

FINAL GEOTECHNICAL STUDY REPORT
MILLER SWEENEY PILE DOLPHINS & FENDER
PILE REPAIRS
OAKLAND HARBOR, CALIFORNIA

AGS Job No. KF1103

Prepared for:

MOFFATT & NICHOL

Submitted by:

AGS, INC.

MARCH 2009

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1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of the geotechnical study conducted by AGS, Inc. for the lateral load analysis of the dolphin piles for the Fruitvale Avenue Highway Bridge. This report includes geotechnical engineering conclusions and recommendations related to subsurface conditions and resistance to lateral loads. The conclusions and recommendations presented in this letter are based on the data from previous geotechnical investigations, and available geologic information for the site vicinity. The conclusions and recommendations presented in this letter should not be extrapolated to other areas or used for other facilities without prior review by AGS.

1.2 PROJECT DESCRIPTION

The project involves the evaluation of dolphin piles for the existing Fruitvale Avenue Highway Bridge. Part of this evaluation includes 6 dolphin piles, shown on Plate 1. The dolphin piles will either be Douglas Fir timber with a 12 inch diameter at the head tapered to 6" diameter at the tip or Green Heart timber with 12 inch diameter at the head tapered to 5.1 inch at the tip. Each dolphin pile consists of 9 piles, 3 battered 2:12, 3 battered 1:12 and 3 with no battering. The bridge is located on Fruitvale Avenue and spans over the channel between the City of Oakland and City of Alameda.

1.3 WORK PERFORMED

The purpose of our study was to provide lateral resistance criteria and design parameters for the proposed pile foundations. We performed lateral pile analysis for a Douglas Fir timber with 12 inch diameter at the head tapered to 6 inch diameter at

the tip and a Green Heart timber with a 12 inch diameter at the head tapered to a 5.1 inch at the tip.

2.0 FINDINGS

2.1 SUBSURFACE CONDITIONS

Eight borings were completed near the Fruitvale Avenue Bridge by S.F. District Corps of Engineers in 1970.

Borings TF-2, TF-3 and TF-6 were drilled closest proximity of the proposed dolphin pile locations, shown on Plate 1. The results of the field exploration program indicate that subsurface conditions near the fender line consist of approximately 63 feet of predominately stiff silty clay and sandy clay with some sand lenses, which is in turn underlain by approximately 7 to 10 feet of dense clayey, gravelly sand. The clayey gravelly sand layer was in turn underlain by very fat clay soils to the maximum depth explored of 90 feet.

The subsurface conditions near the center of the bridge consist of approximately 26 feet of predominately stiff silty clay and sandy clay with some sand lenses, which is in turn underlain by approximately 4 feet of clayey sand. Below the clayey sand, sandy clay was encountered, which is in turn underlain by approximately 8 feet of poorly graded gravel. The poorly graded gravel layer was in turn underlain by stiff sandy clay to the maximum depth explored of 76.7 feet.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 FOUNDATIONS

3.1.1 GENERAL

It is our understanding that Douglas Fir timber and Green Heart timber are being considered for the dolphin piles. The piles will be vibrated 80% of the length and driven the remaining length.

We recommend that the piles be driven with a hammer having a rated energy of at least 12,000 foot-pounds. The practical refusal criteria is defined as 20 blows per foot for the last three feet of penetration or 40 blows per foot for the last foot of penetration assuming that the hammer delivers at least 7,000 foot-pounds of energy per blow

3.1.2 TIMBER PILES

For areas with the top of the piles 24 feet above the mudline, it is our opinion that 12-inch diameter timber piles driven to practical refusal or 36 feet below the mudline whichever is less will achieve the required lateral loads. Piles 24 feet from the mudline require a minimum length of 60 feet.

For areas with the top of the piles 47 feet above the mudline, it is our opinion that 12-inch diameter timber piles driven to practical refusal or 23 feet below the mudline whichever is less will achieve the required lateral loads. Piles 47 feet from the mudline require a minimum length of 70 feet.

It is recommended that the locations of the proposed piles be predrilled to a maximum depth of 10 feet below the mudline with an auger with a diameter not exceeding the pile width.

3.1.3 RESISTANCE TO LATERAL LOADS

Resistance to lateral loads on piles will be provided by passive soil pressure against the pile and by the bending strength of the pile itself. Piles will be subjected to lateral horizontal inertia loads. The deflection, shear force and bending moment distribution along 12-inch piles were computed for inertia case as described in the following sections.

Plates 2.1 through 2.12 – Lateral Pile Capacities, show estimated lateral capacities and maximum induced bending moments and shear forces from the loads acting on top of the piles. 12-inch piles were unrestrained from rotation (free head). The given lateral capacities and moments include no safety factor, depend on the allowable deflection at the top of the pile (which are shown on Plates 2.1 through 2.12.) Each pile size was analyzed with the top of the piles 24 feet from the mudline and the top of the pile 47 feet from the mudline.

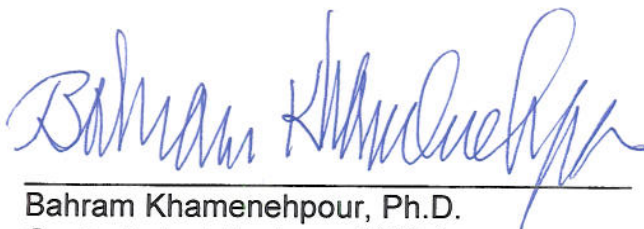
4. CLOSURE

This letter has been prepared in accordance with generally accepted professional geotechnical engineering practice for the exclusive use of Moffatt & Nichol for the proposed Miller Sweeny Pile Dolphins & Fender Pile Repairs in Oakland Harbor, California. No other warranty, express or implied, is made.

The analyses and recommendations submitted in this letter are based upon the data obtained from the previous geotechnical studies. The nature and extent of variations between the borings may not become evident until construction. In the event variations occur it will be necessary to reevaluate the recommendations of this letter.

It is the responsibility of the owner or its representative to ensure that the applicable provisions of this letter are incorporated into the plans and specifications and that the necessary steps are taken to see that the contractor carry out such provisions.

Respectfully submitted,
AGS, Inc.

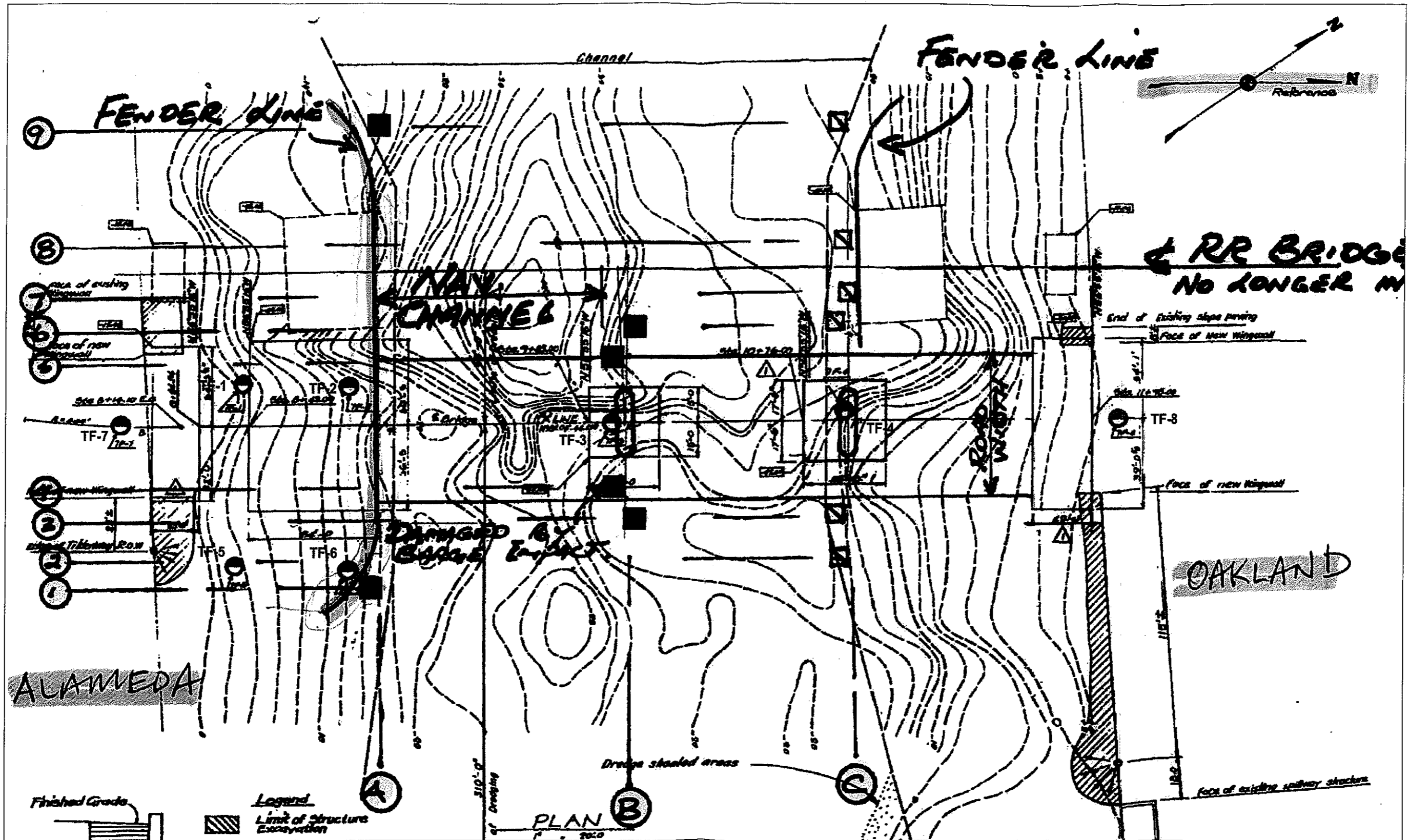


Bahram Khamenehpour, Ph.D.
Geotechnical Engineer #2104





5. REFERENCES

United States Army Corps of Engineers (USACE), San Francisco District, 1970, Soil Borings I & II, Fruitvale Avenue Highway Bridge.



