IAS ACCREDITED DIAMOND PIER
UPLIFT AND LATERAL FIELD LOAD TEST REPORT

Prepared for

PIN FOUNDATIONS, INC.
4810 POINT FOSDICK DRIVE NORTHWEST
PMB 60
GIG HARBOR, WASHINGTON 98335

Prepared by

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4660 MAIN STREET, SUITE 100-1A
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EEI REPORT NO. 07-020-11

JANUARY 23, 2017

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January 23, 2017

Pin Foundations, Inc.
4810 Pt. Fosdick Drive Northwest, PMB 60
Gig Harbor, Washington 98335
Attention: Rick Gagliano

Phone: 253-858-8809
E-mail: info@pinfoundations.com

Subject: IAS Accredited Diamond Pier Uplift and Lateral Field Load Test Report
EEI Report No. 07-020-11

Dear Mr. Gagliano:

Earth Engineers, Inc. (EEI) is pleased to transmit our test report for Diamond Piers, which have been developed and marketed by Pin Foundations, Inc. (PFI). Our services were completed in accordance with EEI Proposal No. 15-P093 dated April 2, 2015, which you authorized by signing on April 6, 2015.

PROJECT BACKGROUND

EEI has been involved in load testing the Diamond Pier product dating back to 2006. In 2006, EEI was engaged by Professional Services Industries, Inc. (PSI) of Portland, Oregon to conduct axial compressive pile load testing on DP-50 Diamond Piers with 36-inch long steel pins (reference PSI Report No. 704-25035-1, dated November 26, 2006). This current report expands on the knowledge base of load carrying capacity of Diamond Piers by testing both DP-50 and DP-75 Diamond Piers with 50-inch pin lengths for both lateral and uplift load carrying capacity (see Appendix A for pier dimensions).

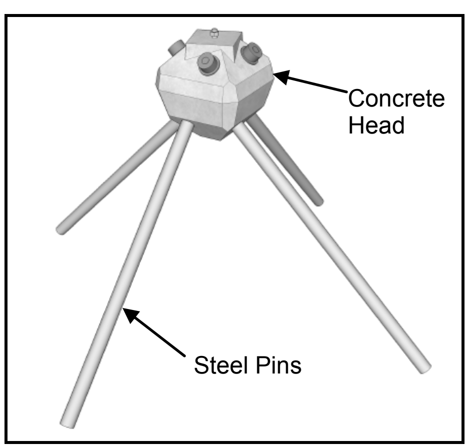


FIGURE 1: Typical schematic drawing for Diamond Pier DP-50 or DP-75.

SCOPE OF SERVICES

EEI's scope of services included a number of tasks related to evaluating the uplift and lateral load carrying capacity of DP-50 and DP-75 Diamond Piers with four 50-inch long bearing pins and concrete heads installed at a site with a 1,500 pounds per square foot (psf) presumptive allowable soil bearing capacity per Table R401.4.1 of the International Residential Code (IRC). These tasks were completed under the direction of EEI Principal Geotechnical Engineer Troy Hull, P.E.

The scope of services included the following:

1. Qualify the load test site. Site qualification included performing 5 soil test borings (B-1 through B-5), laboratory testing, and geotechnical engineering analyses to confirm that the site met the requirements of IRC Table 401.4.1.
2. Select load test samples of the DP-50 and DP-75 Diamond Pier concrete heads at PFI's Gig Harbor facility, as well as the steel pins at the load test site in Washougal, Washington.
3. Perform 6 uplift pile load tests (3 DP-50 Diamond Piers and 3 DP-75 Diamond Piers) in general accordance with ASTM D3689/D3689M – 07 (Reapproved 2013).
4. Perform 6 lateral load tests (3 DP-50 Diamond Piers and 3 DP-75 Diamond Piers) in general accordance with ASTM D3966/D3966M – 07 (Reapproved 2013).
5. Provide a final typed report summarizing the site qualification and load test results.

Note that EEI is an International Accreditation Service (IAS) approved testing agency for conducting the requested load testing services in accordance with the ASTM standards listed above. See the accreditation certificate attached in Appendix N.

TEST SITE QUALIFICATION

EEI conducted a geotechnical subsurface investigation on a select part of the Port of Camas-Washougal's 125-acre Steigerwald Commerce Center property at the east terminus of Grant Street, in Washougal, Clark County, Washington (see Site Location Plan in Appendix B attached). At the time of our subsurface investigation, the test site was a large, undeveloped grass field. The purpose of the subsurface investigation was to confirm the site meets the soil classification criteria outlined in 2015 IRC Table R401.4.1 for load-bearing pressures of 1,500 psf (see Table 1 below).

TABLE 1: IRC Table R401.4.1, Presumptive Load-Bearing Values of Foundation Materials[a]

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy clay, silty clay, clayey silt, silt, sandy silt, and sandy clay (CL, ML, MH and CH)	1,500[b]

a. When soil tests are required by Section 401.4, the allowable bearing capacities of the soil shall be part of the recommendations.

b. When the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

Prior to the subsurface investigation, EEI reviewed available geologic references for the area. According to the “Geologic Map of the Vancouver Quadrangle, Washington and Oregon” (1987), the general area of the site consists of Holocene (the last 11,000 years) to upper Pleistocene (1.8 mya to 10,000 years) aged alluvium (Qal). These alluvial soils typically consist of sand, silt and clay on the floodplains of the Columbia River that are locally up to about 50 meters thick. This is generally consistent with the soil conditions encountered in our subsurface investigation.

On August 13, 2015, five Standard Penetration Test (SPT) soil borings (B-1 through B-5) were performed by PLi Systems of Hillsboro, Oregon using a Beretta T46 track drill rig outfitted with solid stem auger and a calibrated automatic SPT hammer. The SPT was performed by driving a 2-inch, O.D., split-spoon sampler into the undisturbed soil formation located at the bottom of the advanced auger with repeated blows of a 140-pound, pin-guided, automatic mechanical hammer falling a vertical distance of 30 inches. The number of blows required to drive the sampler one foot is a measure of the *consistency* for cohesive soils and *density* for granular soils.

SPT samples were obtained at 2 ½ foot intervals and all soil samples were identified in the field, placed in sealed containers, and transported to the laboratory for further classification, testing and storage. In addition to the SPT sampling, relatively undisturbed Shelby tube samples were obtained at depths selected by EEI Principal Geotechnical Engineer Troy Hull, P.E. The laboratory evaluation consisted of visual and textural examinations (ASTM D2487-00), moisture content tests (ASTM D2216-98), particle size analyses (ASTM D1140), Atterberg limits tests (ASTM D4318-10), unit weight tests (ASTM D2937), and direct shear tests (ASTM D3080). Results of the tests are shown on the attached boring logs.

The following is a summary of soil and groundwater conditions encountered in the 5 borings. All of the borings encountered approximately 12 inches of topsoil. Beneath the topsoil in B-1 through B-5 was sandy silt/clay and silty/clay with sand, which classifies as ML/CL in accordance with the Unified Soil Classification System (USCS). The stratum extended to the maximum depths of the borings (10 ½ feet). The one exception was a thin (approximately 6 inch) seam of silty sand in B-3 from a depth of 3 to 3 ½ feet below grade. Moisture contents of the ML/CL material tested ranged from 6 to 41 percent. In general, the moisture content increased with depth. The fines content (i.e. material passing a #200 sieve) ranged from 52 to 99 percent. Based on the soil conditions encountered in Borings B-1 through B-5, we consider these soils to be characterized as silt/clay soils typically associated with 1,500 psf bearing material.

Groundwater was not encountered in any of the borings at the time of the subsurface investigation. Based on our past experience working at the Steigerwald Commerce Center property, groundwater is typically greater than about 15 feet below the ground surface. It is possible that groundwater levels will vary by season, year, and location across the site.

EEI performed geotechnical engineering analyses based on soil strength characterization using the data from our subsurface investigation and laboratory test data. Our bearing capacity calculations were performed using the General Bearing Capacity Equation, originally developed by Karl Terzaghi and since modified by several researchers and practitioners (McCarthy, 1998). This method considers soil cohesion and internal friction, foundation size, total soil weight, and surcharge effects to determine bearing capacity. Soil cohesion and internal friction values were determined from Direct Shear lab testing. Table 2 is a brief summary of the calculation results.

TABLE 2: SUMMARY OF SITE BEARING CAPACITY CALCULATIONS

	REQUIRED BEARING CAPACITY PER 2015 IRC TABLE R401.4.1 (psf)	**GENERAL BEARING CAPACITY EQUATION NET ALLOWABLE BEARING RESULTS (psf)**
Site #1 (Silt/Clay)	1,500	1,610

<u>In our professional opinion, the engineering analyses confirm that the soil within the zone of influence for Site #1 (i.e. in the area of borings B-1 through B-5) meets the requirement for soil with a load-bearing value of 1,500 psf as outlined in IRC Table R401.4.1.</u>

LOAD TEST PROGRAM

Once the test site at the Port of Camas-Washougal was qualified, the test area was cordoned off with stakes and safety tape (see Photo 3 below). This was done to prevent vehicles or equipment from driving over the site and compacting (improving) the near-surface soils. The approximate size of the cordoned off test site was approximately 75 feet (north-south direction) by 350 feet (east-west direction).

EEI Principal Geotechnical Engineer Troy Hull, P.E. traveled to PFI's Gig Harbor, Washington facility on April 1, 2016 and randomly sampled the precast concrete heads for the DP-50 and DP-75 Diamond Piers to be used for load testing.

PHOTO 1: Pallet of DP-75 precast concrete heads sampled at PFI's Gig Harbor, Washington facility.

Upon arrival at the PFI facility at 2105 34th Avenue Northwest in Gig Harbor, Washington, EEI rep. Troy Hull noted there were 4 pallets of precast concrete heads (2 pallets of DP-50s and 2 pallets of DP-75s).

The concrete heads were precast by PFI supplier Stoneworks of Elk River, Minnesota. Concrete test cylinders were molded by Stoneworks at the time the precast concrete heads were poured. The concrete used to fabricate the load test assemblies was also tested in accordance with ASTM C231 to verify the total air content (percent by volume of concrete) was not less than 5 percent nor more than 7 percent. The cylinders and heads were then shipped to PFI by truck and cured in accordance with Section 9.2 of ASTM C31, except they were cured in the same temperature and moisture environment as the precast concrete heads to be field load tested (uplift and lateral). The concrete test cylinders were subsequently tested by PSI, Inc. of Tacoma, Washington in accordance with ASTM C39. Test results are found in the Compressive Strength Test Reports attached in Appendix J. Note that the concrete compressive strength of the precast concrete heads load tested per ASTM D1143/D1143M cannot exceed 5,500 psi as that is the minimum concrete strength specified in PFI's Quality Control Manual for production heads.

The steel bearing pins for the DP-50 were 1-inch nominal diameter, schedule 40, galvanized steel pipe (1.315-inch actual outside diameter). The pipe wall thickness was 0.133 inches with a tolerance of +/- 1 percent. Each pin had a length of 50 inches +/- ½ inch. The pin corrosion resistance coating consisted of hot dip galvanizing in accordance with ASTM A53-02.

The steel bearing pins for the DP-75 were 1 ¼-inch nominal diameter, schedule 40, galvanized steel pipe (1.660-inch actual outside diameter). The pipe wall thickness was 0.140 inches with a tolerance of +/- 1 percent. Each pin had a length of 50 inches +/- 1/2 inch. The pin corrosion resistance coating consisted of hot dip galvanizing in accordance with ASTM A53-02.

The steel bearing pins consisted of Type E, Grade A (electric-resistance-welded), galvanized steel pipe complying with ASTM A53-02. See the mill test report attached in Appendices M and N.

The galvanized steel anchor bolts precast in the top of each concrete head were 1/2 inch in diameter by 5 inches long for the Diamond Pier DP-50 and 5/8 inch diameter by 5 1/2 inches long for the DP-75. See the certification report attached as Appendices O and P.

On April 4 and 5, 2016, PFI staff installed six DP-50 and six DP-75 Diamond Piers at Site #1 (silt/clay soil with a presumptive load bearing capacity of 1,500 psf). The installation was witnessed by EEI Principal Geotechnical Engineer Troy Hull, P.E. At that time, it was visually confirmed that the ground surface had not been disturbed by any heavy equipment since the August 2015 subsurface investigation was completed. Additionally, all of the steel bearing pins were randomly sampled by Mr. Hull from large bundles of pre-cut lengths of pipe brought to the site by PFI. The manufacturer's markings were checked against the product certification paperwork and the pins were inspected by Mr. Hull for straightness prior to installation. The selected pins were marked with a black felt pen and separated out for installation with the individual concrete heads. The concrete heads were inspected for any cracking after installation. No discontinuities were observed in any of the pins or heads used for load testing.

The Diamond Pier foundation assemblies were installed in a manner as recommended by the manufacturer for construction. A small amount of grass sod was removed with a shovel to seat the concrete head (see Photo 2 below).

PHOTO 2: Sod removed in conical shape of concrete head.

PHOTO 3: Typical concrete head seated and ready for bearing pin installation. Note caution tape in the background to ensure test site was not impacted by vehicular traffic surcharge loads.

Once the concrete head was seated, a small bubble level was used to level the top of the concrete head. The 4 steel bearing pins were placed through precast holes in the concrete head. Each steel bearing pin was driven a few inches with a 3-pound sledge. The steel bearing pins were then installed the rest of the way using a Bosch GSH 16 jackhammer with a pipe driving bit (see Photo 4 below). The levelness of the top of the concrete head was continuously checked when driving the steel bearing pins into the ground. This same procedure was repeated for the other 11 Diamond Pier installations.

PHOTO 4: Typical driving of the steel bearing pins.

PHOTO 5: Typical Diamond Pier after the bearing pins were driven.

After installation, 1 to 2 inches of soil was removed from around the base and sides of the precast concrete head to ensure that the entire test load was carried by the steel bearing pins and not the precast concrete head. Additionally, the soil removal allowed EEI to inspect the base of the concrete head where the steel bearing pins exit the head both before and after load testing was completed.

PHOTO 6: Typical Diamond Pier after 1 to 2 inches of soil was removed from around the bottom and sides.

The following is a summary of the test program for each of these test locations.

TABLE 3: Summary of Diamond Piers installed April 4-5, 2016 on the 1,500 psf Silt Site #1

Test Pier #	Diamond Pier Description	Test Program
CL-U-DP50-1	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Uplift
CL-U-DP50-2	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Uplift
CL-U-DP50-3	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Uplift
CL-U-DP75-1	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Uplift
CL-U-DP75-2	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Uplift
CL-U-DP75-3	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Uplift
CL-L-DP50-1	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Lateral
CL-L-DP50-2	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Lateral
CL-L-DP50-3	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	Lateral
CL-L-DP75-1	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Lateral
CL-L-DP75-2	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Lateral
CL-L-DP75-3	DP-75 precast concrete head with (4) 1 ¼" nominal diameter by 50" long steel pins	Lateral

Uplift Load Testing

Uplift load testing was conducted on 6 Diamond Piers in general accordance with ASTM D3689/D3689M between April 15 and May 6, 2016. The load test reaction frame consisted of two W12x40 by 25 foot long (minimum) wide flange steel beams supported on either end by a single 2.5 by 2.5 by 5 foot, solid concrete block manufactured by Ultrablock Inc. of Vancouver, Washington. Each concrete block weight was about 4,320 pounds. The steel beams and concrete block reaction frame was assembled using an all-terrain forklift working from outside the taped off restricted area to prevent the equipment from compacting the ground in the area of the tests. For each individual load test, vertical tension load was applied using a single, calibrated Enerpac 12-ton hydraulic hollow core ram.

PHOTO 7: Typical uplift load test reaction frame setup.

PHOTO 8: Typical uplift load test setup.

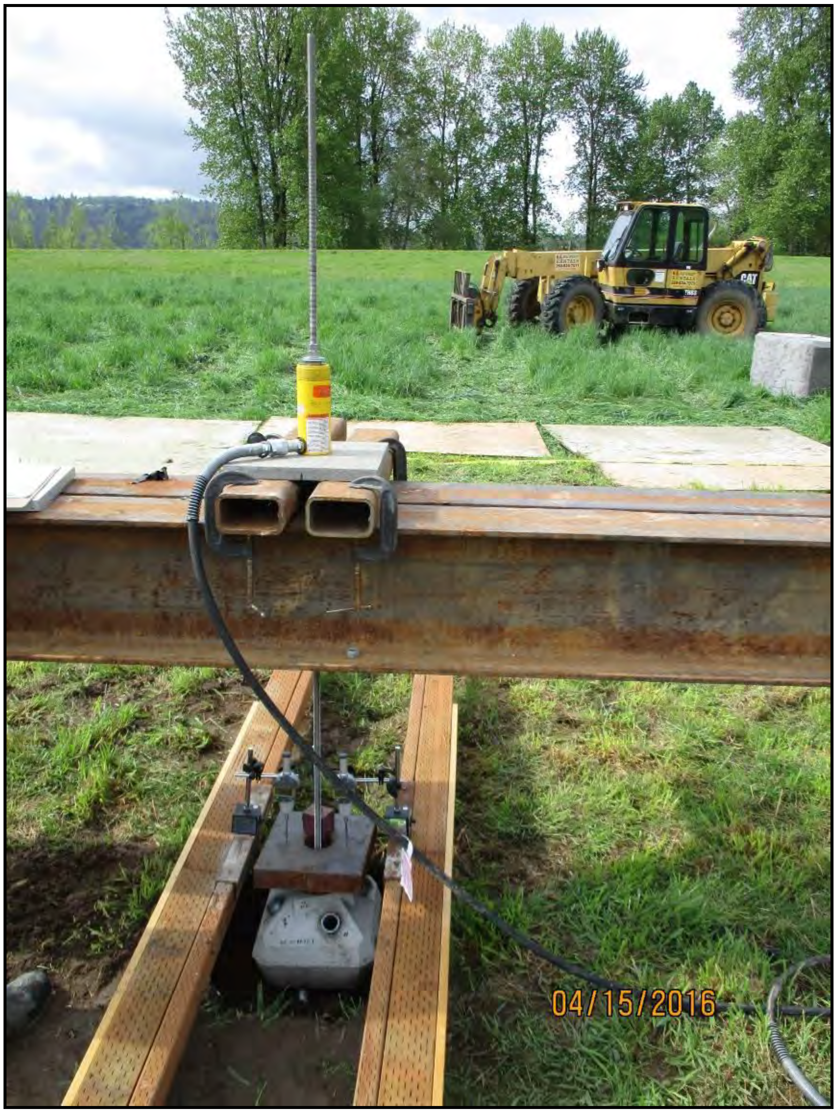


PHOTO 9: Typical uplift load test setup.

The load test was conducted in accordance with Procedure A (Quick Test) of the ASTM. The test intervals were applied in increments of approximately 5% of the anticipated failure load. During each interval, the load was held constant for a time interval not less than 4 minutes and not more than 15 minutes. After reaching the maximum test load, the pier was unloaded in at least 5 decrements and readings were taken for not less than 4 minutes and not more than 15 minutes.

<u>Lateral Load Testing</u>

Lateral load testing was conducted on 6 Diamond Piers in general accordance with Procedure A (Standard Loading) of ASTM D3966/D3966M between April 20 and May 24, 2016. The test load was applied by testing 2 Diamond Piers simultaneously. A calibrated Chief WC Welded hydraulic cylinder was placed in line between the 2 Diamond Piers and connected via a turnbuckle and chain.

Loading was monitored with a calibrated Central 5-ton tension load cell placed in line between the 2 Diamond Piers.

PHOTO 10: Typical lateral load test setup.

CONCLUSIONS

In order to develop the allowable load capacity recommendations for both lateral and uplift as shown in Table 4 below, we determined the average load at a deflection of 1 inch, and applied a safety factor of 2. The results are summarized in Tables 4 and 5 below

TABLE 4: Summary of Uplift Load Test Results in 1,500 psf Bearing (Silt) Soils

Test Pier #	Diamond Pier Description	Test Load @ 1" Deflection	Design Load (Test Load/2)
CL-U-DP50-1	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	2,900	1,450
CL-U-DP50-2	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	3,200	1,600
CL-U-DP50-3	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	3,100	1,550
		AVERAGE FOR DP-50:	**1,533**
CL-U-DP75-1	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	3,100	1,550
CL-U-DP75-2	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	3,700	1,850
CL-U-DP75-3	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	3,500	1,750
		AVERAGE FOR DP-75:	**1,716**

TABLE 5: Summary of Lateral Load Test Results in 1,500 psf Bearing (Silt) Soils

Test Pier #	Diamond Pier Description	Test Load @ 1" Deflection	Design Load (Test Load/2)
CL-L-DP50-1	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	1,600	800
CL-L-DP50-2	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	1,200	600
CL-L-DP50-3	DP-50 precast concrete head with (4) 1" nominal diameter by 50" long steel pins	1,050	525
		AVERAGE FOR DP-50:	**641**
CL-L-DP75-1	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	1,250	625
CL-L-DP75-2	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	1,100	550
CL-L-DP75-3	DP-75 precast concrete head with (4) 1-¼" nominal diameter by 50" long steel pins	1,700	850
		AVERAGE FOR DP-75:	**675**

As part of the testing procedure, the integrity of each Diamond Pier was visually inspected at the test load when at 1 inch deflection. The anchor bolts were straight and intact, with no radial concrete cracking around the anchor bolts. For the uplift tests, there was some minor concrete spalling on the underside of the concrete heads, but no other observed cracking of the concrete heads. We observed no cracking of the concrete heads tested for lateral load.

After completion of the load testing program, the steel bearing pins and precast concrete heads were completely removed from the ground and visually inspected again. The lateral test steel pins showed no inelastic bending, and the anchor bolts were still straight and intact, with no concrete cracking around the anchor bolts.

For the uplift tests, the steel pins were not able to be removed without destroying the integrity of the pins and concrete heads. As such we were not able to check for pin straightness.

At least 3 concrete compression tests were conducted by PSI, Inc. (Pin Foundations' subcontracted testing lab) on 4 inch diameter by 8 inch tall cylinder samples cast in accordance with ASTM C39 from the same batch as the Diamond Piers that were load tested. Three concrete test cylinders were tested in accordance with ASTM C39 (see page 5). The cylinders were tested in the midst of the testing program covered by this report. The average of the three tests established the concrete compressive strength. See Appendix J for the test results. Note that the average of the 3 concrete compressive strength tests (5,330 psi) was less than 5,500 psi, which is the minimum compressive strength requirement in PFI's Quality Control Manual for production piers.

LIMITATIONS

The geotechnical recommendations presented in this report are based on the available project information, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform EEI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. EEI will not be responsible for the implementation of its recommendations when it is not notified of any applicable changes.

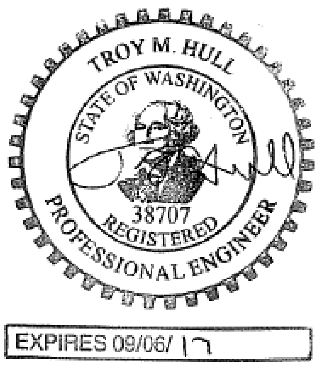
The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

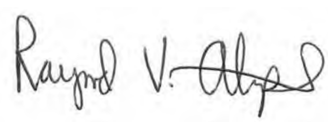
This report has been prepared for the exclusive use of Pin Foundations, Inc. for the specific application to the Diamond Pier load testing conducted in 2016 at the Port of Camas-Washougal's Steigerwald Commerce Center property in Washougal, Washington.

If you have any questions pertaining to this report, or if we may be of further service, please contact Troy Hull at 541-393-6340 (office) or 360-903-2784 (cell).

Sincerely,
Earth Engineers, Inc.

Reviewed by:





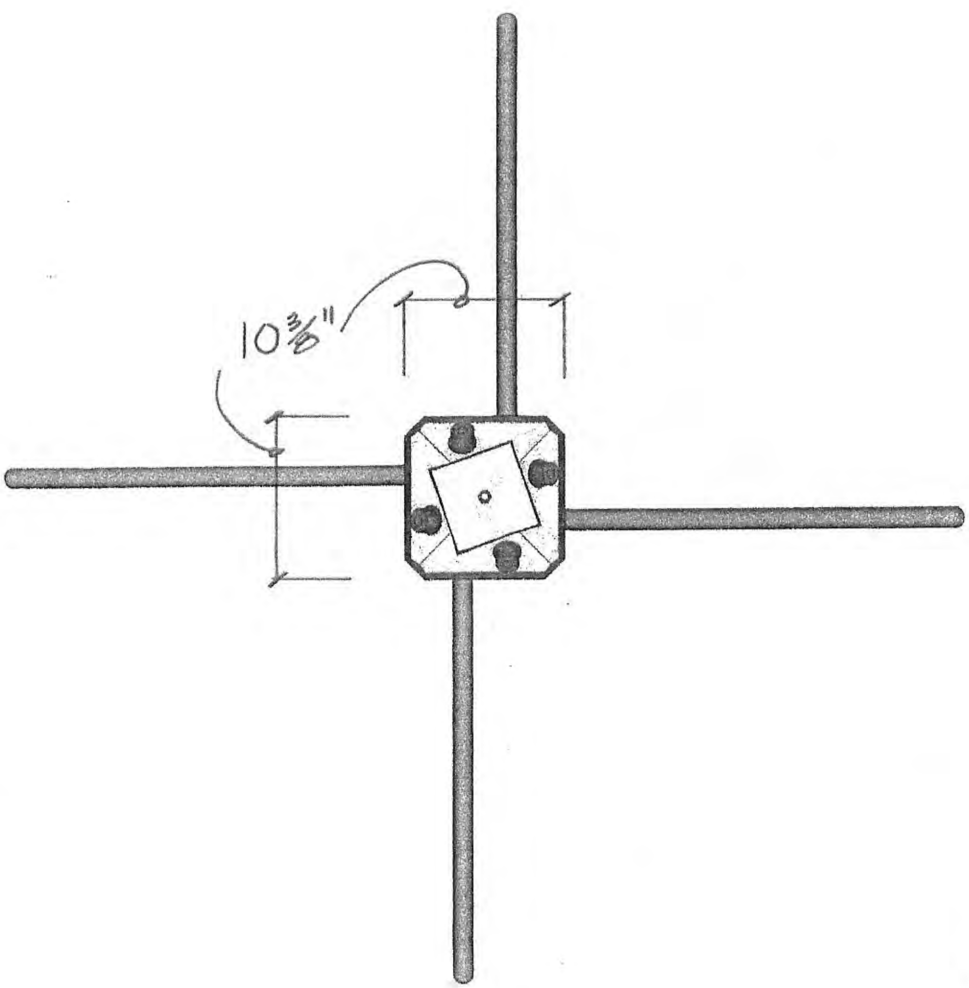
Troy Hull, P.E.
Principal Geotechnical Engineer

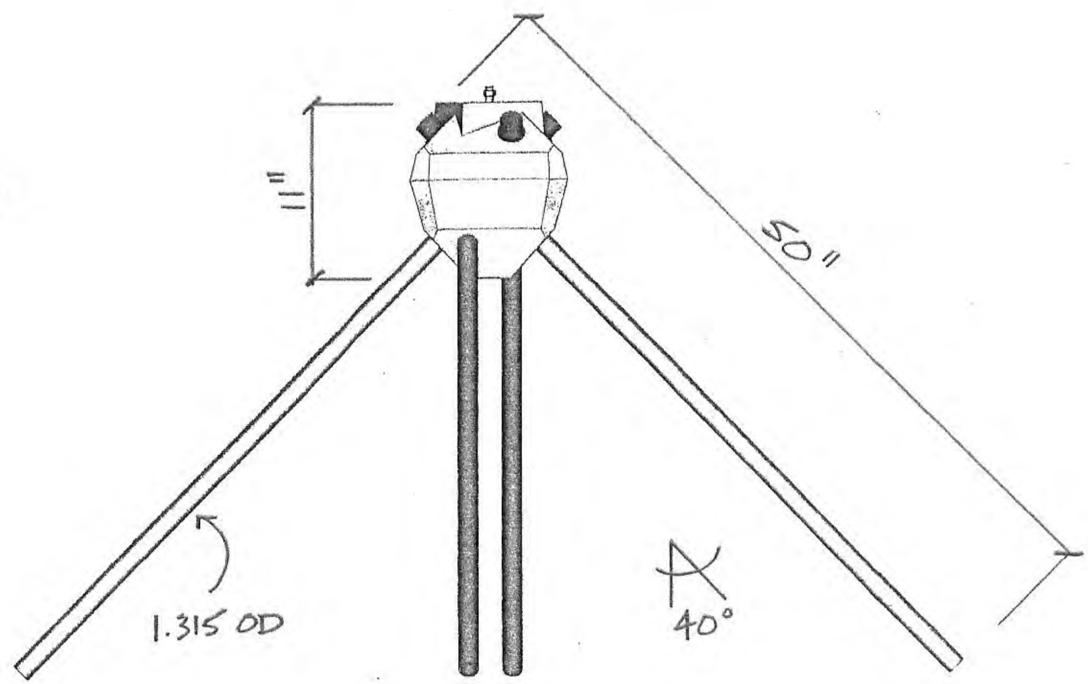
Ray Aliperti
Technical Director

Attachments:	Appendix A:	Diamond Pier Dimensioned Drawing and Concrete Mix Design
	Appendix B:	Site Location Plan
	Appendix C:	Topographic Site Location Plan
	Appendix D:	Site Location Aerial Photo
	Appendix E:	Diamond Pier and Geotechnical Boring Location Plan
	Appendix F:	Boring Logs and Laboratory Test Results
	Appendix G:	Site Qualification Engineering Calculations
	Appendix H:	Load Test Setup Schematics
	Appendix I:	Load Test Equipment List and Hydraulic Ram Calibration Reports
	Appendix J:	Concrete Compressive Strength Test Report
	Appendix K:	Load Test Data
	Appendix L:	ASTM D3689
	Appendix M:	ASTM D3966
	Appendix N:	Earth Engineers Inc.'s IAS Certificate of Accreditation
	Appendix O:	Mill Test Report for 1-inch Diameter Nominal Steel Bearing Pin Pipe from Saha Thai Steel Pipe (Public) Company LTD
	Appendix P:	Mill Test Certificate for 1 1/4-inch Diameter Nominal Steel Bearing Pin Pipe from Al Jazeera Steel Products Company SAOG
	Appendix Q:	Material Certification Report for 1/2-inch Diameter Galvanized Anchor Bolt from Stoneworks Architectural
	Appendix R:	Material Certification Report for 5/8-inch Diameter Galvanized Anchor Bolt from Stoneworks Architectural
	Appendix S:	Bibliography

APPENDIX A: DIAMOND PIER DIMENSIONED DRAWING AND CONCRETE MIX DESIGN

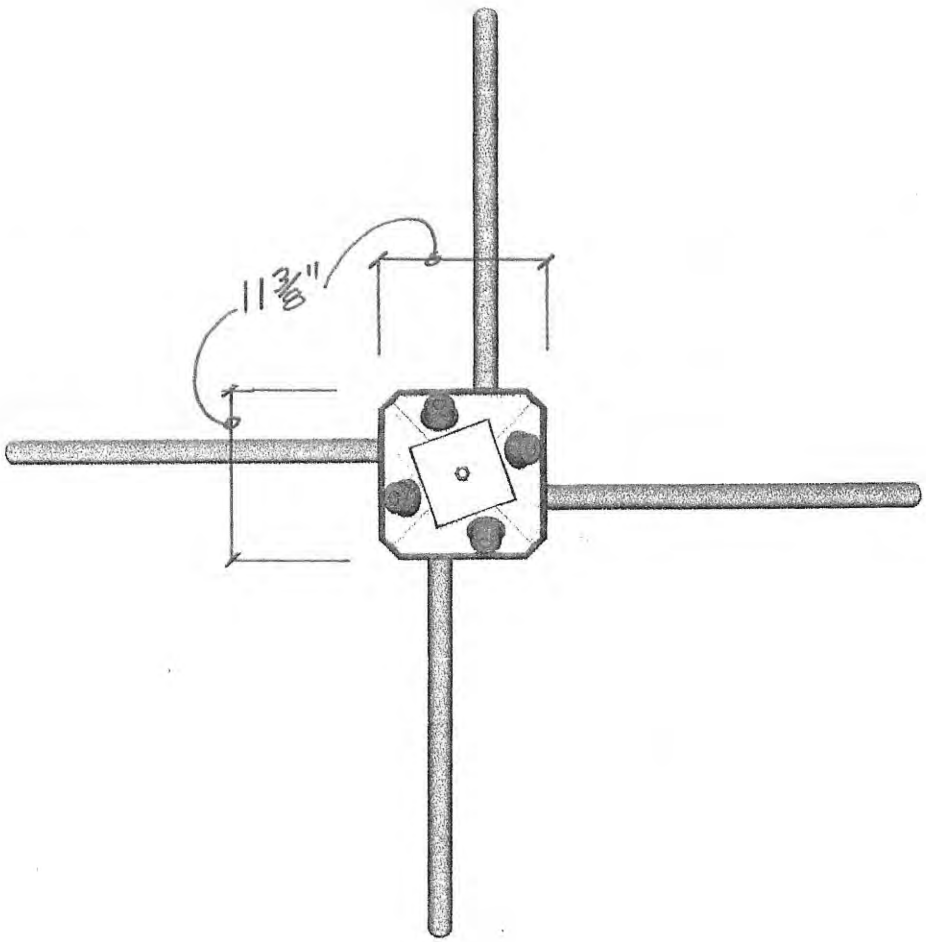
DP-50 Diamond Pier with 50" Pins

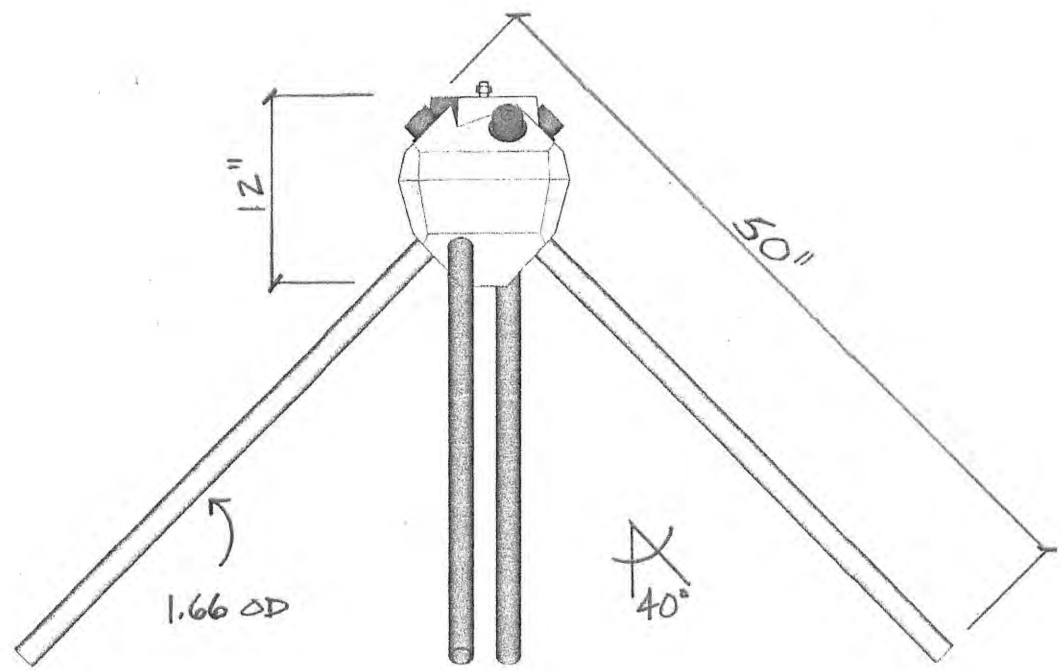




REFER TO DIMENSIONS ONLY
DO NOT SCALE DWGS

DP-75 Diamond Pier with 50” Pins





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DO NOT SCALE DWGS

Stoneworks
ARCHITECTURAL PRECAST, INC.

CONCRETE MIX DESIGN
NO STEEL FIBER

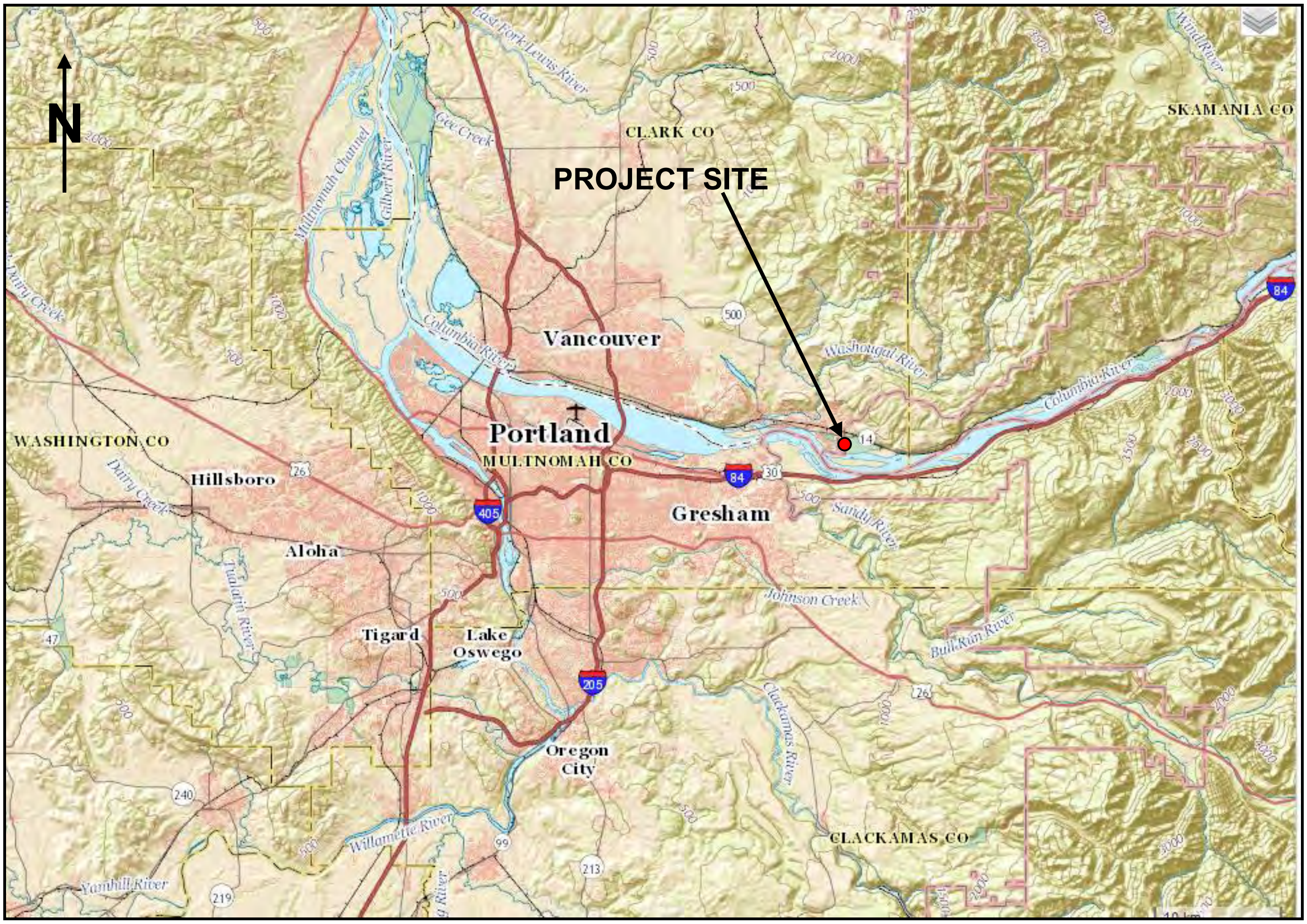
5500 psi @ 28 Days with Air Entrainment - DP-50, No steel Fiber

MATERIAL	POUNDS - SSD	ABSOLUTE VOLUME
Cement (minumum)	836	4.253
Sand	1640	9.843
1/2"/#8	1170	6.868
Water	253	4.054
% Air	6% (+/-1%)	1.620
TOTALS	3899 pounds	26.64 cu ft

Air Entrainment BASF MB-AE -90	Meets ASTM C260	2.25 oz/yd
Water Reducer (Plasticizer) BASF Glenium -7700	Meets ASTM C494, Type F	33.45 oz/yd

Water/Cement Ratio	0.303
Air	5%-7%
Slump	N/A

APPENDIX B: SITE LOCATION PLAN



Source: www.nationalmap.gov.

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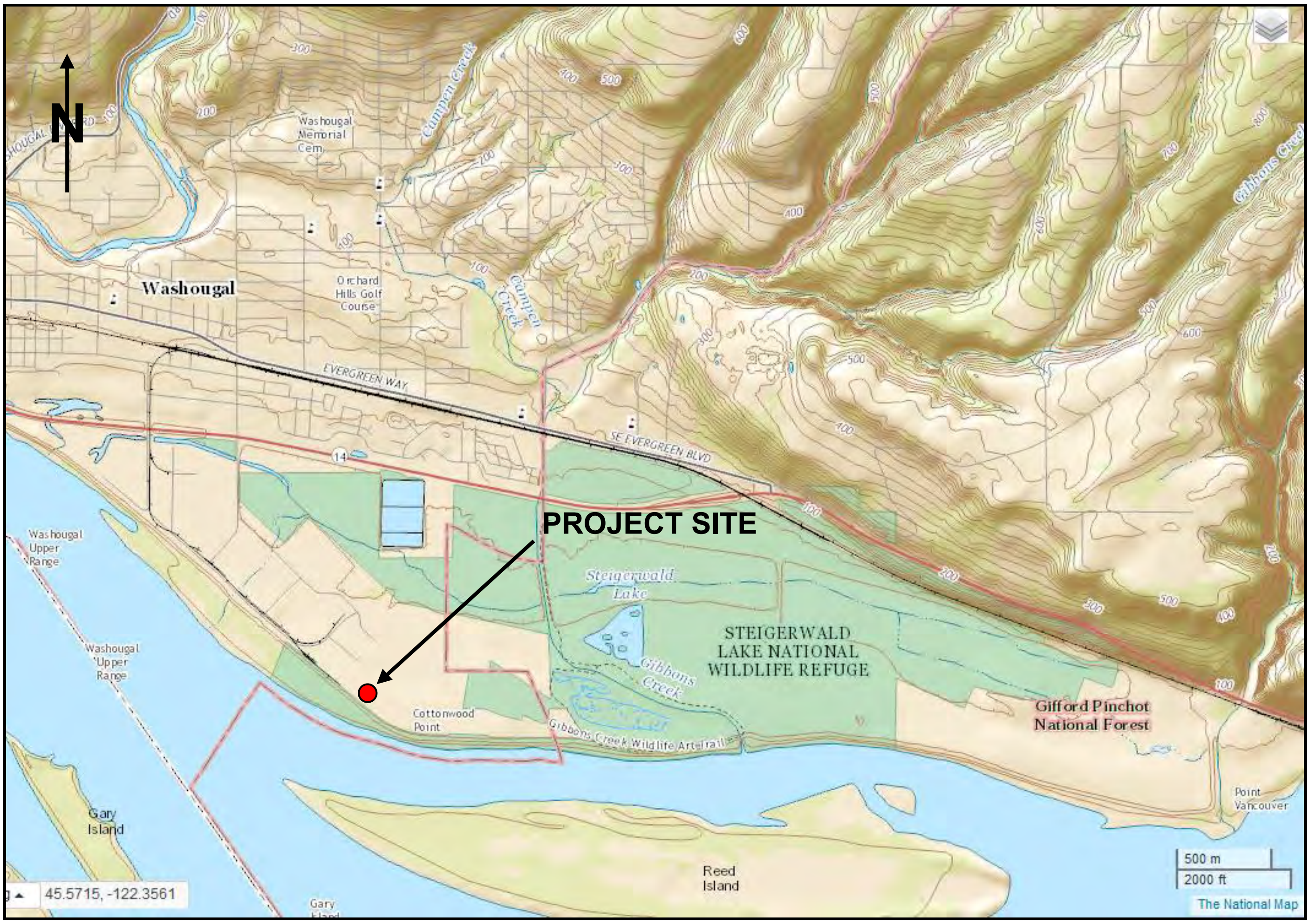
APPENDIX C: TOPOGRAPHIC SITE LOCATION PLAN



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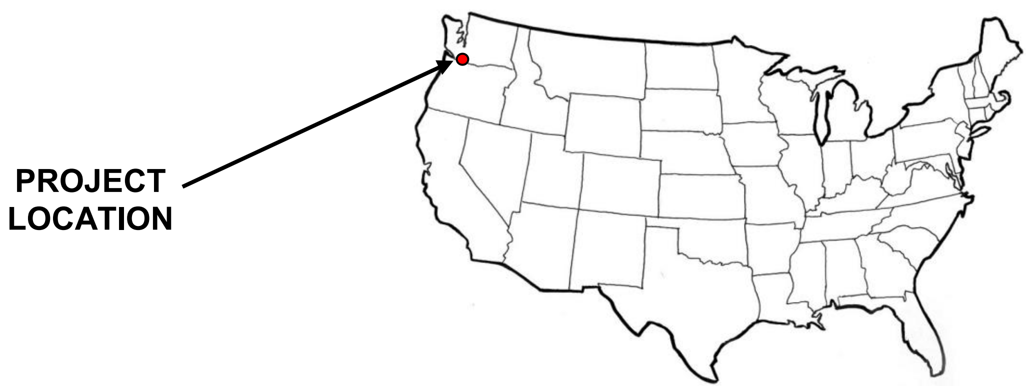

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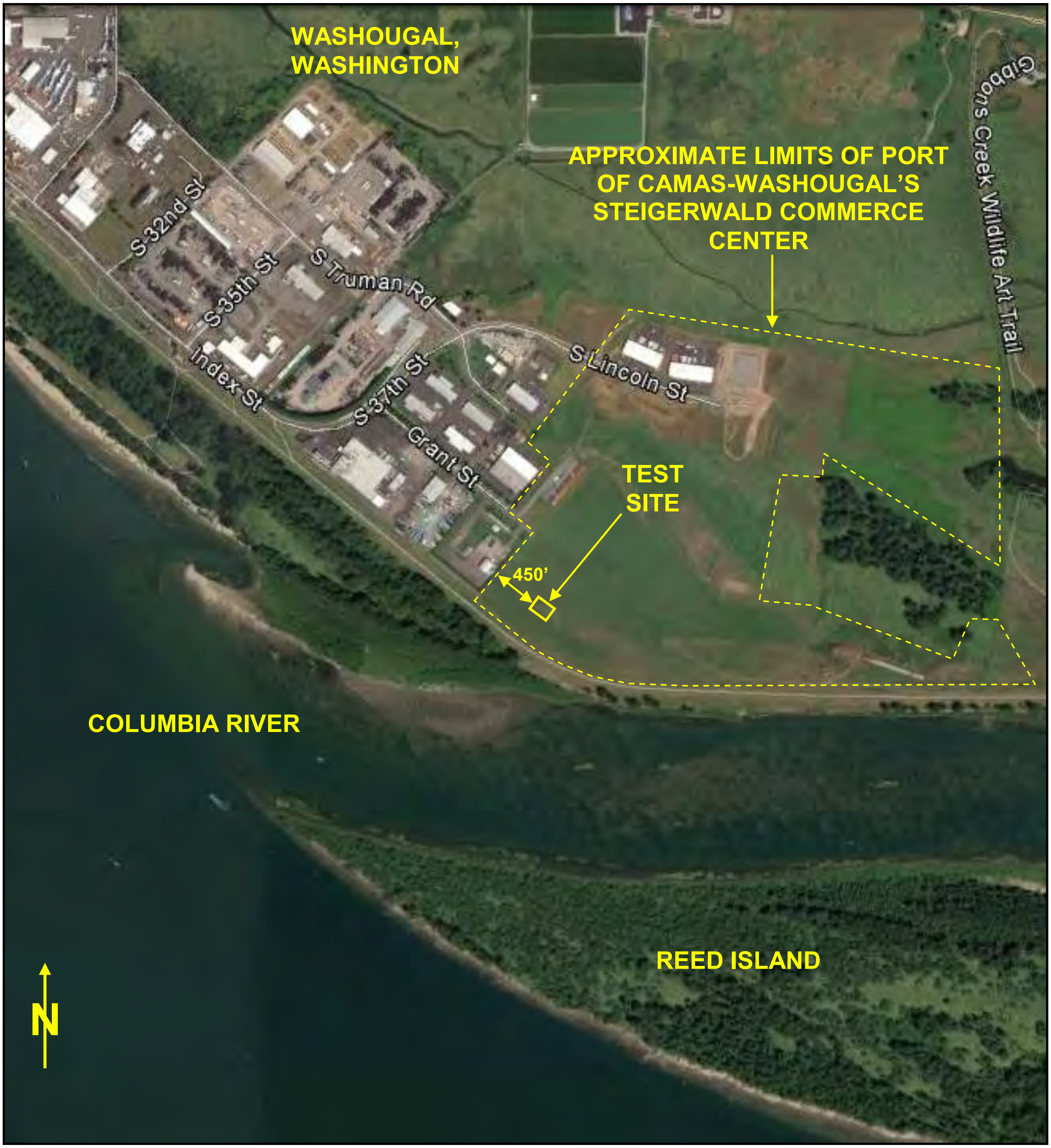
APPENDIX D: SITE LOCATION AERIAL PHOTO



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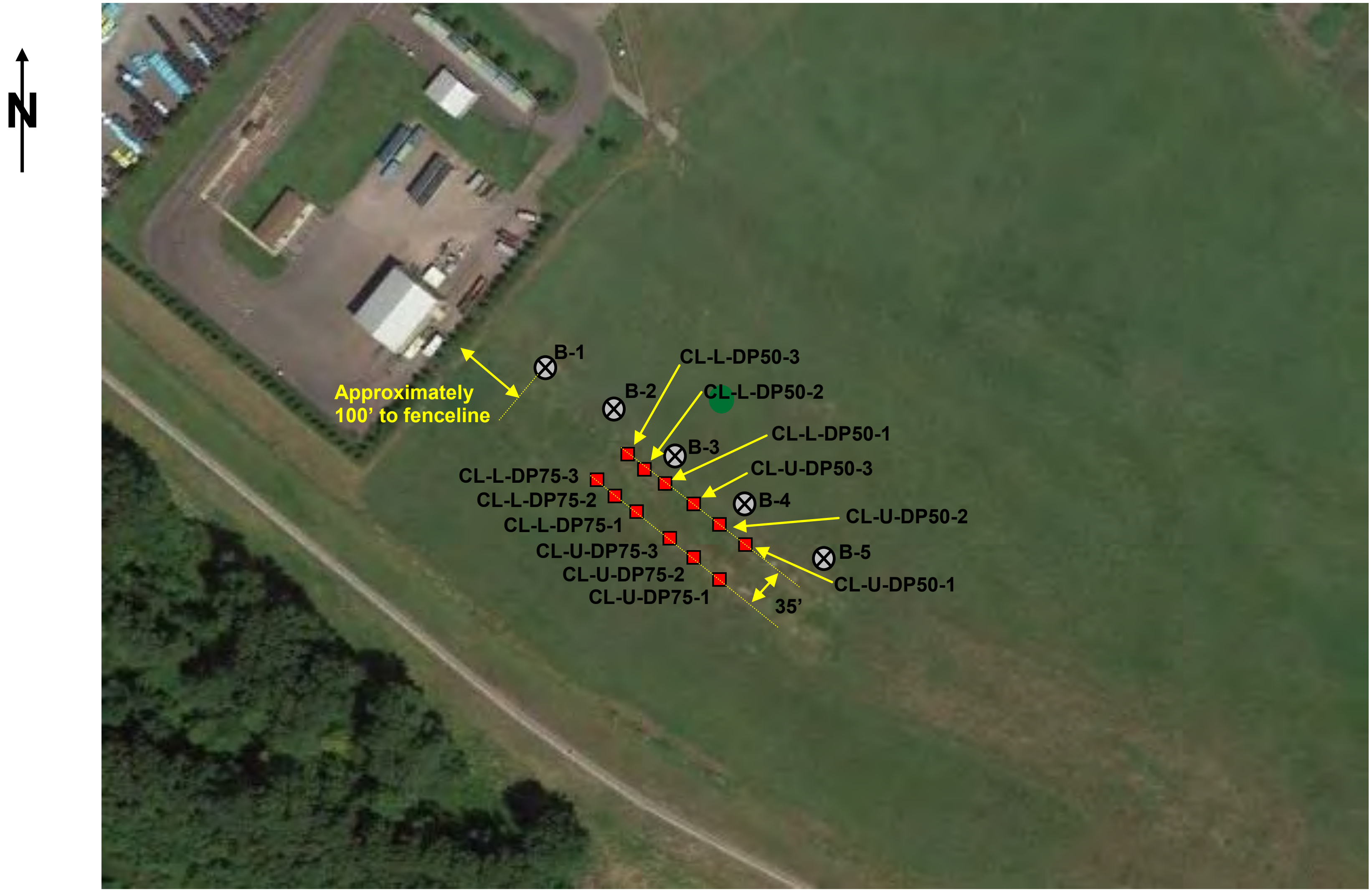
EEI REPORT NO. 07-020-11

JANUARY 23, 2017

APPENDIX E: DIAMOND PIER AND GEOTECHNICAL BORING LOCATION PLAN



Base Aerial Photo Source: Google Earth.

