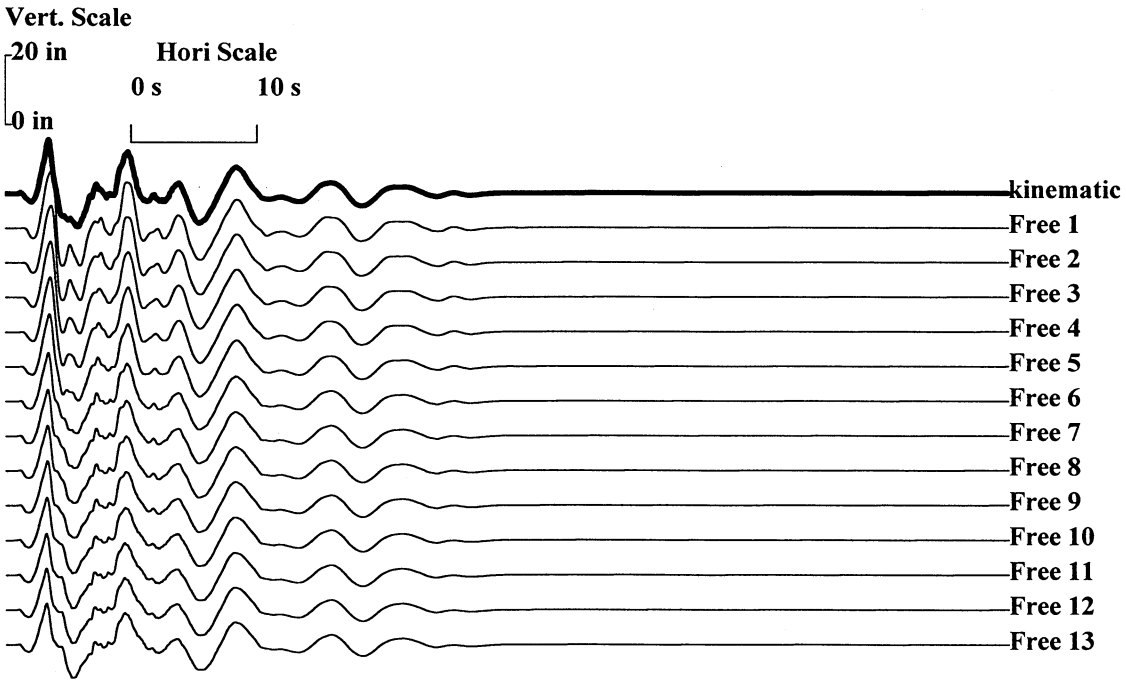

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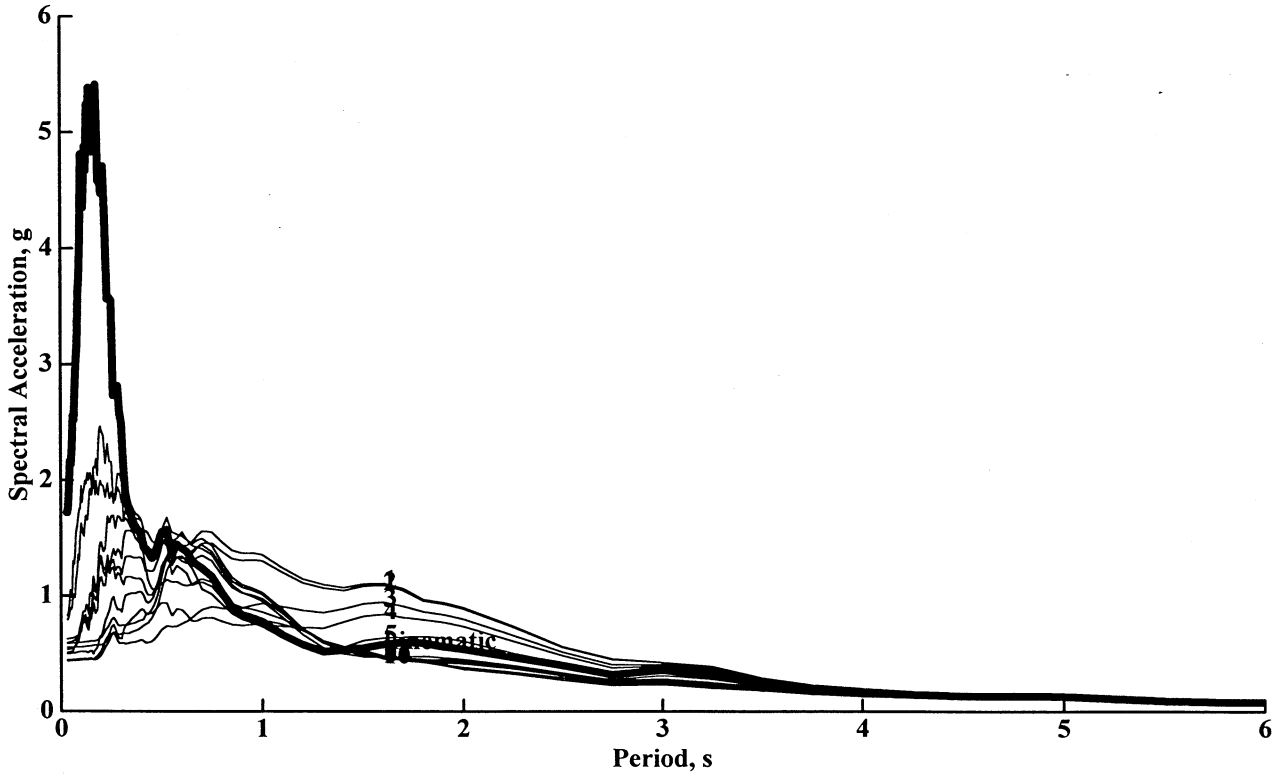

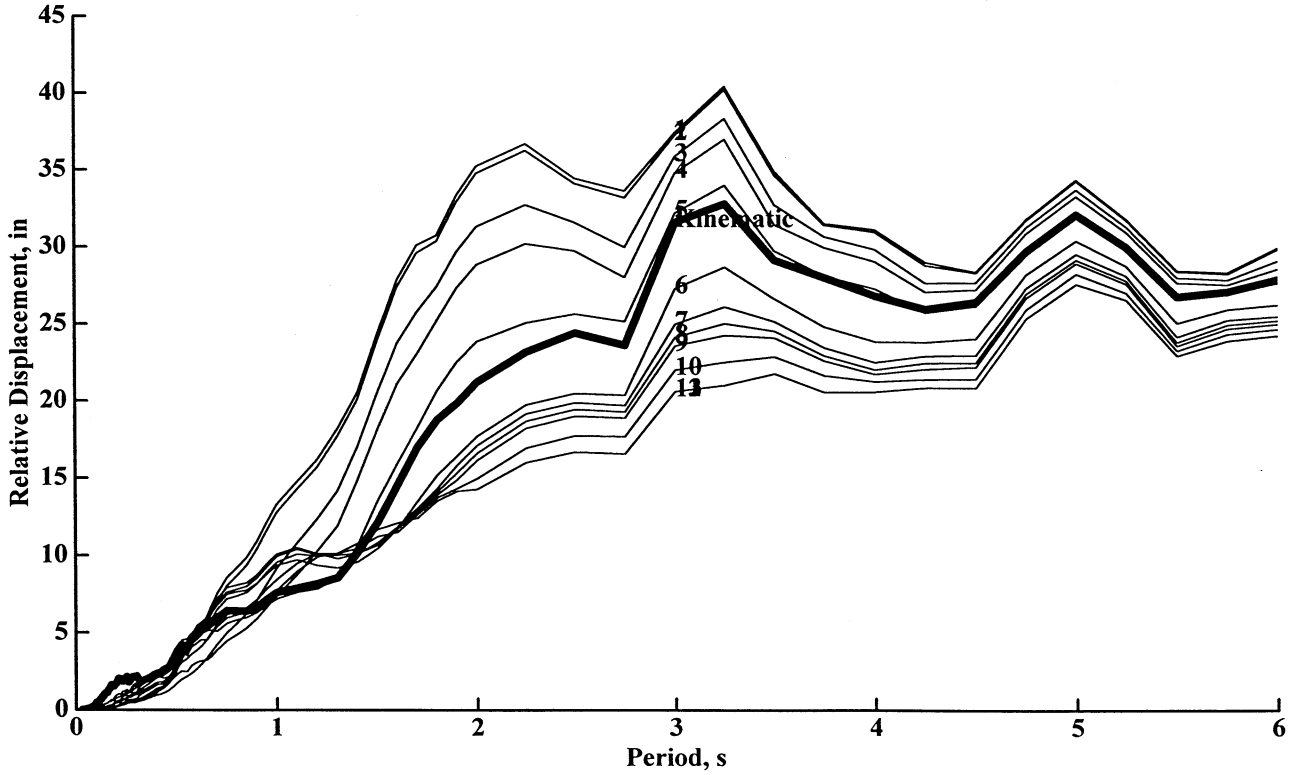

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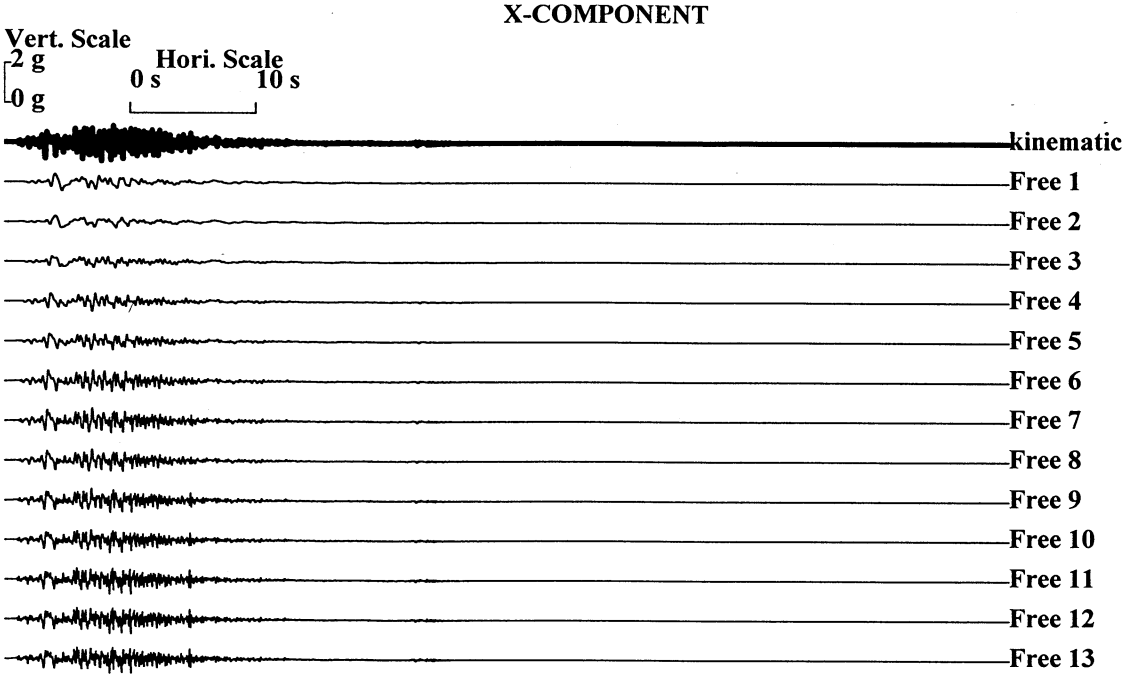

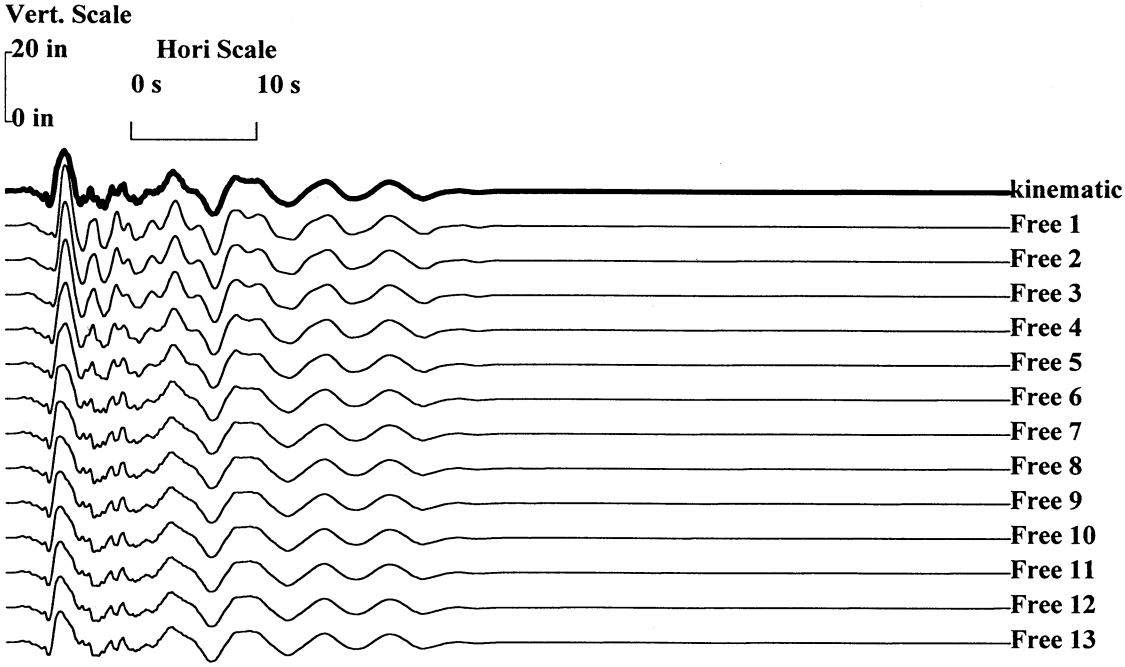

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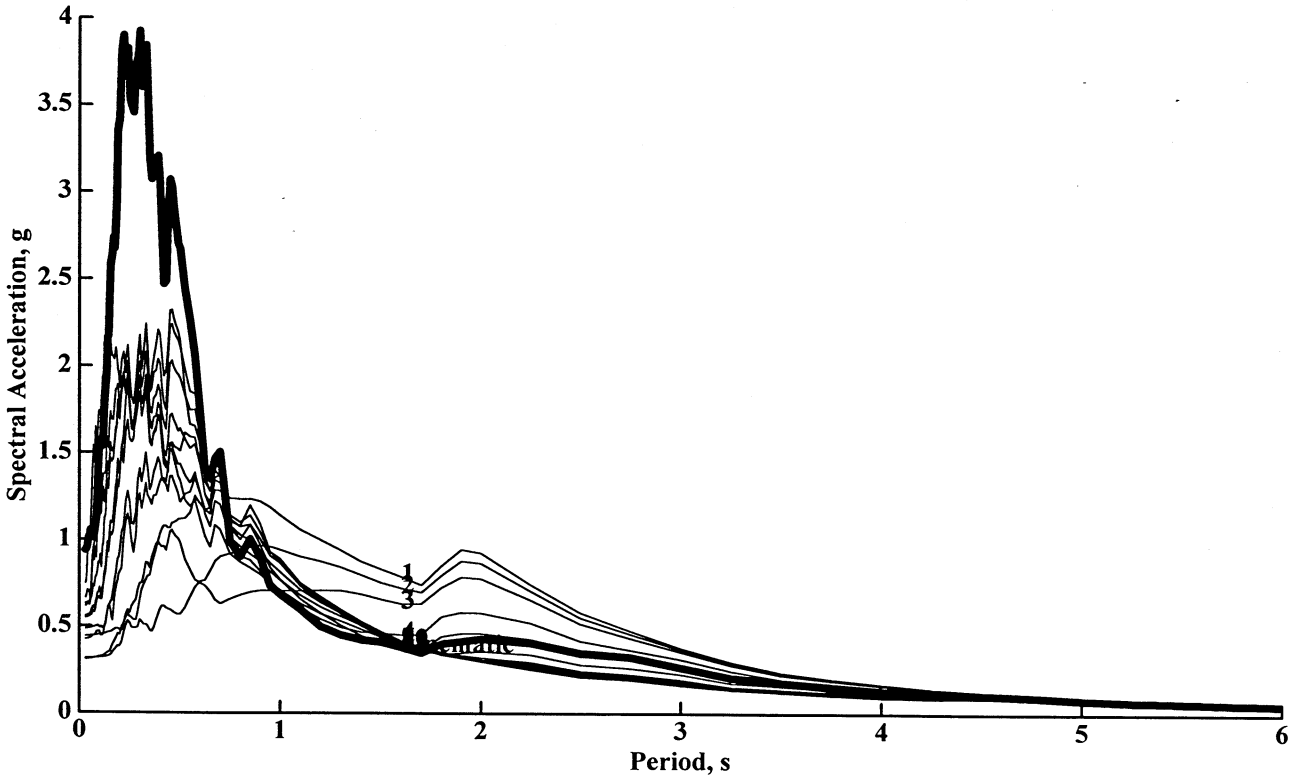

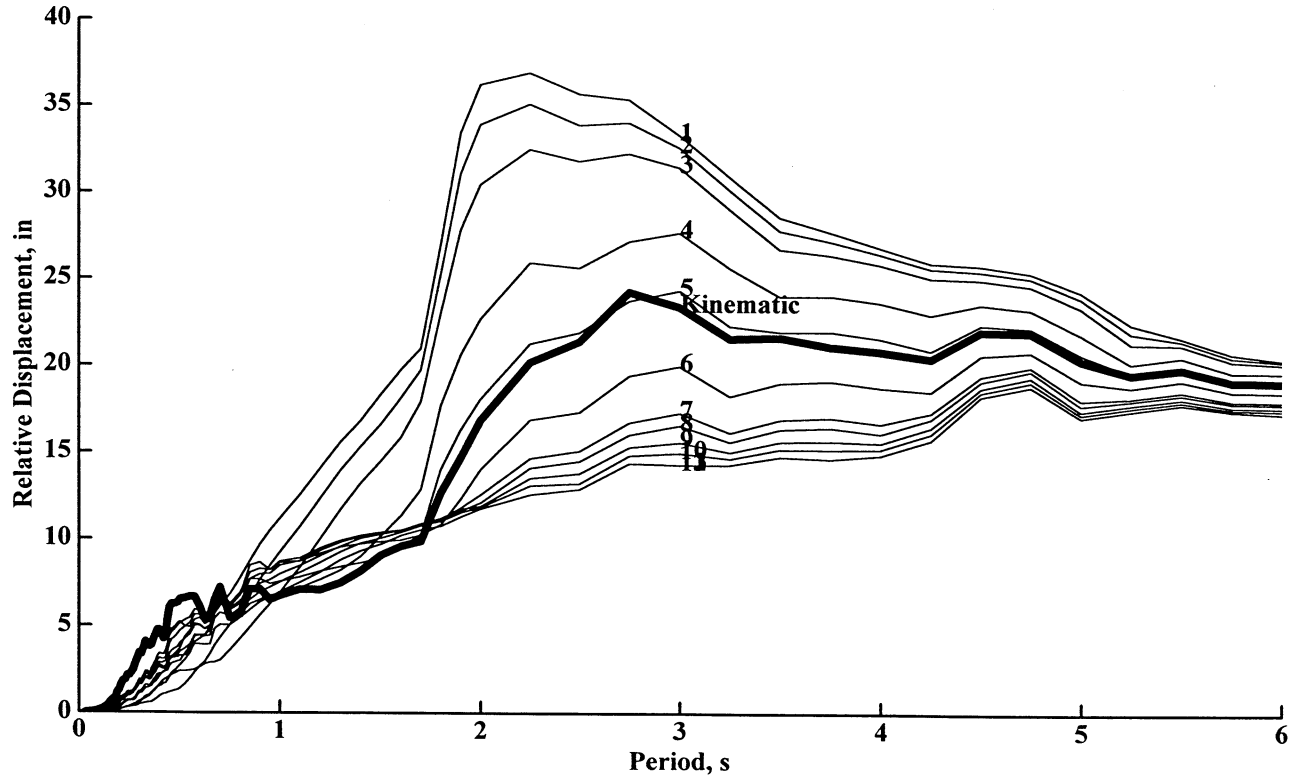

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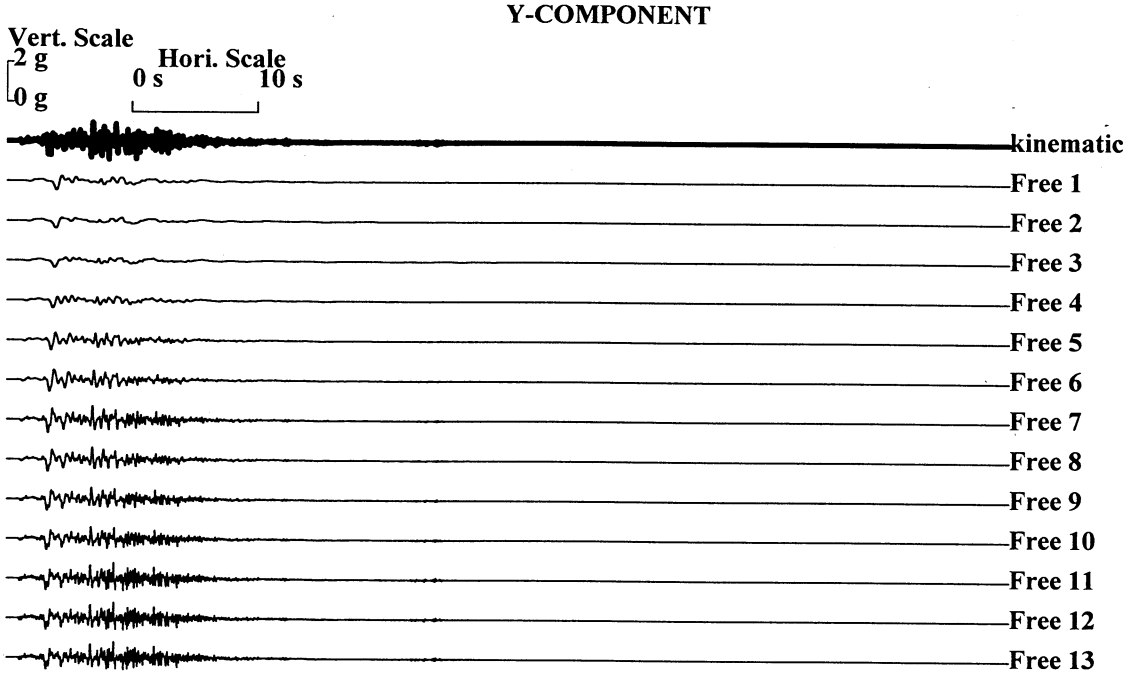

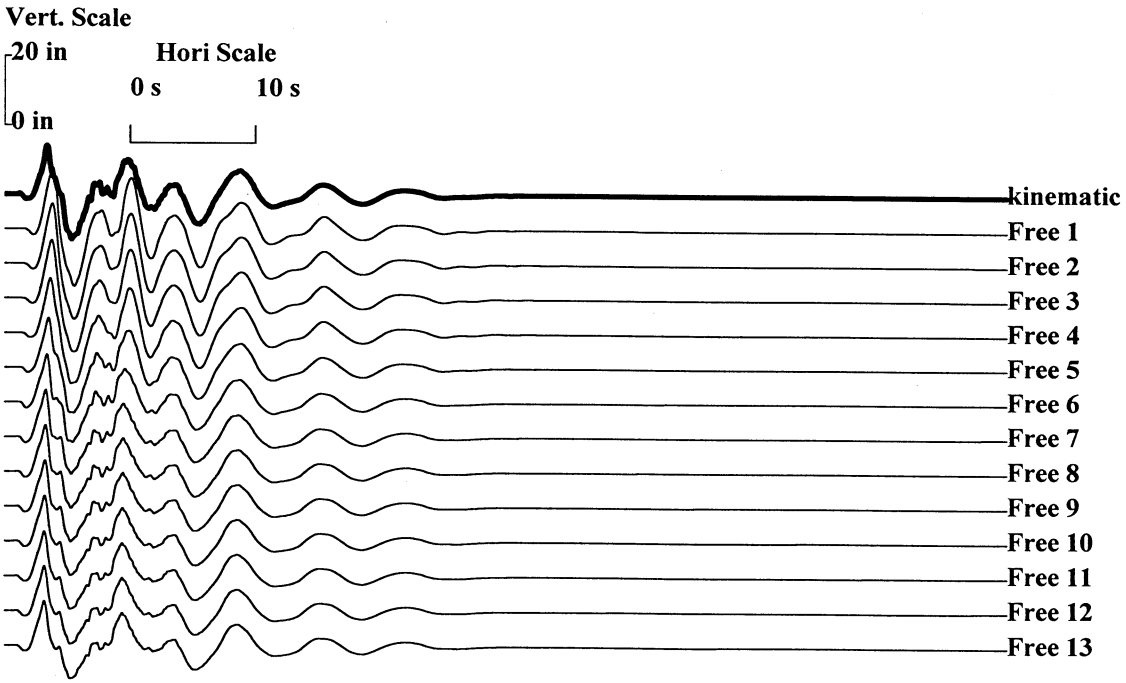

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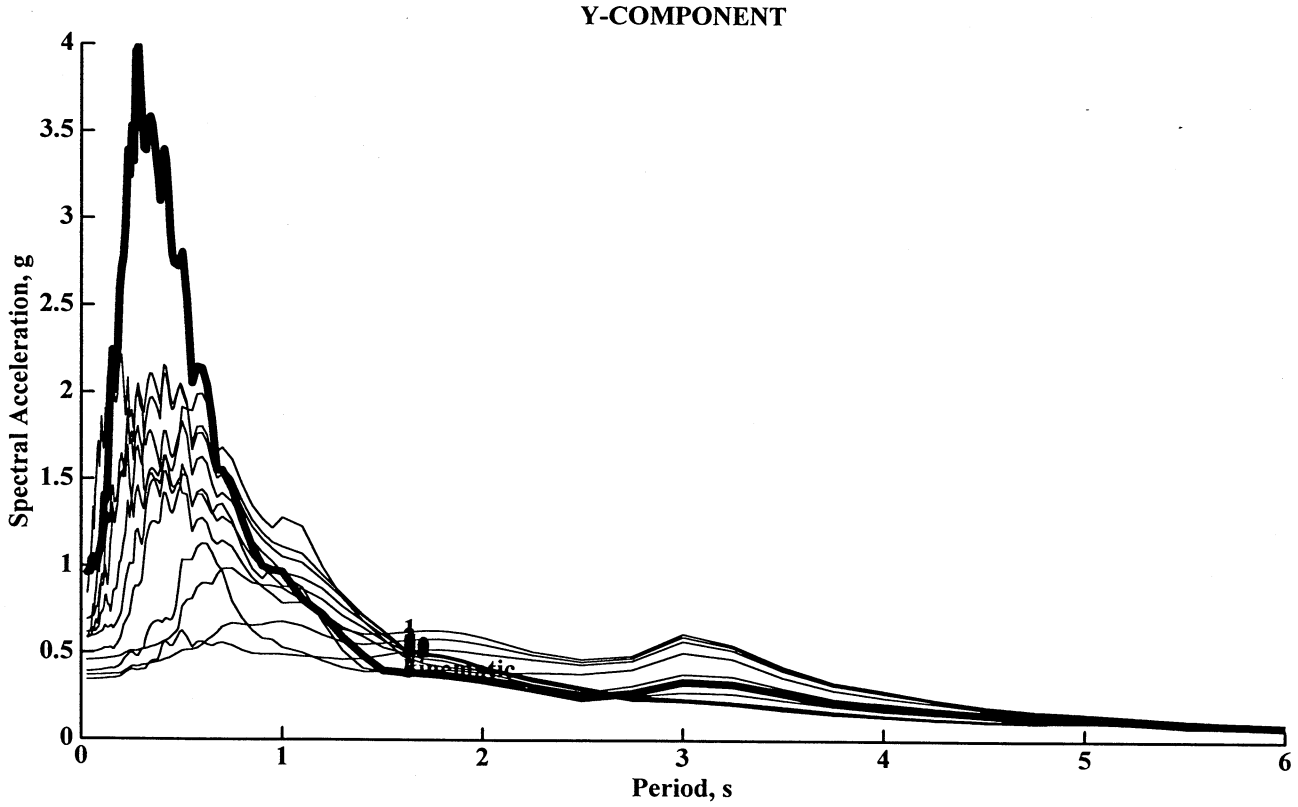

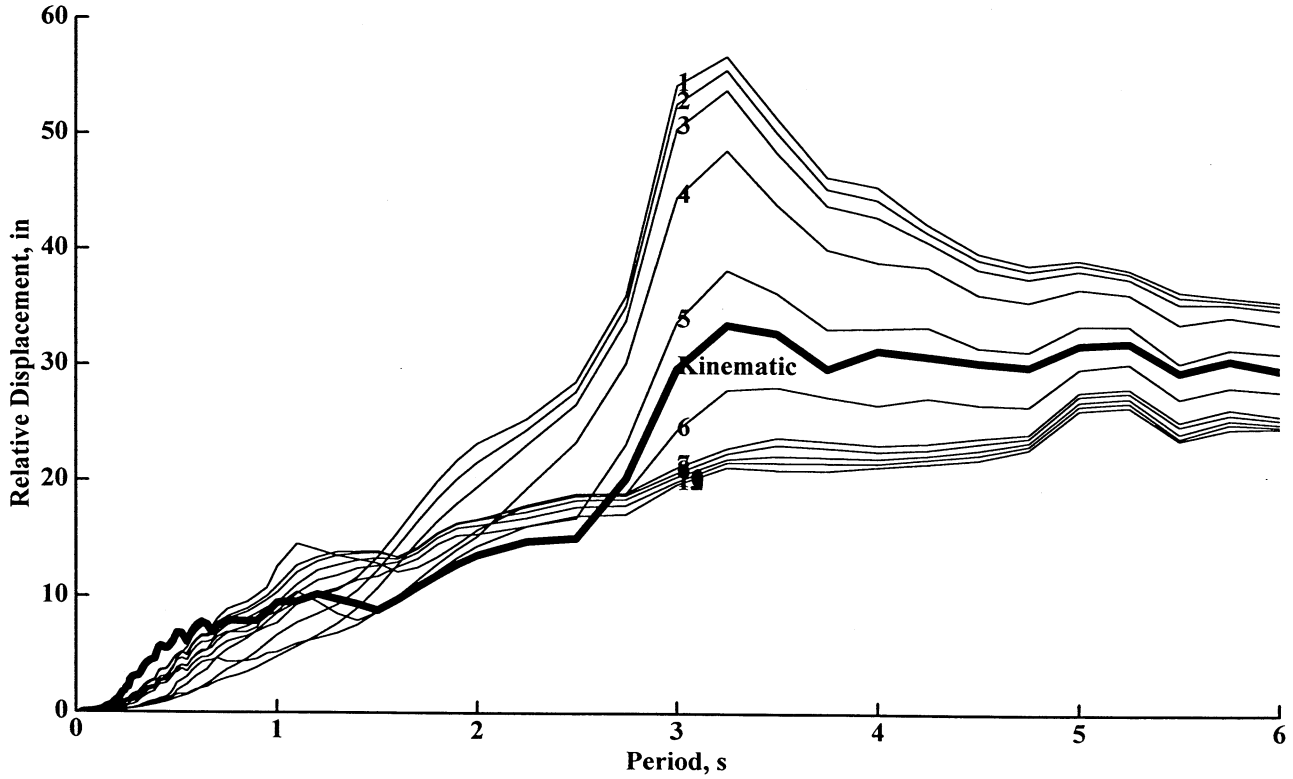

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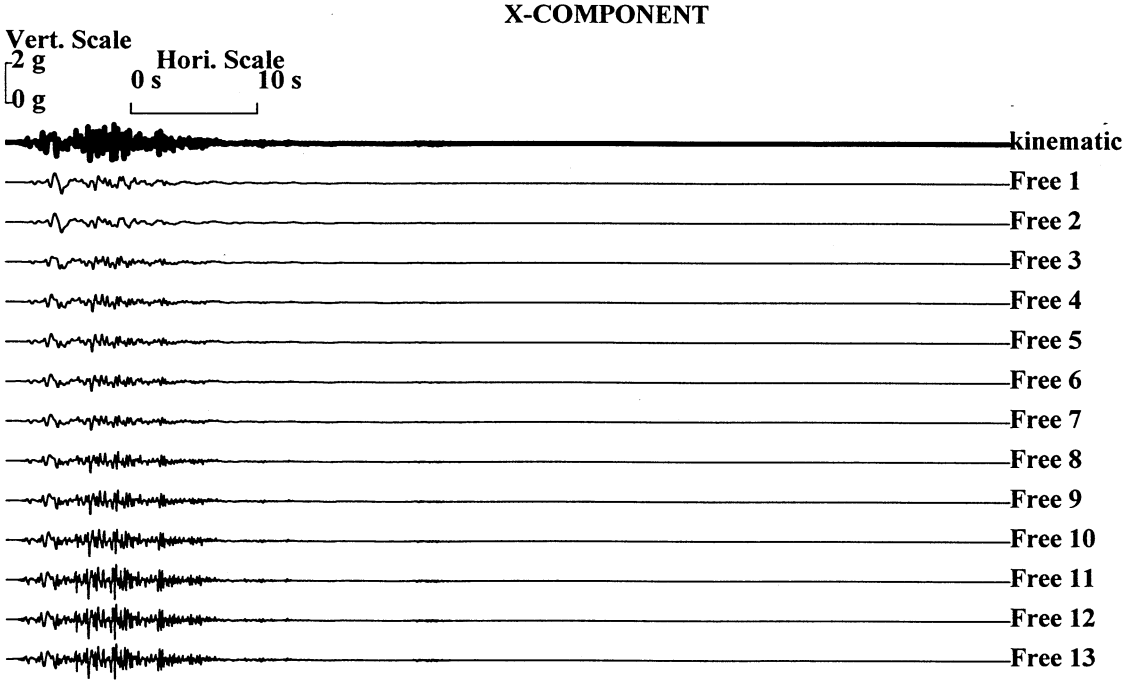

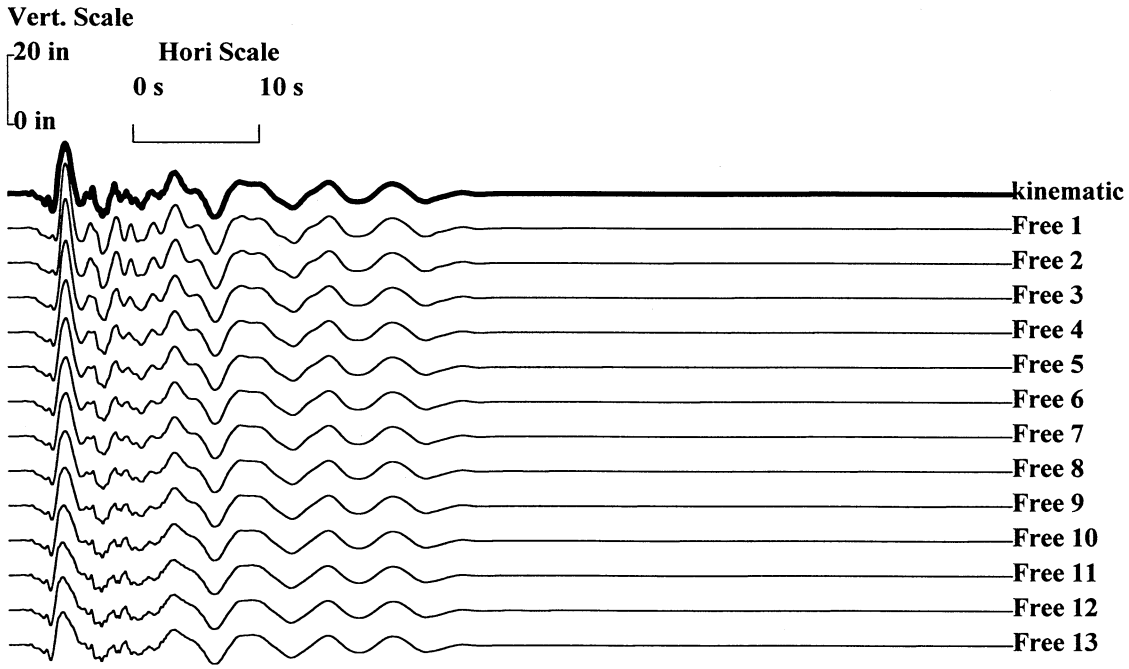

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BENICIA-MARTINEZ

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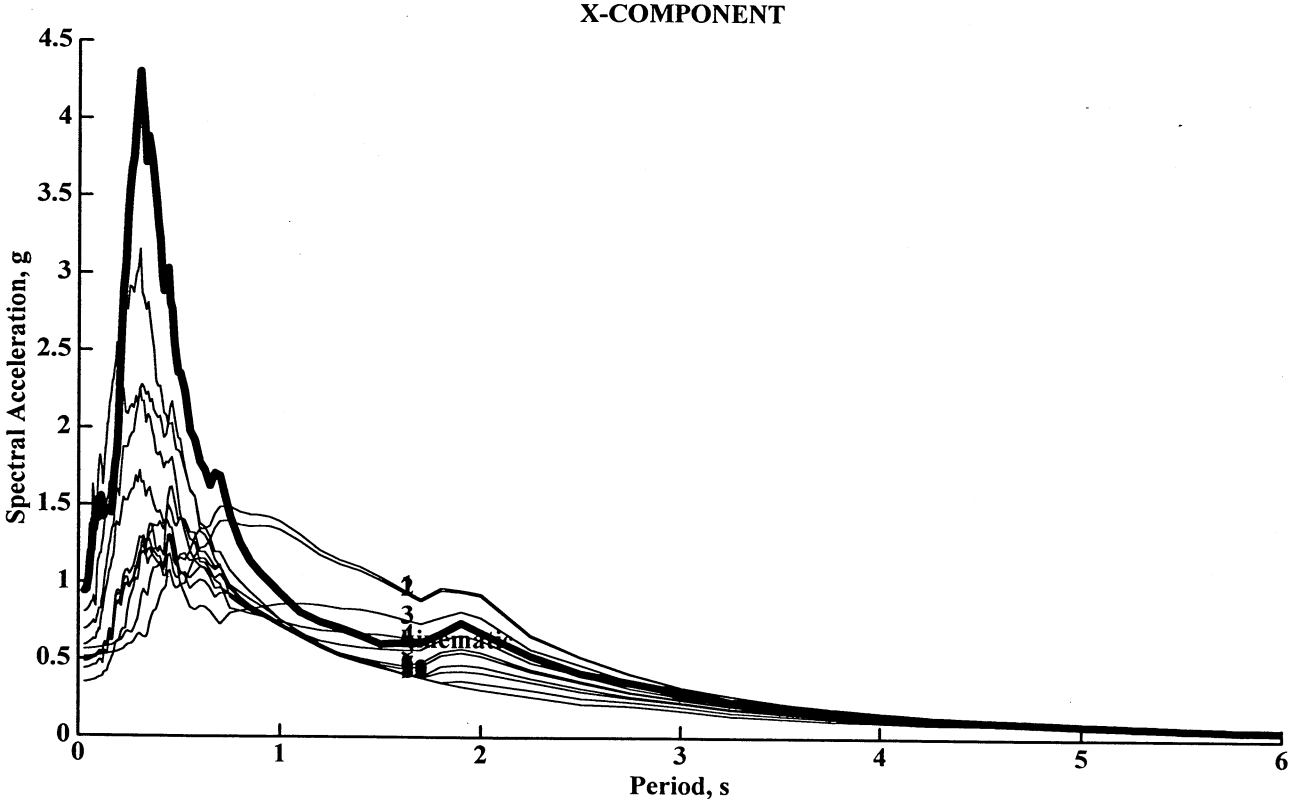

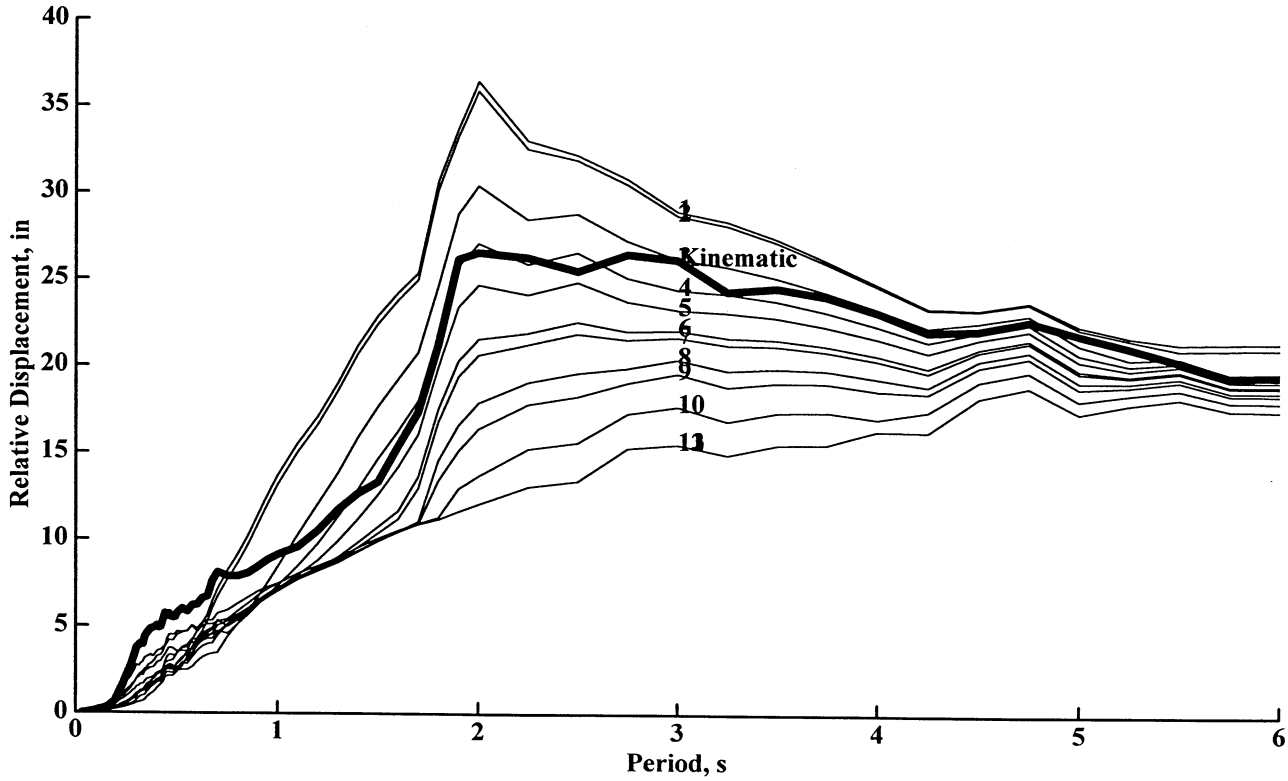

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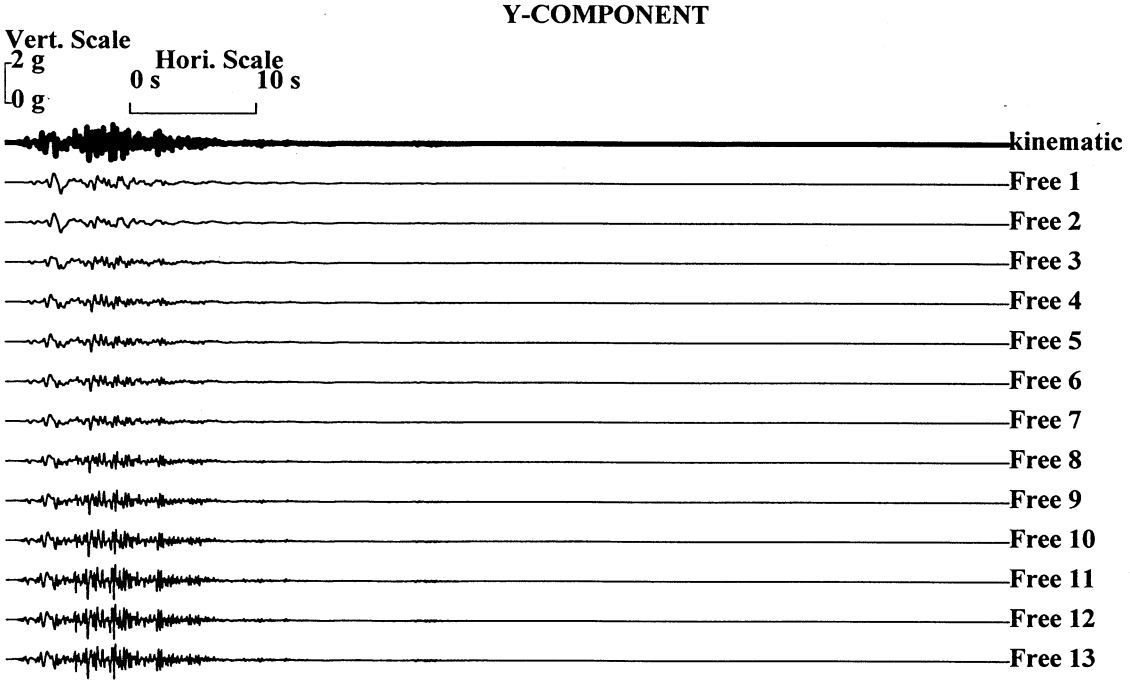
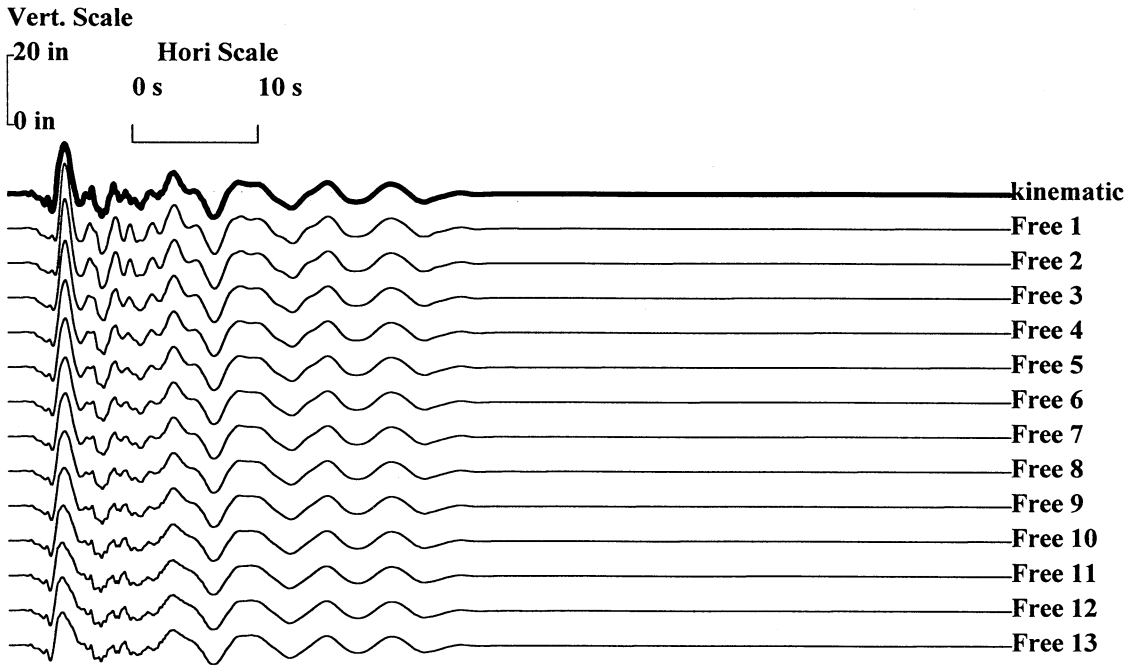
BENICIA-MARTINEZ

Y-COMPONENT





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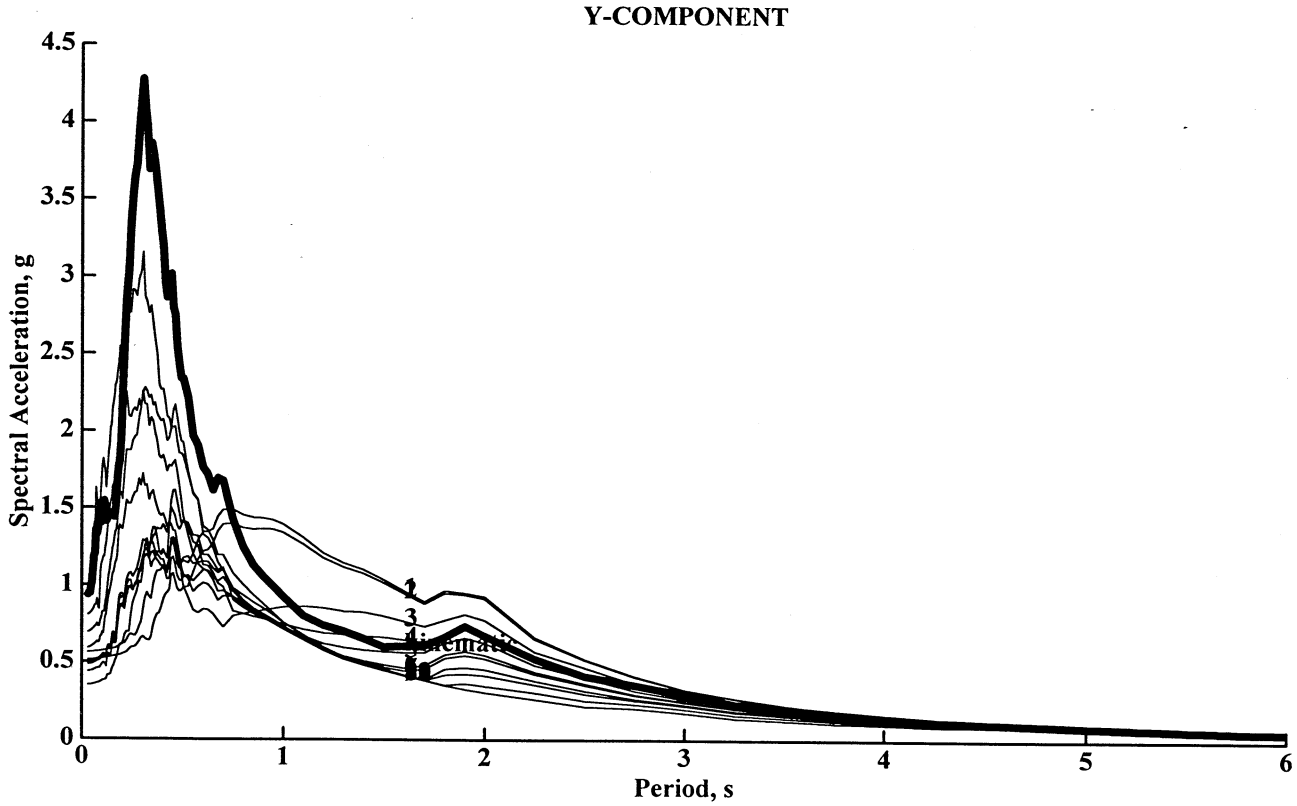

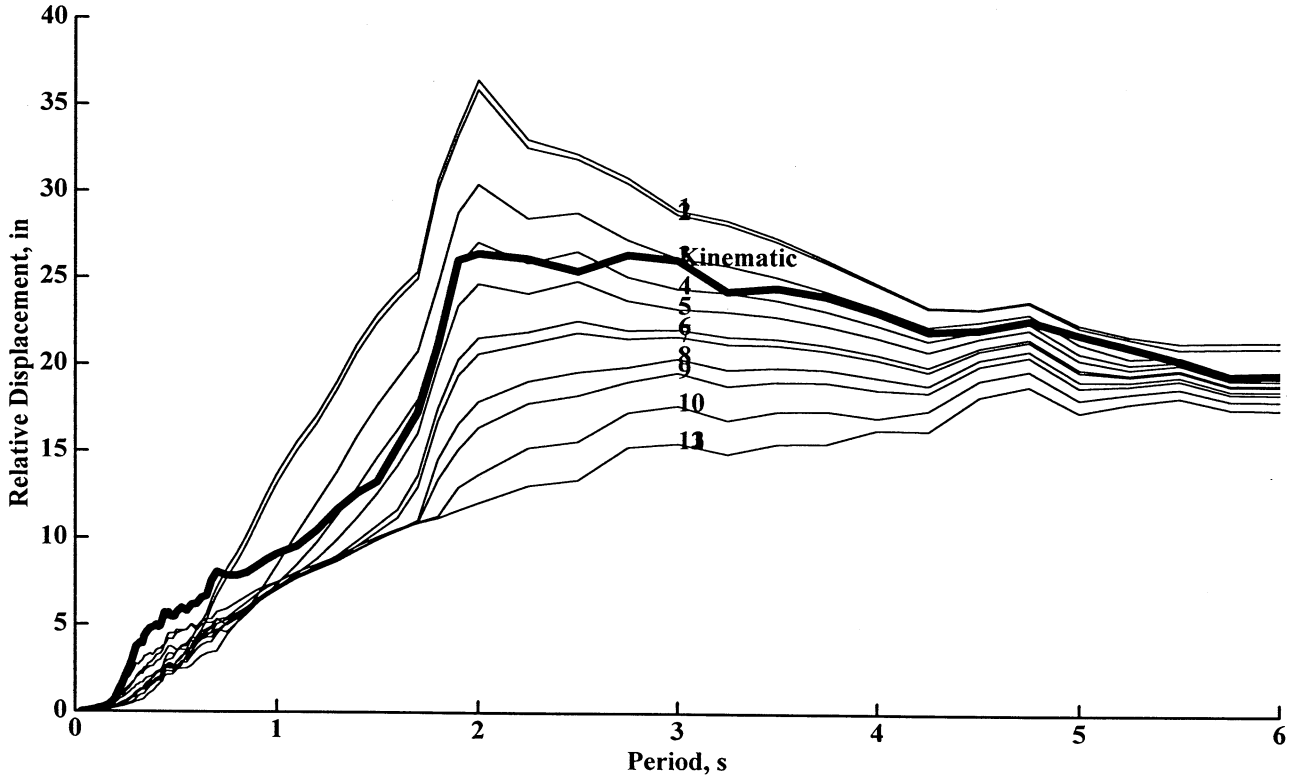

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BENICIA-MARTINEZ

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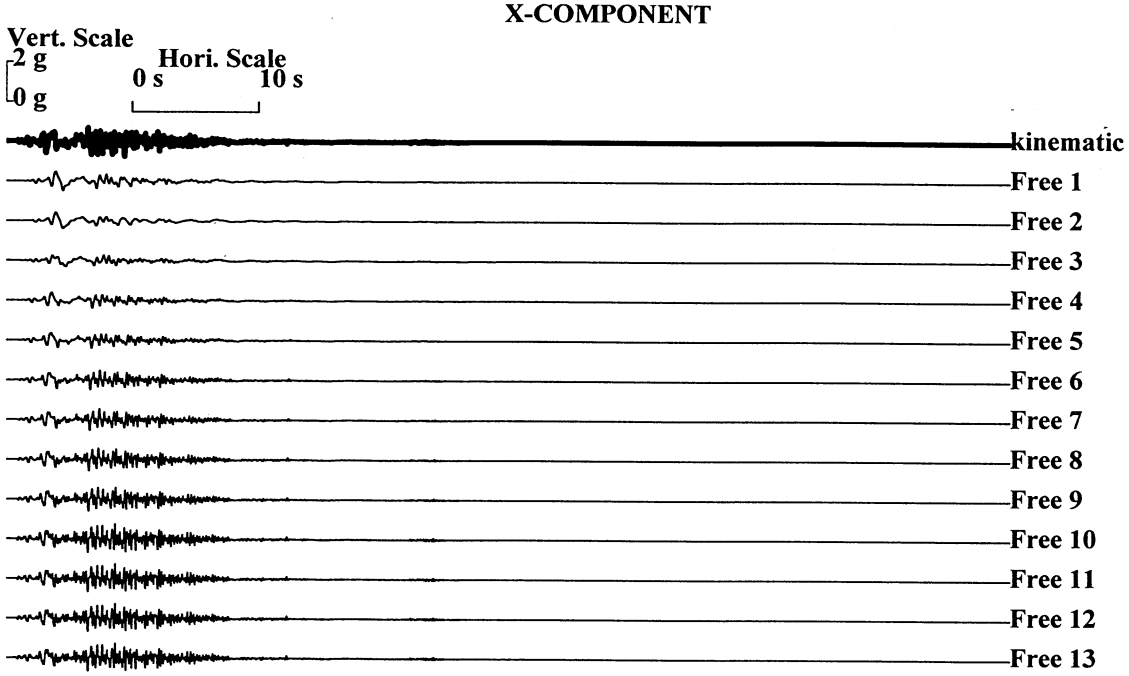

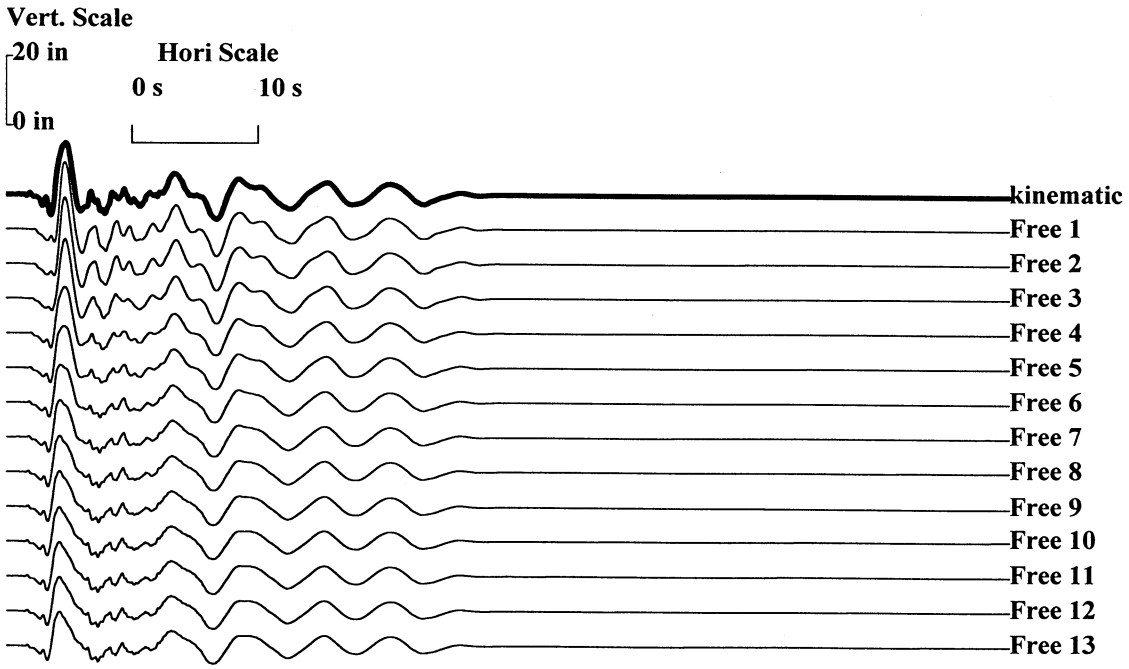

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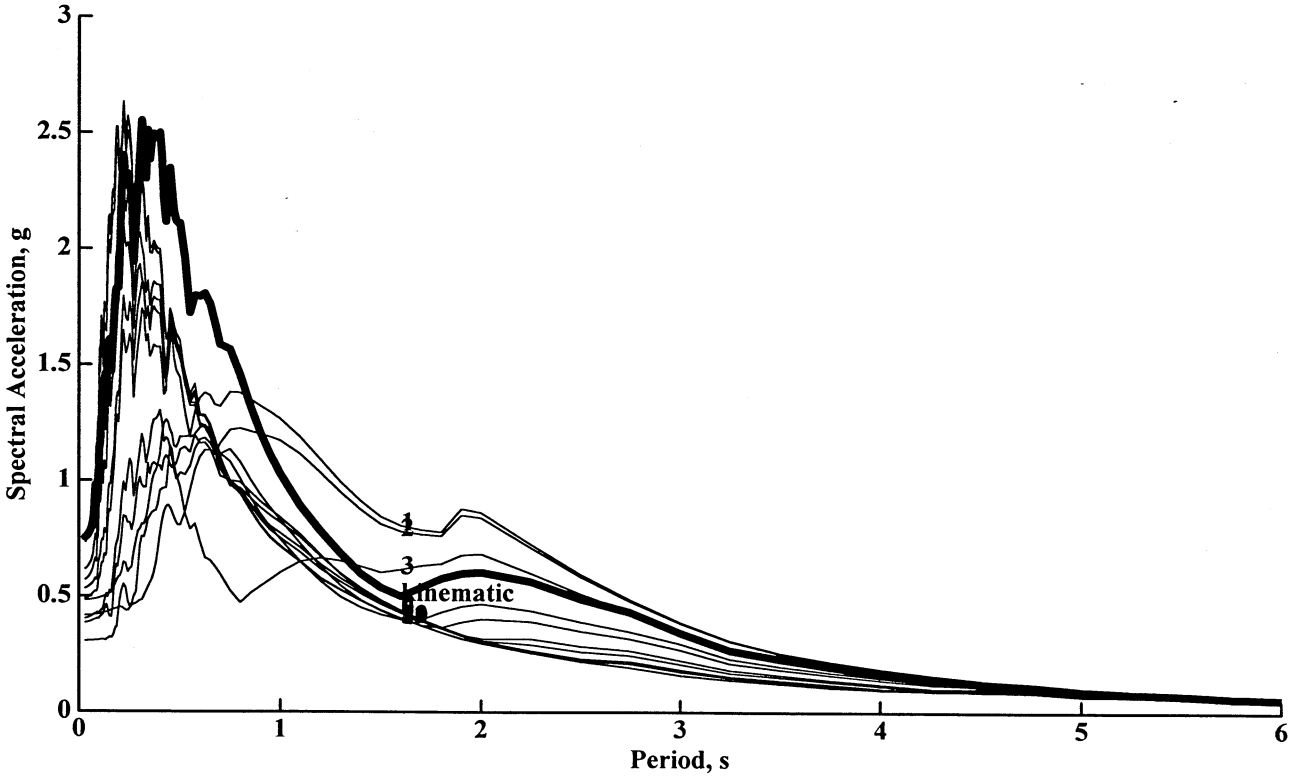

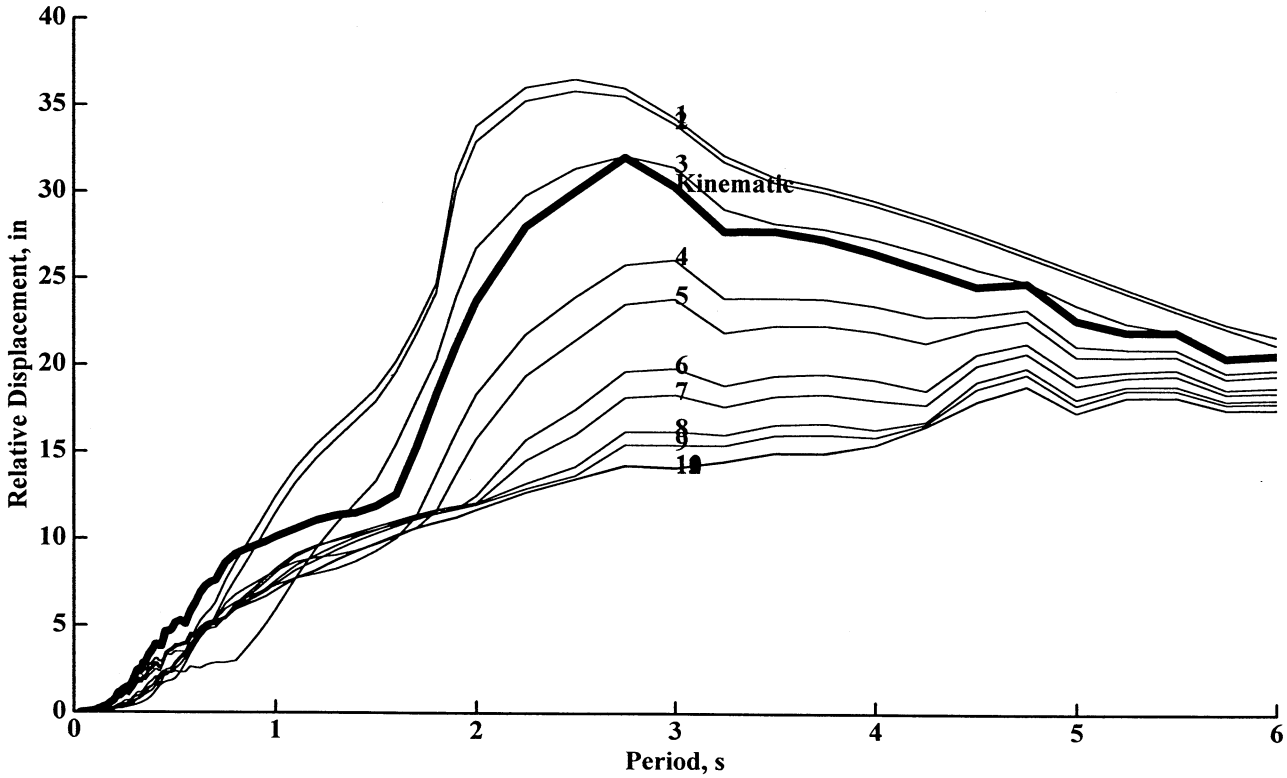

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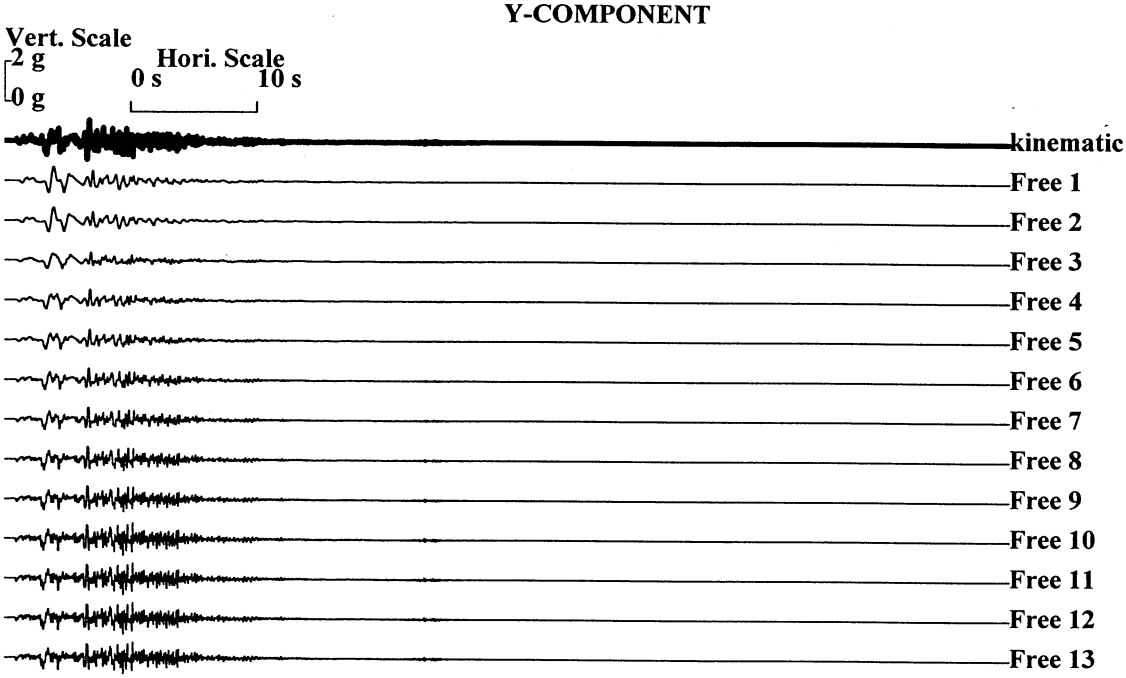

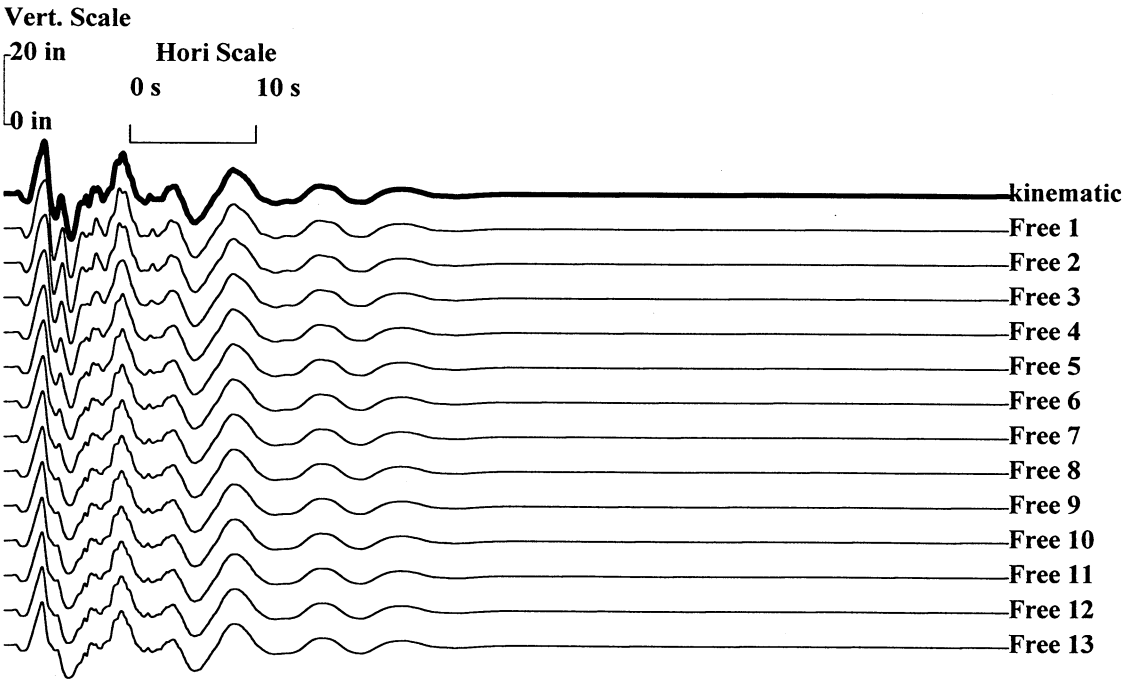

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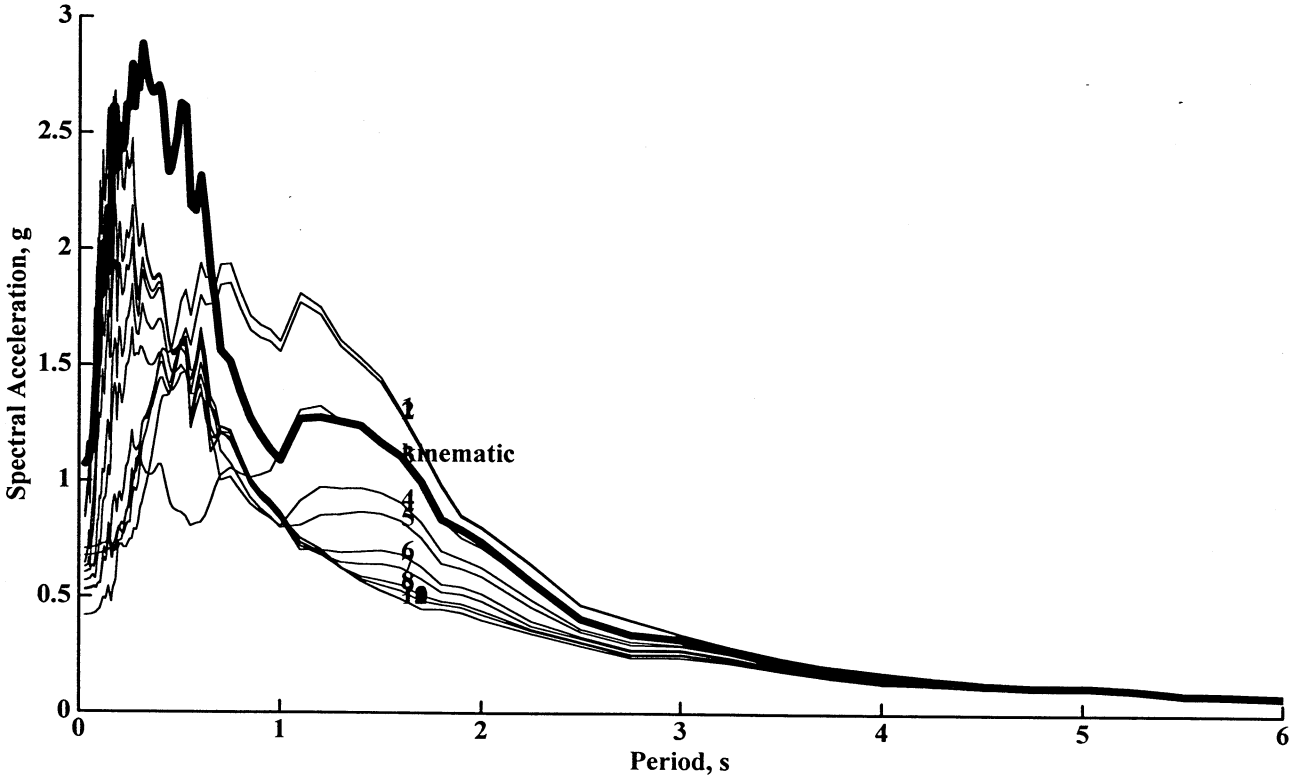

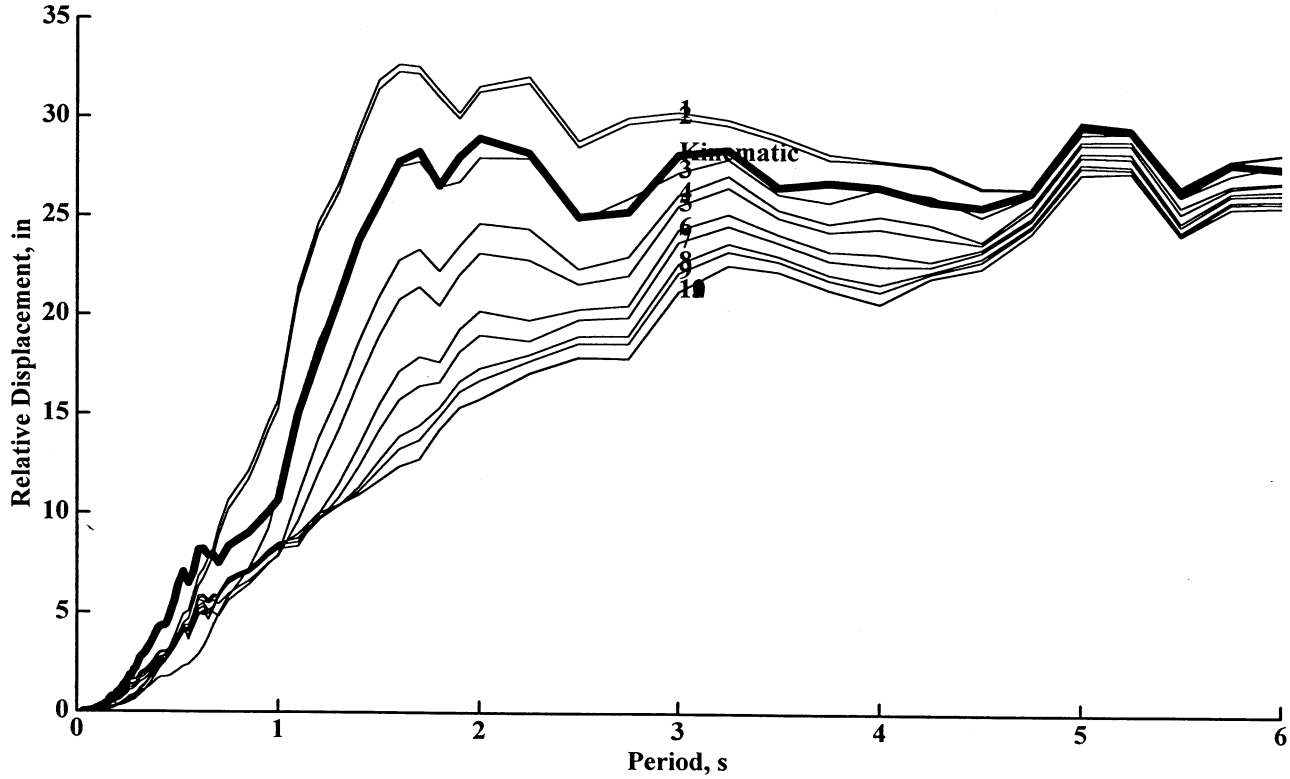

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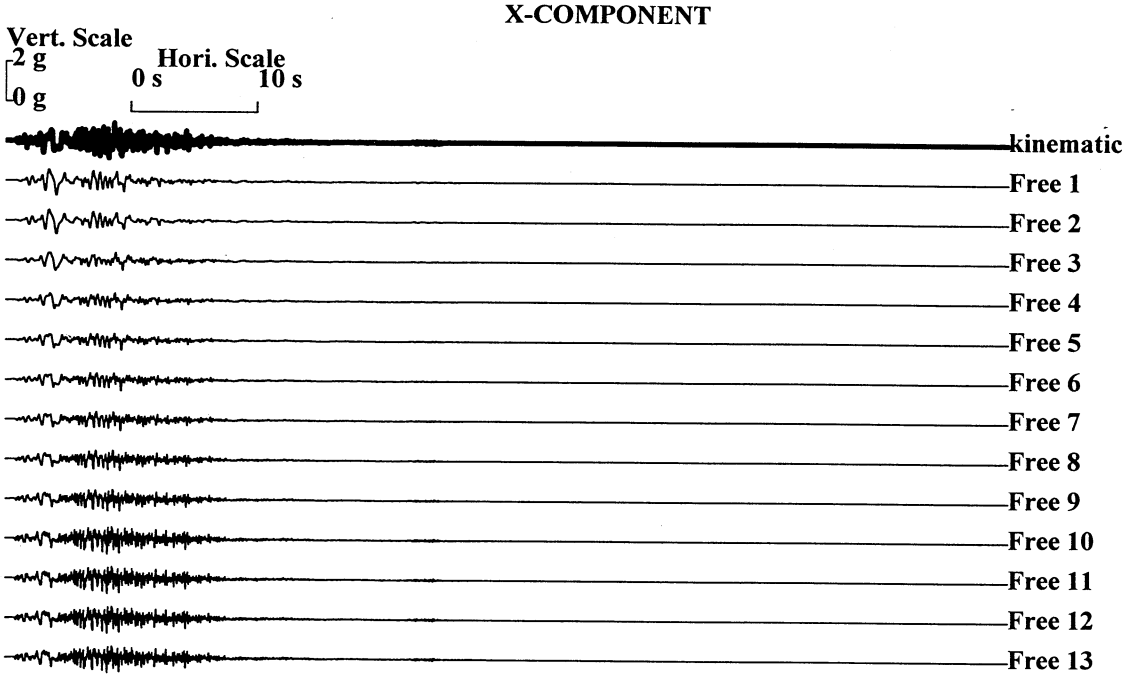

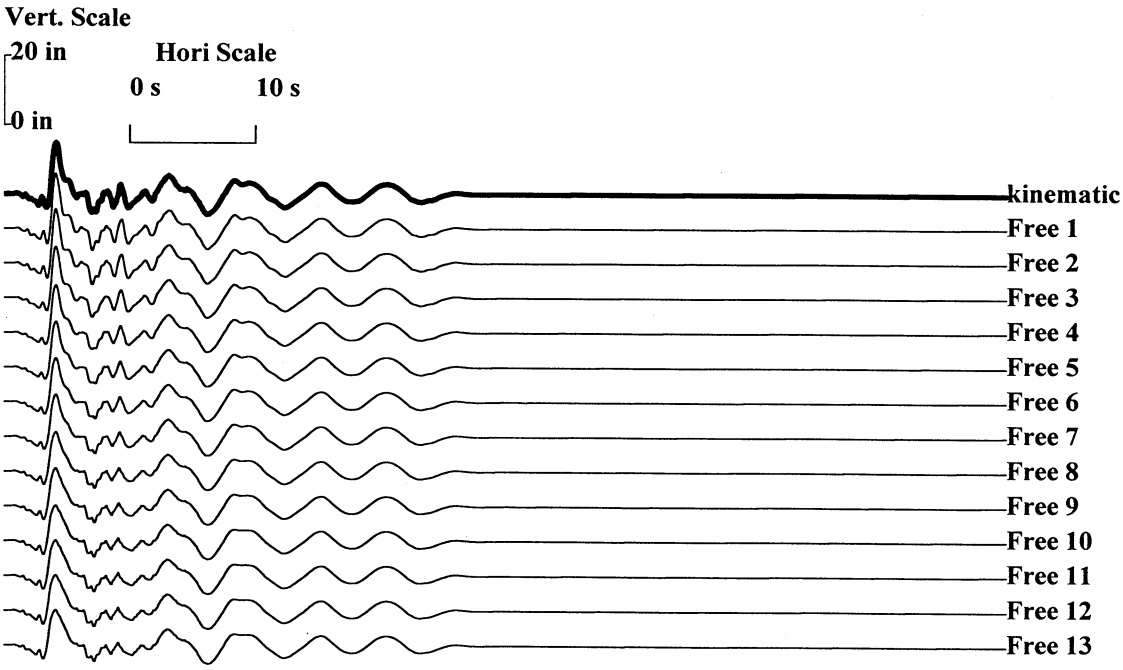

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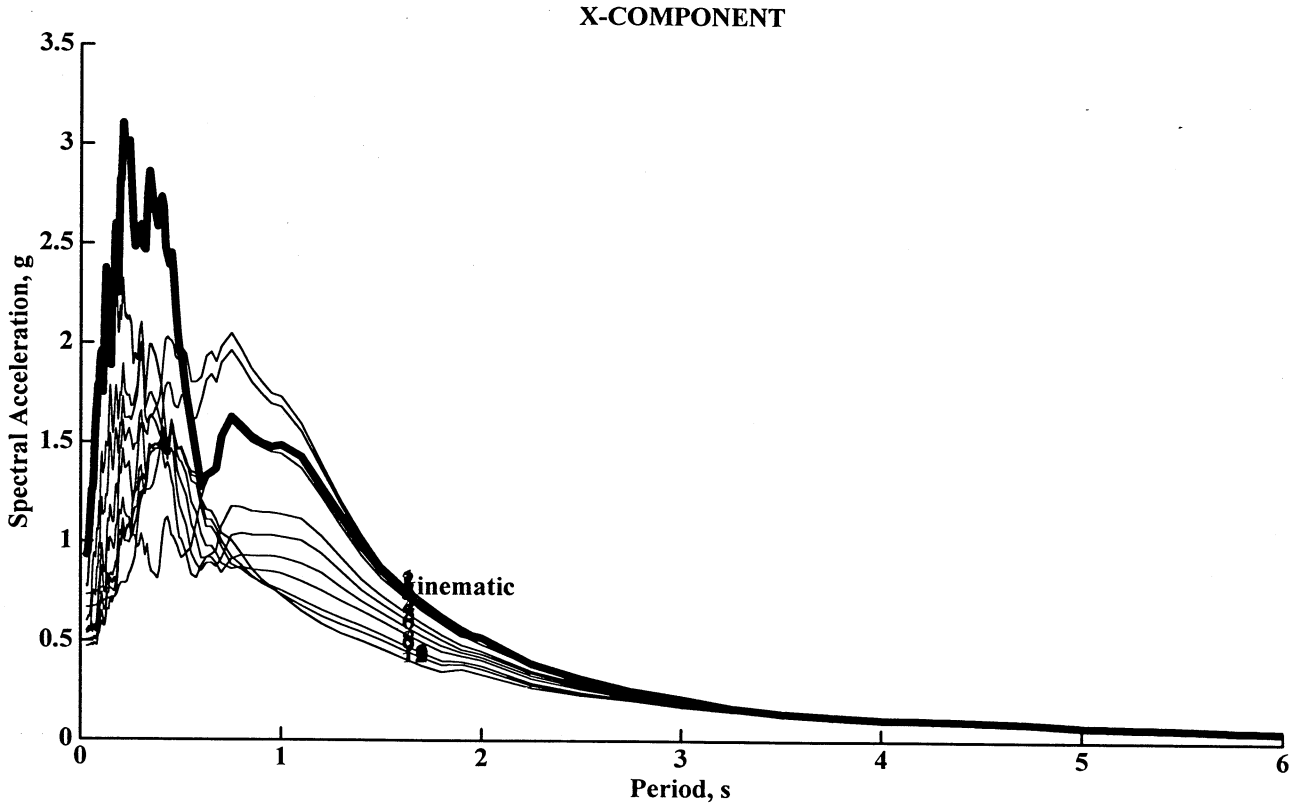

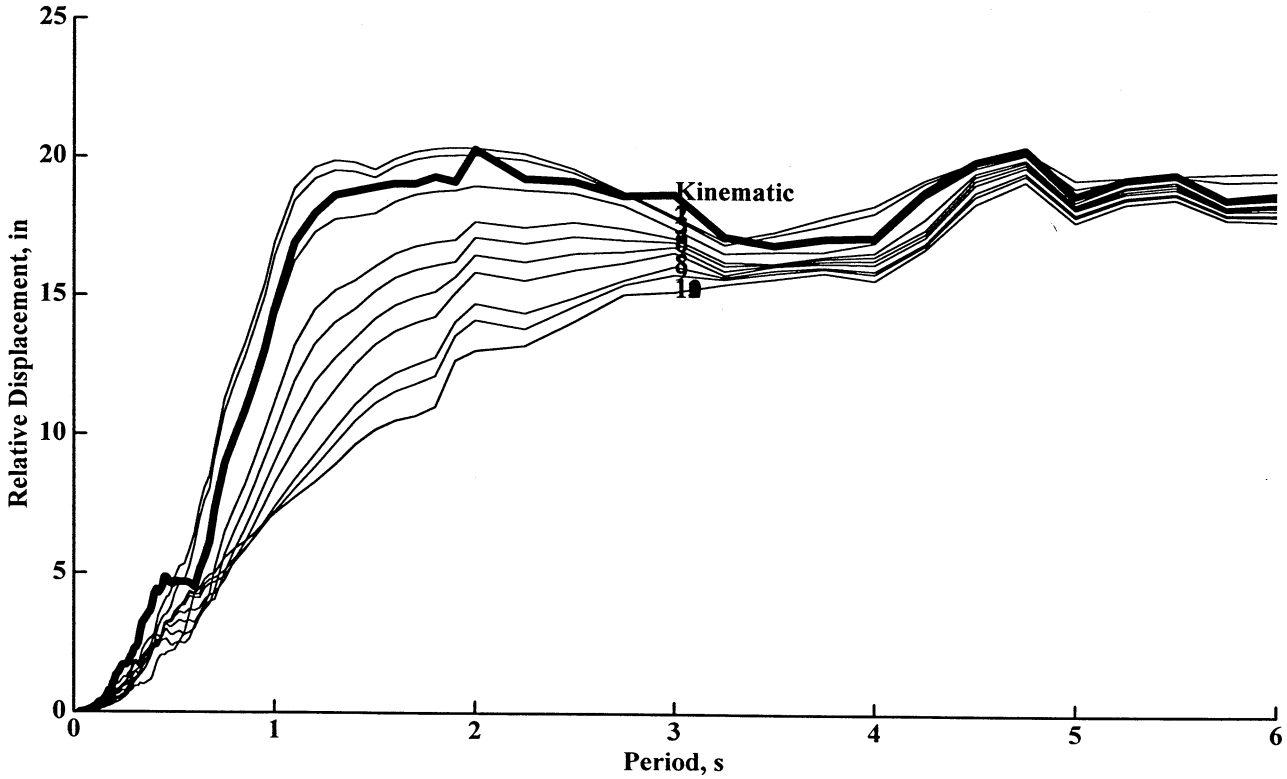

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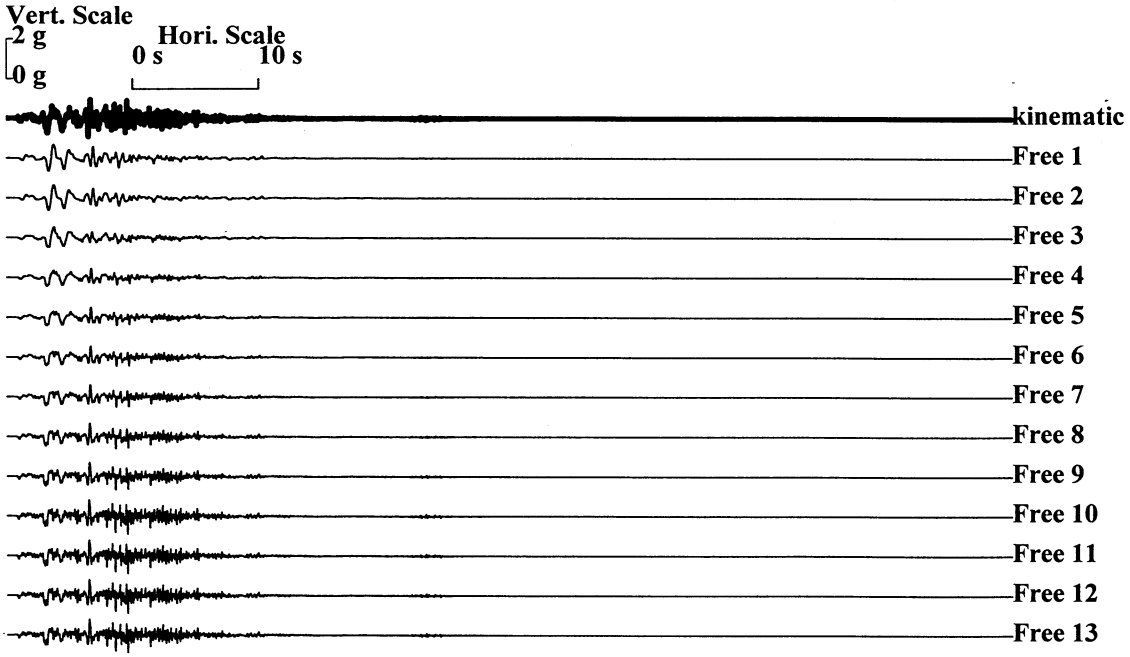

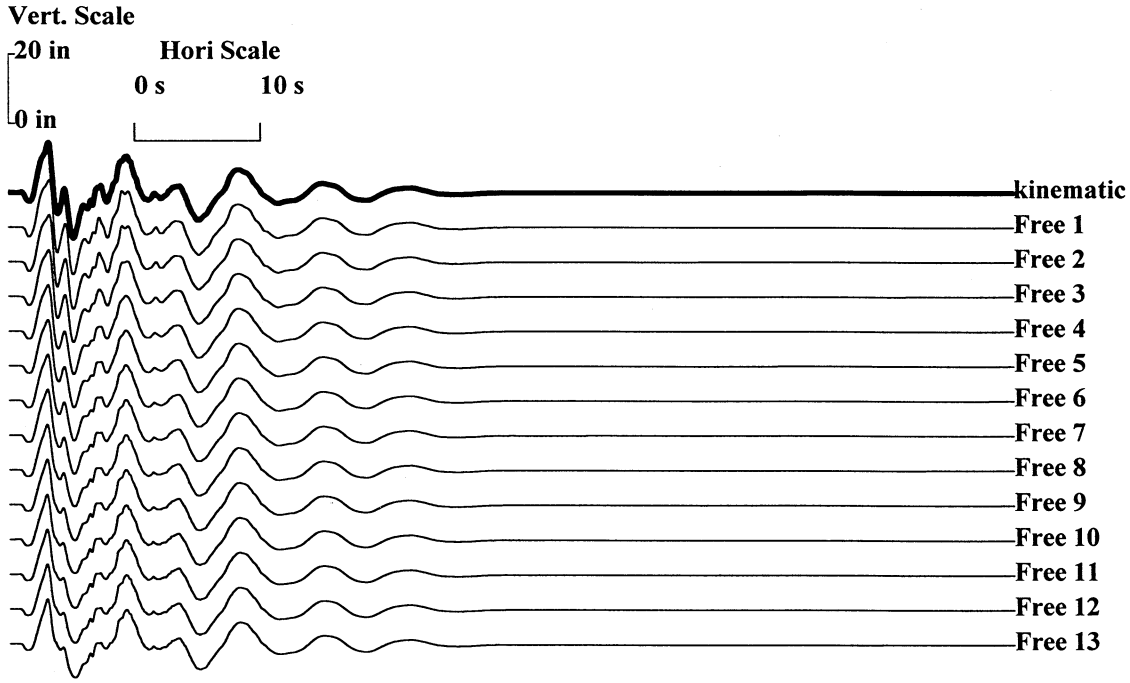

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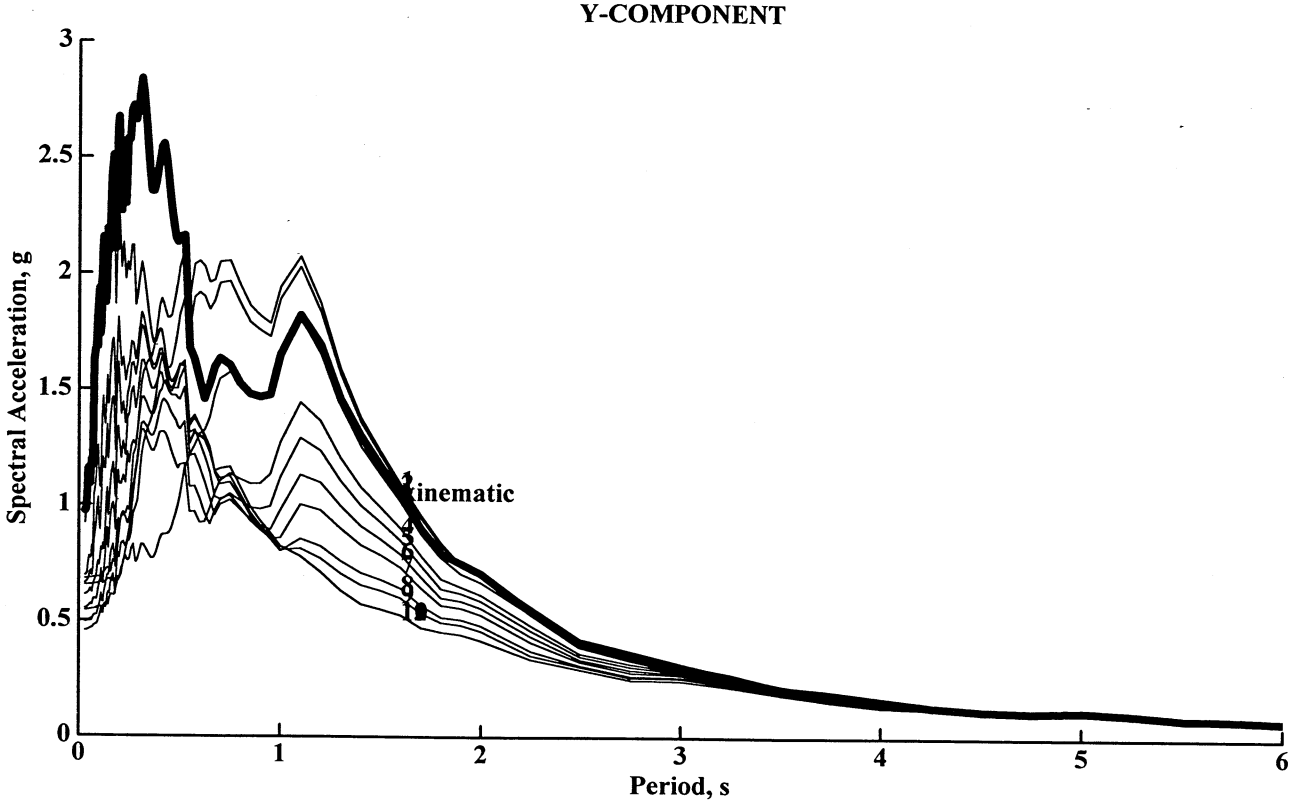

