Appendix C
Structural Design Calculations

CH2MHILL®

Port of Anchorage

Intermodal Expansion Project – 15% Concept Design

Preliminary Structural Design Calculations

February 2013

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US Army Corps of Engineers — **By:** **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**
Pile Axial Capacity Design - Option 1 - Section B Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**
Date: **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 1 - Section B Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile									Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	14	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	182	
Ground Elevation (ft)	-27.4	-23.4	-19.4	-15.4	-11.4	-7.4	-3.4	0.6	4.6	7.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-27.4	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-27.4	-23.4	-19.4	-15.4	-11.4	-10.0	-10.0	-10.0	-10.0	-10.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	2.6	6.6	10.6	14.6	17.4	
Thickness of Soft Mud (ft)	0.0	1.6	5.6	9.6	13.6	15.0	15.0	15.0	15.0	15.0	
Pile Tip Elevation (ft)	-165.0	-160.0	-155.0	-150.0	-145.0	-140.0	-140.0	-140.0	-125.0	-110.0	
Total Pile Length (ft)	198.0	193.5	188.5	183.5	178.5	173.5	173.5	173.5	158.5	143.5	
Pile Length Above Ground Surface (ft)	60.4	56.9	52.9	48.9	44.9	40.9	36.9	32.9	28.9	26.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	137.6	136.6	135.6	134.6	133.6	132.6	136.6	140.6	129.6	117.4	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.75	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5	45.0	
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.5	15.0	
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	72.9	
Crane Rail Beam											
48" Steel Pipe Pile (including Concrete Fill)	219.8	211.2	201.4	191.6	181.8	172.0	164.7	157.5	142.6	129.8	
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	200.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail											50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1259	1217	1205	1194	1182	1170	1162	1153	1017	705	Factored
Nominal Axial Capacity (kips per pile)	4831.8	4462.7	4093.5	3724.1	3354.6	2985	4462.7	3058.4	2641.2	2220	From Geotech
Ultimate Axial Capacity (kips per pile)	1957	1807	1658	1508	1359	1209	1807	1239	1070	749	including group reduction factor and resistance factor
D/C Ratio	0.64	0.67	0.73	0.79	0.87	0.97	0.64	0.93	0.95	0.94	

Purpose of Calculations:

To evaluate the axial capacity of 36-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 1 - Section B BARGE Berth - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-39.9	-36.7	-33.5	-30.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-39.9	-36.7	-33.5	-30.3	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-39.9	-36.7	-33.5	-30.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-135.0	
Total Pile Length (ft)	178.0	178.5	173.5	168.5	
Pile Length Above Ground Surface (ft)	72.9	70.2	67.0	63.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	105.1	108.3	106.5	104.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	232.1	227.5	219.1	210.8
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1046	1067	1057	983	Factored
Nominal Axial Capacity (kips per pile)	3402.1	4044.2	3769	3035	From Geotech
Ultimate Axial Capacity (kips per pile)	1225	1456	1357	1093	including group reduction factor and resistance factor
D/C Ratio	0.85	0.73	0.78	0.90	

US Army Corps of Engineers — **By:** **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**
Pile Axial Capacity Design - Option 1A - Section A Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**
Date: **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 36-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations
Pile Axial Capacity Design - Option 1A - Section A Trestle - 48" Hybrid Pile

By: G. Jankhah
Date: January 29, 2013
Checked By: Vu Phan
Date: February 11, 2013

Pile Data

	Front Row Pile									Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	14	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	182	
Ground Elevation (ft)	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	17.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-17.4	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-17.4	-13.4	-9.4	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	4.6	8.6	12.6	16.6	20.6	24.6	27.4	
Thickness of Soft Mud (ft)	0.0	1.6	5.6	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Pile Tip Elevation (ft)	-155.0	-150.0	-145.0	-140.0	-135.0	-130.0	-125.0	-125.0	-115.0	-100.0	
Total Pile Length (ft)	188.0	183.5	178.5	173.5	168.5	163.5	158.5	158.5	148.5	133.5	
Pile Length Above Ground Surface (ft)	50.4	46.9	42.9	38.9	34.9	30.9	26.9	22.9	18.9	16.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	137.6	136.6	135.6	134.6	133.6	132.6	131.6	135.6	129.6	117.4	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.75	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5	45.0
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.5	15.0
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	72.9
Crane Rail Beam										
48" Steel Pipe Pile (including Concrete Fill)	196.6	188.0	178.2	168.4	158.6	148.8	139.0	131.8	119.4	106.6
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	200.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail											50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1231	1189	1178	1166	1154	1142	1131	1122	989	677	Factored
Nominal Axial Capacity (kips per pile)	3172.612	3134.714	3096.816	3058.919	3021.021	2985	2946	2865.1	2641.2	2220	From Geotech
Ultimate Axial Capacity (kips per pile)	1285	1270	1254	1239	1224	1209	1193	1160	1070	749	including group reduction factor and resistance factor
D/C Ratio	0.96	0.94	0.94	0.94	0.94	0.94	0.95	0.97	0.93	0.90	

Purpose of Calculations:

To evaluate the axial capacity of 36-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**

Pile Axial Capacity Design - Option 1 - Section A BARGE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**

Date: | **February 11, 2013**

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-29.9	-26.7	-23.5	-20.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-29.9	-26.7	-23.5	-20.3	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-29.9	-26.7	-23.5	-20.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-135.0	
Total Pile Length (ft)	178.0	178.5	173.5	168.5	
Pile Length Above Ground Surface (ft)	62.9	60.2	57.0	53.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	115.1	118.3	116.5	114.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	214.0	209.4	201.1	192.7
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1024	1045	1035	962	Factored
Nominal Axial Capacity (kips per pile)	3405.33	4052.81	3773.79	3036.97	From Geotech
Ultimate Axial Capacity (kips per pile)	1226	1459	1359	1093	including group reduction factor and resistance factor
D/C Ratio	0.84	0.72	0.76	0.88	

US Army Corps of Engineers	**By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations	**Date:**	**January 29, 2013**
Pile Axial Capacity Design - Option 1 - Section C Access Trestle - 48" Hybrid Pile	**Checked By:**	**Vu Phan**
	Date:	**February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 36-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
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4. Structural Design Criteria
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Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	3	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**

Pile Axial Capacity Design - Option 1 - Section C Access Trestle - 48" Hybrid Pile | **Checked By:** | **Vu Phan**

Date: | **February 11, 2013**

Pile Data

	Front Row Pile											Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	11	12	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	20	20	20	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	188	208	228	
Ground Elevation (ft)	-37.4	-33.4	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	Based on 5:1 Slope
Top of BCF Elevation (ft)	-45.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-45.0	-41.0	-41.0	-36.0	-31.0	-26.0	-21.0	-19.0	-19.0	-19.0	-19.0	-19.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	7.6	7.6	11.6	10.6	9.6	8.6	7.6	9.6	13.6	17.6	21.6	25.6	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	5.0	10.0	15.0	20.0	22.0	22.0	22.0	22.0	22.0	
Pile Tip Elevation (ft)	-165.0	-160.0	-155.0	-150.0	-145.0	-145.0	-140.0	-135.0	-130.0	-145.0	-140.0	-125.0	
Total Pile Length (ft)	198.0	193.5	188.5	183.5	178.5	178.5	173.5	168.5	163.5	178.5	173.5	158.5	
Pile Length Above Ground Surface (ft)	70.4	66.9	62.9	58.9	54.9	50.9	46.9	42.9	38.9	34.9	30.9	26.9	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	127.6	126.6	125.6	124.6	123.6	127.6	126.6	125.6	124.6	143.6	142.6	131.6	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5	
3" Asphalt Overlay	13.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	12.8	
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	83.7	
Crane Rail Beam													
48" Steel Pipe Pile (including Concrete Fill)	237.9	229.2	219.4	209.6	199.8	192.6	182.8	173.0	163.2	163.7	153.9	139.0	
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail													50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1264	1221	1209	1197	1186	1177	1165	1153	1142	1142	1131	988	Factored
Nominal Axial Capacity (kips per pile)	4606.1	4238	3869.9	3501.6	3133.3	4606.1	4238	3869.9	3501.6	2995.4	2956.5	2544.5	From Geotech
Ultimate Axial Capacity (kips per pile)	1865	1716	1567	1418	1269	1865	1716	1567	1418	1213	1197	1031	including group reduction factor and resistance factor
D/C Ratio	0.68	0.71	0.77	0.84	0.93	0.63	0.68	0.74	0.81	0.94	0.94	0.96	