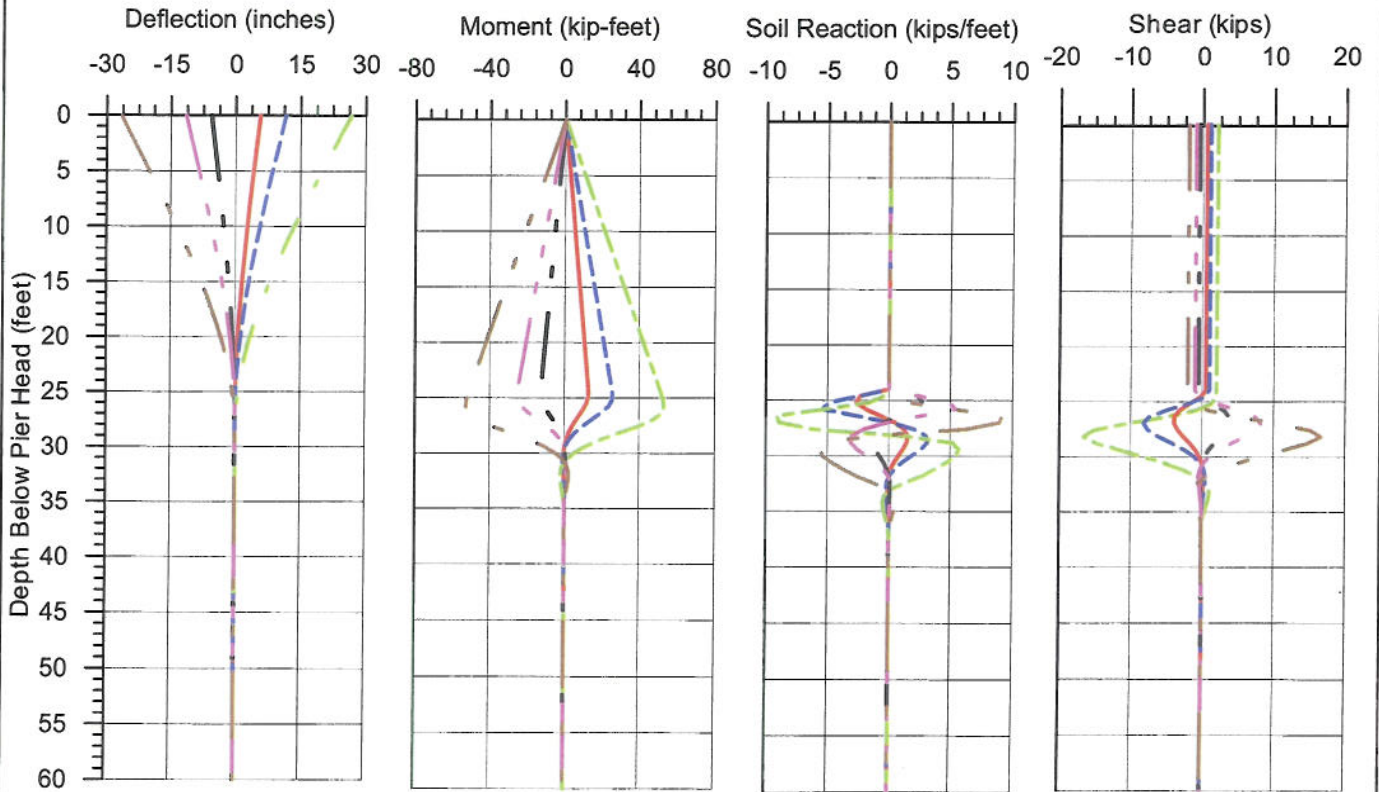
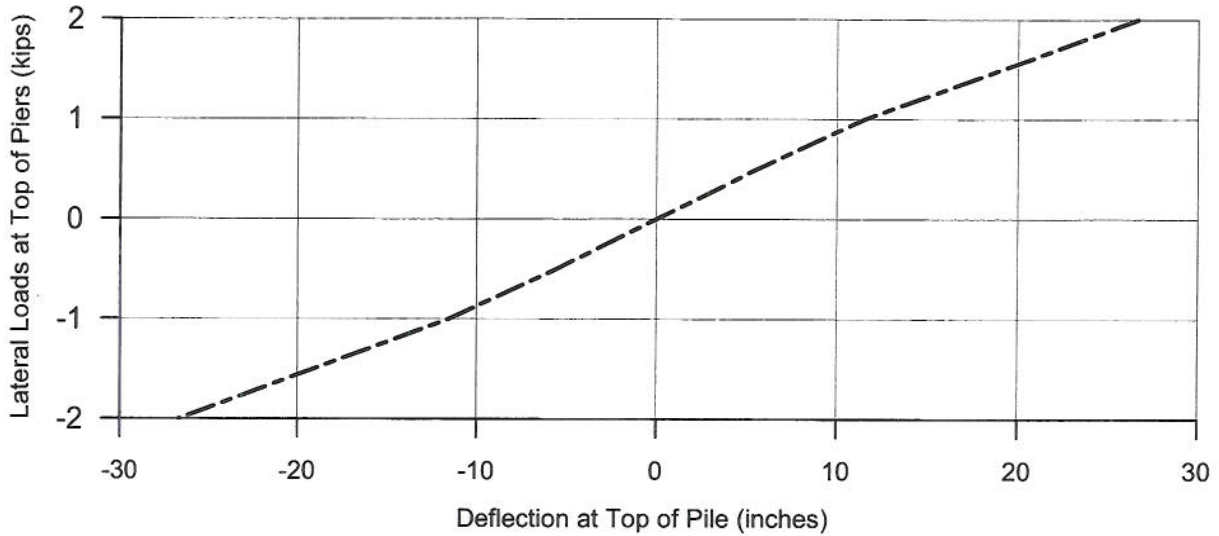
LEGEND

-  BORING LOCATION, S.F. DISTRICT CORPS OF ENGINEERS 1970
-  DOLPHIN LOCATION

SCALE: NOT TO SCALE

DOLPHIN LOCATION MILLER SWEENEY PILE DOLPHINS & FENDER PILE REPAIRS ALAMEDA HARBOR, CALIFORNIA		AGS, INC CONSULTING ENGINEERS
JOB NO: KF1103	DATE: JAN. 2009	

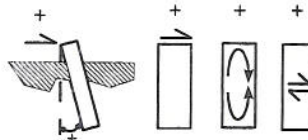
REFERENCE: DRAWING FRUITVALE AVENUE HIGHWAY BRIDGE CHANNEL CROSSING FOUNDATION PLAN DATED 6/21/1971 FROM CHARLES R. ROBERTS.



Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle positive load, moment, and shear)



Applied Shear	
Red line	0.5 Kips
Blue line	1 Kip
Green line	2 Kips
Black line	-0.5 Kips
Magenta line	-1 Kip
Brown line	-2 Kips



RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, NO BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

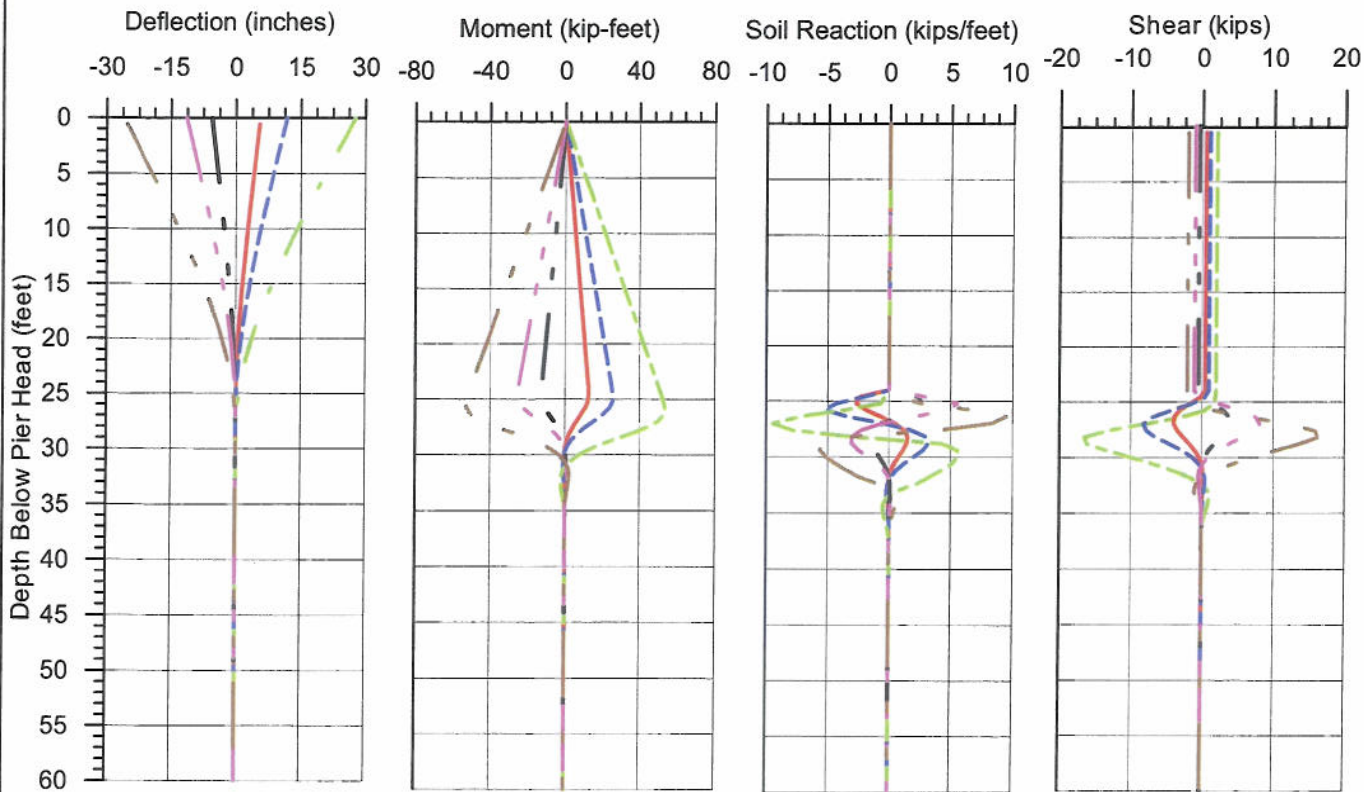
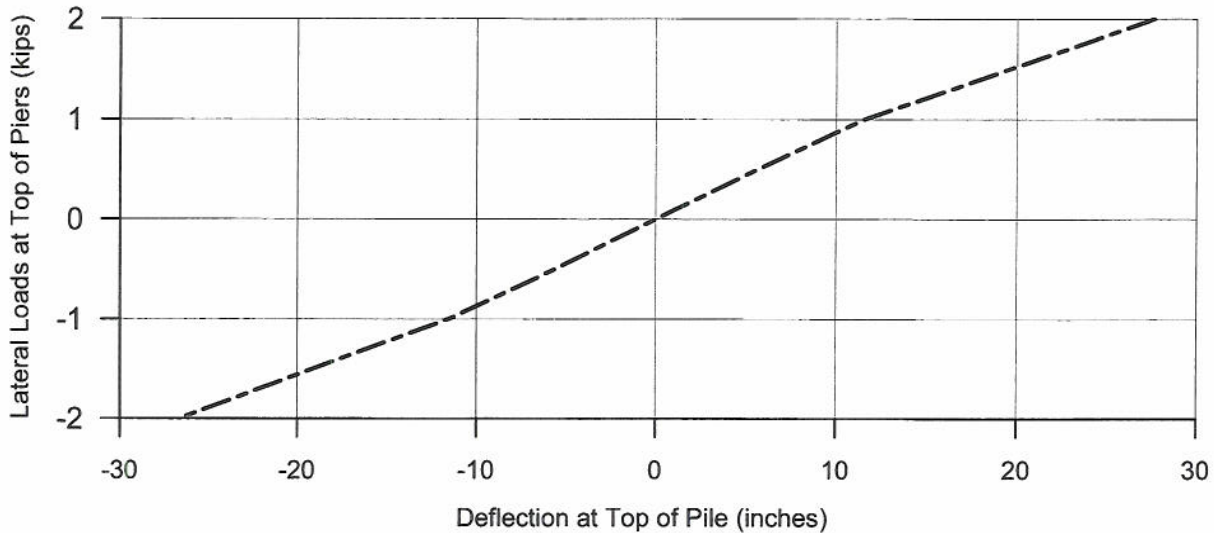
MILLER SWEENEY PILE DOLPHINS & FENDER PILE REPAIRS
 ALAMEDA HARBOR, CALIFORNIA