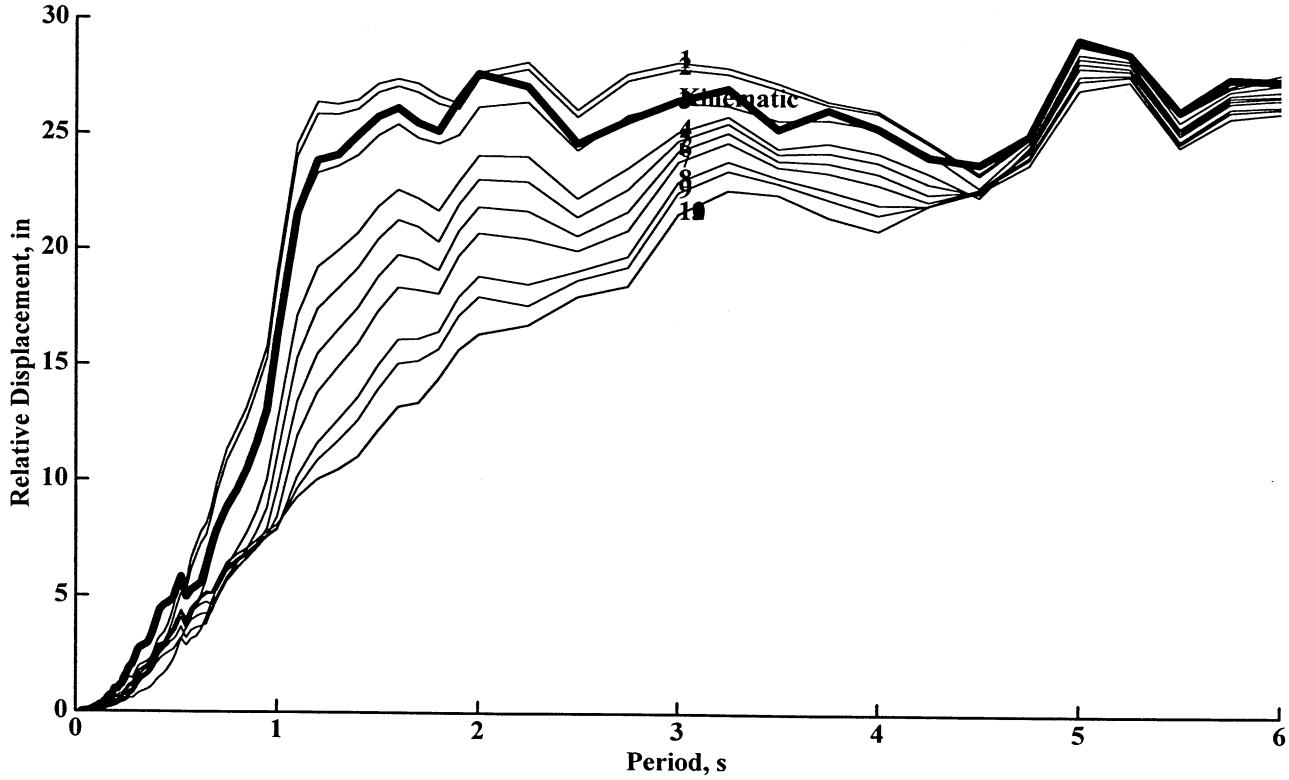

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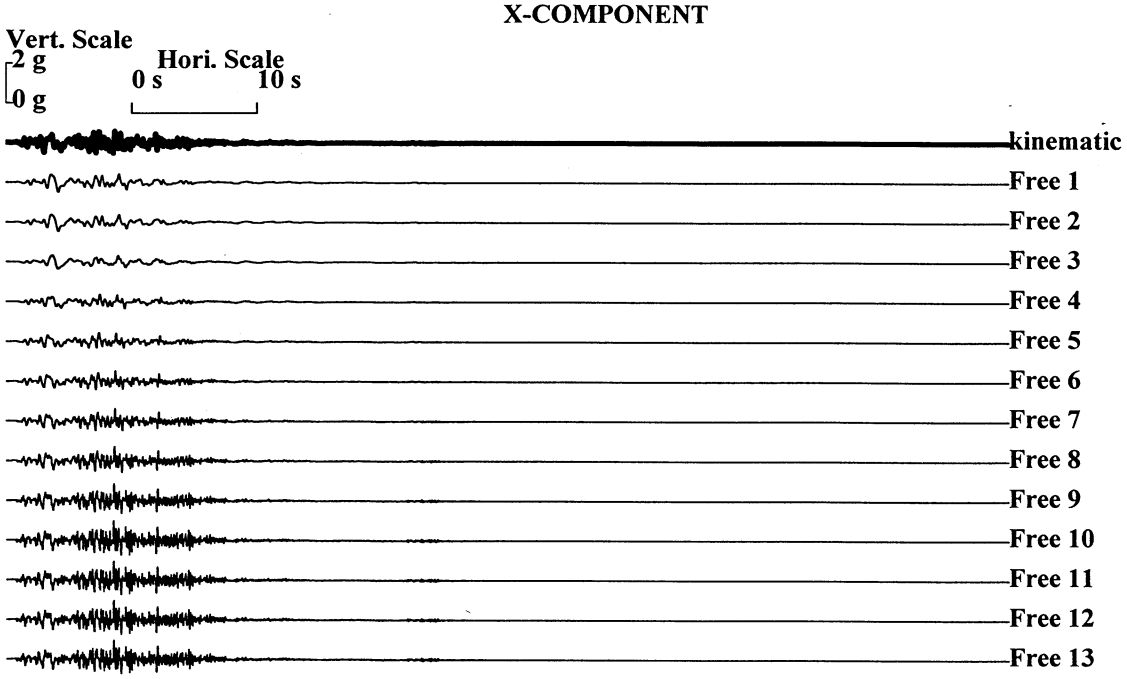

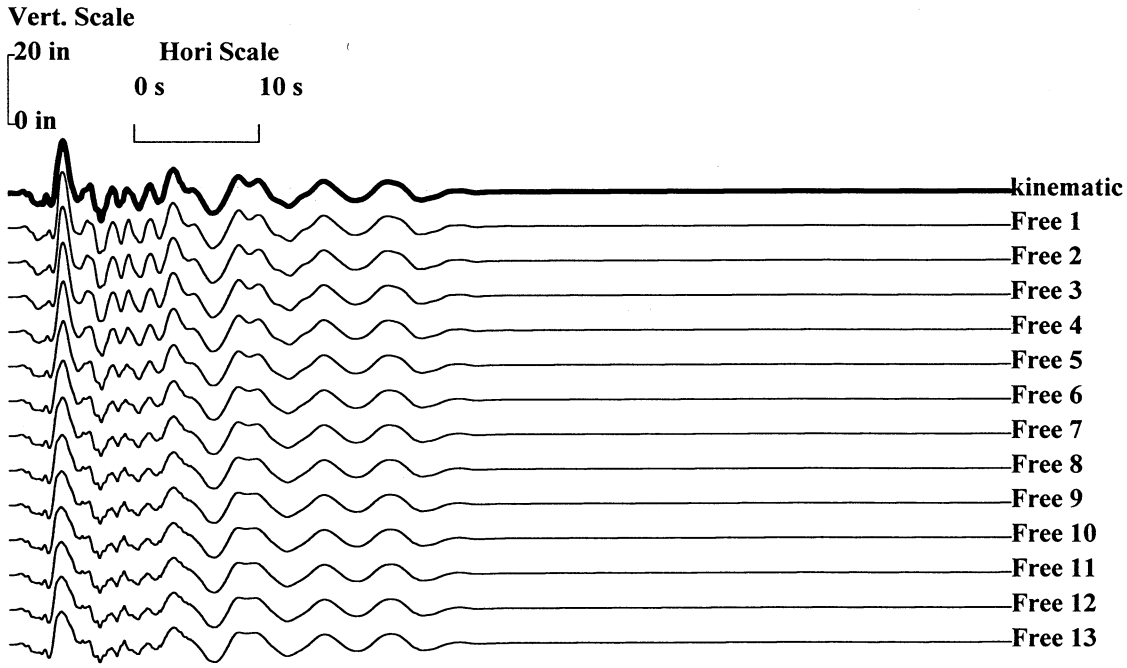

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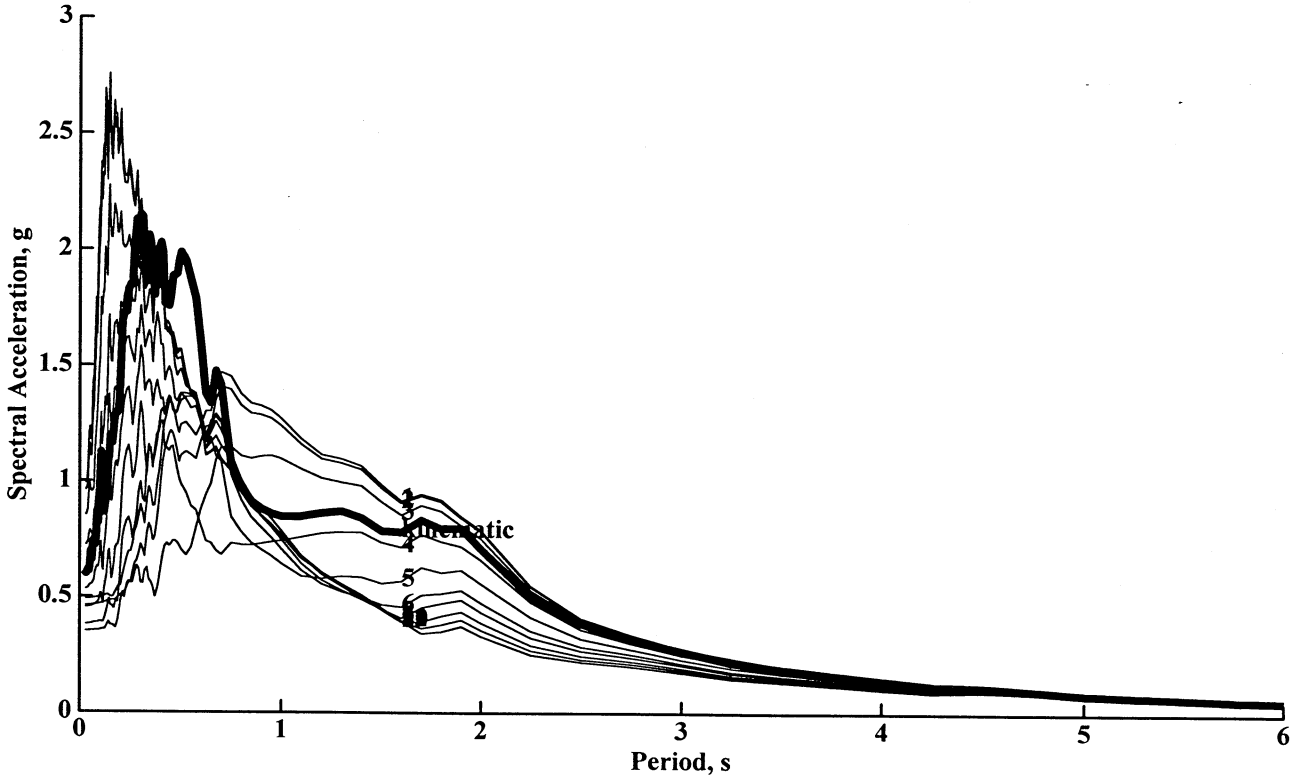

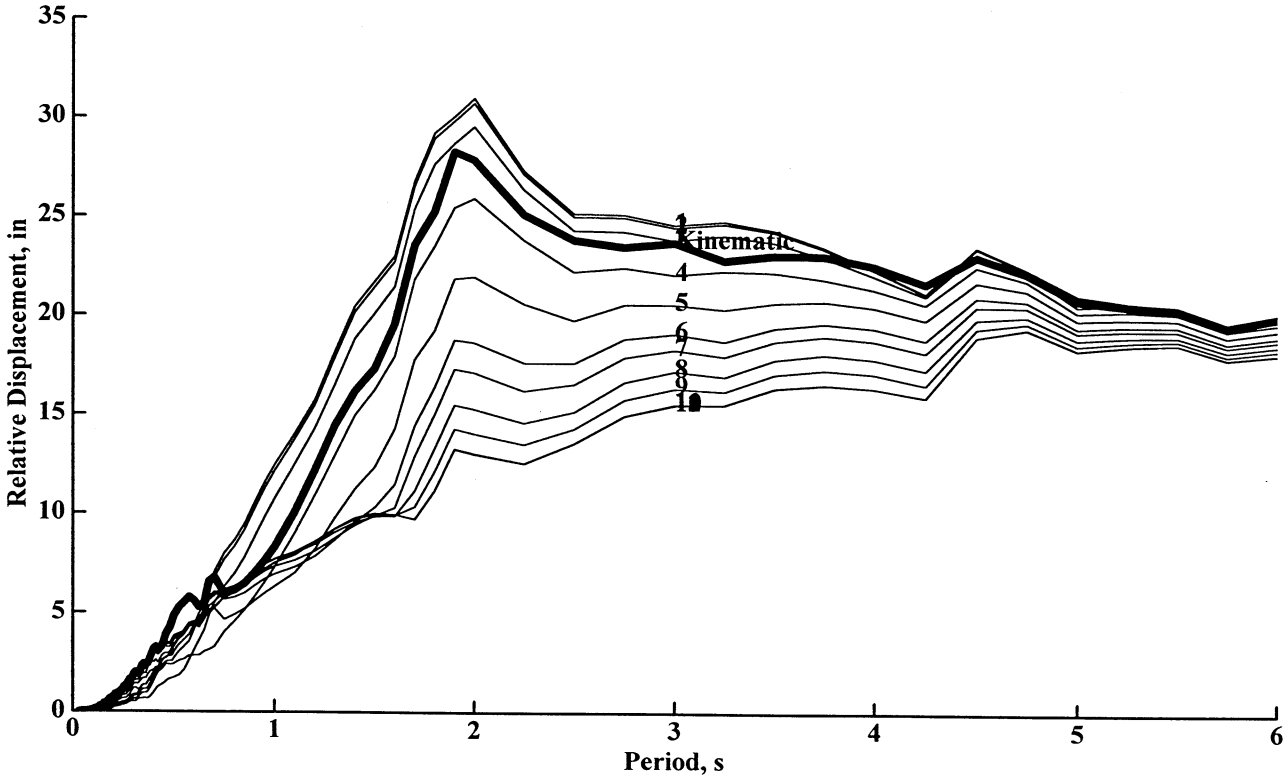

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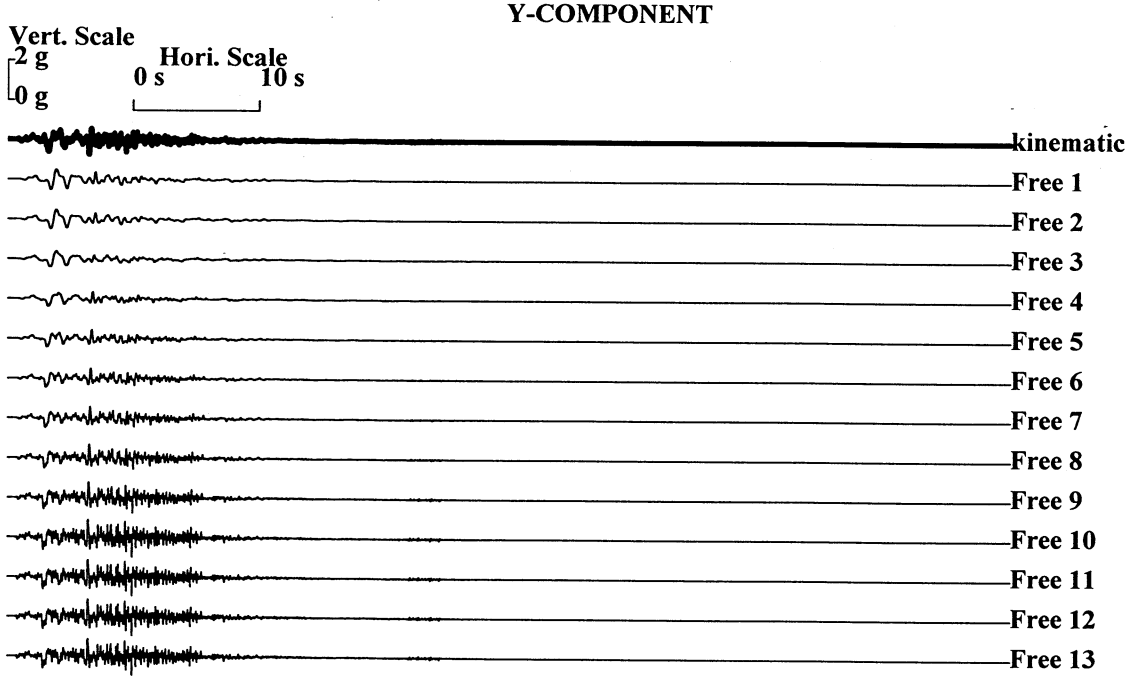

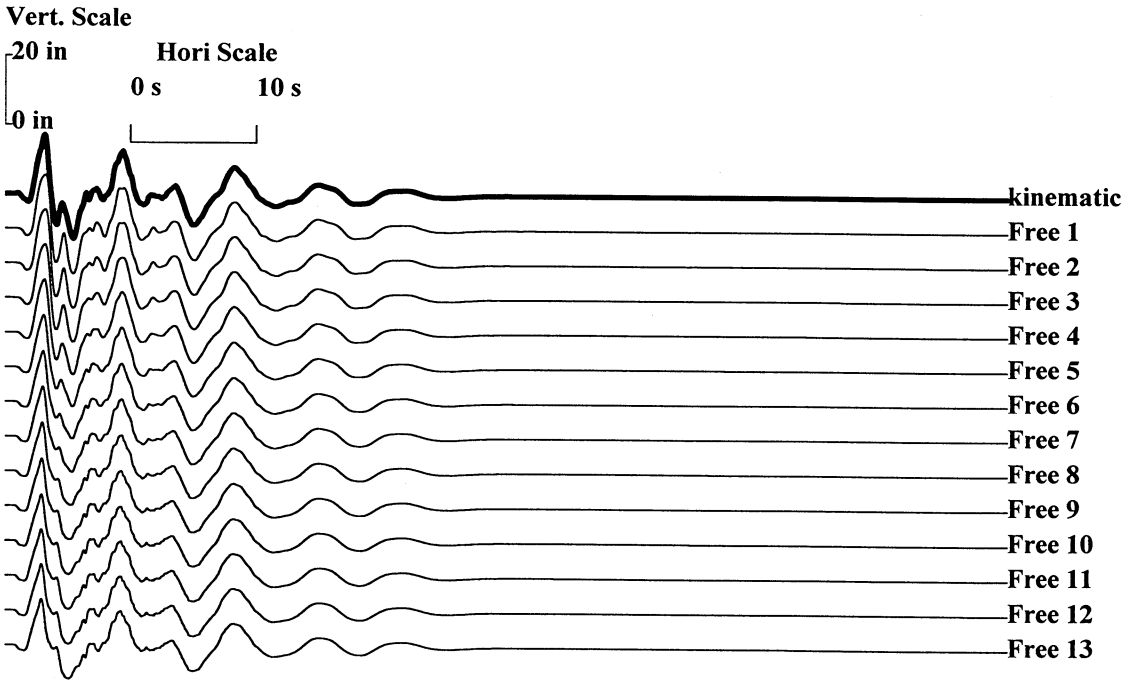

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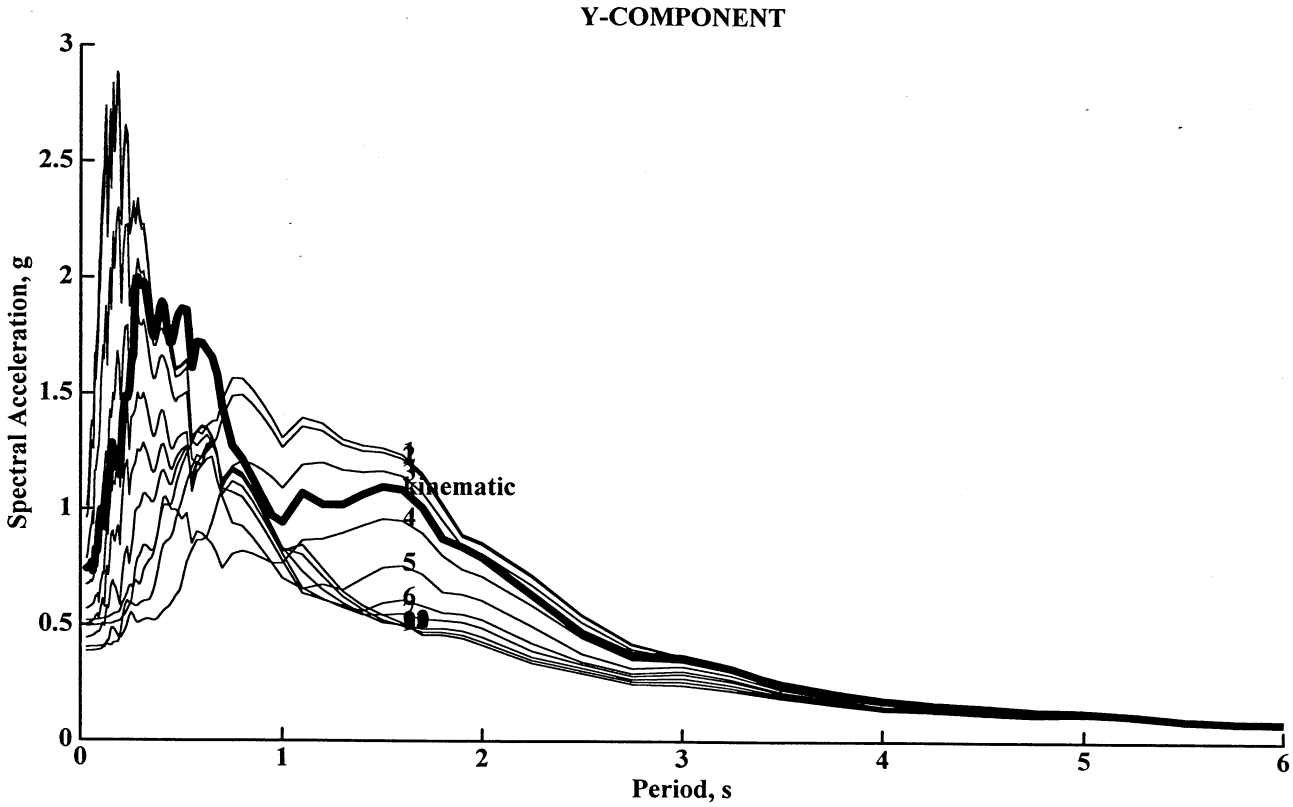

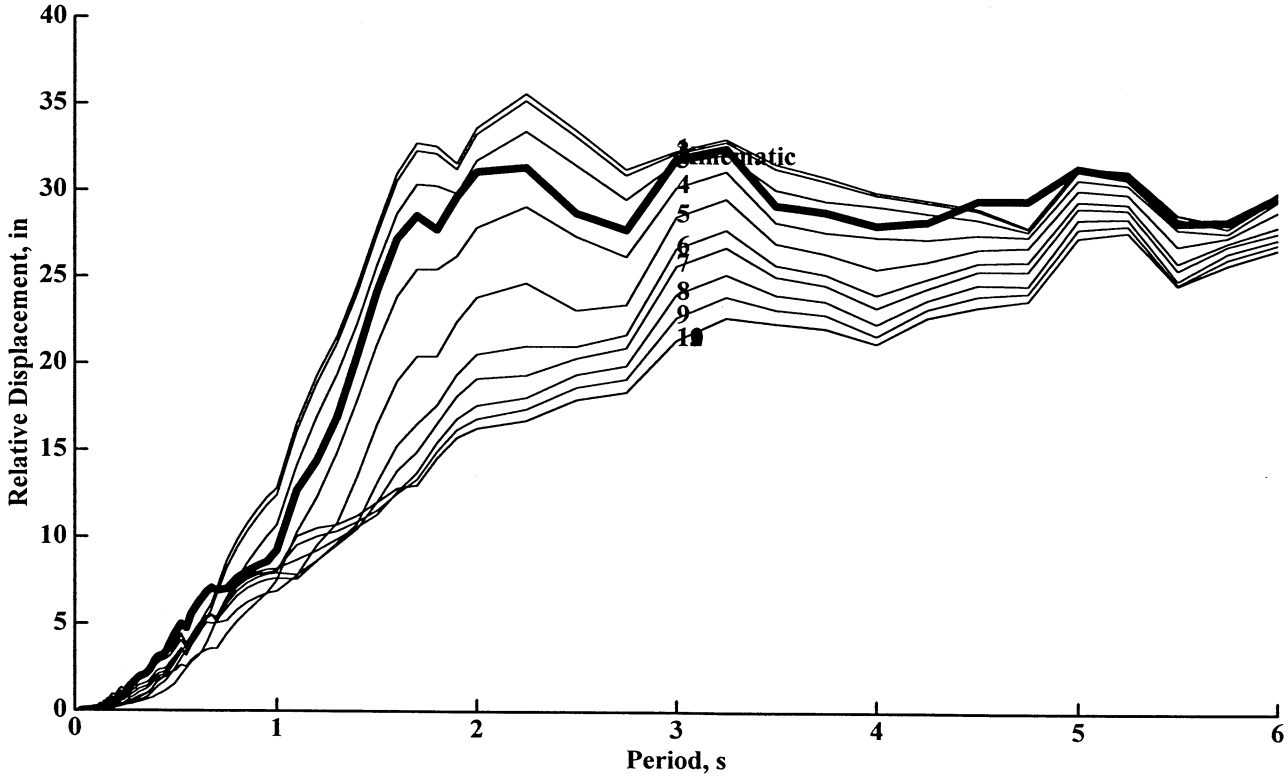

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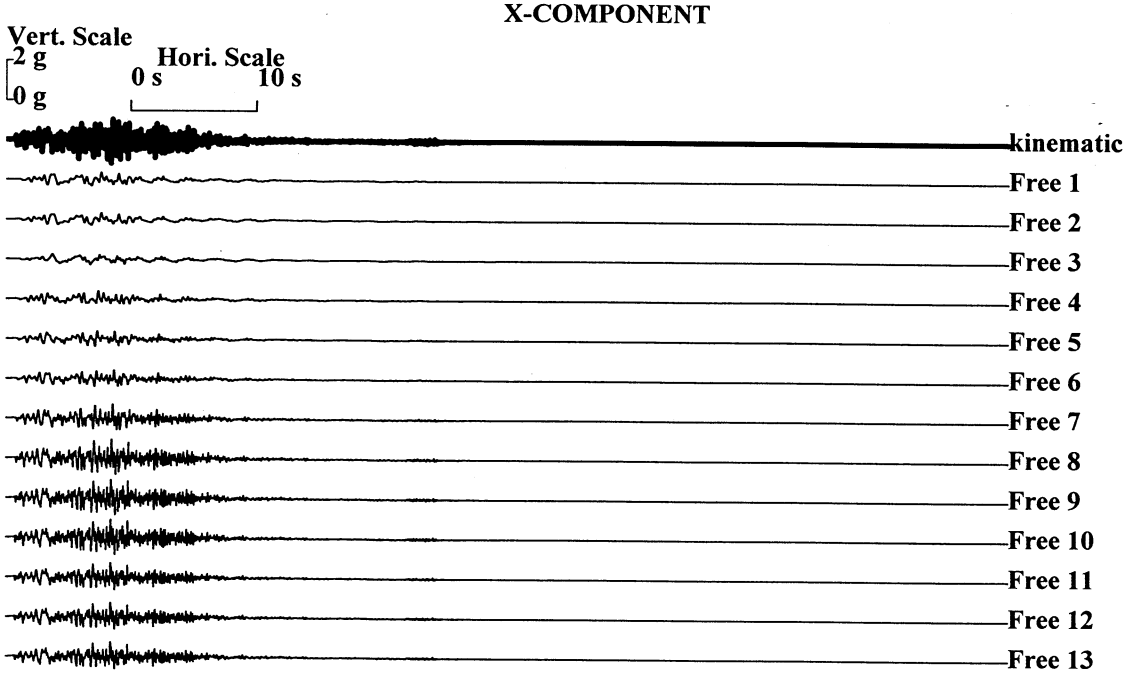

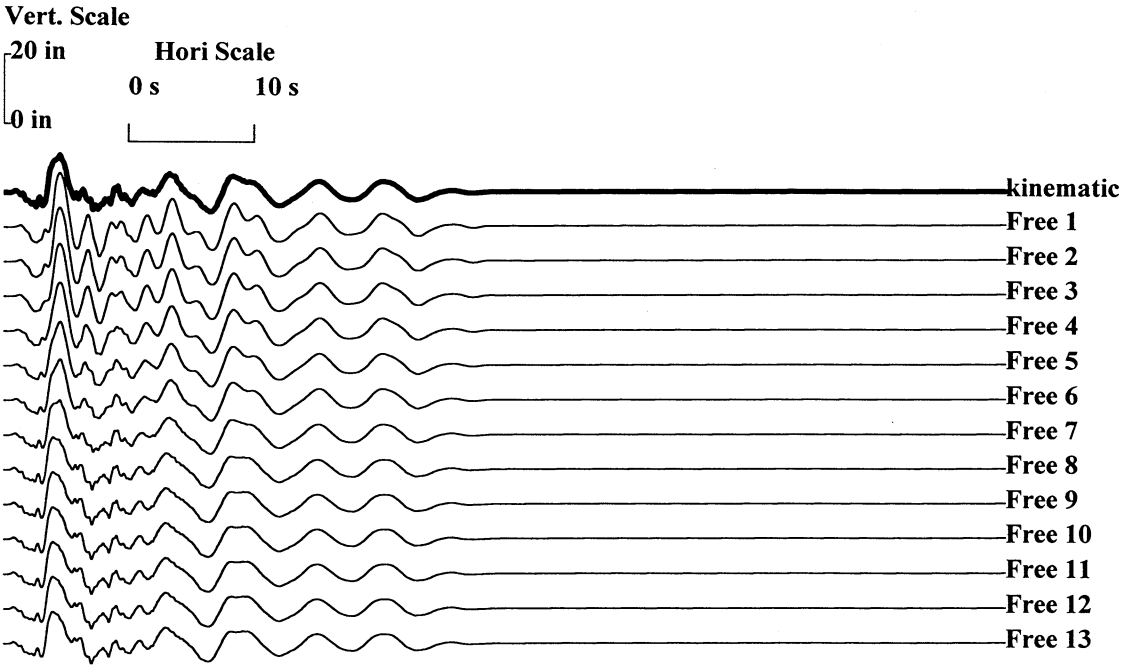

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SET 1, Long. Dir.
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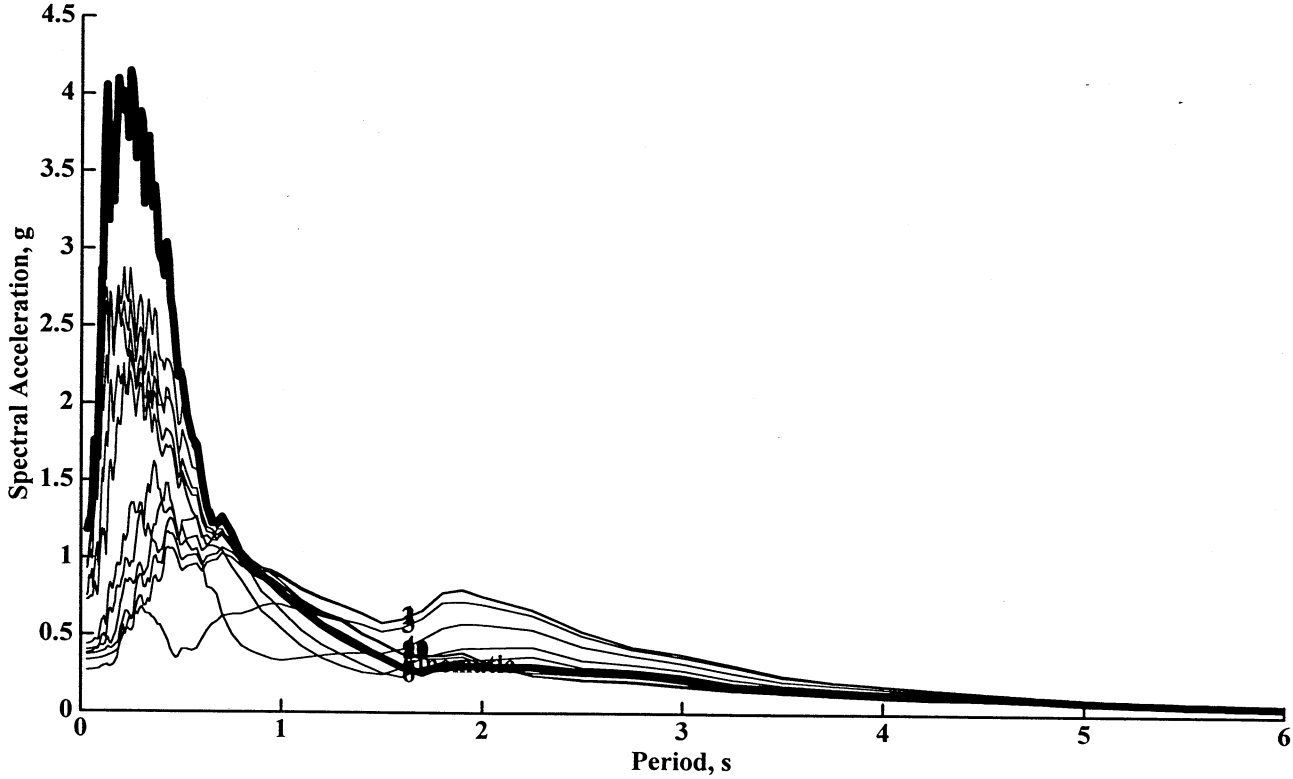

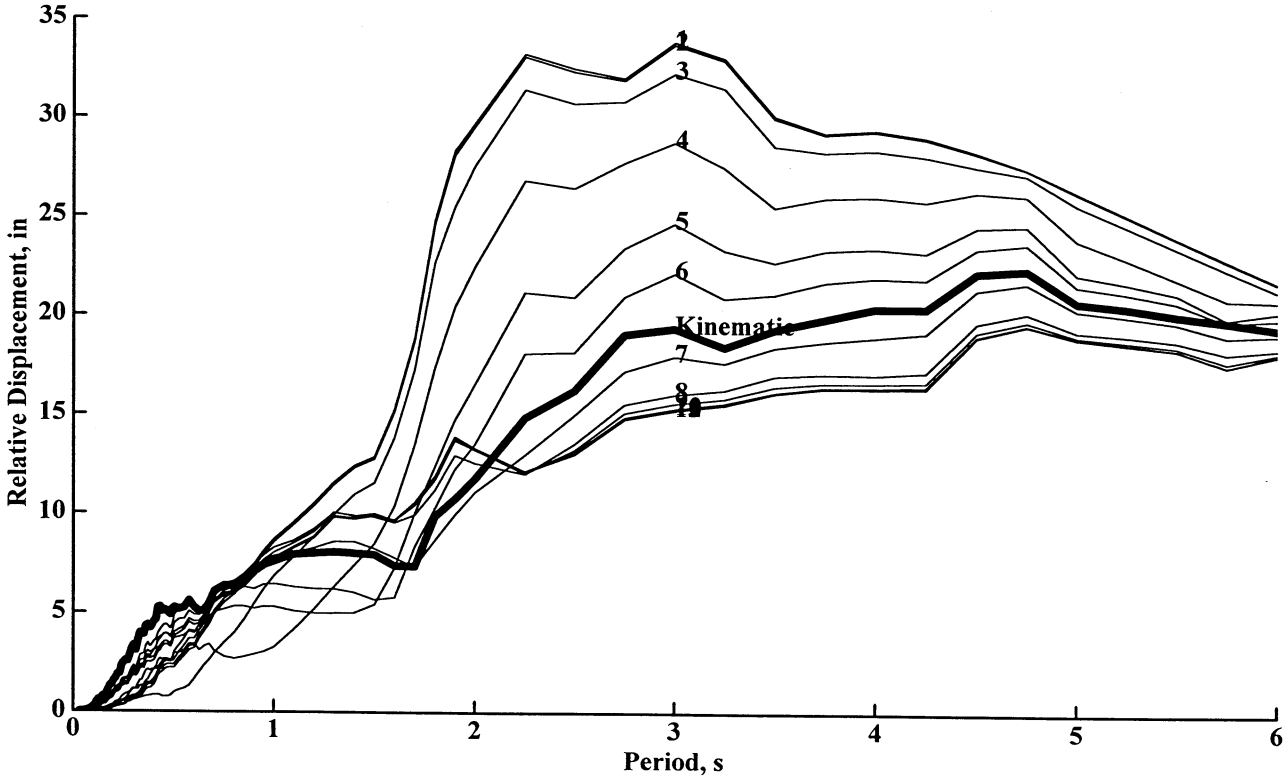

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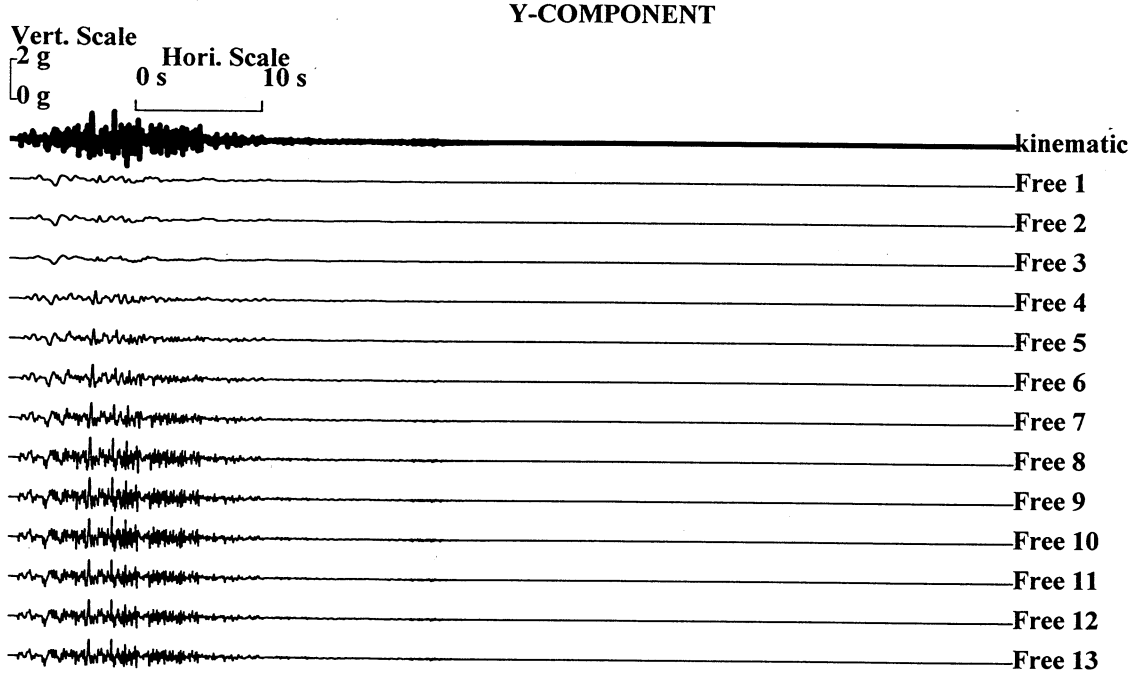

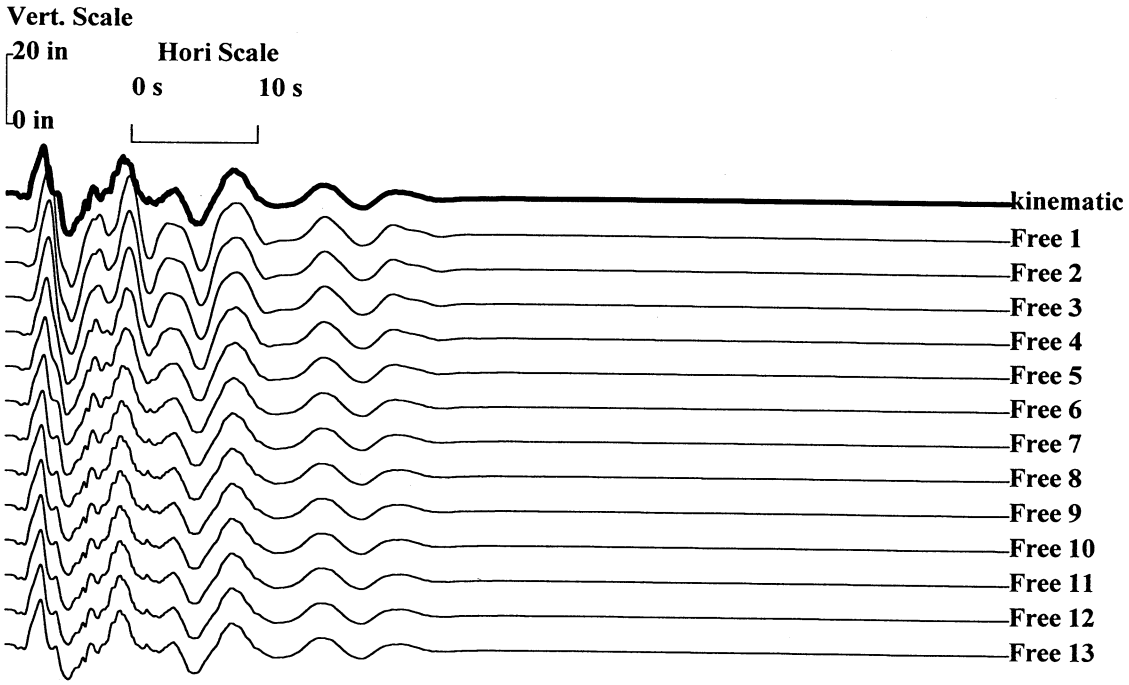

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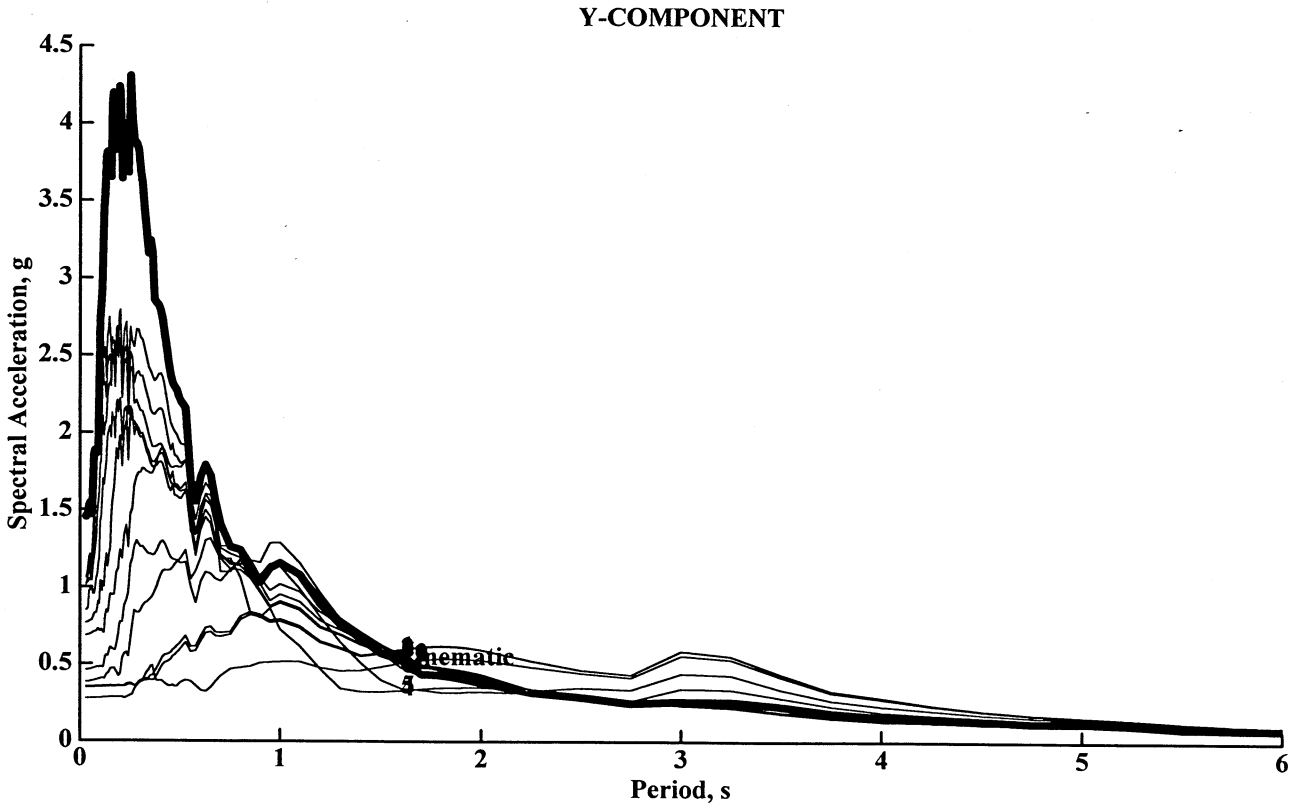

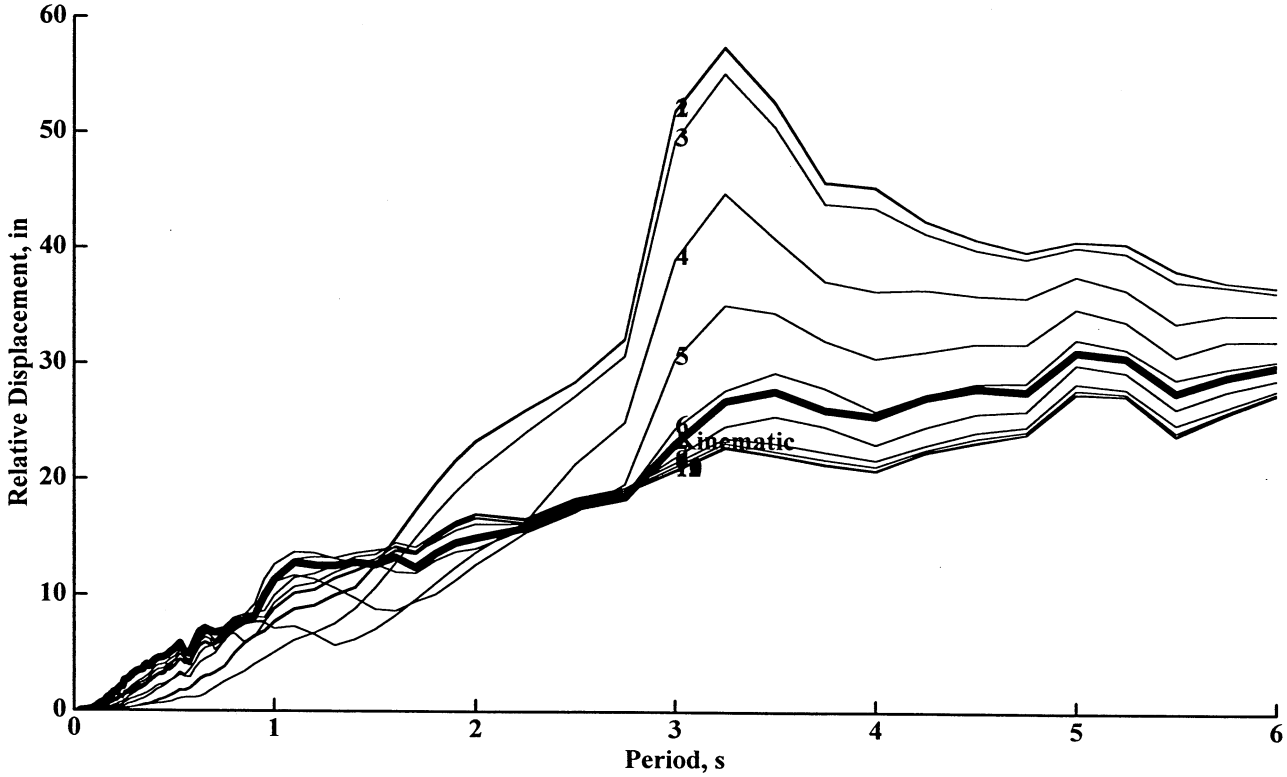

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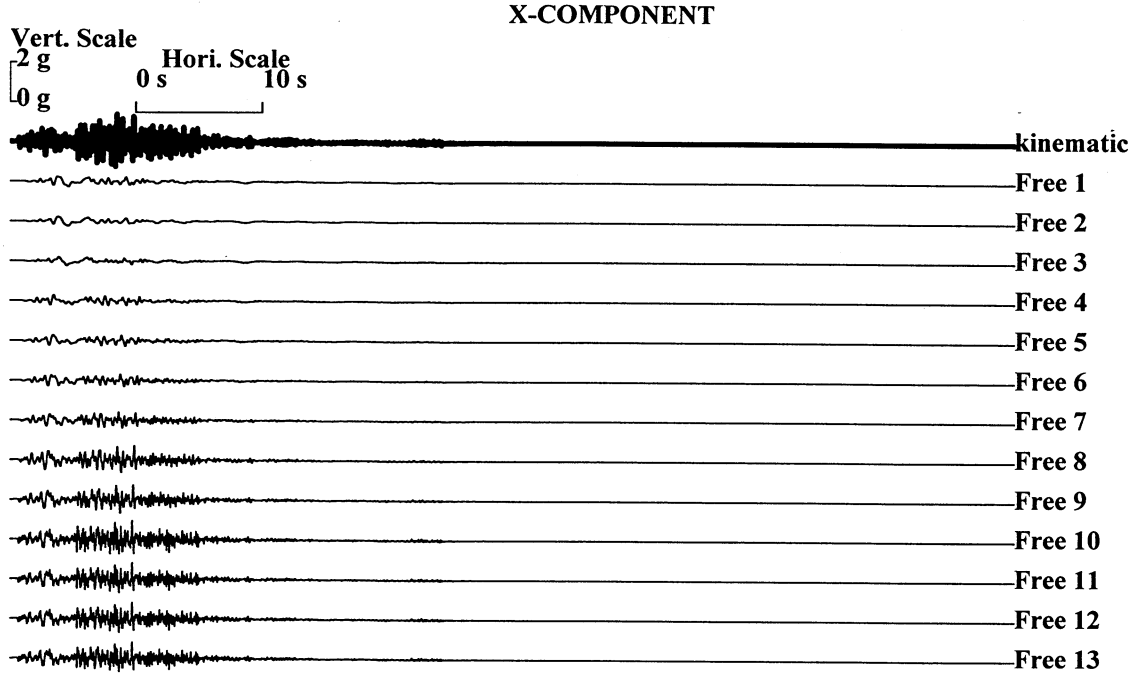

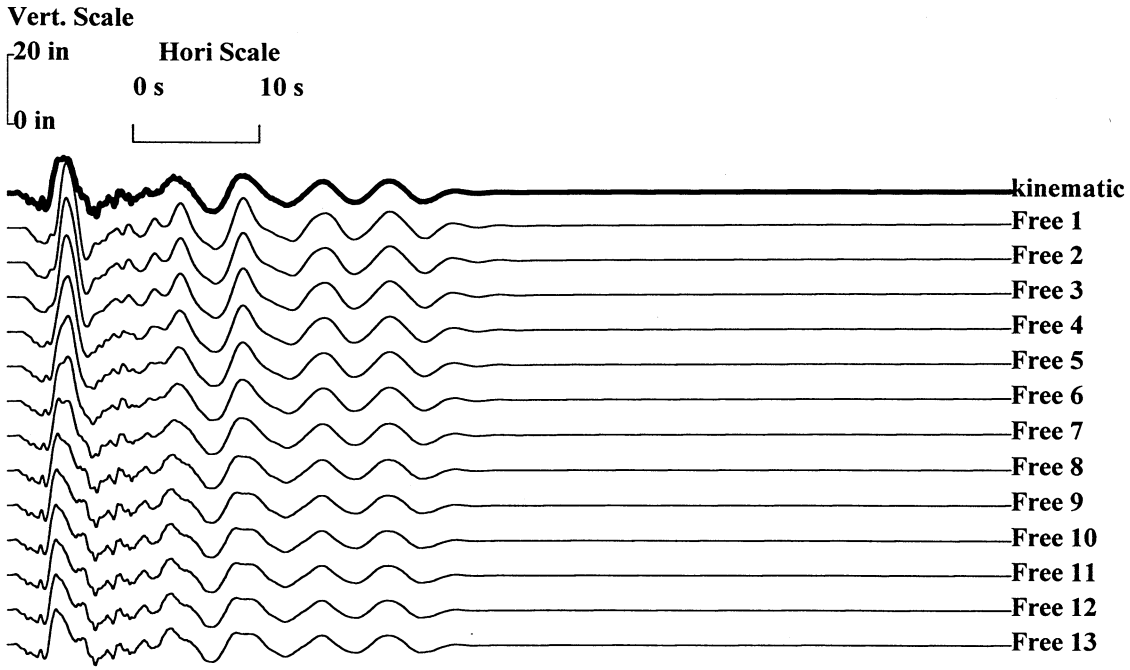

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SET 1, Long. Dir.
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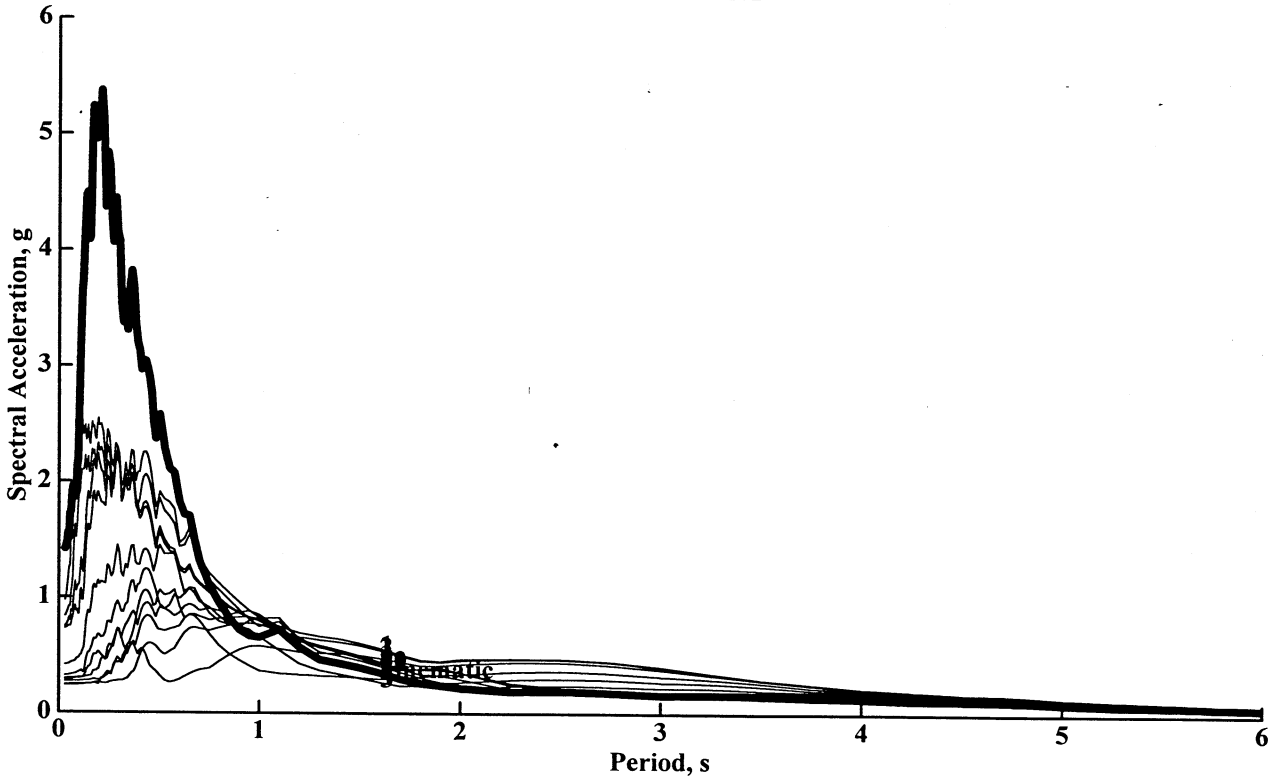

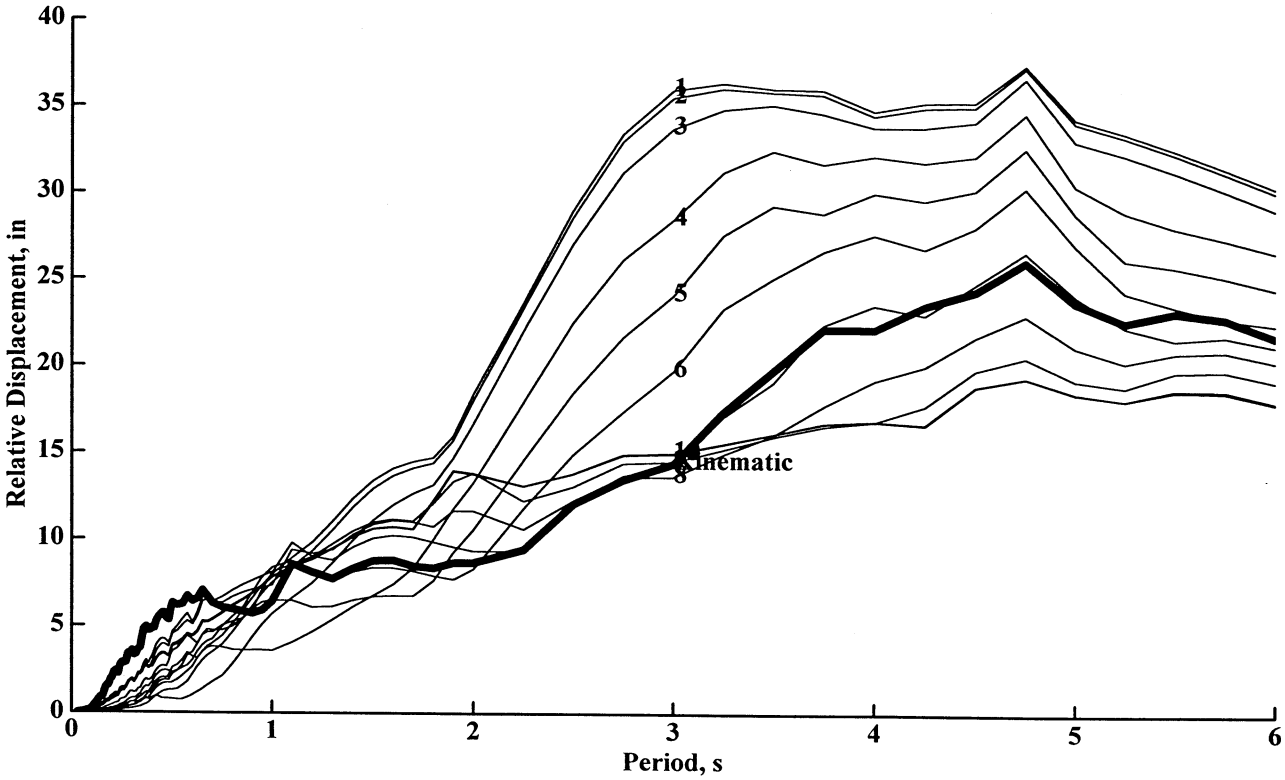

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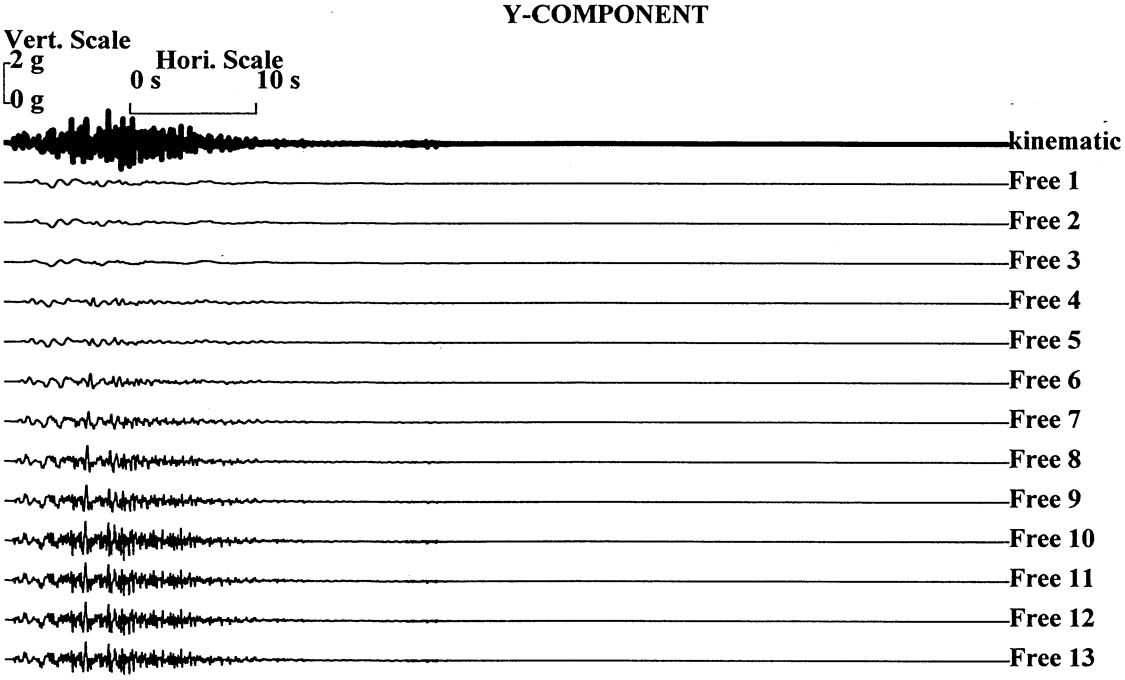

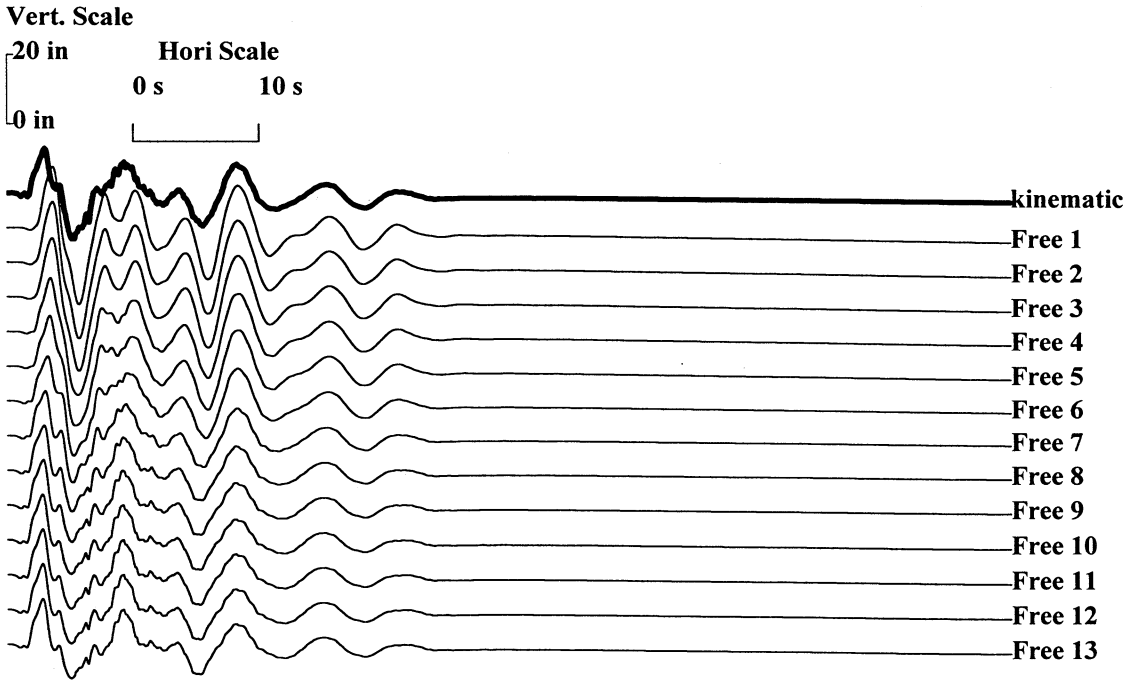

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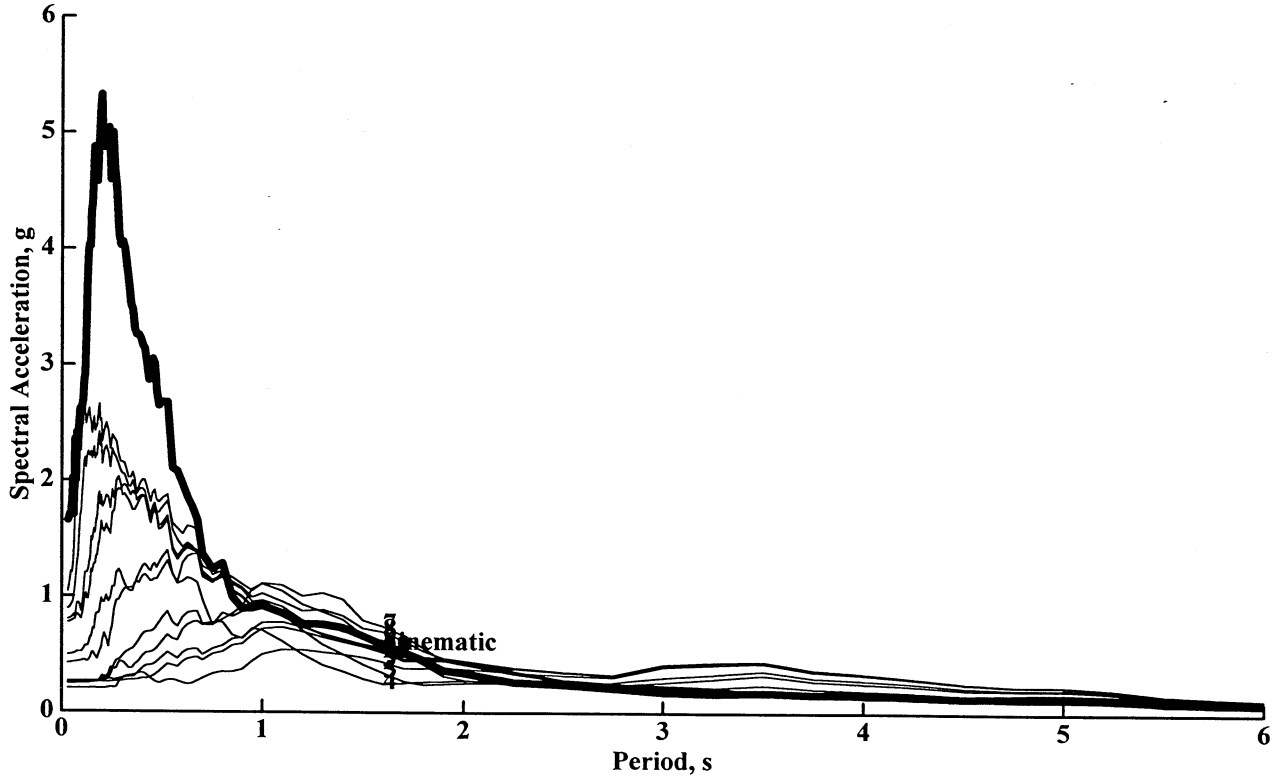

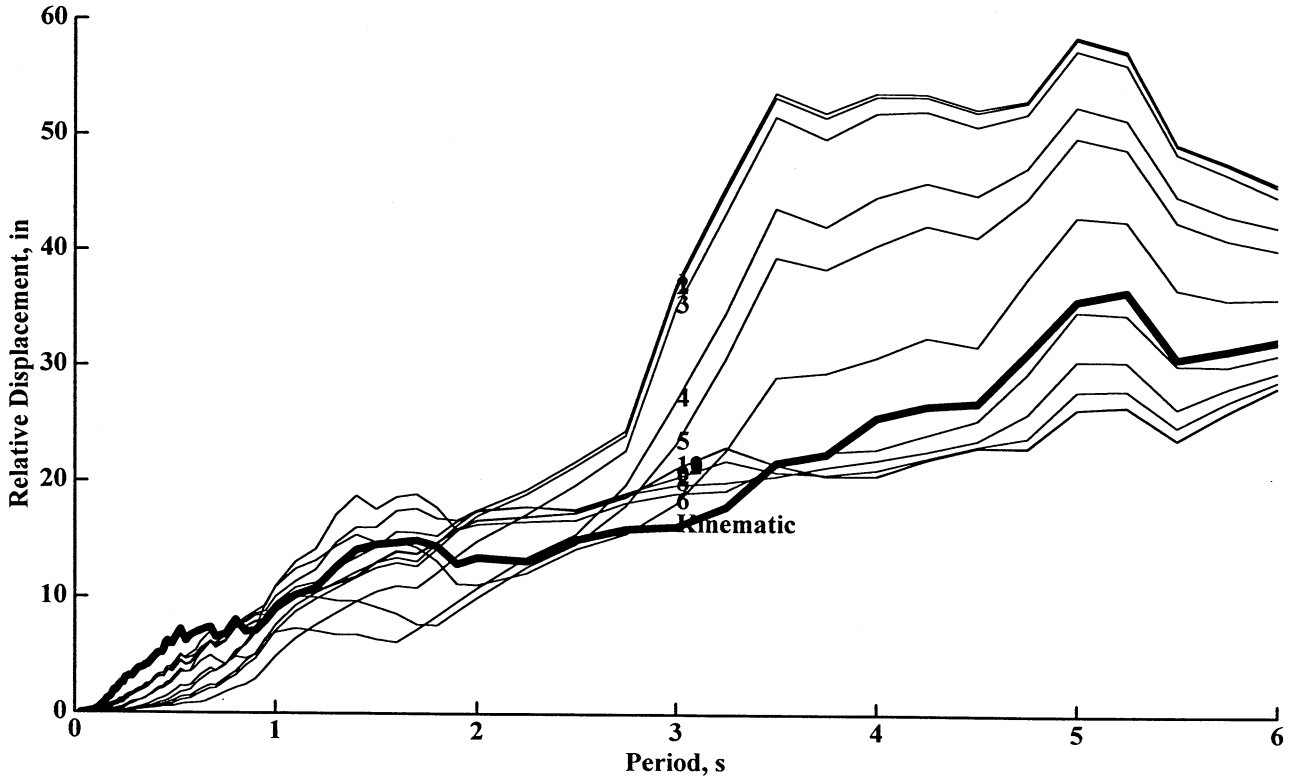

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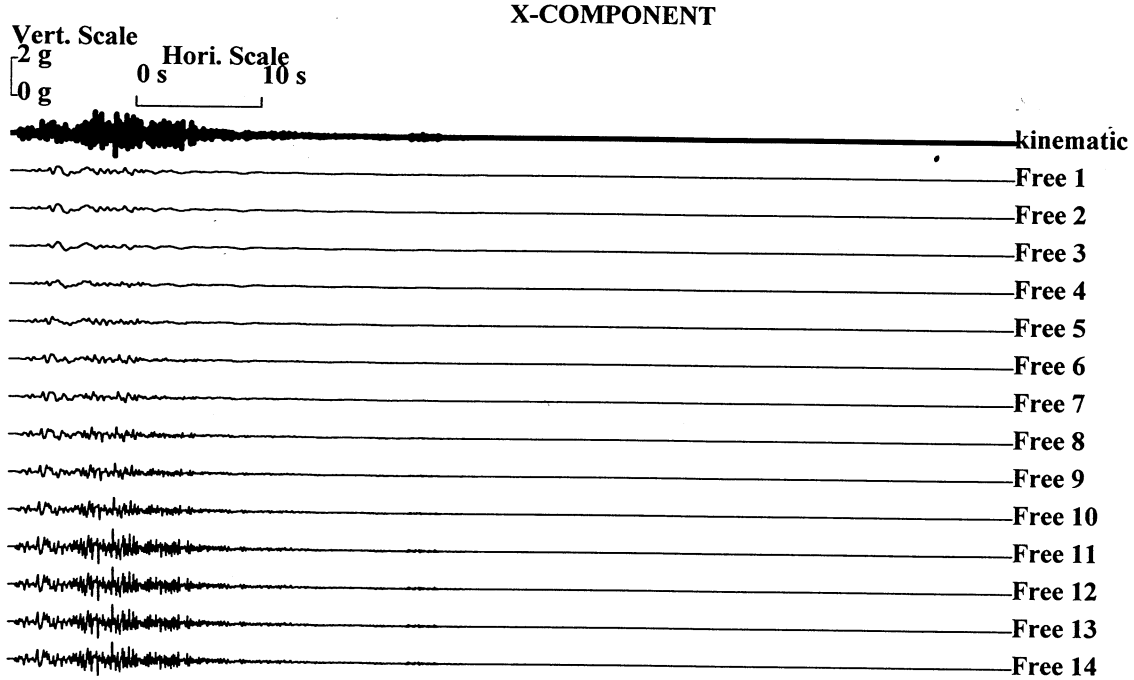

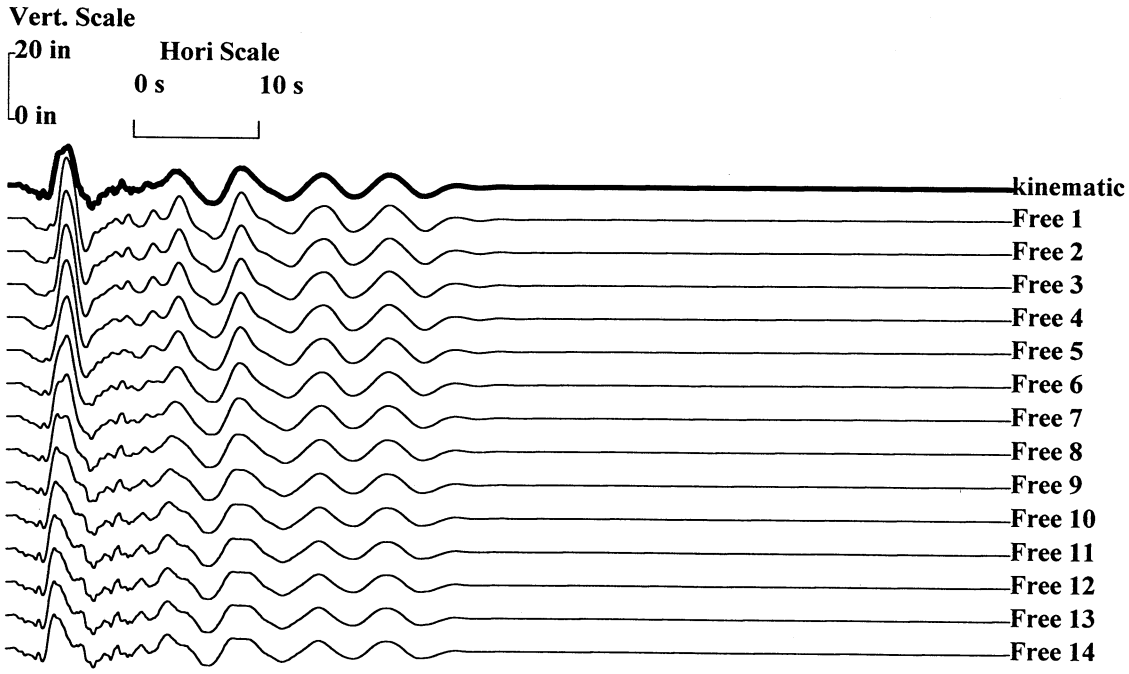

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SET 1, Long. Dir.
BENICIA-MARTINEZ

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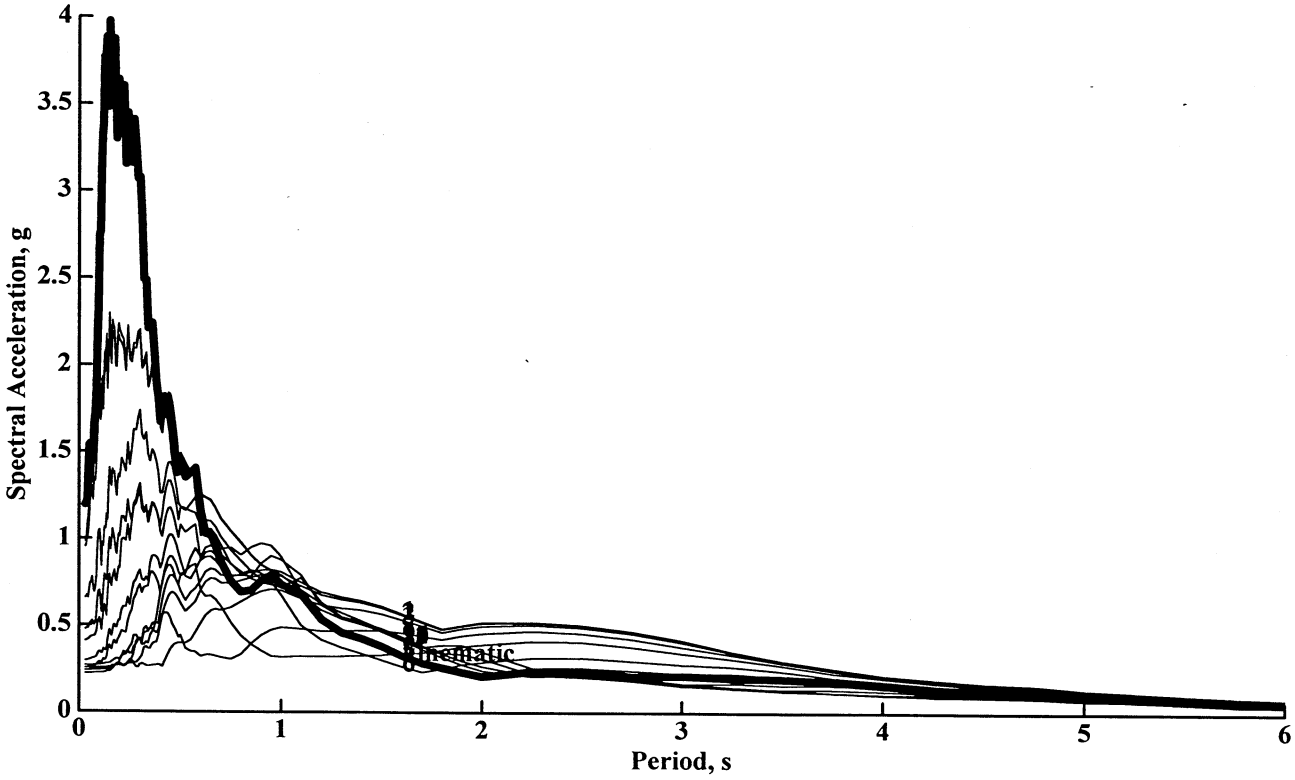

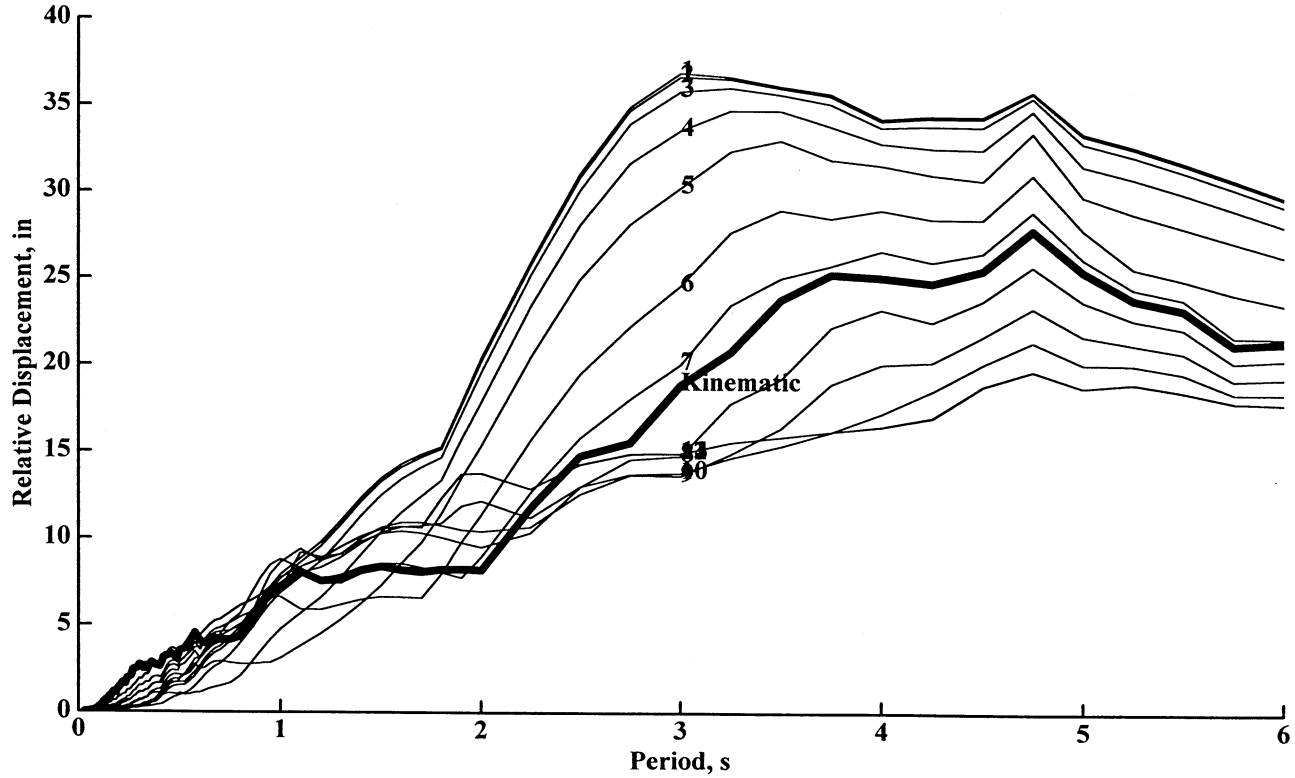

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SET 1, Long. Dir.
BENICIA-MARTINEZ

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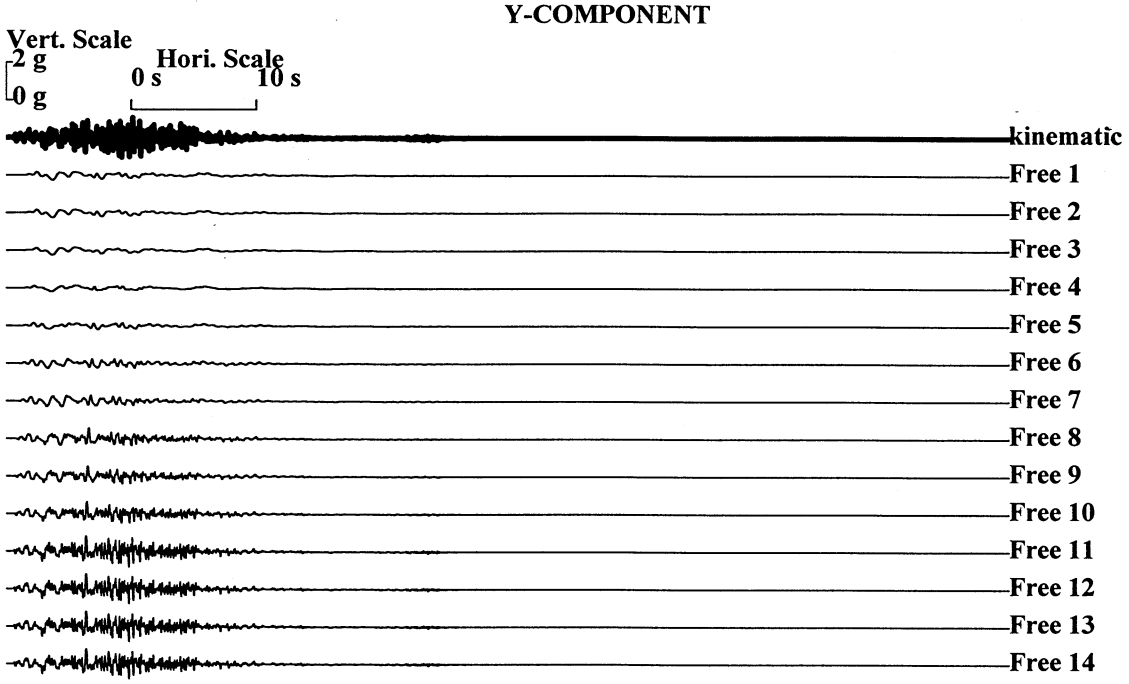

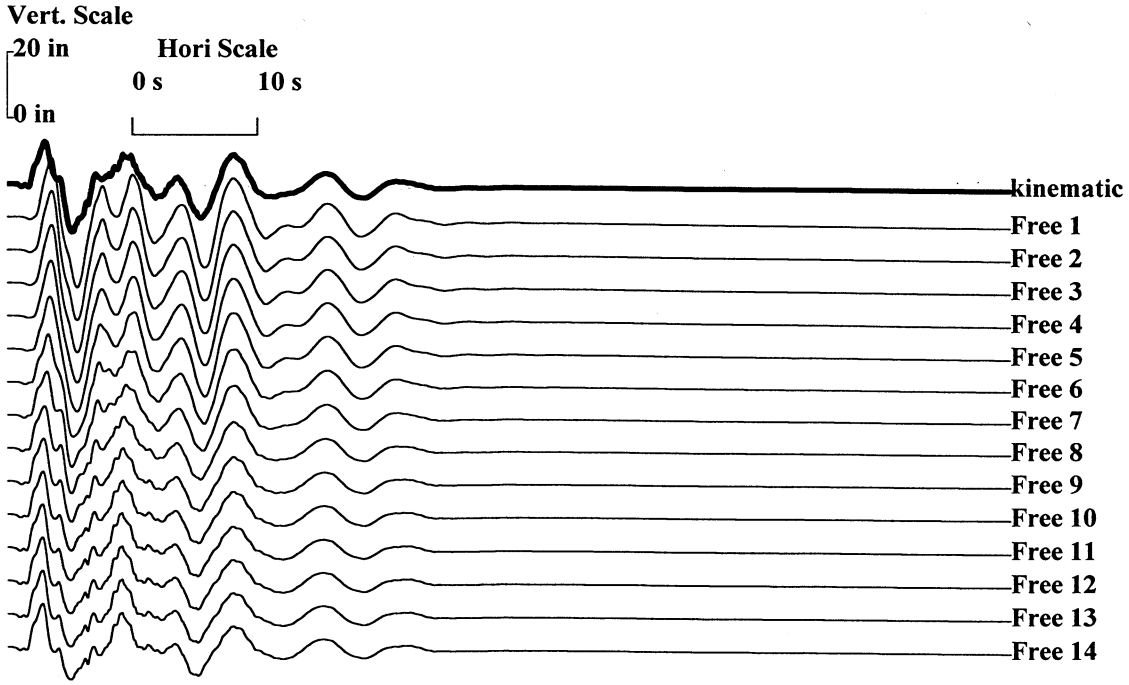

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SET 1, Tran. Dir.
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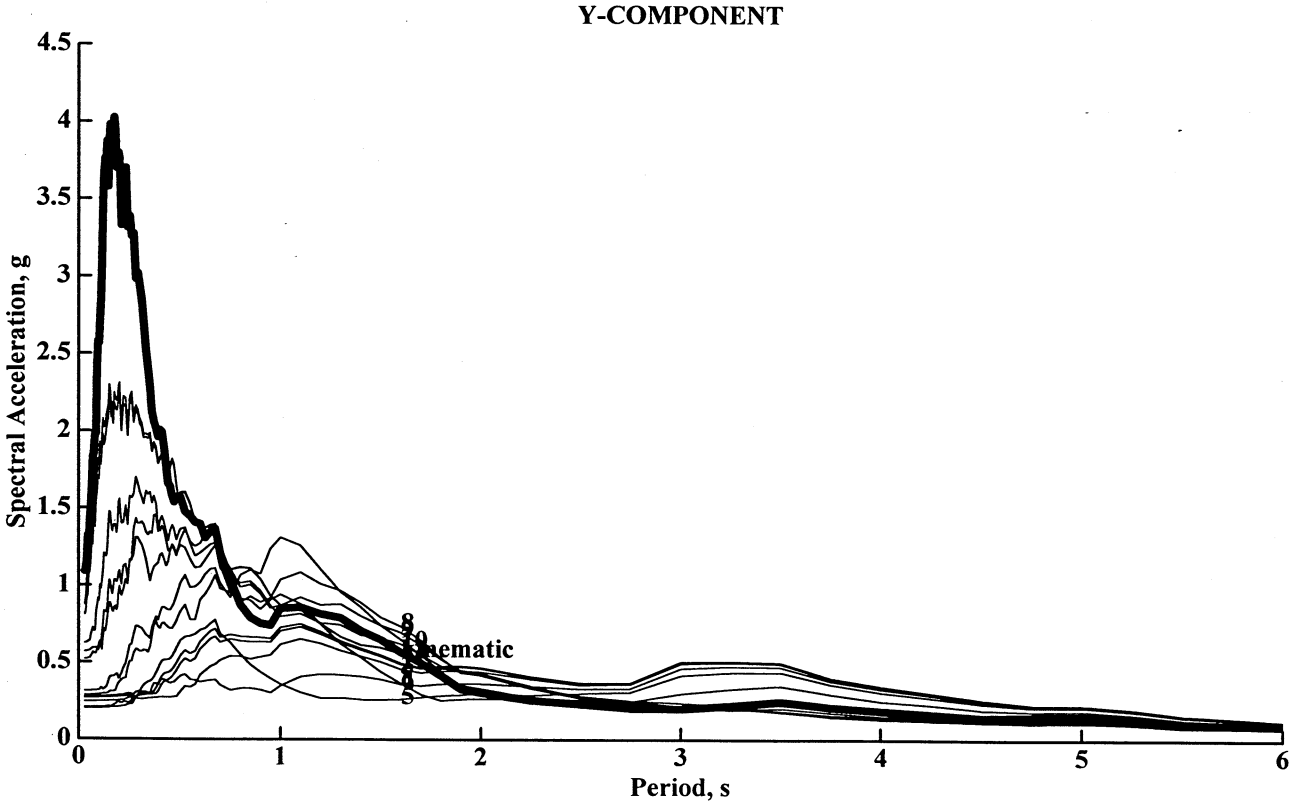

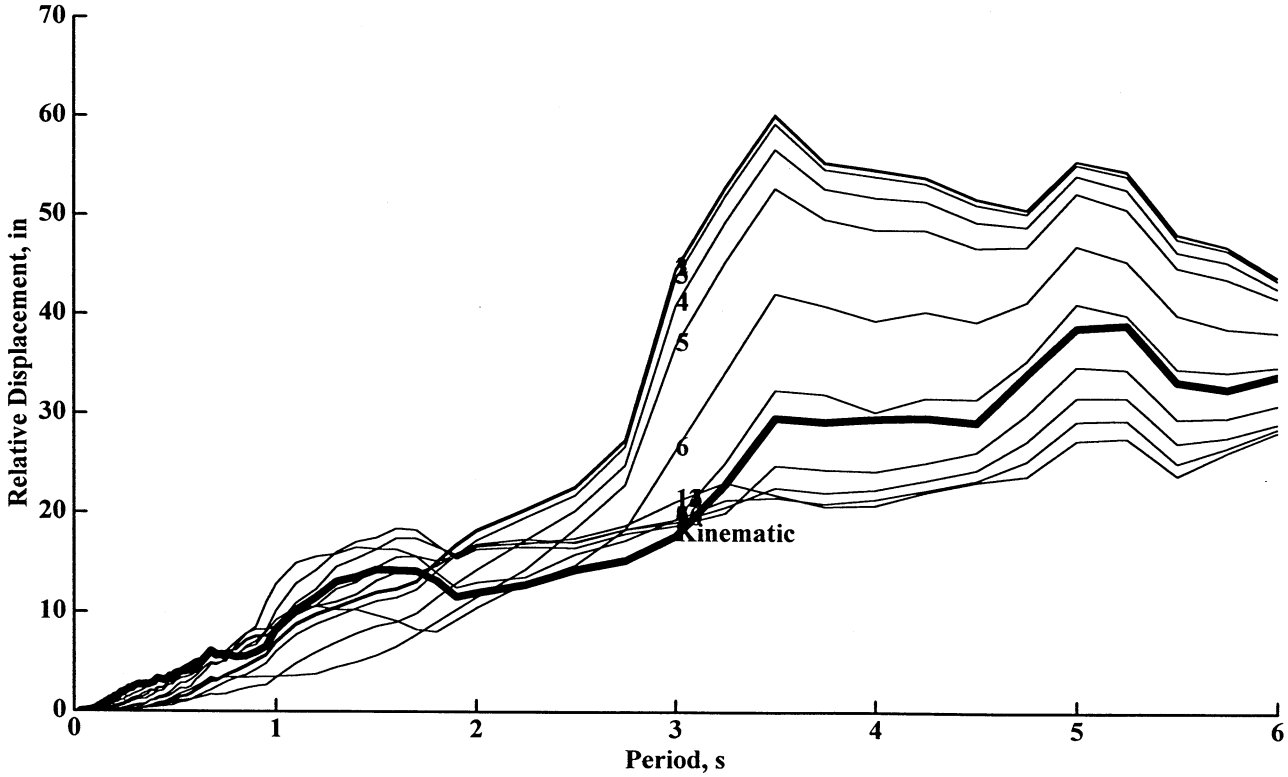

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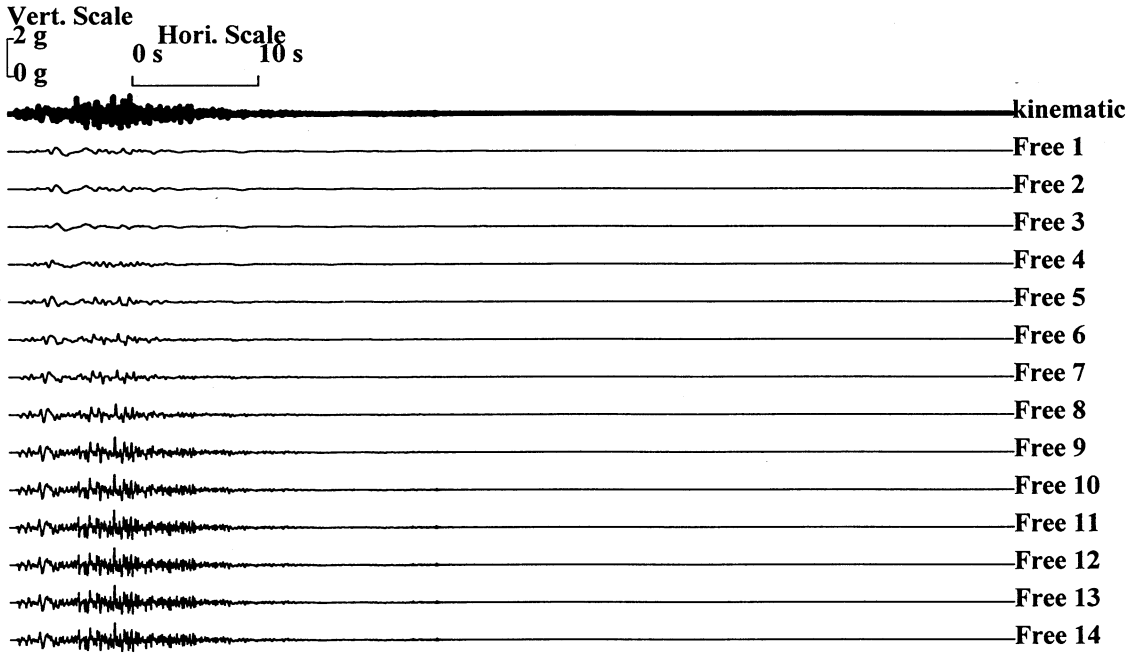