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 1- Section C TOTE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 36-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013

Pile Axial Capacity Design - Option 1- Section C TOTE Berth - 48" Hybrid Pile — **Checked By:** Vu Phan

Date: February 11, 2013

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-49.9	-46.7	-43.5	-40.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-51.0	-51.0	-51.0	-51.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-51.0	-51.0	-51.0	-51.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	1.1	4.3	7.5	10.7	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-140.0	
Total Pile Length (ft)	178.0	178.5	173.5	173.5	
Pile Length Above Ground Surface (ft)	82.9	80.2	77.0	73.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	95.1	98.3	96.5	99.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	250.2	245.6	237.2	231.4
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1067	1089	1079	1008	Factored
Nominal Axial Capacity (kips per pile)	3133.9	3518.6	3397.4	3579.9	From Geotech
Ultimate Axial Capacity (kips per pile)	1128	1267	1223	1289	including group reduction factor and resistance factor
D/C Ratio	0.95	0.86	0.88	0.78	

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section B Trestle - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Pile Data

	Front Row Pile									Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	14	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	182	
Ground Elevation (ft)	-27.4	-23.4	-19.4	-15.4	-11.4	-7.4	-3.4	0.6	4.6	7.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-27.4	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-27.4	-23.4	-19.4	-15.4	-11.4	-10.0	-10.0	-10.0	-10.0	-10.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	2.6	6.6	10.6	14.6	17.4	
Thickness of Soft Mud (ft)	0.0	1.6	5.6	9.6	13.6	15.0	15.0	15.0	15.0	15.0	
Pile Tip Elevation (ft)	-165.0	-160.0	-155.0	-150.0	-145.0	-140.0	-140.0	-140.0	-125.0	-110.0	
Total Pile Length (ft)	198.0	193.5	188.5	183.5	178.5	173.5	173.5	173.5	158.5	143.5	
Pile Length Above Ground Surface (ft)	60.4	56.9	52.9	48.9	44.9	40.9	36.9	32.9	28.9	26.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	137.6	136.6	135.6	134.6	133.6	132.6	136.6	140.6	129.6	117.4	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.75	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5	45.0	
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.5	15.0	
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	72.9	
Crane Rail Beam											
48" Steel Pipe Pile (including Concrete Fill)	219.8	211.2	201.4	191.6	181.8	172.0	164.7	157.5	142.6	129.8	
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	200.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail											50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1259	1217	1205	1194	1182	1170	1162	1153	1017	705	Factored
Nominal Axial Capacity (kips per pile)	4831.8	4462.7	4093.5	3724.1	3354.6	2985	4462.7	3058.4	2641.2	2220	From Geotech
Ultimate Axial Capacity (kips per pile)	1957	1807	1658	1508	1359	1209	1807	1239	1070	749	including group reduction factor and resistance factor
D/C Ratio	0.64	0.67	0.73	0.79	0.87	0.97	0.64	0.93	0.95	0.94	

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section B BARGE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section B BARGE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-39.9	-36.7	-33.5	-30.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-39.9	-36.7	-33.5	-30.3	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-39.9	-36.7	-33.5	-30.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-135.0	
Total Pile Length (ft)	178.0	178.5	173.5	168.5	
Pile Length Above Ground Surface (ft)	72.9	70.2	67.0	63.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	105.1	108.3	106.5	104.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	232.1	227.5	219.1	210.8
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1046	1067	1057	983	Factored
Nominal Axial Capacity (kips per pile)	3402.1	4044.2	3769	3035	From Geotech
Ultimate Axial Capacity (kips per pile)	1225	1456	1357	1093	including group reduction factor and resistance factor
D/C Ratio	0.85	0.73	0.78	0.90	

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 5 - Section A Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile									Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	14	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	182	
Ground Elevation (ft)	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	17.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-17.4	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	-15.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-17.4	-13.4	-9.4	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	-10.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	4.6	8.6	12.6	16.6	20.6	24.6	27.4	
Thickness of Soft Mud (ft)	0.0	1.6	5.6	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Pile Tip Elevation (ft)	-155.0	-150.0	-145.0	-140.0	-135.0	-130.0	-125.0	-125.0	-115.0	-100.0	
Total Pile Length (ft)	188.0	183.5	178.5	173.5	168.5	163.5	158.5	158.5	148.5	133.5	
Pile Length Above Ground Surface (ft)	50.4	46.9	42.9	38.9	34.9	30.9	26.9	22.9	18.9	16.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	137.6	136.6	135.6	134.6	133.6	132.6	131.6	135.6	129.6	117.4	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.75	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5	45.0	
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.5	15.0	
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	72.9	
Crane Rail Beam											
48" Steel Pipe Pile (including Concrete Fill)	196.6	188.0	178.2	168.4	158.6	148.8	139.0	131.8	119.4	106.6	
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	200.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail											50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1231	1189	1178	1166	1154	1142	1131	1122	989	677	Factored
Nominal Axial Capacity (kips per pile)	3172.612	3134.7139	3096.816	3058.919	3021.021	2985	2946	2865.1	2641.2	2220	From Geotech
Ultimate Axial Capacity (kips per pile)	1285	1270	1254	1239	1224	1209	1193	1160	1070	749	including group reduction factor and resistance factor
D/C Ratio	0.96	0.94	0.94	0.94	0.94	0.94	0.95	0.97	0.93	0.90	

US Army Corps of Engineers		**By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations		**Date:**	**January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section A BARGE Berth - 48" Hybrid Pile		**Checked By:**	**Vu Phan**
		Date:	**February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section A BARGE Berth - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-29.9	-26.7	-23.5	-20.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-29.9	-26.7	-23.5	-20.3	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-29.9	-26.7	-23.5	-20.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-135.0	
Total Pile Length (ft)	178.0	178.5	173.5	168.5	
Pile Length Above Ground Surface (ft)	62.9	60.2	57.0	53.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	115.1	118.3	116.5	114.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	214.0	209.4	201.1	192.7
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1024	1045	1035	962	Factored
Nominal Axial Capacity (kips per pile)	3405.33	4052.81	3773.79	3036.97	From Geotech
Ultimate Axial Capacity (kips per pile)	1226	1459	1359	1093	including group reduction factor and resistance factor
D/C Ratio	0.84	0.72	0.76	0.88	

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section C Trestle - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.24	(1V:4.25H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section C Trestle - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Pile Data

	Front Row Pile									Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	20	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	188	
Ground Elevation (ft)	-35.0	-30.3	-25.6	-20.9	-16.2	-11.5	-6.8	-2.1	2.6	7.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-35.0	-30.3	-25.6	-20.9	-16.2	-11.5	-6.8	-2.1	2.6	7.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	20.0	24.7	29.4	34.1	38.8	43.5	48.2	52.9	57.6	62.3	
Pile Tip Elevation (ft)	-170.0	-160.0	-155.0	-150.0	-145.0	-140.0	-135.0	-130.0	-125.0	-95.0	
Total Pile Length (ft)	203.0	193.5	188.5	183.5	178.5	173.5	168.5	163.5	158.5	128.5	
Pile Length Above Ground Surface (ft)	68.0	63.8	59.1	54.4	49.7	45.0	40.3	35.6	30.9	26.2	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	135.0	129.7	129.4	129.1	128.8	128.5	128.2	127.9	127.6	102.3	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	58.5
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	19.5
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	72.9
Crane Rail Beam										
48" Steel Pipe Pile (including Concrete Fill)	236.1	223.6	212.6	201.5	190.4	179.4	168.3	157.2	146.2	122.3
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	260.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail											50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1278	1232	1219	1206	1192	1179	1166	1152	1139	813	Factored
Nominal Axial Capacity (kips per pile)	3327	3124.3	3124.3	3124.3	3084.5	3084.5	3084.5	3044.9	3044.9	2132.5	From Geotech
Ultimate Axial Capacity (kips per pile)	1347	1265	1265	1265	1249	1249	1249	1233	1233	864	including group reduction factor and resistance factor
D/C Ratio	0.95	0.97	0.96	0.95	0.95	0.94	0.93	0.93	0.92	0.94	