Project No.: KF1103

Date: Jan. 2009

Plate

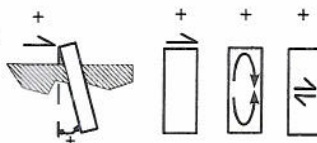
2.1



Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle positive load, moment, and shear)



Applied Shear	
Red solid line	0.5 Kips
Blue dashed line	1 Kip
Green dashed line	2 Kips
Black solid line	-0.5 Kips
Magenta solid line	-1 Kip
Brown solid line	-2 Kips



AGS, Inc.
 CONSULTING ENGINEERS

RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, 1:12 BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

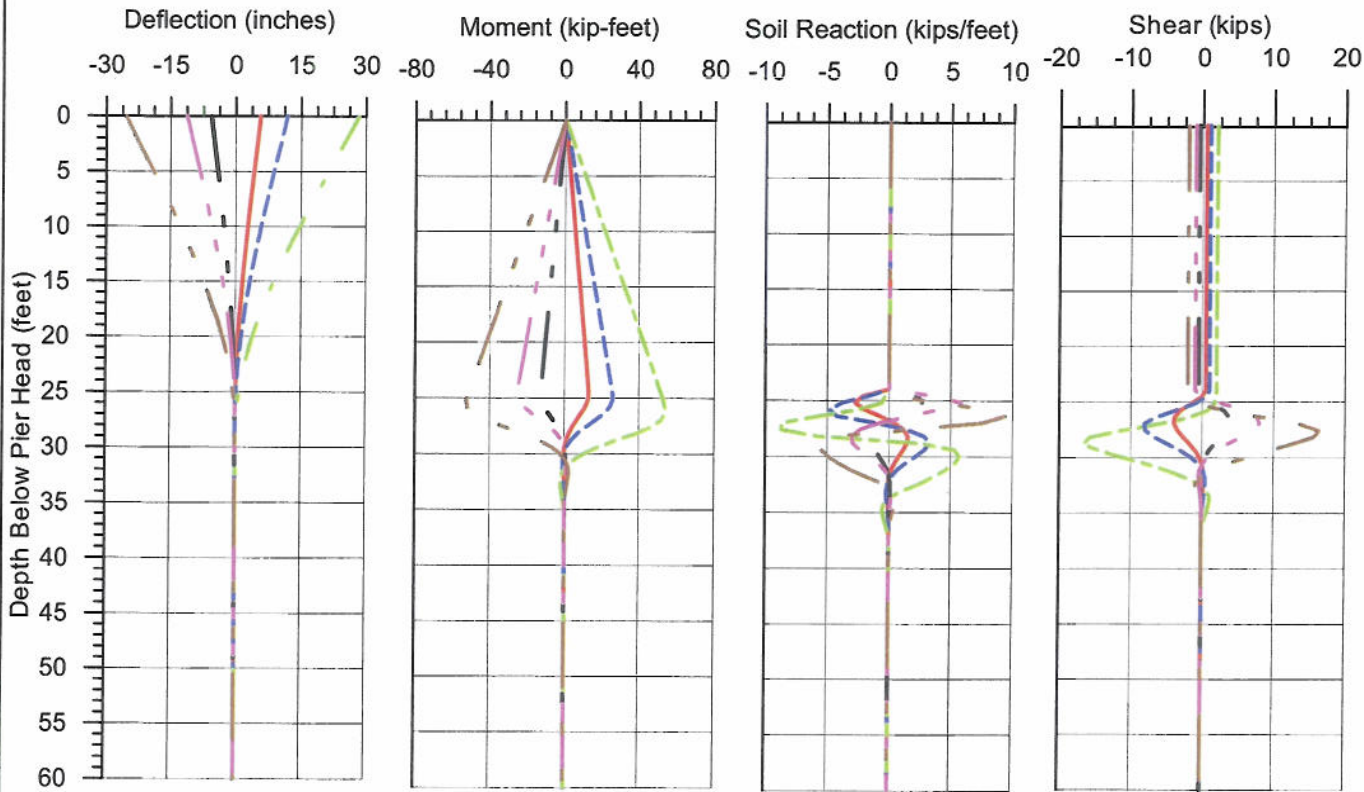
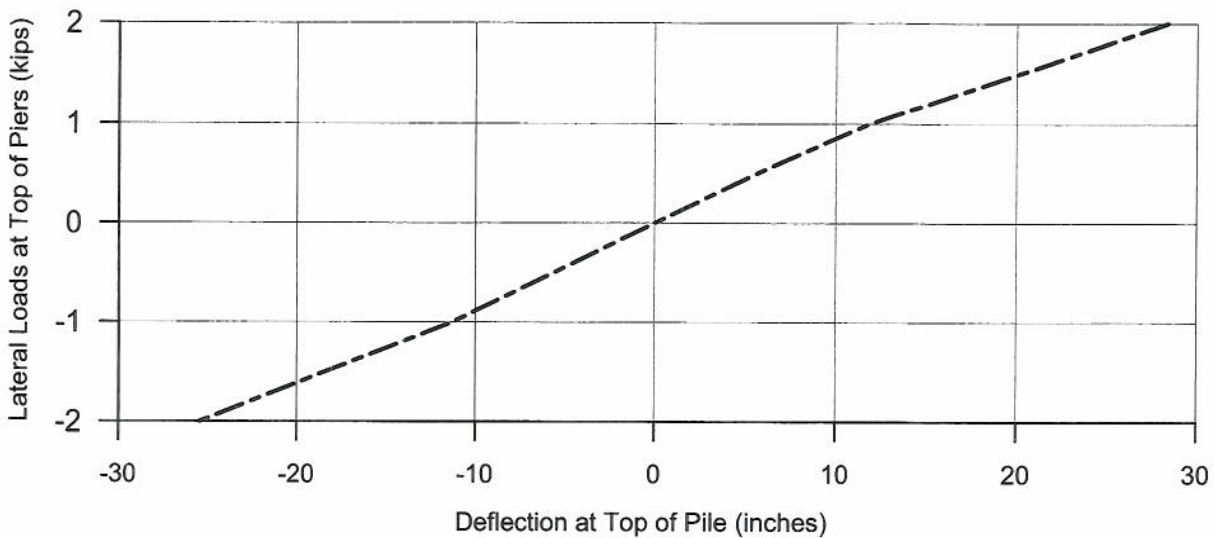
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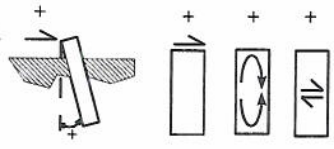
2.2



Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle positive load, moment, and shear)



Applied Shear	
Red line	0.5 Kips
Blue line	1 Kip
Green line	2 Kips
Black line	-0.5 Kips
Magenta line	-1 Kip
Brown line	-2 Kips