Earth Engineers, Inc.	DIAMOND PIER LOAD TESTING PORT OF CAMAS-WASHOUGAL WASHOUGAL, WASHINGTON	EEI REPORT NO. 07-020-11 JANUARY 23, 2017

APPENDIX F: BORING B-1

CLIENT: Pin Foundations, Inc.	EARTH ENGINEERS, INC. REPORT NO.: 07-020-11
PROJECT: Diamond Pier Field Load Testing	EQUIPMENT: Beretta T46 with Auto SPT Hammer
LOCATION: Approximately 100' & 140' from W and S fence lines	APPROXIMATE ELEVATION: 32 feet (Google Earth)
DATE DRILLED: August 13, 2015	LOGGED BY: Cody Sorrelle and Troy Hull, P.E.

DEPTH (ft)	SAMPLE NO.	SAMPLE	SOIL DESCRIPTION	BLOWS PER 6 INCHES	N_{60} VALUE	% PASSING #200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT (%)	POCKET PEN. (t.s.f.)	REMARKS
	SPT-1		**TOPSOIL** - sandy silt/clay, brown with orange mottling, moist, with grass rootlets	4 5 8	17	96				1.75	
			SANDY SILT/CLAY (ML/CL) - brown, moist, medium stiff to stiff								
	SPT-2			3 4 3	9	91				1.00	
5	SPT-3			0 2 2	5	97					
	SPT-4			0 2 2	5	99					
10	SPT-5			2 3 3	8	99				0.50	
15			Boring terminated 11-1/2 feet below ground surface. Groundwater not encountered during drilling. Boring backfilled with bentonite chips. SPT values corrected for hammer energy correction ratio of 1.28 (reference May 28, 2015 calibration report from GeoDesign, Inc.)								
20											
25											

APPENDIX F: BORING B-2

CLIENT: Pin Foundations, Inc.	EARTH ENGINEERS, INC. REPORT NO.: 07-020-11
PROJECT: Diamond Pier Field Load Testing	EQUIPMENT: Beretta T46 with Auto SPT Hammer
LOCATION: Approximately 200' & 140' from W and S fence lines	APPROXIMATE ELEVATION: 32 feet (Google Earth)
DATE DRILLED: August 13, 2015	LOGGED BY: Cody Sorrelle and Troy Hull, P.E.

DEPTH (ft)	SAMPLE NO.	SAMPLE	SOIL DESCRIPTION	BLOWS PER 6 INCHES	N_{60} VALUE	% PASSING #200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT (%)	POCKET PEN. (t.s.f.)	REMARKS
	SPT-1		**TOPSOIL** - sandy silt/clay, brown with orange mottling, moist, with grass rootlets	4 6	15						
			SANDY SILT/CLAY (ML/CL) - brown, moist, medium stiff to stiff	6		63			10		
	SPT-2			3 2 3	6	63			16		
5											
	SPT-3		**SILT/CLAY WITH SAND (ML/CL)** - brown, wet, medium stiff	2 2 2	5	77			33		Shelby Tube (5-7') Qp = 0.75tsf Torvane = 0.45 tsf Wet Unit Wt. = 112.1 pcf Moisture = 38.1% % Fines = 81.7%
	SPT-4			0 2 4	8	74			34	0.50	
10											
	SPT-5			1 2 2	5	74			36	0.50	
			Boring terminated 11-1/2 feet below ground surface. Groundwater not encountered during drilling. Boring backfilled with bentonite chips. SPT values corrected for hammer energy correction ratio of 1.28 (reference May 28, 2015 calibration report from GeoDesign, Inc.) Shelby tube was performed in a separate located 4' south of B-2 and drilled directly to 5'								
15											
20											
25											

EARTH ENGINEERS, Inc.

APPENDIX F: BORING B-3

CLIENT: Pin Foundations, Inc.	EARTH ENGINEERS, INC. REPORT NO.: 07-020-11
PROJECT: Diamond Pier Field Load Testing	EQUIPMENT: Beretta T46 with Auto SPT Hammer
LOCATION: Approximately 300' & 140' from W and S fence lines	APPROXIMATE ELEVATION: 32 feet (Google Earth)
DATE DRILLED: August 13, 2015	LOGGED BY: Cody Sorrelle and Troy Hull, P.E.

DEPTH (ft)	SAMPLE NO.	SOIL DESCRIPTION	BLOWS PER 6 INCHES	N_{60} VALUE	% PASSING #200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT (%)	POCKET PEN. (t.s.f.)	REMARKS
	SPT-1	**TOPSOIL** - sandy silt/clay, brown with orange mottling, moist, with grass rootlets	4 7	17						
		SANDY SILT/CLAY (ML/CL) - brown, moist, medium stiff to stiff	6		66			8		
	SPT-2		4							
		SILTY SAND (SM) - brown, moist, very loose	1	4	47			4		Approximately 6" thick lense.
		SANDY SILT/CLAY (ML/CL) - brown, wet, medium stiff	2							
5	SPT-3		1 1 3	5	69			31		
	SPT-4	**SILT/CLAY WITH SAND (ML/CL)** -brown, wet, medium stiff to stiff	1 3 2	6	81	42	28	35	0.50	Shelby Tube (7.5-10')
10	SPT-5		1 1 3	5	80			34	1.00	
15										
20										
25										

Boring terminated 11-1/2 feet below ground surface. Groundwater not encountered during drilling. Boring backfilled with bentonite chips.

SPT values corrected for hammer energy correction ratio of 1.28 (reference May 28, 2015 calibration report from GeoDesign, Inc.)

Shelby tube was performed in a separate located 4' south of B-3 and drilled directly to 7.5'

EARTH ENGINEERS, Inc.

APPENDIX F: BORING B-4

CLIENT: Pin Foundations, Inc.	EARTH ENGINEERS, INC. REPORT NO.: 07-020-11
PROJECT: Diamond Pier Field Load Testing	EQUIPMENT: Beretta T46 with Auto SPT Hammer
LOCATION: Approximately 400' & 140' from W and S fence lines	APPROXIMATE ELEVATION: 32 feet (Google Earth)
DATE DRILLED: August 13, 2015	LOGGED BY: Cody Sorrelle and Troy Hull, P.E.

DEPTH (ft)	SAMPLE NO.	SAMPLE	SOIL DESCRIPTION	BLOWS PER 6 INCHES	N_{60} VALUE	% PASSING #200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT (%)	POCKET PEN. (t.s.f.)	REMARKS
	SPT-1		**TOPSOIL** - sandy silt/clay, brown with orange mottling, moist, with grass rootlets	3 6	14						
			SANDY SILT/CLAY (ML/CL) - brown, moist, medium stiff to stiff	5		52			6		
	SPT-2		**SILT/CLAY WITH SAND (ML/CL)** -brown, wet, soft to medium stiff	3 3 2	6	74			28		Shelby Tube (3-5') % Fines = 91.8%
5	SPT-3			1 2 2	5	96			31		
	SPT-4			1 2 3	6	83			36	0.50	
10	SPT-5			1 1 2	4	87			35		
15			Boring terminated 11-1/2 feet below ground surface. Groundwater not encountered during drilling. Boring backfilled with bentonite chips. SPT values corrected for hammer energy correction ratio of 1.28 (reference May 28, 2015 calibration report from GeoDesign, Inc.) Shelby tube was performed in a separate located 4' south of B-4 and drilled directly to 3'								
20											
25											

APPENDIX F: BORING B-5

CLIENT: Pin Foundations, Inc.	EARTH ENGINEERS, INC. REPORT NO.: 07-020-11
PROJECT: Diamond Pier Field Load Testing	EQUIPMENT: Beretta T46 with Auto SPT Hammer
LOCATION: Approximately 500' & 140' from W and S fence lines	APPROXIMATE ELEVATION: 33 feet (Google Earth)
DATE DRILLED: August 13, 2015	LOGGED BY: Cody Sorrelle and Troy Hull, P.E.

DEPTH (ft)	SAMPLE NO.	SAMPLE	SOIL DESCRIPTION	BLOWS PER 6 INCHES	N_{60} VALUE	% PASSING #200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT (%)	POCKET PEN. (t.s.f.)	REMARKS
	SPT-1		**TOPSOIL** - sandy silt/clay, brown with orange mottling, moist, with grass rootlets	5 10	23						
			SANDY SILT/CLAY (ML/CL) - brown, moist, medium stiff	8		71			7		
	SPT-2			1 2 2	5	54			19		
5	SPT-3		**SILT/CLAY WITH SAND (ML/CL)** -brown, wet, soft to stiff	1 3 2	6	84			30	1.50	
	SPT-4			0 1 1	3	87			41		Shelby Tube (7.5-9.5') Qp = 0.50 to 0.75 tsf Torvane=0.2 tsf Wet Unit Wt. = 114.0 pcf Moisture = 36.9%
10	SPT-5			0 3 2	6	82			33	1.50	
15			Boring terminated 11-1/2 feet below ground surface. Groundwater not encountered during drilling. Boring backfilled with bentonite chips. SPT values corrected for hammer energy correction ratio of 1.28 (reference May 28, 2015 calibration report from GeoDesign, Inc.) Shelby tube was performed in a separate located 4' south of B-5 and drilled directly to 6.5'								
20											
25											

EARTH ENGINEERS, Inc.

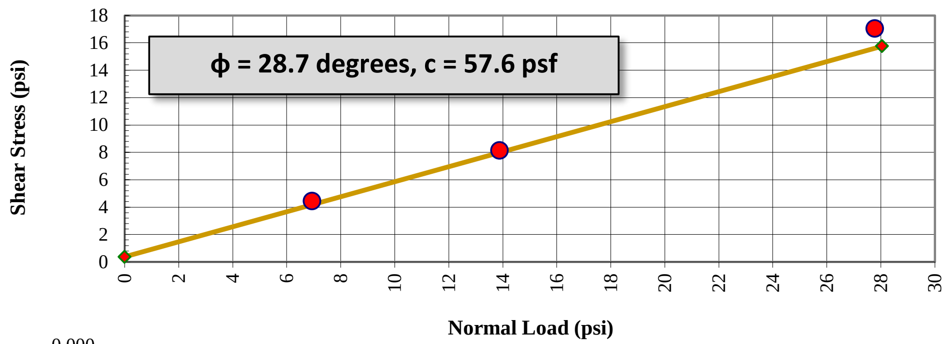
Earth Engineers, Inc.

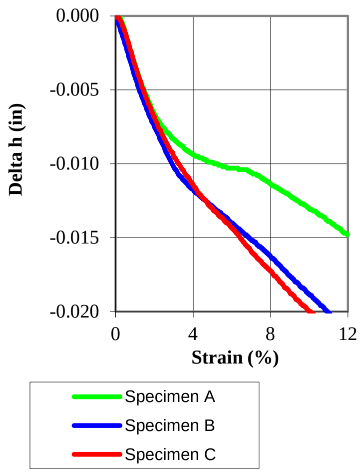
Direct Shear Test (ASTM D3080)

Earth Engineers, Inc.

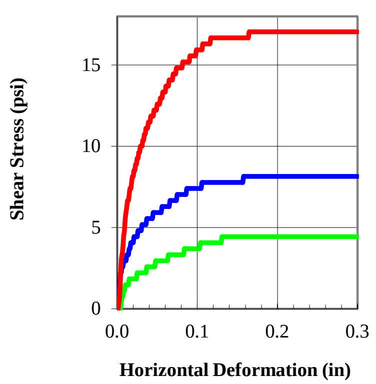
Date: 9/3/2016

Checked By: T. Hull





Initial	Specimen A	B	C
Moisture (%)	34.11	33.62	34.73
Dry Density (pcf)	82.59	82.76	80.76
Void Ratio	1.003	0.999	1.048
Saturation (%)	90.12	89.19	87.79
Diameter (in)	2.506	2.506	2.506
Height (in)	0.995	0.995	0.995



Final	A	B	C
Moisture (%)	37.09	36.77	39.28
Density (pcf)	81.66	82.04	80.26
Void Ratio	1.026	1.016	1.061
Saturation (%)	100.00	100.00	100.00
Diameter (in)	2.506	2.506	2.506
Height (in)	0.957	0.948	0.907
Normal Stress (psi)	6.9	13.9	27.8
Peak Stress (psi)	4.4	8.2	17.0
Strain (%)	12.0	12.0	12.0
Rate (in/min)	0.0005	0.0005	0.0005

Date: 7/2016

Tested By: J Fissel

Project:	Pin Foundations
Location:	Port of Camas/Washougal, Washington
Project Number:	07-020
Boring Number	B2
Depth:	5-7 feet, bottom portion of sample
Other Test Results:	ASTM D1140: Specimen B -81.7%, Specimen C - 93.5% fines
Sample Type:	Undisturbed
Description:	Brown Lean Clay with Fine Sand
Test Type:	Direct Shear
Remarks:	Atterberg Test Results (ASTM D4318: LL= 43. PL=22, PI=21 (CL)

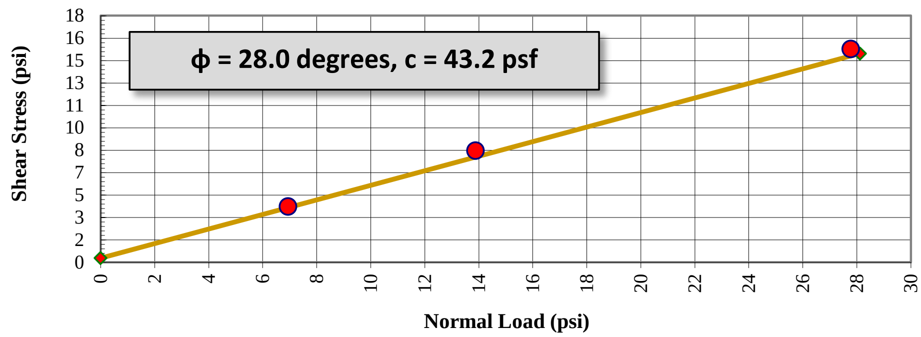
Earth Engineers, Inc.

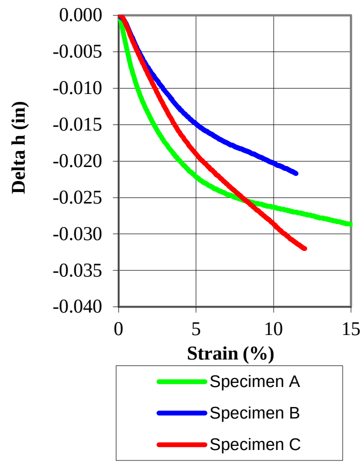
Direct Shear Test (ASTM D3080)

Earth Engineers, Inc.

Date:

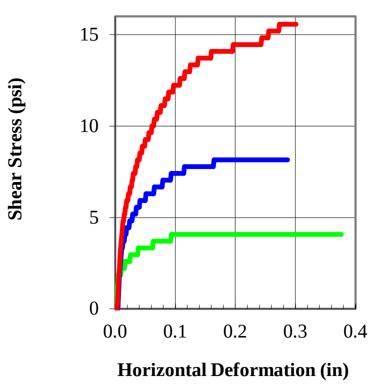
Checked By: T. Hull





Initial	Specimen A	B	C
Moisture (%)	22.27	34.64	34.21
Dry Density (pcf)	91.90	80.32	80.49
Void Ratio	0.800	1.060	1.055
Saturation (%)	73.76	86.65	85.90
Diameter (in)	2.506	2.506	2.506
Height (in)	0.995	0.995	0.995

Final	A	B	C
Moisture (%)	36.27	36.60	40.44
Density (pcf)	86.62	80.80	79.35
Void Ratio	0.910	1.047	1.085
Saturation (%)	100.00	100.00	100.00
Diameter (in)	2.506	2.506	2.506
Height (in)	0.957	0.934	0.946
Normal Stress (psi)	6.9	13.9	27.8
Peak Stress (psi)	4.1	8.2	15.6
Strain (%)	15.0	11.5	12.0
Rate (in/min)	0.0005	0.0005	0.0005



Date: 6/2016

Tested By: J. Fissel

Project:	Pin Foundations
Location:	Port of Camas/Washougal, Washington
Project Number:	07-020
Boring Number:	B4
Depth:	3-5 feet, upper 10 inches of sample
Other Test Results:	ASTM D1140: Specimen A - 91.8% fines
Sample Type:	Undisturbed
Description:	brown silty sand sandy silt
Test Type:	Direct Shear
Remarks:	

APPENDIX G: SITE QUALIFICATION ENGINEERING CALCULATIONS

FOOTING BEARING CAPACITY PROGRAM

(Utilizing Friction & Cohesion: or Standard Penetration Test)

(Program - Bearing Capacity.xls)

CLIENT: Pin Fondations, Inc.
PROJECT: Bearing Pin Pier Load Testing - Silt Site (1,500 psf +/- 10%)
JOB NO: 07-020

INPUT:			***OUTPUT:***		
Width, B:	3	ft	Ultimate bearing capacity, q-ult:	4,870	psf
Length, L:	3	ft	Net bearing capacity, q-net:	4,816	psf
Embedment, D:	0.5	ft	Factor of Safety, FS:	3.0	
Depth to GWT:	12	ft	**Allowable Bearing, qa:**	**1,620**	**psf (ult)**
Slope of Ground:	10000	(H):1(V)		1,610	**psf (net)**
Total Density, y:	109.0	pcf			
Friction angle, Phi:	28.35	degrees	Cohesion component:	2,229	psf
Cohesion, c:	50.0	psf	Embedment component:	1,347	psf
Use Hansen Sy & Dc (1):	1		Friction component:	1,294	psf
Failure-Local (0)/General (1):	1		Ground Slope Inclination,i:	0.0	degrees
			Phi, radians:	0.49	rad
			Effective density:	109.0	pcf
			Surcharge density:	109	pcf

	Bearing Capacity Factors	Shape Factors	Depth Factors	Inclination Factors
	N	S	D	I
Cohesion, c:	26.50	1.58	1.07	1.00
Surcharge, q:	15.30	1.54	1.05	1.00
Friction, y:	13.19	0.60	1.00	1.00

General Bearing Capacity Equation:

q-ult = c*Nc*Sc*Dc*Ic + y*D*Nq*Sq*Dq*Iq + 0.5*y*B*Ny*Sy*Dy*Iy

q-net = q-ult - y*D

Nc = (Nq-1)*cot(phi)

Nq = exp[pi*tan(phi)]*[tan(pi/4+phi/2)]^2

Ny = K*(Nq+1)*tan(phi) K=1.5 (Hansen), 2 (Terzaghi & Peck-1967)

Sc = 1+(B/L)*(Nq/Nc)

Sq = 1+(B/L)*tan(phi)

Sy = 1-0.4*(B/L) (Hansen) 1-0.2*(B/L) (Terzaghi & Peck-1967)

Dc = 1+0.4*(D/B) (Hansen) 1+0.2*(D/B) (Terzaghi & Peck-1967) <= 1.46 maximum

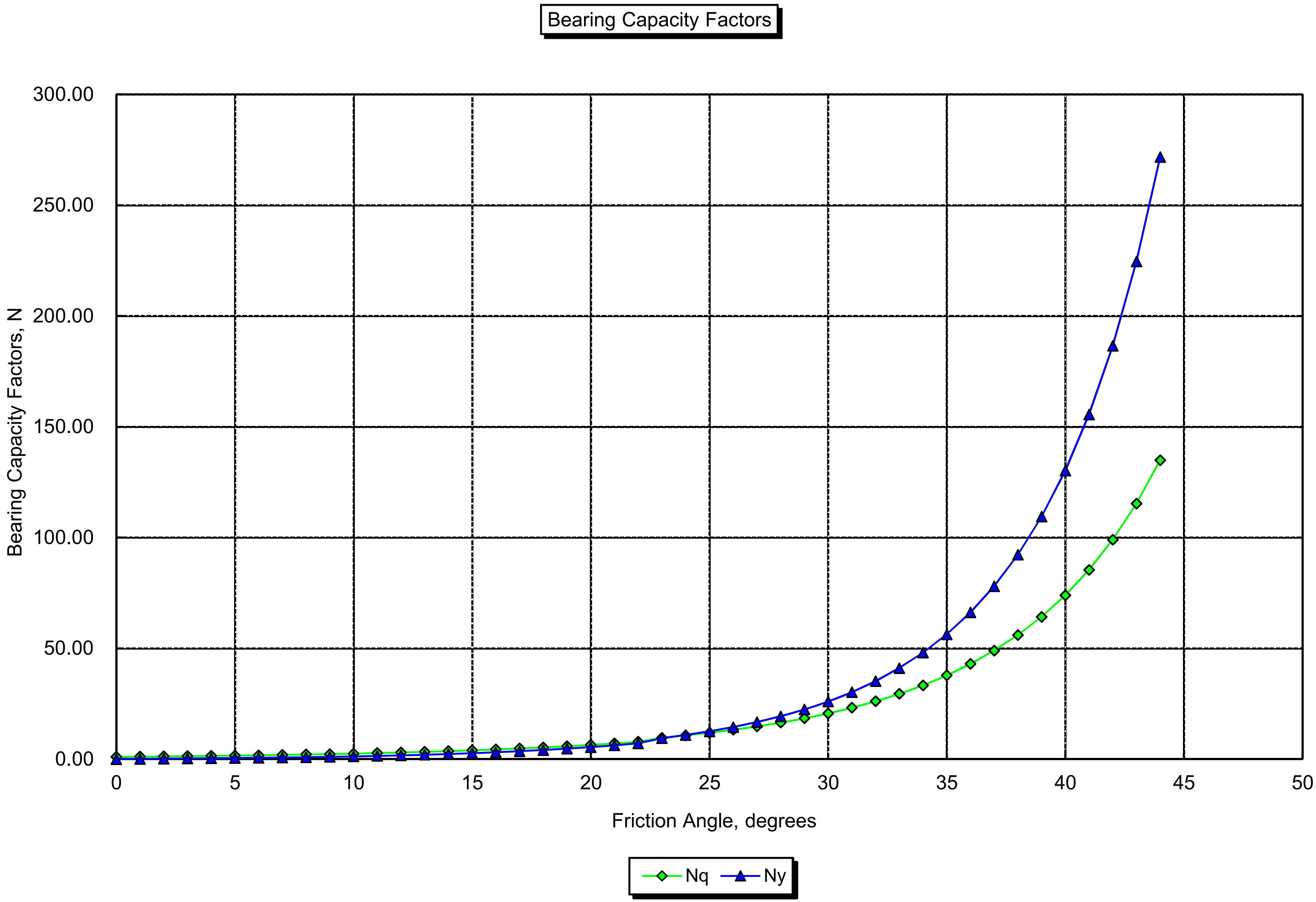
Dq = 1+2*tan(phi)*[1-sin(phi)]^2*D/B

Dy = 1.00

Ic = 1 - [2*i/(pi+2)]

Iq = [1- tan(i)]^2

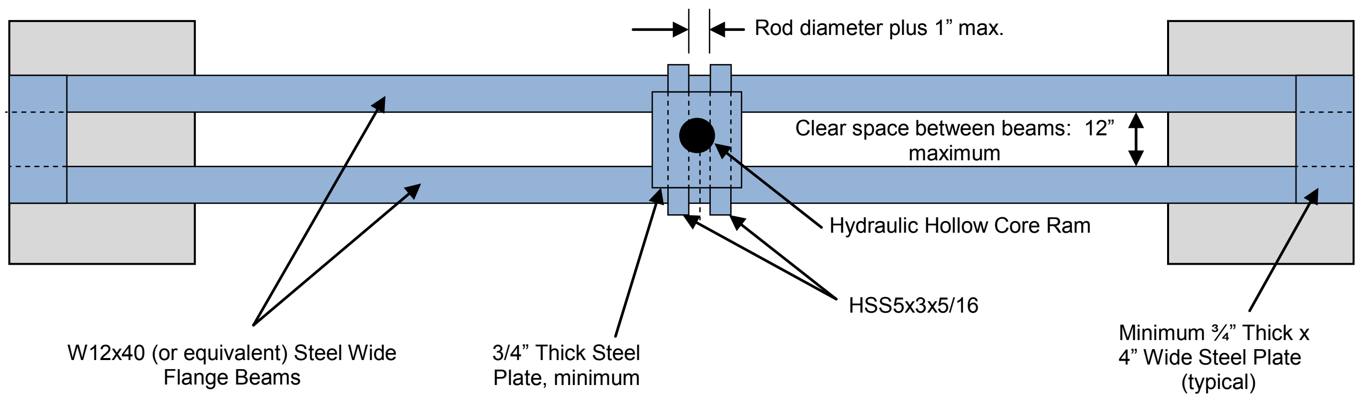
Iy = [1- tan(i)]^2



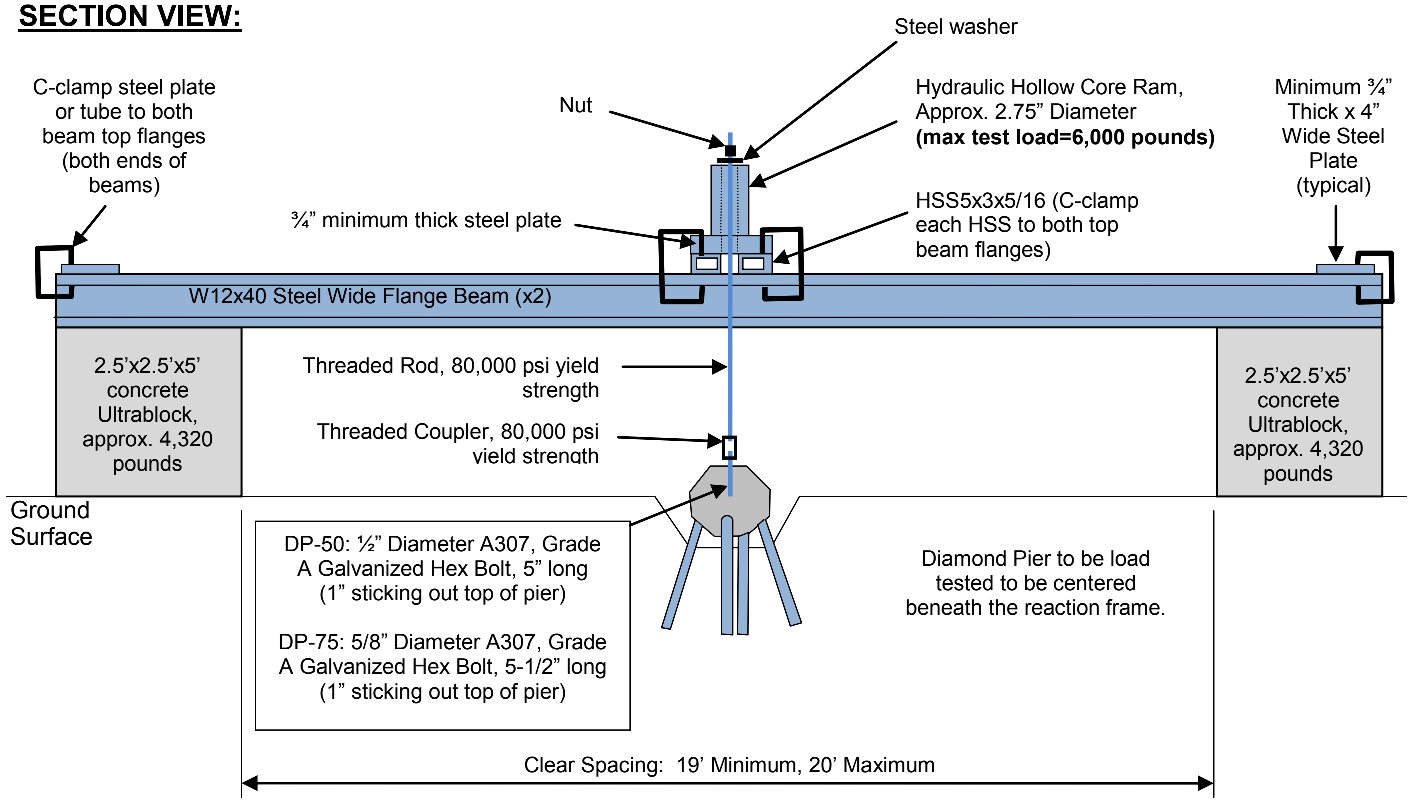
Bearing Capacity Factors
Bearing Capacity Factors, N
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
5
10
15
20
25
30
35
40
45
50
Friction Angle, degrees
Nq
Ny

APPENDIX H: UPLIFT TEST SETUP

PLAN VIEW:



SECTION VIEW:



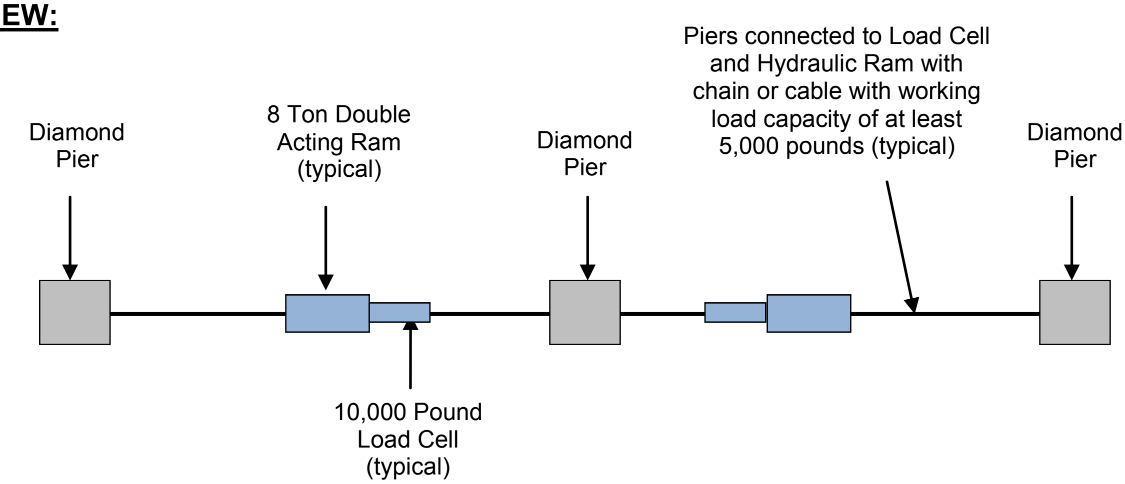
Not to scale.

NOTE: Movement measurement devices (i.e. reference beams, dial gauges, surveying level, steel rule) are not shown on drawing but are to be included in test configuration in accordance with ASTM D3689.

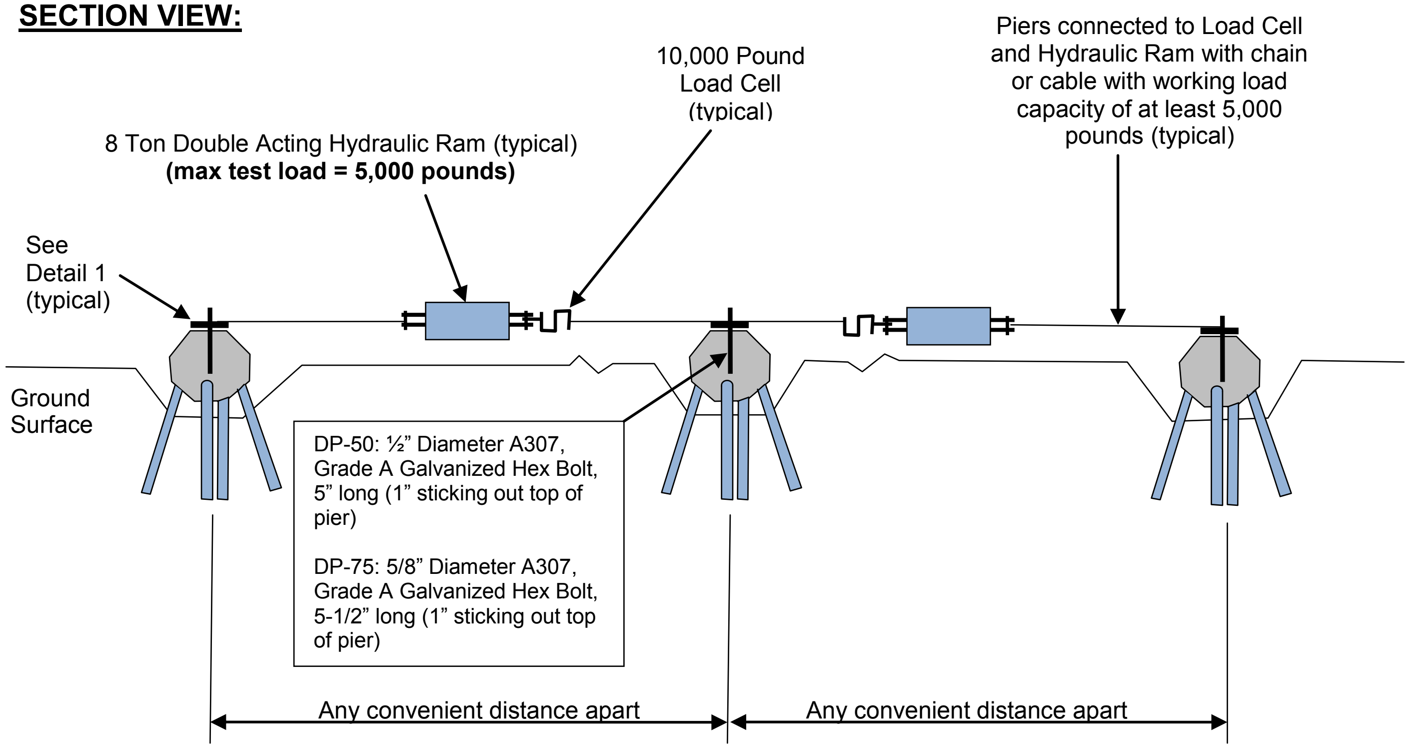
Earth Engineers, Inc.	**DIAMOND PIER LOAD TESTING PORT OF CAMAS-WASHOUGAL WASHOUGAL, WASHINGTON**	**EEI REPORT NO. 07-020-11** **JANUARY 23, 2017**

APPENDIX H: LATERAL LOAD TEST SETUP

PLAN VIEW:



SECTION VIEW:



Not to scale.

NOTE: Movement measurement devices (i.e. reference beams, dial gauges, surveying level, steel rule) are not shown on drawing but are to be included in test configuration in accordance with ASTM D3966.

Earth Engineers, Inc.

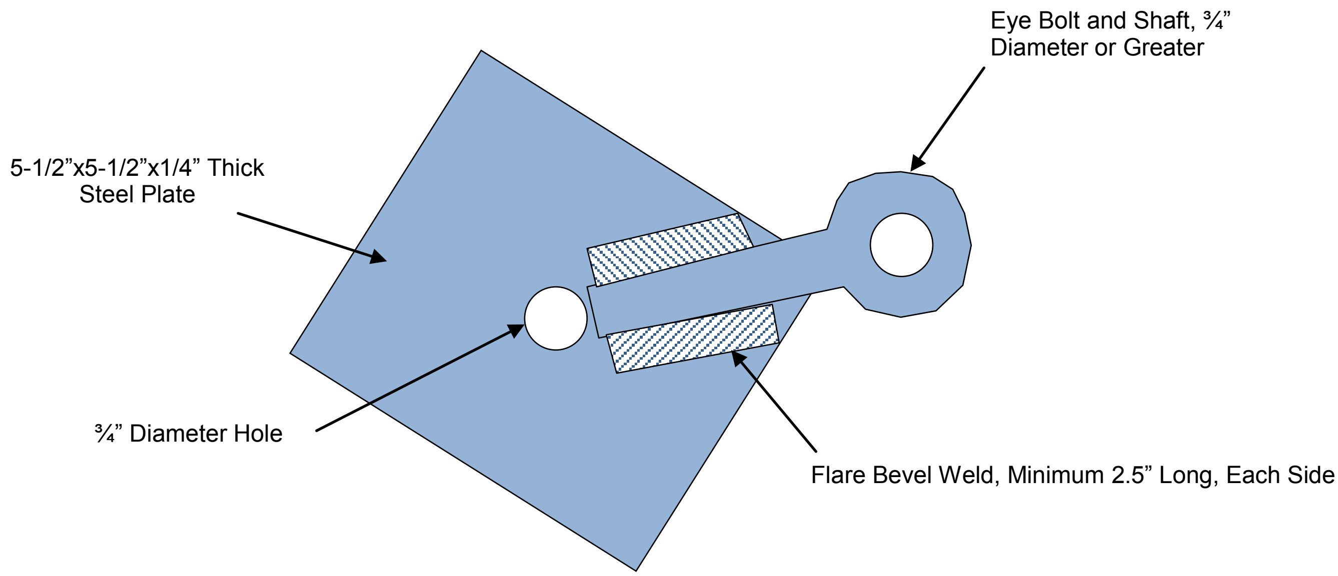
DIAMOND PIER LOAD TESTING
PORT OF CAMAS-WASHOUGAL
WASHOUGAL, WASHINGTON

EEI REPORT NO. 07-020-11

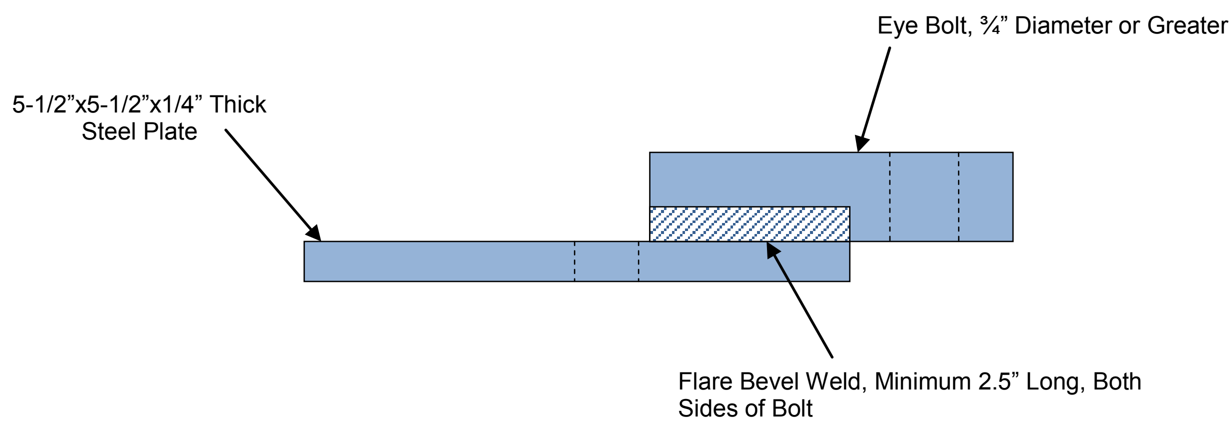
JANUARY 23, 2017

APPENDIX H: LATERAL LOAD TEST SETUP—DIAMOND PIER TOP PLATE DETAIL

PLAN VIEW:



SECTION VIEW:



Not to scale.

Earth Engineers, Inc.	DIAMOND PIER LOAD TESTING PORT OF CAMAS-WASHOUGAL WASHOUGAL, WASHINGTON	EEI REPORT NO. 07-020-11 JANUARY 23, 2017

APPENDIX I: EQUIPMENT LIST

ID No.	Description (Manufacturer, Model No., Serial No., etc.)	Maintenance Frequency	Maintenance By	In-Service Checks	Date Last Checked	Date Calibrated	Calibrated By	Date Next Calibration Due	Calibration Procedure	Equipment Marked for Out of Service (1)
EEI 021	Enerpac 12-ton Hollow Core Hydraulic ram (also referenced as Cylinder #T04-019)	Once/year	R. Aliperti	Once/year		April 7, 2016	Carlson Testing	April 7, 2016	ASTM E74	
EEI 022	Enerpac 12-ton Hollow Core Hydraulic ram (also referenced as Cylinder #T04-020)	Once/year	R. Aliperti	Once/year		April 7, 2016	Carlson Testing	Prior to use	ASTM E74	
EEI 025	WiKa 5000-psi Hydraulic pressure gage (assigned to EEI 021)	Once/year	R. Aliperti	Once/year		April 7, 2016	Carlson Testing	Prior to use	ASTM E74	
EEI 027	WiKa 5000-psi Hydraulic pressure gage (assigned to EEI 022)	Once/year	R. Aliperti	Once/year		April 7, 2016	Carlson Testing	Prior to use	ASTM E74	
EEI 31	Load Cell Central 10k Tension Load Cell, Serial #P438940A	Once/year	R. Aliperti	Once/year		April 7, 2016	Carlson Testing	April 7, 2017	ASTM E74	
EEI 32	6.5 Ton Tension Ram Bailys Chief WC 3000 PSI	Once/year	R. Aliperti	Once/year		Purchased New March 2016	n/a	March 1, 2017	ASTM E74	
EEI 33	Digital Dial Indicator Cen-Tech model #93295 SN #1	Once/year	R. Aliperti	Once/year		Purchased New March 2016	n/a	March 1, 2017	ASME B89.1.10.M	
EEI 34	Digital Dial Indicator Cen-Tech model #93295 SN #2	Once/year	R. Aliperti	Once/year		Purchased New March 2016	n/a	March 1, 2017	ASME B89.1.10.M	
EEI 35	Digital Dial Indicator Cen-Tech model #93295 SN #3	Once/year	R. Aliperti	Once/year		Purchased New March 2016	n/a	March 1, 2017	ASME B89.1.10.M	
EEI 36	Digital Dial Indicator Cen-Tech model #93295 SN #4	Once/year	R. Aliperti	Once/year		Purchased New March 2016	n/a	March 1, 2017	ASME B89.1.10.M	
EEI 41	Enerpac 10-ton Hollow Core Hydraulic Ram, Serial #420995 (temporary rental for Pin Foundations project)	Once/year	R. Aliperti	Once/year		April 18, 2016	Carlson Testing	April 18, 2017	ASTM E74	
EEI 42	Lietz BT-30 Surveying Transit	Once/year	R. Aliperti	Once/year		n/a	n/a	n/a	n/a	

(1) Equipment marked for Out of Service performed by Technical Manager only. After equipment is marked for out of service the equipment shall either be properly discarded or placed in the storage room locker labeled “Out of Service Equipment”.

APPENDIX J: CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Professional Service Industries, Inc.
3011 South Huson Street, Suite B
Tacoma, WA 98421

Phone: (253) 589-1804
Fax: (253) 589-2136

Concrete Test Report

Report No: CTR:0742100-99-C1
Issue No: 1

Client: PIN FOUNDATIONS INC
4810 PT. FOSDICK DR. NW, PMB 60
GIG HARBOR, WA 98335

CC: RICHARD GAGLIANO

Project: PIN FOUNDATIONS
WASHOUGAL, WA

Approved Signatory: Mike Kath (Branch Manager)
Date of Issue: 5/16/2016

Mix Data

Supplier:
Plant:
Mix Identification:
Specified Design Strength (psi):

Sample Details

Date Sampled: 03/08/16
Date Received:
Sample Location: Field Test Batch C
Curing Method:
Field Sample No.:
Field Cure Temp (°F) High:
Low:
Contractor:
Ticket no.:
Truck No.:
Sampled By: Client
Submitted By:
Weather:
Est. Wind (mph):
Est. Rh (%):

Specification:

		Measured	Specified
Slump (in):	ASTM C 143	N/A	
Slump w/ plasticizer (in):		N/A	
Air Temp (°F):		N/A	
Concrete Temp (°F):	ASTM C 1064	N/A	
Air Content (%)	ASTM C 231	N/A	
Unit Weight (pcf):	ASTM C 138	N/A	
Volume of Density Measure (ft³):		N/A	

Batch Size (yd³):
Time Batched:
Yd³ Placed:
Time Sampled:
Water Added (gal) Before:
Time Placed:
After:
Time in Truck (mins):

Compressive Strength of Concrete Cylinders — ASTM C 39

Specimen ID	Date Tested	Age (Days)	Diameter (in)	Length (in)	Area (in²)	Type of Cap	Ultimate Load (lbf)	Fracture Type / Remarks	Compressive Strength (psi)
0742100-99-C1\	05/03/16	56	4.01	8.00	12.63	U	64210	4	5080
0742100-99-C1\	05/03/16	56	4.00	8.05	12.57	U	68630	4	5460
0742100-99-C1\	05/03/16	56	3.99	8.00	12.50	U	68150	4	5450

Average Compressive Strength (psi)
Required Strength (psi)

Notes

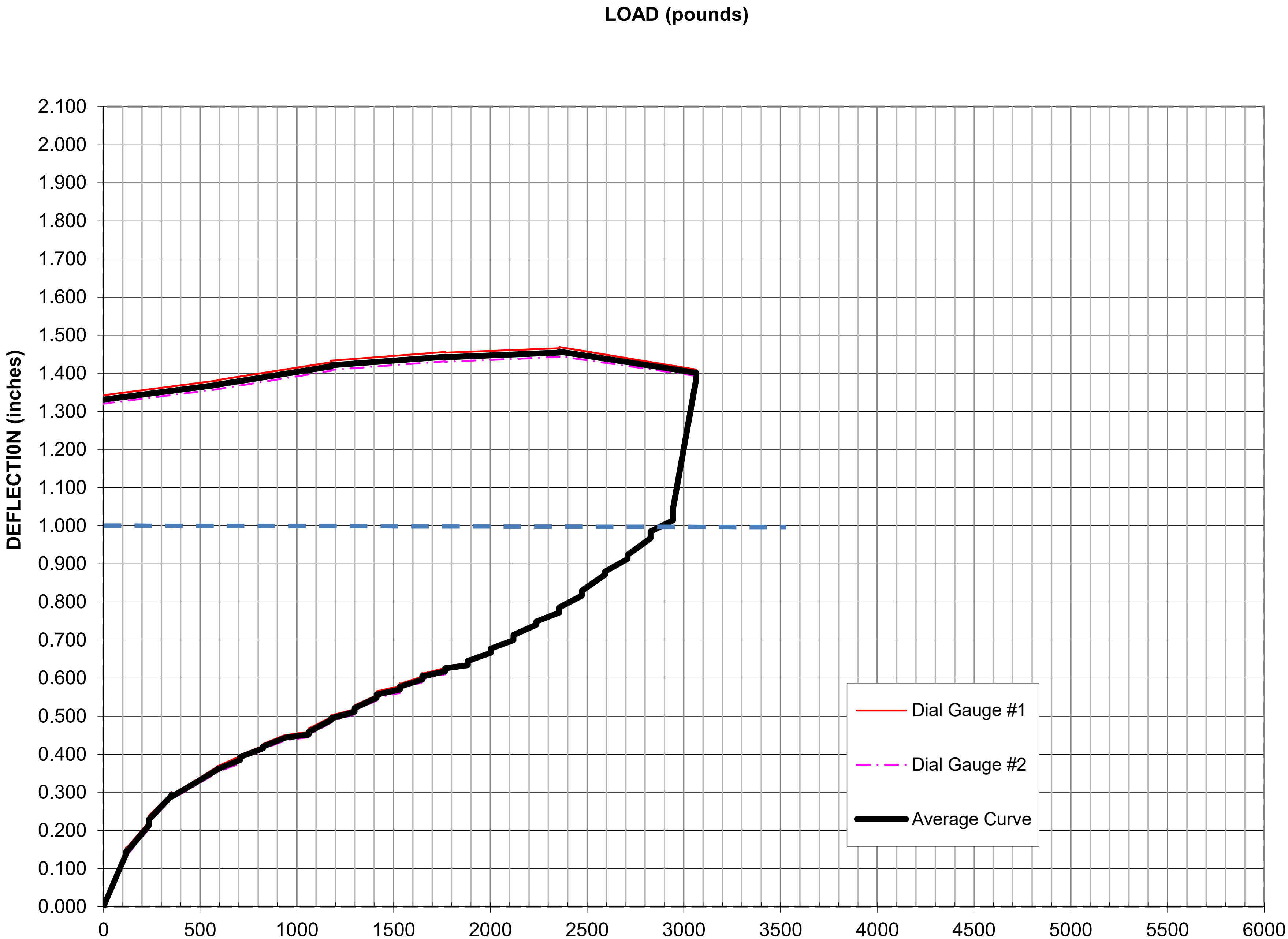
1. Sampling to ASTM C 172
2. Specimen(s) prepared to ASTM C 31
3. Capping B=Bonded ASTM C 617, U=Unbonded ASTM C 1231, C = Combined, G = Ground

Remarks

Fracture Type: 4 = C39: Diagonal fracture; C1314: Tension Break
Test Time 1500 hrs