US Army Corps of Engineers		**By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations		**Date:**	**January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section C TOTE Berth - 48" Hybrid Pile		**Checked By:**	**Vu Phan**
		Date:	**February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.24	(1V:4.25H	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section C TOTE Berth - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-49.7	-45.9	-42.2	-38.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-49.7	-45.9	-42.2	-38.4	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	5.3	9.1	12.8	16.6	
Pile Tip Elevation (ft)	-170.0	-165.0	-165.0	-160.0	
Total Pile Length (ft)	203.0	198.5	198.5	193.5	
Pile Length Above Ground Surface (ft)	82.7	79.4	75.7	71.9	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	120.3	119.1	122.8	121.6	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	262.7	254.5	247.7	238.3
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1082	1099	1091	1016	Factored
Nominal Axial Capacity (kips per pile)	4055.7	3692.5	4781.6	4418.7	From Geotech
Ultimate Axial Capacity (kips per pile)	1460	1329	1721	1591	including group reduction factor and resistance factor
D/C Ratio	0.74	0.83	0.63	0.64	

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section D Trestle - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.24	(1V:4.25H	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 5 - Section D Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile						Back-row Pile	Note
Row	1	2	3	4	5	6	7	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	
Ground Elevation (ft)	-21.8	-17.1	-12.4	-7.7	-3.0	1.7	6.4	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-21.8	-17.1	-12.4	-7.7	-3.0	1.7	6.4	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	33.2	37.9	42.6	47.3	52.0	56.7	61.4	
Pile Tip Elevation (ft)	-160.0	-150.0	-145.0	-140.0	-135.0	-130.0	-115.0	
Total Pile Length (ft)	193.0	183.5	178.5	173.5	168.5	163.5	148.5	
Pile Length Above Ground Surface (ft)	54.8	50.6	45.9	41.2	36.5	31.8	27.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	138.2	132.9	132.6	132.3	132.0	131.7	121.4	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	76.5	
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	25.5	
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	83.7	
Crane Rail Beam								
48" Steel Pipe Pile (including Concrete Fill)	207.1	194.7	183.6	172.5	161.5	150.4	134.2	
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	340.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail								50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1244	1197	1184	1171	1158	1144	998	Factored
Nominal Axial Capacity (kips per pile)	3302.9	3060.5	3060.5	3060.5	3060.5	3020.9	2638	From Geotech
Ultimate Axial Capacity (kips per pile)	1338	1240	1240	1240	1240	1223	1068	including group reduction factor and resistance factor
D/C Ratio	0.93	0.97	0.96	0.94	0.93	0.94	0.93	

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5 - Section D Horizon Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
| **Date:** | **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	18	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	10	ft	
Embankment Slope	0.24	(1V:4.25H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5.25	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** G. Jankhah
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** January 29, 2013
Pile Axial Capacity Design - Option 5 - Section D Horizon Berth - 48" Hybrid Pile — **Checked By:** Vu Phan
Date: February 11, 2013

Pile Data

	Water-side Crane Rail						Land-side Crane Rail	Note
Row	1	2	3	4	5	6	7	
Distance to Previous Row (ft)	0	12	18	18	18	18	16	
Distance to Water-side Crane Rail (ft)	0	12	30	48	66	84	100	
Distance to Wharf Face (ft)	8	20	38	56	74	92	108	
Ground Elevation (ft)	-49.1	-46.3	-42.1	-37.8	-33.6	-29.4	-25.6	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-49.1	-46.3	-42.1	-37.8	-33.6	-29.4	-25.6	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Thickness of Silt/Mud (ft)	5.9	8.7	12.9	17.2	21.4	25.6	29.4	
Pile Tip Elevation (ft)	-190.0	-180.0	-170.0	-165.0	-160.0	-155.0	-165.0	
Total Pile Length (ft)	222.8	213.5	203.5	198.5	193.5	188.5	198.5	
Pile Length Above Ground Surface (ft)	81.9	79.8	75.6	71.3	67.1	62.9	59.1	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	140.9	133.7	127.9	127.2	126.4	125.6	139.4	
Group Reduction Factor	0.65	0.70	0.85	0.85	0.85	0.80	0.65	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel		67.5	81.0	81.0	81.0	76.5	
6" Asphalt Overlay		22.5	27.0	27.0	27.0	25.5	
Pile Cap		86.4	86.4	86.4	86.4	86.4	
Crane Rail Beam	94.5						94.5
48" Steel Pipe Pile (including Concrete Fill)	271.3	262.8	250.0	239.8	229.6	219.3	217.7
8' dia. Ice	56.9	58.1	58.1	58.1	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load		300.0	360.0	360.0	360.0	340.0		1000 psf

Crane Rail Load (kips per pile)

Crane Rail	500.0						500.0	50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1157	1077	1179	1167	1154	1103	1094	Factored
Nominal Axial Capacity (kips per pile)	4855.6	3597.6	3345.9	3345.9	3304.9	3264.1	4493.9	From Geotech
Ultimate Axial Capacity (kips per pile)	1420	1133	1280	1280	1264	1175	1314	including group reduction factor and resistance factor
D/C Ratio	0.81	0.95	0.92	0.91	0.91	0.94	0.83	

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 5H - Section A Access Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile											Back-row Pile	Note
Row	1	2	3	4	5	6	7	8	9	10	11	12	
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	20	20	20	
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	188	208	228	
Ground Elevation (ft)	-37.4	-33.4	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	Based on 5:1 Slope
Top of BCF Elevation (ft)	-45.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-45.0	-41.0	-41.0	-36.0	-31.0	-26.0	-21.0	-19.0	-19.0	-19.0	-19.0	-19.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	7.6	7.6	11.6	10.6	9.6	8.6	7.6	9.6	13.6	17.6	21.6	25.6	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	5.0	10.0	15.0	20.0	22.0	22.0	22.0	22.0	22.0	
Pile Tip Elevation (ft)	-165.0	-160.0	-155.0	-150.0	-145.0	-145.0	-140.0	-135.0	-130.0	-145.0	-140.0	-130.0	
Total Pile Length (ft)	198.0	193.5	188.5	183.5	178.5	178.5	173.5	168.5	163.5	178.5	173.5	163.5	
Pile Length Above Ground Surface (ft)	70.4	66.9	62.9	58.9	54.9	50.9	46.9	42.9	38.9	34.9	30.9	26.9	Assume steel pipe pile will be concrete filled above ground surfa
Pile Embedment in the Soil (ft)	127.6	126.6	125.6	124.6	123.6	127.6	126.6	125.6	124.6	143.6	142.6	136.6	
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	76.5
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.5
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	83.7
Crane Rail Beam												
36" Steel Pipe Pile (including Concrete Fill)	237.9	229.2	219.4	209.6	199.8	192.6	182.8	173.0	163.2	163.7	153.9	141.5
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	340.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail													50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1280	1239	1227	1215	1204	1195	1183	1171	1160	1160	1149	1006	Factored
Nominal Axial Capacity (kips per pile)	4606.1	4238	3869.9	3501.6	3133.3	4606.1	4238	3869.9	3501.6	2995.4	2956.5	2728.2	From Geotech
Ultimate Axial Capacity (kips per pile)	1865	1716	1567	1418	1269	1865	1716	1567	1418	1213	1197	1105	including group reduction factor and resistance factor
D/C Ratio	0.69	0.72	0.78	0.86	0.95	0.64	0.69	0.75	0.82	0.96	0.96	0.91	

US Army Corps of Engineers		**By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations		**Date:**	**January 29, 2013**
Pile Axial Capacity Design - Option 5H - Section A TOTE Berth - 48" Hybrid Pile		**Checked By:**	**Vu Phan**
		Date:	**February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**

Pile Axial Capacity Design - Option 5H - Section A TOTE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**

Date: | **February 11, 2013**

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-49.9	-46.7	-43.5	-40.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-51.0	-51.0	-51.0	-51.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-51.0	-51.0	-51.0	-51.0	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	1.1	4.3	7.5	10.7	
Thickness of Soft Mud (ft)	0.0	0.0	0.0	0.0	
Pile Tip Elevation (ft)	-145.0	-145.0	-140.0	-140.0	
Total Pile Length (ft)	178.0	178.5	173.5	173.5	
Pile Length Above Ground Surface (ft)	82.9	80.2	77.0	73.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	95.1	98.3	96.5	99.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
36" Steel Pipe Pile (including Concrete Fill)	250.2	245.6	237.2	231.4
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1067	1089	1079	1008	Factored
Nominal Axial Capacity (kips per pile)	3133.9	3518.6	3397.4	3579.9	From Geotech
Ultimate Axial Capacity (kips per pile)	1128	1267	1223	1289	including group reduction factor and resistance factor
D/C Ratio	0.95	0.86	0.88	0.78	