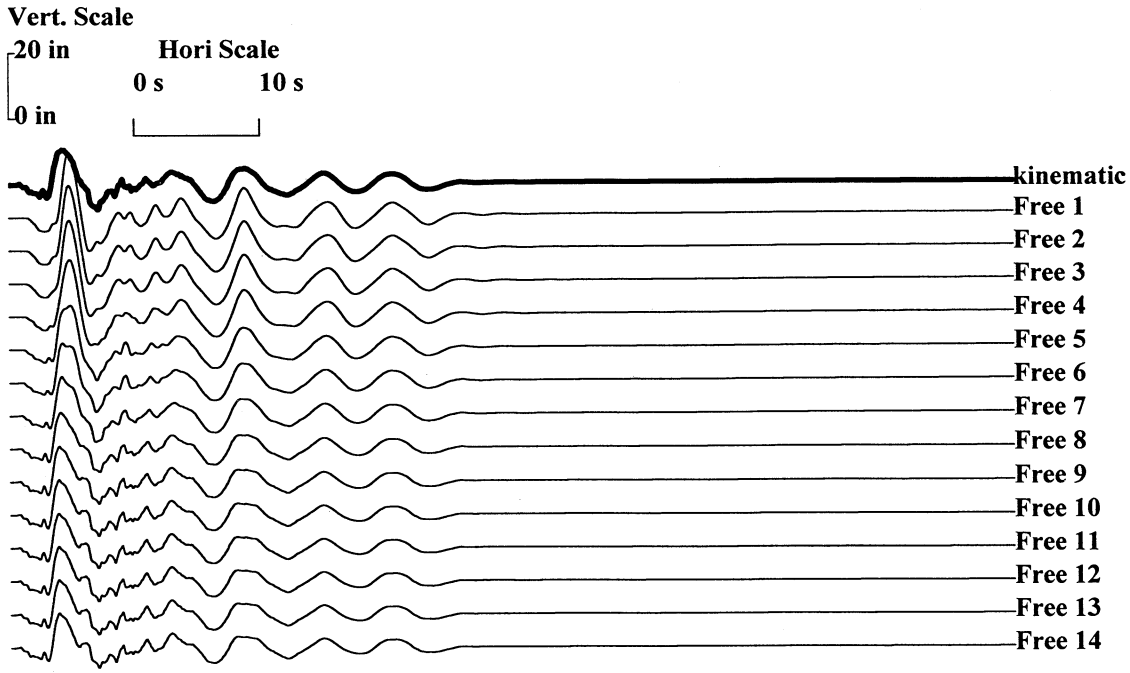

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SET 1, Long. Dir.
BENICIA-MARTINEZ

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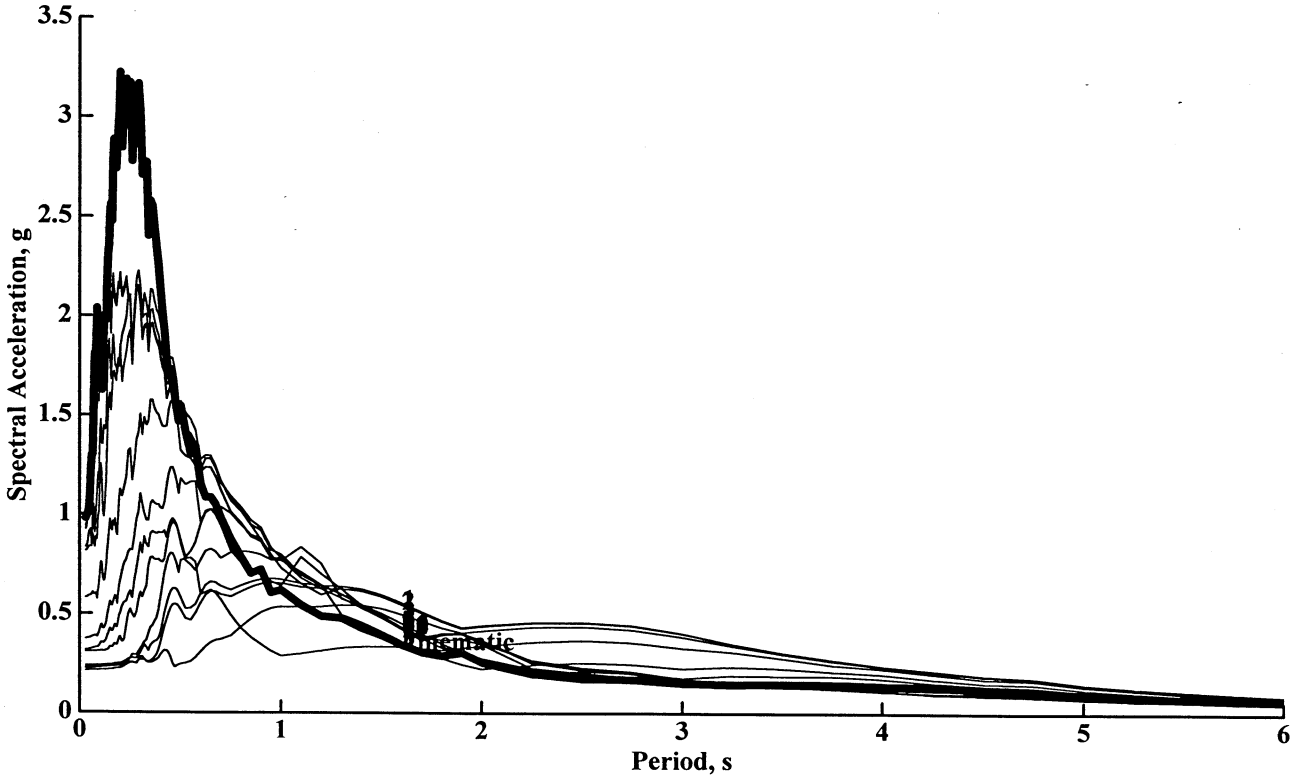

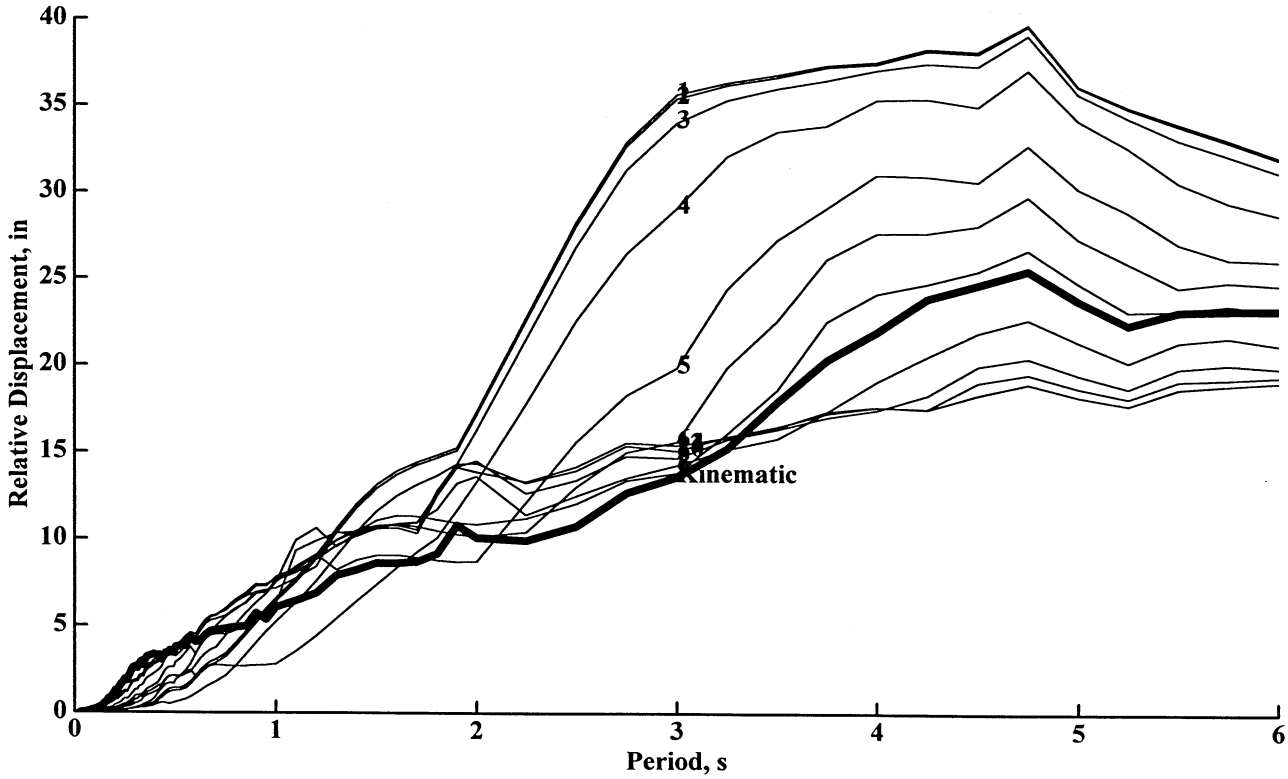

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SET 1, Long. Dir.
BENICIA-MARTINEZ

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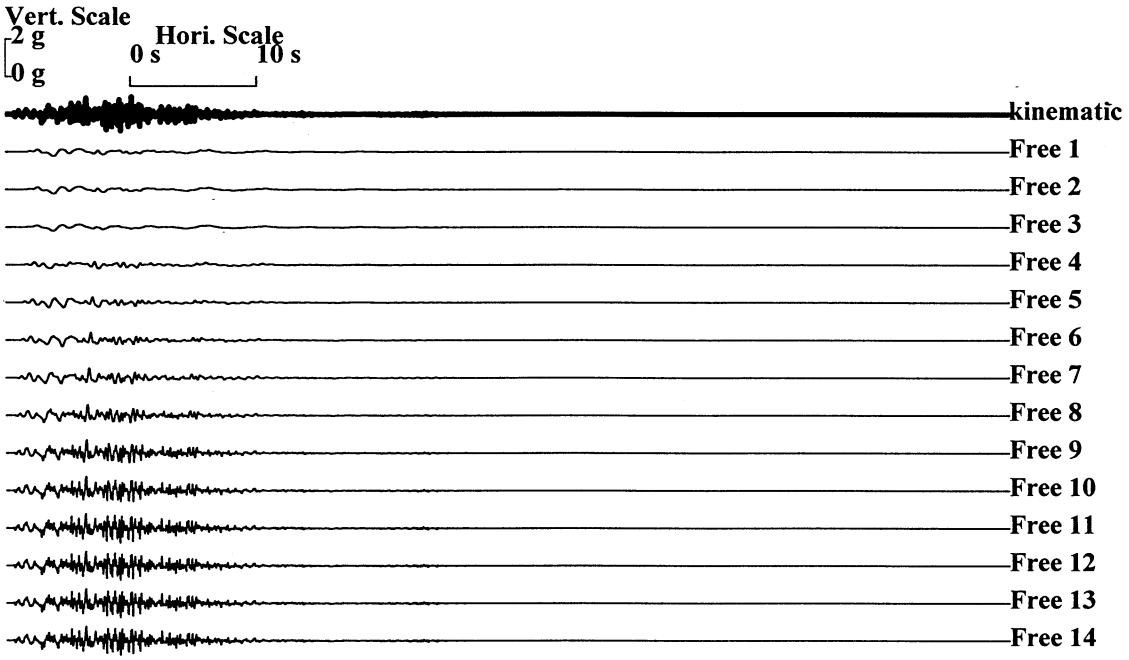

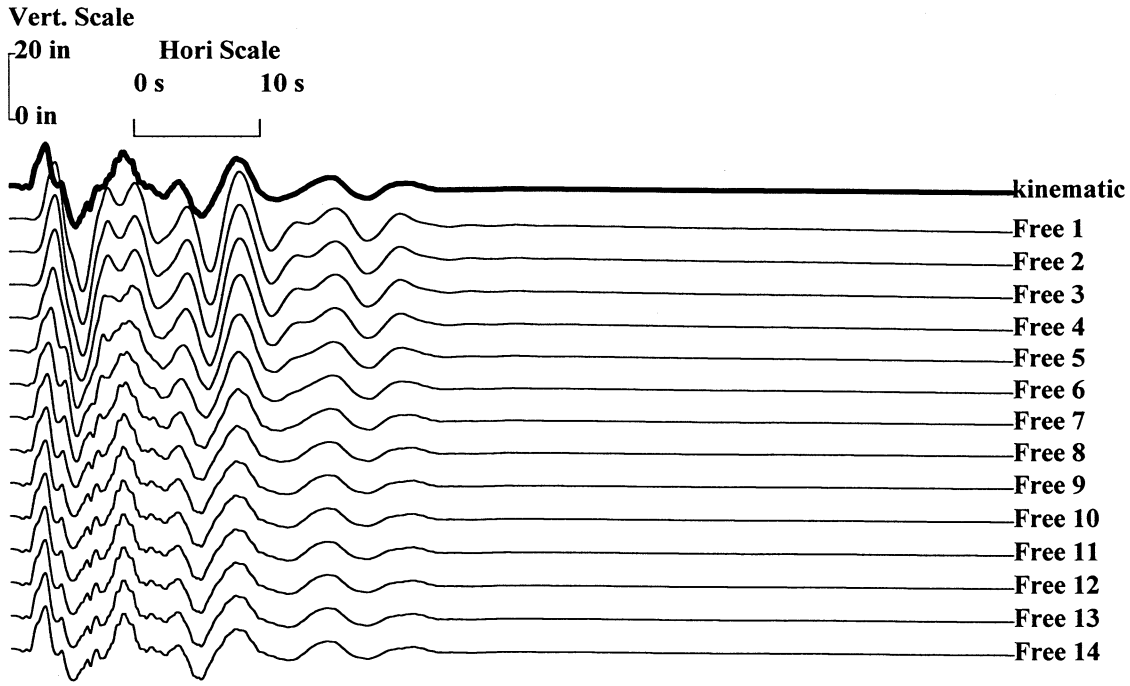

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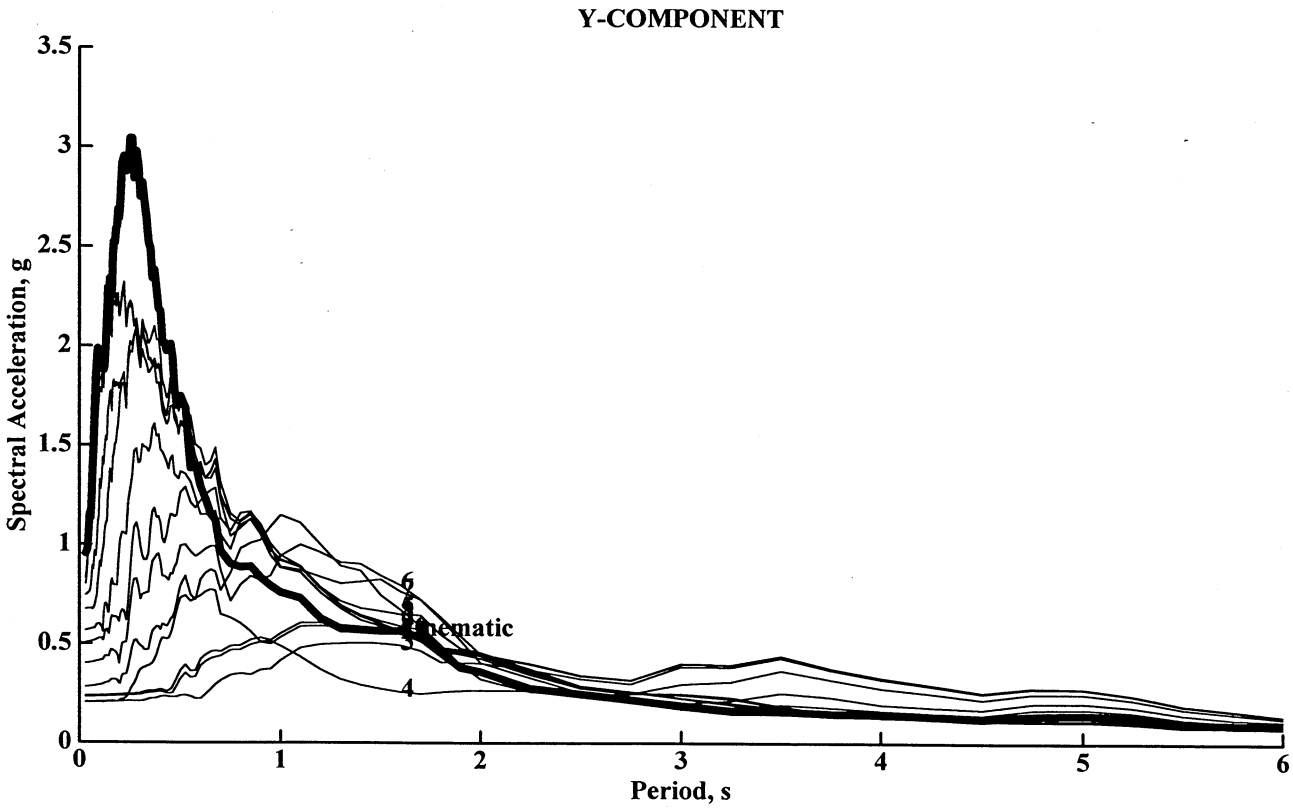
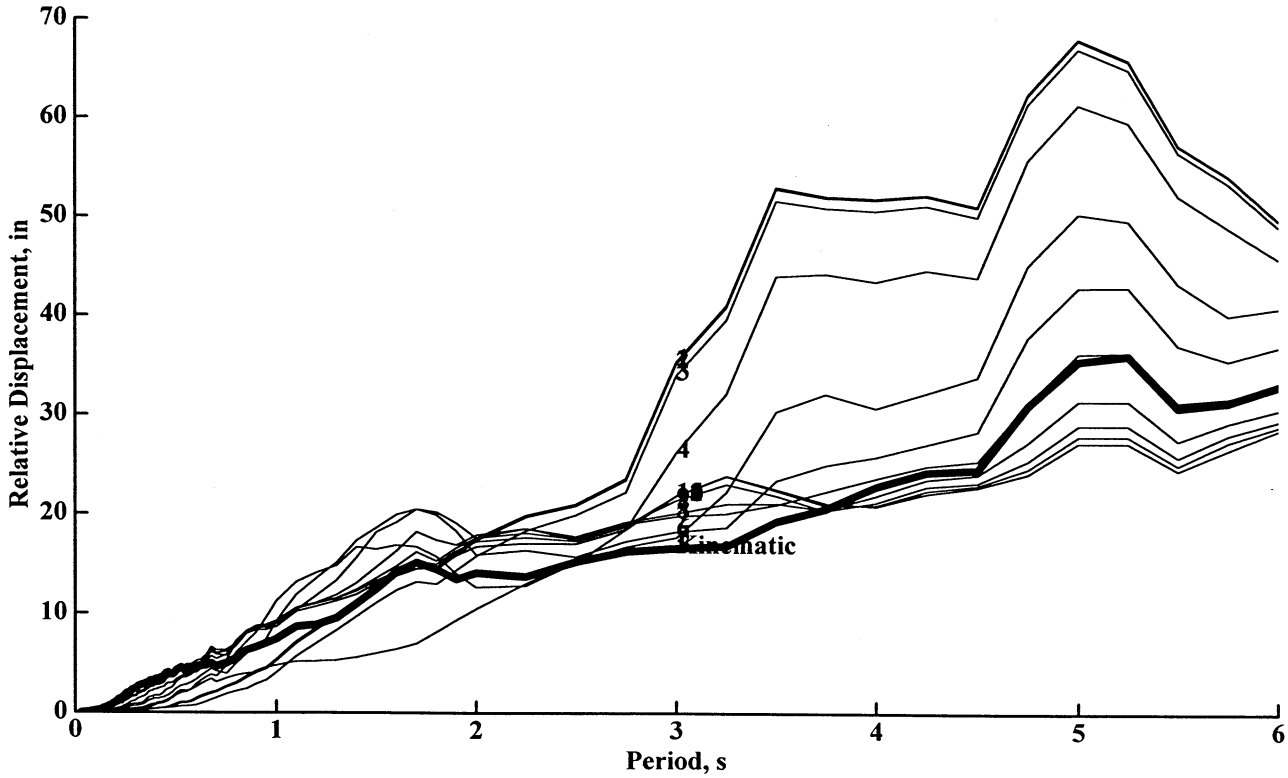
BENICIA-MARTINEZ





PIER 17
SET 1, Tran. Dir.
BENICIA-MARTINEZ

Appendix B

APPENDIX B

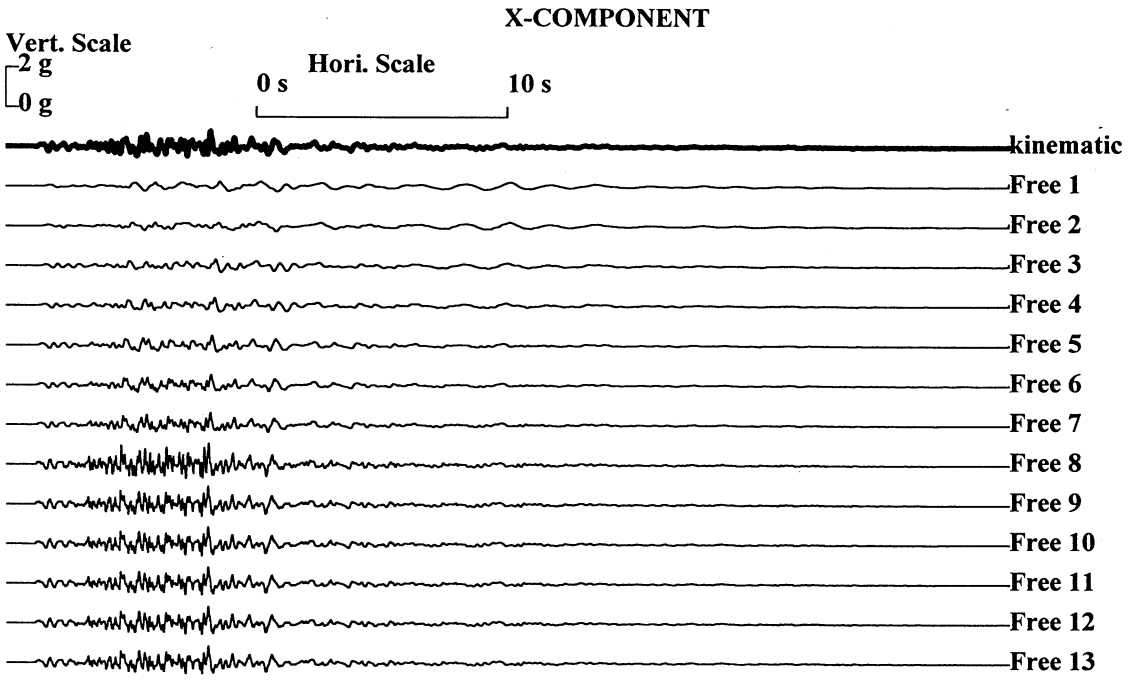
DEPTH-VARYING FREE-FIELD MOTIONS
VERSUS
KINEMATIC MOTIONS CONDENSED AT PILE-CAP
SET 2

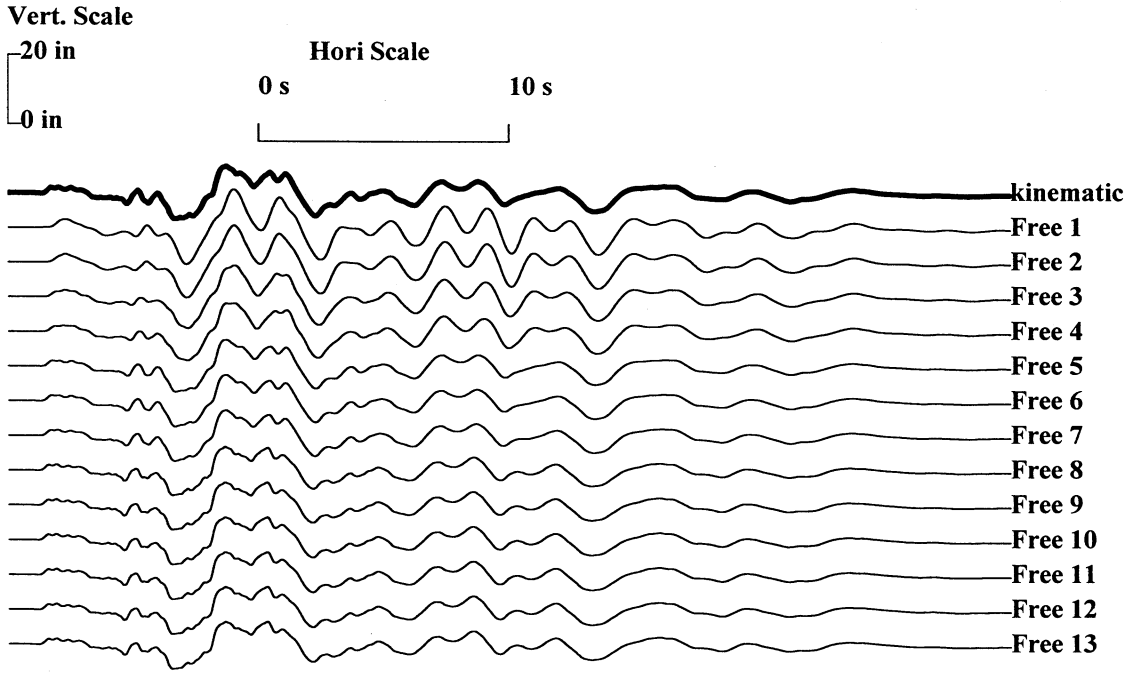
Table A. Elevations (in feet) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

Layer No.	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-6.5	-46	-43	-37	-37	-53	-60	-43	-40	-14	-6.5	-6.5
2	-15	-52	-50	-45	-43	-60	-66	-49	-48	-23	-14	-14
3	-23	-58	-57	-53	-51	-67	-72	-55	-56	-33	-23	-23
4	-31	-65	-64	-60	-56	-75	-78	-62	-66	-43	-33	-33
5	-39	-75	-70	-70	-63	-83	-84	-71	-74	-54	-43	-43
6	-50	-82	-82	-80	-74	-92	-90	-80	-82	-65	-54	-54
7	-55	-90	-92	-90	-76	-98	-95	-89	-90	-77	-65	-65
8	-60	-98	-102	-102	-85	-105	-103	-98	-98	-90	-79	-79
9	-70	-114	-112	-114	-90	-112	-111	-109	-109	-106	-93	-93
10	-80	-116	-125	-126	-106	-120	-120	-120	-120	-124	-105	-105
11	-90	-125	-141	-138	-131	-131	-131	-131	-148	-148	-118	-118
12	-115	-165	-179	-177	-180	-172	-172	-172	-184	-184	-131	-131
13	-160	-204	-217	-217	-216	-213	-213	-213	-220	-220	-174	-174
14	-204										-220	-220

Table B. Elevations (in meters) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

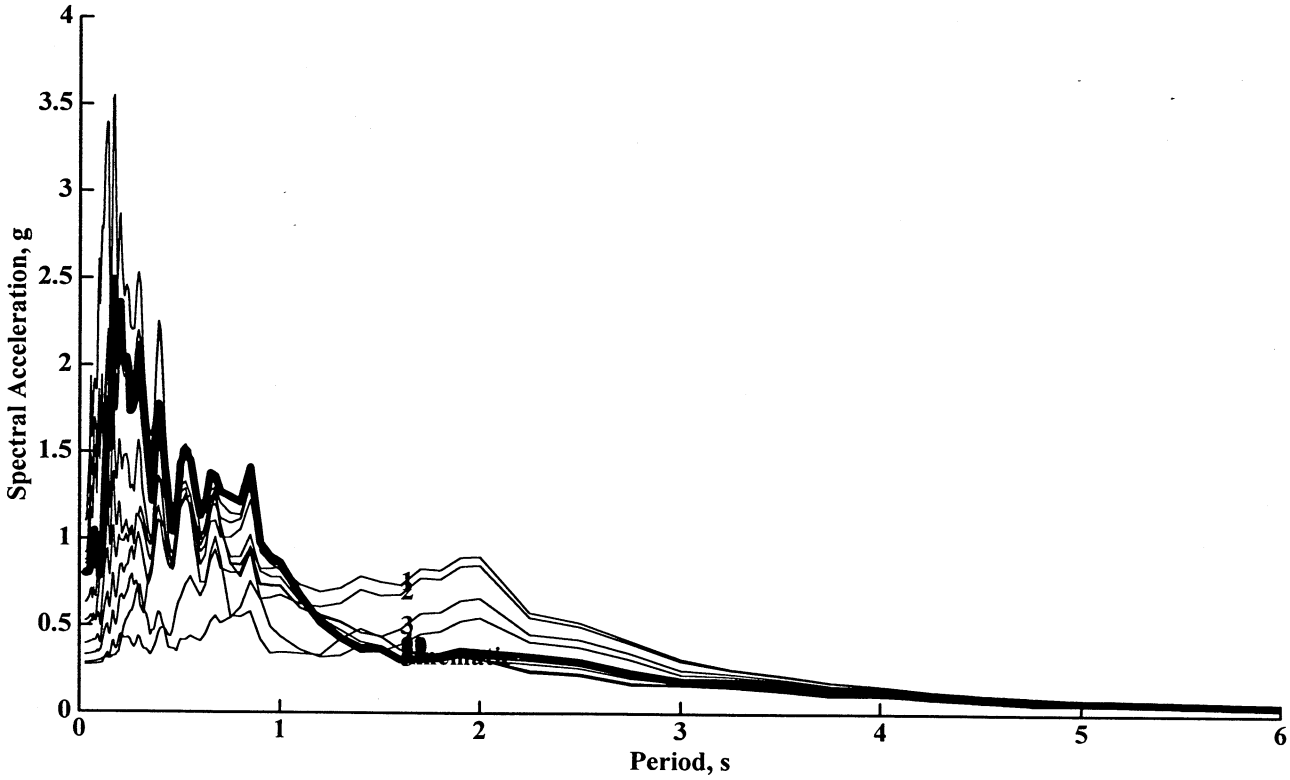
Layer No	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-2.0	-14.0	-13.1	-11.3	-11.3	-16.2	-18.3	-13.1	-12.2	-4.3	-2.0	-2.0
2	-4.6	-15.9	-15.2	-13.7	-13.1	-18.3	-20.1	-14.9	-14.6	-7.0	-4.3	-4.3
3	-7.0	-17.7	-17.4	-16.2	-15.5	-20.4	-22.0	-16.8	-17.1	-10.1	-7.0	-7.0
4	-9.5	-19.8	-19.5	-18.3	-17.1	-22.9	-23.8	-18.9	-20.1	-13.1	-10.1	-10.1
5	-11.9	-22.9	-21.3	-21.3	-19.2	-25.3	-25.6	-21.6	-22.6	-16.5	-13.1	-13.1
6	-15.2	-25.0	-25.0	-24.4	-22.6	-28.0	-27.4	-24.4	-25.0	-19.8	-16.5	-16.5
7	-16.8	-27.4	-28.0	-27.4	-23.2	-29.9	-29.0	-27.1	-27.4	-23.5	-19.8	-19.8
8	-18.3	-29.9	-31.1	-31.1	-25.9	-32.0	-31.4	-29.9	-29.9	-27.4	-24.1	-24.1
9	-21.3	-34.8	-34.1	-34.8	-27.4	-34.1	-33.8	-33.2	-33.2	-32.3	-28.4	-28.4
10	-24.4	-35.4	-38.1	-38.4	-32.3	-36.6	-36.6	-36.6	-36.6	-37.8	-32.0	-32.0
11	-27.4	-38.1	-43.0	-42.1	-39.9	-39.9	-39.9	-39.9	-45.1	-45.1	-36.0	-36.0
12	-35.1	-50.3	-54.6	-54.0	-54.9	-52.4	-52.4	-52.4	-56.1	-56.1	-39.9	-39.9
13	-48.8	-62.2	-66.2	-66.2	-65.9	-64.9	-64.9	-64.9	-67.1	-67.1	-53.0	-53.0
14	-62.2										-67.1	-67.1

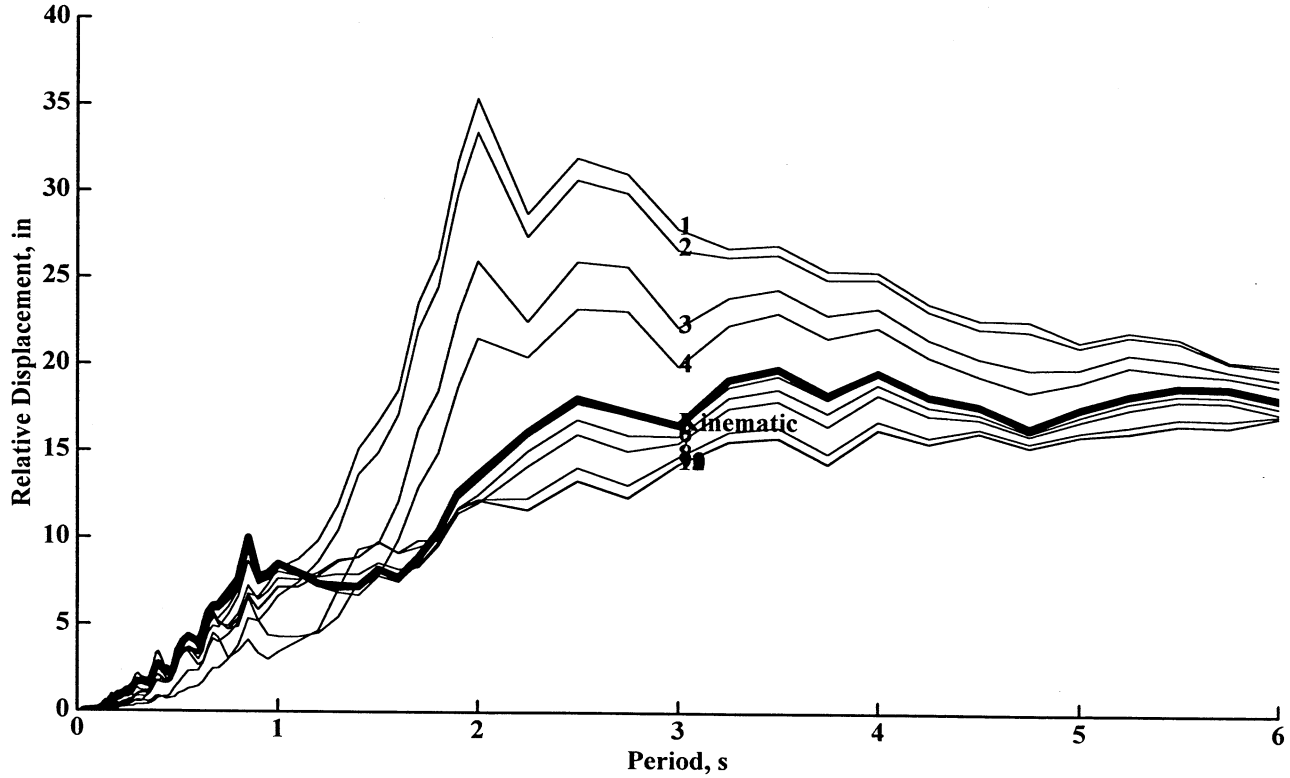




PIER 6
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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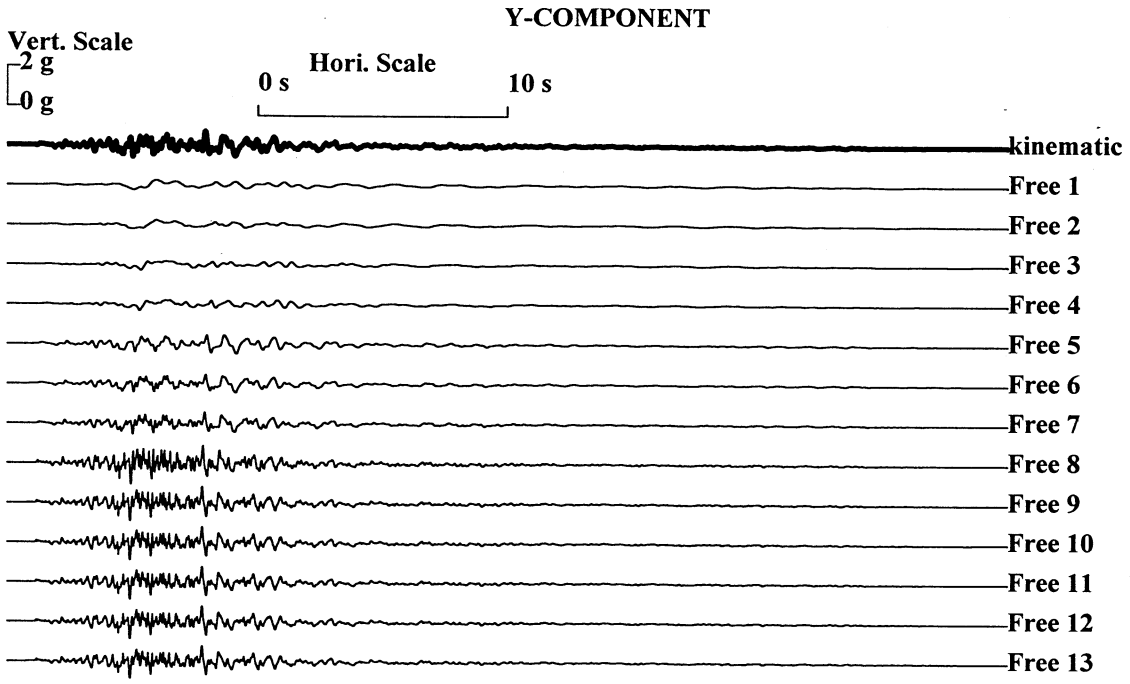
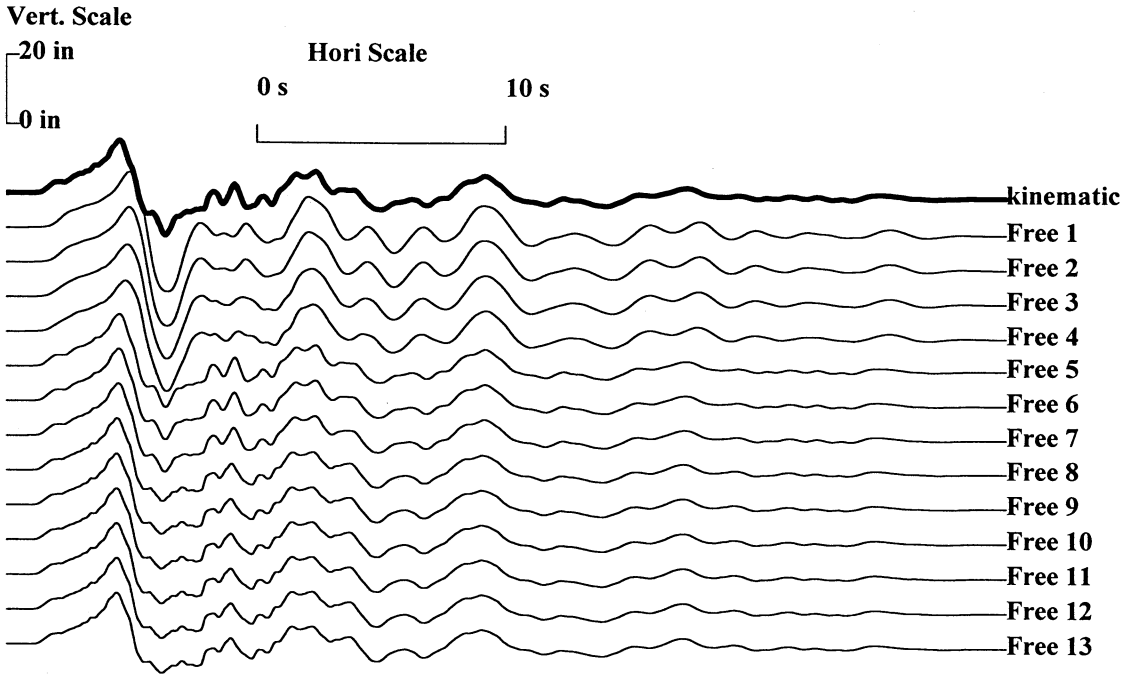
SET 2, Long. Dir.
BENICIA-MARTINEZ





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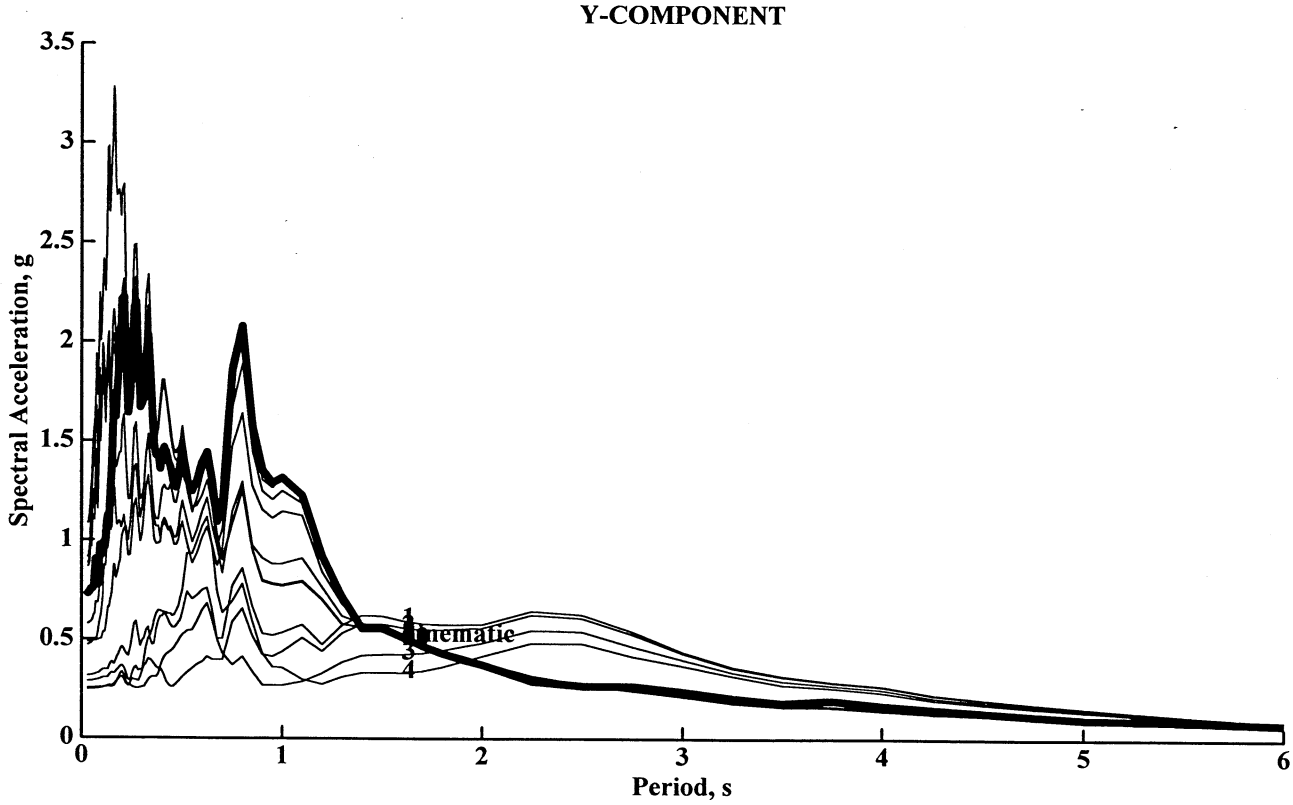
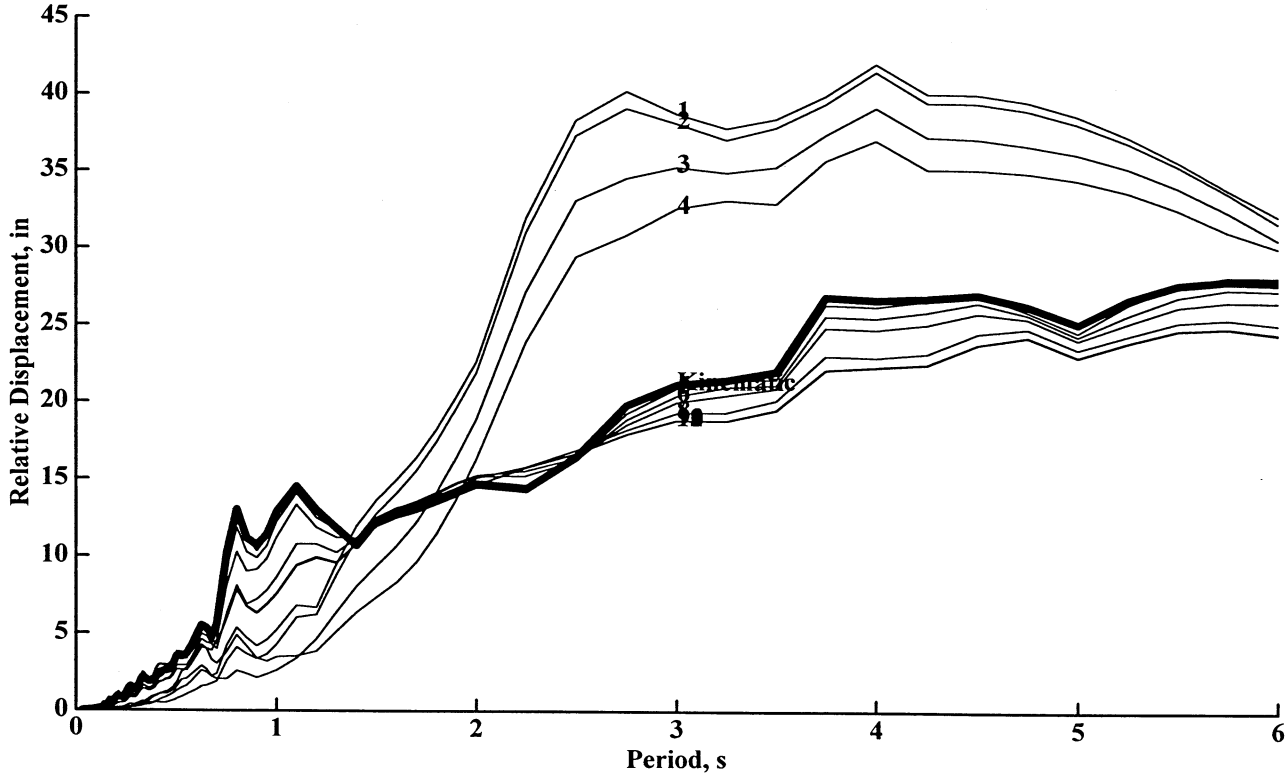
BENICIA-MARTINEZ





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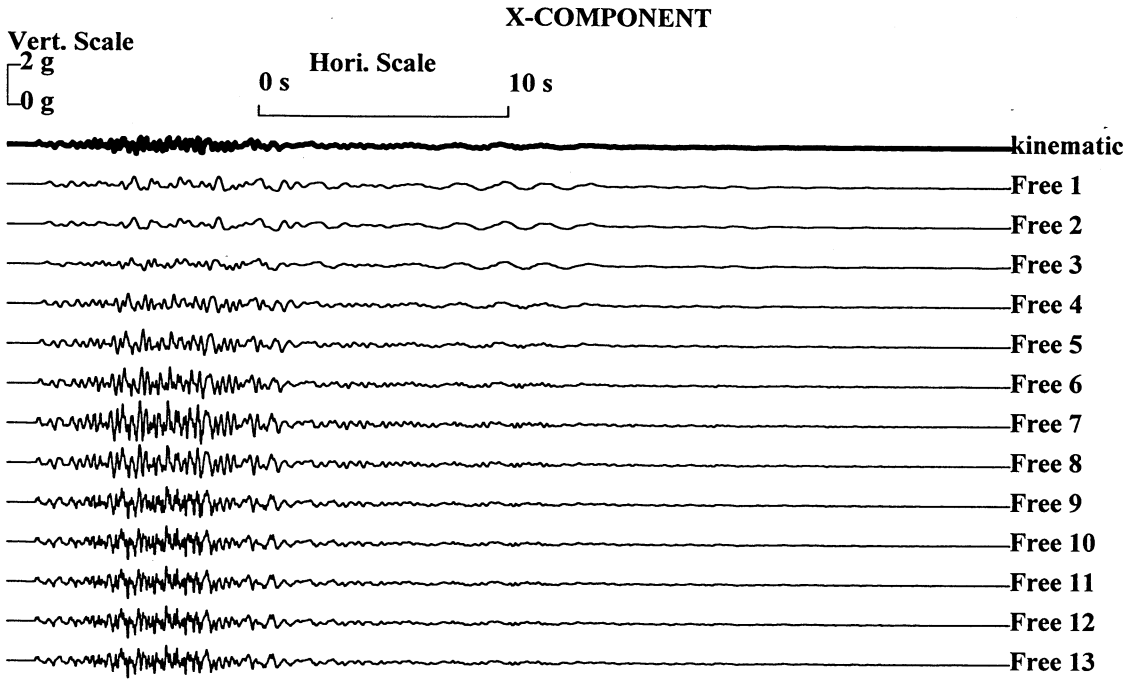

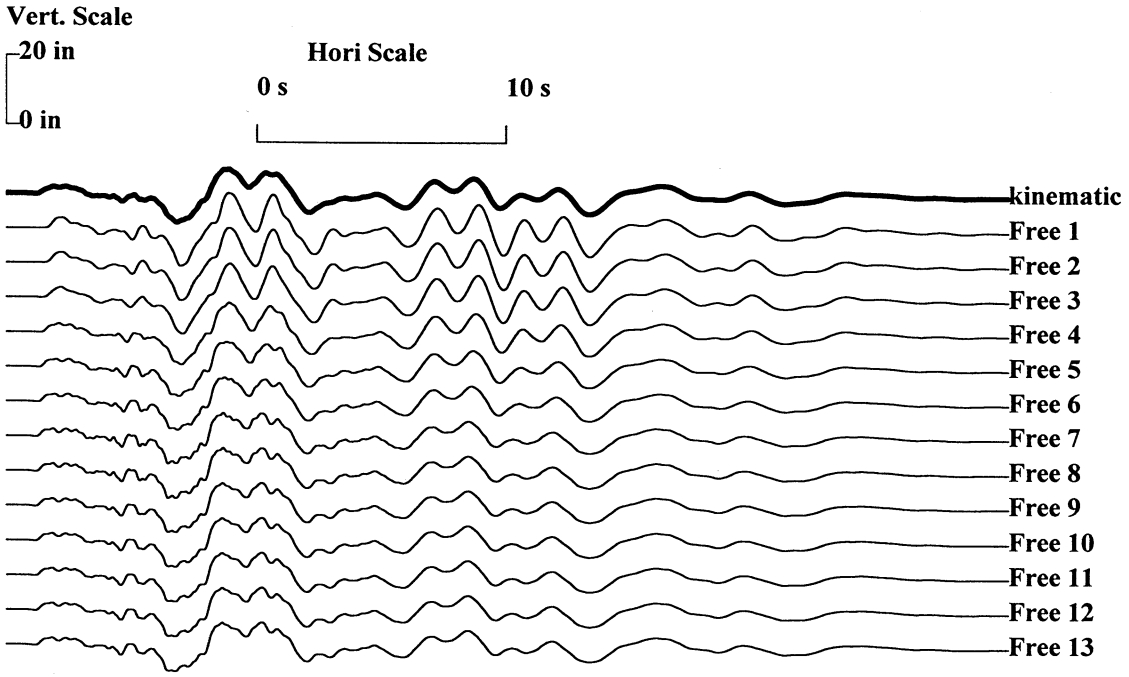

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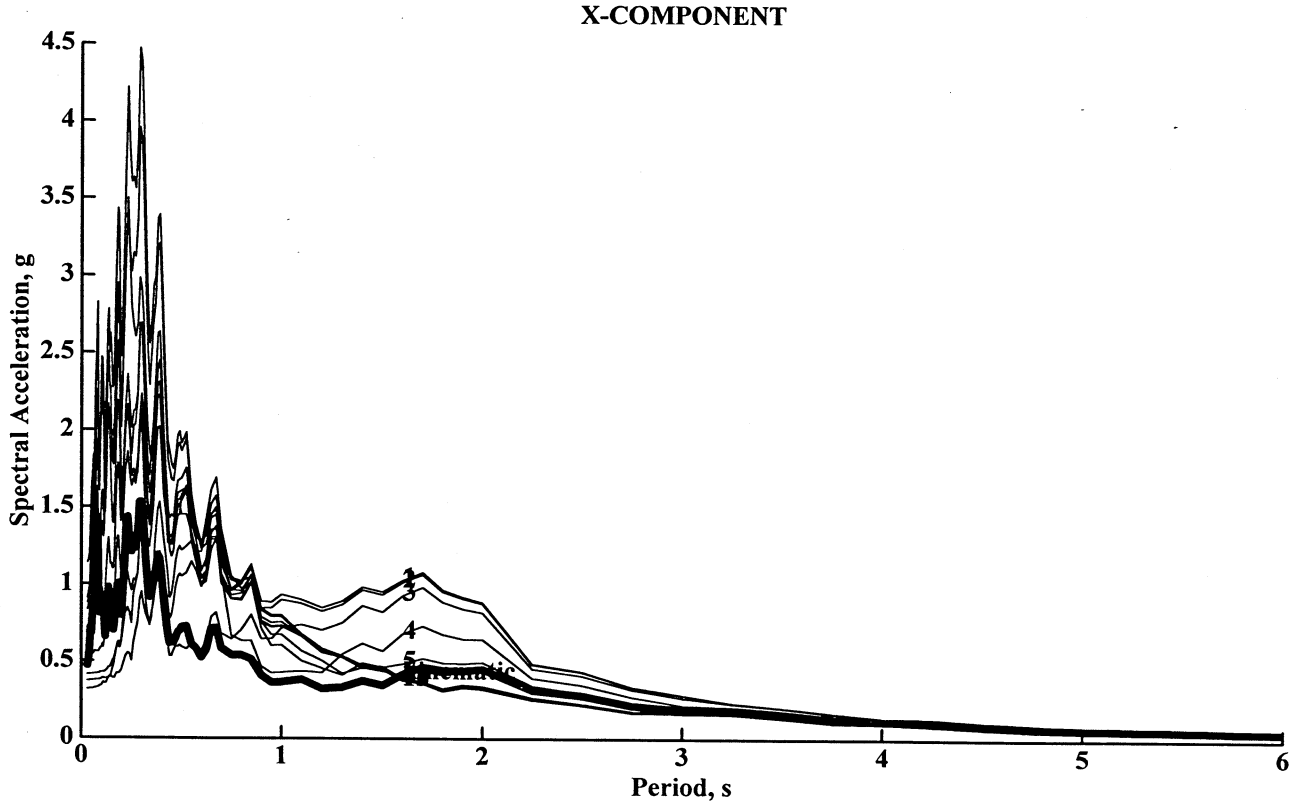
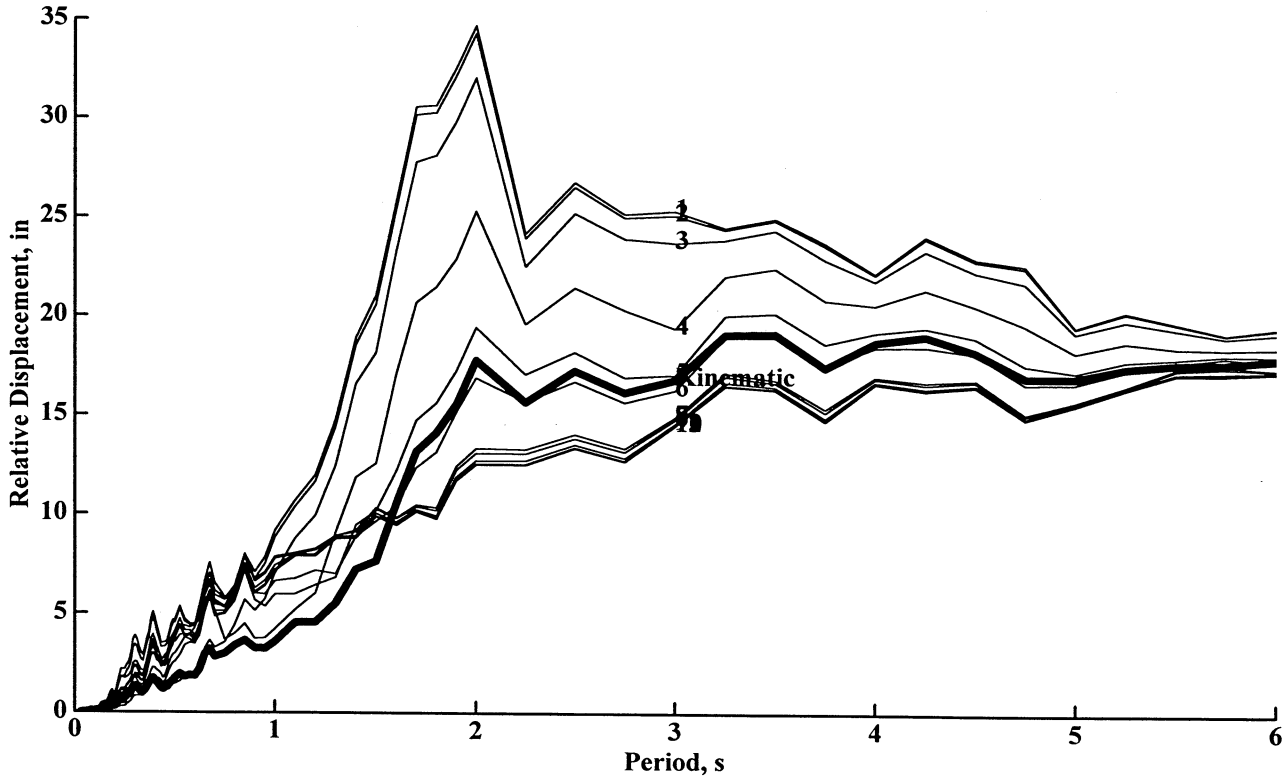
BENICIA-MARTINEZ





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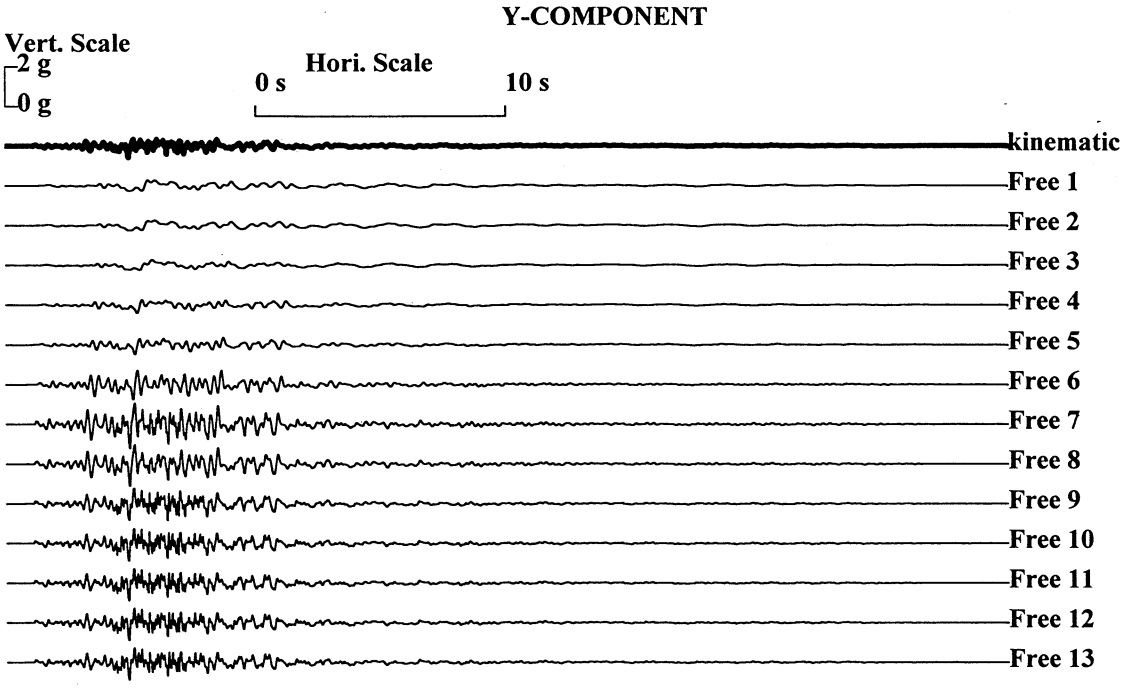

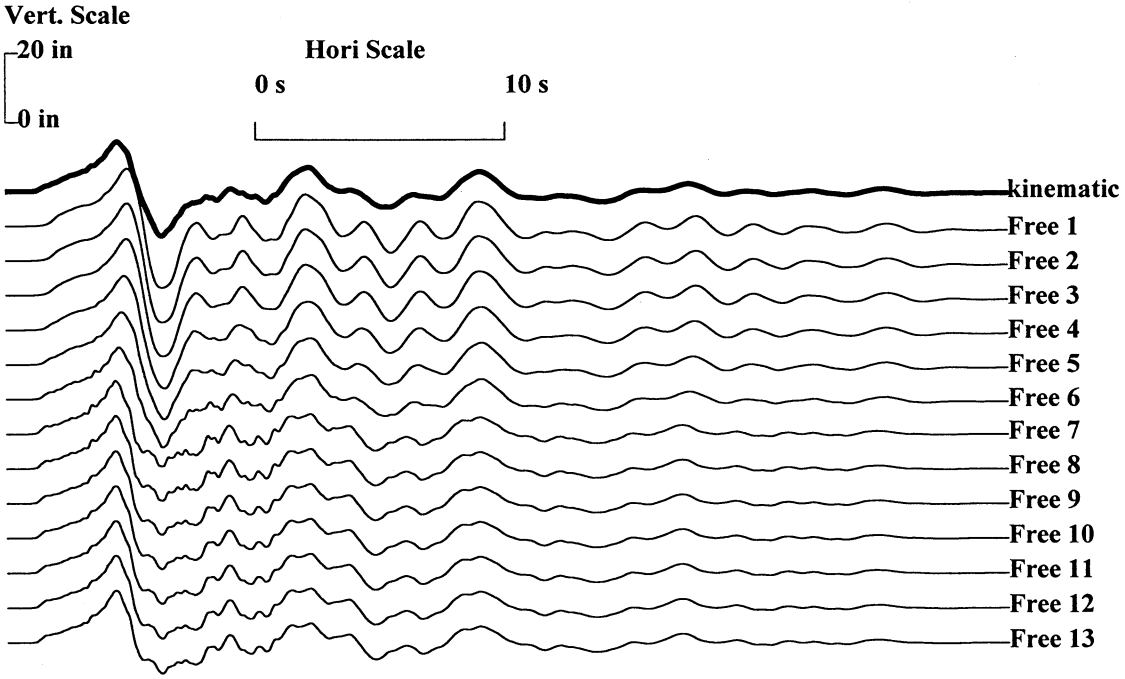

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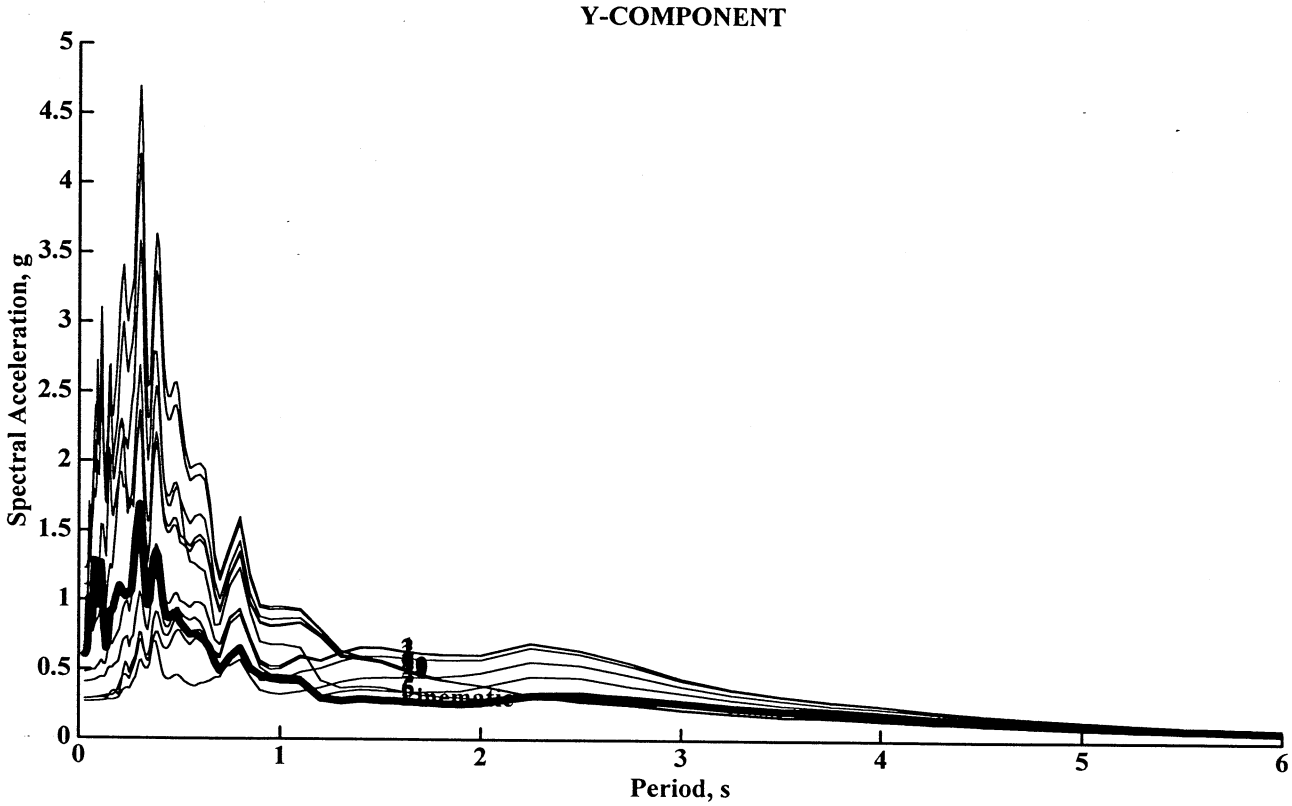
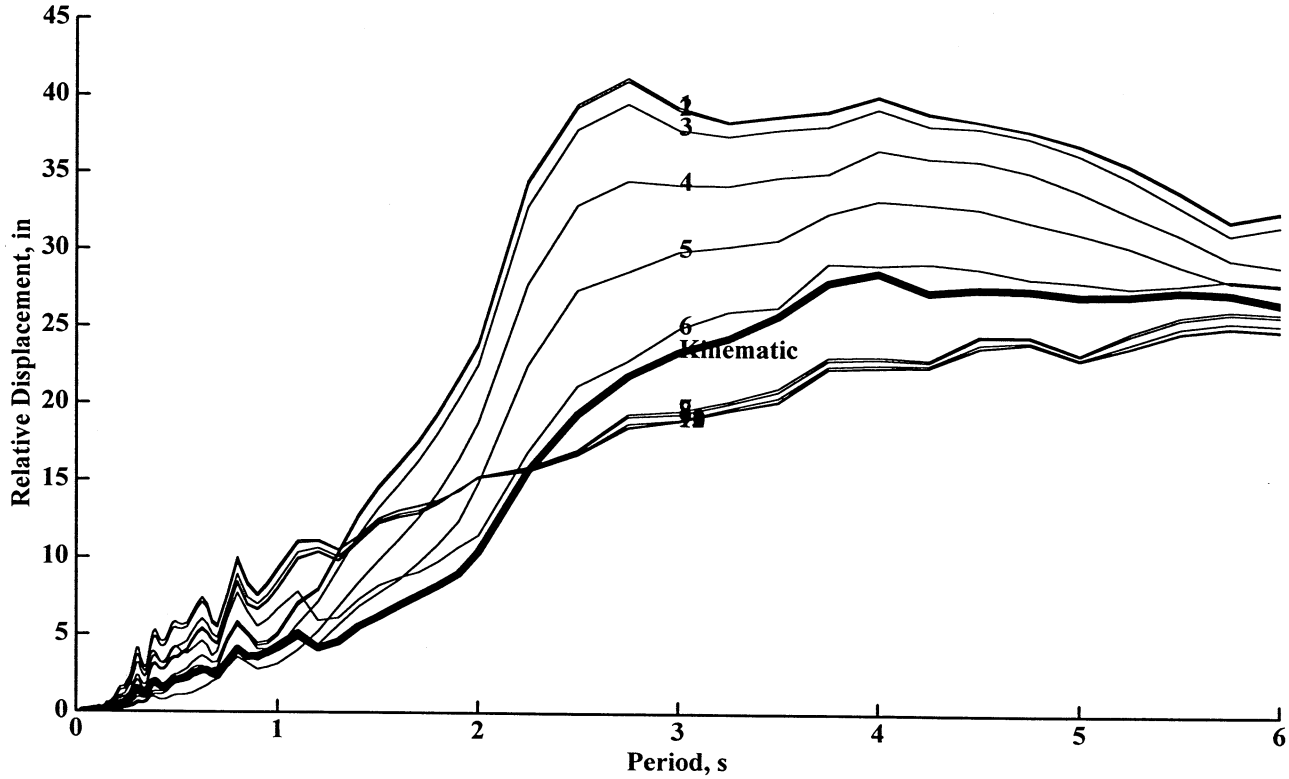
SET 2, Tran. Dir.
BENICIA-MARTINEZ





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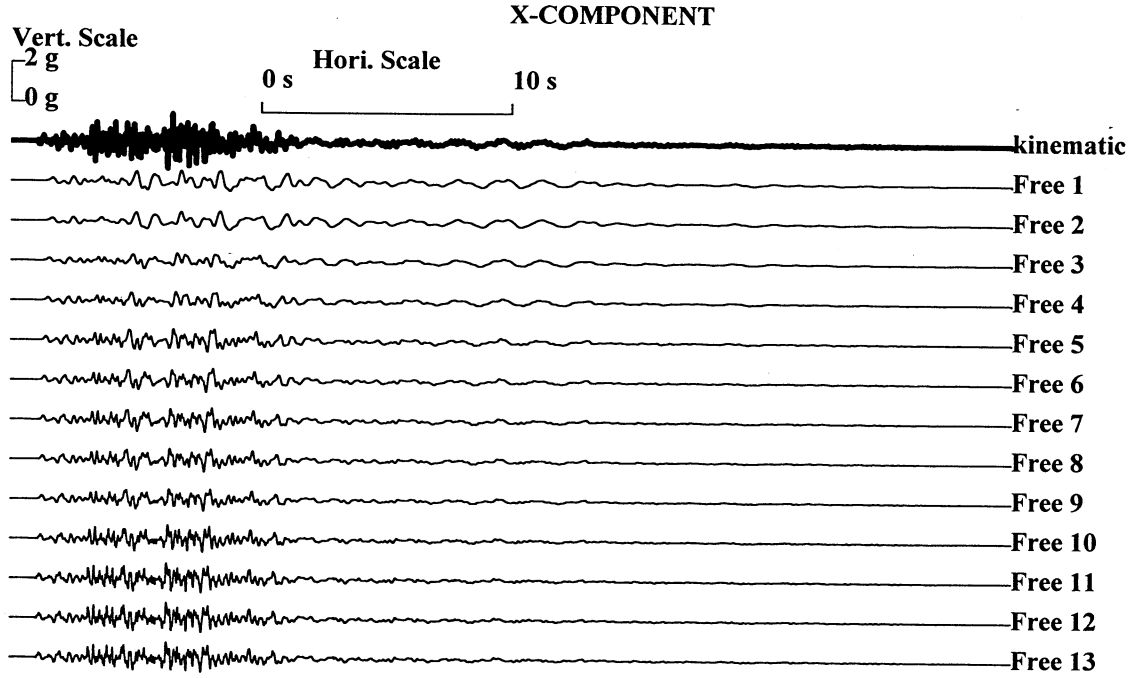
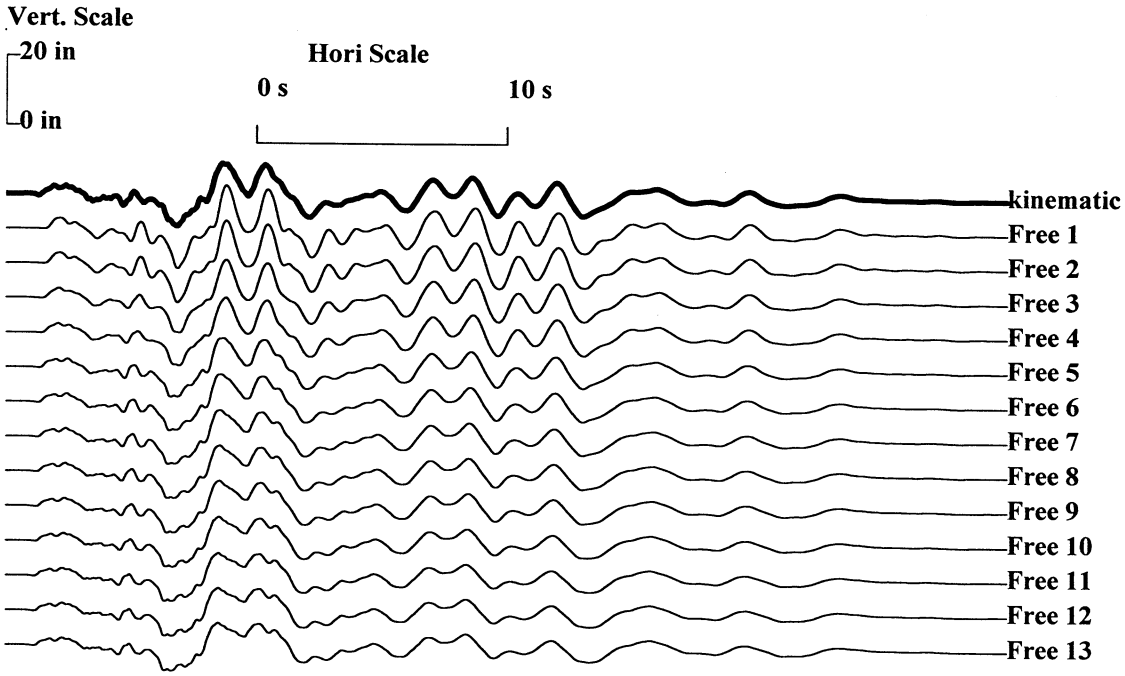
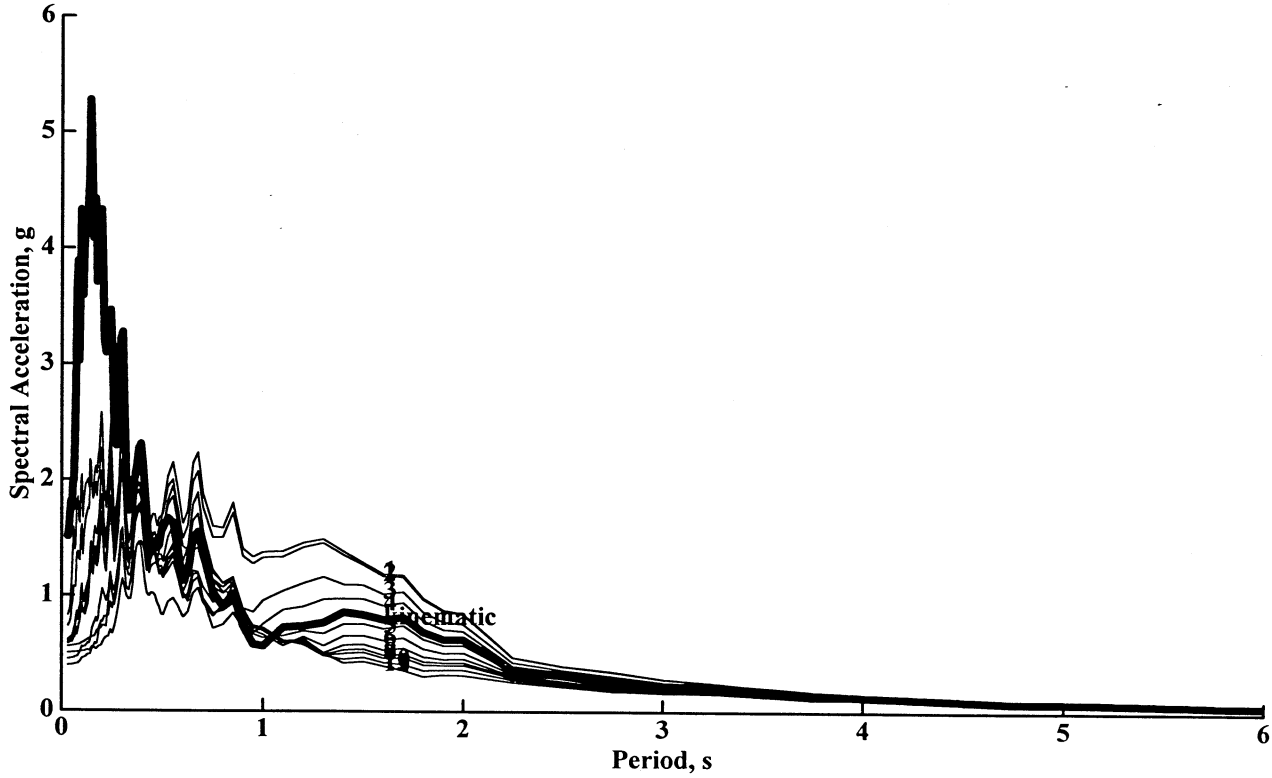
SET 2, Tran. Dir.
BENICIA-MARTINEZ

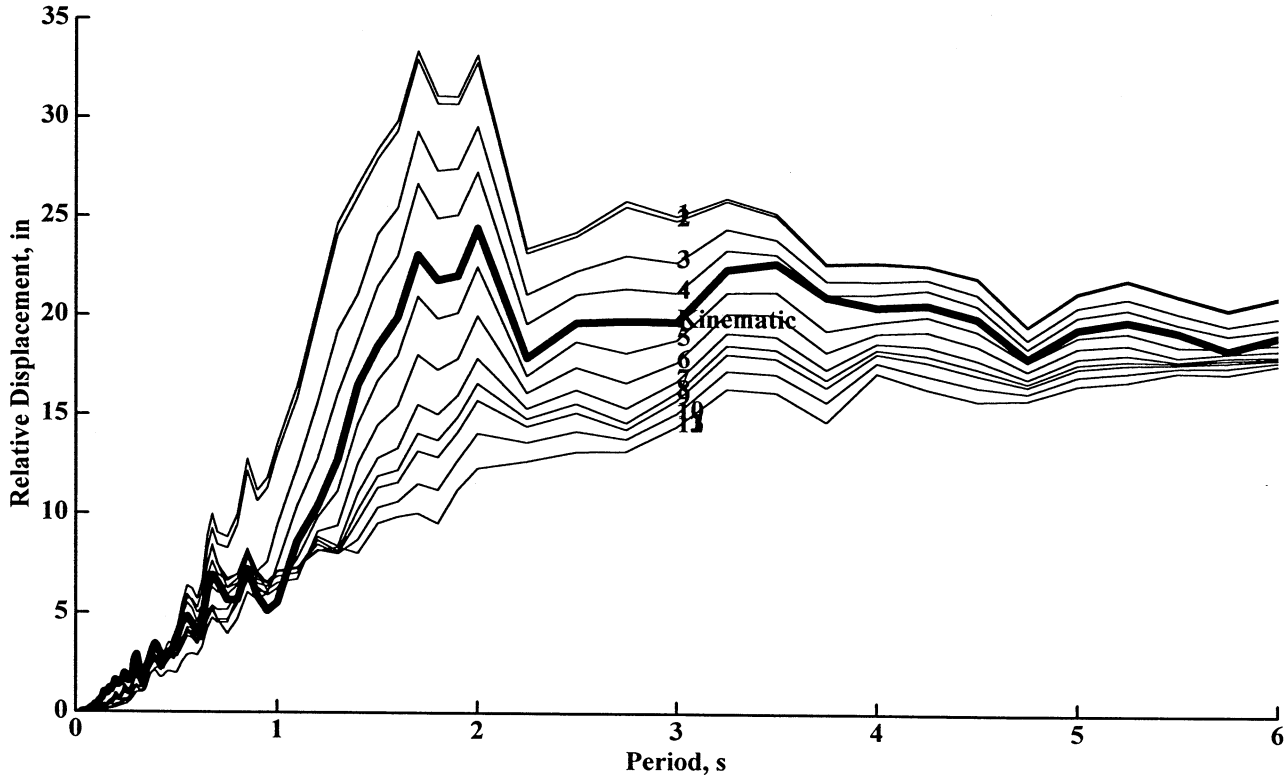




PIER 8
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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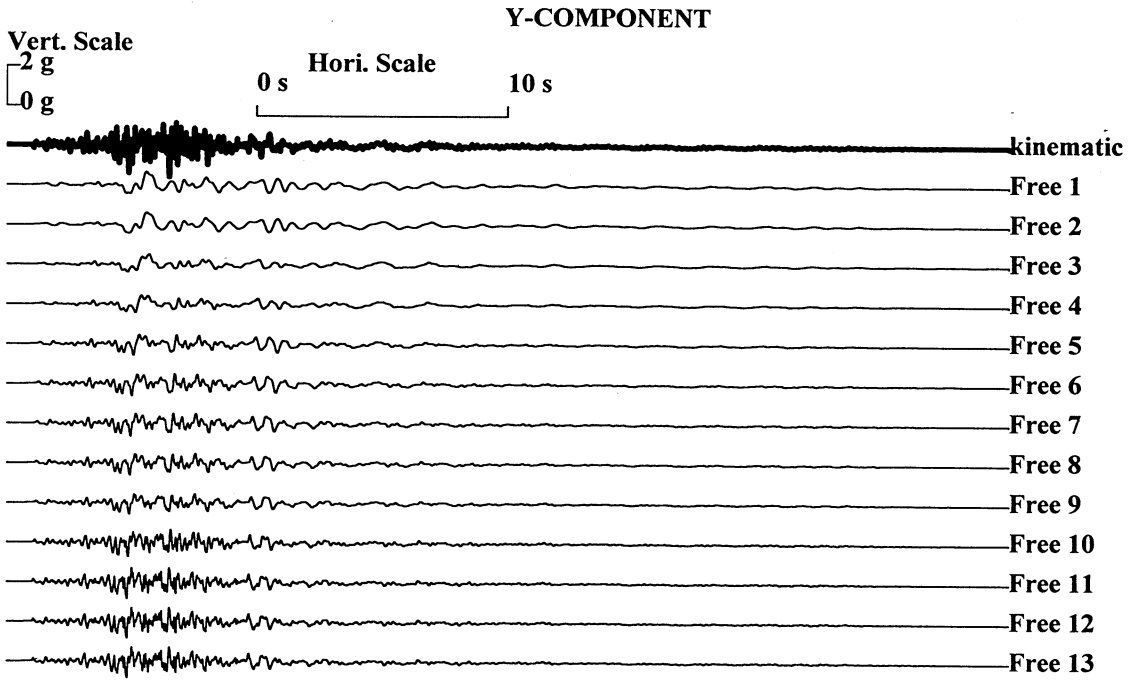
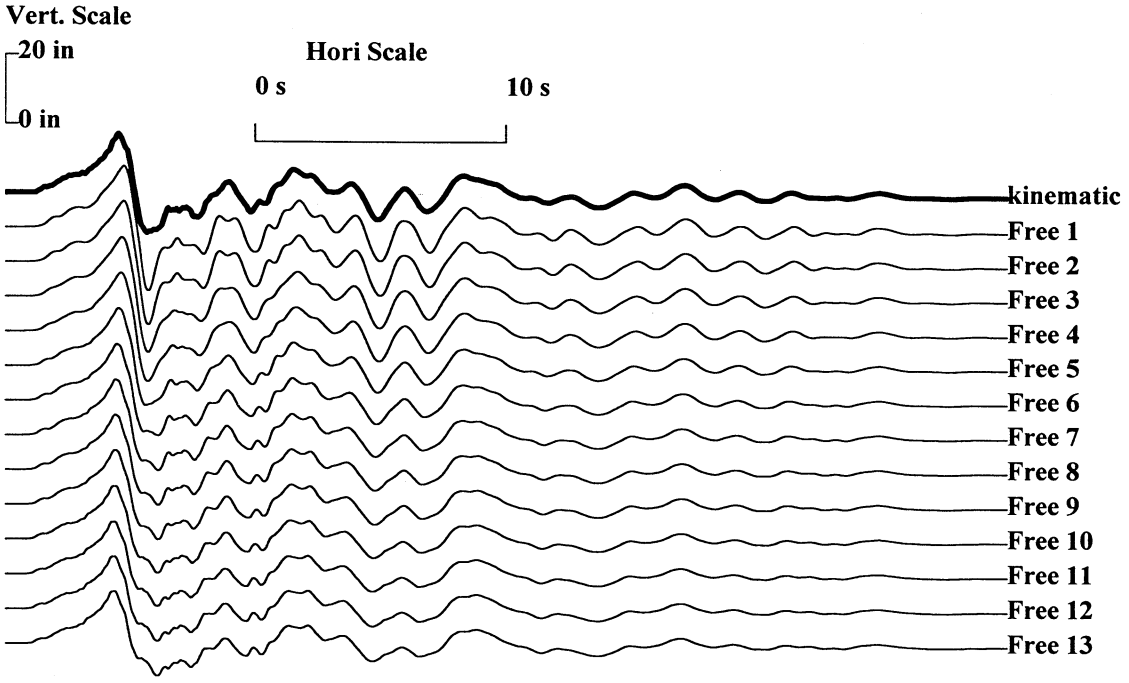
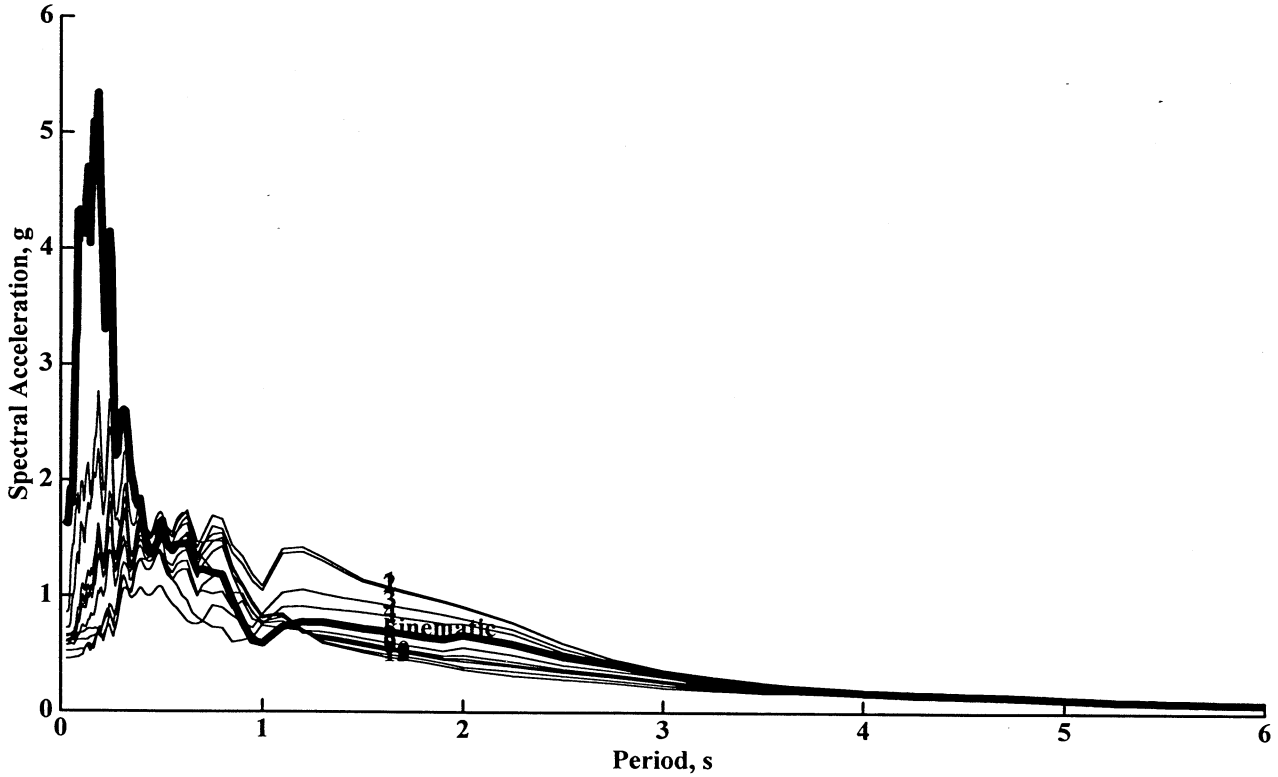
SET 2, Long. Dir.
BENICIA-MARTINEZ