APPENDIX K: LOAD TEST DATA

PIER #CL-U-DP50-1, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 4/19/16)
AXIAL TENSION LOAD TEST - SILT SITE



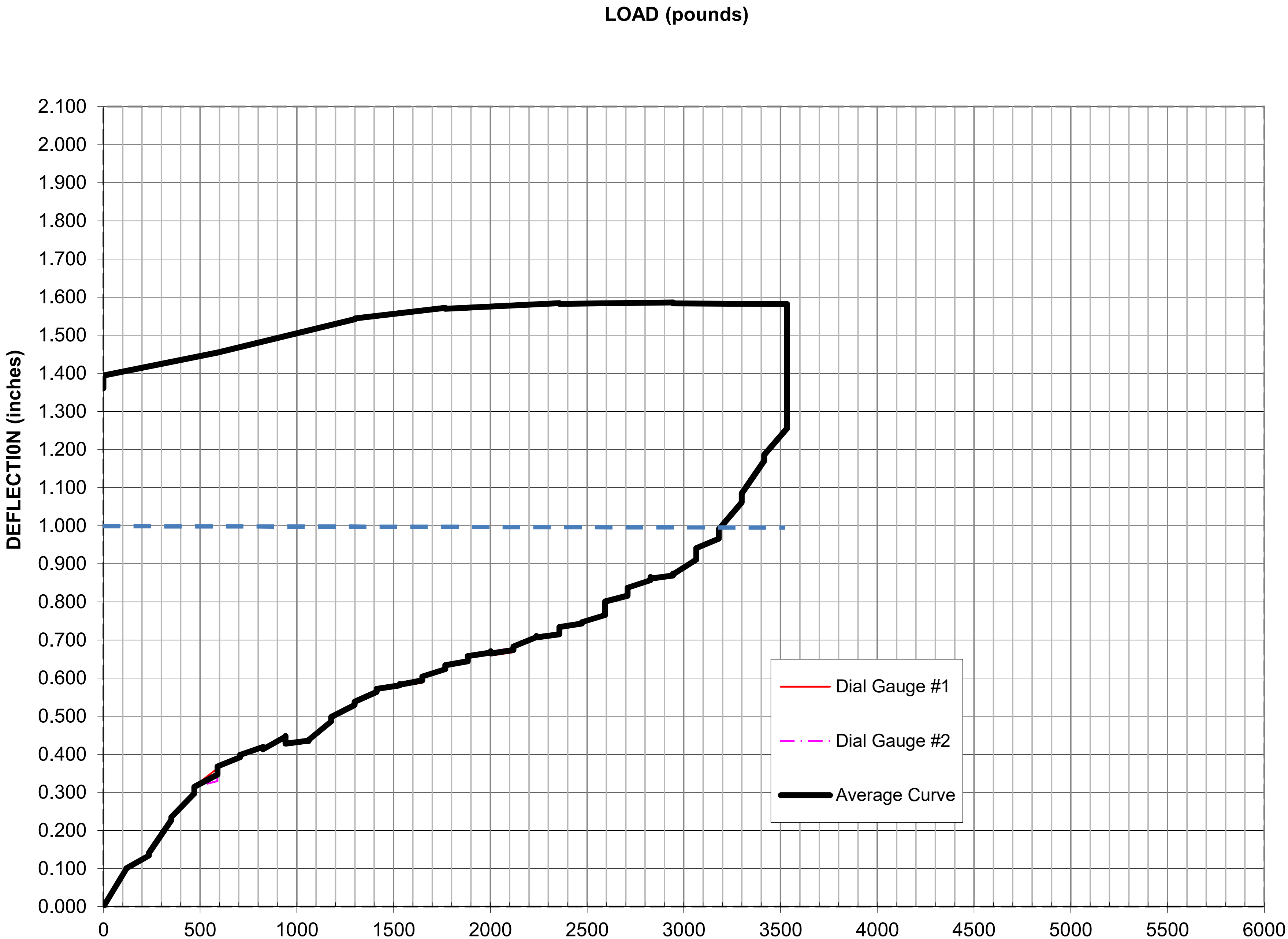
Project Name:	Diamond Pier foundation field load testing
EEI Project No.:	07-020
Site:	SILT (presumptive bearing capacity of 1,500 psf)
Test Method:	Uplift - ASTM D3689
Diamond Pier Tested:	#CL-U-DP50-1
Date Installed:	4/4/2016
Date Test Started:	4/19/2016
Date Test Completed:	4/19/2016
Staff:	Ken Andrieu, Bruce Lane
Hydraulic Ram:	EEI Equipment #EEI 022
Equation of the Line:	Load = (Gauge Pressure - 2) / 0.361
Dial Gauge #1:	EEI Equipment #EEI 33
Dial Gauge #2:	EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	12:37	0	0.000	0.000	0.000	1	
119	45	12:38	0	0.149	0.131	0.140	1 9/64	
119	45	12:39	1	0.153	0.134	0.144		
119	45	12:40	2	0.156	0.137	0.147		
119	45	12:41	3	0.152	0.135	0.144		
119	45	12:42	4	0.153	0.135	0.144		
119	45	12:43	5	0.153	0.133	0.143	1 9/64	
235	87	12:43	0	0.222	0.204	0.213	1 13/64	
235	87	12:44	1	0.227	0.208	0.218		
235	87	12:45	2	0.228	0.209	0.219		
235	87	12:46	3	0.233	0.214	0.224		
235	87	12:47	4	0.235	0.216	0.226		
235	87	12:48	5	0.238	0.219	0.229	1 13/64	
352	129	12:49	0	0.297	0.284	0.291	1 17/64	
352	129	12:50	1	0.299	0.285	0.292		
352	129	12:51	2	0.301	0.287	0.294		
352	129	12:52	3	0.301	0.286	0.294		
352	129	12:53	4	0.300	0.285	0.293		
352	129	12:54	5	0.295	0.282	0.289	1 1/4	
471	172	12:55	0	0.330	0.316	0.323	1 19/64	
471	172	12:56	1	0.331	0.317	0.324		
471	172	12:57	2	0.329	0.317	0.323		
471	172	12:58	3	0.329	0.317	0.323		
471	172	12:59	4	0.329	0.317	0.323		
471	172	13:00	5	0.330	0.317	0.324	1 5/16	
590	215	13:01	0	0.368	0.352	0.360	1 11/32	
590	215	13:02	1	0.369	0.354	0.362		
590	215	13:03	2	0.368	0.353	0.361		
590	215	13:04	3	0.368	0.353	0.361		
590	215	13:05	4	0.368	0.353	0.361		
590	215	13:06	5	0.368	0.353	0.361	1 11/32	
706	257	13:07	0	0.394	0.376	0.385	1 3/8	
706	257	13:08	1	0.394	0.377	0.386		
706	257	13:09	2	0.396	0.382	0.389		
706	257	13:10	3	0.398	0.385	0.392		
706	257	13:11	4	0.398	0.387	0.393		
706	257	13:12	5	0.398	0.388	0.393	1 3/8	
825	300	13:13	0	0.422	0.409	0.416	1 25/64	
825	300	13:14	1	0.426	0.411	0.419		
825	300	13:15	2	0.426	0.411	0.419		
825	300	13:16	3	0.426	0.411	0.419		
825	300	13:17	4	0.426	0.413	0.420		
825	300	13:18	5	0.427	0.414	0.421	1 25/64	
942	342	13:22	0	0.451	0.437	0.444	1 13/32	
942	342	13:23	1	0.451	0.437	0.444		
942	342	13:24	2	0.451	0.437	0.444		
942	342	13:25	3	0.450	0.437	0.444		
942	342	13:26	4	0.450	0.437	0.444		
942	342	13:27	5	0.450	0.437	0.444	1 13/32	
1061	385	13:29	0	0.459	0.445	0.452	1 29/64	

1061	385	13:30	1	0.460	0.447	0.454		
1061	385	13:31	2	0.462	0.447	0.455		
1061	385	13:32	3	0.463	0.448	0.456		
1061	385	13:33	4	0.466	0.449	0.458		
1061	385	13:34	5	0.467	0.450	0.459	1 29/64	
1177	427	13:35	0	0.497	0.483	0.490	1 31/64	
1177	427	13:36	1	0.498	0.485	0.492		
1177	427	13:37	2	0.500	0.486	0.493		
1177	427	13:38	3	0.502	0.486	0.494		
1177	427	13:39	4	0.502	0.486	0.494		
1177	427	13:40	5	0.502	0.486	0.494	1 31/64	
1299	471	13:42	0	0.518	0.505	0.512	1 33/64	
1299	471	13:43	1	0.522	0.509	0.516		
1299	471	13:44	2	0.527	0.512	0.520		
1299	471	13:45	3	0.527	0.513	0.520		
1299	471	13:46	4	0.527	0.513	0.520		
1299	471	13:47	5	0.528	0.515	0.522	1 17/32	
1413	512	13:48	0	0.555	0.541	0.548	1 35/64	
1413	512	13:49	1	0.560	0.545	0.553		
1413	512	13:50	2	0.560	0.545	0.553		
1413	512	13:51	3	0.561	0.546	0.554		
1413	512	13:52	4	0.563	0.548	0.556		
1413	512	13:53	5	0.565	0.549	0.557	1 35/64	
1532	555	13:55	0	0.579	0.561	0.570	1 9/16	
1532	555	13:56	1	0.586	0.568	0.577		
1532	555	13:57	2	0.585	0.569	0.577		
1532	555	13:58	3	0.585	0.569	0.577		
1532	555	13:59	4	0.585	0.570	0.578		
1532	555	14:00	5	0.584	0.570	0.577	1 9/16	
1648	597	14:01	0	0.604	0.589	0.597	1 37/64	
1648	597	14:02	1	0.609	0.595	0.602		
1648	597	14:03	2	0.612	0.597	0.605		
1648	597	14:04	3	0.614	0.598	0.606		
1648	597	14:05	4	0.611	0.598	0.605		
1648	597	14:06	5	0.611	0.597	0.604	1 37/64	
1767	640	14:07	0	0.626	0.610	0.618	1 39/64	
1767	640	14:08	1	0.630	0.616	0.623		
1767	640	14:09	2	0.631	0.619	0.625		
1767	640	14:10	3	0.631	0.62	0.626		
1767	640	14:11	4	0.631	0.62	0.626		
1767	640	14:12	5	0.631	0.621	0.626	1 39/64	
1884	682	14:17	0	0.639	0.629	0.634	1 5/8	
1884	682	14:18	1	0.642	0.632	0.637		
1884	682	14:19	2	0.645	0.635	0.640		
1884	682	14:20	3	0.647	0.636	0.642		
1884	682	14:21	4	0.65	0.638	0.644		
1884	682	14:22	5	0.65	0.639	0.645	1 41/64	
2003	725	14:23	0	0.671	0.662	0.667	1 21/32	
2003	725	14:24	1	0.675	0.667	0.671		
2003	725	14:25	2	0.677	0.668	0.673		
2003	725	14:26	3	0.677	0.669	0.673		
2003	725	14:27	4	0.679	0.671	0.675		
2003	725	14:28	5	0.682	0.673	0.678	1 43/64	
2119	767	14:29	0	0.704	0.695	0.700	1 11/16	
2119	767	14:30	1	0.709	0.701	0.705		
2119	767	14:31	2	0.712	0.704	0.708		
2119	767	14:32	3	0.713	0.706	0.710		
2119	767	14:33	4	0.714	0.708	0.711		
2119	767	14:34	5	0.716	0.71	0.713	1 45/64	
2238	810	14:36	0	0.743	0.737	0.740	1 23/32	
2238	810	14:37	1	0.75	0.743	0.747		
2238	810	14:38	2	0.75	0.744	0.747		
2238	810	14:39	3	0.749	0.744	0.747		
2238	810	14:40	4	0.752	0.745	0.749		
2238	810	14:41	5	0.752	0.745	0.749	1 23/32	
2357	853	14:42	0	0.775	0.769	0.772	1 3/4	
2357	853	14:43	1	0.777	0.772	0.775		
2357	853	14:44	2	0.78	0.776	0.778		
2357	853	14:45	3	0.782	0.778	0.780		
2357	853	14:46	4	0.785	0.78	0.783		

2357	853	14:47	5	0.788	0.783	0.786	1 3/4	
2474	895	14:51	0	0.819	0.813	0.816	1 25/32	
2474	895	14:52	1	0.825	0.82	0.823		
2474	895	14:53	2	0.825	0.821	0.823		
2474	895	14:54	3	0.826	0.822	0.824		
2474	895	14:55	4	0.828	0.823	0.826		
2474	895	14:56	5	0.832	0.826	0.829	1 51/64	
2593	938	14:57	0	0.876	0.867	0.872	1 27/32	
2593	938	14:58	1	0.879	0.873	0.876		
2593	938	14:59	2	0.88	0.875	0.878		
2593	938	15:00	3	0.88	0.875	0.878		
2593	938	15:01	4	0.881	0.876	0.879		
2593	938	15:02	5	0.882	0.877	0.880	1 55/64	
2709	980	15:04	0	0.915	0.911	0.913	1 57/64	
2709	980	15:05	1	0.922	0.917	0.920		
2709	980	15:06	2	0.922	0.919	0.921		
2709	980	15:07	3	0.924	0.92	0.922		
2709	980	15:08	4	0.924	0.921	0.923		
2709	980	15:09	5	0.924	0.922	0.923	1 29/32	
2828	1023	15:10	0	0.968	0.966	0.967	1 15/16	
2828	1023	15:11	1	0.977	0.974	0.976		
2828	1023	15:12	2	0.979	0.976	0.978		
2828	1023	15:13	3	0.984	0.98	0.982		
2828	1023	15:14	4	0.986	0.981	0.984		
2828	1023	15:15	5	0.986	0.983	0.985	1 61/64	
2945	1065	15:19	0	1.015	1.013	1.014	1 63/64	
2945	1065	15:20	1	1.023	1.02	1.022		
2945	1065	15:21	2	1.042	1.033	1.038		
2945	1065	15:22	3	1.044	1.035	1.040		
2945	1065	15:23	4	1.047	1.036	1.042		
2945	1065	15:24	5	1.049	1.041	1.045	2 1/64	
3064	1108	15:26	0	1.393	1.378	1.386	2 3/8	
3064	1108	15:27	1	1.401	1.387	1.394		
3064	1108	15:28	2	1.406	1.391	1.399		
3064	1108	15:29	3	1.407	1.392	1.400		
3064	1108	15:30	4	1.408	1.392	1.400		
3064	1108	15:31	5	1.41	1.393	1.402	2 3/8	
2357	853	16:17	1	1.469	1.445	1.457	2 23/64	
2357	853	16:21	4	1.466	1.443	1.455	2 3/8	
1767	640	16:23	1	1.454	1.43	1.442	2 23/64	
1767	640	16:27	4	1.456	1.431	1.444	2 23/64	
1177	427	16:29	1	1.433	1.409	1.421	2 21/64	
1177	427	16:32	4	1.429	1.407	1.418	2 21/64	
590	215	16:35	1	1.382	1.358	1.370	2 9/32	
590	215	16:38	4	1.381	1.358	1.370	2 17/64	
0	0	16:40	1	1.342	1.32	1.331	2 7/32	
0	0	16:43	4	1.342	1.319	1.331	2 15/64	
0	0	16:47	8	1.343	1.319	1.331	2 7/32	
0	0	16:54	15	1.343	1.32	1.332	2 7/32	

PIER #CL-U-DP50-2, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/5/16)
AXIAL TENSION LOAD TEST - SILT SITE



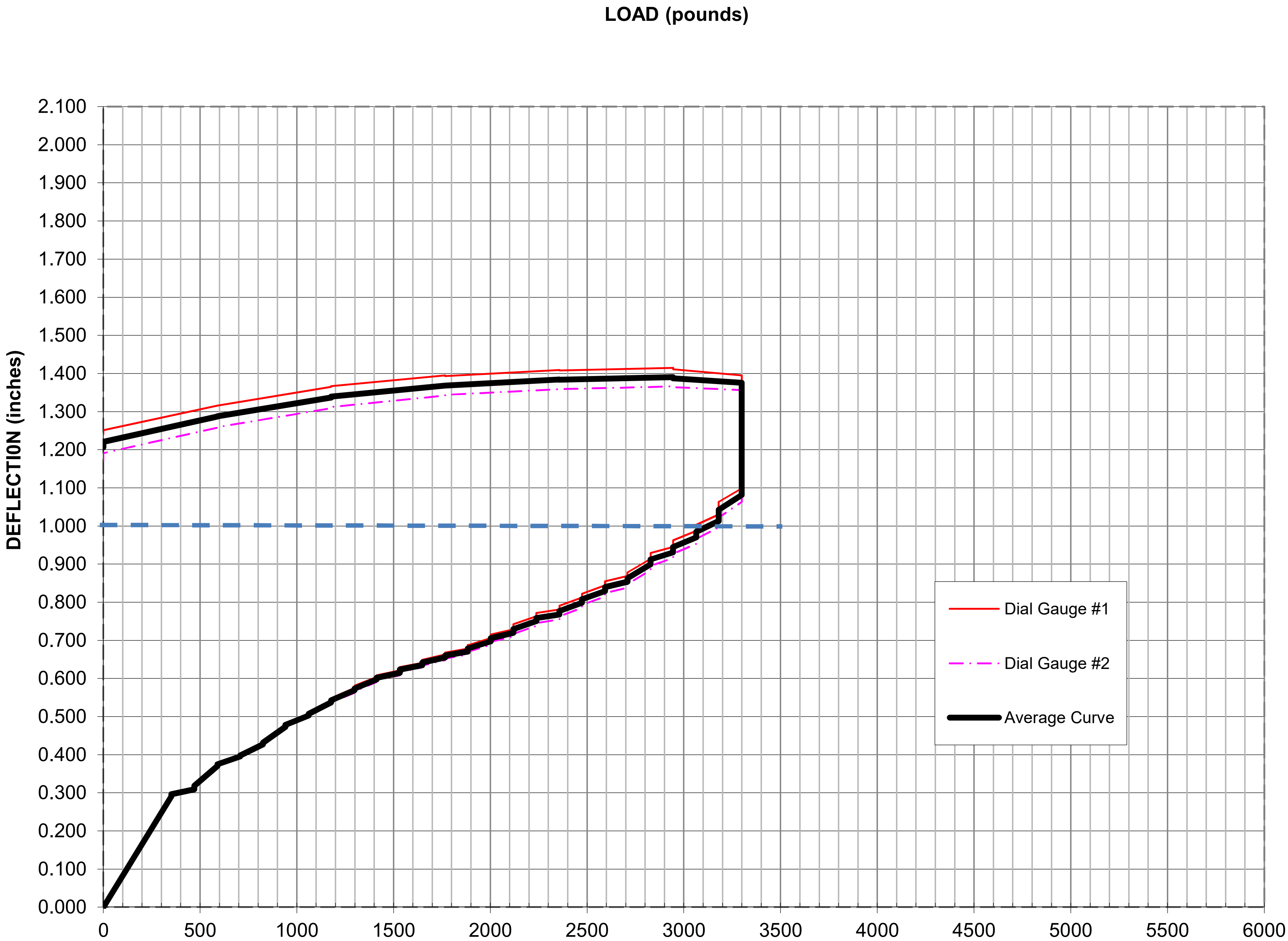
Project Name: Diamond Pier foundation field load testing
EEI Project No.: 07-020
Site: SILT (presumptive bearing capacity of 1,500 psf)
Test Method: Uplift- ASTM D3689
Diamond Pier Tested: #CL-U-DP50-2
Date Installed: 4/4/2016
Date Test Started: 5/5/2016
Date Test Completed: 5/5/2016
Staff: Ken Andrieu, Bruce Lane
Hydraulic Ram: EEI Equipment #EEI 022
Equation of the Line: Load = (Gauge Pressure - 2) / 0.361
Dial Gauge #1: EEI Equipment #EEI 33
Dial Gauge #2: EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	13:32	0	0.000	0.000	0.000	1	
119	45	13:33	0	0.103	0.096	0.100	1 1/8	
119	45	13:34	1	0.104	0.097	0.101		
119	45	13:35	2	0.104	0.097	0.101		
119	45	13:36	3	0.104	0.098	0.101		
119	45	13:37	4	0.104	0.098	0.101		
119	45	13:38	5	0.104	0.098	0.101		
235	87	13:38	0	0.137	0.131	0.134	1 5/32	
235	87	13:39	1	0.139	0.134	0.137		
235	87	13:40	2	0.140	0.135	0.138		
235	87	13:41	3	0.140	0.136	0.138		
235	87	13:42	4	0.142	0.137	0.140		
235	87	13:43	5	0.145	0.137	0.141	1 5/32	
352	129	13:45	0	0.231	0.224	0.228	1 1/4	
352	129	13:46	1	0.237	0.227	0.232		
352	129	13:47	2	0.240	0.228	0.234		
352	129	13:48	3	0.240	0.229	0.235		
352	129	13:49	4	0.240	0.229	0.235		
352	129	13:50	5	0.240	0.229	0.235	1 1/4	
471	172	13:51	0	0.299	0.295	0.297		
471	172	13:52	1	0.301	0.299	0.300		
471	172	13:53	2	0.303	0.300	0.302		
471	172	13:54	3	0.307	0.302	0.305		
471	172	13:55	4	0.312	0.308	0.310		
471	172	13:56	5	0.316	0.314	0.315		
590	215	13:57	0	0.363	0.330	0.347	1 21/64	
590	215	13:58	1	0.368	0.364	0.366		
590	215	13:59	2	0.368	0.365	0.367		
590	215	14:00	3	0.369	0.366	0.368		
590	215	14:01	4	0.369	0.366	0.368		
590	215	14:02	5	0.370	0.366	0.368	1 21/64	
706	257	14:03	0	0.394	0.390	0.392	1 3/8	
706	257	14:05	1	0.400	0.391	0.396		
706	257	14:06	2	0.401	0.393	0.397		
706	257	14:07	3	0.401	0.394	0.398		
706	257	14:08	4	0.401	0.394	0.398		
706	257	14:09	5	0.401	0.395	0.398		
825	300	14:10	0	0.422	0.416	0.419	1 13/32	
825	300	14:11	1	0.421	0.416	0.419		
825	300	14:12	2	0.418	0.413	0.416		
825	300	14:13	3	0.416	0.411	0.414		
825	300	14:14	4	0.415	0.411	0.413		
825	300	14:15	5	0.415	0.411	0.413	1 13/32	
942	342	14:17	0	0.449	0.443	0.446	1 29/64	
942	342	14:18	1	0.451	0.445	0.448		
942	342	14:19	2	0.447	0.442	0.445		
942	342	14:20	3	0.440	0.437	0.439		
942	342	14:21	4	0.436	0.433	0.435		
942	342	14:22	5	0.429	0.426	0.428	1 15/32	
1061	385	14:25	0	0.436	0.435	0.436	1 31/64	
1061	385	14:26	1	0.437	0.437	0.437		

1061	385	14:27	2	0.434	0.435	0.435		
1061	385	14:28	3	0.436	0.436	0.436		
1061	385	14:29	4	0.438	0.438	0.438		
1061	385	14:30	5	0.438	0.437	0.438	1 31/64	
1177	427	14:31	0	0.484	0.488	0.486	1 1/2	
1177	427	14:32	1	0.494	0.495	0.495		
1177	427	14:33	2	0.496	0.497	0.497		
1177	427	14:34	3	0.496	0.498	0.497		
1177	427	14:35	4	0.496	0.498	0.497		
1177	427	14:36	5	0.497	0.499	0.498	1 1/2	
1299	471	14:37	0	0.526	0.532	0.529	1 35/64	
1299	471	14:38	1	0.527	0.534	0.531		
1299	471	14:39	2	0.528	0.536	0.532		
1299	471	14:40	3	0.530	0.538	0.534		
1299	471	14:41	4	0.532	0.541	0.537		
1299	471	14:42	5	0.534	0.542	0.538		
1413	512	14:43	0	0.559	0.568	0.564	1 37/64	
1413	512	14:44	1	0.563	0.569	0.566		
1413	512	14:45	2	0.564	0.571	0.568		
1413	512	14:46	3	0.566	0.573	0.570		
1413	512	14:47	4	0.568	0.575	0.572		
1413	512	14:48	5	0.568	0.575	0.572		
1532	555	14:48	0	0.577	0.585	0.581	1 37/64	
1532	555	14:49	1	0.580	0.588	0.584		
1532	555	14:50	2	0.580	0.588	0.584		
1532	555	14:51	3	0.581	0.588	0.585		
1532	555	14:52	4	0.579	0.587	0.583		
1532	555	14:53	5	0.578	0.587	0.583		
1648	597	14:53	0	0.588	0.599	0.594	1 19/32	
1648	597	14:54	1	0.591	0.601	0.596		
1648	597	14:55	2	0.592	0.602	0.597		
1648	597	14:56	3	0.595	0.605	0.600		
1648	597	14:57	4	0.597	0.607	0.602		
1648	597	14:58	5	0.600	0.609	0.605		
1767	640	14:58	0	0.619	0.628	0.624	1 5/8	
1767	640	14:59	1	0.622	0.630	0.626		
1767	640	15:00	2	0.623	0.631	0.627		
1767	640	15:01	3	0.626	0.633	0.630		
1767	640	15:02	4	0.628	0.635	0.632		
1767	640	15:03	5	0.63	0.637	0.634		
1884	682	15:04	0	0.64	0.648	0.644	1 5/8	
1884	682	15:05	1	0.642	0.651	0.647		
1884	682	15:06	2	0.643	0.653	0.648		
1884	682	15:07	3	0.645	0.654	0.650		
1884	682	15:08	4	0.645	0.655	0.650		
1884	682	15:09	5	0.66	0.656	0.658		
2003	725	15:10	0	0.662	0.672	0.667	1 21/32	
2003	725	15:11	1	0.666	0.674	0.670		
2003	725	15:12	2	0.667	0.674	0.671		
2003	725	15:13	3	0.666	0.674	0.670		
2003	725	15:14	4	0.662	0.673	0.668		
2003	725	15:15	5	0.659	0.67	0.665		
2119	767	15:16	0	0.668	0.679	0.674	1 11/16	
2119	767	15:17	1	0.671	0.683	0.677		
2119	767	15:18	2	0.672	0.684	0.678		
2119	767	15:19	3	0.672	0.684	0.678		
2119	767	15:20	4	0.675	0.685	0.680		
2119	767	15:21	5	0.678	0.688	0.683		
2238	810	15:22	0	0.704	0.711	0.708	1 45/64	
2238	810	15:23	1	0.709	0.712	0.711		
2238	810	15:24	2	0.709	0.712	0.711		
2238	810	15:25	3	0.708	0.712	0.710		
2238	810	15:26	4	0.705	0.711	0.708		
2238	810	15:27	5	0.703	0.711	0.707		
2357	853	15:28	0	0.711	0.719	0.715	1 3/4	
2357	853	15:29	1	0.714	0.721	0.718		
2357	853	15:30	2	0.716	0.723	0.720		
2357	853	15:31	3	0.721	0.727	0.724		
2357	853	15:32	4	0.731	0.736	0.734		
2357	853	15:33	5	0.732	0.736	0.734		

2474	895	15:34	0	0.741	0.745	0.743	1 49/64	
2474	895	15:35	1	0.744	0.748	0.746		
2474	895	15:36	2	0.744	0.748	0.746		
2474	895	15:37	3	0.744	0.748	0.746		
2474	895	15:38	4	0.744	0.749	0.747		
2474	895	15:39	5	0.745	0.749	0.747		
2593	938	15:40	0	0.762	0.768	0.765	1 25/32	
2593	938	15:41	1	0.775	0.782	0.779		
2593	938	15:42	2	0.784	0.79	0.787		
2593	938	15:43	3	0.791	0.793	0.792		
2593	938	15:44	4	0.796	0.797	0.797		
2593	938	15:45	5	0.801	0.801	0.801		
2709	980	15:46	0	0.817	0.816	0.817	1 51/64	
2709	980	15:47	1	0.825	0.823	0.824		
2709	980	15:48	2	0.829	0.828	0.829		
2709	980	15:49	3	0.831	0.83	0.831		
2709	980	15:50	4	0.835	0.832	0.834		
2709	980	15:51	5	0.839	0.835	0.837		
2828	1023	15:52	0	0.858	0.856	0.857	1 27/32	
2828	1023	15:53	1	0.866	0.863	0.865		
2828	1023	15:54	2	0.867	0.864	0.866		
2828	1023	15:55	3	0.867	0.864	0.866		
2828	1023	15:56	4	0.863	0.863	0.863		
2828	1023	15:57	5	0.86	0.862	0.861		
2945	1065	15:58	0	0.867	0.871	0.869	1 7/8	
2945	1065	15:59	1	0.872	0.876	0.874		
2945	1065	16:00	2	0.872	0.876	0.874		
2945	1065	16:01	3	0.87	0.875	0.873		
2945	1065	16:02	4	0.87	0.875	0.873		
2945	1065	16:03	5	0.87	0.875	0.873		
3064	1108	16:04	0	0.908	0.914	0.911	1 15/16	
3064	1108	16:05	1	0.921	0.925	0.923		
3064	1108	16:06	2	0.925	0.927	0.926		
3064	1108	16:07	3	0.932	0.931	0.932		
3064	1108	16:08	4	0.938	0.936	0.937		
3064	1108	16:09	5	0.942	0.94	0.941		
3180	1150	16:10	0	0.965	0.966	0.966	1 61/64	
3180	1150	16:11	1	0.976	0.971	0.974		
3180	1150	16:12	2	0.982	0.978	0.980		
3180	1150	16:13	3	0.985	0.981	0.983		
3180	1150	16:14	4	0.988	0.985	0.987		
3180	1150	16:15	5	0.991	0.989	0.990		
3299	1193	16:16	0	1.065	1.057	1.061	2 1/32	
3299	1193	16:17	1	1.076	1.065	1.071		
3299	1193	16:18	2	1.08	1.07	1.075		
3299	1193	16:19	3	1.082	1.072	1.077		
3299	1193	16:20	4	1.086	1.075	1.081		
3299	1193	16:21	5	1.089	1.079	1.084		
3416	1235	16:22	0	1.175	1.166	1.171	2 1/8	
3416	1235	16:23	1	1.186	1.175	1.181		
3416	1235	16:24	2	1.189	1.179	1.184		
3416	1235	16:25	3	1.19	1.18	1.185		
3416	1235	16:26	4	1.191	1.181	1.186		
3416	1235	16:27	5	1.191	1.181	1.186		
3535	1278	16:28	0	1.257	1.254	1.256	2 9/32	
3535	1278	16:29	1	1.319	1.319	1.319		
3535	1278	16:30	2	1.319	1.319	1.319		
3535	1278	16:31	3	1.58	1.575	1.578		
3535	1278	16:32	4	1.581	1.577	1.579		
3535	1278	16:33	5	1.583	1.58	1.582		
2945	1065	16:35	1	1.586	1.581	1.584	2 35/64	
2945	1065	16:38	4	1.589	1.583	1.586		
2357	853	16:44	1	1.586	1.579	1.583		
2357	853	16:47	4	1.587	1.581	1.584		
1767	640	16:48	1	1.572	1.566	1.569	2 33/64	
1767	640	16:51	4	1.575	1.568	1.572		
1302	472	16:52	1	1.547	1.541	1.544	2 31/64	
1302	472	16:55	4	1.546	1.539	1.543		
590	215	16:56	1	1.456	1.453	1.455	2 3/8	
590	215	16:58	4	1.456	1.453	1.455		
0	0	16:59	1	1.395	1.393	1.394	2 5/16	
0	0	17:02	4	1.376	1.375	1.376		
0	0	17:06	8	1.368	1.369	1.369		
0	0	17:13	15	1.358	1.362	1.360	2 17/64	

PIER #CL-U-DP50-3, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/6/16)
AXIAL TENSION LOAD TEST - SILT SITE



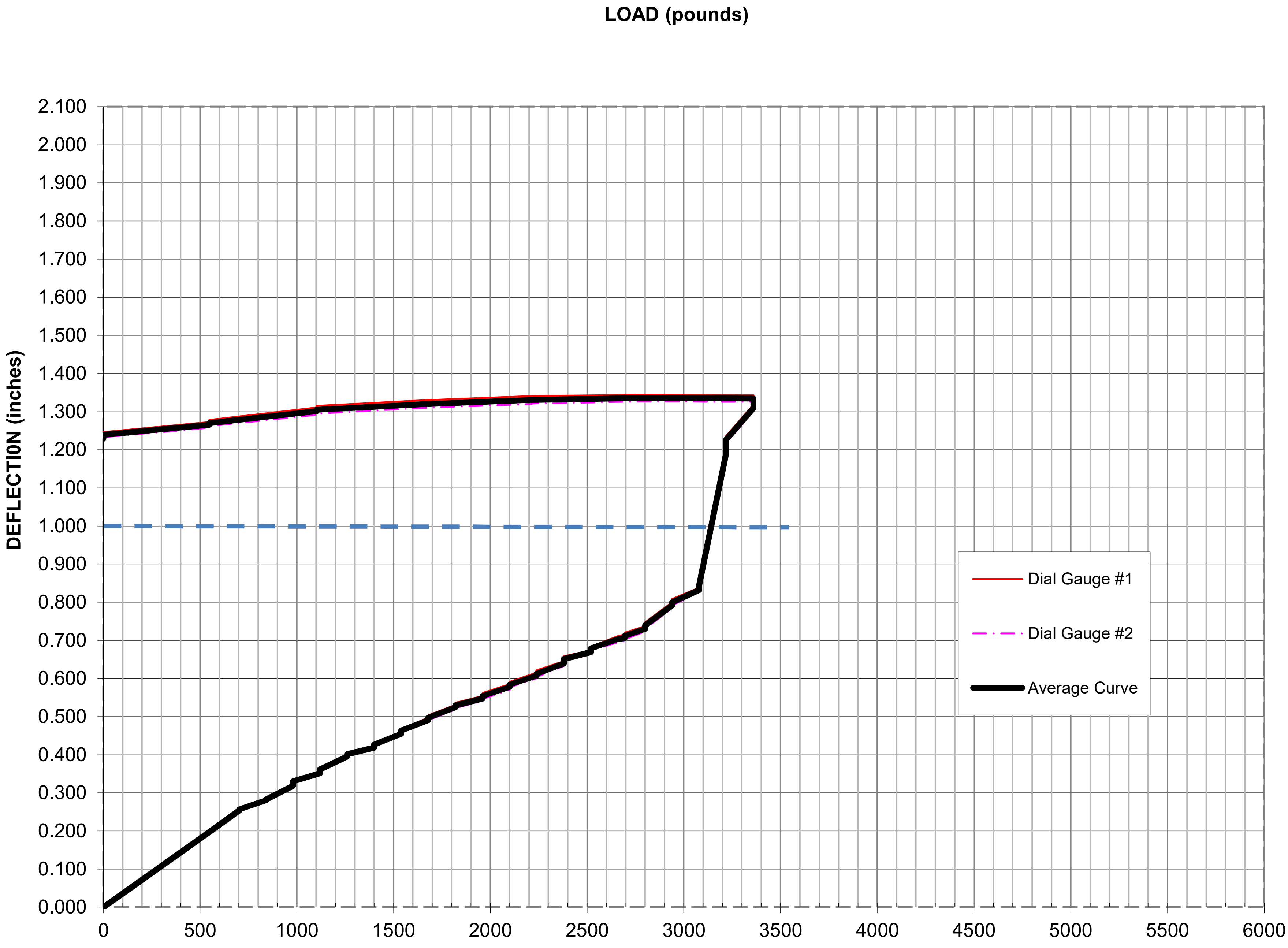
Project Name: Diamond Pier foundation field load testing
EEI Project No.: 07-020
Site: SILT (presumptive bearing capacity of 1,500 psf)
Test Method: Uplift - ASTM D3689
Diamond Pier Tested: #CL-U-DP50-3
Date Installed: 4/4/2016
Date Test Started: 5/6/2016
Date Test Completed: 5/6/2016
Staff: Ken Andrieu, Bruce Lane
Hydraulic Ram: EEI Equipment #EEI 022
Equation of the Line: Load = (Gauge Pressure - 2) / 0.361
Dial Gauge #1: EEI Equipment #EEI 33
Dial Gauge #2: EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	12:30	0	0.000	0.000	0.000	1	
352	129	12:31	0	0.291	0.291	0.291	1 19/64	
352	129	12:32	1	0.292	0.292	0.292		
352	129	12:33	2	0.293	0.293	0.293		
352	129	12:34	3	0.294	0.294	0.294		
352	129	12:35	4	0.298	0.294	0.294		
352	129	12:36	5	0.298	0.295	0.297		
471	172	12:37	0	0.309	0.309	0.309	1 5/16	
471	172	12:38	1	0.310	0.311	0.311		
471	172	12:39	2	0.314	0.315	0.315		
471	172	12:40	3	0.316	0.316	0.316		
471	172	12:41	4	0.318	0.317	0.318		
471	172	12:42	5	0.319	0.318	0.319		
590	215	12:42	0	0.369	0.372	0.371	1 3/8	
590	215	12:43	1	0.371	0.372	0.372		
590	215	12:44	2	0.371	0.373	0.372		
590	215	12:45	3	0.373	0.373	0.373		
590	215	12:46	4	0.373	0.374	0.374		
590	215	12:47	5	0.374	0.376	0.375		
706	257	12:48	0	0.395	0.395	0.395	1 25/64	
706	257	12:49	1	0.397	0.395	0.396		
706	257	12:50	2	0.398	0.395	0.397		
706	257	12:51	3	0.398	0.396	0.397		
706	257	12:52	4	0.399	0.396	0.398		
706	257	12:53	5	0.399	0.396	0.398		
825	300	12:54	0	0.429	0.425	0.427	1 27/64	
825	300	12:55	1	0.433	0.427	0.430		
825	300	12:56	2	0.434	0.427	0.431		
825	300	12:57	3	0.434	0.427	0.431		
825	300	12:58	4	0.435	0.427	0.431		
825	300	12:59	5	0.435	0.428	0.432		
942	342	12:59	0	0.477	0.470	0.474	1 15/32	
942	342	13:00	1	0.482	0.473	0.478		
942	342	13:01	2	0.483	0.473	0.478		
942	342	13:02	3	0.482	0.473	0.478		
942	342	13:03	4	0.482	0.473	0.478		
942	342	13:04	5	0.484	0.473	0.479		
1061	385	13:05	0	0.506	0.499	0.503	1 1/2	
1061	385	13:06	1	0.509	0.501	0.505		
1061	385	13:07	2	0.510	0.501	0.506		
1061	385	13:08	3	0.512	0.502	0.507		
1061	385	13:09	4	0.512	0.502	0.507		
1061	385	13:10	5	0.512	0.502	0.507		
1177	427	13:10	0	0.542	0.533	0.538	1 17/32	
1177	427	13:11	1	0.545	0.535	0.540		
1177	427	13:12	2	0.545	0.535	0.540		
1177	427	13:13	3	0.546	0.536	0.541		
1177	427	13:14	4	0.547	0.536	0.542		
1177	427	13:15	5	0.548	0.537	0.543		
1299	471	13:15	0	0.575	0.563	0.569	1 9/16	

1299	471	13:16	1	0.577	0.567	0.572		
1299	471	13:17	2	0.579	0.566	0.573		
1299	471	13:18	3	0.580	0.566	0.573		
1299	471	13:19	4	0.578	0.566	0.572		
1299	471	13:20	5	0.581	0.566	0.574		
1413	512	13:20	0	0.604	0.591	0.598	1 37/64	
1413	512	13:21	1	0.607	0.594	0.601		
1413	512	13:22	2	0.608	0.595	0.602		
1413	512	13:23	3	0.608	0.595	0.602		
1413	512	13:24	4	0.608	0.595	0.602		
1413	512	13:25	5	0.608	0.595	0.602		
1532	555	13:25	0	0.621	0.608	0.615	1 19/32	
1532	555	13:26	1	0.626	0.612	0.619		
1532	555	13:27	2	0.626	0.612	0.619		
1532	555	13:28	3	0.629	0.614	0.622		
1532	555	13:29	4	0.629	0.616	0.623		
1532	555	13:30	5	0.630	0.616	0.623		
1648	597	13:31	0	0.641	0.629	0.635	1 5/8	
1648	597	13:32	1	0.647	0.632	0.640		
1648	597	13:33	2	0.648	0.634	0.641		
1648	597	13:34	3	0.648	0.634	0.641		
1648	597	13:35	4	0.649	0.634	0.642		
1648	597	13:36	5	0.649	0.634	0.642		
1767	640	13:36	0	0.663	0.648	0.656	1 41/64	
1767	640	13:37	1	0.665	0.649	0.657		
1767	640	13:38	2	0.667	0.650	0.659		
1767	640	13:39	3	0.667	0.650	0.659		
1767	640	13:40	4	0.667	0.651	0.659		
1767	640	13:41	5	0.668	0.652	0.660		
1884	682	13:41	0	0.678	0.663	0.671	1 21/32	
1884	682	13:42	1	0.685	0.669	0.677		
1884	682	13:43	2	0.685	0.669	0.677		
1884	682	13:44	3	0.688	0.669	0.679		
1884	682	13:45	4	0.687	0.670	0.679		
1884	682	13:46	5	0.687	0.670	0.679		
2003	725	13:46	0	0.706	0.688	0.697	1 43/64	
2003	725	13:47	1	0.714	0.693	0.704		
2003	725	13:48	2	0.713	0.694	0.704		
2003	725	13:49	3	0.715	0.696	0.706		
2003	725	13:50	4	0.715	0.696	0.706		
2003	725	13:51	5	0.715	0.696	0.706		
2119	767	13:51	0	0.729	0.710	0.720	1 11/16	
2119	767	13:52	1	0.735	0.714	0.725		
2119	767	13:53	2	0.738	0.715	0.727		
2119	767	13:54	3	0.741	0.717	0.729		
2119	767	13:55	4	0.741	0.717	0.729		
2119	767	13:56	5	0.742	0.717	0.730		
2238	810	13:57	0	0.763	0.738	0.751	1 23/32	
2238	810	13:58	1	0.767	0.743	0.755		
2238	810	13:59	2	0.770	0.744	0.757		
2238	810	14:00	3	0.771	0.745	0.758		
2238	810	14:01	4	0.772	0.745	0.759		
2238	810	14:02	5	0.772	0.745	0.759		
2357	853	14:02	0	0.781	0.755	0.768	1 47/64	
2357	853	14:03	1	0.788	0.761	0.775		
2357	853	14:04	2	0.789	0.762	0.776		
2357	853	14:05	3	0.790	0.762	0.776		
2357	853	14:06	4	0.791	0.763	0.777		
2357	853	14:07	5	0.791	0.763	0.777		
2474	895	14:07	0	0.812	0.785	0.799	1 49/64	
2474	895	14:08	1	0.815	0.788	0.802		
2474	895	14:09	2	0.819	0.790	0.805		
2474	895	14:10	3	0.821	0.792	0.807		
2474	895	14:11	4	0.822	0.793	0.808		
2474	895	14:12	5	0.822	0.793	0.808		
2593	938	14:12	0	0.844	0.815	0.830	1 51/64	
2593	938	14:13	1	0.851	0.821	0.836		
2593	938	14:14	2	0.852	0.823	0.838		
2593	938	14:15	3	0.853	0.823	0.838		
2593	938	14:16	4	0.853	0.824	0.839		

2593	938	14:17	5	0.855	0.824	0.840		
2709	980	14:17	0	0.869	0.838	0.854	1 13/16	
2709	980	14:18	1	0.874	0.843	0.859		
2709	980	14:19	2	0.875	0.844	0.860		
2709	980	14:20	3	0.878	0.846	0.862		
2709	980	14:21	4	0.878	0.846	0.862		
2709	980	14:22	5	0.878	0.848	0.863		
2828	1023	14:22	0	0.914	0.884	0.899	1 55/64	
2828	1023	14:23	1	0.920	0.889	0.905		
2828	1023	14:24	2	0.925	0.892	0.909		
2828	1023	14:25	3	0.927	0.894	0.911		
2828	1023	14:26	4	0.928	0.894	0.911		
2828	1023	14:27	5	0.929	0.895	0.912		
2945	1065	14:27	0	0.945	0.916	0.931	1 57/64	
2945	1065	14:28	1	0.953	0.921	0.937		
2945	1065	14:29	2	0.958	0.923	0.941		
2945	1065	14:30	3	0.960	0.925	0.943		
2945	1065	14:31	4	0.962	0.927	0.945		
2945	1065	14:32	5	0.962	0.927	0.945		
3064	1108	14:32	0	0.987	0.953	0.970	1 15/16	
3064	1108	14:33	1	0.993	0.960	0.977		
3064	1108	14:34	2	0.998	0.962	0.980		
3064	1108	14:35	3	1.001	0.964	0.983		
3064	1108	14:36	4	1.001	0.965	0.983		
3064	1108	14:37	5	1.003	0.966	0.985		
3180	1150	14:37	0	1.030	0.996	1.013	1 31/32	
3180	1150	14:38	1	1.037	1.003	1.020		
3180	1150	14:39	2	1.041	1.003	1.022		
3180	1150	14:40	3	1.043	1.003	1.023		
3180	1150	14:41	4	1.043	1.003	1.023		
3180	1150	14:42	5	1.063	1.022	1.043		
3299	1193	14:42	0	1.099	1.063	1.081	2 3/64	
3299	1193	14:49	1	1.109	1.068	1.089		
3299	1193	14:50	2	1.114	1.072	1.093		
3299	1193	14:51	3	1.130	1.084	1.107		
3299	1193	14:52	4	1.391	1.352	1.372		
3299	1193	14:53	5	1.395	1.356	1.376	2 5/16	
2945	1065	14:54	1	1.411	1.364	1.388	2 21/64	
2945	1065	14:57	4	1.415	1.366	1.391		
2357	853	14:58	1	1.408	1.359	1.384	2 21/64	
2357	853	15:01	4	1.409	1.359	1.384		
1767	640	15:02	1	1.393	1.344	1.369	2 5/16	
1767	640	15:05	4	1.395	1.342	1.369		
1177	427	15:06	1	1.367	1.312	1.340	2 9/32	
1177	427	15:09	4	1.365	1.309	1.337		
590	215	15:11	1	1.316	1.259	1.288	2 15/64	
590	215	15:14	4	1.316	1.258	1.287		
0	0	15:16	1	1.251	1.191	1.221	2 5/32	
0	0	15:19	4	1.242	1.180	1.211		
0	0	15:23	8	1.240	1.176	1.208		
0	0	15:30	15	1.240	1.172	1.206	2 9/64	

PIER #CL-U-DP75-1, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 4/15/16)
AXIAL TENSION LOAD TEST - SILT SITE



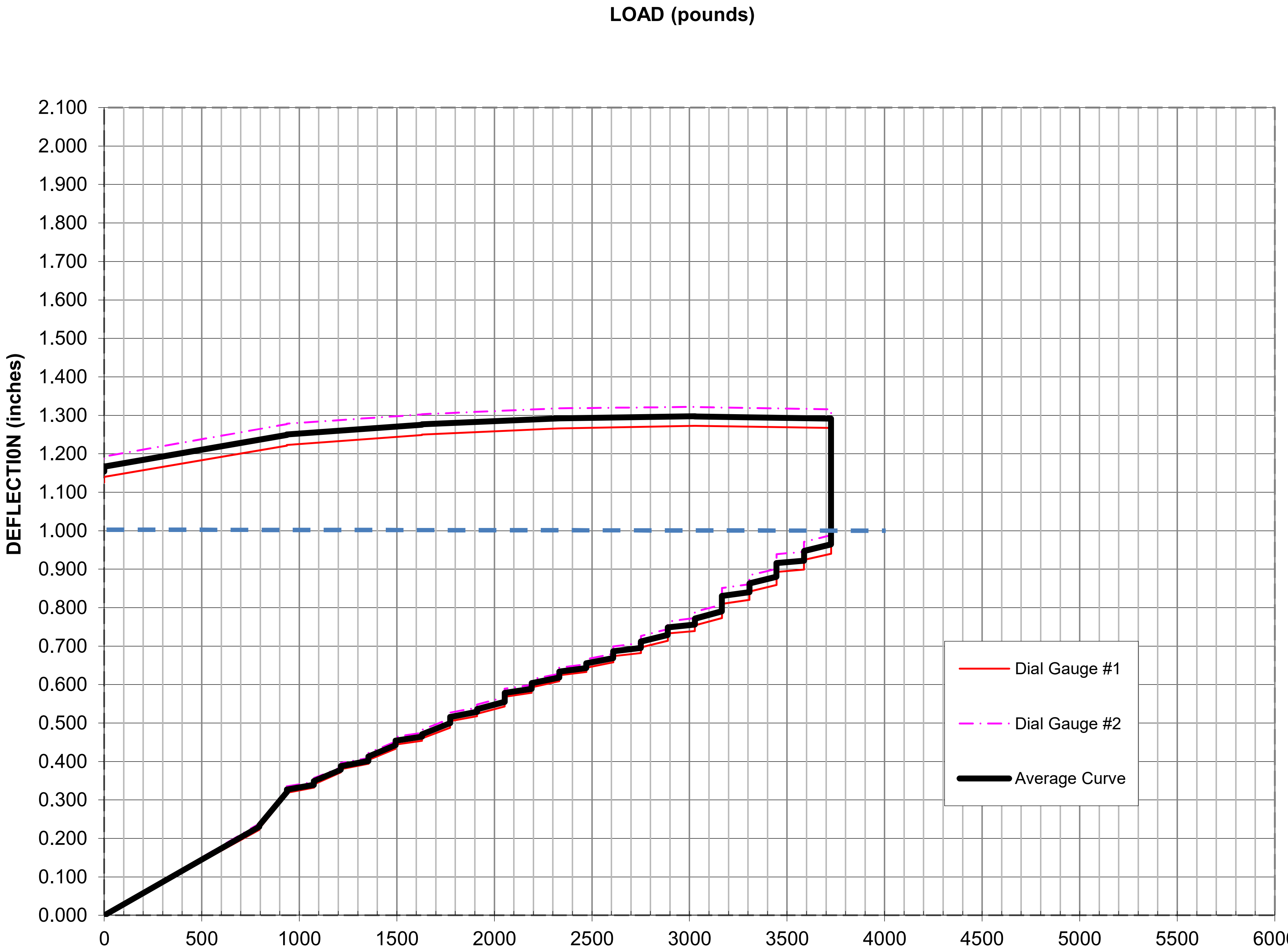
Project Name: Diamond Pier foundation field load testing
EEI Project No.: 07-020
Site: SILT (presumptive bearing capacity of 1,500 psf)
Test Method: Uplift - ASTM D3689
Diamond Pier Tested: #CL-U-DP75-1
Date Installed: 4/4/2016
Date Test Started: 4/15/2016
Date Test Completed: 4/15/2016
Staff: Bruce Lane
Hydraulic Ram: EEI Equipment #EEI 022
Equation of the Line: Load = (Gauge Pressure - 2) / 0.361
Dial Gauge #1: EEI Equipment #EEI 33
Dial Gauge #2: EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	11:04	0	0.000	0.000	0.000		
548	200	11:05	0	0.198	0.196	0.197		
548	200	11:06	1	0.198	0.197	0.198		
548	200	11:07	2	0.198	0.197	0.198		
548	200	11:08	3	0.198	0.197	0.198		
548	200	11:09	4	0.198	0.197	0.198		
548	200	11:10	5	0.198	0.197	0.198		
704	256	11:10	0	0.255	0.254	0.255		
704	256	11:11	1	0.257	0.257	0.257		
704	256	11:12	2	0.257	0.257	0.257		
704	256	11:13	3	0.257	0.257	0.257		
704	256	11:14	4	0.257	0.257	0.257		
704	256	11:15	5	0.257	0.257	0.257		
839	305	11:16	0	0.280	0.280	0.280		
839	305	11:17	1	0.282	0.282	0.282		
839	305	11:18	2	0.282	0.282	0.282		
839	305	11:19	3	0.282	0.282	0.282		
839	305	11:20	4	0.282	0.282	0.282		
839	305	11:21	5	0.282	0.282	0.282		
981	356	11:22	0	0.318	0.319	0.319		
981	356	11:23	1	0.319	0.320	0.320		
981	356	11:24	2	0.319	0.320	0.320		
981	356	11:25	3	0.328	0.328	0.328		
981	356	11:26	4	0.330	0.330	0.330		
981	356	11:27	5	0.330	0.330	0.330		
1119	406	11:27	0	0.352	0.350	0.351		
1119	406	11:28	1	0.353	0.351	0.352		
1119	406	11:29	2	0.362	0.360	0.361		
1119	406	11:30	3	0.363	0.360	0.362		
1119	406	11:31	4	0.363	0.360	0.362		
1119	406	11:32	5	0.363	0.360	0.362		
1260	457	11:33	0	0.397	0.394	0.396		
1260	457	11:34	1	0.399	0.396	0.398		
1260	457	11:35	2	0.400	0.396	0.398		
1260	457	11:36	3	0.402	0.398	0.400		
1260	457	11:37	4	0.402	0.398	0.400		
1260	457	11:38	5	0.404	0.399	0.402		
1399	507	11:38	0	0.422	0.415	0.419		
1399	507	11:39	1	0.424	0.416	0.420		
1399	507	11:40	2	0.425	0.418	0.422		
1399	507	11:41	3	0.427	0.420	0.424		
1399	507	11:42	4	0.428	0.421	0.425		
1399	507	11:43	5	0.430	0.423	0.427		
1540	558	11:44	0	0.458	0.452	0.455		
1540	558	11:45	1	0.462	0.456	0.459		
1540	558	11:46	2	0.465	0.461	0.463		
1540	558	11:47	3	0.466	0.461	0.464		
1540	558	11:48	4	0.466	0.461	0.464		
1540	558	11:49	5	0.466	0.461	0.464		
1679	608	11:49	0	0.497	0.484	0.491		
1679	608	11:50	1	0.499	0.485	0.492		