US Army Corps of Engineers	**By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations	**Date:**	**January 29, 2013**
Pile Axial Capacity Design - Option 5H - Section B Trestle - 48" Hybrid Pile	**Checked By:**	**Vu Phan**
	Date:	**February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 5H - Section B Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile																		Back-row Pile
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	348	368
Ground Elevation (ft)	-37.4	-33.4	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	18.6	22.6	26.6	30.6	34.6
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0
Top of Silt/Mud (ft)	-37.4	-33.4	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	18.6	22.6	26.6	30.6	34.6
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thickness of Soft Mud (ft)	17.6	21.6	25.6	29.6	33.6	37.6	41.6	45.6	49.6	53.6	57.6	61.6	65.6	69.6	73.6	77.6	81.6	85.6	89.6
Pile Tip Elevation (ft)	-175.0	-170.0	-165.0	-160.0	-155.0	-150.0	-145.0	-140.0	-135.0	-130.0	-125.0	-135.0	-130.0	-125.0	-120.0	-115.0	-110.0	-105.0	-105.0
Total Pile Length (ft)	208.0	203.5	198.5	193.5	188.5	183.5	178.5	173.5	168.5	163.5	158.5	168.5	163.5	158.5	153.5	148.5	143.5	138.5	138.5
Pile Length Above Ground Surface (ft)	70.4	66.9	62.9	58.9	54.9	50.9	46.9	42.9	38.9	34.9	30.9	26.9	22.9	18.9	14.9	10.9	6.9	2.9	-1.1
Pile Embedment in the Soil (ft)	137.6	136.6	135.6	134.6	133.6	132.6	131.6	130.6	129.6	128.6	127.6	141.6	140.6	139.6	138.6	137.6	136.6	135.6	139.6
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Dead Load (kips per pile)																			
24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	99.0
6" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	33.0
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	97.2
Crane Rail Beam																			
48" Steel Pipe Pile (including Concrete Fill)	243.0	234.4	224.6	214.8	205.0	195.2	185.4	175.6	165.8	156.0	146.2	144.1	134.3	124.5	114.7	104.9	95.1	85.3	78.1
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1
Live Load (kips per pile)																			
Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	440.0
Crane Rail Load (kips per pile)																			
Crane Rail																			
Demand vs. Capacity																			
Total Axial Demand (kips per pile)	1287	1245	1233	1222	1210	1198	1186	1175	1163	1151	1139	1137	1125	1113	1102	1090	1078	1066	1142
Nominal Axial Capacity (kips per pile)	3451.5	3409.8	3368.3	3327	3286	3245.2	3204.7	3164.4	3124.3	3084.5	3044.9	3069.4	3029.7	2990.2	2950.9	2911.8	2873	2834.4	2990.2
Ultimate Axial Capacity (kips per pile)	1398	1381	1364	1347	1331	1314	1298	1282	1265	1249	1233	1243	1227	1211	1195	1179	1164	1148	1211
D/C Ratio	0.92	0.90	0.90	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.94

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5H - Section B TOTE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	16	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5H - Section B TOTE Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
Date: | **February 11, 2013**

Pile Data

	Front Row Pile			Back-row Pile	Note
Row	1	2	3	4	
Distance to Previous Row (ft)	0	16	16	16	
Distance to Wharf Face (ft)	5.5	21.5	37.5	53.5	
Ground Elevation (ft)	-49.9	-46.7	-43.5	-40.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-49.9	-46.7	-43.5	-40.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	
Thickness of Soft Mud (ft)	5.1	8.3	11.5	14.7	
Pile Tip Elevation (ft)	-170.0	-165.0	-165.0	-160.0	
Total Pile Length (ft)	203.0	198.5	198.5	193.5	
Pile Length Above Ground Surface (ft)	82.9	80.2	77.0	73.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	120.1	118.3	121.5	119.7	
Group Reduction Factor	0.80	0.80	0.80	0.80	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel	60.8	72.0	72.0	65.3
6" Asphalt Overlay	20.3	24.0	24.0	21.8
Pile Cap	141.0	81.0	81.0	77.0
Crane Rail Beam				
48" Steel Pipe Pile (including Concrete Fill)	263.0	255.8	250.0	241.7
8' dia. Ice	57.3	58.1	58.1	58.1

Live Load (kips per pile)

Uniform Live Load	270.0	320.0	320.0	290.0	1000 psf

Crane Rail Load (kips per pile)

Crane Rail					50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1083	1101	1094	1020	Factored
Nominal Axial Capacity (kips per pile)	4055.7	3329.3	4418.7	3692.5	From Geotech
Ultimate Axial Capacity (kips per pile)	1460	1199	1591	1329	including group reduction factor and resistance factor
D/C Ratio	0.74	0.92	0.69	0.77	

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	20	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	N/A	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers — **By:** **G. Jankhah**

Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations — **Date:** **January 29, 2013**

Pile Axial Capacity Design - Option 5H - Section C Trestle - 48" Hybrid Pile — **Checked By:** **Vu Phan**

Date: **February 11, 2013**

Pile Data

	Front Row Pile																Back-row Pile
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Distance to Previous Row (ft)	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	12
Distance to Wharf Face (ft)	8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	320
Ground Elevation (ft)	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	17.8	21.8	25.8	29.8	33.8	36.2
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0
Top of Silt/Mud (ft)	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	17.8	21.8	25.8	29.8	33.8	36.2
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thickness of Soft Mud (ft)	28.8	32.8	36.8	40.8	44.8	48.8	52.8	56.8	60.8	64.8	68.8	72.8	76.8	80.8	84.8	88.8	91.2
Pile Tip Elevation (ft)	-165.0	-160.0	-155.0	-150.0	-145.0	-140.0	-135.0	-130.0	-125.0	-140.0	-135.0	-130.0	-125.0	-120.0	-115.0	-115.0	-90.0
Total Pile Length (ft)	198.0	193.5	188.5	183.5	178.5	173.5	168.5	163.5	158.5	173.5	168.5	163.5	158.5	153.5	148.5	148.5	123.5
Pile Length Above Ground Surface (ft)	59.2	55.7	51.7	47.7	43.7	39.7	35.7	31.7	27.7	23.7	19.7	15.7	11.7	7.7	3.7	-0.3	-2.7
Pile Embedment in the Soil (ft)	138.8	137.8	136.8	135.8	134.8	133.8	132.8	131.8	130.8	149.8	148.8	147.8	146.8	145.8	144.8	148.8	126.2
Group Reduction Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.70	0.70
Dead Load (kips per pile)																	
24" Precast Haunched Deck Panel	81.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	72.0	45.0
3" Asphalt Overlay	27.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	24.0	15.0
Pile Cap	183.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	91.8	75.6
Crane Rail Beam																	
48" Steel Pipe Pile (including Concrete Fill)	217.6	209.0	199.2	189.4	179.6	169.8	160.0	150.2	140.4	140.9	131.1	121.3	111.5	101.7	91.9	84.7	67.5
8' dia. Ice	57.3	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1	58.1
Live Load (kips per pile)																	
Uniform Live Load	360.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	320.0	200.0
Crane Rail Load (kips per pile)																	
Crane Rail																	
Demand vs. Capacity																	
Total Axial Demand (kips per pile)	1256	1215	1203	1191	1179	1168	1156	1144	1132	1133	1121	1109	1098	1086	1074	909	633
Nominal Axial Capacity (kips per pile)	3302.9	3261.9	3221.2	3180.6	3140.3	3100.3	3060.5	3020.9	2981.5	3058.8	3019.3	2980	2940.9	2902.1	2863.5	3019.3	2208.5
Ultimate Axial Capacity (kips per pile)	1338	1321	1305	1288	1272	1256	1240	1223	1208	1239	1223	1207	1191	1175	1160	951	696
D/C Ratio	0.94	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.91	0.92	0.92	0.92	0.92	0.93	0.96	0.91

US Army Corps of Engineers | **By:** | **G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations | **Date:** | **January 29, 2013**
Pile Axial Capacity Design - Option 5H - Section C Horizon Berth - 48" Hybrid Pile | **Checked By:** | **Vu Phan**
| **Date:** | **February 11, 2013**

Purpose of Calculations:

To evaluate the axial capacity of 48-in hybrid pipe piles under the design loading and verify the pile embedments.