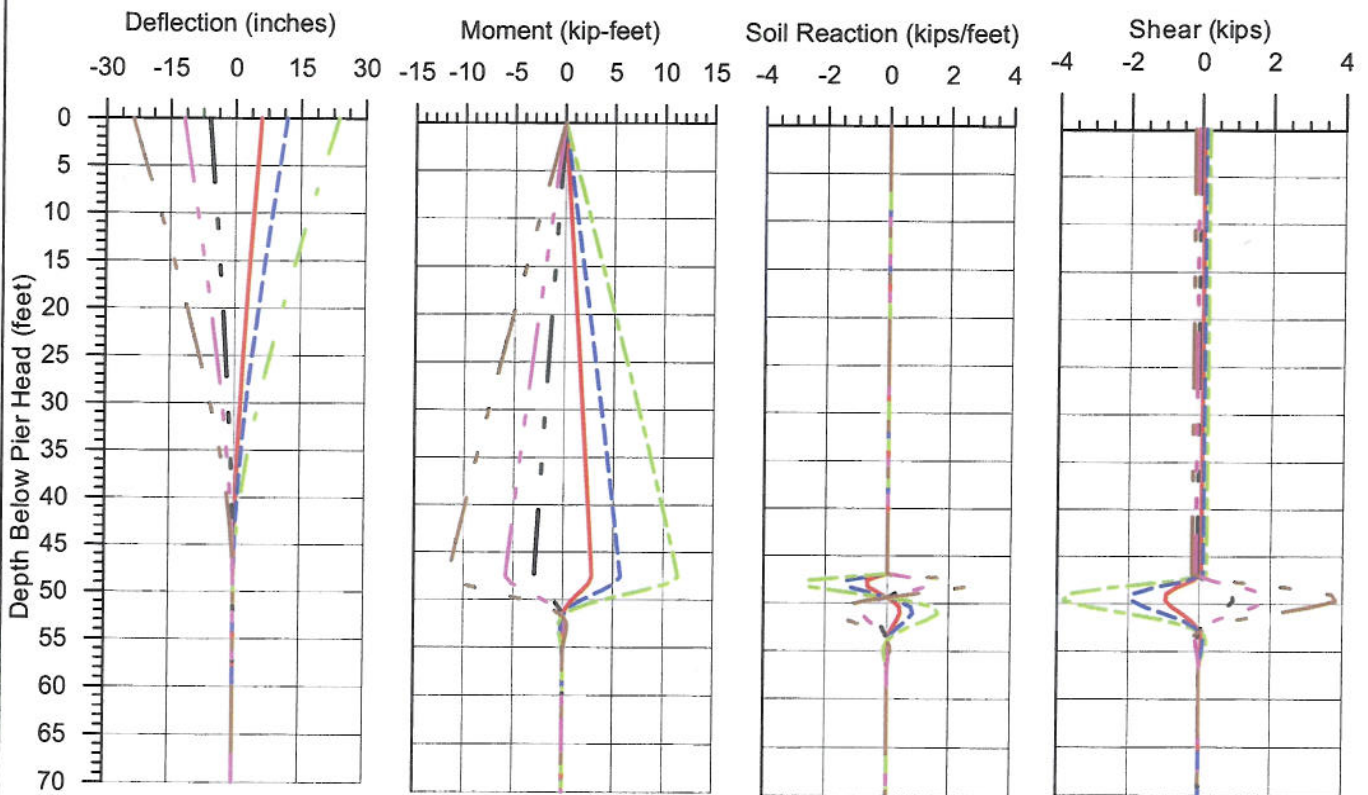
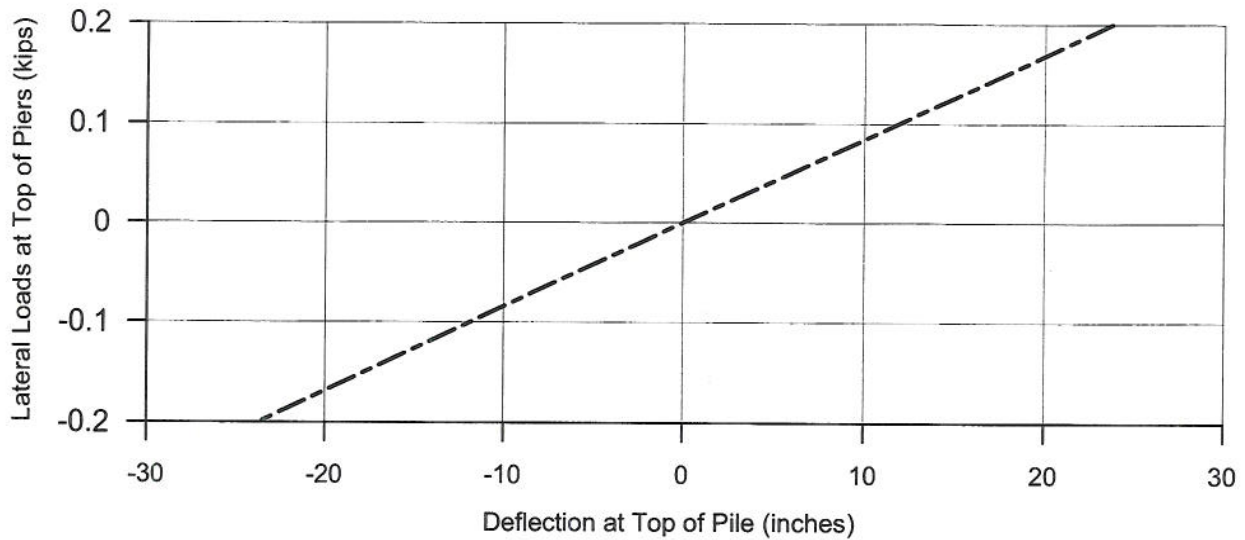


RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, 2:12 BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

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 ALAMEDA HARBOR, CALIFORNIA

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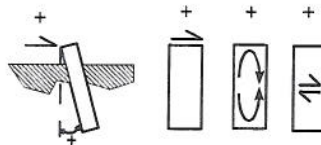
Plate
 2.3



Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.05 Kips
Blue dashed line	0.1 Kip
Green dashed line	0.2 Kips
Black solid line	-0.05 Kips
Purple solid line	-0.1 Kip
Brown solid line	-0.2 Kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, NO BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

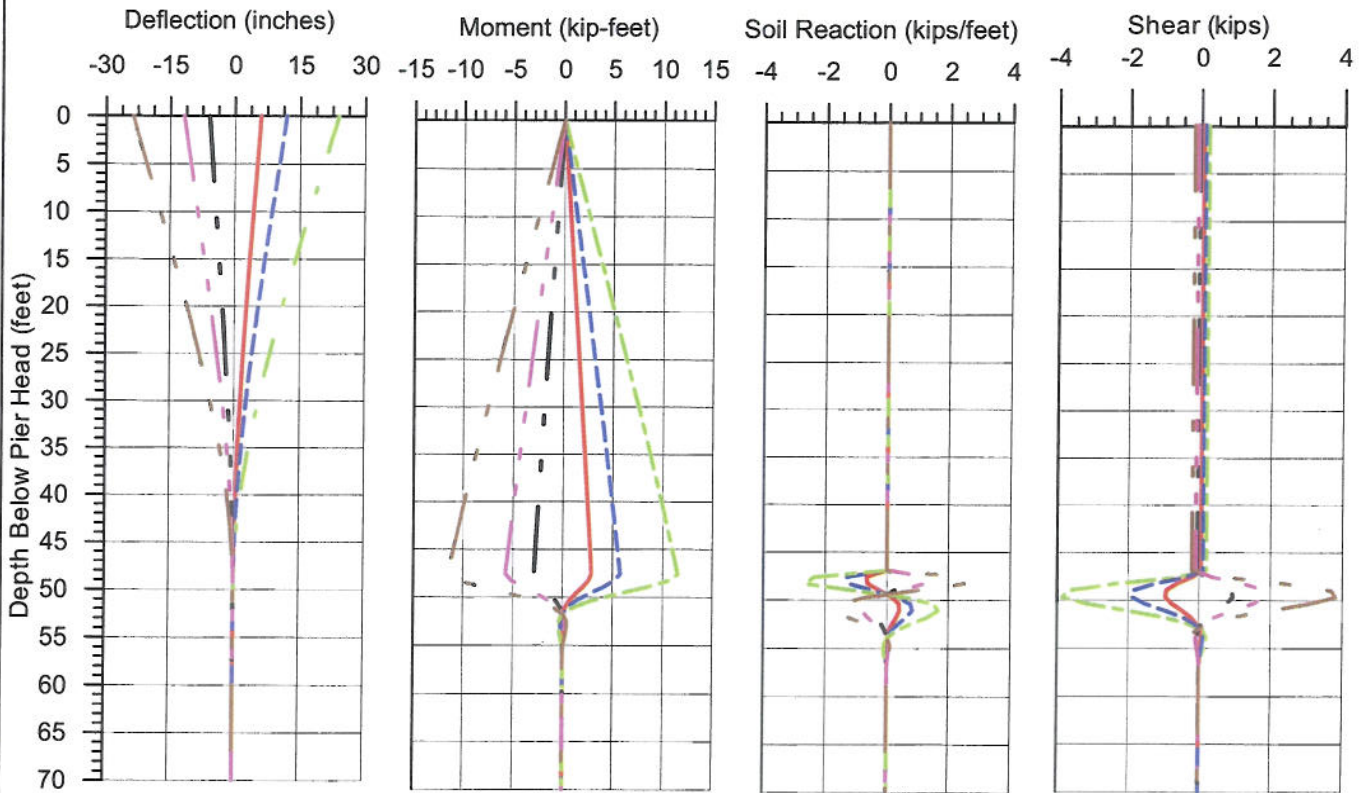
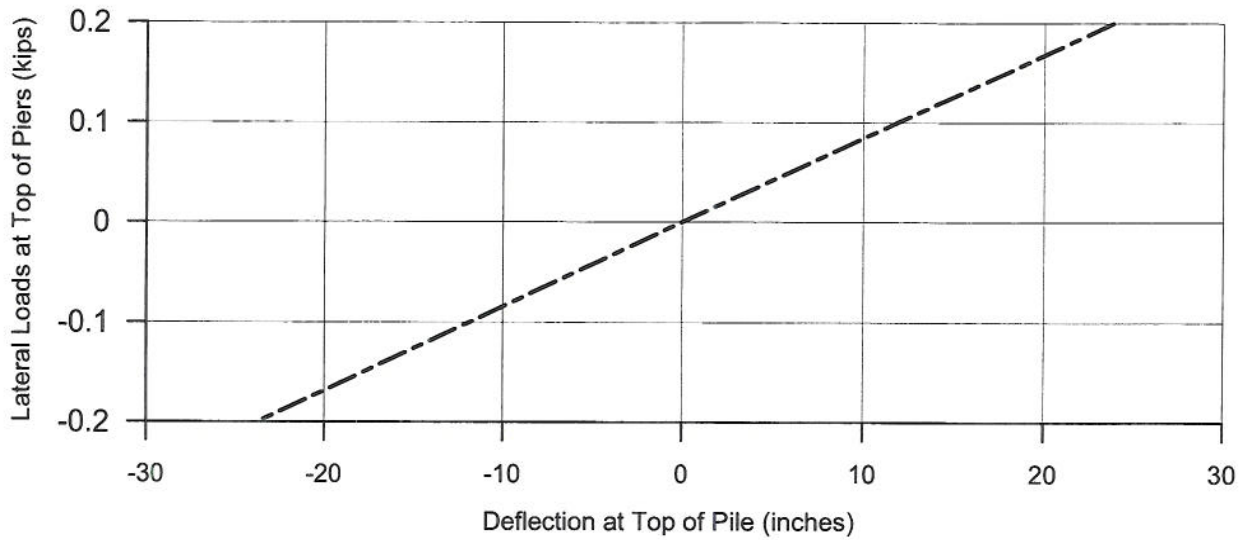
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Date: Jan. 2009

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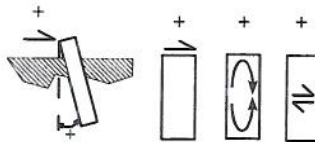
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Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.05 Kips
Blue line	0.1 Kip
Green line	0.2 Kips
Black line	-0.05 Kips
Magenta line	-0.1 Kip
Brown line	-0.2 Kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, 1:12 BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