1679	608	11:51	2	0.501	0.487	0.494		
1679	608	11:52	3	0.502	0.488	0.495		
1679	608	11:53	4	0.503	0.489	0.496		
1679	608	11:54	5	0.503	0.491	0.497		
1820	659	11:55	0	0.531	0.518	0.525		
1820	659	11:56	1	0.534	0.520	0.527		
1820	659	11:57	2	0.534	0.521	0.528		
1820	659	11:58	3	0.535	0.522	0.529		
1820	659	11:59	4	0.536	0.522	0.529		
1820	659	12:00	5	0.536	0.523	0.530		
1961	710	12:00	0	0.554	0.541	0.548		
1961	710	12:01	1	0.557	0.543	0.550		
1961	710	12:02	2	0.560	0.545	0.553		
1961	710	12:03	3	0.560	0.546	0.553		
1961	710	12:04	4	0.562	0.547	0.555		
1961	710	12:05	5	0.562	0.547	0.555		
2100	760	12:05	0	0.585	0.570	0.578		
2100	760	12:06	1	0.588	0.572	0.580		
2100	760	12:07	2	0.589	0.573	0.581		
2100	760	12:08	3	0.590	0.575	0.583		
2100	760	12:09	4	0.591	0.576	0.584		
2100	760	12:10	5	0.591	0.577	0.584		
2238	810	12:10	0	0.615	0.600	0.608		
2238	810	12:11	1	0.617	0.602	0.610		
2238	810	12:12	2	0.619	0.603	0.611		
2238	810	12:13	3	0.620	0.604	0.612		
2238	810	12:14	4	0.620	0.604	0.612		
2238	810	12:15	5	0.621	0.604	0.613		
2380	861	12:15	0	0.645	0.633	0.639		
2380	861	12:16	1	0.647	0.634	0.641		
2380	861	12:17	2	0.653	0.641	0.647		
2380	861	12:18	3	0.657	0.644	0.651		
2380	861	12:19	4	0.657	0.644	0.651		
2380	861	12:20	5	0.658	0.644	0.651		
2521	912	12:20	0	0.674	0.665	0.670		
2521	912	12:21	1	0.680	0.670	0.675		
2521	912	12:22	2	0.681	0.671	0.676		
2521	912	12:23	3	0.683	0.672	0.678		
2521	912	12:24	4	0.684	0.674	0.679		
2521	912	12:25	5	0.684	0.674	0.679		
2659	962	12:25	0	0.711	0.695	0.703		
2695	975	12:26	1	0.715	0.698	0.707		
2695	975	12:27	2	0.717	0.700	0.709		
2695	975	12:28	3	0.719	0.702	0.711		
2695	975	12:29	4	0.719	0.702	0.711		
2695	975	12:30	5	0.720	0.703	0.712		
2801	1013	12:30	0	0.737	0.723	0.730		
2801	1013	12:31	1	0.742	0.727	0.735		
2801	1013	12:32	2	0.744	0.728	0.736		
2801	1013	12:33	3	0.746	0.730	0.738		
2801	1013	12:34	4	0.747	0.731	0.739		
2801	1013	12:35	5	0.748	0.731	0.740		
2939	1063	12:35	0	0.800	0.784	0.792		
2939	1063	12:36	1	0.802	0.786	0.794		
2939	1063	12:37	2	0.805	0.788	0.797		
2939	1063	12:38	3	0.806	0.790	0.798		
2939	1063	12:39	4	0.807	0.791	0.799		
2939	1063	12:40	5	0.808	0.792	0.800		
3080	1114	12:40	0	0.838	0.827	0.833		
3080	1114	12:41	1	0.843	0.831	0.837		
3080	1114	12:42	2	0.847	0.834	0.841		
3080	1114	12:43	3	0.849	0.836	0.843		
3080	1114	12:44	4	0.852	0.838	0.845		
3080	1114	12:45	5	0.853	0.840	0.847		
3219	1164	12:47	0	1.201	1.183	1.192		
3219	1164	12:48	1	1.206	1.187	1.197		
3219	1164	12:49	2	1.227	1.209	1.218		
3219	1164	12:50	3	1.234	1.216	1.225		
3219	1164	12:51	4	1.236	1.217	1.227		
3219	1164	12:52	5	1.236	1.218	1.227		
3360	1215	12:52	0	1.318	1.301	1.310		

3360	1215	12:53	1	1.321	1.304	1.313		
3360	1215	12:54	2	1.324	1.306	1.315		
3360	1215	12:55	3	1.334	1.321	1.328		
3360	1215	12:56	4	1.341	1.324	1.333		
3360	1215	12:57	5	1.343	1.326	1.335		
2765	1000	12:57	0	1.344	1.327	1.336		
2765	1000	12:58	1	1.344	1.327	1.336		
2765	1000	12:59	2	1.344	1.327	1.336		
2765	1000	13:00	3	1.344	1.327	1.336		
2765	1000	13:01	4	1.344	1.327	1.336		
2765	1000	13:02	5	1.344	1.327	1.336		
2211	800	13:02	0	1.341	1.321	1.331		
2211	800	13:03	1	1.341	1.320	1.331		
2211	800	13:04	2	1.341	1.320	1.331		
2211	800	13:05	3	1.341	1.320	1.331		
2211	800	13:06	4	1.341	1.320	1.331		
2211	800	13:07	5	1.341	1.320	1.331		
1657	600	13:07	0	1.330	1.310	1.320		
1657	600	13:08	1	1.330	1.310	1.320		
1657	600	13:09	2	1.330	1.310	1.320		
1657	600	13:10	3	1.330	1.310	1.320		
1657	600	13:11	4	1.330	1.310	1.320		
1657	600	13:12	5	1.330	1.310	1.320		
1102	400	13:12	0	1.315	1.295	1.305		
1102	400	13:13	1	1.314	1.294	1.304		
1102	400	13:14	2	1.312	1.293	1.303		
1102	400	13:15	3	1.312	1.293	1.303		
1102	400	13:16	4	1.312	1.293	1.303		
1102	400	13:17	5	1.311	1.292	1.302		
548	200	13:17	0	1.278	1.262	1.270		
548	200	13:18	1	1.276	1.259	1.268		
548	200	13:19	2	1.274	1.259	1.267		
548	200	13:20	3	1.274	1.259	1.267		
548	200	13:21	4	1.273	1.258	1.266		
548	200	13:22	5	1.273	1.258	1.266		
0	0	13:22	0	1.246	1.233	1.240		
0	0	13:23	1	1.239	1.227	1.233		
0	0	13:24	2	1.238	1.227	1.233		
0	0	13:25	3	1.236	1.226	1.231		
0	0	13:26	4	1.235	1.225	1.230		
0	0	13:27	5	1.234	1.224	1.229		

PIER #CL-U-DP75-2, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/5/16)
AXIAL TENSION LOAD TEST - SILT SITE



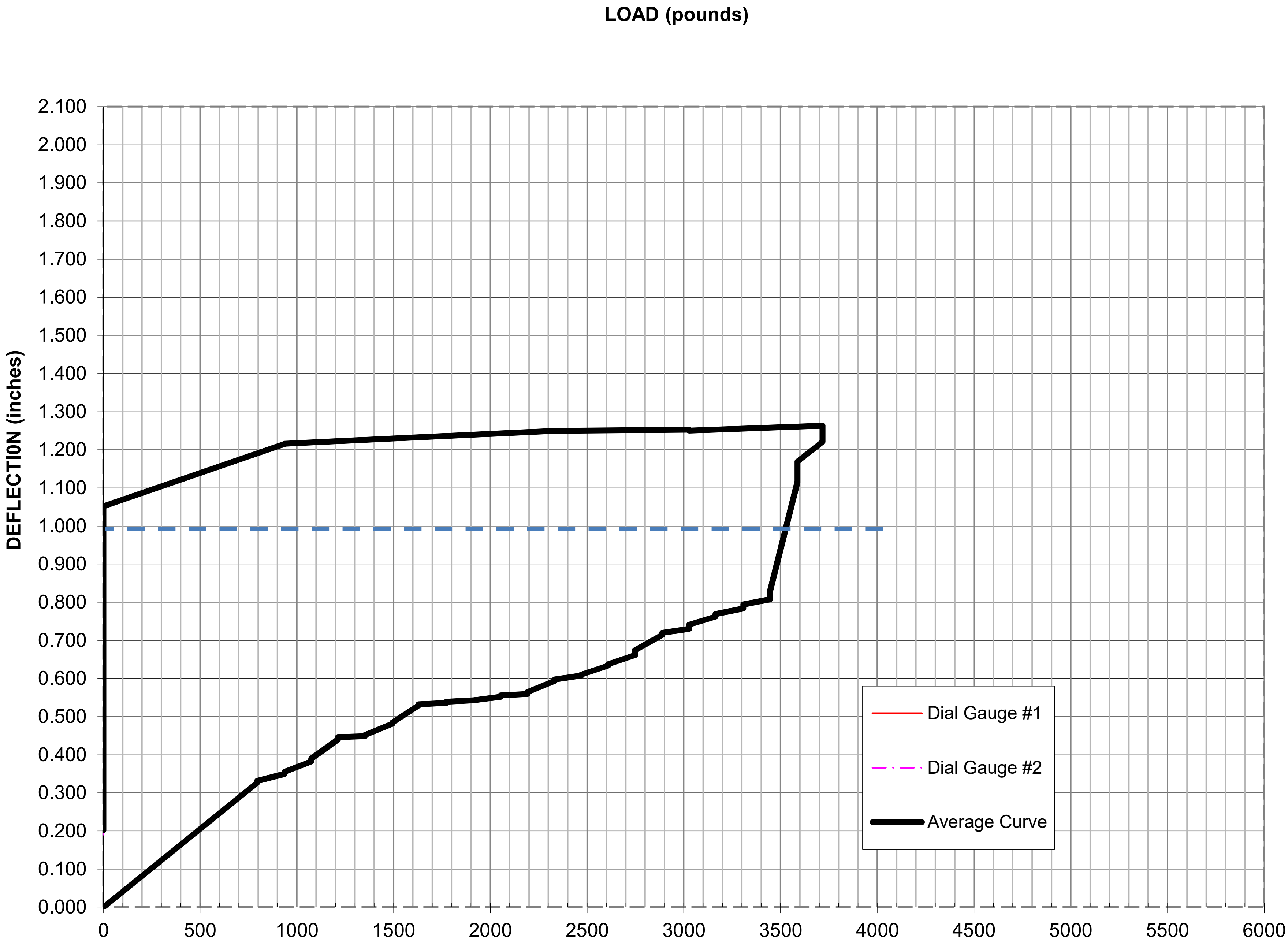
Project Name:	Diamond Pier foundation field load testing
EEI Project No.:	07-020
Site:	SILT (presumptive bearing capacity of 1,500 psf)
Test Method:	Uplift - ASTM D3689
Diamond Pier Tested:	#CL-U-DP75-2
Date Installed:	4/4/2016
Date Test Started:	5/5/2016
Date Test Completed:	5/5/2016
Staff:	Bruce Lane
Hydraulic Ram:	EEI Equipment #EEI 021
Equation of the Line:	Load = (Gauge Pressure - 88) / 0.365
Dial Gauge #1:	EEI Equipment #EEI 33
Dial Gauge #2:	EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	13:33	0	0.000	0.000	0.000	1	
795	289	13:34	0	0.222	0.239	0.231		
795	289	13:35	1	0.223	0.240	0.232		
795	289	13:36	2	0.223	0.240	0.232		
795	289	13:37	3	0.224	0.241	0.233	1 7/32	
795	289	13:38	4	0.224	0.242	0.233		
795	289	13:39	5	0.225	0.242	0.234		
936	340	13:39	0	0.313	0.327	0.320		
936	340	13:40	1	0.315	0.328	0.322		
936	340	13:41	2	0.315	0.329	0.322		
936	340	13:42	3	0.315	0.329	0.322		
936	340	13:43	4	0.318	0.332	0.325	1 5/16	
936	340	13:44	5	0.319	0.335	0.327		
1075	390	13:45	0	0.332	0.347	0.340		
1075	390	13:46	1	0.336	0.351	0.344		
1075	390	13:47	2	0.338	0.352	0.345		
1075	390	13:48	3	0.339	0.354	0.347	1 11/32	
1075	390	13:49	4	0.340	0.356	0.348		
1075	390	13:50	5	0.341	0.357	0.349		
1213	440	13:50	0	0.372	0.385	0.379		
1213	440	13:51	1	0.372	0.387	0.380		
1213	440	13:52	2	0.375	0.390	0.383	1 3/8	
1213	440	13:53	3	0.378	0.393	0.386		
1213	440	13:54	4	0.380	0.395	0.388		
1213	440	13:55	5	0.380	0.396	0.388		
1355	491	13:55	0	0.394	0.409	0.402		
1355	491	13:56	1	0.399	0.416	0.408		
1355	491	13:57	2	0.400	0.417	0.409		
1355	491	13:58	3	0.402	0.418	0.410	1 13/32	
1355	491	13:59	4	0.403	0.421	0.412		
1355	491	14:00	5	0.404	0.422	0.413		
1493	541	14:00	0	0.433	0.452	0.443		
1493	541	14:01	1	0.436	0.455	0.446		
1493	541	14:02	2	0.438	0.457	0.448		
1493	541	14:03	3	0.440	0.459	0.450	1 7/16	
1493	541	14:04	4	0.442	0.462	0.452		
1493	541	14:05	5	0.444	0.464	0.454		
1629	590	14:05	0	0.454	0.475	0.465		
1629	590	14:06	1	0.455	0.476	0.466		
1629	590	14:07	2	0.457	0.479	0.468		
1629	590	14:08	3	0.458	0.480	0.469	1 7/16	
1629	590	14:09	4	0.459	0.481	0.470		
1629	590	14:10	5	0.460	0.482	0.471		
1773	642	14:11	0	0.488	0.511	0.500		
1773	642	14:12	1	0.493	0.516	0.505		
1773	642	14:13	2	0.498	0.520	0.509		
1773	642	14:14	3	0.500	0.523	0.512	1 1/2	
1773	642	14:15	4	0.504	0.526	0.515		
1773	642	14:16	5	0.505	0.527	0.516		
1911	692	14:16	0	0.518	0.540	0.529		

1911	692	14:17	1	0.518	0.540	0.529		
1911	692	14:18	2	0.520	0.543	0.532	1 17/32	
1911	692	14:19	3	0.521	0.545	0.533		
1911	692	14:20	4	0.522	0.546	0.534		
1911	692	14:21	5	0.524	0.548	0.536		
2053	743	14:21	0	0.543	0.567	0.555		
2053	743	14:22	1	0.548	0.572	0.560		
2053	743	14:23	2	0.556	0.580	0.568		
2053	743	14:24	3	0.558	0.581	0.570	1 17/32	
2053	743	14:25	4	0.565	0.587	0.576		
2053	743	14:26	5	0.568	0.589	0.579		
2191	793	14:26	0	0.579	0.599	0.589		
2191	793	14:27	1	0.584	0.604	0.594		
2191	793	14:28	2	0.585	0.605	0.595	1 9/16	
2191	793	14:29	3	0.588	0.609	0.599		
2191	793	14:30	4	0.591	0.612	0.602		
2191	793	14:31	5	0.593	0.614	0.604		
2332	844	14:31	0	0.609	0.628	0.619	1 37/64	
2332	844	14:32	1	0.613	0.632	0.623		
2332	844	14:33	2	0.616	0.635	0.626		
2332	844	14:34	3	0.620	0.640	0.630		
2332	844	14:35	4	0.621	0.641	0.631		
2332	844	14:36	5	0.624	0.644	0.634		
2471	894	14:37	0	0.633	0.653	0.643		
2471	894	14:38	1	0.635	0.655	0.645		
2471	894	14:39	2	0.639	0.660	0.650	1 39/64	
2471	894	14:40	3	0.642	0.663	0.653		
2471	894	14:41	4	0.644	0.665	0.655		
2471	894	14:42	5	0.644	0.666	0.655		
2609	944	14:42	0	0.658	0.680	0.669		
2609	944	14:43	1	0.662	0.686	0.674		
2609	944	14:44	2	0.665	0.689	0.677		
2609	944	14:45	3	0.668	0.693	0.681	1 5/8	
2609	944	14:46	4	0.672	0.696	0.684		
2609	944	14:47	5	0.674	0.699	0.687		
2751	995	14:47	0	0.682	0.708	0.695		
2751	995	14:48	1	0.684	0.711	0.698		
2751	995	14:49	2	0.688	0.715	0.702	1 21/32	
2751	995	14:50	3	0.692	0.721	0.707		
2751	995	14:51	4	0.695	0.725	0.710		
2751	995	14:52	5	0.697	0.726	0.712		
2889	1045	14:52	0	0.714	0.744	0.729		
2889	1045	14:53	1	0.720	0.750	0.735		
2889	1045	14:54	2	0.723	0.754	0.739	1 11/16	
2889	1045	14:55	3	0.728	0.759	0.744		
2889	1045	14:56	4	0.732	0.763	0.748		
2889	1045	14:57	5	0.733	0.764	0.749		
3028	1095	14:57	0	0.739	0.773	0.756		
3028	1095	14:58	1	0.741	0.774	0.758		
3028	1095	14:59	2	0.745	0.779	0.762	1 45/64	
3028	1095	15:00	3	0.747	0.780	0.764		
3028	1095	15:01	4	0.750	0.784	0.767		
3028	1095	15:02	5	0.754	0.789	0.772		
3166	1145	15:02	0	0.773	0.808	0.791		
3166	1145	15:03	1	0.775	0.811	0.793		
3166	1145	15:04	2	0.783	0.821	0.802	1 3/4	
3166	1145	15:05	3	0.792	0.829	0.811		
3166	1145	15:06	4	0.805	0.845	0.825		
3166	1145	15:07	5	0.810	0.851	0.831		
3307	1196	15:07	0	0.820	0.861	0.841		
3307	1196	15:08	1	0.825	0.861	0.843		
3307	1196	15:09	2	0.830	0.871	0.851		
3307	1196	15:10	3	0.836	0.877	0.857	1 13/16	
3307	1196	15:11	4	0.839	0.881	0.860		
3307	1196	15:12	5	0.842	0.884	0.863		
3446	1246	15:13	0	0.859	0.901	0.880		
3446	1246	15:14	1	0.869	0.913	0.891	1 27/32	
3446	1246	15:15	2	0.877	0.921	0.899		
3446	1246	15:16	3	0.883	0.929	0.906		
3446	1246	15:17	4	0.889	0.934	0.912		

3446	1246	15:18	5	0.893	0.939	0.916			
3587	1297	15:18	0	0.899	0.945	0.922			
3587	1297	15:19	1	0.905	0.952	0.929			
3587	1297	15:20	2	0.910	0.956	0.933	1 7/8		
3587	1297	15:21	3	0.917	0.963	0.940			
3587	1297	15:22	4	0.922	0.969	0.946			
3587	1297	15:23	5	0.924	0.971	0.948			
3726	1347	15:24	0	0.940	0.989	0.965			
3726	1347	15:25	1	0.950	0.999	0.975			
3726	1347	15:26	2	0.959	1.079	1.019			
3726	1347	15:28	4	1.209	1.255	1.232			
3726	1347	15:29	5	1.234	1.282	1.258			
3726	1347	15:35	11	1.267	1.316	1.292			
3028	1095	15:38	0	1.273	1.321	1.297	2 1/4		
3028	1095	15:42	4	1.273	1.322	1.298			
2332	844	15:42	0	1.266	1.318	1.292	2 15/64		
2332	844	15:46	4	1.266	1.318	1.292			
1629	590	15:46	0	1.250	1.303	1.277	2 7/32		
1629	590	15:50	4	1.249	1.302	1.276			
936	340	15:50	0	1.223	1.278	1.251	2 3/16		
936	340	15:54	4	1.221	1.277	1.249			
0	0	15:54	0	1.140	1.193	1.167	2 3/32		
0	0	15:58	4	1.125	1.182	1.154			

PIER #CL-U-DP75-3, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/6/16)
AXIAL TENSION LOAD TEST - SILT SITE



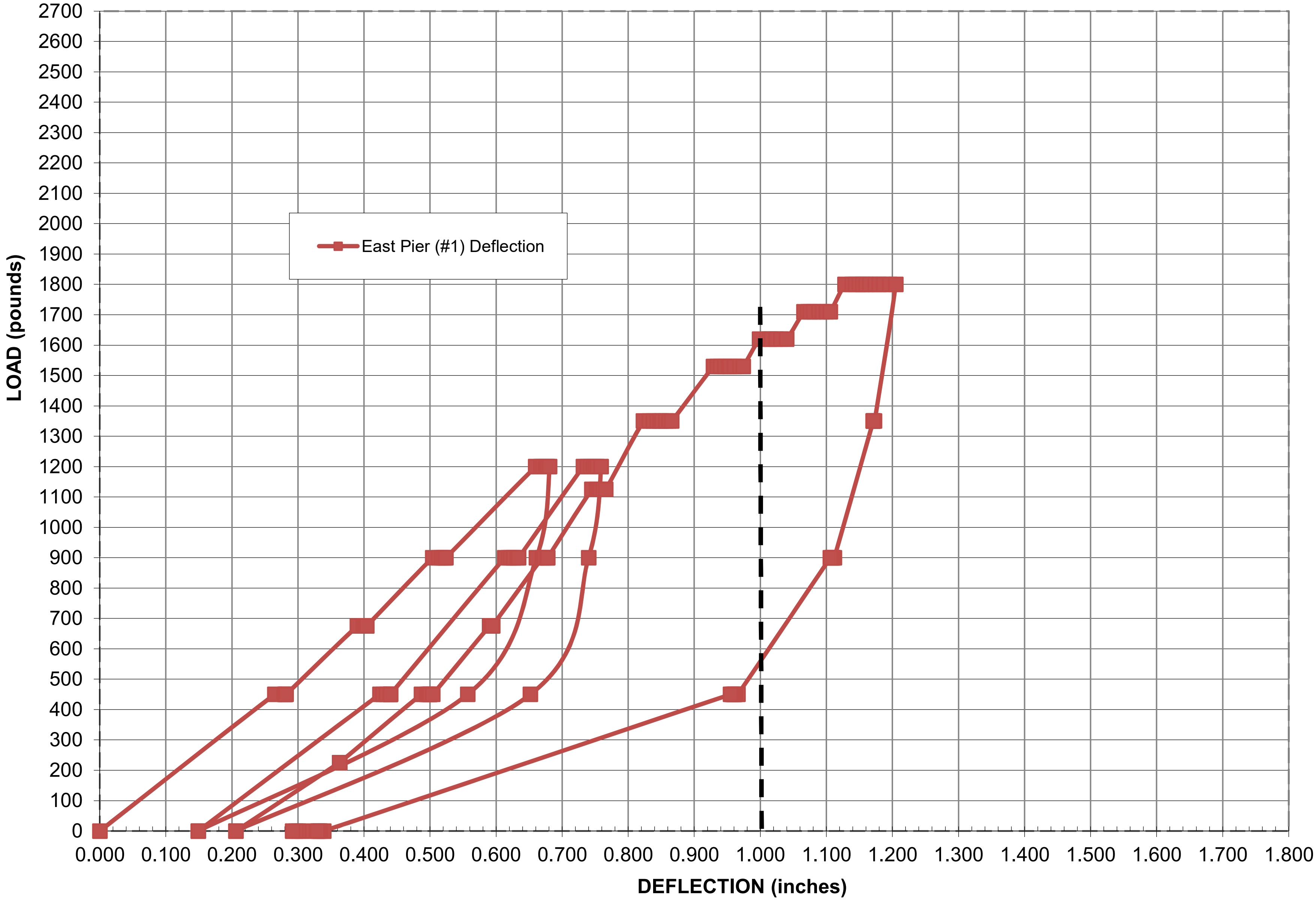
Project Name: Diamond Pier foundation field load testing
EEI Project No.: 07-020
Site: SILT (presumptive bearing capacity of 1,500 psf)
Test Method: Uplift - ASTM D3689
Diamond Pier Tested: #CL-U-DP75-3
Date Installed: 4/4/2016
Date Test Started: 5/6/2016
Date Test Completed: 5/6/2016
Staff: Bruce Lane
Hydraulic Ram: EEI Equipment #EEI 021
Ram Equation of the Line: Load = (Gauge Pressure - 88) / 0.365
Dial Gauge #1: EEI Equipment #EEI 33
Dial Gauge #2: EEI Equipment #EEI 34

Load (pounds)	Gauge Pressure (psi)	Clock	Minutes	Dial Gauge #1 (in.)	Dial Gauge #2 (in.)	Dial Gauge Average (in.)	Transit	Test Remarks
0	0	13:00	0	0.000	0.000	0.000		
795	289	13:01	0	0.326	0.327	0.327	2 13/32	
795	289	13:02	1	0.328	0.329	0.329		
795	289	13:03	2	0.329	0.330	0.330		
795	289	13:04	3	0.329	0.330	0.330		
795	289	13:05	4	0.330	0.330	0.330		
795	289	13:06	5	0.332	0.331	0.332		
936	340	13:07	0	0.350	0.350	0.350	2 13/32	
936	340	13:08	1	0.351	0.351	0.351		
936	340	13:09	2	0.353	0.352	0.353		
936	340	13:10	3	0.354	0.354	0.354		
936	340	13:11	4	0.355	0.354	0.355		
936	340	13:12	5	0.355	0.355	0.355		
1075	390	13:13	0	0.383	0.382	0.383	2 3/8	
1075	390	13:14	1	0.383	0.383	0.383		
1075	390	13:15	2	0.385	0.384	0.385		
1075	390	13:16	3	0.387	0.385	0.386		
1075	390	13:17	4	0.389	0.388	0.389		
1075	390	13:18	5	0.390	0.389	0.390		
1213	440	13:19	0	0.440	0.440	0.440	2 25/64	
1213	440	13:20	1	0.443	0.442	0.443		
1213	440	13:21	2	0.444	0.443	0.444		
1213	440	13:22	3	0.445	0.443	0.444		
1213	440	13:23	4	0.445	0.445	0.445		
1213	440	13:24	5	0.447	0.445	0.446		
1352	490	13:25	0	0.450	0.448	0.449	2 25/64	
1352	490	13:26	1	0.450	0.448	0.449		
1352	490	13:27	2	0.451	0.449	0.450		
1352	490	13:28	3	0.452	0.450	0.451		
1352	490	13:29	4	0.452	0.450	0.451		
1352	490	13:30	5	0.452	0.451	0.452		
1493	541	13:31	0	0.481	0.481	0.481	2 13/32	
1493	541	13:32	1	0.481	0.482	0.482		
1493	541	13:33	2	0.482	0.483	0.483		
1493	541	13:34	3	0.482	0.483	0.483		
1493	541	13:35	4	0.483	0.484	0.484		
1493	541	13:36	5	0.484	0.485	0.485		
1629	590	13:37	0	0.527	0.531	0.529	2 1/2	
1629	590	13:38	1	0.527	0.532	0.530		
1629	590	13:39	2	0.527	0.533	0.530		
1629	590	13:40	3	0.528	0.534	0.531		
1629	590	13:41	4	0.528	0.534	0.531		
1629	590	13:42	5	0.529	0.535	0.532		
1773	642	13:43	0	0.533	0.539	0.536	2 1/2	
1773	642	13:44	1	0.535	0.541	0.538		
1773	642	13:45	2	0.535	0.542	0.539		
1773	642	13:46	3	0.535	0.542	0.539		
1773	642	13:47	4	0.535	0.542	0.539		
1773	642	13:48	5	0.536	0.542	0.539		
1911	692	13:49	0	0.539	0.546	0.543	2 1/2	
1911	692	13:50	1	0.540	0.546	0.543		
1911	692	13:51	2	0.540	0.546	0.543		

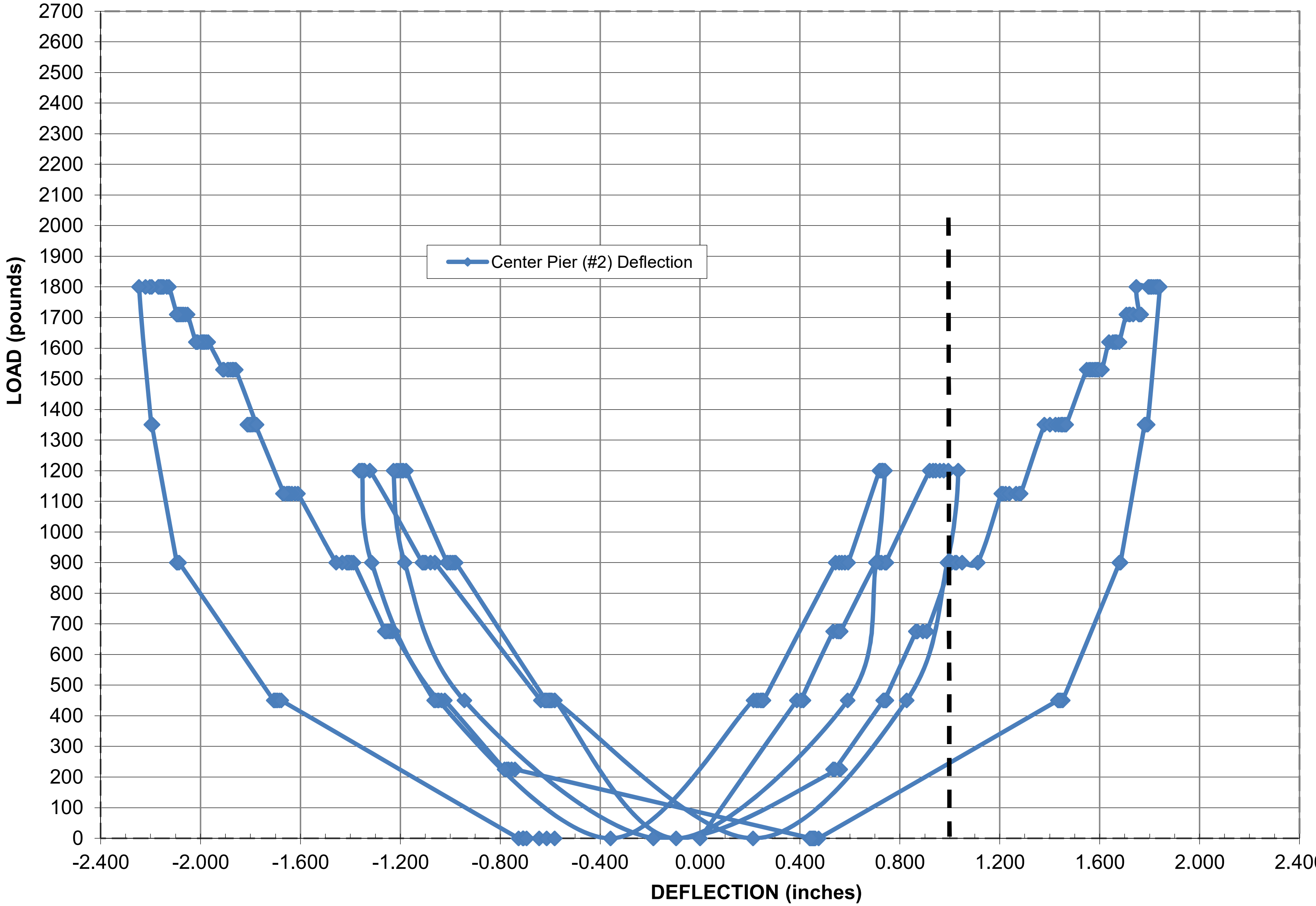
1911	692	13:52	3	0.540	0.546	0.543		
1911	692	13:53	4	0.540	0.546	0.543		
1911	692	13:54	5	0.540	0.546	0.543		
2053	743	13:55	0	0.549	0.555	0.552	2 1/2	
2053	743	13:56	1	0.550	0.556	0.553		
2053	743	13:57	2	0.550	0.556	0.553		
2053	743	13:58	3	0.550	0.556	0.553		
2053	743	13:59	4	0.551	0.558	0.555		
2053	743	14:00	5	0.552	0.559	0.556		
2191	793	14:01	0	0.556	0.563	0.560	2 33/64	
2191	793	14:02	1	0.558	0.565	0.562		
2191	793	14:03	2	0.559	0.566	0.563		
2191	793	14:04	3	0.559	0.567	0.563		
2191	793	14:05	4	0.560	0.567	0.564		
2191	793	14:06	5	0.560	0.568	0.564		
2332	844	14:07	0	0.590	0.598	0.594	2 35/64	
2332	844	14:08	1	0.591	0.599	0.595		
2332	844	14:09	2	0.592	0.600	0.596		
2332	844	14:10	3	0.593	0.601	0.597		
2332	844	14:11	4	0.594	0.601	0.598		
2332	844	14:12	5	0.594	0.601	0.598		
2471	894	14:13	0	0.603	0.613	0.608	2 35/64	
2471	894	14:14	1	0.607	0.614	0.611		
2471	894	14:15	2	0.607	0.614	0.611		
2471	894	14:16	3	0.607	0.614	0.611		
2471	894	14:17	4	0.607	0.614	0.611		
2471	894	14:18	5	0.607	0.614	0.611		
2609	944	14:19	0	0.631	0.637	0.634	2 37/64	
2609	944	14:20	1	0.634	0.639	0.637		
2609	944	14:21	2	0.634	0.639	0.637		
2609	944	14:22	3	0.634	0.639	0.637		
2609	944	14:23	4	0.635	0.639	0.637		
2609	944	14:24	5	0.635	0.640	0.638		
2748	994	14:25	0	0.659	0.664	0.662	2 39/64	
2748	994	14:26	1	0.666	0.670	0.668		
2748	994	14:27	2	0.667	0.672	0.670		
2748	994	14:28	3	0.670	0.675	0.673		
2748	994	14:29	4	0.671	0.676	0.674		
2748	994	14:30	5	0.672	0.677	0.675		
2889	1045	14:31	0	0.712	0.717	0.715	2 41/64	
2889	1045	14:32	1	0.715	0.719	0.717		
2889	1045	14:33	2	0.716	0.720	0.718		
2889	1045	14:34	3	0.716	0.720	0.718		
2889	1045	14:35	4	0.717	0.721	0.719		
2889	1045	14:36	5	0.718	0.721	0.720		
3028	1095	14:37	0	0.728	0.733	0.731	2 21/32	
3028	1095	14:38	1	0.735	0.739	0.737		
3028	1095	14:39	2	0.737	0.740	0.739		
3028	1095	14:40	3	0.739	0.743	0.741		
3028	1095	14:41	4	0.740	0.743	0.742		
3028	1095	14:42	5	0.740	0.743	0.742		
3163	1144	14:43	0	0.760	0.764	0.762	2 11/16	
3163	1144	14:44	1	0.763	0.766	0.765		
3163	1144	14:45	2	0.764	0.766	0.765		
3163	1144	14:46	3	0.767	0.769	0.768		
3163	1144	14:47	4	0.768	0.770	0.769		
3163	1144	14:48	5	0.768	0.770	0.769		
3307	1196	14:49	0	0.782	0.785	0.784	2 23/32	
3307	1196	14:50	1	0.786	0.788	0.787		
3307	1196	14:51	2	0.786	0.788	0.787		
3307	1196	14:52	3	0.791	0.793	0.792		
3307	1196	14:53	4	0.793	0.795	0.794		
3307	1196	14:54	5	0.793	0.795	0.794		
3446	1246	14:55	0	0.806	0.809	0.808	2 3/4	
3446	1246	14:56	1	0.819	0.821	0.820		
3446	1246	14:57	2	0.825	0.827	0.826		
3446	1246	14:58	3	0.826	0.827	0.827		
3446	1246	14:59	4	0.827	0.828	0.828		
3446	1246	15:00	5	0.829	0.830	0.830		
3587	1297	15:01	0	1.111	1.120	1.116	2 3/64	
3587	1297	15:02	1	1.114	1.123	1.119		
3587	1297	15:03	2	1.138	1.145	1.142		
3587	1297	15:04	3	1.145	1.156	1.151		

3587	1297	15:05	4	1.150	1.157	1.154		
3587	1297	15:06	5	1.165	1.173	1.169		
3717	1344	15:07	0	1.218	1.224	1.221	2 9/64	
3717	1344	15:08	1	1.222	1.229	1.226		
3717	1344	15:09	2	1.238	1.243	1.241		
3717	1344	15:10	3	1.248	1.253	1.251		
3717	1344	15:11	4	1.258	1.262	1.260		
3717	1344	15:12	5	1.260	1.266	1.263		
3028	1095	15:13	1	1.248	1.252	1.250	2 1/6	
3028	1095	15:17	4	1.250	1.255	1.253		
2332	844	15:18	1	1.247	1.252	1.250		
2332	844	15:22	4	1.248	1.251	1.250		
1640	594	15:23	1	1.231	1.235	1.233		
1640	594	15:27	4	1.232	1.234	1.233		
936	340	15:28	1	1.215	1.217	1.216		
936	340	15:32	4	1.215	1.215	1.215		
0	0	15:33	1	1.053	1.050	1.052		
0	0	15:37	4	0.212	0.191	0.202		

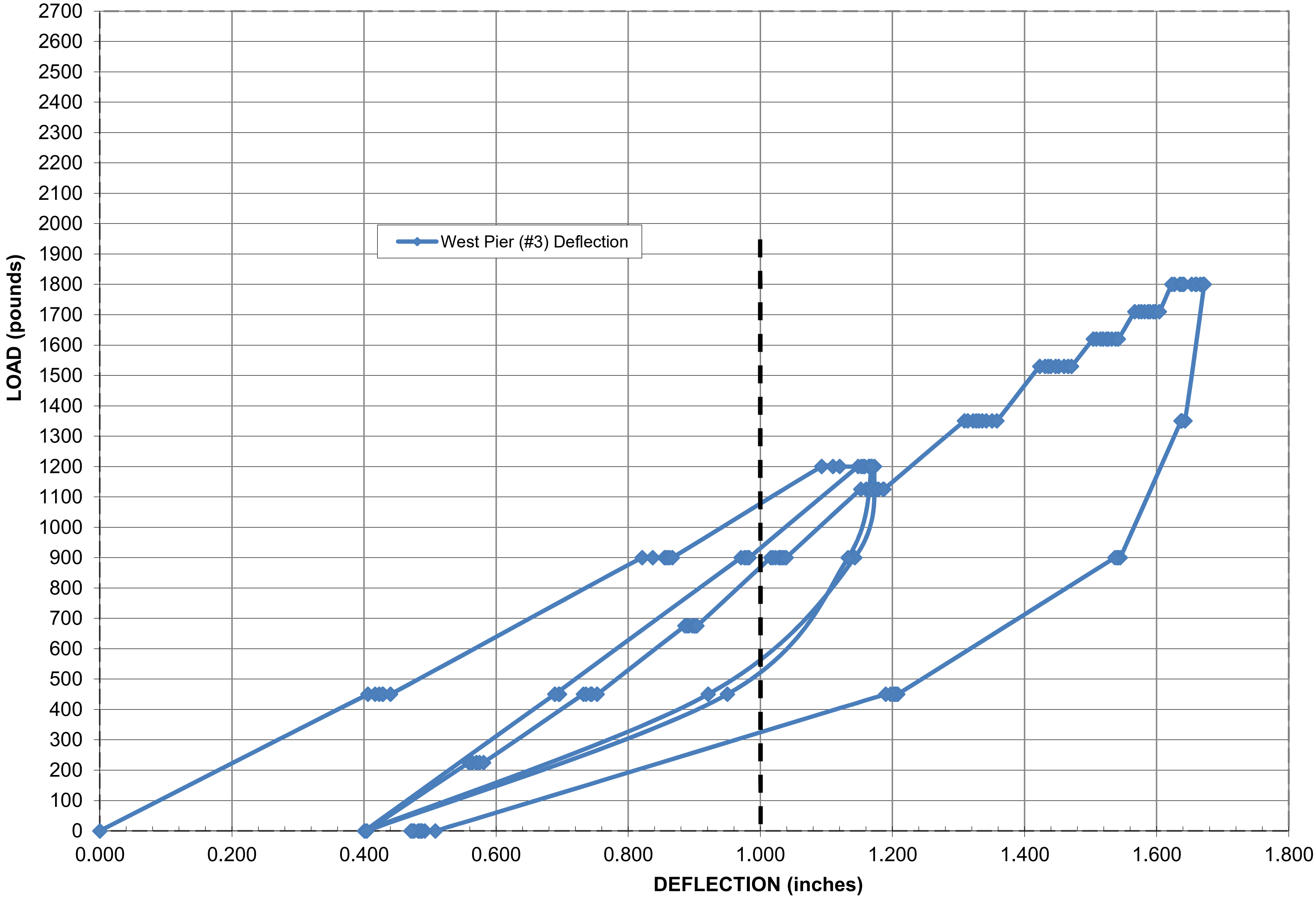
PIER #CL-L-DP50-1, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 4/2016 - 4/28/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



PIER #CL-L-DP50-2, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 4/20/16 - 4/28/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



PIER #CL-L-DP50-3, 1" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 4/20/16 - 4/28/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



Project Name:	Diamond Pier foundation field load testing
EEI Project No.:	07-020
Site:	SILT (presumptive bearing capacity of 1,500 psf)
Test Method:	Lateral - ASTM D3966
Diamond Piers Tested:	#CL-L-DP50-1, #CL-L-DP50-2, #CL-L-DP50-3
Date Installed:	4/4/2016
Date Test Started:	4/20/2016
Date Test Completed:	4/28/2016
Staff:	Bruce Lane, Ken Andrieu
Hydraulic Ram:	6.5 Ton tension ram, Bailys Chief WC 3000 PSI
Dial Gauge #1:	EEI Equipment #EEI 33
Dial Gauge #2:	EEI Equipment #EEI 34

Load (pounds)	Clock	Minutes	East Pier (#1) Dial Gauge (in.)	Center Pier (#2) Dial Gauge (in.)	West Pier (#3) Dial Gauge (in.)	Transit	Test Remarks
0	11:49	0	0.000	0.000			Start Cycle #1 (east direction).
450	11:50	0	0.265	0.388		2 5/16	Test started on 4/20/16.
450	11:53	3	0.279	0.405			No 1 or 2 minute readings.
450	11:54	4	0.281	0.414			
450	11:55	5	0.281	0.414			
450	12:00	10	0.282	0.404			
675	12:01	0	0.390	0.533			
675	12:02	1	0.399	0.547			
675	12:03	2	0.401	0.554			
675	12:04	3	0.402	0.554			
675	12:05	4	0.403	0.560			
675	12:06	5	0.404	0.563			
675	12:11	10	0.404	0.563		2 13/32	
900	12:14	0	0.504	0.703			
900	12:15	1	0.513	0.720			
900	12:16	2	0.517	0.727			
900	12:17	3	0.520	0.740			
900	12:18	4	0.522	0.746			
900	12:19	5	0.523	0.746		2 17/32	
900	12:24	10	0.524	0.743			
1,200	12:25	0	0.660	0.919			
1,200	12:26	1	0.668	0.933			
1,200	12:27	2	0.671	0.944			
1,200	12:28	3	0.675	0.960			
1,200	12:29	4	0.677	0.976			
1,200	12:30	5	0.678	0.994			
1,200	12:35	10	0.681	1.034		2 11/16	
900	12:36	0	0.661	0.990		2 21/32	
450	12:37	0	0.557	0.827			
0	12:39	0	0.149	0.212	0.000		Start Cycle #2 (west direction).
450	13:09	0		-0.583	0.406	2 21/32	Test started on 4/20/16.
450	13:11	2		-0.602	0.417		No 1 minute reading.
450	13:12	3		-0.612	0.423		
450	13:13	4		-0.621	0.428		
450	13:14	5		-0.623	0.429		
450	13:19	10		-0.637	0.440		
900	13:20	0		-1.062	0.821		
900	13:21	1		-1.079	0.837		
900	13:22	2		-1.099	0.855		
900	13:23	3		-1.102	0.857		
900	13:24	4		-1.107	0.860		
900	13:25	5		-1.110	0.863	2 3/16	
900	13:30	10		-1.112	0.867		
1,200	13:31	0		-1.322	1.093		
1,200	13:32	1		-1.365	1.110		
1,200	13:33	2		-1.344	1.120		
1,200	13:34	3		-1.350	1.156		
1,200	13:35	5		-1.357	1.165	2	
1,200	13:40	10		-1.353	1.173		
900	13:41	0		-1.315	1.143	2 1/32	
450	13:42	0		-1.047	0.921		

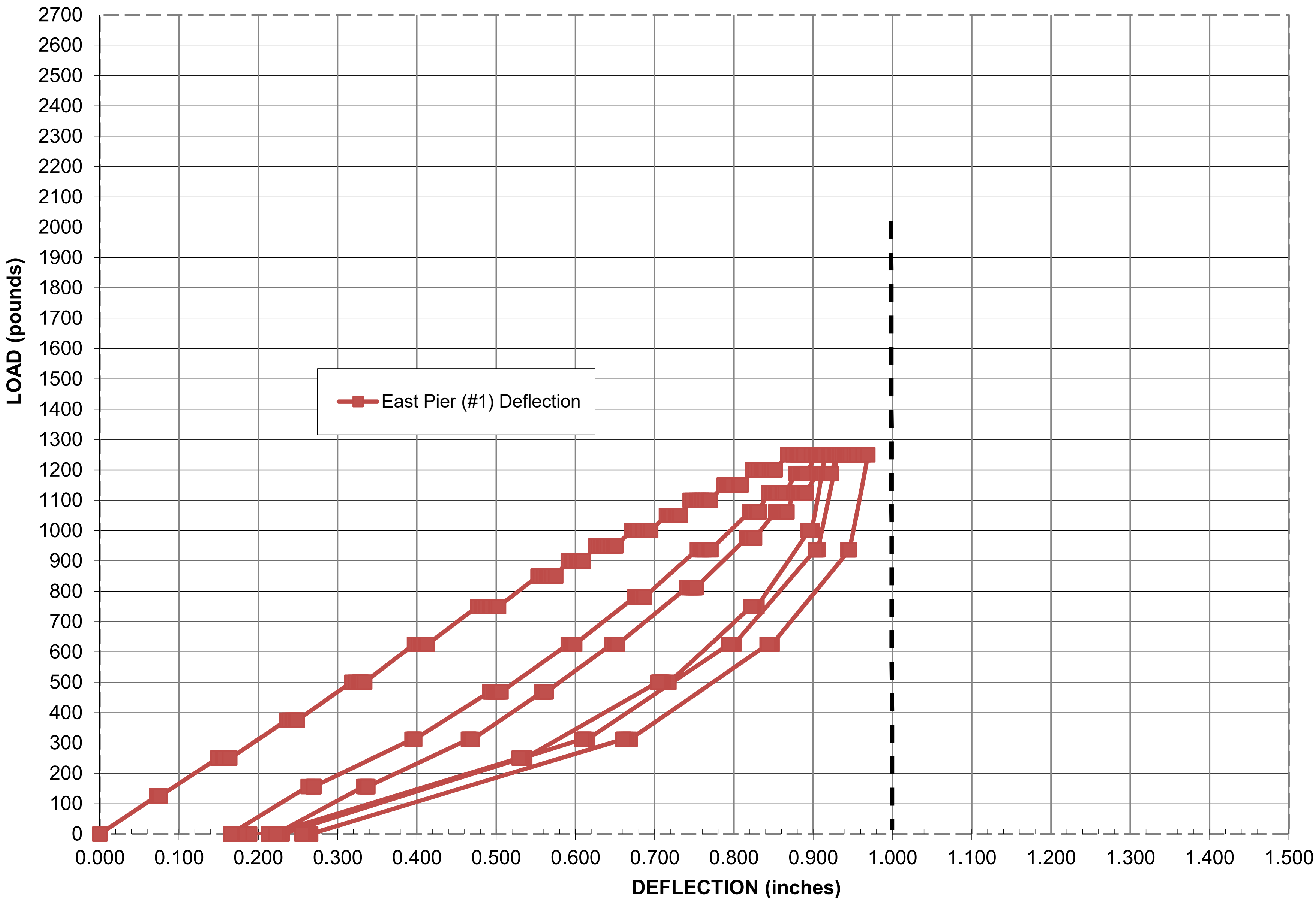
0	14:08	0	0.149	-0.358	0.401	2 11/16	
450	14:09	0	0.424	0.214			Start Cycle #3 (east direction).
450	14:10	1	0.429	0.226			Test started on 4/20/16.
450	14:11	2	0.434	0.233			
450	14:12	3	0.440	0.241			
450	14:13	4	0.440	0.246			
450	14:14	5	0.440	0.250		3 13/32	
450	14:19	10	0.440	0.254			
900	14:20	0	0.613	0.543			
900	14:21	1	0.619	0.557			
900	14:22	2	0.622	0.568			
900	14:23	3	0.626	0.580			
900	14:24	4	0.627	0.580			
900	14:25	5	0.632	0.579		3 5/8	
900	14:30	10	0.634	0.593			
1,200	14:31	0	0.732	0.718			
1,200	14:32	1	0.738	0.724			
1,200	14:33	2	0.743	0.731			
1,200	14:34	3	0.747	0.732			
1,200	14:35	4	0.750	0.731		3 47/64	
1,200	14:36	5	0.753	0.729			
1,200	14:41	10	0.759	0.740			
900	14:42	0	0.740	0.705		3 23/32	
450	14:43	0	0.652	0.591		3 41/64	
0	14:44	0	0.206	-0.096	0.401	3 3/16	
450	15:49	0		-0.581	0.689		Start Cycle #4 (west direction).
450	15:50	1		-0.593	0.696		Test started on 4/20/16.
450	15:51	2		-0.596	0.695		
450	15:52	3		-0.599	0.696		
450	15:53	4		-0.605	0.695		
450	15:54	5		-0.605	0.695		
450	15:59	10		-0.617	0.689		
900	16:00	0		-0.978	0.971		
900	16:01	1		-0.984	0.976		
900	16:02	2		-0.991	0.979		
900	16:03	3		-0.999	0.982		
900	16:04	4		-1.002	0.982		
900	16:05	5		-1.009	0.983		
900	16:10	10		-1.013	0.983		
1,200	16:11	0		-1.177	1.148		
1,200	16:12	1		-1.188	1.153		
1,200	16:13	2		-1.193	1.158		
1,200	16:14	3		-1.201	1.164	2 9/16	
1,200	16:15	4		-1.209	1.167		
1,200	16:16	5		-1.216	1.169		
1,200	16:21	10		-1.227	1.169		
900	16:22	0		-1.183	1.133	2 7/16	
450	16:23	0		-0.944	0.950	2 5/8	
0	16:24	0	0.206	-0.187	0.404		
225	11:19	0	0.363	0.559		1 1/4	Start Cycle #5 (east direction).
225	11:20	1	0.363	0.560			Test started on 4/27/16.
225	11:21	2	0.363	0.561			
225	11:22	3	0.363	0.561			
225	11:23	4	0.363	0.533			
225	11:24	5	0.363	0.533			
225	11:29	10	0.363	0.540			
450	11:30	0	0.487	0.735			
450	11:31	1	0.495	0.744			
450	11:32	2	0.497	0.746		1 3/8	
450	11:33	3	0.499	0.743			
450	11:34	4	0.500	0.742			
450	11:35	5	0.500	0.733			
450	11:40	10	0.504	0.738			
675	11:41	0	0.590	0.865			
675	11:42	1	0.593	0.870			
675	11:43	2	0.593	0.870			
675	11:44	3	0.593	0.869			
675	11:45	4	0.594	0.864			
675	11:46	5	0.595	0.864		1 31/64	
675	11:51	10	0.593	0.892			
675	11:56	15	0.594	0.908			
900	11:57	0	0.670	1.008			