References:

1. AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Sixth Edition with Interims, 2012
2. Port of Anchorage 15% Concept Plans
3. LBFoster Pipe Piling
4. Structural Design Criteria
5. Geotechnical Memorandum

Design Assumptions:

General Wharf Configuration

Typical Pile Longitudinal Spacing	20	ft	Per Plan Sheet
Typical Pile Transverse Spacing	18	ft	Per Plan Sheet
Crane Rail Pile Longitudinal Spacing	10	ft	
Embankment Slope	0.2	(1V:5H)	Per Plan Sheet
Deck Elevation	38	ft	Per Plan Sheet
Low Water Elevation (Bot. Ice)	-5	ft	Per Plan Sheet

Structural Dimensions

Deck Slab Thickness	18	inch	Precast Haunched Deck Panel
Asphalt Overlay Thickness	6	inch	Per Plan Sheet
Pile Cap Width	6	ft	Per Plan Sheet
Pile Cap Depth	3	ft	Per Plan Sheet
Pile Cap Depth at Face of Wharf	5.25	ft	Per Plan Sheet
Crane Rail Beam Size	63	ft^2	5.25' (D) x 12' (W) including deck; Per Plan Sheet
Pile Diameter	48	inch	Steel Pipe Pile; Per Plan Sheet
Pile Wall Thickness	1	inch	Steel Pipe Pile Only; Per Plan Sheet
Pile Area	148	inch^2	
Pile Weight	513	lbs/ft	LBFoster Pipe Piling
Inside Concrete Fill Area	1735	inch^2	Steel Hybrid Pile Only
Ice Diameter	8	ft	Per Structural Design Criteria

Material Properties

Unit Weight - Reinforced Concrete	0.15	kcf	Per Structural Design Criteria
Unit Weight - Structural Steel	0.49	kcf	Per Structural Design Criteria
Unit Weight - Asphalt Paving	0.15	kcf	Per Structural Design Criteria
Unit Weight - Ice	0.04	kcf	Per Structural Design Criteria

Load and Resistance Factors - LRFD

Dead Load Factor	1.2	Static Case; Per Structural Design Criteria
Live Load Factor	1.6	Static Case; Per Structural Design Criteria
Crane Rail Load Factor	1.3	Per Structural Design Criteria
Axial Resistance Factor	0.45	for Driven Pile

US Army Corps of Engineers
Port of Anchorage - Intermodal Expansion Project - 15% Design - Preliminary Calculations
Pile Axial Capacity Design - Option 5H - Section C Horizon Berth - 48" Hybrid Pile

By: G. Jankhah
Date: January 29, 2013
Checked By: Vu Phan
Date: February 11, 2013

Pile Data

	Water-side Crane Rail						Land-side Crane Rail	Note
Row	1	2	3	4	5	6	7	
Distance to Previous Row (ft)	0	12	18	18	18	18	16	
Distance to Water-side Crane Rail (ft)	0	12	30	48	66	84	100	
Distance to Wharf Face (ft)	8.5	20.5	38.5	56.5	74.5	92.5	108.5	
Ground Elevation (ft)	-49.3	-46.9	-43.3	-39.7	-36.1	-32.5	-29.3	Based on 5:1 Slope
Top of BCF Elevation (ft)	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	-55.0	Estimated, based on North Extension As-built Drawing
Top of Silt/Mud (ft)	-49.3	-46.9	-43.3	-39.7	-36.1	-32.5	-29.3	Estimated, based on North Extension As-built Drawing
Thickness of Backfill (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Thickness of Silt/Mud (ft)	5.7	8.1	11.7	15.3	18.9	22.5	25.7	
Pile Tip Elevation (ft)	-190.0	-180.0	-170.0	-165.0	-160.0	-160.0	-170.0	
Total Pile Length (ft)	222.8	213.5	203.5	198.5	193.5	193.5	203.5	
Pile Length Above Ground Surface (ft)	82.1	80.4	76.8	73.2	69.6	66.0	62.8	Assume steel pipe pile will be concrete filled above ground surface
Pile Embedment in the Soil (ft)	140.7	133.1	126.7	125.3	123.9	127.5	140.7	
Group Reduction Factor	0.65	0.70	0.85	0.85	0.85	0.80	0.65	

Dead Load (kips per pile)

24" Precast Haunched Deck Panel		67.5	81.0	81.0	81.0	76.5		
6" Asphalt Overlay		22.5	27.0	27.0	27.0	25.5		
Pile Cap		86.4	86.4	86.4	86.4	86.4		
Crane Rail Beam	94.5						94.5	
48" Steel Pipe Pile (including Concrete Fill)	271.6	263.9	252.3	243.2	234.1	227.6	227.0	
8' dia. Ice	56.9	58.1	58.1	58.1	58.1	58.1	58.1	

Live Load (kips per pile)

Uniform Live Load		300.0	360.0	360.0	360.0	340.0		1000 psf

Crane Rail Load (kips per pile)

Crane Rail	500.0						500.0	50 klf, including both dead and live load from crane rail

Demand vs. Capacity

Total Axial Demand (kips per pile)	1158	1078	1182	1171	1160	1113	1105	Factored
Nominal Axial Capacity (kips per pile)	4855.6	3597.6	3304.9	3264.1	3183.2	3345.9	4855.6	From Geotech
Ultimate Axial Capacity (kips per pile)	1420	1133	1264	1249	1218	1205	1420	including group reduction factor and resistance factor
D/C Ratio	0.82	0.95	0.93	0.94	0.95	0.92	0.78	

Background: The following summarizes the displacement demand and capacity of the wharf system under seismic demands. The demand to capacity ratio of the structure is verified to be equal to or less than 1.0 for the MCE, CLE, and OLE seismic events.

Design Assumptions: The displacement demand was determined from a linear response spectrum analysis performed on SAP2000 using a 3D model. For the foundation, a point of fixity for each pile was approximated based on LPILE analysis.

The displacement capacity was determined from nonlinear static pushover analysis performed on SAP2000 using 2D models of a critical cross sections. Pile concrete and steel strains were limited based on MOTEMS and POLB seismic criteria and is summarized in Appendix B - Structures Design Criteria. Expected material properties were used for this analysis.

References: (1) Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), California Building Code, Section 3104F, 2011
(2) Port of Long Beach (POLB) Wharf Design Criteria, Section 4, v 3.0, 2012
(3) AASHTO LRFD Bridge Design Specifications, Section 10, 6th Edition with Interims, 2012

RC Pile Properties

Expectd Rebar Steel Yield Strength	66	ksi	MOTEMS 3107F.2.1.1
Pile Rebar Size	11		Analysis is based on 24 #11 bars in connection to pile cap
Pile Rebar Diameter	1.375	in	

Steel Pile Properties

Expected Steel Yield Strength	55	ksi	MOTEMS 3107F.2.1.1
Modulus of Elasticity	29000	ksi	
Pile Diameter	48	in	Per conceptual plans
Pile Wall Thickness	1	in	Per conceptual plans; Gross Thickness
Pile Area	148	in^2	
Pile Moment of Inertia	40790	in^4	
Plastic Modulus	2209	in^3	

Point of Fixity Computation - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Sea-side Pile			Land-side Pile
Row	1	2	3	4
Pile Spacing (ft)	16	16	16	16
Axial Demand (kips)	200	208	210	213
P-Multiplier	0.50	0.50	0.50	0.50
Top of Pile Elevation	33.00	33.00	33.00	33.00
Mudline Elevation	-29.90	-26.70	-23.50	-20.30
Top of Clay Layer	-29.90	-26.70	-23.50	-20.30
Approx. No. Diameters to Fixity	5	5	5	5
Approx. Point of Fixity Elevation	-49.9	-46.7	-43.5	-40.3
SAP Mudline Shear (kips)	162.0	183.0	203.0	223.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