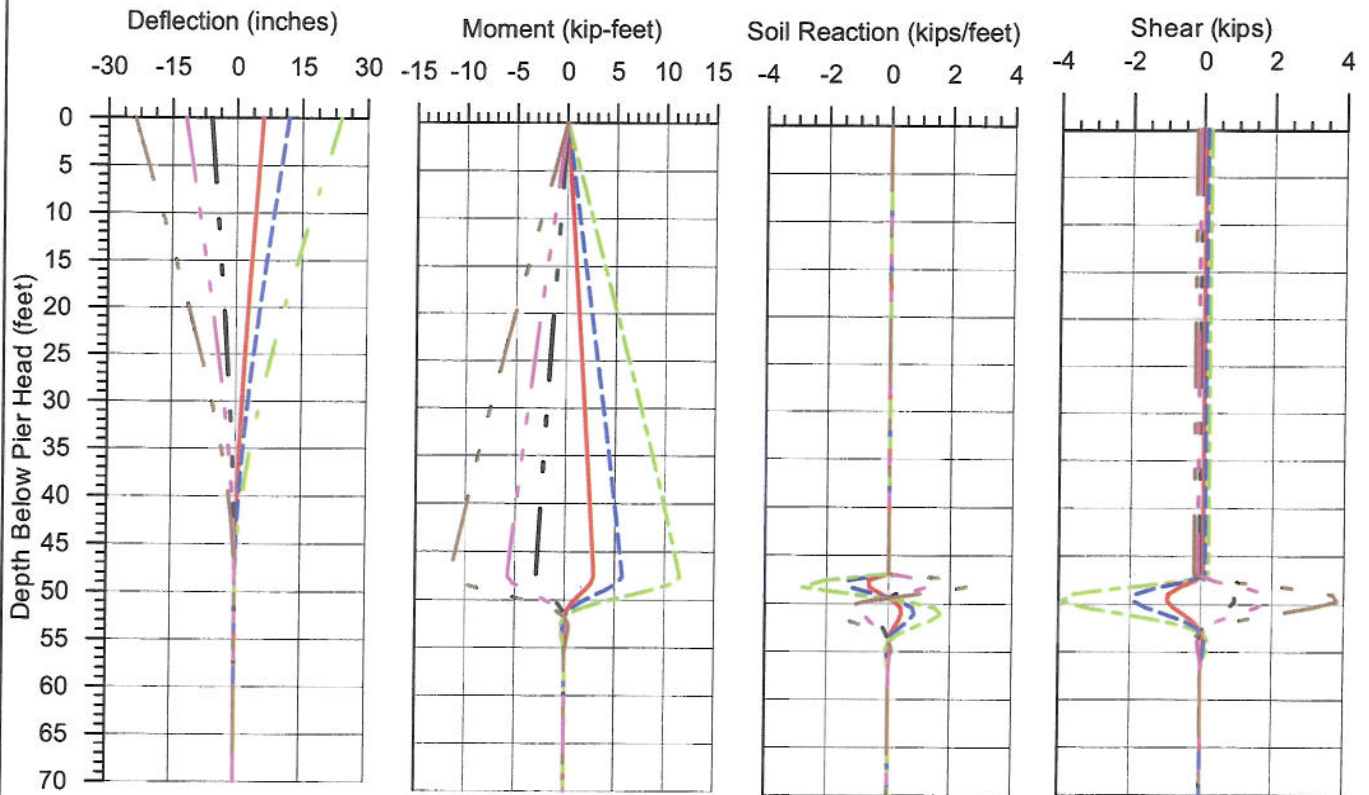
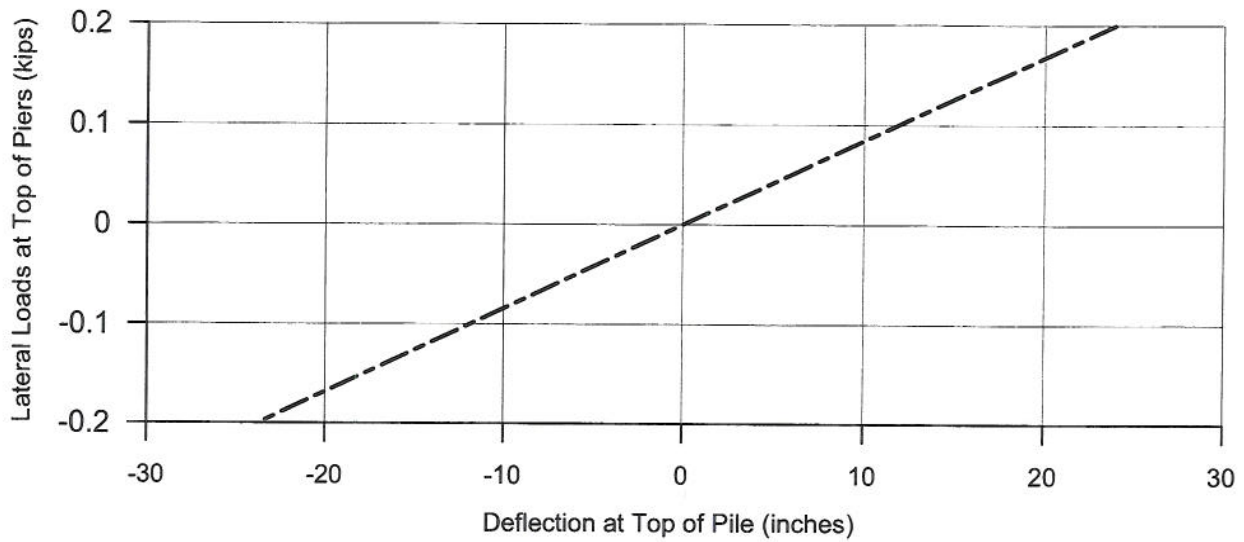
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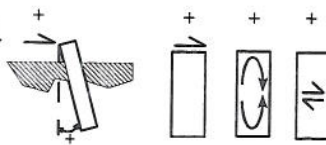
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Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Douglas Fir timber was assumed 1,500,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.05 Kips
Blue line	0.1 Kip
Green line	0.2 Kips
Black line	-0.05 Kips
Magenta line	-0.1 Kip
Brown line	-0.2 Kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, 2:12 BATTER
 FREE HEAD DOUGLAS FIR TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

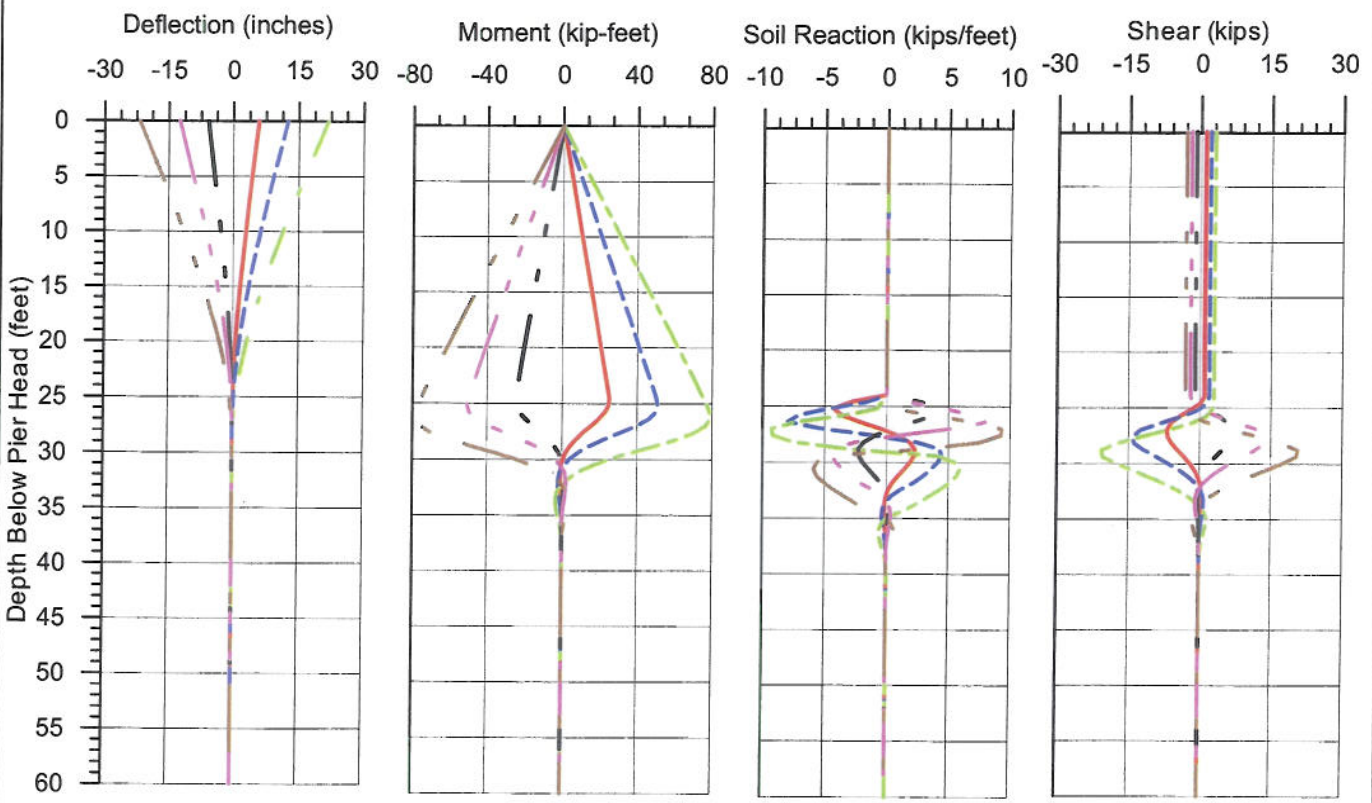
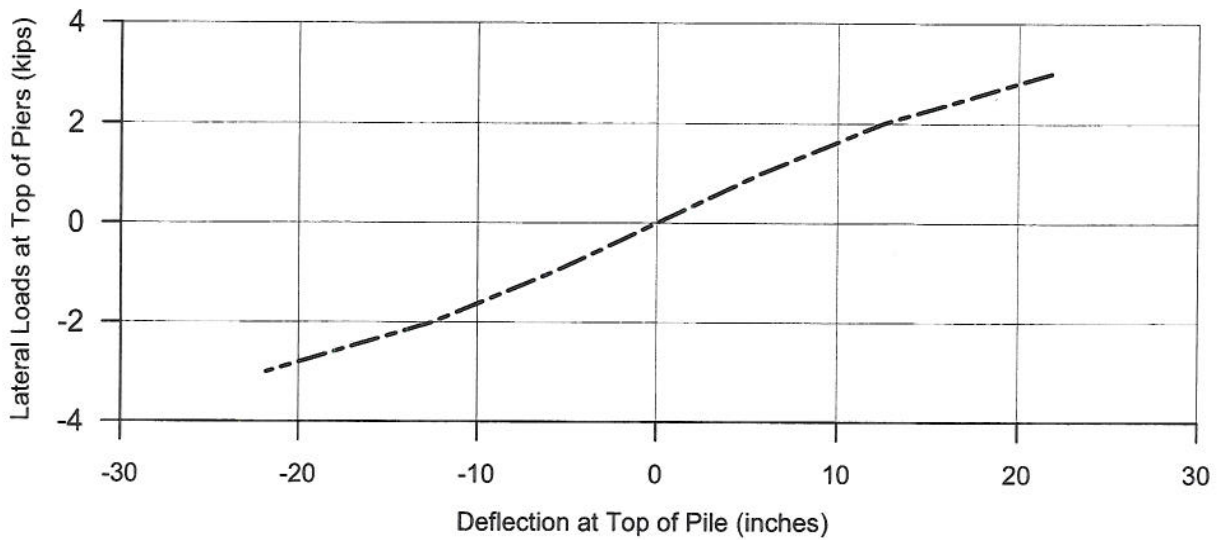
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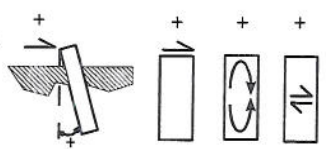
2.6



Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle positive load, moment, and shear)



Applied Shear	
Red line	1 Kip
Blue line	2 Kips
Green line	3 Kips
Black line	-1 Kip
Magenta line	-2 Kips
Brown line	-3 Kips



RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, NO BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

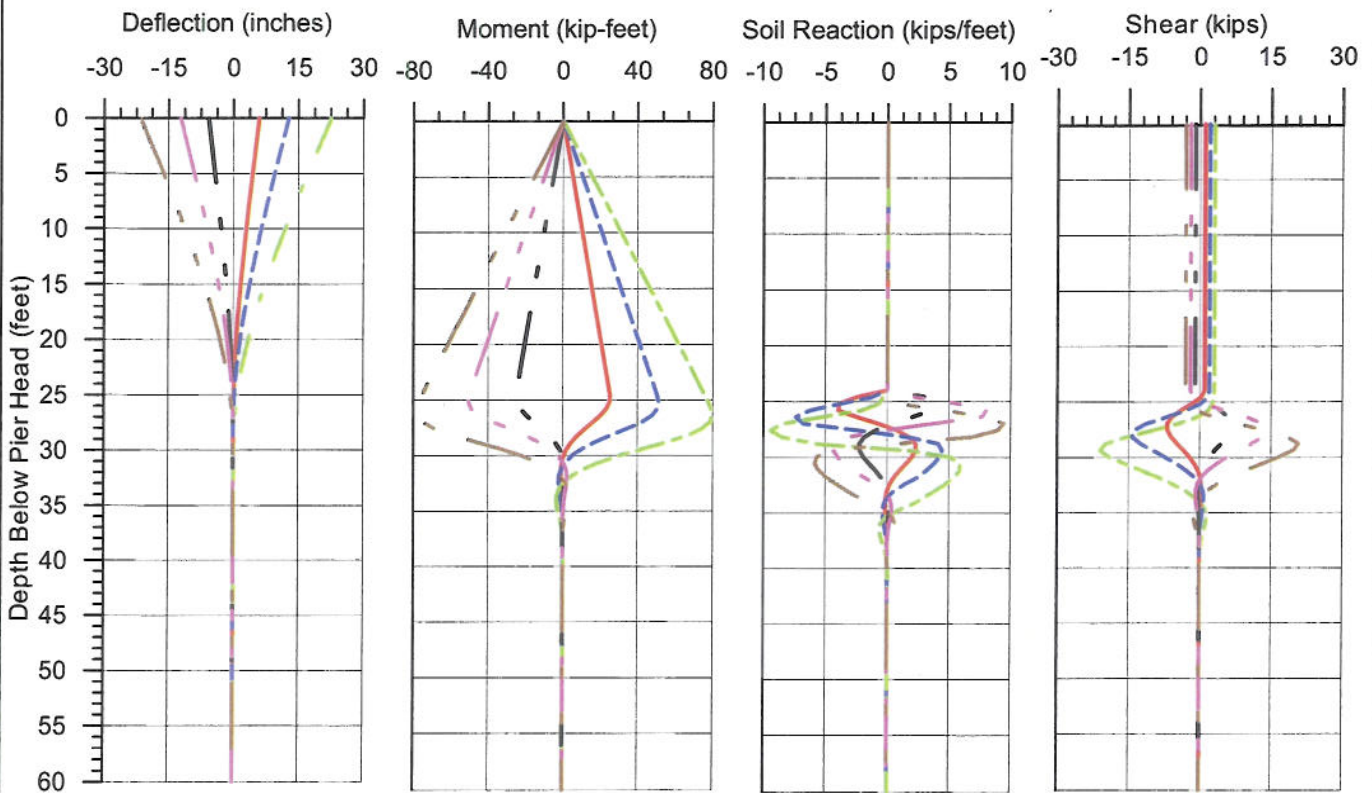
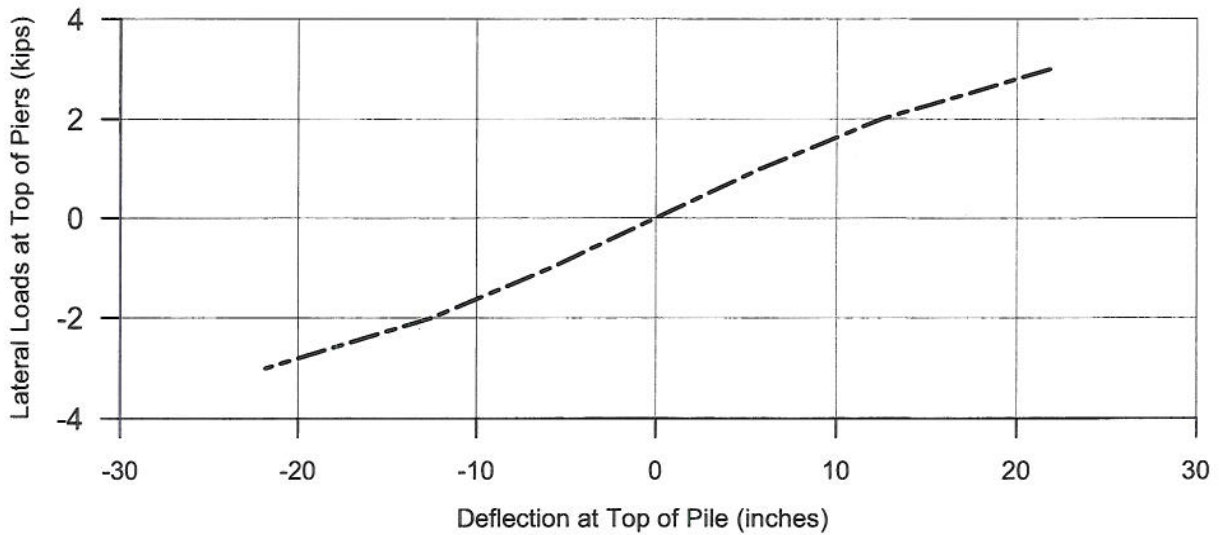
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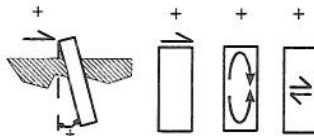
2.7



Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle positive load,
 moment, and shear)



Applied Shear	
Red line	1 Kip
Blue line	2 Kips
Green line	3 Kips
Black line	-1 Kip
Magenta line	-2 Kips
Brown line	-3 Kips



RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, 1:12 BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

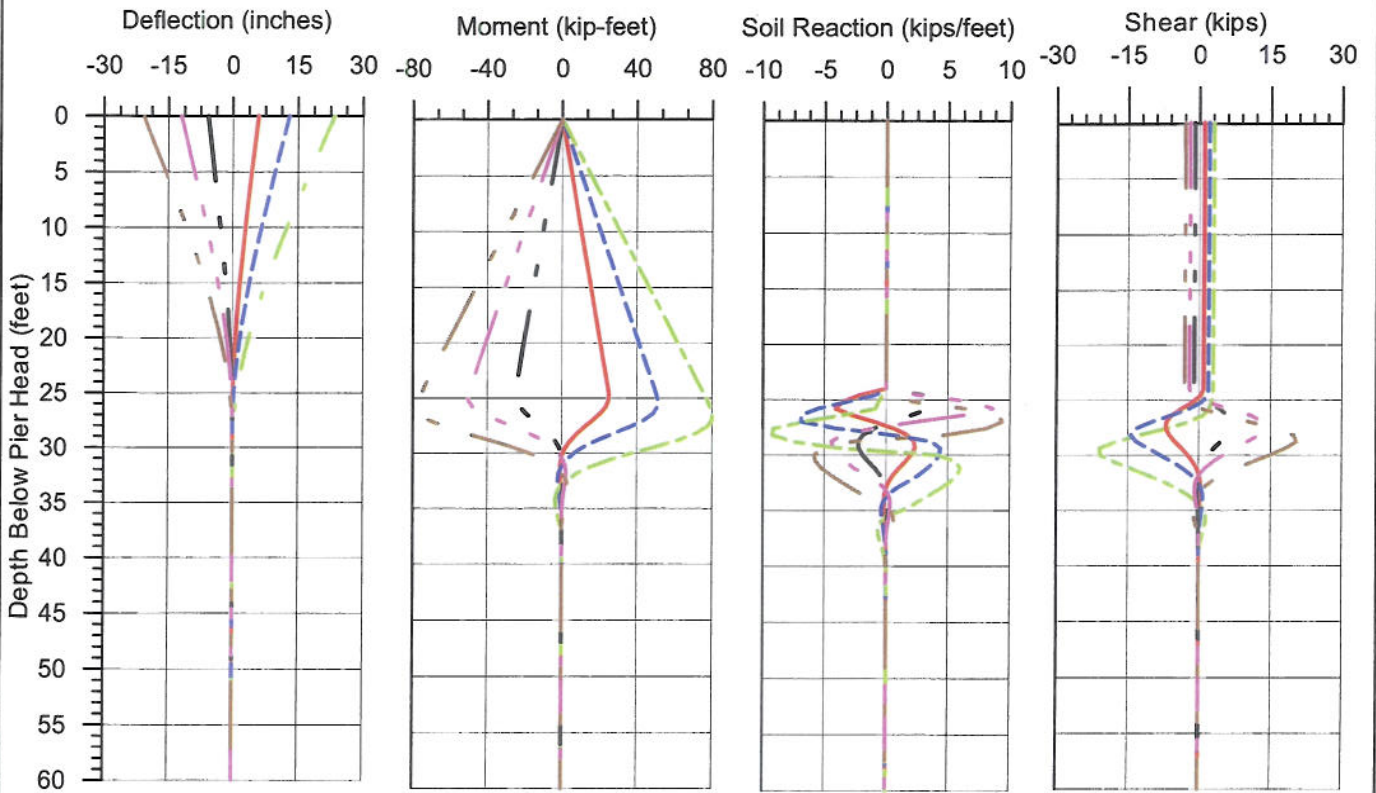
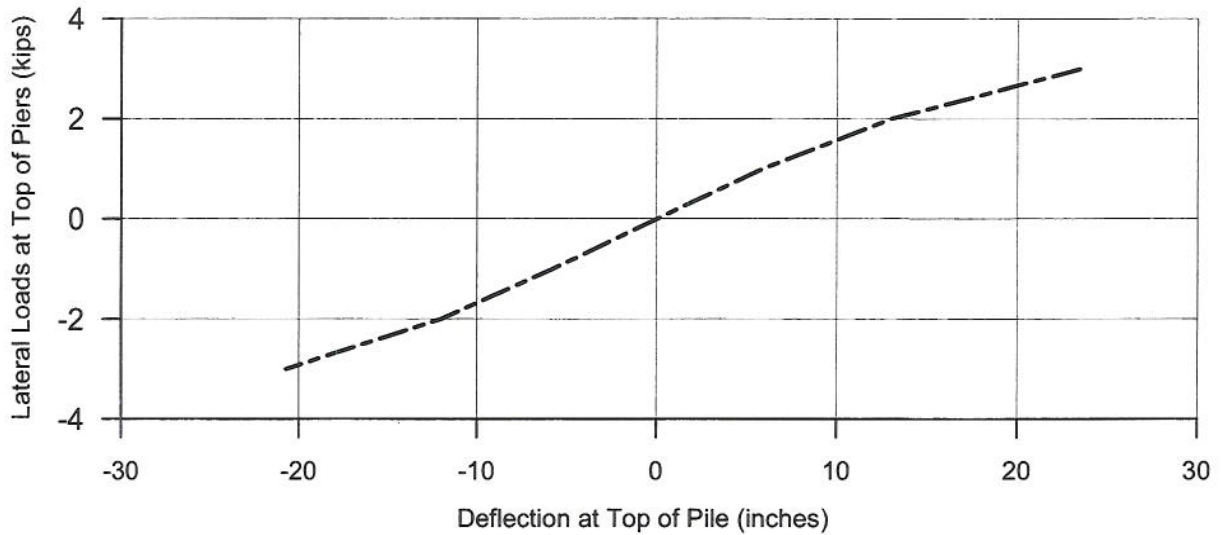
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Date: Jan. 2009