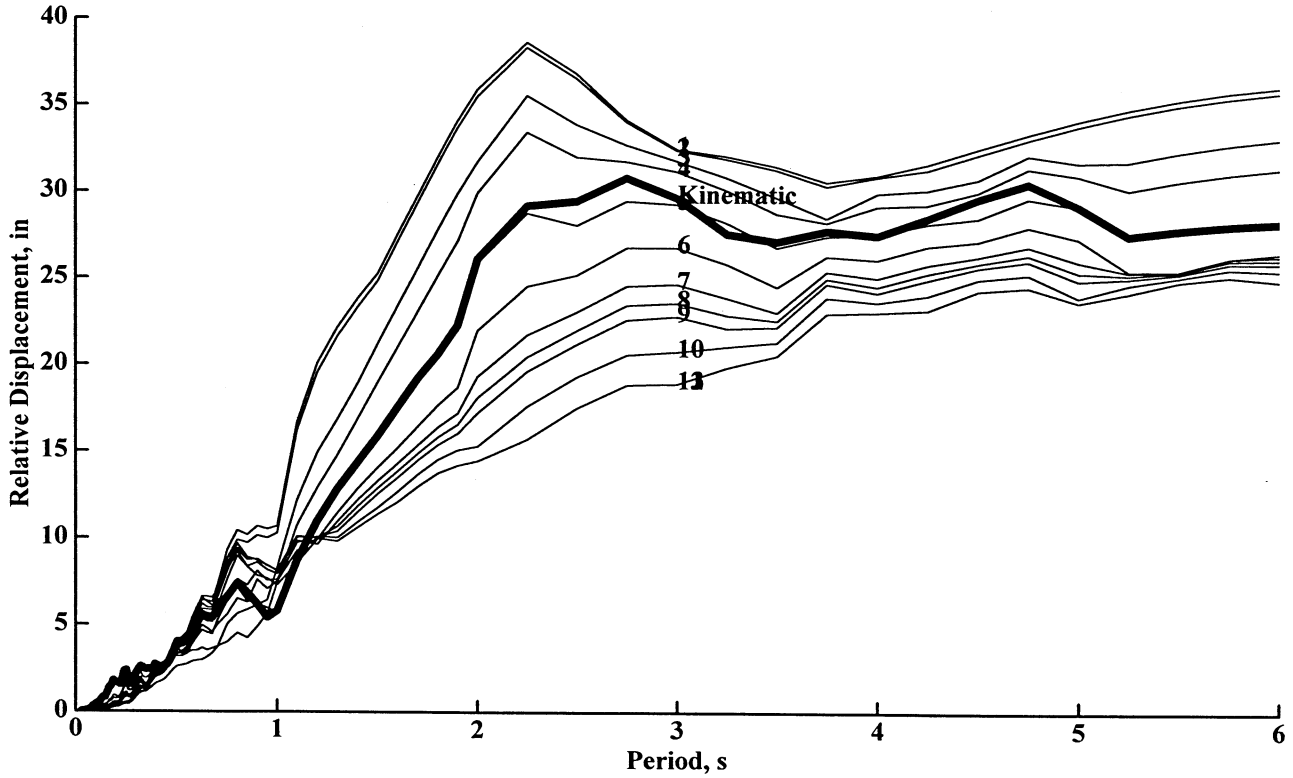




PIER 8
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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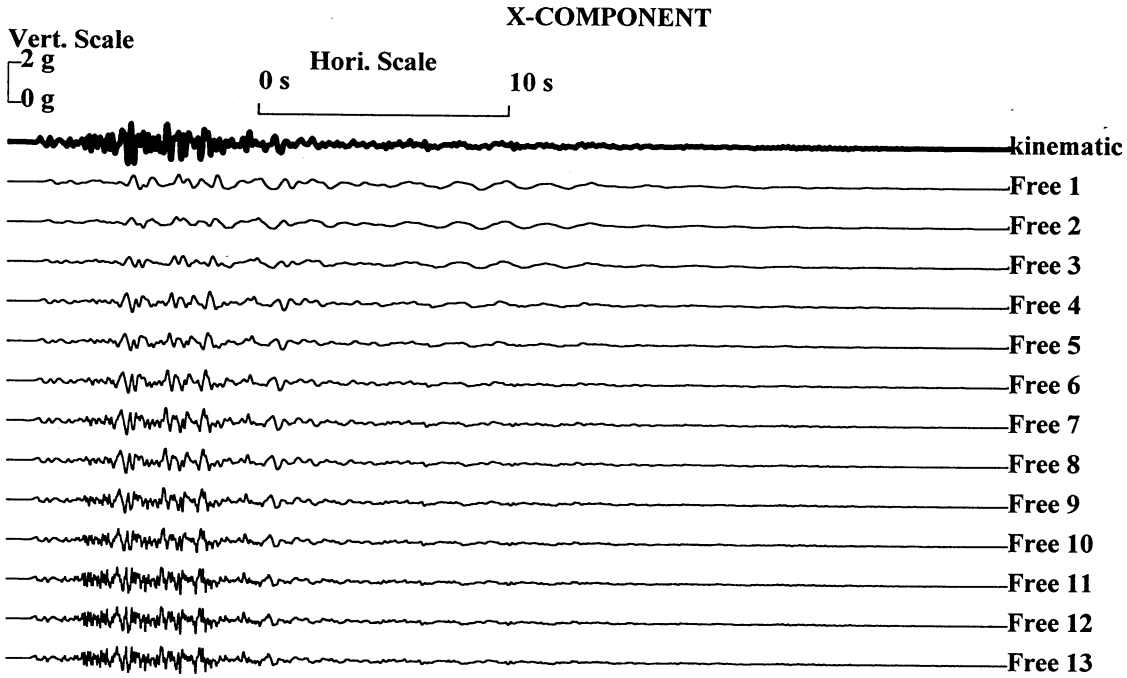
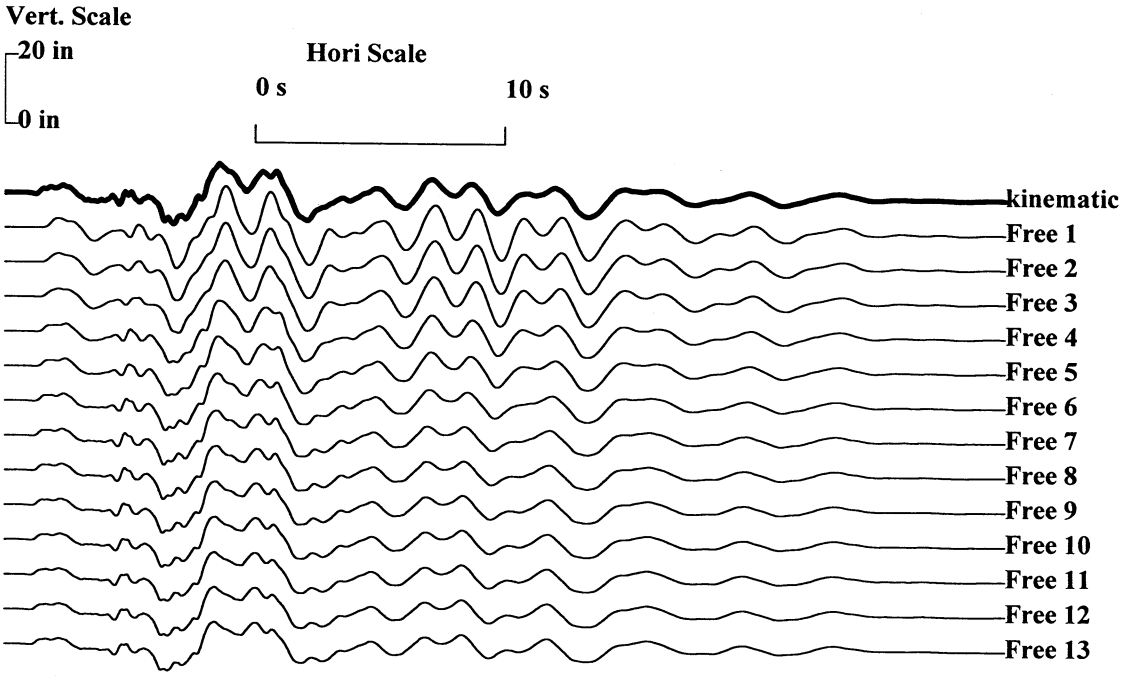
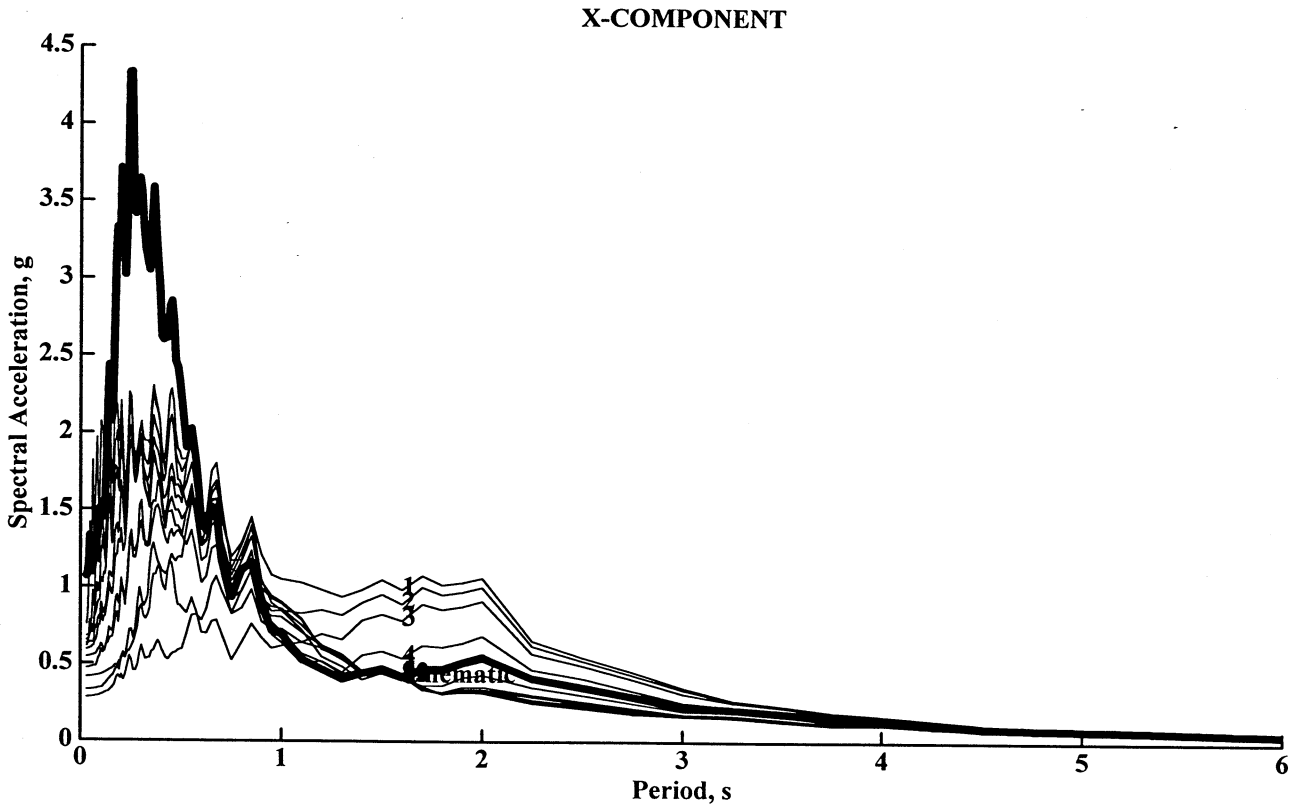
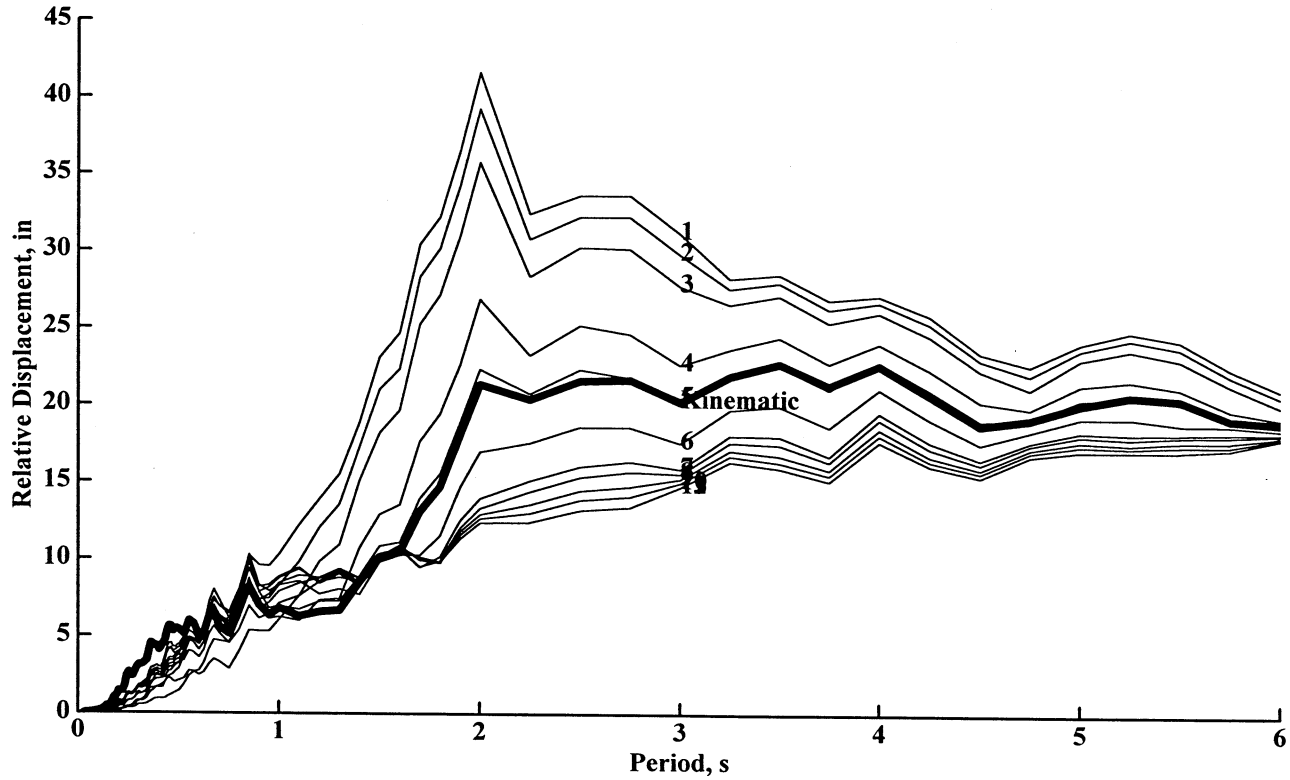




PIER 9
SET 2, Long. Dir.
BENICIA-MARTINEZ





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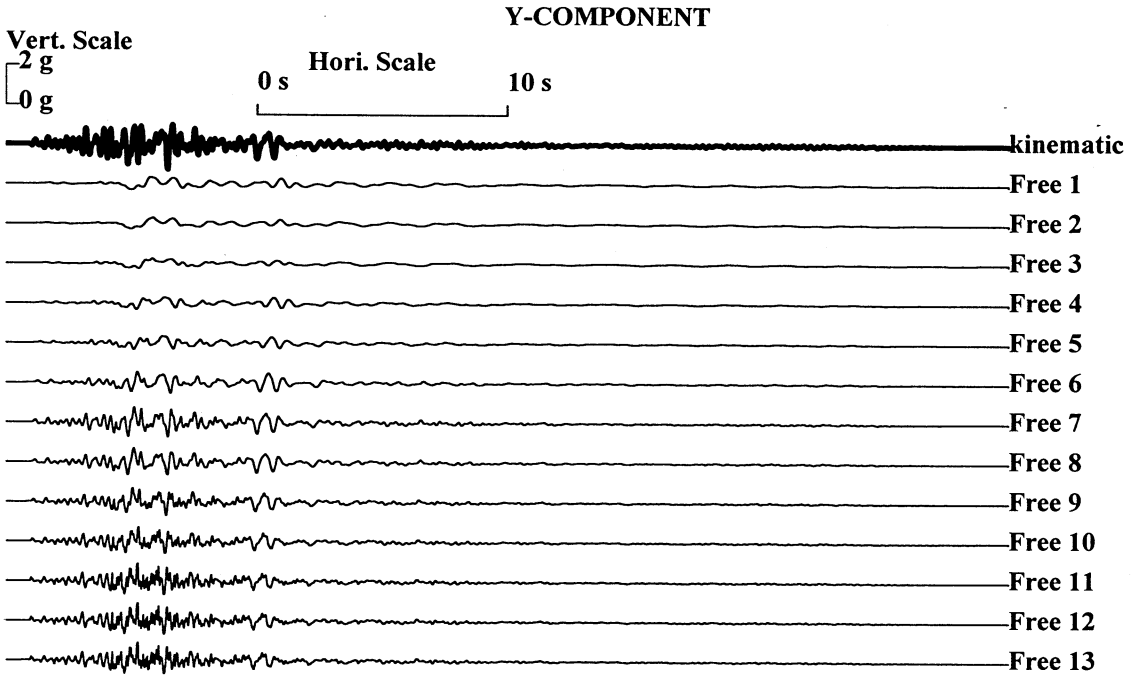
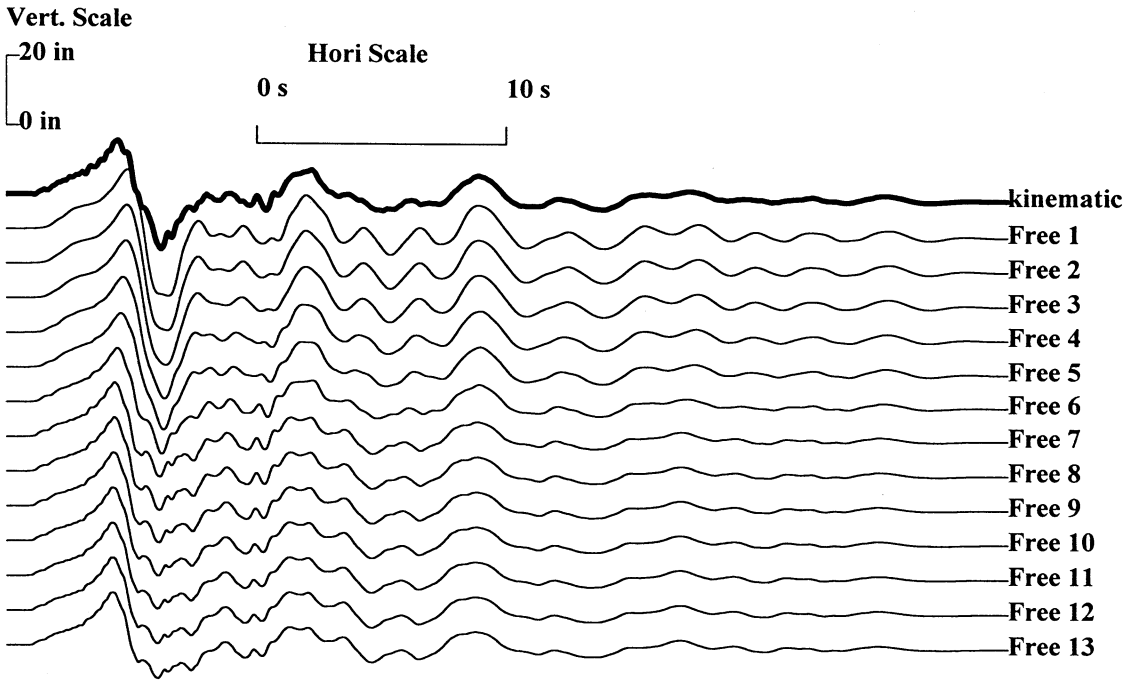
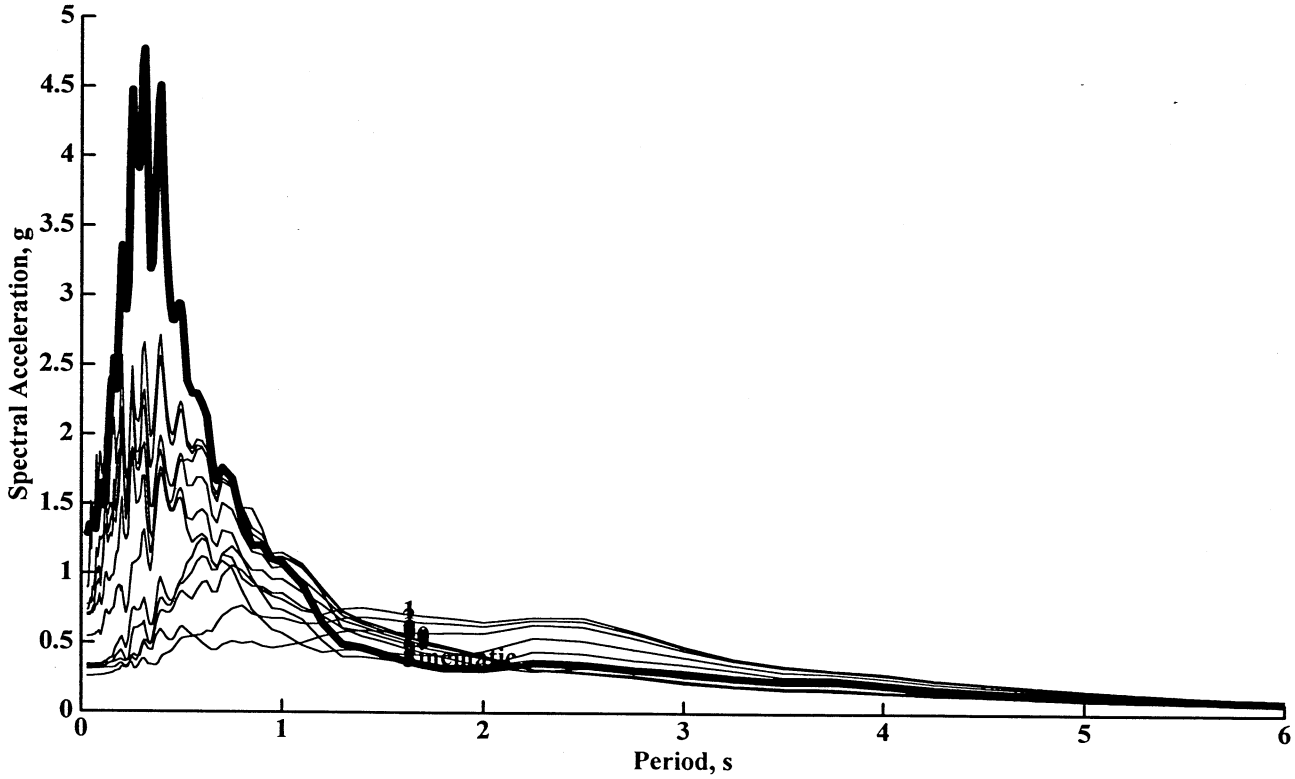
SET 2, Long. Dir.
BENICIA-MARTINEZ

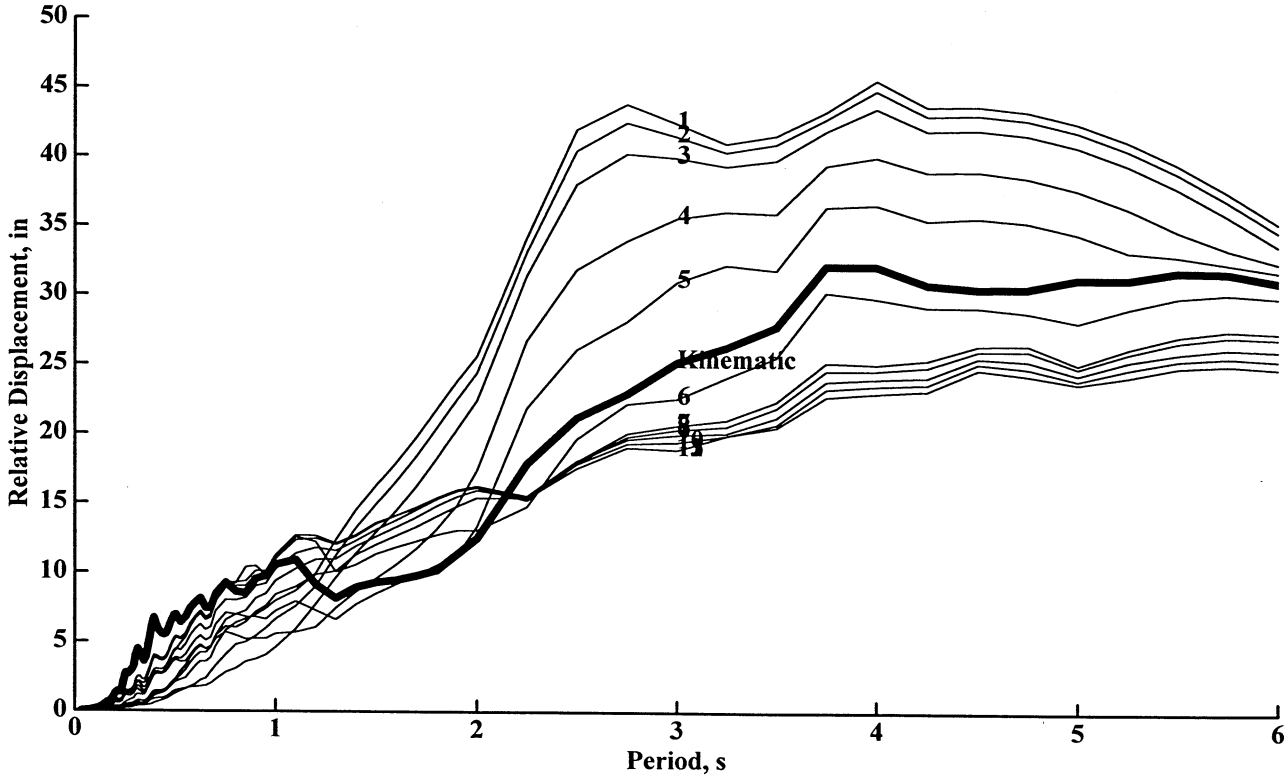




PIER 9
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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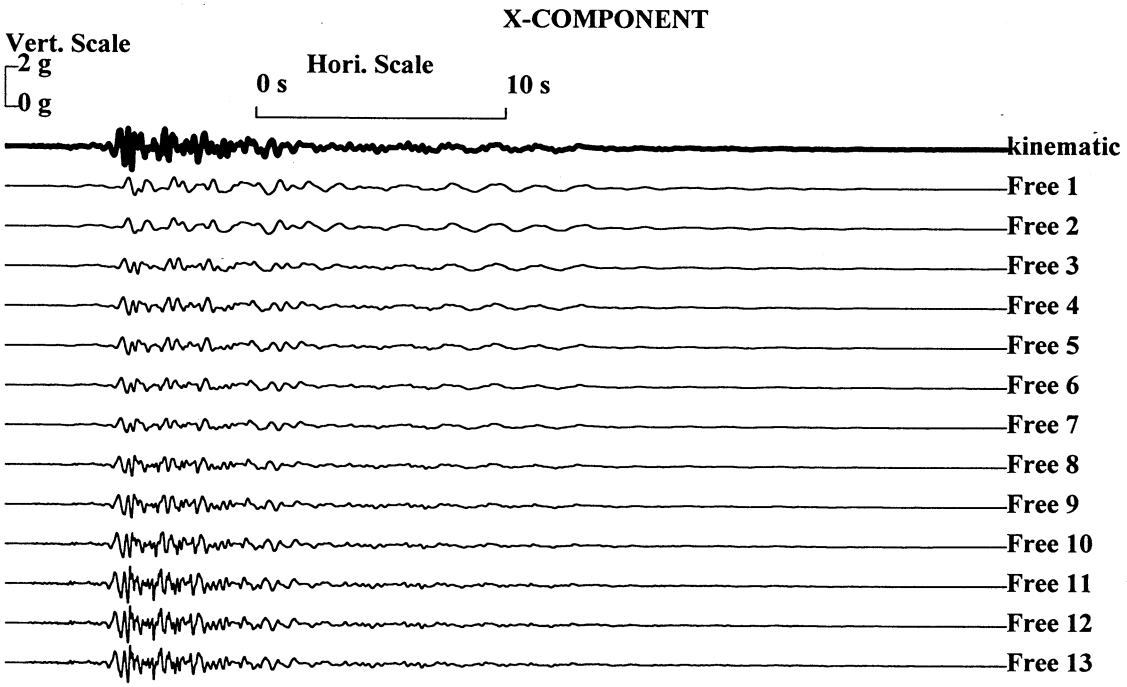
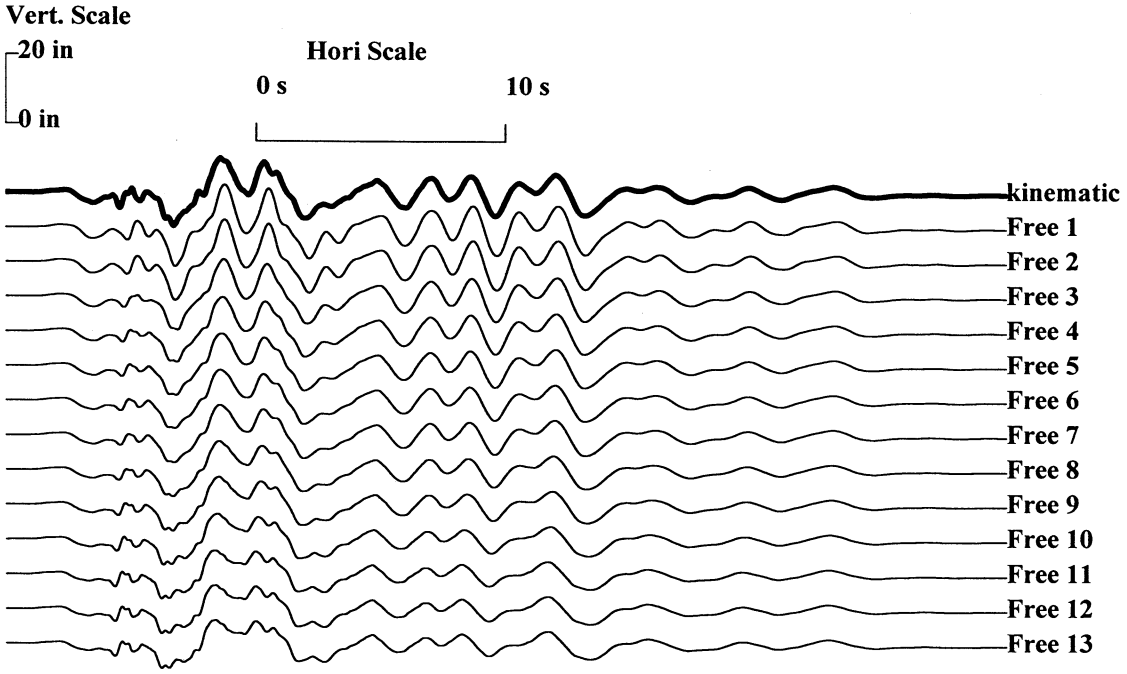
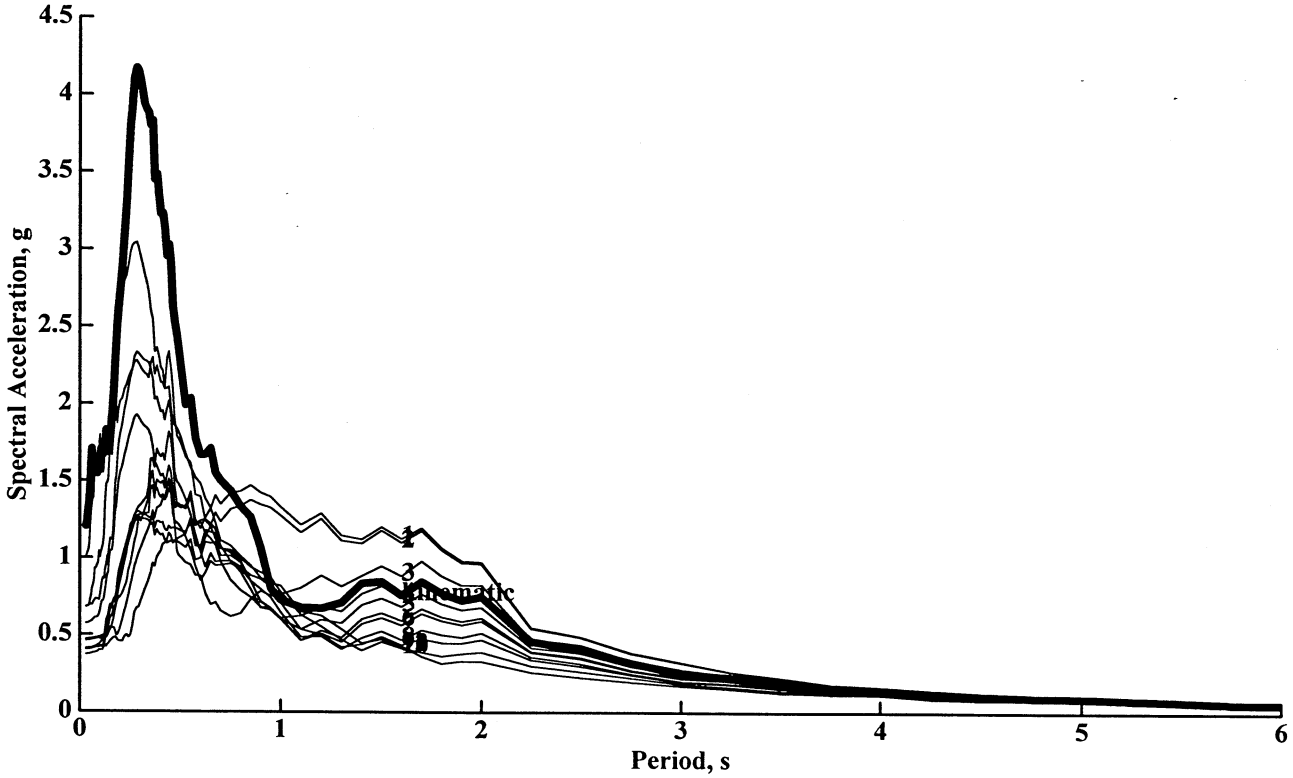
BENICIA-MARTINEZ

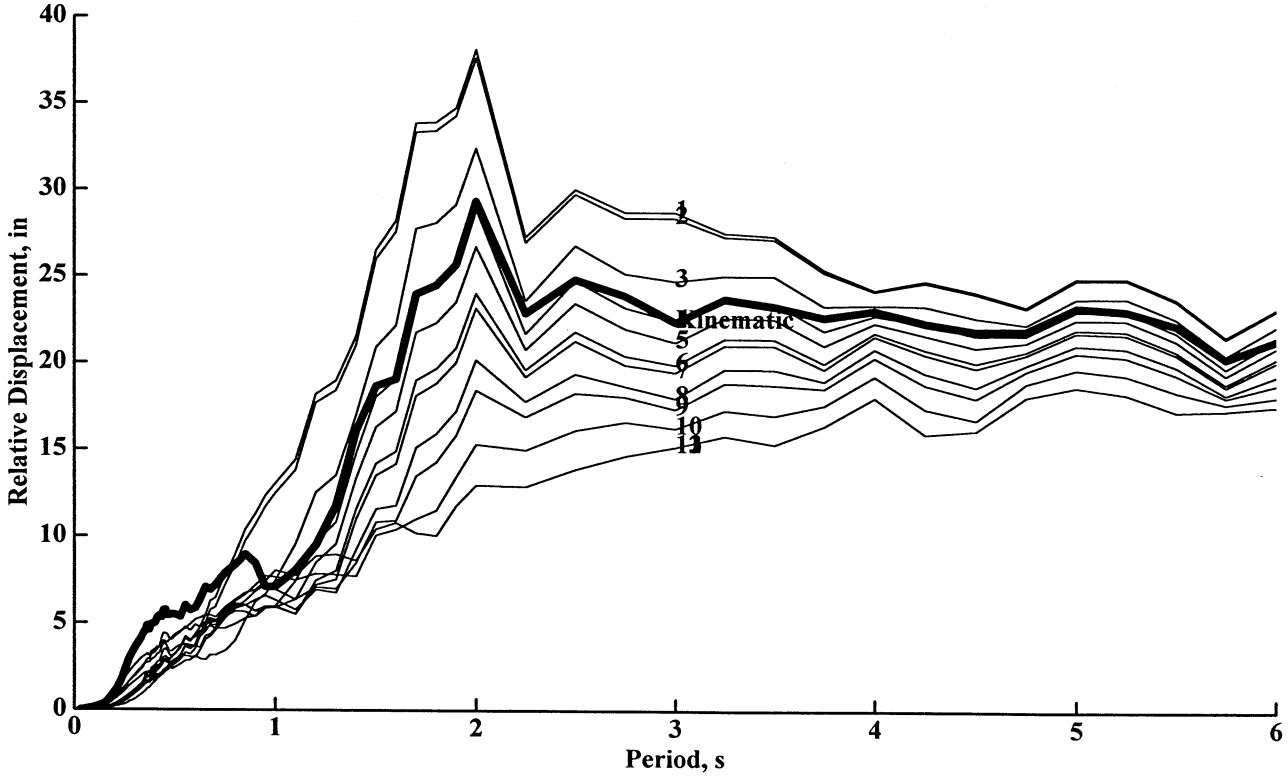




PIER 10
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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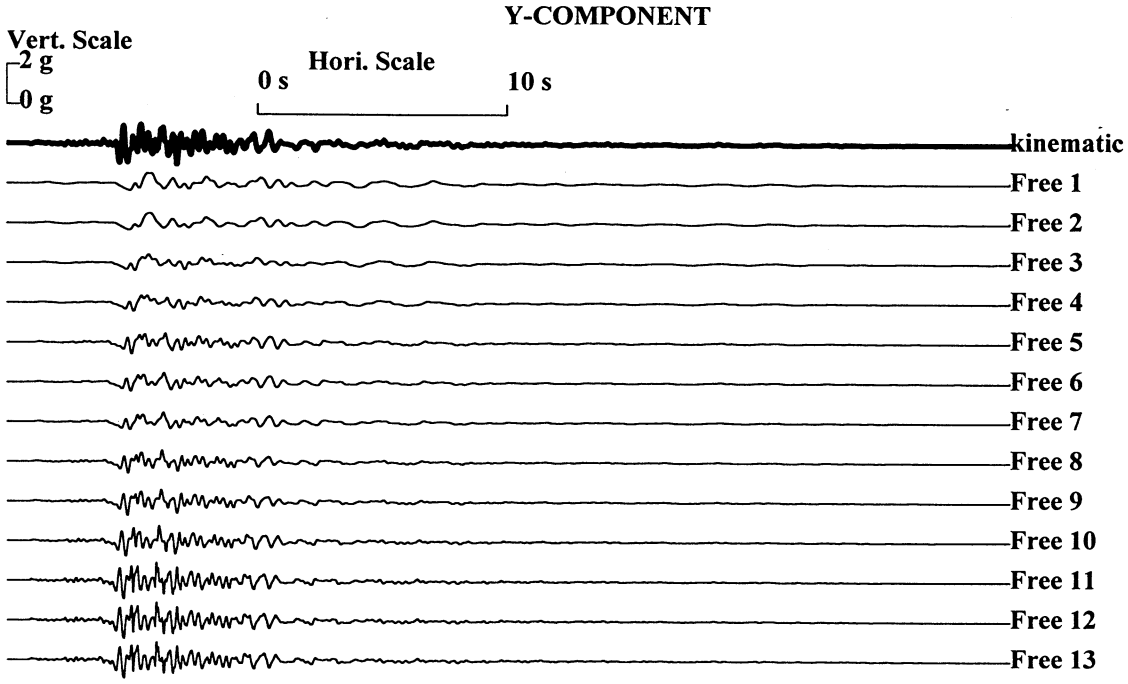
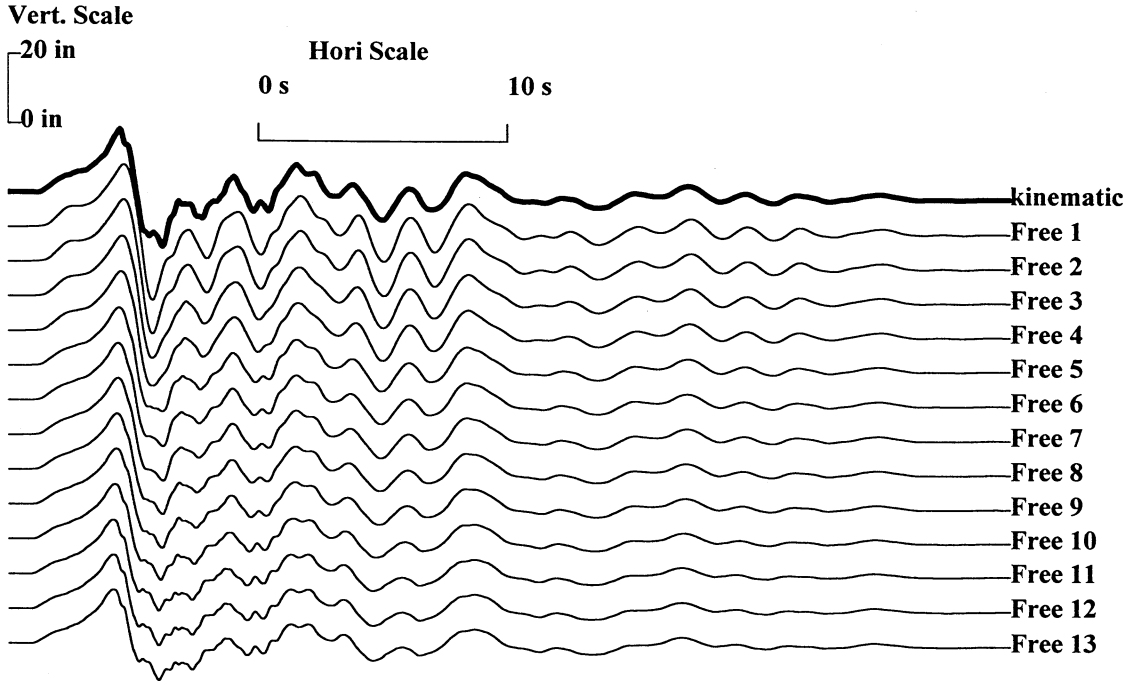
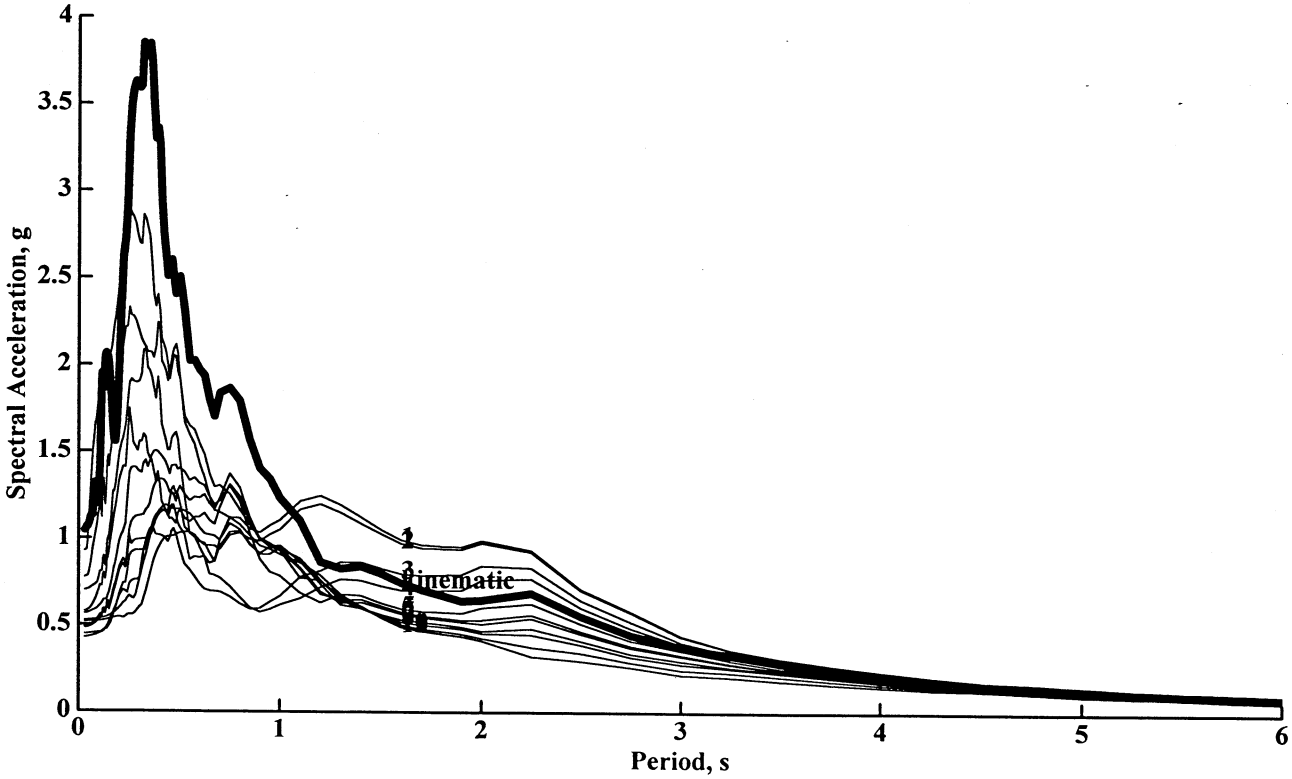
SET 2, Long. Dir.
BENICIA-MARTINEZ

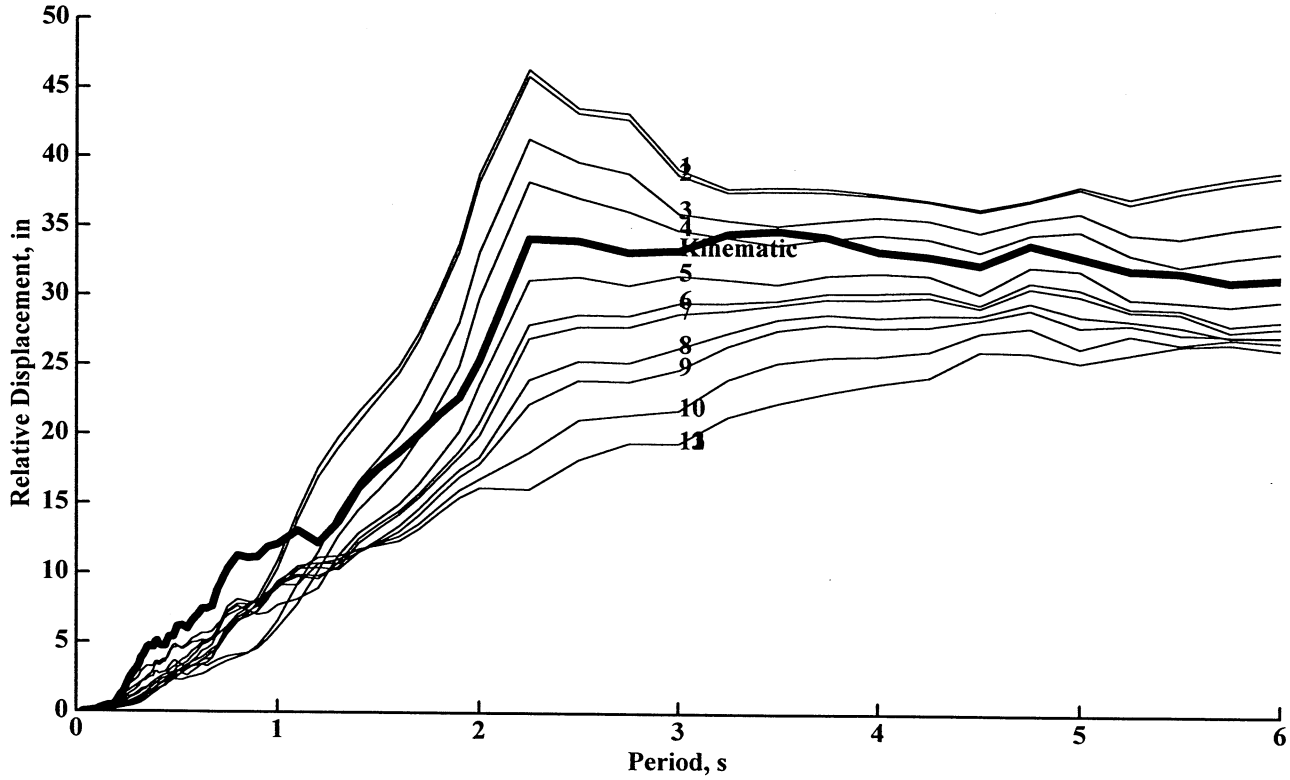




PIER 10
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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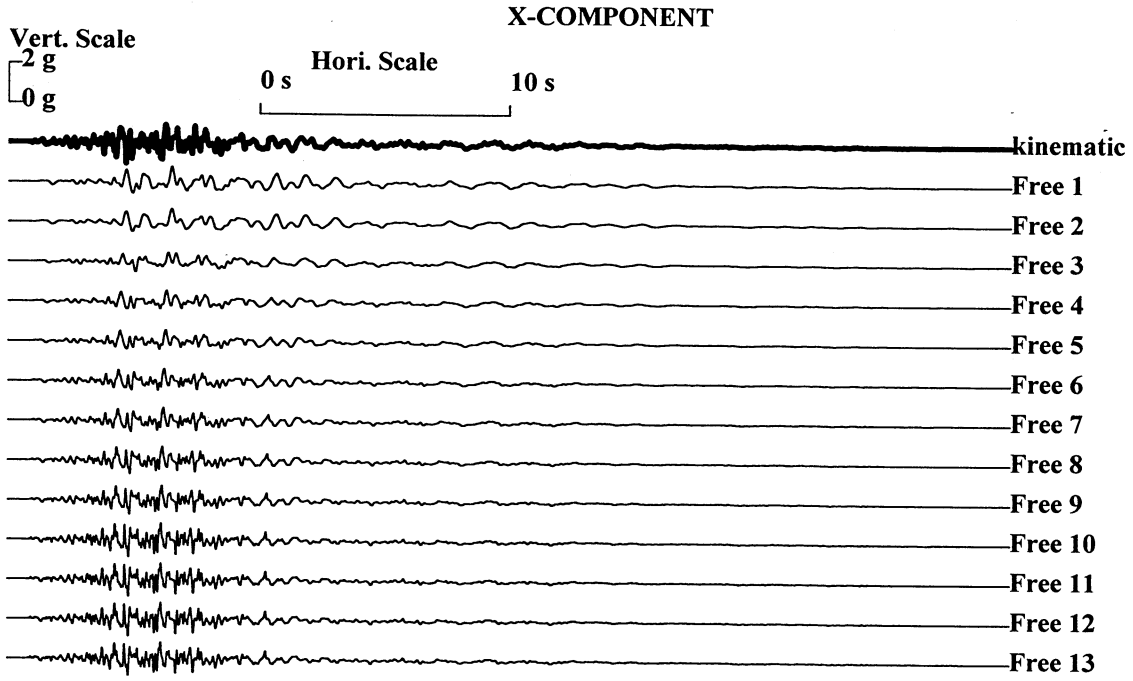
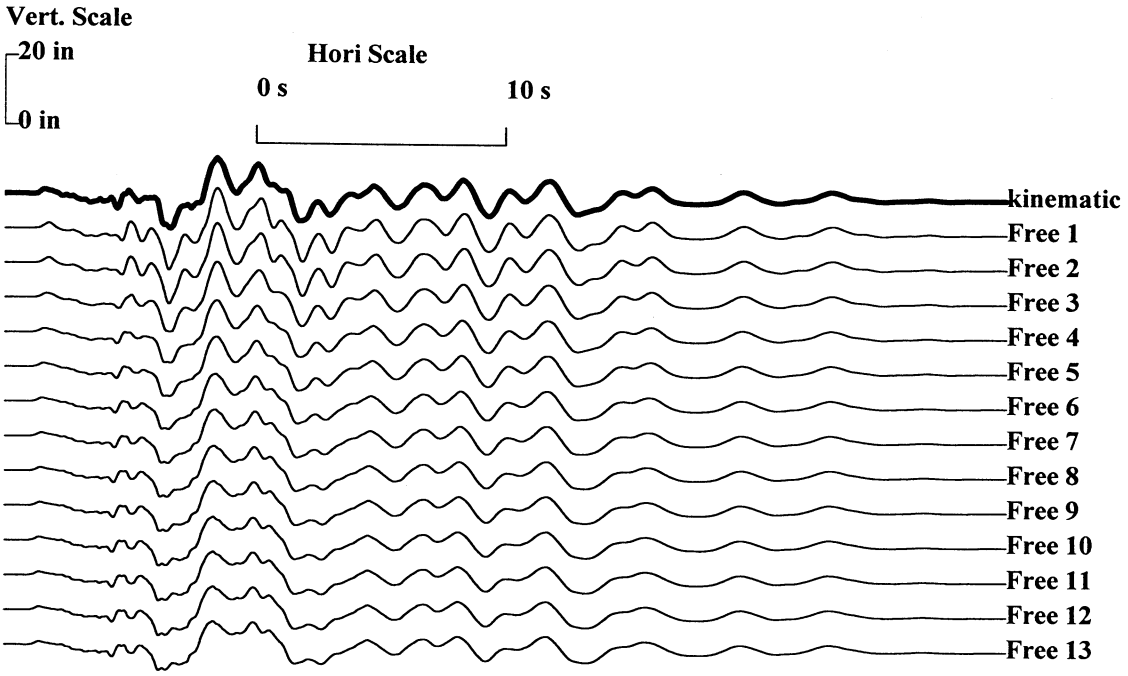
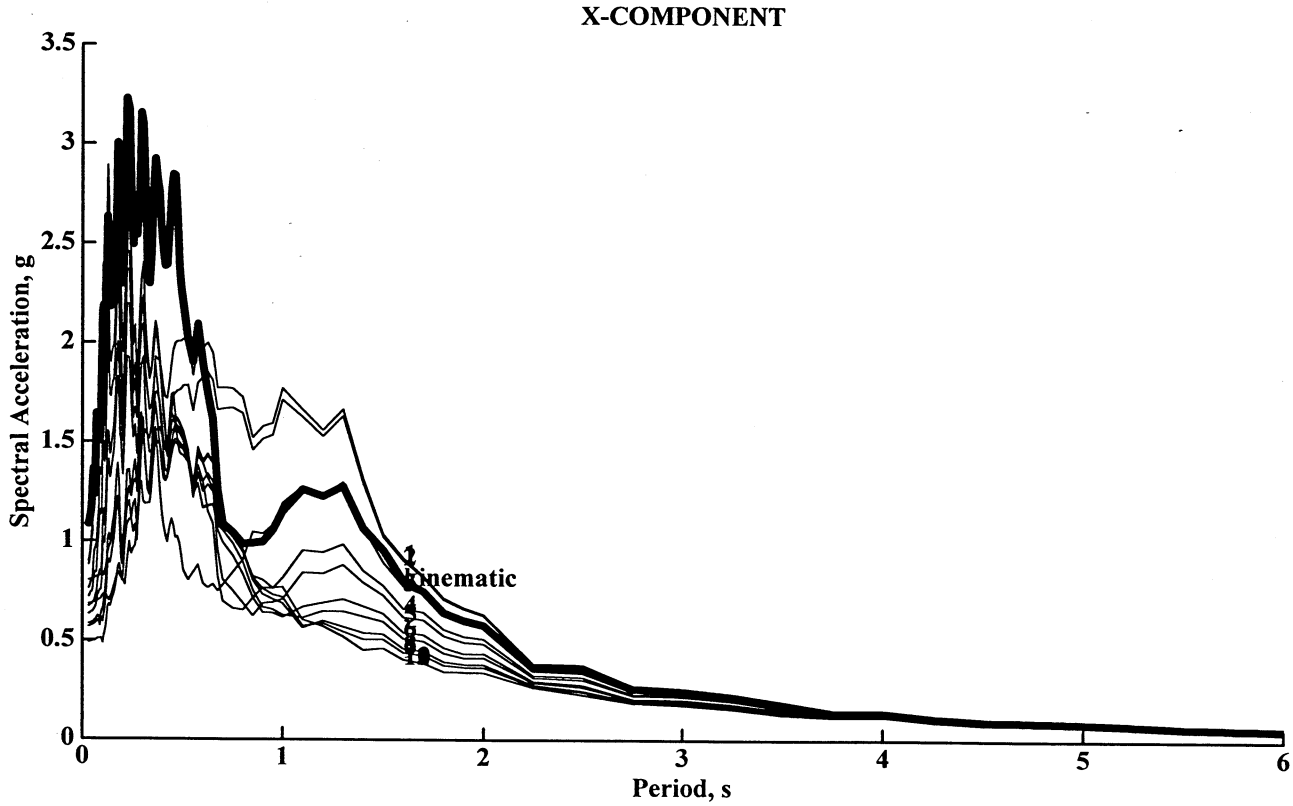
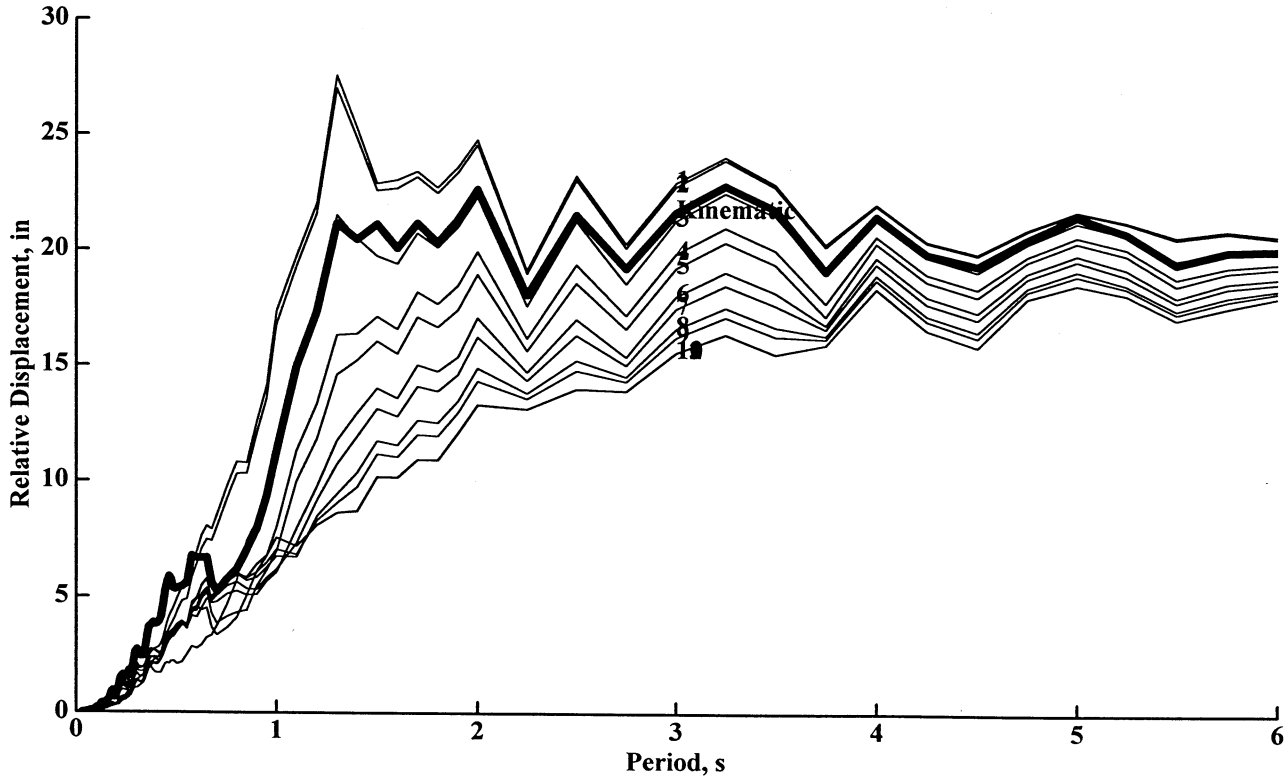
SET 2, Tran. Dir.
BENICIA-MARTINEZ





PIER 11
SET 2, Long. Dir.
BENICIA-MARTINEZ





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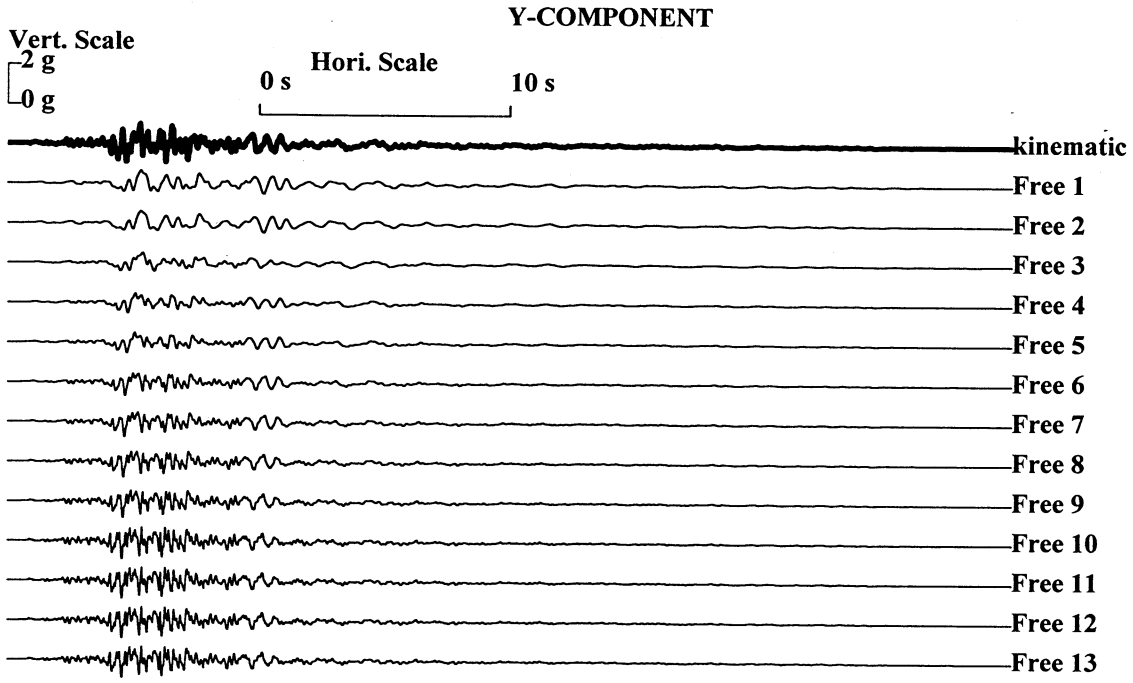
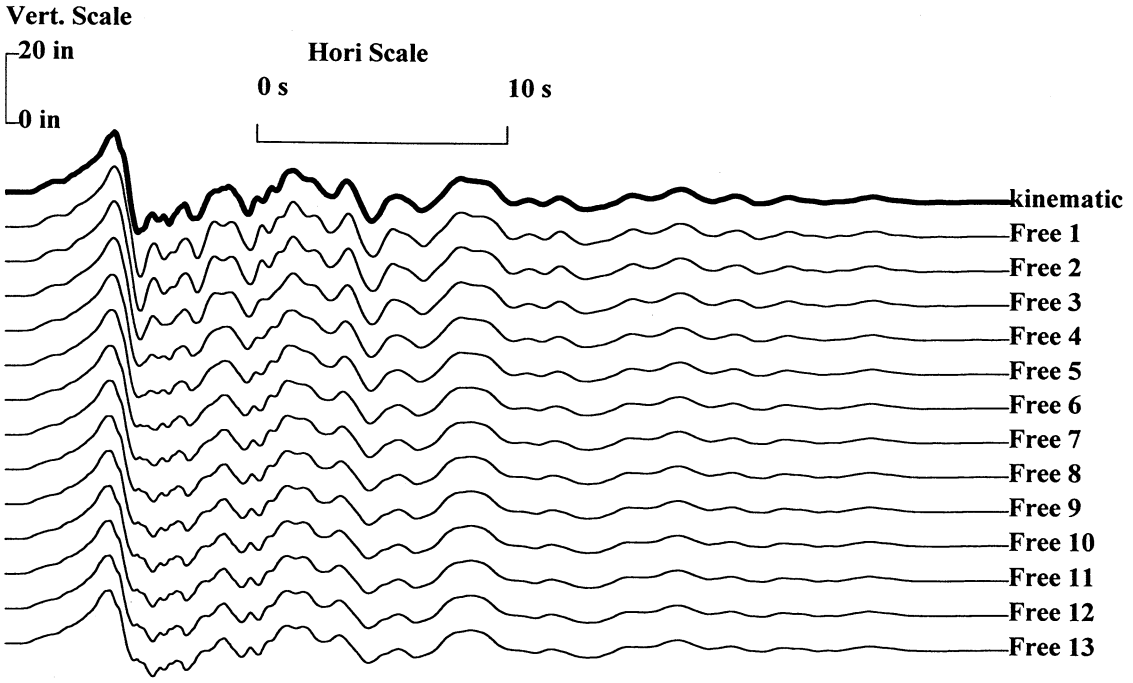
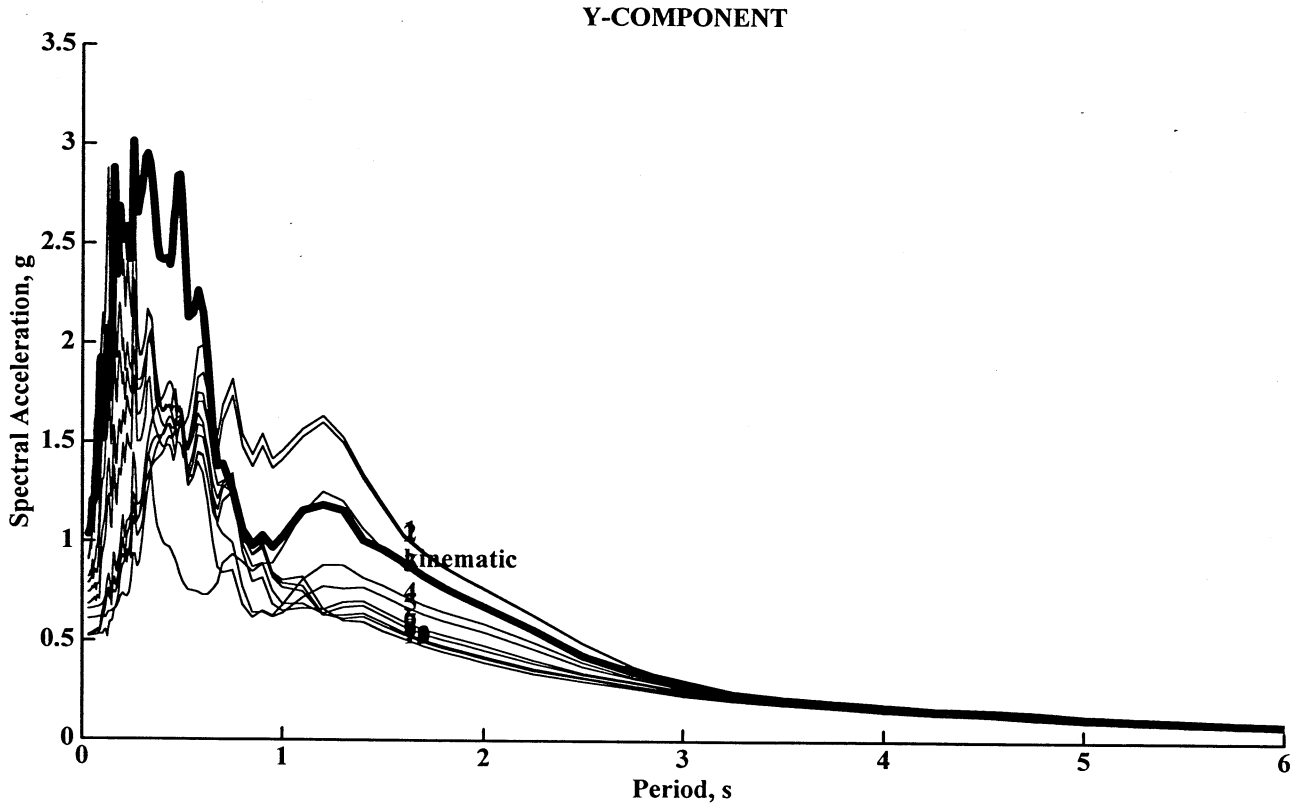
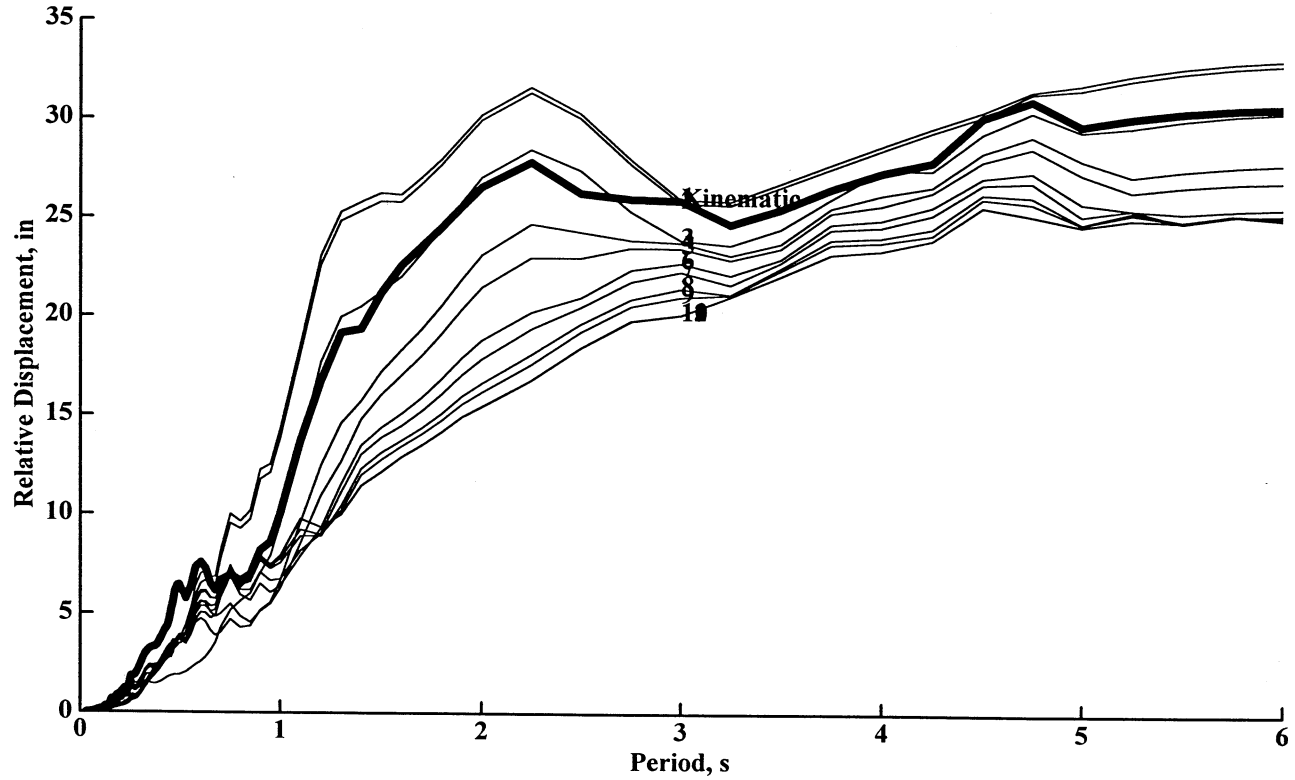
SET 2, Long. Dir.
BENICIA-MARTINEZ





PIER 11
SET 2, Tran. Dir.
BENICIA-MARTINEZ





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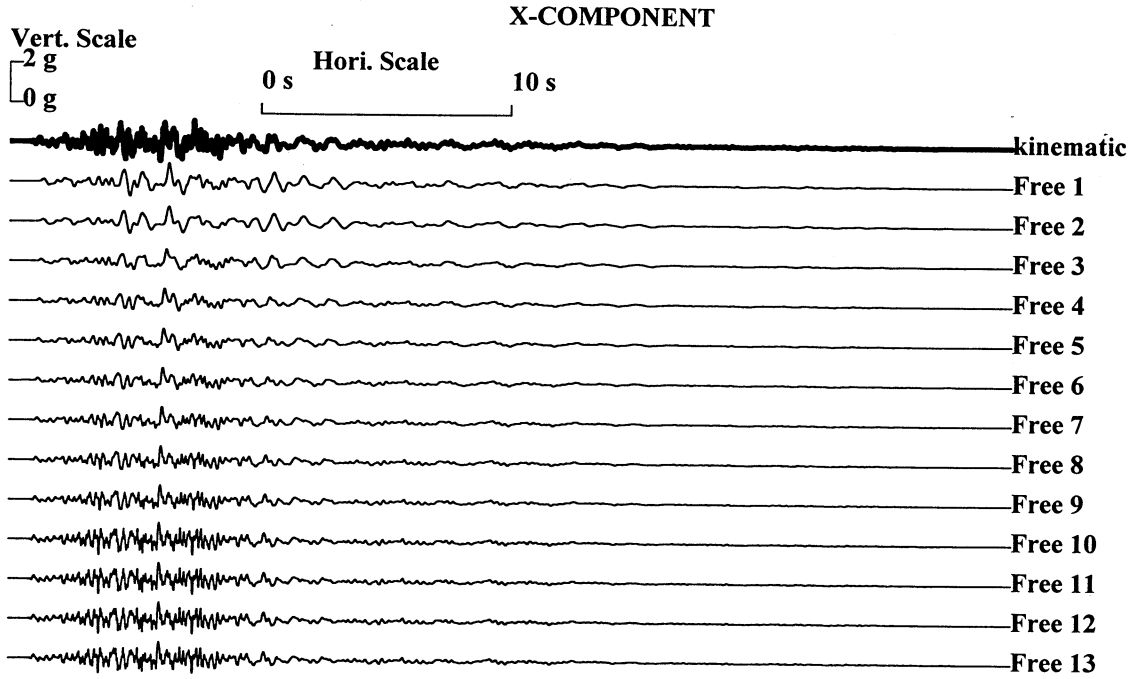

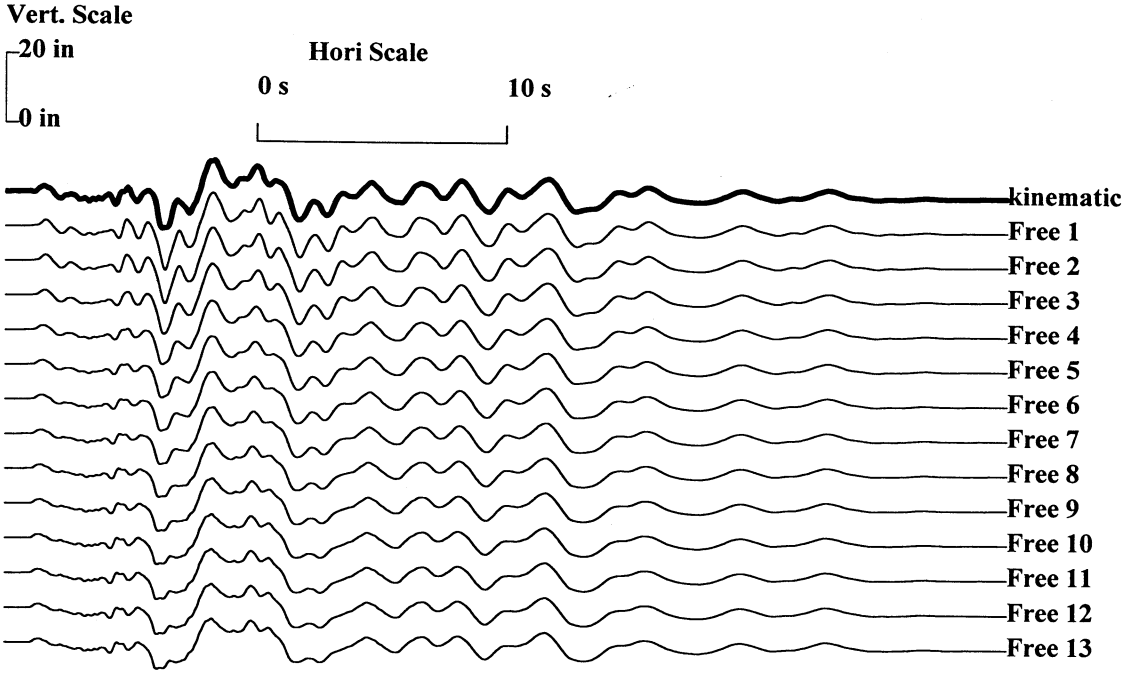

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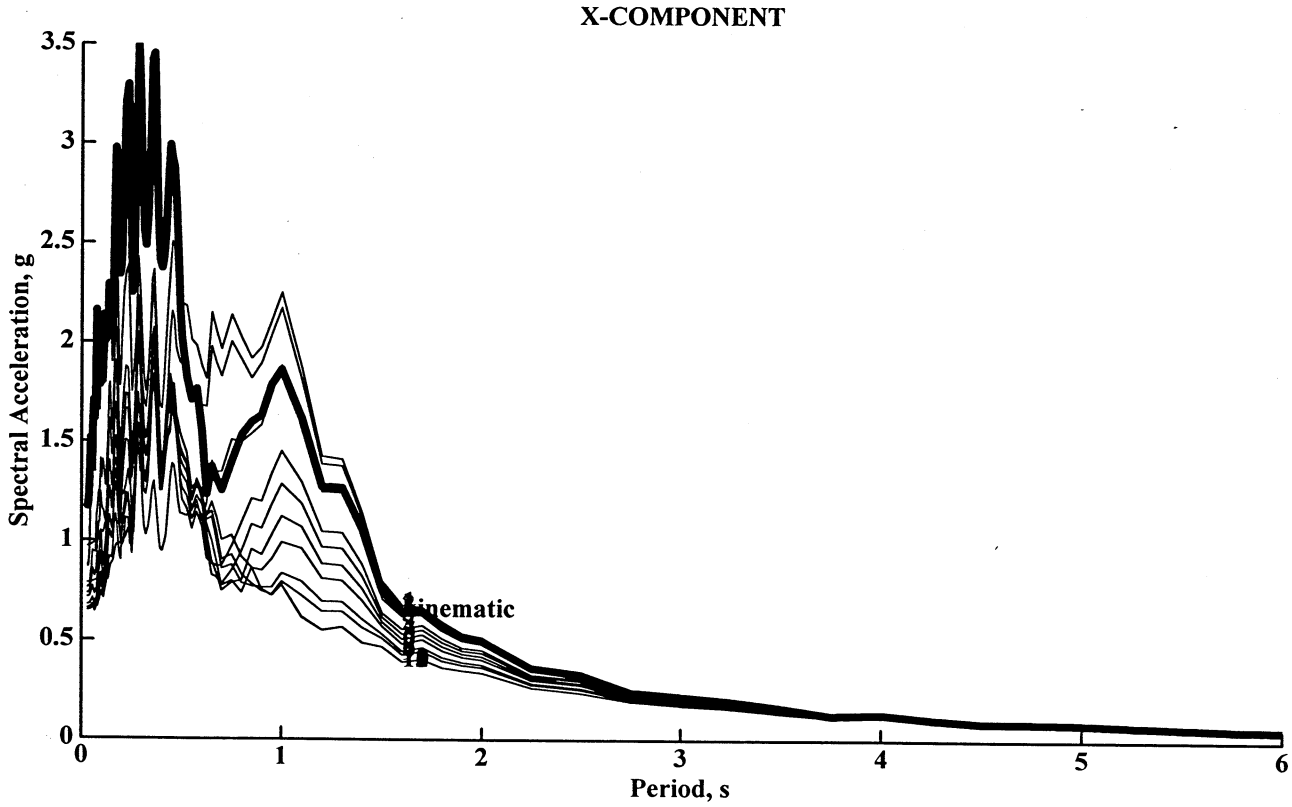

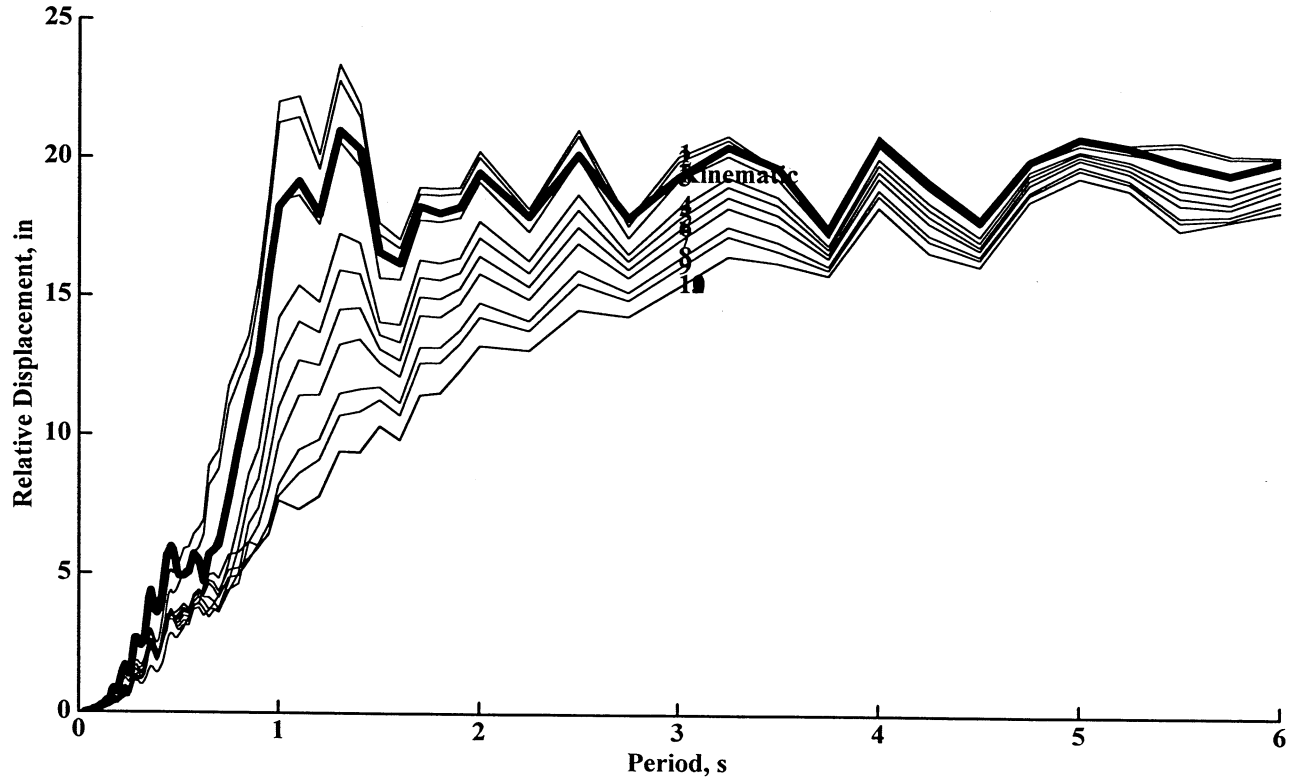

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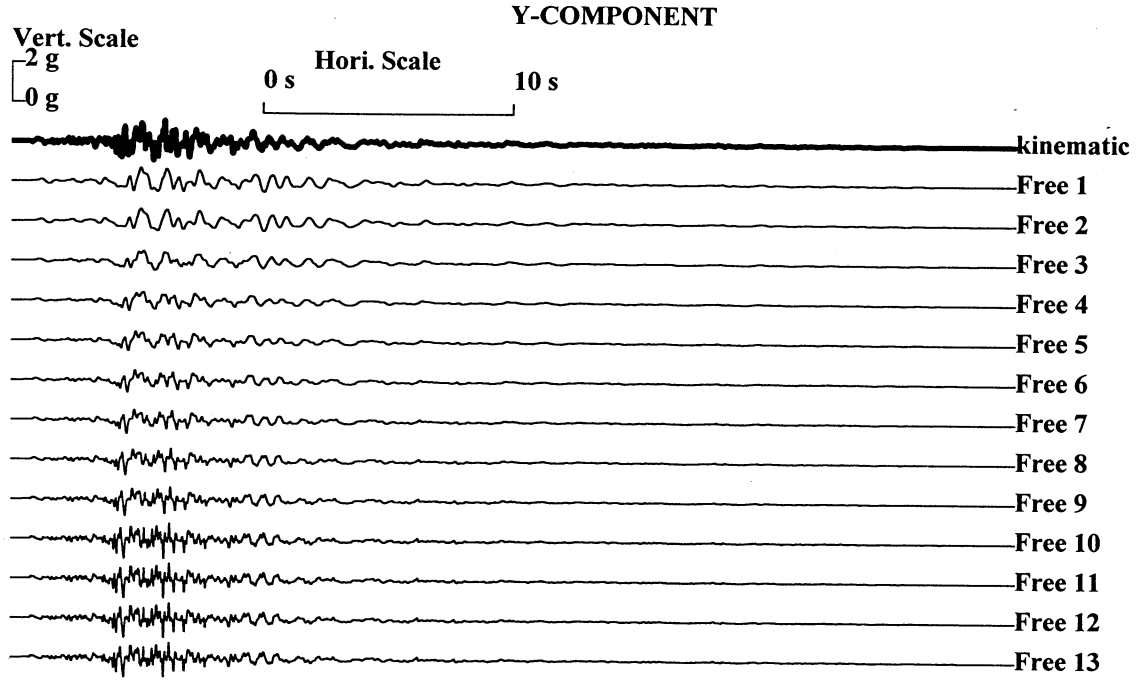

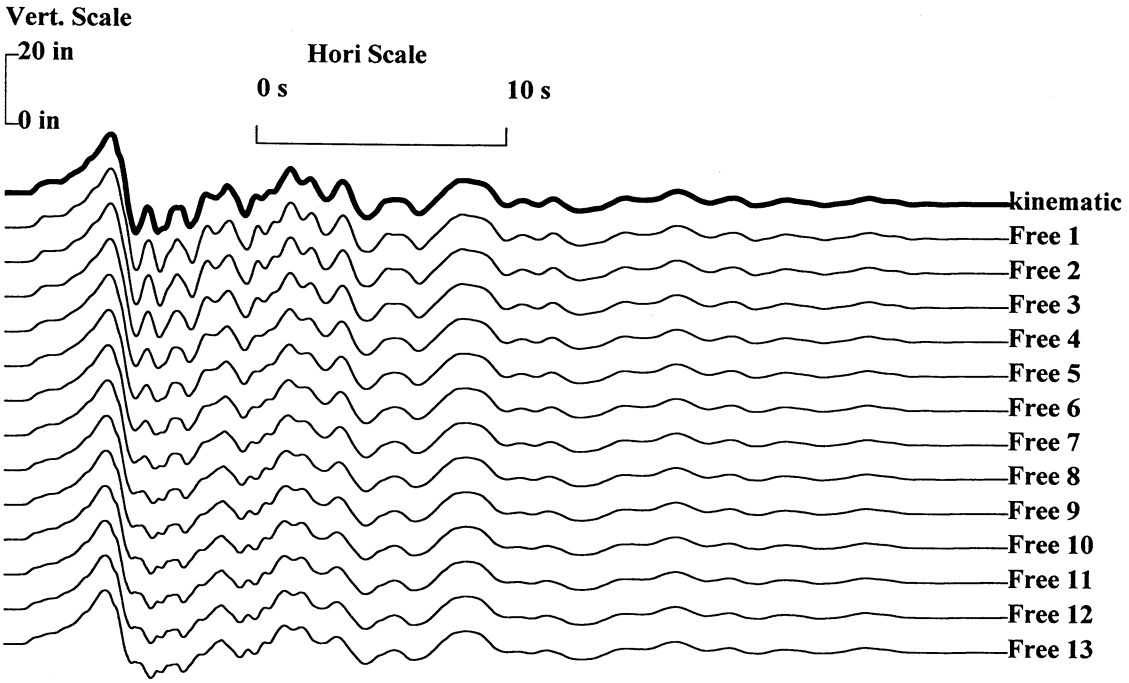

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SET 2, Tran. Dir.
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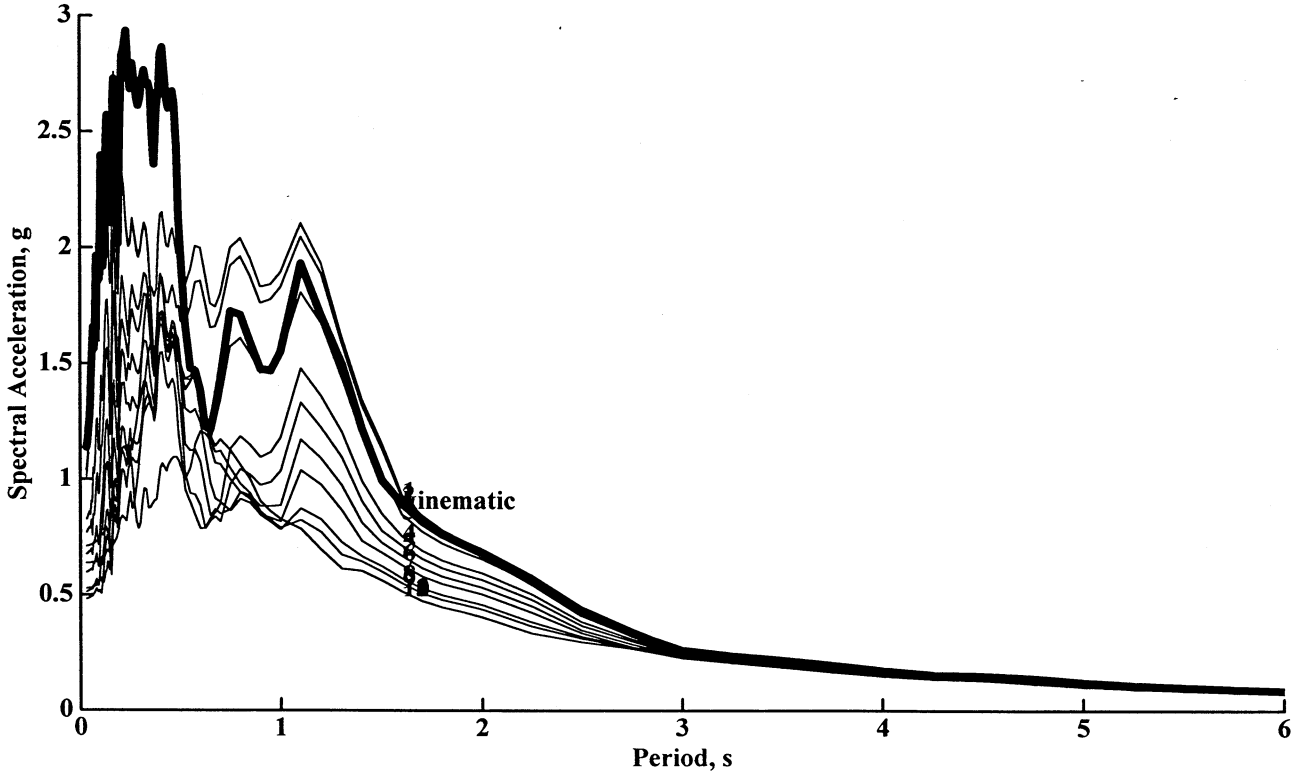
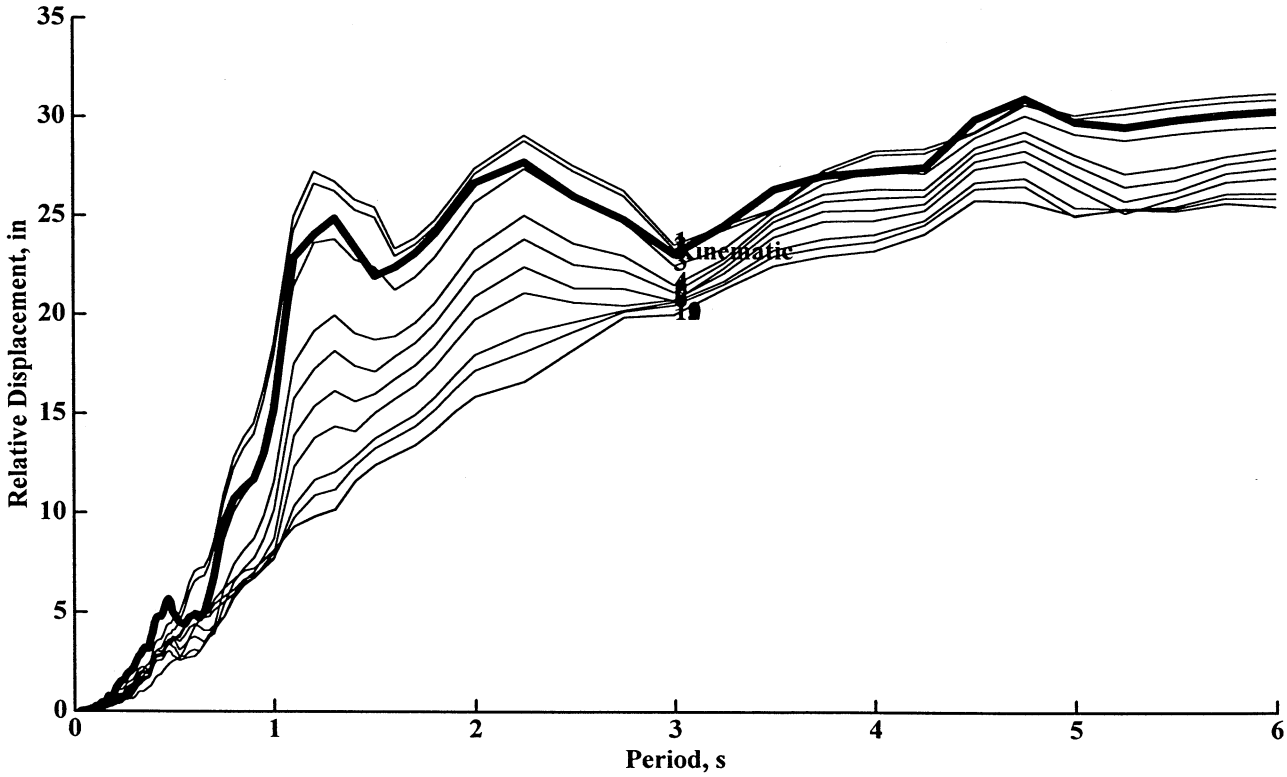
Y-COMPONENT





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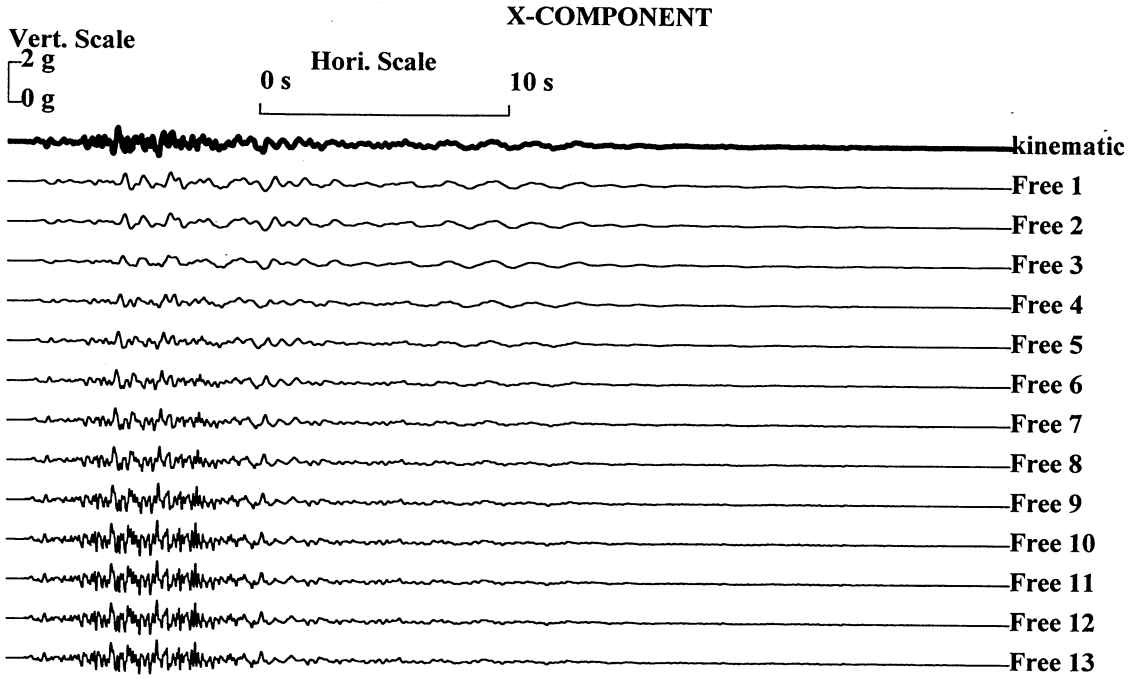

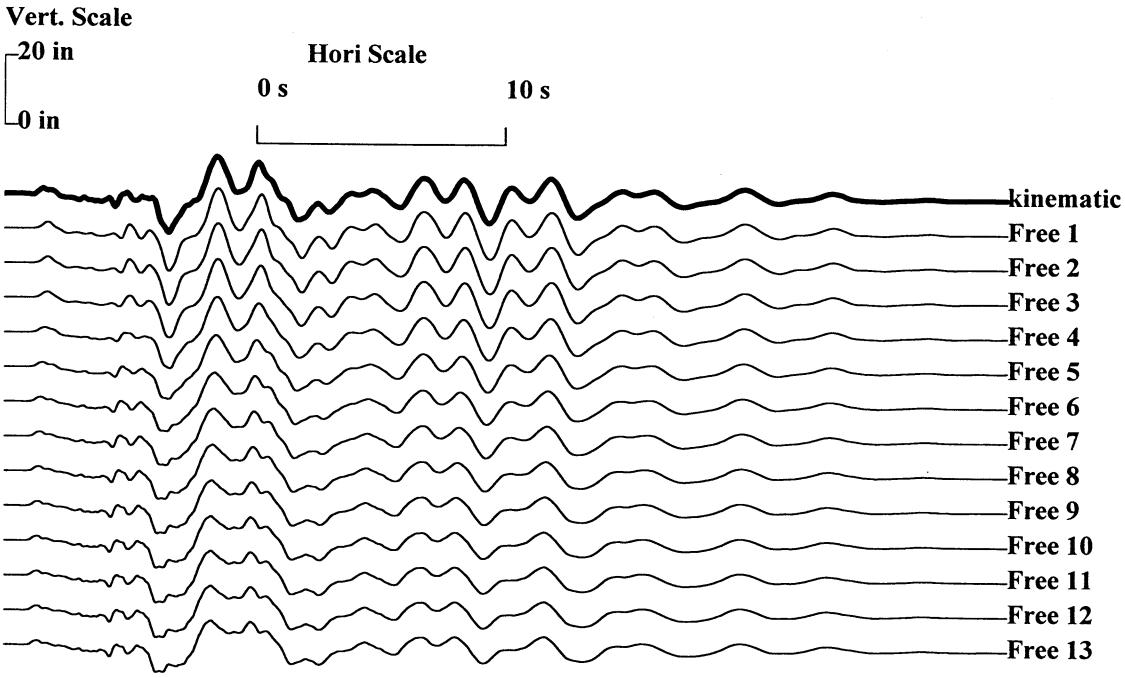

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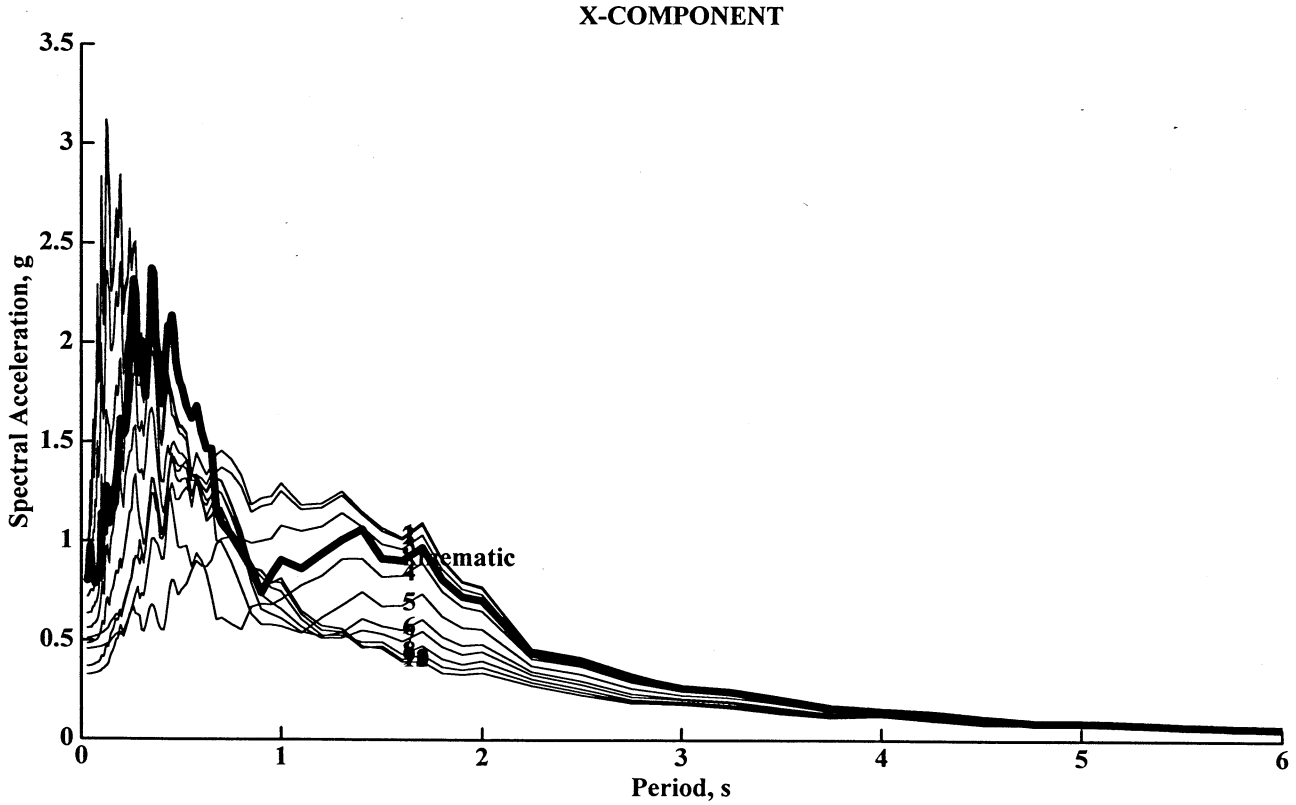