Point of Fixity Computation - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile			Land-side Pile
Row	1	2	3	4
Pile Spacing (ft)	16	16	16	16
Axial Demand (kips)	200	208	210	213
P-Multiplier	0.50	0.50	0.50	0.50
Top of Pile Elevation	33.00	33.00	33.00	33.00
Mudline Elevation	-29.90	-26.70	-23.50	-20.30
Top of Clay Layer	-29.90	-26.70	-23.50	-20.30
Approx. No. Diameters to Fixity	5.5	5.5	5.5	5.5
Approx. Point of Fixity Elevation	-51.9	-48.7	-45.5	-42.3
SAP Mudline Shear (kips)	127.0	145.0	163.0	183.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

P-Delta Check [MOTEMS 3104F.4.3] - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Sea-side Pile			Land-side Pile	
Row	1	2	3	4	
Axial Demand (kips)	200	208	210	200	From SAP Output
Δ_{xx}	16.6	16.6	16.6	16.6	From SAP Output
Δ_{xy}	2.5	2.5	2.5	2.5	From SAP Output
Δ_{yx}	0	0	0	0	From SAP Output
Δ_{yy}	17.1	17.1	17.1	17.1	From SAP Output
Δ_d	18.53	18.53	18.53	18.53	for MCE event; MOTEMS 3104F.4.2
V/W	0.81	0.88	0.97	1.12	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.07	0.08	0.08	0.08	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	MOTEMS 3104F.4.3

P-Delta Check [MOTEMS 3104F.4.3] - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile			Land-side Pile	
Row	1	2	3	4	
Axial Demand (kips)	200	208	210	200	From SAP Output
Δ_{xx}	25.5	25.5	25.5	25.5	From SAP Output
Δ_{xy}	5	5	5	5	From SAP Output
Δ_{yx}	0	0	0	0	From SAP Output
Δ_{yy}	26.6	26.6	26.6	26.6	From SAP Output
Δ_d	29.12	29.12	29.12	29.12	for MCE event; MOTEMS 3104F.4.2
V/W	0.64	0.70	0.78	0.92	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.11	0.12	0.12	0.13	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	MOTEMS 3104F.4.3

Pile Displacement Capacity - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Demand	Capacity	Check	D/C Ratio	
OLE	5	15	GOOD	0.33	Top Hinge Failed
CLE	12	23	GOOD	0.52	Top Hinge Failed
MCE	19	29	GOOD	0.66	Top Hinge Failed

Pile Displacement Capacity - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Demand	Capacity	Check	D/C Ratio	
OLE	5	22	GOOD	0.23	Top Hinge Failed
CLE	13	32	GOOD	0.41	Top Hinge Failed
MCE	29	40	GOOD	0.73	Top Hinge Failed

Background: The following summarizes the displacement demand and capacity of the wharf system under seismic demands. The demand to capacity ratio of the structure is verified to be equal to or less than 1.0 for the MCE, CLE, and OLE seismic events.

Design Assumptions: The displacement demand was determined from a linear response spectrum analysis performed on SAP2000 using a 3D model. For the foundation, a point of fixity for each pile was approximated based on LPILE analysis.

The displacement capacity was determined from nonlinear static pushover analysis performed on SAP2000 using 2D models of a critical cross sections. Pile concrete and steel strains were limited based on MOTEMS and POLB seismic criteria and is summarized in Appendix B - Structures Design Criteria. Expected material properties were used for this analysis.

References: (1) Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), California Building Code, Section 3104F, 2011
(2) Port of Long Beach (POLB) Wharf Design Criteria, Section 4, v 3.0, 2012
(3) AASHTO LRFD Bridge Design Specifications, Section 10, 6th Edition with Interims, 2012

RC Pile Properties

Expectd Rebar Steel Yield Strength	66	ksi	MOTEMS 3107F.2.1.1
Pile Rebar Size	11		Analysis is based on 24 #11 bars in connection to pile cap
Pile Rebar Diameter	1.375	in	

Steel Pile Properties

Expected Steel Yield Strength	55	ksi	MOTEMS 3107F.2.1.1
Modulus of Elasticity	29000	ksi	
Pile Diameter	48	in	Per conceptual plans
Pile Wall Thickness	1	in	Per conceptual plans; Gross Thickness
Pile Area	148	in^2	
Pile Moment of Inertia	40790	in^4	
Plastic Modulus	2209	in^3	

Point of Fixity Computation - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Sea-side Pile			Land-side Pile
Row	1	2	3	4
Pile Spacing (ft)	16	16	16	16
Axial Demand (kips)	200	208	210	213
P-Multiplier	0.50	0.50	0.50	0.50
Top of Pile Elevation	33.00	33.00	33.00	33.00
Mudline Elevation	-49.90	-46.70	-43.50	-40.30
Top of Clay Layer	-51.00	-51.00	-51.00	-51.00
Approx. No. Diameters to Fixity[1]	5	5	5	5
Approx. Point of Fixity Elevation	-69.9	-66.7	-63.5	-60.3
SAP Mudline Shear (kips)	141.0	157.0	171.0	184.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

Point of Fixity Computation - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile			Land-side Pile
Row	1	2	3	4
Pile Spacing (ft)	16	16	16	16
Axial Demand (kips)	200	208	210	213
P-Multiplier	0.50	0.50	0.50	0.50
Top of Pile Elevation	33.00	33.00	33.00	33.00
Mudline Elevation	-49.90	-46.70	-43.50	-40.30
Top of Clay Layer	-51.00	-51.00	-51.00	-51.00
Approx. No. Diameters to Fixity[1]	4.5	4.5	4.5	4.5
Approx. Point of Fixity Elevation	-67.9	-64.7	-61.5	-58.3
SAP Mudline Shear (kips)	114.0	126.0	139.0	153.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

P-Delta Check [MOTEMS 3104F.4.3] - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Sea-side Pile			Land-side Pile	
Row	1	2	3	4	
Axial Demand (kips)	200	208	210	213	From SAP Output
Δ_{xx}	22.7	22.7	22.7	22.7	From SAP Output
Δ_{xy}	2.7	2.7	2.7	2.7	From SAP Output
Δ_{yx}	0	0	0	0	From SAP Output
Δ_{yy}	23.3	23.3	23.3	23.3	From SAP Output
Δ_{d}	25.05	25.05	25.05	25.05	for MCE event; MOTEMS 3104F.4.2
V/W	0.71	0.75	0.81	0.86	MOTEMS 3104F.4.3
$4*\Delta_{d}/H$	0.08	0.08	0.09	0.09	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	MOTEMS 3104F.4.3

P-Delta Check [MOTEMS 3104F.4.3] - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile			Land-side Pile	
Row	1	2	3	4	
Axial Demand (kips)	200	208	210	213	From SAP Output
Δ_{xx}	44.1	44.1	44.1	44.1	From SAP Output
Δ_{xy}	6.6	6.6	6.6	6.6	From SAP Output
Δ_{yx}	0	0	0	0	From SAP Output
Δ_{yy}	45.3	45.3	45.3	45.3	From SAP Output
Δ_{d}	49.10	49.10	49.10	49.10	for MCE event; MOTEMS 3104F.4.2
V/W	0.57	0.61	0.66	0.72	MOTEMS 3104F.4.3
$4*\Delta_{d}/H$	0.16	0.17	0.17	0.18	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	MOTEMS 3104F.4.3

Pile Displacement Capacity - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Demand	Capacity	Check	D/C Ratio	
OLE	4	19	GOOD	0.21	Top Hinge Failed
CLE	12	31	GOOD	0.39	Top Hinge Failed
MCE	25	42	GOOD	0.60	Top Hinge Failed

Pile Displacement Capacity - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Demand	Capacity	Check	D/C Ratio	
OLE	7	33	GOOD	0.21	Top Hinge Failed
CLE	20	45	GOOD	0.44	Top Hinge Failed
MCE	49	56	GOOD	0.88	Top Hinge Failed

Background: The following summarizes the displacement demand and capacity of the wharf system under seismic demands. The demand to capacity ratio of the structure is verified to be equal to or less than 1.0 for the MCE, CLE, and OLE seismic events.

Design Assumptions: The displacement demand was determined from a linear response spectrum analysis performed on SAP2000 using a 3D model. For the foundation, a point of fixity for each pile was approximated based on LPILE analysis.

The displacement capacity was determined from nonlinear static pushover analysis performed on SAP2000 using 2D models of a critical cross sections. Pile concrete and steel strains were limited based on MOTEMS and POLB seismic criteria and is summarized in Appendix B - Structures Design Criteria. Expected material properties were used for this analysis.