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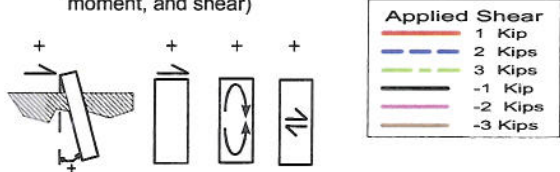
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Notes:

This evaluation applies to piers 60 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



RESPONSE OF 12 INCH DIAMETER, 60-FOOT LONG, 2:12 BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 24 FEET ABOVE THE MUDLINE

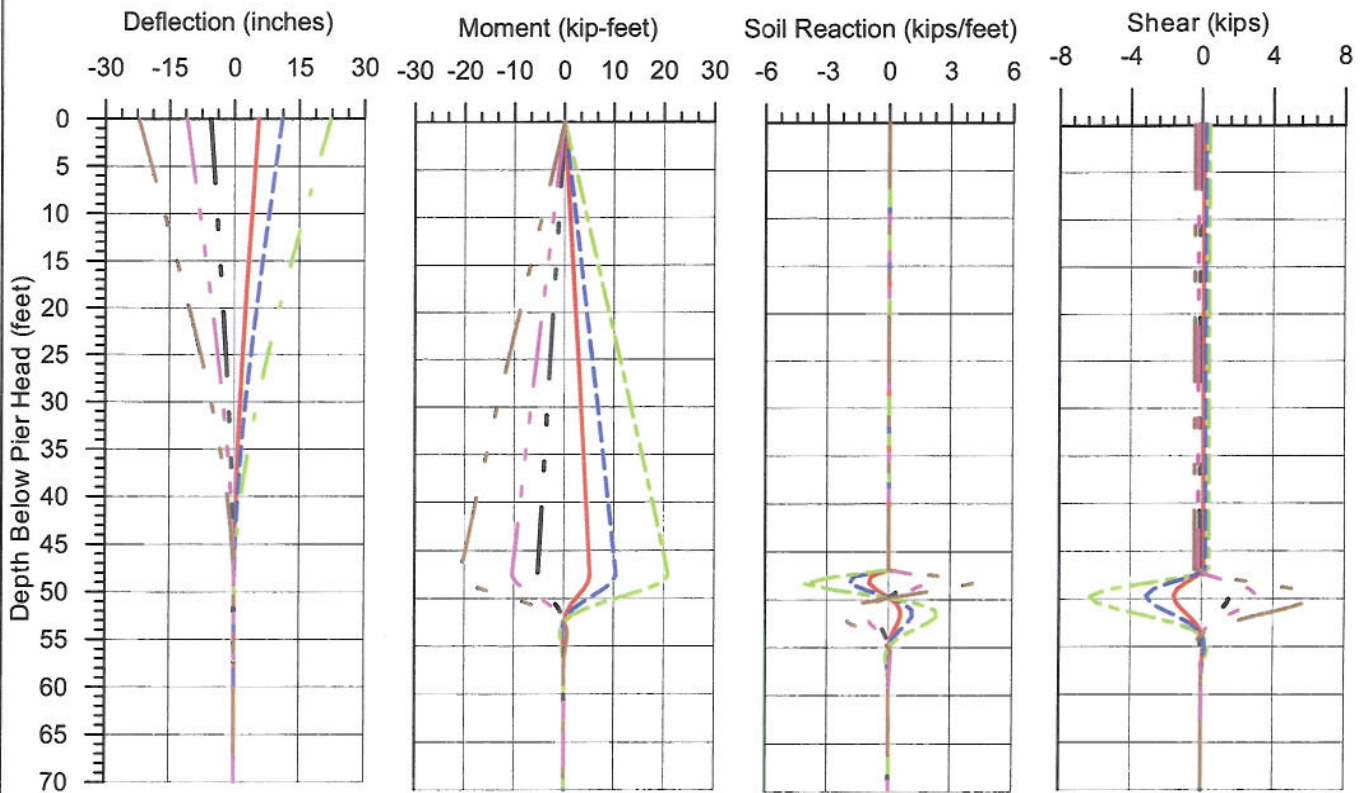
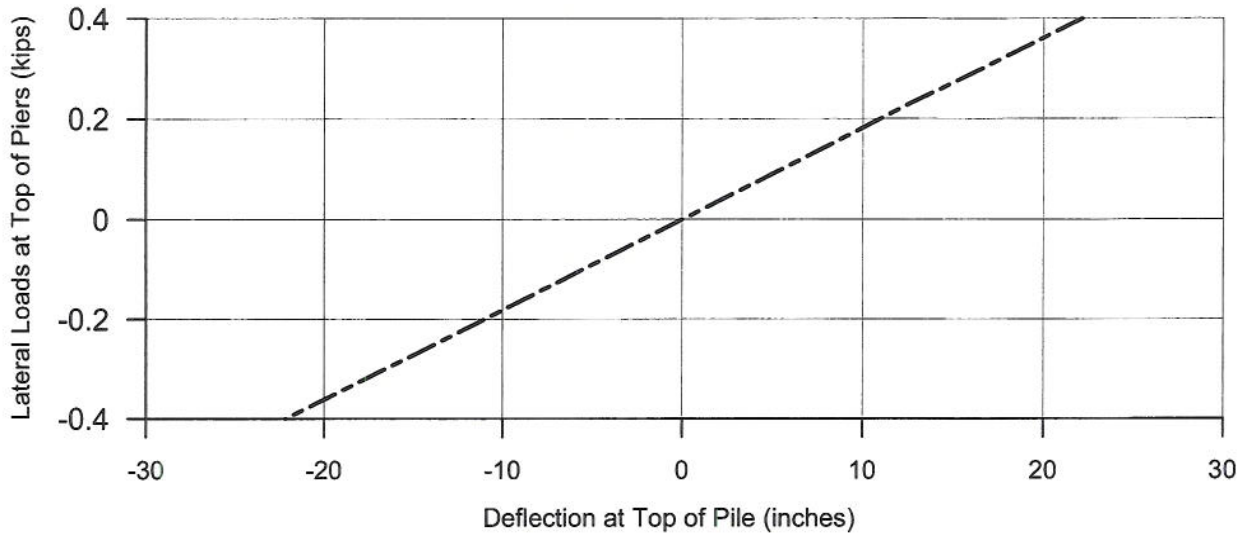
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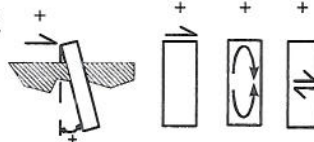
2.9



Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.1 Kip
Blue line	0.2 Kips
Green line	0.4 Kips
Black line	-0.1 Kip
Purple line	-0.2 Kips
Brown line	-0.4 Kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, NO BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