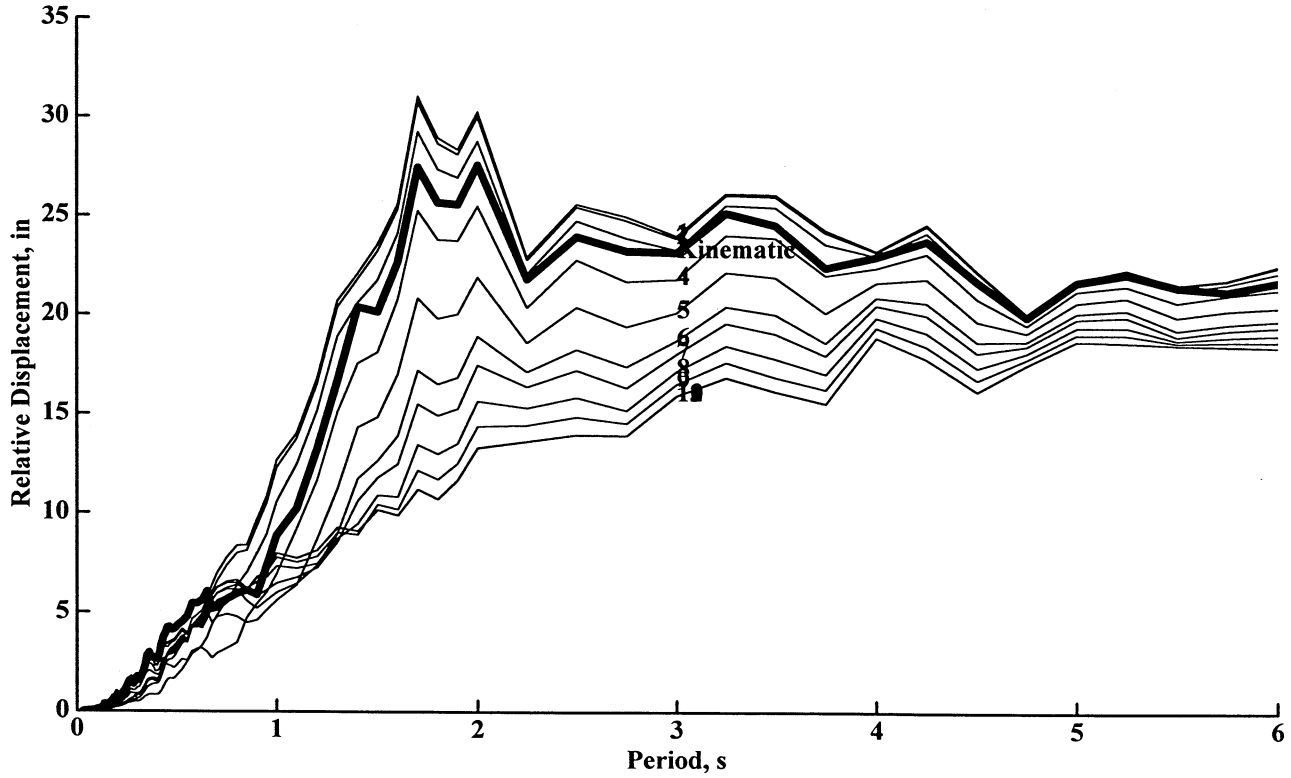

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SET 2, Long. Dir.
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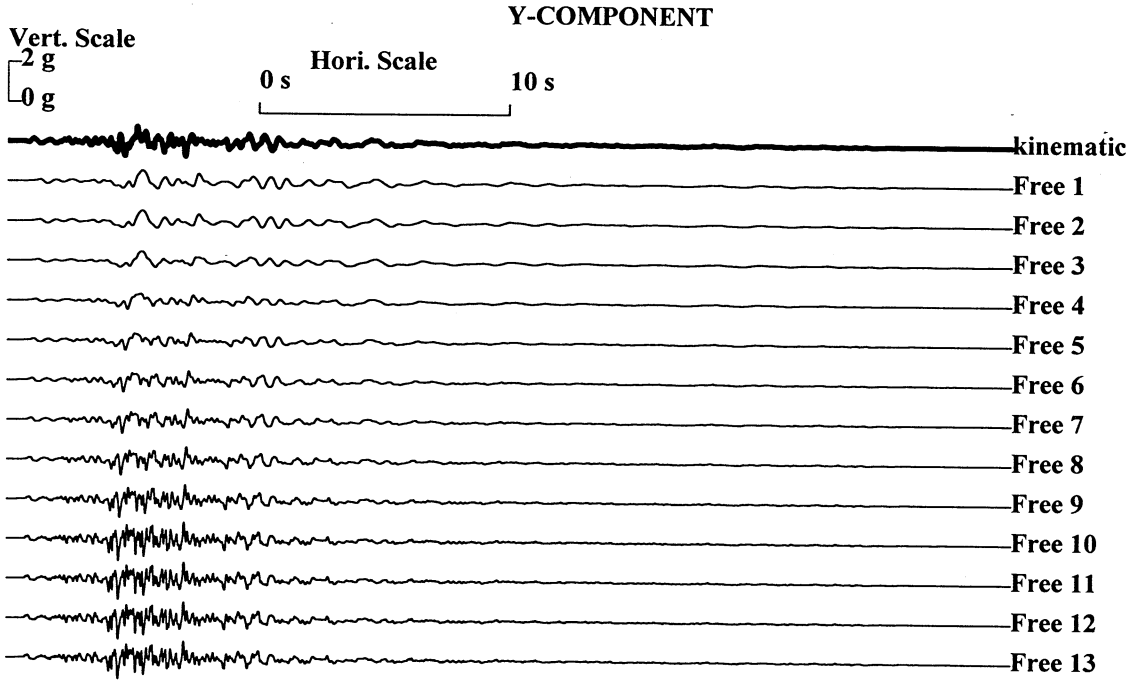

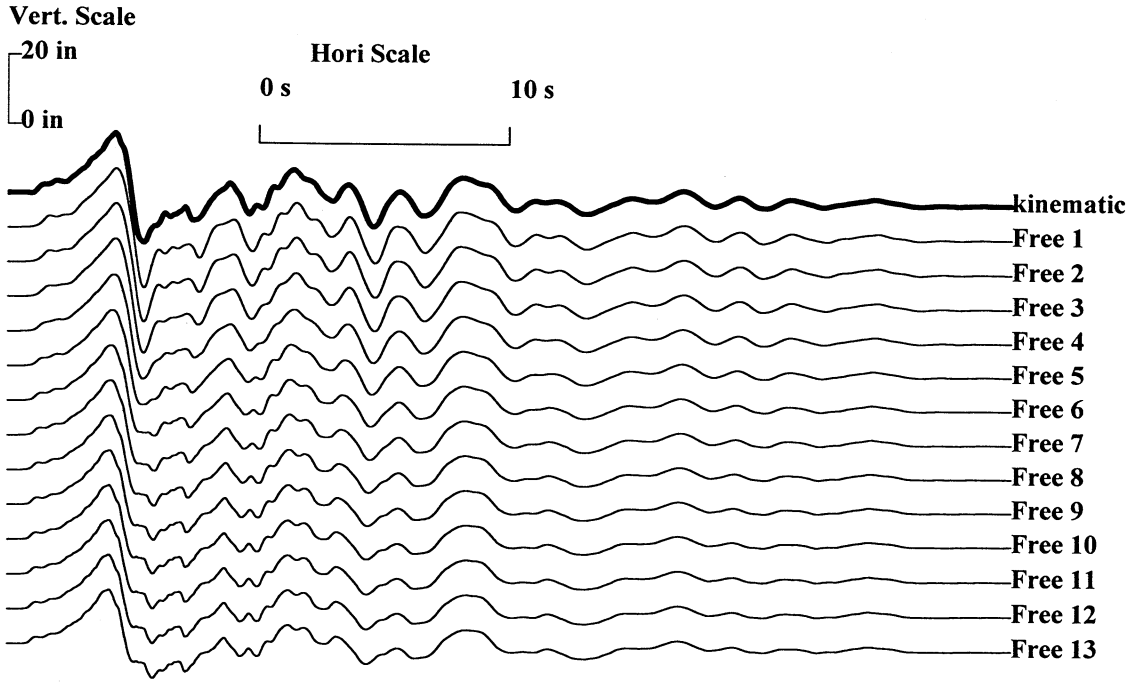

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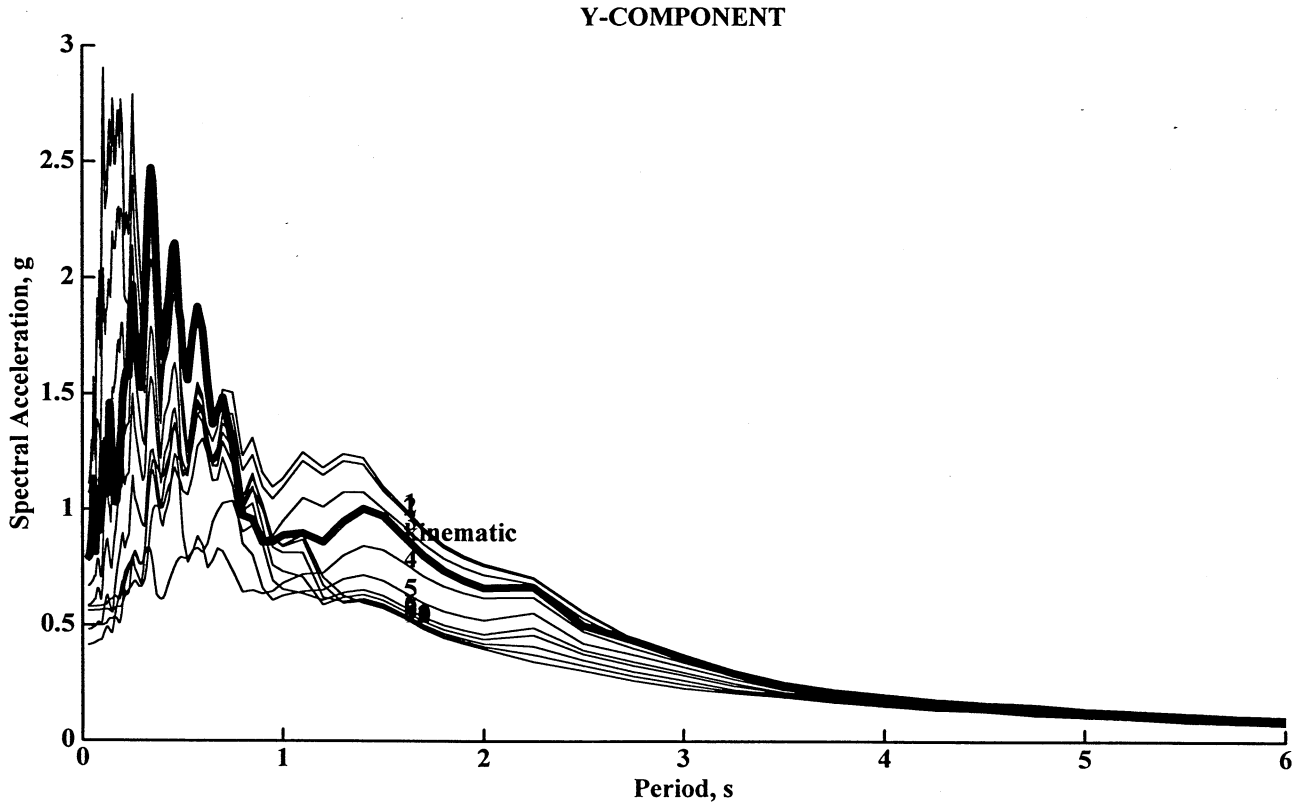
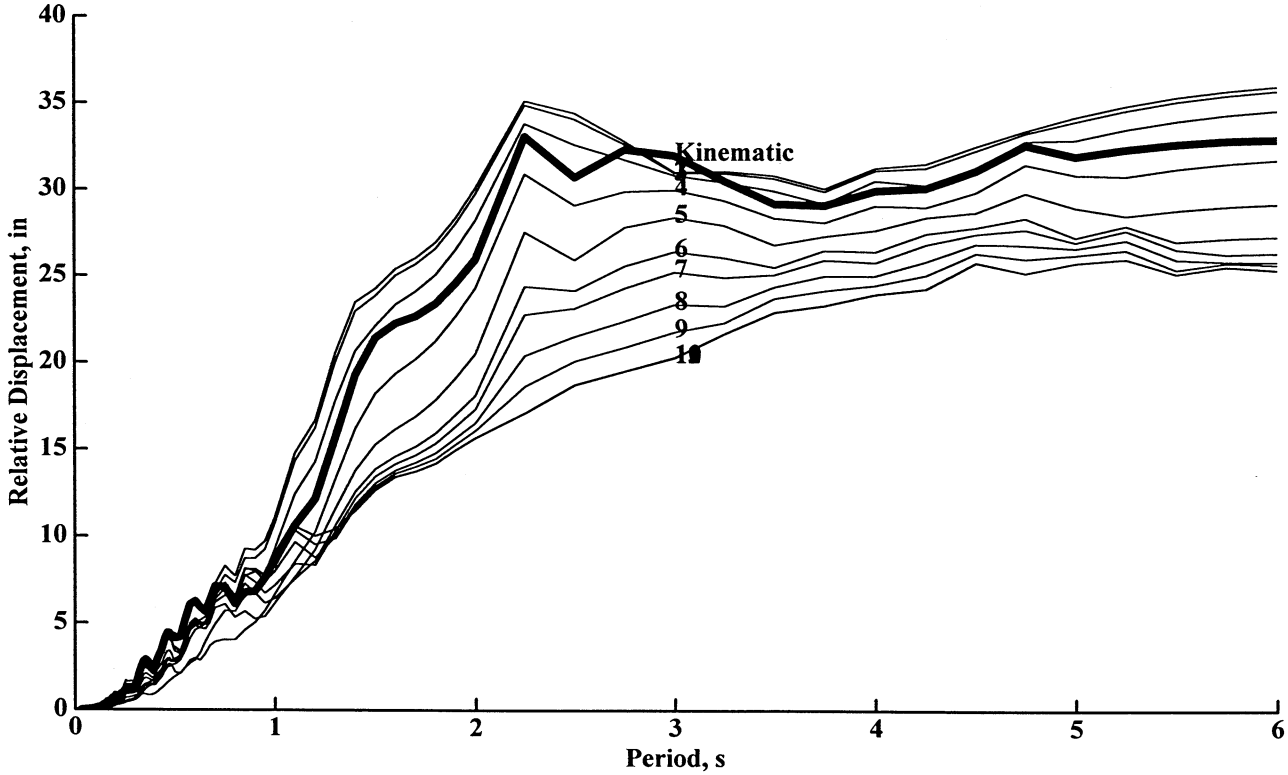
SET 2, Tran. Dir.
BENICIA-MARTINEZ





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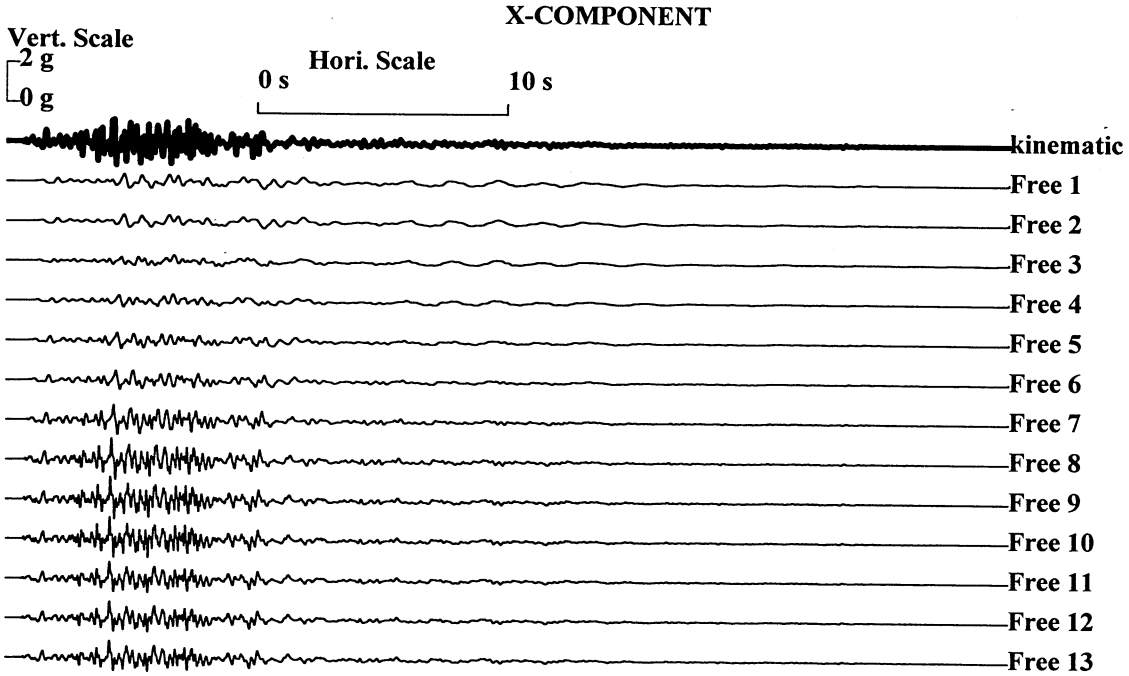
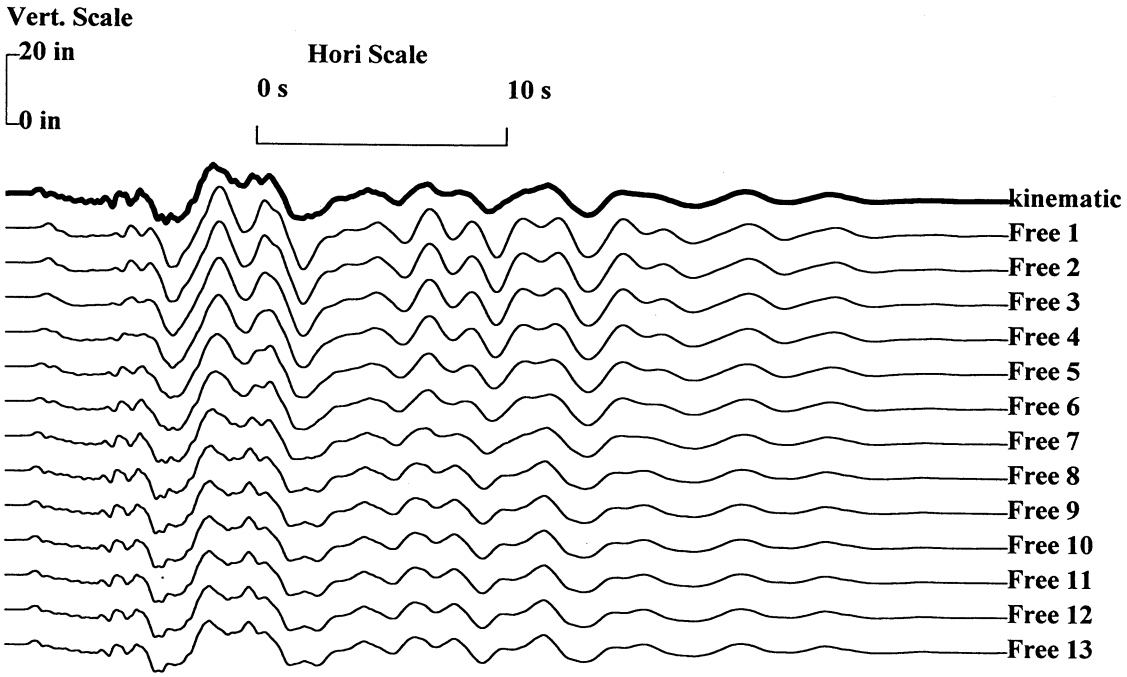
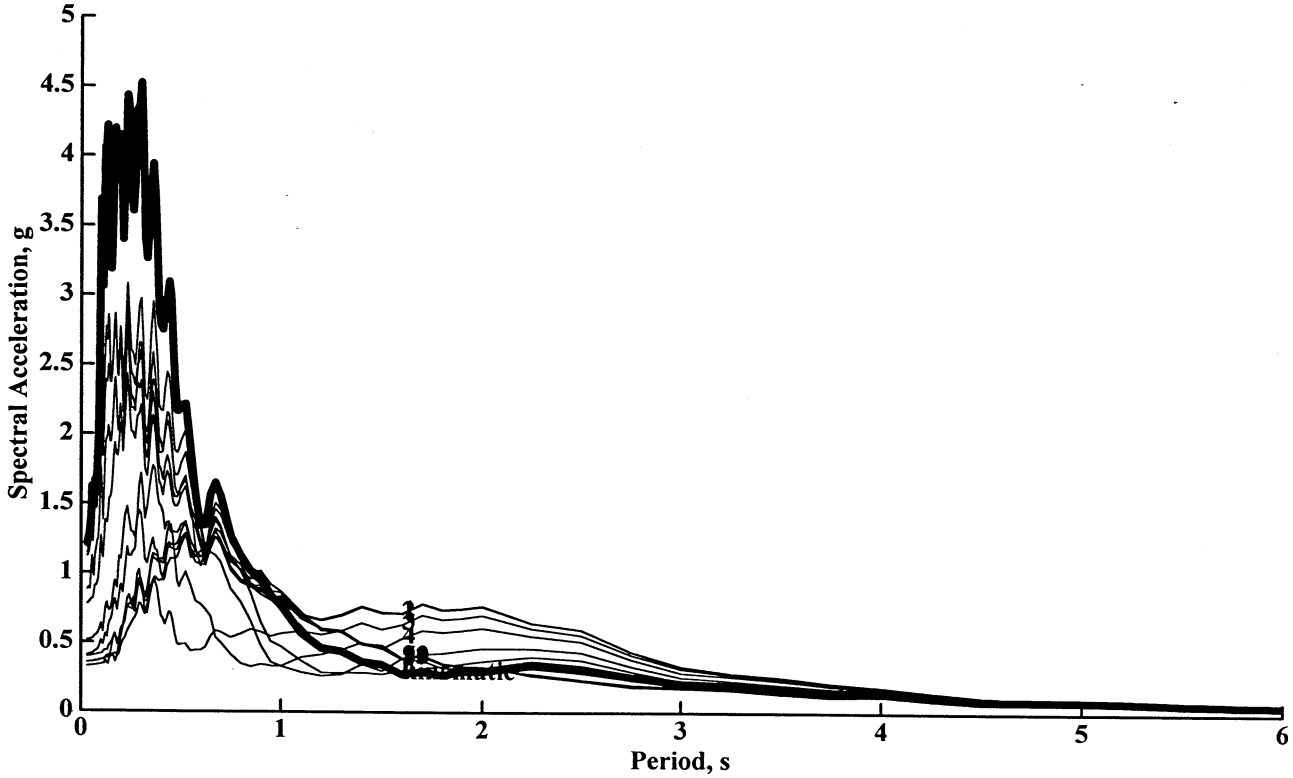
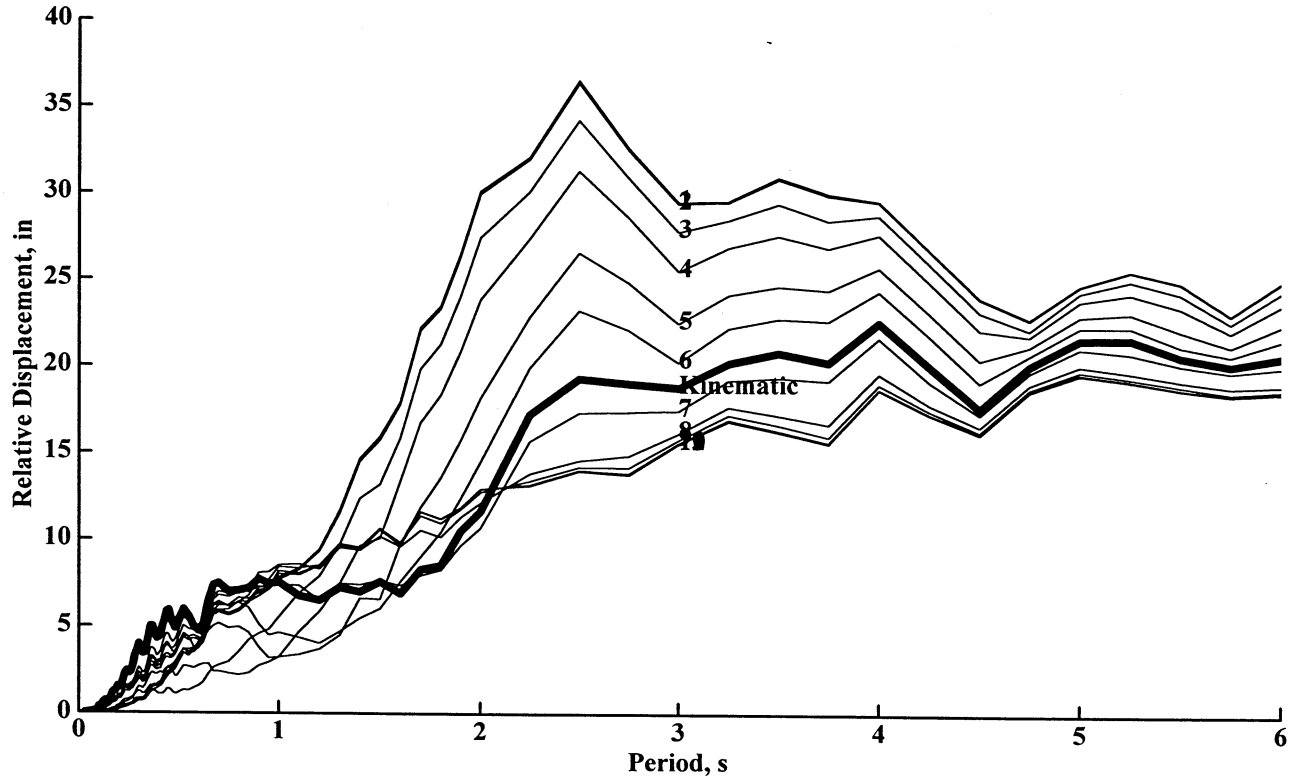




PIER 14
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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SET 2, Long. Dir.
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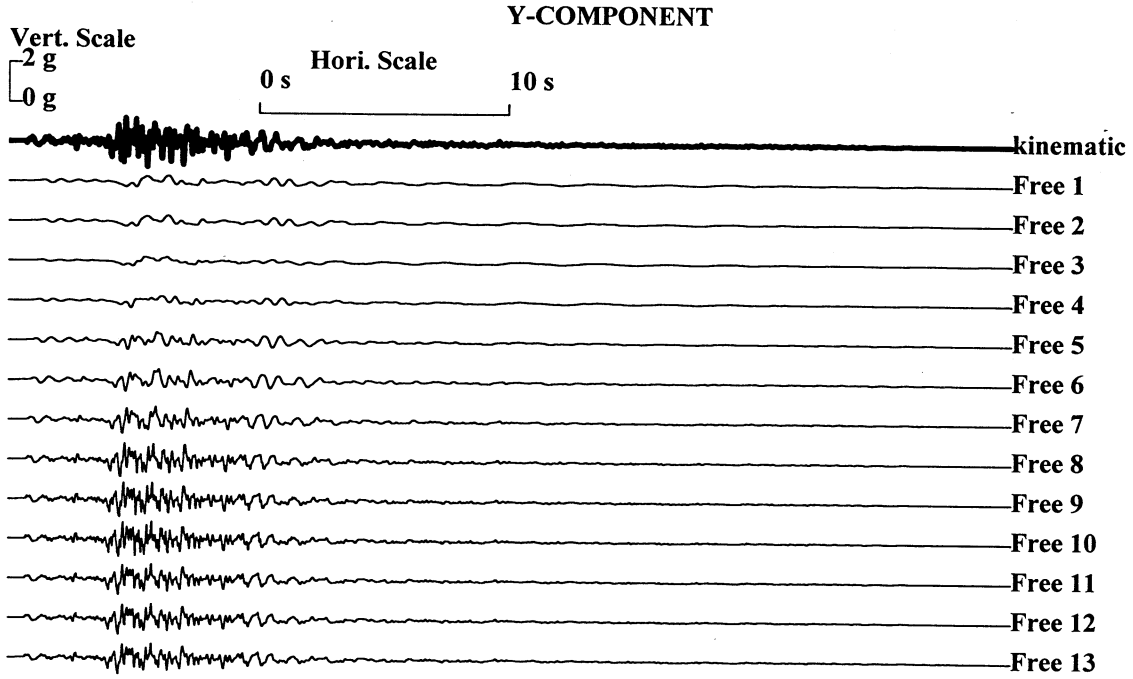
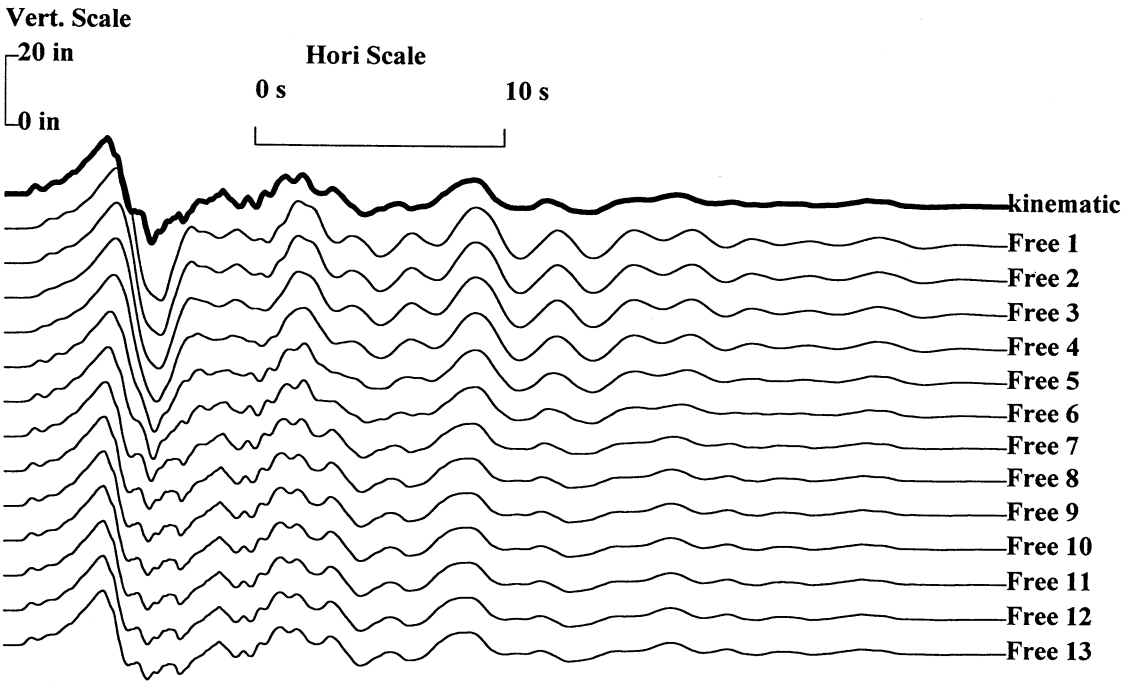
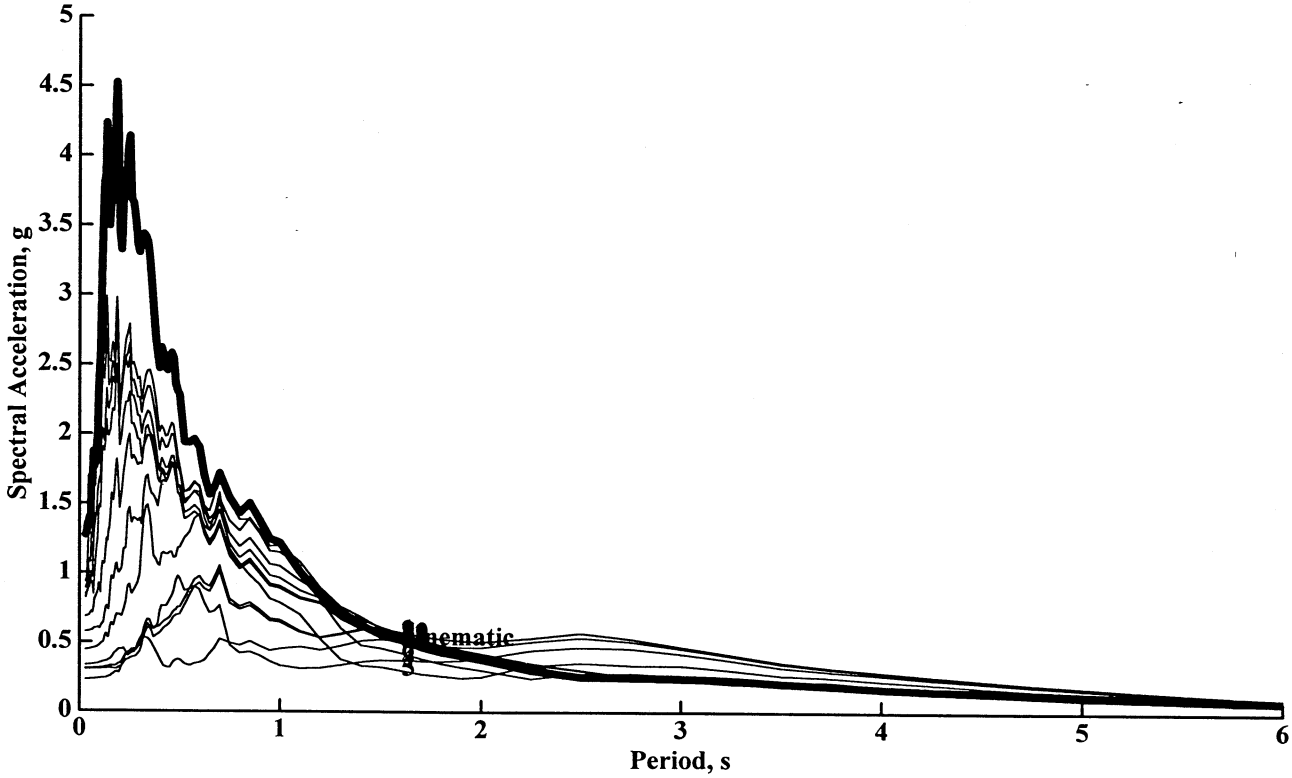
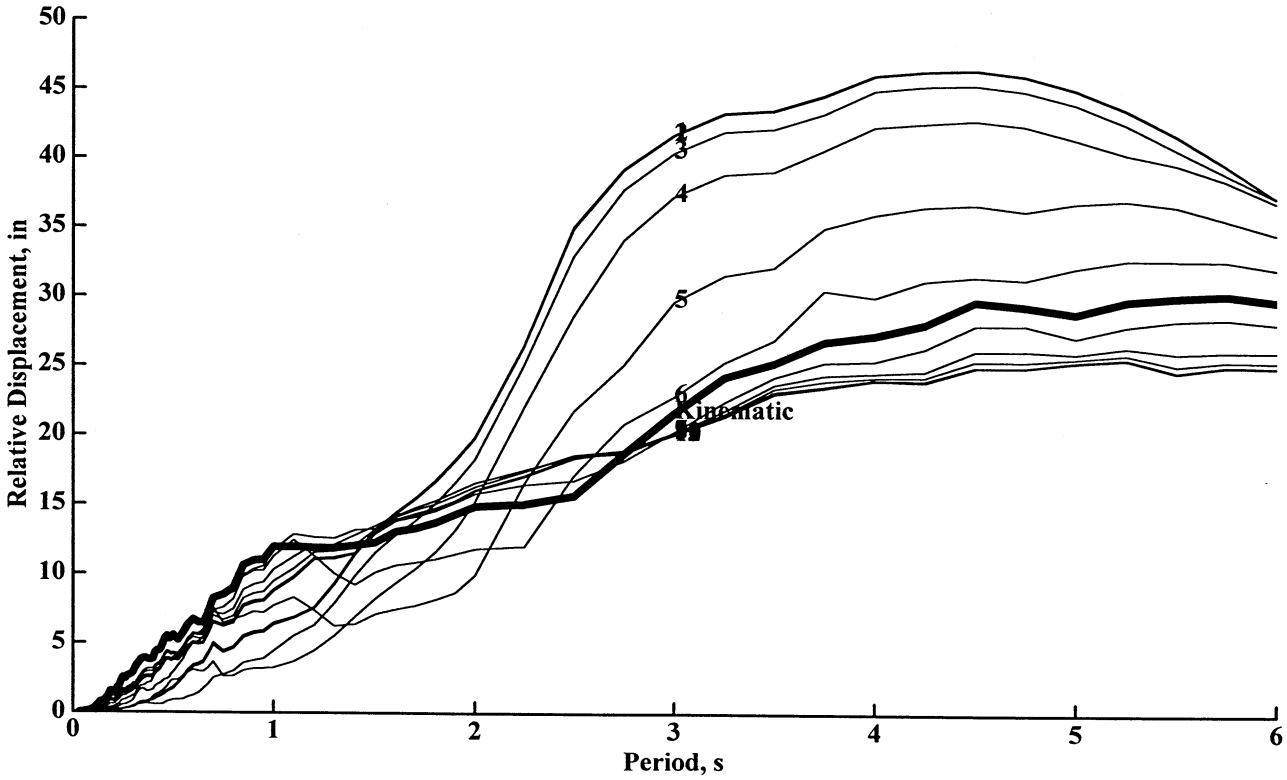




PIER 14
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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SET 2, Tran. Dir.
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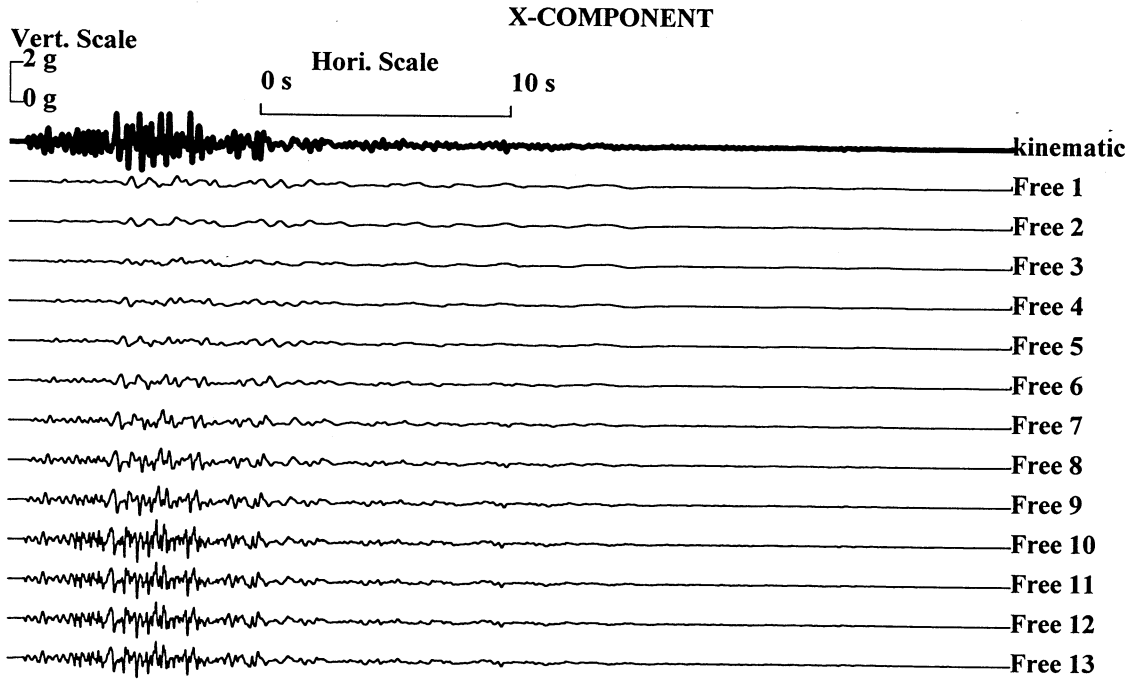

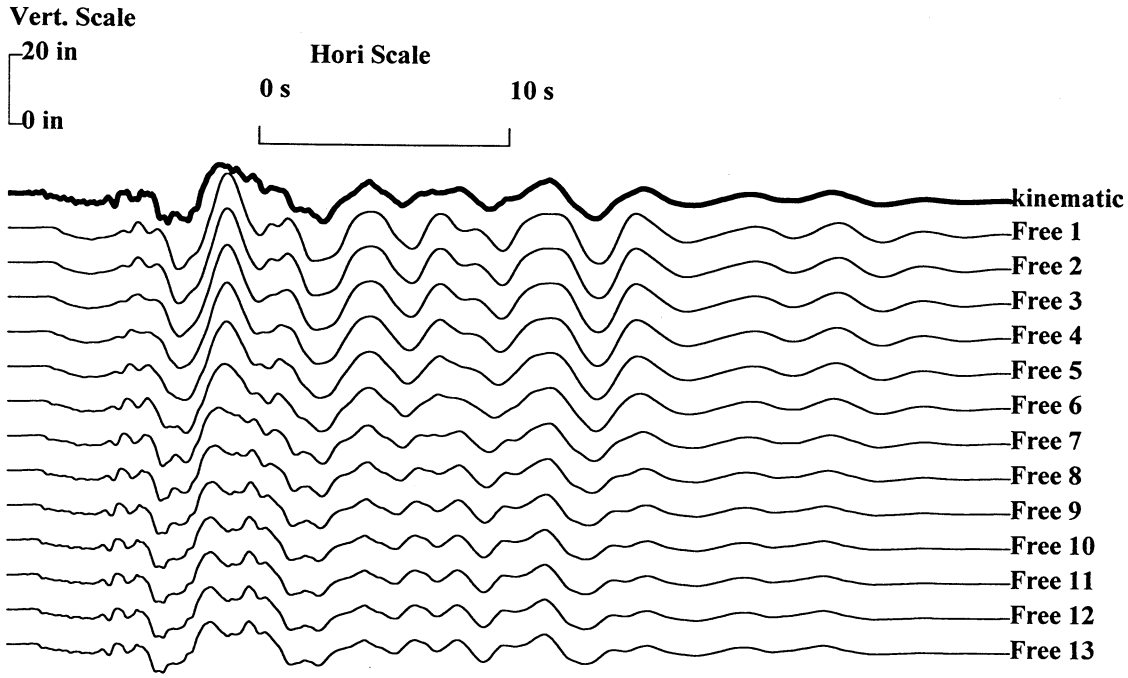

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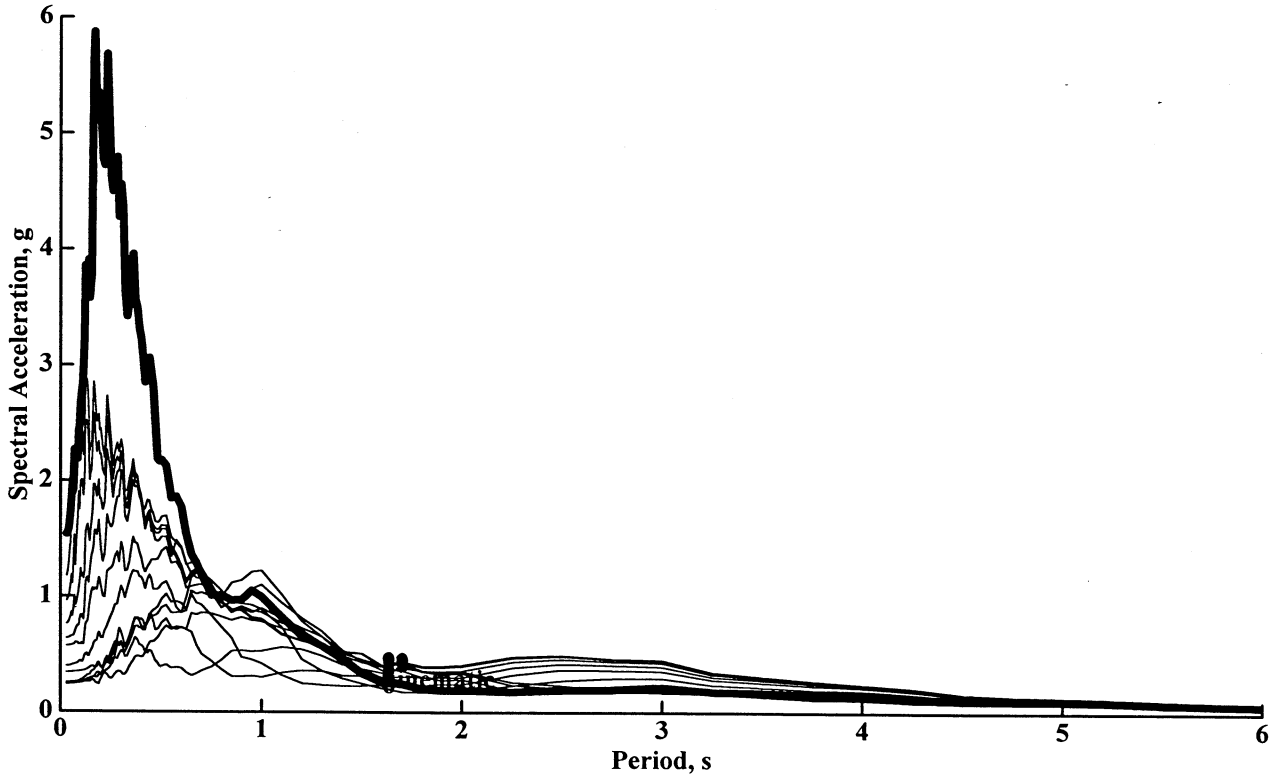
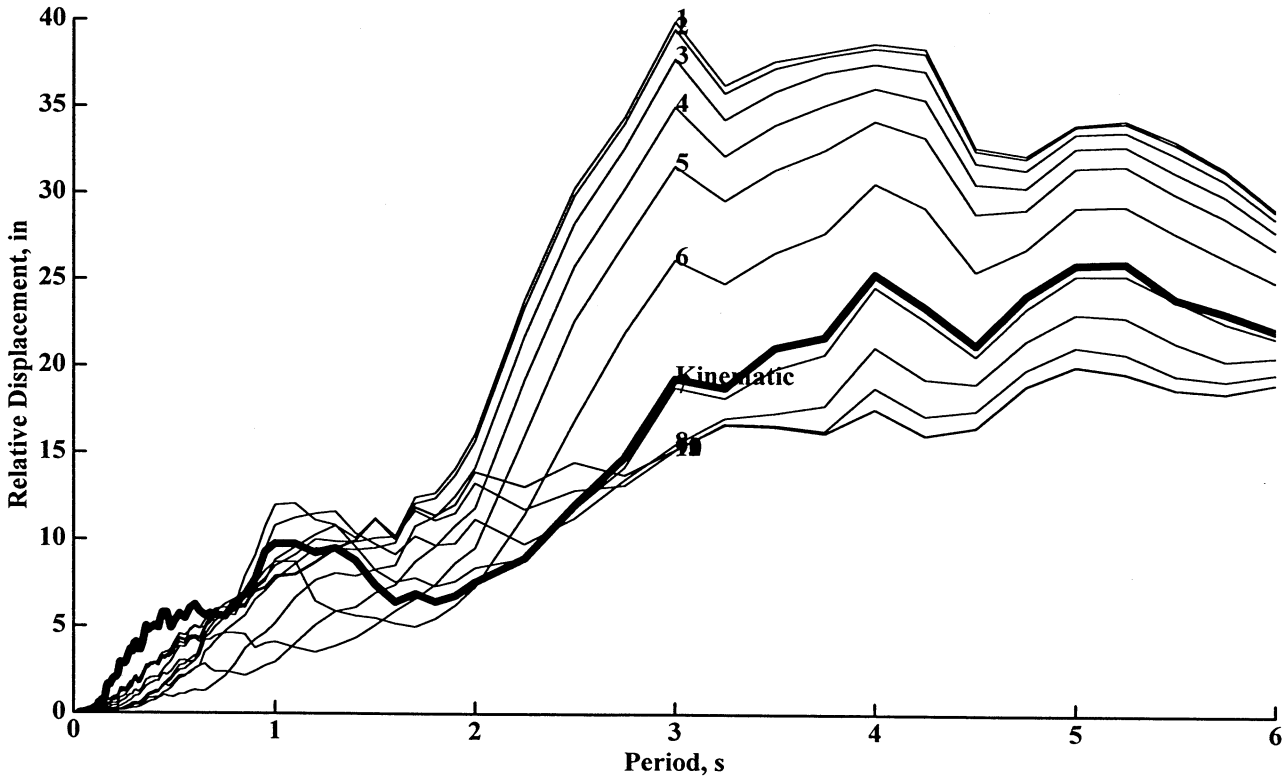
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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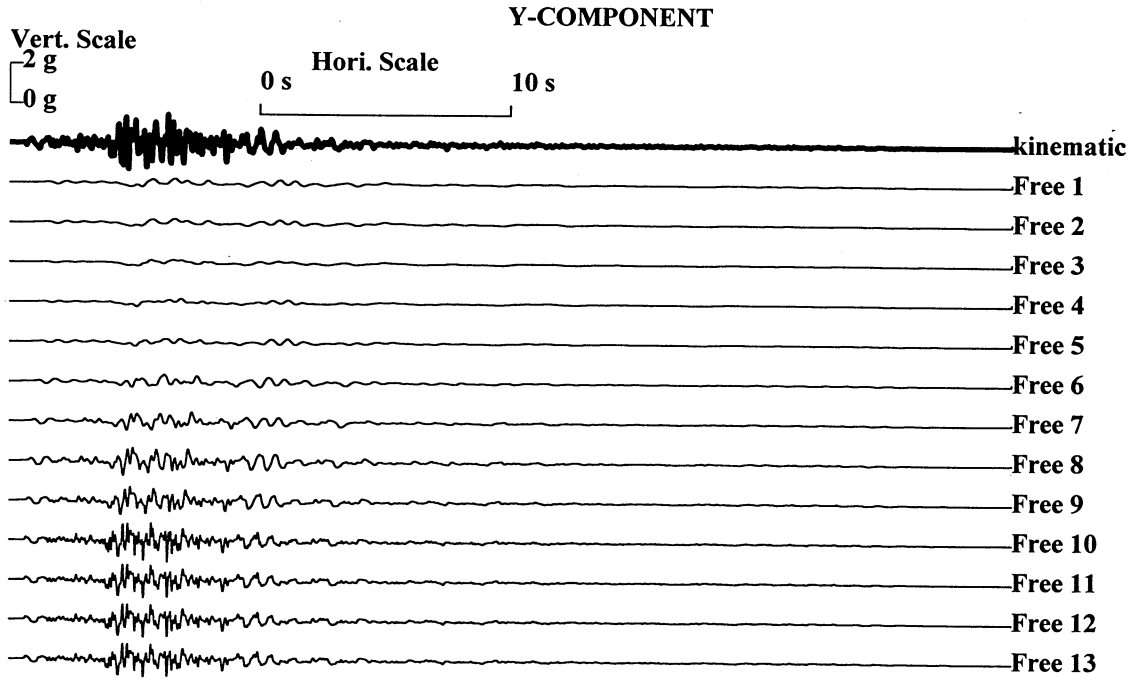
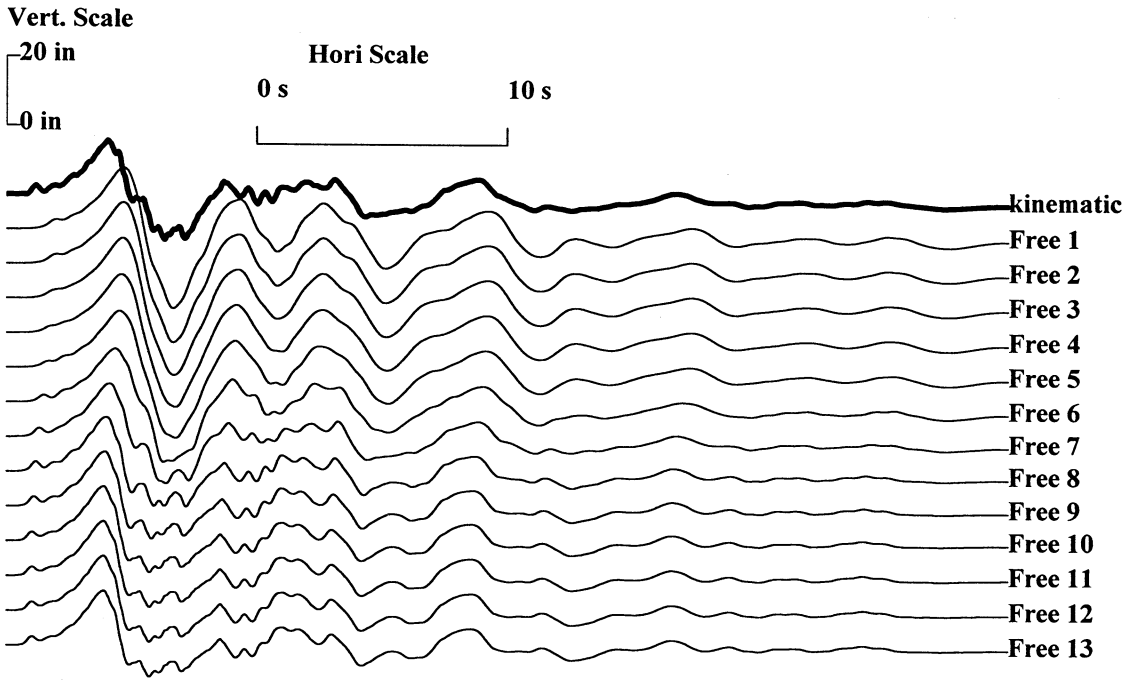
SET 2, Long. Dir.
BENICIA-MARTINEZ





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SET 2, Tran. Dir.
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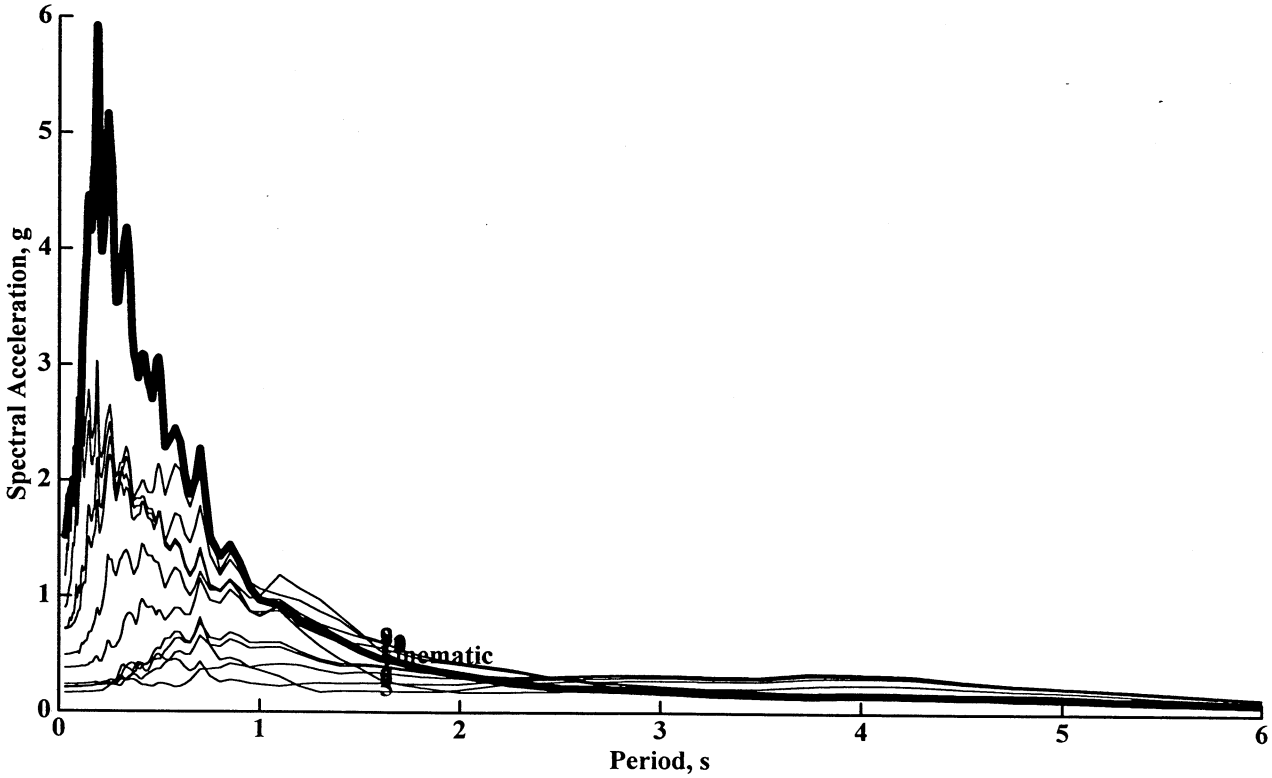

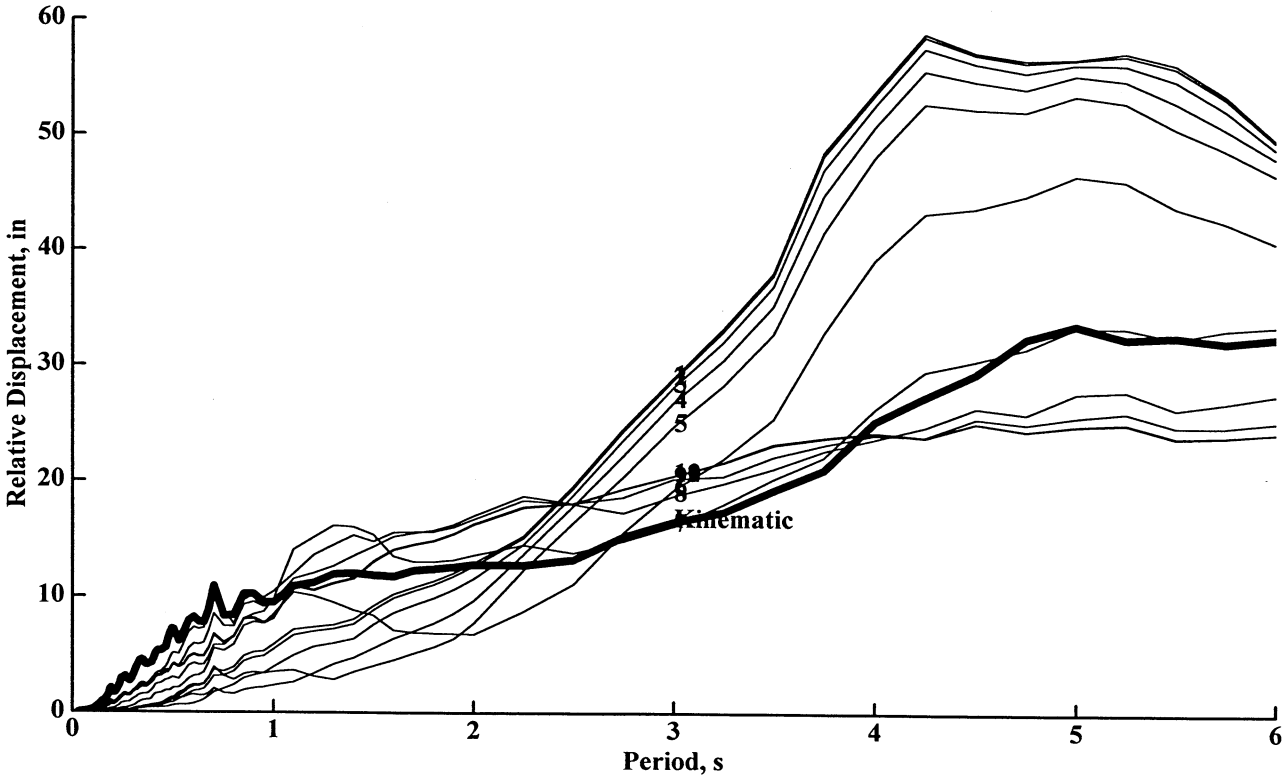

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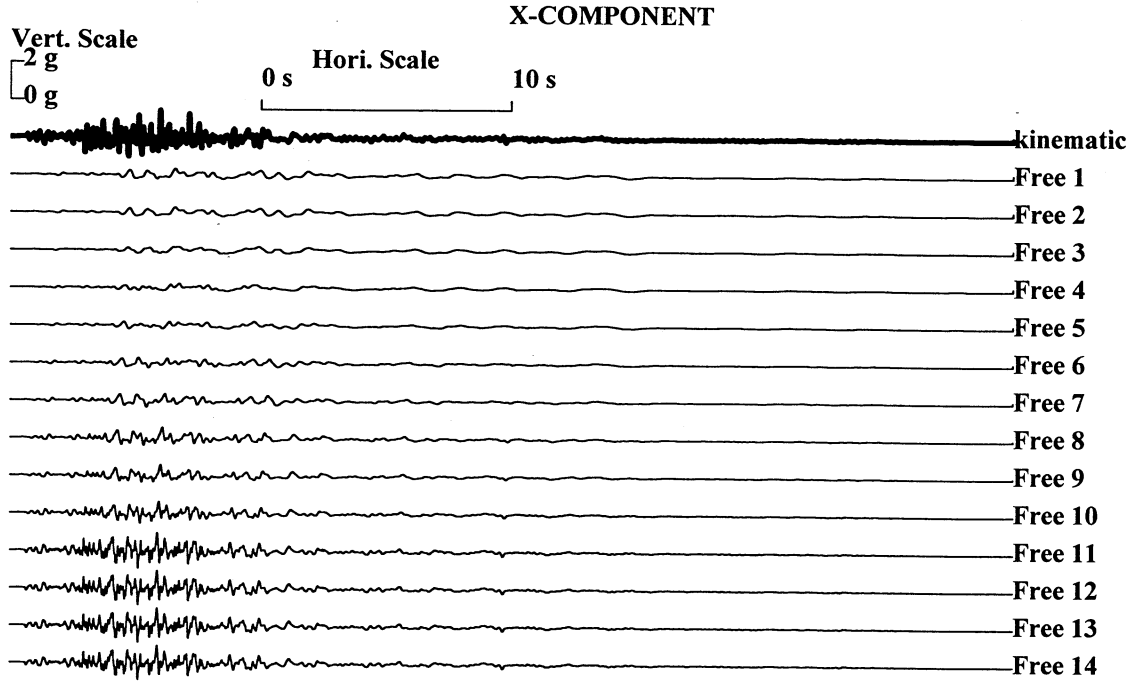

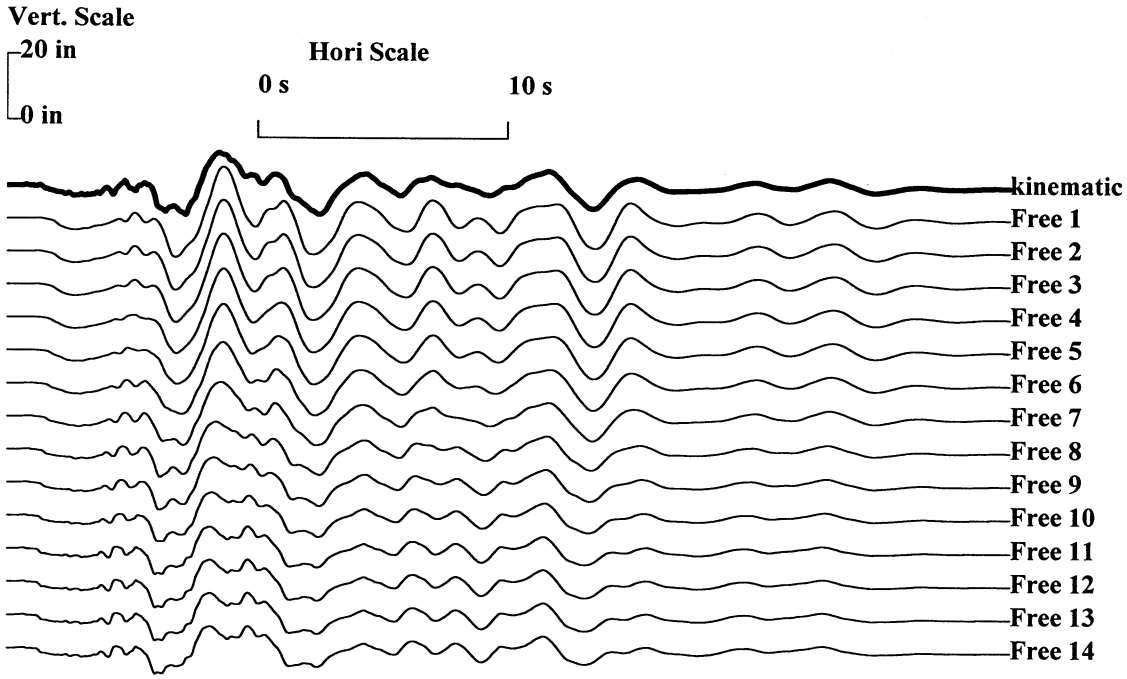

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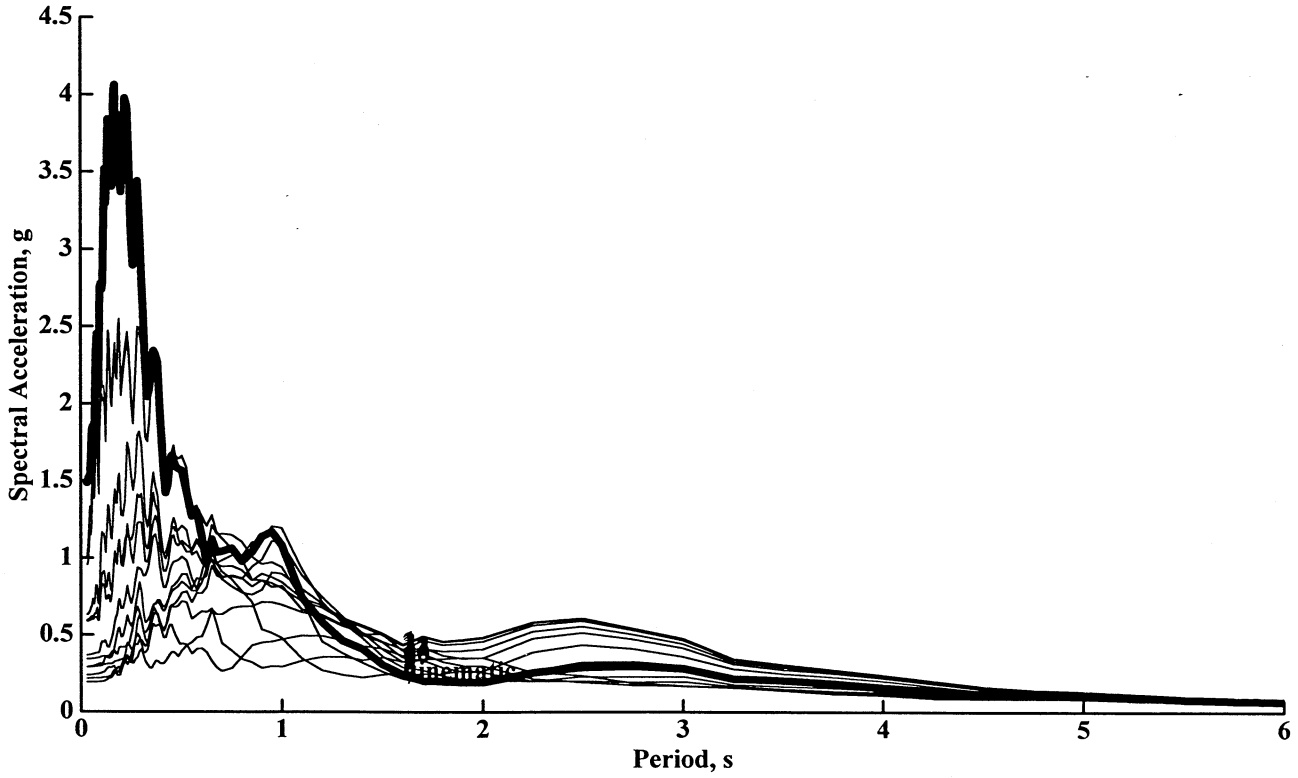
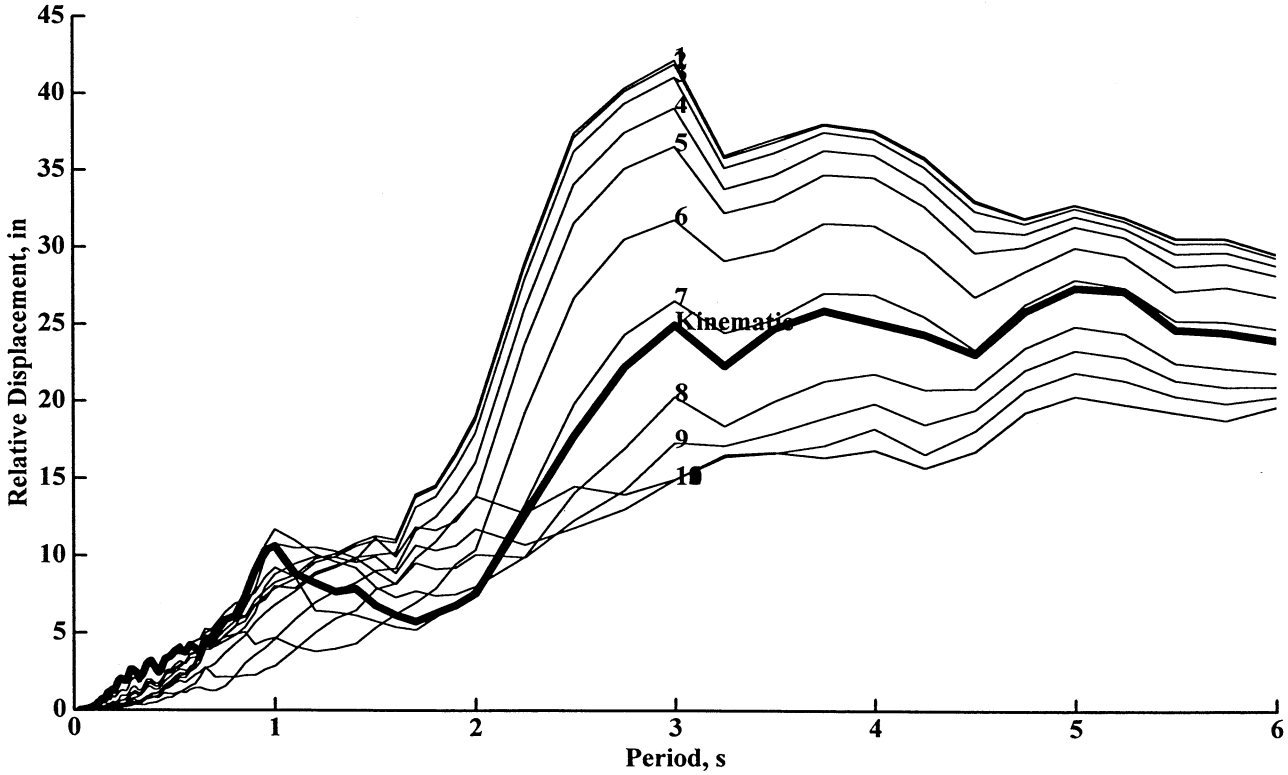
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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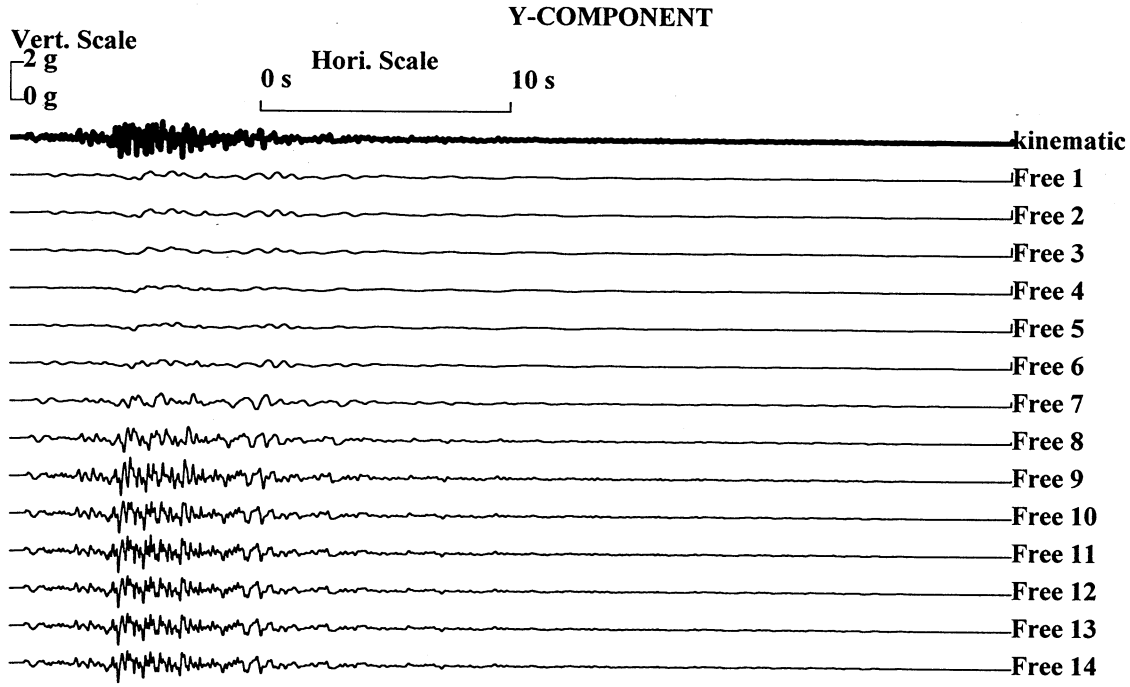
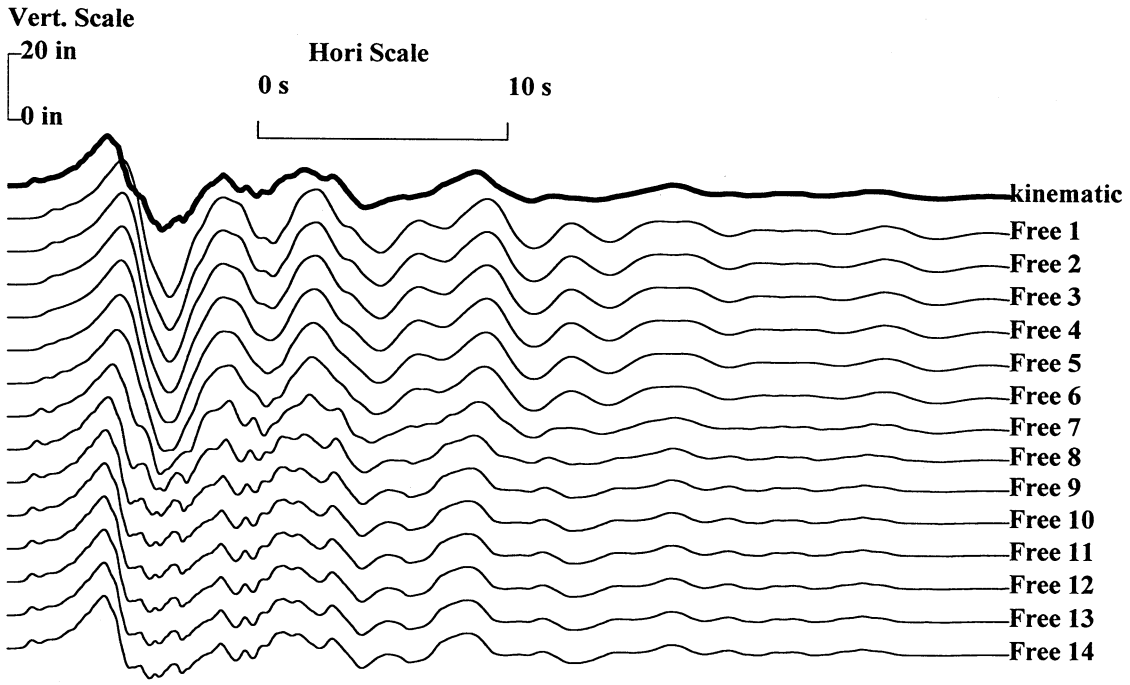
SET 2, Long. Dir.
BENICIA-MARTINEZ





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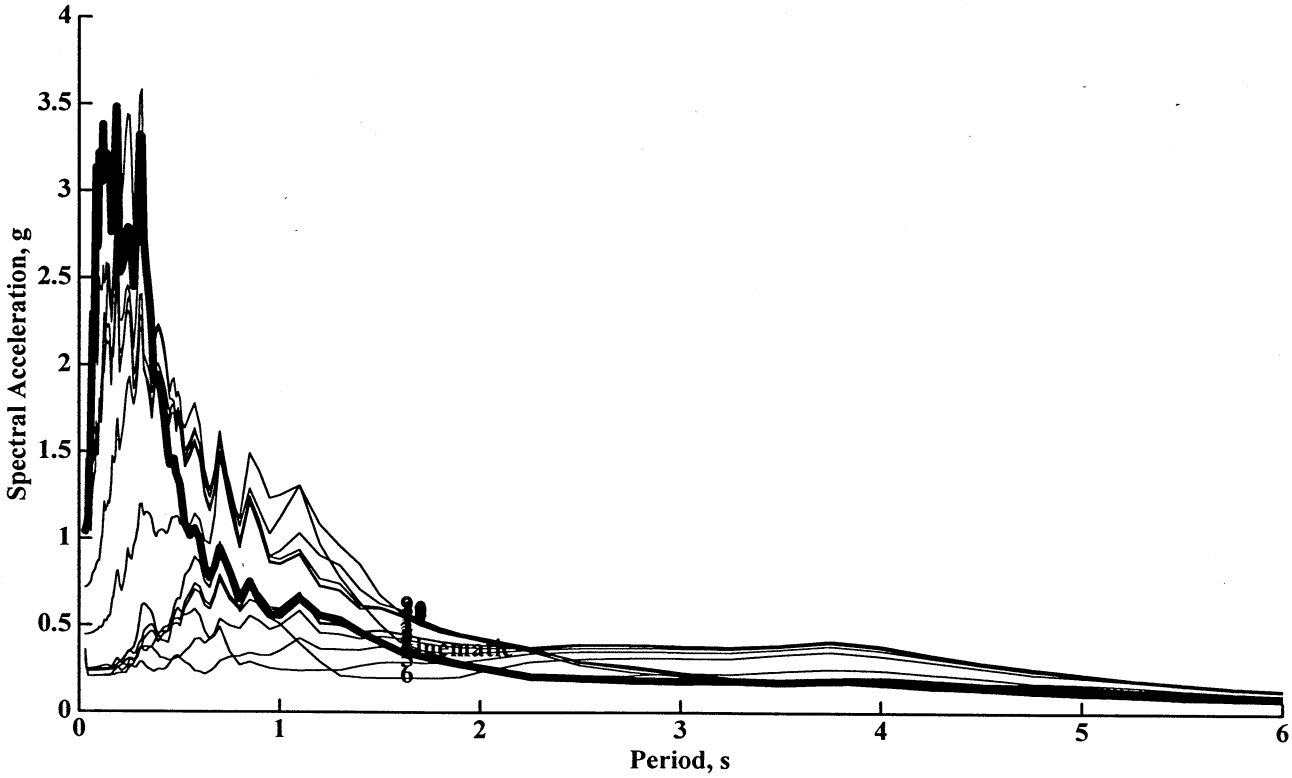
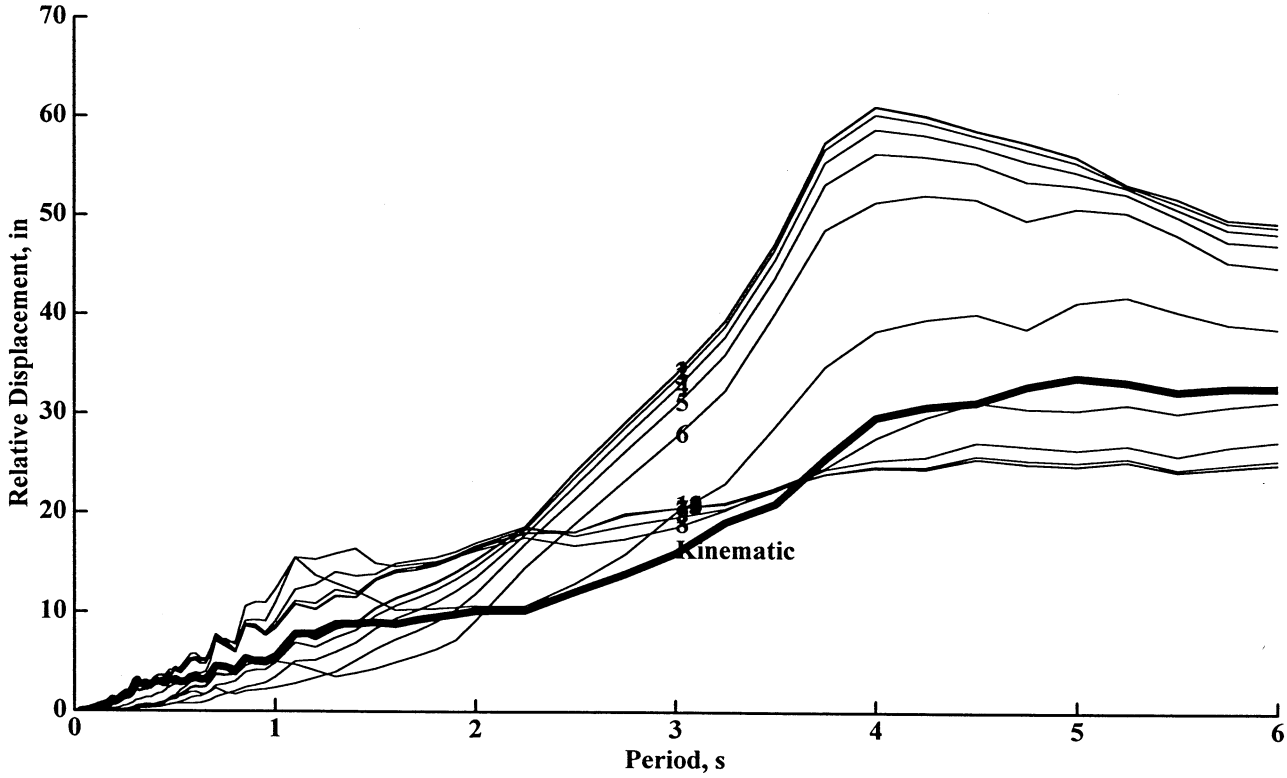
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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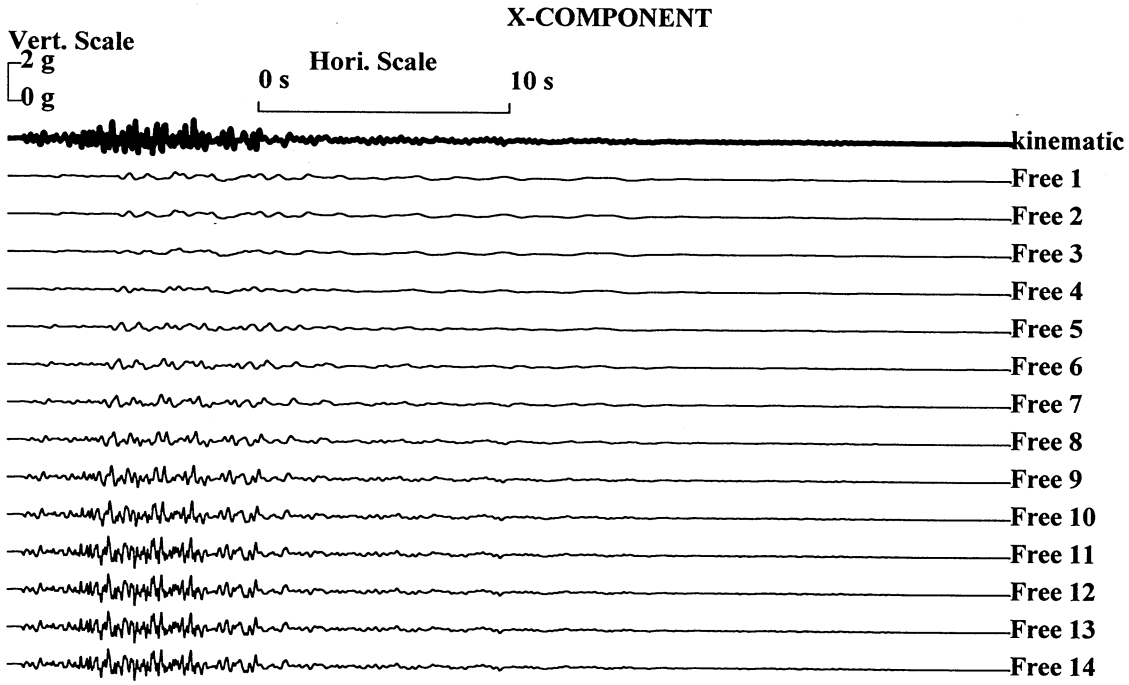
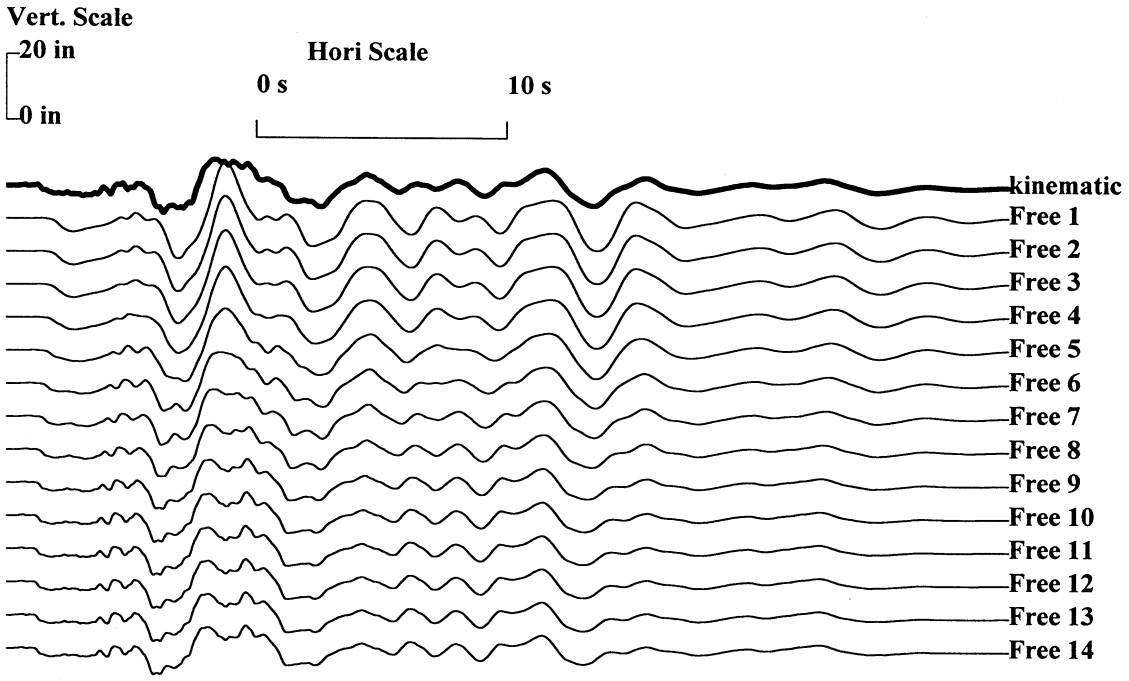
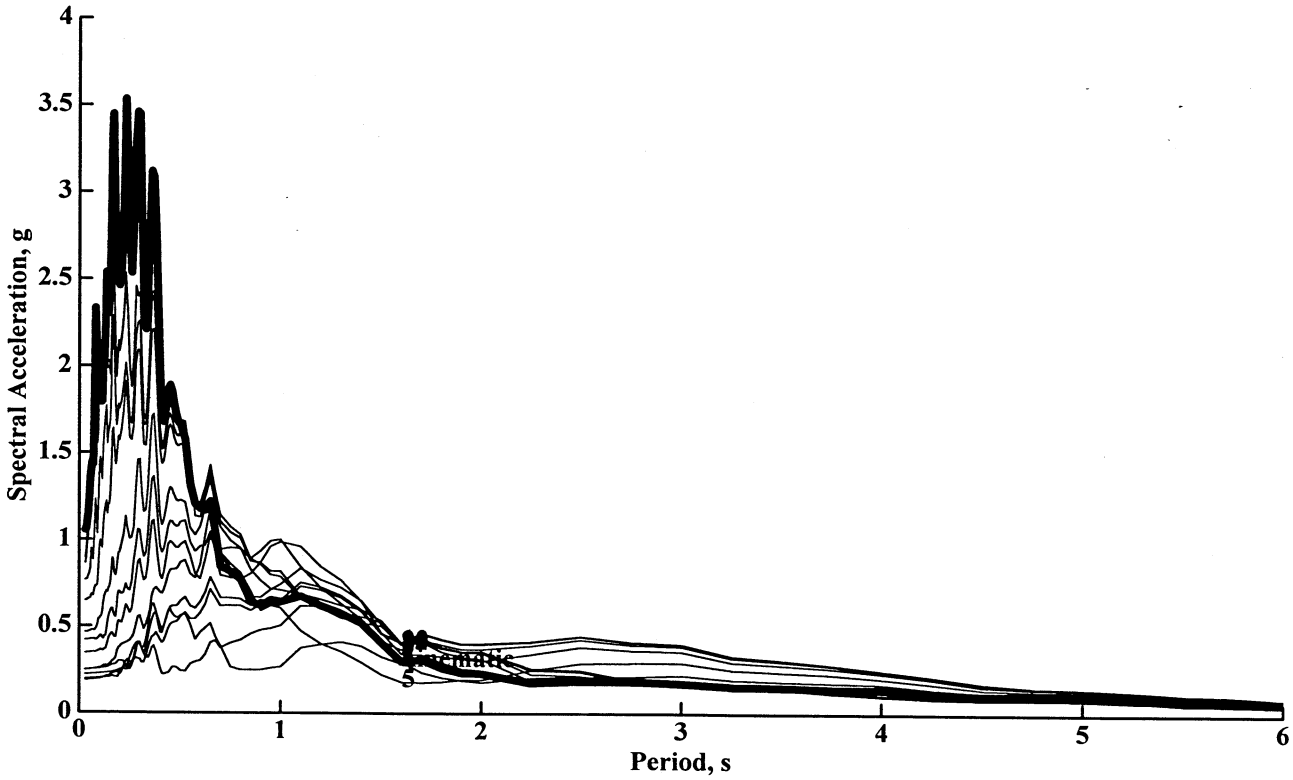
BENICIA-MARTINEZ

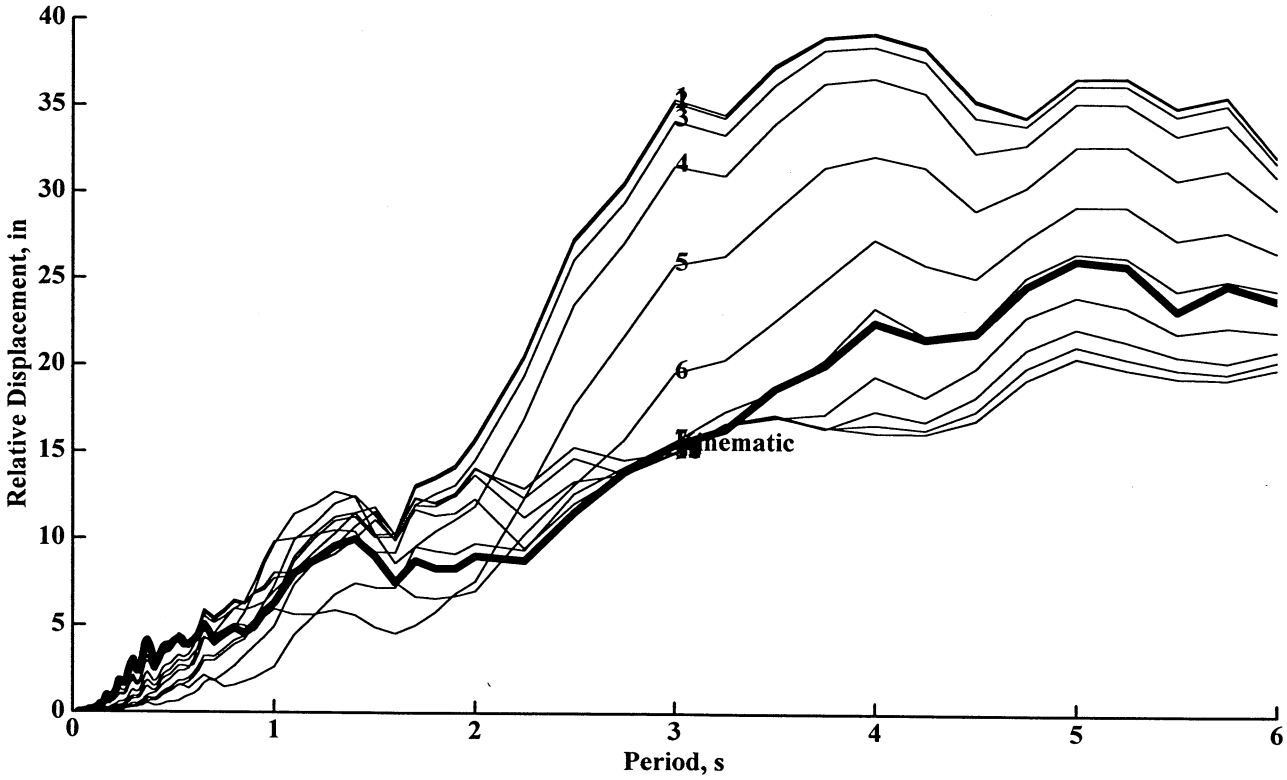




PIER 17
SET 2, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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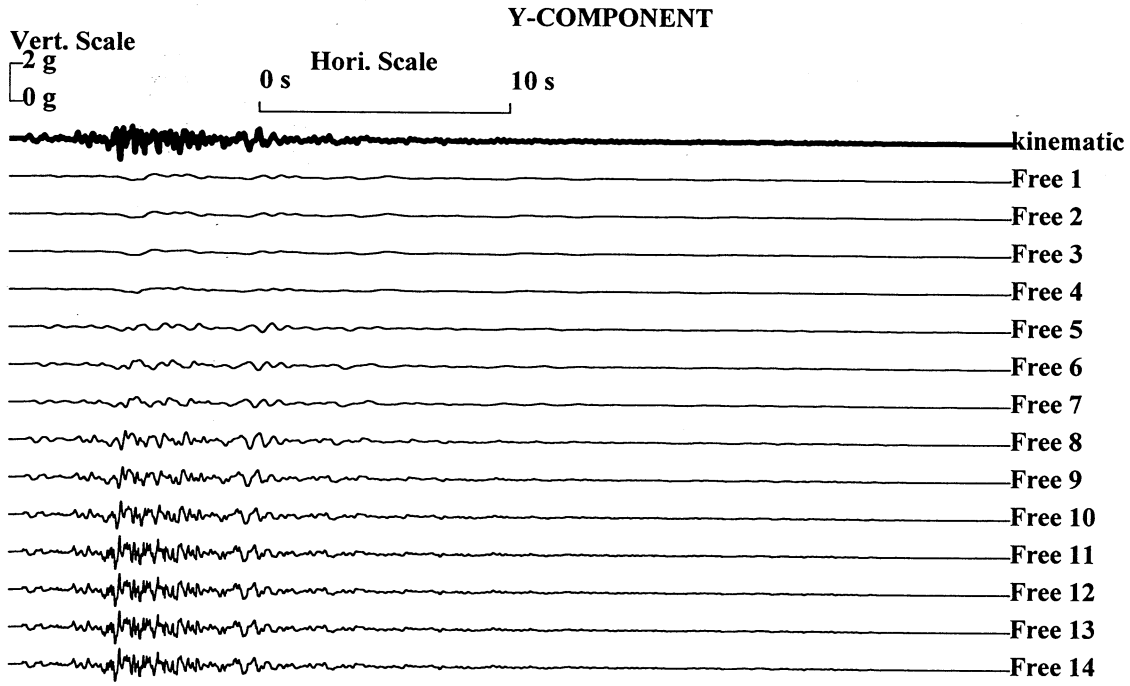
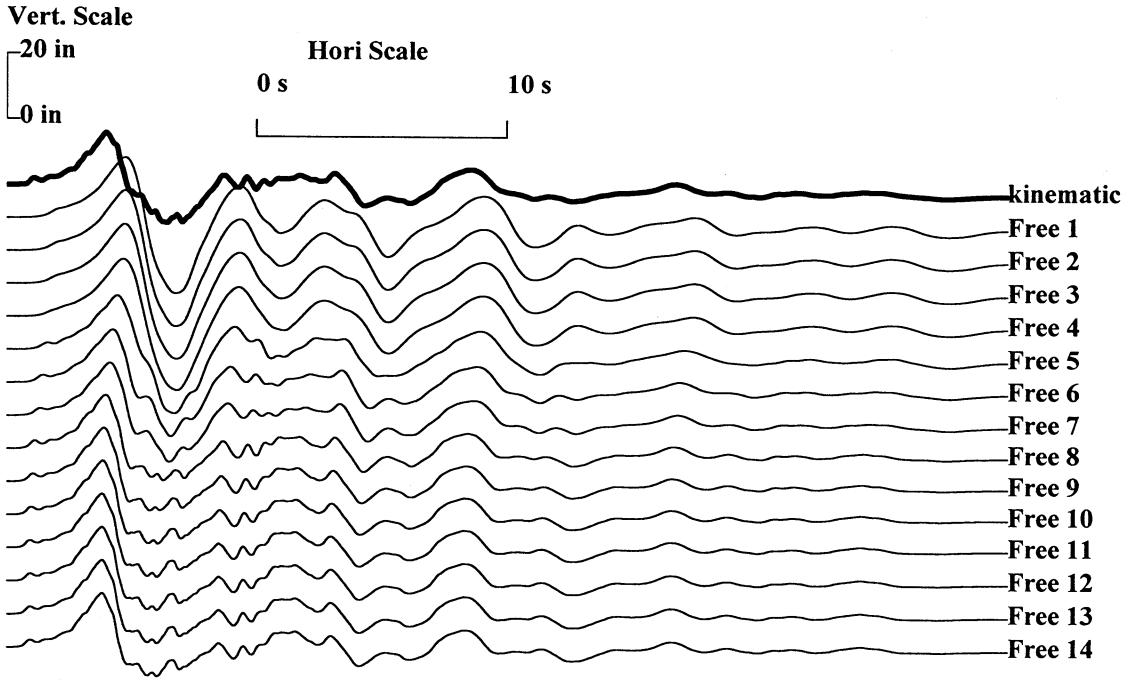
SET 2, Long. Dir.
BENICIA-MARTINEZ