References: (1) Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), California Building Code, Section 3104F, 2011
(2) Port of Long Beach (POLB) Wharf Design Criteria, Section 4, v 3.0, 2012
(3) AASHTO LRFD Bridge Design Specifications, Section 10, 6th Edition with Interims, 2012

RC Pile Properties

Expectd Rebar Steel Yield Strength	66	ksi	MOTEMS 3107F.2.1.1
Pile Rebar Size	11		Analysis is based on 24 #11 bars in connection to pile cap
Pile Rebar Diameter	1.375	in	

Steel Pile Properties

Expected Steel Yield Strength	55	ksi	MOTEMS 3107F.2.1.1
Modulus of Elasticity	29000	ksi	
Pile Diameter	48	in	Per conceptual plans
Pile Wall Thickness	0.75	in	Per conceptual plans; Gross Thickness
Pile Area	111	in^2	
Pile Moment of Inertia	31077	in^4	
Plastic Modulus	1675	in^3	

Point of Fixity Computation - Corroded Pile Section Properties

	Sea-side Pile						Land-side Pile
Row	1	2	3	4	5	6	7
Pile Spacing (ft)	12	18	18	18	18	16	16
Axial Demand (kips)	260	216	205	209	203	171	252
P-Multiplier	0.30	0.60	0.60	0.60	0.60	0.50	0.50
Top of Pile Elevation	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Mudline Elevation	-49.30	-46.90	-43.30	-39.70	-36.10	-32.50	-29.30
Top of Clay Layer	-55.00	-55.00	-55.00	-55.00	-55.00	-55.00	-55.00
Approx. No. Diameters to Fixity[1]	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Approx. Point of Fixity Elevation	-71.3	-68.9	-65.3	-61.7	-58.1	-54.5	-51.3
SAP Mudline Shear (kips)	97.0	104.0	117.0	130.0	147.0	166.0	172.0

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

P-Delta Check [MOTEMS 3104F.4.3] - Corroded Pile Section Properties

	Sea-side Pile						Land-side Pile
Row	1	2	3	4	5	6	7
Axial Demand (kips)	176	204	209	209	207	157	169
Δ_{xx}	38	35	32	30.5	30	30	30
Δ_{xy}	30	30	30	30	30	30	30
Δ_{yx}	0	0	0	0	0	0	0
Δ_{yy}	38	38	38	38	38	38	38
Δ_d	39.10	39.10	39.10	39.10	39.10	39.10	39.10
V/W	0.55	0.51	0.56	0.62	0.71	1.06	1.02
$4*\Delta_d/H$	0.12	0.13	0.13	0.14	0.14	0.15	0.15
P-Delta effect required?	NO	NO	NO	NO	NO	NO	NO

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

From SAP Output

From SAP Output

From SAP Output

From SAP Output

From SAP Output

for MCE event; MOTEMS 3104F.4.2

MOTEMS 3104F.4.3

MOTEMS 3104F.4.3

MOTEMS 3104F.4.3

Pile Displacement Capacity - Corroded Pile Section Properties

	Demand	Capacity	Check	D/C
OLE	N/A	N/A	N/A	N/A
CLE	16	39	GOOD	0.41
MCE	39	51	GOOD	0.76

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

Top Hinge Failed

Top Hinge Failed

US Army Corps of Engineers		**Designed By:**	**G. Jankhah**
Port of Anchorage - Intermodal Expansion Project - 15% Design		**Date:**	**February 4, 2013**
Option 1 - 48" Steel Hybrid Pipe Pile Lateral Seismic Design - Section A - Trestle		**Checked By:**	**H. Guan**
		Date:	**February 11, 2013**

Background: The following summarizes the displacement demand and capacity of the wharf system under seismic demands. The demand to capacity ratio of the structure is verified to be equal to or less than 1.0 for the MCE, CLE, and OLE seismic events.

Design Assumptions: The displacement demand was determined from a linear response spectrum analysis performed on SAP2000 using a 3D model. For the foundation, a point of fixity for each pile was approximated based on LPILE analysis.

The displacement capacity was determined from nonlinear static pushover analysis performed on SAP2000 using 2D models of a critical cross sections. Pile concrete and steel strains were limited based on MOTEMS and POLB seismic criteria and is summarized in Appendix B - Structures Design Criteria. Expected material properties were used for this analysis.

References: (1) Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), California Building Code, Section 3104F, 2011
(2) Port of Long Beach (POLB) Wharf Design Criteria, Section 4, v 3.0, 2012
(3) AASHTO LRFD Bridge Design Specifications, Section 10, 6th Edition with Interims, 2012

RC Pile Properties

Expectd Rebar Steel Yield Strength	66	ksi	MOTEMS 3107F.2.1.1
Pile Rebar Size	11		Analysis is based on 24 #11 bars in connection to pile cap
Pile Rebar Diameter	1.375	in	

Steel Pile Properties

Expected Steel Yield Strength	55	ksi	MOTEMS 3107F.2.1.1
Modulus of Elasticity	29000	ksi	
Pile Diameter	48	in	Per conceptual plans
Pile Wall Thickness	0.75	in	Per conceptual plans; Gross Thickness
Pile Area	111	in^2	
Pile Moment of Inertia	31077	in^4	
Plastic Modulus	1675	in^3	

Point of Fixity Computation - Gross Pile Section Properties

Assumes gross composite section properties for pile

	Sea-side Pile									Land-side Pile
Row	1	2	3	4	5	6	7	8	9	10
Pile Spacing (ft)	20	20	20	20	20	20	20	20	20	14
Axial Demand (kips)	202	202	209	211	191	211	211	211	181	124
P-Multiplier	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.40
Top of Pile Elevation	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Mudline Elevation	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	17.4
Top of Clay Layer	-17.4	-15	-15	-15	-15	-15	-15	-15	-15	-15
Approx. No. Diameters to Fixity	3	3	3	3	3	3	3	3	3	3
Approx. Point of Fixity Elevation	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	5.4
SAP Mudline Shear (kips)	177.0	177.0	179.0	178.0	173.0	160.0	139.0	111.0	122.0	206.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

Point of Fixity Computation - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile									Land-side Pile
Row	1	2	3	4	5	6	7	8	9	15
Pile Spacing (ft)	20	20	20	20	20	20	20	20	20	14
Axial Demand (kips)	202	202	209	211	191	211	211	211	181	125
P-Multiplier	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.40
Top of Pile Elevation	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Mudline Elevation	-17.4	-13.4	-9.4	-5.4	-1.4	2.6	6.6	10.6	14.6	17.4
Top of Clay Layer	-17.4	-15	-15	-15	-15	-15	-15	-15	-15	-15
Approx. No. Diameters to Fixity	4	4	4	4	4	4	4	4	4	4
Approx. Point of Fixity Elevation	-33.4	-29.4	-25.4	-21.4	-17.4	-13.4	-9.4	-5.4	-1.4	1.4
SAP Mudline Shear (kips)	172.0	177.0	185.0	189.0	189.0	180.0	161.0	135.0	159.0	270.0

Approximate; Based on SAP Output

Based on AASHTO Table 10-7.2.4-1 for Row 3 and higher

Approximate

Determined through LPILE analysis

P-Delta Check [MOTEMS 3104F.4.3] - Gross Pile Section Properties

Assumes gross composite section properties for the pile

	Sea-side Pile									Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	15	
Axial Demand (kips)	202	202	209	211	191	211	211	211	181	124	From SAP Output
Δ_{xx}	8.5	7.3	6.2	5	4	3	2	1.2	1	1.3	From SAP Output
Δ_{xy}	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	From SAP Output
Δ_{yx}	0	0	0	0	0	0	0	0	0	0	From SAP Output
Δ_{yy}	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	From SAP Output
Δ_d	8.59	7.40	6.32	5.15	4.18	3.24	2.62	2.58	2.57	2.58	for MCE event; MOTEMS 3104F.4.2
V/W	0.88	0.88	0.86	0.84	0.91	0.76	0.66	0.53	0.67	1.66	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.03	0.03	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	MOTEMS 3104F.4.3