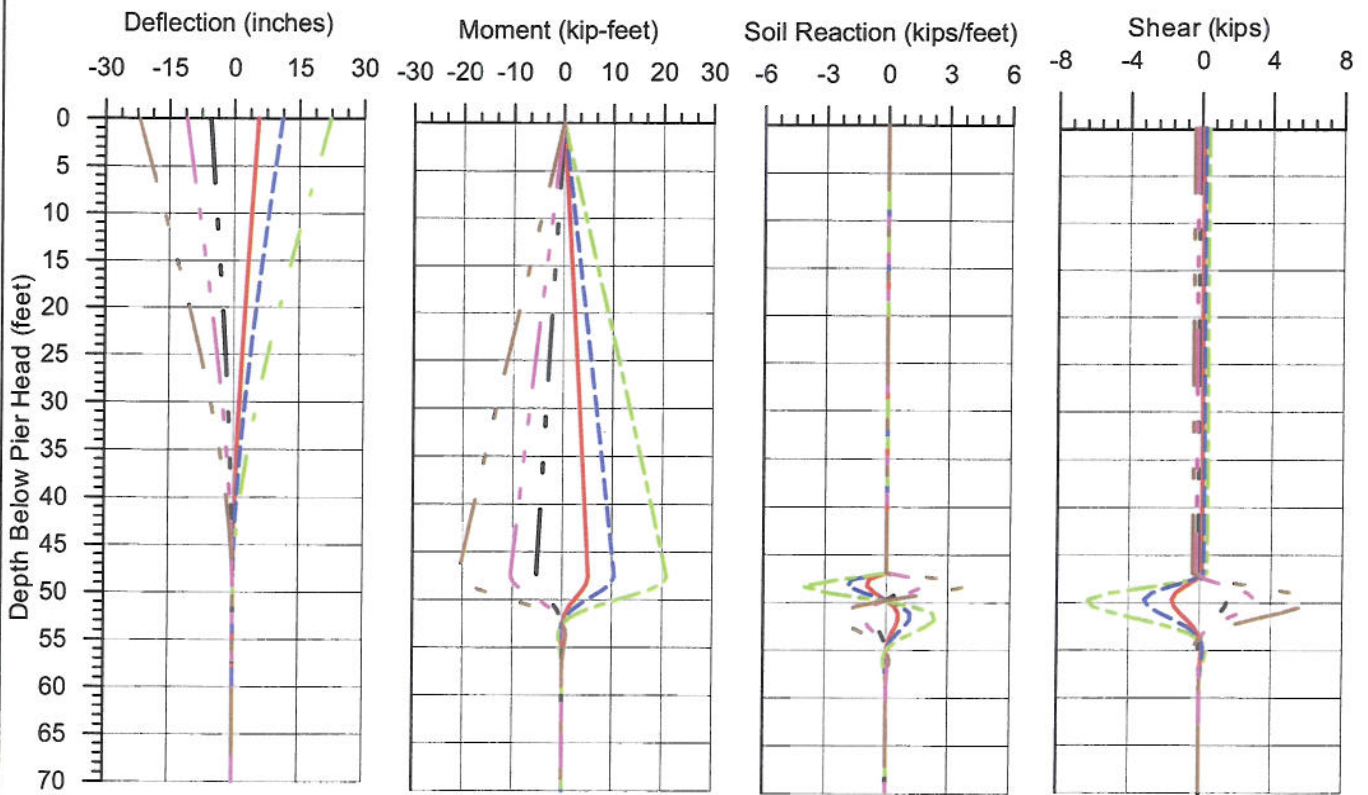
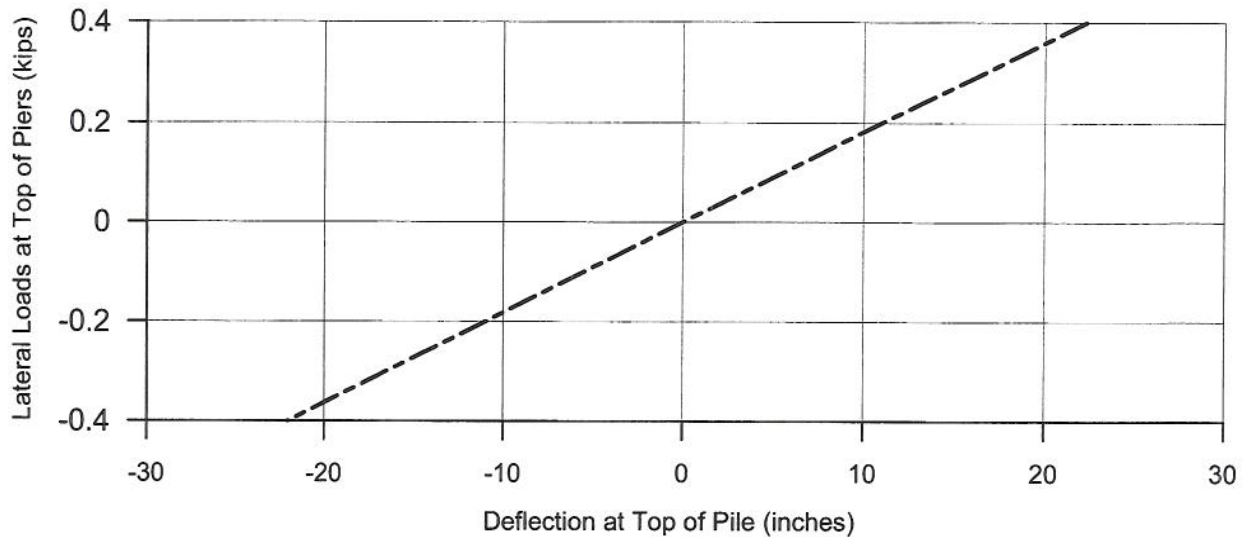
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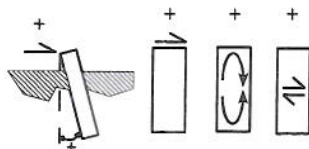
2.10



Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.1 Kip
Blue line	0.2 Kips
Green line	0.4 Kips
Black line	-0.1 Kip
Magenta line	-0.2 Kips
Brown line	-0.4 kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, 1:12 BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

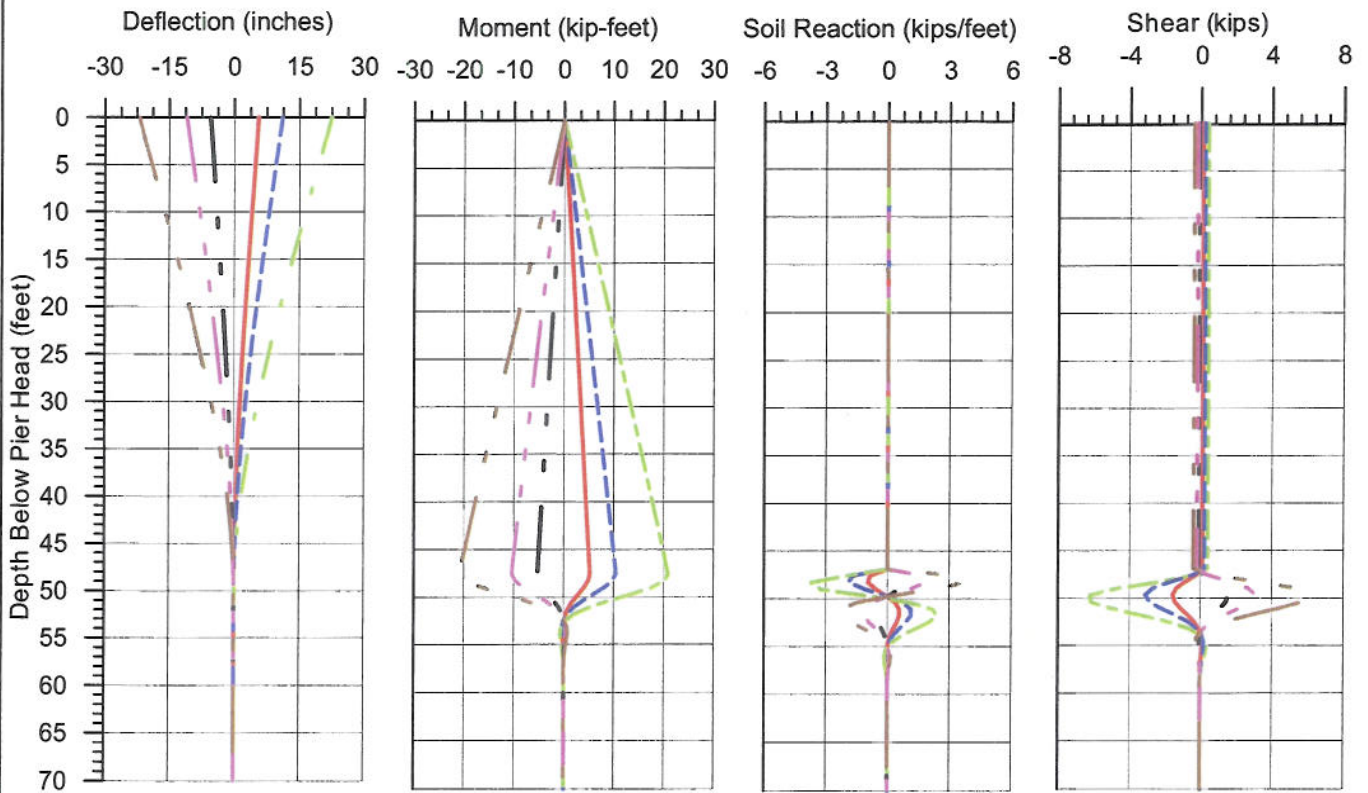
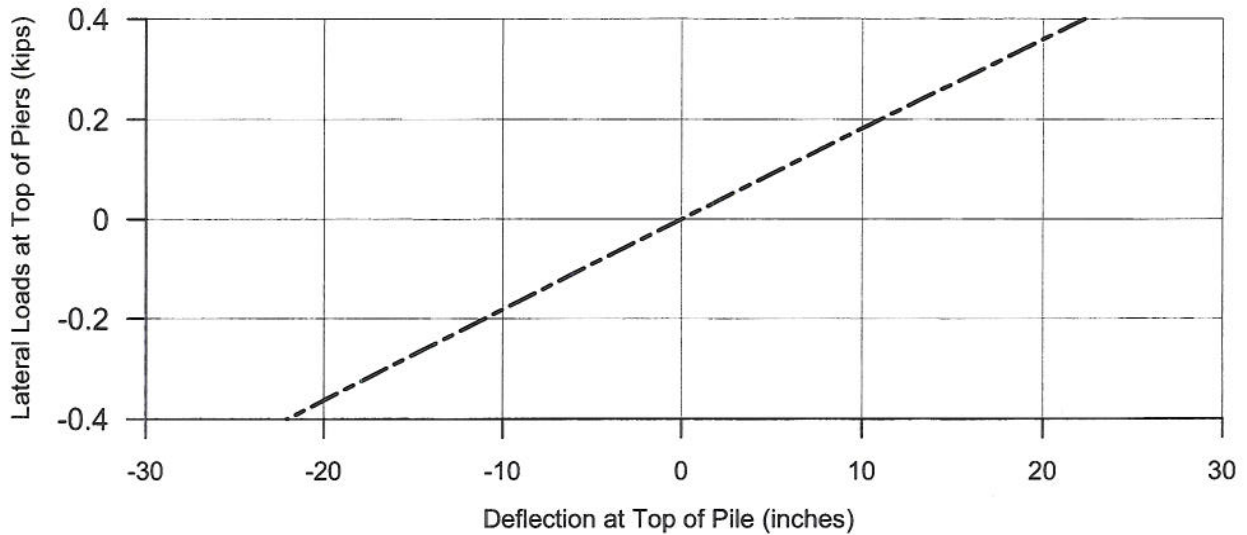
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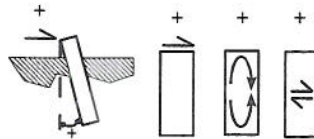
2.11



Notes:

This evaluation applies to piers 70 feet long or longer.
 Modulus of Elasticity of Green Heart timber was assumed 3,000,000 psi.
 Vertical Load of 1 kip was applied at the pile head.

Sign Conventions
 (direction of positive batter angle, positive load, moment, and shear)



Applied Shear	
Red line	0.1 Kip
Blue dashed line	0.2 Kips
Green dashed line	0.4 Kips
Black line	-0.1 Kip
Purple line	-0.2 Kips
Brown line	-0.4 Kips



RESPONSE OF 12 INCH DIAMETER, 70-FOOT LONG, 2:12 BATTER
 FREE HEAD GREEN HEART TIMBER PILE TO LATERAL LOADING
 TOP OF PILE 47 FEET ABOVE THE MUDLINE

MILLER SWEENEY PILE DOLPHINS & FENDER PILE REPAIRS
 ALAMEDA HARBOR, CALIFORNIA

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Date: Jan. 2009

Plate

2.12