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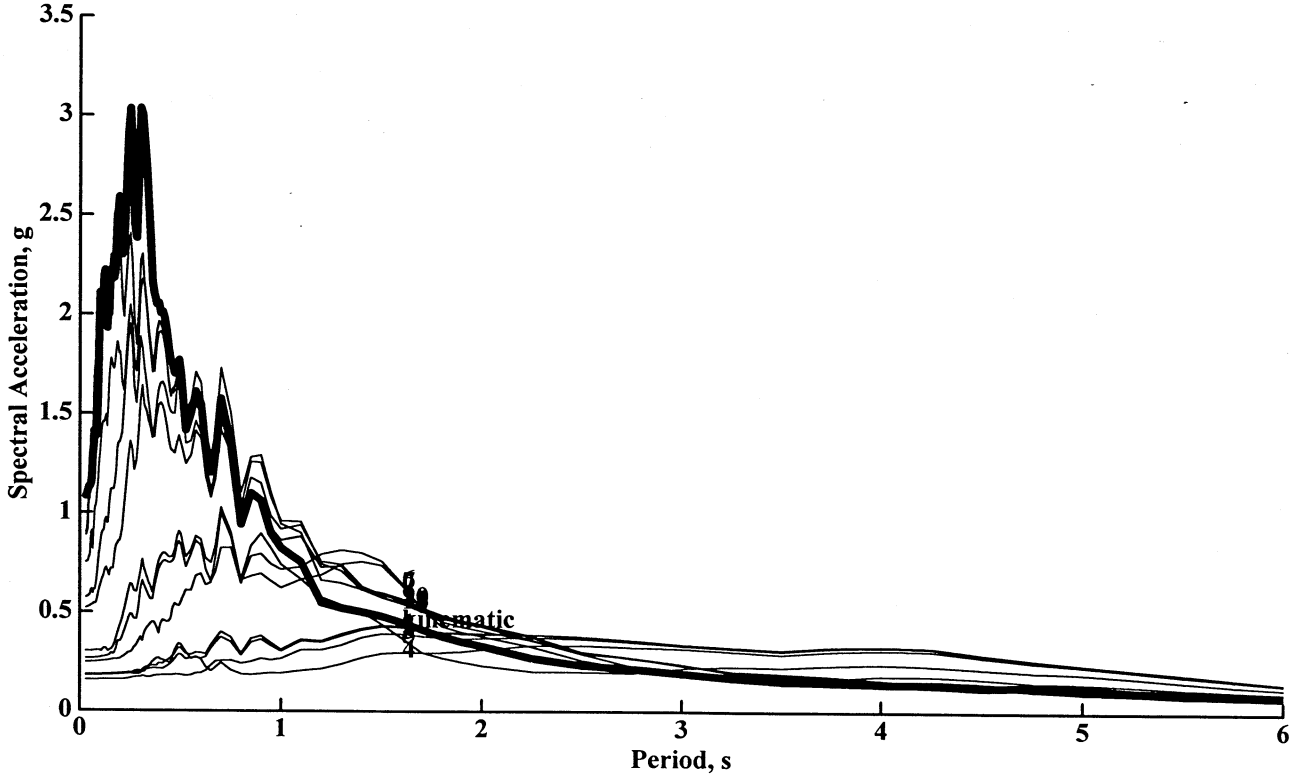
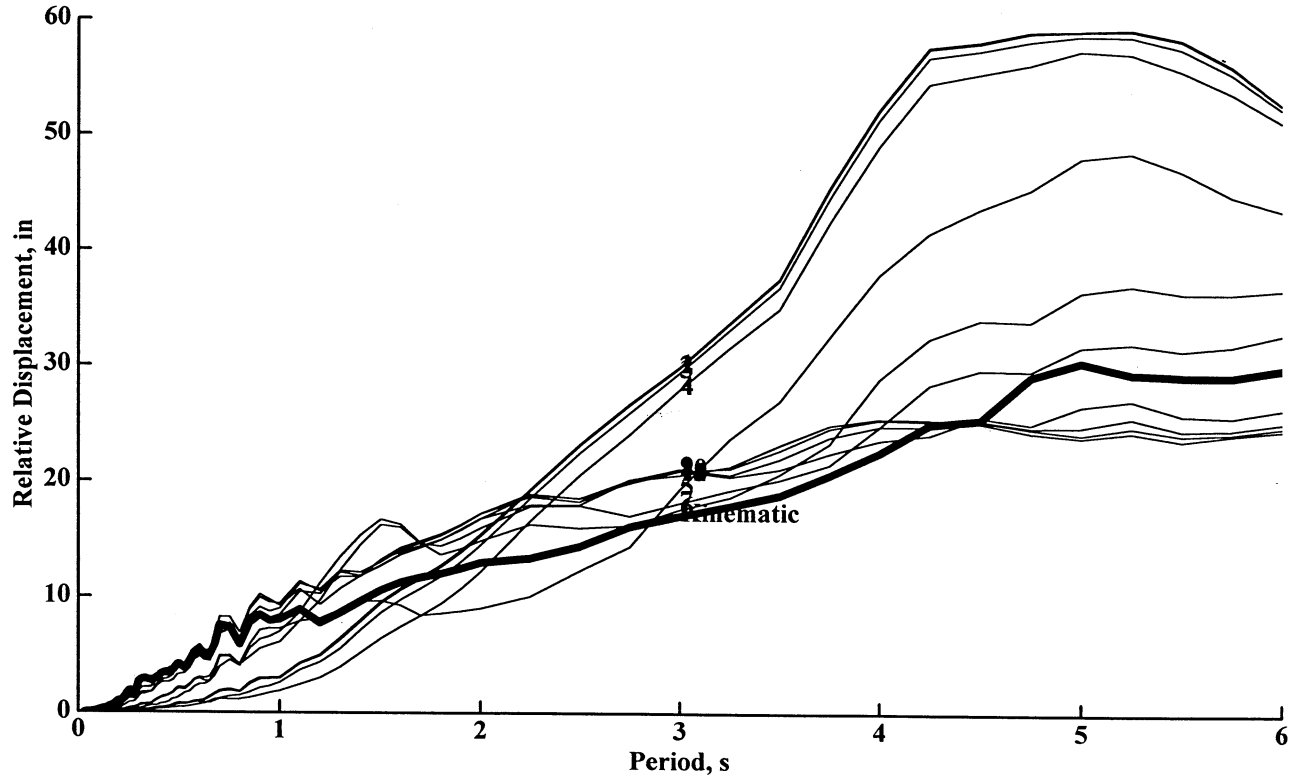
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





PIER 17
SET 2, Tran. Dir.
BENICIA-MARTINEZ

Appendix C

APPENDIX C

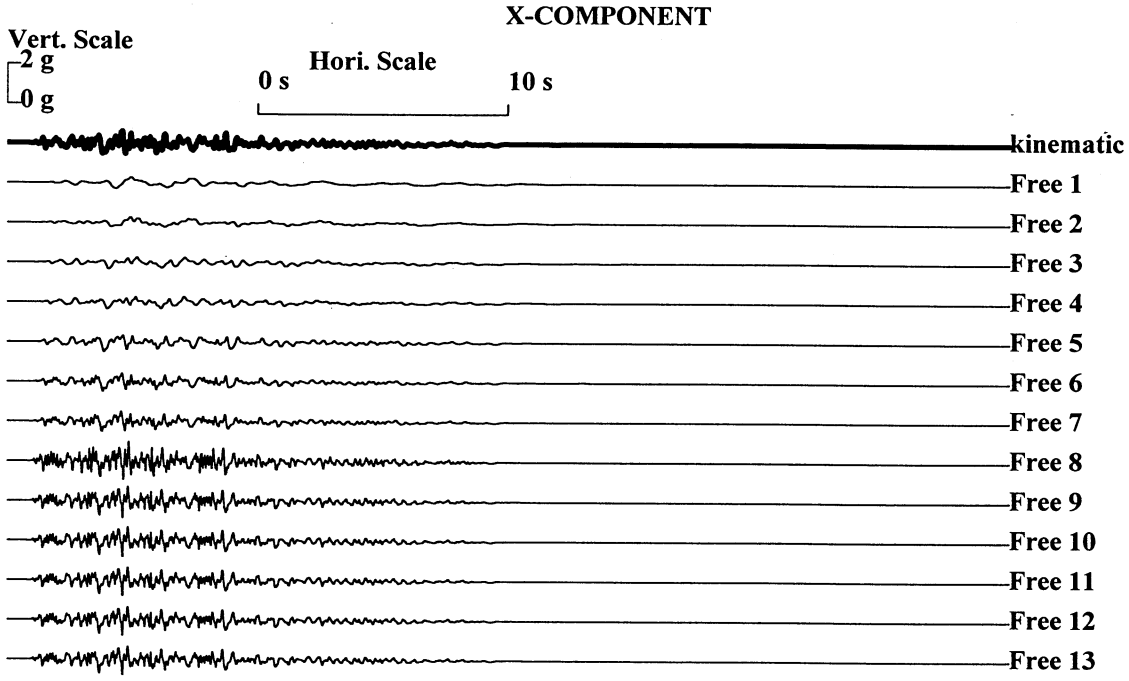
DEPTH-VARYING FREE-FIELD MOTIONS
VERSUS
KINEMATIC MOTIONS CONDENSED AT PILE-CAP
SET 3

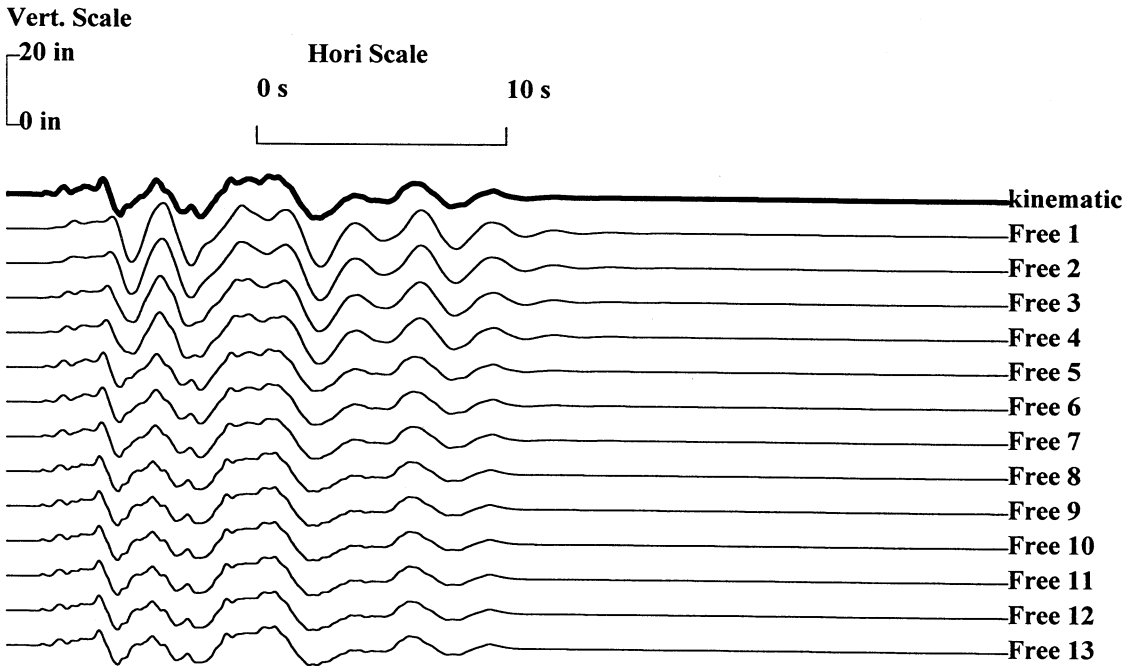
Table A. Elevations (in feet) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

Layer No.	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-6.5	-46	-43	-37	-37	-53	-60	-43	-40	-14	-6.5	-6.5
2	-15	-52	-50	-45	-43	-60	-66	-49	-48	-23	-14	-14
3	-23	-58	-57	-53	-51	-67	-72	-55	-56	-33	-23	-23
4	-31	-65	-64	-60	-56	-75	-78	-62	-66	-43	-33	-33
5	-39	-75	-70	-70	-63	-83	-84	-71	-74	-54	-43	-43
6	-50	-82	-82	-80	-74	-92	-90	-80	-82	-65	-54	-54
7	-55	-90	-92	-90	-76	-98	-95	-89	-90	-77	-65	-65
8	-60	-98	-102	-102	-85	-105	-103	-98	-98	-90	-79	-79
9	-70	-114	-112	-114	-90	-112	-111	-109	-109	-106	-93	-93
10	-80	-116	-125	-126	-106	-120	-120	-120	-120	-124	-105	-105
11	-90	-125	-141	-138	-131	-131	-131	-131	-148	-148	-118	-118
12	-115	-165	-179	-177	-180	-172	-172	-172	-184	-184	-131	-131
13	-160	-204	-217	-217	-216	-213	-213	-213	-220	-220	-174	-174
14	-204										-220	-220

Table B. Elevations (in meters) of Freefield Motions from 1-D Site Response Analysis Provided in This Appendix

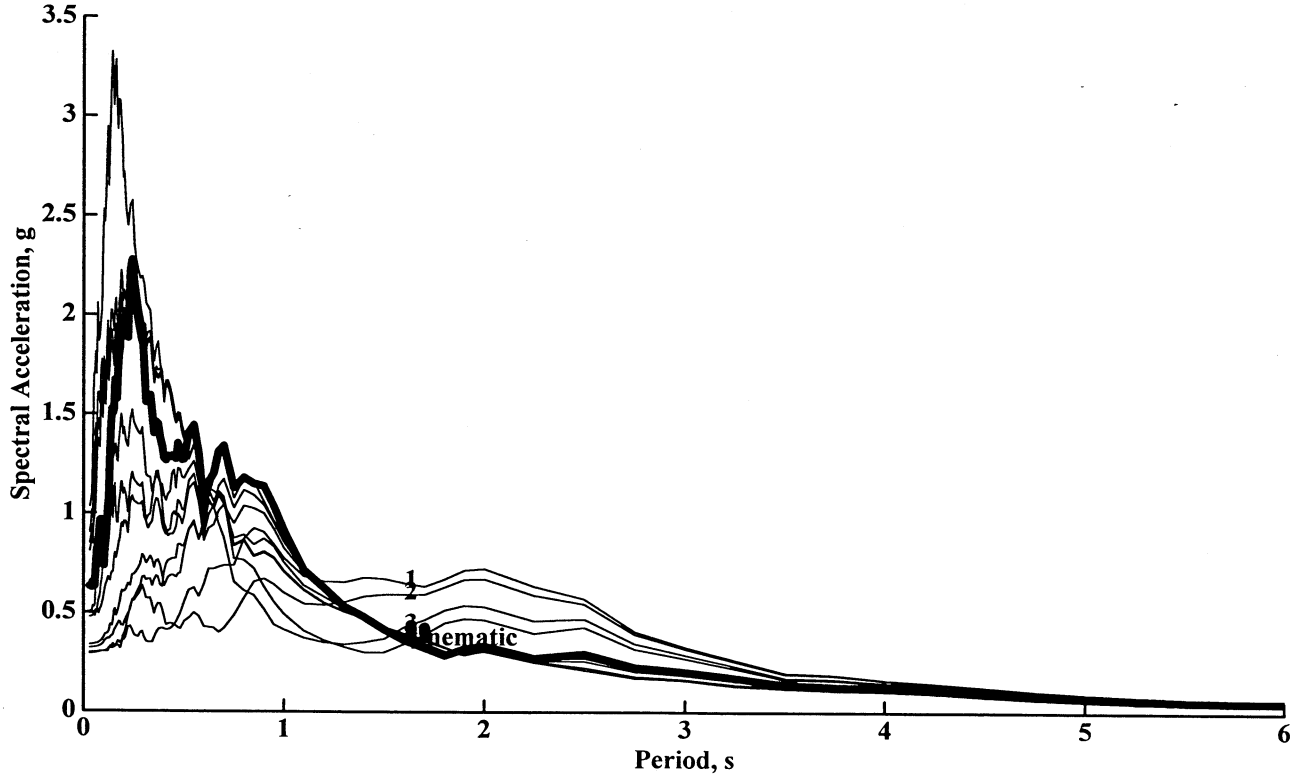
Layer No	Pier 6 ft	Pier 7 ft	Pier 8 ft	Pier 9 ft	Pier 10 ft	Pier 11 ft	Pier 12 ft	Pier 13 ft	Pier 14 ft	Pier 15 ft	Pier 16 ft	Pier 17 ft
1	-2.0	-14.0	-13.1	-11.3	-11.3	-16.2	-18.3	-13.1	-12.2	-4.3	-2.0	-2.0
2	-4.6	-15.9	-15.2	-13.7	-13.1	-18.3	-20.1	-14.9	-14.6	-7.0	-4.3	-4.3
3	-7.0	-17.7	-17.4	-16.2	-15.5	-20.4	-22.0	-16.8	-17.1	-10.1	-7.0	-7.0
4	-9.5	-19.8	-19.5	-18.3	-17.1	-22.9	-23.8	-18.9	-20.1	-13.1	-10.1	-10.1
5	-11.9	-22.9	-21.3	-21.3	-19.2	-25.3	-25.6	-21.6	-22.6	-16.5	-13.1	-13.1
6	-15.2	-25.0	-25.0	-24.4	-22.6	-28.0	-27.4	-24.4	-25.0	-19.8	-16.5	-16.5
7	-16.8	-27.4	-28.0	-27.4	-23.2	-29.9	-29.0	-27.1	-27.4	-23.5	-19.8	-19.8
8	-18.3	-29.9	-31.1	-31.1	-25.9	-32.0	-31.4	-29.9	-29.9	-27.4	-24.1	-24.1
9	-21.3	-34.8	-34.1	-34.8	-27.4	-34.1	-33.8	-33.2	-33.2	-32.3	-28.4	-28.4
10	-24.4	-35.4	-38.1	-38.4	-32.3	-36.6	-36.6	-36.6	-36.6	-37.8	-32.0	-32.0
11	-27.4	-38.1	-43.0	-42.1	-39.9	-39.9	-39.9	-39.9	-45.1	-45.1	-36.0	-36.0
12	-35.1	-50.3	-54.6	-54.0	-54.9	-52.4	-52.4	-52.4	-56.1	-56.1	-39.9	-39.9
13	-48.8	-62.2	-66.2	-66.2	-65.9	-64.9	-64.9	-64.9	-67.1	-67.1	-53.0	-53.0
14	-62.2										-67.1	-67.1

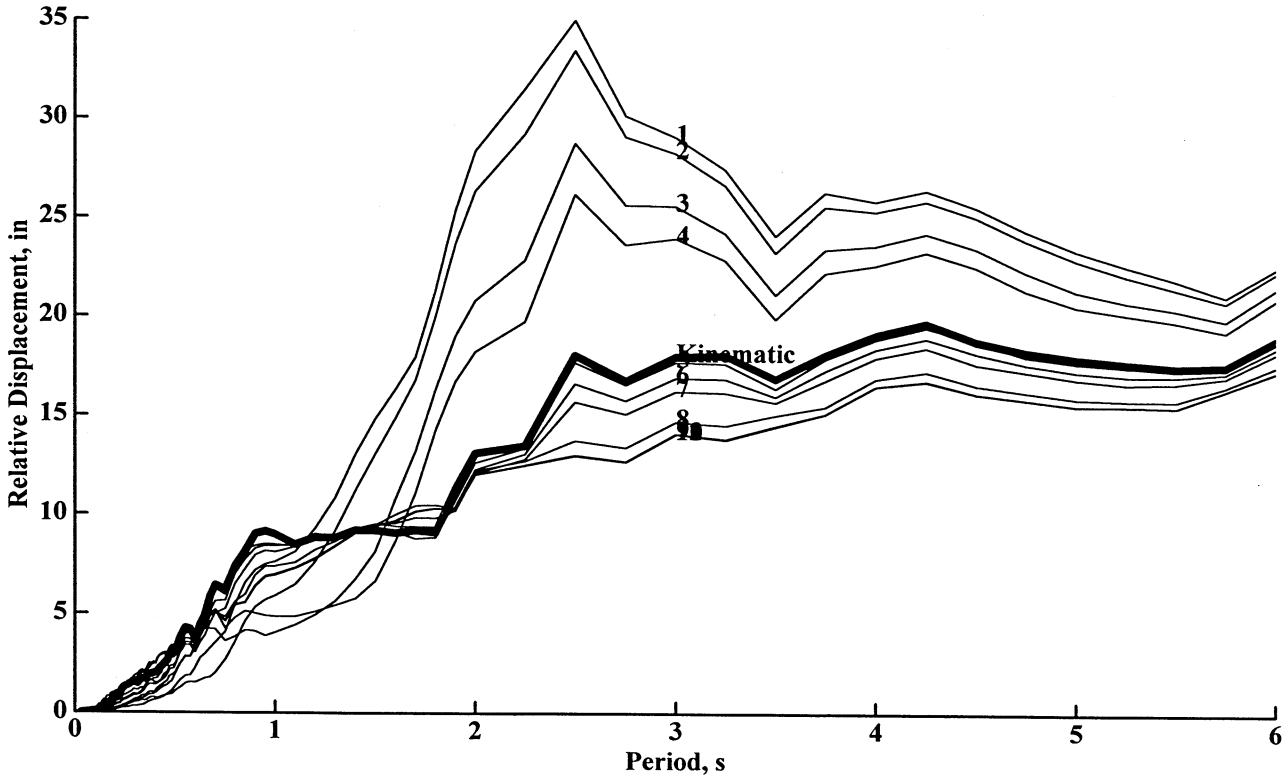




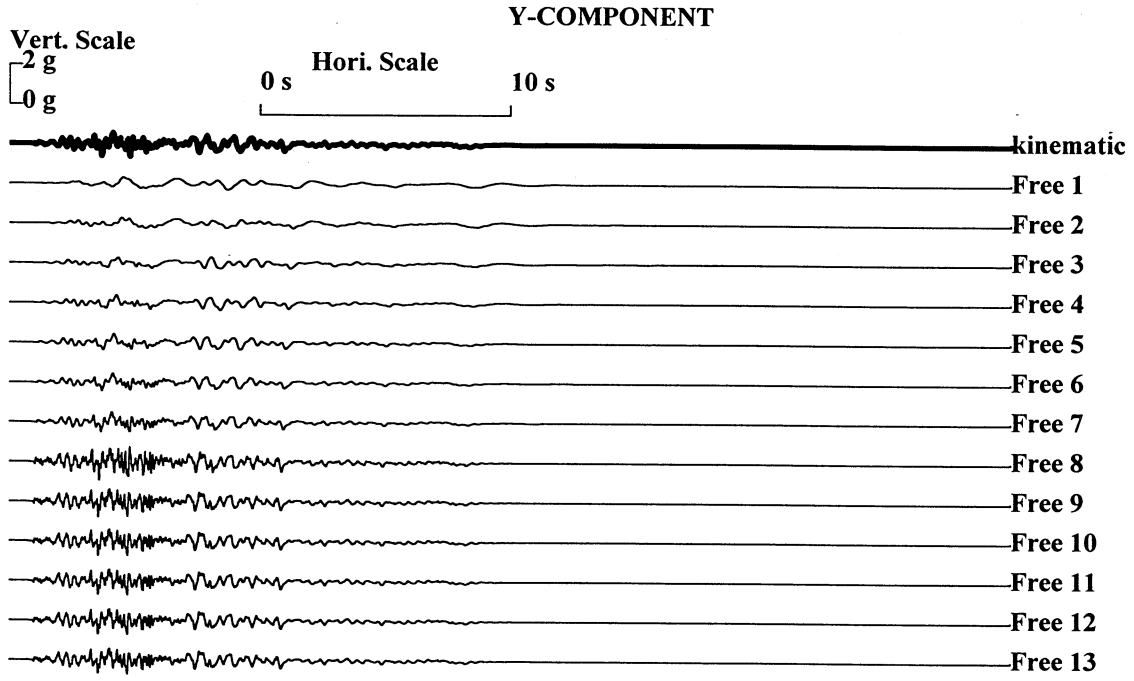
PIER 6
SET 3, Long. Dir.
BENICIA-MARTINEZ

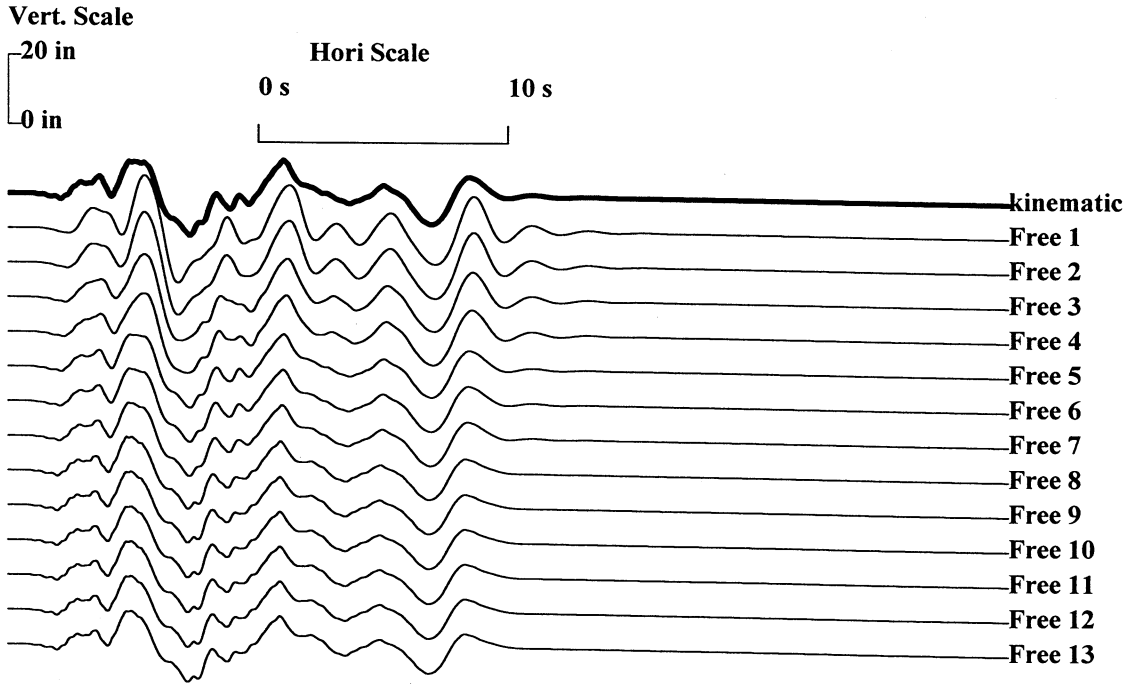
X-COMPONENT



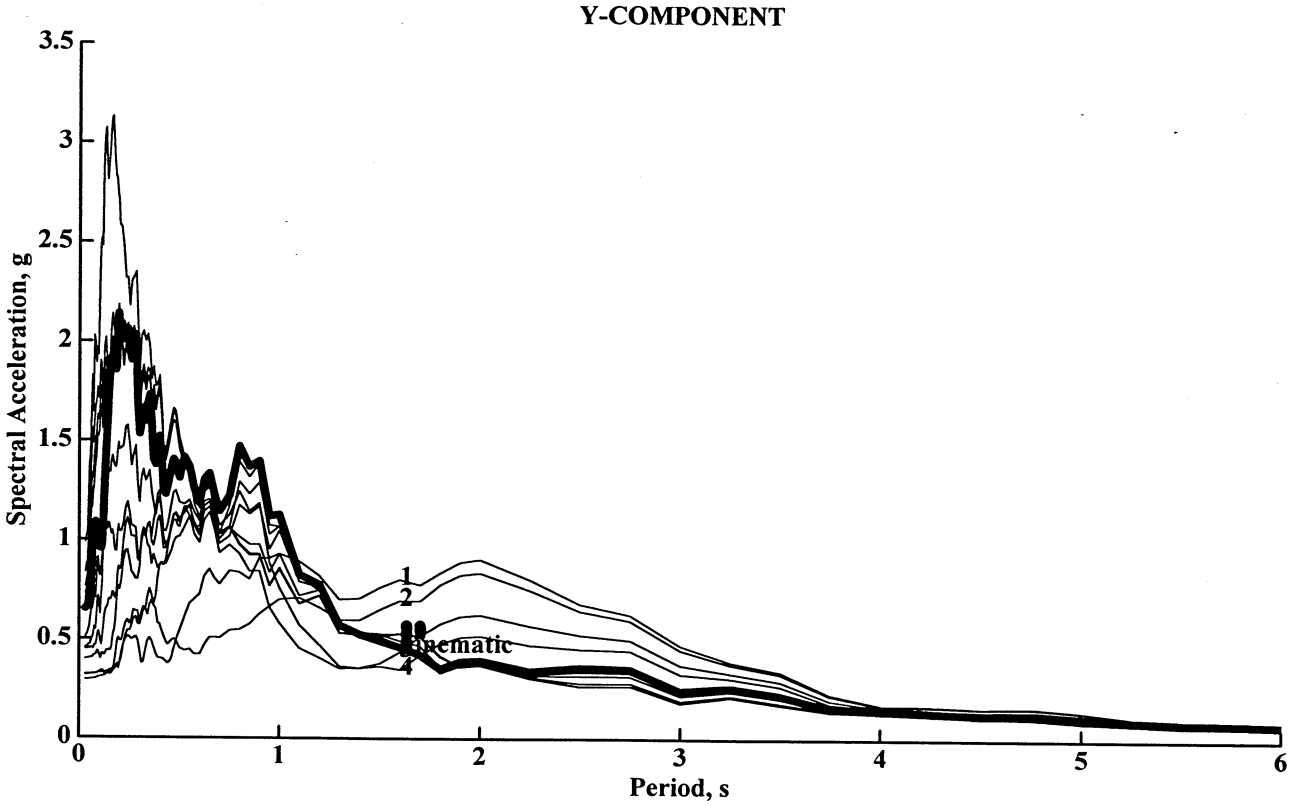


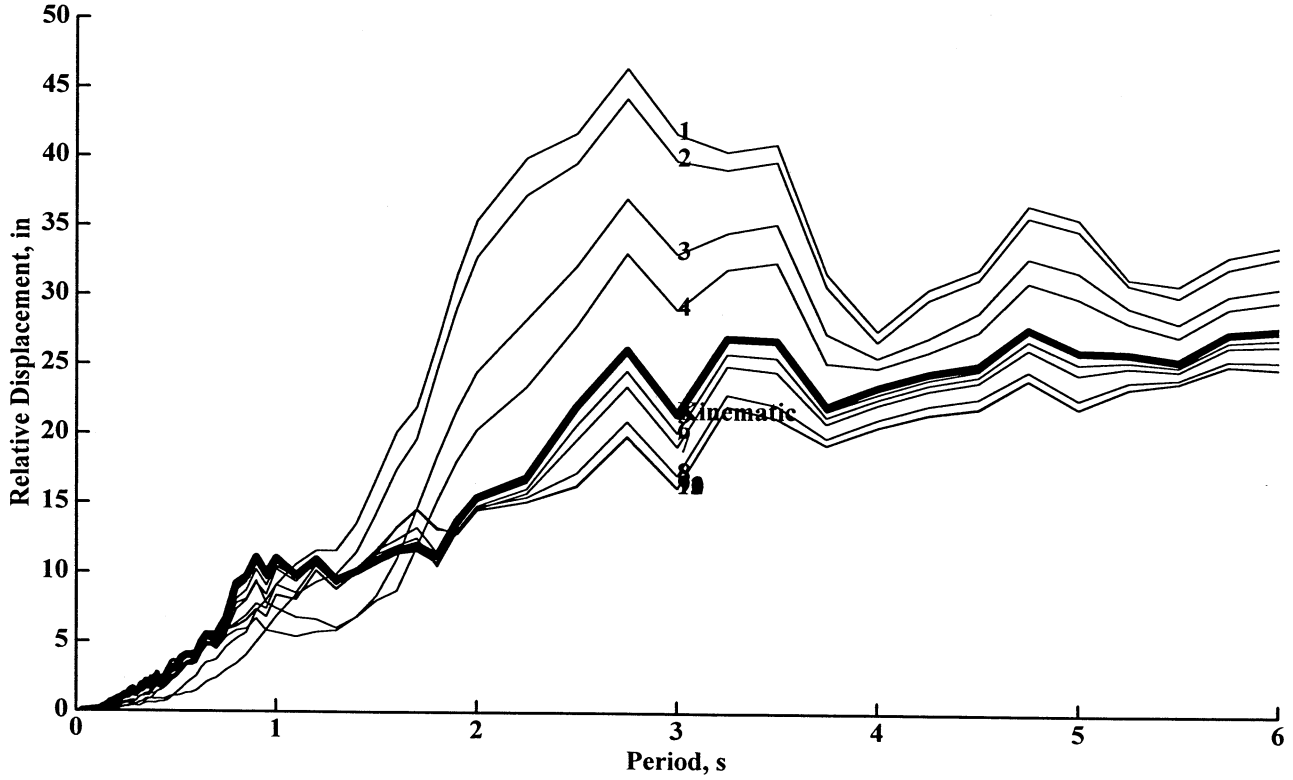
PIER 6
SET 3, Long. Dir.
BENICIA-MARTINEZ



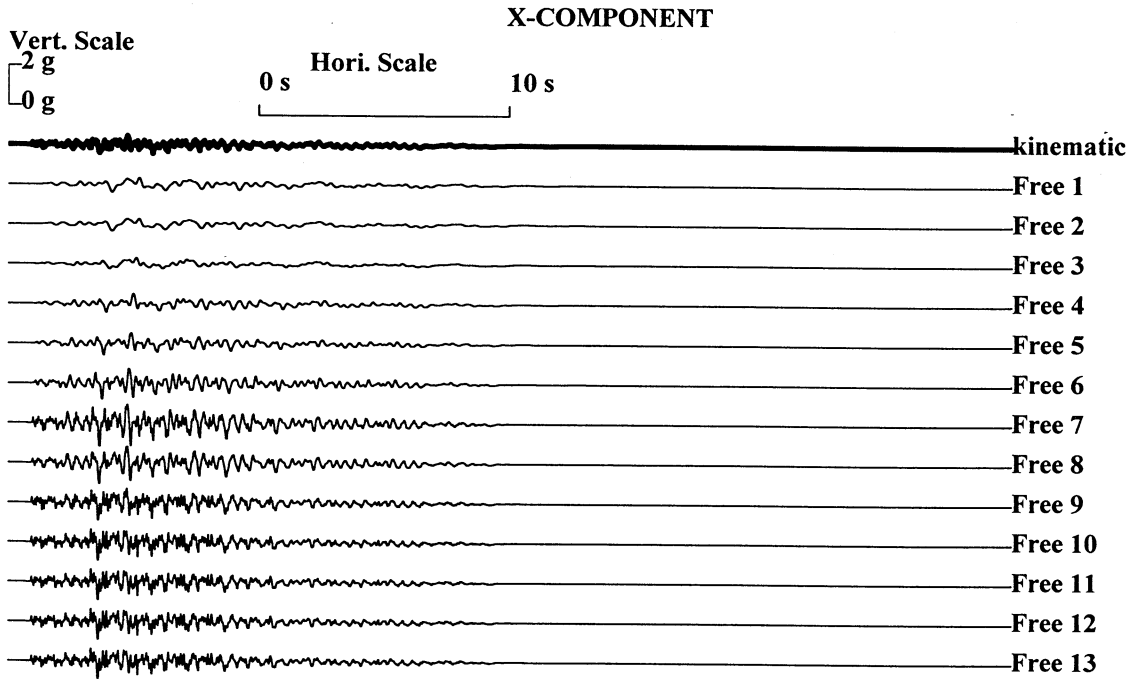


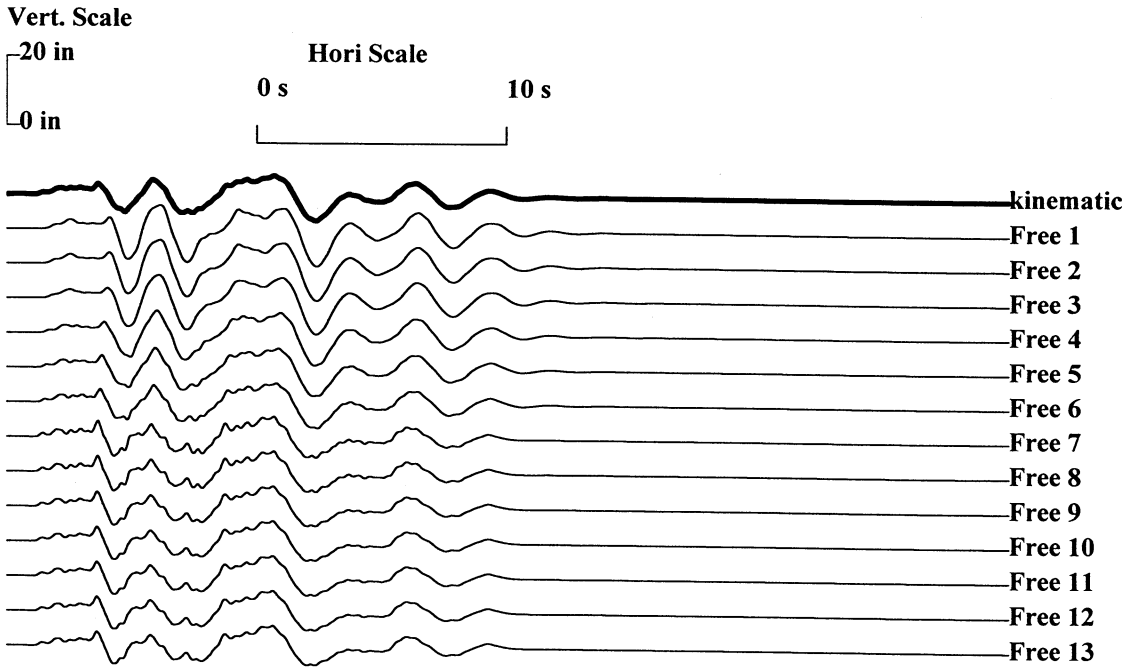
PIER 6
SET 3, Tran. Dir.
BENICIA-MARTINEZ





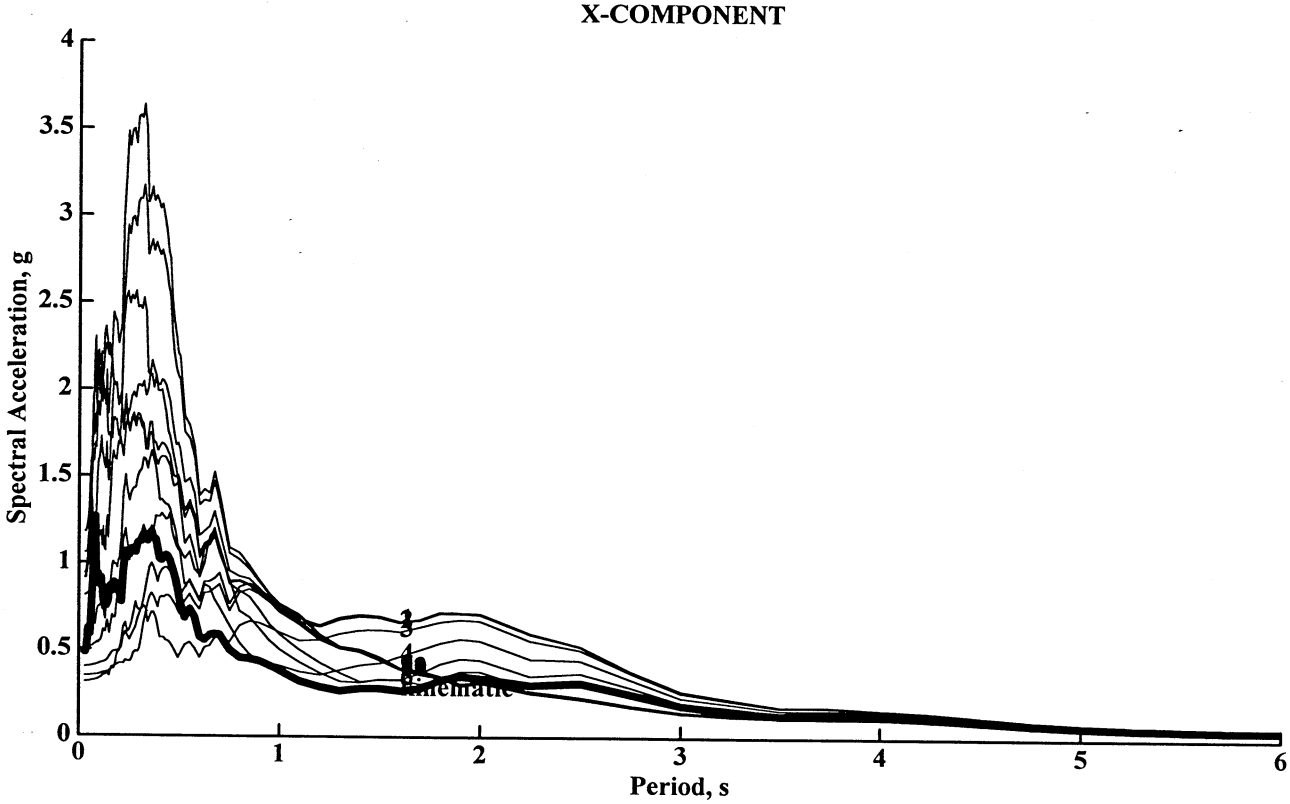
PIER 6
SET 3, Tran. Dir.
BENICIA-MARTINEZ

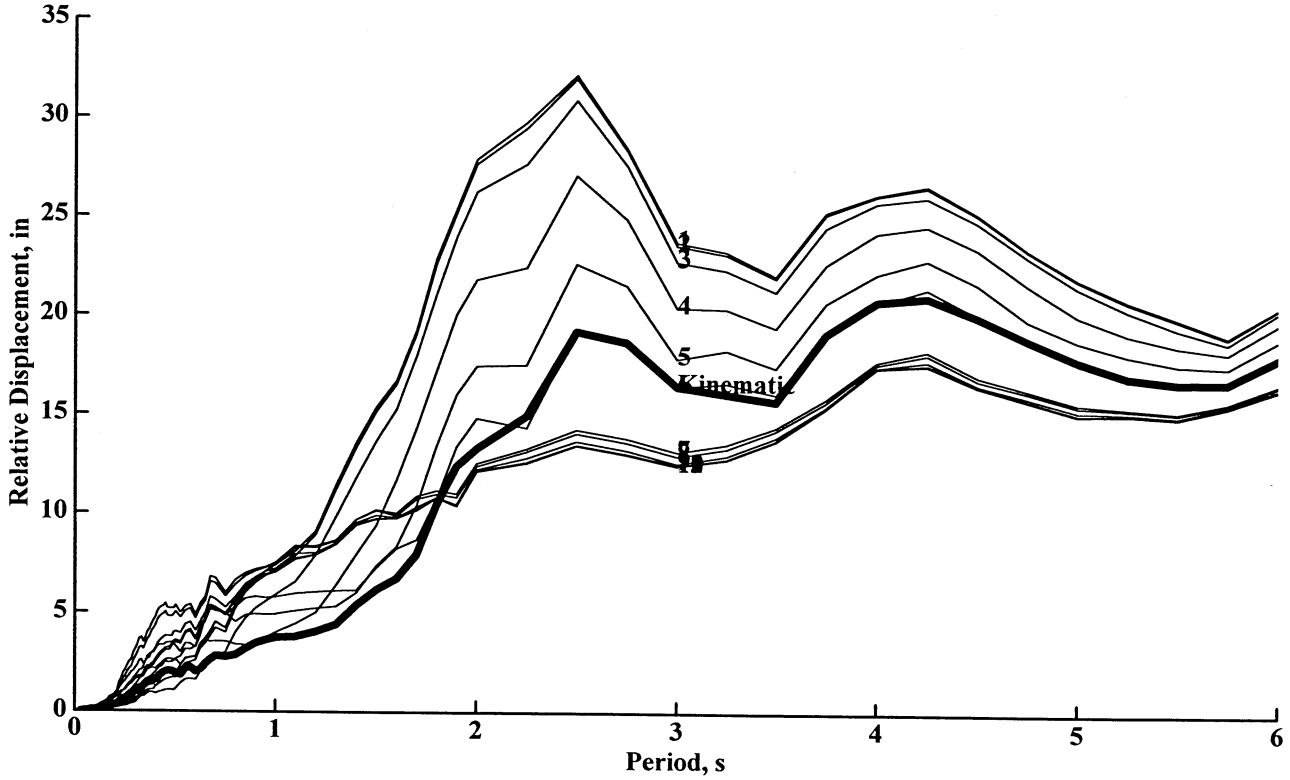




PIER 7
SET 3, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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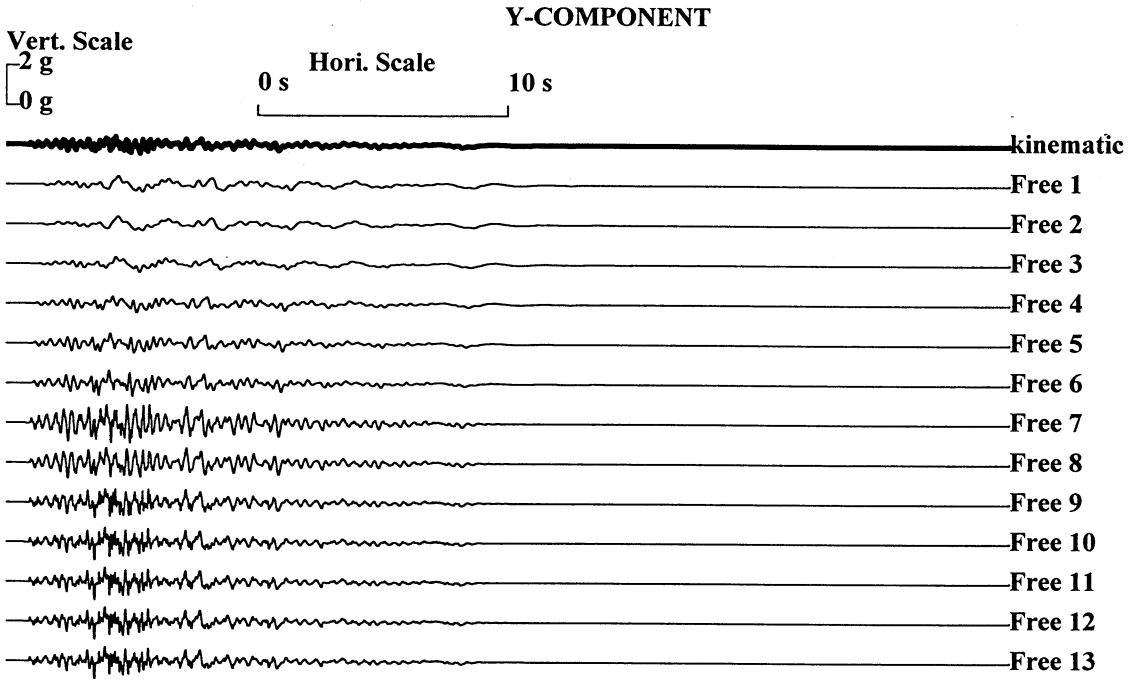
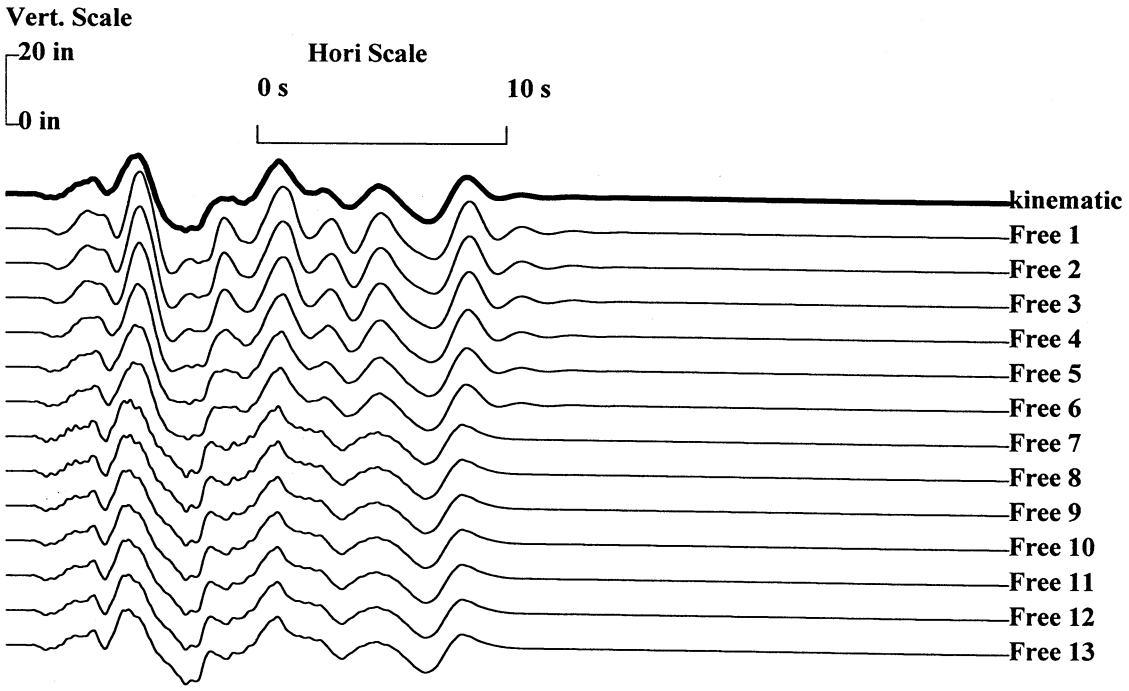
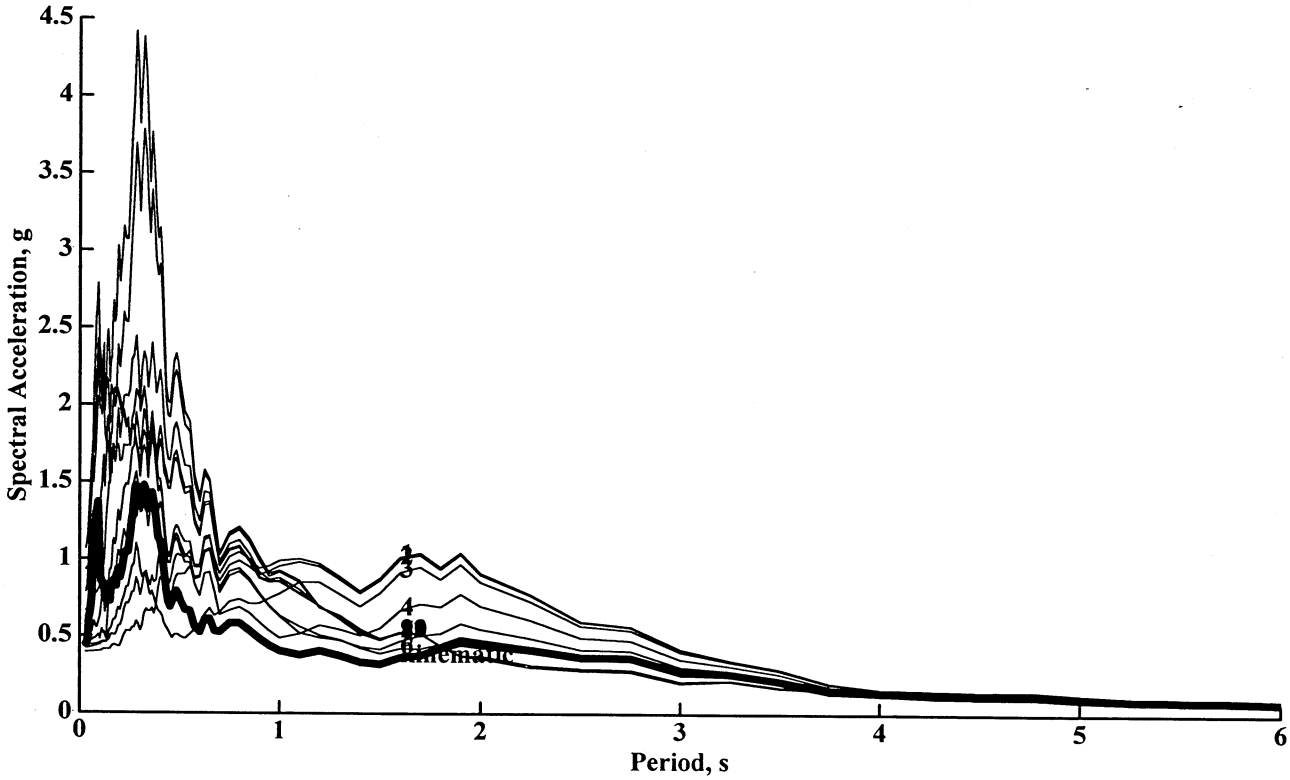
SET 3, Long. Dir.
BENICIA-MARTINEZ

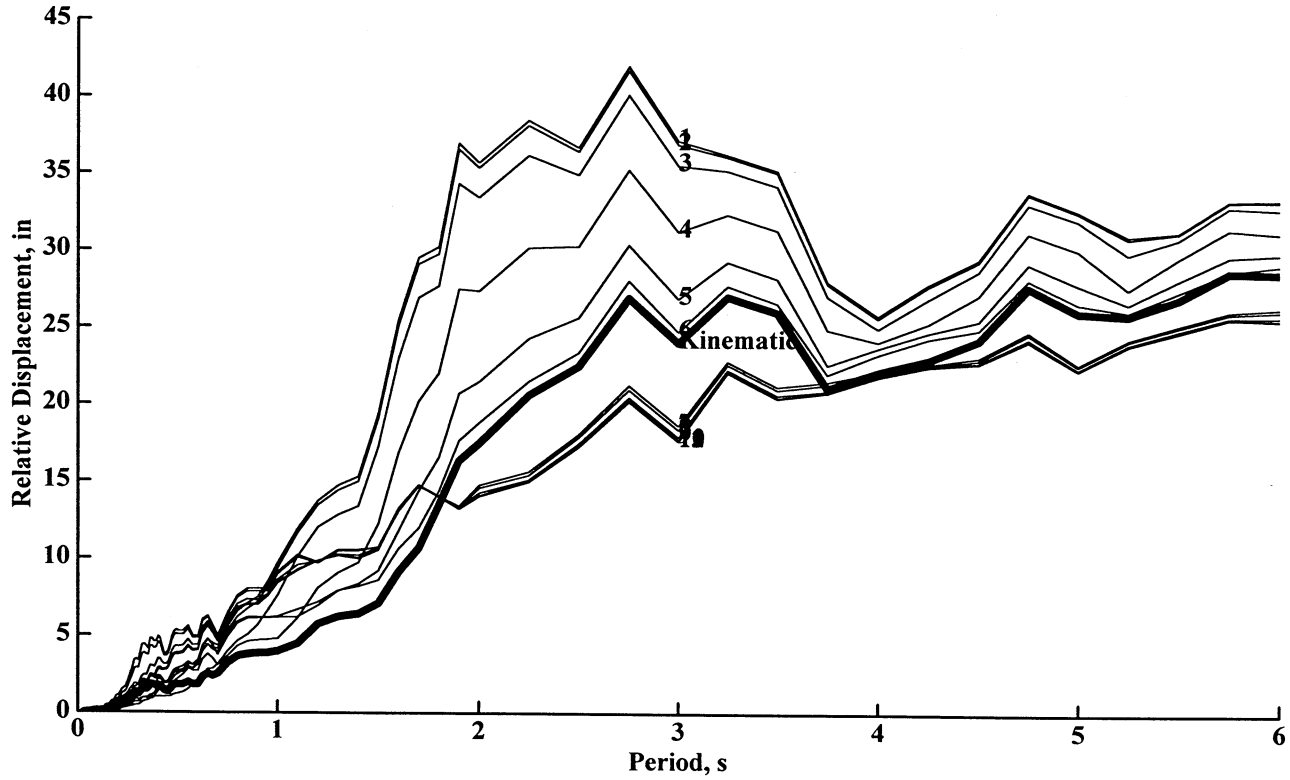




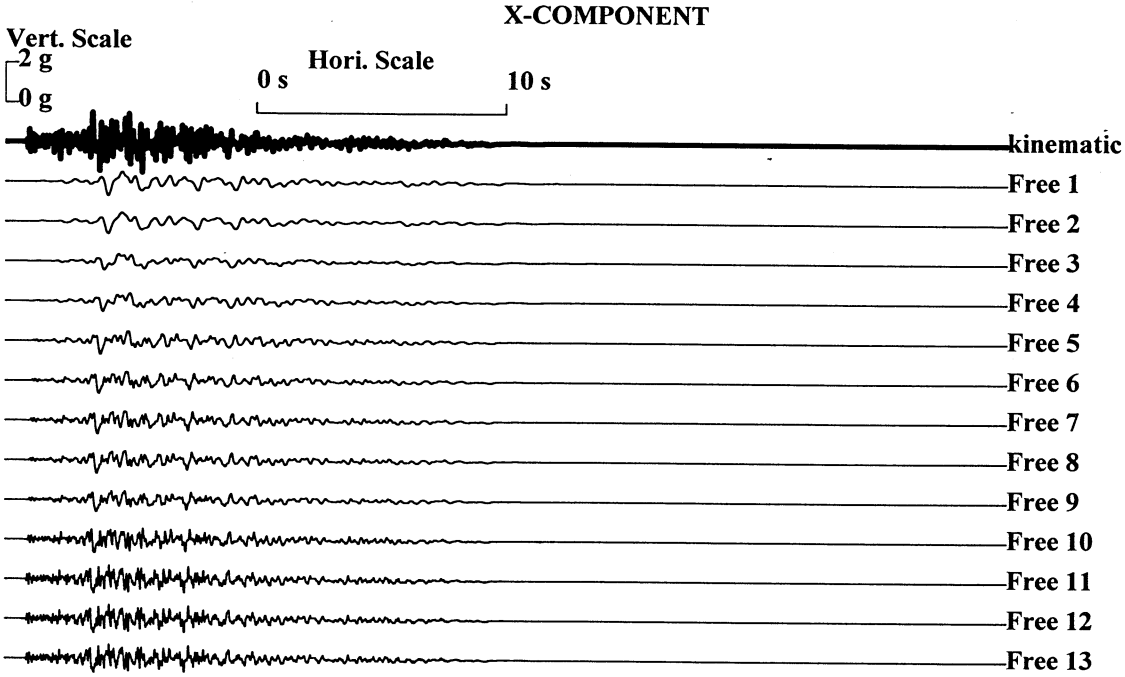
PIER 7
SET 3, Tran. Dir.
BENICIA-MARTINEZ

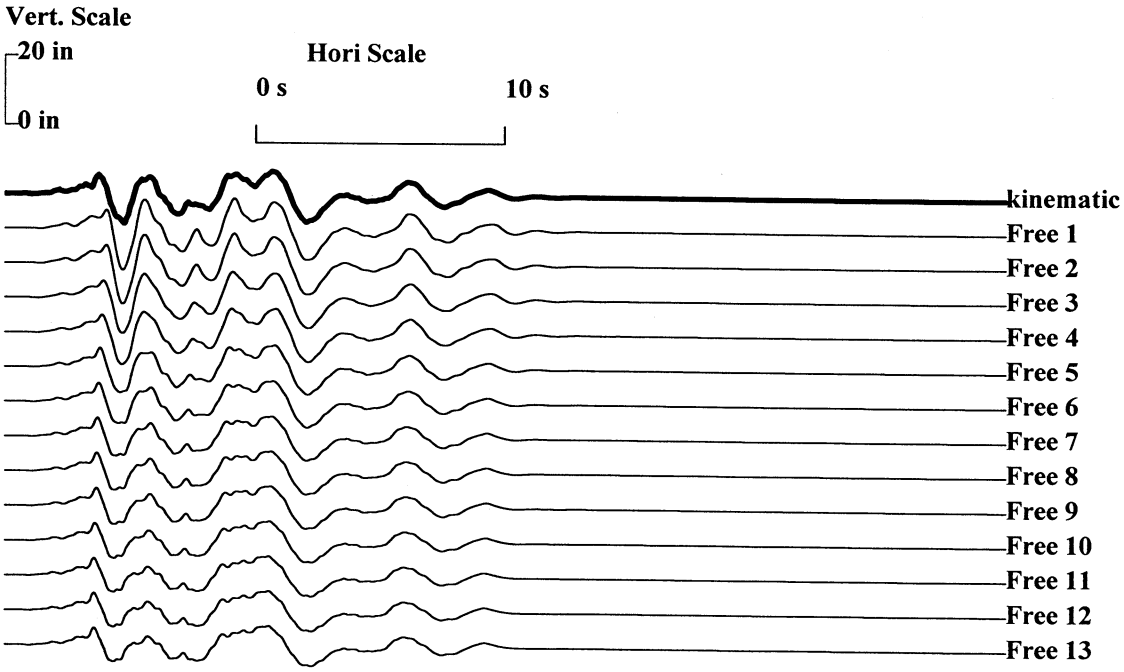
Y-COMPONENT





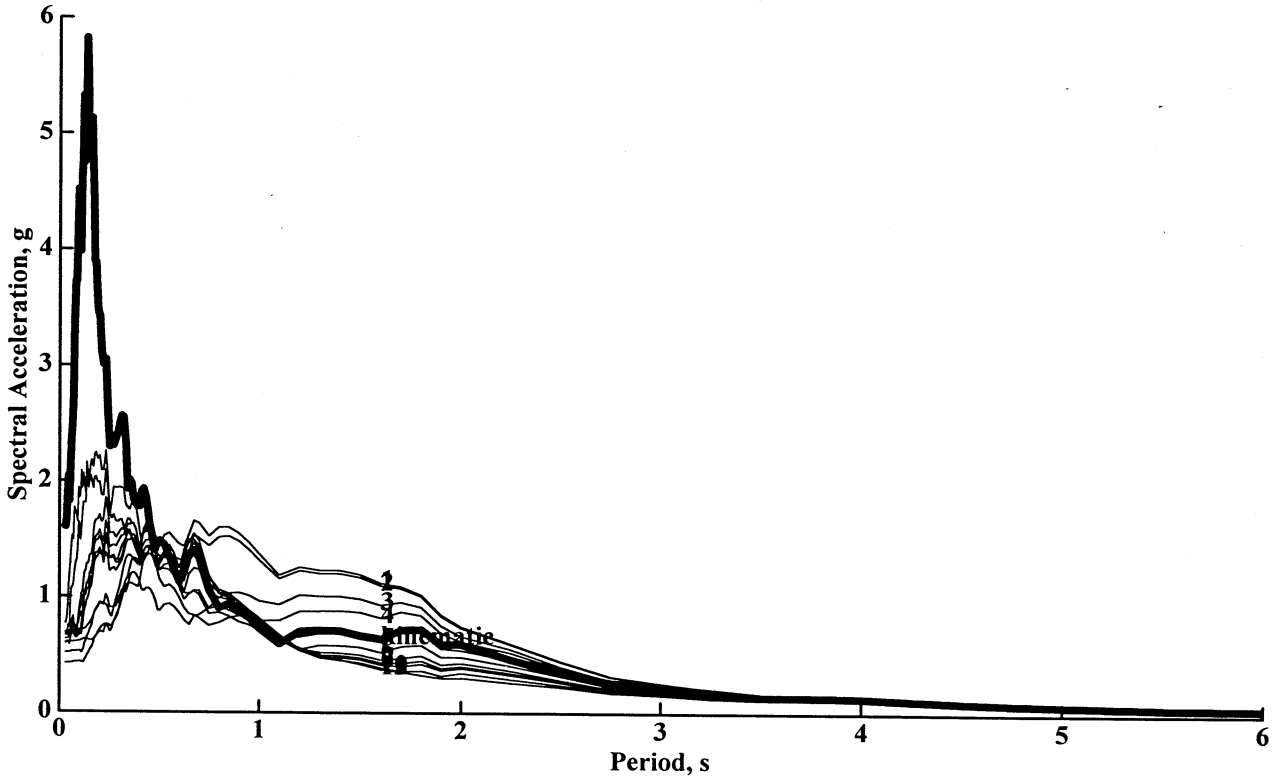
PIER 7
SET 3, Tran. Dir.
BENICIA-MARTINEZ

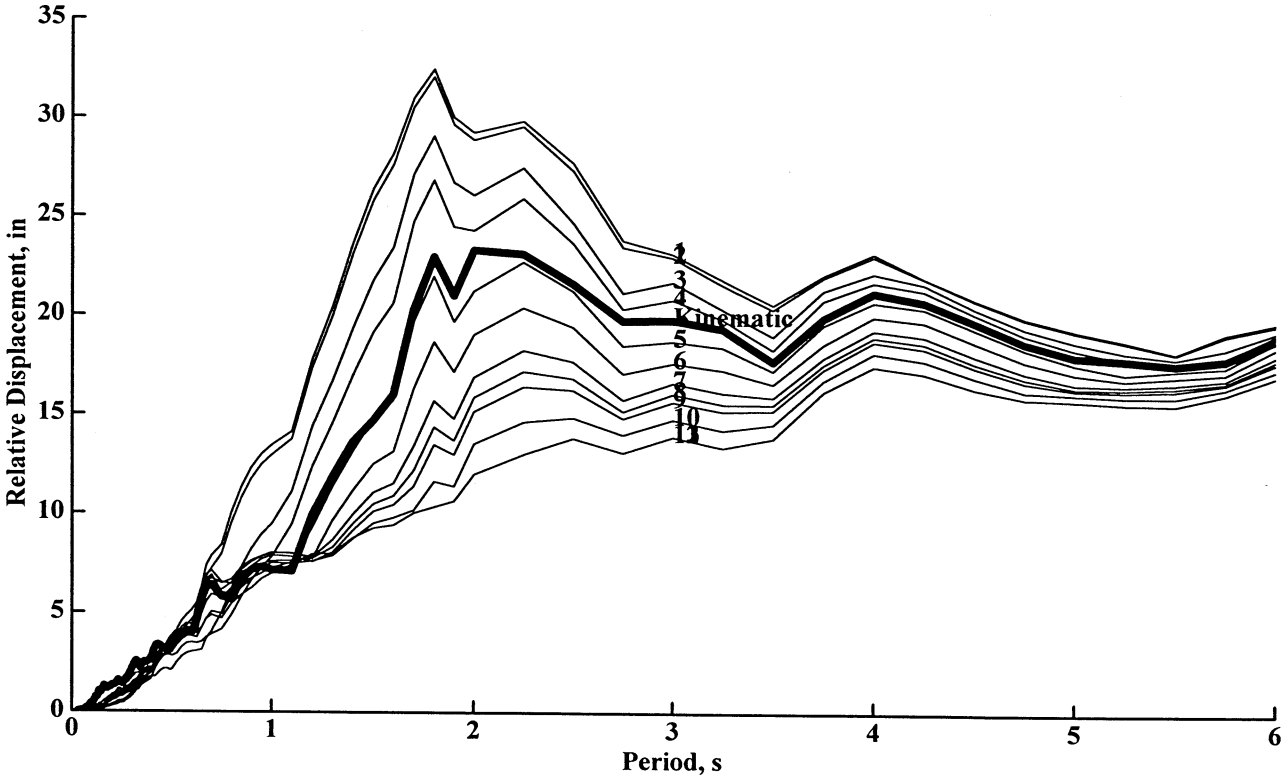




PIER 8
SET 3, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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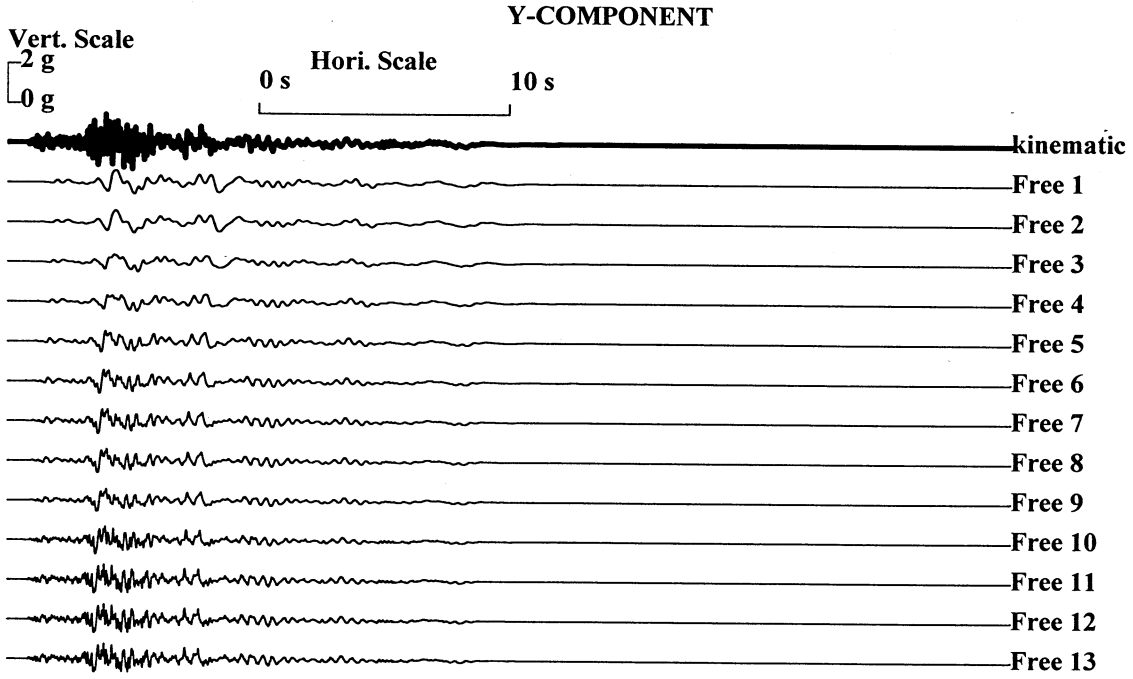
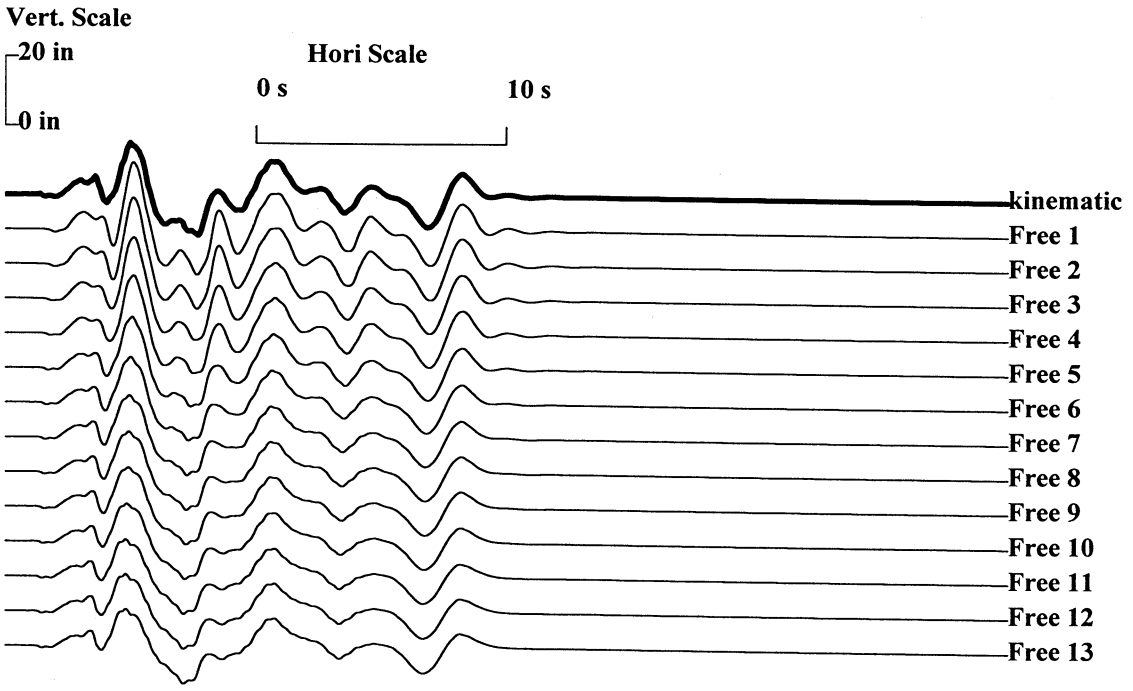
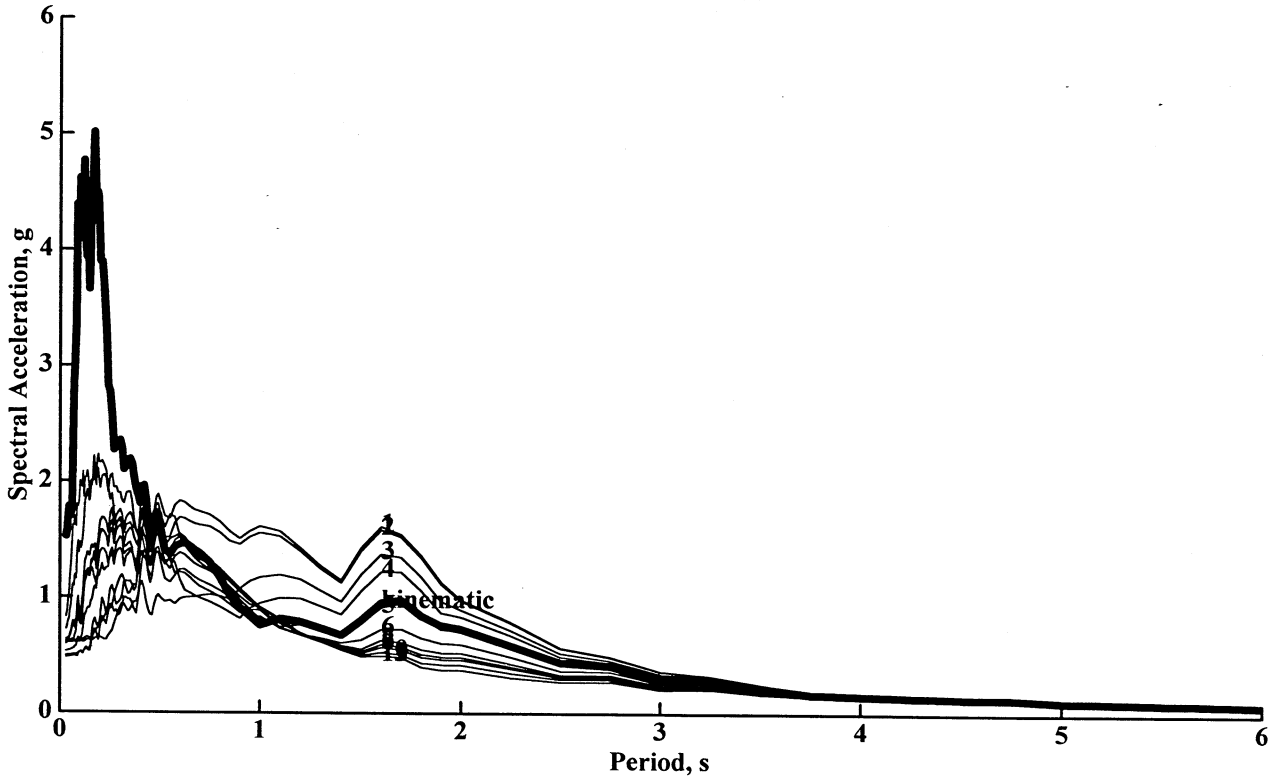
SET 3, Long. Dir.
BENICIA-MARTINEZ

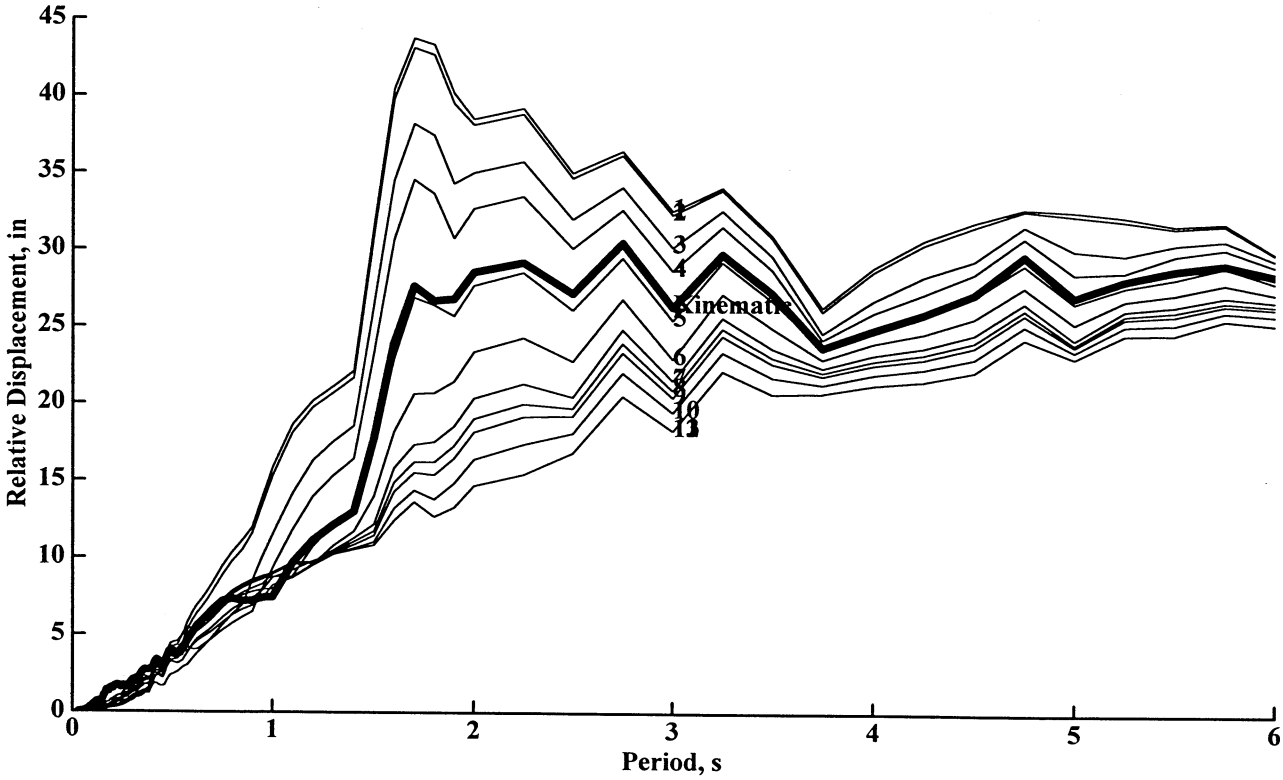




PIER 8
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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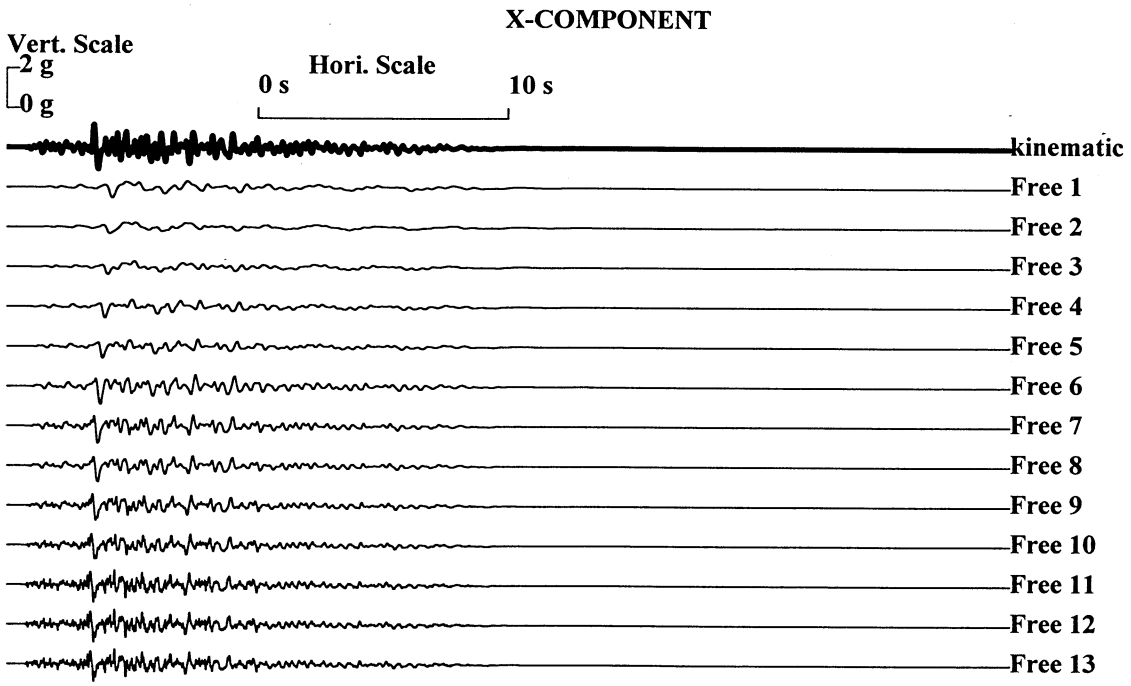
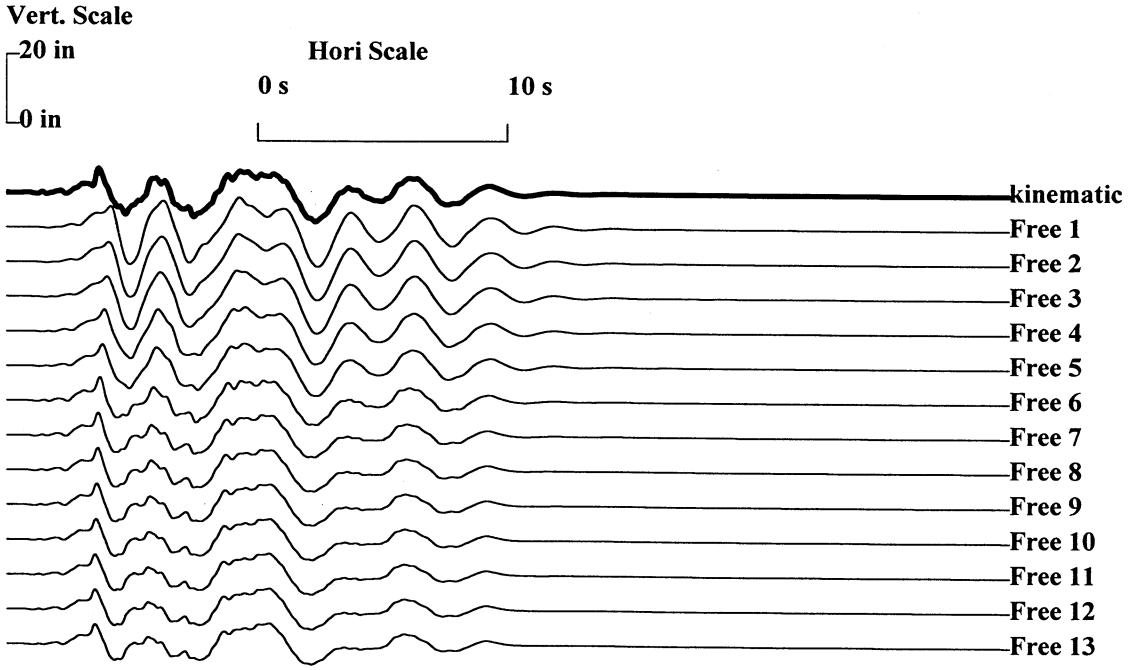
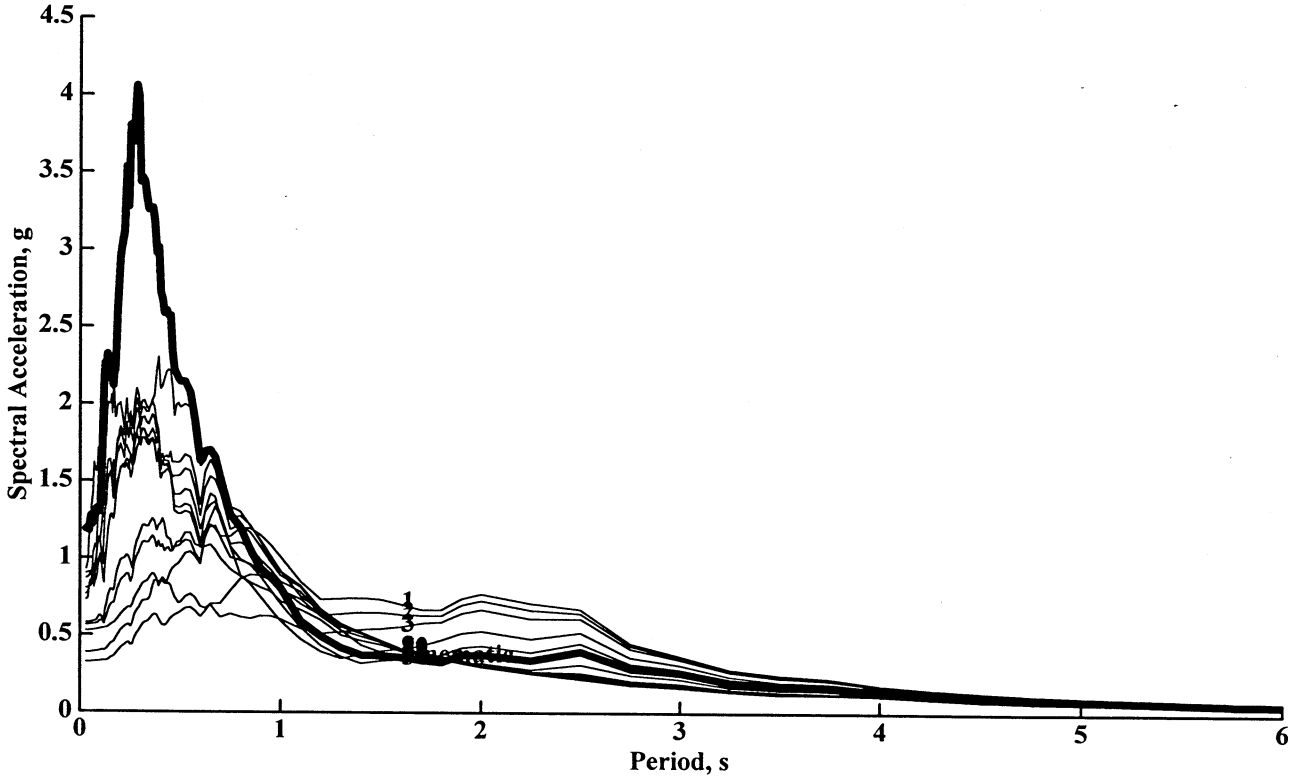
SET 3, Tran. Dir.
BENICIA-MARTINEZ

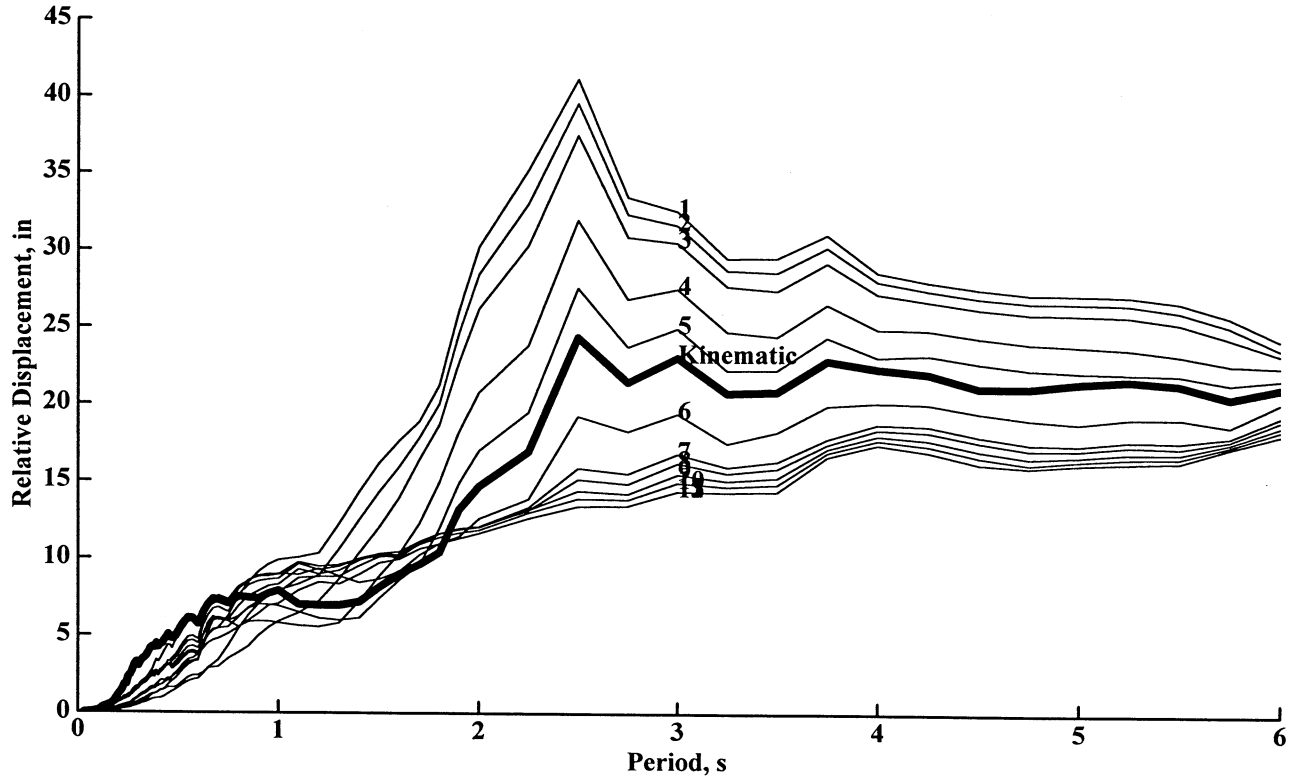




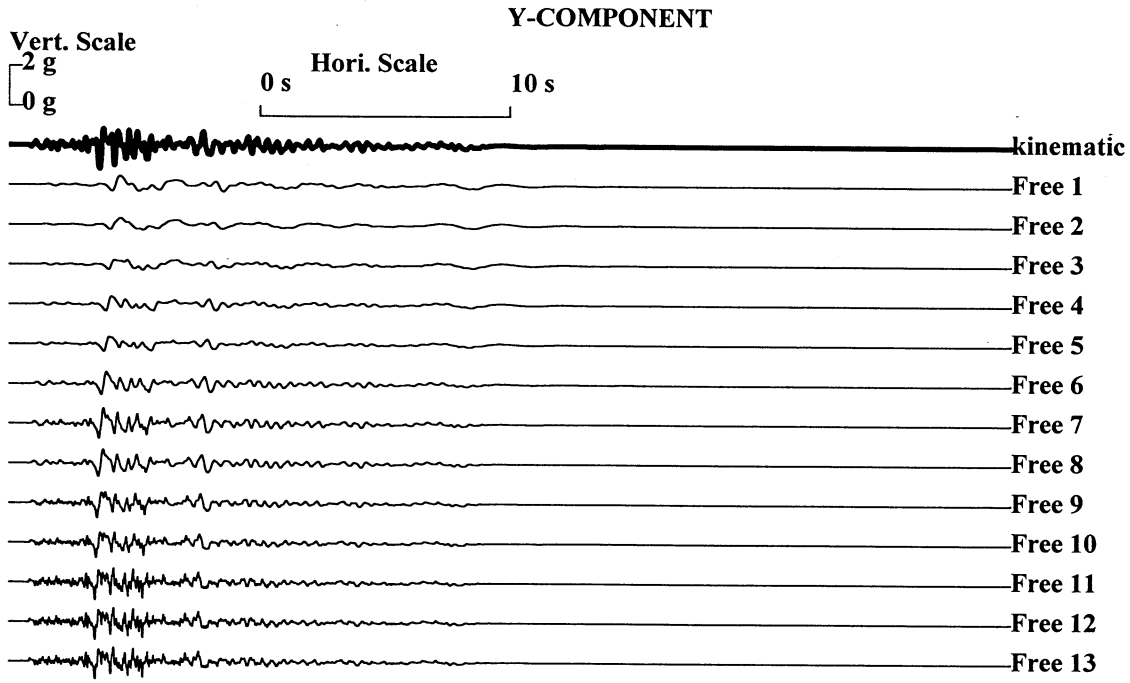
PIER 9
SET 3, Long. Dir.
BENICIA-MARTINEZ