900	11:58	1	0.673	1.021			
900	12:02	5	0.677	1.027		1 35/64	No 2,3,4 minute readings
900	12:07	10	0.678	1.049			
900	12:25	20	0.678	1.112			No 15 minute reading
1125	12:26	0	0.745	1.206			
1125	12:28	2	0.752	1.213			No 1 minute reading
1125	12:29	3	0.754	1.224			
1125	12:31	5	0.756	1.238		1 39/64	No 4 minute reading
1125	12:36	10	0.758	1.265			
1125	12:41	15	0.762	1.278			
1125	12:46	20	0.766	1.284			
1350	12:47	0	0.823	1.379			
1350	12:48	1	0.832	1.401			
1350	12:49	2	0.838	1.423			
1350	12:50	3	0.844	1.436			
1350	12:51	4	0.848	1.445			
1350	12:52	5	0.851	1.449		1 23/32	
1350	12:57	10	0.857	1.452			
1350	13:02	15	0.862	1.460			
1350	13:07	20	0.866	1.466			
1530	13:08	0	0.929	1.548			
1530	13:09	1	0.935	1.558			
1530	13:10	2	0.940	1.565			
1530	13:11	3	0.946	1.572			
1530	13:12	4	0.952	1.580			
1530	13:13	5	0.954	1.585			
1530	13:17	10	0.961	1.591		1 51/64	
1530	13:22	15	0.969	1.596			
1530	13:27	20	0.974	1.609			
1620	13:28	0	0.999	1.637			
1620	13:31	3	1.010	1.653			No 1 or 2 minute reading
1620	13:32	4	1.014	1.660			
1620	13:33	5	1.017	1.663		1 55/64	
1620	13:38	10	1.024	1.668			
1620	13:43	15	1.031	1.679			
1620	13:48	20	1.040	1.679		1 7/8	
1710	13:49	0	1.066	1.707			
1710	13:50	1	1.072	1.718			
1710	13:51	2	1.076	1.720			
1710	13:52	3	1.081	1.721			
1710	13:54	5	1.089	1.734			
1710	13:59	10	1.094	1.756		1 15/16	
1710	14:04	15	1.100	1.766			
1710	14:09	20	1.106	1.760			
1800	14:10	0	1.128	1.747			
1800	14:11	1	1.139	1.795			
1800	14:12	2	1.144	1.801			
1800	14:13	3	1.150	1.807			
1800	14:14	4	1.155	1.809			
1800	14:15	5	1.160	1.816			
1800	14:20	10	1.166	1.830			
1800	14:25	15	1.174	1.833		1 63/64	
1800	14:30	20	1.180	1.833			
1800	14:40	30	1.187	1.824			
1800	14:55	45	1.196	1.832			
1800	15:10	60	1.205	1.841			
1350	15:12	0	1.173	1.792			
1350	15:14	2	1.171	1.784			No 1 minute reading
1350	15:15	3	1.171	1.784		1 31/32	
1350	15:16	4	1.171	1.784			
1350	15:17	5	1.171	1.784			
1350	15:22	10	1.171	1.780			
900	15:23	0	1.112	1.684			
900	15:24	1	1.110	1.683			
900	15:25	2	1.110	1.681			
900	15:26	3	1.110	1.681			
900	15:27	4	1.109	1.679			
900	15:28	5	1.108	1.679		1 57/64	
900	15:33	10	1.106	1.680			
450	15:34	0	0.966	1.452			
450	15:35	1	0.962	1.445			
450	15:36	2	0.961	1.443			
450	15:37	3	0.960	1.439			
450	15:38	4	0.959	1.438			
450	15:39	5	0.957	1.438		1 47/64	

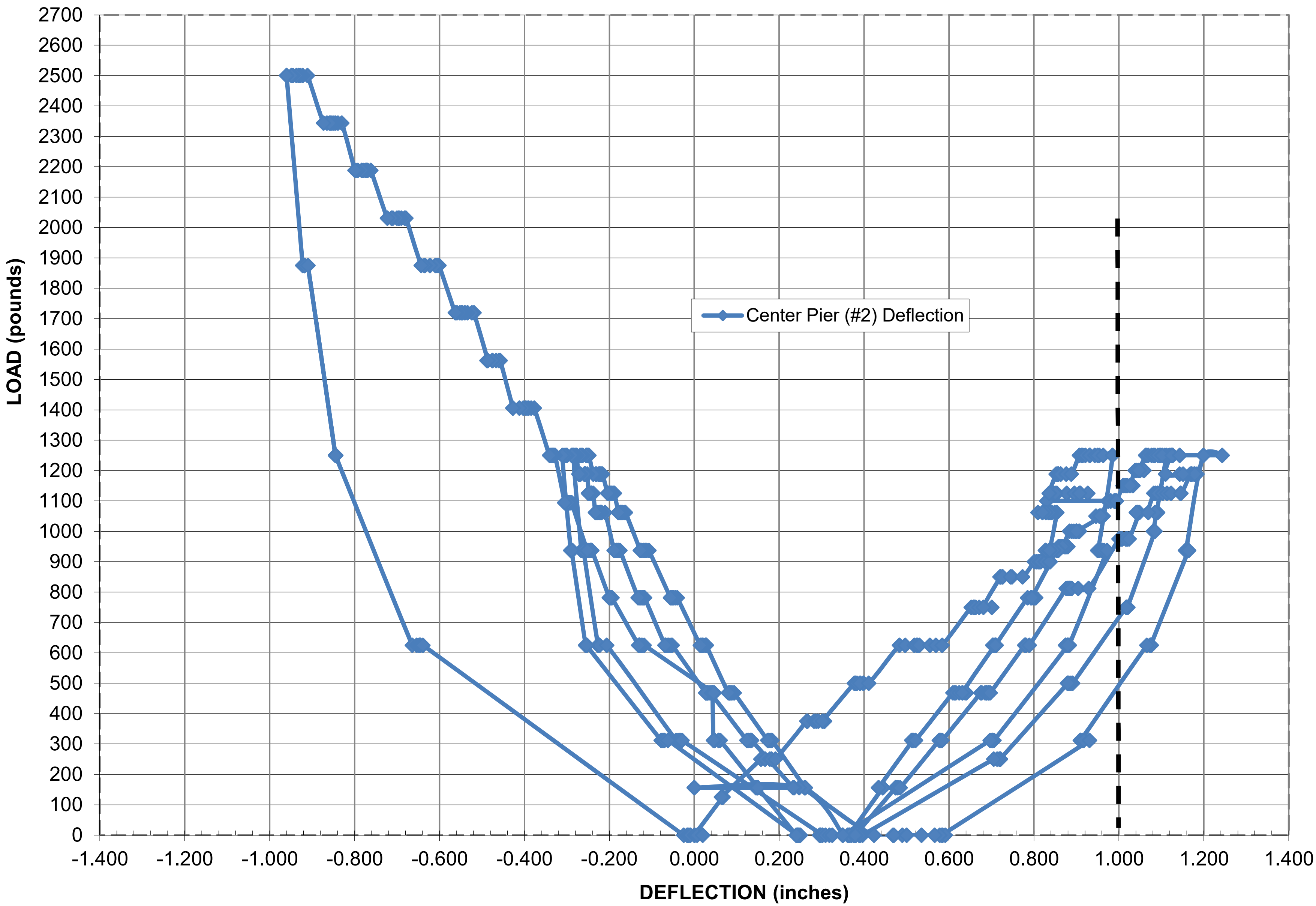
450	15:44	10	0.955	1.433			
0	15:45	0	0.339	0.475			
0	15:46	1	0.334	0.461			
0	15:47	2	0.333	0.458			
0	15:48	3	0.331	0.456			
0	15:49	4	0.330	0.453			
0	15:50	5	0.329	0.452		1 1/16	
0	15:55	10	0.307	0.450			
0	16:00	15	0.301	0.444			
0	16:05	20	0.297	0.439			
0	16:15	30	0.292	0.445	0.404	1 1/16	
225	9:48	0		-0.741	0.559		Start Cycle #6 (west direction).
225	9:49	1		-0.755	0.564		Test started on 4/28/16.
225	9:50	2		-0.755	0.563		
225	9:51	3		-0.766	0.570		
225	9:52	4		-0.768	0.570		
225	9:53	5		-0.774	0.575	1 7/32	
225	9:58	10		-0.783	0.581		
450	9:59	0		-1.022	0.732		
450	10:00	1		-1.036	0.736		
450	10:01	2		-1.046	0.743		
450	10:02	3		-1.048	0.744		
450	10:03	4		-1.050	0.745		
450	10:04	5		-1.059	0.753	1 7/16	
450	10:09	10		-1.065	0.753		
675	10:10	0		-1.230	0.886		
675	10:11	1		-1.238	0.889		
675	10:12	2		-1.245	0.892		
675	10:13	3		-1.254	0.897		
675	10:14	4		-1.258	0.900		
675	10:15	5		-1.259	0.901		
675	10:20	10		-1.262	0.902		
675	10:25	15		-1.260	0.904		
900	10:26	0		-1.387	1.016		
900	10:27	1		-1.395	1.019		
900	10:28	2		-1.403	1.023		
900	10:29	3		-1.408	1.028		
900	10:30	4		-1.409	1.030		
900	10:31	5		-1.411	1.030	1 45/64	
900	10:36	10		-1.415	1.033		
900	10:41	15		-1.433	1.036		
900	10:46	20		-1.457	1.039		
1125	10:47	0		-1.610	1.152		
1125	10:48	1		-1.622	1.160		
1125	10:49	2		-1.634	1.164		
1125	10:50	3		-1.644	1.166		
1125	10:51	4		-1.649	1.169		
1125	10:52	5		-1.655	1.176		
1125	10:57	10		-1.670	1.179	1 55/64	
1125	11:02	15		-1.665	1.186		
1125	11:07	20		-1.666	1.187	1 55/64	
1350	11:08	0		-1.781	1.309		
1350	11:09	1		-1.790	1.314		
1350	11:10	2		-1.797	1.322		
1350	11:11	3		-1.804	1.327		
1350	11:12	4		-1.810	1.331		
1350	11:13	5		-1.812	1.336		
1350	11:18	10		-1.800	1.342	1 63/64	
1350	11:23	15		-1.778	1.351		
1350	11:28	20		-1.776	1.358		
1530	11:29	0		-1.859	1.423		
1530	11:30	1		-1.867	1.431		
1530	11:31	2		-1.872	1.436		
1530	11:32	3		-1.873	1.440		
1530	11:33	4		-1.880	1.447		
1530	11:34	5		-1.888	1.452		
1530	11:39	10		-1.892	1.460	2 7/64	
1530	11:44	15		-1.906	1.466		
1530	11:49	20		-1.910	1.471		
1620	11:50	0		-1.969	1.504		
1620	11:51	1		-1.977	1.509		
1620	11:52	2		-1.984	1.515		
1620	11:53	3		-1.989	1.519		
1620	11:54	4		-1.994	1.524		
1620	11:55	5		-1.999	1.527	2 13/64	

1620	12:00	10		-2.011	1.532		
1620	12:05	15		-2.015	1.538		
1620	12:10	20		-2.019	1.542		
1710	12:11	0		-2.052	1.567		
1710	12:12	1		-2.060	1.573		
1710	12:13	2		-2.068	1.577		
1710	12:14	3		-2.074	1.582		
1710	12:15	4		-2.080	1.587		
1710	12:16	5		-2.086	1.590	2 17/64	
1710	12:21	10		-2.088	1.595		
1710	12:26	15		-2.092	1.598		
1710	12:31	20		-2.095	1.604	2 9/32	
1800	12:32	0		-2.126	1.623		
1800	12:33	1		-2.135	1.627		
1800	12:34	2		-2.148	1.635		
1800	12:35	3		-2.153	1.637		
1800	12:36	4		-2.158	1.640		
1800	12:37	5		-2.161	1.641		
1800	12:42	10		-2.167	1.653	2 11/32	
1800	12:47	15		-2.169	1.659		
1800	12:52	20		-2.195	1.660		
1800	13:02	30		-2.203	1.666		
1800	13:17	45		-2.220	1.670	2 25/64	
1800	13:32	60		-2.246	1.672	2 25/64	
1350	13:33	0		-2.197	1.643		
1350	13:34	1		-2.192	1.638		
1350	13:35	2		-2.193	1.638		
1350	13:36	3		-2.193	1.638		
1350	13:37	4		-2.193	1.638		
1350	13:38	5		-2.193	1.637		
1350	13:43	10		-2.195	1.637		
900	13:44	0		-2.095	1.545		
900	13:45	1		-2.092	1.542		
900	13:46	2		-2.092	1.541		
900	13:47	3		-2.092	1.541		
900	13:48	4		-2.092	1.541		
900	13:49	5		-2.092	1.540	2 23/64	
900	13:54	10		-2.086	1.537		
450	13:56	0		-1.707	1.208		
450	13:57	1		-1.704	1.206		
450	13:58	2		-1.700	1.204		
450	13:59	3		-1.694	1.203		
450	14:00	4		-1.692	1.202		
450	14:01	5		-1.685	1.197		
450	14:06	10		-1.677	1.190	2 3/64	
0	14:07	0		-0.727	0.508		
0	14:08	1		-0.709	0.492		
0	14:09	2		-0.709	0.488		
0	14:10	3		-0.708	0.487		
0	14:11	4		-0.708	0.486		
0	14:12	5		-0.707	0.484	1 11/32	
0	14:17	10		-0.695	0.482		
0	14:22	15		-0.644	0.476		
0	14:27	20		-0.614	0.473		
0	14:37	30		-0.582	0.471	1 17/64	

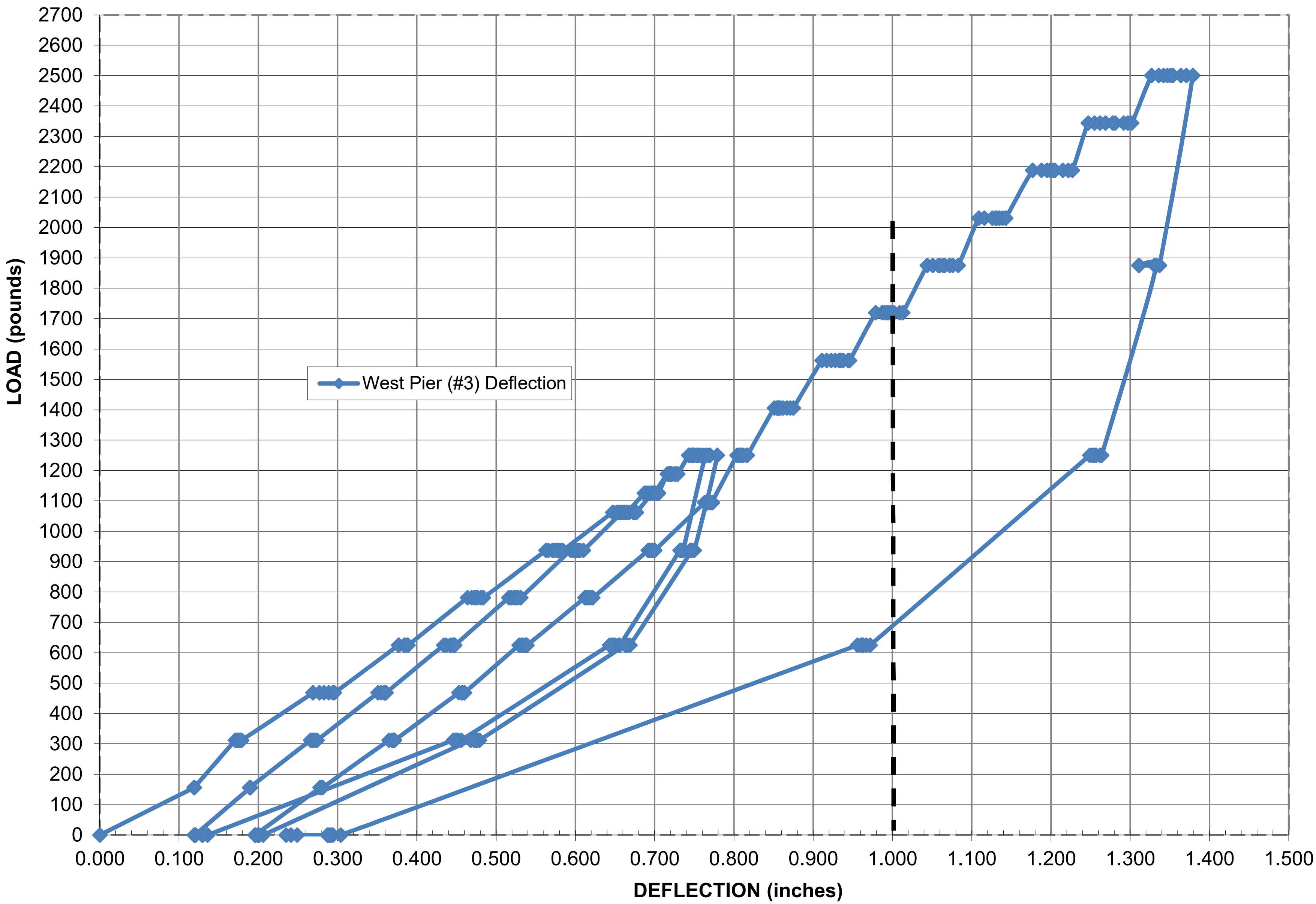
PIER #CL-L-DP75-1, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/18/16-5/24/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



PIER #CL-L-DP75-2, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/18/16-5/24/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



PIER #CL-L-DP75-3, 1.25" NOMINAL DIAMETER x 50" LONG PINS
(INSTALLED 4/4/16, TESTED 5/18/16-5/24/16)
CYCLIC LATERAL LOAD TEST - SILT SITE



Project Name:	Diamond Pier foundation field load testing
EEI Project No.:	07-020
Site:	SILT (presumptive bearing capacity of 1,500 psf)
Test Method:	Lateral - ASTM D3966
Diamond Piers Tested:	#CL-L-DP75-1, #CL-L-DP75-2, #CL-L-DP75-3
Date Installed:	4/4/2016
Date Test Started:	5/18/2016
Date Test Completed:	5/24/2016
Staff:	Bruce Lane, Ken Andrieu
Hydraulic Ram:	6.5 Ton Tension Ram, Bailys Chief WC 3000 PSI
Dial Gauge #1:	EEI Equipment #EEI 33
Dial Gauge #2:	EEI Equipment #EEI 34

Load (pounds)	Clock	Minutes	East Pier (#1) Dial Gauge (in.)	Center Pier (#2) Dial Gauge (in.)	West Pier (#3) Dial Gauge (in.)	Transit	Test Remarks
0	11:15	0	0.000	0.000			Start Cycle #1 (east direction)
125	11:16	0	0.072	0.067			Started 5/18/16
125	11:17	1	0.072	0.067			
125	11:18	2	0.072	0.067			
125	11:19	3	0.072	0.067			
125	11:20	4	0.074	0.067			
125	11:21	5	0.074	0.067			
125	11:26	10	0.076	0.064			
250	11:26	0	0.149	0.157			
250	11:27	1	0.149	0.157			
250	11:28	2	0.155	0.167			
250	11:29	3	0.155	0.167			
250	11:30	4	0.157	0.178			
250	11:31	5	0.157	0.182			
250	11:36	10	0.164	0.191			
375	11:37	0	0.236	0.265			
375	11:38	1	0.239	0.267			
375	11:39	2	0.243	0.282			
375	11:40	3	0.244	0.287			
375	11:41	4	0.247	0.292			
375	11:42	5	0.248	0.306			
375	11:47	10	0.248	0.307			
375	11:52	15	0.249	0.302			
500	11:52	0	0.318	0.377			
500	11:53	1	0.323	0.379			
500	11:54	2	0.327	0.381			
500	11:55	3	0.327	0.383			
500	11:56	4	0.329	0.391			
500	11:57	5	0.329	0.398			
500	12:02	10	0.331	0.399			
500	12:07	15	0.334	0.390			
500	12:12	20	0.334	0.411			
625	12:13	0	0.397	0.483			
625	12:14	1	0.402	0.497			
625	12:15	2	0.405	0.518			
625	12:16	3	0.405	0.526			
625	12:17	4	0.407	0.524			
625	12:18	5	0.408	0.530			
625	12:23	10	0.407	0.555			
625	12:28	15	0.411	0.569			
625	12:33	20	0.413	0.584			
750	12:34	0	0.477	0.652			
750	12:35	1	0.482	0.659			
750	12:36	2	0.484	0.663			
750	12:37	3	0.487	0.657			
750	12:38	4	0.487	0.658			
750	12:39	5	0.492	0.660			
750	12:44	10	0.494	0.671			
750	12:49	15	0.500	0.701			
750	12:54	20	0.503	0.681			
850	12:55	0	0.553	0.721			
850	12:56	1	0.556	0.722			
850	12:57	2	0.560	0.720			
850	12:58	3	0.564	0.721			
850	12:59	4	0.565	0.726			
850	13:00	5	0.567	0.726			
850	13:05	10	0.570	0.748			

850	13:10	15	0.575	0.745			
850	13:15	20	0.575	0.773			
900	13:16	0	0.591	0.801			
900	13:17	1	0.595	0.807			
900	13:18	2	0.597	0.811			
900	13:19	3	0.602	0.805			
900	13:20	4	0.604	0.813			
900	13:21	5	0.604	0.816			
900	13:26	10	0.608	0.826			
900	13:31	15	0.609	0.838			
900	13:36	20	0.610	0.837			
950	13:37	0	0.626	0.858			
950	13:38	1	0.629	0.861			
950	13:39	2	0.632	0.868			
950	13:40	3	0.636	0.872			
950	13:41	4	0.637	0.876			
950	13:42	5	0.640	0.880			
950	13:47	10	0.645	0.874			
950	13:52	15	0.649	0.864			
950	13:57	20	0.651	0.867			
1,000	13:58	0	0.671	0.884			
1,000	13:59	1	0.673	0.889			
1,000	14:00	2	0.674	0.894			
1,000	14:01	3	0.675	0.899			
1,000	14:02	4	0.678	0.900			
1,000	14:03	5	0.679	0.906			
1,000	14:08	10	0.685	0.907			
1,000	14:13	15	0.692	0.901			
1,000	14:18	20	0.695	0.900			
1,050	14:29	0	0.715	0.961			
1,050	14:30	1	0.718	0.960			
1,050	14:31	2	0.718	0.961			
1,050	14:32	3	0.718	0.963			
1,050	14:33	4	0.720	0.961			
1,050	14:34	5	0.722	0.960			
1,050	14:39	10	0.727	0.946			
1,050	14:44	15	0.729	0.954			
1,050	14:49	20	0.732	0.957			
1,100	14:50	0	0.745	0.974			
1,100	14:51	1	0.748	0.975			
1,100	14:52	2	0.753	0.980			
1,100	14:53	3	0.756	0.981			
1,100	14:54	4	0.759	0.830			
1,100	14:55	5	0.760	0.989			
1,100	15:00	10	0.764	0.992			
1,100	15:05	15	0.768	0.989			
1,100	15:10	20	0.770	0.994			
1150	15:11	0	0.788	1.010			
1150	15:12	1	0.791	1.010			
1150	15:13	2	0.794	1.011			
1150	15:14	3	0.794	1.015			
1150	15:15	4	0.796	1.017			
1150	15:16	5	0.798	1.020			
1150	15:21	10	0.806	1.033			
1150	15:26	15	0.807	1.026			
1150	15:31	20	0.809	1.026			
1200	15:32	0	0.824	1.038			
1200	15:33	1	0.827	1.042			
1200	15:34	2	0.831	1.050			
1200	15:35	3	0.835	1.059			
1200	15:36	4	0.837	1.059			
1200	15:37	5	0.839	1.059			
1200	15:42	10	0.845	1.047			
1200	15:47	15	0.848	1.047			
1200	15:52	20	0.852	1.047			
1250	15:53	0	0.868	1.063			
1250	15:54	1	0.875	1.066			
1250	15:55	2	0.881	1.069			
1250	15:56	3	0.880	1.077			
1250	15:57	4	0.882	1.082			
1250	15:58	5	0.884	1.085			
1250	16:03	10	0.888	1.097			
1250	16:08	15	0.889	1.097			
1250	16:13	20	0.898	1.097			
1250	16:23	30	0.903	1.092			
1250	16:38	45	0.912	1.108			
1250	16:53	60	0.915	1.112			
1000	16:53	0	0.898	1.081			

1000	16:54	1	0.893	1.082			
1000	16:55	2	0.894	1.082			
1000	16:56	3	0.899	1.082			
1000	16:57	4	0.897	1.082			
1000	16:58	5	0.896	1.084			
1000	17:03	10	0.895	1.085			
750	17:04	0	0.829	1.020			
750	17:05	1	0.825	1.017			
750	17:06	2	0.822	1.018			
750	17:07	3	0.821	1.018			
750	17:08	4	0.823	1.019			
750	17:09	5	0.822	1.021			
750	17:14	10	0.822	1.017			
500	17:15	0	0.718	0.891			
500	17:16	1	0.711	0.887			
500	17:17	2	0.709	0.885			
500	17:18	3	0.708	0.882			
500	17:19	4	0.706	0.882			
500	17:20	5	0.706	0.879			
500	17:25	10	0.704	0.880			
250	17:26	0	0.536	0.720			
250	17:27	1	0.533	0.721			
250	17:28	2	0.533	0.721			
250	17:29	3	0.531	0.720			
250	17:30	4	0.530	0.718			
250	17:31	5	0.530	0.713			
250	17:36	10	0.529	0.705			
0	17:37	0	0.216	0.396			
0	17:38	1	0.214	0.391			
0	17:39	2	0.213	0.389			
0	17:40	3	0.213	0.388			
0	17:41	4	0.188	0.381			
0	17:42	5	0.189	0.379			
0	17:42	10	0.176	0.375			
0	17:52	15	0.167	0.370			
0	18:07	30	0.165	0.365			Start Cycle #2 (east direction)
156	9:15	0	0.263	0.444			Started 5/18/16
156	9:16	1	0.270	0.444			
156	9:17	2	0.270	0.444			
156	9:18	3	0.270	0.444			
156	9:19	4	0.270	0.444			
156	9:20	5	0.270	0.434		1 5/64	
156	9:25	10	0.270	0.434			
312	9:25	0	0.394	0.515			
312	9:26	1	0.395	0.516			
312	9:27	2	0.395	0.516			
312	9:28	3	0.397	0.513			
312	9:29	4	0.397	0.512			
312	9:30	5	0.397	0.514			
312	9:35	10	0.397	0.521		1 9/64	
468	9:36	0	0.492	0.609			
468	9:37	1	0.494	0.613			
468	9:38	2	0.497	0.616			
468	9:39	3	0.499	0.624			
468	9:40	4	0.501	0.632			
468	9:41	5	0.502	0.638		1 13/16	
468	9:46	10	0.504	0.641			
468	9:51	15	0.506	0.631			
625	9:52	0	0.591	0.708			
625	9:53	1	0.594	0.710			
625	9:54	2	0.595	0.710			
625	9:55	3	0.595	0.706			
625	9:56	4	0.595	0.703			
625	9:57	5	0.595	0.703			
625	10:02	10	0.597	0.711		1 9/32	
625	10:07	15	0.599	0.706			
625	10:12	20	0.599	0.709			
781	10:13	0	0.675	0.785			
781	10:14	1	0.677	0.793			
781	10:15	2	0.679	0.800			
781	10:16	3	0.681	0.802			
781	10:17	4	0.683	0.804			
781	10:18	5	0.683	0.803		1 11/32	
781	10:23	10	0.686	0.801			
781	10:28	15	0.686	0.800			
781	10:33	20	0.687	0.795			
937	10:34	0	0.754	0.854			
937	10:35	1	0.758	0.857			
937	10:36	2	0.760	0.846			
937	10:37	3	0.760	0.837			
937	10:38	4	0.762	0.828			

937	10:39	5	0.763	0.827		1 13/32	
937	10:44	10	0.769	0.828			
937	10:49	15	0.771	0.835			
937	10:54	20	0.771	0.837			
1062	10:55	0	0.820	0.854			
1062	10:56	1	0.822	0.849			
1062	10:57	2	0.823	0.842			
1062	10:58	3	0.823	0.839			
1062	10:59	4	0.824	0.834			
1062	11:00	5	0.825	0.835		1 31/64	
1062	11:05	10	0.829	0.828			
1062	11:10	15	0.832	0.809			
1062	11:15	20	0.831	0.820			
1125	11:16	0	0.844	0.845			
1125	11:17	1	0.848	0.854			
1125	11:18	2	0.850	0.877			
1125	11:19	3	0.853	0.895			
1125	11:20	4	0.854	0.909			
1125	11:21	5	0.856	0.927		1 1/2	
1125	11:26	10	0.861	0.907			
1125	11:31	15	0.862	0.850		1 1/2	
1125	11:36	20	0.865	0.836			
1188	11:37	0	0.878	0.852			
1188	11:38	1	0.878	0.855			
1188	11:39	2	0.881	0.857			
1188	11:40	3	0.884	0.858			
1188	11:41	4	0.884	0.863			
1188	11:42	5	0.886	0.863		1 17/32	
1188	11:47	10	0.887	0.876			
1188	11:52	15	0.890	0.876			
1188	11:57	20	0.891	0.888			
1250	11:58	0	0.905	0.907			
1250	11:59	1	0.908	0.912			
1250	12:00	2	0.910	0.915			
1250	12:01	3	0.912	0.921			
1250	12:02	4	0.913	0.932			
1250	12:03	5	0.914	0.932		1 17/32	
1250	12:08	10	0.920	0.931			
1250	12:13	15	0.921	0.943			
1250	12:18	20	0.923	0.954			
1250	12:28	30	0.928	0.950			
1250	12:43	45	0.929	0.963			
1250	12:58	60	0.931	0.985			
937	12:59	0	0.906	0.951			
937	13:00	1	0.906	0.950			
937	13:01	2	0.905	0.954			
937	13:02	3	0.904	0.959			
937	13:03	4	0.904	0.962			
937	13:04	5	0.904	0.965			
937	13:09	10	0.903	0.972			
625	13:10	0	0.800	0.883			
625	13:11	1	0.798	0.881			
625	13:12	2	0.797	0.879			
625	13:13	3	0.797	0.878			
625	13:14	4	0.796	0.875			
625	13:15	5	0.796	0.874		1 15/32	
625	13:20	10	0.794	0.880			
312	13:21	0	0.615	0.706			
312	13:22	1	0.612	0.703			
312	13:23	2	0.611	0.702			
312	13:24	3	0.611	0.701			
312	13:25	4	0.611	0.702			
312	13:26	5	0.611	0.702		1 11/32	
312	13:31	10	0.608	0.697			
0	13:31	0	0.230	0.350			
0	13:32	1	0.227	0.349			
0	13:33	2	0.226	0.350			
0	13:34	3	0.224	0.361			
0	13:35	4	0.224	0.364		1 1/32	
0	13:36	5	0.224	0.366			
0	13:41	10	0.224	0.366			
0	13:46	15	0.225	0.366			
0	14:01	30	0.222	0.377		1 1/32	
0	14:04	0	0.222	0.379		1 1/32	Start Cycle #3 (east direction)
156	14:05	0	0.333	0.474			Started 5/18/16
156	14:06	1	0.335	0.474			
156	14:07	2	0.335	0.474			
156	14:08	3	0.338	0.475			
156	14:09	4	0.337	0.479		1 7/64	
156	14:10	5	0.337	0.479			
156	14:15	10	0.338	0.485			

312	14:16	0	0.465	0.577			
312	14:17	1	0.465	0.578			
312	14:18	2	0.466	0.578			
312	14:19	3	0.466	0.580			
312	14:20	4	0.466	0.581			
312	14:21	5	0.468	0.583		1 3/16	
312	14:26	10	0.470	0.584			
468	14:26	0	0.558	0.675			
468	14:27	1	0.558	0.677			
468	14:28	2	0.558	0.685			
468	14:29	3	0.558	0.688			
468	14:30	4	0.560	0.689			
468	14:31	5	0.560	0.693		1 17/64	
468	14:36	10	0.562	0.694			
468	14:41	15	0.563	0.697			
625	14:43	0	0.646	0.778			
625	14:44	1	0.650	0.779			
625	14:45	2	0.651	0.780			
625	14:46	3	0.652	0.781			
625	14:47	4	0.652	0.781		1 21/64	
625	14:48	5	0.652	0.781			
625	14:53	10	0.653	0.789			
812	14:54	0	0.741	0.876			
812	14:55	1	0.744	0.878			
812	14:56	2	0.746	0.879			
812	14:57	3	0.747	0.881			
812	14:58	4	0.749	0.884			
812	14:59	5	0.749	0.886			
812	15:04	10	0.751	0.889		1 13/32	
812	15:09	15	0.751	0.904			
812	15:14	20	0.752	0.929			
975	15:15	0	0.816	1.000			
975	15:16	1	0.818	1.003			
975	15:17	2	0.819	1.006			
975	15:18	3	0.821	1.007			
975	15:19	4	0.822	1.017			
975	15:20	5	0.822	1.020		1 15/32	
975	15:25	10	0.825	1.008			
975	15:30	15	0.826	1.016			
975	15:35	20	0.826	1.024			
1062	15:36	0	0.853	1.048			
1062	15:37	1	0.855	1.045			
1062	15:38	2	0.856	1.045			
1062	15:39	3	0.858	1.047			
1062	15:40	4	0.859	1.044			
1062	15:41	5	0.859	1.041		1 1/2	
1062	15:46	10	0.862	1.091			
1062	15:51	15	0.864	1.085			
1062	15:56	20	0.867	1.069			
1125	15:56	0	0.876	1.082			
1125	15:57	1	0.879	1.086			
1125	15:58	2	0.882	1.091			
1125	15:59	3	0.883	1.092			
1125	16:00	4	0.883	1.103			
1125	16:01	5	0.884	1.113		1 33/64	
1125	16:06	10	0.885	1.145			
1125	16:11	15	0.889	1.123			
1125	16:16	20	0.891	1.146			
1188	16:17	0	0.905	1.168			
1188	16:18	1	0.909	1.171			
1188	16:19	2	0.911	1.172			
1188	16:20	3	0.914	1.177			
1188	16:21	4	0.914	1.184			
1188	16:22	5	0.914	1.179		1 35/64	
1188	16:27	10	0.917	1.143			
1188	16:32	15	0.920	1.151			
1188	16:37	20	0.923	1.110			
1250	16:38	0	0.930	1.123			
1250	16:39	1	0.934	1.127			
1250	16:40	2	0.937	1.127			
1250	16:41	3	0.940	1.124			
1250	16:42	4	0.942	1.123			
1250	16:43	5	0.944	1.119		1 9/16	
1250	16:48	10	0.947	1.102			
1250	16:53	15	0.952	1.102			
1250	16:58	20	0.955	1.125			
1250	17:08	30	0.956	1.143			
1250	17:23	45	0.963	1.243			
1250	17:38	60	0.969	1.199		1 9/16	
937	17:39	0	0.946	1.158			
937	17:40	1	0.946	1.157			

937	17:41	2	0.944	1.158			
937	17:42	3	0.945	1.159			
937	17:43	4	0.945	1.162			
937	17:44	5	0.944	1.164		1 17/32	
937	17:49	10	0.946	1.164			
625	17:50	0	0.848	1.075			
625	17:51	1	0.847	1.076			
625	17:52	2	0.845	1.076			
625	17:53	3	0.844	1.076			
625	17:54	4	0.842	1.075			
625	17:55	5	0.844	1.073		1 15/32	
625	18:00	10	0.843	1.066			
312	18:01	0	0.669	0.910			
312	18:02	1	0.667	0.909			
312	18:03	2	0.664	0.909			
312	18:04	3	0.661	0.909			
312	18:05	4	0.661	0.915			
312	18:06	5	0.661	0.917		1 21/64	
312	18:11	10	0.660	0.931			
0	18:12	0	0.266	0.583			
0	18:13	1	0.264	0.584			
0	18:14	2	0.262	0.585			
0	18:15	3	0.261	0.591			
0	18:16	4	0.259	0.578			
0	18:17	5	0.258	0.566			
0	18:22	10	0.257	0.490			
0	18:27	15	0.257	0.468		1 1/32	
0	18:42	30	0.255	0.470			
0	19:02	50	--	0.500	0.497		No East Pier reading
0	19:22	70	--	0.535	0.510		No East Pier reading
0	10:06	0		0.423	0.000		Start Cycle #4 (west direction)
156	10:07	0		0.261	0.119		Started 5/21/16
156	10:08	1		0.260	0.119		
156	10:09	2		0.260	0.119		
156	10:10	3		0.261	0.119		
156	10:11	4		0.261	0.119		
156	10:12	5		0.261	0.119		
156	10:17	10		0.261	0.119		
312	10:17	0		0.183	0.171		
312	10:18	1		0.182	0.172		
312	10:19	2		0.180	0.174		
312	10:20	3		0.176	0.176		
312	10:21	4		0.176	0.176		
312	10:22	5		0.175	0.178		
312	10:27	10		0.173	0.179		
468	10:28	0		0.094	0.269		
468	10:29	1		0.094	0.269		
468	10:30	2		0.089	0.277		
468	10:31	3		0.089	0.277		
468	10:32	4		0.086	0.283		
468	10:33	5		0.083	0.289		
468	10:38	10		0.083	0.294		
468	10:43	15		0.080	0.296		
625	10:44	0		0.028	0.377		
625	10:45	1		0.028	0.377		
625	10:46	2		0.026	0.377		
625	10:47	3		0.026	0.377		
625	10:48	4		0.021	0.384		
625	10:49	5		0.019	0.385		
625	10:54	10		0.018	0.388		
625	10:59	15		0.016	0.388		
625	11:04	20		0.014	0.389		
781	11:05	0		-0.040	0.464		
781	11:06	1		-0.044	0.469		
781	11:07	2		-0.048	0.472		
781	11:08	3		-0.050	0.474		
781	11:09	4		-0.051	0.476		
781	11:10	5		-0.052	0.477		
781	11:15	10		-0.053	0.481		
781	11:20	15		-0.056	0.481		
781	11:25	20		-0.056	0.484		
937	11:26	0		-0.107	0.563		
937	11:27	1		-0.112	0.566		
937	11:28	2		-0.115	0.571		
937	11:29	3		-0.116	0.573		
937	11:30	4		-0.118	0.576		
937	11:31	5		-0.119	0.578		
937	11:36	10		-0.124	0.579		
937	11:41	15		-0.126	0.581		
937	11:46	20		-0.127	0.584		
1062	11:47	0		-0.162	0.647		

1062	11:48	1		-0.165	0.648		
1062	11:49	2		-0.169	0.652		
1062	11:50	3		-0.172	0.655		
1062	11:51	4		-0.173	0.657		
1062	11:52	5		-0.174	0.658		
1062	11:57	10		-0.175	0.661		
1062	12:02	15		-0.178	0.662		
1062	12:07	20		-0.179	0.665		
1125	12:08	0		-0.188	0.687		
1125	12:09	1		-0.190	0.689		
1125	12:10	2		-0.193	0.690		
1125	12:11	3		-0.195	0.692		
1125	12:12	4		-0.197	0.692		
1125	12:13	5		-0.199	0.695		
1125	12:18	10		-0.201	0.696		
1125	12:23	15		-0.201	0.697		
1125	12:28	20		-0.204	0.699		
1188	12:29	0		-0.216	0.716		
1188	12:30	1		-0.218	0.718		
1188	12:31	2		-0.221	0.719		
1188	12:32	3		-0.223	0.720		
1188	12:33	4		-0.224	0.721		
1188	12:34	5		-0.226	0.722		
1188	12:39	10		-0.230	0.725		
1188	12:44	15		-0.232	0.726		
1188	12:49	20		-0.238	0.729		
1250	12:50	0		-0.248	0.743		
1250	12:51	1		-0.250	0.744		
1250	12:52	2		-0.252	0.746		
1250	12:53	3		-0.253	0.747		
1250	12:54	4		-0.254	0.749		
1250	12:55	5		-0.255	0.750		
1250	13:05	15		-0.263	0.753		
1250	13:10	20		-0.266	0.755		
1250	13:20	30		-0.269	0.757		
1250	13:35	45		-0.277	0.768		
1250	13:50	60		-0.285	0.764		
937	13:51	0		-0.266	0.736		
937	13:52	1		-0.265	0.735		
937	13:53	2		-0.264	0.734		
937	13:54	3		-0.263	0.733		
937	13:55	4		-0.263	0.733		
937	13:56	5		-0.263	0.732		
937	14:01	10		-0.261	0.732		
625	14:02	0		-0.227	0.656		
625	14:03	1		-0.226	0.654		
625	14:04	2		-0.224	0.650		
625	14:05	3		-0.224	0.649		
625	14:06	4		-0.223	0.647		
625	14:07	5		-0.223	0.646		
625	14:12	10		-0.206	0.643		
312	14:13	0		-0.043	0.456		
312	14:15	2		-0.038	0.452		
312	14:16	3		-0.035	0.450		
312	14:18	5		-0.032	0.449		
312	14:23	10		-0.029	0.446		
0	14:24	0		0.302	0.136		
0	14:27	3		0.298	0.130		
0	14:29	5		0.295	0.129		
0	14:34	10		0.297	0.121		
0	14:39	15		0.302	0.119		
0	14:54	30		0.309	0.120		
0	15:09	45		0.318	0.120		
0	15:24	60		0.325	0.120		
0	9:05	0		0.350	0.120		Start Cycle #5 (west direction)
156	9:06	0		0.247	0.190		Started 5/24/16
156	9:07	1		0.000	0.190		
156	9:08	2		0.000	0.190		
156	9:09	3		0.000	0.190		
156	9:10	4		0.235	0.190		
156	9:11	5		0.235	0.190	1 1/16	
156	9:16	10		0.233	0.189		
312	9:16	0		0.135	0.266		
312	9:17	1		0.132	0.268		
312	9:18	2		0.132	0.268		
312	9:19	3		0.128	0.271		
312	9:20	4		0.127	0.271		
312	9:21	5		0.126	0.271	1 9/64	
312	9:26	10		0.124	0.274		
468	9:26	0		0.038	0.351		
468	9:27	1		0.035	0.355		

468	9:28	2		0.032	0.359		
468	9:29	3		0.031	0.359		
468	9:30	4		0.030	0.360		
468	9:31	5		0.028	0.360	1 7/32	
468	9:36	10		0.027	0.361		
468	9:41	15		0.027	0.361		
625	9:42	0		-0.052	0.434		
625	9:43	1		-0.054	0.437		
625	9:44	2		-0.057	0.442		
625	9:45	3		-0.061	0.445		
625	9:46	4		-0.064	0.445		
625	9:47	5		-0.067	0.446	1 9/32	
625	9:52	10		-0.067	0.447		
625	9:59	15		-0.069	0.447		
625	10:04	20		-0.069	0.448		
781	10:05	0		-0.117	0.516		
781	10:06	1		-0.119	0.519		
781	10:07	2		-0.120	0.522		
781	10:08	3		-0.121	0.523		
781	10:09	4		-0.121	0.523		
781	10:10	5		-0.123	0.524		
781	10:15	10		-0.126	0.526		
781	10:20	15		-0.128	0.528	1 21/64	
781	10:25	20		-0.132	0.531		
937	10:28	0		-0.175	0.594		
937	10:29	1		-0.178	0.597		
937	10:30	2		-0.179	0.599		
937	10:31	3		-0.180	0.599		
937	10:32	4		-0.183	0.602		
937	10:33	5		-0.184	0.603	1 3/8	
937	10:38	10		-0.187	0.604		
937	10:43	15		-0.188	0.606		
937	10:48	20		-0.189	0.610		
1062	10:49	0		-0.210	0.659		
1062	10:50	1		-0.218	0.662		
1062	10:51	2		-0.219	0.664		
1062	10:52	3		-0.221	0.665		
1062	10:53	4		-0.221	0.665		
1062	10:54	5		-0.224	0.668		
1062	10:59	10		-0.227	0.673	1 13/32	
1062	11:04	15		-0.230	0.675		
1062	11:09	20		-0.233	0.677		
1125	11:10	0		-0.238	0.697		
1125	11:11	1		-0.241	0.699		
1125	11:12	2		-0.241	0.700		
1125	11:13	3		-0.242	0.700		
1125	11:14	4		-0.243	0.700	1 13/32	
1125	11:15	5		-0.245	0.701		
1125	11:20	10		-0.246	0.703		
1125	11:25	15		-0.249	0.705		
1125	11:30	20		-0.249	0.705		
1188	11:31	0		-0.252	0.716		
1188	11:32	1		-0.256	0.718		
1188	11:33	2		-0.256	0.718		
1188	11:34	3		-0.259	0.720		
1188	11:35	4		-0.259	0.720		
1188	11:36	5		-0.259	0.719	1 27/64	
1188	11:41	10		-0.268	0.722		
1188	11:46	15		-0.271	0.727		
1188	11:51	20		-0.272	0.729		
1250	11:52	0		-0.278	0.743		
1250	11:53	1		-0.280	0.747		
1250	11:54	2		-0.283	0.748		
1250	11:55	3		-0.286	0.749		
1250	11:56	4		-0.286	0.749		
1250	11:57	5		-0.286	0.750	1 29/64	
1250	12:02	10		-0.289	0.753		
1250	12:07	15		-0.300	0.758		
1250	12:12	20		-0.300	0.761		
1250	12:27	35		-0.307	0.765		
1250	12:37	45		-0.304	0.770		
1250	12:52	60		-0.311	0.779		
937	12:53	0		-0.291	0.750		
937	12:54	1		-0.290	0.746		
937	12:55	2		-0.287	0.746		
937	12:56	3		-0.289	0.745		
937	12:57	4		-0.289	0.745		
937	12:58	5		-0.289	0.746	1 29/64	
937	13:03	10		-0.289	0.747		
625	13:04	0		-0.256	0.669		
625	13:05	1		-0.256	0.666		

625	13:06	2		-0.253	0.665		
625	13:07	3		-0.253	0.665		
625	13:08	4		-0.253	0.664		
625	13:09	5		-0.253	0.664	1 27/64	
625	13:14	10		-0.254	0.663		
312	13:15	0		-0.078	0.479		
312	13:16	1		-0.076	0.476		
312	13:17	2		-0.074	0.475		
312	13:18	3		-0.073	0.474		
312	13:19	4		-0.071	0.473		
312	13:20	5		-0.070	0.472		
312	13:25	10		-0.062	0.468	1 17/64	
0	13:26	0		0.243	0.206		
0	13:27	1		0.245	0.201		
0	13:28	2		0.247	0.201		
0	13:29	3		0.247	0.201		
0	13:30	4		0.247	0.199		
0	13:31	5		0.247	0.199	1 1/32	
0	13:36	10		0.250	0.200		
0	13:41	15		0.244	0.196		
0	13:46	20		0.243	0.196		
0	13:56	30		0.240	0.196		
0	13:57	0		0.240	0.196	1 1/32	Start Cycle #6 (west direction)
156	13:58	0		0.149	0.278		Started 5/24/16
156	13:59	1		0.145	0.278		
156	14:00	2		0.146	0.278		
156	14:01	3		0.146	0.278		
156	14:02	4		0.149	0.280		
156	14:03	5		0.150	0.281	1 3/32	
156	14:08	10		0.150	0.281		
312	14:09	0		0.061	0.365		
312	14:10	1		0.057	0.369		
312	14:11	2		0.057	0.370		
312	14:12	3		0.048	0.370		
312	14:13	4		0.048	0.370		
312	14:14	5		0.048	0.370	1 11/64	
312	14:19	10		0.045	0.372		
468	14:20	0		0.043	0.453		
468	14:21	1		0.042	0.457		
468	14:22	2		0.042	0.457		
468	14:23	3		0.042	0.457		
468	14:24	4		0.042	0.457		
468	14:25	5		0.042	0.457		
468	14:30	10		0.047	0.460	1 1/4	
468	14:35	15		0.046	0.460		
625	14:36	0		-0.118	0.529		
625	14:37	1		-0.123	0.532		
625	14:38	2		-0.123	0.532		
625	14:39	3		-0.128	0.534		
625	14:40	4		-0.128	0.537		
625	14:41	5		-0.128	0.537	1 5/16	
625	14:46	10		-0.129	0.537		
625	14:51	15		-0.129	0.536		
625	14:56	20		-0.131	0.539		
781	14:57	0		-0.194	0.612		
781	14:58	1		-0.195	0.613		
781	14:59	2		-0.198	0.614		
781	15:00	3		-0.198	0.615		
781	15:01	4		-0.198	0.617		
781	15:02	5		-0.198	0.617	1 3/8	
781	15:07	10		-0.198	0.620		
781	15:12	15		-0.200	0.621		
781	15:17	20		-0.200	0.622		
937	15:18	0		-0.241	0.692		
937	15:19	1		-0.242	0.693		
937	15:20	2		-0.243	0.694		
937	15:21	3		-0.244	0.696		
937	15:22	4		-0.244	0.696		
937	15:23	5		-0.245	0.697	1 13/32	
937	15:28	10		-0.248	0.698		
937	15:33	15		-0.248	0.700		
937	15:38	20		-0.252	0.700		
1094	15:39	0		-0.289	0.763		
1094	15:40	1		-0.292	0.765		
1094	15:41	2		-0.292	0.765		
1094	15:42	3		-0.293	0.766		
1094	15:43	4		-0.294	0.766		
1094	15:44	5		-0.295	0.767	1 7/16	
1094	15:49	10		-0.297	0.770		
1094	15:54	15		-0.305	0.773		
1094	15:59	20		-0.305	0.772		

1250	16:00	0		-0.328	0.804		
1250	16:01	1		-0.331	0.807		
1250	16:02	2		-0.330	0.807		
1250	16:03	3		-0.333	0.808		
1250	16:04	4		-0.335	0.809		
1250	16:05	5		-0.335	0.810	1 15/32	
1250	16:10	10		-0.335	0.812		
1250	16:15	15		-0.338	0.816		
1250	16:20	20		-0.341	0.817		
1406	16:21	0		-0.377	0.851		
1406	16:22	1		-0.384	0.854		
1406	16:23	2		-0.390	0.856		
1406	16:24	3		-0.394	0.857		
1406	16:25	4		-0.398	0.859		
1406	16:26	5		-0.403	0.862	1 33/64	
1406	16:31	10		-0.412	0.867		
1406	16:36	15		-0.427	0.871		
1406	16:41	20		-0.427	0.875		
1562	16:42	0		-0.457	0.911		
1562	16:43	1		-0.460	0.917		
1562	16:44	2		-0.467	0.923		
1562	16:45	3		-0.476	0.928		
1562	16:46	4		-0.475	0.933		
1562	16:47	5		-0.475	0.935	1 37/64	
1562	16:52	10		-0.488	0.938		
1562	16:57	15		-0.487	0.944		
1562	17:02	20		-0.486	0.946		
1719	17:03	0		-0.519	0.979		
1719	17:04	1		-0.524	0.987		
1719	17:05	2		-0.534	0.990		
1719	17:06	3		-0.540	0.993		
1719	17:07	4		-0.546	0.995		
1719	17:08	5		-0.548	0.998		
1719	17:13	10		-0.552	1.002	1 41/64	
1719	17:18	15		-0.559	1.009		
1719	17:23	20		-0.563	1.013		
1875	17:24	0		-0.601	1.044		
1875	17:25	1		-0.606	1.051		
1875	17:26	2		-0.610	1.058		
1875	17:27	3		-0.623	1.060		
1875	17:28	4		-0.622	1.064		
1875	17:29	5		-0.622	1.066	1 45/64	
1875	17:34	10		-0.634	1.072		
1875	17:39	15		-0.636	1.076		
1875	17:44	20		-0.643	1.083		
2031	17:47	0		-0.679	1.109		
2031	17:48	1		-0.682	1.116		
2031	17:49	2		-0.690	1.126		
2031	17:50	3		-0.695	1.130		
2031	17:51	4		-0.696	1.132		
2031	17:52	5		-0.700	1.135	1 49/64	
2031	17:57	10		-0.710	1.139		
2031	18:02	15		-0.713	1.143		
2031	18:07	20		-0.723	1.143		
2188	18:08	0		-0.762	1.177		
2188	18:09	1		-0.769	1.188		
2188	18:10	2		-0.772	1.195		
2188	18:11	3		-0.775	1.199		
2188	18:12	4		-0.780	1.203		
2188	18:13	5		-0.783	1.205	1 53/64	
2188	18:18	10		-0.792	1.215		
2188	18:23	15		-0.797	1.222		
2188	18:28	20		-0.799	1.227		
2344	18:29	0		-0.830	1.247		
2344	18:30	1		-0.839	1.255		
2344	18:31	2		-0.845	1.262		
2344	18:32	3		-0.849	1.269		
2344	18:33	4		-0.853	1.278		
2344	18:34	5		-0.856	1.281		
2344	18:39	10		-0.865	1.292		
2344	18:44	15		-0.859	1.297	1 59/64	
2344	18:49	20		-0.873	1.302		
2500	18:50	0		-0.911	1.327		
2500	18:51	1		-0.922	1.336		
2500	18:52	2		-0.928	1.342		
2500	18:53	3		-0.932	1.347		
2500	18:54	4		-0.937	1.351		
2500	18:55	5		-0.945	1.354	1 63/64	
2500	19:00	10		-0.949	1.364		
2500	19:05	15		-0.960	1.371		
2500	19:10	20		-0.960	1.379		

1875	19:11	0		-0.922	1.337		
1875	19:12	1		-0.918	1.331		
1875	19:13	2		-0.918	1.331		
1875	19:14	3		-0.918	1.311		
1875	19:15	4		-0.918	1.311		
1875	19:16	5		-0.917	1.311	1 31/32	
1875	19:21	10		-0.910	1.333		
1250	19:22	0		-0.845	1.264		
1250	19:23	1		-0.844	1.262		
1250	19:24	2		-0.844	1.257		
1250	19:25	3		-0.845	1.255		
1250	19:26	4		-0.845	1.254		
1250	19:27	5		-0.845	1.252	1 29/32	
1250	19:32	10		-0.845	1.249		
625	19:33	0		-0.664	0.972		
625	19:34	1		-0.654	0.967		
625	19:35	2		-0.648	0.963		
625	19:36	3		-0.647	0.962		
625	19:37	4		-0.646	0.961		
625	19:38	5		-0.645	0.960	1 47/64	
625	19:43	10		-0.639	0.956		
0	19:44	0		-0.025	0.304		
0	19:45	1		-0.017	0.294		
0	19:46	2		-0.016	0.292		
0	19:47	3		-0.014	0.290		
0	19:48	4		-0.010	0.288		
0	19:49	5		-0.009	0.287	1 15/64	
0	19:54	10		0.001	0.249		
0	19:59	15		0.007	0.241		
0	20:14	30		0.020	0.235		

APPENDIX L: ASTM D3689

Designation: D3689/D3689M − 07 (Reapproved 2013)ε1

Standard Test Methods for Deep Foundations Under Static Axial Tensile Load[1]

This standard is issued under the fixed designation D3689/D3689M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—Designation was editorially corrected to match units information in June 2013.