P-Delta Check [MOTEMS 3104F.4.3] - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile									Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	15	
Axial Demand (kips)	202	202	209	211	191	211	211	211	181	125	From SAP Output
Δ_{xx}	20.6	17.9	15.2	12.5	9.9	7.4	5	3.1	2.7	3.6	From SAP Output
Δ_{xy}	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	From SAP Output
Δ_{yx}	0	0	0	0	0	0	0	0	0	0	From SAP Output
Δ_{yy}	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	From SAP Output
Δ_d	20.86	18.19	15.55	12.92	10.42	8.09	6.79	6.69	6.67	6.71	for MCE event; MOTEMS 3104F.4.2
V/W	0.85	0.88	0.89	0.90	0.99	0.85	0.76	0.64	0.88	2.16	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.10	0.10	0.09	0.08	0.07	0.06	0.05	0.06	0.06	0.07	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	MOTEMS 3104F.4.3

Pile Displacement Capacity - Gross Pile Section Properties

Assumes gross composite section properties for pile

	Y				X			
	Demand	Capacity	Check	D/C	Demand	Capacity	Check	D/C
OLE	1.9	N/A	N/A	N/A	3.7	N/A	N/A	N/A
CLE	3.3	N/A	N/A	N/A	7.3	N/A	N/A	N/A
MCE	3.6	13.9	GOOD	0.3	8.6	23	GOOD	0.4

Top Hinge Failed
Top Hinge Failed
Top Hinge Failed

Pile Displacement Capacity - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Y				X			
	Demand	Capacity	Check	D/C	Demand	Capacity	Check	D/C
OLE	3.2	N/A	N/A	N/A	5.7	N/A	N/A	N/A
CLE	6.9	N/A	N/A	N/A	13.6	N/A	N/A	N/A
MCE	9.1	17.5	GOOD	0.5	20.9	26.4	GOOD	0.8

Top Hinge Failed
Top Hinge Failed
Top Hinge Failed

Background: The following summarizes the displacement demand and capacity of the wharf system under seismic demands. The demand to capacity ratio of the structure is verified to be equal to or less than 1.0 for the MCE, CLE, and OLE seismic events.

Design Assumptions: The displacement demand was determined from a linear response spectrum analysis performed on SAP2000 using a 3D model. For the foundation, a point of fixity for each pile was approximated based on LPILE analysis.

The displacement capacity was determined from nonlinear static pushover analysis performed on SAP2000 using 2D models of a critical cross sections. Pile concrete and steel strains were limited based on MOTEMS and POLB seismic criteria and is summarized in Appendix B - Structures Design Criteria. Expected material properties were used for this analysis.

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(3) AASHTO LRFD Bridge Design Specifications, Section 10, 6th Edition with Interims, 2012

RC Pile Properties

Expectd Rebar Steel Yield Strength	66	ksi	MOTEMS 3107F.2.1.1
Pile Rebar Size	11		Analysis is based on 24 #11 bars in connection to pile cap
Pile Rebar Diameter	1.375	in	

Steel Pile Properties

Expected Steel Yield Strength	55	ksi	MOTEMS 3107F.2.1.1
Modulus of Elasticity	29000	ksi	
Pile Diameter	48	in	Per conceptual plans
Pile Wall Thickness	0.75	in	Per conceptual plans; Gross Thickness
Pile Area	111	in^2	
Pile Moment of Inertia	31077	in^4	
Plastic Modulus	1675	in^3	

Point of Fixity Computation - Gross Pile Section Properties

Assumes gross composite section properties

	Sea-side Pile														Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Pile Spacing (ft)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
Axial Demand (kips)	202	202	209	211	191	211	211	211	211	211	211	211	211	208	180	Approximate; Based on SAP Output
P-Multiplier (Y)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	Based on AASHTO Table 10-7.2.4-1 for Row 3+
P-Multiplier (X)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Top of Pile Elevation	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	Approximate
Mudline Elevation	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	17.8	21.8	25.8	29.8	
Top of Clay Layer	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	Determined through LPILE analysis
Approx. No. Diameters to Fixity	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Approx. Point of Fixity Elevation	-38.2	-34.2	-30.2	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	17.8	
SAP Mudline Shear (kips) X	166.0	169.0	174.0	178.0	180.0	182.0	182.0	180.0	175.0	167.0	152.0	136.0	134.0	209.0	290.0	

Point of Fixity Computation - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile														Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Pile Spacing (ft)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Approximate; Based on SAP Output
Axial Demand (kips)	202	202	209	211	191	211	211	211	211	211	211	211	211	208	180	AASHTO Table 10-7.2.4-1 for Row 3 and higher
P-Multiplier	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
Top of Pile Elevation	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	Approximate
Mudline Elevation	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	17.8	21.8	25.8	29.8	
Top of Clay Layer	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	Determined through LPILE analysis
Approx. No. Diameters to Fixity	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
Approx. Point of Fixity Elevation	-42.2	-38.2	-34.2	-30.2	-26.2	-22.2	-18.2	-14.2	-10.2	-6.2	-2.2	1.8	5.8	9.8	13.8	
SAP Mudline Shear (kips)	134.0	141.0	151.0	161.0	172.0	183.0	192.0	201.0	208.0	209.0	176.0	143.0	143.0	236.0	406.0	

Assumes gross composite section properties

P-Delta Check [MOTEMS 3104F.4.3] - Gross Pile Section Properties

	Sea-side Pile														Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	From SAP Output
Axial Demand (kips)	202	202	209	211	191	211	211	211	211	211	211	211	211	208	180	From SAP Output
Δ_{xx}	10.7	9.6	8.5	7.3	6.3	5.3	4.3	3.4	2.6	1.9	1.3	0.8	0.5	0.5	0.8	From SAP Output
Δ_{xy}	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	From SAP Output
Δ_{yx}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	From SAP Output
Δ_{yy}	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	for MCE event; MOTEMS 3104F.4.2
Δ_d	10.74	9.64	8.55	7.36	6.37	5.38	4.40	3.52	2.76	2.11	1.60	1.57	1.56	1.56	1.57	MOTEMS 3104F.4.3
V/W	0.82	0.84	0.83	0.84	0.94	0.86	0.86	0.85	0.83	0.79	0.72	0.64	0.64	1.00	1.61	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.03	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

P-Delta Check [MOTEMS 3104F.4.3] - Corroded Pile Section Properties

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

	Sea-side Pile														Land-side Pile	
Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	From SAP Output
Axial Demand (kips)	202	202	209	211	191	211	211	211	211	211	211	211	211	208	180	From SAP Output
Δ_{xx}	23.6	21.4	19.2	16.9	14.7	12.6	10.5	8.6	6.8	5.1	3.6	2.3	1.3	1.4	2.4	From SAP Output
Δ_{xy}	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	From SAP Output
Δ_{yx}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	From SAP Output
Δ_{yy}	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	for MCE event; MOTEMS 3104F.4.2
Δ_d	23.70	21.51	19.32	17.03	14.85	12.78	10.72	8.86	7.13	5.53	4.24	4.16	4.12	4.12	4.16	MOTEMS 3104F.4.3
V/W	0.66	0.70	0.72	0.76	0.90	0.87	0.91	0.95	0.99	0.99	0.83	0.68	0.68	1.13	2.26	MOTEMS 3104F.4.3
$4*\Delta_d/H$	0.11	0.10	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.05	0.06	0.07	MOTEMS 3104F.4.3
P-Delta effect required?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Pile Displacement Capacity - Gross Pile Section Properties

	Y				X			
	Demand	Capacity	Check	D/C	Demand	Capacity	Check	D/C
OLE	1.6	4	GOOD	0.4	4.1	14.8	GOOD	0.3
CLE	3.3	7.5	GOOD	0.4	9.3	20	GOOD	0.5
MCE	3.6	9.8	GOOD	0.4	10.7	25	GOOD	0.4

Assumes gross composition section properties for the pile

Top Hinge Failed
Top Hinge Failed
Top Hinge Failed

Pile Displacement Capacity - Corroded Pile Section Properties

	Y				X			
	Demand	Capacity	Check	D/C	Demand	Capacity	Check	D/C
OLE	2.8	4.5	GOOD	0.6	6.3	13.5	GOOD	0.5
CLE	5.6	9.6	GOOD	0.6	14.4	25	GOOD	0.6
MCE	8.2	11.8	GOOD	0.7	23.7	31	GOOD	0.8

Assumes steel section above mudline is fully corroded and 0.3" loss of steel below mudline

Top Hinge Failed
Top Hinge Failed
Top Hinge Failed