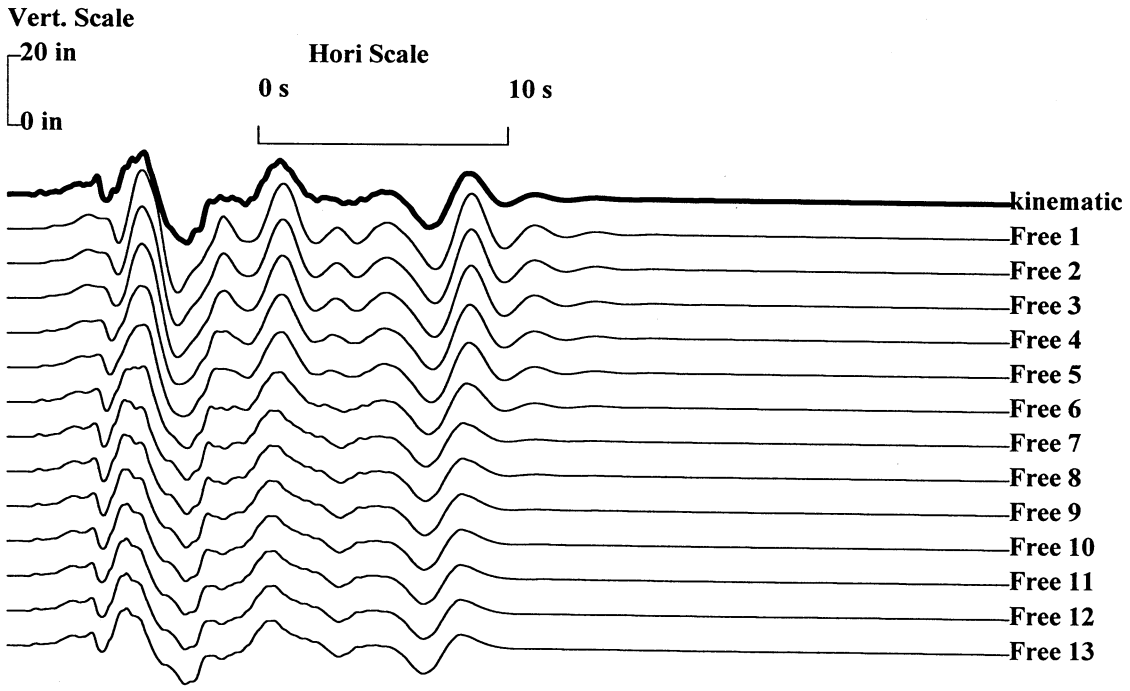
X-COMPONENT





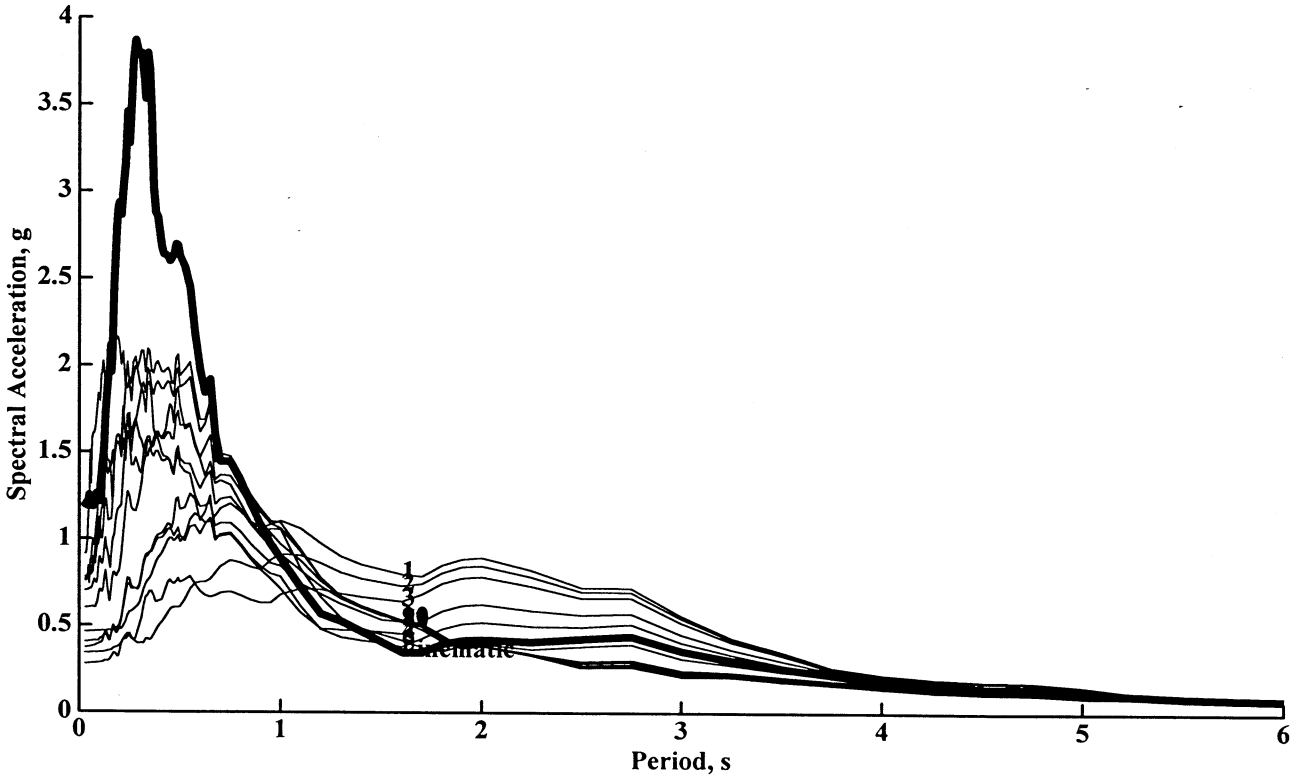
PIER 9
SET 3, Long. Dir.
BENICIA-MARTINEZ

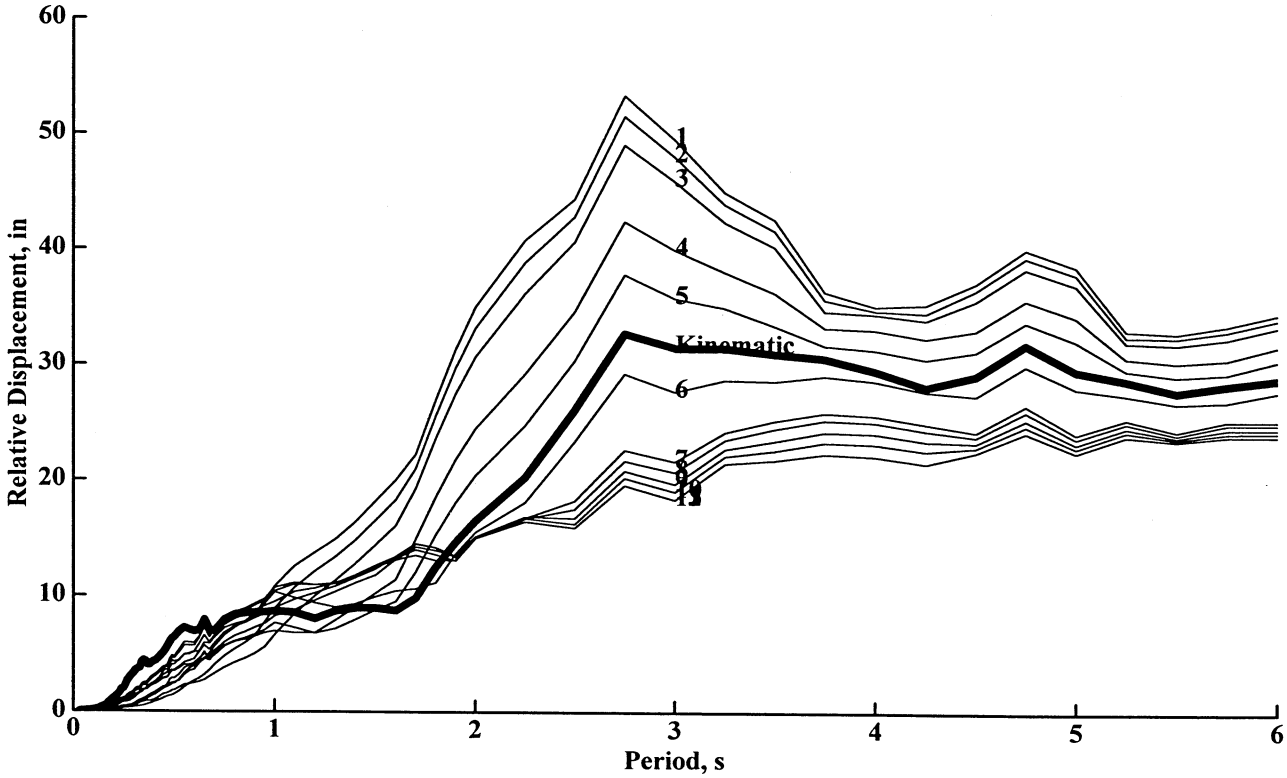




PIER 9
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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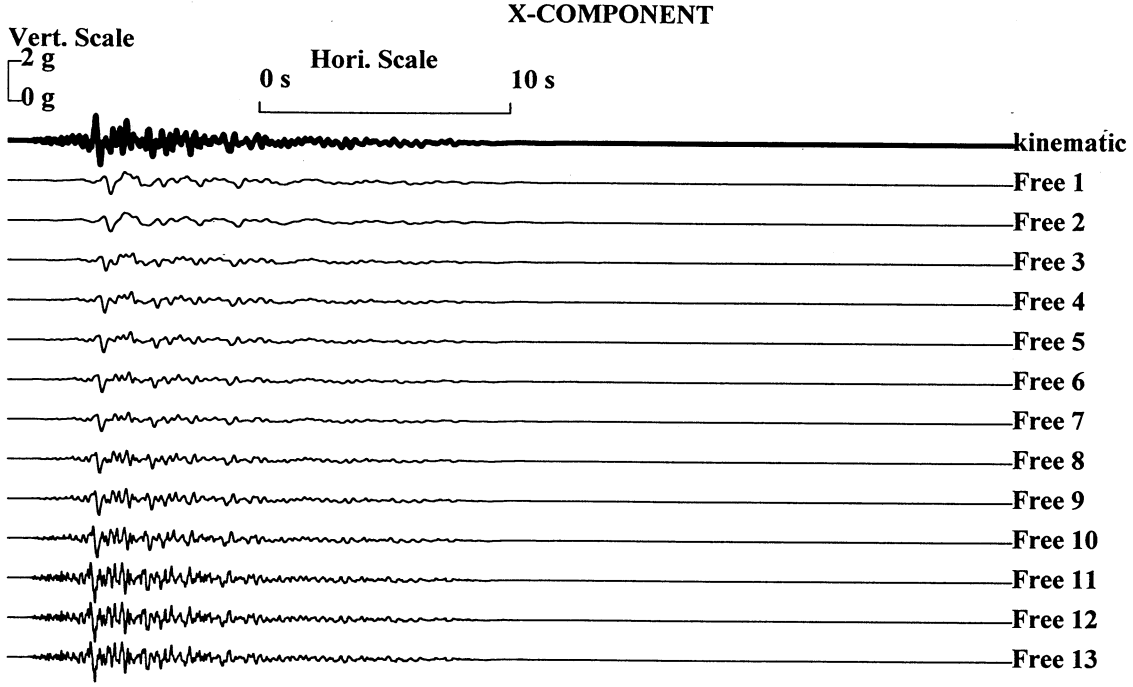
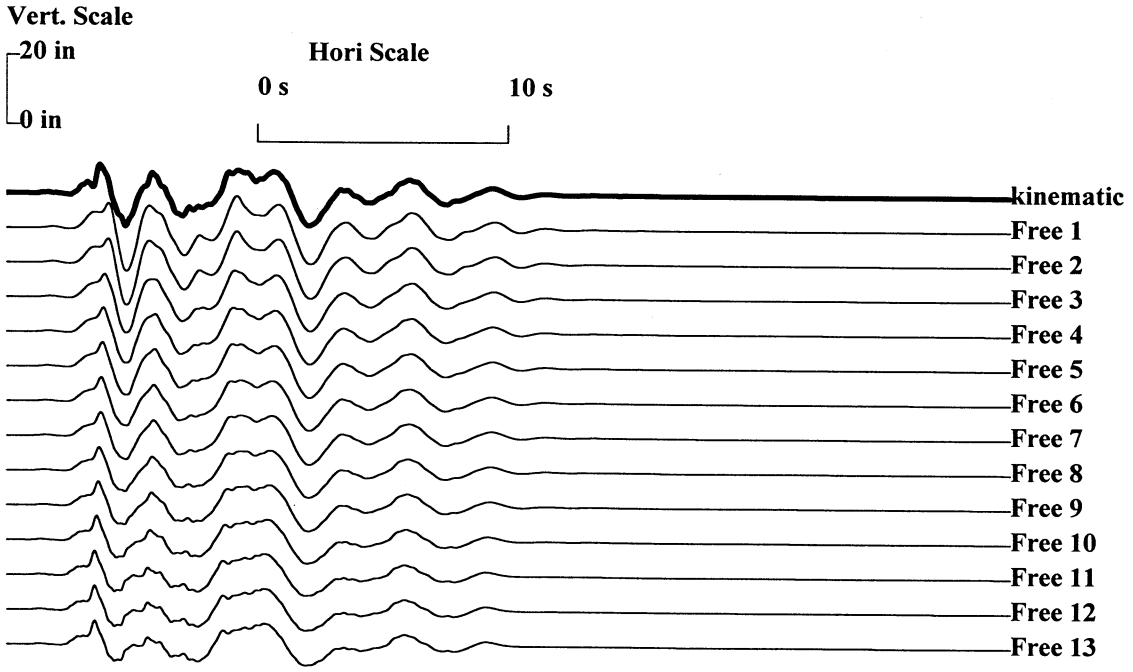
SET 3, Tran. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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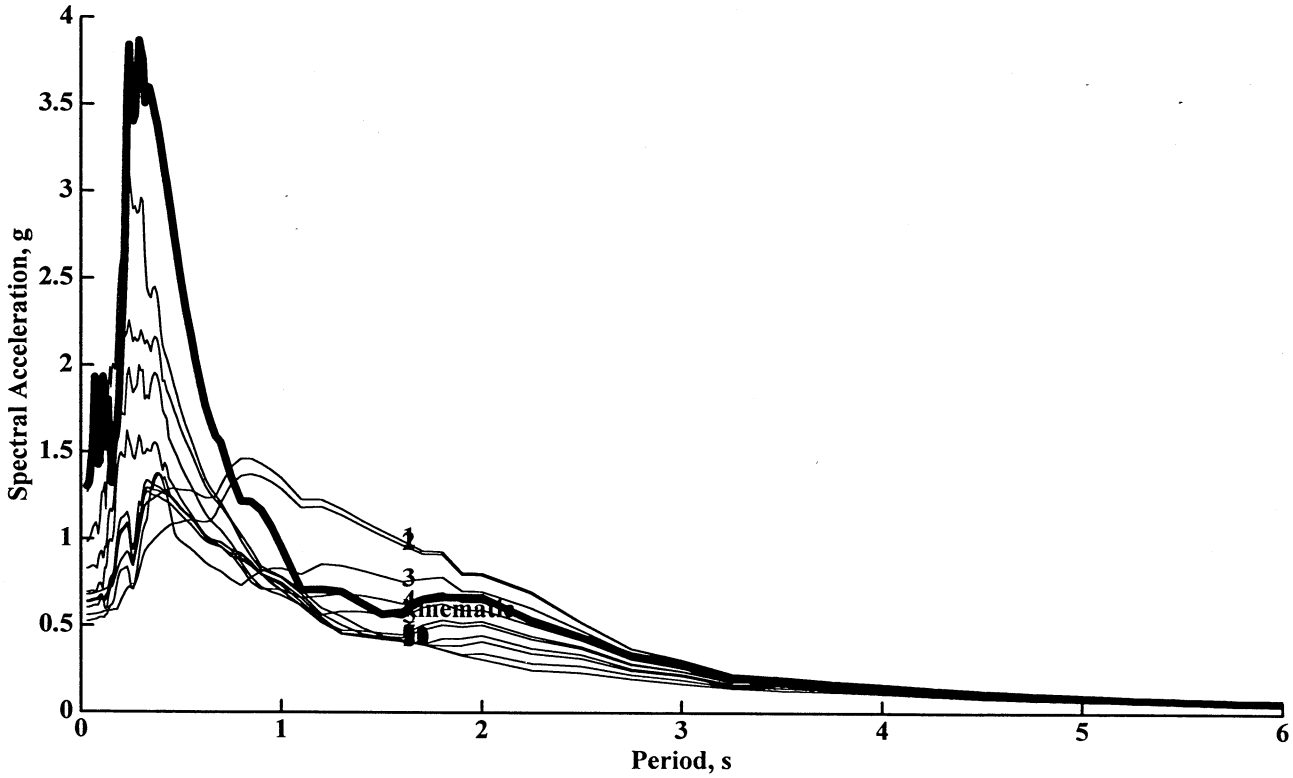
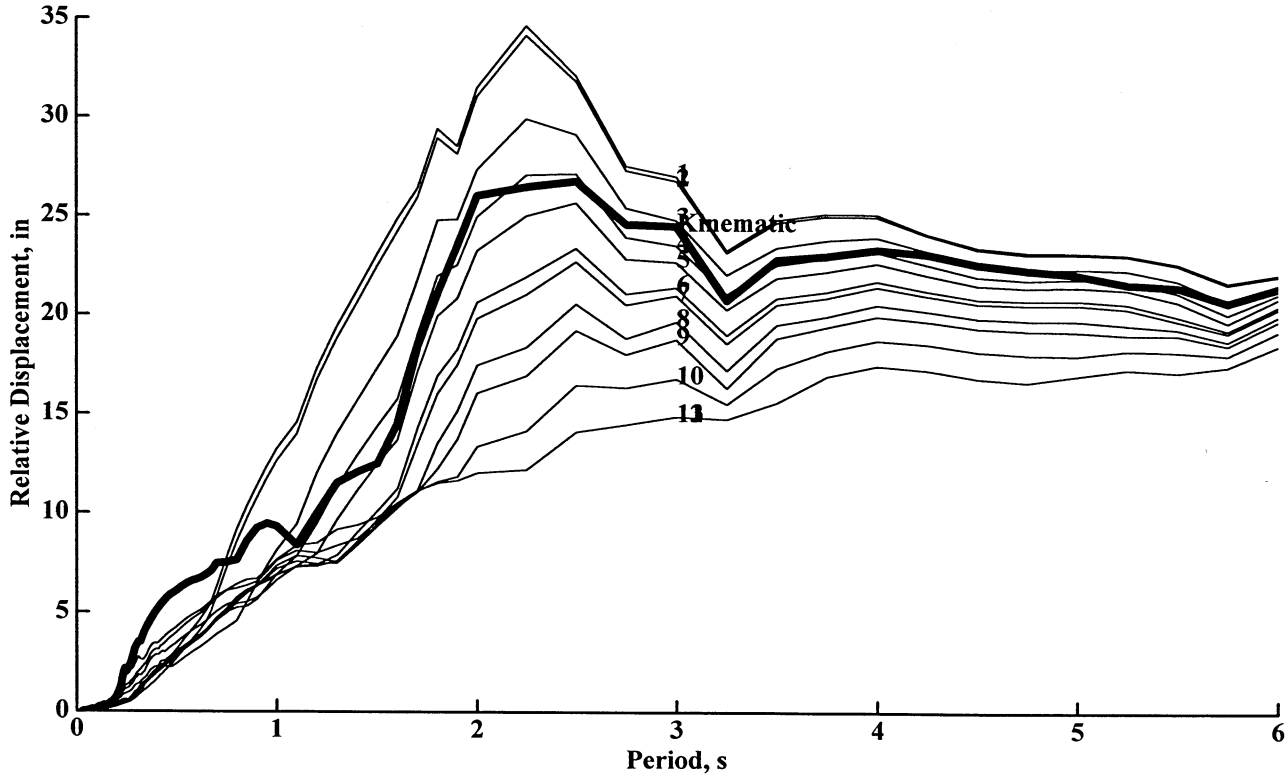
SET 3, Long. Dir.
BENICIA-MARTINEZ

X-COMPONENT





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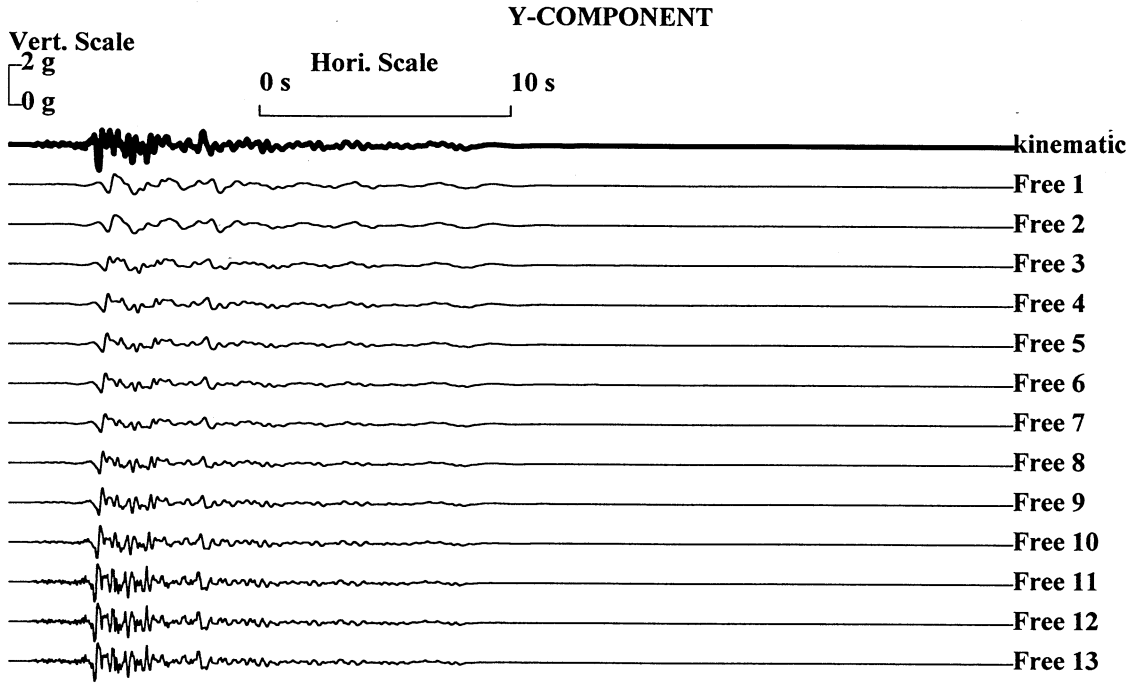
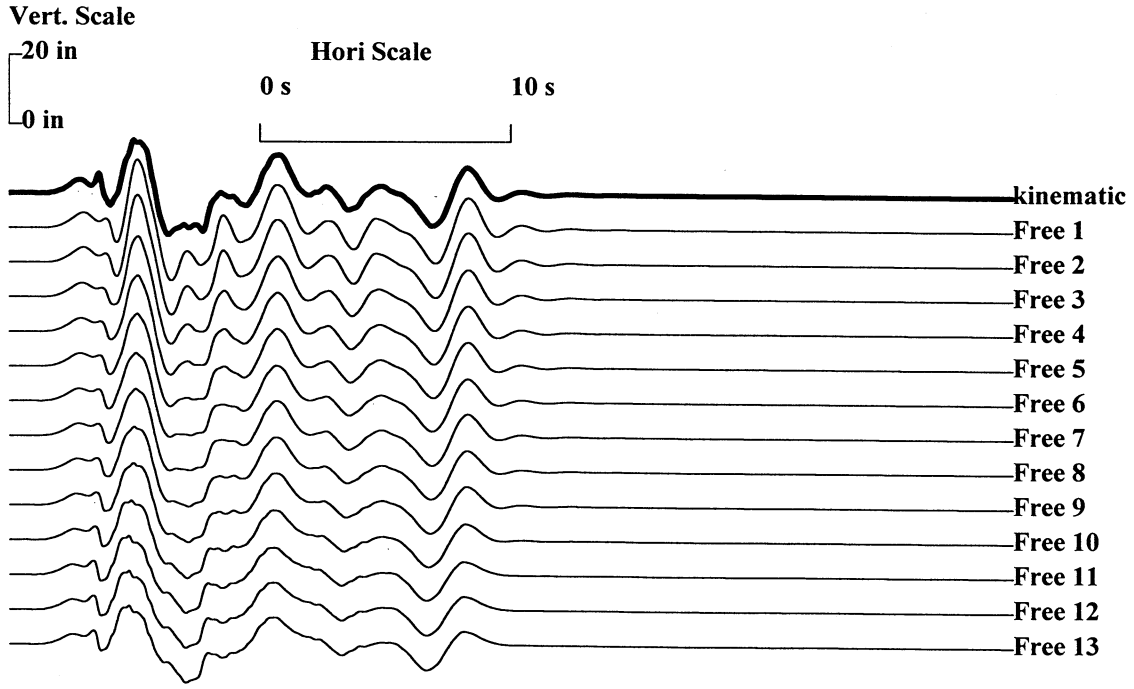
SET 3, Long. Dir.
BENICIA-MARTINEZ





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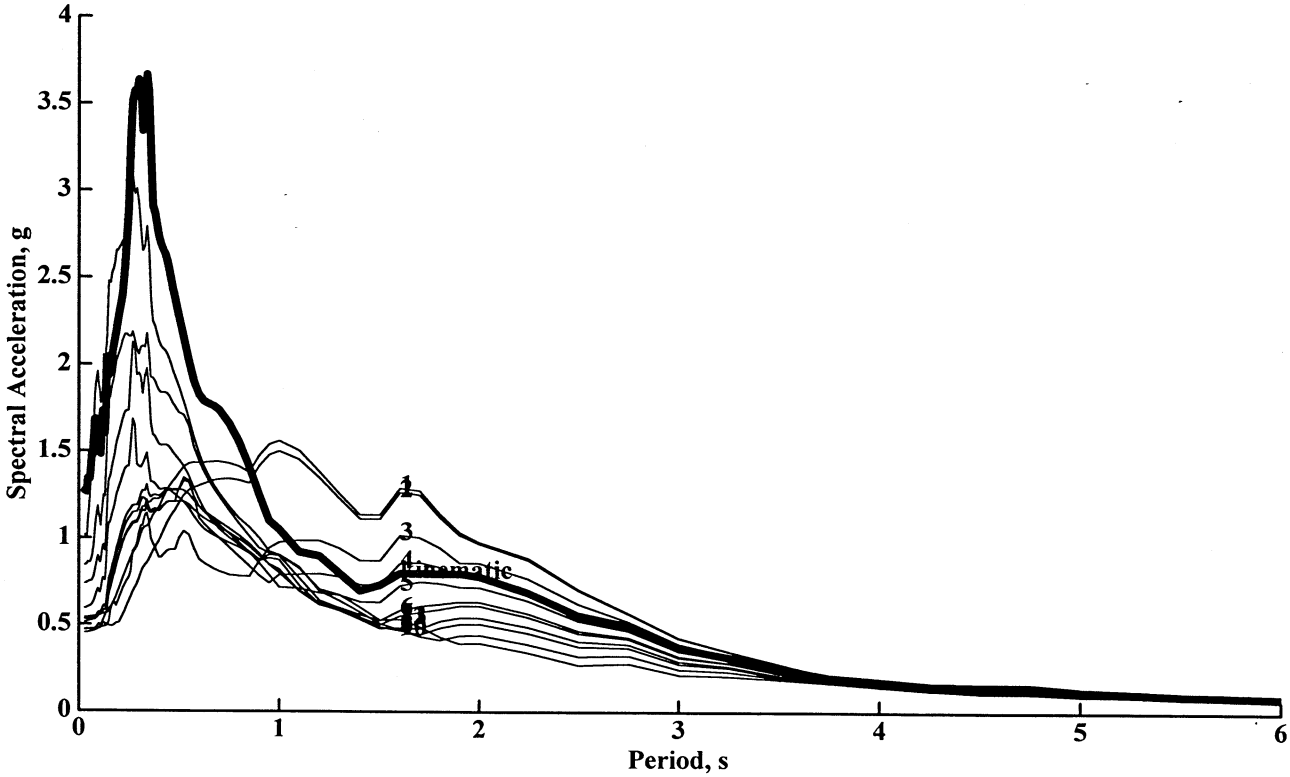
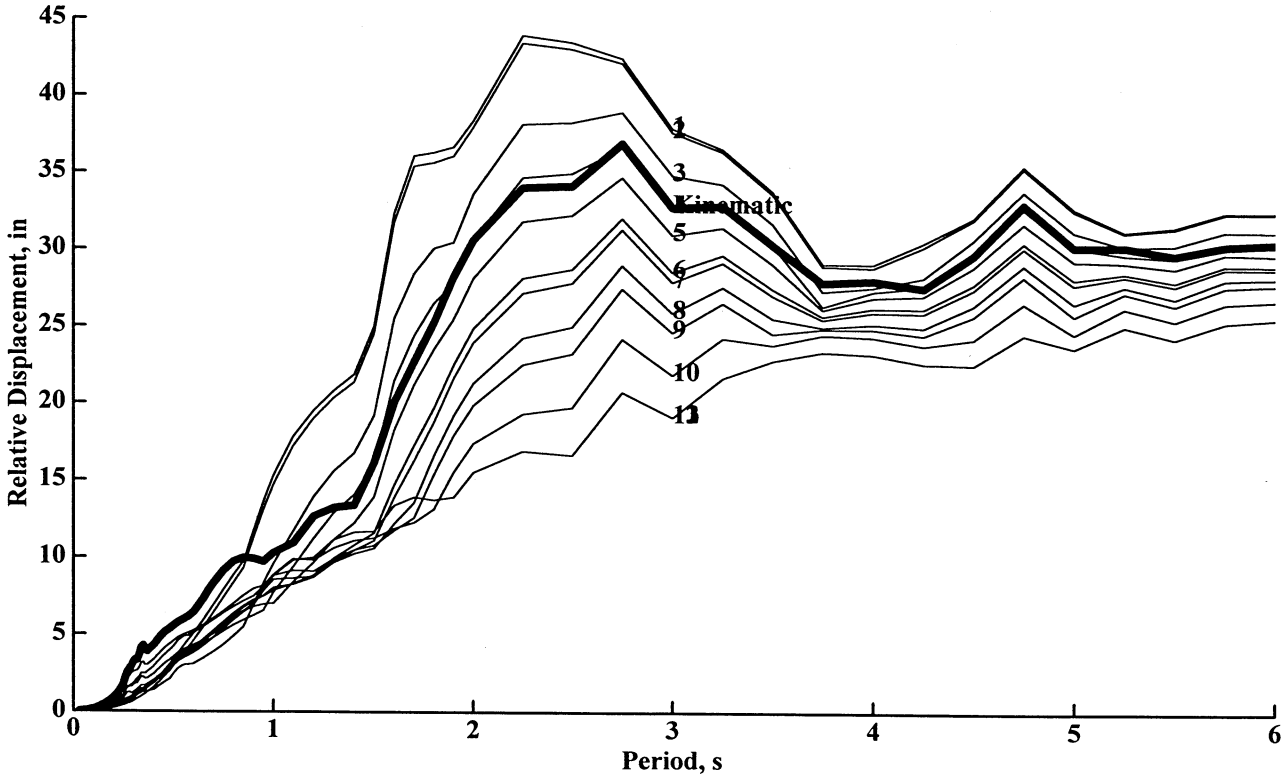
SET 3, Tran. Dir.
BENICIA-MARTINEZ

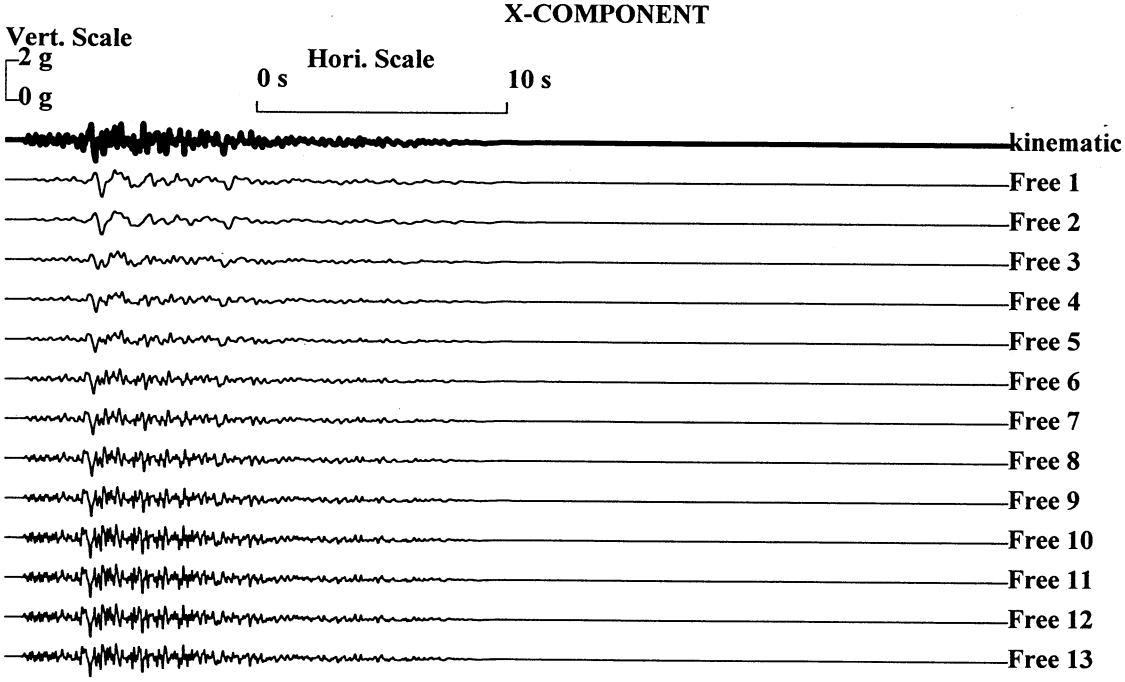
Y-COMPONENT

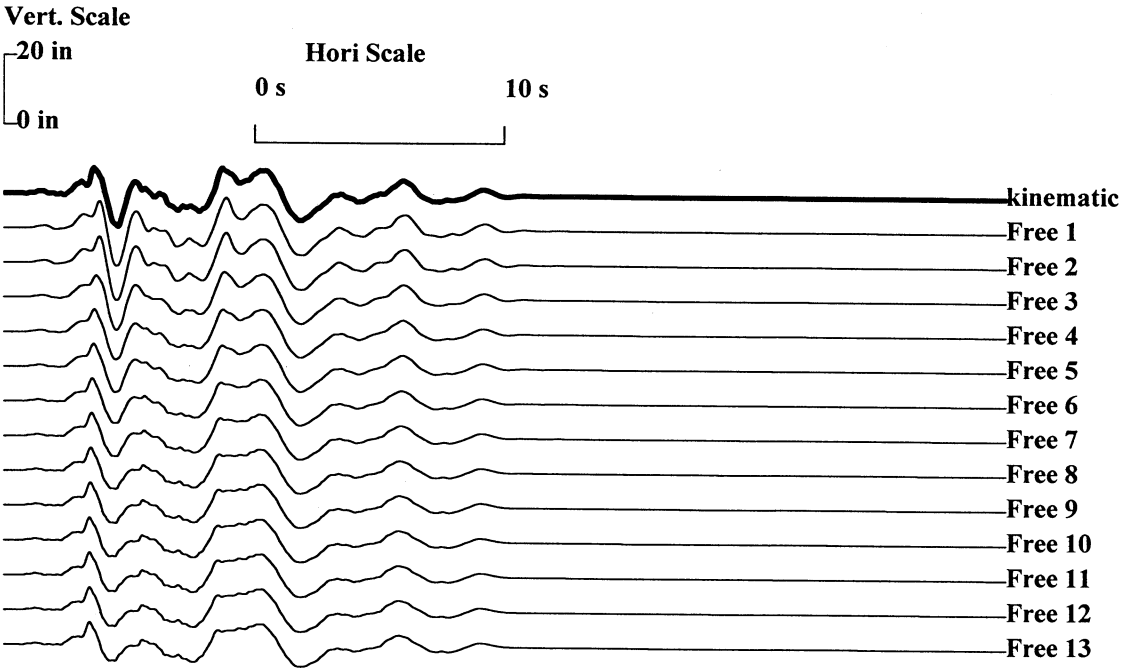




PIER 10
SET 3, Tran. Dir.
BENICIA-MARTINEZ

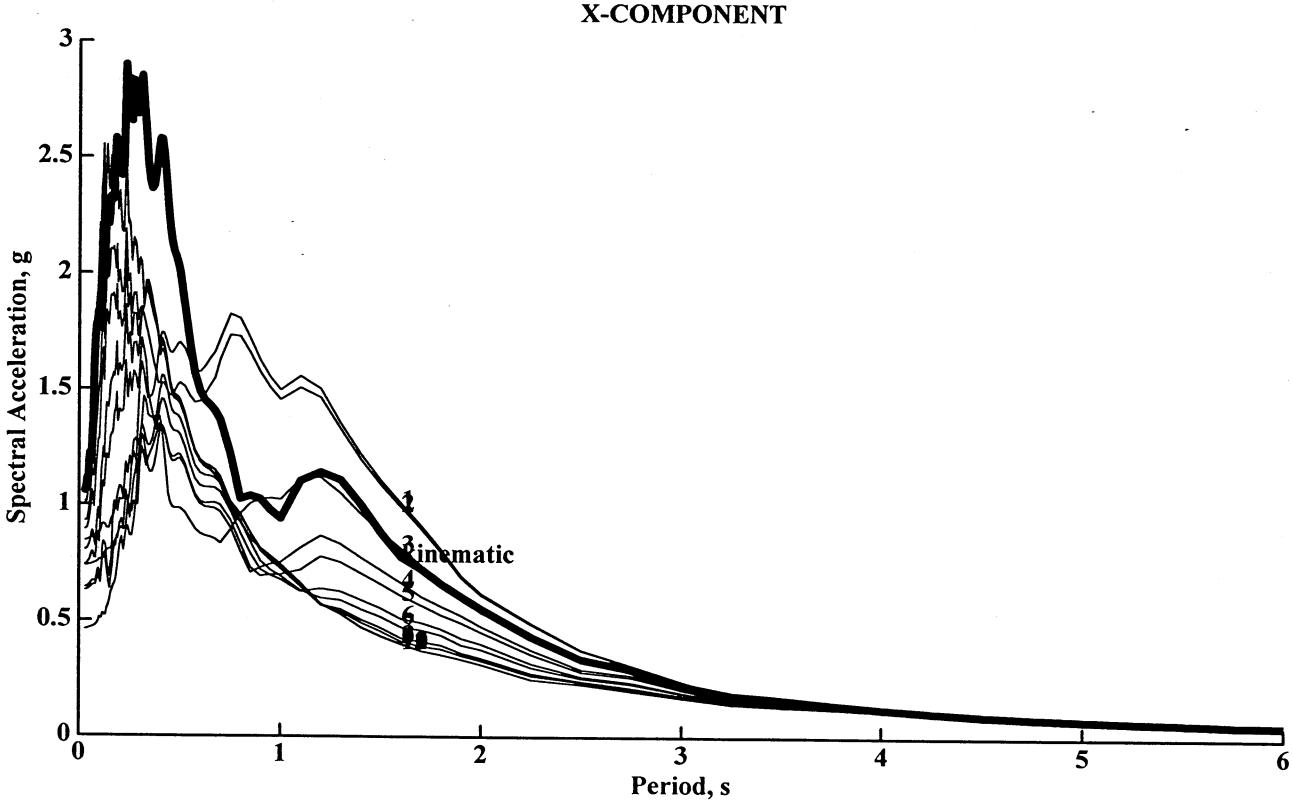
X-COMPONENT

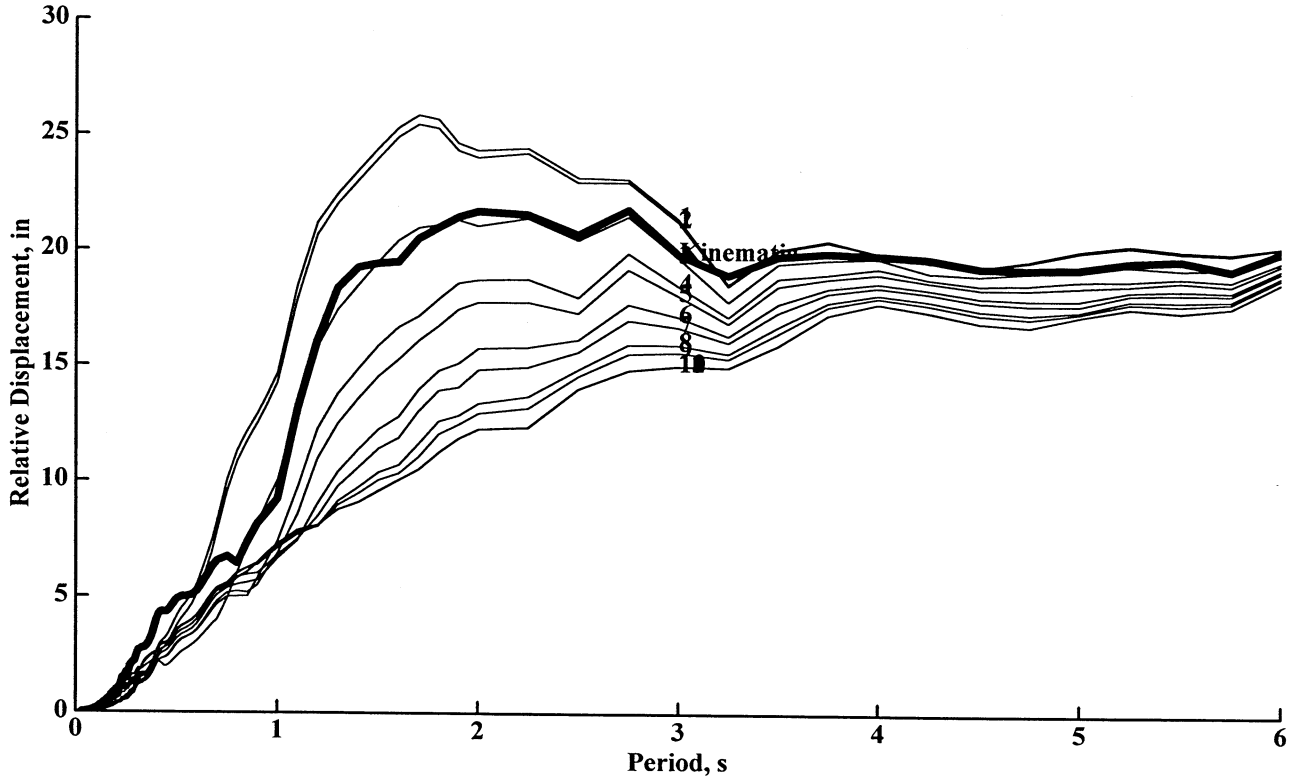




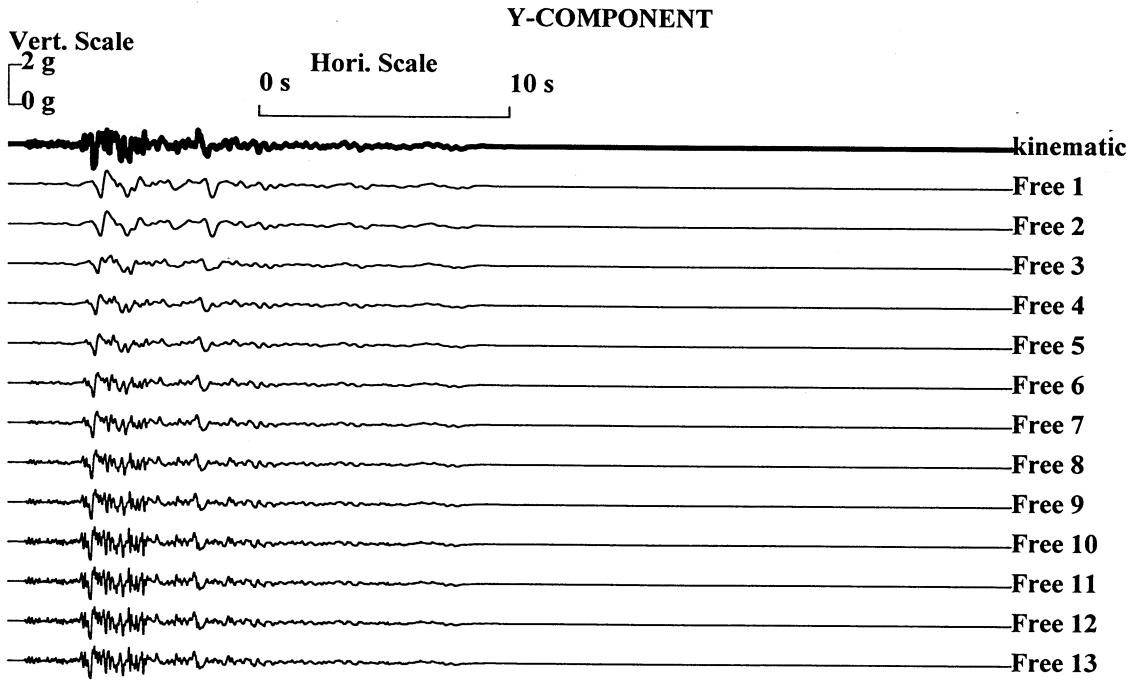
PIER 11
SET 3, Long. Dir.
BENICIA-MARTINEZ

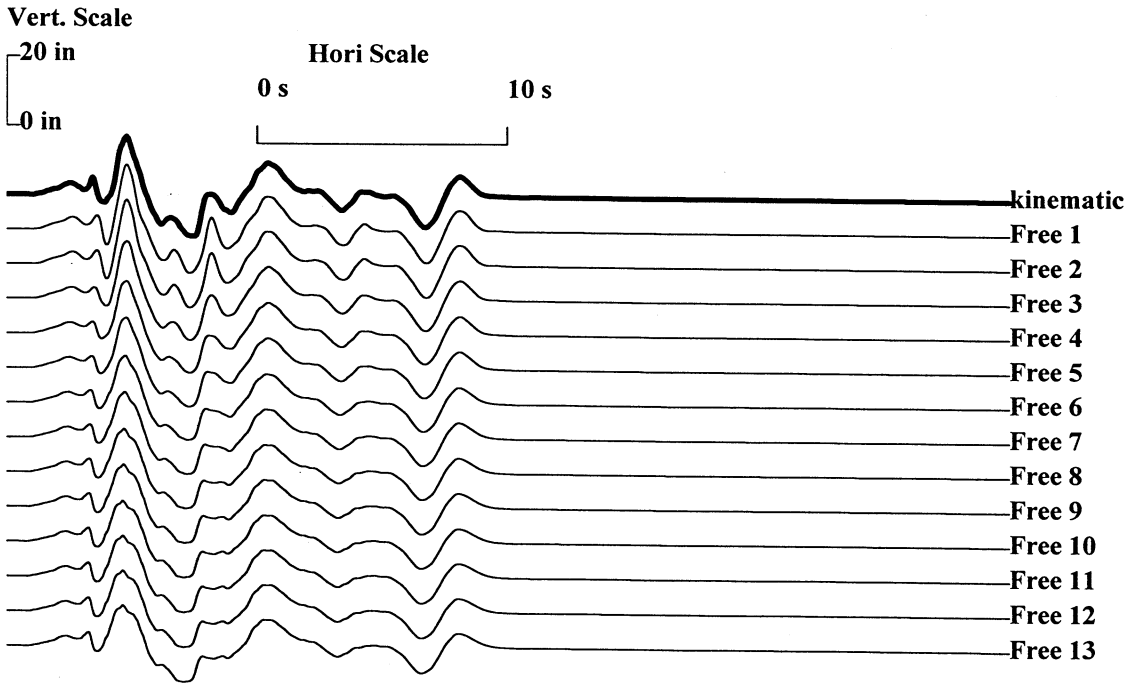
X-COMPONENT





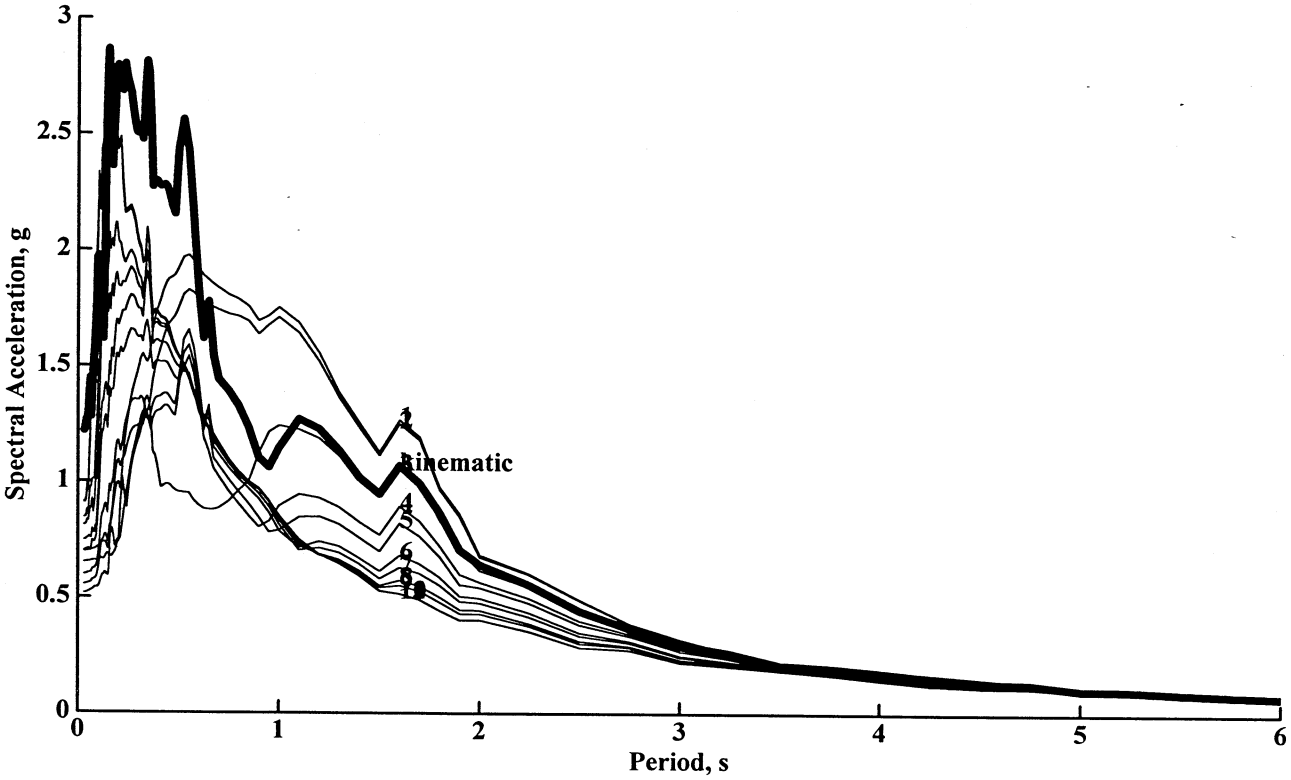
PIER 11
SET 3, Long. Dir.
BENICIA-MARTINEZ

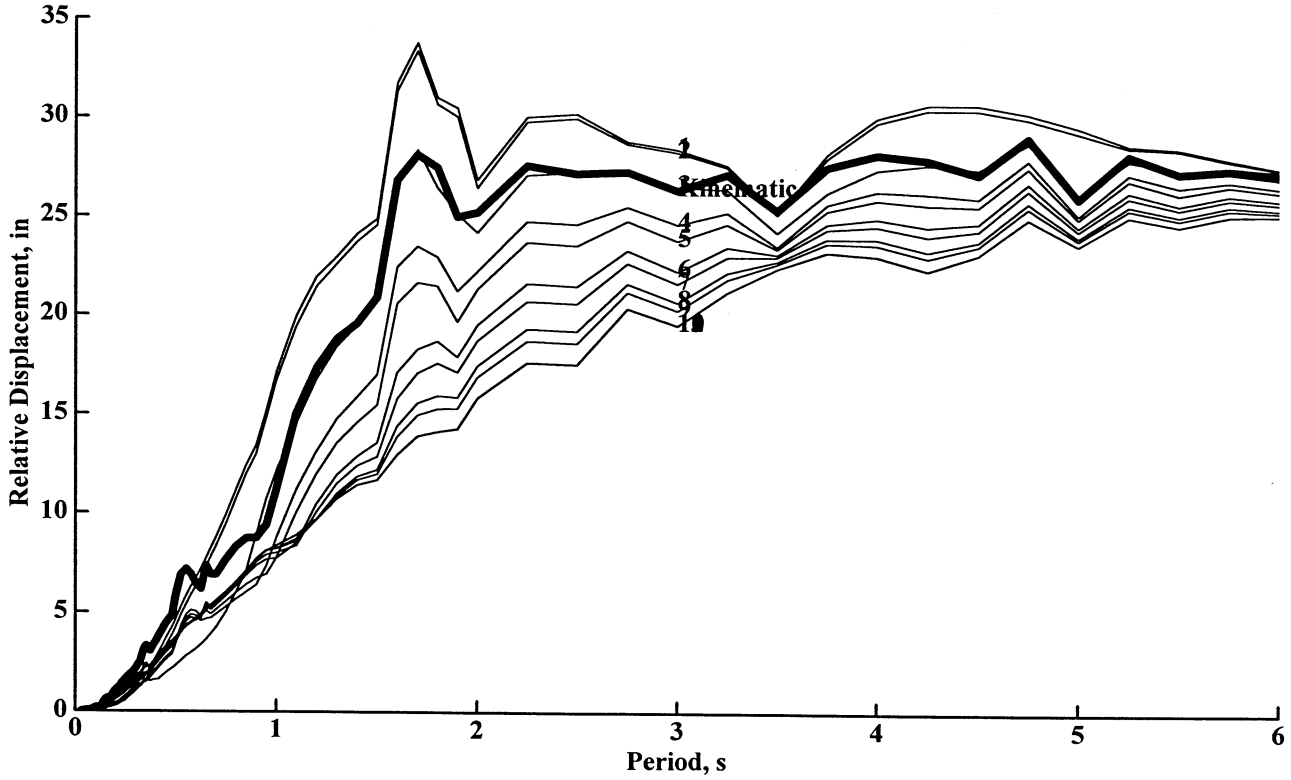




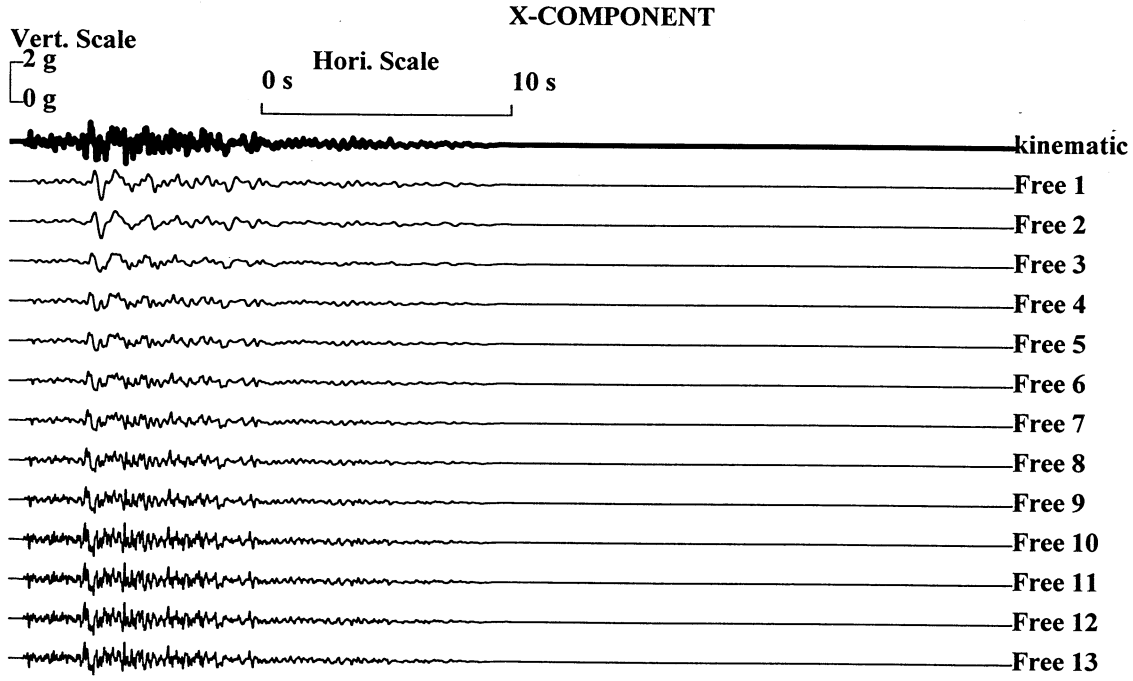
PIER 11
SET 3, Tran. Dir.
BENICIA-MARTINEZ

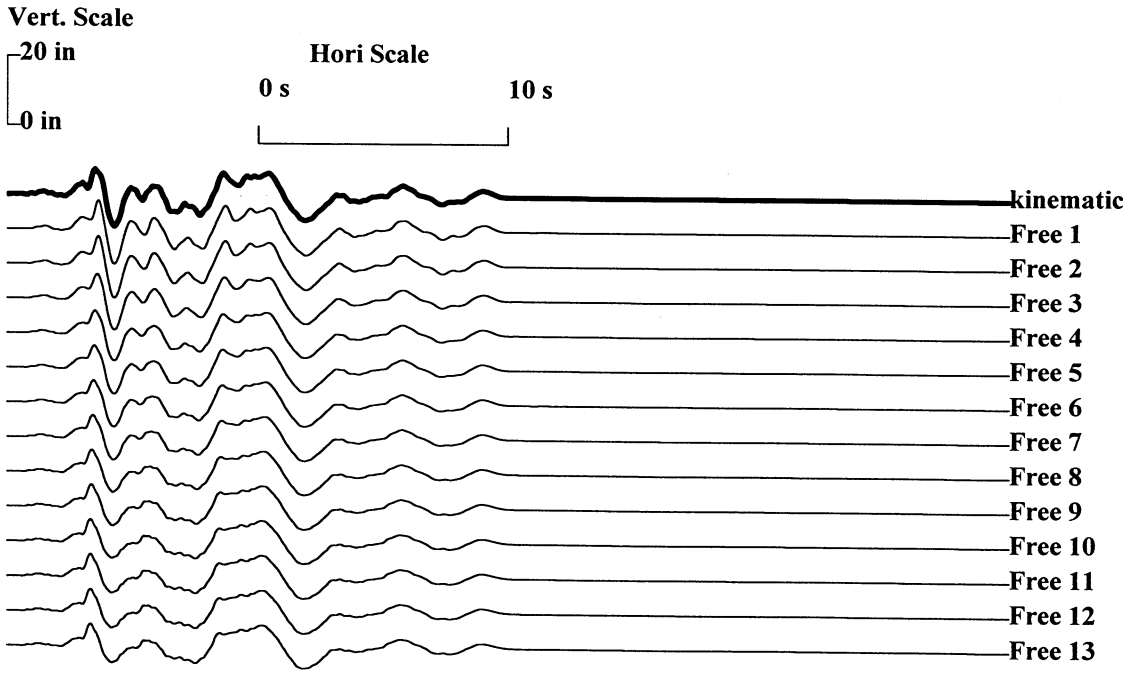
Y-COMPONENT





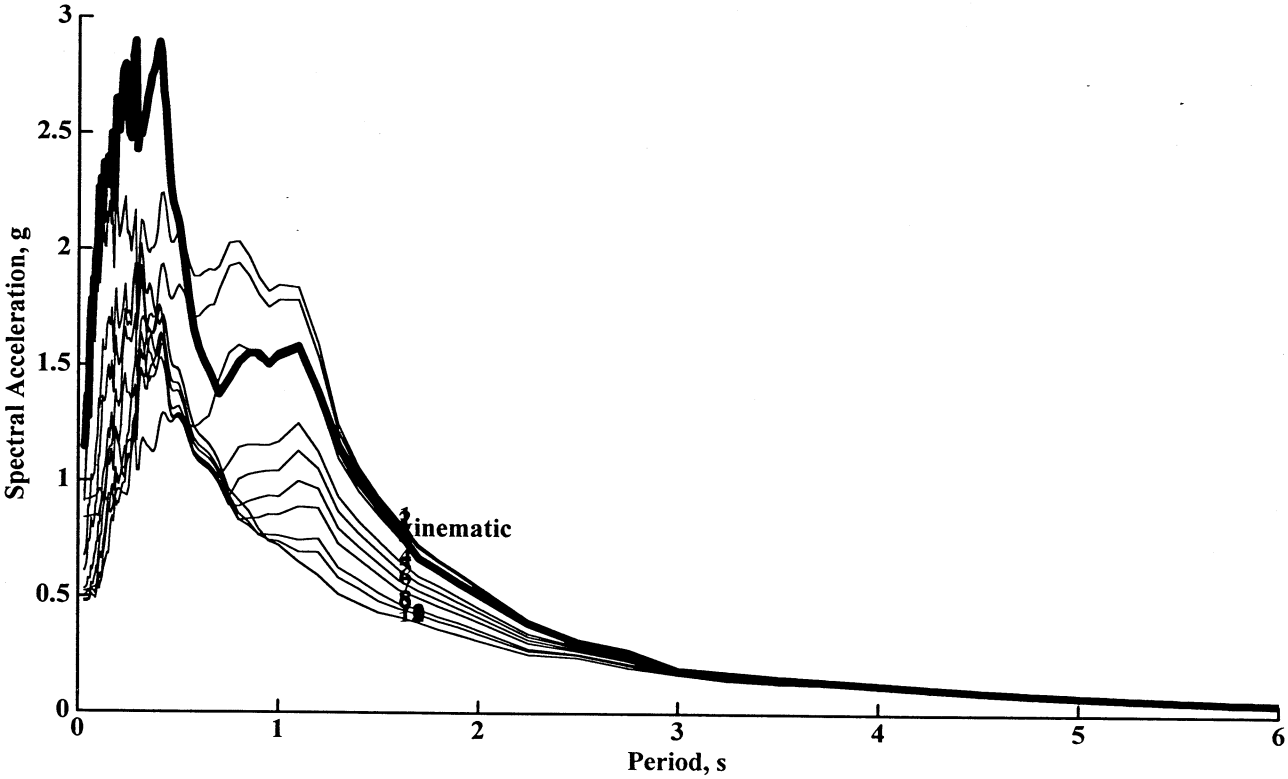
PIER 11
SET 3, Tran. Dir.
BENICIA-MARTINEZ

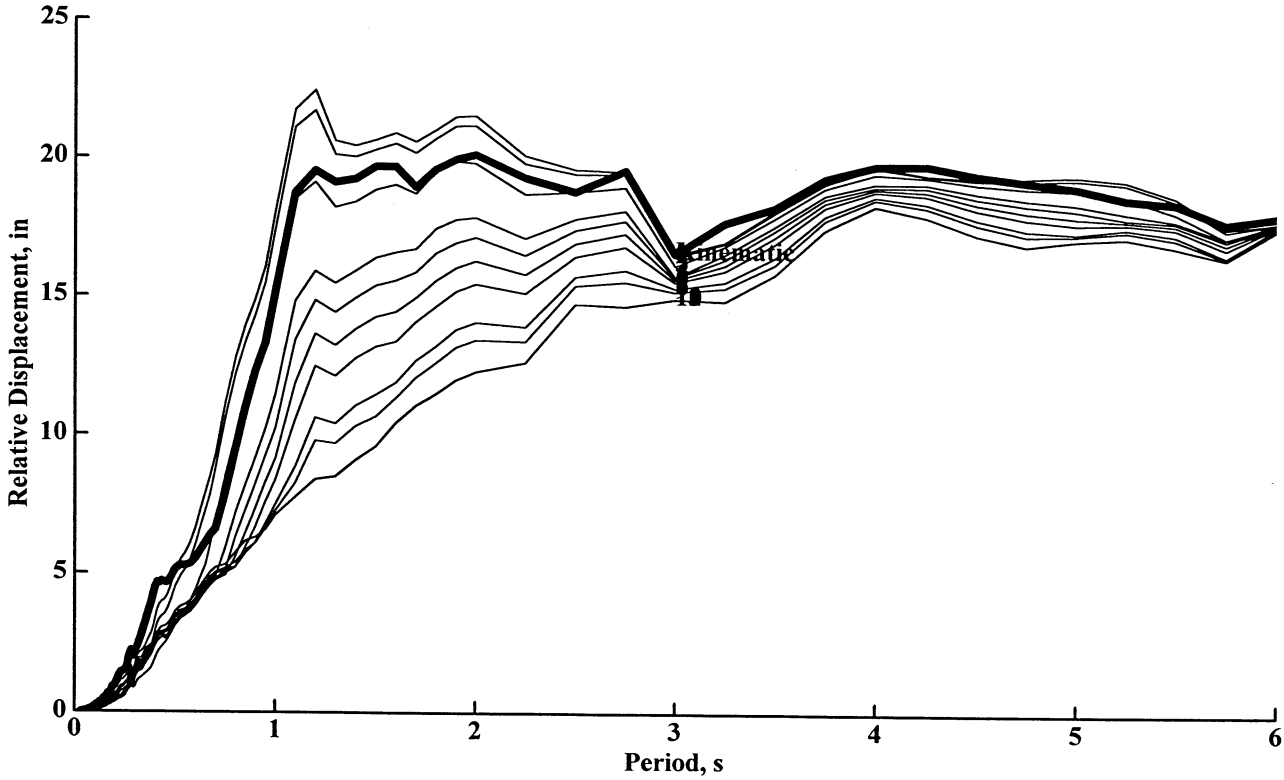




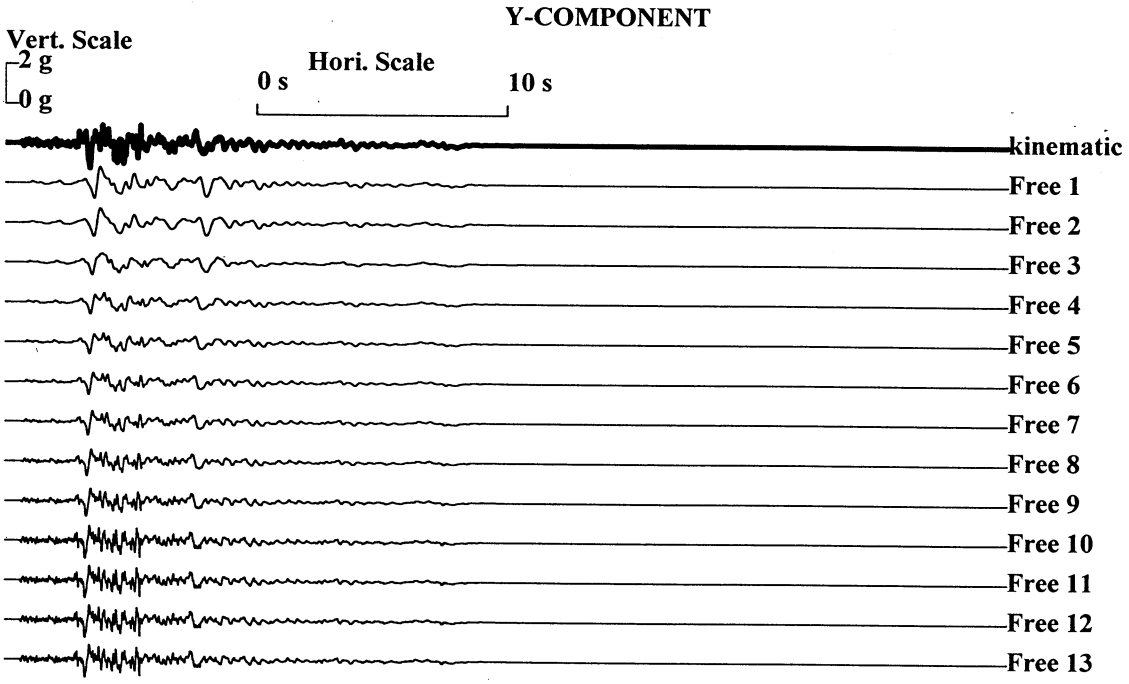
PIER 12
SET 3, Long. Dir.
BENICIA-MARTINEZ

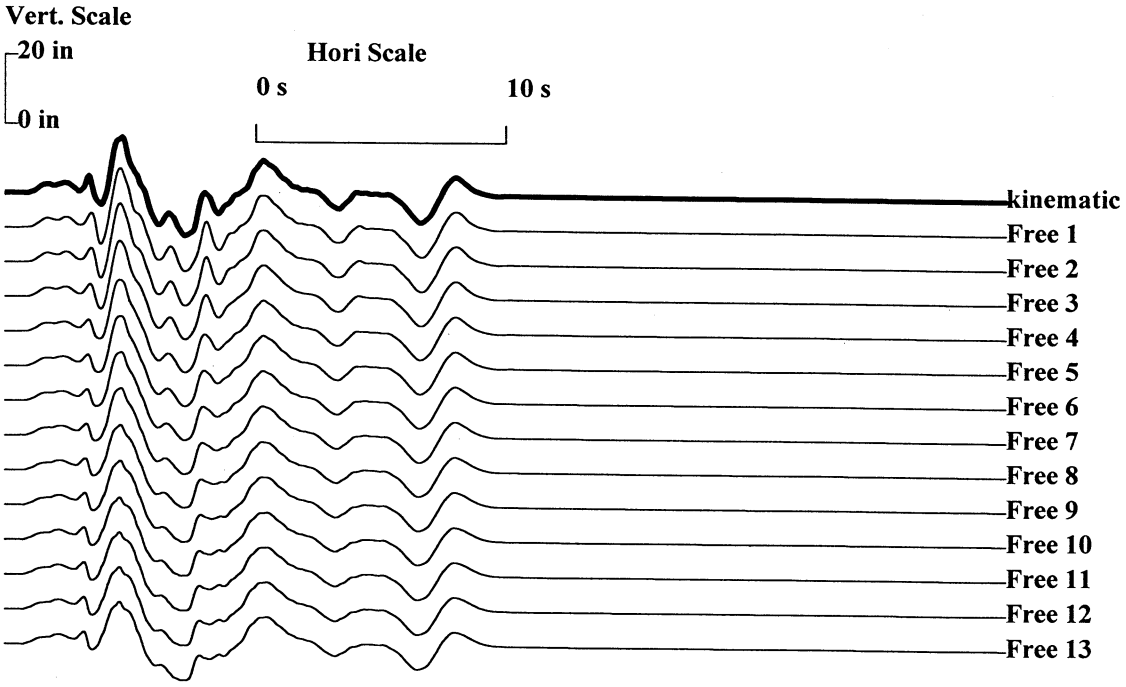
X-COMPONENT





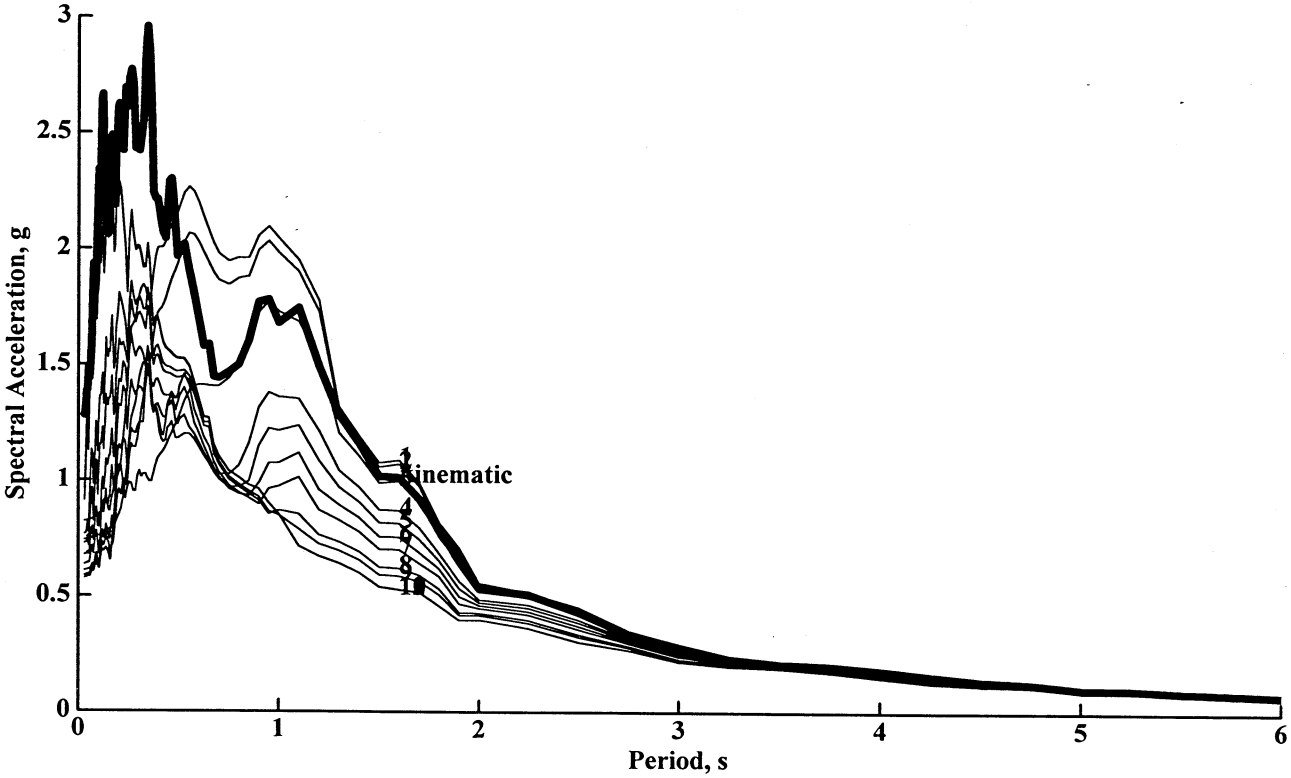
PIER 12
SET 3, Long. Dir.
BENICIA-MARTINEZ

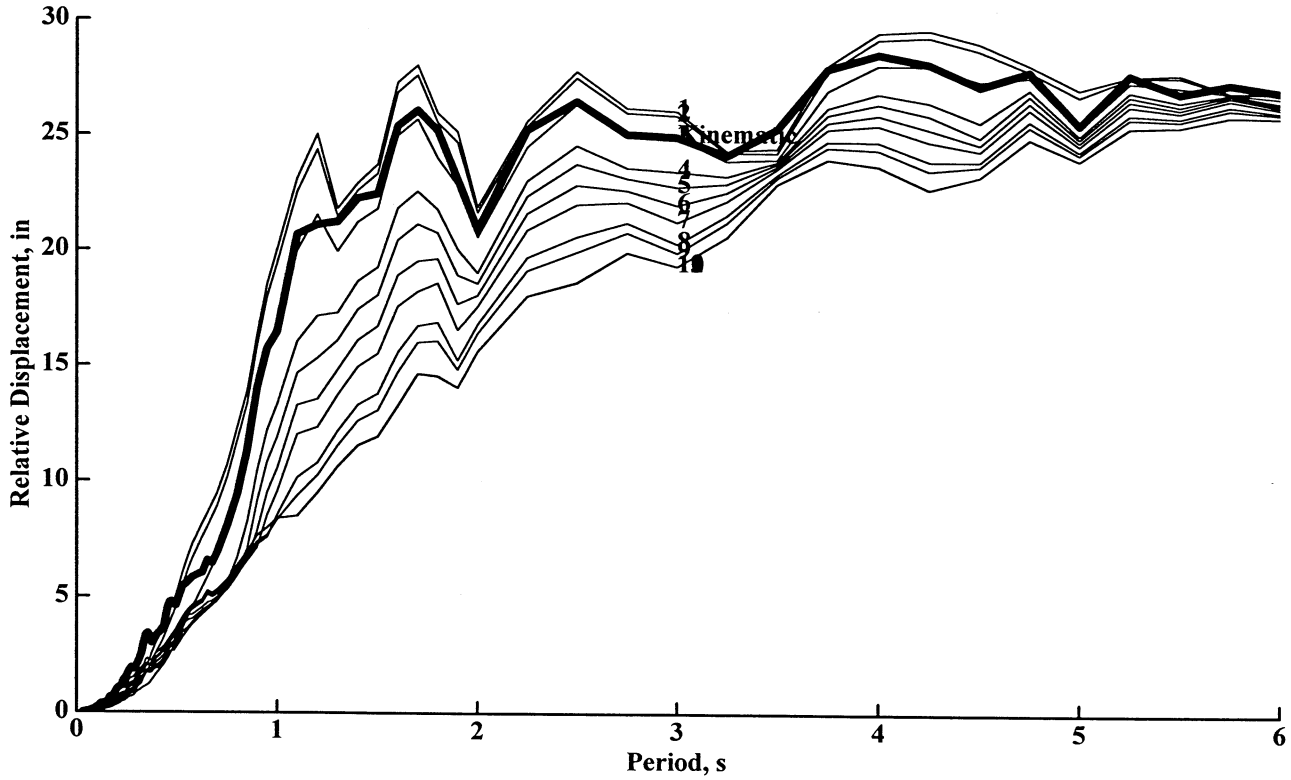




PIER 12
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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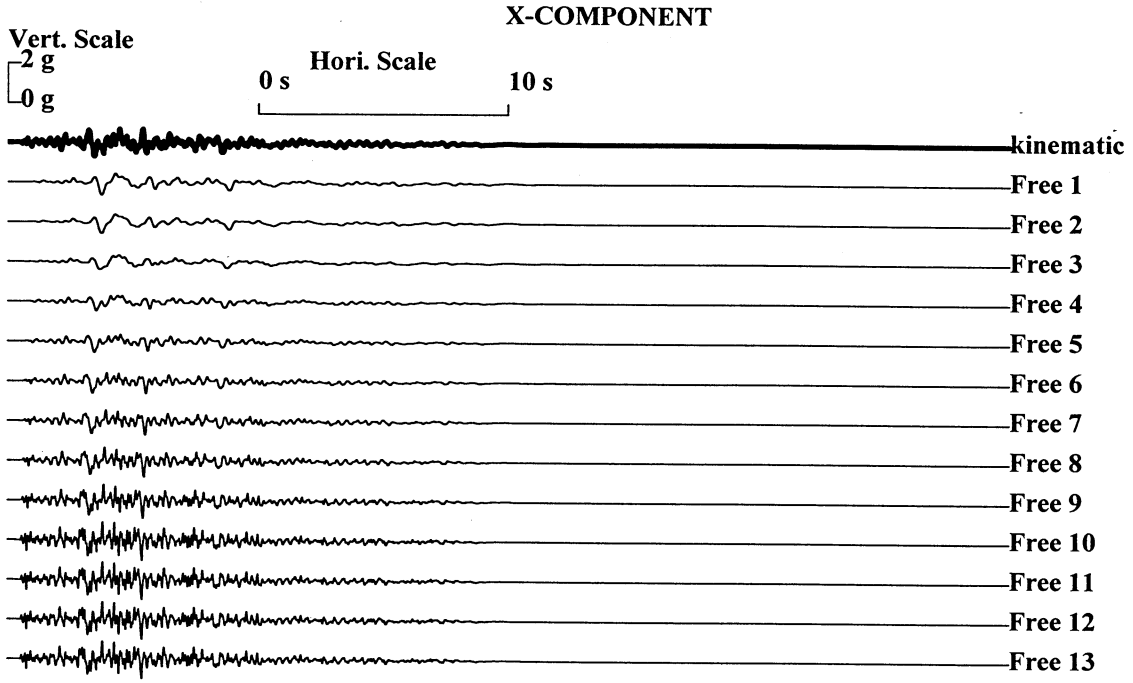
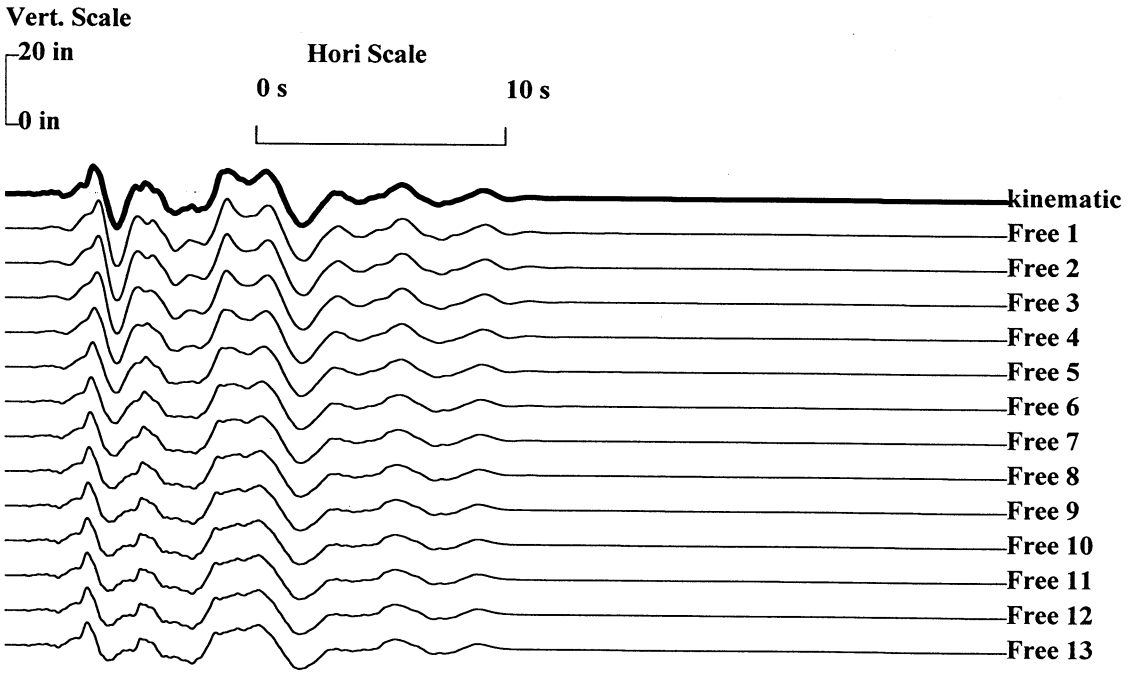
BENICIA-MARTINEZ





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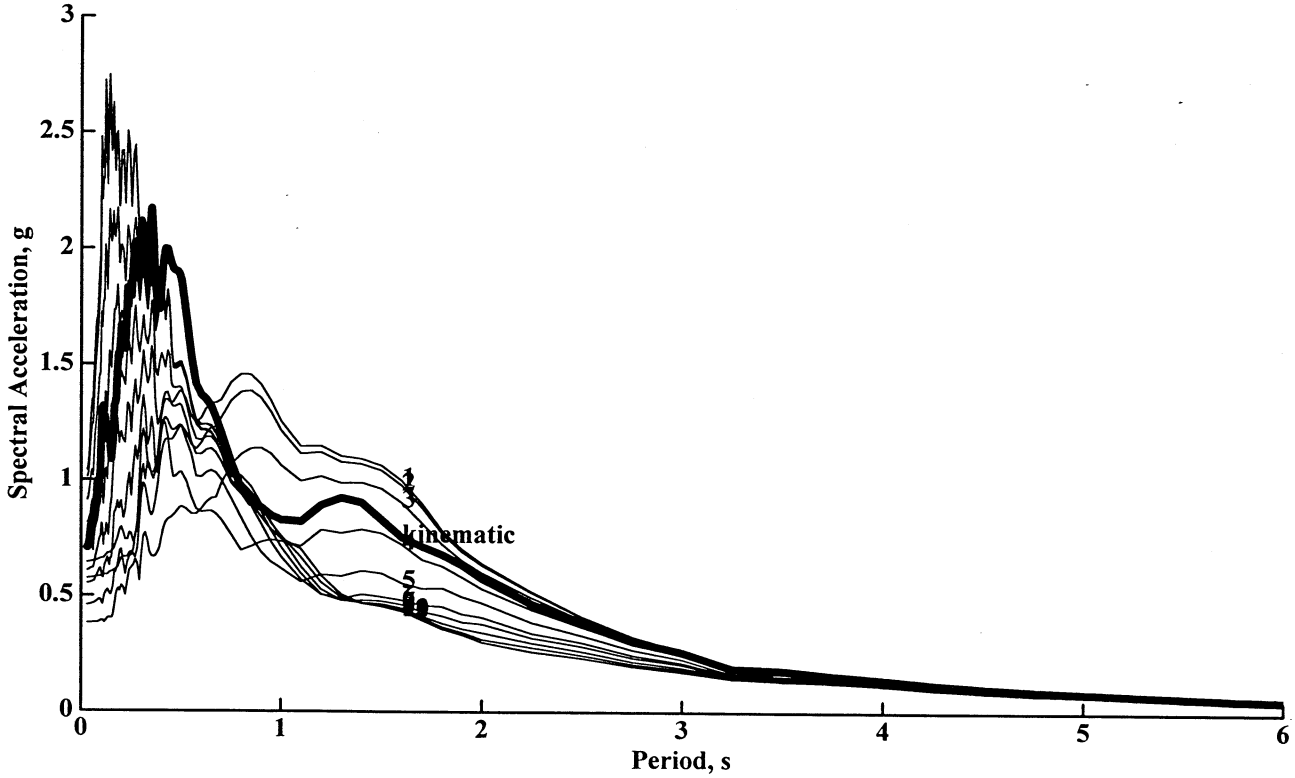
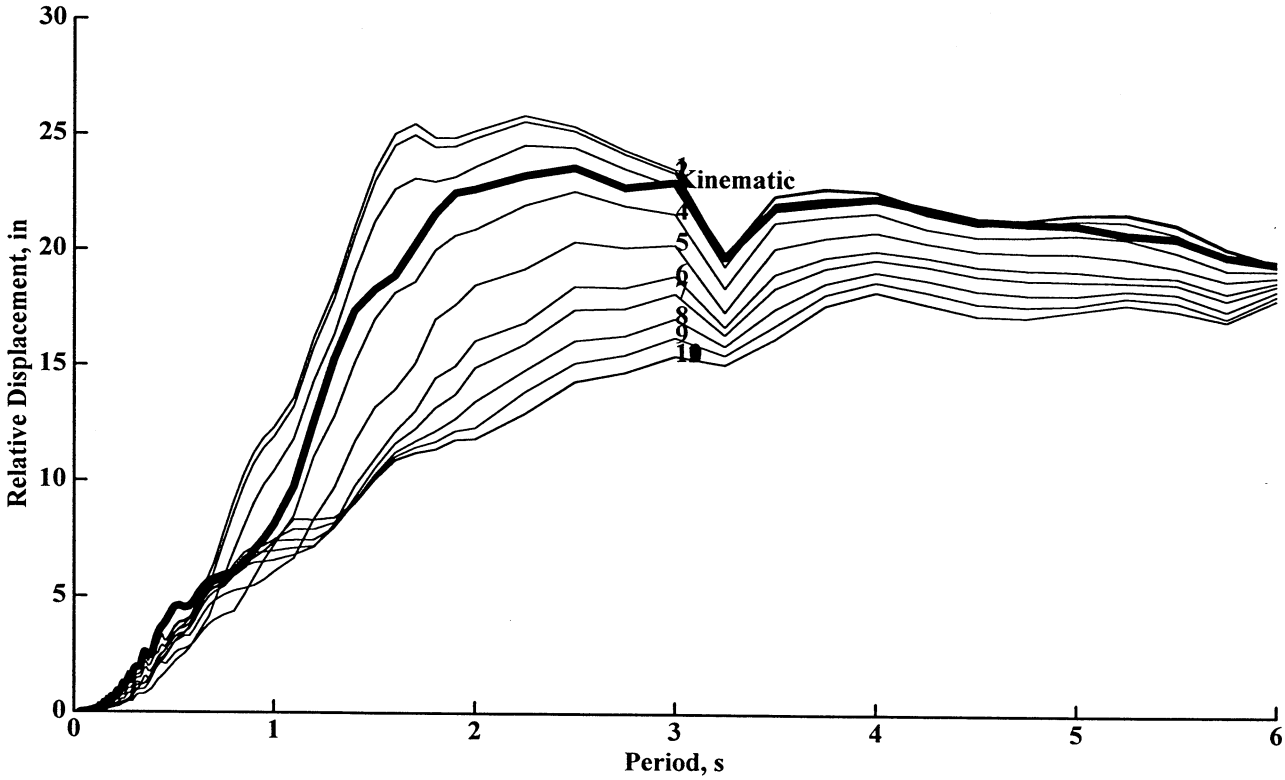
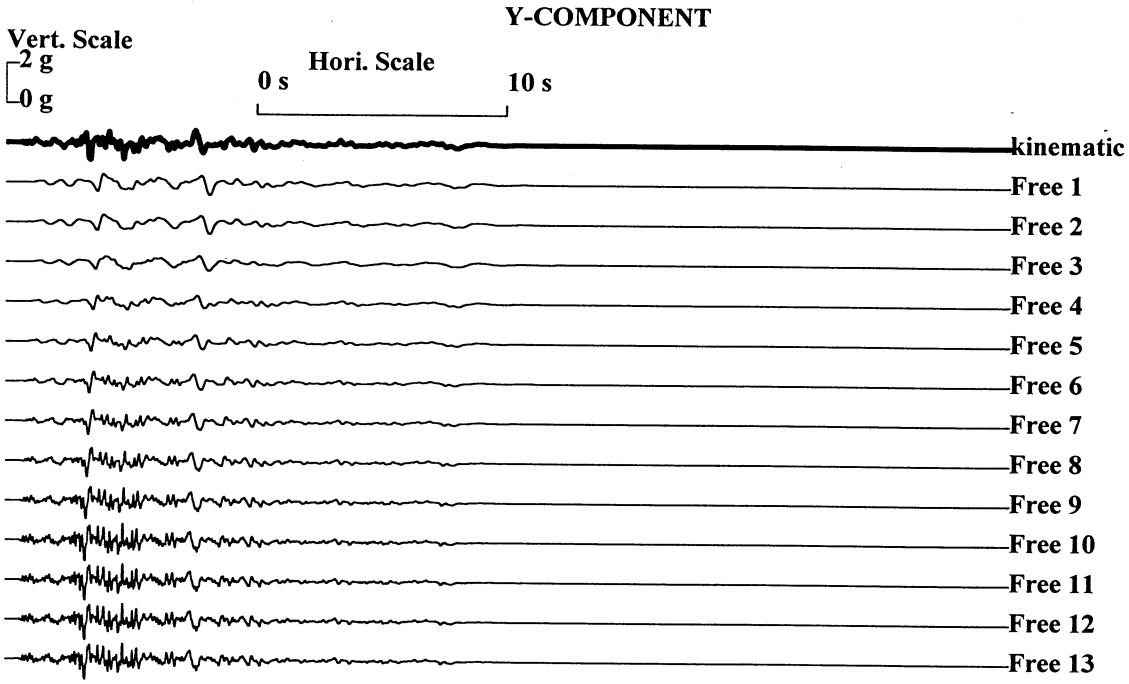
SET 3, Long. Dir.
BENICIA-MARTINEZ

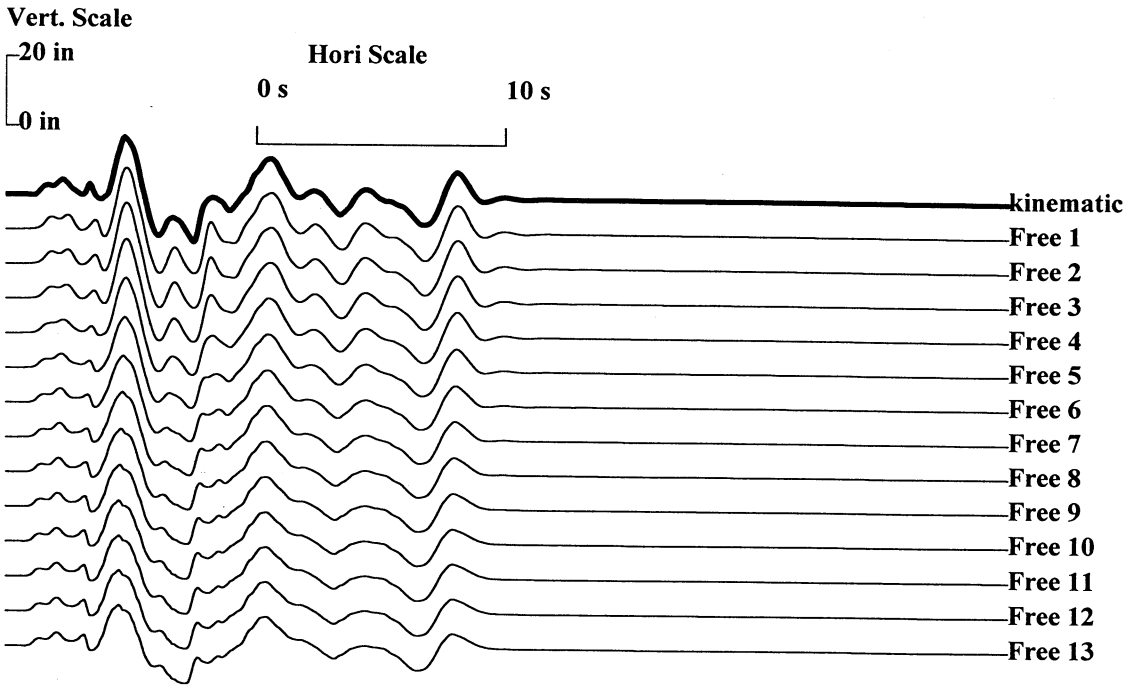
X-COMPONENT



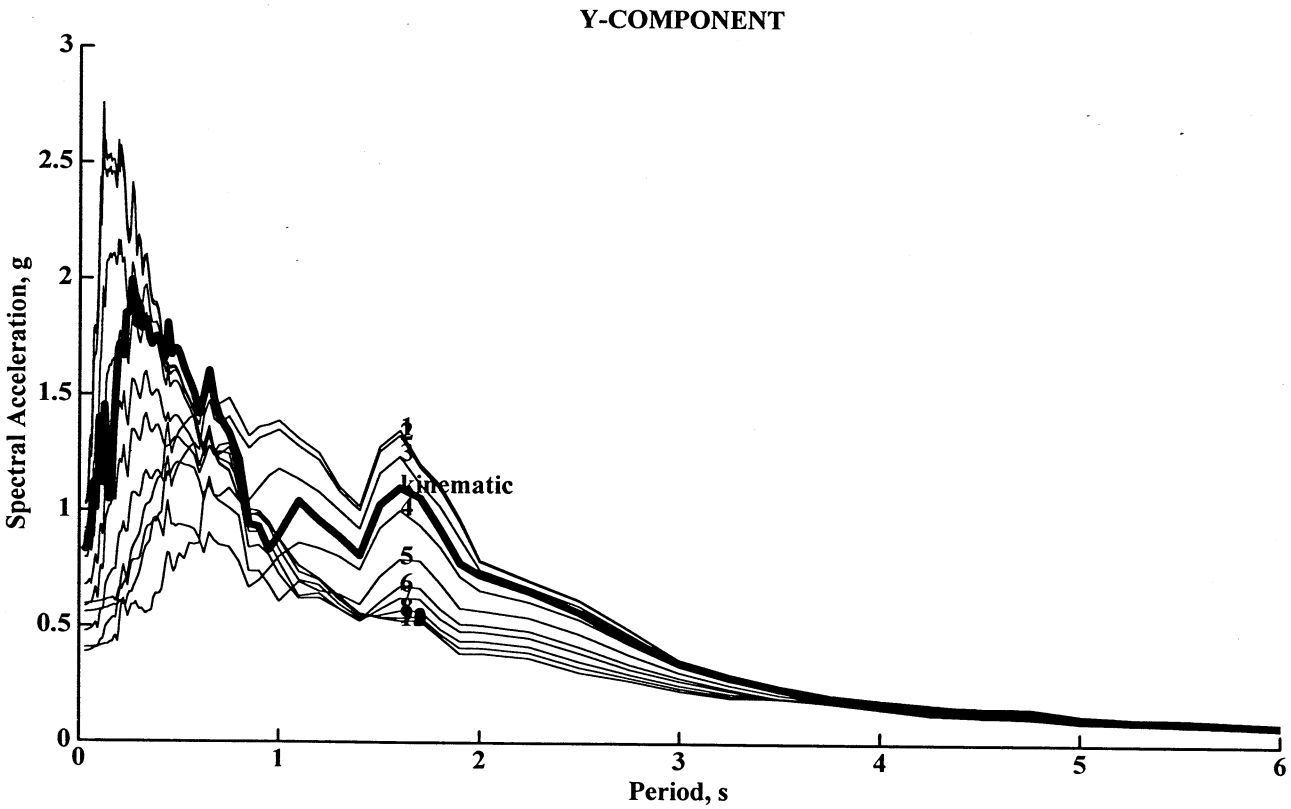


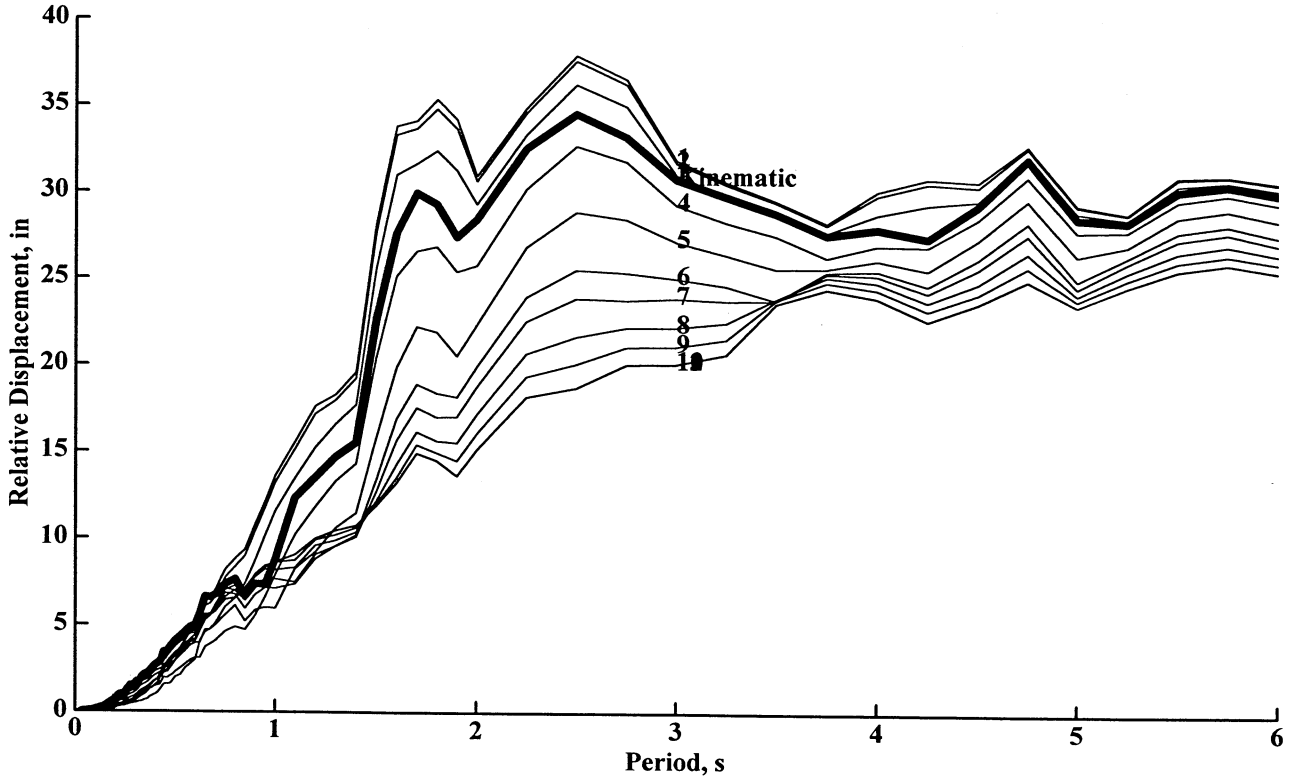
PIER 13
SET 3, Long. Dir.
BENICIA-MARTINEZ