1. Scope

1.1 The test methods described in this standard measure the axial deflection of a vertical or inclined deep foundation when loaded in static axial tension. These methods apply to all deep foundations, referred to herein as "piles," that function in a manner similar to driven piles or cast in place piles, regardless of their method of installation, and may be used for testing single piles or pile groups. The test results may not represent the long-term performance of a deep foundation.

1.2 This standard provides minimum requirements for testing deep foundations under static axial tensile load. Plans, specifications, provisions, or any combination thereof prepared by a qualified engineer may provide additional requirements and procedures as needed to satisfy the objectives of a particular test program. The engineer in responsible charge of the foundation design, referred to herein as the engineer, shall approve any deviations, deletions, or additions to the requirements of this standard.

1.3 This standard allows the following test procedures:

Procedure	Test	Section
A	Quick Test	8.1.2
B	Maintained Test (optional)	8.1.3
C	Loading in Excess of Maintained Test (optional)	8.1.4
D	Constant Time Interval Test (optional)	8.1.5
E	Constant Rate of Uplift Test (optional)	8.1.6
F	Cyclic Loading Test (optional)	8.1.7

1.4 Apparatus and procedures herein designated "optional" may produce different test results and may be used only when approved by the engineer. The word "shall" indicates a mandatory provision, and the word "should" indicates a recommended or advisory provision. Imperative sentences indicate mandatory provisions.

1.5 A qualified geotechnical engineer should interpret the test results obtained from the procedures of this standard so as to predict the actual performance and adequacy of piles used in the constructed foundation. See Appendix X1 for comments regarding some of the factors influencing the interpretation of test results.

1.6 A qualified engineer shall design and approve all loading apparatus, loaded members, support frames, and test procedures. The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered requirements of the standard. This standard also includes illustrations and appendices intended only for explanatory or advisory use.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.8 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound [lbf] represents a unit of force [weight], while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic [F=ma] calculations are involved.

1.9 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.10 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.11 ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.11 on Deep Foundations.

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patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

1.12 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D5882 Test Method for Low Strain Impact Integrity Testing of Deep Foundations

D6026 Practice for Using Significant Digits in Geotechnical Data

D6760 Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing

2.2 *American National Standards:*

ASME B30.1 Jacks[3]

ASME B40.100 Pressure Gages and Gauge Attachments[3]

ASME B89.1.10.M Dial Indicators (For Linear Measurements)[3]

3. Terminology

3.1 *Definitions*—For common definitions of terms used in this standard see Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cast in-place pile, n*—a deep foundation unit made of cement grout or concrete and constructed in its final location, e.g. drilled shafts, bored piles, caissons, auger cast piles, pressure-injected footings, etc.

3.2.2 *deep foundation, n*—a relatively slender structural element that transmits some or all of the load it supports to soil or rock well below the ground surface, such as a steel pipe pile or concrete drilled shaft.

3.2.3 *driven pile, n*—a deep foundation unit made of preformed material with a predetermined shape and size and typically installed by impact hammering, vibrating, or pushing.

3.2.4 *failure load, n—for the purpose of terminating an axial tensile load test*, the test load at which continuing, progressive movement occurs, or at which the total axial movement exceeds 15 % of the pile diameter or width, or as specified by the engineer.

3.2.5 *telltale rod, n*—an unstrained metal rod extended through the test pile from a specific point to be used as a reference from which to measure the change in the length of the loaded pile.

3.2.6 *wireline, n*—a steel wire mounted with a constant tension force between two supports and used as a reference line to read a scale indicating movement of the test pile.

4. Significance and Use

4.1 Field tests provide the most reliable relationship between the axial load applied to a deep foundation and the resulting axial movement. Test results may also provide information used to assess the distribution of side shear resistance along the pile shaft and the long-term load-deflection behavior. A foundation designer may evaluate the test results to determine if, after applying an appropriate factor of safety, the pile or pile group has an ultimate static capacity and a deflection at service load satisfactory to support a specific foundation. When performed as part of a multiple-pile test program, the designer may also use the results to assess the viability of different piling types and the variability of the test site.

4.2 If feasible, without exceeding the safe structural load on the pile(s) or pile cap, the maximum load applied should reach a failure load from which the engineer may determine the ultimate axial static tensile load capacity of the pile(s). Tests that achieve a failure load may help the designer improve the efficiency of the foundation by reducing the piling length, quantity, or size.

4.3 If deemed impractical to apply axial test loads to an inclined pile, the engineer may elect to use axial test results from a nearby vertical pile to evaluate the axial capacity of the inclined pile.

NOTE 1—The quality of the result produced by these test methods is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of these test methods are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

5. Test Foundation Preparation

5.1 Excavate or add fill to the ground surface around the test pile or pile group to the final design elevation unless otherwise approved by the engineer.

5.2 Design and construct the test pile(s) so that any location along the depth of the pile will safely sustain the maximum anticipated axial compressive and tensile load to be developed at that location. Cut off or build up the test pile(s) as necessary to permit construction of the load-application apparatus, placement of the necessary testing and instrumentation equipment, and observation of the instrumentation. Remove any damaged or unsound material from the pile top as necessary to properly install the apparatus for measuring movement, for applying load, and for measuring load.

5.3 For tests on pile groups, cap the pile group with steel-reinforced concrete or a steel load frame designed to safely sustain the anticipated loads.

5.4 Install structural tension connectors extending from the test pile or pile cap, constructed of steel straps, bars, cables, and/or other devices bolted, welded, cast into, or otherwise

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

firmly affixed to the test pile or pile cap to safely apply the maximum required tensile test load without slippage, rupture, or excessive elongation. Carefully inspect these tension members for any damage that may reduce their tensile capacity. Tension members with a cross-sectional area reduced by corrosion or damage, or material properties compromised by fatigue, bending, or excessive heat, may rupture suddenly under load. Do not use brittle materials for tension connections.

NOTE 2—Deep foundations sometimes include hidden defects that may go unnoticed prior to static testing. Low strain integrity tests as described in Test Method D5882 and ultrasonic crosshole integrity tests as described in Test Method D6760 may provide a useful pre-test evaluation of the test foundation.

6. Apparatus for Applying and Measuring Loads

6.1 *General:*

6.1.1 The apparatus for applying tensile loads to a test pile or pile group shall conform to one of the methods described in 6.3 – 6.6. The method in 6.3 is recommended. The method in 6.5 can develop high tensile loads with relatively low jacking capacity, but does not perform well for tests to failure or for large upward movements.

6.1.2 Reaction piles, if used, shall be of sufficient number and installed so as to safely provide adequate reaction capacity without excessive movement. When using two or more reaction piles at each end of the test beam(s), cap them with reaction beams (Fig. 1). Locate reaction piles so that resultant test beam load supported by them acts at the center of the reaction pile group. Cribbing, if used as a reaction, shall be of sufficient plan dimensions to transfer the reaction loads to the soil without settling at a rate that would prevent maintaining the applied loads.

6.1.3 Cut off or build up reaction piles as necessary to place the reaction or test beam(s). Remove any damaged or unsound material from the top of the reaction piles, and provide a smooth bearing surface parallel to the reaction or test beam(s). To minimize stress concentrations due to minor surface irregularities, set steel bearing plates on the top of precast or cast-in-place concrete reaction piles in a thin layer of quick-setting, non-shrink grout, less than 6 mm [0.25 in.] thick and having a compressive strength greater than the reaction pile at the time of the test. For steel reaction piles, weld a bearing plate to each pile, or weld the cap or test beam(s) directly to each pile. For timber reaction piles, set the bearing plate(s) directly on the cleanly cut top of the pile, or in grout as described for concrete piles.

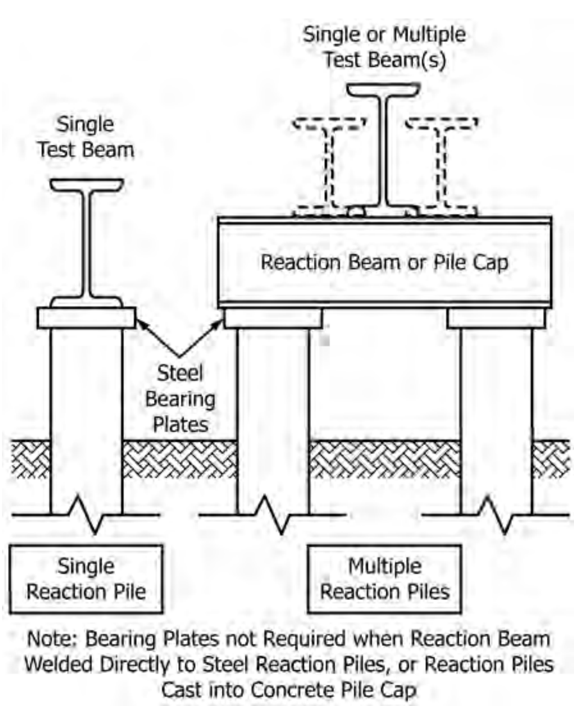

FIG. 1 Typical End Views of Test Beam(s) and Reaction Pile(s)

6.1.4 Provide a clear distance between the test pile(s) and the reaction piles or cribbing of at least five times the maximum diameter of the largest test or reaction pile(s), but not less than 2.5 m [8 ft]. The engineer may increase or decrease this minimum clear distance based on factors such as the type and depth of reaction, soil conditions, and magnitude of loads so that reaction forces do not significantly effect the test results.

NOTE 3—Excessive vibrations during reaction pile installation in non-cohesive soils may affect test results. Reaction piles that penetrate deeper than the test pile may affect test results. Install the anchor piles nearest the test pile first to help reduce installation effects.

6.1.5 Each jack shall include a lubricated hemispherical bearing or similar device to minimize lateral loading of the pile or pile group. The hemispherical bearing(s) should include a locking mechanism for safe handling and setup.

6.1.6 Provide bearing stiffeners as needed between the flanges of test and reaction beams.

6.1.7 Provide steel bearing plates to spread the load to and between the jack(s), load cell(s), hemispherical bearing(s), test beam(s), reaction beam(s), and reaction pile(s). Unless otherwise specified by the engineer, the size of the bearing plates shall be not less than the outer perimeter of the jack(s), load cell(s), or hemispherical bearing(s), nor less than the total width of the test beam(s), reaction beam(s), reaction piles so as to provide full bearing and distribution of the load. Bearing plates supporting the jack(s), test beam(s), or reaction beams on timber or concrete cribbing shall have an area adequate for safe bearing on the cribbing.

6.1.8 Unless otherwise specified, where using steel bearing plates, provide a total plate thickness adequate to spread the bearing load between the outer perimeters of loaded surfaces at a maximum angle of 45 degrees to the loaded axis. For center hole jacks and center hole load cells, also provide steel plates adequate to spread the load from their inner diameter to the their central axis at a maximum angle of 45 degrees, or per manufacturer recommendations.

6.1.9 Align the test load apparatus with the longitudinal axis of the test pile or pile group to minimize eccentric loading. Align bearing plate(s), jack(s), load cell(s), and hemispherical bearing(s) on the same longitudinal axis. Place jacks to center the load on the test beam(s). Place test beam(s) to center the load on reaction beams or cribbing, and reaction beams to center the load on reaction piles or cribbing. These plates, beams, and devices shall have flat, parallel bearing surfaces. Set bearing plates on cribbing in the horizontal plane.

6.1.10 When testing inclined piles, align the test apparatus and reaction piles parallel to the inclined longitudinal axis of the test pile(s) and orient the test beam(s) perpendicular to the direction of incline.

6.1.11 A qualified engineer shall design and approve all loading apparatus, loaded members, support frames, and loading procedures. Unless otherwise specified by the engineer, the apparatus for applying and measuring loads, including all structural members, shall have sufficient size, strength, and stiffness to safely prevent excessive deflection and instability up to 120 % of the maximum anticipated test load.

NOTE 4—Rotations and lateral displacements of the test pile or test pile group, reaction piles, cribbing support(s), or pile cap(s) may occur during loading, especially for sites with weak soils. The user should design and construct the support reactions to prevent instability and to limit undesired rotations or lateral displacements.

6.2 *Hydraulic Jacks, Gages, Transducers, and Load Cells:*

6.2.1 The hydraulic jack(s) and their operation shall conform to ASME B30.1 and shall have a nominal load capacity exceeding the maximum anticipated jack load by at least 20 %. The jack, pump, and any hoses, pipes, fittings, gages, or transducers used to pressurize it shall be rated to a safe pressure corresponding to the nominal jack capacity.

6.2.2 The hydraulic jack ram(s) shall have a travel greater than the sum of the anticipated maximum axial movement of the pile plus the deflection of the test beam and the elongation of the tension connection, but not less than 15 % of the average pile diameter or width. Use a single high capacity jack when possible. When using a multiple jack system, provide jacks of the same make, model, and capacity, and supply the jack pressure through a common manifold with a master pressure gage. Fit the manifold and each jack with a pressure gage to detect malfunctions and imbalances.

6.2.3 Unless otherwise specified, the hydraulic jack(s), pressure gage(s), and pressure transducer(s) shall have a calibration to at least the maximum anticipated jack load performed within the six months prior to each test or series of tests. Furnish the calibration report(s) prior to performing a test, which shall include the ambient temperature and calibrations performed for multiple ram strokes up to the maximum stroke of the jack.

6.2.4 Each complete jacking and pressure measurement system, including the hydraulic pump, should be calibrated as a unit when practicable. The hydraulic jack(s) shall be calibrated over the complete range of ram travel for increasing and decreasing applied loads. If two or more jacks are to be used to apply the test load, they shall be of the same make, model, and size, connected to a common manifold and pressure gage, and operated by a single hydraulic pump. The calibrated jacking system(s) shall have accuracy within 5 % of the maximum applied load. When not feasible to calibrate a jacking system as a unit, calibrate the jack, pressure gages, and pressure transducers separately, and each of these components shall have accuracy within 2 % of the applied load.

6.2.5 Pressure gages shall have minimum graduations less than or equal to 1 % of the maximum applied load and shall conform to ASME B40.100 with an accuracy grade 1A having a permissible error ±1 % of the span. Pressure transducers shall have a minimum resolution less than or equal to 1 % of the maximum applied load and shall conform to ASME B40.100 with an accuracy grade 1A having a permissible error ±1 % of the span. When used for control of the test, pressure transducers shall include a real-time display.

6.2.6 If the maximum test load will exceed 900 kN [100 tons], place a properly constructed load cell or equivalent device in series with each hydraulic jack. Unless otherwise specified the load cell(s) shall have a calibration to at least the maximum anticipated jack load performed within the six months prior to each test or series of tests. The calibrated load cell(s) or equivalent device(s) shall have accuracy within 1 % of the applied load, including an eccentric loading of up to 1 % applied at an eccentric distance of 25 mm [1 in.]. After calibration, load cells shall not be subjected to impact loads. A load cell is recommended, but not required, for lesser load. If not practicable to use a load cell when required, include embedded strain gages located in close proximity to the jack to confirm the applied load.

6.2.7 Do not leave the hydraulic jack pump unattended at any time during the test. An automatic regulator is recommended to help hold the load constant as pile movement occurs. Automated jacking systems shall include a clearly marked mechanical override to safely reduce hydraulic pressure in an emergency.

6.3 *Tensile Load Applied by Hydraulic Jack(s) Supported on Test Beam(s) (Figs. 2 and 3)* —Support the ends of the test beam(s) on reaction piles or cribbing, using reaction beams as needed to cap multiple reaction piles as shown in Fig. 1. Place the hydraulic jack(s), load cell(s), hemispherical bearing(s), and bearing plates on top of the test beam(s). Center a reaction frame over the jack(s), and anchor it to the tension connections (see 5.4) extending from the test pile or pile group. Design and construct the test beam(s), reaction frame, and reaction piles or cribbing, and arrange the jack(s) symmetrically so as to apply the resultant tensile load at, and parallel to, to the longitudinal axis of the test pile or pile group. Leave adequate clear space beneath the bottom flange(s) of the test beam(s) to allow for the maximum anticipated upward movement of the test pile or pile cap plus the deflection of the test beam(s).

6.4 *Tensile Load Applied by Hydraulic Jacks Acting Upward at Both Ends of Test Beam(s) (Figs. 4 and 5)*—Support each end of the test beam(s) on hydraulic jack(s) centered beneath the beam web(s) and placed equidistant from the longitudinal axis of the test pile or pile group. Support the jacks on reaction piles or cribbing, using reaction beams as needed to cap multiple reaction piles. Center a reaction frame over the test beam(s) and anchor it to the tension connections (see 5.4) extending from the test pile or pile group. Place a single load cell and hemispherical bearing between the reaction frame and the test beam(s) (preferred), or alternatively, place a load cell and hemispherical bearing with each jack beneath the test beam(s). Design and construct the test beam(s), reaction frame, and reaction piles or cribbing, and arrange the jack(s) symmetrically so as to apply the resultant tensile load at, and parallel to, to the longitudinal axis of the test pile or pile group.

6.5 *Tensile Load Applied by Hydraulic Jack(s) Acting Upward at One End of Test Beam(s) (Figs. 5 and 6)*—Support one

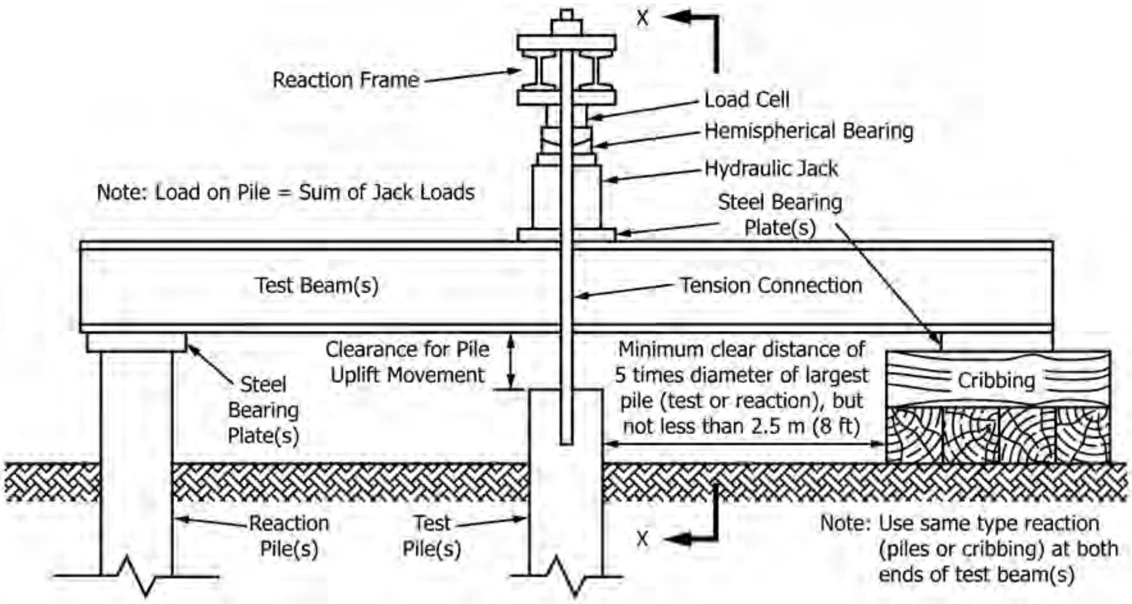

FIG. 2 Typical Setup for Tensile Load Test Using Hydraulic Jack(s) Supported on Test Beams

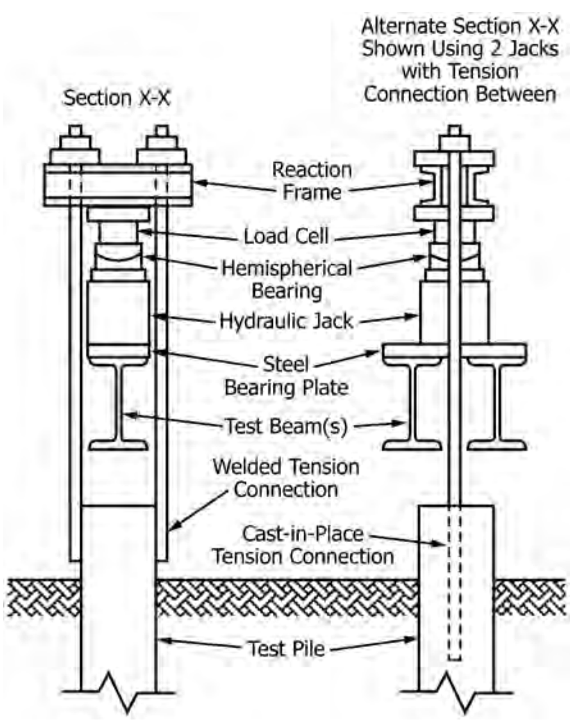

FIG. 3 Typical Section X-X (Fig. 2) of Test Beam(s) at Test Pile

end of the test beam(s) on hydraulic jack(s) centered beneath the beam web(s). Support the jacks on reaction piles or cribbing, using reaction beams as needed to cap multiple reaction piles. Support the other end of the test beam(s) on a steel fulcrum or similar device placed on a steel plate supported on a reaction pile(s) or cribbing, using reaction beams as needed to cap multiple reaction piles. Center a reaction frame over the test beam(s) and anchor it to the tension connections (see 5.4) extending from the test pile or pile group. Place a single load cell and hemispherical bearing between the reaction frame and the test beam(s) (preferred), or alternatively, place a load cell and hemispherical bearing with each jack beneath the test beam(s). If using the latter arrangement, obtain accurate measurements of the plan locations of the jack(s), test pile or pile group, and the fulcrum to determine the magnification factor to apply to the measured loads to determine the resultant tensile load. Design and construct the test beam(s), reaction frame, and reaction piles or cribbing, and arrange the jack(s) symmetrically so as to apply the resultant tensile load at, and parallel to, to the longitudinal axis of the test pile or pile group.

6.6 *Load Applied to Pile by Hydraulic Jack(s) Acting at Top of an A-Frame or a Tripod (*Fig. 7*) (optional)*—Support an A frame or tripod centered over the test pile or pile group on concrete footings, reaction piles, or cribbing, using reaction beams as needed to cap multiple reaction piles. Using tension members, tie together the bottoms or supports of the A frame or tripod legs so as to prevent them from spreading apart under load. Secure the top of an A frame against lateral movement with not less than four guy cables anchored firmly to the ground. Place the hydraulic jack(s), load cell(s), hemispherical bearing(s), and bearing plates on top of the A frame or tripod. Center a reaction frame over the jack(s), and anchor it to the tension connections (see 5.4) extending from the test pile or pile group. Design and construct the A frame or tripod, reaction frame, and footings, reaction piles or cribbing, and arrange the jack(s) symmetrically so as to apply the resultant tensile load at, and parallel to, to the longitudinal axis of the test pile or pile group. Leave adequate clear space beneath the A frame or tripod members to allow for the maximum anticipated upward movement of the test pile or pile cap plus the deflection of the A frame or tripod.

6.7 *Other Types of Loading Apparatus (optional)*—The engineer may specify another type of loading apparatus satisfying the basic requirements of 6.3 – 6.6.

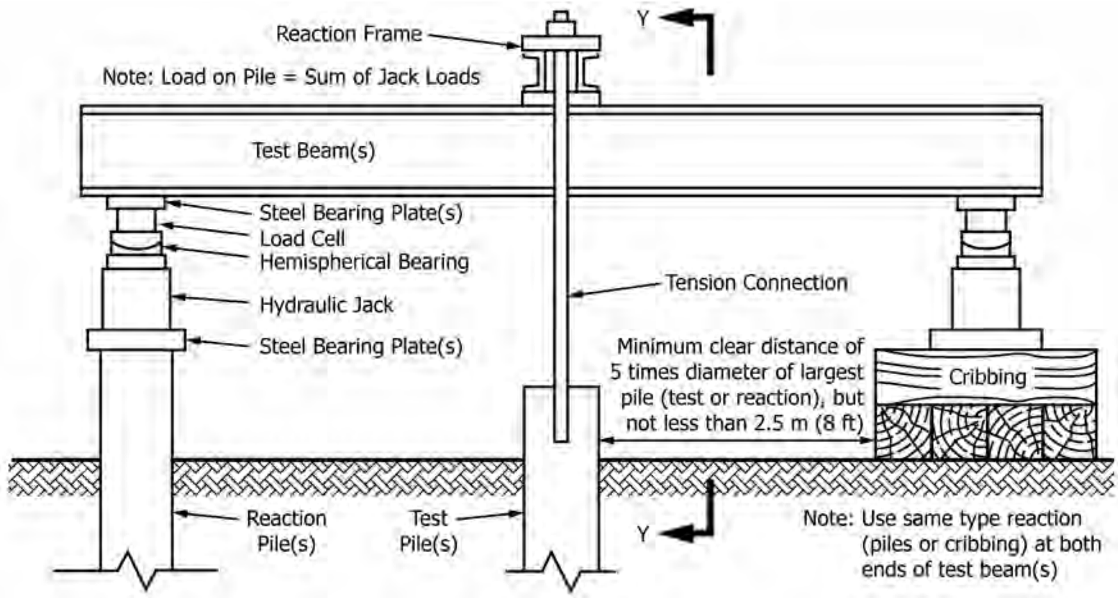

FIG. 4 Typical Setup for Tensile Load Test Using Hydraulic Jacks Acting Upward on Both Ends of Test Beam(s)

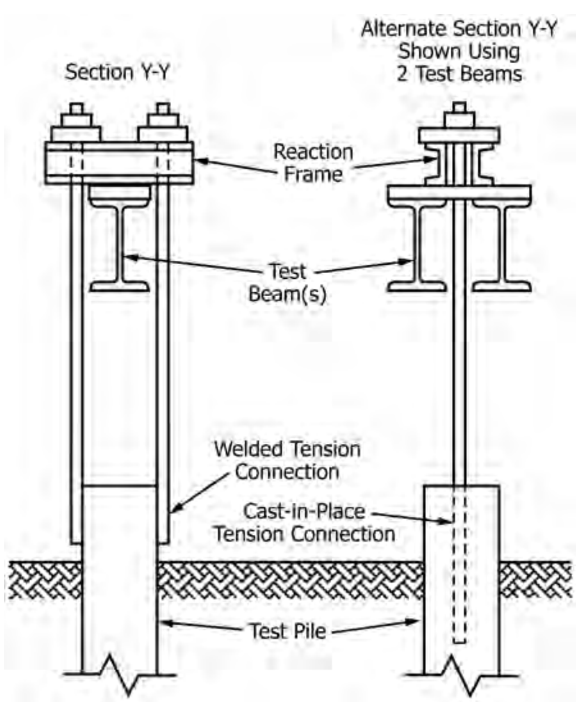

FIG. 5 Typical Section Y-Y (Fig. 4, Fig. 6) of Test Beam(s) at Test Pile

7. Apparatus for Measuring Movement

7.1 *General:*

7.1.1 Reference beams and wirelines shall be supported independent of the loading system, with supports firmly embedded in the ground at a clear distance from the test pile of at least five times the diameter of the test pile(s) but not less than 2.5 m [8 ft], and at a clear distance from any anchor piles of at least five times the diameter of the anchor pile(s) but not less than 2.5 m [8 ft]. Reference supports shall also be located as far as practicable from any cribbing supports but not less than a clear distance of 2.5 m [8 ft].

7.1.2 Reference beams shall have adequate strength, stiffness, and cross bracing to support the test instrumentation and minimize vibrations that may degrade measurement of the pile movement. One end of each beam shall be free to move laterally as the beam length changes with temperature variations. Supports for reference beams and wirelines shall be isolated from moving water and wave action. Provide a tarp or shelter to prevent direct sunlight and precipitation from affecting the measuring and reference systems.

7.1.3 Dial and electronic displacement indicators shall conform to ASME B89.1.10.M and should generally have a travel of 100 mm [4 in.], but shall have a minimum travel of at least 50 mm [2 in.]. Provide greater travel, longer stems, or sufficient calibrated blocks to allow for greater movement if anticipated. Electronic indicators shall have a real-time display of the movement available during the test. Provide a smooth bearing surface for the indicator stem perpendicular to the direction of stem travel, such as a small, lubricated, glass plate glued in place. Except as required in 7.4, indicators shall have minimum graduations of 0.25 mm [0.01 in.] or less, with similar accuracy. Scales used to measure pile movements shall have a length no less than 150 mm [6 in.], minimum graduations of 0.5 mm [0.02 in.] or less, with similar accuracy, and shall be read to the nearest 0.1 mm [0.005 in.]. Survey rods shall have minimum graduations of 1 mm [0.01 ft] or less, with similar accuracy, and shall be read to the nearest 0.1 mm [0.001 ft].

7.1.4 Dial indicators and electronic displacement indicators shall be in good working condition and shall have a full range calibration within three years prior to each test or series of tests. Furnish calibration reports prior to performing a test, including the ambient air temperature during calibration.

7.1.5 Clearly identify each displacement indicator, scale, and reference point used during the test with a reference number or letter.

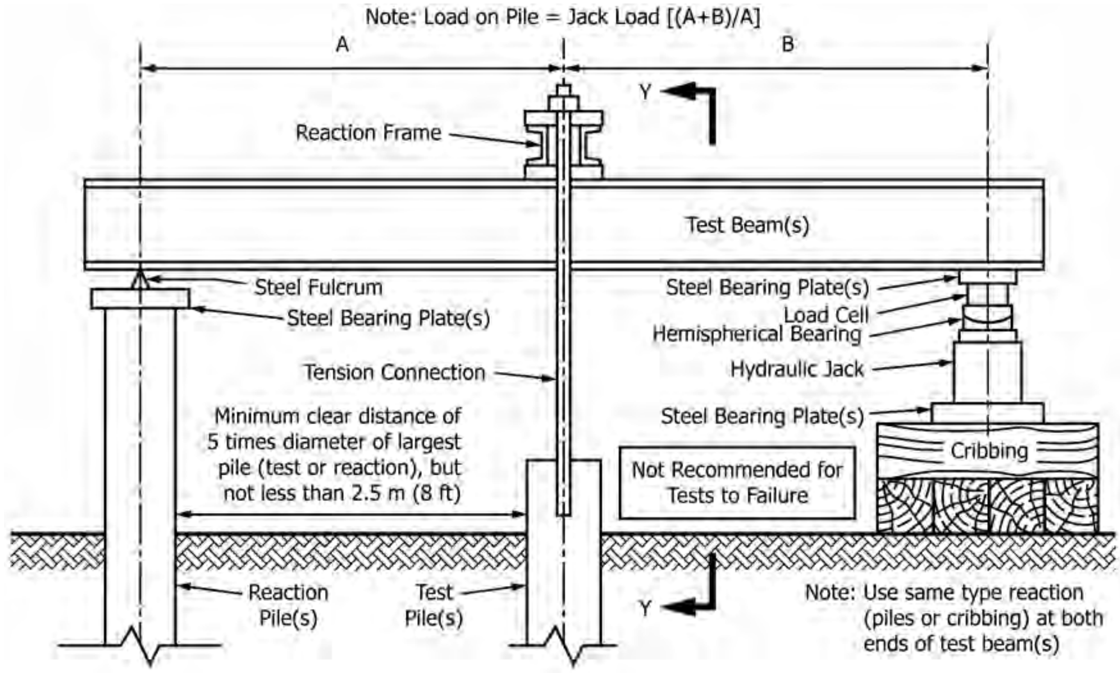

FIG. 6 Typical Setup for Tensile Load Test Using Hydraulic Jack(s) Acting Upward on One End of Test Beam(s)

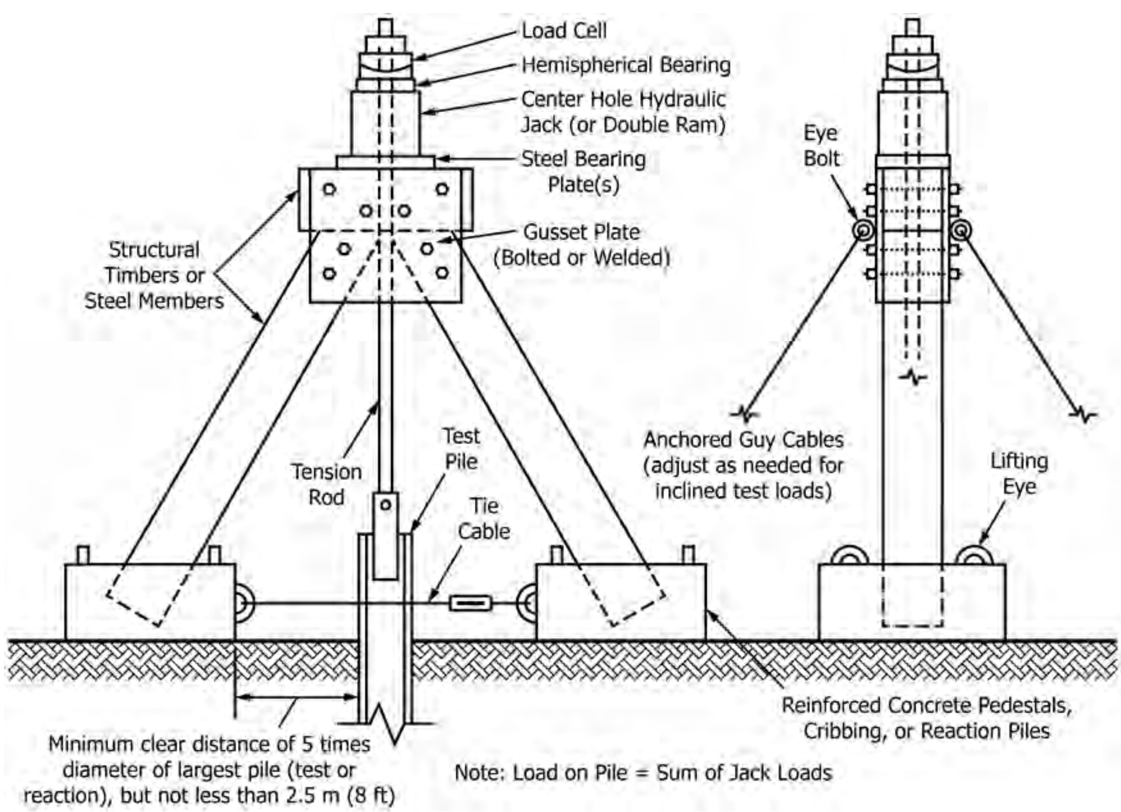

FIG. 7 Typical Setup for Tensile Load Test Using Hydraulic Jack(s) Acting at Top of an A-frame

7.1.6 Indicators, scales, or reference points attached to the test pile, pile cap, reference beam, or other references shall be firmly affixed to prevent movement relative to the test pile or pile cap during the test. Unless otherwise approved by the engineer, verify that reference beam and wireline supports do not move during the test by using a surveyor's level to take readings on a survey rod or a scale with reference to a permanent bench mark located outside of the immediate test area.

7.2 *Pile Top Axial Movements (Fig. 8):*

7.2.1 Unless otherwise specified, all axial tensile load tests shall include apparatus for measuring the axial movement of the test pile top, or piles within a group, or the pile group cap. This apparatus as described herein shall include a primary measurement system and at least one redundant, secondary system.

7.2.2 *Displacement Indicators*—Mount a minimum of two displacement indicators on the reference beams to bear on the pile top at axisymmetric points equidistant from the center of the test pile, or pile cap, with stems parallel to the longitudinal axis of the pile, inclined pile, or pile group. Orient two parallel reference beams, one on each side of the test pile or pile cap, in a direction that permits placing their supports as far as feasible from anchor piles or cribbing. Alternatively, mount the two indicators on axisymmetric points equidistant from the center of the test pile, or pile cap, with the stems parallel to the longitudinal axis of the pile or pile group to bear on the reference beams.

NOTE 5—When possible use displacement indicators as the primary system to obtain the most precise measurements. Use the redundant system(s) to check top movement data and provide continuity when the measuring system is disturbed or reset for additional movement.

NOTE 6—For tests on inclined piles, monitor lateral pile movements as described in 7.3 to detect instability that may result from gravitational forces during the test.

NOTE 7—Use three, or preferably four, displacement indicators to measure and compensate for lateral movement or rotation of the pile top. Locate indicators around the pile perimeter at axisymmetrical points spaced equidistant from the centroid of the test pile.

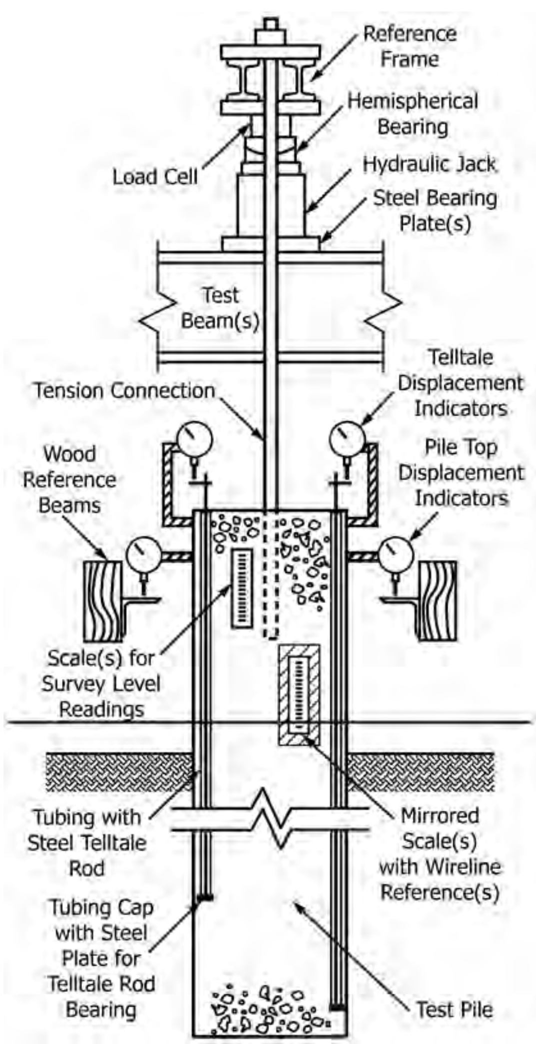

FIG. 8 Schematic of Instrumentation for Measuring Axial Pile Movements

7.2.3 *Wireline, Mirror, and Scale*—Orient two wirelines parallel to each other and perpendicular to and located on opposite sides equidistant from the axis of the test pile, or pile group, in a direction that permits placing the wireline supports as far as practicable from anchor piles or cribbing. The wirelines shall include a weight or spring to maintain a constant tension force in the wire, so that, when plucked or tapped, the wireline will return to its original position. Use clean, uncoated steel wire with a diameter of 0.25 mm [0.01 in.] or less for the wirelines. Each wireline shall pass across, and remain clear of, a scale mounted on the test pile or pile cap parallel to the axis of the pile or pile group. Mount the scale on a mirror affixed to the test pile or pile cap and use the wireline as a reference line to read the scale. Use the mirror to eliminate parallax error in the scale reading by lining up the wire and its image in the mirror. Align the wire not more than 13 mm [0.5 in.] from the face of the scale.

7.2.4 *Surveyor's Level or Laser Beam*— Movement readings obtained using a surveyor's level or laser beam shall be taken on a survey rod or a scale and shall be referenced to a permanent bench mark located outside of the immediate test area or, alternatively, the surveyor's level shall be mounted on an object of fixed elevation (for example a driven pile) outside of the immediate test area. Reference points or scales used in taking displacement readings shall be mounted on the sides of the test pile or pile cap and located on opposite sides except that reference points may be located on top of the pile cap or readings may be taken on a single fixed point in the center of the test pile top, test plate or pile cap.

7.2.5 *Other Types of Measurement Systems (optional)* —The engineer may specify another type of measurement system satisfying the basic requirements of 7.2.

7.3 *Lateral Movements (optional)*—Measure the lateral movements of the top of the test pile or pile group to within an accuracy of 2.5 mm [0.1 in.] using either of the following methods: *(a)* two displacement indicators oriented in orthogonal directions, mounted with their stems perpendicular to the longitudinal axis of the test pile(s) and bearing against lubricated glass plates affixed to the sides of the test pile or pile cap, or *(b)* a surveyor's transit reading from scales mounted laterally on two perpendicular sides of the test pile or pile cap with readings referenced to fixed foresights or backsights. For tests on inclined piles, orient the indicators or scales parallel and perpendicular to the vertical plane of the incline and perpendicular to the longitudinal axis of the test pile(s).

7.4 *Pile Extension and Strain Measurements (optional):*

7.4.1 Measure the extension or strain of the test pile(s) during loading at locations specified by the engineer to help evaluate the distribution of load transfer from the pile to the surrounding soil.

7.4.2 Determine pile extension using displacement indicators to measure the relative movement between the pile top and an unstrained telltale rod (Fig. 8) bearing at a point within the pile. Unless located on the pile axis, install paired telltales in the pile with the rods in each pair oriented symmetrically opposite each other and equidistant from and parallel to the pile axis. Terminate telltale pairs near the pile bottom and at other points along the pile as required. Measure and record the distance from the pile top to the telltale termination point(s) to the nearest 10 mm [0.5 in.]. Install the telltales in a sheath or casing to insure free rod movement during the test. The rods shall have a rounded tip that bears on a clean steel plate affixed to the pile or shall be threaded into a nut affixed to the pile. Clean the telltale rods prior to installation, oil them during or after installation, and provide centralizers to restrain lateral movement but not axial movement at the pile top. The displacement indicators shall have a travel of at least a 5 mm [0.2 in.] and minimum graduations of 0.01 mm [0.0001 in.] or less, with similar accuracy. Mount a smooth bearing surface for the indicator stem on the telltale rod perpendicular to the direction of stem travel, such as a small, lubricated, glass plate clamped or glued in place.

7.4.3 *Other Types of Telltale (optional)*— The engineer may specify another type of telltale for the measurement of pile extension that satisfies the basic requirements of 7.4.2.

7.4.4 Measure pile strain directly using strain gages installed along the length of the pile axis. Install single gages along the pile axis, or gage pairs with the gages in each pair oriented symmetrically opposite each other and equidistant from and parallel to the pile axis. Measure and record the distance from the pile top to the gages to the nearest 10 mm [0.5 in.]. The gage type and installation shall be as specified by the engineer and shall include temperature compensation as recommended by the gage manufacturer. Where feasible, measurement programs involving strain gages should include calibration of the fully instrumented pile and a complete history of gage readings starting before their installation in the pile.

NOTE 8—To interpret strain measurements and estimate pile stresses, the engineer will require a depth profile describing the variation of pile constituents and their strength, cross sectional area, and stiffness. Stiffness properties may vary with the applied stress, especially for grout or concrete. Obtain this information from installation records and separate material property tests as needed.

8. Test Procedures

8.1 *Loading:*

8.1.1 *General:*

8.1.1.1 Apply test loads following one of the procedures described below for each test method, or as modified by the engineer. If feasible, the maximum applied load should reach a failure that reflects the ultimate axial static tensile load capacity of the pile(s). Do not exceed the safe structural capacity of the pile or pile group, or the loading apparatus. Do not leave a loaded pile unattended.

8.1.1.2 To avoid excessive creep and possible structural failure of cast-in-place concrete piles, delay load testing after concrete placement to permit the fresh concrete to gain adequate strength and stiffness. Use test cylinders or cores of the pile concrete to determine the appropriate wait time, recognizing that the test cylinders will generally cure more quickly than concrete in the pile.

8.1.1.3 The static axial capacity of piles typically changes as time elapses after pile installation, possibly increasing (setup) or decreasing (relaxation), depending on the soil or rock properties and the pore water pressure and soil structure disturbance induced by installation. This behavior may affect both driven piles and cast-in-place piles. The engineer may specify a waiting period between pile installation and static testing to investigate time effects. The waiting period may range from 3 to 30 days, or longer, based on testing (for example redriving piles) or prior experience.

8.1.1.4 When temporarily dewatering a test site with piles installed in granular soils, maintain the groundwater level as near to the ground surface as possible and record the groundwater surface elevation during the test. Correct the axial pile capacity for the difference in groundwater level as judged appropriate, but generally only when the difference exceeds 1.5 m [5 ft].

8.1.2 *Procedure A: Quick Test*—Apply the test load in increments of 5 % of the anticipated failure load. Add each load increment in a continuous fashion and immediately following the completion of movement readings for the previous load interval. Add load increments until reaching a failure load, but do not exceed the safe structural capacity of the pile, pile group, or loading apparatus. During each load interval, keep the load constant for a time interval of not less than 4 min and not more than 15 min, using the same time interval for all loading increments throughout the test. Remove the load in five to ten approximately equal decrements, keeping the load constant for a time interval of not less than 4 min and not more than 15 min, using the same time interval for all unloading decrements. Consider longer time intervals for the failure load to assess creep behavior and for the final zero load to assess rebound behavior.

8.1.3 *Procedure B: Maintained Test (optional)*—Unless failure occurs first, load the pile to a maximum maintained load of 200 % of the anticipated design load for tests on individual piles, or 150 % of the pile group design load, applying the load in increments of 25 % of the design load. Maintain each load increment until the rate of axial movement does not exceed 0.25 mm [0.01 in.] per hour, with a minimum time adequate to verify this movement rate based on the accuracy of the movement indicator readings, and with a maximum of 2 h. After applying the maximum load and reaching an overall test duration of at least 12 h, begin unloading when the axial movement measured over a period of 1 h does not exceed 0.25 mm [0.01 in.]; otherwise allow the maximum load to remain on the pile or pile group for 24 h. If failure occurs during loading, maintain the failure load, or the maximum load possible, until the total axial movement equals 15 % of the pile diameter or width. After completing the final load increment, remove the load in decrements of 25 % of the maximum test load with 1 h between decrements.

NOTE 9—If negligible permanent axial movement occurs after unloading the pile, consider reloading the test pile(s) to a greater load or use the procedure in 8.1.4. If the test pile(s) approach failure during the maintained loading procedure, consider decreasing the final load increments to obtain a more accurate failure load.

8.1.4 *Procedure C: Loading in Excess of the Maintained Test (optional)*—After the load has been applied and removed in accordance with 8.1.3, reload the test pile or pile group to the maximum maintained load in increments of 50 % of the pile or pile group design load, allowing 20 min between load increments. Then apply additional load in increments of 10 % of the design load for the pile or pile group until reaching the maximum required load or failure, allowing 20 min between load increments. If failure occurs continue jacking the pile until the settlement equals 15 % of the pile diameter or width. If failure does not occur, hold the full load for 2 h and then remove the load in four equal decrements, allowing 20 min between decrements.

8.1.5 *Procedure D: Constant Time Interval Loading Test (optional)*—Follow the procedures of 8.1.3, but apply the load in increments of 20 % of the pile or group design load with 1 h between load increments. Then unload the pile(s) in decrements of 25 % of the maximum test load with 1 h between decrements.

8.1.6 *Procedure E: Constant Rate of Uplift Test (optional):*

8.1.6.1 The apparatus for applying loads shall have a capacity as specified and shall be in accordance with section 6.3, 6.4, or 6.6. Use a mechanical hydraulic jacking system equipped with a bleed valve, variable speed device, or other means for providing a smooth variable pressure delivery.

8.1.6.2 Vary the applied load as necessary to maintain a pile uplift rate of 0.5 to 1.0 mm [0.02 to 0.04 in.], or as specified by the engineer. Continue loading the pile until achieving continuous uplift at the specified rate. Hold the maximum applied load until obtaining a total pile withdrawal of at least 15 % of the average pile diameter or width, or until the pile withdrawal stops. Gradually release the final load to protect the load and measurement systems.

8.1.6.3 Control the rate of penetration by checking the time taken for successive small equal increments of penetration and then adjusting the jacking accordingly. Alternatively, use a mechanical or electrical device to monitor and control the penetration rate so that it remains constant.

8.1.6.4 See 8.2.3 for measurement procedures. When using a video recording system, locate all gages for easy reading within the camera's field of view, as well as a digital clock displaying time to the nearest second.

8.1.7 *Procedure F: Cyclic Loading Test (optional)*—For the first application of test load increments, apply such increments in accordance with 8.1.3. After the application of loads equal to 50, 100 and 150 % of the pile design load for tests of individual piles or 50 and 100 % of the group design load for tests on pile groups, maintain the total test load in each case for 1 h and remove the load in decrements equal to the loading increments, allowing 20 min between decrements. After removing each maximum applied load, reapply the load to each preceding load level in increments equal to 50 % of the design load, allowing 20 min between increments. Apply additional loads in accordance with 8.1.3. After the maximum required test load has been applied, hold and remove the test load in accordance with 8.1.3.

8.2 *Recording Test Readings:*

8.2.1 *General:*

8.2.1.1 For the required time intervals described below for each test method, record the time, applied load, and movement readings (displacement, and strain if measured) for each properly identified gage, scale, or reference point taken as nearly simultaneously as practicable. The engineer may specify different reading intervals from those given below as needed to satisfy the objectives of a particular test pile program. Obtain additional test readings as specified by the engineer, or as convenient for testing purposes, that is, when using a datalogger to record readings at a constant time interval. Clearly record and explain any field adjustments made to instrumentation or recorded data.

8.2.1.2 Verify the stability of the reference beams and load reaction system (including reaction piles) using a surveyor's level or transit and target rod or scales to determine movement. Record readings taken before applying any test load, at the proposed design load, at the maximum test load, and after the removal of all load. Intermediate readings for each load increment are recommended to provide additional quality assurance and detect potential failure of the load reaction system.

8.2.1.3 When using embedded strain gages to obtain incremental strain measurements as in 7.4, record strain readings just before starting the test and, as a minimum, during the test whenever recording readings of time, load, and movement. The engineer may also require gage readings taken before and after the pile installation to obtain a complete strain history and investigate residual stress behavior.

8.2.2 *Procedure A: Quick Test*—Record test readings taken at 0.5, 1, 2 and 4 min after completing the application of each load increment, and at 8 and 15 min when permitted by longer load intervals. Record test readings taken at 1 and 4 min after completing each load decrement, and at 8 and 15 min when permitted by a longer unload intervals. Record readings taken at 1, 4, 8 and 15 min after all removing all load.

NOTE 10—The movement measured between readings for a given load increment provides an indication of creep behavior.

8.2.3 *Procedure B: Maintained Test (also Procedures C, D, and F) (optional)*—Record test readings taken before and after the application of each load increment or decrement. During each load interval, provided that the test pile or pile group has not failed, record additional readings taken at 2, 4, 8, 15, 45, 60, 80, 100, and 120 min following application of the load increment, and every 60 min thereafter as needed. If pile failure occurs, also record readings taken immediately before removing the first load decrement. During unloading, record readings taken at time intervals of no more than 30 min for each unload interval. Record readings at 1, 2, and 12 h after removing all load.

8.2.4 *Procedure E: Constant Rate of Uplift (optional)*—Record test readings taken at least every 30 s or at sufficient intervals to determine the actual rate of uplift. Operate any automatic monitoring and recording devices continuously during each test. When the test pile has achieved its specified rate of uplift, continue to take and record readings for the duration of the loading, and determine the maximum load applied. Take and record readings during unloading, immediately after unloading, and again 1 h after removing all load.

9. Safety Requirements

9.1 All operations in connection with pile load testing shall be carried out in such a manner so as to minimize, avoid, or eliminate the exposure of people to hazard. The following safety rules are in addition to general safety requirements applicable to construction operations:

9.1.1 Keep all test and adjacent work areas, walkways, platforms, etc. clear of scrap, debris, small tools, and accumulations of snow, ice, mud, grease, oil, or other slippery substances.

9.1.2 Provide timbers, blocking and cribbing materials made of quality material and in good serviceable condition with flat surfaces and without rounded edges.

9.1.3 Hydraulic jacks shall be equipped with hemispherical bearing plates or shall be in complete and firm contact with the bearing surfaces and shall be aligned so as to avoid eccentric loading.

9.1.4 Loads shall not be hoisted, swung, or suspended over anyone and shall be controlled by tag lines.

9.1.5 The test beam(s), reaction frame, reaction piles, anchoring devices, and their connections and supports shall be designed and approved by a qualified engineer and installed to transmit the required loads with an adequate factor of safety.

9.1.6 For tests on inclined piles, all inclined jacks, bearing plates, test beam(s), or frame members shall be firmly fixed into place or adequately blocked to prevent slippage upon release of load.

9.1.7 All reaction components shall be stable and balanced. During testing, movements of the reaction system should be monitored to detect impending unstable conditions.

9.1.8 All test beams, reaction frames, and test apparatus shall be adequately supported at all times.

9.1.9 Only authorized personnel shall be permitted within the immediate test area, and only as necessary to monitor test equipment. As best as possible, locate pumps, load cell readouts, dataloggers, and test monitoring equipment at a safe distance away from jacks, loaded beams, and their supports and connections.

10. Report

10.1 The report of the load test shall include the following information as required by the engineer and as appropriate to the pile type, test apparatus, and test method:

10.1.1 *General:*

10.1.1.1 Project identification and location,

10.1.1.2 Test site location,

10.1.1.3 Owner, structural engineer, geotechnical engineer, pile contractor, boring contractor,

10.1.1.4 Nearest test boring(s) or sounding(s), and their location with reference to test location,

10.1.1.5 In situ and laboratory soil test results, and

10.1.1.6 Horizontal and vertical control datum.

10.1.2 *Pile Installation Equipment:*

10.1.2.1 Make, model, type and size of hammer,

10.1.2.2 Weight of hammer and ram,

10.1.2.3 Stroke or ram,

10.1.2.4 Rated energy of hammer,

10.1.2.5 Rated capacity of boiler or compressor,

10.1.2.6 Type and dimensions of capblock and pile cushion,

10.1.2.7 Weight and dimensions of drive cap and follower,

10.1.2.8 Size of predrilling or jetting equipment,

10.1.2.9 Weight of clamp, follower, adaptor, and oscillator for vibratory driver,

10.1.2.10 Type, size, length, and weight of mandrel,

10.1.2.11 Type, size, and length of auger,

10.1.2.12 Type and size of grout pump,

10.1.2.13 Type, size, wall thickness, and length of drive casing,

10.1.2.14 Detailed description of drilling equipment and techniques, and

10.1.2.15 Size, type, length, and installation or extraction (or both) method of casings.

10.1.3 *Test and Anchor Pile Details:*

10.1.3.1 Identification and location of test and anchor piles,

10.1.3.2 Design load of test pile or pile group,

10.1.3.3 Type and dimensions of test and anchor piles,

10.1.3.4 Test pile material including basic specifications,

10.1.3.5 Pile quality including knots, splits, checks and shakes, and straightness of piles, reservative treatment and conditioning process used for timber test piles including inspection certificates,

10.1.3.6 Wall thickness of pipe test pile,

10.1.3.7 Weight per foot of H test pile,

10.1.3.8 Description of test pile tip reinforcement or protection,

10.1.3.9 Description of banding-timber piles,

10.1.3.10 Description of special coatings used,

10.1.3.11 Test pile (mandrel) weight as driven,

10.1.3.12 Date precast test piles made,

10.1.3.13 Details of concrete design, grout mix design, or both.

10.1.3.14 Concrete or grout, or both, placement techniques and records,

10.1.3.15 Concrete and/or grout sample strengths and date of strength test,

10.1.3.16 Description of internal reinforcement used in test pile (size, length, number longitudinal bars, arrangement, spiral, or tie steel),

10.1.3.17 Condition of precast piles including spalled areas, cracks, top surface, and straightness of piles,

10.1.3.18 Effective prestress,

10.1.3.19 Degree of inclination for each pile,

10.1.3.20 Length of test pile during driving,

10.1.3.21 Final pile top and bottom elevations, and ground elevation referenced to a datum,

10.1.3.22 Embedded length-test and anchor piles, 10.1.3.23 Tested length of test pile, and

10.1.3.24 Final elevation of test pile butt(s) referenced to fixed datum.

10.1.4 *Test and Anchor Pile Installation:*

10.1.4.1 Date installed,

10.1.4.2 Volume of concrete or grout placed in pile,

10.1.4.3 Grout pressure used,

10.1.4.4 Description of pre-excavation or jetting (depth, size, pressure, duration),

10.1.4.5 Operating pressure for double-acting and differential type hammers,

10.1.4.6 Throttle setting—diesel hammer (at final driving),

10.1.4.7 Fuel type—diesel hammer,

10.1.4.8 Horsepower delivered and frequency of vibratory driver during final 3 m [10 ft] of pile penetration,

10.1.4.9 Description of special installation procedures used such as piles cased off,

10.1.4.10 Type and location of pile splices,

10.1.4.11 Driving or drilling records,

10.1.4.12 Final penetration resistance (blows per centimetre [blows per inch]),

10.1.4.13 Rate of pile penetration in m/s [ft/s] for last 3 m [10 ft], vibratory driving,

10.1.4.14 When capblock replaced (indicate on log),

10.1.4.15 When pile cushion replaced (indicate on log),

10.1.4.16 Cause and duration of interruptions in pile installation, and

10.1.4.17 Notation of any unusual occurrences during installation.

10.1.5 *Pile Testing:*

10.1.5.1 Date and type of test,

10.1.5.2 Temperature and weather conditions during tests,

10.1.5.3 Number of piles in group test,

10.1.5.4 Brief description of load application apparatus, including jack capacity,

10.1.5.5 Description of instrumentation used to measure pile movement including location of indicators, scales, and other reference points with respect to pile top,

10.1.5.6 Description of special instrumentation such as strain rods or strain gages including location of such with reference to pile top,

10.1.5.7 Special testing procedures used,

10.1.5.8 Tabulation of all time, load, and movement readings,

10.1.5.9 Identification and location sketch of all indicators, scales, and reference points,

10.1.5.10 Description and explanation of adjustments made to instrumentation or field data, or both,

10.1.5.11 Notation of any unusual occurrences during testing,

10.1.5.12 Test jack and other required calibration reports,

10.1.5.13 Groundwater level, and

10.1.5.14 Suitable photographs showing the test instrumentation and set-up.

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of these test methods. It is either not feasible or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site. Each test pile is unique due to the variable nature of the ground in which it is embedded. Furthermore, retesting a particular pile commonly results in different data from the initial testing due to plastic movement of the ground in which the pile is embedded.

11.1.1 The Subcommittee D18.11 is seeking any data from the users of these test methods that might be used to make a limited statement on precision.

11.2 *Bias*—There is no accepted reference value for these test methods, therefore, bias cannot be determined.

12. Keywords

12.1 axial static tensile pile capacity; field testing; jack; load cell; loading procedure; reference beam

APPENDIX

(Nonmandatory Information)

X1. SOME FACTORS INFLUENCING INTERPRETATION OF TEST RESULTS

X1.1 Potential residual loads in the pile which could influence the interpreted distribution of load at the pile tip and along the pile shaft.

X1.2 Possible interaction of friction loads from test pile with downward friction transferred to the soil from reaction piles or cribbing obtaining part or all of their support in soil at levels above the tip level of the test pile.

X1.3 Changes in pore water pressure in the soil caused by pile driving, construction fill, and other construction operations which may influence the test results for frictional support in relatively impervious soils such as clay and silt.

X1.4 Differences between conditions at time of testing and after final construction such as changes in grade or groundwater level.

X1.5 Loss or gain of test pile soil resistance due to changes in the soil stress distribution around the test pile(s) such as excavation, scour, fill, etc.

X1.6 Possible differences in the performance of a pile in a group or of a pile group from that of a single isolated pile.

X1.7 Affect on long-term pile performance of factors such as creep, environmental effects on pile material, negative friction loads, swelling soils, and strength losses.

X1.8 Type of structure to be supported, including sensitivity of structure to movement and relation between live and dead loads.

X1.9 Special testing procedures which may be required for the application of certain acceptance criteria or methods of interpretation.

X1.10 Requirement that non tested pile(s) have essentially identical conditions to those for tested pile(s) including, but not limited to, subsurface conditions, pile type, length, size and stiffness, and pile installation methods and equipment so that application or extrapolation of the test results to such other piles is valid.

APPENDIX M: ASTM D3966

Designation: D3966/D3966M – 07 (Reapproved 2013)$^{\varepsilon 1}$

Standard Test Methods for Deep Foundations Under Lateral Load[1]

This standard is issued under the fixed designation D3966/D3966M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε^1 NOTE—Designation was editorially corrected to match units information in June 2013.

1. Scope

1.1 The test methods described in this standard measure the lateral deflection of a vertical or inclined deep foundation when subjected to lateral loading. These methods apply to all deep foundations, referred to herein as "pile(s)," that function in a manner similar to driven piles or cast in place piles, regardless of their method of installation, and may be used for testing single piles or pile groups. The test results may not represent the long-term performance of a deep foundation.

1.2 These test methods provide minimum requirements for testing deep foundations under lateral load. Plans, specifications, provisions, or combinations thereof prepared by a qualified engineer may provide additional requirements and procedures as needed to satisfy the objectives of a particular test program. The engineer in responsible charge of the foundation design, referred to herein as the engineer, shall approve any deviations, deletions, or additions to the requirements of these test methods.

1.3 These test methods allow the following test procedures:

Procedure	Test	Section
A	Standard Loading	8.1.2
B	Excess Loading (Optional)	8.1.3
C	Cyclic Loading (Optional)	8.1.4
D	Surge Loading (Optional)	8.1.5
E	Reverse Loading (Optional)	8.1.6
F	Reciprocal Loading (Optional)	8.1.7
G	Specified Lateral Movement (Optional)	8.1.8
H	Combined Loading (Optional)	8.1.9

1.4 Apparatus and procedures herein designated "optional" may produce different test results and may be used only when approved by the engineer. The word "shall" indicates a mandatory provision, and the word "should" indicates a recommended or advisory provision. Imperative sentences indicate mandatory provisions.

1.5 A qualified geotechnical engineer should interpret the test results obtained from the procedures of these test methods so as to predict the actual performance and adequacy of piles used in the constructed foundation. See Appendix X1 for comments regarding some of the factors influencing the interpretation of test results.

1.6 A qualified engineer shall design and approve all loading apparatus, loaded members, support frames, and test procedures. The text of these test methods references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the test methods. These test methods also include illustrations and appendices intended only for explanatory or advisory use.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.8 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound [lbf] represents a unit of force [weight], while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic [F=ma] calculations are involved.

1.9 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.10 The method used to specify how data are collected, calculated, or recorded in these test methods is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.11 ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.11 on Deep Foundations.

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patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

1.12 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1143 Test Method for Piles Under Static Axial Compressive Load (Withdrawn 2005)[3]

D3689 Test Methods for Deep Foundations Under Static Axial Tensile Load

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D5882 Test Method for Low Strain Impact Integrity Testing of Deep Foundations

D6026 Practice for Using Significant Digits in Geotechnical Data

D6760 Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing

2.2 *American Society of Mechanical Engineer Standards:*[4]

ASME B30.1 Jacks

ASME B40.100 Pressure Gauges and Gauge Attachments

ASME B46.1 Surface Texture

ASME B89.1.10.M Dial Indicators (For Linear Measurements)

3. Terminology

3.1 *Definitions*—For common definitions of terms used in this standard, see Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cast in-place pile, n*—a deep foundation unit made of cement grout or concrete and constructed in its final location, for example, drilled shafts, bored piles, caissons, auger cast piles, pressure-injected footings, etc.

3.2.2 *deep foundation, n*—a relatively slender structural element that transmits some or all of the load it supports to soil or rock well below the ground surface, such as a steel pipe pile or concrete drilled shaft.

3.2.3 *driven pile, n*—a deep foundation unit made of preformed material with a predetermined shape and size and typically installed by impact hammering, vibrating, or pushing.

3.2.4 *failure load, n—for the purpose of terminating a lateral load test*, the test load at which continuing, progressive movement occurs, or as specified by the engineer.

3.2.5 *wireline, n*—a steel wire mounted with a constant tension force between two supports and used as a reference line to read a scale indicating movement of the test pile.

4. Significance and Use

4.1 Field tests provide the most reliable relationship between the lateral load applied to a deep foundation and the resulting lateral movement. Test results may also provide information used to assess the distribution of lateral resistance along the pile shaft and the long-term load-deflection behavior. A foundation designer may evaluate the test results to determine if, after applying an appropriate factor of safety, the pile or pile group has an ultimate lateral capacity and a deflection at service load satisfactory to satisfy specific foundation requirements. When performed as part of a multiple-pile test program, the designer may also use the results to assess the viability of different piling types and the variability of the test site.

4.2 The analysis of lateral test results obtained using proper instrumentation helps the foundation designer characterize the variation of pile-soil interaction properties, such as the coefficient of horizontal subgrade reaction, to estimate bending stresses and lateral deflection over the length of the pile for use in the structural design of the pile.

4.3 If feasible, without exceeding the safe structural load on the pile(s) or pile cap, the maximum load applied should reach a failure load from which the engineer may determine the ultimate lateral load capacity of the pile(s). Tests that achieve a failure load may help the designer improve the efficiency of the foundation by reducing the piling length, quantity, or size.

4.4 If deemed impractical to apply lateral test loads to an inclined pile, the engineer may elect to use lateral test results from a nearby vertical pile to evaluate the lateral capacity of the inclined pile.

NOTE 1—The quality of the result produced by this test method is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this test method are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

5. Test Foundation Preparation

5.1 Excavate or fill the test area to the final grade elevation within a radius of 6 m [20 ft] from the test pile or group using the same material and backfilling methods as for production piles. Cut off or build up the test pile(s) as necessary to permit construction of the load-application apparatus, placement of the necessary testing and instrumentation equipment, and

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

observation of the instrumentation. Remove any damaged or unsound material from the pile top as necessary to properly install the apparatus for measuring movement, for applying load, and for measuring load.

5.2 For tests of single piles, install solid steel test plate(s) at least 50 mm [2 in.] thick against the side of the pile at the point(s) of load application and perpendicular to the line of the load action. The test plate shall have side dimensions not more than, and not less than one half of, the diameter or side dimension of the test pile(s). The test plate(s) shall span across and between any unbraced flanges on the test pile.

5.3 For tests on pile groups, cap the pile group with steel-reinforced concrete or a steel load frame designed and constructed to safely sustain and equally distribute the anticipated loads. The connection between the piles and the cap shall simulate in-service conditions. Pile caps shall be cast above grade unless otherwise specified and may be formed on the ground surface.

5.4 For each loading point on a pile cap, provide a solid steel test plate oriented perpendicular to the axis of the pile group with a minimum thickness of 50 mm [2 in.], as needed to safely apply load to the pile cap. Center a single test plate on the centroid of the pile group. Locate multiple test plates symmetrically about the centroid of the pile group.

5.5 To minimize stress concentrations due to minor irregularities of the pile surface, set test plates bearing on precast or cast-in-place concrete piles in a thin layer of quick-setting, non-shrink grout, less than 6 mm [0.25 in.] thick and having a compressive strength greater than the test pile at the time of the test. Set test plates designed to bear on a concrete pile cap in a thin layer of quick-setting, non-shrink grout, less than 6 mm [0.25 in.] thick and having a compressive strength greater than the pile cap at the time of the test. For tests on steel piles, or a steel load frame, weld the test plates to the pile or load frame. For test piles without a flat side of adequate width to mount the test plate, cap the head of the pile to provide a bearing surface for the test plate or set the test plate in high-strength grout. In all cases, provide full bearing for the test plate against the projected area of the pile.

5.6 *Elimination of Pile Cap Friction (Optional)*—Provide a clear space beneath the pile cap as specified by the engineer. This option isolates the lateral response of the piles from that of the pile cap.

5.7 *Passive Soil Pressure Against Pile Cap (Optional)*—Develop passive soil pressure against the pile cap by constructing the pile cap below the ground surface and backfilling with compacted fill on the side opposite the point of load application, or by constructing the pile cap above the ground surface against an embankment. If specified, place compacted against the sides of the pile cap to the extent practicable.

NOTE 2—Deep foundations sometimes include hidden defects that may go unnoticed prior to static testing. Low strain integrity tests as described in Test Method D5882 and ultrasonic crosshole integrity tests as described in Test Method D6760 may provide a useful pre-test evaluation of the test foundation.

6. Apparatus for Applying and Measuring Loads

6.1 *General:*

6.1.1 The apparatus for applying tensile loads to a test pile or pile group shall conform to one of the methods described in 6.3-6.6. Unless otherwise specified, construct the test apparatus so that the resultant loads are applied horizontally, at approximately pile cut-off elevation, and in line with the central vertical axis of the pile or pile group so as to minimize eccentric loading and avoid a vertical load component.

NOTE 3—For lateral tests on inclined pile frames or pile groups involving inclined piles, consider applying the lateral test loads at the actual or theoretical point of intersection of the longitudinal axis of the piles in the frame or group.

6.1.2 *Struts and Blocking*—Struts shall be of steel and of sufficient size and stiffness to transmit the applied test loads without bending or buckling. Blocking used between reaction piles or between the hydraulic jack and the reaction system shall be of sufficient size and strength to prevent crushing or other distortion under the applied test loads.

6.1.3 Reaction piles, if used, shall be of sufficient number and installed so as to safely provide adequate reaction capacity without excessive movement. When using two or more reaction piles at each end of the test beam(s), cap or block them as needed to develop the reaction load. Locate reaction piles so that resultant test beam load supported by them acts at the center of the reaction pile group. Cribbing or deadmen, if used as a reaction, shall be of sufficient plan dimensions and weight to transfer the reaction loads to the soil without excessive lateral movement that would prevent maintaining the applied loads.

6.1.4 Provide a clear distance between the test pile(s) and the reaction piles or cribbing of at least five times the maximum diameter of the largest test or reaction pile(s), but not less than 2.5 m [8 ft]. The engineer may increase or decrease this minimum clear distance based on factors such as the type and depth of reaction, soil conditions, and magnitude of loads so that reaction forces do not significantly effect the test results.

NOTE 4—Excessive vibrations during reaction pile installation in non cohesive soils may affect test results. Reaction piles that penetrate deeper than the test pile may affect test results. Install the anchor piles nearest the test pile first to help reduce installation effects.

6.1.5 Each jack shall include a lubricated hemispherical bearing or similar device to minimize lateral loading of the pile or pile group. The hemispherical bearing(s) should include a locking mechanism for safe handling and setup.

6.1.6 Provide bearing stiffeners as needed between the flanges of test and reaction beams.

6.1.7 Provide steel bearing plates to spread the load to and between the jack(s), load cell(s), hemispherical bearing(s), test beam(s), reaction beam(s), and reaction pile(s). Unless otherwise specified by the engineer, the size of the bearing plates shall be not less than the outer perimeter of the jack(s), load cell(s), or hemispherical bearing(s), nor less than the total width of the test beam(s), reaction beam(s), reaction piles so as to provide full bearing and distribution of the load. Bearing plates supporting the jack(s), test beam(s), or reaction beams on timber or concrete cribbing shall have an area adequate for safe bearing on the cribbing.

6.1.8 Unless otherwise specified, where using steel bearing plates, provide a total plate thickness adequate to spread the bearing load between the outer perimeters of loaded surfaces at a maximum angle of 45 degrees to the loaded axis. For center hole jacks and center hole load cells, also provide steel plates adequate to spread the load from their inner diameter to the their central axis at a maximum angle of 45 degrees, or per manufacturer recommendations.

6.1.9 Align all struts, blocking, bearing plates, jacks, load cells, hemispherical bearings, and testing apparatus to minimize eccentric loading, and, where necessary, restrain them from shifting as test loads are applied so as not to affect the test results and to prevent instability. Test members and apparatus shall have flat, parallel bearing surfaces. Design and construct the support reactions to prevent instability and to limit undesired rotations or lateral displacements.

6.1.10 Unless otherwise specified by the engineer, design and construct the apparatus for applying and measuring loads, including all struts and structural members, of steel with sufficient size, strength, and stiffness to safely prevent excessive deflection and instability up to 125 % of the maximum anticipated test load.

6.1.11 Inspect all tension rods, lines, rope, cable, and their connections used for pull tests to insure good, serviceable condition. Unless otherwise specified by the engineer, design and construct these tension members with sufficient strength to safely resist a load at least 50 % greater than the maximum anticipated test load. Tension members with a cross-sectional area reduced by corrosion or damage, or with material properties compromised by fatigue, bending, or excessive heat, may rupture suddenly under load. Do not use brittle materials for tension connections.

6.1.12 A qualified engineer shall design and approve all loading apparatus, loaded members, support frames, and loading procedures.

6.2 *Hydraulic Jacks, Gauges, Transducers, and Load Cells:*

6.2.1 The hydraulic jack(s) and their operation shall conform to ASME B30.1 and shall have a nominal load capacity exceeding the maximum anticipated jack load by at least 20 %. The jack, pump, and any hoses, pipes, fittings, gauges, or transducers used to pressurize it shall be rated to a safe pressure corresponding to the nominal jack capacity.

6.2.2 The hydraulic jack ram(s) shall have a travel greater than the sum of the anticipated maximum axial movement of the pile plus the deflection of the test beam and the elongation of the tension connection, but not less than 15 % of the average pile diameter or width. Use a single high capacity jack when possible. When using a multiple jack system, provide jacks of the same make, model, and capacity, and supply the jack pressure through a common manifold with a master pressure gauge. Fit the manifold and each jack with a pressure gauge to detect malfunctions and imbalances.

6.2.3 Unless otherwise specified, the hydraulic jack(s), pressure gauge(s), and pressure transducer(s) shall have a calibration to at least the maximum anticipated jack load, over their complete range of piston travel for increasing and decreasing applied loads and performed within the six months prior to each test or series of tests. Hydraulic jacks used in double-action shall be calibrated in both the push and pull modes. Furnish the calibration report(s) prior to performing a test, which shall include the ambient temperature and calibrations performed for multiple ram strokes up to the maximum stroke of the jack.

6.2.4 If the lateral load is applied by pulling, the apparatus used to produce the pulling force shall be capable of applying a steady constant force over the required load testing range. The dynamometer(s), or other in-line load indicating device(s), shall be calibrated to an accuracy within 10 % of the applied load.

6.2.5 Each complete jacking and pressure measurement system, including the hydraulic pump, should be calibrated as a unit when practicable. The hydraulic jack(s) shall be calibrated over the complete range of ram travel for increasing and decreasing applied loads. If two or more jacks are to be used to apply the test load, they shall be of the same make, model, and size, connected to a common manifold and pressure gauge, and operated by a single hydraulic pump. The calibrated jacking system(s) shall have accuracy within 5 % of the maximum applied load. When not feasible to calibrate a jacking system as a unit, calibrate the jack, pressure gauges, and pressure transducers separately, and each of these components shall have accuracy within 2 % of the applied load.

6.2.6 Pressure gauges shall have minimum graduations less than or equal to 1 % of the maximum applied load and shall conform to ASME B40.100 with an accuracy grade 1A having a permissible error ±1 % of the span. Pressure transducers shall have a minimum resolution less than or equal to 1 % of the maximum applied load and shall conform to ASME B40.100 with an accuracy grade 1A having a permissible error ±1 % of the span. When used for control of the test, pressure transducers shall include a real-time display.

6.2.7 If the maximum test load will exceed 900 kN [100 tons], place a properly constructed load cell or equivalent device in series with each hydraulic jack or pulling apparatus. Unless otherwise specified the load cell(s) shall have a calibration to at least the maximum anticipated jack load performed within the six months prior to each test or series of tests. The calibrated load cell(s) or equivalent device(s) shall have accuracy within 1 % of the applied load, including an eccentric loading of up to 1 % applied at an eccentric distance of 25 mm [1 in.]. After calibration, load cells shall not be subjected to impact loads. A load cell is recommended, but not required, for lesser load. If not practicable to use a load cell when required, include embedded strain gauges located in close proximity to the jack to confirm the applied load.

6.2.8 Do not leave the hydraulic jack pump unattended at any time during the test. An automatic regulator is recommended to help hold the load constant as pile movement occurs. Automated jacking systems shall include a clearly marked mechanical override to safely reduce hydraulic pressure in an emergency.

6.3 *Load Applied by Hydraulic Jack(s) Acting Against a Reaction System (Fig. 1):*

6.3.1 *General*—Apply the test loads to the pile or pile group using one or more hydraulic cylinders and a suitable reaction system according to 6.3.2, 6.3.3, 6.3.4, or 6.3.5. The reaction

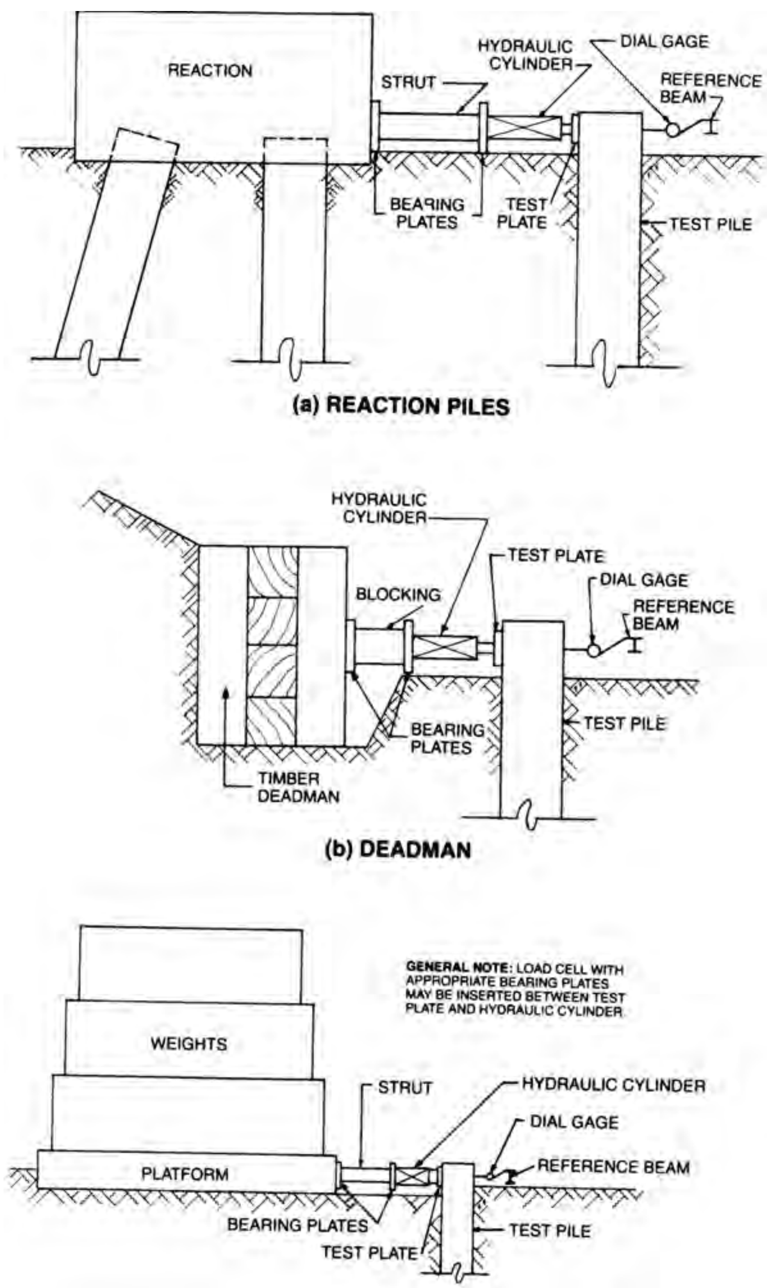


FIG. 1 Typical Set-ups for Applying Lateral Load with Conventional Hydraulic Jack

system may be any convenient distance from the test pile or pile group and shall provide a resistance greater than the anticipated maximum lateral test load. Set the hydraulic cylinder(s) (with load cell(s) if used) against the test plate(s) at the point(s) of load application in a horizontal position and on the line(s) of load application. Place a steel strut(s) or suitable blocking between the base(s) of the cylinder(s) and the reaction system with steel bearing plates between the strut(s) or blocking and the cylinder(s) and between the strut(s) and the reaction system. If a steel strut(s) is used, place it horizontally and on the line(s) of load application and brace the strut(s) to ensure it does not shift during load application. If two hydraulic jacks are used, place the jacks, load cells (if used), and struts or blocking at the same level and equidistant from a line parallel to the lines of load application and passing through the center of the test group. Support the jack(s), bearing plate(s), strut(s), and blocking on cribbing if necessary for stability.

6.3.2 *Reaction Piles (*Fig. 1*a)*—Install two or more reaction piles vertically or on an incline (or a combination of vertical and incline) so as to provide the necessary reactive capacity for the maximum anticipated lateral test loads. Cap the reaction piles with reinforced concrete, steel, or timber, or brace between the piles, or fasten the tops of the piles together so as to develop the lateral resistance of the entire group. Install any inclined reaction piles in a direction away from the test pile or group (see Fig. 1*a*).

6.3.3 *Deadman (*Fig. 1*b)*—Where soil or site conditions are suitable, install a deadman consisting of cribbing, timber panels, sheeting, or similar construction bearing against an embankment or the sides of an excavation so as to provide the necessary reactive capacity to the maximum anticipated lateral test loads.

6.3.4 *Weighted Platforms (*Fig. 1*c)*—Construct a platform of any suitable material such as timber, concrete, or steel, and load the platform with sufficient weights to provide the necessary resistance to the maximum anticipated lateral test loads to be applied. Provide a suitable bearing surface on the edge of the platform against which the reactive lateral load will be applied.

6.3.5 *Other Reaction Systems (Optional)*—Use any other specified suitable reaction system such as an existing structure.

6.4 *Load Applied by Hydraulic Jack(s) Acting Between Two Test Piles or Test Pile Groups (*Fig. 2*)*—Test the lateral capacity of two single piles or two similar pile groups simultaneously by applying either a compressive or tensile force between the pile or pile groups with a hydraulic jack(s). Test piles or test groups may be any convenient distance apart. If necessary, insert a steel strut(s) between the hydraulic jack(s) and one of the test piles or groups. Remove all temporary blocking and cribbing underneath plates, strut(s), and cylinder(s) (and load cell(s) if used), after the first load increment has been applied and do not brace any strut(s).

6.5 *Load Applied by Pulling (Optional):*

6.5.1 *General*—Apply the lateral load by pulling test pile or group using a suitable power source such as a hydraulic jack, turnbuckle or winch connected to the test pile or group with a suitable tension member such as a wire rope or a steel rod and connected to an adequate reaction system or anchorage. Securely fasten the tension member to the test pile or pile cap so that the line of load application passes through the vertical central axis of the test pile or group. If two tension members are used, fasten them to the test pile or pile cap at points equidistant from a line parallel to the lines of load application and passing through the vertical central axis of the test pile or group.

6.5.2 *Anchorage System*—Maintain a clear distance of not less than 6 m [20 ft] or 20 pile diameters between the test pile or group and the reaction or anchorage system complying with 6.3, or as otherwise specified by the engineer. Furnish an anchorage system sufficient to resist without significant movement the reaction to the maximum lateral load to be applied to the test pile or group.

6.5.3 *Pulling Load Applied by Hydraulic Jack Acting against a Reaction System (*Fig. 3*)*—Apply the lateral tensile load to the test pile or pile group using any suitable hydraulic cylinder such as conventional type, push-pull type, or center-hole type. Center the conventional hydraulic cylinder (and load cell if used) on the line of load application with its base bearing against a suitable reaction system and its piston acting against a suitable yoke attached by means of two parallel tension members to the test pile or pile group (see Fig. 3*a*). Where required to adequately transmit the jacking load, install steel bearing plates. If a double-acting hydraulic jack is used (Fig. 3*b*), place the jack cylinder on the line of load application connecting the cylinder's casing to the anchorage system and the jack piston to a suitable strut or steel rod adequately secured to the test pile or pile group. The steel strut or rod may be supported at intermediate points provided such supports do not restrain the strut or rod from moving in the direction of load application. If a center-hole jack is used (Fig. 3*c*), center the jack cylinder (and load cell if used) along the line of load application with its base bearing against a suitable reaction and with its piston acting against a suitable clamp or nut attached to a steel rod or cable fastened securely to the test pile or group. Provide a hole through the reaction system for the tension member. If necessary to transmit the jacking forces, insert a steel bearing plate between the reaction and the jack base.

6.5.4 *Pulling Load Applied by Other Power Source Acting against an Anchorage System (*Fig. 4*)*—Apply the lateral tensile load with a winch or other suitable device. Insert a dynamometer or other load indicating device in the pulling line between the power source and the test pile or group (see Fig. 4*a*). If a multiple part line is used, insert the dynamometer or equivalent device in the line connecting the pulling blocks with either the test pile (or group) or the anchorage system. (See Fig. 4*b*).

6.6 *Fixed-Head Test (Optional):*

6.6.1 *Individual Pile (*Fig. 5*)*—Install the test pile so that it extends a sufficient distance above the adjacent ground surface to accommodate the steel frames but not less than 2 m [6.5 ft]. Firmly attach by clamping, welding, or some other means, a right angle (approximately 30–60–90) frame to each side of that portion of the pile extending above ground surface. Design and construct the frame so as to prevent the top of the pile from rotating under the maximum lateral load to be applied. Support the ends of the frames on steel rollers acting between steel bearing plates with the bottom bearing plate supported on a

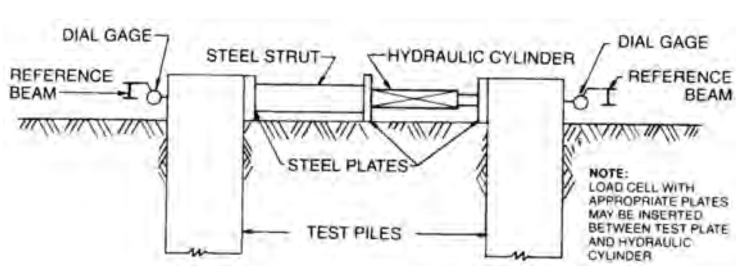


FIG. 2 Typical Arrangement for Testing Two Piles Simultaneously

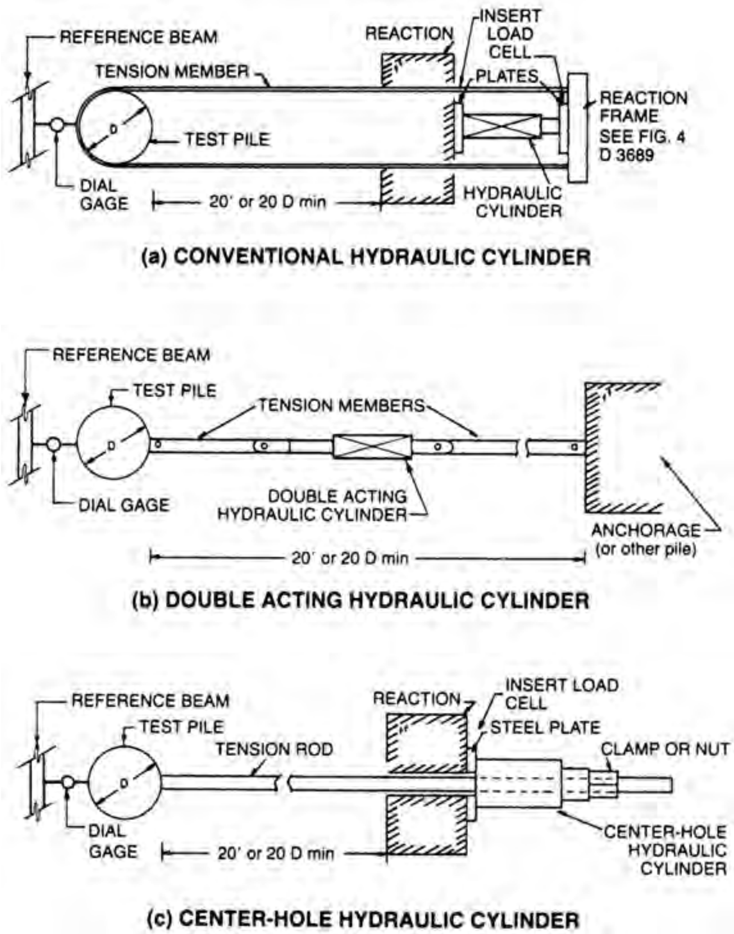


FIG. 3 Typical Arrangements for Applying Pulling Loads with Hydraulic Jack (Top Views)

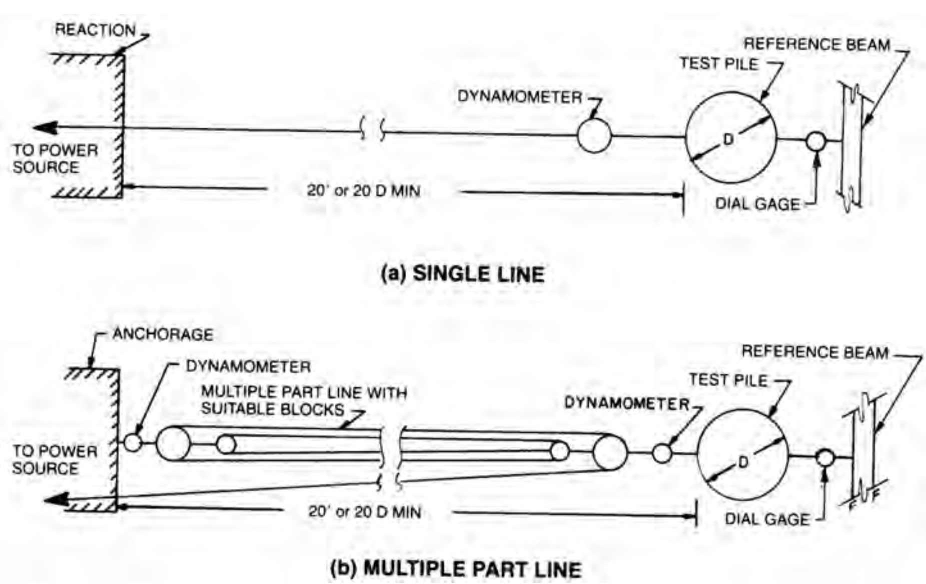


FIG. 4 Typical Arrangements for Applying Lateral Loads with Power Source such as Winch (Top Views)

pile(s) or cribbing with sufficient bearing capacity to prevent any significant vertical deflections of the ends of the frame. Maintain a clear distance of not less than 3 m [10 ft] between the test pile and support for the ends of the frames. The steel bearing plate shall be of sufficient size to accommodate the ends of the frames and the steel rollers including the maximum anticipated lateral travel. Steel rollers shall be solid and shall be of sufficient number and diameter (but not less than 50 mm

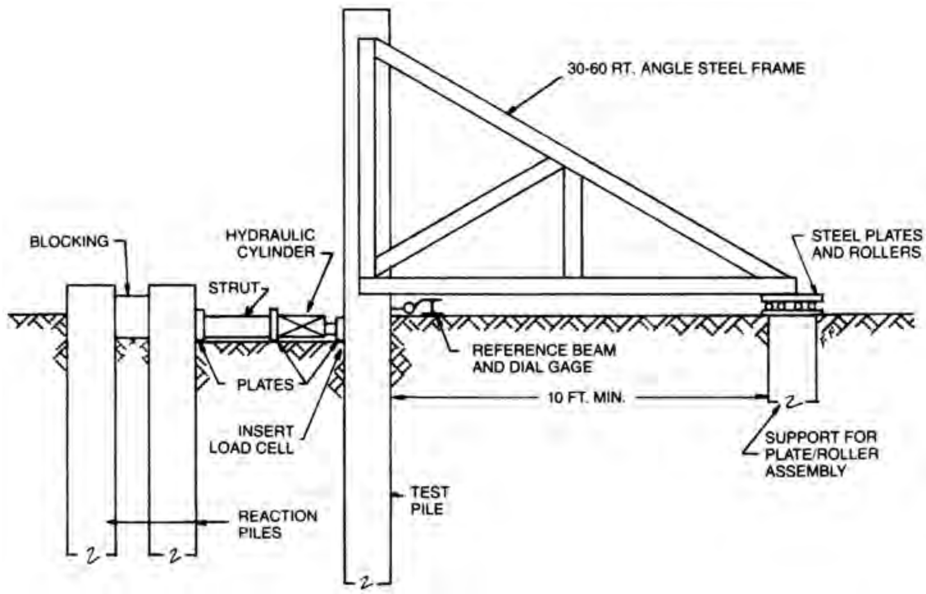


FIG. 5 Example of Fixed-Head Test Set-up for Lateral Test on Individual Pile

[2 in.] in diameter) so as to permit free horizontal movement of the frames under the anticipated downward pressures resulting from the maximum lateral test load to be applied.

NOTE 5—For practical purposes for a 3-m [10-ft] spacing between the test pile and frame support, it can be assumed that the vertical reaction at the ends of the frames is equal to the lateral load being applied to the test pile at the ground surface.

6.6.2 *Pile Group (Fig. 6)*—Install the test piles with pile tops a sufficient distance above the point of load application to provide fixity when the test group is capped. Cap the test group with an adequately designed and constructed reinforced concrete or steel grillage cap with sufficient embedment of the piles in the cap to provide fixity and with the side of the cap opposite the point of load application extended a sufficient distance to provide for the support pile(s). To prevent rotation of the pile cap under lateral load, support the end of the cap opposite that of the point of load application on one or more bearing piles with steel plates and rollers in accordance with 6.6.1 between the bottom of the cap and the top of the bearing pile(s).

6.7 *Combined Lateral and Axial Loading (Optional):*

6.7.1 *General*—Test the pile or pile group under a combination of lateral loading and axial compressive or tensile loading as specified. Apply the lateral load using method 6.3 or 6.4. Employ suitable methods and construction to ensure that the pile or pile group is not significantly restrained from lateral movement by the axial load.

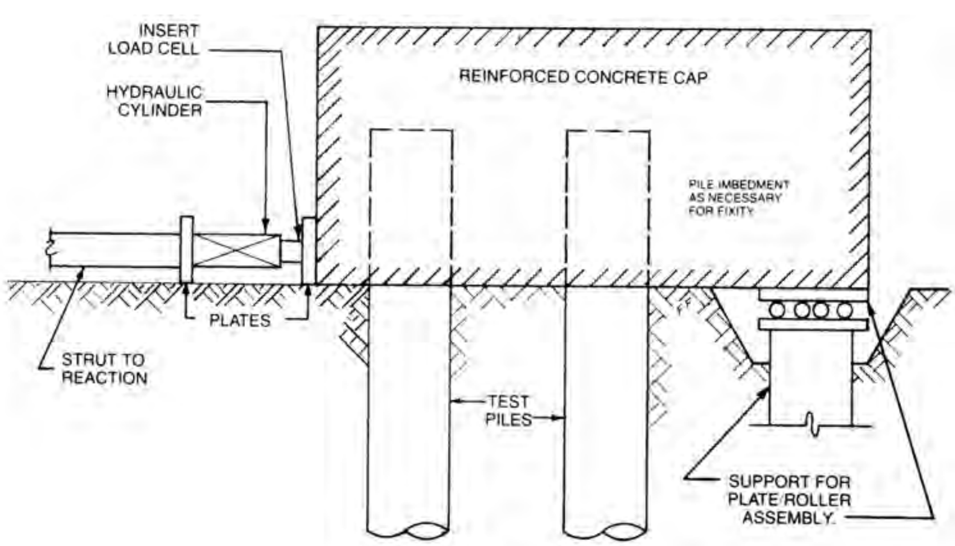


FIG. 6 Example of Fixed-Head Test Set-up for Lateral Test on Pile Group

6.7.2 *Compressive Load (Fig. 7)*—Apply the specified axial compressive load in accordance with Test Method D1143. Place an anti-friction device in accordance with 6.7.2.1, 6.7.2.2, or as otherwise specified between the compressive loading jack and the test plate on top of the test pile or pile group.

6.7.2.1 *Plate and Roller Assembly (Fig. 8a)*—The plate and roller assembly shall be designed to support the maximum applied compressive load without crushing or flattening of rollers and without indention or distortion of plates, and to provide minimal restraint to the lateral movement of the test pile or group as the lateral test loads are applied. Fig. 8*a* illustrates a typical assembly having a compressive load limit of 890 kN [100 tons]. The two plates shall be of Specification A572/A572M steel or equal with a minimum yield strength of 290 MPa [42 000 psi] and shall have a minimum thickness of 75 mm [3 in.]. The plates shall have sufficient lateral dimensions to accommodate the length of rollers required for the compressive loads and for the anticipated travel of the rollers as the test pile or group moves laterally under load. The contacting surfaces of the steel plates shall have a minimum surface roughness of 63 as defined and measured by ASME B46.1. The rollers shall be of sufficient number and length to accommodate the compressive loads and shall be of Specification A572/A572M steel Grade 45 or equal (minimum yield strength 310 MPa [45 000 psi]) with a minimum diameter of 75 ± 0.03 mm [3 ± 0.001 in.]. The rollers shall have a minimum surface roughness of 63 as defined and measured by ASME B46.1. The plates shall be set level and the rollers shall be placed perpendicular to the direction of lateral load application with adequate spacing to prevent binding as lateral movement occurs.

6.7.2.2 *Antifriction Plate Assembly (Fig. 8b)*—The antifriction plate assembly shall be designed and constructed as illustrated in Fig. 8*b* and shall consist of the following elements: *(1)* a minimum 25-mm (1-in.) thick steel plate, *(2)* a minimum 3.4 mm (10-gauge) steel plate tack welded to the 25-mm [1-in.] thick plate, *(3)* a minimum 2.4-mm [3⁄32-in.] sheet of virgin tetrafluoroethylene polymer with reinforcing aggregates prebonded to the 3.4-mm [10-gauge] plate by a heat-cured epoxy, and *(4)* a minimum 6.4-mm [1⁄4-in.] thick plate of Specification A240/A240M Type 304 stainless steel having a minimum surface roughness of 4 as defined and measured by ASME B46.1. The area of contact between the tetrafluoroethylene polymer and the stainless steel plate shall be sufficient to maintain a unit pressure of less than 14 MPa [2000 psi] under the compressive loads to be applied. The area of the stainless steel plate shall be sufficient to maintain full surface contact with the tetrafluoroethylene polymer as the test pile or group deflects laterally. The stainless steel plate shall be formed with lips on opposite sides to engage the edges of the test plate under the lateral load. During the lateral test, the lips shall be oriented in the direction of the applied lateral load. The use of a plate assembly having an equivalent sliding friction shall be permitted. The use of two steel plates with a layer of grease in between shall not be permitted.

NOTE 6—Combined lateral and axial compressive loading is recommended to simulate in-service conditions. Precautions should be taken to avoid a vertical component resulting from the applied lateral load or a lateral component from the applied axial load.

NOTE 7—An apparatus for applying an axial tensile load to the test pile in combination with a lateral test load is difficult to construct without restraining the test pile from moving laterally under the lateral test loads. If it is required that a pile be tested under combined axial tensile and lateral loading, the use of a suitable crane equipped with a line load indicator is suggested for applying the uplift or tensile loads. Some type of universal acting device should be used in the tension member connecting the test pile with the crane hook. That in combination with the crane falls should minimize restraint against lateral movement of the test pile under lateral loads.

7. Apparatus for Measuring Movement

7.1 *General:*

7.1.1 Reference beams and wirelines shall be supported independent of the loading system, with supports firmly embedded in the ground at a clear distance from the test pile of at least five times the diameter of the test pile(s) but not less than 2.5 m [8 ft], and at a clear distance from any anchor piles of at least five times the diameter of the anchor pile(s) but not less than 2.5 m [8 ft]. Reference supports shall also be located as far as practicable from any struts or supports but not less than a clear distance of 2.5 m [8 ft].

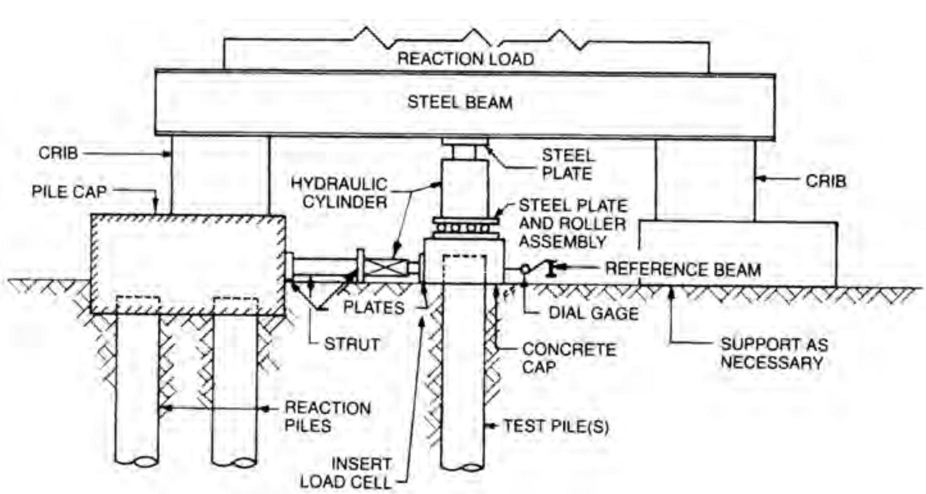


FIG. 7 Typical Example of Set-up For Combined Lateral and Axial Compressive Load

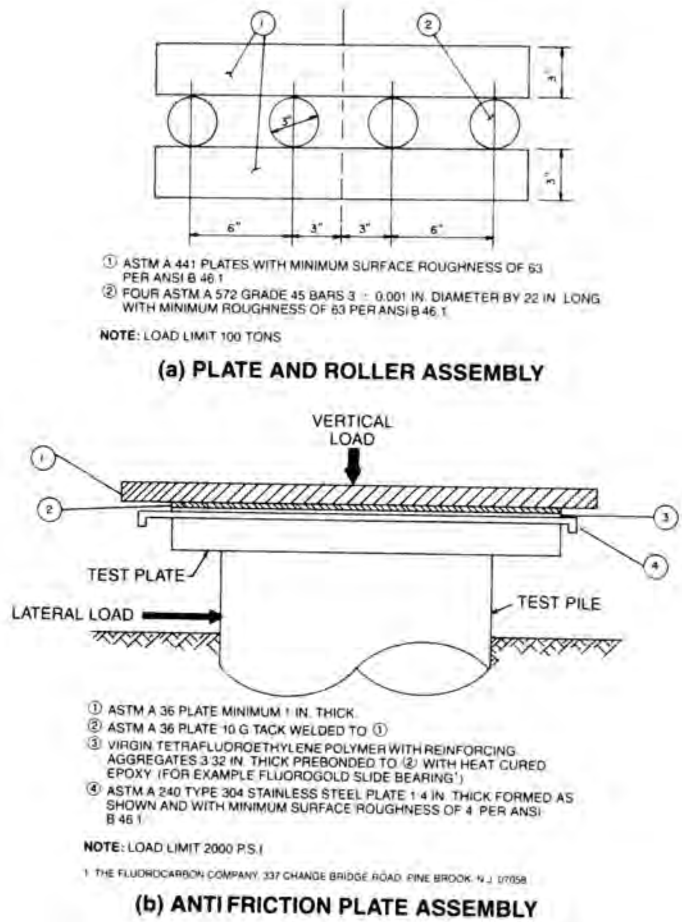


FIG. 8 Typical Anti-friction Devices for Combined Load Test

7.1.2 Reference beams shall have adequate strength, stiffness, and cross bracing to support the test instrumentation and minimize vibrations that may degrade measurement of the pile movement. One end of each beam shall be free to move laterally as the beam length changes with temperature variations. Supports for reference beams and wirelines shall be isolated from moving water and wave action. Provide a tarp or shelter to prevent direct sunlight and precipitation from affecting the measuring and reference systems.