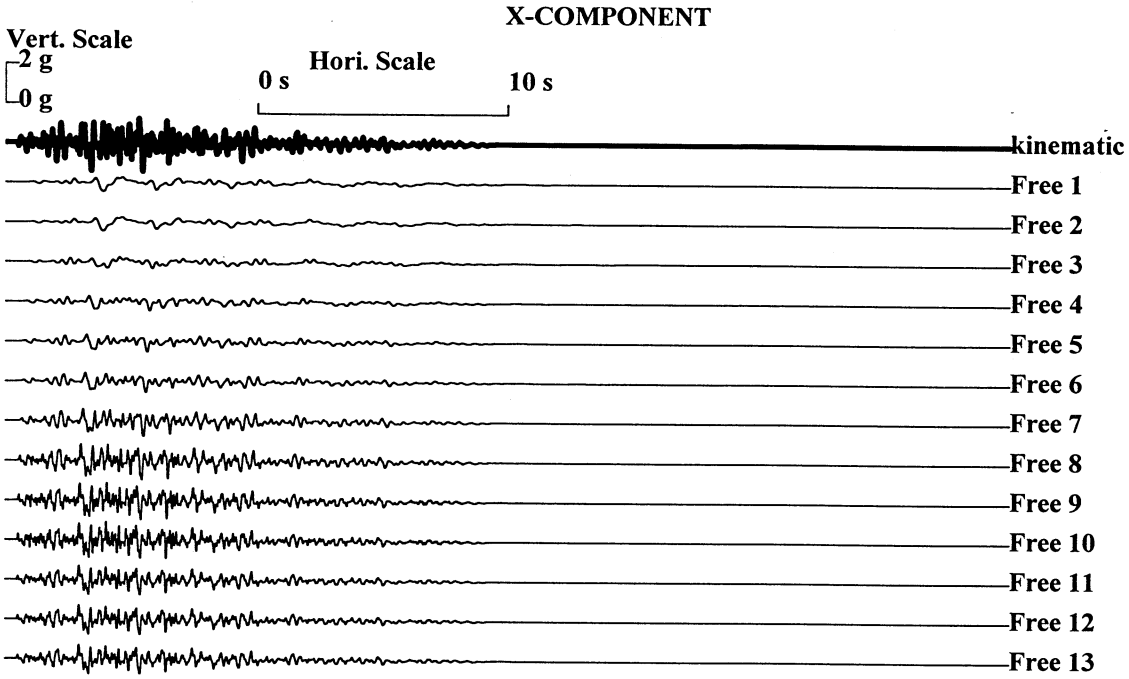


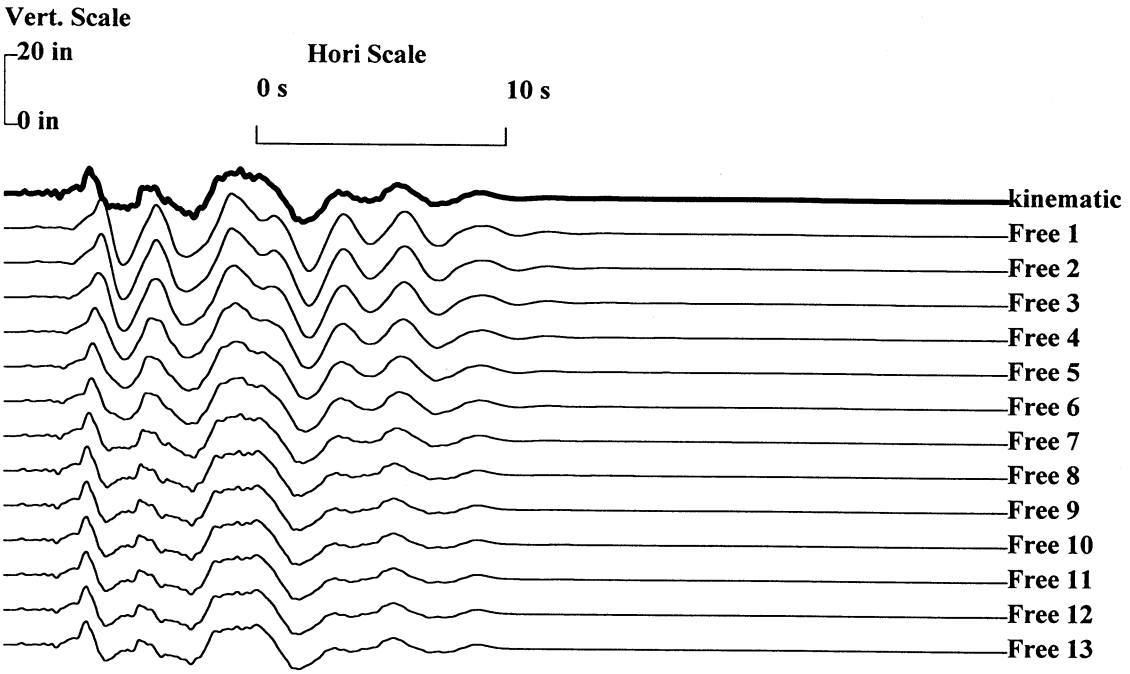
PIER 13
SET 3, Tran. Dir.
BENICIA-MARTINEZ





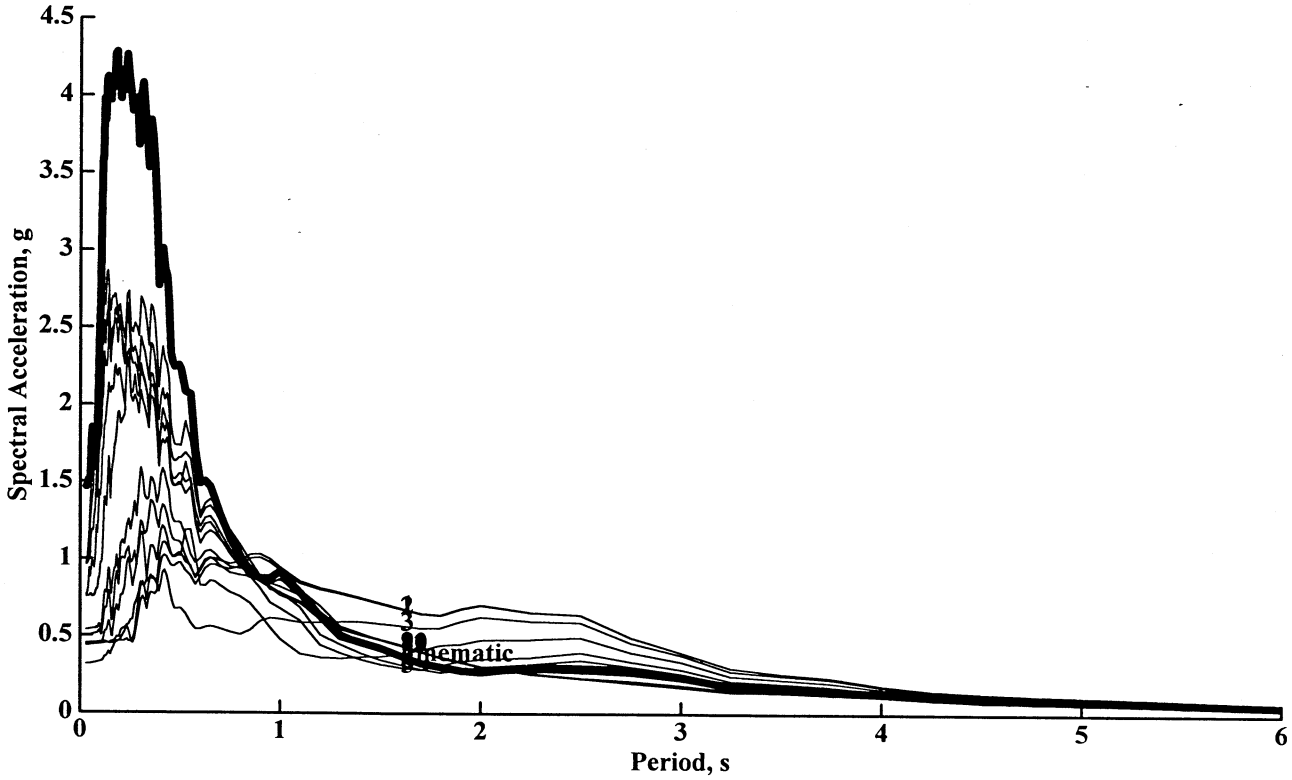
PIER 13
SET 3, Tran. Dir.
BENICIA-MARTINEZ

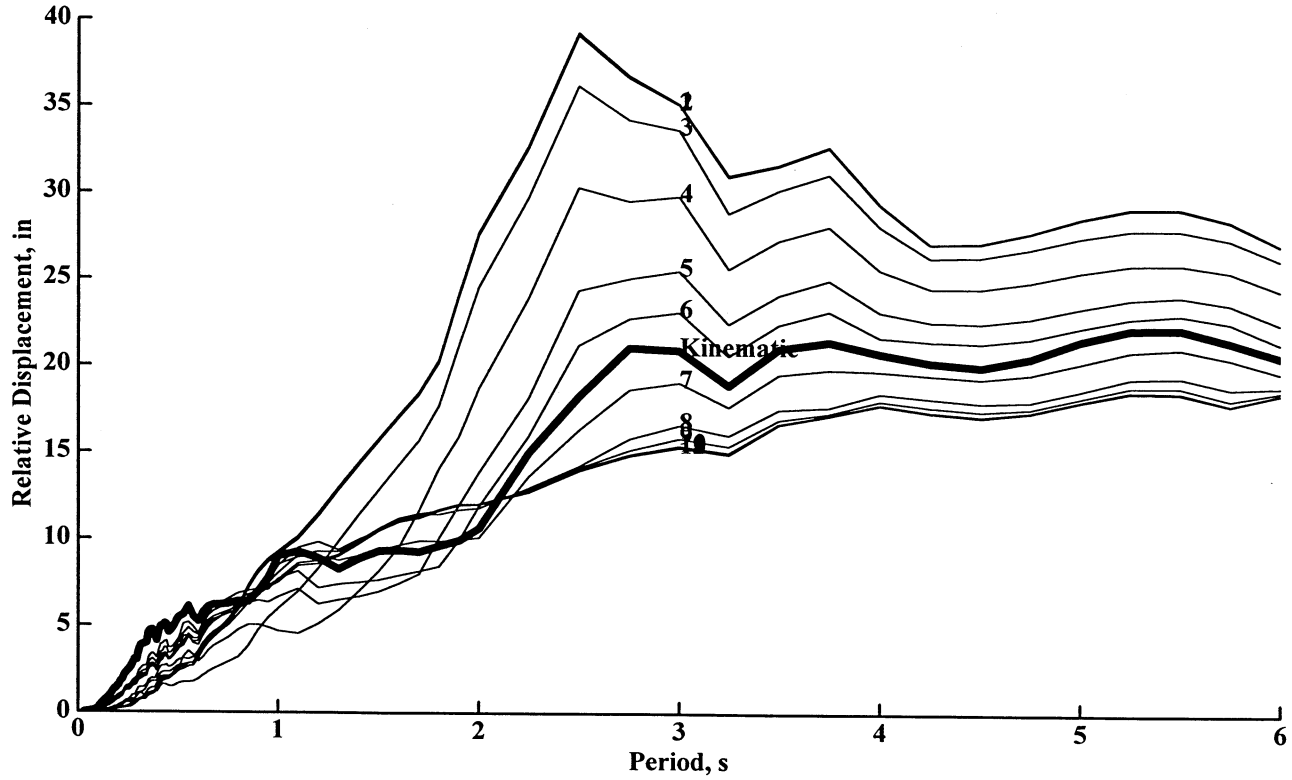




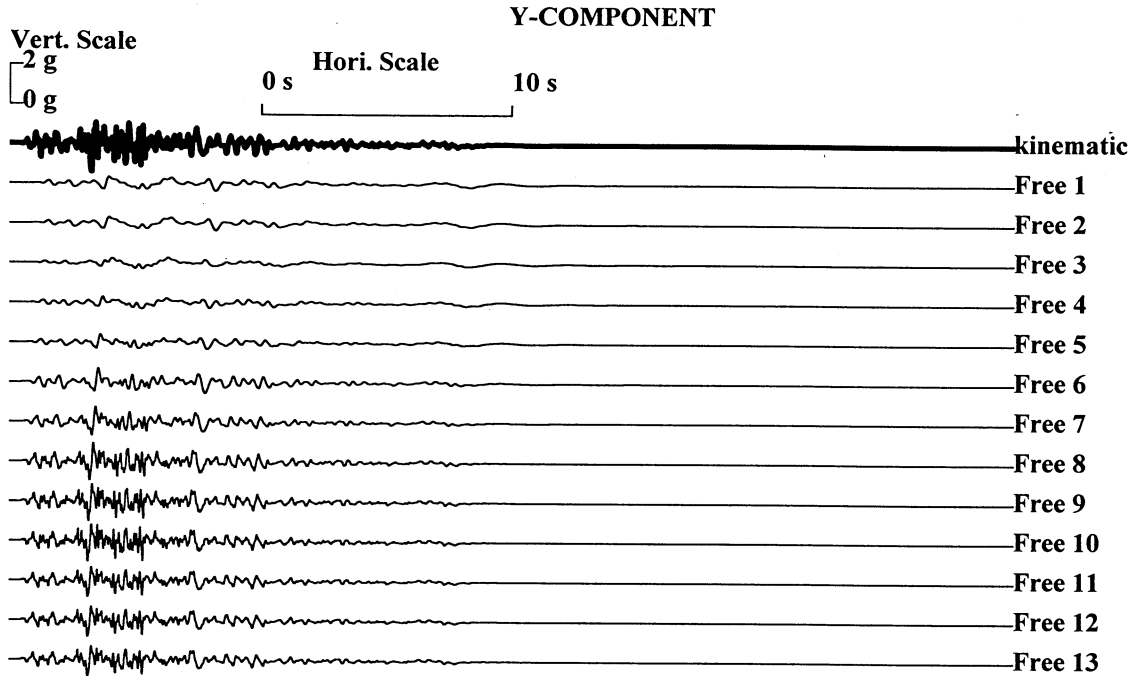
PIER 14
SET 3, Long. Dir.
BENICIA-MARTINEZ

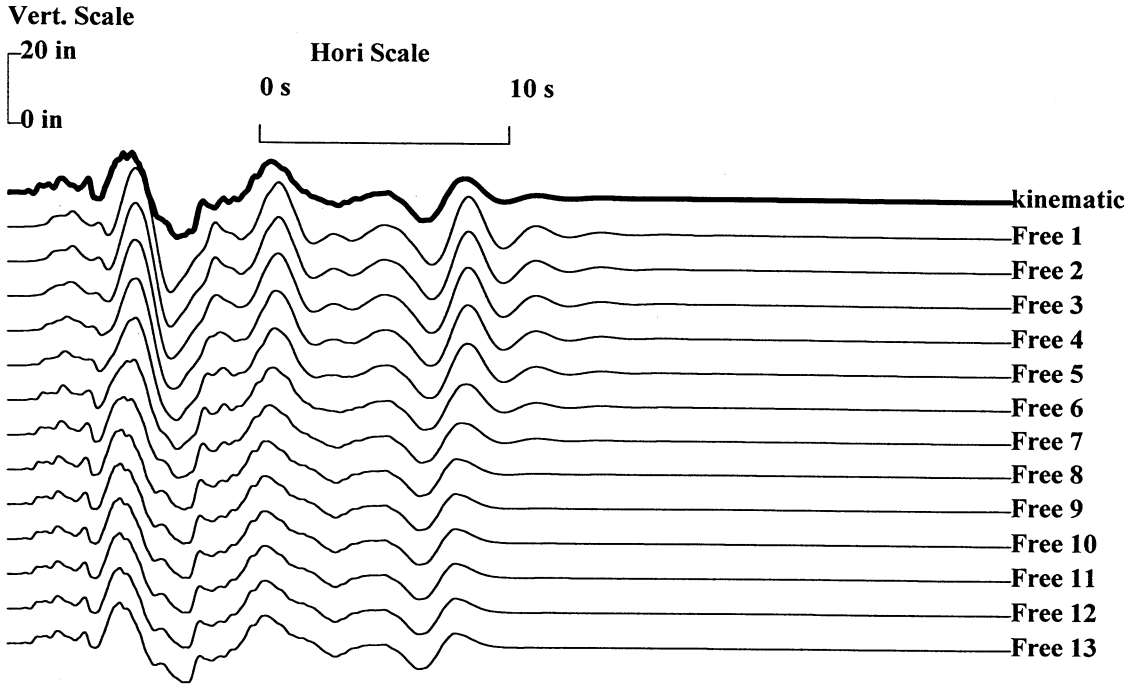
X-COMPONENT





PIER 14
SET 3, Long. Dir.
BENICIA-MARTINEZ





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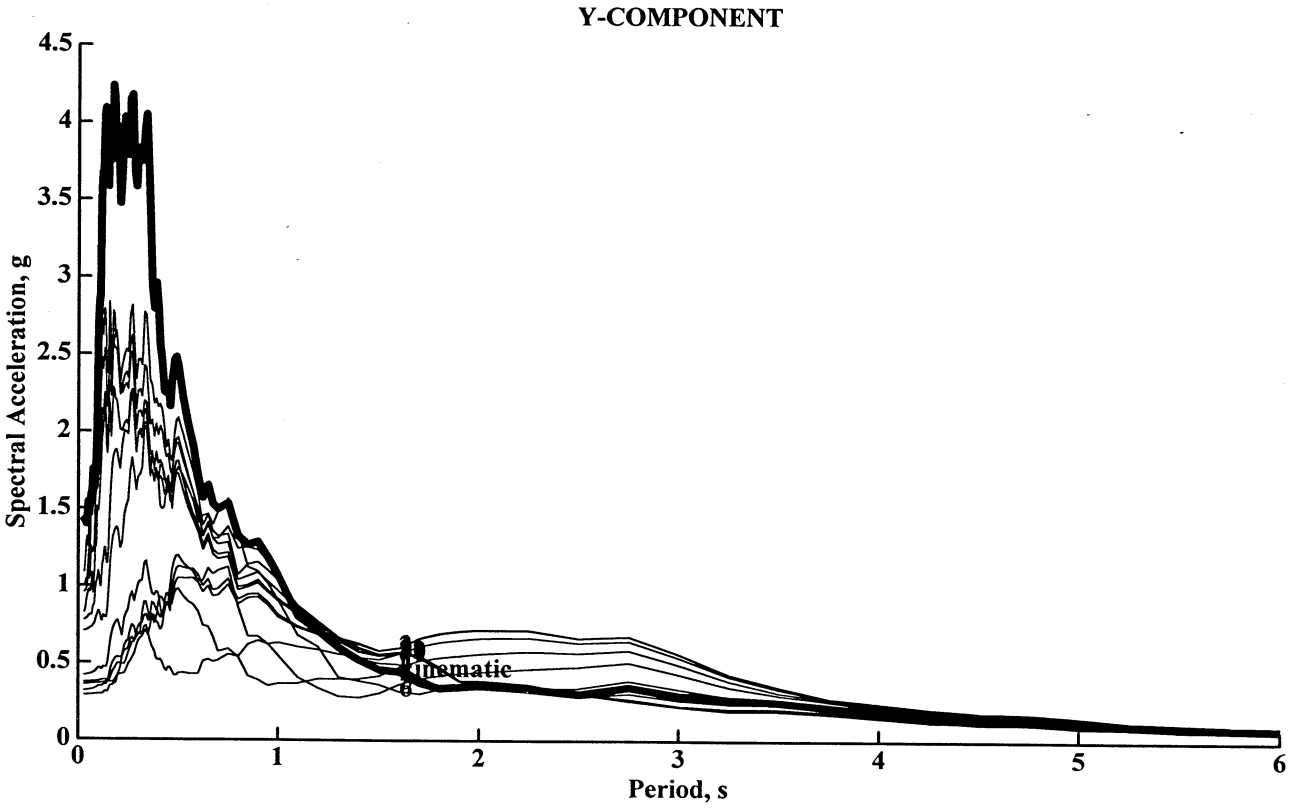
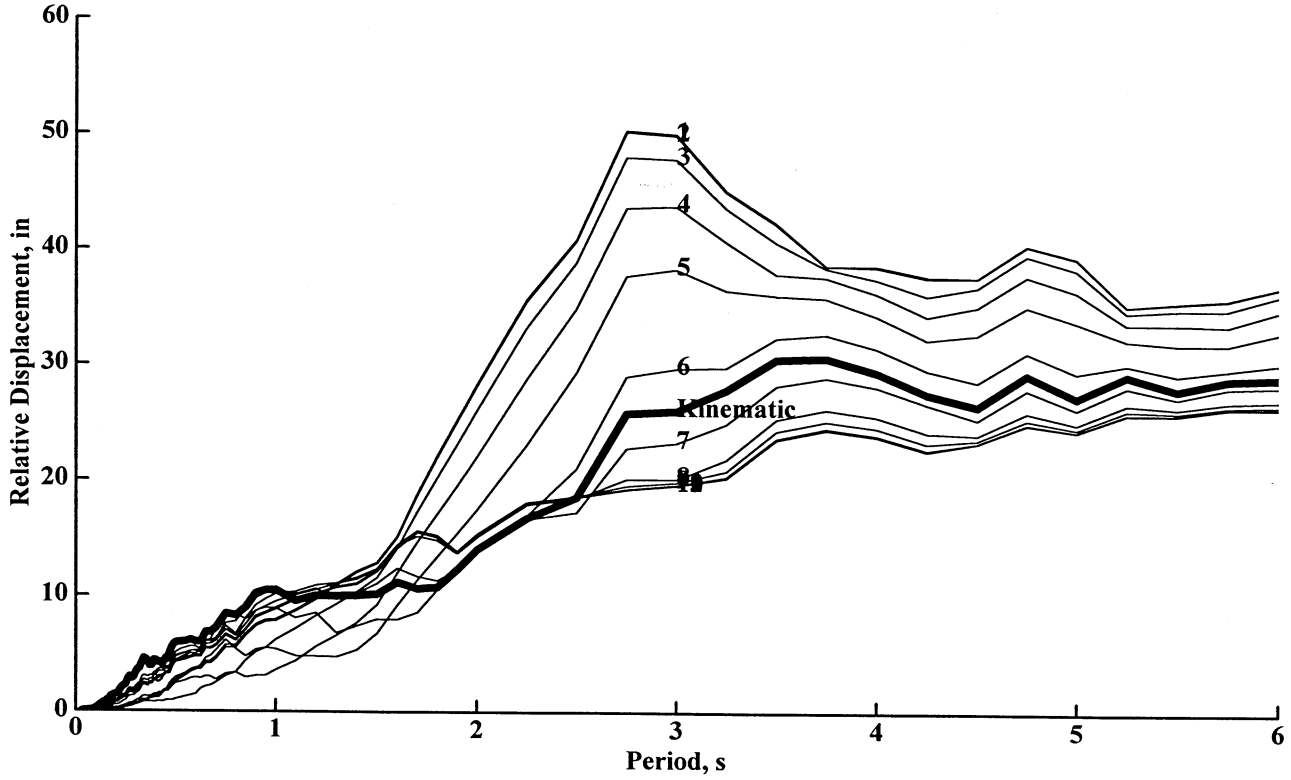
SET 3, Tran. Dir.
BENICIA-MARTINEZ





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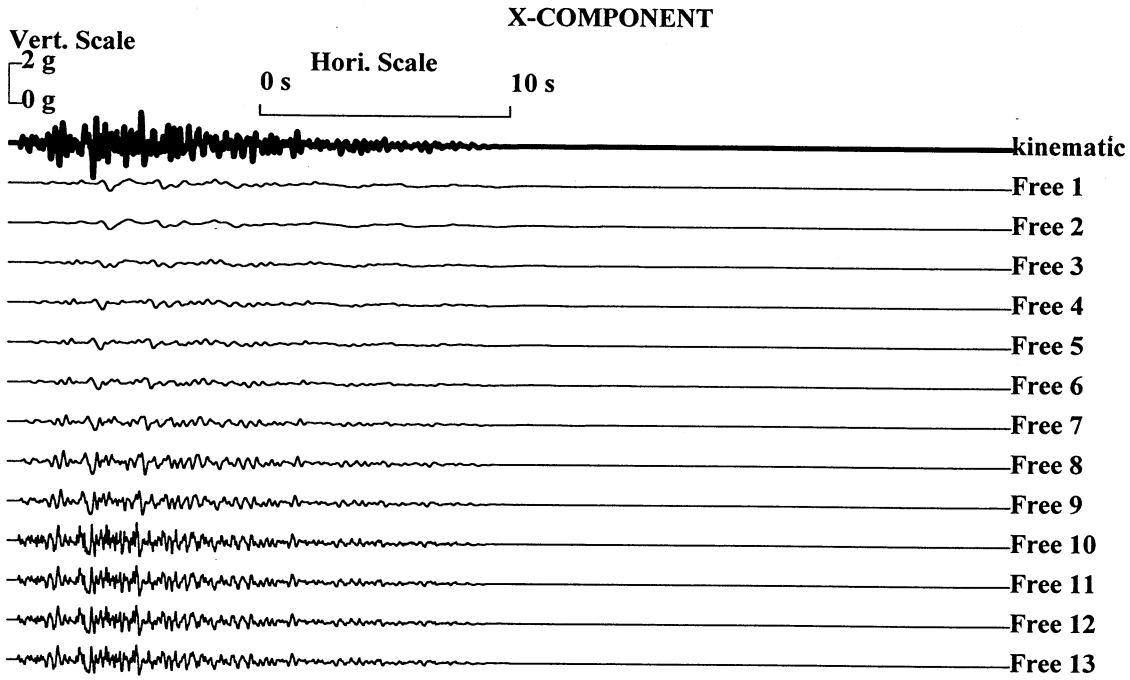
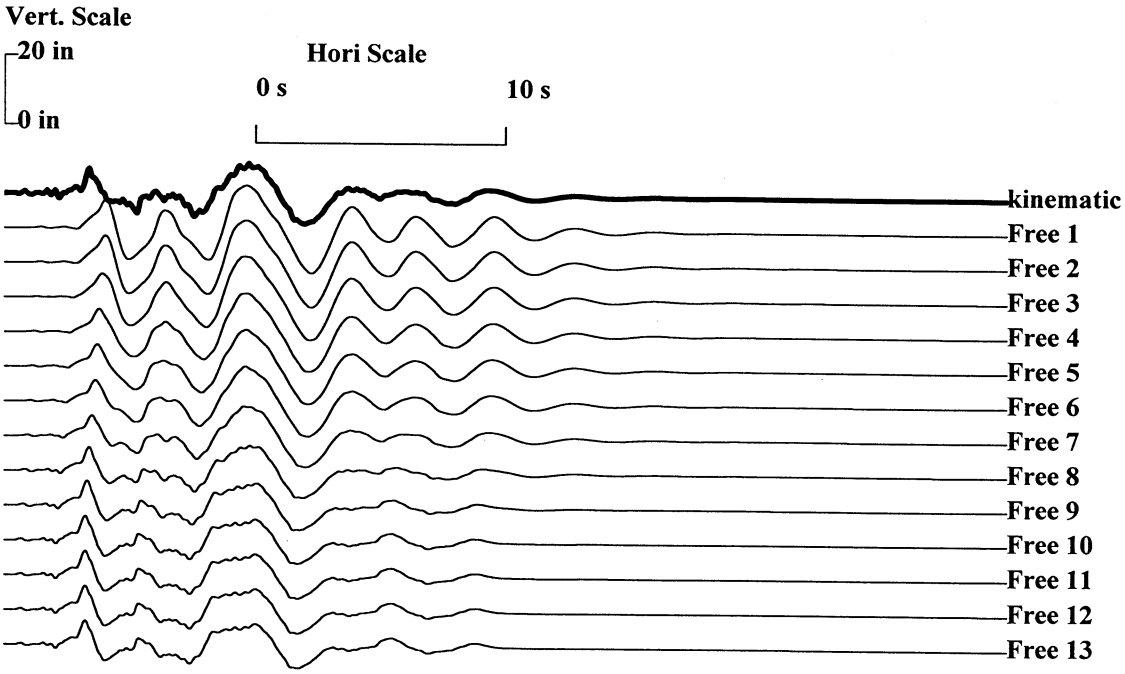
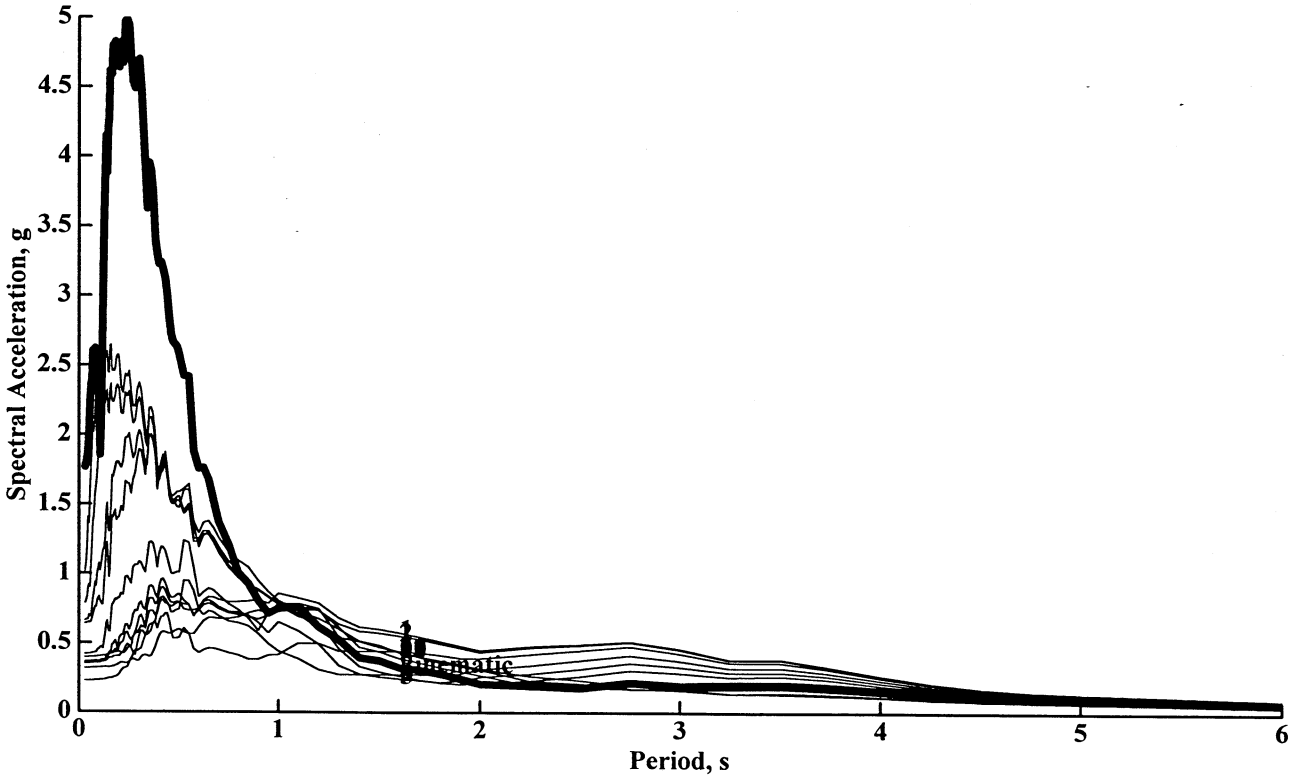
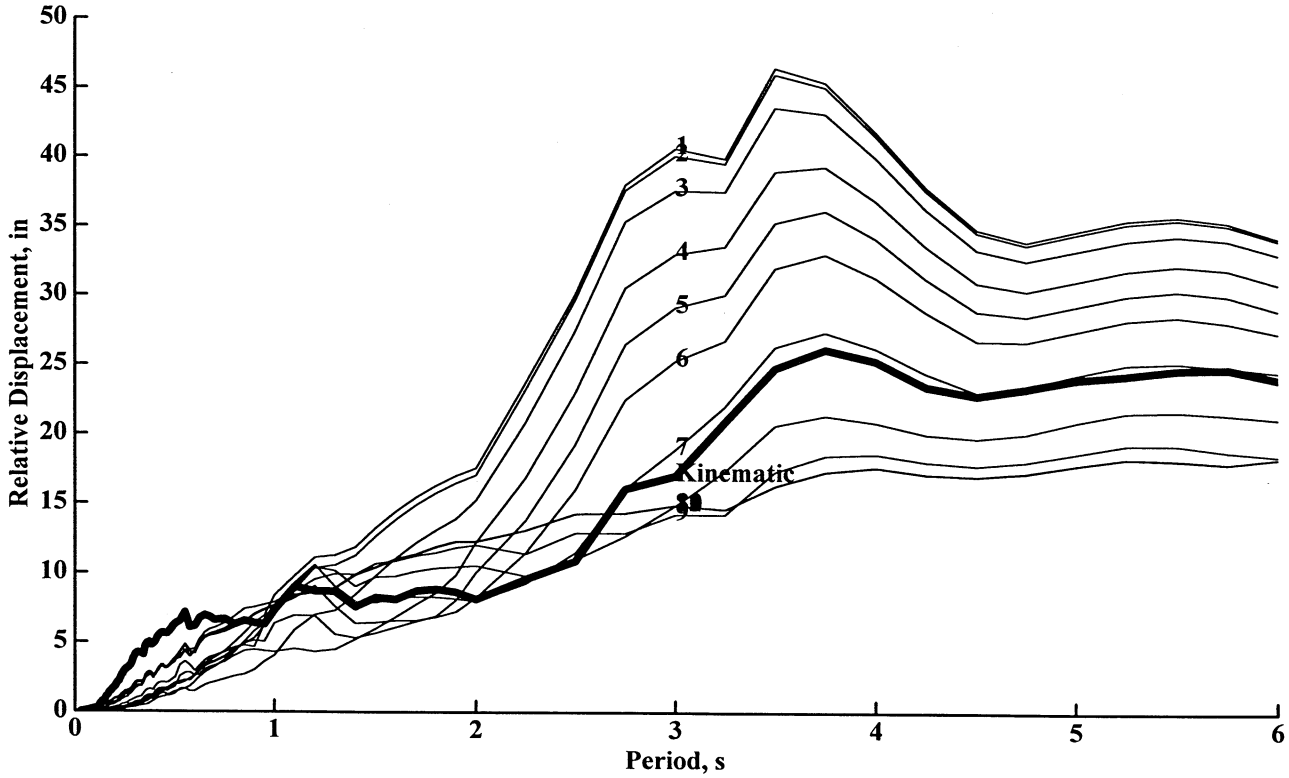




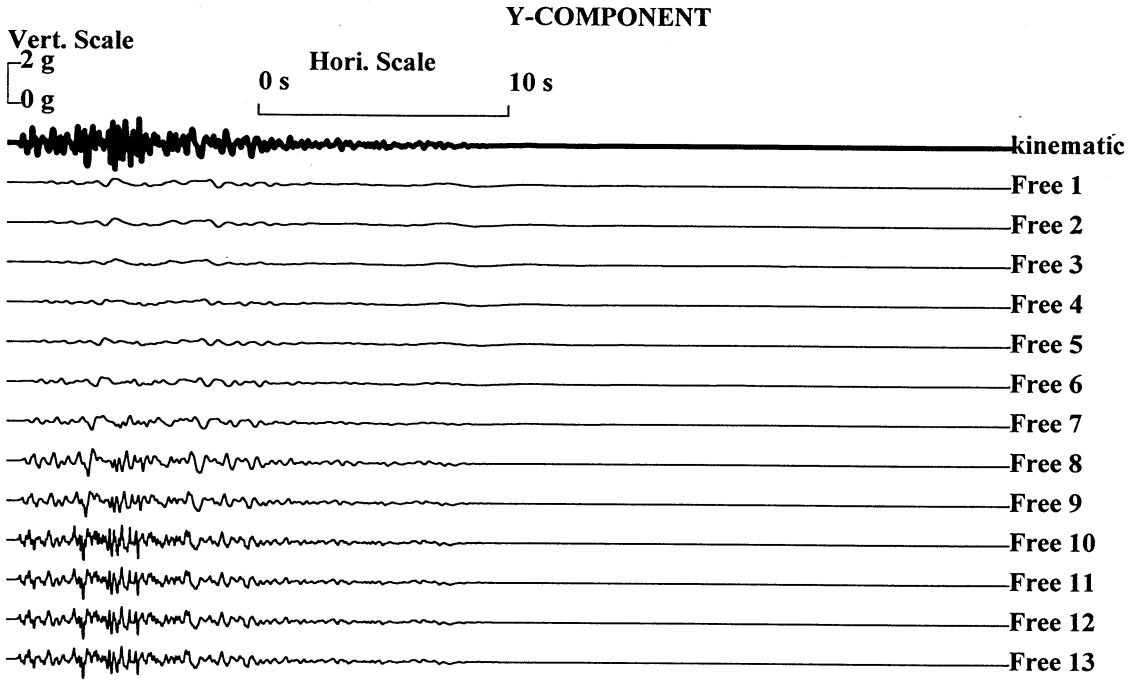
PIER 15
SET 3, Long. Dir.
BENICIA-MARTINEZ

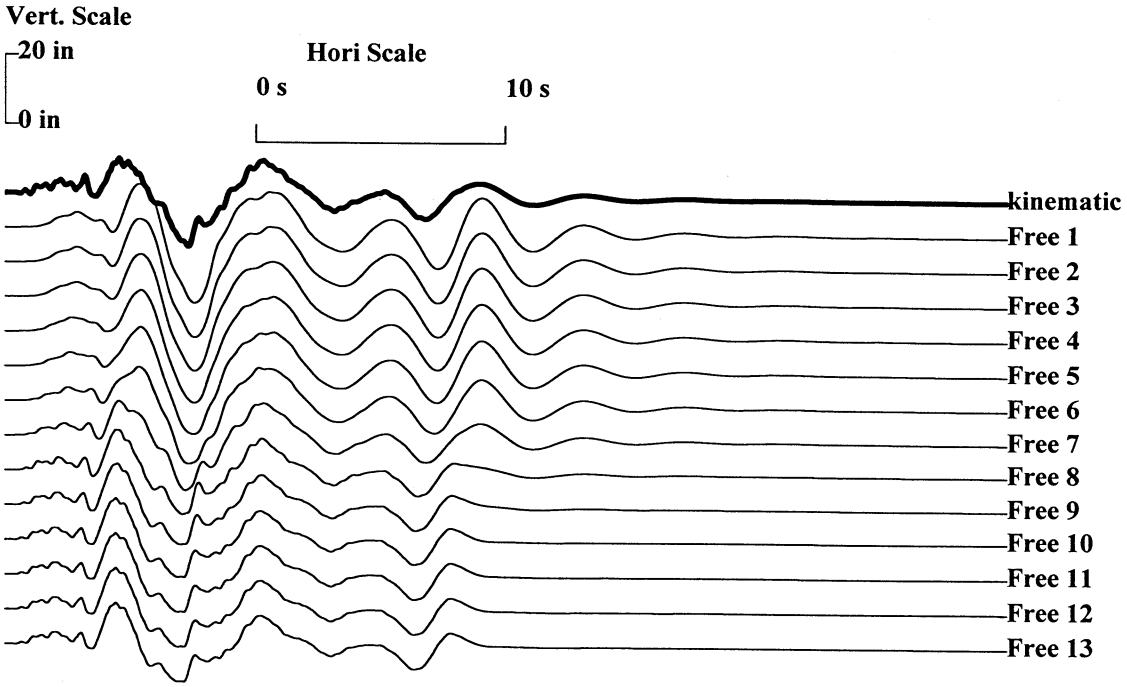
X-COMPONENT





PIER 15
SET 3, Long. Dir.
BENICIA-MARTINEZ





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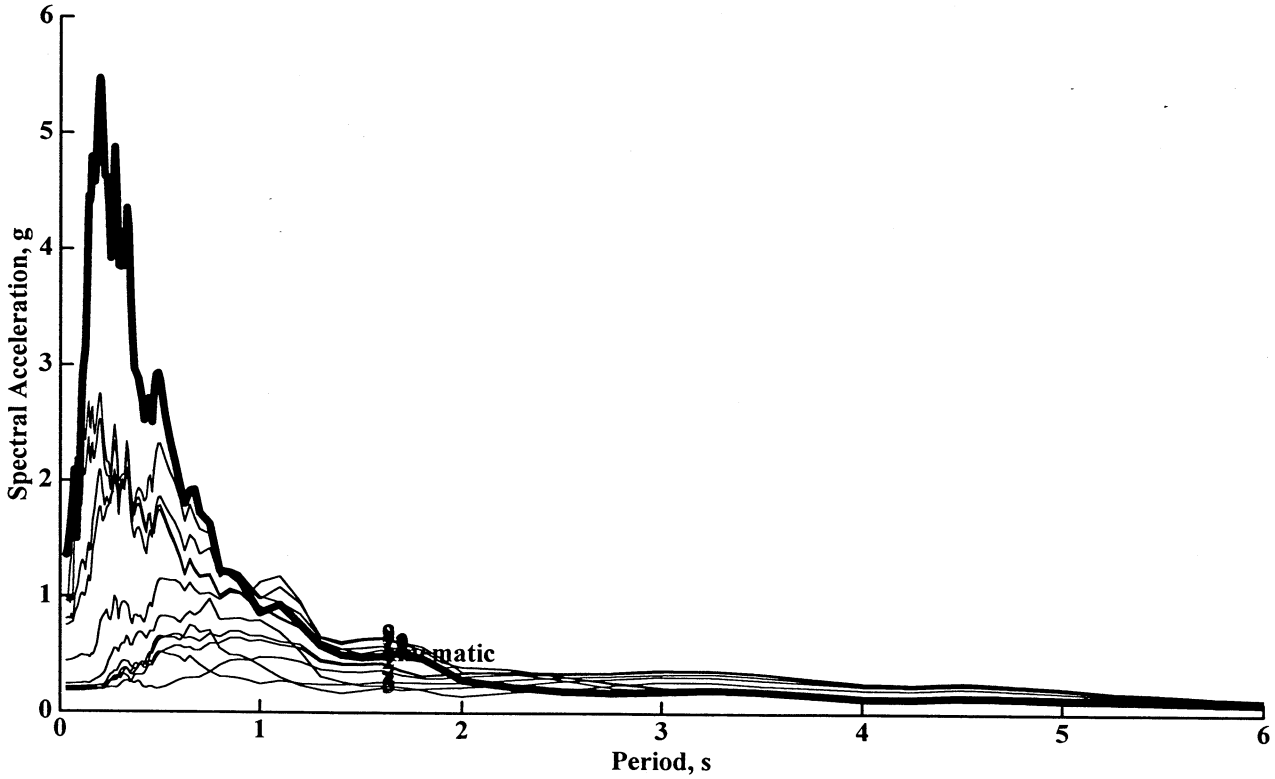
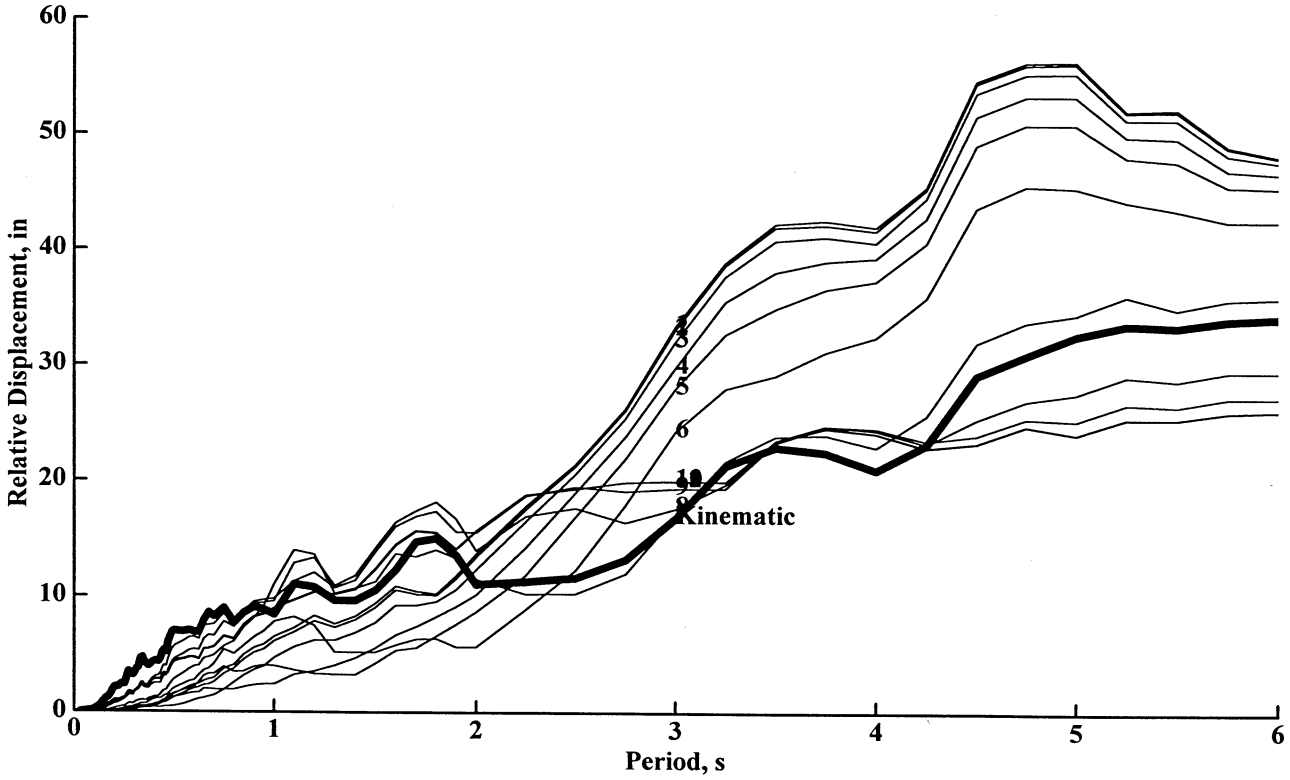
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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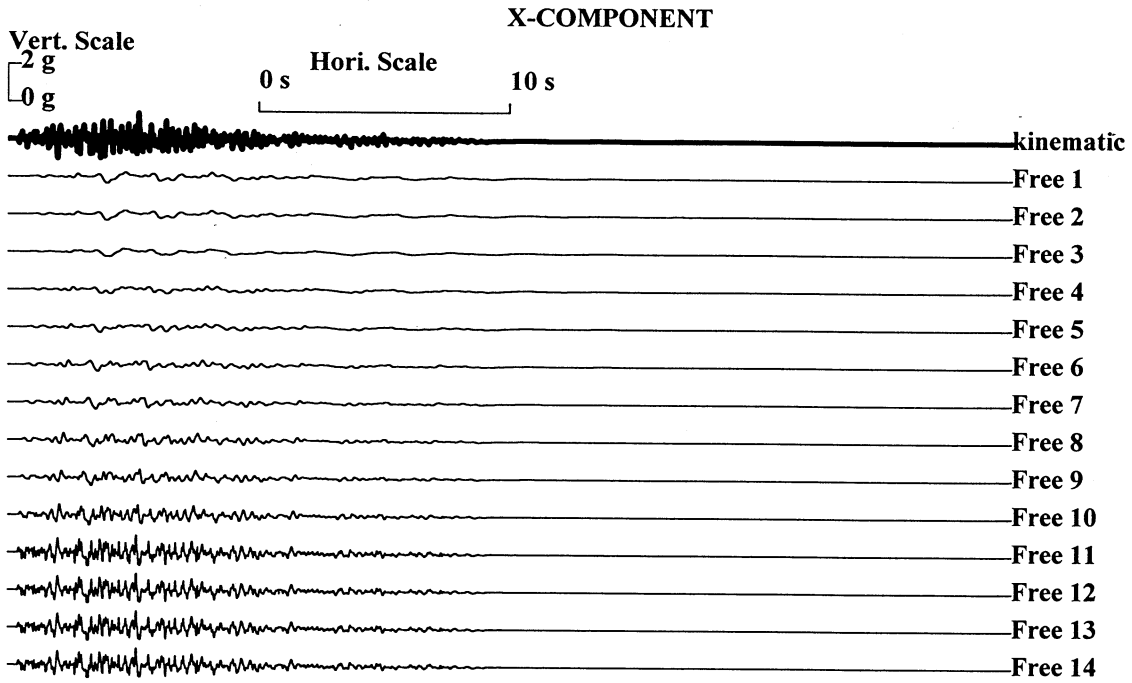
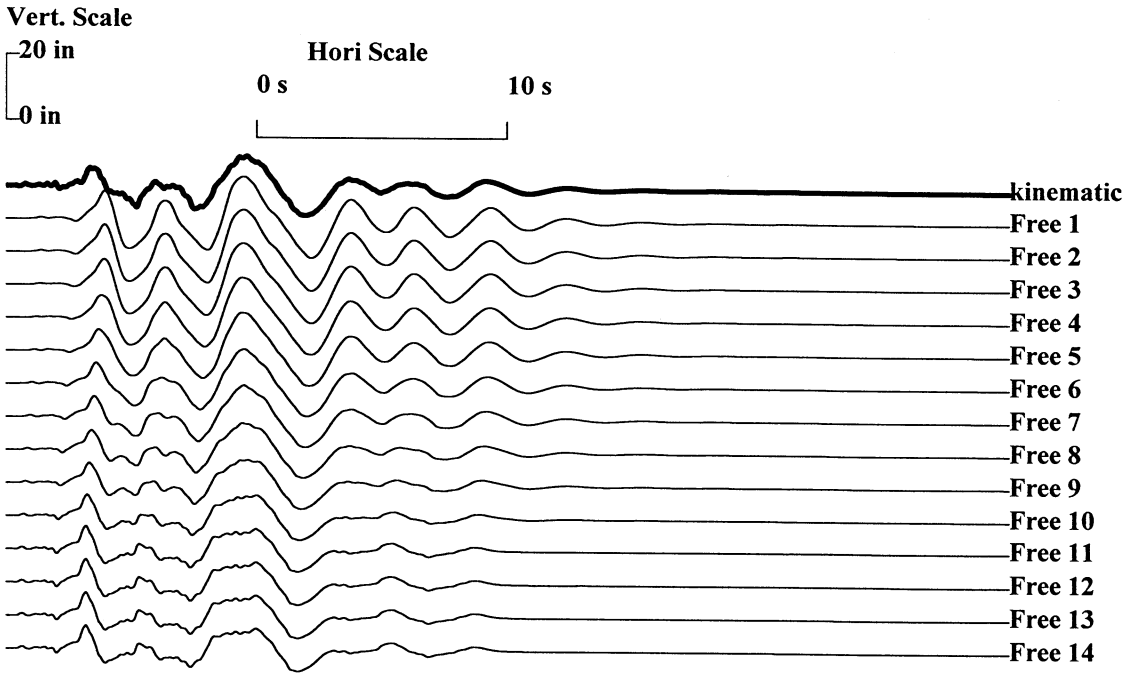
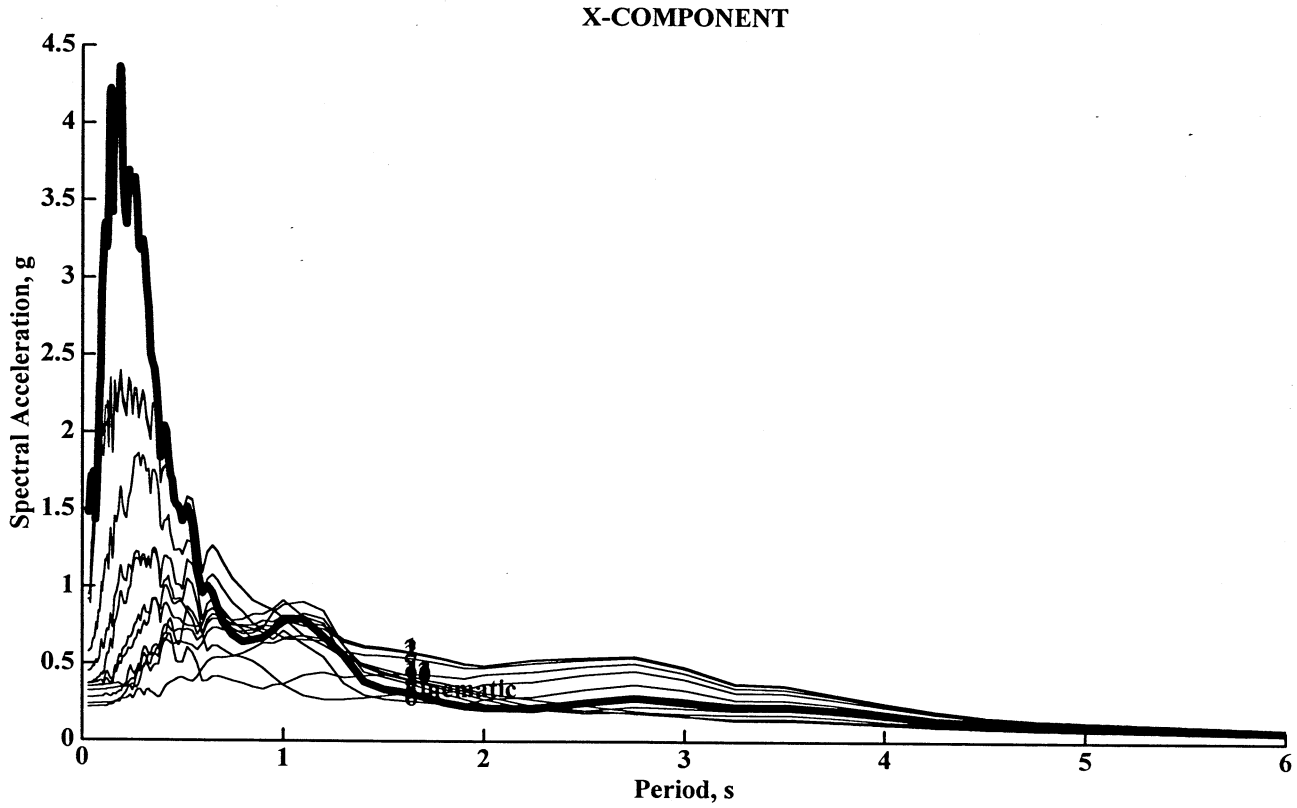
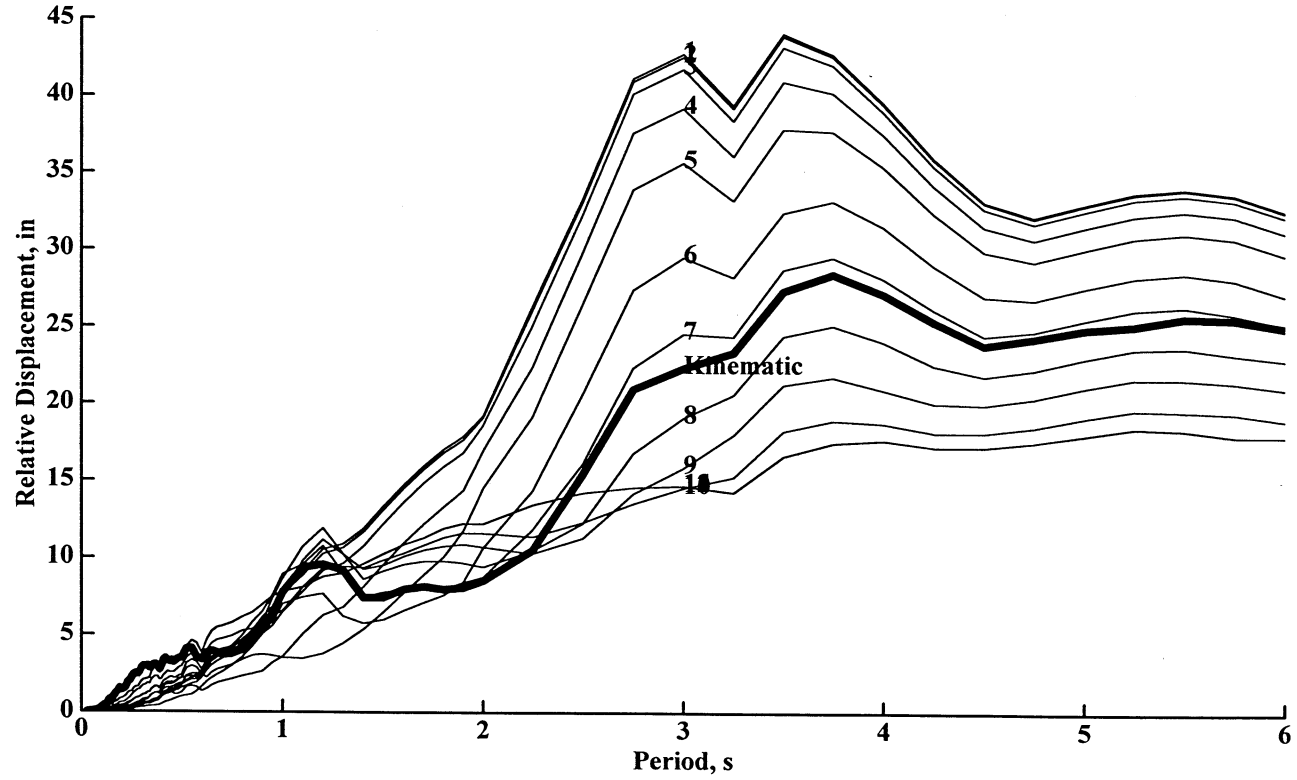
SET 3, Tran. Dir.
BENICIA-MARTINEZ





PIER 16
SET 3, Long. Dir.
BENICIA-MARTINEZ





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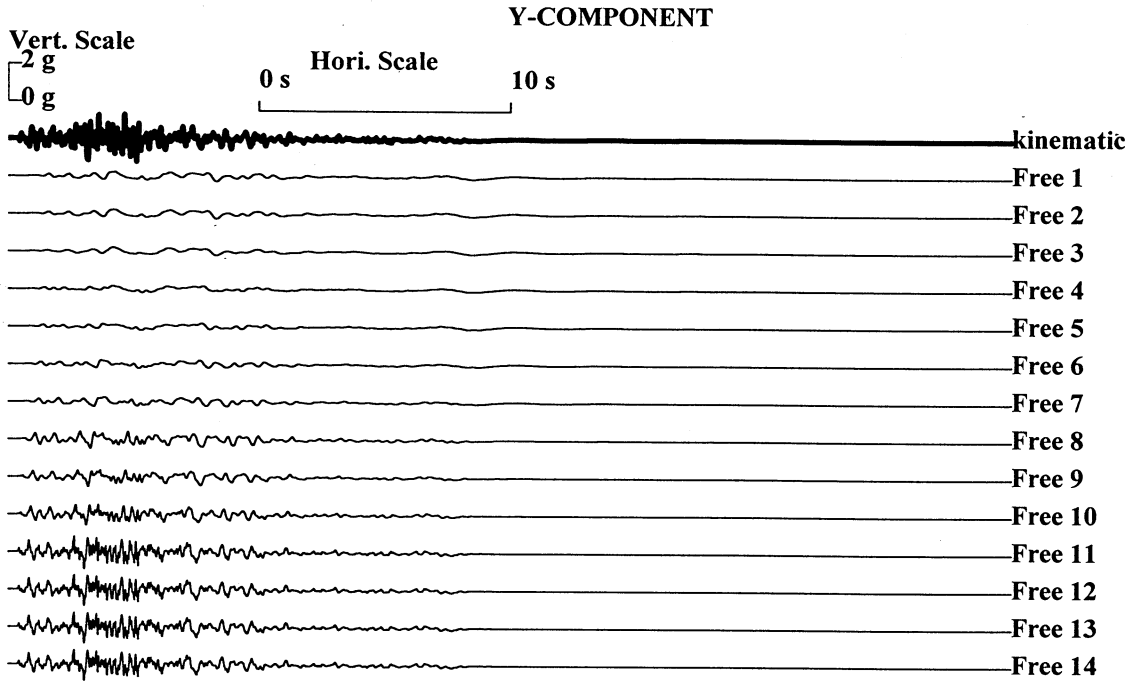
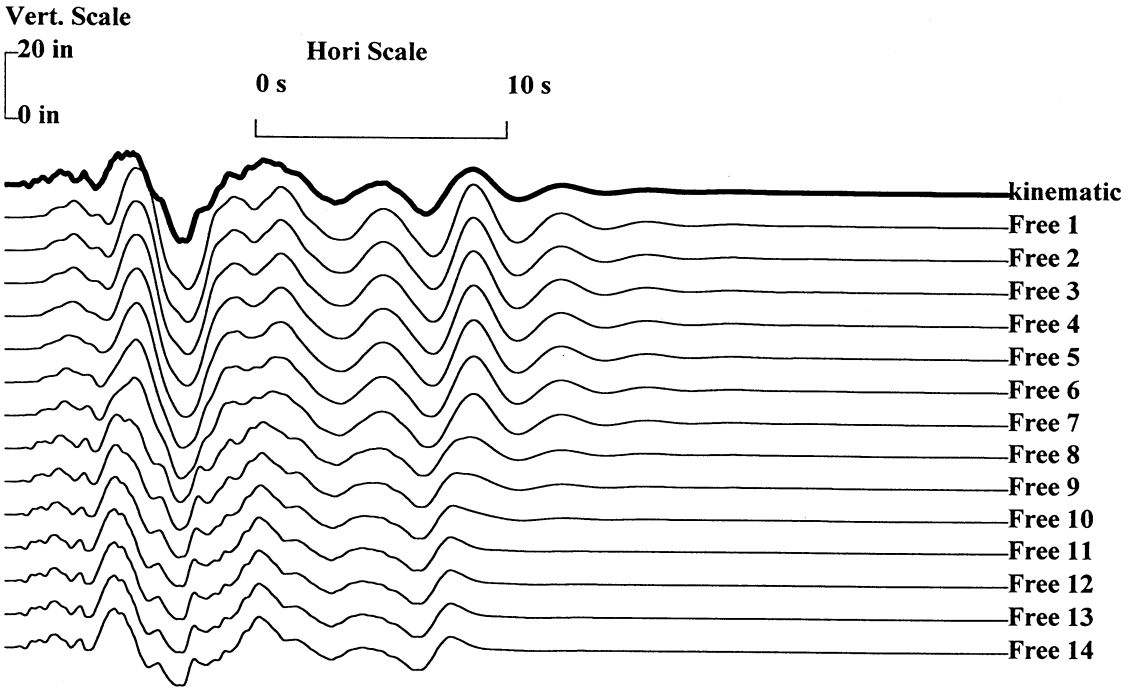
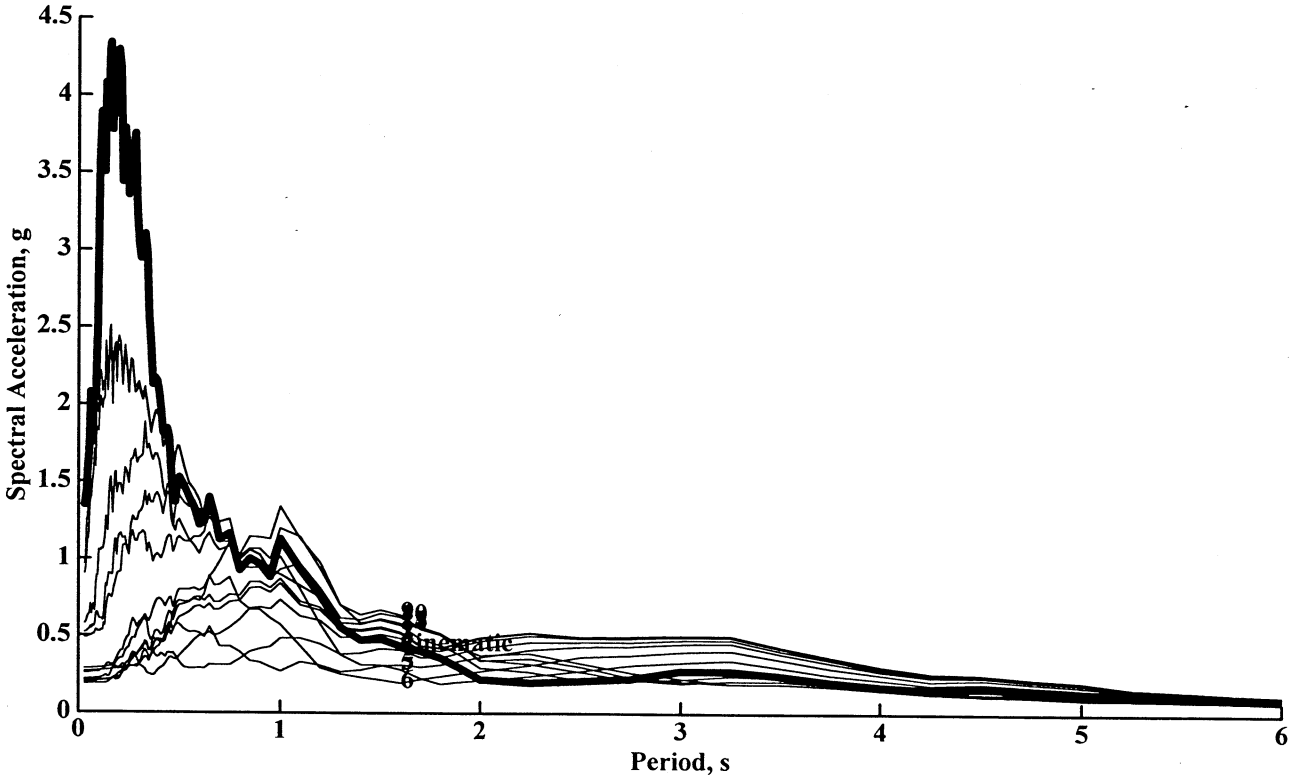
SET 3, Long. Dir.
BENICIA-MARTINEZ

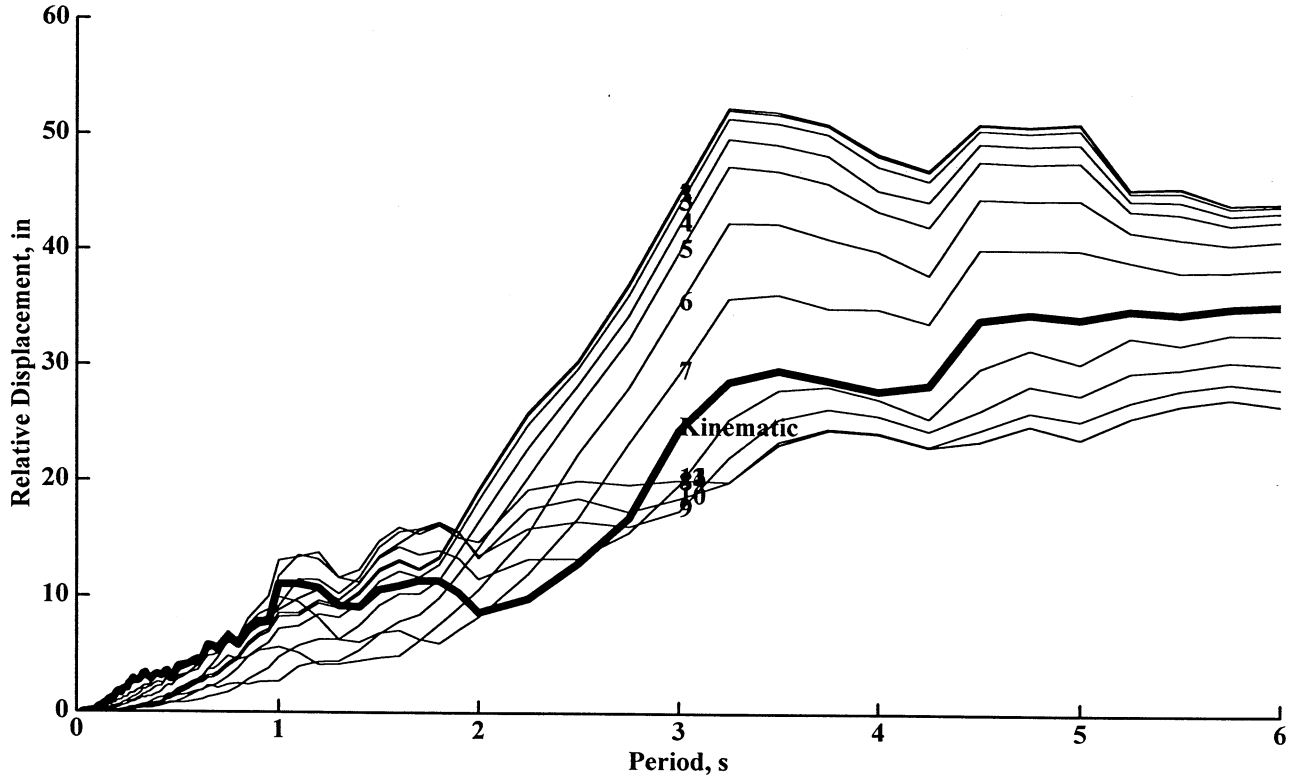




PIER 16
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





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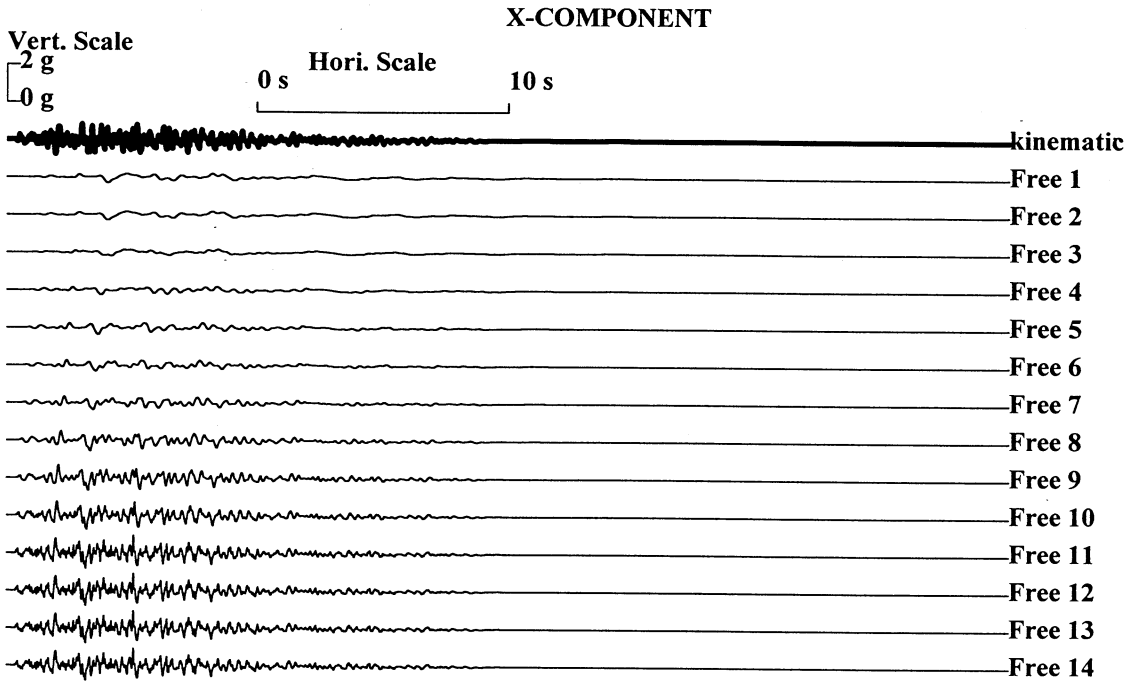
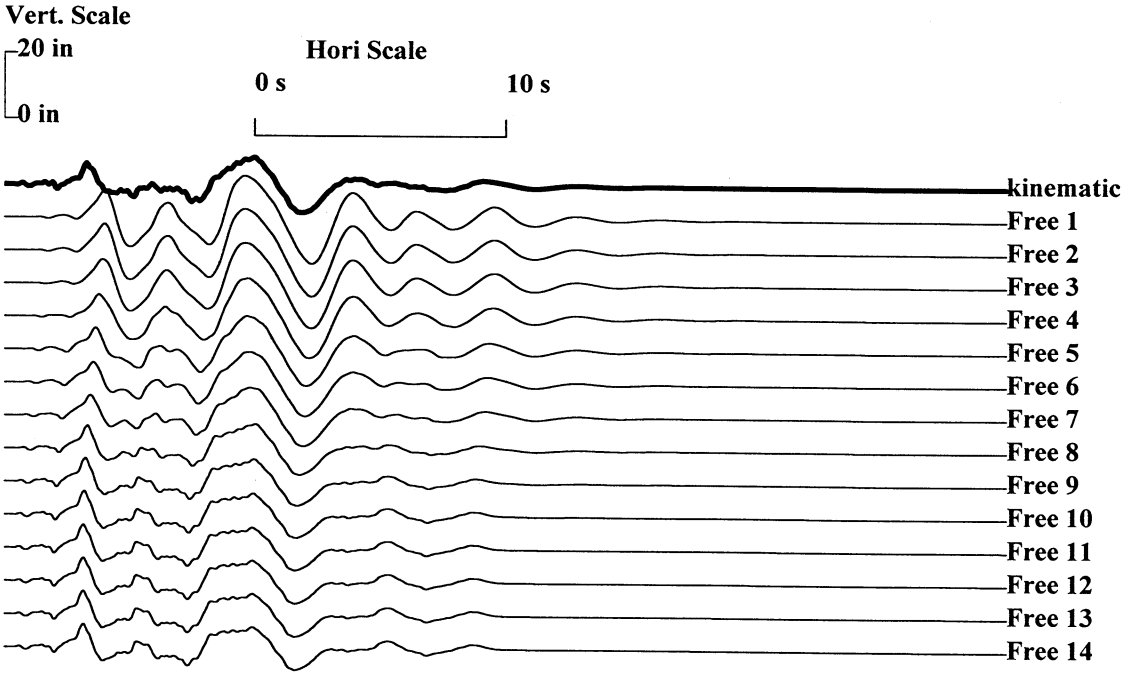
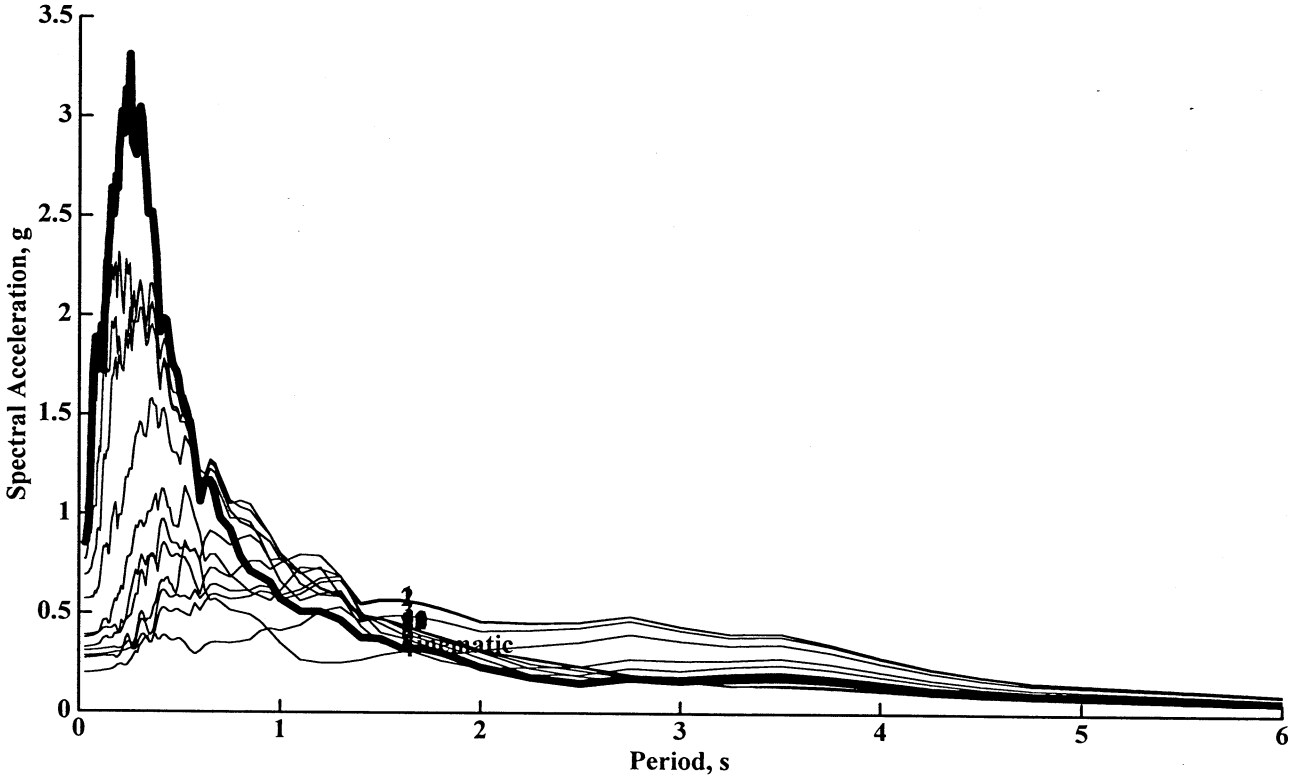
SET 3, Tran. Dir.
BENICIA-MARTINEZ

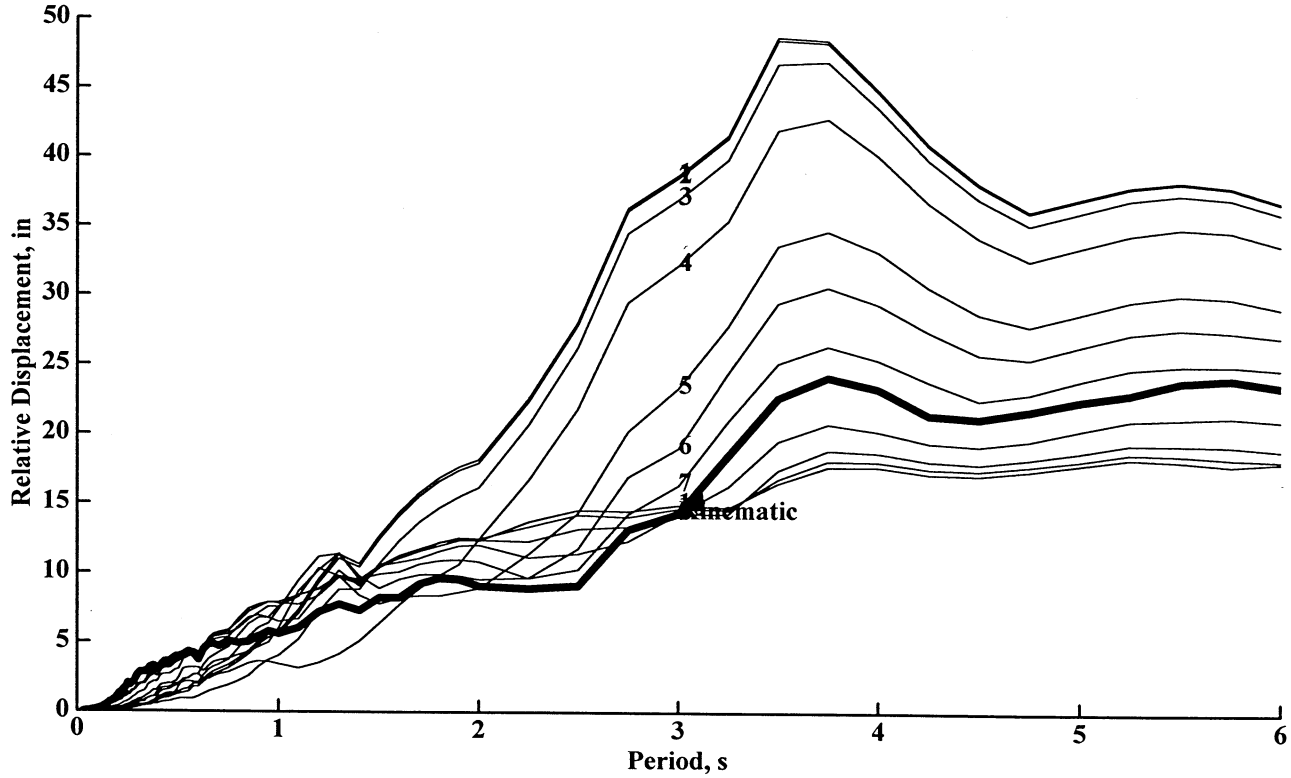




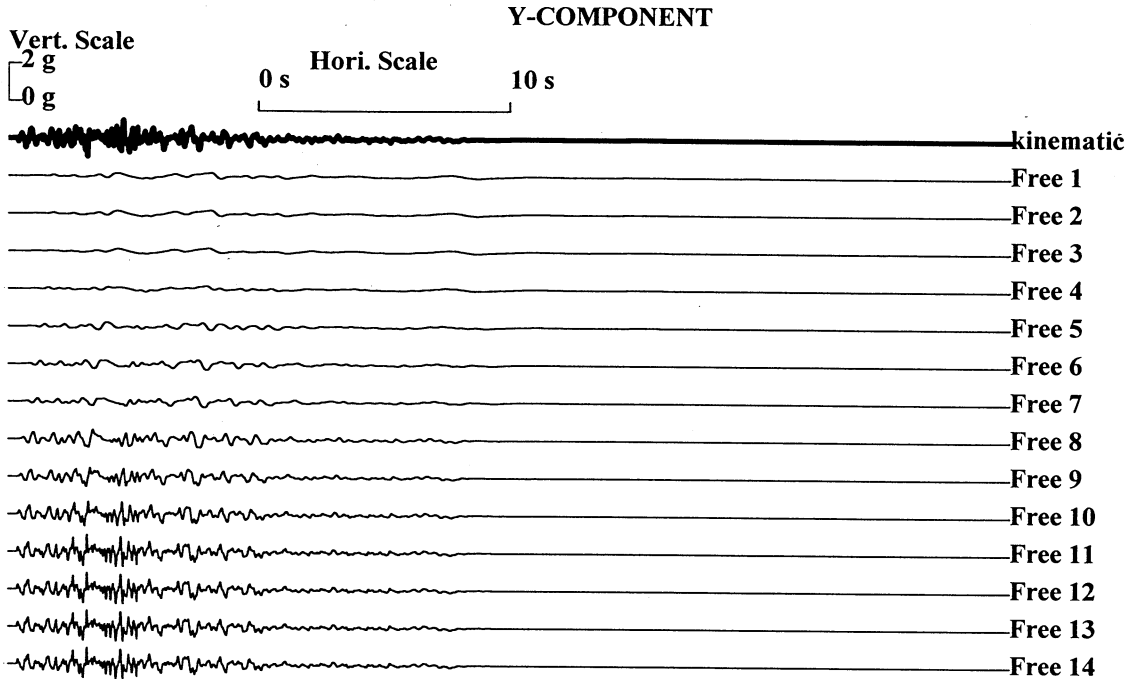
PIER 17
SET 3, Long. Dir.
BENICIA-MARTINEZ

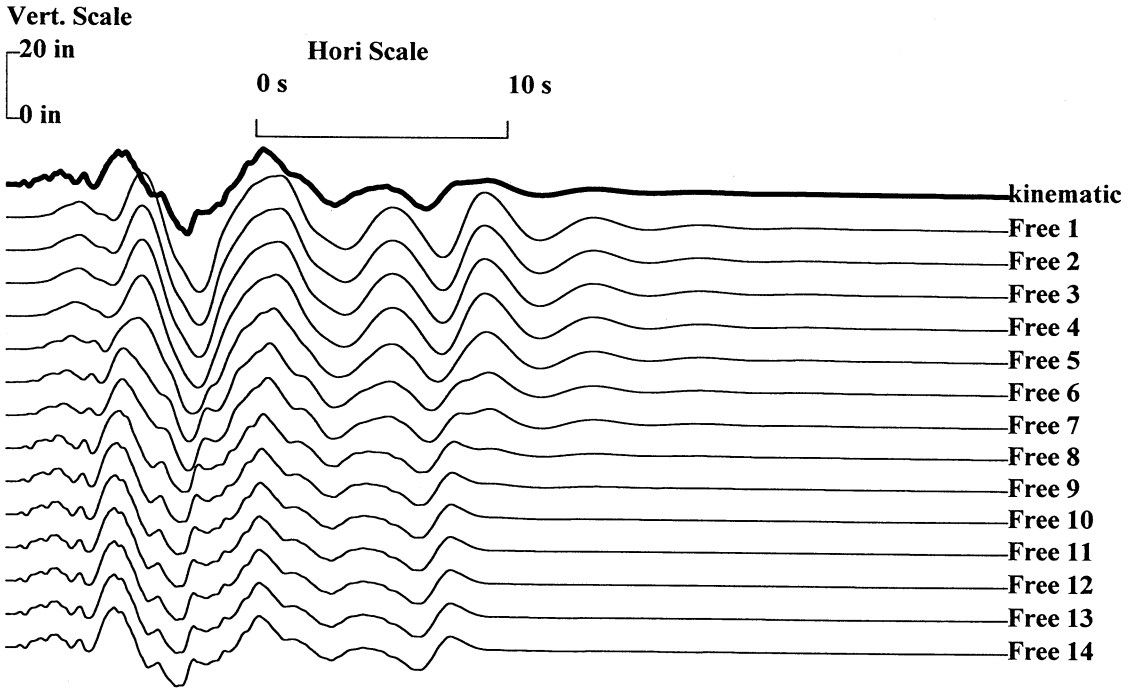
X-COMPONENT





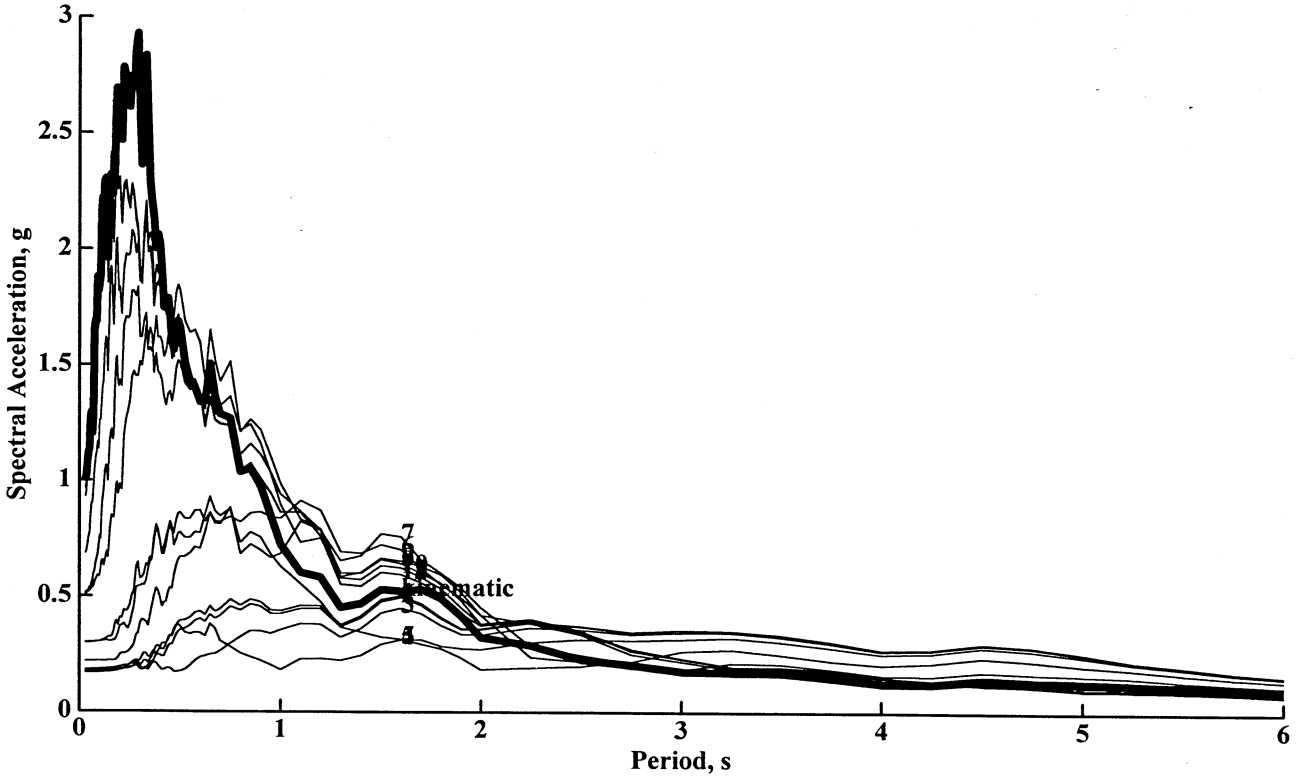
PIER 17
SET 3, Long. Dir.
BENICIA-MARTINEZ

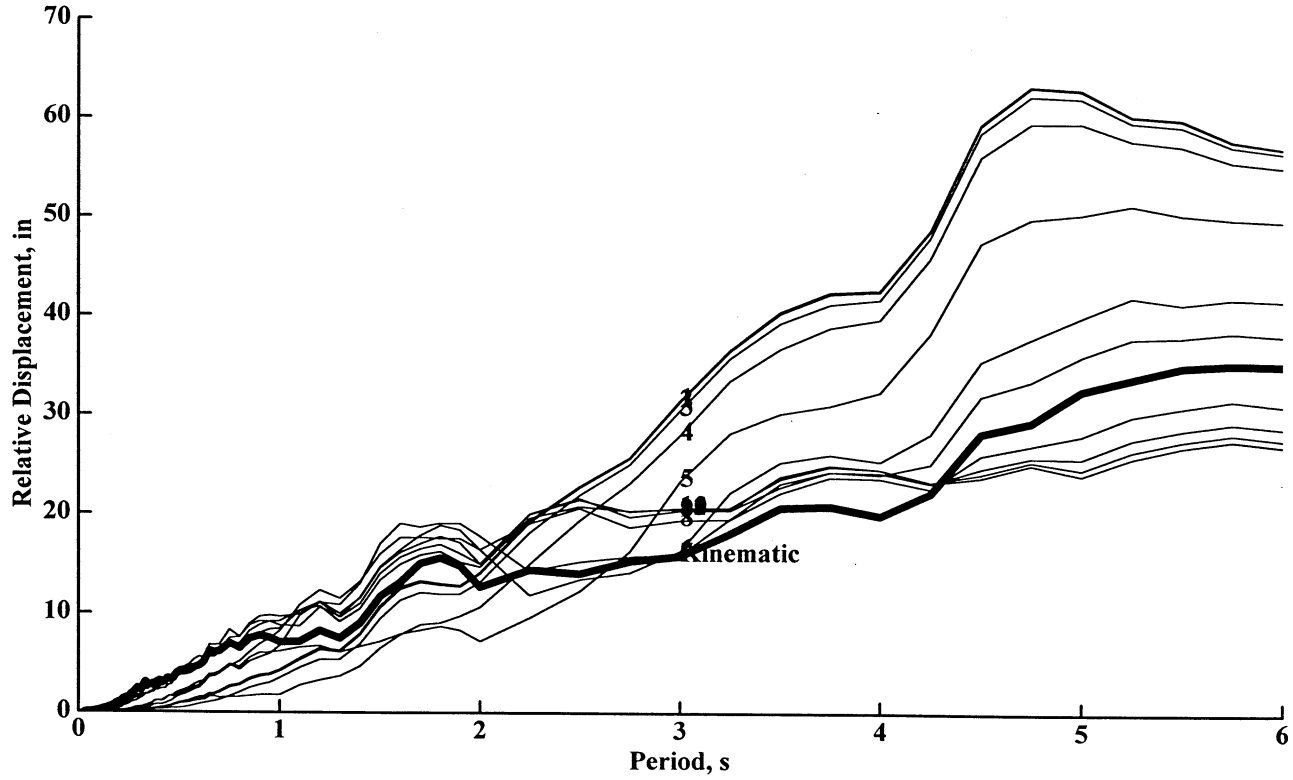




PIER 17
SET 3, Tran. Dir.
BENICIA-MARTINEZ

Y-COMPONENT





PIER 17
SET 3, Tran. Dir.
BENICIA-MARTINEZ