7.1.3 Dial and electronic displacement indicators shall conform to ASME B89.1.10.M and should generally have a travel of 100 mm [4 in.], but shall have a minimum travel of at least 75 mm [3 in.]. Provide greater travel, longer stems, or sufficient calibrated blocks to allow for greater movement if anticipated. Electronic indicators shall have a real-time display of the movement available during the test. Provide a smooth bearing surface for the indicator stem perpendicular to the direction of stem travel, such as a small, lubricated, glass plate glued in place. Except as required in 7.4, indicators shall have minimum graduations of 0.25 mm [0.01 in.] or less, with similar accuracy. Scales used to measure pile movements shall have a length no less than 150 mm [6 in.], minimum graduations of 0.5 mm [0.02 in.] or less, with similar accuracy, and shall be read to the nearest 0.1 mm [0.005 in.]. Survey rods shall have minimum graduations of 1 mm [0.01 ft] or less, with similar accuracy, and shall be read to the nearest 0.1 mm [0.001 ft].

7.1.4 Dial indicators and electronic displacement indicators shall be in good working condition and shall have a full range calibration within three years prior to each test or series of tests. Furnish calibration reports prior to performing a test, including the ambient air temperature during calibration.

7.1.5 Clearly identify each displacement indicator, scale, and reference point used during the test with a reference number or letter.

7.1.6 Indicators, scales, or reference points attached to the test pile, pile cap, reference beam, or other references shall be firmly affixed to prevent movement relative to the test pile or pile cap during the test. Unless otherwise approved by the engineer, verify that reference beam and wireline supports do not move during the test as provided in 7.6.

7.2 *Pile Top Lateral Movements:*

7.2.1 Unless otherwise specified, all lateral load tests shall include apparatus for measuring the lateral movement of the test pile top, or piles within a group, or the pile group cap. This apparatus as described herein shall include a primary measurement system and at least one redundant, secondary system.

NOTE 8—When possible use displacement indicators as the primary system to obtain the most precise measurements. Use the redundant system(s) to check top movement data and provide continuity when the measuring system is disturbed or reset for additional movement.

7.2.2 *Displacement Indicators (Fig. 1)*—Orient the reference beam(s) perpendicular to the line of load application, placing the beam supports as far as feasible from the test pile, anchor piles, deadmen, or cribbing. Mount the displacement indicator(s) on the reference beams to bear on the pile top along the line of load application of the test pile, or pile cap, with stems parallel to the line of load application. Alternatively, mount two indicators on axisymmetric points equidistant from the center of the test pile, or pile cap, with the stems parallel to the line of load application to bear on the reference beam(s). When locating reference beam(s) on the side of the test pile, or pile cap, opposite a compressive load, or on the same side as tensile load application, allow sufficient clearance between the test pile or pile cap and the reference beam for the anticipated lateral movement of the pile or pile group.

7.2.3 *Wireline, Mirror, and Scale (Fig. 9)*—Orient a wireline perpendicular to the line of load application placing the wireline supports as far as feasible from the test pile(s), anchor pile(s), deadmen, or cribbing. The wireline shall include a weight or spring to maintain a constant tension force in the wire, so that, when plucked or tapped, the wireline will return to its original position. Use clean, uncoated steel wire with a diameter of 0.25 mm [0.01 in.] or less for the wirelines. Each wireline shall pass across, and remain clear of, a scale mounted on the test pile or pile cap parallel to the line of load application. Mount the scale on a mirror affixed to the test pile or pile cap and use the wireline as a reference line to read the scale. Use the mirror to eliminate parallax error in the scale reading by lining up the wire and its image in the mirror. Align the wire not more than 13 mm [0.5 in.] from the face of the scale. When locating a wireline on the side of the test pile, or pile cap, opposite a compressive load, or on the same side as tensile load application, allow sufficient clearance between the test pile or pile cap and the wireline for the anticipated lateral movement of the pile or pile cap.

7.2.4 *Surveyor's Transit and Scale*—Mount a scale parallel to the line of load application on the side or top of the test pile or pile cap and readable from the side. Establish outside of the immediate test area a permanent transit station and a permanent backsight or foresight reference point on a line perpendicular to the line of load application and passing through the target scale. Take readings of lateral movement on the target scale using a surveyor's transit referenced to the fixed backsight or foresight.

7.2.5 *Other Types of Measurement Systems (Optional)*—The engineer may specify another type of measurement system satisfying the basic requirements of 7.2.

7.3 *Rotational Movement (Optional) (Fig. 10)*—Measure the rotation of the head of the test pile using a steel extension member firmly attached to, or embedded in, and in axial alignment with the test pile, and extending a minimum of 0.6 m [2 ft]. Mount the displacement indicator(s) on a reference beam with the gauge stem(s) parallel to the line of load application and bearing against the side of the extension member near its top (Fig. 10*a*). Measure the rotation of a pile cap by either *(1)* readings on reference points located on top of and at opposite ends of the pile cap in the line with the load application and obtained with either displacement indicators mounted on an independent reference system, or a surveyor's level to read either a target rod or vertical scales with reference to a fixed bench mark; or *(2)* a displacement indicator with its stem parallel to the line of load application and bearing against the side of the pile or pile cap, or a suitable extension thereto, and mounted on a reference beam a minimum of 0.6 m [2 ft] vertically above the displacement indicator used to measure the lateral pile top movement (Fig. 10*b*). For fixed-head tests on individual piles, use the apparatus for measuring rotation of free-head tests except that the upper displacement indicator may bear against the pile or measure the vertical movements at the ends of the steel frames using either a displacement indicator or a surveyor's level with a target rod or vertical scale (Fig. 10*c*).

7.4 *Vertical Movement (Optional)*—Measure the vertical movements of the test pile(s) or pile group in accordance with Test Method D1143 except that only one measuring system shall be required. For a test on an individual pile a single reference point on the pile is sufficient. For a test on a pile cap, take readings on two reference points on opposite sides of the pile cap and in line with the applied load.

7.5 *Side Movement (Optional)*—Measure the movement of the test pile(s) or pile group in a direction perpendicular to the line of load application using either a dial gauge mounted on a reference beam with the gauge stem bearing against the side of the pile or pile cap or a scale mounted horizontally on the pile or pile cap perpendicular to the line of load application and

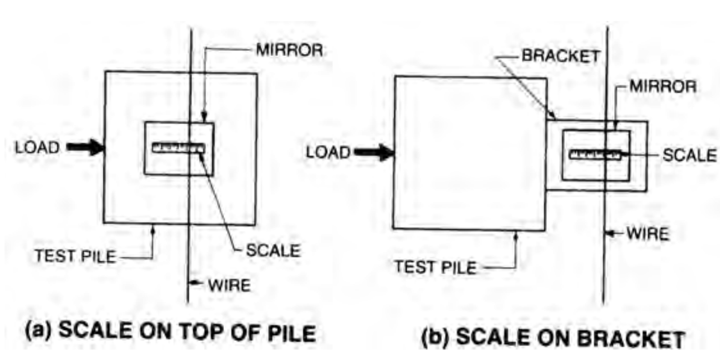
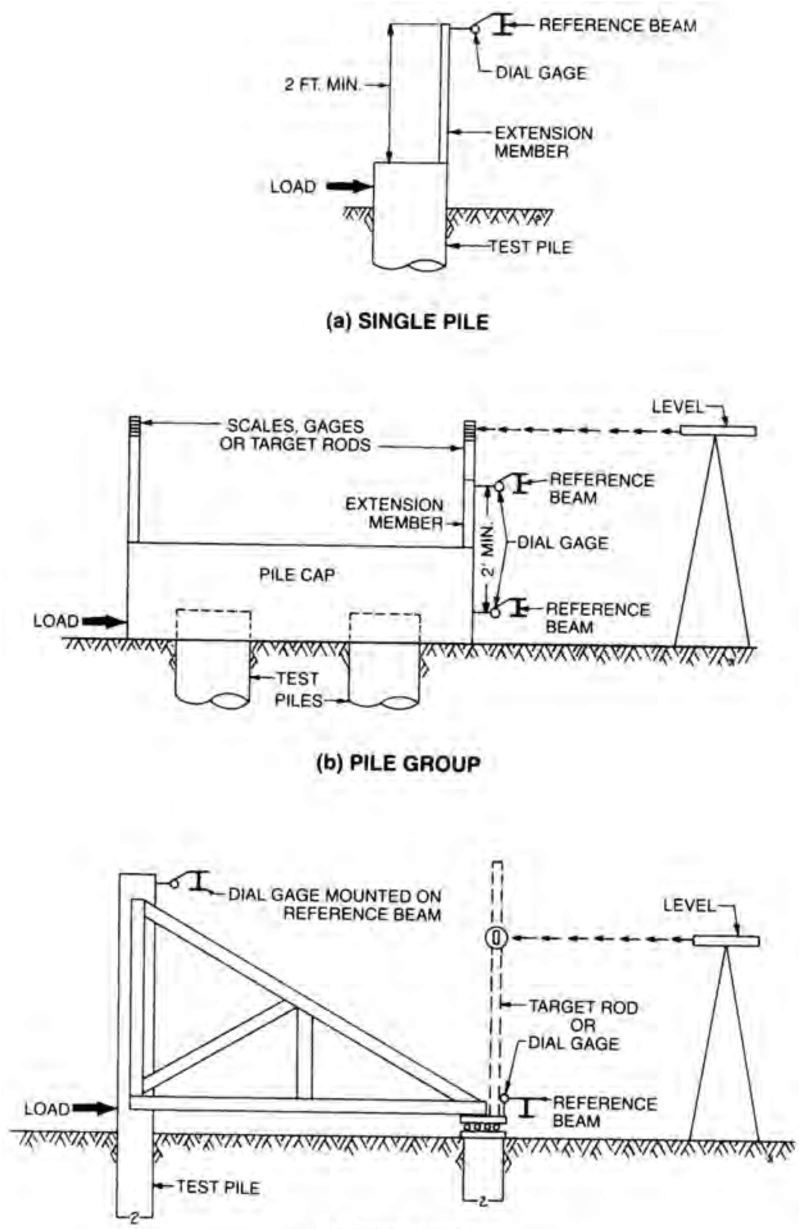


FIG. 9 Typical Wire-Scale Arrangements to Measure Lateral Deflections (Top Views)



(c) FIXED-HEAD

FIG. 10 Typical Arrangements for Measuring Pile Head Rotation

read with an engineer's transit set up at a fixed position with the line of sight referenced to a fixed foresight or backsight.

NOTE 9—The measurement of vertical and side movements of the test pile under lateral loading may reveal eccentric loading or an abnormal behavior of the test pile. Such measurements are recommended if the precise response of the test pile to the lateral test load is required.

7.6 *Movement of Testing Apparatus:*

7.6.1 *Lateral Movements*—Measure the movements along the line of load application of the reference beam(s) and reaction system using either a surveyor's transit reading target scales attached to the reference beam(s) and the reaction system at strategic locations along the line of load application or displacement indicators suitably mounted and referenced. For transit readings, establish permanent transit stations and fixed backsights or foresights outside of the immediate test area.

7.6.2 *Vertical Movement (Optional)*—Measure vertical movements of the reference beam(s) and reaction system using a surveyor's level reading and a target rod or vertical scale located at strategic reference points along the line of load application. Reference level readings to a fixed benchmark located outside of the test area.

7.7 *Axial Deflections (Optional)*—Install in or on the test pile(s) to the depth(s) specified, tubing or ducts suitable to accommodate the types of inclinometer specified to be used.

NOTE 10—Except for very short stiff piles, inclinometer measurements are generally not warranted for the full length of the pile. Generally such measurements can be limited to the upper third or half of the pile length. The project specifications should clearly indicate the contractor's responsibility for providing this instrumentation system as appropriate including materials, installation, equipment, and use.

7.8 *Strain Measurements (Optional)*—Measure the strain of the test pile(s) during loading at locations specified by the engineer to help evaluate the distribution of load transfer from the pile to the surrounding soil. Measure pile strain directly using strain gauges installed along the length of the pile axis. Install the gauge in pairs to measure axial strain, with the gauges in each pair located at the same depth, symmetrically opposite each other, equidistant from and parallel to the pile axis, and in line with the applied load. Measure and record the distance from the pile top to the gauges to the nearest 10 mm [0.5 in.]. The gauge type and installation shall be as specified by the engineer and shall include temperature compensation as recommended by the gauge manufacturer. Where feasible, measurement programs involving strain gauges should include calibration of the fully instrumented pile and a complete history of gauge readings starting before their installation in the pile.

NOTE 11—To interpret strain measurements and estimate pile stresses, the engineer will require a depth profile describing the variation of pile constituents and their strength, cross sectional area, and stiffness. Stiffness properties may vary with the applied stress, especially for grout or concrete. Obtain this information from installation records and separate material property tests as needed.

8. Test Procedures

8.1 *Loading:*

8.1.1 *General:*

8.1.1.1 Apply test loads following one of the procedures described below for each test method, or as modified by the engineer. If feasible, the maximum applied load should reach a failure that reflects the ultimate axial static tensile load capacity of the pile(s). Do not exceed the safe structural capacity of the pile or pile group, or the loading apparatus. Do not leave a loaded pile unattended.

8.1.1.2 To avoid excessive creep and possible structural failure of cast-in-place concrete piles, delay load testing after concrete placement to permit the fresh concrete to gain adequate strength and stiffness. Use test cylinders or cores of the pile concrete to determine the appropriate wait time, recognizing that the test cylinders will generally cure more quickly than concrete in the pile.

8.1.1.3 When temporarily dewatering a test site with piles installed in granular soils, maintain the groundwater level as near to the ground surface as possible and record the groundwater surface elevation during the test. Correct the axial pile capacity for the difference in groundwater level as judged appropriate, but generally only when the difference exceeds 1.5 m [5 ft].

8.1.2 *Procedure A: Standard Loading*—Unless failure occurs first, apply and remove a total test load equal to 200 % of the proposed lateral design load of the pile or pile group as follows:

Standard Loading Schedule

Percent of Design Load	Load Duration, min
0	—
25	10
50	10
75	15
100	20
125	20
150	20
170	20
180	20
190	20
200	60
150	10
100	10
50	10
0	—

NOTE 12—Consideration should be given to limiting the lateral test load to that which would produce a maximum specified lateral movement, established for safety and load stability reasons.

8.1.3 *Procedure B: Excess Loading (Optional)*—After applying and removing the standard test load in accordance with 8.1.2 (and 8.1.4 for standard loading if applicable), apply and remove the additional specified test loads in accordance with the following table:

Excess Loading Schedule
(following 8.1.2 loading)

Percent of Design Load	Load Duration, min
0	10
50	10
100	10
150	10
200	10
210	15
220	15
230	15
240	15
250	15
etc. to maximum load specified in 10 % increments	etc. at 15 min intervals
max	30
75 max	10
50 max	10
25 max	10
0	—

8.1.4 *Procedure C: Cyclic Loading (Optional)*—Apply and remove the test load in accordance with the following table:

Cyclic Loading Schedules
Standard Loading

Percent of Design Load	Load Duration min	Percent of Design Load	Load Duration min
0	—	75	10
25	10	0	10
50	10	50	10
25	10	100	10
0	10	150	10
50	10	170	20
75	15	180	20
100	20	190	20

Cyclic Loading Schedules
Standard Loading

Percent of Design Load	Load Duration min	Percent of Design Load	Load Duration min
50	10	200	60
0	10	150	10
50	10	100	10
100	10	50	10
125	20	0	—
150	20	—	—

Cyclic Loading Schedules
Excess Loading[A]

Percent of Design Load	Load Duration min	Percent of Design Load	Load Duration min
Follow standard cyclic loading schedule to 200 %		100	10
		0	10
		50	10
200	60	100	10
100	10	150	10
0	10	200	10
50	10	250	10
100	10	260	15
150	10	270	15
200	10	280	15
210	15	290	15
220	15	300	30
230	15	225	10
240	15	150	10
250	15	75	10
200	10	0	—

[A] Schedule for 300 % maximum load. For loading in excess of 300 %, hold 300 % load for 15 min, follow loading and holding time pattern for additional loading and hold maximum load for 30 min.

8.1.5 *Procedure D: Surge Loading (Optional):*

8.1.5.1 *General*—Surge loading involves the application of any specified number of multiple loading cycles at any specified load level. Surge loading may be applied in conjunction with standard loading or after the completion of standard loading. Apply surge loads at a uniform rate by continuous activation of the hydraulic jack (or other power source) and remove the surge load at a uniform rate by continuous release of the power source.

8.1.5.2 *Surge Loading with Standard Loading*—Apply and remove the test load in accordance with the following table:

Surge Loading Schedule[A]
with Standard Loading

Percent of Design Load	Load Duration, min
0	—
25	10
50	10
75	15
100	20
50	10
0	10
100	—
0	—
100	—
0	—
50	10
75	10
100	10
125	20
150	20
75	10
0	10
150	—
0	—
150	—

Surge Loading Schedule[A]
with Standard Loading

Percent of Design Load	Load Duration, min
0	—
50	10
100	10
150	10
170	20
180	20
190	20
200	60
100	10
0	10
200	—
0	—
200	—
150	10
100	10
50	10
0	—

[A] Schedule shown for two surges each at three load levels. If additional surges are specified or at other load levels follow the same loading and holding pattern.

8.1.5.3 *Surge Loading After Standard Load*—After applying and removing loads in accordance with 8.1.2, reapply the load to each specified load level and for the specified number of loading cycles, allowing sufficient time at each zero and peak load level for taking and recording the required load-movement data.

8.1.6 *Procedure E: Reverse Loading (Optional)*—Reverse loading involves the application of lateral test loads in either the push mode followed by the pull mode or vice versa. Test the pile or pile group in accordance with the loading schedule in 8.1.2-8.1.5 as specified first in one direction and then in the opposite direction.

8.1.7 *Procedure F: Reciprocal Loading (Optional)*—Apply and remove each specified lateral load level first in one direction and then in the opposite direction for the number of specified cycles. Hold each peak and zero load until load-deflection readings can be taken.

NOTE 13—Suitable apparatus is required to permit reversing the loads. Double-acting hydraulic cylinders are available in various sizes that can be activated by hand-operated, electric-powered, or air-hydraulic-powered pumps. Fig. 11 illustrates various possible setups for applying reverse and reciprocal loading. Reciprocal loads can be applied with a suitable powered crank and connecting rod system combined with a device to measure the applied loads.

8.1.8 *Procedure G: Specified Lateral Movement (Optional)*—Apply the lateral test loads in accordance with 8.1.2-8.1.5 as specified until the gross lateral movement of the test pile or group is as specified and then remove the test load in four equal decrements allowing 10 min between decrements.

8.1.9 *Procedure H: Combined Loading (Optional)*—When the pile or pile group is tested under combined loading, in accordance with 6.7, apply the specified axial load before applying the lateral loads and hold the axial load constant during the application of the lateral loads in accordance with 8.1.2-8.1.5, or as specified.

8.2 *Recording Test Readings:*

8.2.1 *General:*

8.2.1.1 For the required time intervals described below for each test method, record the time, applied load, and movement readings (displacement, and if measured, axial deflection and

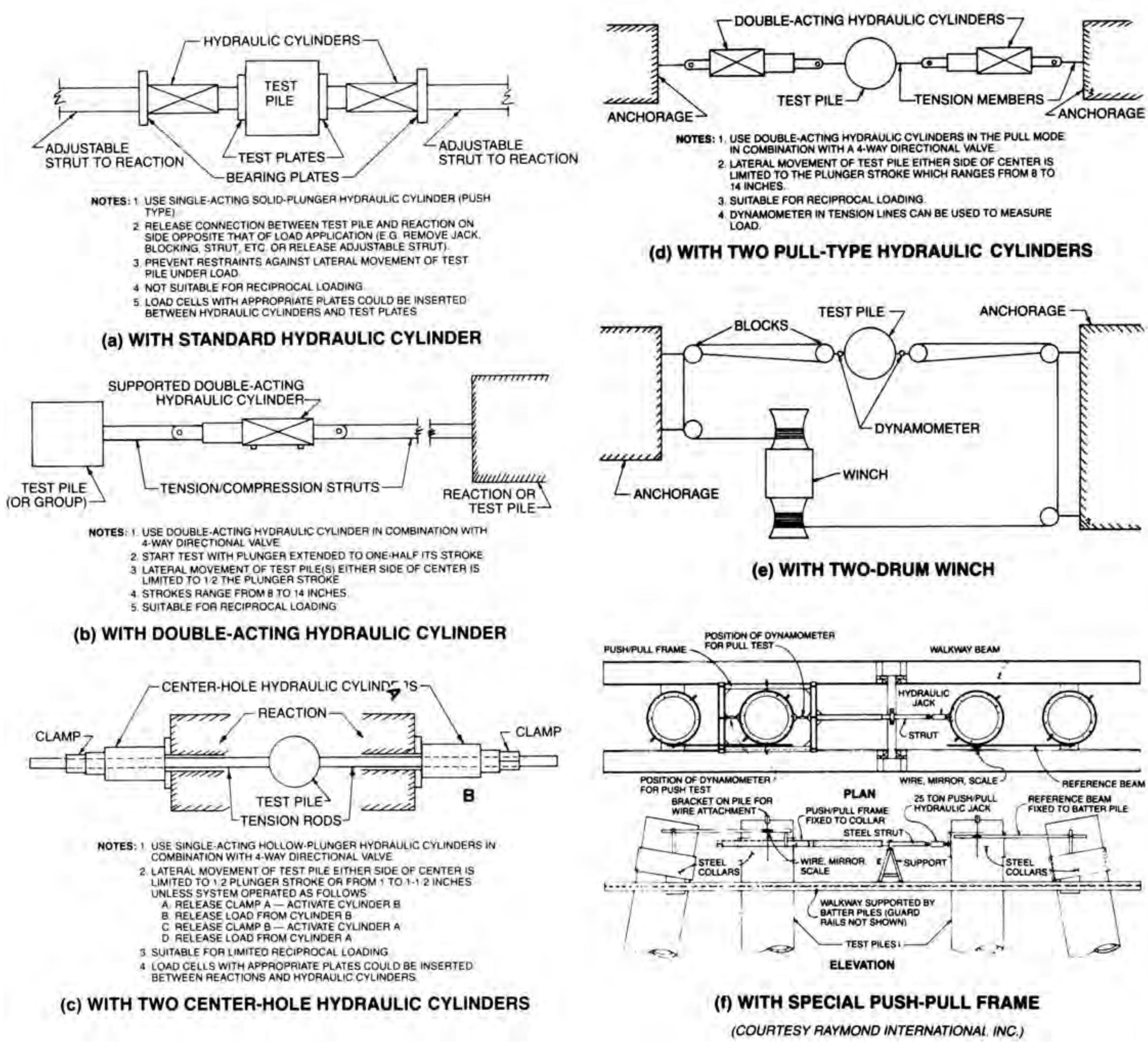


FIG. 11 Typical Reverse Lateral Loading Set-ups

strain) for each properly identified gauge, scale, or reference point taken as nearly simultaneously as practicable. The engineer may specify different reading intervals from those given below as needed to satisfy the objectives of a particular test pile program. Obtain additional test readings as specified by the engineer, or as convenient for testing purposes, that is, when using a datalogger to record readings at a constant time interval. Clearly record and explain any field adjustments made to instrumentation or recorded data.

8.2.1.2 Verify the stability of the reference beams and load reaction system (including reaction piles) using a surveyor's level or transit and target rod or scales to determine movement. Record readings taken before applying any test load, at the proposed design load, at the maximum test load, and after the removal of all load. Intermediate readings for each load increment are recommended to provide additional quality assurance and detect potential failure of the load reaction system.

8.2.1.3 When using inclinometers to obtain axial deflection measurements as in 7.7, record the axial deflection just before starting the test and, as a minimum, at the end of each loading increment during the test.

8.2.1.4 When using embedded strain gauges to obtain incremental strain measurements as in 7.8, record strain readings just before starting the test and, as a minimum, during the test whenever recording readings of time, load, and movement. The engineer may also require readings taken before and after the pile installation to obtain a complete strain history and investigate residual stress behavior.

8.2.2 *Procedure A, B, C, E, F, G, and H: Standard Measurement Intervals*—Record test readings immediately before and after the application of each load increment and the removal of each load decrement. Record additional test readings at 5-min intervals between load increments and load decrements. While the total test load is applied, record test readings at not less than 15-min intervals. Record test readings 15 min and 30 min after the total load have been removed. If pile failure occurs, record test readings immediately before removing the first load decrement.

8.2.3 *Procedure D: Surge Loading*—For initial application of test loads, for holding periods, for initial removal of the load and after removal of all loads, record the test readings in accordance with 8.2.2. For the surge loading, record test readings at the start and end of each load application.

8.2.4 *Rotational Movements*—When measuring rotational movements, record these test readings of immediately before and after the application of each load increment and the removal of each load decrement. Also record readings 30 min after removing the final test load.

8.2.5 *Vertical or Side Movements*—When measuring vertical or side movements, record these test readings before any test load is applied, at the proposed design load, at the maximum applied load, and after all loads have been removed. Intermediate readings for each load increment are recommended to provide additional quality assurance.

9. Safety Requirements

9.1 All operations in connection with pile load testing shall be carried out in such a manner so as to minimize, avoid, or eliminate the exposure of people to hazard. The following safety rules are in addition to general safety requirements applicable to construction operations:

9.1.1 Keep all test and adjacent work areas, walkways, platforms, etc. clear of scrap, debris, small tools, and accumulations of snow, ice, mud, grease, oil, or other slippery substances.

9.1.2 Provide timbers, blocking, and cribbing materials made of quality material and in good serviceable condition with flat surfaces and without rounded edges.

9.1.3 Hydraulic jacks shall be equipped with hemispherical bearing plates or shall be in complete and firm contact with the bearing surfaces and shall be aligned so as to avoid eccentric loading.

9.1.4 Loads shall not be hoisted, swung, or suspended over anyone and shall be controlled by tag lines.

9.1.5 The test apparatus shall be designed and approved by a qualified engineer and installed to transmit the required loads with an adequate factor of safety.

9.1.6 All jacks, bearing plates, test beam(s), or frame members shall be firmly fixed into place or adequately blocked to prevent slippage under load and upon release of load.

9.1.7 All reaction components shall be stable and balanced. During testing, monitor movements of the reaction system to detect impending unstable conditions.

9.1.8 All test members, reaction frames, and test apparatus shall be adequately supported at all times.

9.1.9 Only authorized personnel shall be permitted within the immediate test area, and only as necessary to monitor test equipment. As best as possible, locate pumps, load cell readouts, dataloggers, and test monitoring equipment at a safe distance away from jacks, loaded members (tension or compression), and their supports and connections.

10. Report

10.1 The report of the load test shall include the following information as required by the engineer and as appropriate to the pile type, test apparatus, and test method:

10.1.1 *General:*

10.1.1.1 Project identification and location,

10.1.1.2 Test site location,

10.1.1.3 Owner, structural engineer, geotechnical engineer, pile contractor, boring contractor,

10.1.1.4 Nearest test boring(s) or sounding(s), and their location with reference to test location,

10.1.1.5 In situ and laboratory soil test results, and

10.1.1.6 Horizontal and vertical control datum.

10.1.2 *Pile Installation Equipment:*

10.1.2.1 Make, model, type and size of hammer,

10.1.2.2 Weight of hammer and ram,

10.1.2.3 Stroke or ram,

10.1.2.4 Rated energy of hammer,

10.1.2.5 Rated capacity of boiler or compressor,

10.1.2.6 Type and dimensions of capblock and pile cushion,

10.1.2.7 Weight and dimensions of drive cap and follower,

10.1.2.8 Size of predrilling or jetting equipment,

10.1.2.9 Weight of clamp, follower, adaptor, and oscillator for vibratory driver,

10.1.2.10 Type, size, length, and weight of mandrel,

10.1.2.11 Type, size, and length of auger,

10.1.2.12 Type and size of grout pump,

10.1.2.13 Type, size, wall thickness, and length of drive casing,

10.1.2.14 Detailed description of drilling equipment and techniques, and

10.1.2.15 Size, type, length, and installation or extraction method of casings, or both.

10.1.3 *Test and Anchor Pile Details:*

10.1.3.1 Identification and location of test and anchor piles,

10.1.3.2 Design load of test pile or pile group,

10.1.3.3 Type and dimensions of test and anchor piles,

10.1.3.4 Test pile material including basic specifications,

10.1.3.5 Pile quality including knots, splits, checks and shakes, and straightness of piles, preservative treatment and conditioning process used for timber test piles including inspection certificates,

10.1.3.6 Wall thickness of pipe test pile,

10.1.3.7 Weight per foot of H test pile,

10.1.3.8 Description of test pile tip reinforcement or protection,

10.1.3.9 Description of banding–timber piles,

10.1.3.10 Description of special coatings used,

10.1.3.11 Test pile (mandrel) weight as driven, 10.1.3.12 Date precast test piles made,

10.1.3.13 Details of concrete design, grout mix design, or both.

10.1.3.14 Concrete or grout (or both) placement techniques and records,

10.1.3.15 Concrete or grout (or both) sample strengths and date of strength test,

10.1.3.16 Description of internal reinforcement used in test pile (size, length, number longitudinal bars, arrangement, spiral, or tie steel),

10.1.3.17 Condition of precast piles including spalled areas, cracks, top surface, and straightness of piles,

10.1.3.18 Effective prestress,

10.1.3.19 Degree of inclination for each pile,

10.1.3.20 Length of test pile during driving,

10.1.3.21 Final pile top and bottom elevations, and ground elevation referenced to a datum,

10.1.3.22 Embedded length-test and anchor piles,

10.1.3.23 Tested length of test pile, and

10.1.3.24 Final elevation of top of test pile referenced to fixed datum.

10.1.4 *Test and Anchor Pile Installation:*

10.1.4.1 Date installed,

10.1.4.2 Volume of concrete or grout placed in pile,

10.1.4.3 Grout pressure used,

10.1.4.4 Description of pre-excavation or jetting (depth, size, pressure, duration),

10.1.4.5 Operating pressure for double-acting and differential type hammers,

10.1.4.6 Throttle setting—diesel hammer (at final driving),

10.1.4.7 Fuel type—diesel hammer,

10.1.4.8 Horsepower delivered and frequency of vibratory driver during final 3 m [10 ft] of pile penetration,

10.1.4.9 Description of special installation procedures used such as piles cased off,

10.1.4.10 Type and location of pile splices,

10.1.4.11 Driving or drilling records,

10.1.4.12 Final penetration resistance (blows per centimetre [blows per inch]),

10.1.4.13 Rate of pile penetration in m/s [ft/s] for last 3 m [10 ft], vibratory driving,

10.1.4.14 When cap block replaced (indicate on log),

10.1.4.15 When pile cushion replaced (indicate on log),

10.1.4.16 Cause and duration of interruptions in pile installation, and

10.1.4.17 Notation of any unusual occurrences during installation.

10.1.5 *Pile Testing:*

10.1.5.1 Date and type of test,

10.1.5.2 Temperature and weather conditions during tests,

10.1.5.3 Number of piles in group test,

10.1.5.4 Brief description of load application apparatus, including jack capacity,

10.1.5.5 Location of point of load application with reference to top of pile or pile cap, and to ground surface,

10.1.5.6 Description of instrumentation used to measure pile movement including location of indicators, scales, and other reference points with respect to pile top,

10.1.5.7 Description of special instrumentation such as inclinometers or strain gauges including location of such with reference to pile top,

10.1.5.8 Axial load—type, amount, how applied,

10.1.5.9 Special testing procedures used,

10.1.5.10 Tabulation of all time, load, and movement readings,

10.1.5.11 Tabulation of inclinometer readings, declination versus depth,

10.1.5.12 Identification and location sketch of all indicators, scales, and reference points,

10.1.5.13 Description and explanation of adjustments made to instrumentation or field data, or both,

10.1.5.14 Notation of any unusual occurrences during testing,

10.1.5.15 Test jack and other required calibration reports,

10.1.5.16 Groundwater level, and

10.1.5.17 Suitable photographs showing the test instrumentation and set-up.

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site. Each test pile is unique due to the variable nature of the ground in which it is embedded. Furthermore, retesting a particular pile commonly results in different data from the initial testing due to plastic movement of the ground in which the pile is embedded.

11.1.1 The Subcommittee D18.11 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 field testing; jack; lateral static pile capacity; load cell; loading procedure; reference beam

APPENDIX

(Nonmandatory Information)

X1. SOME FACTORS INFLUENCING INTERPRETATION OF TEST RESULTS

X1.1 Possible interaction of lateral loads from test pile(s) with lateral loads transferred to the soil from reaction piles or cribbing obtaining part or all of their support in soil at levels above the tip level of the test pile.

X1.2 Changes in pore water pressure in the soil caused by pile driving, construction fill, and other construction operations which may influence the test results for frictional support in relatively impervious soils such as clay and silt.

X1.3 Differences between conditions at time of testing and after final construction such as changes in grade or groundwater level.

X1.4 Loss or gain of test pile soil resistance due to changes in the soil stress distribution around the test pile(s) such as excavation, scour, fill, etc.

X1.5 Possible differences in the performance of a pile in a group or of a pile group from that of a single isolated pile.

X1.6 Affect on long-term pile performance of factors such as creep, environmental effects on pile material, negative friction loads, swelling soils, and strength losses.

X1.7 Type of structure to be supported, including sensitivity of structure to movement and relation between live and dead loads.

X1.8 Special testing procedures which may be required for the application of certain acceptance criteria or methods of interpretation.

X1.9 Requirement that non tested pile(s) have essentially identical conditions to those for tested pile(s) including, but not limited to, subsurface conditions, pile type, length, size and stiffness, and pile installation methods and equipment so that application or extrapolation of the test results to such other piles is valid.

APPENDIX N: EARTH ENGINEER INC.'S IAS CERTIFICATE OF ACCREDITATION

INTERNATIONAL ACCREDITATION SERVICE®

CERTIFICATE OF ACCREDITATION

This is to attest that

EARTH ENGINEERS, INC.

4660 MAIN STREET, SUITE 100-1A
SPRINGFIELD, OREGON 97478

Testing Laboratory TL-694

has met the requirements of the IAS Accreditation Criteria for Testing Laboratories (AC89), has demonstrated compliance with ISO/IEC Standard 17025:2005, *General requirements for the competence of testing and calibration laboratories*, and has been accredited, commencing May 31, 2016, for the test methods listed in the approved scope of accreditation.

(See laboratory's scope of accreditation for fields of testing and accredited test methods.)

This accreditation certificate supersedes any IAS accreditation bearing an earlier effective date. The certificate becomes invalid upon suspension, cancellation or revocation of accreditation.
See http://iasonline.org/More/search.html for current accreditation information, or contact IAS at 562-364-8201.

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ilac-MRA

CPRamani

C.P. Ramani, P.E., C.B.O
President

15-12065

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SCOPE OF ACCREDITATION

IAS Accreditation Number	TL-694
Accredited Entity	Earth Engineers, Inc.
Address	4660 Main Street, Suite 100-1a Springfield, OR 97478
Contact Name	Ray Aliperti, Branch Manager
Telephone	+1 (541) 393-6340
Effective Date of Scope	May 31, 2016
Accreditation Standard	ISO/IEC 17025:2005

ACCREDITED TEST METHODS	METHOD REFERENCE
ASTM D1143	Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
ASTM D3689	Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966	Standard Test Methods for Deep Foundations Under Lateral Load

INTERNATIONAL ACCREDITATION SERVICE®

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APPENDIX O: MILL TEST REPORT FOR 1-INCH DIAMETER NOMINAL STEEL BEARING PIN PIPE FROM SAHA THAI STEEL PIPE (PUBLIC) COMPANY LTD

SAHA THAI STEEL PIPE (PUBLIC) COMPANY LTD

78 MOO 3 POOCHAOSAMINGPRAI ROAD, BANGYAPHAEK, PHRAPRADAENGK, SAMUTPRAKARN, 10130
THAILAND TEL: (662) 3859023 (6 LINES), 7544138 - 42, FAX: (662) 3859283, 7544100

MILL TEST REPORT

NO. STS/127/14

PO NO. 7273

SIZES	THICK. (INCHES)	LGTH/FT.	BUNDLES	PIECES	NET WT. (MT.)	NO. OF PCS/B'DLE	CHEMICAL COMPOSITION %											TENSILE TEST			PB %	AVERAGE ZINC COATING TEST(G/M²)	HYDRO TEST PRESSURE PSI.	BATCH NO.
							C	Si	Mn	P	S	Cu	V	Ni	Cr	Mo	Al	T.S. MPa	Y.P. MPa	EL %				
GALVANIZED STEEL PIPES, GPE, ASTM A 53 GR.A, SCH. 40																								
1"	0.133	21	11	660	10.560	60	0.045	0.009	0.224	0.007	0.007	0.003	0.003	0.008	0.014	0.001	0.030	332.60	309.16	51.94	0.013	598.78	1200	14216
1-1/4"	0.140	21	55	2,310	49.942	42	0.045	0.016	0.207	0.009	0.007	0.001	0.003	0.008	0.026	0.004	0.034	341.64	318.91	37.56	0.012	611.35	1200	14217
2"	0.154	21	33	858	29.910	26	0.056	0.036	0.159	0.009	0.003	0.008	0.005	0.015	0.315	0.001	0.030	367.39	342.70	33.74	0.012	601.81	2300	14219
2"	0.154	24	77	2,002	78.780	26	0.046	0.026	0.143	0.010	0.004	0.008	0.010	0.015	0.305	0.001	0.028	430.21	408.15	33.76	0.011	586.59	2300	14219
3-1/2"	0.226	21	12	144	12.509	12	0.063	0.006	0.292	0.006	0.014	0.025	0.003	0.023	0.023	0.001	0.04	389.88	370.28	27.70	0.011	574.40	2030	14222
3-1/2"	0.226	21	1	7	0.608	7	0.063	0.006	0.292	0.006	0.014	0.025	0.003	0.023	0.023	0.001	0.04	389.88	370.28	27.70	0.011	574.40	2030	14222
4"	0.237	21	59	590	60.693	10	0.045	0.007	0.225	0.007	0.007	0.001	0.000	0.009	0.026	0.001	0.024	357.90	260.64	45.24	0.011	586.50	1900	14223
6"	0.280	21	55	385	69.643	7	0.053	0.029	0.124	0.010	0.003	0.011	0.011	0.016	0.308	0.001	0.025	386.48	372.13	40.40	0.011	579.82	1520	14225
6"	0.280	24	14	98	20.260	7	0.053	0.029	0.124	0.010	0.003	0.011	0.011	0.016	0.308	0.001	0.025	386.48	372.13	40.40	0.011	579.82	1520	14225
6"	0.280	24	1	4	0.827	4	0.053	0.029	0.124	0.010	0.003	0.011	0.011	0.016	0.308	0.001	0.025	386.48	372.13	40.40	0.011	579.82	1520	14225
8"	0.322	21	15	75	20.418	5	0.152	0.007	0.441	0.004	0.004	0.002	0.015	0.01	0.011	0.008	0.054	457.36	392.56	34.82	0.012	574.77	1340	14227
SUB TOTAL			333	7,133	356.130																			
GALVANIZED STEEL PIPES, GPE, ASTM A 53 GR.A, SCH. 80																								
2"	0.218	21	40	1,040	49.826	26	0.045	0.016	0.177	0.011	0.006	0.001	0.002	0.007	0.021	0.000	0.033	397.49	370.13	32.40	0.011	567.04	2500	14219
SUB TOTAL			40	1,040	49.826																			
GALVANIZED STEEL PIPES, GPE, ASTM A 53 GR.A, SCH. 10																								
1-1/2"	0.109	21	9	549	10.931	61	0.079	0.027	0.259	0.008	0.014	0.054	0.014	0.028	0.031	0.006	0.037	363.22	302.54	38.11	0.011	583.29	1000	14218
1-1/2"	0.109	21	1	39	0.776	39	0.079	0.027	0.259	0.008	0.014	0.054	0.014	0.028	0.031	0.006	0.037	363.22	302.54	38.11	0.011	583.29	1000	14218
2"	0.109	21	33	1,221	30.708	37	0.044	0.014	0.189	0.007	0.008	0.000	0.000	0.011	0.025	0.001	0.022	347.64	307.96	37.70	0.012	574.83	1000	14219
3"	0.120	21	26	494	20.378	19	0.065	0.013	0.329	0.006	0.008	0.135	0.007	0.062	0.037	0.007	0.013	428.92	381.01	35.62	0.012	580.17	1000	14222
4"	0.120	21	16	304	16.273	19	0.068	0.012	0.340	0.008	0.008	0.072	0.013	0.052	0.039	0.015	0.023	416.04	386.60	36.92	0.011	568.99	960	14223
6"	0.134	21	17	119	10.542	7	0.057	0.007	0.382	0.006	0.006	0.035	0.007	0.023	0.021	0.001	0.052	427.21	357.81	36.28	0.015	581.04	730	14225
SUB TOTAL			102	2,726	89.608																			

INSPECTOR : ....

APPROVED BY : ....

(CONTINUED PAGE 3...)

APPENDIX P: MILL TEST REPORT FOR 1 1/4-INCH DIAMETER NOMINAL STEEL BEARING PIN PIPE FROM AL JAZEERA STEEL PRODUCTS COMPANY SAOG

Jazeera Steel حديد الجزيرة

AL JAZEERA STEEL PRODUCTS COMPANY SAOG

PO BOX 40, PC 327, Sohar Industrial Estate
SULTANATE OF OMAN
Phone : 968 26751763/4/5 Fax 968 26751766

MILL TEST CERTIFICATE

MTC NO. :544/10/2014 DATED 23/10/2014 P.O. NO. : 40356
INVOICE NO. :AJSPC/EXP/217 DATED 23/10/2014
CUSTOMER'S NAME :AMERICAN INTERNATIONAL FOREST PRODUCTS LLC
ADDRESS PO BOX 4166/PORTLAND,OR 97208 5560 SW 107TH AVE
BEAVERTON,OR 97005
PHONE: (503)520-5455. FAX: (503)469-7555

SR NO.	NPS (Inch)	OD (Inch)	WT (Inch)	LENGTH (Feet)	TYPE	Lb / Ft	HEAT NO.	BUNDLES	PCS	TOTAL (FEET)	NET WT. (MT)	MECHANICAL TESTING: UTS (psi)	YS (psi)	% EL IN GL 2"	FLATTENING / BEND TEST	HYADRAULIC TEST (psi)	CHEMICAL ANALYSIS (%): C / Cu	Mn / Ni	P / Cr	S / Mo	Si / V	Zinc Coating (Oz/Ft^2)
ERW STEEL PIPE CONFORMING TO THE SPECIFICATION ASTM A 53 - 07 SCH 40 GRA BARE & GPE/ ASTM A 53 - 07 SCH 40 GRB GPE																						
1	3/4" (UL)	1.050	0.113	21.0	BARE	1.13	A1406214	15	1260	26460	13.562	61904/62780	45990/46720	35/37	OK	700	0.133 0.011	0.400 0.018	0.007 0.009	0.019 0.006	0.007 0.007	--
2	1" (UL+FM)	1.315	0.133	21.0	BARE	1.68	A1408218	9	540	11340	8.642	63072/63948	45406/46136	40/42	OK	700	0.134 0.022	0.401 0.064	0.007 0.009	0.016 0.007	0.007 0.004	--
3	1.1/4" (UL+FM)	1.660	0.140	21.0	BARE	2.27	A1409219	50	2100	44100	45.408	61320/62196	46428/47304	40/42	OK	1200	0.102 0.017	0.420 0.009	0.018 0.009	0.010 0.006	0.010 0.005	--
4	1.1/2" (UL+FM)	1.900	0.145	21.0	BARE	2.72	A1409131	50	1800	37800	46.637	61758/62488	41902/42632	36/38	OK	1200	0.146 0.007	0.342 0.007	0.023 0.009	0.009 0.005	0.007 0.005	--
5	1.1/4" (UL+FM)	1.660	0.140	21.0	GPE	2.27	A1409219	5	210	4410	4.541	61320/62196	46428/47304	40/42	OK	1200	0.102 0.017	0.420 0.009	0.018 0.009	0.010 0.006	0.010 0.005	1.88/1.90
6	2" (UL+FM)	2.375	0.154	21.0	GPE	3.65	A1408128	2	52	1092	1.808	62634/63510	45990/46720	35/37	OK	2300	0.128 0.020	0.608 0.021	0.025 0.017	0.010 0.005	0.007 0.005	1.86/1.88
7	**2" (GRB-ASME-UL+FM)**	**2.375**	**0.154**	**21.0**	**GPE**	**3.65**	**B1405119**	**2**	**52**	**1092**	**1.808**	**63510/64240**	**45260/46136**	**35/37**	**OK**	**2500**	**0.199 0.009**	**0.728 0.096**	**0.011 0.009**	**0.009 0.007**	**0.016 0.004**	**1.86/1.88**
8	2.1/2" (UL+FM)	2.875	0.203	21.0	GPE	5.79	A1409130	3	54	1134	2.978	62634/63510	46574/47304	34/36	OK	2500	0.138 0.028	0.623 0.030	0.026 0.032	0.010 0.007	0.019 0.004	1.87/1.89
9	3.1/2" (UL+FM)	4.000	0.226	21.0	GPE	9.11	A1409129	2	24	504	2.083	58400/59130	40150/42194	37/39	OK	2030	0.137 0.050	0.404 0.035	0.023 0.042	0.018 0.004	0.007 0.004	1.86/1.88
10	4" (UL+FM)	4.500	0.237	21.0	GPE	10.79	A1408429	10	100	2100	10.278	63072/63656	46720/47596	35/37	OK	1900	0.128 0.014	0.611 0.034	0.026 0.021	0.011 0.006	0.007 0.004	1.87/1.89
11	6" (UL+FM)	6.625	0.280	21.0	GPE	18.97	A1409431	10	70	1470	12.649	59130/59860	40150/41026	34/36	OK	1520	0.117 0.007	0.375 0.010	0.017 0.009	0.009 0.006	0.007 0.005	1.87/1.89
							GRAND TOTAL	**158**	**6262**	**131502**	**150.394**											

THIS IS TO CERTIFY THAT THE MATERIAL CONFORMS TO THE SPECIFICATION **ASTM A 53 GRADE-A & B**
ALL THE PIPES ARE TESTED NON DESTRUCTIVELY BY EDDY CURRENT METHOD AND HYDROSTATICALLY TESTED AT THE PRESSURE MENTIONED ABOVE.

For Al Jazeera Steel Products Company SAOG

AL JAZEERA STEEL PRODUCTS CO. (SAOG) P.O. Box : 40 Sohar Postal Code : 327 S. of Oman

Authorized Signatory
Quality Control

APPENDIX Q: MATERIAL CERTIFICATION REPORT FOR ½-INCH DIAMETER GALVANIZED ANCHOR BOLT FROM STONEWORKS ARCHITECTURAL

Stoneworks Architectural
Sales Order 253763

Unlimited Supplies Inc

2/29/2016

Material Certification

Qty - 851 **1/2-13 x 5 HHCS A307 Galvanized** **Lot#** **95638CHI**

G50C500HH2

Headed bolts, threaded rods and bent bolts intended for general applications.

A307 Mechanical Properties

Grade	Tensile, ksi	Yield, min, ksi	Elong %, min
A	60 min	--	18
B	60 - 100	--	18
C*	58 - 80	36	23

A307 Chemical Properties

Element	Grade A	Grade B
Carbon, max	0.29%	0.29%
Manganese, max	1.20%	1.20%
Phosphorus, max	0.04%	0.04%
Sulfur, max	0.15%	0.05%

ASTM-A153 ASTM-F2329

Scope

Meets Specifications as listed

The ASTM-A153 Specification Covers zinc coating (hot dip) on iron and steel hardware. See the below chart for the different classes covered under A153. A newer and more fastener-appropriate specification, designed to replace A153 Class C, approved in 2005 and covering the requirement for hot-dip galvanizing bolts, screws, nuts, washers and other threaded fasteners is ASTM-F2329. It is slowly becoming more widely used and referenced, but many publications and technical manuals are not revised on a regular basis, so it may be a while before ASTM-F2329 is widely adopted. ASTM-A123 is a related hot-dip galvanizing specification covering iron and steel products made from rolled and pressed shapes, castings, plates, bars, and strips. The equilavent AASHTO specification to ASTM-A153 is AASHTO-M232.

Stoneworks Architectural
Sales Order 253763

Unlimited Supplies Inc

2/29/2016

Material Certification

Class	Description	Min Avg Coating Thickness, mils	Min Coating Thickness, Any Individual Specimen, mils
Class A	Castings, Malleable Iron Steel	3.4	3.1
Class B	Rolled, pressed, forged articles except those covered by Class C & D	See below B-1 through B-3	See below B-1 through B-3
Class B-1	3/16" and over in thickness and over 15" in length	3.4	3.1
Class B-2	Under 3/16" in thickness and over 15" in length	2.6	2.1
Class B-3	Any thickness and under 15" in length	2.2	1.9
Class C	Fasteners over 3/8" in diameter and similar articles, washers 3/16" to 1/4" thick	2.1	1.7
Class D	Fasteners 3/8" and under in diameter , rivets, nails and similar articles, washers under 3/16" thick	1.7	1.4

Authenticated by: ______________________

Jim Hegedus

APPENDIX R: MATERIAL CERTIFICATION REPORT FOR 5/8-INCH DIAMETER GALVANIZED ANCHOR BOLT FROM STONEWORKS ARCHITECTURAL

:toneworks Architectural
Sales Order 252787

Unlimited Supplies Inc

2/12/2016

Material Certification

Qty - 600 **5/8-11 x 5-1/2 HHCS A307 Galvanized** **Lot# 93719CHI**

G62C550HH2

Headed bolts, threaded rods and bent bolts intended for general applications.

A307 Mechanical Properties

Grade	Tensile, ksi	Yield, min, ksi	Elong %, min
A	60 min	--	18
B	60 - 100	--	18
C*	58 - 80	36	23

A307 Chemical Properties

Element	Grade A	Grade B
Carbon, max	0.29%	0.29%
Manganese, max	1.20%	1.20%
Phosphorus, max	0.04%	0.04%
Sulfur, max	0.15%	0.05%

ASTM-A153 ASTM-F2329

Scope

Meets Specifications as listed

The ASTM-A153 Specification Covers zinc coating (hot dip) on iron and steel hardware. See the below chart for the different classes covered under A153. A newer and more fastener-appropriate specification, designed to replace A153 Class C, approved in 2005 and covering the requirement for hot-dip galvanizing bolts, screws, nuts, washers and other threaded fasteners is ASTM-F2329. It is slowly becoming more widely used and referenced, but many publications and technical manuals are not revised on a regular basis, so it may be a while before ASTM-F2329 is widely adopted. ASTM-A123 is a related hot-dip galvanizing specification covering iron and steel products made from rolled and pressed shapes, castings, plates, bars, and strips. The equilavent AASHTO specification to ASTM-A153 is AASHTO-M232.

Stoneworks Architectural
Sales Order 252787

Unlimited Supplies Inc

2/12/2016

Material Certification

Class	Description	Min Avg Coating Thickness, mils	Min Coating Thickness, Any Individual Specimen, mils
Class A	Castings, Malleable Iron Steel	3.4	3.1
Class B	Rolled, pressed, forged articles except those covered by Class C & D	See below B-1 through B-3	See below B-1 through B-3
Class B-1	3/16" and over in thickness and over 15" in length	3.4	3.1
Class B-2	Under 3/16" in thickness and over 15" in length	2.6	2.1
Class B-3	Any thickness and under 15" in length	2.2	1.9
Class C	Fasteners over 3/8" in diameter and similar articles, washers 3/16" to 1/4" thick	2.1	1.7
Class D	Fasteners 3/8" and under in diameter , rivets, nails and similar articles, washers under 3/16" thick	1.7	1.4

Authenticated by:

Jim Hegedus

APPENDIX S: BIBLIOGRAPHY

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